Final Focused Feasibility Study Report
Ground Water Remediation

Shieldalloy Metallurgical Corporation
Newfield, New Jersey

February 1994

TRC

TRC Environmental Corporation

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Prepared for:
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EXECUTIVE SUMMARY

A Remedial Investigation/Feasibility Study (RI/FS) is being conducted for Shieldalloy Metallurgical Corporation (SMC) at their Newfield, New Jersey facility by TRC Environmental Corporation (TRC), as required under a New Jersey Department of Environmental Protection and Energy (NJDEPE) Administrative Consent Order (ACO), dated October 5, 1988. The purpose of the RI/FS is to investigate the nature and extent of contamination at the facility, characterize environmental impact and potential health risks posed by the facility, and evaluate remedial alternatives to provide a basis for the selection of a remedial alternative that is protective of human health and the environment. Presented herein is a Focused Feasibility Study (FFS) conducted specifically for ground water contamination (referred to as the ground water operable unit) at the SMC Newfield facility. Other contaminated media will be addressed in a separate Feasibility Study to be conducted at a future date.

The SMC facility consists of approximately 67.5 acres. The manufacturing facilities and support areas are located on approximately 60 acres in Newfield, New Jersey, Gloucester County, and 7.5 acres of farmlands southwest of the main facility, in Vineland, New Jersey, Cumberland County.

The SMC facility has been in operation since 1955. SMC operates a manufacturing facility which processes ores and minerals and produces metals, specialty metals, and ferroalloys. The principal production processes employed by SMC include aluminothermic and reduction smelting of ores, which produces purified metal, slags, and various other by-products, co-products, or other materials. Raw materials currently used at the facility contain the following metals: manganese, nickel, bismuth, iron, vanadium, chromium, titanium, silicon, copper, zirconium, magnesium, aluminum, lead and oxides of columbium (niobium), vanadium, barium, calcium, aluminum and fluoride salts.

In the past, oxides of chromium were used at the facility. As a result of present and past manufacturing processes, the facility has generated slag, dross, baghouse dust, and wastewaters.

The nature and extent of the contamination associated with the past activities at the SMC facility were initially investigated in 1972 by Roy F. Weston, in response to the detection of hexavalent chromium in a newly installed Newfield municipal supply well. The well, which was never used to supply water to the Newfield water supply system, was sealed in the early 1970s. In 1973, Woodward-Moorehouse Associates, Inc. conducted an investigation of ground water and surface water quality both on-site and to the southwest of the site. Ground water extraction and ion exchange treatment for the removal of hexavalent and trivalent chromium was initiated in 1979. In 1983, Dan Raviv Associates, Inc. (DRAI) reviewed available data and initiated a more intensive ground water monitoring program. Fourteen wells, including shallow and deep off-site wells were installed during this study. The analytical scope was expanded to include such parameters as sodium, pH, sulfate and volatile organic compounds. In September 1984, the NJDEPE and SMC entered into an Administrative Consent Order (ACO) which required SMC to conduct a Feasibility Study for remediation of the ground water contamination and to continue the ground water remediation program. In January 1988, DRAI completed an evaluation of Ground Water Remediation Alternatives (DRAI, 1988a), in accordance with the 1984 ACO. As a result of this study, an increase in the ground water extraction and treatment rate from 80 gallons per minute (gpm), 13 to 16 hours per day, 5 days per week, to 400 gpm, 24 hours per day, 7 days per week was recommended to minimize contaminant migration and ensure timely removal of the contamination. In October 1988, the NJDEPE and SMC entered into a second ACO to initiate operation of a 400 gpm pump and treat system. Four additional ground water extraction wells were installed to supplement the existing extraction well in capturing and preventing further downgradient migration of contaminated ground water, with the extracted ground water to be treated by a new on-site ion exchange treatment system. However, because of unforseen operational difficulties, the effectiveness of the ion exchange system in treating the ground water at a 400 gpm rate was variable. The system required operation at a lower flow rate and periodic shutdowns for regeneration of the ion exchange columns. In January 1991, DRAI completed an Evaluation of Ground Water Pumping Effectiveness in response to the request of the NJDEPE. At the time of preparation of the 1991 report, ground water was being extracted at a rate of 120 gpm from one shallow well and at 80 gpm from a deep well. The study concluded that the interim pumping rate was effective in controlling the toe of the hexavalent chromium plume in the shallow portion of the aquifer but additional pumping was necessary to control the hexavalent chromium plume in the deep portion of the aquifer.

In October 1990, TRC began field investigations for the RI/FS required under the 1988 ACO. The RI program was structured to investigate specific areas of former plant processes and associated materials storage areas, including the Manufacturing Area, the Undeveloped Plant Property, the By-product Storage Area, and the Lagoon Area. The scope of the Remedial Investigation was extensive, including surface soil sampling, surface water and sediment sampling, test pit sampling, soil boring sampling, monitoring well installation, and ground water sampling. Because this FFS considers the remediation of contaminated ground water only, ground water investigation activities will be described in more detail than other site investigation activities. The hydrologic investigation portion of the RI was conducted in order to identify geologic and hydrogeologic conditions, characterize ground water quality, and define the nature and extent of contamination. Ground water samples were collected for laboratory analysis from on-site and off-site newly installed wells and existing monitoring wells during two separate monitoring events. Fifty-one wells were sampled during the first sampling event (December 1990) and thirty-seven wells were sampled during the second sampling event (April 1991).

Ground water analytical results indicated that volatile organic and inorganic contamination exists beneath the SMC facility, extending in a general plume to the southwest. Trichloroethene (TCE) was the major volatile organic detected at levels exceeding MCLs and was distributed as follows:

- In the upper Cohansey Sand, TCE contamination is centered around the location of the Former Manpro-Vibra Degreasing Unit, and extends to the southwest.
- In the lower Cohansey Sand, TCE is first detected downgradient of the suspected source area for the TCE plume in the upper zone (as referenced above), and extends to the southwest. An increase in TCE concentrations was identified in the northeast portion of SMC's 7.5 acre parcel, located to the southwest of the main facility. This increase in TCE levels strongly suggests the likelihood of a separate contaminant source or sources contributing to the elevated TCE levels other than the source at the SMC facility.

The major inorganic constituent detected in ground water samples is chromium. Inorganic ground water contamination is distributed across the SMC facility as follows:

- In the upper Cohansey Sand, the total chromium plume is centered under the Manufacturing Area, with a lobe extending to the east, towards the By-product Storage Area. Downgradient, total chromium extends to the southwest.
- The shallow hexavalent chromium plume is centered to the east and southeast of the total chromium plume, in the general areas of the By-product Storage Area and the Lagoons.
- In the lower Cohansey Sand, total chromium and hexavalent chromium levels are greatest south of the Lagoon Area, extending to the southwest.

- Lead was detected in an upgradient shallow well, located along the northern property line, as well as in the area near the Underground Storage Tanks and Railroad Siding. It was also detected in shallow monitoring well F at a concentration of 102 µg/1.

- Antimony was detected south of the Lagoon Area

The installation of additional monitoring wells subsequent to the completion of the RI has resulted in the identification of TCE and chromium contamination south of the SMC facility. Additional investigation will be required to further define the extent of contamination in this area. Additional investigation will also be conducted in the vicinity of well IW2, near the toe of the chromium plume, to further define the extent of contamination.

A Human Health and Environmental Health Evaluation was conducted to quantitatively assess the potential impacts of the SMC site on human health and the environment. For the Human Health Evaluation, both current and future land use scenarios were considered and developed to represent potential situations in which humans may be exposed to contaminants originating from the site. The routes of exposure of most concern included dermal contact with soil, ingestion of ground water, ingestion of soil/dust and incidental ingestion of surface water. The chemicals of primary concern which were detected in the soils included DDT, PCBs, and inorganics (arsenic, trivalent chromium, vanadium and beryllium). The only scenario which evaluated exposures to contaminated ground water was the current residential use scenario, under which both the total cancer risks and the hazard index ratios exceeded the target risk levels. The major contributing factors to the calculation of cancer risk for this scenario are ingestion of arsenic and beryllium (in both the shallow and deep ground water) and inhalation of TCE (deep ground water only). Ingestion of inorganics was also the source of the major contributions to the total hazard index ratio for the upper Cohansey Sand (due to arsenic, beryllium, vanadium, cyanide and boron) and the lower Cohansey Sands (due to antimony, arsenic, chromium [tri- and hexavalent], and vanadium).

The Feasibility Study process uses the information on the nature and extent of contamination and associated health and environmental risks developed during the RI to develop and evaluate potential remedial alternatives and their overall protection of human health and the environment. As described previously, this Focused Feasibility Study only addresses ground water contamination at the SMC facility.

It should be noted that, while this report has been written to equally evaluate all components of ground water remedial alternatives, one of the ground water treatment options evaluated herein, electrochemical treatment, has been implemented at the SMC facility in order to comply with the requirements of a 1988 Administrative Consent Order (ACO). These requirements included the continuous operation of a 400 gallon per minute treatment system for 24 hours per day, 7 days per week, as an interim remedial measure. An existing ion exchange treatment system, as described later in this report, was not capable of achieving these requirements. Therefore, SMC evaluated remedial options and selected the electrochemical treatment technology as providing the most efficient means of treatment while protecting human health and the environment. The evaluation process for the various inorganic treatment alternatives presented herein reflects the evaluation process which was conducted prior to the implementation of the electrochemical treatment system. The evaluation process presented for the other remedial alternatives and options, including ground water extraction, organic treatment and discharge options, is based on current conditions.

The electrochemical treatment system has been in operation since October 1992. It has been effective in the treatment of the chromium contamination within the ground water, achieving significantly lower effluent levels than were achievable using the previously existing treatment system. However, the NJDEPE has recently proposed new discharge to surface water permit conditions which are more stringent than previous permit conditions. They include daily maximum allowable concentrations of 5.8 mg/l (ppb) chromium and 166 mg/l (ppm) total dissolved solids (TDS). Since the existing electrochemical treatment system may not be able to achieve these proposed discharge permit conditions, an analysis of alternate means of meeting these conditions, either through modification of the electrochemical system or through implementation of a separate polishing treatment process, is also presented.

The initial step in conducting the Focused Feasibility Study was to compare ground water contaminant levels to applicable regulatory levels (ARARs) and current guidance criteria (TBCs) or to risk-based cleanup levels, which were developed as appropriate. On the basis of this evaluation, remedial action objectives were developed. They include the following:

- Prevent exposure, due to ground water ingestion, to ground water contaminants attributable to the SMC facility which have been detected at levels exceeding acceptable ARARs/TBCs, as indicated in Tables 3-1 and 3-2, or acceptable risk-based cleanup levels;
- Minimize migration of ground water contaminants; and
- Remediate the ground water contamination attributable to the SMC facility to achieve ARARs/TBCs.

General response actions which address the remedial response objectives were determined, followed by the identification and screening of ground water remedial technologies on the basis of technical implementability. Technology process options were then evaluated on the basis of effectiveness, implementability, and cost, and representative process options to be used in the development of remedial alternatives were selected. Three remedial alternatives were developed based on guidelines for alternative development specified in the National Contingency Plan. The three alternatives included the No Action Alternative, Continuation of Existing Actions, and Modified Ground Water Restoration. Under Alternative 3, Modified Ground Water Restoration, several process options were developed for extraction, organic and inorganic treatment, and discharge of the ground water.

A preliminary screening of the three alternatives and associated process options were evaluated on the basis of implementability, effectiveness and cost. On the basis of this preliminary evaluation, one organic treatment process option and one inorganic treatment process option under Alternative 3 were screened from further analysis. The organic treatment Option T1, powdered activated carbon treatment (PACT™), was determined to provide a level of organic treatment comparable to other organic treatment options but at a significantly higher cost. Based on the evaluation of operational problems in the existing ion exchange treatment system, it was determined that inorganic treatment Option T4, expansion of the existing ion exchange system, would not be effective in the treatment of an elevated flow rate and therefore was screened from further analysis on the basis of effectiveness.

The alternatives and process options retained for detailed analysis are presented in Table ES-1. These alternatives were evaluated on the basis of the following seven criteria:

- Short-term effectiveness;
- Long-term effectiveness and permanence;
- Implementability;
- Reduction of toxicity, mobility, or volume through treatment;
- Compliance with ARARs;
- Overall protection of human health and the environment; and
- Cost.

The results of these analyses, by alternative, are summarized in Tables ES-2 through ES-8.

Based on the alternative evaluation, the recommended remedial alternative is Alternative 3, Modified Ground Water Restoration, comprised of the following process options:

- Extraction Option E2 - Modified Extraction System;
- Organic Treatment Option T2 - Air Stripping (Optional);
- Inorganic Treatment Option T8 - Electrochemical Treatment (with supplemental treatment as required to meet discharge permit conditions); and
- Discharge Option D2 - Discharge to Surface Water.

The alternative would consist of implementation of a modified ground water extraction system in which one deep and three shallow extraction wells would be installed to supplement the existing extraction system. Additional investigation is to be conducted in the vicinity of wells IW2 and SC26D and additional ground water modeling will be conducted during remedial design. The final extraction system design may be modified on the basis of these studies. Electrochemical treatment provides for removal of inorganic contaminants, especially chromium. The electrochemical system would be used as the sole inorganic treatment method if discharge limitations can be achieved. If discharge limitations are not achievable, the system will be modified or the existing ion exchange system would be utilized to polish the effluent prior to discharge. Similarly, the degassing process in the electrochemical treatment system has the potential to provide removal of chlorinated organics from the contaminated ground water. If organics are not successfully treated by the electrochemical treatment system, the ground water will be treated using the existing air stripper. Discharge to surface water is the preferred method of treated ground water discharge, due to its ease of implementation and its successful operational history. Implementation of this discharge option will be critically dependent upon the ability of the treatment technology to achieve proposed surface water discharge permit conditions. If implementation of a discharge to ground water option were required on the basis of chemical-specific discharge conditions, additional studies would be required during the conceptual design stage to provide additional design information.

The alternative also includes continued ground water monitoring and a five-year review of the remedial action decision, in accordance with the requirements of the NCP.

Two additional criteria will also be considered in the final selection of the preferred remedial alternative. The community acceptance criterion is evaluated through the Public Meeting/Comment Period which follows public announcement of the proposed remedial action. The federal acceptance criterion will be evaluated on the basis of support agency comments on the RI/FS report and the proposed remedial plan. The evaluation of these criteria will be presented in the Record of Decision for the ground water operable unit.

TABLE ES–1
SUMMARY OF GROUND WATER REMEDIAL ALTERNATIVES RETAINED FOR DETAILED ANALYSIS
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	DESCRIPTION
No action	Discontinuation of pump and treat activities; Subject to a five–year review; One round of ground water monitoring prior to five–year review
Continuation of Existing Actions	Continuation of operation of existing pump and treat system at existing extraction rate of approximately 200 gallons per minute
Modified Ground Water Restoration	Modification of ground water extraction, treatment and discharge system such that it can operate at the design pumping rate of approximately 400 gallons per minute while meeting discharge requirements
Extraction:	
Option E1 – Existing Extraction System	Use existing extraction wells and one new supplemental extraction well to extract approximately 400 gallons per minute
Option E2 – Modified Extraction System	Use a modified extraction system consisting of existing wells and four additional wells to extract approximately 400 gallons per minute
Organic Treatment:	
Option T2 – Air Stripping	Air stripper provides removal of volatile organic compounds
Option T3 – Carbon Adsorption	Carbon adsorption provides removal of volatile organic compounds
Option T4 – UV Oxidation	Ultraviolet oxidation provides removal of volatile organic compounds
Inorganic Treatment:	
Option T6 – Coagulation and Flocculation	Coagulation and flocculation used to supplement inorganic removal provided by existing ion exchange system
Option T7 – Membrane Microfiltration	Membrane microfiltration used to supplement inorganic removal provided by existing ion exchange system
Option T8 – Electrochemical	Electrochemical treatment used as a stand–alone process to remove inorganic contaminants; supplemental treatment provided by ion exchange polishing or through modification of the electrochemical treatment system to achieve lower chromium levels, as required to meet proposed discharge to surface water permit conditions
Discharge	
Option D1 – Ground Water	Treated water is recharged to the ground water via recharge basins
Option D2 – Surface Water	Treated water is discharge to the surface water via direct outfall
Option D3 – Combined Discharge to Surface Water and Ground Water	Treated water is discharged both to surface water via direct outfall and ground water via recharge basins

TABLE ES–2
COMPARISON AMONG GROUND WATER ALTERNATIVES
SHORT–TERM EFFECTIVENESS
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	DESCRIPTION
No action	No remedial activities conducted; Therefore, no short–term risks result; Remedial response objectives not achieved
Continuation of Existing Actions	Utilizes existing treatment system; Therefore, no short–term risks result
Modified Ground Water Restoration	Minimal short–term risks; Achieves remedial response objectives in shortest time frame
Extraction:	
Option E1 – Existing Extraction System	Requires minimal construction activities; Utilizes existing extraction wells and piping sytems; Therefore, no significant short–term risks associated with implementation
Option E2 – Modified Extraction System	Requires construction of additional extraction wells and installation of additional piping; Short–term risks are not expected to be significant; Expected to achieve remedial response objectives within a shorter time frame
Organic Treatment:	
Option T2 – Air Stripping	No significant short–term risks to the community or remedial workers anticipated; Utilizes an existing on–site treatment system; Effective in meeting remedial response objectives
Option T3 – Carbon Adsorption	Minimal short–term risks to community or remedial workers due to enclosed nature of treatment system and regeneration of spent carbon units; Treatment units are readily available; Effective in meeting remedial response objectives
Option T4 – UV Oxidation	Minimal short–term risks to the community due to destruction of contaminants; Process chemicals may pose short–term risks to remedial workers, depending on selected technology vendor; Potential additional risks associated with those UV treatment technologies which employ ozone in the treatment process; Treatment unit availability is improving; Effective in meeting remedial response objectives
Inorganic Treatment:	
Option T6 – Coagulation and Flocculation	Minimal short–term risks to the community; Requires handling of inorganic sludge; Treatment system readily available; May not be effective in meeting remedial response objectives
Option T7 – Membrane Microfiltration	Minimal short–term risks to community or remedial workers; Requires handling of sludge collected on membrane and periodic changes of the membrane; Effective in meeting remedial response objectives
Option T8 – Electrochemical	Minimal short–term risks to the community; Requires handling of inorganic sludge and replacement of electrodes in electrochemical cells; Effective in meeting remedial response objectives; Supplemental treatment technologies equally effective in the short–term although ion exchange and electrochemical treatment are most easily implemented

TABLE ES-2
COMPARISON AMONG GROUND WATER ALTERNATIVES
SHORT-TERM EFFECTIVENESS
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	DESCRIPTION
Discharge	
Option D1 – Ground Water	Minimal short-term risks to remedial workers, community and environment when combined with treatment; Requires construction of recharge system
Option D2 – Surface Water	Minimal short-term risks to remedial workers, community and environment when combined with treatment; Very easy to implement based on presence of existing discharge system
Option D3 – Combined Discharge to Surface Water and Ground Water	Minimal short-term risks to remedial workers, community and environment when combined with treatment; Requires construction of recharge system and use of existing surface water discharge system

TABLE ES–3
COMPARISON AMONG GROUND WATER ALTERNATIVES
LONG–TERM EFFECTIVENESS AND PERMANENCE
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	DESCRIPTION
No action	Existing site–related risks remain; Does not prevent contaminated ground water migration; Requires a five–year review
Continuation of Existing Actions	Existing system effective in minimizing the majority of contaminant migration beyond the identified plume area; Requires off–site disposal of brine solution and filter cake sludge, and long–term ground water monitoring; Exposures limited through existence of well restriction area
Modified Ground Water Restoration	Optimizes operation of ground water restoration program; Operation and maintenance requirements depend on selected options
Extraction:	
Option E1 – Existing Extraction System	Effective in implementing increased extraction rate but does not provide capture of contamination near potential source area(s)
Option E2 – Modified Extraction System	Provides greater control over contaminant plume; Removes contaminants closer to the potential contaminant source area(s)
Organic Treatment:	
Option T2 – Air Stripping	Effective in treating organic contaminants of concern from the wastestream; Requires minimal long–term maintenance of air stripper
Option T3 – Carbon Adsorption	Effective in treating both chlorinated and aromatic contaminants; Contaminants destroyed through thermal treatment; Requires periodic removal and regeneration of spent carbon
Option T4 – UV Oxidation	Effective in treating organic contaminants of concern; Contaminants destroyed by treatment process; Requires replacement of UV lamps and provision of hydrogen peroxide
Inorganic Treatment:	
Option T6 – Coagulation and Flocculation	May not be effective in treating colloidal contaminants, as indicated by preliminary testing; Requires hazardous waste characterization and disposal of residual sludge; Must be combined with ion exchange
Option T7 – Membrane Microfiltration	Effective in treating inorganic contaminants; Requires hazardous waste characterization and disposal of residual sludge, and replacement of membrane; Must be combined with ion exchange
Option T8 – Electrochemical	Effective in treating inorganic contaminants; Requires hazardous waste characterization and disposal of residual sludge; Provides greatest degree in contaminant reduction (based on treatability studies); With supplemental treatment, such as ion exchange, or by modifying the electrochemical treatment system, proposed discharge to surface water discharge permit conditions are expected to be achievable

TABLE ES-3
COMPARISON AMONG GROUND WATER ALTERNATIVES
LONG-TERM EFFECTIVENESS AND PERMANENCE
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	DESCRIPTION
Discharge	
Option D1 – Ground Water	Requires long-term maintenance of recharge system to prevent clogging; Requires regular monitoring of discharge quality and of effects of mounding on extraction system
Option D2 – Surface Water	Requires minimal long-term maintenance; Requires regular monitoring of discharge quality
Option D3 – Combined Discharge to Surface Water and Ground Water	Requires long-term maintenance of recharge system to prevent clogging of the ground water recharge portion of the discharge system; Requires regular monitoring of discharge quality and monitoring of recharge system to determine effects of mounding on extraction system

TABLE ES-4
COMPARISON AMONG GROUND WATER ALTERNATIVES
IMPLEMENTABILITY
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	TECHNICAL FEASIBILITY	ADMINISTRATIVE FEASIBILITY	SERVICE & MATERIAL AVAILABILITY
No action	Easily implemented; Does not limit implementation of future remedial actions	Requires five-year review	No equipment required except for five-year ground water monitoring event
Continuation of Existing Actions	Easily implemented; System already in place and operational; Does not limit implementation of future remedial actions	Continuation of current administrative requirements	Current suppliers of operation and maintenance equipment readily available
Modified Ground Water Restoration	See option descriptions below	See option descriptions below	See option descriptions below
Extraction:			
Option E1 – Existing Extraction System	Easily implemented based on use of existing extraction wells and one supplemental well; Does not limit implementation of future remedial actions	Continuation of current administrative requirements; Requires well installation permit	Suppliers of equipment and services are readily available
Option E2 – Modified Extraction System	Easily implemented but requires installation of additional wells; Does not limit implementation of future remedial actions	Requires well installation permits	Suppliers of equipment and services are readily available
Organic Treatment:			
Option T2 – Air Stripping	Easily implemented since the system already exists on-site; Expansion of system is fairly easy, if necessary	Administrative feasibility good based on system's historic use at site	Suppliers of equipment and services are readily available
Option T3 – Carbon Adsorption	Easily implemented; Requires set-up of an on-site carbon adsorption unit and replacement of carbon on a regular basis; Simplicity of unit allows for use of multiple units or subsequent additions of units, if necessary	Requires compliance with requirements of a treatment works permit	Requires regeneration of spent carbon; Suppliers of equipment and services are readily available
Option T4 – UV Oxidation	Fairly easily implemented; Requires set-up of an on-site UV oxidation system; Requires maintenance of chemical supplies and UV lamps	Requires compliance with requirements of a treatment works permit	Although previously considered an innovative technology, suppliers of equipment and services are becoming more readily available

TABLE ES-4
COMPARISON AMONG GROUND WATER ALTERNATIVES
IMPLEMENTABILITY
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	TECHNICAL FEASIBILITY	ADMINISTRATIVE FEASIBILITY	SERVICE & MATERIAL AVAILABILITY
Inorganic Treatment:			
Option T6 – Coagulation and Flocculation	Fairly easily implemented; Start-up could result in technical problems based on preliminary testing; Requires maintenance of chemical supplies and sludge disposal	Requires compliance with requirements of a treatment works permit	Requires disposal of residual sludge; Suppliers of equipment and services are readily available
Option T7 – Membrane Microfiltration	Fairly easily implemented; Does not limit implementation of future remedial actions; Requires construction of additional on-site facility	Requires compliance with requirements of a treatment works permit	Requires disposal of residual sludge and replacement of membrane; Suppliers of equipment and services are fairly readily available
Option T8 – Electrochemical	Fairly easily implemented, although construction of an additional on-site facility is required; Does not limit implementation of future remedial actions; Ion exchange or modification of electrochemical system are fairly easily implemented as supplemental treatment technology, if required	Requires compliance with requirements of a treatment works permit	Requires maintenance of electrochemical cells, chemical supplies, and sludge handling; Suppliers of equipment and services limited due to innovative nature of treatment option; Availability of ion exchange suppliers for supplemental treatment is good
Discharge			
Option D1 – Ground Water	Requires construction of an extensive recharge system	Requires compliance with discharge to ground water permit	Suppliers of equipment and services are readily available
Option D2 – Surface Water	Easily implemented since current system discharges to surface water	Requires compliance with surface water discharge criteria	Suppliers of equipment are readily available
Option D3 – Combined Discharge to Surface Water and Ground Water	Requires construction of an extensive recharge system	Requires compliance with discharge to ground water permit and surface water discharge criteria	Suppliers of equipment and services are readily available

TABLE ES-5
COMPARISON AMONG GROUND WATER ALTERNATIVES
REDUCTION OF TOXICITY (T), MOBILITY (M), OR VOLUME (V) THROUGH TREATMENT
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	DESCRIPTION
No action	No reductions of T,M or V of contaminated ground water; Potential risk of downgradient migration if existing system is shutdown
Continuation of Existing Actions	Reductions of T,M or V of contaminated ground water; Residual brine and sludge produced; May not effectively capture all identified ground water contamination
Modified Ground Water Restoration	Reductions of T, M, or V of contaminated ground water; Most effective in capturing contaminated ground water
Extraction:	
Option E1 – Existing Extraction System	M of contaminated ground water reduced through increased pumping using current extraction system and supplemental extraction well; T and V of contaminated ground water not reduced
Option E2 – Modified Extraction System	M of contaminated ground water reduced through increased pumping of a revised extraction system designed to optimize contaminant capture; T of contaminated ground water not reduced; V of contaminated ground water potentially reduced over long-term due to extraction near to potential source area(s)
Organic Treatment:	
Option T2 – Air Stripping	Reduces T of organic ground water contaminants through transfer of contaminants from aqueous to vapor phase; Contaminants undergo additional natural breakdown in atmosphere
Option T3 – Carbon Adsorption	Reduces T of organic ground water contaminants through adsorption of contaminants onto carbon and susequent destruction using thermal processes
Option T4 – UV Oxidation	Reduces T of organic ground water contaminants through oxidation processes without production of contaminant residuals
Inorganic Treatment:	
Option T6 – Coagulation and Flocculation	Initial studies indicate this option may not be effective in reducing T of inorganic ground water contamination; Residual sludge produced; Would have to be combined with current ion exchange treatment system
Option T7 – Membrane Microfiltration	Reduces T of undissolved inorganic ground water contamination; Would have to be combined with current ion exchange treatment system; Residual sludge produced
Option T8 – Electrochemical	Reduces T of inorganic ground water contamination; Residual sludge produced; Provides greatest degree of inorganic removal from ground water; If required to meet proposed discharge to surface water permit conditions, supplemental treatment such as ion exchange or modification of the electrochemical treatment system could provide even greater inorganic removals

TABLE ES-5
COMPARISON AMONG GROUND WATER ALTERNATIVES
REDUCTION OF TOXICITY (T), MOBILITY (M), OR VOLUME (V) THROUGH TREATMENT
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	DESCRIPTION
Discharge	
Option D1 – Ground Water	No significant effect on T or V of contaminated ground water; Recharged water could enhance the extraction system and minimize contaminant migration
Option D2 – Surface Water	No significant effect on T, M or V of contaminated ground water
Option D3 – Combined Discharge to Surface Water and Ground Water	No significant effect on T or V of contaminated ground water; Recharge to ground water could enhance the extraction system and minimize contaminant migration

TABLE ES-6
COMPARISON AMONG GROUND WATER ALTERNATIVES
COMPLIANCE WITH ARARs
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	CHEMICAL-SPECIFIC	LOCATION-SPECIFIC	ACTION-SPECIFIC
No action	ARARs/TBCs not attained for ground water	No construction required; not applicable	Remedial action undertaken; not applicable
Continuation of Existing Actions	Existing extraction and treatment system may not achieve ground water quality ARARs or discharge requirements	No construction required; not applicable	Must comply with requirements of a New Jersey treatment works permit and RCRA hazardous waste transport and treatment regulations
Modified Ground Water Restoration	ARARs/TBCs expected to be attained for ground water contaminants and treated water discharge	Construction activities required to comply with floodplain, wetlands, and farmland protection requirements	See options below for specific requirements
Extraction:			
Option E1 – Existing Extraction System	Provides for extraction of most ground water with contaminant levels which exceed ARARs	Construction of additional ground water extraction well must comply with floodplain, wetlands, and farmland protection requirements	Must comply with ground water allocation regulations
Option E2 – Modified Extraction System	Most effective in extracting ground water with contaminant levels which exceed ARARs closest to potential source area(s)	Construction of additional ground water extraction wells must comply with floodplain, wetlands, and farmland protection requirements	Must comply with well installation and ground water allocation regulations
Organic Treatment:			
Option T2 – Air Stripping	Discharge to surface water TBCs attained for volatile organic contaminants of concern	Using existing on-site treatment system; therefore, not applicable	Must comply with requirements of a New Jersey treatment works permit and air pollution discharge regulations
Option T3 – Carbon Adsorption	Discharge to surface water TBCs attained for volatile organic contaminants of concern	Construction of on-site treatment system may be required to comply with floodplain and wetland requirements	Must comply with requirements of a New Jersey treatment works permit and RCRA hazardous waste transport and treatment regulations
Option T4 – UV Oxidation	Discharge to surface water TBCs attained for volatile organic contaminants of concern	Construction of on-site treatment system may be required to comply with floodplain and wetland requirements	Must comply with requirements of a New Jersey treatment works permit

TABLE ES-6
COMPARISON AMONG GROUND WATER ALTERNATIVES
COMPLIANCE WITH ARARs
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	CHEMICAL-SPECIFIC	LOCATION-SPECIFIC	ACTION-SPECIFIC
Inorganic Treatment:			
Option T6 – Coagulation and Flocculation	Discharge to surface water TBCs are not expected to be attainable for inorganic contaminants of concern based on preliminary testing	Construction of on-site treatment system may be required to comply with floodplain and wetland requirements	Must comply with requirements of a New Jersey treatment works permit and hazardous waste characterization, transport and treatment regulations
Option T7 – Membrane Microfiltration	With additional ion exchange, discharge to surface water TBCs may be obtainable but treatability study testing would be required	Construction of on-site treatment system may be required to comply with floodplain and wetland requirements	Must comply with requirements of a New Jersey treatment works permit and hazardous waste characterization, transport and treatment regulations
Option T8 – Electrochemical	Discharge to surface water TBCs may be attained for inorganic contaminants of concern based on initial testing; modification of the electrochemical treatment system or provision of supplemental ion exchange may be required to consistently meet discharge requirements	Construction of on-site treatment system may be required to comply with floodplain and wetland requirements	Must comply with requirements of a New Jersey treatment works permit and hazardous waste characterization, transport and treatment regulations
Discharge			
Option D1 – Ground Water	Dependent on treatment system and requirements of discharge to ground water permit	Construction of recharge system must comply with floodplain, wetlands, and farmland protection requirements	Must comply with requirements of discharge to ground water permit
Option D2 – Surface Water	Dependent on treatment system and requirements of discharge to surface water permit	Operation of discharge system must comply with floodplain, wetlands and farmland protection requirements	Must comply with requirements of discharge to surface water permit
Option D3 – Combined Discharge to Surface Water and Ground Water	Dependent on treatment system and requirements of discharge to ground water and discharge to surface water permits	Construction of recharge system must comply with floodplain, wetlands, and farmland protection requirements	Must comply with requirements of discharge to ground water and discharge to surface water permits

TABLE ES-7
COMPARISON AMONG GROUND WATER ALTERNATIVES
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	DESCRIPTION
No action	Least protective alternative; Risk of additional downgradient contamination exists if current treatment system is shut down
Continuation of Existing Actions	Provides a degree of long-term protection of human health and the environment; Partially addresses potential risks associated with existing ground water contamination through ground water extraction and treatment
Modified Ground Water Restoration	Provides the greatest degree of long-term protection of human health and the environment through the optimization of the ground water extraction and treatment system
Extraction:	
Option E1 – Existing Extraction System	Protective of human health and the environment through ground water containment and extraction; May not provide efficient capture of all contaminated ground water
Option E2 – Modified Extraction System	Protective of human health and the environment through ground water containment and extraction; Maximizes capture of contaminated ground water through modification of existing extraction system; Provides for extraction of contaminated ground water closer to potential source area(s)
Organic Treatment:	
Option T2 – Air Stripping	Effective in long-term and short-term; Expected to meet chemical-specific discharge to surface water TBCs for VOCs; Contaminants are transferred from the aqueous phase to the vapor phase where they undergo natural attenuation
Option T3 – Carbon Adsorption	Effective in long-term and short-term; Expected to meet chemical-specific discharge to surface water TBCs for VOCs; Contaminants are thermally destroyed off-site
Option T4 – UV Oxidation	Effective in long-term and short-term; Expected to meet chemical-specific discharge to surface water TBCs for VOCs; Contaminants are chemically destroyed
Inorganic Treatment:	
Option T6 – Coagulation and Flocculation	Expected to provide some degree of protection of human health and the environment; Not expected to achieve discharge to surface water TBCs for inorganic compounds of concern; Sludge residual disposed of off-site
Option T7 – Membrane Microfiltration	Effective in long-term and short-term when combined with current ion exchange system; Expected to meet chemical-specific discharge to surface water TBCs for inorganics; Sludge residual disposed of off-site

TABLE ES-7
COMPARISON AMONG GROUND WATER ALTERNATIVES
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	DESCRIPTION
Inorganic Treatment (Cont.):	
Option T8 – Electrochemical	Effective in long-term and short-term; Expected to meet chemical specific discharge to surface water TBCs for inorganics, especially with the provision of supplemental ion exchange treatment, may possibly treat organic contaminants of concern; Sludge residual disposed of off-site
Discharge	
Option D1 – Ground Water	Protective of human health and the environment, provided treatment system meets discharge criteria; Provides added element of hydraulic control; Potential for significant maintenance requirements
Option D2 – Surface Water	Protective of human health and the environment, provided treatment system meets discharge criteria; Easily implemented with minimal maintenance required
Option D3 – Combined Discharge to Surface Water and Ground Water	Protective of human health and the environment, provided treatment system meets discharge criteria; Provides an added element of hydraulic control; May require added maintenance

TABLE ES-8
COMPARISON AMONG GROUND WATER ALTERNATIVES
COST
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	TOTAL CAPITAL COST	ANNUAL O&M COST	PRESENT WORTH O&M COST (1)	TOTAL PRESENT WORTH (2)
No Action	–	–	$40,000	$48,000
Continuation of Existing Actions	–	$1,300,000	$5,600,000	$6,700,000
Modified Ground Water Restoration				
Extraction:				
Option E1 – Existing Extraction System	$25,000	$27,000	$110,000	$170,000
Option E2 – Modified Extraction System	$106,000	$27,000	$110,000	$260,000
Organic Treatment:				
Option T2 – Air Stripping	$23,000	$14,000	$59,000	$98,000
Option T3 – Carbon Adsorption	$290,000	$100,000	$440,000	$880,000
Option T4 – UV Oxidation	$860,000	$400,000	$1,700,000	$3,100,000
Inorganic Treatment:				
Option T6 – Coagulation and Flocculation (3)	$140,000	$2,300,000	$10,000,000	$12,000,000
Option T7 – Membrane Microfiltration (3)	$730,000	$1,600,000	$6,800,000	$9,000,000
Option T8 – Electrochemical (4)	$1,500,000	$500,000	$2,200,000	$4,400,000
Supplemental Ion Exchange Polishing	$150,000	$500,000	$2,200,000	$2,800,000
Modification of Electrochemical Treatment	$100,000	$140,000	$600,000	$840,000
Discharge:				
Option D1 – Ground Water	$240,000	$220,000	$900,000	$1,400,000
Option D2 – Surface Water	–	$210,000	$900,000	$1,100,000
Option D3 – Combination of Ground Water and Surface Water	$240,000	$250,000	$1,100,000	$1,600,000

(1) Based on 5% discount rate

(2) Includes 20% contingency on all components

(3) Includes ion exchange

(4) Costs presented for Supplemental Ion Exchange Polishing include capital costs associated with repiping of the treatment system and resin replacement and estimated operational costs associated with brine disposal
Costs presented for Modification of the Electrochemical Treatment System include capital costs for additional filtration and annual O&M costs for filtration and additional sludge disposal

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FIGURE

APPENDICES

APPENDIX

1.0 INTRODUCTION

TRC Environmental Corporation (TRC) is conducting a Remedial Investigation/ Feasibility Study (RI/FS) at the Shieldalloy Metallurgical Corporation (SMC) facility, located in Newfield, New Jersey. The investigation of the site is being conducted in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA). The study is being performed for SMC as required under a New Jersey Department of Environmental Protection and Energy (NJDEPE) Administrative Consent Order (ACO), dated October 5, 1988. Cited in the ACO are the following New Jersey statutes: the Water Pollution Control Act, N.J.A.C. 58:10A-1 et seq., the Spill Compensation and Control Act, N.J.A.C. 58:10-23.11 et seq., and the Solid Waste Management Act, N.J.A.C. 13:1E-1 et seq.

A Remedial Investigation (RI) was conducted at the SMC facility to investigate the physical characteristics of the site, as well as to identify potential sources of contamination, determine the nature and extent of contamination and characterize potential health risks and environmental impacts. In order to accomplish the goals and objectives of the RI, environmental site investigations were conducted. Detailed site background information and the findings of the investigations were presented in a report entitled Remedial Investigation Technical Report (TRC, 1992a).

The Feasibility Study (FS) portion of the RI/FS is being performed in two phases. The first phase, preparation of a Focused Feasibility Study (FFS) addressing contaminated ground water at and emanating from the site, is presented herein. The purpose of this report is to identify and evaluate alternatives for mitigating ground water contamination, thereby minimizing potential impacts on human health and the environment. It has been prepared in accordance with NJDEPE's Conditional Approval of a Feasibility Study Work Plan (TRC, 1992b). By evaluating remedial solutions selected from a range of technologies available for ground water remediation, a response can be formulated which is technically feasible, protects public health and the environment, is cost-effective, and is consistent with applicable or relevant environmental standards. Other contaminated media at the SMC site will be addressed in the second phase of FS activities.

The Feasibility Study process was formulated by the U.S. EPA to properly implement CERCLA. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP, 40 CFR Part 300) establishes the framework for performing the Feasibility Study. Further definition of the FS process is outlined in the Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (USEPA, Interim Final, October 1988).

Figure 1-1 provides a summary of the approach used to formulate an appropriate remedial response for ground water at SMC. The FFS report incorporates this approach into the following report format:

Section	Description of Contents
1	Introduction/Background Information
2	Assessment of Applicable or Relevant and Appropriate Requirements (ARARs)
3	Identification and Screening of Technologies
4	Development and Screening of Alternatives
5	Detailed Analysis of Alternatives
6	References

It should be noted that, while this report has been written to equally evaluate all components of ground water remedial alternatives, one of the ground water treatment options evaluated herein, electrochemical treatment, has been implemented at the SMC facility in order to comply with the requirements of a 1988 Administrative Consent Order (ACO). These requirements included the continuous operation of a 400 gallon per minute treatment system for 24 hours per day, 7 days per week, as an interim remedial measure. An existing treatment system, as described later in this report, was not capable of achieving these requirements. Therefore, SMC evaluated remedial options and selected the electrochemical treatment technology as providing the most efficient means of treatment while protecting human health and the environment. The evaluation process for the various inorganic treatment alternatives presented herein reflects the evaluation process which was conducted prior to the implementation of the electrochemical treatment system. The evaluation process presented for the other remedial alternatives and options, including ground water extraction, organic treatment and discharge options (and the evaluation of the use of supplemental treatment technologies to meet draft discharge to surface water permit conditions), is based on current conditions.

The electrochemical treatment system has been in operation since October 1992. It has been effective in the treatment of the chromium contamination within the ground water, achieving significantly lower effluent levels than were achievable using the previously existing treatment system.

1.1 Site Location and Description

The SMC facility consists of approximately 67.5 acres. The manufacturing facilities and support areas are located on approximately 60 acres in Newfield, New Jersey, within Gloucester County. SMC also owns 7.5 acres of farmlands southwest of the main facility, in Vineland, New Jersey, within Cumberland County. This 7.5 acre parcel is located approximately 2,000 feet southwest of the 60 acre parcel. A site location map is provided in Figure 1-2.

The SMC Newfield property is bounded by a Conrail rail line to the west and to the north. Wooded areas, residences, and small businesses are located east of the site. The Hudson Branch, a tributary to Burnt Mill Branch and the Maurice River, flows along the southern portion of the site, just north of residences located along Weymouth Road. A large portion of the site is enclosed by a 10-foot steel-wire fence. A detailed site map showing site boundaries and cultural features is presented in Figure 1-3.

The SMC facility can be described as consisting of four areas of interest. These areas, summarized in Table 1-1 and delineated in Figure 1-4, are described below.

Manufacturing Area - This area is currently characterized by the plant operations, offices, loading docks, etc. For the most part, this area is covered with buildings, and asphalt or concrete pavement. Specific areas located within the Manufacturing Area include the location of the Former Manpro-Vibra Degreasing Unit, which was used to remove dirt, fines and grease from manufactured metals and operated from 1965 to 1967. Trichloroethene was the primary degreasing compound used in the unit. Other areas include the Underground Storage Tank Area; the Railroad Siding Area (located to the north of the Manufacturing Area); the Department 106 Area; and the Department 102 Area.

The Manufacturing Area also includes the Wastewater Treatment Facility, housed in Building 216, which is used to treat wastewater containing hexavalent chromium. The wastewater is generated through the operation of a series of five ground water extraction wells (wells identified as Layne, W9, RW6S, RW6D, and RIW2). Well locations are provided in Figure 1-5. The treatment system consists of a 400 gallon per minute (gpm) ion exchange unit with both cation and anion treatment system components. The cation treatment system operates as a hydrogen cycle strong acid cation exchanger. In the adsorption column, trivalent chromium and other cations such as sodium, calcium, and magnesium are removed from the water. The spent resin is regenerated within an elution column using sulfuric acid. A similar anion treatment train is interlocked with the cation train. The treatment system is described in detail in the August 1988 Treatment Works Application. Because the extracted ground water also contains volatile organic compounds (VOCs), an air stripper is used to supplement the ion exchange process and treat the VOCs. Discharge from the treatment facility is to the Hudson Branch tributary of the Maurice River, and has historically been regulated under NJPDES permit NJ0004103.

Undeveloped Plant Property - This area is located along the southern plant property boundary and includes areas east of and adjacent to the Manufacturing Area. This area does not contain manufacturing buildings or offices. An area of interest within the Undeveloped Plant Property is the Tank T12 Chromium Wastewater Spill Area, the site of a 1990 spill of chromium wastewater.

By-product Storage Area - The By-product Storage Area is located in the eastern portion of the site. This area is used to store by-product materials generated as a result of the manufacturing processes. The area overlaps with an area referred to as the NRC (controlled) area. Due to the presence of naturally occurring thorium and uranium in the raw material which SMC uses for ferro-columbium, portions of the SMC facility are subject to regulation by the Nuclear Regulatory Commission (NRC). The NRC (controlled) area is an area where slags and dusts generated during processing and containing low levels of radioactive isotopes are stored, as permitted by NRC license.

Lagoon Area - This area, referenced on Figure 1-4 as the Leachate and By-product Storage Area, consists of nine lagoons located in the central portion of the facility. An unlined lagoon was used to hold untreated wastewaters during the 1960's and was replaced in 1971 by lined lagoons which received treated wastewater.

1.2 Site History

SMC (formerly Shieldalloy Corporation) has been operating at the Newfield facility since 1955, processing ores and minerals to produce primary metals, specialty metals and ferroalloys. The principal production processes include aluminothermic and reduction smelting of ores which produce purified metal, slag and various other by-products, co-products or other materials. Raw materials currently used at the facility contain the following metals: manganese, nickel, bismuth, iron, vanadium, chromium, titanium, silicon, copper, zirconium, magnesium, aluminum, lead and oxides of columbium (niobium), vanadium, barium, calcium, aluminum and fluoride salts.

In the past, boron, strontium metal, steel and oxides of chromium were used at the facility. Past production processes include: chromium oxide and chromium metal production, ferrovanadium production, ferrocolumbium and columbium nickel production. A titanium metal degreasing operation was operated from 1965 to 1967. As a result of present and past manufacturing processes, the facility has generated slag, dross, baghouse dust, and wastewaters. A more detailed description of historic site operations is presented in the Remedial Investigation Technical Report (TRC, 1992a).

1.3 Previous Investigations

Previous investigations focusing on ground water contamination, particularly with respect to chromium and volatile organic compounds, have been conducted at the facility. The first study was conducted in 1972 by Roy

F. Weston, in response to the detection of hexavalent chromium in a newly installed Newfield municipal supply well (see Figure 1-3 for the former well location). The well was drilled to a depth of 206 feet, and screened from 129 to 149 feet. The well, which was never used to supply water to the Newfield water supply system, was sealed in the early 1970s. TRC was unable to identify historical data on specific contaminant concentrations for the municipal well. Twelve jetted well points (wells A through L) and one well (the Layne well) were installed as part of the Roy F. Weston study. The Layne well has been used for ground water extraction since 1979. Well locations which were still existing at the time of the Remedial Investigation are indicated in Figure 1-5.

In 1973, Woodward-Moorehouse Associates, Inc. conducted an investigation of ground water and surface water quality. The installation of "W" series wells (see Figure 1-5), which are screened in the shallow and deep portions of the Cohansey Sand, was completed during this study. Two of the wells were installed off-site. The "initial well cluster", which consisted of five wells each completed at a different depth in the aquifer (wells IWC-1 through IWC-5, see Figure 1-5), was also installed at this time. Ground water extraction and treatment (ion exchange) for the removal of hexavalent and trivalent chromium was initiated in 1979.

In 1983, Dan Raviv Associates, Inc. (DRAI) reviewed available data and initiated a more intensive ground water monitoring program. Fourteen wells, including shallow and deep off-site wells and a replacement irrigation well, were installed during this study. Sampling of domestic wells, the Hudson Branch and on-site lagoons was also conducted at this time. The analytical scope was expanded to include such parameters as sodium, pH, sulfate and volatile organic compounds (VOCs). In September 1984, NJDEPE and SMC entered into an Administrative Consent Order (ACO) which required SMC to conduct a Feasibility Study for remediation of the ground water contamination and to continue the ground water remediation program. In January 1988, DRAI completed an evaluation of Ground Water Remediation Alternatives (DRAI, 1988a), in accordance with the 1984 ACO, which considered the effectiveness of the existing pump and treat system and presented alternatives for improvement of the remedial system. The study included the application of the USGS MODFLOW ground water flow model to the site conditions to determine the effect of pumping from different well configurations. As a result of this study, an increase in the ground water extraction and treatment rate from 80 gallons per minute (gpm), 13 to 16 hours per day, 5 days per week, to 400 gpm, 24 hours per day, 7 days per week was recommended to minimize contaminant migration and ensure timely removal of the contamination.

In October 1988, NJDEPE and SMC entered into a second ACO. SMC was required to initiate operation of a 400 gpm ground water remediation system as an interim remedial measure and to conduct a comprehensive RI/FS. Four additional ground water extraction wells (W9, RW6S, RW6D and RIW2) were installed both within the boundaries of the SMC facility and to the southwest of the facility to supplement the existing extraction well (Layne) in capturing and preventing further downgradient migration of contaminated ground water. The ground water extracted from these recovery wells was treated within a new on-site ion exchange treatment system designed to treat 400 gpm, with operation of the new pump and treat system commencing in 1989.

The design pumping schedule included continuous pumping from the five previously referenced extraction wells. However, because of unforeseen operational difficulties, the effectiveness of the ion exchange system in treating the ground water at a 400 gpm rate was variable. The system could not operate in a continuous treatment mode so the ion exchange columns operated in a fixed-bed mode, requiring periodic shutdowns (every 1 to 2 days) for regeneration, a process which requires approximately 5 to 6 hours per regeneration cycle. While evaluating the operation of the treatment system, ground water was extracted at the highest rate at which it could be treated effectively, with an emphasis on controlling the leading edge of the plume in both the shallow and deep portions of the aquifer. In January 1991, DRAI completed an Evaluation of Ground Water Pumping Effectiveness in response to the request of NJDEPE, due to the variation between the actual pumping schedule and the design pumping schedule. At the time of preparation of the January 1991 report, ground water was regularly being extracted at a rate of 120 gpm from shallow well RIW2 and at 80 gpm from a deep well, either RW6D or W9. The study concluded that the interim pumping schedule was effective in controlling the toe of the hexavalent chromium plume in the shallow portion of the aquifer but additional pumping was necessary to control the hexavalent chromium plume in the deep portion of the aquifer. Modifications to the pumping schedule were recommended.

Under the 1988 ACO, the performance of a comprehensive RI/FS was required. Field investigations began in October 1990, following the preparation of an RI Work Plan (TRC, 1990) and are described in more detail below.

1.4 Site Investigation Summary

The Remedial Investigation of the SMC site was designed to characterize potential sources of environmental contamination at the site, determine the nature, type and physical states of contamination, determine the horizontal and vertical extent of contamination, identify potential contaminant migration pathways, determine the impact of contaminants on human health and the environment, and collect information necessary to support the evaluation of remedial technologies potentially applicable to the site.

The RI program was structured to investigate specific areas of former plant processes and associated materials storage areas, including those areas previously identified in Section 1.1 and listed in Table 1-1.

The scope of the Remedial Investigation was extensive, including but not limited to the following activities: surface soil sampling; surface water and sediment sampling; test pit sampling; soil boring sampling; monitoring well installation; and ground water sampling. Because this FFS considers the remediation of contaminated ground water only, ground water investigation activities will be described in more detail than other site investigation activities. A detailed description of all RI activities can be found in the Remedial Investigation Technical Report (TRC, 1992a).

The hydrologic investigation portion of the RI was conducted in order to identify geologic and hydrogeologic conditions, characterize ground water quality, and define the nature and extent of contamination. Specifically, nineteen ground water monitoring wells were installed at fourteen locations, and included twelve shallow wells and seven deep wells. The locations of existing wells and wells installed during the RI are shown in Figure 1-5. Well construction information for existing wells is provided in Table 1-2 while information on wells installed during the RI is provided in Table 1-3. Ground water samples were collected for laboratory analysis from on-site and off-site newly installed and existing monitoring wells during two separate monitoring events. Fifty-one (51) wells were sampled during the first sampling event (December 1990) and thirty-seven (37) wells were sampled during the second sampling event (April 1991).

Since the preparation of the RI Report, additional ground water monitoring activities have been conducted at the SMC facility, including the installation of additional monitoring wells, replacement of existing monitoring wells and closure of certain wells. The following wells have been replaced with their replacement well designations noted: SC2D by SC2D(R), SC3D by SC3D(R) and SC11S by SC11S(R). Well W2 was replaced with a shallow well, W2(R). Additional wells installed include wells SC20D, SC25S, and SC26D. These replacement well and new well locations are shown in Figure 1-5. It should be noted that other Section 1 and Section 3 figures present data (ground water elevations or chemical data) collected during the RI and therefore show only those wells which existed at the time the RI was conducted. Well logs for the newly installed and replacement wells are presented in Appendix D. Several existing old wells have been closed or are scheduled for closure in the near future. They include wells C, E, G1S, G2D, H, I, W3S, DW2, and DW4. Well D is scheduled for closure in the immediate future. Regular ground water sampling and analysis (monthly, quarterly and annually) are conducted to monitor the toe and perimeter of the chromium and volatile organic plumes.

1.5 Geology, Hydrology and Hydrogeology

1.5.1 Surface Water Hydrology

The predominant surface water body at the SMC facility is the Hudson Branch. The Hudson Branch is a tributary of Burnt Mill Branch, in the Maurice River Basin. The Hudson Branch originates at the southeast corner of the SMC property, borders the southern site boundary and flows east to west. The waters of the stream are supplied by a combination of discharging ground water and storm water. It is primarily a gaining stream (obtains base water flow from ground water) and, therefore at its headwaters, the Hudson Branch is an intermittent stream due to seasonal fluctuations in the ground water table elevation (the water table falls approximately two feet from late summer through mid-winter). During major storm events, the Hudson Branch can locally transform into a losing stream and, as a result, the ground water in the vicinity of Hudson Branch may become mounded.

While the National Wetland Inventory Map identifies no wetlands on-site, a wetland area in association with the Hudson Branch is identified to the south of the site (TRC, 1992c). A wetlands delineation will be conducted at the site.

SMC has three (3) outfalls into the Hudson Branch (see Figure 1-3). Outfalls 002 and 003 are discharge points for SMC's storm water runoff system, while the third outfall (001) is permitted and discharges SMC facility water into the Hudson Branch. Discharge from Outfall 001 consists of city water (non-contact cooling water), treated ground water, and treated and untreated storm water. There is a small pond located near Outfall 001. The pond ranges in depth from two to six feet. The Hudson Branch exits the western portion of the pond area.

1.5.2 Geology

Regional Geology - The SMC site is located within the New Jersey Coastal Plain, which extends from the Delaware Bay in the southwest to the Raritan Bay in the northeast, and from the Fall Line in the west to the Atlantic Ocean in the east.

The Coastal Plain is a seaward-dipping wedge of unconsolidated sediments that range in age from Cretaceous to Holocene. These sediments are composed of clay, silt, sand and gravel and are classified as continental, coastal, or marine-type deposits.

The middle to lower Cretaceous sediments are primarily continental deposits consisting of alternating layers of clay, silt, sand and gravel. The Upper Cretaceous and most Tertiary sediments were deposited in beach and shelf environments, and tend to be finer grained than continental deposits. Very fine grained sediments are recognized as transgressive marine deposits, which formed during major incursions of the sea. Coarsening-upward deposits that overlie the fine-grained units are recognized as marine regressions, deposited in inner-shelf, near-shore or beach environments as the ocean was retreating.

Site-Specific Geology - Site-specific geologic conditions were defined during the RI through monitoring well soil borings. Figure 1-6 shows the locations of the three (3) cross sections that were developed on the basis of the Remedial Investigations to describe the geology of the SMC site. These cross sections are presented in Figures 1-7, 1-8 and 1-9 and are referenced as A, B, and C, respectively. Well logs are located in Appendix E of the Remedial Investigation Technical Report (TRC, 1992a). Additional information was also gathered from the logs of wells installed during previous investigations at the site.

A review of the Geologic Map of New Jersey (Lewis and Kummel, 1950) indicates that the surficial materials at the site and in the Newfield area are comprised of the Quaternary Bridgeton Formation. This formation is characterized by gravel and sand that is cemented in some areas by iron oxide. The Bridgeton Formation, a Miocene fluvial deposit, reveals itself at the SMC site as a brown sand. Its thickness ranges from 0 feet in the vicinity of well SC-17D to 28 feet in the vicinity of well SC-12D.

The major subsurface geologic feature identified at the SMC Newfield facility is the Cohansey Sand. The Cohansey Sand is composed primarily of variegated fine- to coarse-grained sands with some local silt and clay beds.

Grain size varies both vertically and laterally, which is consistent with deposition within a coastal environment. Inspection of the geologic boring logs compiled during the RI investigation indicates that, in general, the Cohansey Sand is composed of coarse sands and little to trace silt in the upper 40 feet, and finer sand and some silt, with some clay and silt stringers in the lower 60 to 80 feet. Prior investigations at the SMC facility reported a 20- to 60-foot thick semi-confining layer composed of discontinuous silt and clay lenses separating the Cohansey Sand into upper and lower units. This description was based on well logs developed from observations of drill cuttings during well construction using mud rotary techniques. As discussed in the RI, logging stratigraphy on this basis is difficult because the depth of the cutting cannot be determined, the geology can be mis-interpreted (e.g., when the drilling mud is thin or drilling encounters a coarse sand layer and no cuttings are brought to the surface, the drilling mud could be mis-interpreted as a clay layer), and there is no way to determine the percentage of silt or to differentiate a silt layer from a clay layer.

Based on the typically continuous split-spoon sampling conducted by TRC during the RI soil borings, subsurface conditions were logged more accurately. Data gathered from the RI does not support the definition of a two-aquifer system in the Cohansey Sand at the SMC site. Thin, discontinuous silt and clay lenses were identified at several locations, including in the vicinity of SC12D and SC13D (depth of 28 to 34 feet) and at the pilot hole for SC22D (4-inch layer at a depth of 30 feet). Due to the variations in depth, thickness and horizontal extent of these discontinuous zones, the mapping of these zones was not attempted. The local variability is considered to be significant only in terms of general trends with respect to hydrogeologic impacts. Small discontinuous silt layers will not greatly impact the regional ground water flow and provide no major separation between the upper and lower zones of the aquifer.

While it has been concluded that there is no semi-confining layer in the Cohansey Sand, this does not mean that the Cohansey Sand is considered as one unit. Based on the pump test analysis, the shallow and deep transmissivities differ for the upper and lower Cohansey Sands. Discussions of the upper and lower Cohansey also allow for a presentation of the variation in contaminant distribution within the shallow portions of the aquifer as opposed to the deeper portions of the aquifer. This presentation supports a subsequent evaluation of pumping from various depths within the aquifer to capture contamination from the zones with the highest contaminant levels. While wells installed during the RI program tend to be screened within the shallow (less than 20 feet) or deep portions of the aquifer (greater than 100 feet - see Table 1-3 of the FFS), previously installed wells tend to be screened within the intermediate portion of the aquifer. Because many of these wells are no longer being monitored or are being replaced, the characteristics and extent of contamination in the upper (water table) and lower Cohansey Sands will be addressed separately, where appropriate.

The top of the Kirkwood Formation was encountered in all deep wells installed across the SMC site by TRC during the Phase I Remedial Investigation (TRC, April 1992). The upper ten (10) feet of the Kirkwood Formation was penetrated and was characterized, based on visual observations of split spoon samples, as a gray/black clay.

A review of well logs (including the log for the Layne Well) from previous investigations conducted at SMC indicates that black clays were encountered at depths of 120 to 160 feet. During the initial SMC ground water investigation conducted by Roy F. Weston, Inc. in 1972, the Layne well was drilled to a depth of 170 feet below ground surface. Review of the Layne well's boring log indicates that a Gray Marl (clay) was encountered at a depth of 130 to 152 feet (22 feet of clay), with the Gray Marl underlain by a coarse gray sand (Kirkwood Formation). This coarse gray sand graded to medium gray sand after 15 feet, at which depth the boring was terminated and the boring grouted to its present depth of 47 feet below ground surface.

During the Phase II Groundwater Contamination Study conducted by Woodward-Moorehouse in 1974, well W1 was installed to a depth of 160 feet below ground surface. Well W1 encountered a 20-foot clay layer at 130 feet. The same gray sand as was identified in the Layne well boring was encountered from 150 - 160 feet. Woodward-Moorehouse installed monitoring well W1 and collected a ground water sample from the 160 foot interval. The sample was analyzed for Cr^{+6}, and the results indicated that the Cr^{+6} concentration in the Kirkwood Formation was less than 0.01 mg/l. Well W1 was grouted to its present depth of 40 feet below ground surface.

The results of the two previous investigations along with the Phase I RI boring and well logs indicate that the clay layer is continuous across the Newfield area.

1.5.3 Hydrogeology

Regional Hydrogeology - The principal aquifer in Gloucester County is the Cohansey Sand. The Cohansey Sand dips southeast about 11 feet per mile and is about 130 feet thick at Newfield, NJ (USGS, 1969). The Cohansey Sand is underlain by the Kirkwood Formation. The upper portion of the Kirkwood Formation is composed of a dark gray silt and clay. Where present, the upper Kirkwood Formation can act as a confining layer, restricting the downward flow of ground water from the Cohansey Sand. As presented in the previous section, the upper Kirkwood Formation was characterized as a continuous clay layer across the facility.

In accordance with NJS 40:63-52, et seq., the City of Vineland has designated an area of the city as a well restriction area, requiring mandatory connection with public water systems. The well restriction area is indicated in Figure 1-10.

Site-Specific Hydrogeology - As previously presented in Section 1.5.2, for discussion purposes, the characteristics and extent of contamination in the upper (water table) and lower Cohansey Sands are addressed separately. Based on the results of the RI conducted at the SMC Newfield facility, the Cohansey Sand is a water table aquifer with depths to ground water ranging from 4 feet in the southern portion of the site to 16 feet in the northern portion. Seasonal fluctuations in the water table elevations are on the order of a few feet. The thickness of the Cohansey Sand was found to range from 110 to 120 feet in the RI well borings.

The ground water flow directions in both the water table and lower Cohansey Sand closely correspond with the general topography of the site, which slopes towards the southwest. The water table and lower Cohansey Sand piezometric surface contour maps, which are based on data obtained during the two ground water sampling events conducted during the RI field investigation, are provided in Figures 1-11 through 1-14. The water level elevations obtained during the ground water sampling events in December 1990 and April 1991 are provided in Table 1-4. As presented in Table 1-4 and shown in Figures 1-11 and 1-12, the water table piezometric surface slopes downward from the slight topographic high at the northern edge of the site toward the Hudson Branch. The water table piezometric surface follows the Hudson Branch downstream toward Burnt Hill Pond.

As presented in Table 1-4 and shown in Figures 1-13 and 1-14, the lower Cohansey Sand piezometric surface also follows the Hudson Branch. The only irregularities observed on the lower Cohansey Sand piezometric contour maps were noted near the existing recovery wells, as expected. The largest fluctuation was observed near RW6D, where the effect of pumping has distorted the shape of the contours as well as the slope of the piezometric surface. While recovery well RIW2 is only screened to a depth of 55 feet, it clearly distorts the adjacent deep piezometric contour interval.

The distortion of the deep contours indicates that there is a hydraulic connection between the shallow and deep portions of the Cohansey Sand. A downward vertical hydraulic gradient was observed at most of the well clusters across the site. The transmissivities (T) and specific yields (Sy) varied between the upper and lower Cohansey Sands. The transmissivity and specific yield of the lower Cohansey Sand, due to the smaller grain size sand and increased percentage of silt and clay, were lower than in the upper Cohansey Sand. The average linear shallow ground water flow velocity was calculated to be approximately 2 feet per day (TRC, 1992a). Since the upper and lower Cohansey Sand have different hydrologic properties, the ground water data obtained from each monitoring well was characterized as either shallow (monitoring well screened above 50 feet) or deep (monitoring well screened below 50 feet).

As discussed in Section 1.5.2, site investigation results indicate that the Kirkwood Formation is continuous across the site investigation area, thus preventing contaminant movement into the underlying aquifer system. Therefore, for the purposes of this investigation, the Kirkwood Formation (Gray Marl) is considered to act as a confining layer, restricting the downward flow of ground water from the Cohansey Sands.

1.6 Nature and Extent of Contamination

Soils - Soil contamination at the SMC facility consists primarily of inorganic constituents and is typically limited to near-surface (0 to 2 feet) contamination. Localized areas of surficial contamination and the major inorganics which were detected at levels significantly exceeding guidance levels (soil action levels applicable at the time of preparation of the RI) in these areas are listed below:

- An area along the Hudson Branch, located within the southwestern portion of the Undeveloped Plant Property, where the maximum detected levels of beryllium, chromium, nickel and vanadium were found;
- Areas along the eastern and western sides of the By-product Storage Area (beryllium, chromium, nickel and vanadium);
- An area north of the Lagoon Area, adjacent to the Former Manpro-Vibra Degreasing Unit drainage ditch (beryllium, nickel and vanadium);
- The Railroad Siding Area (beryllium, chromium, nickel and vanadium);
- Department 106 Area (chromium and vanadium);
- Department 102 Area (chromium);
- Department 101(B) Area (chromium); and
- Tank T12 Area (vanadium).

Stream Sediment and Surface Water - The stream sediment and surface water samples collected from the Hudson Branch were primarily contaminated with inorganics. Few volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), or pesticides/PCBs were detected in any surface water samples. VOCs, SVOCs, and pesticides/PCBs were detected in the stream sediments but their source could not be determined.

Surface water runoff analytical results indicate that runoff from the SMC facility contains inorganics at levels exceeding regulatory levels, and may be contributing to elevated inorganic levels within the waters and sediments of the Hudson Branch. SMC also discharges city water (non-contact cooling water) treated ground water and treated and untreated storm water into the Hudson Branch. Evaluation of the results of the RI surface water sampling and the subsequent 1991 ACO surface water sampling indicates that these discharges are not significantly impacting the water quality of the Hudson Branch.

As discussed in the RI Report, stream and sediment sampling do not indicate that significant downstream migration of contamination is occurring. While contaminants, specifically inorganics, were detected at elevated levels in Hudson Branch water and sediment samples collected adjacent to the SMC facility, concentrations generally decreased as a function of distance downstream of the SMC facility. Therefore, migration of contaminated sediments by the Hudson Branch is not considered a major contaminant transport mechanism.

As described previously in Section 1.5.1, in the vicinity of SMC the Hudson Branch is primarily a gaining stream (obtains base water flow from ground water). Therefore, it is likely that contaminated ground water enters the Hudson Branch, although the exact volume of this discharge is unknown. During major storm events, the Hudson Branch can locally transform into a losing stream and, as a result, the ground water in the vicinity of Hudson Branch may become mounded. The impact of the ground water mounding on a ground water remediation system is expected to be minimal, because the mounding is of limited duration and of sporadic frequency. In addition, ground water mounding could act as a temporary barrier to the migration of contaminated ground water into the Hudson Branch as well as provide a driving force towards the recovery wells. The presence of VOCs and SVOCs in sediments a quarter mile downstream from the SMC facility presents the possibility that sources other than SMC, such as runoff from roads, businesses and farming, are contributing to the Hudson Branch sediment contamination.

Eight stream sampling events conducted by Dan Raviv Associates, Inc. (DRAI) over a period from August 1991 through May 1992 and reported to NJDEPE in accordance with the 1991 ACO further support the conclusion that the Hudson Branch is not acting as a major pathway for contaminant transport, especially with respect to the shallow ground water, within the area for which ground water quality information exists. The surface water sampling included the collection of surface water samples at ten locations: four located on-site or to the southwest, not extending beyond SMC's off-site 7.5 acre property; four located downgradient, within the Hudson Branch; and two located in the Maurice River, one upgradient of the river's confluence with the Hudson Branch and one downgradient of the confluence. In general, hexavalent chromium was non-detectable at all surface water sampling locations (with the exception of two samples collected during the August 1991 sampling round) and total chromium was consistently detected at all sampling locations.

Surface water samples collected on-site by DRAI in the general vicinity of Outfalls 001 and 002 exhibited total chromium levels ranging from 0.0254 to 0.0906 ppm over the eight sampling rounds. The on-site shallow wells located nearest to the Hudson Branch exhibited similar levels of total chromium, ranging from 0.0178 ppm to 0.0846 ppm (both in SC22S) in the December 1990 and April 1991 ground water sampling rounds. A downstream surface water sampling location, located adjacent to shallow well SC6S, exhibited total chromium at levels ranging from 0.0043 ppm (May 1992) to 0.65 ppm (August 1991). As indicated in Figures 3-7 and 3-8, significantly higher total chromium levels (11.7 ppm and 5.19 ppm) were detected in well SC6S in December 1990 and April 1991 sampling rounds, respectively and, as indicated in Figures 3-9 and 3-10, similarly elevated levels of hexavalent chromium were also detected in this well. Based on these observations, the presence of downgradient shallow ground water contamination in the vicinity of the SMC facility at levels significantly higher than adjacent and upgradient Hudson Branch surface water sample locations indicates that the majority of this contamination is due to contaminated ground water migration and not migration of contamination within the stream.

Considering further downgradient surface water sampling locations, at a sampling location in the vicinity of shallow well SC3S, total chromium concentrations ranged from 0.0073 ppm (April 1992) to 0.29 ppm (August 1991), with an average of 0.0709 ppm over the eight sampling rounds. At well SC3S, total chromium was detected at 0.368 ppm, which is consistent with monthly monitoring data. Again, these results indicate the stream is not acting as a significant mechanism for contaminant migration, as evidenced by fact that chromium is present in shallow wells at concentrations which are elevated in comparison to the adjacent surface water sample.

Ground water has not been sampled downgradient of SMC's 7.5 acre parcel. Therefore, no data exist to support a comparative evaluation of surface water and ground water quality downgradient of this point.

<u>Ground Water</u> - Ground water analytical results indicate that volatile organic and inorganic contamination exists beneath the SMC facility, extending in a general plume to the southwest. Trichloroethene (TCE) was the major volatile organic detected at levels exceeding MCLs. In the upper Cohansey Sand, TCE contamination is centered around the location of the Former Manpro-Vibra Degreasing Unit, and extends to the southwest. In the lower Cohansey Sand, TCE is first detected downgradient of the suspected source area for the TCE plume in the upper zone (as referenced above), and extends to the

southwest. An increase in TCE concentrations has been identified in the northeast portion of SMC's 7.5 acre parcel, located to the southwest of the main facility. This increase in TCE levels strongly suggests the likelihood of a separate contaminant source or sources contributing to the elevated TCE levels other than the source at the SMC facility. TCE has also been detected in newly installed well SC26D, located south of the SMC facility.

The major inorganic constituent detected in ground water samples is chromium. In the upper Cohansey Sand, the total chromium plume is centered under the Manufacturing Area, with a lobe extending to the east, towards the By-product Storage Area. Downgradient, total chromium extends to the southwest. The shallow hexavalent chromium plume is centered to the east and southeast of the total chromium plume, in the general areas of the By-product Storage Area and the Lagoons, and also extends to the southwest. Total chromium and hexavalent chromium levels in the lower Cohansey Sand are greatest south of the Lagoon Area, extending to the southwest. Lead was detected in an upgradient shallow well, located along the northern property line between the By-product Storage Area and the Manufacturing Area, as well as in the area near the Underground Storage Tanks and Railroad Siding. It was also detected in shallow monitoring well F at a concentration of 102 μg/l. Antimony was identified south of the Lagoon Area, with a downgradient increase in contaminant levels in the same general area in which elevated downgradient TCE levels were detected. Both lead and antimony levels in the ground water generally decreased to the southwest.

During sampling for the Remedial Investigation, non-detectable levels to 3.41 ppm of total chromium and non-detectable levels of hexavalent chromium were reported for shallow wells located near the former municipal well (see Section 1.2.2). Downgradient deep wells exhibited 0.485 to 0.715 ppm total chromium and non-detectable levels to 500 ppm hexavalent chromium. Given the use of the Layne well for ground water extraction since 1979 and the use of additional extraction wells since 1989, it is likely that the more recently reported non-detectable levels of hexavalent chromium in shallow wells in the area of the former municipal well are indicative of improved ground water quality.

1.7 Human Health and Ecological Evaluation

A Human Health and Environmental Health Evaluation (TRC, 1992c) was conducted to quantitatively assess the potential impacts of the SMC site on human health and the environment. For the Human Health Evaluation, both current and future land use scenarios were considered and developed to represent potential situations in which humans may be exposed to contaminants originating from the site. Current land use scenarios evaluated include a trespassing use scenario (children trespassing on the site), a commercial/ industrial use scenario (adult employess of the facility), and a residential use scenario (residents living outside of the well restrction area who could potentially be exposed to ground water contaminants). Future land use scenarios evaluated include a construction use scenario (one-year construction period with no remedial activities prior to construction) and a residential use scenario (exposure to children from 0 to 6 years of age and to adults through future residential site use). The routes of exposure of most concern included dermal contact with soil, ingestion of ground water, ingestion of soil/dust and incidental ingestion of surface water. The chemicals of primary concern which were detected in the soils included DDT, PCBs, and inorganics (arsenic, trivalent chromium, vanadium and beryllium). The chemicals of primary concern detected in the ground water as well as in the surface water included inorganics (arsenic and beryllium). Target risk levels were exceeded under the future construction use scenario and the future residential use scenario, based on exposures to contaminated soils.

The only scenario which evaluated exposures to contaminated ground water was the current residential use scenario. The well restriction area to the southwest of the site should restrict any potable ground water use in that area. However, residences are also located south of the site, outside of the well restriction area. While city water supply is available in this residential area, it has not been confirmed that no potable use of ground water is occurring. Therefore, the Human Health Evaluation considered potential residential exposures to contaminated ground water in this area. At the time the Human Health Evaluation was conducted (i.e., prior to the installation of additional monitoring wells, as described in Section 1.4), data from monitoring wells SC-22S, SC-22D, SC-13S, SC-13D, W2 and D were selected as being representative of contamination to the south of the SMC site. Under this residential use scenario, risks associated with exposures to contaminants in the upper Cohansey Sand were evaluated separately from those associated with exposures to contaminants in the lower Cohansey Sand, because if there are active potable wells in this area, it is unknown whether they have been screened within the shallow or deep portions of the Cohansey Sand.

The total cancer risks and the hazard index ratios (which represent non-carcinogenic risks) for the residential exposure scenario (both upper and lower Cohansey Sands) exceeded the target risk levels. The major contributing factors to the calculation of cancer risk are ingestion of arsenic and beryllium (in both the shallow and deep ground water) and inhalation of TCE (deep ground water only). Ingestion of inorganics was also the source of the major contributions to the total hazard index ratio for the upper Cohansey

Sands (due to the presence of arsenic, beryllium, vanadium, cyanide and boron) and lower Cohansey Sands (due to the presence of antimony, arsenic, chromium [tri- and hexavalent], and vanadium).

A qualitative assessment of impacts of the SMC Newfield facility on plants and animals was conducted. Ecosystems, habitats, and populations likely to be found at the site were identified. There were no federal threatened or endangered species identified on-site. Contaminants of concern within the soil were identified on the basis of elevated concentration, potential migration, toxicity and the potential for bioaccumulation. Contaminants of concern identified at the site included chromium, copper, vanadium, arsenic, beryllium and zinc. Based on a qualitative assessment, there is some indication that the potential exists for the elevated inorganic levels in the soil to produce adverse environmental effects.

2.0 IDENTIFICATION OF POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA, 1986), and the NCP (1990), require that all remedial response actions attain or exceed applicable or relevant and appropriate requirements of Federal and more stringent promulgated requirements of State environmental statute(s). The NCP defines applicable requirements as "those cleanup standards, standards of control, other substantive environmental protection requirements or criteria, or limitations promulgated under federal environmental or state environmental facility siting law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances found at a CERCLA site." Relevant and appropriate requirements are defined in the NCP as "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at the CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site."

To-Be-Considered materials (TBCs) are non-promulgated advisories or guidance issued by federal or state government that are not legally binding and do not have the status of potential ARARs. However, in many circumstances TBCs may be considered along with ARARs in determining the necessary level of cleanup for protection of health or the environment.

ARARs may be categorized as: 1) chemical-specific requirements, which may define acceptable exposure levels and, therefore, be used in establishing preliminary cleanup goals; 2) location-specific requirements, which may set restrictions on activities within specific locations such as floodplains or wetlands; and 3) performance, design or other action-specific requirements, which may set controls or restrictions for particular treatment and disposal activities related to the management of hazardous wastes. The documents, CERCLA Compliance With Other Laws Manual (USEPA, 1988b), and CERCLA Compliance with Other Laws Manual: Part II. Clean Air Act and Other Environmental Statutes and State Requirements (USEPA, 1989a), contain detailed information on identifying and complying with ARARs.

This section provides an overview of the potentially applicable chemical-specific, location-specific, and action-specific ARARs and To-Be-Considered (TBC) criteria, both on the federal and state levels, which will be used in this report to evaluate remedial alternatives. A comprehensive and conservative approach has been used in developing these lists of ARARs/TBCs, which reflect the types, quantities and extent of contaminants detected at the SMC site, locational considerations, and the types of remedial actions likely to be required to mitigate the public health and environmental threats posed by site contaminants.

In Chapter 5, individual remedial alternatives will be evaluated in detail to determine their compliance with ARARs/TBCs and potential impacts of ARARs/TBCs on their implementation. Upon definition of the specific remedial components included in each alternative, action-specific ARARs/TBCs will be defined in greater detail.

2.1 Potential Chemical-Specific ARARs/TBCs

2.1.1 Potential Federal Chemical-Specific ARARs/TBCs

Potential federal chemical-specific ARARs and TBC criteria are presented in Table 2-1. While ground water at the SMC site is not a current source of drinking water, Maximum Contaminant Levels (MCLs) published under the Safe Drinking Water Act (40 CFR 141.11-.16 and 141.60-.63) may be relevant and appropriate to ground water remediation.

Maximum Contaminant Level Goals (MCLGs), also published under the Safe Drinking Water Act (40 CFR 141.50-141.52) represent non-enforceable health goals for public water supply systems. Under the NCP, non-zero MCLGs are to be used as remedial goals for current or potential sources of drinking water. While ground water is not a current source of drinking water at the SMC Newfield facility, MCLGs may be relevant and appropriate to ground water remediation.

For remedial actions which could impact surface waters, Ambient Water Quality Criteria (AWQC) and Effluent Discharge Limitations represent TBC criteria and potential ARARs, respectively. Each have been promulgated under the Clean Water Act.

The Clean Air Act establishes maximum concentrations for particulates and fugitive dust emissions and could be applicable to remedial alternatives which impact ambient air.

2.1.2 Potential New Jersey Chemical-Specific ARARs/TBCs

Potential New Jersey chemical-specific ARARs and TBC criteria are presented in Table 2-2. Potential chemical-specific ARARs for ground water remediation include the New Jersey MCLs (NJAC 7:10 1.1-7.3) and the NJ Ground Water Quality Standards (GWQS) (NJAC 7:9-6). Ground water in the vicinity of the SMC site is classified as Class II.[1]

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1 Nothing herein constitutes a waiver of SMC's right to petition for a change in classification pursuant to NJAC 7:9-6.10.

The NJ Clean Water Act includes Surface Water Quality Standards (NJAC 7:9-4) which are potential ARARs for the site. The classification of the Hudson Branch, a tributary of Burnt Mill Branch, located in the Maurice River Basin, is Class FW2-NT. Toxic Effluent Limitations have also been established by the NJDEPE (NJAC 7:14A-1 et seq.) and represent potential ARARs for alternatives which would involve discharges to surface water. NJDEPE has developed site-specific draft discharge to surface water permit conditions which are TBCs for alternatives involving discharges to surface water. In addition, New Jersey Proposed Surface Water Quality Standards (7:9B-1) represent chemical-specific To-Be-Considered (TBC) criteria. These non-promulgated criteria include the proposed addition of criteria for 104 toxic substances, in addition to proposed changes for 18 of the 20 existing toxic substances.

The NJ Clean Air Act (NJAC 7:27-13) has promulgated standards similar to the federal Clean Air Act, including Ambient Air Quality Standards and Emissions Standards for Hazardous Air Pollutants, each of which constitute potential ARARs for remedial alternatives which involve discharges to the air.

2.2 Potential Location-Specific ARARs/TBCs

An area's location is a fundamental determinant of its potential impact on human health and the environment. Location-specific ARARs are restrictions placed on the concentrations of hazardous substances or the conduct of activities solely because they are in a specific location (USEPA, 1988b). Some examples of these unique locations include floodplains, wetlands, coastal areas, historic places and sensitive ecosystems or habitats.

The SMC Newfield facility is not located within a coastal zone as designated by the State of New Jersey nor is it situated adjacent to a river or stream designated as "scenic". A formal delineation of wetlands and floodplains and a cultural resources review of the SMC Newfield facility will be conducted for the site. Therefore, associated potential requirements have been considered in this analysis.

The presence of wetlands on or near the site was initially evaluated as part of the Human Health and Environmental Health Evaluation (TRC, 1992c). The National Wetlands Inventory Map for the site area does not identify wetlands on-site, although wetland areas are identified south and southwest of the site, in areas surrounding the Hudson Branch.

As part of the Human Health and Environmental Health Evaluation (TRC, 1992c), the potential presence of rare, threatened or endangered organisms or natural communities on-site was also evaluated through a review of information on file with the New Jersey Natural Heritage Program as well as through on-site observations. The Natural Heritage Program data base contained no records of rare plants, animals or natural communities on-site. Rare and endangered species of plants and animals identified in a search of the vicinity of the site prefer habitats that are not located on or in close proximity to the site or have not been identified visually on-site.

To determine the potential applicability of the Farmland Protection Policy Act, the U.S. Department of Agriculture Important Farmlands Maps for Gloucester and Cumberland Counties were reviewed. These maps were developed on the basis of soil survey information. They indicate that areas designated as Prime Farmland are located immediately adjacent to SMC's 60-acre facility to the north and east, and that the 7.5-acre parcel owned by SMC and located southwest of the main facility consists of Prime Farmland.

2.2.1 Potential Federal Location-Specific ARARs/TBCs

Based on a review of site-specific locational features, as described above, the federally promulgated location-specific ARARs and TBC criteria designed to protect coastal areas, riverways and wildlife are not applicable to the SMC site. However, federal requirements for the protection of wetlands, floodplains, farmlands and historic places may be applicable to the evaluation of remedial alternatives. The potential federal location-specific ARARs for the SMC site are presented in Table 2-3.

Wetland regulations, including Executive Order 11990, Wetlands Construction and Management Procedures, and Section 404 of the Clean Water Act, may apply to any remedial action which impacts wetlands. Likewise, the federal floodplain regulations are potential ARARs for the SMC site, and therefore may affect the implementation of any remedial actions conducted in floodplain areas, if present on-site. The Executive Order 11988, the Flood Disaster Protection Act of 1973 and associated guidelines and policies serve to regulate and restrict the types of activities which may be conducted in a floodplain. The National Historic Preservation Act of 1966 provides protection for properties included in or eligible for the National Register of Historic Places and minimizes harm to national historic landmarks. The Farmland Protection Policy Act requires the evaluation of potential impacts on significant/important farmlands.

2.2.2 State Location-Specific ARARs/TBCs

The NJDEPE has promulgated regulations for the protection of riverways, recreational areas, riparian lands, natural areas, flood-prone areas, and coastal areas. Based on a review of site-specific locational features, as described in the introduction to Section 2.2, the state location-specific

ARARs and TBC criteria designed to protect riverways, recreational areas, and coastal areas are not applicable to the SMC site. The potential state location-specific ARARs for the SMC site are presented in Table 2-4.

Wetland regulations, including the New Jersey Freshwater Wetlands Protection Act (NJSA 13:9B), the New Jersey Freshwater Wetlands Regulations (NJAC 7:7), and the New Jersey Flood Hazard Area Control Act (NJSA 58:16A-50 et seq.) will apply to any remedial action which impacts wetlands or floodplains. The New Jersey Conservation Restriction and Historic Preservation Restriction Act (NJSA 13:8 B-1) is a potential ARAR for alternatives which would impact any historic properties at the SMC site. The Agriculture Retention and Development Act (NJSA 4:1C-11, et seq.) authorizes the establishment of county agricultural development boards and requires these boards to develop and adopt agriculture retention and development programs and farmland preservation programs. This Act would be an ARAR applicable to remedial alternatives which impact important farmlands.

2.3 Potential Action-Specific ARARs/TBCs

Based on the identification of ground water contamination, remediation activities may be required and numerous state and federal requirements could apply to the implementation of these activities. Potential action-specific ARARs/TBCs cannot be well-defined until remedial alternatives are developed and response actions defined. A discussion of potential action-specific ARARs/TBCs pertaining to such general response actions as no action, institutional controls, containment, and ground water collection, treatment and discharge is provided in the following sections.

2.3.1 Potential Federal Action-Specific ARARs/TBCs

Numerous federally promulgated action-specific ARARs and TBC criteria could potentially affect the implementation of remedial measures. The primary federal regulatory requirements potentially applicable to the SMC site appear in Table 2-5.

The primary federal administrative requirements which will guide remediation are those established under CERCLA and SARA. The revised NCP (40 CFR Part 300) incorporates SARA Title III requirements that alternatives satisfy ARARs and utilize technologies that will provide a permanent reduction in the toxicity, volume and mobility of contamination, to the extent practicable.

Additional potential federal requirements include those pertaining to worker health and safety, as established under the Occupational Safety and Health Act (OSHA). ARARs associated with hazardous waste treatment, storage and disposal actions include RCRA requirements governing administrative (permitting, manifesting, etc.) and substantive (design) issues. The federal Clean Air Act (CAA), Clean Water Act (CWA) and Safe Drinking Water Act (SDWA) are also potentially applicable to the evaluation of remedial activities which result in discharges to ambient air, surface water bodies or ground water. Rules concerning the transportation of hazardous materials are promulgated under the Hazardous Materials Transportation Act (49 CFR 170,171) and are potential ARARs for remedial alternatives involving the off-site shipment of hazardous materials or waste. Federal requirements pertinent to land disposal, manifested in the Hazardous and Solid Waste Amendments of 1984 (HSWA) and under RCRA (40 CFR 268), are potential ARARs which may limit the use of land disposal in remediating certain hazardous waste.

2.3.2 Potential State Action-Specific ARARs/TBCs

NJDEPE has promulgated state environmental protection regulations similar to those of the federal government. The potential state action-specific ARARs for the SMC site appear in Table 2-6.

The NJ Hazardous Waste Regulations (NJAC 7:26) establish performance specifications for treatment options (e.g., incineration), design requirements for storage, containment and disposal options and requirements applicable to hazardous waste handling activities.

The NJ Pollutant Discharge Elimination System Regulations (NJAC 7:14A) control the discharge of effluents to land or water. These regulations also specify treatment works approval requirements, which are potentially applicable to ground water treatment systems. New Jersey Surface Water Regulations (NJAC 7:9-5.1) provide effluent standards and treatment requirements for discharges to surface water bodies. The New Jersey Water Supply Management Regulations (NJAC 7:19) address ground water withdrawals and well installations. These regulations are potentially applicable to remedial activities which involve ground water monitoring, extraction, treatment or discharge.

The NJ Air Pollution Control Regulations (NJAC 7:27-12, 16 and 17) regulate a larger array of emissions than the federal CAA, including toxic volatile organic compounds (VOCs). The NJ Air Pollution Control Regulations are potentially applicable to remedial activities which would result in discharges to ambient air.

3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

The overall remedial technology screening and identification process was outlined previously in Figure 1-1. A discussion of the specific activities involved is presented below.

In order to identify and screen potential remedial technologies, an initial identification of remedial action objectives and cleanup criteria is required. Regulatory criteria and risk-based levels are typically considered in evaluating cleanup criteria.

Once remedial action objectives are developed, general response actions are identified which satisfy the objectives. An initial evaluation is made of the areas and volumes of media to which the general response actions will be applied.

The general response actions are then used to develop a list of potential remedial technologies for each environmental matrix to be remediated. An initial screening of the technologies is conducted based on the technical implementability for the various technologies. Specific site characteristics or waste characteristics typically limit the applicability of certain technologies and these characteristics are considered in determining which technologies are not appropriate for further consideration.

For those technologies which pass the initial screening, the associated technology process options are evaluated in greater detail to allow the selection of one process option to represent each technology type. The representative process option provides a basis for developing performance specifications which are used in evaluating that technology type; however, the specific process actually used to implement the remedial action may not be selected until the remedial design phase. To select a representative process, each process option is evaluated on the basis of effectiveness, implementability, and cost, with the greatest focus on effectiveness factors. Innovative technologies are either carried through the screening as a selected process option (if there is a reasonable belief that they offer potential for better treatment performance or implementability, few or lesser adverse impacts than other available approaches, or lower costs than demonstrated technologies) or are "represented" by another process option of the same technology type.

3.1 Remedial Action Objectives and Cleanup Criteria

Remedial response objectives are developed in order to set goals for protecting human health and the environment early in the alternative development process. The goals should be as specific as possible but should not unduly limit the range of alternatives that can be developed. For the SMC FFS, the results of the RI have been used to define specific contaminants of interest and allowable exposures based on the baseline risk assessment and ARARs/TBCs.

As discussed previously, this Focused Feasibility Study addresses the remediation of contaminated ground water associated with the SMC facility. Contaminants detected in other media will be addressed within a separate Feasibility Study.

In developing remedial response objectives, ARARs/TBCs and risk-based cleanup criteria are considered. In accordance with the National Contingency Plan (NCP) [40 CFR 300.43(e)(2)(i)], preliminary remedial action goals are developed based on readily available information, such as chemical-specific ARARs or other reliable information. The NCP also specifies that remediation goals shall also consider, for known or suspected carcinogens, acceptable exposure levels that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} to 10^{-6}. The 10^{-6} risk level shall be used as a point of departure for determining remedial goals for alternatives when ARARs are not available or are not sufficiently protective because of the presence of multiple contaminants or multiple exposure pathways at a site. For systemic toxicants, acceptable exposure levels shall represent concentration levels to which the human population, including sensitive subgroups, may be exposed without adverse effect during a lifetime or part of a lifetime, incorporating an adequate margin of safety.

In developing preliminary remedial action goals for ground water remediation for the FFS, ARARs were evaluated initially to determine which contaminants have applicable ARARs that can be used as preliminary remedial action goals. Because ARARs such as Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs) for public drinking water supplies have been developed with human health considerations in mind, they are considered to be protective of human health. Based on these and other ARARs (e.g., Ground Water Quality Standards (GWQS)), the extent of contamination exceeding ARARs and potentially requiring remediation can be further defined. This evaluation is presented in Section 3.1.1. Also presented in Section 3.1.1 are draft discharge to surface water permit conditions developed by NJDEPE. While not applicable to determining the extent of ground water contamination requiring remediation, these draft limitations are to be considered in the development and evaluation of remedial alternatives which involve discharges to surface water.

For those contaminants for which no ARARs were identified and which resulted in carcinogenic risks of greater than 10^{-6} or noncarcinogenic hazard index ratios of greater than unity (as defined within the Human Health and Environmental Health Evaluation [TRC, 1992c]), risk-based cleanup levels were developed based on a 10^{-6} carcinogenic risk or hazard index value of one. The extent of contamination exceeding these risk-based cleanup levels further defines the extent of contamination requiring remediation. This evaluation is presented in Section 3.1.2.

Factors related to technical limitations such as detection/quantification limits, factors related to uncertainty, cumulative risks, water quality criteria and environmental impacts may also play a role in the determination of final remedial goals for a site.

Based on the identification of preliminary remedial response goals in Sections, 3.1.1 and 3.1.2, remedial response objectives are presented in Section 3.1.3.

3.1.1 Distribution of Contamination and Comparison to ARARs/TBCs

Ground water samples exhibited contaminants at levels exceeding ARARs and/or TBCs in the two ground water sampling rounds which were conducted during the Remedial Investigation. Variations in contaminant distributions from one round to the next may be partially attributable to a variation in the ground water extraction scenario between sampling rounds. Prior to the initial sampling event (December 1990), ground water was being extracted for on-site treatment primarily from recovery wells RIW2 and SC6D. On January 21, 1991, the pumping regime was modified to increase the extraction of ground water from the lower Cohansey Sand, including ground water extraction at wells RW6D and W9. The extraction rate at well RIW2 was decreased and little or no pumping occurred at the RW6S and Layne extraction wells. The modified pumping program could be partially accountable for variations in detected contaminant concentrations at monitoring wells from one sampling round to the next, especially in the area of wells A and SC22D, which could be affected by ground water extraction at well W9.

Figures 3-1 through 3-18 depict the distribution of detected contaminant levels for various contaminants for the December 1990 and April 1991 sampling rounds. The wells which were sampled are identified by either the detected contaminant concentration or an "ND" (for not detected) noted immediately adjacent to the well identifier. It should be kept in mind that apparent changes in the distribution of contaminants from December to April, as interpreted from the isopleths indicated in the figures, are typically due to differences in the number of wells which were sampled from one round to the next. For example, the apparent differences in total chromium concentrations in the deep zone at the far southwest part of the plume (see Figures 3-11 and 3-12 as well as Figures 3-13 and 3-14) do not actually reflect changes in the contaminant distribution but rather reflect changes in the wells which were sampled from one round to the next. In December 1990, well IW2 was sampled and exhibited 26,400 ppb total chromium while well SC4D exhibited 12,600 ppb total chromium. Well SC3D also exhibited total chromium at a concentration of 32.6 ppb. Surrounding wells SC1D, SC5D, SC18D, SC19D and SC21D all exhibited no detectable levels of total chromium. In the April 1991 sampling round, the suite of wells which were sampled changed from those sampled in December 1990, with an emphasis on sampling those wells near the outer fringes of the chromium plume. Again, wells SC1D, SC5D, SC18D, SC19D and SC21D exhibited no detectable levels of total chromium while well SC4D exhibited total chromium at 12,600 ppb. However, wells IW2 and SC3D were not resampled in this round. Therefore, the chromium concentrations could not be shown as extending into the area of these wells based on the lack of data in this area.

Based on the results of the RI, a summary of ground water contaminants and a comparison of their detected levels to ARARs/TBCs are provided below. The identification of remedial response objectives, presented in Section 3.1.3, will be based on this evaluation.

The overall contaminants of interest within the ground water include VOCs (trichloroethene and others) and inorganics. In evaluating ground water contaminant levels, only final (promulgated) State and Federal standards (e.g., Maximum Contaminant Levels and Ground Water Quality Standards) were used as ARARs. Ground water quality is classified as Class II in the vicinity of the SMC site.

Comparisons of maximum detected levels of ground water contaminants for the upper and lower Cohansey Sands to ARARs are provided in Table 3-1 for organics and in Table 3-2 for unfiltered inorganics. Those contaminants detected at a level exceeding ARARs in at least one sampling round are highlighted. In Table 3-3, the filtered inorganic levels which exceed ARARs are summarized as an indication of the concentrations of soluble inorganics in the ground water which may not be treated by normal filtering mechanisms.

Trichloroethene (TCE) was the volatile organic compound most commonly detected at levels exceeding ARARs. In the first round, the New Jersey MCL (NJMCL) and GWQS for TCE (1 ppb) was exceeded in 23 of 27 well samples, while in the second round it was exceeded in 23 of 33 samples. In shallow wells screened in the upper Cohansey Sand, the highest levels of TCE in each sampling round (120 ppb and 840 ppb, respectively) were detected in the general location of the Former Manpro-Vibra Degreasing Unit (SC20S). See Figures 3-1 and 3-2 for the distribution of TCE in shallow wells in each sampling round. Lower levels (5 to 55 ppb) were detected downgradient to the southwest, extending to the northeast portion of SMC's 7.5 acre parcel.

In the lower Cohansey Sand, maximum concentrations of TCE were detected in the first sampling round south of the Lagoon Area (70 ppb at SC22D) and to the southwest, with a "hot spot" detected in the northeast corner of SMC's 7.5 acre parcel (330 ppb at SC5D). See Figures 3-3 and 3-4 for the distribution of TCE in the deep wells in each sampling round. During the second sampling round, maximum TCE concentrations shifted west, from south of the Lagoon Area (35 ppb) to the southwest portion of the Undeveloped Plant Property (120 ppb). The "hot spot" previously identified in the northeast portion of the 7.5 acre parcel was confirmed by the second round of sampling (430 ppb).

This increase in TCE levels strongly suggests the likelihood of a separate contaminant source or sources contributing to the elevated TCE levels other than the source at the SMC facility, as based on the following:

- Ground water contamination would be expected to migrate in accordance with the regional ground water flow direction;

- While clay stringers were identified in the vicinity of wells SC12D, SC13D and SC22D, no continuous confining zone has been identified and no similar clay stringers of geologic significance were identified in other portions of the site;

- The chromium contamination migration pathway generally mirrors the TCE contamination migration pathway, with the exception of the TCE "hot spot" area near well SC5D;

- If the "hot spot" was due to a slug of contamination which had migrated from the SMC facility, residual contamination in wells upgradient of the "hot spot" would be expected due to the effect of aquifer heterogeneity upon the velocity distribution of the slug;

- As a result of on-going ground water extraction, the observed concentrations of TCE in well SC5D continue to increase, further suggesting an off-site source area of significantly higher concentrations, whereas concentrations in wells SC4D and SC2D remain relatively constant.

- The ground water in the general area around the SMC facility is known to be contaminated with VOCs, with at least three (3) additional identified potentially responsible parties (PRPs). The lack of deep wells at PRP sites represents a data gap which could definitively identify the presence of an off-site source; and

- Inspection of data presented in a suit against SMC (see PARS, August 1991) indicates that contamination at other properties includes PCE (which was not detected at SMC) as well as TCE. TCE is a known breakdown product of PCE, further suggesting an off-site source.

Additional evaluation of the nature and extent of contamination in the southwestern part of the site will be possible following further investigation in this area.

Newly installed deep well SC26D (see Figure 1-5 for well location) was sampled in August 1992, with the results presented in the August Monthly Groundwater Monitoring Report (SMC, 1992). Due to a previous lack of deep wells south of the SMC facility, the extent of TCE contamination in this direction was difficult to define prior to the installation of this well. In August 1992, well SC26D contained 12 ppb TCE, indicating that the extent of the plume in the deep aquifer may extend further to the south than as indicated in Figures 3-3 and 3-4.

Other volatile organics were detected at levels exceeding MCLs and GWQS at a much lower frequency (1 to 4 times per sampling round), including tetrachloroethene, 1,1-dichloroethene, 1,2-dichloroethene (total), benzene, toluene, and xylene. The well locations where these organics were detected at levels exceeding ARARs are noted in Figure 3-5 for the upper Cohansey Sand and in Figure 3-6 for the lower Cohansey Sand. In both rounds, benzene, toluene and xylene were detected in well SC23S, which is located adjacent to an underground storage tank location. Methylene chloride and acetone, common laboratory contaminants, were typically detected in ground water samples but were also detected in laboratory blanks, trip blanks and/or field blanks, indicating their presence may be associated with laboratory contamination.

No semivolatile organics or pesticides/PCBs were detected in monitoring wells at levels exceeding MCLs or GWQS.

Inorganic analytes were detected in ground water samples at concentrations exceeding ARARs. Filtered and unfiltered ground water samples were collected for inorganics analysis during the first sampling round. Major anion and cation analysis was also conducted on 15 first round samples to be used in conjunction with Eh and pH data to determine the valence state of chromium in the ground water. Only unfiltered samples were collected during the second round of sampling.

In general, total chromium, lead and antimony were the inorganics most commonly detected at levels exceeding MCLs and GWQS. Other inorganics also detected at levels exceeding MCLs include arsenic, beryllium, cadmium, cyanide, mercury, nickel, nitrate, and selenium. Other contaminants which were detected at levels exceeding GWQS include aluminum, iron, manganese, sodium, chloride, fluoride, and sulfate. The major anion and cation analysis indicated that chromium exists primarily in a trivalent state in the ground water.

Summaries of the maximum detected inorganic concentrations in filtered and unfiltered samples are presented in Tables 3-2 and 3-3. Based on a comparison of the results presented in these tables, in some cases maximum detected concentrations of certain inorganics (e.g., barium, beryllium, potassium, sodium, selenium, boron, arsenic, total chromium, antimony and vanadium) in filtered samples appear to exceed the corresponding values in unfiltered samples. Of the apparent discrepancies noted, the only filtered analytical results which were more than 10% greater than the unfiltered analytical results were those for barium and beryllium in the upper Cohansey and those for arsenic in the lower Cohansey. For most of these results, the maximum filtered and maximum unfiltered analytical results listed in Tables 3-2 and 3-3 were detected in samples collected from the same well. In the case of selenium in the upper Cohansey Sand, the maximum filtered level was detected in well SC13S. Since the unfiltered sample for this well was not analyzed for selenium, a direct comparison of maximum filtered and unfiltered analytical results for selenium as presented in Tables 3-2 and 3-3 cannot be made. Although some variability was found, an overall comparison of filtered and unfiltered ground water sample analyses indicates that soluble inorganics are present in the ground water, with inorganic concentrations in filtered samples typically at similar concentrations to those detected in unfiltered samples. The extent of chromium and other inorganics in the ground water based on unfiltered ground water samples is discussed in detail below.

The major inorganic constituent detected in ground water samples is chromium. In the upper Cohansey Sand, the total chromium plume is centered under the Manufacturing Area, with a lobe extending to the east, towards the By-product Storage Area (see Figures 3-7 and 3-8). Downgradient, total chromium extends to the southwest. The shallow hexavalent chromium plume is centered to the east and southeast of the total chromium plume, in the general areas of the By-product Storage Area and the Lagoons, and also extends to the southwest (see Figures 3-9 and 3-10). In the lower Cohansey Sand, total chromium and hexavalent chromium levels are greatest south of the Lagoon Area, extending to the southwest, as indicated in Figures 3-11 through 3-14. Ground water monitoring of the toe of the chromium plume conducted since the preparation of the RI Report has indicated no significant change in the downgradient extent of either the shallow or deep total chromium or hexavalent chromium contamination with the exception of the identification of chromium at a concentration of 0.98 ppm (1.13 ppm in a duplicate sample) within newly installed well SC26D, located south of the SMC facility (SMC, 1992). Additional investigation is required to further define the extent of contamination in this area.

With respect to other inorganic analytes, those locations where lead and antimony were detected at levels exceeding MCLs and GWQS are indicated in

Figure 3-15 for shallow wells (screened in the upper Cohansey Sand) and in Figure 3-16 for deep wells (screened in the lower Cohansey Sand). Other inorganic analytes detected at levels exceeding MCLs and GWQS are indicated in Figures 3-17 and 3-18 for the upper and lower Cohansey Sands, respectively.

Lead was detected at levels exceeding the USEPA action level of 15 ppb in unfiltered samples from eight shallow wells and six deep wells. The greatest concentrations of lead (greater than 100 ppb) were detected in an upgradient shallow well (W3S) at 137 ppb, in a shallow well in the Lagoon Area (F) at 102 ppb, and in a deep well in the Manufacturing Area (G1S) at 262 ppb. The New Jersey GWQS of 10 ppb for lead was also exceeded in one of two sampling rounds in wells SC1S, SC5D, SC6S and SC-19S.

Antimony was detected at levels exceeding the MCL of 6 ppb (which is more stringent than the GWQS of 20 ppb) in unfiltered samples from 17 shallow wells and 9 deep wells. The greatest concentrations of antimony (greater than 100 ppb) were detected in the following shallow wells: well L in the Manufacturing Area at 396 ppb, well K in the Undeveloped Plant Area at 152 ppb, wells SC6S and IW2 southwest of the facility at 235 ppb and 573 ppb, respectively. The greatest concentrations of antimony detected in the lower Cohansey Sand were detected in the following wells: well SC22D in the Lagoon Area at 2,140 ppb, and, with increasing distance to the southwest of the facility, in well A at 1,130 ppb, well SC6D at 465 ppb and well SC4D at 272 ppb.

Other inorganic analytes exceeded MCLs or GWQS in the upper Cohansey Sand in four general areas: in the Underground Storage Tank Area (beryllium, mercury, and nickel), in the By-product Storage Area (arsenic, beryllium, cadmium, and cyanide), near the Lagoons and T12 Chromium Wastewater Spill Area (nickel) and southwest of the facility (arsenic). The upgradient background well, W3S, exhibited nitrate at 24,300 ppb, which exceeds the federal MCL of

10,000 ppb. In the lower Cohansey Sands, other inorganic analytes were detected at levels exceeding MCLs or GWQS near the Lagoons and T12 Chromium Wastewater Spill Area (arsenic, beryllium, and selenium) and southwest of the facility (arsenic, cadmium, mercury, selenium and cyanide). As in the upper Cohansey Sand, the background well, W3D, exhibited nitrate at 12,800 ppb, which exceeds the federal MCL.

Other inorganic analytes detected at levels exceeding New Jersey GWQS in the shallow and deep portions of the Cohansey Sand include aluminum, iron, manganese, sodium, chloride, fluoride and sulfate. The background shallow well, W3S, exhibited iron, aluminum and manganese at levels exceeding GWQS while the deep background well, W3D, contained manganese at a level exceeding the GWQS.

Another factor to keep in mind in evaluating the extent of contamination is the screened interval of the wells which were sampled during each round and the interpretation of these wells as shallow or deep wells. In general, wells which were screened at a depth of less than 50 feet below grade were considered to be shallow wells, while wells screened at depths of greater than 50 feet were considered to be deep wells. Wells existing prior to the RI were screened over widely varying intervals. Therefore, for each well for which there was chemical data developed during the RI, Table 1-2 indicates whether the well is considered a shallow or deep well in the analysis of the extent of contamination within the upper and lower Cohansey Sands. To further define the vertical distribution of contamination, the existing wells can be characterized as being screened at depths which are very shallow (less than 30 feet), intermediately shallow (30 to 50 feet), intermediately deep (50 to 90 feet) or very deep (greater than 90 feet). Wells installed during the RI consisted of very shallow (screened at less than 30 feet below grade) or very deep (screened at depths of greater than 100 feet) wells.

The extent of TCE and chromium contamination during the two sampling rounds was evaluated to determine if a better understanding of contaminant distribution could be achieved by considering the intermediately shallow and intermediately deep wells separately from the very shallow and very deep wells. This was conducted by reviewing existing Figures 3-1, 3-2, 3-7, and 3-8 to determine where the very shallow wells were located with respect to the intermediately shallow wells and the respective contaminant distributions within these wells. Similarly, Figures 3-3, 3-4, 3-11 and 3-12 were reviewed with respect to the locations of intermediately deep and very deep wells and the associated contaminant distributions within these wells. Limited conclusions can be drawn, due in part to the areal distributions of the various types of wells. The very shallow wells are generally located around the perimeter of the TCE and chromium plumes while the intermediately shallow wells are generally located within the plume area. There are very few intermediately deep wells, with two (SC2D and SC3D) screened in both the intermediately deep and very deep zones at the time they were sampled (both have since been replaced and are only screened at depths of greater than 90 feet). Therefore, the following additional discussion of the vertical distribution of contamination can only be presented in general terms.

During the two sampling rounds of the RI, TCE contamination was detected in only two very shallow wells (SC20S at 120 ppb/840 ppb and SC11S at 3 ppb), both located on-site. In the intermediately shallow wells and in the few intermediately deep wells, TCE contamination was detected in the southwest portion of the plant area (at 110 ppb in well K) and extends off-site to the southwest, providing the basis for the elongated plume and decreasing contaminant levels with increasing distance off-site shown in Figures 3-1 and

3-2. Contaminant levels in the very deep wells were generally comparable to the intermediately shallow wells, with TCE detected at levels of 23 to 120 ppb in wells A and SC22D in the southwest portion of the plant area, extending off-site to the southwest. As previously noted, subsequent to conducting the RI, TCE was also detected in well SC26D, a very deep well located to the south of the facility, in an area not previously investigated.

Chromium was detected in very shallow wells located in the plant area, with the highest concentration (4.230 ppb) detected in well SC12S, near the By-product Storage Area. In the north central part of the Manufacturing Area, total chromium was present in very shallow wells in the 100 to 300 ppb range. Chromium was not detected in off-site very shallow wells or was detected at low concentrations (less than 20 ppb). In intermediately shallow wells, chromium was detected at a very high level (20,800 ppb) in well L in the Manufacturing Area. Significant levels (up to 11,700 ppb) were also detected off-site in the vicinity of SC6S. Concentrations decreased with increasing distance to the southwest in the intermediately shallow wells but elevated chromium levels were detected to the southwest in intermediately deep well IW2 (26,400 ppb). On-site, chromium was detected at elevated levels (ranging from 29,500 ppb to 108,000 ppb) in very deep wells SC22D and A). Off-site, chromium was present in very deep wells RW6D, SC10D and SC4D at levels ranging from 2,590 ppb to 21,000 ppb).

Based on this analysis of the vertical distribution of the two most commonly detected contaminants at the site, it can generally be stated that no major anomalies can be identified with respect to contaminant distribution which prohibit an approach in which the aquifer is evaluated with respect to the upper and lower Cohansey Sands. The general lack of intermediately deep wells and the locations of very shallow and intermediately shallow wells with respect to the distribution of the contaminant plumes does not support a more detailed analysis. The presence of chromium at an elevated level in intermediately deep well IW2 warrants additional investigation in this area to further define the extent of this contamination. Similarly, additional investigation will be conducted in the vicinity of very deep well SC26D.

Draft discharge to surface water permit conditions developed by NJDEPE are presented in Table 3-4. While not applicable to the evaluation of the extent of ground water contamination requiring remediation, these draft limitations are to be considered in the development and evaluation of remedial alternatives.

Drinking water standards (MCLs) applicable to radiologic contaminants are also applicable to ground water at the SMC facility. Radiologic analysis of ground water samples has been conducted under the 1988 ACO. Based on the results of quarterly ground water monitoring sampling (already provided to the NJDEPE), MCLs for radiologic parameters have not been exceeded. Since a portion of the SMC facility is subject to regulation under the Nuclear Regulatory Commission, any required remediation of radiologic contamination at the facility resulting from licensed operations comes under the jurisdiction of the Nuclear Regulatory Commission and will be addressed as a part of facility licensing or decommissioning. With respect to this FFS, the ground water requires no remediation based on radiologic contaminant-specific ARARs.

3.1.2 Risk-Based Considerations

As described in the NCP and as previously discussed in Section 3.1, "The 10^{-6} risk level shall be used as the point of departure for determining remediation goals for alternatives when ARARs are not available...". The 10^{-6}

starting point indicates USEPA's preference for setting cleanup levels at the more protective end of the acceptable 10^{-4} to 10^{-6} risk range for Superfund remedial actions. Site-specific and remedy-specific factors are then taken into consideration in the determination of where within the 10^{-4} to 10^{-6} risk range the cleanup standard for a given contaminant will be established. For the purposes of this evaluation, the risk-based cleanup levels which correspond to a 10^{-6} risk are calculated for those contaminants identified in the Human Health and Environmental Health Evaluation (TRC, 1992c) as contributing significantly to cancer and non-cancer risk estimates under Scenario 3 (residential exposure to contaminated ground water).

Those ground water contaminants which contribute an individual cancer risk of greater than 1×10^{-6} to the overall cancer risk estimate were evaluated to determine if there are any for which an ARAR has not been identified. Arsenic, beryllium and TCE drove the carcinogenic risk estimates associated with exposures to ground water (see Tables A.3-5S through A.3-7S, and A.3-5D through A.3-7D of Appendix A, Human Health and Environmental Health Evaluation TRC, 1992c). Since each of these contaminants has an associated MCL or GWQS (see Tables 3-1 and 3-2), no risk-based cleanup levels were calculated for these carcinogenic compounds.

Similarly, those noncarcinogens which contribute an individual chronic hazard index value of greater than unity to the overall non-cancer risk were evaluated to determine if there are any for which an ARAR has not been identified. Antimony, arsenic, beryllium, boron, trivalent and hexavalent chromium, cyanide, manganese and vanadium drove the noncarcinogenic hazard index ratios, with individual values which exceeded unity (see Tables A.3-8S through A.3-10S and A.3-8 through A.3-10, Appendix A, Human Health and Environmental Health Evaluation, TRC, 1992c). In conducting this evaluation, it was determined that the risk associated with the presence of manganese was incorrectly calculated on the basis of a detected level of magnesium, rather than manganese. When the hazard index value was re-calculated based on detected manganese concentrations, the hazard index value was less than unity. Of the remaining analytes with hazard index values exceeding unity, only boron and vanadium do not have an associated ARAR (see Table 3-2). Therefore, for these analytes, a risk-based cleanup level has been calculated based on a chronic hazard index value of one and exposure assumptions identical to those used for Scenario 3, residential exposure to contaminated ground water, in the Human Health and Environmental Health Evaluation (TRC, 1992c). These risk-based cleanup levels are presented in Table 3-5.

In shallow wells, vanadium was detected at levels exceeding the risk-based cleanup level (260 ppb) at well locations SC13S (greater than 100,000 ppb in both sampling rounds), and SC15S (detected in first round only at 306 ppb). Boron was detected at levels exceeding the risk-based cleanup level (3,000 ppb) at well locations SC12S, SC13S, G1S and IWC2, with a maximum detected concentration of 17,600 ppb in well SC12S. In deep wells, vanadium was detected at levels exceeding the risk-based cleanup level in both sampling rounds at well SC22D (2,000 ppb and 1,300 ppb). Boron was not detected at levels exceeding risk-based cleanup levels in any deep monitoring wells.

3.1.3 Remedial Response Objectives

Based on the information presented in Sections 3.1.1 and 3.1.2 and the requirements of the 1988 ACO, the remedial action objectives for ground water are as follows:

- Prevent exposure, due to ground water ingestion, to ground water contaminants attributable to the SMC facility which have been detected at levels exceeding acceptable ARARs/TBCs, as indicated in Tables 3-1 and 3-2, or acceptable risk-based cleanup levels;

- Minimize migration of ground water contaminants; and
- Remediate the ground water contamination attributable to the SMC facility to achieve ARARs/TBCs.

3.2 General Response Actions

General response actions are those remedial actions which will satisfy the remedial objectives. General response actions for the SMC site were formulated based on the results of the Remedial Investigation.

The first step in determining appropriate general response actions for a given media is an initial determination of the areas or volumes to which the general response actions may be applied. The extent of ground water contamination at the SMC facility and off-site of the facility, as defined by the Remedial Investigation, is indicated in Figures 3-1 through 3-18. As discussed previously in Section 3.1.1, the "hot spot of TCE contamination identified in the northeast portion of SMC's 7.5 acre parcel strongly suggests the likelihood of a separate contaminant source or sources contributing to the elevated TCE levels in this portion of the site. In determining the extent of ground water requiring remediation, only contamination which is attributable to SMC, not from other potential sources, is considered.

The installation of well SC26D to the south of the facility (see Figure 1-5 for the well location) subsequent to the RI has identified that the extent of TCE and chromium contamination extends in this direction. Addition plume delineation is required to confirm or refute the extent of this contamination and to confirm that SMC is the source of this contamination (especially the organic component).

Therefore, the areal extent of ground water requiring remediation in accordance with the remedial response objectives generally includes the area beneath the SMC facility, extending to the southwest towards SMC's off-site

7.5 acre parcel, with the extent of contamination to the south which requires remediation not well-defined at this point in time. Remedial alternatives will be developed to address ground water contamination within this general area, with the intent of providing at a minimum hydraulic control over deep ground water between SMC and well SC26D, to the south of the site and with the overall goal of meeting the remedial response objectives (including ARARs) in this area. The installation of an additional deep well to further define the southerly extent of contamination can be conducted during the remedial design phase of the selected remedial action.

A listing of general response actions developed for remediation of the ground water is provided below.

- No Action
- Institutional Control
- Containment
- Extraction/Treatment/Discharge

3.3 Identification and Screening of Technologies and Process Options

The general response actions are developed further through the identification and screening of remedial technologies which could potentially meet the remedial action objectives and cleanup criteria. Inorganic treatment technologies were evaluated on the basis of their ability to provide stand-alone treatment or to supplement the existing ion exchange system. Following a screening of the remedial technologies on the basis of technical implementability, the process options associated with each technology are screened based on effectiveness, implementability and cost. Representative process options are chosen for inclusion in the comprehensive remedial alternatives developed for the site.

3.3.1 Technology Screening

The technology screening was performed to evaluate technologies for the remediation of ground water. Table 3-6 presents the screening results for this media of concern. The table includes brief descriptions of the individual technologies or process options, and comments on their applicability to the site. The technologies or technology process options which do not pass the screening process on the basis of technical implementability are shaded in the table and will not be retained for further consideration. More detailed descriptions of the technologies and process options are presented below, along with a summary of their screening status.

Legal Restrictions

Legal restrictions represent a means to restrict ground water use through legal means, such as deed restrictions or well permit restrictions. Basically, all properties within a contaminated area are restricted with respect to ground water usage based on restrictions placed within the deed to the property or through the denial of well installation permits. Well drillers are required in the State of New Jersey to secure a permit before installing any ground water wells. This process allows the NJDEPE to review the permit application and either deny or conditionally approve permit applications in those areas that have been designated as well-restriction areas. Well-restriction areas are established by the NJDEPE on the basis of ground water quality information as well as other geologic data. A portion of Vineland, as illustrated in Figure 1-10, has been designated by the city as a well restriction area, in accordance with NJS 40:43-52. Mandatory connection to public water systems is required within this area. Extension of this area could be protective of any additional potential downgradient receptors; therefore, this process option is retained for further consideration.

Alternate Water Supply

Alternate water supply represents another type of institutional control in restricting ground water usage. Basically, ground water that is contaminated is no longer utilized as a potable water source, and an alternate source is tapped. Since no impacts to active private potable wells have been identified, this option is screened from further consideration.

Capping

Capping is a process used to cover contaminated materials to prevent direct contact with the contaminated materials, infiltration of precipitation and/or leaching of contamination into the ground water.

There are a variety of designs and capping materials available. The designs of modern caps may conform to the performance standards of 40 CFR 264.310, which addresses RCRA landfill closure requirements. Most cap designs are multi-layered in accordance with the above-mentioned design standards; however, single-layered designs are also used for special purposes. The selection of capping materials and a cap design is influenced by specific factors such as local availability, costs of cover materials, desired function of cover materials, the nature of the contaminated materials, local climate, hydrogeology, and projected future use of the site in question.

Capping is applicable whenever contaminated materials are to be buried or left in place at a site to prevent infiltration of precipitation or leaching of contaminants to the ground water. In general, capping is performed when extensive subsurface contamination at a site precludes excavation and removal of wastes because of potential hazards and/or unrealistic costs.

Capping is often performed together with ground water extraction or other containment technologies to prevent, or significantly reduce additional ground water contamination and further plume development, thus reducing the time needed to complete ground water cleanup operations.

The main disadvantages of capping are the need for long-term maintenance and uncertain design life. Another disadvantage to capping is the high cost (in certain areas of the country) of the soil and drainage materials needed to construct the cap.

Currently existing land use limits the technical implementability of this technology. It is screened from further consideration as a ground water remediation technology.

Vertical Barriers

Vertical barriers are low permeability cut-off walls or diversions installed below ground to contain, capture, or redirect ground water flow in the vicinity of a site. The most commonly used vertical barriers are slurry walls, particularly soil-bentonite slurry walls. Less common are cement-bentonite or concrete slurry walls, grouted barriers, and sheet piling cut-offs. Vertical barriers are most effective when they can "key" into natural subsurface impermeable layers. Shallow slurry walls keyed into impermeable clays offer a cost-effective means of reducing the ground water flow in unconsolidated earth materials.

The lack of a natural shallow subsurface impermeable barrier at the SMC site limits the technical implementability of this technology and provides the basis for its screening.

Horizontal Barriers

Horizontal barriers are installed below grade in order to prevent downward migration of contaminants. Vertical or directional drilling is commonly used to inject the grout beneath the zone of contamination. This technology is typically employed only to limited cases with the appropriate environmental characteristics.

The depth of ground water contamination limits the technical implementability of creating a horizontal barrier at the SMC site; therefore, it is screened from further consideration.

Extraction Wells

Extraction wells represent a conventional technology which is frequently used in the removal of contaminated ground water. Stainless steel or PVC well casings and screens are installed within the contaminant plume, and submersible pumps are most commonly used to extract water from the well. An array of wells with overlapping radii of influence can be designed to capture an entire plume or to halt further contaminant migration. Accurate data from a site-specific pump test usually provides the hydrogeologic parameters necessary for the design of well system configurations.

Extraction wells are a proven means of capturing ground water contamination at the SMC facility. They are retained for further consideration.

Treatment at a POTW

This technology involves the discharge of wastewater from a site to a Publicly Owned Treatment Works (POTW) for off-site treatment. Aqueous wastes can constitute the majority of waste treated during a remedial cleanup effort. These aqueous wastes can include ground water, leachate, surface runoff, and other aqueous wastes. A number of criteria must be met when utilizing a POTW. These restrictions, as they apply to CERCLA sites, are detailed in the USEPA's CERCLA Site Discharges to POTWs: Guidance Manual (USEPA, 1990a).

Due to the absence of an adjacent sanitary sewer and the potential inability of POTW treatment operations to treat the contaminants of concern, this technology is screened from further consideration.

Treatment at a RCRA Facility

Discharge to a RCRA facility represents an off-site treatment technology for remediating contaminated ground water. The extracted ground water is collected and transported off-site to a licensed RCRA facility for treatment. High extraction rates, as are anticipated for any remedial action at the SMC facility, greatly limit the cost-effectiveness of this alternative. Therefore, it is screened from further analysis.

Biological Treatment

Biological water treatment methods have been well-proven in their application at municipal wastewater treatment facilities. Recently, their application to the treatment of hazardous wastes has been evaluated. Biological treatment removes organic matter from the wastestream through biological degradation.

The most prevalent form of biological treatment is aerobic (i.e., in the presence of oxygen). Aerobic biological treatment can be effective for the treatment of aromatic hydrocarbons, polynuclear aromatic hydrocarbons, and phenols. The wastestream's biological oxygen demand (BOD) can provide an indication of the treatability of the waste by aerobic treatment.

Specialized biological treatment systems are being developed for specific contaminants not treatable under normal aerobic conditions. Such systems utilize contaminant-specific bacteria or special environmental conditions to enhance the biodegradation of the target contaminants.

Due to the presence of chlorinated hydrocarbons and inorganics, constituents not treated by standard biological treatment processes, this technology is screened from further consideration.

Powdered Activated Carbon Treatment/Wet Air Oxidation

Powdered activated carbon treatment (PACT™) is a treatment process where powdered activated carbon is added to a traditional aerated biological treatment process. Treatment is achieved both through the biological degradation of contaminants and the adsorption of non-degradable contaminants onto the carbon. It is often combined with wet air oxidation (WAO), where the WAO destroys the adsorbed pollutants and biomass while regenerating the carbon for reuse in the treatment system. WAO is a chemical treatment process which utilizes high temperatures (347-608° F) and pressures (300-3000 psig) to oxidize dissolved or suspended contaminants in aqueous waste streams. Generally, WAO is applicable for treating certain organic-containing media that are too toxic for biological remediation and too dilute to incinerate economically (Surprenant, 1988). Pressure, temperature, and time are controlled to achieve desired reductions in contaminant levels.

PACT can be applicable to the treatment of chlorinated compounds; therefore it will be retained for further consideration.

Air Stripping

Air stripping, a physical treatment method, consists of the mass transfer of a volatile chemical from a liquid phase to air by bringing a flow of air in contact with the liquid. Air strippers come in a variety of configurations, but the basic principle behind their operation is the same for each type.

The most common configuration in ground water treatment is the countercurrent packed tower, in which contaminated water is trickled downward over rings, spheres, or other types of packing material in a stainless steel, fiberglass, or PVC cylinder. Clean air is blown upward through the tower, volatilizing contaminants and exhausting them out the top. Air stripping is effective with contaminants exhibiting high Henry's law constants, which relate equilibrium concentrations of a chemical compound in liquid and gas phases. Removal efficiencies can vary widely depending on types of contaminant, influent concentrations, stripper design, temperature, and a number of other factors. However, a properly designed and operated air stripper can be expected to achieve greater than 95% removal efficiency for contaminants (Canter, et al., 1986).

Emission controls on the stripping column are often required to collect exhausted contaminants. Although this reduces the simplicity of the system, small carbon adsorption units can be connected to the gaseous outflow to capture contaminants. Environmental effects of exhausted contaminants are probably minimal, since most volatile organic compounds have atmospheric half-lives (time to degrade 50% of the contaminant) on the order of minutes or hours (Cuppitt, 1980).

Based on air stripping's effectiveness in treating chlorinated hydrocarbons, and the availability of an air stripper on-site, it is retained for further consideration.

Steam Stripping

Steam stripping differs from air stripping by the injection of steam, as opposed to air, into a tray or packed distillation column in order to remove volatile organic chemicals from waste streams. This type of process option is most effectively applied to aqueous solutions for the removal of volatile organic compounds that are immiscible in water. Steam stripping is more economical and effective than air stripping for treating wastes with high concentrations of volatiles and wastes with contaminants which have a low volatility (Surprenant, 1988). The wastestream enters near the top of the column and then flows by gravity countercurrent to the steam. As the wastestream passes down through the column, volatile compounds within the wastestream are lost to the steam/organic vapor stream rising from the bottom of the column. The concentration of volatile compounds in the wastestream reaches a minimum at the bottom of the column. The overhead vapor is condensed as it exits the column and the condensate is then decanted to achieve water/solvent separation.

Stream stripping would be effective in treating organic ground water contaminants and is therefore retained for further consideration.

Carbon Adsorption

One of the most frequently applied technologies for the removal of low concentrations of organics from wastestreams is carbon adsorption. The process consists of bringing contaminated ground water in contact with a bed of granular activated carbon (GAC), where contaminants are held by physical and/or chemical forces on the activated surface of the carbon itself. The system is usually configured as one or several columns in series which are filled with activated carbon. Carbon adsorption is effective with a wide variety of organic contaminants, but the performance of the process can be influenced by pH, the adsorptive capacity of the carbon, and temperature. Removal efficiencies of greater than 99% can be expected (Canter, et al., 1986).

Spent activated carbon (carbon which has reached its adsorption capacity) must be regenerated through the application of heat. This usually entails removal of carbon from the unit for regeneration at an off-site incinerator. Operation of units in series prevents shutoff of the entire system during regeneration.

Carbon adsorption is effective in treating the organic contaminants of concern and therefore is retained for further consideration.

Resin Adsorption

Resin adsorption represents another physical treatment option for the removal of organic contaminants from aqueous wastestreams. The operation of resin adsorption is similar to that of carbon adsorption. Specifically, organic molecules contacting the resin surface are held on the surface by physical forces and are subsequently removed during the resin regeneration cycle. Even though the process operation of resin adsorption is similar to carbon adsorption, many aspects of the two technologies differ. For example, the bonding forces in resin adsorption are usually weaker than those encountered in granulated activated carbon adsorption and therefore, resins may be regenerated chemically rather than thermally, as carbon adsorption systems must be regenerated. Resins generally have a lower adsorption capacity than carbon. Resin adsorption is most practical for treatment of colored organic wastes, when material recovery is practical, where selective adsorption is desired, where low leakage rates are required, where carbon regeneration is not practical and where the wastestream contains high levels of dissolved inorganic solids (Berkowitz, et al., 1978).

Since resin adsorption can be effective for organic removal and is commonly combined with ion exchange, a potential inorganic contaminant treatment technology, it will be retained for further consideration.

Ultraviolet (UV) Oxidation

UV oxidation is a chemical process which utilizes an oxidant in combination with ultraviolet radiation to treat specific wastestreams containing phenols, cyanides, chlorinated hydrocarbons, organic sulfur compounds, and other rapidly oxidized organics. This process option transforms the contaminants into a less hazardous form. When reactions are carried to completion, halogenated compounds are converted to carbon dioxide, water, and residual halides. Treatment data indicate that destruction of organic contaminants to non-detectable levels is achieved within minutes (Hager, et al., 1987). UV oxidation is not effective in treating single-bonded organics, such as 1,1,1-trichloroethane.

UV oxidation has been proven in the treatment of chlorinated hydrocarbons; therefore it will be retained for further consideration.

Dehalogenation

Dehalogenation is a chemical treatment process whereby a chemical agent is mixed with the waste stream to remove halogen atoms from chlorinated hydrocarbons. Dehalogenation is primarily used to treat PCB transformer oils. Dehalogenation does not treat non-chlorinated hydrocarbons.

Because dehalogenation is typically applied to the treatment of PCB transformer oils, it will not be retained for additional consideration as a ground water treatment technology.

Reverse Osmosis

Osmosis is the spontaneous flow of solvent from a dilute solution through a semipermeable membrane (impurities or solute permeate at a much slower rate) to a more concentrated solution. Reverse osmosis is the application of sufficient pressure to the concentrated solution to overcome the osmotic pressure and force the net flow of water through the membrane toward the dilute phase. This allows the concentration of solute (impurities) to be built up in a circulating system on one side of the membrane while relatively pure water is transported through the membrane. Ions and small molecules in true solution can be separated from water by this technique.

In the treatment of hazardous wastestreams, the use of reverse osmosis is primarily limited to polishing low flow streams containing highly toxic contaminants. In general, good removal can be expected for high molecular weight organics and charged anions and cations. Multivalent ions are treated more effectively than are univalent ions. However, reverse osmosis units are subject to chemical attack, fouling, and plugging. Pretreatment requirements can be expensive. Wastewater must be pretreated to remove oxidizing materials such as iron and manganese salts, to filter out particulates, adjust pH, and to remove oil, grease, and other film forms.

The most critical design consideration applicable to reverse osmosis technology is the design of the semipermeable membrane. Membranes are usually fabricated in flat sheets or tubular forms and are assembled into modules. The most common materials used are cellulose acetate and other polymers such as polyamides and polyether-polysulphone.

Based on its applicability as a polishing technology and potential clogging which may be associated with the presence of metals and low level organics, reverse osmosis will be screened from further consideration as a primary inorganic treatment technology.

Ion Exchange

Ion exchange is a process whereby the toxic ions are removed from the aqueous phase by being exchanged with relatively harmless ions held by the ion exchange material. Ion exchange is a well-established technology for removal of heavy metals and hazardous anions from dilute solutions. Ion exchange can be expected to perform well for applications involving wastes of variable composition, provided the system's effluent is monitored to determine when exhaustion of the resin bed has occurred. The reliability of ion exchange can be affected by the presence of suspended solids.

Ion exchange systems are commercially available from a number of vendors. The units are relatively compact and are not energy intensive. Exchange columns can be operated manually or automatically; manual operation may be better suited for hazardous waste site applications because of the diversity of wastes encountered. Use of several exchange columns at a site can provide added operational flexibility.

Ion exchange will be retained for further consideration based on its general applicability to the treatment of inorganics and based on the fact that the existing on-site treatment system utilizes an ion exchange system.

Precipitation

Precipitation is a physiochemical process whereby some or all of a substance in solution is transformed into a solid phase. It is based on alteration of the chemical equilibrium relationships affecting the solubility of inorganic species. Removal of metals as hydroxides or sulfides is the most common precipitation application in wastewater treatment. Generally, lime or sodium sulfide is added to the wastewater in a rapid mixing tank along with flocculating agents. The wastewater flows to a flocculating chamber in which adequate mixing and retention time is provided for agglomeration of precipitate particles. Agglomerated particles are separated from the liquid phase by settling in a sedimentation chamber, and/or by other physical processes such as filtration.

Precipitation is a process commonly applied to the treatment of inorganics. It will be retained for further consideration.

Coagulation and Flocculation

While chemical precipitation involves the alteration of the ionic equilibrium of a metallic compound to produce an insoluble precipitate, chemical coagulation and filtration are terms often used interchangeably to describe a process where chemical addition enhances sedimentation processes. The solution is destabilized through the neutralization of repulsive forces between particles, allowing the particles to approach each other and agglomerate. The coagulation and flocculation process typically involves rapid mixing of the solution and added coagulant, followed by slow and gentle mixing which allows the particles to agglomerate. Solids are then collected within a clarifier and removed for dewatering prior to off-site disposal.

Based on the applicability of this technology to inorganic treatment, it will be retained for further consideration.

Membrane Microfiltration

Membrane microfiltration involves the use of an automatic pressure filter in which the filter material has tiny openings (0.10 microns or 1 ten-millionth of a meter) which allow for the filtration of particles normally not separated from the wastestream using standard filtration processes. Membrane microfiltration is most applicable to hazardous waste suspensions, ground water contaminated with heavy metals, landfill leachate and process wastewaters containing uranium (USEPA, 1991).

Utilizing a physical separation process, this technology is successful in removing inorganic particles which may not be removed by normal filtering processes. Therefore, it will be retained for further consideration.

Electrochemical

Electrochemical treatment provides treatment of inorganic contaminants at a wide range of flow rates. Contaminated water passes through an electrochemical cell where ferrous ions, hydroxide ions and hydrogen are produced. The ferrous ions act as reducing agents for oxidized heavy metals and also react with the hydroxide ions, forming iron hydroxides and metal hydroxides. The metal hydroxides are removed by adsorption onto the iron hydroxide precipitate that is formed. Based on previous applications, the resultant sludge potentially can be disposed of as a non-hazardous waste, dependent on the results of waste characterization tests. The technology was originally developed in the 1970's for treatment of wastewater contaminated with hexavalent chrome and other heavy metals. The process is effective at a neutral pH, which is an advantage in most ground water treatment applications.

Since electrochemical treatment has been proven effective in the treatment of inorganics, it will be retained for further consideration.

In Situ Biodegradation

In situ biodegradation is a technique for treating zones of contamination by microbial degradation processes. The basic concept involves altering environmental conditions to enhance microbial catabolism or cometabolism of organic contaminants, resulting in the breakdown and detoxification of those contaminants. This technology has developed rapidly over recent years.

Microbial metabolic activity can be classified into three main categories: aerobic respiration, in which oxygen is required as a terminal electron acceptor; anaerobic respiration, in which sulfate or nitrate serves as a terminal electron acceptor; and fermentation, in which the microorganism rids itself of excess electrons by exuding reduced organic compounds.

The bioreclamation method that has been most developed and is most feasible for in-situ treatment is one which relies on aerobic (oxygen-requiring) microbial processes. This method involves optimizing environmental conditions by providing an oxygen source and nutrients which are delivered to the subsurface through an injection well or infiltration system to enhance microbial activity.

The feasibility of bioreclamation as an in-situ treatment technique is dictated by waste and site characteristics. More specifically, those factors which determine the applicability of a bioreclamation approach are: biodegradability of the organic contaminants, environmental factors which affect microbial activity, and site hydrogeology. In-situ biodegradation is most suitable for simple hydrocarbons (C_1 to C_{15}), alcohols, phenols, amines, acids, esters, and amides; for well-defined point sources; for permeable aquifers (greater than 10^{-3} cm/sec) with greater than 10-foot aquifer thickness, uniform geology and a depth to the aquifer of greater than 10 feet; and for ground water of near-neutral pH and low inorganic levels.

The presence of chlorinated hydrocarbons, which are difficult to degrade under aerobic conditions, and the presence of aromatic hydrocarbons, which require aerobic conditions to degrade, limit the technical implementability of this technology. The presence of inorganic contaminants and the depth of ground water contamination further limit the implementation of an in situ treatment process. Therefore, this technology is screened from further consideration.

Ground Water Discharge Technologies

Potential ground water discharge technologies include discharge to ground water, discharge to surface water, a combined discharge to surface and ground water, and discharge to a sanitary sewer. Due to the absence of an adjacent sanitary sewer, discharge to a sanitary sewer is eliminated from further consideration. The remaining discharge options are retained for further consideration.

3.3.2 Process Option Screening

Upon identification of those technologies which are technically implementable based upon the characteristics of the site and environmental setting, the process options are further evaluated to allow the selection of a representative process option for each technology type. The process options are evaluated on the basis of effectiveness, implementability, and cost. Process option evaluations for ground water remediation are presented in Table 3-7. The selected representative process options are indicated with an asterisk and are summarized in Table 3-8. For some technologies, more than one process option was retained for further detailed evaluation during remedial alternative development.

No action was retained for further analysis, per the requirements of the NCP. Both continued ground water monitoring and legal restrictions applicable to ground water use were selected as representative institutional control process options. Both ground water extraction options, use of the existing extraction wells and use of a revised extraction well system, were also selected as representative process options. For treatment of organic ground water contaminants, PACT, air stripping, carbon adsorption and UV oxidation were retained for consideration within potential remedial alternatives. Air stripping and carbon adsorption are effective in treating the identified organic contaminants and are implementable and cost-effective. UV oxidation and PACT are more innovative treatment technologies, also expected to provide treatment of these contaminants. Resin adsorption is not as easily implemented as these technologies, and steam stripping offers no significant advantage over other technologies considered but is more expensive to implement. For the treatment of inorganics, ion exchange, coagulation and flocculation, membrane microfiltration and electrochemical treatment were all selected as representative process options. Precipitation was not retained because it was not expected to be as effective in the treatment of inorganics as the other tecnologies being considered. Discharge process options, including discharge to ground water, to surface water, or a combined discharge to both ground and surface water, were all selected as representative process options to be considered in alternative development.

4.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

The technologies and process options developed in Section 3 are typically combined to form a range of remedial alternatives which address site cleanup to varying degrees and meet the criteria set forth in the NCP for the types of remedial alternatives which must be considered. The criteria defined in the NCP include the following:

- For alternatives which provide control of the source of contamination, the range of alternatives should include the following:
  - A range of alternatives in which treatment that reduces the toxicity, mobility, or volume of the hazardous substances is a principal element. This range should include an alternative that removes or destroys hazardous substances to the maximum extent feasible, eliminating or minimizing the need for long-term management.
  - One or more alternatives that involve little or no treatment, but provide protection of human health and the environment primarily by preventing or controlling exposure to hazardous substances through engineering controls and/or institutional controls.
- For ground water response actions, a limited number of remedial alternatives should be developed that attain site-specific remediation levels within different restoration time periods utilizing one or more different technologies.
- The development of one or more innovative treatment technologies for further consideration.
- The no action alternative.

Because this FFS addresses only ground water contamination, source control remedial alternatives will not be addressed herein. Remedial alternative development will focus on the development of alternatives which attain ground water remediation levels using various treatment technologies within different restoration time periods.

For the alternatives which are developed, general descriptions of the alternatives and associated technologies are provided. The alternatives then undergo an initial screening process. These activities are described further in Section 4.2.

4.1 Development of Alternatives

Remedial response objectives, as presented in Section 3.1, are used as a guide in the development of remedial alternatives. It is at this point in the Feasibility Study that medium-specific actions are typically combined to form sitewide remedial alternatives, thereby allowing consideration of interactions between media in the evaluation of site remediation as a whole. Because contaminant source areas will be addressed within a separate FS, this FFS addresses the first phase, referred to as an operable unit (OU-1), of the remedial process for the SMC site. Only remediation of ground water will be addressed in this operable unit. Therefore, remedial alternatives are limited to those listed in Table 4-1, consisting of no action, continuation of existing actions (continued operation of existing treatment facility and continuation of existing ground water monitoring program and ground water use restrictions) and modified restoration program (modified ground water extraction/treatment/discharge system). Individual remedial process options for the ground water extraction, treatment and discharge components of the modified restoration program will be retained as appropriate throughout the FS to allow flexibility in the final remedial alternative selection process.

4.2 Definition and Screening of Alternatives

For each of the alternatives and technology options presented in Table 4-1, a description of the alternative/technology option and an initial evaluation of the alternative/technology option based on effectiveness, implementability and cost criteria are presented.

The remedial alternative descriptions presented in the following sections refer to a five-year review. Under the NCP, if a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often every five years after initiation of the selected remedial action. It is unlikely that residual ground water contamination levels will be so low after five years of ground water extraction, treatment and discharge so as to allow for unlimited use and unrestricted exposure to ground water. Therefore, each of the alternatives includes a five-year review of the remedial action decision. Similarly, since it is very difficult to estimate the remedial period required to achieve remedial goals, especially since contamination in other media at the site will be addressed in a separate operable unit at a later date, the remedial time frame for the purposes of developing cost estimates has been set at five years.

As mentioned previously in Section 3.2, additional investigation will be required to further define the extent of ground water contamination in the vicinity of well SC26D, south of the SMC facility, and in the vicinity of Well IW2, southwest of the facility.

The effectiveness screening evaluates the effectiveness of each alternative or technology in protecting human health and the environment through reduction of the toxicity, mobility or volume of the contaminated ground water. Both long- and short-term effectiveness are considered. Because draft surface water discharge criteria have been proposed, the effectiveness of treatment and discharge options in meeting these criteria will be considered. Evaluation on the basis of implementability takes into consideration the technical and administrative feasibility of constructing, operating and maintaining a remedial action. The final evaluation criterion, cost, involves the estimation of both capital and operation and maintenance (O&M) costs associated with each alternative. Because of the level of refinement of alternative development, cost estimates may not be as accurate as those developed during the detailed analysis of alternatives. However, estimates are comparative in terms of relative accuracy to allow cost decisions to be made at this point.

Following this individual screening and analysis, a comparative analysis of the alternatives is typically performed based on the three screening criteria, and the alternatives to be retained for detailed analysis are selected. The objective of alternative screening is to narrow the list of potential alternatives/technology options that will be evaluated in detail. This screening aids in streamlining the FS process, while ensuring that the most promising alternatives and technologies are seriously considered. The range of treatment alternatives initially developed is retained, where practicable, through the screening process, with comparisons typically focussing on similar alternatives, the most promising of which is carried forward for further analysis. Since only three alternatives have been developed for the SMC site, the individual screening will expand to include analysis and screening of the individual ground water extraction, treatment, and discharge technology options being considered.

4.2.1 Alternative 1 - No Action

4.2.1.1 Description

The no action alternative would involve no remedial response activities. No removal or treatment of contaminated ground water would be conducted. Consideration of the no action alternative is required under the NCP. Because no treatment of ground water contamination would be provided, a five-year review of the no action decision would be required. A round of ground water sampling would be conducted at the time of the five-year review to provide an update of existing ground water conditions.

4.2.1.2 Evaluation

Effectiveness

The no action alternative would provide no reduction in toxicity, mobility or volume of contamination. It would also provide no protection of human health or the environment, other than that provided by the existing well restriction area.

Implementability

The no action alternative would require no implementation activities other than the completion of a round of ground water sampling prior to conducting a five-year review of the no action decision.

Cost

The only costs associated with implementation of the no action alternative are the ground water monitoring costs. An initial estimate of the cost of Alternative 1 is a present worth value of $40,000.

4.2.2 Alternative 2 - Continuation of Existing Actions

4.2.2.1 Description

This alternative consists of the continued operation of the existing ground water extraction, treatment (ion-exhange) and discharge system, continued ground water monitoring, and a continuation of the existing ground water use restrictions.

Operation of the existing ground water extraction, treatment and discharge system would provide a continuation of existing operations. While the existing system is halting the majority of the downgradient migration of contaminated ground water, it does not meet the design extraction rate recommended as a result of previous hydrogeological studies, and therefore may not provide capture of the entire contaminated ground water plume or as timely of a response as a system operating at an increased extraction rate.

The existing ground water monitoring system would continue to provide a means of monitoring the extent of ground water contamination and any changes in ground water quality over time.

The existing well restriction area limits potential exposures to ground water contamination. The operation of extraction wells within the aquifer exclusion area provides further protection against potential exposures. If determined to be necessary to protect additional downgradient receptors, an expansion of the current well restriction area could be included in this alternative.

4.2.2.2 Evaluation

Effectiveness - Alternative 2 would provide a reduction in toxicity, mobility or volume of contamination in the ground water, although it may not provide capture of the entire plume or a timely response to ground water remediation. Risks associated with potential future exposures to contaminated ground water would be limited by the existing well restriction area, although some potential receptors may be located to the south, outside of the confines of the current restriction area. Short-term and long-term effectiveness would be comparable, since the remedial and monitoring systems included in the alternative are already in-place. The existing treatment system would not be expected to achieve the stringent proposed chemical-specific discharge to surface water permit conditions.

Implementability - Alternative 2 would be very easy to implement since it involves existing remedial actions already in-place. The institution of an additional aquifer exclusion area could be implemented if ground water use is identified in areas south of the site not currently covered by the well restriction area.

Cost - The main cost factors associated with Alternative 2 would be the continued operation of the existing extraction, treatment and discharge system, and continued ground water monitoring costs. An initial estimate of the cost for Alternative 2 is a present worth value of $7,000,000. This estimate is based on an assumed five-year operational period for the ground water extraction and treatment system prior to conducting the 5-year review.

4.2.3 Alternative 3 - Modified Ground Water Restoration (Modified Extraction/Treatment/Discharge Program)

4.2.3.1 Description

Alternative 3 consists of a modified ground water restoration program consisting of an amended combination of extraction, treatment and discharge technologies. The objective for the development of a modified extraction/treatment/discharge alternative would be to optimize the existing treatment system, thereby allowing the remedial system to operate at an optimum rate to provide capture of contaminated ground water at and/or emanating from the SMC site, while achieving remediation goals and meeting discharge requirements. Based on detailed design studies previously conducted (DRAI 1988 and DRAI 1991), modeling indicated that a pumping rate of 200 gpm would be sufficient to address ground water contamination, but that a total pumping rate of 400 gpm would ensure timely remediation of the ground water. While additional information on the extent of ground water contamination has been developed subsequent to those studies, for preliminary screening purposes, a ground water extraction rate of 400 gpm will be assumed. This extraction rate will be further evaluated in the detailed analysis of alternatives, providing this alternative is retained for further consideration. The main focus of the initial screening of this alternative will be a re-evaluation of the extraction system (including well locations, screened depths and individual well extraction rates to ensure optimum capture of contaminated ground water), the treatment system (to determine the best means of reliably treating the increased influent rate), and the discharge system (to determine the most appropriate means for discharging the effluent).

The analysis provided in this section is intended to provide the basis for a general comparison between Alternatives 1, 2 and 3. Detailed analyses of the effectiveness, implementability and costs of the individual technology options which would comprise Alternative 3 are presented in Sections 4.2.4 through 4.2.16.

4.2.3.2 Evaluation

Effectiveness - Alternative 3 would provide a reduction in the toxicity, mobility and volume of contaminated ground water through extraction, treatment and subsequent discharge of treated water. It would be expected to attain site-specific remediation levels within a shorter time frame than the existing system, through the extraction of 400 gpm as opposed to the existing extraction rate of approximately 200 gpm. It also includes the re-evaluation of the ground water extraction system to ensure the capture of contaminated ground water. Depending on the individual technologies which would comprise Alternative 3, the alternative could also achieve a greater reduction in the toxicity of the ground water through the achievement of lower effluent standards. The degree of toxicity reduction and the potential ability of the alternative to meet proposed discharge to surface water permit conditions would be dependent upon the individual treatment technology selected.

Implementability - Alternative 3 is implementable, although its implementability is highly dependent upon the individual technologies included in the alternative. In general, implementation requires the proper administrative authority to extract ground water via existing or proposed extraction wells, availability of the selected treatment technology and administrative authority to discharge the treated ground water, as appropriate.

Cost - As with implementability, cost would be highly dependent upon the individual technologies included in the alternative. In general, Alternative 3 would be more expensive than Alternatives 1 or 2 due to the modification or addition of active restoration activities involved in its implementation. As discussed in Section 4.2, a five-year treatment period is assumed for the development of comparable cost estimates.

4.2.4 Alternate 3 - Ground Water Extraction Option E1 - Existing Extraction Well System

4.2.4.1 Description

This alternative technology option would be incorporated into Alternative 3 as a means of ground water extraction. Option E1 consists of extraction of contaminated ground water via pumping of the existing ground water extraction wells (Layne, W9, RW6S, RW6D and RIW2) at a combined rate of 400 gpm. This option would be combined with a ground water treatment option and discharge option to form a complete restoration remedial alternative.

4.2.4.2 Evaluation

Effectiveness - Pumping of the five existing extraction wells would be effective in capturing the majority of the contaminated ground water from the shallow and deep Cohansey Sands, although it is very unlikely to address contamination south of the SMC facility (per newly installed deep well SC26D). Additional ground water modeling (which is conducted under the detailed alternative analysis presented in Section 5) is required to determine if the existing extraction wells are located to provide optimum capture of the ground water contamination.

Implementability - Option E1 would be easily implemented since it requires no well construction and no construction of additional piping to the treatment system.

Cost - Costs associated with implementing Option E1 are relatively minor, consisting only of the operation and maintenance of the existing extraction well system. The cost of Option E1 is initially estimated at a present worth value of $150,000.

4.2.5 Alternative 3 - Ground Water Extraction Option E2 - Modified Extraction System

4.2.5.1 Description

This alternative technology option would be incorporated into Alternative 3 as a modified means of ground water extraction. For preliminary evaluation purposes, it is assumed that installation of one shallow and one deep well will be required to optimize the extraction system under Option E2. If retained for detailed analysis, additional evaluation of the components (number of wells, well locations, extraction rates, etc.) required to optimize a ground water extraction system will be conducted as part of the detailed analyses. As with Option E1, extraction at 400 gpm is assumed for the preliminary analysis. This option would be combined with a ground water treatment option and discharge option to form a complete remedial alternative.

4.2.5.2 Evaluation

Effectiveness - The modified ground water extraction system would be effective in capturing contaminated ground water from the shallow and deep Cohansey Sands. Its effectiveness in capturing contaminated ground water over an extended period of time is expected to be better than the existing extraction system. Additional ground water modeling (which is conducted under the detailed analysis presented in Section 5) is required to determine if the extraction system can be optimized through modification of the existing system.

Implementability - Option E2 would be easily implemented but would require installation of additional extraction wells and associated piping to the treatment system.

Cost - Costs associated with the implementation of Option E2 include the installation of ground water extraction wells and the piping of the extracted ground water to the treatment system, as well as operation and maintenance costs associated with operation of the extraction system. The cost of Option E2 is initially estimated at a present worth value of $200,000, assuming a five-year extraction period.

4.2.6 Alternative 3 - Ground Water Treatment Option T1 - Powdered Activated Carbon Treatment (PACT)

4.2.6.1 Description

This ground water treatment technology option, Option T1, consists of on-site treatment of organic ground water contaminants using a Powdered Activated Carbon Treatment (PACT) process. The PACT system incorporates the use of powdered activated carbon in a conventional activated sludge system. The physical adsorption provided by the activated carbon, combined with the biological oxidation provided by the activated sludge, is effective in treating dilute wastewaters which are variable in concentration and composition.

4.2.6.2 Evaluation

Effectiveness - PACT would be effective in treating biodegradable organics through conventional aerobic biodegradation. Organics which are not as easily biodegraded would be treated by carbon adsorption. This technology would be expected to achieve surface water discharge to permit conditions for organic contaminants.

Implementability - The technical implementability of this alternative would be expected to be good, although available vendors are limited.

Cost - The major cost components of this treatment option include the installation and operation and maintenance costs associated with the ground water treatment system. The cost of Option T1 is initially estimated at a present worth value of $5,000,000, assuming a five-year treatment period.

4.2.7 Alternative 3 - Ground Water Treatment Option T2 - Air Stripping

4.2.7.1 Description

This ground water treatment technology option, Option T2, consists of on-site treatment of organic ground water contaminants using an air stripping system. Air strippers transfer volatile organic ground water contaminants from the extracted ground water to the vapor phase by trickling the ground water through a plastic media while air is blown countercurrent to the water flow direction. Another technology which provides similar treatment is diffuse bubble aeration, where air is bubbled through a ground water storage tank to provide removal of volatile organics.

4.2.7.2 Evaluation

Effectiveness - Air stripping is expected to be highly effective in the removal of chlorinated hydrocarbons and aromatic hydrocarbons from the extracted ground water. Rather than being destroyed, the contaminants are transferred from the water phase to the vapor phase. Depending on off-gas concentrations, air stripping may be combined with vapor-phase carbon treatment to meet air discharge regulations. The technology would be expected to achieve proposed discharge to surface water permit conditions for organics.

Implementability - Air stripping is a well-proven, widely available ground water treatment technology, with numerous vendors and high reliability. Air stripping is also administratively feasible, with compliance with air discharge requirements the major administrative concern. An air stripper is currently available on-site and was used to provide organic treatment as part of the existing wastewater treatment system. Therefore, air stripping could easily be implemented at the SMC site.

Cost - The major costs of implementation of the existing air stripping system are the operational costs. Assuming the existing air stripper can be utilized for organic treatment, the cost of Option T2 is initially estimated at a present worth value of $90,000 for a five-year treatment period.

4.2.8 Alternative 3 - Ground Water Treatment Option T3 - Carbon Adsorption

4.2.8.1 Description

This ground water treatment technology, Option T3, consists of on-site treatment of organic ground water contaminants using a carbon adsorption treatment system. In carbon adsorption, organic contaminants are adsorbed to the carbon particles within a carbon filtration system.

4.2.8.2 Evaluation

Effectiveness - Carbon adsorption, like air stripping, is an effective and well-proven means of removing organics from ground water. Through carbon regeneration, contaminants are thermally destroyed. This technology would be expected to achieve proposed discharge to surface water permit conditions for organics.

Implementability - Carbon adsorption treatment systems are widely available, with numerous vendors and a high degree of reliability. Carbon adsorption is also administratively feasible. Periodic replacement of spent carbon is the main operation and maintenance activity required.

Cost - The major costs of implementation of a carbon adsorption unit are the installation and operation costs (including carbon regeneration). The cost of Option T3 is initially estimated at a present worth value of $800,000 for a five-year treatment period.

4.2.9 Alternative 3 - Ground Water Treatment Option T4 - UV Oxidation

4.2.9.1 Description

This ground water treatment technology option, Option T4, consists of on-site treatment of organic ground water contaminants using an ultraviolet (UV) oxidation system. UV oxidation destroys chlorinated hydrocarbons through oxidation using a combination of ultraviolet light, hydrogen peroxide, ozone, and/or catalysts, depending on the individual vendor. The technology provides complete destruction of most chlorinated contaminants with no emissions or waste by-products.

4.2.9.2 Evaluation

Effectiveness - UV oxidation is effective in the treatment of most chlorinated hydrocarbons while its effectiveness is reduced for aliphatic, single-bonded chlorinated hydrocarbons, like 1,1,1-trichloroethane. Such constituents are not major contaminants at the SMC site. UV oxidation also provides treatment of aromatic hydrocarbons. Therefore, this technology would be expected to achieve proposed discharge to surface water permit conditions for organics.

Implementability - The implementability of UV oxidation is relatively good, with several vendors offering various treatment processes. Maintenance of the UV lamps and chemical supplies are the major operational activities. Administrative feasibility is expected to be good.

Cost - The major costs of implementation of a UV oxidation treatment system are the installation and operation costs. The cost of Option T4 is initially estimated at a present worth value of $3,000,000 for a five-year treatment period.

4.2.10 Alternative 3 - Ground Water Treatment Option T5 - Ion Exchange

4.2.10.1 Description

This ground water treatment technology, Option T5, consists of on-site treatment of inorganic ground water contaminants using an ion exchange treatment system. The existing ion exchange system at the SMC facility is not effective in treating the 400 gpm design flow rate. This option consists of expanding/improving the current system to allow treatment of the greater flow rate.

When it became apparent that the existing ion exchange system could not treat the extracted ground water at the design extraction rate of 400 gpm, the system was evaluated to determine the cause of the performance limitations. The system was designed to deionize a wastestream high in total dissolved solids (TDS). The influent specification for the design indicated that water containing particle sizes up to 75 microns could be treated by the system, with a specific mention of the system's capability of removing colloidal materials. However, it was determined that the colloidal materials in the wastestream were causing interference in the performance of the system. The treatment system manufacturer was unable to rectify the operational problems.

As a condition of the 1991 ACO, SMC was required to evaluate the feasibility of utilizing equalization or surge tanks in combination with the existing ion exchange system to increase pumping efficiency. In a Treatment Optimization Study prepared by Stone & Webster Environmental Services (Stone & Webster, 1991), this option was evaluated. The presence of equalization tanks would allow the extraction system to continue pumping during ion exchange regeneration periods. However, the existing system's capacity is limited due to the high incoming solids loading. Therefore, in order to take advantage of the capacity of flow equalization tanks, the system would have to be operated at higher than the design capacity (operating in the fixed bed mode). The use of equalization tanks or surge tanks would not allow the existing system to operate at the design extraction rate while maintaining discharge limitations. Based on this additional evaluation of the existing ion exchange system, it was determined that the only means of continued use of the treatment system would be through the implementation of a pretreatment process which would remove the colloidal particles and enhance the performance of the existing ion exchange system.

4.2.10.2 Evaluation

Effectiveness - As determined by additional studies of the existing treatment system (as described above), the expansion of the existing ion exchange system would not be effective in removing the colloidal particles, which are currently causing interference in the system's performance, without the addition of a pretreatment process. The ability of the system to meet the proposed discharge to surface water permit conditions for inorganics is also highly questionable, based on historic performance.

Implementability - The technical implementability of expanding the existing ion exchange system is good, based on the availability of the technology. However, the administrative implementability would be hampered by the potential inability of an expanded ion exchange system to meet treatment objectives.

Cost - Based on the lack of effectiveness of this alternative and the lack of administrative implementability, no costs were developed for this alternative.

4.2.11 Alternative 3 - Ground Water Treatment Option T6 - Coagulation and Flocculation

4.2.11.1 Description

This ground water treatment technology, Option T6, consists of on-site treatment of inorganic ground water contamination using a coagulation and flocculation pretreatment process prior to ion exchange. Chemicals are added to the ground water under this option to enhance sedimentation. Under coagulation, the reduction of electrostatic particle surface charges causes particle agglomeration. Flocculation is a time-dependent physical process in which fine particles aggregate into solids large enough to be separated by gravitational settling.

4.2.11.2 Evaluation

Effectiveness - Coagulation and flocculation is a conventional treatment technology for inorganic contaminants. Its effectiveness in reducing toxicity and meeting cleanup goals would be expected to be good, when combined with ion exchange. However, effectiveness is ultimately dependent upon the flocculating and settling characteristics of the particles to be removed. Treatability studies would be required to confirm its effectiveness.

Implementability - Option T6 would be fairly easy to implement, requiring the installation of a chemical coagulation and flocculation system. Most systems are relatively simple and readily available.

Cost - The major costs of implementation of a coagulation and flocculation pretreatment system are the installation and operational costs combined with the operational costs of the existing ion exchange system. The cost of Option T6 is initially estimated at a present worth value of $11,000,000, based on a five-year treatment period.

4.2.12 Alternative 3 - Ground Water Treatment Option T7 - Membrane Microfiltration

4.2.12.1 Description

This ground water treatment technology, Option T7, consists of on-site treatment of inorganic ground water contaminants using a membrane microfiltration pretreatment process prior to ion exchange. In membrane microfiltration, inorganic suspended contaminants can be removed from the wastestream by using a pressure filter which captures contaminants by not allowing them to pass through the very small openings of the filter.

4.2.12.2 Evaluation

Effectiveness - Membrane microfiltration can be very effective in removing particles which range in size down to a few microns. Microfiltration will not removed dissolved solids, however. Combined with ion exchange, it is expected that effective inorganic treatment would be provided. The ability of the combined treatment system to meet proposed discharge to surface water permit conditions is difficult to assess without treatability data.

Implementability - Microfiltration could be fairly easily implemented.

Cost - The major costs of implementation of Option T7 are the installation and operation and maintenance costs of the system, combined with the operational costs of the existing ion exchange system. The cost of Option T7 is initially estimated at a present worth value of $9,000,000, based on a five-year treatment period.

4.2.13 Alternative 3 - Ground Water Treatment Option T8 - Electrochemical Inorganic Removal

4.2.13.1 Description

This ground water treatment technology, Option T8, consists of on-site treatment of inorganic ground water contaminants using an electrochemical treatment system. Electrochemical treatment could potentially provide sufficient treatment alone, without supplemental ion exchange treatment, to meet discharge requirements. Electrochemical inorganic treatment consists of a system in which the water to be treated passes through an electrochemical cell where ferrous ions, hydroxide ions and hydrogen are produced. The ferrous ions act as reducing agents for oxidized heavy metals and also react with the hydroxide ions, forming iron hydroxides and metal hydroxides. The metal hydroxides are removed by adsorption onto the iron hydroxide precipitate that is formed.

4.2.13.2 Evaluation

Effectiveness - Electrochemical treatment has been widely proven in industrial wastewater treatment with recent applications in contaminated ground water treatment. It has been shown to be effective in the treatment of cadmium, copper, chromium, arsenic, lead and zinc (Hazardous Waste Consultant, 1991). It could potentially be effective as a stand-alone treatment process although its ability to meet proposed discharge to surface water permit conditions is difficult to assess without evaluation of treatability data.

Implementability - The implementability of this alternative is limited by the limited availability of vendors which provide the treatment system.

Cost - The major costs of implementation of Option T8 are the installation and operation and maintenance costs of the system. The cost of Option T8 is initially estimated at a present worth value of $3,900,000, based on an estimated five-year treatment period and assuming no supplemental treatment using the ion exchange system is required. If electrochemical pretreatment is provided to ground water prior to treatment by ion exchange, the cost of Option T8 is estimated at a present worth value of $6,500,000. The major difference in cost is associated with off-site brine disposal under the option which includes ion exchange.

4.2.14 Alternative 3 - Ground Water Discharge Option D1 - Discharge to Ground Water

4.2.14.1 Description

This ground water discharge technology option, Option D1, consists of discharge to the ground water, using infiltration galleries, reinjection wells or a combination of the two. Discharge monitoring and ground water monitoring have also been included in this option.

4.2.14.2 Evaluation

Effectiveness - Discharge to ground water could potentially speed the flushing of contaminants through the segment of the aquifer located between the injection point and the extraction point.

Implementability - Implementation of a reinjection system would require the appropriate authority for siting and installation of the injection system and compliance with the requirements of a discharge to ground water permit. Technically, potential operational problems, such as clogging, could be expected, leading to periodic shutdowns and maintenance of the reinjection system. Testing of an injection well was reportedly conducted in 1984 with limited success due to the high ground water table and the presence of iron bacteria.

Cost - The major costs of implementation of a reinjection system are the installation and maintenance costs. Discharge monitoring and ground water monitoring costs also contribute to the total estimated cost. The cost of Option D1 is estimated at a present worth value of $1,300,000 for a five-year injection period.

4.2.15 Alternative 3 - Ground Water Discharge Option D2 - Discharge to Surface Water

4.2.15.1 Description

This alternative technology option would be incorporated into Alternative 3 as a means of discharge for the treated ground water. Option D2 consists of discharge to surface water (the Hudson Branch tributary of the Maurice River), using direct discharge via a dedicated pipe, existing Outfall 001. Discharge monitoring and ground water monitoring are included in this option.

4.2.15.2 Evaluation

Effectiveness - Discharge to surface water would be an effective method of handling the treated ground water and is the method of discharge used for the existing ground water treatment system.

Implementability - Implementation of discharge to surface water would involve the use of existing Outfall 001. It would also require compliance with the requirements of a discharge to surface water permit. NJDEPE has proposed discharge to surface water permit conditions, as presented in Table 3-4. Technically, discharge to surface water would be more reliable and easier to implement than discharge to ground water, with few operational problems anticipated.

Cost - The costs of implementation of a discharge to surface water system are relatively minor, requiring only the tie-in of the modified treatment system to the existing discharge pipe. Discharge monitoring and ground water monitoring costs also contribute to the total estimated cost. The cost of Option D2 is initially estimated at a present worth value of $1,000,000.

4.2.16 Alternative 3 - Ground Water Discharge Option D3 - Combined Discharge to Surface Water and Ground Water

4.2.16.1 Description

This alternative technology option would be incorporated into Alternative 3 as a means of discharge for treated ground water. It consists of a combined discharge system, whereby a portion of the treated ground water would be discharged to surface water and a portion would be discharged to ground water. A discussion of the effectiveness, implementability and cost of each of these treated ground water discharge options was previously presented in Sections 4.2.14 and 4.2.15. This section evaluates the relative merits of a discharge system which combines these discharge options. Discharge monitoring and ground water monitoring have also been included in this option.

4.2.16.2 Evaluation

Effectiveness - Combined discharge to surface water and ground water would be an effective method of handling the treated ground water. The reinjection of ground water into the aquifer could aid in flushing contaminants towards the extraction wells.

Implementability - Implementation of discharge to surface water would involve the use of the existing outfall (Outfall 001) while discharge to ground water would require the construction of a recharge system. Implementation of this option would also require compliance with discharge to surface water and discharge to ground water permit requirements. Technically, discharge to surface water would be more reliable than discharge to ground water, with few operational problems anticipated. The combined discharge could potentially provide flexibility in terms of providing discharge to ground water but also providing an alternate means of discharge (entirely to surface water), should the recharge system require shut-down for maintenance.

Cost - The major costs of implementation of a combined discharge system are the costs of construction of a ground water recharge system and its associated maintenance costs. Discharge monitoring and ground water monitoring costs also contribute to the total estimated cost. The cost of Option D3 is initially estimated at a present worth value of $1,500,000, based on a five-year discharge period.

4.3 Selection of Alternatives for Detailed Analysis

A comparative analysis of the three individual alternatives (no action, continuation of existing actions, and modified ground water restoration) and of the individual extraction, treatment and discharge options based on the three evaluation criteria is conducted to allow the elimination of selected alternatives or options from the detailed analysis process, where appropriate.

4.3.1 Effectiveness

With respect to long-term effectiveness, those alternatives which involve reductions in the toxicity, mobility or volume of ground water contamination within the most timely fashion will provide the greatest protection. With respect to short-term effectiveness, those alternatives which are protective of human health and the environment during the construction and implementation period are most effective.

For the remedial alternatives developed, the alternatives which provide the greatest long-term effectiveness are Alternatives 2 and 3, both of which provide ground water treatment. For Alternative 3, the ground water extraction option consisting of a modified extraction system (Option E2) would be expected to provide greater capture of the contaminated ground water and a reduction in ground water contaminant volume and mobility within the shortest time frame by extracting contaminated ground water closer to the anticipated contaminant source areas and directly from the impacted aquifers. Extraction Option E1, using the existing extraction system, would be effective but would most likely not optimize the extraction of contaminated ground water. Most treatment and discharge options would generally be comparable in terms of long-term effectiveness. Treatment Option T5, expansion of the existing ion exchange system, is not expected to be effective based on its inability to operate effectively without pretreatment of colloidal particles. Inorganic treatment Option T8, electrochemical treatment, could be more effective than other inorganic treatment options, potentially achieving effluent limitations as a stand-alone treatment option. Discharge Option D1, discharge to ground water, could provide greater long-term effectiveness than other discharge options by enhancing the flushing of contaminants to the extraction wells.

Alternative 2 is also effective in treating the majority of the contaminated ground water but is not expected to provide the most timely response, and may not provide adequate capture of the entire contaminant plume.

Alternative 1 involves no remediation of contaminated ground water and therefore has minimal long-term effectiveness. Alternative 1 provides a minimal degree of protection against exposures to contaminated ground water through the existing aquifer exclusion area, which limits current downgradient exposures to contaminated ground water, but does not address risks posed by continued migration of contaminated ground water from the site.

The alternatives vary minimally in the degree of short-term effectiveness provided, since none of the alternatives result in significant short-term impacts due to implementation. Alternative 1 does not include ground water treatment; therefore, short-term impacts would be expected to be less than those alternatives which include ground water treatment.

Alternatives 2 and 3 involve ground water treatment and, therefore, have a slightly greater potential for short-term impacts than Alternative 1. Since Alternative 2 involves no modifications to the existing ground water extraction, treatment and discharge system, it is very effective in the short-term.

Alternative 3 requires modification of the existing remedial systems and, therefore, could result in potential increases in short-term risks due to construction activities. Under Alternative 3, Organic Treatment Option T2, air stripping, would involve the least short-term impacts of the ground water treatment alternatives due to the on-site availability of the technology and efficiency in the removal of ground water contaminants. Options T1, T3 and T4 would be relatively comparable in the short-term, all requiring construction of a new on-site treatment system.

The inorganic treatment options, T5, T6, T7 and T8 are expected to be relatively comparable in terms of short-term impacts. Option T5 could be the most implementable alternative, involving only a modification of the existing treatment system, but is not expected to be effective in the long-term in maintaining effluent limitations. Options T6, T7 and T8 all require construction of a new on-site (pre)treatment system.

For discharge options, discharge to the surface water, Option D2, has limited short-term impacts associated with its implementation due to the presence of the existing discharge system. Implementation of discharge options D1 and D3 would each require installation of a ground water recharge system.

4.3.2 Implementability

Implementability is a measure of the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative. Alternatives 1 and 2 are the most implementable alternatives from a construction standpoint, due either to the lack of associated implementation activities (Alternative 1) or due to the presence of existing systems which comprise the alternative (Alternative 2).

Alternative 3 is less implementable due to the required modification of the extraction, treatment or discharge technologies involved. Ground water extraction Option E1, using the existing extraction system, would be easily implemented, requiring no construction activities. Extraction Option E2, using a modified extraction system, would require the construction of additional extraction wells and associated piping to the treatment system.

Of the organic treatment options evaluated under Alternative 3, Option T2, air stripping, is the most easily implemented treatment alternative based on the presence of the existing air stripper on-site. The other organic treatment options, in order of descending implementability based on availability of the treatment technologies, include carbon adsorption (Option T3), UV oxidation (Option T4) and PACT (Option T1).

Of the inorganic treatment options of Alternative 3, implementation of Option T5, ion exchange, would require modification of the existing treatment system while implementation of Options T6, T7 and T8 would require construction of a new treatment system. Option T6, coagulation and flocculation, is a more widely available and demonstrated technology than Option T7, membrane microfiltration, and Option T8, electrochemical treatment.

For the discharge options, Option D2, discharge to surface water, is the most technically implementable alternative, due to the presence of the existing discharge system. Administrative feasibility of this option is dependent upon the ability to meet discharge to surface water permit conditions. Discharge Option D3, combined discharge to surface water and ground water, follows Option D2 in terms of technical implementability. It would use the existing discharge to surface water system in combination with a newly constructed system to discharge a portion of the effluent to the ground water. The shallow depth to ground water and potential for inorganic clogging of the reinjection system could limit the implementability of discharging to ground water. This option would also require administrative compliance with discharge to surface water and discharge to ground water requirements. Option D1, discharge to ground water, would be more technically difficult to implement due to the volume of treated water which would require discharge to the ground water. Administratively, compliance with the requirements of a discharge to ground water permit would be necessary.

4.3.3 Cost

Preliminary remedial costs for the individual alternatives and associated technology options are summarized in Table 4-2. Alternative 1 is the lowest cost alternative. Alternative 2 is expected to be lower in cost than Alternative 3 because Alternative 2 utilizes existing ground water extraction, treatment and discharge systems. However, Alternative 2 has significant off-site disposal costs associated with its continued implementation. The exact cost of Alternative 3 will depend on the individual options combined to form the final alternative. For extraction options, Option E1, use of the existing extraction system, costs less than Option E2, due to the lack of well and piping installation costs which are associated with the modification of the existing extraction system.

For organic treatment options, air stripping, Option T2, can be implemented for the lowest estimated cost, due to the presence of an existing air stripper on-site. Carbon adsorption, Option T3, follows air stripping at roughly ten times the cost. UV oxidation and PACT treatment, Options T4 and T1, respectively, are the most expensive treatment options. Both options are expensive both in terms of capital costs and long-term operation and maintenance costs. PACT is the most expensive organic treatment option.

For inorganic treatment options, electrochemical treatment, Option T8, can be implemented for the lowest cost, based on its potential treatment of the ground water without supplemental treatment by ion exchange. If supplemental ion exchange treatment is provided, the cost rises with Option T7, membrane microfiltration, and Option T6, coagulation and flocculation, following in order of increasing cost. No cost was developed for expansion of the ion exchange system since it was determined to be an ineffective means of meeting discharge criteria.

For discharge options, Option D2, discharge to surface water, is the lowest cost option since it utilizes the existing discharge system. Option D3, combined discharge to surface water and discharge to the ground water, follows in order of increasing cost. Option D1, discharge to ground water, is the most expensive discharge option.

4.3.4 Selection of Alternatives for Further Consideration

Based on the comparative analysis presented in the previous section, each of Alternatives 1, 2 and 3 will be retained for detailed analysis. Of the extraction, treatment and discharge options included in Alternative 3, however, two are proposed to be eliminated from the range of options undergoing detailed analysis. These include organic treatment Option T1, PACT treatment, and inorganic treatment Option T5, ion exchange (without pretreatment). When compared against other alternatives in terms of their effectiveness and/or cost, these alternatives do not provide significant advantages which would justify their being retained for further analysis. Both treatment options are not as effective as or are similar in terms of effectiveness to the other treatment options in treating the ground water contaminants of concern.

5.0 DETAILED ANALYSIS OF ALTERNATIVES

As presented in the previous section, the remediation of contamination at the SMC site will consist of a minimum of two operable units: one which addresses the identified ground water contamination and one or more which will address other contaminated media at the site. Only the remediation of ground water contamination is addressed herein.

Based on the initial screening of alternatives presented in Section 4, three alternatives and eleven technology options are retained for further consideration. These alternatives/options are summarized in Table 5-1.

5.1 Introduction

In the following sections, the remedial alternatives and technology options are described and evaluated in detail. Initially, descriptions of work components common to several alternatives are presented. Then each alternative or technology option is presented, including a detailed description followed by a detailed analysis. Per the requirements of the NCP, the detailed analyses are divided into seven evaluation categories, including the following:

- Short-Term Effectiveness;
- Long-Term Effectiveness and Permanence;
- Implementability;
- Reduction of Toxicity, Mobility and Volume through Treatment;
- Compliance with ARARs;
- Overall Protection of Human Health and the Environment; and
- Cost.

Detailed cost estimates for the alternatives are presented in Appendix A.

Consideration of two additional evaluation criteria is required by the NCP. Community Acceptance is determined on the basis of public input after completion of the FFS. Federal Acceptance is determined on the basis of support agency comments on the study.

Following individual analyses of the alternatives/options, a comparative analysis against the seven evaluation criteria is also presented.

5.2 Common Elements and Considerations

Prior to the presentation of the specific alternative descriptions, a discussion of certain work elements and considerations common to a number of the alternatives or options is presented.

Ground Water Monitoring

An existing ground water monitoring program is currently being implemented under the requirements of the 1984 and 1988 ACOs. Summaries of the wells included in the current monitoring program and the analytical requirements and sampling frequencies are presented for on-site and off-site wells, respectively, in Tables 5-2 and 5-3.

For Alternative 1 (no action), sampling of the wells for the parameters listed in Tables 5-2 and 5-3 will be conducted on a one-time basis at the end of five years, prior to conducting a five-year review of the no action decision.

For Alternative 2 (continuation of existing actions), continuation of the existing ground water monitoring program, as defined in Tables 5-2 and 5-3, has been evaluated. A five-year monitoring period has been considered.

For Alternative 3 (modified ground water restoration), a modified ground water monitoring program has been considered under the ground water discharge options (Options D1 through D3). Based on the existence of a good data base of ground water quality data which has been developed with the current monitoring program, Alternative 3 has been developed assuming a revised program consisting of quarterly sampling of those wells which are currently sampled on a monthly basis, as well as quarterly and annual sampling of the remaining wells in accordance with the existing schedule. During design activities and implementation, this assumed schedule will be re-evaluated and revised, as appropriate, to provide adequate monitoring of the effectiveness of the extraction and treatment system in capturing ground water contamination. The assumed monitoring program is presented in Tables 5-4 and 5-5.

Ground Water Treatment Period

As previously discussed in Section 4.2, the remedial time frame required to obtain remedial goals is difficult to estimate, especially in a case where an operable unit is being implemented with additional contaminated media to be addressed within a separate operable unit at a future date. The actual ability of an active ground water remedial system to achieve and maintain remedial goals is also a factor in estimating remedial periods (as is discussed further in Section 5.3.3.2). Therefore, for this detailed analysis, a five-year remedial operational period has been assumed for the development of costs for remedial alternatives. A five-year period is considered appropriate because, if remedial levels which allow for unlimited use and unrestricted exposure are not achieved by the selected action, a review of the action is required no less often than every five years after initiation.

5.3 Individual Analysis of Alternatives

In Section 4.2, preliminary descriptions of alternatives and technology options were presented. These are further defined in this section, prior to conducting the detailed alternative analysis. Included in these definitions are descriptions of the various elements of the alternatives, implementation of the elements, the time frame required to achieve cleanup and the common elements included in each alternative. Following the description of each alternative/technology option, the alternative/technology option is evaluated on the basis of the seven criteria listed in Section 5.1.

5.3.1 Alternative 1 - No Action

5.3.1.1 Description

The no action alternative involves no remedial actions to reduce the toxicity, mobility or volume of existing ground water contamination. The existing well restriction area, which covers a portion of the City of Vineland located downgradient of the site, will continue to provide a means of limiting the exposure of residents in this area to the ground water contaminants; however, no protection against continued downgradient contaminated ground water migration will be provided. Also included in this alternative is a round of ground water monitoring prior to conducting a five-year review of the no action decision, as described in Section 5.2.

5.3.1.2 Criteria Assessment

Short-Term Effectiveness - No elevated short-term risks will result from the implementation of this alternative. The potential for human exposure to ground water contamination will be limited within the existing well restriction area. Remedial action objectives will not be achieved.

Long-Term Effectiveness and Permanence - The no action alternative will provide no reduction in risk and does not utilize controls to treat or manage contamination or contaminant sources. A discussion of the risks posed by potential residential exposures under existing environmental conditions is presented in Section 1.7.

The NCP [300.430(f)(4)(ii)] requires that, if a remedial alternative is selected which results in hazardous substances remaining at a site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such an action no less than once every five years after initiation of the alternative. Therefore the selection of the no action alternative will require a five-year review. In addition, the alternative should be reviewed if future use of the ground water in contaminated areas is proposed.

Long-term management of this alternative will include conducting a round of ground water monitoring after a period of five years.

<u>Implementability</u> - The no action alternative is the most easily implemented alternative, involving only a round of ground water sampling after five years has passed. Its implementation will not limit the future implementation of additional remedial actions, if necessary.

<u>Reduction of Toxicity, Mobility or Volume Through Treatment</u> - The no action alternative does not include any treatment methods other than naturally occurring degradation processes. The risks associated with providing no treatment of the ground water are expected to be generally equivalent to those presented in the Human Health and Environmental Health Evaluation (TRC, 1992c). In the long-term, downgradient migration of higher contaminant levels could be expected if operation of the existing pump and treat system was discontinued. Therefore, the potential for subsequent impacts to downgradient potable wells exists.

<u>Compliance with ARARs</u> - The no action alternative does not attain chemical-specific ARARs for contaminants detected in the ground water. ARARs may be waived under certain circumstances defined in the NCP, including situations where the alternative is an interim measure and will become part of a total remedial action that will attain ARARs, where compliance with the requirement will result in greater risk to human health or the environment

than other alternatives, where compliance is technically unpracticable from an engineering perspective, or where the alternative will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, through use of another method or approach.

Overall Protection of Human Health and the Environment - The no action alternative does not provide long-term protection of human health and the environment, because it does not address potential risks through the elimination, reduction, or control through treatment of the contaminated ground water. Implementation of the no action alternative will require a review of the no action decision at a minimum frequency of every five years under the NCP's requirements for sites where contaminants remain following remediation. Should ground water in the area of contamination ever be considered for potable use, protection of human health may not be provided under the no action alternative.

Cost - The only costs associated with the no action alternative will be the costs of the five-year ground water monitoring event. The estimated cost includes $40,000 in ground water monitoring costs (net present value). The present worth value of this alternative, including contingency, is estimated at $48,000. A detailed cost estimate is presented in Appendix A.

5.3.2 Alternative 2 - Continuation of Existing Actions

5.3.2.1 Description

Alternative 2 consists of the continuation of existing remedial action and monitoring programs, including operation of the existing pump and treat system, ground water monitoring and enforcement of the existing well restriction area.

Continued operation of the existing pump and treat system will include ground water extraction from the existing extraction wells (wells W9, RW6S, RW6D, Layne and RIW2), as indicated in Figure 5-1, at the extraction rate of approximately 200 gpm.

Extracted ground water will be treated within the existing ion exchange system. In ion exchange, ions of the contaminant species (e.g., Cr^{+3}, Cr^{+6}) exchange with ions of less concern (e.g., hydroxide ions) as the contaminated water flows through the resin. Modern ion exchange resins are primarily synthetic organic materials containing ionic functional groups to which exchangeable ions are attached. These synthetic resins are structurally stable (i.e., can tolerate a range of temperature and pH conditions), exhibit a high exchange capacity, and can be tailored to show selectivity towards specific ions.

The existing ion exchange system consists of a strong acid cation resin followed by a weak basic anion resin. The strong acid cation resin behaves as a strong acid, exchanging cations in the wastestream with hydroxide ions from the resin and reducing the pH. The wastestream then passes through the weak base cation exchange column, where hydronium (OH^-) anions are exchanged with anions in the water, such as sulfate, thereby raising the pH.

As the available exchanging ions in the resin are replaced by the contaminant ions, the effectiveness of the system is reduced and the resins require regeneration. The strong acid cation resin is regenerated through the addition of sulfuric acid, forming hydrogen and sulfates which are then treated by reduction and precipitation. Regeneration of the weak basic anion resin is accomplished through the addition of dilute sodium hydroxide, followed by the addition of acid, if necessary.

The existing ion exchange system was designed as a continuous operation system. At the end of each adsorption period, loaded resin would be removed from the top of the adsorption column and backwashed to remove any accumulated suspended solids. The resin would then be transferred to an elution column where, after undergoing four cycles of regeneration, it would reach the outlet of the column, ready to again enter the bottom of the adsorption column following rinsing. A schematic of the existing ion exchange treatment system is provided in Figure 5-2.

The continuous operation mode, when implemented, did not operate effectively. The system was designed to meet the historic TDS and chromium permit effluent levels at a continuous flow rate of 400 gpm, but in actual operation, compliance with effluent limitations could only be achieved by pumping at reduced rates in a fixed bed mode and by periodic shutdown of the system for resin regeneration. It was determined that the presence of colloidal particles in the extracted ground water was interfering with system performance. The ion exchange system manufacturer was unable to rectify the operational problems, resulting in the continued operation of the treatment system at a reduced ground water extraction rate. Therefore, this alternative is based on continued operation of the system at an average ground water extraction rate of 200 gpm, with periodic shutdowns of the system for resin regeneration.

The regenerant solution (spent sulfuric or caustic acids) produced during operation of the ion exchange system is further treated through a chrome reduction process. The pH is lowered to 2.5 and sodium bisulfite is added to reduce the hexavalent chromium to trivalent chromium. The effluent flows into a pH adjustment tank where the pH is raised to 7.5. The water flows into a flocculation chamber where a coagulant is added to enhance settling characteristics. The wastewater then enters a separator where the solids settle to the bottom and the supernatent flows into a transfer tank. From the transfer tank, the wastewater is discharged to a storage tank for off-site disposal. This wastestream is referred to as "brine". The sludge from the separator is transferred to a sludge thickener and dewatered using a filter press. The dewatered sludge is temporarily stored within super sacks or roll-off containers in a covered area with an impervious floor for a period of less than ninety days before being disposed of off-site as a hazardous waste (D007).

Supplementing the inorganic treatment system is an air stripper for the treatment of organics in the extracted ground water. Air stripping is a mass transfer process in which a compound in solution in water is transferred to solution in a gas. The Henry's law constant, which relates the liquid phase concentration of a particular compound to the gas phase concentration, provides an indication of the strippability of a compound. Chlorinated hydrocarbons and other compounds with Henry's law constants generally greater than 0.003 atm-m^3/mol can effectively be removed by air stripping. The main organic contaminants of concern at the SMC site (1,1-dichloroethene, 1,2-dichloroethene, trichloroethene, benzene, toluene, xylene, and tetrachloroethene) all have Henry's law constants greater than 0.003 atm-m^3/mol. In the existing treatment system configuration, the air stripper comes before the ion exchange treatment system to prevent organic fouling of the ion exchange resins.

The air stripper system consists of an air stripping column filled with packing material and a blower system. A diagram of the air stripping system is provided in Figure 5-3. The existing air stripper is approximately 35 feet tall and has an inside diameter of 4.5 feet. Based on a ground water extraction rate of 200 gallons per minute, it historically has treated chlorinated compounds to effluent concentrations of 2 ppb or less.

Extracted ground water is pumped to the top of the tower. As the water flows through the tower, air is blown from the bottom of the tower, countercurrent to the direction of water flow. The contaminants are transferred from the aqueous phase to the vapor phase during this process. Volatile organic emissions from the stripper historically have not required emission controls in accordance with federal or state standards. If determined to be necessary in the future based on unexpected changes in the extracted ground water quality, a system using activated carbon could be implemented to control VOC emissions.

The existing discharge system consists of the discharge of treated ground water to the Hudson Branch tributary of the Maurice River. The 1991 ACO stipulated a maximum allowable daily effluent limit of 0.13 kg/d for total chromium, with sampling to be conducted on a weekly basis, and a daily maximum COD of 100 kg/l, based on a monthly grab sample. Total volatile organics, as defined under NJAC 7:14A, were measured on a quarterly basis at the outfall. NJDEPE has proposed new discharge to surface water permit conditions, as presented in Table 3-4, which are more stringent than the 1991 ACO requirements. For example, the proposed maximum allowable daily effluent limit for total chromium is 0.013 kg/d (5.8 µg/l).

As discussed previously in Section 5.2, a ground water monitoring program is also in effect at the SMC facility. The purpose of this program is to monitor the toe of the plume, incorporating new wells installed during the Remedial Investigation, and fulfilling the ground water monitoring requirements of the 1984 and 1988 ACOs, including volatile organic and inorganic sampling and analyses. Summaries of the on-site and off-site wells included in the monitoring program, along with analytical requirements and sampling frequencies, are presented in Tables 5-2 and 5-3, respectively.

5.3.2.2 Criteria Assessment

Short-Term Effectiveness - Continued implementation of the existing remedial actions will result in minimal short-term impacts due to the present operational status of the systems included in this alternative. However, the estimated time frame required to meet remedial response objectives under this alternative is longer than an alternative which would involve a higher ground water extraction rate.

Long-Term Effectiveness and Permanence - Alternative 2 addresses the principal threats associated with ground water contamination by minimizing the migration of contamination beyond the majority of the identified plume area. Based on a study conducted in 1991 (DRAI, 1991) of the extraction of ground water at a rate of 120 gpm from shallow well RIW2 and at 80 gpm from a deep well (RW6D or W9), it was concluded that the pumping schedule was effective in controlling the toe of the hexavalent chromium plume in the shallow portion of the aquifer but additional pumping was necessary to control the hexavalent chromium plume in the deep portion of the aquifer. As a result of the recommendations presented in that study, modifications in the pumping schedule were implemented in January 1991. Ground water was extracted at increased rates from the deep extraction wells (50 to 60 gpm at W9 and 70 to 80 gpm at RW6D), and at a decreased rate at the shallow extraction well (65 to 85 gpm at RIW2). The effects of the change in the pumping scheme are evident in Figures 1-13 and 1-14, which respectively present the lower Cohansey Sand piezometric surface contours for December 1990 (before the pumping schedule modification) and April 1991 (after the modification). Since the modification in the pumping schedule, no downgradient increases in contaminant levels have been identified in regular ground water monitoring in either the upper or lower Cohansey Sands, with the exception of ground water contamination identified south of the facility, in newly installed well SC26D. Capture of the entire plume is not assured, however. Additional investigation is required in the vicinity of wells IW2 and SC26D to further define the extent of contamination.

While Alternative 2 is effective in the minimization of the majority of the contaminant plume, the current treatment system has not been consistently successful in meeting historic effluent limitations and is not expected to be effective in meeting the more stringent requirements of the proposed discharge to surface water permit conditions.

Operation and maintenance activities associated with the system include the off-site disposal of the brine solution and the filter cake sludge. Long-term management in the form of ground water monitoring is also required under this alternative.

Implementability - The technical feasibility of operating the existing ground water extraction, treatment and discharge system is good, since it is an existing, operating system. The administrative feasibility is not as good, since the system operates at a maximum average ground water extraction rate of 200 gpm and is not expected to achieve effluent limitations.

The implementation of additional remedial actions in the future would not be limited by the continued operation of the existing system. If determined to be necessary, the system could be upgraded in the future to handle additional flow. Similarly, the ground water monitoring network could be expanded accordingly, using existing or newly installed monitoring wells, as necessary.

Reduction of Toxicity, Mobility or Volume Through Treatment - Alternative 2 provides a reduction in contaminant toxicity, mobility and volume through ground water extraction and treatment. It addresses ground water contamination by minimizing the migration of contamination beyond the majority of the identified plume area and by treating the contaminants in the extracted ground water. The entire contaminated ground water area would not be addressed by the existing system, however.

Residuals produced by the treatment system include sludge and brine, which require off-site disposal and treatment, respectively. The sludge is disposed of as a D007 waste at a RCRA-permitted land disposal facility, while the brine is treated at an off-site RCRA-permitted treatment facility.

Compliance with ARARs - Alternative 2 may achieve chemical-specific ARARs, particularly with respect to chromium and chlorinated organics, within most of the aquifer over an extended period of operation, although actual achievable aquifer concentrations are difficult to predict (see discussion regarding long-term effectiveness in Section 5.3.3.2). Alternative 2 is expected to achieve historical surface water discharge limits, although past performance has resulted in periodic exceedances. It is not anticipated to achieve proposed discharge to surface water permit conditions. As described in Section 5.3.1.2, ARARs may be waived under certain circumstances, including the implementation of an interim remedial measure, provided that it will become part of a total remedial action that will attain ARARs. This alternative provides protection against exposures to ground water contamination through the existing well restriction area and provides protection against contaminated ground water migration through continued operation of the pump and treat system.

Overall Protection of Human Health and the Environment - This alternative provides a degree of long-term protection of human health and the environment by limiting exposure to contaminated ground water through contaminant migration control and the existing well restriction area. It also addresses potential risks associated with existing ground water contamination through ground water extraction and treatment, although extraction rates may not be optimum in terms of achieving a timely reduction in contaminant concentrations and the entire plume area may not be captured by this alternative.

Cost - The major costs associated with Alternative 2 include long-term operational costs associated with the ground water treatment system as well as long-term ground water monitoring costs. The overall cost includes $1,300,000 in annual operation and maintenance costs ($5,600,000 net present value). The present worth value of this alternative, including contingency, is estimated at $6,700,000. A detailed cost estimate is presented in Appendix A.

5.3.3 Alternative 3 - Modified Ground Water Restoration (Modified Ground Water Extraction/Treatment/Discharge Program)

5.3.3.1 Description

Alternative 3 consists of a modified ground water restoration program consisting of an amended combination of extraction, treatment and discharge technologies. The objective for the development of a modified extraction/treatment/discharge alternative would be to optimize the existing treatment system, thereby allowing the remedial system to operate at an optimum rate, capturing contaminated ground water at and/or emanating from the SMC facility while achieving remediation goals and meeting discharge requirements. The main focus of the development of this alternative is a re-evaluation of the extraction system (including well locations, screened depths and individual well extraction rates to optimize the capture of contaminated ground water), the treatment system (to determine the best means of reliably treating an increased influent rate), and the discharge system (to determine the most appropriate means for discharging the effluent).

As a condition of the 1991 ACO, SMC was required to conduct a Treatment Optimization Study to generate the data necessary to issue a final NJPDES DSW permit and to determine the actions required to comply with permit discharge limitations while also maintaining the increased ground water extraction rate required under the 1988 ACO. Under this study, it was required that the feasibility of utilizing equalization or surge tanks in combination with the existing system to increase pumping efficiency be evaluated, as previously described in Section 4.2.10. It had been determined that the existing treatment system's capacity was limited due to the high incoming solids loading and, therefore, the system was operated in a fixed bed mode, requiring periodic shutdowns for regeneration of the ion exchange columns. Flow equalization tanks would provide storage capacity to allow ground water extraction to continue during column regeneration periods. However, in order to take advantage of the added capacity, the treatment system would subsequently have to be operated at treatment rates higher than the optimum fixed bed treatment rates. Therefore, the use of equalization tanks or surge tanks to increase pumping efficiency would not have any effect on the existing system's inability to treat the water at a higher rate while still maintaining discharge limitations. Based on this evaluation of the existing ion exchange system, it was determined that the only means of continued use of the treatment system would be through the implementation of a pretreatment process which would remove the colloidal particles and enhance the performance of the system. Information generated as a result of additional studies of potential pretreatment processes conducted under the direction of SMC is incorporated herein, as applicable.

This alternative will consist of a combination of extraction, treatment and discharge technology options, as described in detail in Sections 5.3.4

through 5.3.14. Ground water monitoring, as described in Section 5.2, would also be implemented under Alternative 3.

Additional investigation to further define the extent of ground water contamination in the vicinity of well SC26D, south of the SMC facility, and well IW2, southwest of the facility, will be required prior to conducting any remedial design work.

To evaluate ground water extraction and discharge options under Alternative 3, an extensive ground water modeling effort was undertaken. This effort is presented in detail in Appendix B. The effort involved the detailed consideration of seven different extraction and/or discharge scenarios (referred to in Appendix B as simulations), as well as a sensitivity analysis. For most scenarios, numerous evaluations were made to determine the optimum combination of variables (e.g., extraction rates, well locations, etc.) for that scenario. Of the seven scenarios, a scenario which uses existing wells to the greatest extent (Simulation 1) and a scenario which implements the installation of new extraction wells to supplement existing extraction wells (Simulation 4A) were selected as the basis for the detailed analyses of Extraction Options E1 and E2, respectively. For the discharge to ground water options, three scenarios were evaluated during ground water modeling, including simulations of ground water recharge using reinjection wells and recharge basins. Simulation 5, in which ground water would be recharged by modifying an existing thermal pond and by constructing an additional recharge basin, was selected as the basis for the detailed analysis of Discharge Options D1 and D3. More information is provided in the individual detailed analyses of these options.

In the following discussions of extraction, treatment and discharge options, 400 gpm is commonly used to describe the extraction, treatment and discharge rates. However, it should be noted that this is an approximate rate that may be varied during actual system design and/or implementation. While 400 gpm is an effective extraction rate based on existing information on the extent of ground water contamination and as defined by the ground water modeling activities, additional site investigation activities and monitoring of the actual extraction system during implementation will provide an indication if this extraction rate provides capture of the contaminated ground water. Additional ground water modeling will also be conducted during the remedial design phase. Modifications to the overall extraction rate or individual well extraction rates may be implemented as a result of these activities. Similarly, the treatment and discharge rates will not necessarily be equal to the extraction rate due to the recirculation of waste streams within the ground water treatment processes and the potential discharge of non-contact cooling water and stormwater as well as treated ground water via Outfall 001. Therefore, references to 400 gpm extraction, treatment and discharge rates should be considered to be an approximate rate of 400 gpm, with some variation possible during implementation.

5.3.3.2 Criteria Assessment

The following criteria assessment addresses only the general features of ground water extraction, treatment and discharge for the purpose of comparison to Alternatives 1 and 2.

Short-Term Effectiveness

Alternative 3 will potentially present limited short-term risks to remedial workers, depending on the selected ground water extraction and treatment options. Personal protective equipment will be implemented, as necessary, to minimize the potential impact to remedial workers. The time required to complete construction of the ground water extraction system and/or treatment system is estimated at a maximum of one to two years. No significant added short-term risks to the adjacent community or the environment are anticipated as a result of extraction well or treatment system installation or operation.

While the time required to meet ground water remediation goals is difficult to estimate at this point in time, it is expected that ground water remediation goals will be achieved in a more timely manner than would be achievable under Alternative 2, due to the increased pumping rate.

Long-Term Effectiveness and Permanence - A modified ground water extraction, treatment and discharge system will effectively treat the ground water contamination. While it extracts and treats ground water at a greater rate than Alternative 2 and therefore is expected to be more effective in the long-term, the permanence of Alternative 3 will depend, in part, on the source(s) of the ground water contamination. Based on a review of ground water extraction and remediation case studies conducted under the Superfund program (Sutter, et. al., 1991), extraction system performance and permanence was determined to be related to the potential presence of non-aqueous phase liquids (NAPLs), such as chlorinated hydrocarbons. While the presence of these liquids is often difficult to locate in the field, they often provide a continuous source of contamination to surrounding ground water through direct dissolution. Therefore, while pump and treat systems have been successful in containing aqueous contaminant plumes and removing a substantial mass of contaminants from the aquifers, once their operation is discontinued, high contaminant levels may return if NAPLs are present.

Long-term future use of the ground water will be dependent on the level of remediation achievable by the pump and treat system. Achievement of ground water goals for chlorinated hydrocarbons and other contaminants can be an extended process due to the physical processes involved in the transport of these contaminants and observed performance of other pump and treat systems. The previously referenced Superfund study (which is based upon the evaluation of twenty-four sites, most of which had VOCs as their contaminants of concern), described evidence of a "leveling out" of contaminant concentrations in pump and treat systems prior to reaching the cleanup goal. Significant decreases in contaminant concentrations typically occurred within the first two years of extraction. The "leveling out" phenomenon was observed at many sites within the immediate source areas only; the overall sizes of the plumes were generally substantially reduced through pumping.

Long-term management will consist of ground water treatment system and discharge system operation and maintenance and ground water monitoring. Maintenance of these systems should not be difficult, although technical problems could be associated with operation of the ground water treatment and discharge systems, depending on the treatment option chosen. It has been assumed that ground water monitoring will be conducted over the assumed five-year operational period, as previously described in Section 5.2.

Implementability - The construction of a modified ground water extraction, treatment and discharge system will be fairly easily implemented but will be dependent on the chosen technology options. The implementation of this alternative is not expected to pose difficulties in implementing future remedial actions or difficulties in terms of monitoring.

The administrative feasibility of implementing this alternative will be highly dependent on the technology options chosen. In general, ground water extraction, treatment and discharge remedial actions are administratively feasible. The ability of this alternative to meet discharge requirements is expected to be better than Alternatives 1 and 2; however, it will be dependent on the selected treatment technology and discharge system.

Reduction of Toxicity, Mobility or Volume Through Treatment - This alternative addresses the principal threat associated with the presence of the contaminated ground water through minimization of contaminant migration and a reduction in the overall volume of contaminated ground water through an increased ground water extraction rate. The toxicity of the ground water contamination will be reduced through the treatment processes employed.

Compliance with ARARs - Alternative 3 may achieve chemical-specific ARARs within the aquifer over an extended period of operation, although actual achievable aquifer concentrations are difficult to predict (see previous discussion regarding long-term effectiveness). The ground water treatment system will be used to reduce contaminant levels to meet discharge criteria. Effluent from the treatment process must meet the discharge requirements applicable to the discharge option selected. Compliance with the requirements of a New Jersey treatment works permit is also anticipated.

To determine the effectiveness of this alternative in maintaining contaminant levels below remedial cleanup criteria once operation of the pump and treat system is discontinued, continued ground water monitoring will be required.

Overall Protection of Human Health and the Environment - This alternative provides control of risks posed by ground water contamination through extraction and treatment. Minimal short-term risks may be associated with the implementation of the ground water extraction and treatment systems. The long-term effectiveness is expected to be good, based on the increased ground water extraction rate and the optimization of the ground water extraction system. The treatment system should be able to attain ARARs applicable to discharge and should be successful in achieving or approaching ARARs within the aquifer. The ability of the treatment systems to treat all contaminants of concern will depend on the individual treatment options which are selected for the final alternative.

Cost - The major costs associated with Alternative 3 include the construction/modification of the ground water extraction, treatment and discharge systems. The cost will be highly dependent on the individual technology options chosen, as presented in Sections 5.3.4 through 5.3.14.

5.3.4 Alternative 3 - Ground Water Extraction Option E1 - Existing Extraction System

5.3.4.1 Description

Option E1 is based on ground water modeling Simulation 1, as presented in Appendix B. It consists of ground water extraction using existing extraction wells Layne, W9, RW6S, RW6D and RIW2. An additional deep extraction well, referred to as RIW2 deep, is also proposed to be included in this option to provide capture of contaminated ground water within the lower Cohansey Sand in this downgradient area. The well would be paired with existing extraction well RIW2. The locations of existing extraction wells and proposed extraction well RIW2 deep are presented in Figure 5-4.

Based on the ground water modeling, the extraction rates for the existing wells under this option are as follows:

Layne	95 gpm
W9	35 gpm
RW6S	95 gpm
RW6D	25 gpm
RIW2	125 gpm
RIW2 deep	25 gpm

5.3.4.2 Criteria Assessment

Short-Term Effectiveness - Option E1 is effective in the short-term because it uses existing extraction wells and requires the installation of only one additional extraction well. Existing extraction system piping is also used. Short-term risks resulting from implementation are expected to be minimal and are easily addressed through the use of proper health and safety equipment.

Long-Term Effectiveness and Permanence - In the long-term, Option E1 will be effective in capturing most of the shallow and deep contaminated ground water. However, chromium-contaminated ground water in the vicinity of shallow well SC3S and deep well SC26D may not be captured under this option. Shallow ground water that is contaminated with elevated levels of chromium in the vicinity of wells H, L, and SC23S would lie only within the capture zone of RIW2, located some 3,000 feet downgradient. Therefore, significant dispersion and diffusion of this contaminated ground water could occur prior to extraction.

Implementability - Option E1 would be implementable based on the use of the existing extraction system with the addition of only one extraction well. Existing piping to the treatment system could be used, further supporting the ease of implementation. Administrative feasibility is expected to be good as well as the availability of required services and materials.

Reduction of Toxicity, Mobility or Volume through Treatment - Option E1 would provide a reduction in the mobility of contaminated ground water through its capture using the existing extraction system with one supplemental well, although capture of all ground water contaminated at levels exceeding ARARs emanating from the SMC facility is not likely. The toxicity of ground water contaminants would be subsequently reduced through ground water treatment. The volume of contaminated ground water could potentially increase due to dispersion when shallow contaminated ground water must travel some 3,000 feet downgradient to be extracted.

Compliance with ARARs - Option E1 is expected to provide extraction of most but not all of the ground water with contaminant levels exceeding ARARs. Construction of the additional extraction well must be conducted in accordance with appropriate location-specific and action-specific requirements.

Overall Protection of Human Health and the Environment - Option E1 is protective of human health and the environment through the extraction of contaminated ground water for on-site treatment. This extraction option does not provide the most efficient means of extraction, however, because ground water contaminants may be allowed to disperse prior to extraction downgradient of potential source area(s) and because it may not provide for the capture of the entire contaminant plume.

Cost - The cost of implementation of Option E1 involves the cost of installation of an additional extraction well, hook-up to the existing piping system and continued operation of the extraction system. The overall estimated cost includes $22,000 in direct capital costs, $3,000 in indirect capital costs, and $27,000 in annual operation and maintenance costs ($110,000 net present value). The present worth value of this alternative, including contingency, is estimated at $170,000. A detailed cost estimate is presented in Appendix A.

5.3.5 Alternative 3 - Ground Water Extraction Option E2 - Modified Extraction System

5.3.5.1 Description

Option E2 is based on ground water modeling Simulation 4A, as presented in Appendix B. It consists of ground water extraction using existing extraction wells Layne, W9, RW6S, RW6D and RIW2. An additional deep extraction well, referred to as RIW2 deep, is also proposed to be included in this option to provide capture of contaminated ground water within the lower Cohansey Sand in this downgradient area. The well would be paired with existing extraction well RIW2. In addition, two supplemental shallow extraction wells, referred to as SRW1 and SRW2, are proposed to capture the shallow ground water with high chromium levels in the vicinity of wells H, L, and SC23S, close to potential source area(s) and one supplemental shallow extraction well, referred to as SRW3, is proposed to capture chromium levels which exceed MCLs in the vicinity of well SC3S. The "lobe" of shallow chromium-contaminated ground water which exists in the vicinity of well SC12S would also be captured under this extraction scenario, as would the majority of the deep chromium-contaminated ground water (the extent of which will be better defined following completion of additional investigations). The locations of existing extraction wells and proposed extraction wells RIW2 deep, SRW1, SRW2 and SRW3 are presented in Figure 5-5.

Based on the ground water modeling, the extraction rates for the recovery wells under this option are as follows:

Layne	70 gpm
W9	25 gpm
RW6S	25 gpm
RW6D	25 gpm
RIW2	40 gpm
RIW2 deep	25 gpm
SRW1	70 gpm
SRW2	70 gpm
SRW3	50 gpm

Following the completion of additional site investigation in the vicinity of wells SC26D and IW2, adjustments to the proposed extraction system may be required.

5.3.5.2 Criteria Assessment

Short-Term Effectiveness - Option E2 is effective in the short-term because it uses existing extraction wells and requires the installation of four additional extraction wells. Existing extraction system piping is also used, with some additional piping required to convey the extracted ground water from SRW1, SRW2 and SRW3 to the treatment system. Short-term risks resulting from implementation are expected to be minimal and are easily addressed through the use of proper health and safety equipment. By locating SRW1 and SRW2 close to the potential source(s) of the shallow ground water chromium levels, this option is expected to achieve remedial response objectives within a shorter time frame than Option E1.

Long-Term Effectiveness and Permanence - In the long-term, Option E2 will be effective in capturing both the shallow and deep chromium-contaminated ground water, although additional investigation is required in the vicinity of SC26D to confirm the capture of deep chromium-contaminated ground water in this area. In addition, the shallow ground water contaminated with high levels of chromium in the vicinity of wells H, L and SC23S would be captured close to the potential source area(s), therefore minimizing the potential for significant dispersion and diffusion of this contaminated ground water prior to extraction.

Implementability - Option E2 would be implementable based on the use of the existing extraction system with the addition of four extraction wells. Existing piping to the treatment system would be supplemented with the piping necessary to convey the flows from SRW1, SRW2 and SRW3. Administrative feasibility is expected to be good, as well as the availability of required services and materials.

Reduction of Toxicity, Mobility or Volume through Treatment - Option E2 would provide a reduction in the mobility of contaminated ground water through its capture strategy using the existing extraction system with four supplemental wells. The toxicity of ground water contaminants would be subsequently reduced through ground water treatment. By locating SRW1 and SRW2 so as to capture shallow ground water which exhibits relatively high chromium levels near to the potential source area(s), the volume of contaminated shallow ground water should not significantly increase due to dispersion.

Compliance with ARARs - Option E2 is expected to provide extraction of shallow and deep ground water with chromium levels which exceed ARARs, particularly focusing on shallow ground water areas close to the potential source area(s). Revisions to the proposed extraction system may be required to ensure capture in areas where additional investigations are planned. Construction of the additional extraction wells must be in accordance with appropriate location-specific and action-specific requirements.

Overall Protection of Human Health and the Environment - Option E2 is protective of human health and the environment through the extraction of contaminated ground water for on-site treatment. This extraction option provides a more efficient means of extraction than Option E1; capturing contaminated shallow ground water closer to the potential source area(s) will minimize contaminant dispersion prior to extraction and therefore can be expected to minimize the overall remedial period required. This option also includes the capture of shallow chromium-contaminated ground water in the vicinity of SC3S.

Cost - The cost of implementation of Option E2 involves the cost of installation of three additional extraction wells, hook-up to the existing piping system, installation of conveyance piping for SRW1 and SRW2, and continued operation of the extraction system. The overall estimated cost includes $93,000 in direct capital costs, $13,000 in indirect capital costs, and $27,000 in annual operation and maintenance costs ($110,000 net present value). The present worth value of this alternative, including contingency, is estimated at $260,000. A detailed cost estimate is presented in Appendix A.

5.3.6 Alternative 3 - Ground Water Treatment Option T2 - Air Stripping

5.3.6.1 Description

Option T2 involves the treatment of organic ground water contaminants using an air stripper, a well-proven and widely available treatment technology.

Air stripping is a mass transfer process in which a compound in solution in water is transferred to solution in a gas. The Henry's law constant, which relates the liquid phase concentration of a particular compound to the gas phase concentration, provides an indication of the strippability of a compound. Chlorinated hydrocarbons and other compounds with Henry's law constants generally greater than 0.003 atm-m^3/mol can effectively be removed by air stripping. As described previously in Section 5.3.2.1, the main organic contaminants of concern at the SMC site (1,1-dichloroethene, 1,2-dichloroethene, trichloroethene, benzene, toluene, xylene, and tetrachloroethene) all have Henry's law constants greater than 0.003.

The use of the existing air stripping column at the SMC facility is evaluated under this organic treatment option. The system consists of an air stripping column filled with packing material and a blower system, as previously shown in Figure 5-3. A detailed description of the existing air stripper and its operation was previously presented in Section 5.3.2.1. Historically, it has treated chlorinated compounds to effluent concentrations of 2 ppb or less. Therefore, it is expected to provide removal of the chlorinated compounds in accordance with the proposed discharge to surface water permit conditions. While treatment of air emissions has historically not been required based on the treatment rate and VOC levels, potential emission rates are compared to regulatory levels on the basis of measured VOC influent levels and a 400 gallon per minute treatment rate in the calculations presented in Appendix C. Based on these calculations, emissions treatment is not expected to be required. However, monitoring would be conducted during operations to ensure compliance with air discharge regulations.

Because inorganic contaminants (e.g., iron) may eventually clog the packing material within an air stripper and decrease its efficiency, inorganic pretreatment prior to air stripping is preferred.

5.3.6.2 Criteria Assessment

Short-Term Effectiveness - Short-term risks to workers under this alternative are not expected to be significant based on the use of an existing treatment unit. No significant added risks to the adjacent community or the environment are anticipated as a result of treatment system installation or operation.

Long-Term Effectiveness and Permanence - The long-term risks associated with the organic residuals of ground water treatment by air stripping will be relatively small, since air stripping is a very efficient means of removing chlorinated hydrocarbons and other organic contaminants of concern from the wastestream. Long-term operation and maintenance of the treatment system is expected to pose no significant difficulties. Placement of the air stripping system following any inorganic treatment system would reduce potential fouling of the packing material within the air stripper.

Implementability - The implementability of an air stripping treatment system is very good, since the system already exists on-site. The implementation of air stripping will not impact the implementation of any future remedial actions. If additional flow should be added to the treatment system at a future date, the system could be expanded fairly easily through the addition of another treatment unit. Operational activities include maintaining the blower system and ensuring no clogging of the packing material occurs. Administrative feasibility is also expected to be good based on the system's historic use at the site.

Reduction of Toxicity, Mobility or Volume Through Treatment - This alternative will provide a reduction in the toxicity of ground water through treatment. Air stripping transfers contaminants from the aqueous phase to the vapor phase. Although treatment of the air discharge from the air stripper is not expected to be necessary to comply with federal and state regulations, as demonstrated by the calculations presented in Appendix C, it could be provided if influent VOC concentrations significantly increase, causing acceptable air emission levels to be exceeded. Such treatment could consist of vapor phase carbon which would adsorb the contaminants, with subsequent off-site destruction during carbon regeneration.

Compliance with ARARs - The ability of the treatment system to meet discharge ARARs/TBCs applicable to organic contaminants is expected to be good, due to the high efficiency of air stripping in removing the contaminants of concern. The effluent from the treatment process would have to meet the applicable discharge requirements, as discussed in Sections 5.3.12 through 5.3.14. Air stripping is expected to be able to achieve the proposed discharge to surface water permit conditions for TCE, based on historical performance. The treatment process itself must comply with the requirements of a New Jersey treatment works permit as well as with air discharge regulations.

Overall Protection of Human Health and the Environment - Option T2 is expected to provide overall protection of human health and the environment through treatment of organic contaminants in the ground water. The long-term effectiveness and permanence and short-term effectiveness are expected to be good, and the ARARs/TBCs associated with discharge of the treated water are anticipated to be achievable.

Cost - The major costs associated with Option T2 are the operation and maintenance costs. The overall estimated cost includes $20,000 in direct capital costs, $3,000 in indirect capital costs and $14,000 in annual operation and maintenance costs ($59,000 net present value). The present worth value of this alternative, including contingency, is estimated at $98,000. A detailed cost estimate is presented in Appendix A.

5.3.7 Alternative 3 - Ground Water Treatment Option T3 - Carbon Adsorption

5.3.7.1 Description

Option T3 involves the treatment of organic ground water contaminants using carbon adsorption, a well-proven and widely available treatment technology. Carbon adsorption provides treatment of many organic compounds and may act as a filter in removing suspended inorganics.

To treat the ground water contamination at the SMC site, a carbon adsorption unit consisting of two adsorption columns operated in series is expected to provide adequate treatment of the residual organic contaminants. A schematic of the treatment unit is presented in Figure 5-6. The first column provides the major portion of the treatment with the second column acting as a polishing column. Based on an average design flow rate of 400 gpm, an assumed carbon usage of approximately 0.5 lb carbon per 1,000 gallons treated (Stenzel, M.H., and Gupta, U.S., 1985), and a typical application rate of 2 to 10 gpm per square foot, it is estimated that a system such as the Calgon Model 10 Adsorption System will be appropriate. The Model 10

Adsorption System consists of two adsorber vessels each containing approximately 715 cubic feet of carbon (20,000 pounds). Based on the assumed carbon usage rate, the carbon within one of the vessels will require replacement every two months. The system will be operated in a cyclic fashion, with the influent rerouted to the second vessel once the carbon in the first vessel is replaced. Such operation ensures that the partially used carbon provides the majority of the contaminant removal, while the virgin carbon is used for polishing. Carbon can be replaced using the carbon transfer piping built into the treatment system. Calgon provides carbon replacement services.

5.3.7.2 Criteria Assessment

Short-Term Effectiveness - Short-term risks to workers under this alternative are not expected to be significant. The spent carbon transfer piping built into the treatment system allows for efficient removal of spent carbon with little or no potential risks to on-site workers. No significant added risks to the adjacent community or the environment are anticipated as a result of treatment system installation or operation.

Long-Term Effectiveness and Permanence - The long-term risks associated with carbon adsorption will be minimal based on the efficiency of the carbon in treating the contaminants of concern. Carbon adsorption will be effective in treating both chlorinated and aromatic contaminants. Potential long-term risks associated with the residuals of carbon adsorption will also be relatively small, since the carbon is regenerated and reusable. Long-term operation and maintenance of the treatment system is expected to pose no significant difficulties. Potential clogging of the carbon filter could be avoided through the placement of the organic treatment system following the inorganic treatment system.

Implementability - The implementability of a carbon adsorption treatment system is also expected to be good. Treatment units are readily available and easily implemented. The Calgon Model 10 adsorption system is skid-mounted for ease of installation. Start-up is not expected to result in unanticipated technical problems. The implementation of carbon adsorption will not impact the implementation of any future remedial actions. If additional flow should be added to the treatment system at a future date, the system could be expanded fairly easily through the addition of another treatment unit. Operational activities include monitoring the breakthrough rate of the carbon and replacing the carbon, as required. Administrative feasibility is also expected to be good.

Reduction of Toxicity, Mobility or Volume Through Treatment - This alternative will provide a reduction in the toxicity of identified organic ground water contaminants through treatment. The subsequent carbon regeneration process thermally destroys the adsorbed contamination.

Compliance with ARARs - The ability of the treatment system to meet discharge requirements applicable to organic contaminants is expected to be good, due to the high efficiency of carbon adsorption in removing the contaminants of concern. Applicable discharge requirements are discussed in more detail in Sections 5.3.12 through 5.3.14. The treatment process itself must comply with the requirements of a New Jersey treatment works permit. Removal and disposal or regeneration of the spent carbon requires compliance with the appropriate waste transportation, disposal and treatment regulations.

Overall Protection of Human Health and the Environment - Option T3 is expected to provide overall protection of human health and the environment through treatment of organic contaminants in the ground water. The long-term effectiveness and permanence and short-term effectiveness are expected to be good, and discharge ARARs/TBCs are anticipated to be achievable.

Cost - The major costs associated with Option T3 are the capital costs associated with the carbon adsorption unit and associated operation and maintenance costs, including carbon regeneration. The overall estimated cost includes $240,000 in direct capital costs, $48,000 in indirect capital costs and $100,000 in annual operation and maintenance costs ($440,000 net present value). The present worth value of this alternative, including contingency, is estimated at $880,000. A detailed cost estimate is presented in Appendix A.

5.3.8 Alternative 3 - Ground Water Treatment Option T4 - UV Oxidation

5.3.8.1 Description

Option T4 involves the treatment of extracted organic ground water contamination using UV oxidation, a technology which has recently been demonstrated in the USEPA's SITE program and which is becoming more commercially available.

UV oxidation is a process in which UV light and hydrogen peroxide chemically oxidize organic contaminants dissolved in water. A drawing of a typical treatment system is provided in Figure 5-7. Hydrogen peroxide is converted in the presence of UV light to hydroxyl radicals, which are powerful oxidizers. Concurrently, organic molecules absorb energy from the UV light, making them more receptive to the hydroxyl radicals. The combined UV light and hydroxyl radicals promote rapid breakdown of organics into carbon dioxide and water without the creation of air emissions or residual waste streams.

Self-contained UV oxidation units are manufactured by such vendors as Peroxidation Systems, Inc. and Ultrox International, Inc., and are available in various configurations. Each vendor's system operates under unique conditions and has its own attributes and drawbacks.

For costing and evaluation purposes, use of a Peroxidation Systems, Inc. (PSI) unit has been assumed, due to its ability to handle high flow rates.

PSI units combine high-intensity UV light and hydrogen peroxide, which is easily soluble in water. The high-intensity lamps provide a shorter residence time than systems which use low-intensity lamps, thereby allowing treatment of high flow rates. The water temperature is raised approximately 5^{o} per minute of residence time. Under some circumstances, increased water temperature has been linked to increased fouling of the quartz tubes that hold the UV lamps (Roy, 1990a).

The system is successful in treating most chlorinated hydrocarbons, although single-bonded compounds such as TCA and DCA are not treated. Since single-bonded compounds are not included in the contaminants of concern at the SMC site, this limitation is not significant. In addition to treating most chlorinated hydrocarbons, UV oxidation has been demonstrated to be effective in treating aromatic contaminants.

Operation and maintenance of the PSI UV oxidation unit consists of the provision of electricity, UV lamp replacement and maintenance of the hydrogen peroxide supply. Operational problems include the precipitation of sediment on the quartz lamps, which can significantly reduce the system's destruction efficiency (Ibid.).

Other available systems include Ultrox International's system and VM Technology's UVOX system. The Ultrox system uses low-intensity UV lamps installed in chambers of a reactor. Ozone is introduced into the bottom of the chambers and hydrogen peroxide is also added to the influent. The ozone produces the hydroxyl radicals which oxidize the contaminants. Residual ozone is decomposed to oxygen in a separate treatment unit. The low intensity lamps generate less heat than the high intensity lamps of the PSI unit. Because the ozone is "bubbled" through the wastewater, single-bonded contaminants not treated in the PSI unit are stripped from the wastestream and subsequently treated in the ozone destruction unit. Maximum removal efficiencies in the SITE program demonstration ranged from 99 percent for TCE to 65 and 85 percent for 1,1-DCA and 1,1,1-TCA respectively. The ozone used in the process is generated on-site. Ozone is a toxic gas and must be handled accordingly (Roy, 1990b).

VM Technology's UVOX system provides UV oxidation without contact between the wastestream and the quartz sheaths covering the UV lamps. Compressed air is exposed to the UV lamps, creating ozone. The incoming wastestream is filtered to removed solid particles down to 5 microns. The wastestream and ozone are then mixed, with unreacted gas subsequently treated in a carbon bed. The treated wastewater flows through a carbon filtration system and filter before it is discharged (Roy, 1990a).

5.3.8.2 Criteria Assessment

Short-Term Effectiveness - Short-term risks to workers under this alternative are not expected to be significant. Maintaining the hydrogen peroxide supply and the UV lamps are the major operation and maintenance activities, although handling of ozone, a toxic gas, could be required, depending on the selected technology vendor. No significant added risks to the adjacent community or the environment are anticipated as a result of treatment system installation or operation, based on the complete destruction of most contaminants of concern.

Long-Term Effectiveness and Permanence - The long-term risks associated with UV oxidation will be minimal based on the system's ability to treat the organic contaminants of concern and based on the lack of treatment residuals associated with UV oxidation. Long-term operation and maintenance of the treatment system is expected to pose no significant difficulties, although elevated inorganic levels can cause fouling of the UV lamps. Placement of the UV oxidation system after the inorganic treatment system would reduce the potential for fouling of the UV lamps.

Implementability - The implementation of a UV oxidation system is also expected to be good, based on an increasing number of commercially available units. The PSI unit which was used as the basis for this evaluation is modular and skid-mounted for ease of installation. Start-up is not expected to result in unanticipated technical problems and the implementation of the UV oxidation treatment system is not expected to impact the implementation of any future remedial actions. Operational activities include maintenance of the hydrogen peroxide supply and the UV lamps, as required. Administrative feasibility is also expected to be good.

Reduction of Toxicity, Mobility or Volume Through Treatment - This alternative will provide a reduction in the toxicity of identified organic ground water contaminants through treatment. The toxicity of the contaminants is reduced with no significant treatment residuals produced by the process.

Compliance with ARARs - The ability of the treatment system to meet discharge requirements applicable to organic ground water contaminants is expected to be good. Treatability studies could further define the efficiency of the treatment system prior to implementation. The effluent from the treatment process is expected to meet the applicable discharge requirements, as discussed in Sections 5.3.12 through 5.3.14. The treatment process itself must comply with the requirements of a New Jersey treatment works permit.

Overall Protection of Human Health and the Environment - Option T4 is expected to provide overall protection of human health and the environment through treatment of organic ground water contaminants. The long-term effectiveness and permanence and short-term effectiveness are expected to be good, and ARARs/TBCs are anticipated to be achievable for most organic compounds of concern.

Cost - The major costs associated with Option T4 are the capital costs associated with the UV oxidation unit and associated operation and maintenance costs, including hydrogen peroxide, maintenance, parts, and power. The overall estimated cost includes $710,000 in direct capital costs, $140,000 in indirect capital costs and $400,000 in annual operation and maintenance costs ($1,700,000 net present value). The present worth value of this alternative, including contingency, is estimated at $3,100,000. A detailed cost estimate is presented in Appendix A.

5.3.9 Alternative 3 - Ground Water Treatment Option T6 - Coagulation and Flocculation

5.3.9.1 Description

Option T6 involves the pretreatment of inorganic ground water contaminants using chemical coagulation and flocculation, followed by treatment within the existing ion exchange system. Chemical coagulation and flocculation is an inorganic removal method often used in industry.

Coagulation is a process which involves the reduction of electrostatic particle surface charges, resulting in the agglomeration of particles. The potential for coagulation can be measured in terms of the Zeta potential, the electric potential difference between the shear plane of an ion and the surrounding solution. As the Zeta potential approaches zero, the tendency for coagulation increases. The rate at which coagulated particles coalesce is related to the frequency of collisions between particles. Since the total number of collisions increases with time, the degree of flocculation also generally increases with residence time in a reaction chamber (Palmer, et. al., 1988).

A coagulation and flocculation system generally consists of three treatment steps, as indicated in Figure 5-8. First, the coagulating/flocculating agent is added to the wastewater. The wastewater is rapidly mixed to allow dispersion of the agent throughout the liquid. This is followed by slow and gently mixing to allow for contact between small particles and, therefore, agglomeration into larger particles. Since this system does not treat dissolved inorganics, it would be used as a pretreatment system with the existing ion exchange system.

Preliminary treatability studies conducted by ALCOA for SMC of insoluble solids removal by flocculant or coagulant additions prior to ion exchange treatment resulted in only marginal success, with colloidal solids remaining in the treated effluent (Stone & Webster, 1991).

5.3.9.2 Criteria Assessment

Short-Term Effectiveness - Short-term risks to workers under this alternative are not expected to be significant. Maintenance of chemical supplies and sludge handling are the major operation and maintenance activities associated with the coagulation/flocculation system. No significant added risks to the adjacent community or the environment are anticipated as a result of treatment system installation or operation.

Long-Term Effectiveness and Permanence - The long-term effectiveness associated with coagulation/flocculation may not be good. Preliminary testing has indicated the system may be unable to treat the contaminants of concern. If not effective in treating colloidal contaminants, the system may not adequately pretreat the wastestream and may result in the continued inability to operate the ion exchange system at the 400 gpm flow rate or failure to meet discharge requirements.

The coagulation/flocculation treatment system produces a sludge that will require hazardous waste characterization and appropriate disposal. Long-term operation and maintenance of the treatment system is expected to pose no significant difficulties, although variations in such properties as flow, solids concentration, pH, temperature, and hexavalent chromium concentration can affect performance.

Implementability - The implementation of a coagulation/flocculation system is generally expected to be good. However, start-up could result in technical problems since the preliminary studies of this technology did not prove effective. Implementation of this treatment system is not expected to impact the implementation of any future remedial actions. Operational activities include maintenance of the chemical supplies and sludge handling. Administrative feasibility is expected to be good.

Reduction of Toxicity, Mobility or Volume Through Treatment - This alternative is expected to provide a reduction in the toxicity of identified inorganic ground water contaminants through treatment, although its effectiveness may be marginal. The volume of contaminated media is reduced through the physical removal of contaminants from the ground water and subsequent production of a concentrated sludge residual. The coagulation/flocculation treatment system would have to be combined with the existing ion exchange system to provide treatment of all of the inorganic contaminants of concern.

Compliance with ARARs - The ability of the treatment system to adequately treat colloidal particles and thereby, when combined with the existing ion exchange system, meet discharge ARARs/TBCs applicable to inorganic ground water contaminants was not clearly demonstrated by initial studies. The effluent from the treatment process will have to meet the applicable discharge requirements, as discussed in Sections 5.3.12 through 5.3.14. The treatment process itself must comply with the requirements of a New Jersey treatment works permit. Sludge transport and disposal would have to be in accordance with applicable waste transportation and disposal regulations.

Overall Protection of Human Health and the Environment - Option T6 is expected to provide some degree of protection of human health and the environment through treatment of inorganic ground water contaminants, although its overall effectiveness has not been proven in preliminary studies. ARARs/TBCs may not be achievable for the inorganic compounds of concern.

Cost - The major costs associated with Option T6 are the capital costs associated with the addition of a flocculator/clarifier unit and associated operation and maintenance costs, including chemical supply costs and sludge disposal costs. It is assumed that the existing filter press can be used for dewatering of the sludge prior to off-site disposal. The overall estimated cost includes $120,000 in direct capital costs, $24,000 in indirect capital costs and $2,300,000 in annual operation and maintenance costs ($10,000,000 net present value). The present worth value of this alternative, including contingency, is estimated at $12,000,000. A detailed cost estimate is presented in Appendix A.

5.3.10 Alternative 3 - Ground Water Treatment Option T7 - Membrane Microfiltration

5.3.10.1 Description

Option T7 involves the pretreatment of inorganic ground water contaminants using membrane microfiltration, followed by treatment within the existing ion exchange system. Membrane microfiltration is a physical process for removing fine particulate matter from a wastestream. Because this system removes only undissolved inorganics, it would be used as a pretreatment system for the existing ion exchange treatment system.

A membrane microfiltration treatment system being developed by E.I. DuPont de Nemours & Company (DuPont) is currently included in the U.S. EPA's Superfund Innovative Technology Evaluation (SITE) program. The system is designed to remove solid particles from liquid wastes, forming filter cakes typically ranging from 40 to 60 percent solids. It consists of an automatic pressure filter (Oberlin) combined with DuPont's special Tyvek filter material (Tyvek T-980) made of spun-bonded olefin. A schematic of the system is presented in Figure 5-9.

The microfiltration unit operates in a cyclical manner. The waste feed enters an upper chamber and is pumped through the filter fabric. The fabric allows water and solids less than about one tenth of a micron in diameter to pass through the openings in the fabric. Filtered solids accumulate on the fabric, forming a filter cake, while the filtrate accumulates in a lower chamber. Air is fed into the upper chamber at about 45 pounds per square inch and used to further dry the cake and remove any remaining liquid. When the cake has been dried, the upper chamber is lifted and the filter cake discharged. The entire system is enclosed and therefore can be used to treat wastestreams containing volatile organics.

Pilot tests using this technology have been conducted at the Palmerton Zinc Superfund site in Palmerton, Pennsylvania, where ground water is contaminated with heavy metals such as cadmium, lead and zinc. The tests produced a 35 to 45 percent-solids filter cake, and a filtrate with non-detectable levels of heavy metals. The filter cake also passed TCLP analysis to render it a non-hazardous waste (U.S. EPA, 1989).

A microfiltration treatability study was conducted on ground water samples from the SMC facility (Stone & Webster, 1991). The microfiltration system used for the treatability study was able to physically separate particles 0.2

microns or larger in size from smaller particles. Soluble hexavalent chrome passed through the membrane filter. The particles greater in size than 0.2 microns blocked by the membrane are collected in a concentrate tank and are subsequently dewatered using the filter press. The treatability study proposed that only ground water extracted from the wells identified during the treatability study as containing the fine particulate material (wells W9 and RW6D) be pretreated by the microfiltration system, with ground water extracted from all of the wells treated within the ion exchange system. While no chemical-specific effluent levels were reported in the supporting documents available for review, the study indicated membrane microfiltration could potentially be effective in the removal of colloidal particles prior to ion exchange.

5.3.10.2 Criteria Assessment

Short-Term Effectiveness - Short-term risks to workers under this alternative are not expected to be significant. Maintenance requirements for the system are not significant and consist mainly of periodic membrane replacement and sludge handling. No significant added risks to the adjacent community or the environment are anticipated as a result of treatment system installation or operation.

Long-Term Effectiveness and Permanence - The long-term effectiveness of the membrane microfiltration system is expected to be good. However, the treatment system produces a sludge that will require hazardous waste characterization and appropriate disposal. Long-term operation and maintenance of the treatment system is expected to pose no significant difficulties.

Implementability - The implementation of a membrane microfiltration system is good. Start-up is not expected to result in unanticipated technical problems. Its implementation is not expected to impact the implementation of any future remedial actions. Operational activities include maintenance of the membranes and sludge handling. The membranes have a limited life expectancy and may be subject to fouling. Administrative feasibility is expected to be good.

Reduction of Toxicity, Mobility or Volume Through Treatment - This alternative will provide a reduction in the toxicity of undissolved inorganic ground water contaminants through treatment, although it provides no treatment of dissolved contaminants and therefore requires additional treatment within the ion exchange system. The volume of contaminated media is reduced through removal of the inorganic particles from the ground water and subsequent production of a concentrated sludge residual. Since no chemicals are added, the sludge volume produced by this treatment system is generally less than that produced by chemical addition treatment systems. The sludge produced by the DuPont treatment system has passed TCLP tests at a Superfund site, thereby allowing for its disposal as a non-hazardous waste.

Compliance with ARARs - The ability of the treatment system to meet discharge ARARs/TBCs applicable to inorganic ground water contaminants is expected to be good, although additional treatment within the existing ion exchange system will be required to treat the dissolved inorganics. The efficiency of the system in treating all inorganics of concern and its ability to meet the proposed discharge to surface water permit conditions could be further defined by additional treatability study testing. The effluent from the treatment process will have to meet the applicable discharge requirements, as discussed in Sections 5.3.12 through 5.3.14. The treatment process itself must comply with the requirements of a New Jersey treatment works permit. Sludge transport and disposal would have to be in accordance with applicable waste transportation and disposal regulations.

Overall Protection of Human Health and the Environment - Option T7, when combined with the existing ion exchange treatment system, is expected to provide overall protection of human health and the environment through treatment of inorganic ground water contaminants. The long-term effectiveness and permanence and short-term effectiveness are expected to be good, and discharge ARARs/TBCs are anticipated to be achievable for most inorganic compounds of concern.

Cost - The major costs associated with Option T7 are the capital costs associated with the addition of the membrane microfiltration unit and associated operation and maintenance costs, including sludge disposal costs. The overall estimated cost includes $610,000 in direct capital costs, $120,000 in indirect capital costs and $1,600,000 in annual operation and maintenance costs ($6,800,000 net present value). The present worth value of this alternative, including contingency, is estimated at $9,000,000. A detailed cost estimate is presented in Appendix A.

5.3.11 Alternative 3 - Ground Water Treatment Option T8 - Electrochemical Treatment

5.3.11.1 Description

Option T8 involves the treatment of inorganic ground water contaminants using electrochemical methods. Electrochemical treatment is an inorganic removal method which is often used in industry although it has not been widely applied to ground water treatment. Treatability studies conducted at other sites have shown electrochemical treatment to be effective in the removal of many inorganics, including arsenic, beryllium, cadmium, chromium, cyanide, mercury, nickel, lead, antimony, selenium, vanadium, and silver (Andco, 1992). Effluent levels ranging from non-detectable to less than 50 ppb were commonly achieved in these studies.

In the electrochemical treatment process, an electric current passing through a sacrificial electrode generates ferrous ions (Fe^{+2}) within the wastewater stream. The ferrous ions then act as reducing agents for oxidized heavy metal species. The electric current also causes water to break down at the cathode, forming hydrogen gas and hydroxyl ions. The reaction results in the formation of ferric hydroxide and insoluble metal hydroxides which are then removed by adsorption onto the iron hydroxide precipitate that is formed.

In the case of chromium, ferrous ions produced at the anode act as a reducing agent for the hexavalent chromium (Cr^{+6}). The hexavalent chromium is reduced to trivalent chromium (Cr^{+3}), which is less toxic and is more readily precipitated as a hydroxide. Excess hydroxide produced in the reaction is available for precipitation of other heavy metal species.

A process flow diagram of an electrochemical reduction process offered by Andco Environmental Processes, Inc. is provided in Figure 5-10. Influent enters an equalization tank where, if necessary, the pH is adjusted to a neutral level. The water then passes through an electrochemical cell, where ferrous ions, hydroxide ions and hydrogen are produced. After exiting the electrochemical cell, the treated water containing the iron/metal hydroxide matrix enters a degassing tank where the hydrogen gas is allowed to effervesce from the liquid. Next the liquid enters a pH adjustment tank where the pH is adjusted to between 8.0 and 8.5 so ferrous ions will adsorb and coprecipitate the dissolved trivalent chromium. Hydrogen peroxide is also added to facilitate the oxidation of residual ferrous ions (Fe^{+2}) to ferric ions (Fe^{+3}) which precipitate as ferric hydroxide. The solution then enters a clarifier where a polyelectrolyte is added to promote flocculation/coagulation of the insoluble hydroxides. After settling out, the solids are dewatered within a filter press.

To remove small amounts of floc that exit the clarifier, the effluent may be further treated within a multi-media filtering system. In such a system, the effluent passes through a mix of media including garnet, filter sand, and several sizes of support media, where remaining particles down to 10 microns in size are removed.

A bench scale treatability study was performed by Andco to determine the effectiveness of the electrochemical treatment system in pretreating ground water at the SMC facility. The study indicated that the system would be capable of meeting a total chromium content (Cr^{+6} and Cr^{+3}) of less than 0.03 ppm in the effluent based on the 400 gpm flow rate. Pilot tests were subsequently conducted to further evaluate the effectiveness of the treatment system. Ground water samples from the SMC facility were used to run the tests. Most effluent samples exhibited less than 0.01 ppm Cr^{+6} and less than 0.05 ppm total chromium after treatment in the pilot test. The electrochemical cells were not found to be susceptible to variations in the ground water quality or to the presence of colloidal materials. Some of the pilot tests showed an increase in TDS following the electrochemical precipitation and TSS removal processes. Therefore, the ability of the treatment system to meet the existing discharge of 1000 mg/l without additional treatment (e.g., ion exchange) was considered to be possible but could not be confirmed. The proposed discharge to surface water permit condition is a daily maximum of 166 mg/l, which would be more difficult to achieve. Both bench-scale and pilot treatability study test results are presented in the Industrial Wastewater Treatment System Approval Application (TRC, 1992e). Also, because of the degassing process included in the electochemical treatment system, there is a potential for removal of strippable organic compounds within the electrochemical treatment process. Additional testing would be required to confirm this potential treatment.

As discussed in the introduction to this report (Section 1.0), in accordance with the requirements of the 1988 ACO, SMC evaluated inorganic treatment options using the evaluation process which is provided herein in Sections 5.3.9 through 5.3.11. Based on this evaluation process, the electrochemical treatment system has actually been implemented at the SMC facility and has been in operation since October 1992. It has been effective in the treatment of the chromium contamination within the ground water, achieving significantly lower effluent levels than were achievable using the previously existing treatment system. Operating data is being reported to NJDEPE on a monthly basis as part of the monthly well reports and Discharge Monitoring Reports (DMRs). Typical operating data for the month of May 1993 is presented in Appendix E-1, along with normal operating parameters.

Since the implementation of the electrochemical treatment system, NJDEPE has proposed surface water discharge permit conditions which are presented in Table 3-4. These proposed conditions are more stringent than previously applied surface water discharge requirements and include a maximum daily allowance of 5.8 ppb total chromium. While the electrochemical treatment system has successfully removed chromium from the extracted ground water, it has not consistently achieved this effluent level. The proposed discharge conditions also include a maximum daily total dissolved solids limitation of 166 ppm, which has not currently been achievable by the electrochemical treatment system.[1]

Therefore, a secondary evaluation of the potential means by which the proposed discharge to surface water permit conditions can be achieved was conducted. This evaluation is presented in Section 5.3.11.3, which follows the Criteria Assessment (Section 5.3.11.2).

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1 Shieldalloy has filed its comments and request for variance challenging these WQBEL ARARs for chromium and TDS.

5.3.11.2 Criteria Assessment

Short-Term Effectiveness - Short-term risks to workers under this alternative are not expected to be significant. Maintenance of the electrochemical cells and sludge handling are the major operation and maintenance activities associated with the electrochemical system. Maintenance of the cells requires cleaning of the sacrificial electrodes and their periodic replacement. No significant added risks to the adjacent community or the environment are anticipated as a result of treatment system installation or operation.

Long-Term Effectiveness and Permanence - The long-term risks associated with electrochemical treatment will be minimal based on the system's ability to treat the inorganic contaminants of concern. It is possible that electrochemical treatment could treat the inorganics within the wastestream without supplemental treatment using the existing ion exchange system, although supplemental treatment may be required to meet draft discharge to surface water permit conditions (see Section 5.3.11.3). The electrochemical treatment system produces a sludge that will require hazardous waste characterization and appropriate disposal. Long-term operation and maintenance of the treatment system is expected to pose no significant difficulties.

Implementability - The implementation of an electrochemical treatment system is good, although it requires construction of an additional on-site treatment facility. Start-up is not expected to result in unanticipated technical problems. Its implementation is not expected to impact the implementation of any future remedial actions. Operational activities include maintenance of the electrochemical cells and chemical supplies and sludge handling. Administrative feasibility is also expected to be good.

Reduction of Toxicity, Mobility or Volume Through Treatment - This alternative will provide a reduction in the toxicity of identified inorganic ground water contaminants through treatment. The volume of contaminated media is reduced through removal of contaminants from the ground water and subsequent production of a sludge residual.

Compliance with ARARs - The ability of the treatment system to meet ARARs applicable to inorganic ground water contaminants is expected to be very good, as based on bench scale and pilot testing. The effluent from the treatment process will have to meet the applicable discharge requirements, as discussed in Sections 5.3.12 through 5.3.14; supplemental treatment as discussed in Section 5.3.11.3 may be required. The treatment process itself must comply with the requirements of a New Jersey treatment works permit. Sludge transport and disposal would have to be in accordance with applicable waste transportation and disposal regulations.

Overall Protection of Human Health and the Environment - Option T8 is expected to provide overall protection of human health and the environment through treatment of inorganic ground water contaminants. It may possibly remove organic contaminants as well, without supplemental treatment. The long-term effectiveness and permanence and short-term effectiveness are expected to be good. ARARs/TBCs applicable to the discharge of treated water are anticipated to be achievable with supplemental treatment.

Cost - The major costs associated with Option T8 are the capital costs associated with the construction of an electrochemical treatment system and associated operation and maintenance costs, including iron electrode and sludge disposal costs. The overall estimated cost based on electrochemical treatment alone includes $1,200,000 in direct capital costs, $240,000 in indirect capital costs and $500,000 in annual operation and maintenance costs

($2,200,000 net present value). The present worth value of this alternative, including contingency, is estimated at $4,400,000. A detailed cost estimate is presented in Appendix A.

5.3.11.3 Secondary Treatment Analysis

As described in Section 5.3.11.1, an evaluation of the potential means by which the proposed discharge to surface water permit conditions can be achieved was conducted. This evaluation is presented in detail in Appendix E and is summarized in this section. The study includes an analysis of the following options: 1) Supplemental treatment using a technology such as ion exchange, reverse osmosis, or microfiltration/ultrafiltration to meet the proposed permit conditions; or 2) Upgrading the electrochemical treatment process to meet the proposed permit conditions. Each of these treatment processes is discussed below.

Ion-Exchange - The addition of an ion-exchange unit process may provide a means of polishing electrochemical treatment system effluent to achieve the proposed chromium effluent limit. Ion exchange is a reversible chemical reaction between a solid resin and a fluid where undesirable cations (positively charged particles) or anions (negatively charged particles) are replaced with, or bound to, more desirable ionic groups contained within the resin. Following the exchange process the resin must be regenerated to achieve its original properties or replaced. The goal of the treatment process is to replace, or bind, undesirable chromium cations (primarily Cr^{+3}) such that the final effluent contains less than 5.8 ppb total chromium. The existing ion exchange system at the SMC facility was previously depicted in Figure 5-2.

Ion-exchange resins consist of non-specific cationic resins or targeted chelation resins. Chelation resins are designed to selectively remove particular groups of metals from a solution by binding the metallic ions to nonmetallic groups within the structure of the resin. Removal of chromium to a level of below 5.8 ppb may be achievable using either type of resin. Factors such as chromium speciation, pH, contact time, competing ionic species present within the wastestream and other factors may affect performance and, therefore, bench or pilot scale tests would be appropriate to verify the effectiveness of any resin under consideration.

Treatability testing was conducted in April 1990 to evaluate the potential treatment of ground water using electrochemical treatment followed by ion exchange. The study was conducted by Andco using ground water samples from the SMC facility. The ground water samples were treated using electrochemical treatment, multi-media filtration and ion exchange. Tests were run at electrochemical iron (Fe^{2+}) addition levels of 75 ppm, 150 ppm and 350 ppm. The initial untreated ground water sample contained 20.5 ppm chromium and 1,100 ppm TDS. At 150 and 350 ppm Fe^{2+} addition, post-multi-media filter chromium concentrations were less than 15 ppb and TDS ranged from 570 to 830 ppm. Reductions in both chromium (to less than 4 ppb) and TDS concentrations (to 270 to 350 ppm) were noted after treatment with the cation exchange resin. TDS continued to decrease (to 25 to 41 ppm) following treatment by the anion exchange resin; however chromium levels increased slightly (9 to 11 ppb). Additional samples were collected following treatment in the anion exchange resin after approximately 15 minutes to help understand how the test set-up performed over time. These samples both exhibited less than 4 ppb chrome with TDS ranging from 28 to 160 ppm. Therefore, existing treatability study testing indicates that achievement of chromium and TDS proposed surface water discharge limitations may be achievable using ion exchange as a polishing technology. Additional testing would be required to determine if a cation resin alone would provide sufficient treatment of TDS and chromium such that the existing system could be operated as a fixed-bed system with only cation resins used for removal. The treatability study report is included in Appendix E-2.

To implement ion exchange at the SMC facility, the existing system could potentially be retrofitted to provide secondary treatment, although the applicability of the existing equipment would be dependent on the selected resin(s) and associated vendor. At a minimum, new ion exchange resin would have to be purchased and the existing system would have to be tied in to the electrochemical treatment unit. Capital costs are estimated to be around $150,000 with the approximate cost for ion-exchange resin alone on the order of $80,000. The costs associated with the operation and maintenance of the ion exchange system include the costs associated with brine disposal, and are estimated at approximately $500,000 annually.

The main advantage of using an ion-exchange resin to perform chrome polishing is the presence of existing ion-exchange equipment at SMC. Other advantages include the possibility of specifically targeting the removal of chromium and the potential removal of TDS. A disadvantage associated with ion exchange is the production, handling and disposal of acidic waste streams or brine produced by the resin regeneration process, which are expected to require disposal as a hazardous waste. Also, the TDS in the wastestream may cause early fouling of the resin.

Reverse Osmosis - Osmosis is the spontaneous flow of solvent (e.g., water) from a dilute solution through a semi-permeable membrane (impurities or solute permeates at a much slower rate) to a more concentrated solution. A certain amount of potential energy exists between the solutions on either side of the membrane. Flow will occur from the solution with the higher potential energy level (the purer water, referred to as the dilute solution) to the solution with the lower potential energy level (the less pure water, referred to as the concentrated solution). Reverse osmosis (RO) is the application of sufficient pressure to the concentrated solution to overcome the osmotic pressure and force the net flow of water through the membrane toward the dilute phase. This allows the concentration of solute (impurities, ions, small molecules) to be built up on one side of the membrane while relatively pure water is transported through the membrane. The driving force for separation is the applied pressure gradient. The solution passes across the membrane, and the pressure forces only a percentage of the solvent through the membrane, while some of the initial solution, enriched in solutes, remains to be carried away via the turbulent flow maintained at the surface of the membrane. Osmosis and reverse processes are depicted graphically in Figure 5-11.

The membranes used in RO are assembled into modules containing sheets (spiral wound), tubes or hollow fibers. The modules can be connected in series, in parallel, or a combination of the two. The most common RO membrane materials used are cellulose acetate and other polymers such as polyamides and polyether-polysulphones.

Similar to the non-selective ion exchange systems, RO systems are non-selective and would result in the removal of all ions and dissolved species greater than a certain particle size and containing a certain ionic charge. Operating conditions which affect the ability of reverse osmosis to achieve separation include:

- ionic charge of the separating species,
- pressure differential,
- the apparent or differential, osmotic pressure between the solutions, and
- the area and characteristics of the membrane.

In addition, the presence of colloidal and organic matter can clog the membrane surface, thus reducing the available surface area for permeate flow.

Overall membrane performance is affected by feed constituent concentrations, operating pressure and temperature, flow rate and pH. In general, flux and rejection data are not affected by changes in pH, but extreme pH values can limit the life of the membrane. The presence of low molecular weight, dissolved organics can present operational difficulties and may require pretreatment. Pretreatment techniques such as activated carbon adsorption may be required to extend service life.

Advantages of a RO polishing system would be the potential removal of chromium and TDS. In addition, once the systems are fabricated and installed, operational costs tend to be generally low due to the limited energy requirements of the pumping equipment.

Disadvantages of reverse osmosis membranes (cellulous acetate, aromatic polyamides, and thin film composites) are high capital cost, potential fouling problems, poor resistance to chlorine, and susceptibility to microbial attack. Operational upsets, pH changes and other conditions may limit the lifetime of the membrane. Reverse osmosis also produces a concentrated waste stream which would contain the separated chromium and other ionic species, and would most likely require off-site disposal/treatment as a hazardous waste. Operation and maintenance costs, estimated at approximately $300,000 annually, will include membrane replacement, waste disposal and electricity costs.

Rough estimates indicate that design and construction of a reverse osmosis system for a 400 gpm process effluent may cost on the order of $1,000,000. Prior to implementation, preliminary bench scale testing of the process to assess its applicability to the electrochemical system effluent would be required.

Microfiltration/Ultrafiltration - Membrane microfiltration was previously discussed in Section 5.3.10 with respect to providing pre-treatment prior to ion exchange. This discussion focuses on the applicability of microfiltration/ ultrafiltration as a polishing step following electrochemical treatment.

In general, filtration removes particles down to about 1 micron, whereas microfiltration may remove solids down to about 0.01 microns in diameter and ultrafiltration may be effective for particles as small as 0.001 microns in diameter. The basic driving force behind microfiltration is pressure. Microfiltration discriminates on the basis of molecular size, and shape and is used to physically remove particles and ions from solutions. This is a physical process where all matter larger than a certain size is unable to pass through the filtration system. Therefore, larger particles or ions are retained on the influent side of the filtration system, while filtered fluid is able to pass through the membrane.

Microfiltration essentially relies on chemical pretreatment in which precipitation is followed by a series of filtration steps which results in the non-selective removal of particles. Ultrafiltration systems are typically operated at pressures ranging from 10 to 100 psig, resulting in flow rates that are several orders of magnitude below conventional filtration processes, but with the retention of much smaller sized particles (10 to 200 angstroms). Therefore, ultrafiltration is not sufficient by itself to remove dissolved ionic species such as metal ions. However, both ultrafiltration and microfiltration are capable of effectively collecting colloidal metal suspensions following precipitation of dissolved metal ions. Available background information indicates that removal of chromium to less than 10 ppb may be achievable with this technology, depending on the specific characteristics of the wastestream.

As with reverse osmosis membranes, ultrafiltration membrane systems can consist of tubular, hollow fiber, plate-type or spiral-wound units. Turbulent flow at the membrane surface can carry rejected solids back to the beginning of the system or, in the case of a plate system, the system can be operated cyclically, with accumulated solids discharged with each operating cycle. The residual filter cake requires off-site disposal. A diagram of the Dupont/Oberlin microfiltration system was previously presented in Figure 5-9.

Advantages to microfiltration systems are the generally lower pressures required for filtration as compared to RO systems, the generally wider selection of materials of construction from which filter membranes are fabricated, and the non-selective nature of the process where other undesirable materials may be removed from the waste stream. Disadvantages include the inability of the system to treat dissolved inorganics, and the high initial design and capital cost to fabricate such a system. Also, an ultrafiltration system may have difficulty treating the flow rate at the SMC facility and, therefore, multiple units may be required.

Available rough estimates indicate that the approximate cost to design and build an ultrafiltration system for a 400 gpm process stream would be on the order of $700,000 to $1,000,000. Operation and maintenance costs can average over $100,000 to $500,000 per year.

Existing Electrochemical Treatment System Modifications

This option would involve modifying the existing Andco electrochemical precipitation system (see Figure 5-10) to meet the 5.8 ppb discharge limit for total chromium. A review of existing process data indicates that modification of process stream conditions may result in the attainment of the proposed chromium effluent limit. Background process data which support this position include results of a March 1990 bench scale and a May 1993 full-scale 24-hour operational test. Each of these tests is described below.

A bench-scale test conducted by Andco in March 1990 resulted in an effluent chromium concentration of 1.9 ppb when an 18-fold stoichiometric excess (20 ppm chromium, 350 ppm ferrous ions) of ferrous ions was maintained in the treatment system. Other bench-scale process conditions which helped to achieve the low chromium concentration within the effluent included the addition of a polyelectrolyte to aid floc formation and clarification. Results of the March 1990 bench-scale testing are provided in Appendix E-5.

A 24-hour, full-scale treatment test was conducted using existing process equipment on May 22, 1993. Process conditions for this test included an influent ground water flow rate of 401 gallons per minute (gpm) from the five extraction wells. This flow was increased by the addition of recycle streams to a total process flow rate of approximately 450 gpm. The influent chromium concentration was 10 ppm. Treatment was conducted at a five-fold excess of ferrous ions to chromium ions at a pH ranging from 7.6 to 7.9. Hourly samples of treated effluent were analyzed by SMC's internal laboratory, by a laboratory (E&E) contracted by Andco, the treatment system manufacturer, and an independent "referee" laboratory (National Environmental Testing, Inc.). Results of this analysis are summarized in Table E-2 of Appendix E-1. Chromium was not detected in the samples analyzed by E&E and NET (each lab had a detection limit of 10 ug/l or ppb). Analyses conducted by SMC's laboratory exhibited total chromium levels ranging from non-detectable (less than 1.0 ppb) to 15.1 ppb. Process conditions and analytical results of the 24-hour pilot test are provided in Appendix E-5.

While variations in operational parameters (pump operation, cycle periods, etc.) have been used to optimize system operation, the reliability of operating the electrochemical system to consistently achieve a level of chromium in the effluent which is less than 5.8 ppb has not been demonstrated. When contacted regarding potential improvements to the system to lower chromium effluent levels on a consistent basis, the manufacturer indicated that achievement of treatment levels in the single part per billion range is not a normal operating requirement. While modification of the system can likely attain the desired effluent level (5.8 ppb total chromium) on a consistent basis, operating data (other than SMC's 24-hour test) are not available to verify removal rates below about 10 ppb. The basic reason for this data gap is that most chromium treatment processes are not required to treat to levels below about 50 ppb. Also based on chromium's practical quantitation limit (PQL) of 10 ppb, standard water analyses run on other operating systems are typically not sensitive enough to detect such a level of treatment. The system is not expected to comply with proposed TDS surface water discharge permit conditions under normal operating procedures.

Advantages to utilizing the existing electrochemical precipitation system to attain the proposed chromium discharge to surface water permit conditions include; the presence of the process equipment on-site and on-line; the familiarity of SMC personnel with the existing equipment; the relatively low capital costs associated with any required modification of the existing system; and the documented performance of the system to achieve the proposed chromium limit under test conditions.

The major disadvantage is the anticipated increased consumption of iron electrodes necessary to achieve conditions suitable for removal of chromium to below 5.8 ppb. Increased electrode consumption would increase sludge generation. A series of preliminary calculations indicate that at normal operating conditions (9 ppm hexavalent chromium, 45 ppm ferrous ion concentration, 450 gpm flow), a total of approximately 80 cubic feet of metal hydroxide sludge (30% weight percent solids) should be produced per day. If process conditions were modified to achieve a 15- to 20-fold stoichiometric excess of ferrous to chromium ion concentration, sludge generation could increase approximately three- to four-fold. Other factors which would change as a result of process stream modifications would be the increased consumption of the sacrificial iron electrodes, the increased need for hydrogen peroxide to oxidize residual ferrous ions, and increased power consumption required to produce the necessary ferrous ion concentration. Additional filtration capacity would also be required. Capital costs for system modification are estimated at approximately $100,000 for filtration improvements and annual O&M costs are estimated to be approximately $140,000 based on increased operating costs and additional sludge disposal.

In summary, modifications of the existing electrochemical treatment system would appear to be relatively easy to implement, and capital cost-effective in achieving the proposed chromium discharge to surface water permit condition. However, the long-term reliability of the system to consistently achieve this level is unknown at this time and the inability of the treatment system to achieve proposed TDS discharge to surface water permit conditions is a disadvantage.

Comparative Evaluation - This section presents a brief comparative evaluation of each of the four identified treatment technologies on the basis of the following criteria:

- Effectiveness,
- Implementability, and
- Cost.

A summary of the comparative analysis is provided in Table 5-14.

Each of the four treatment technologies may be effective in reducing the total chromium content of the effluent stream to below 5.8 ppb, depending on the type of separation process used and its associated applicability to the physical state of the chromium in the electrochemical system effluent. In general, treatability data for these additional systems which demonstrate chromium removal rates below 10 ppb typically are not available.

Of the four treatment technologies outlined above only modification of the Andco system and addition of a chelation ion exchange resin have the capability to selectively remove heavy metals such as chromium from the effluent. The Andco system is not expected to provide adequate removal of TDS to meet the proposed surface water discharge permit conditions. The effectiveness of the ion exchange system in providing primary treatment of the ground water was limited based on the presence of colloidal particles in the wastestream; the potential for fouling of the resins as a result of treating the electrochemical treatment system effluent is currently undefined. Preliminary treatability study testing indicates an ion exchange system may be able to meet both chromium and TDS effluent conditions. The Andco system produces a non-hazardous waste while the ion exchange waste is expected to be hazardous.

The other two technologies, reverse osmosis and microfiltration/ultrafiltration are non-specific in their removal capabilities. The microfiltration/ultrafiltration technology would not be effective in removing dissolved species. The reverse osmosis waste is expected to be hazardous while the microfiltration waste will require characterization to determine if it is hazardous.

Implementability refers to the technical and administrative feasibility of implementing a remedy. Given the presence of the Andco treatment system at the site, and the available process equipment for ion-exchange present at the SMC facility, these two options are clearly more readily implemented than reverse osmosis and microfiltration systems. Initial treatability study testing of the Andco and ion exchange treatment systems has been completed. Design and pilot scale development of the reverse osmosis and microfiltration systems would likely take a longer time period as compared to modification of the Andco system or evaluation of alternate resin systems.

As noted within the descriptions of each of the four treatment technologies, capital and especially operations and maintenance costs may be quite variable for each system. However, the capital cost required for design and construction of either a microfiltration or reverse osmosis system is far greater than that required to either modify the existing electrochemical precipitation process or add an ion exchange unit process to the existing system. Therefore, selection of either the existing system modification or addition of an ion exchange system would be most cost-effective in the short-term. Long-term operational costs are more difficult to define based on existing data.

<u>Conclusions</u> - Based on the information presented above, as well as that presented in Appendix E, it appears technically possible to achieve a total chromium content in the electrochemical treatment system effluent of less than 5.8 ppb using several technologies. The following two technologies offer the best combination of:

- Modification of the existing Andco Electrochemical Treatment Unit, and
- Ion Exchange.

Additional study through bench-scale, or, in the case of electrochemical treatment, possibly full-scale tests is recommended to further establish the best technology.

5.3.12 Alternative 3 - Discharge Option D1 - Discharge to Ground Water

5.3.12.1 Description

Option D1 involves the recharge of treated ground water back to the ground. Recharge of approximately 400 gallons per minute will require a comprehensive reinjection system.

For the purposes of this evaluation, a recharge system consisting of two open basins is proposed, based on ground water modeling Simulation 5, as presented in Appendix B. For the purposes of this evaluation, one basin, approximately three acres in size and essentially an eastward extension of the existing SMC thermal pond, is assumed to receive treated water discharge for 4.5 days; the other basin, approximately two acres in size and located on SMC-owned property along Weymouth Road in Newfield, is assumed to receive discharge for 3.0 days. Proposed basin locations are indicated in Figure 5-11. Discharge of the treated ground water would be rotated between the two basins according to such a schedule. Additional investigations would be required during the conceptual design stage to further refine the proposed recharge system.

The recharge basin locations were selected from available areas based on their positions relative to the area of shallow ground water total chromium contamination. The establishment of shallow ground water mounds in these areas could result in increased hydraulic gradients between the mounds and the extraction wells, which would speed the flushing of shallow ground water contaminants downgradient of the mounds. An additional component of this option would involve the installation and monitoring of a network of piezometers or monitoring wells around the basins, to assess the mounding impact upon the shallow ground water adjacent to the basins.

An additional model, Simulation 6, involved directing most (350 gpm) of the treated discharge to the two large recharge basins; in addition, the remaining 50 gpm of treated discharge would be directed to SMC Lagoons B-6, B-7 and B-8. The intent of developing a scenario which involves discharging into the lagoons was to enhance the flushing of chromium in the shallow ground water downgradient of the lagoons. Implementation of this scenario could be further evaluated pending future cleanup of the lagoons, which would be required before this option could be implemented.

5.3.12.2 Criteria Assessment

Short-Term Effectiveness - Short-term risks to workers under this alternative are not expected to be significant. Installation of the reinjection system and piezometers should be in uncontaminated areas, thereby limiting exposure risks. The reinjection system will need to be monitored and maintained to ensure continuous recharge of treated ground water. Since only treated ground water will be reinjected by the system, no significant added risks to the adjacent community or the environment are anticipated.

Long-Term Effectiveness and Permanence - The long-term risks associated with ground water reinjection will be minimal, provided the treatment system is operating properly. The reinjection system may enhance the ground water extraction system by flushing contaminants toward the extraction wells. Additional testing could provide a better indication of the system's effectiveness. Long-term operation and maintenance of the treatment system is likely to pose problems due to clogging or due to the volume and rate at which the treated ground water would be reinjected. Long-term monitoring of the discharge water quality and of the shallow ground water mounding effects will be required.

Implementability - The implementation of the recharge system requires installation of an extensive reinjection system and associated piping.

Maintenance of the system will be key to its continued operation. Continued monitoring of the discharged water quality and of the shallow ground water mounding will be required. The administrative feasibility of discharging treated ground water back to the ground is good, provided compliance with the requirements of a discharge to ground water permit is maintained.

Reduction of Toxicity, Mobility or Volume Through Treatment - This alternative could enhance the performance of the ground water extraction system, although it will not provide an actual reduction in the toxicity, mobility or volume of ground water contaminants.

Compliance with ARARs - The ground water quality of the effluent from the treatment process will have to meet the requirements of a discharge to ground water permit. The ability of the alternative to meet these requirements will be dependent upon the treatment technology selected and the contaminant-specific effluent requirements.

Overall Protection of Human Health and the Environment - Option D1 could provide overall protection of human health and the environment through enhancement of the ground water extraction system by the flushing action of the recharged ground water. The long-term effectiveness and permanence of this option are limited by the potential operational problems associated with a ground water recharge system.

Cost - The major costs associated with Option D1 are the capital costs associated with the reinjection system and piezometer network installation and long-term operation and maintenance costs. The overall estimated cost includes $210,000 in direct capital costs, $30,000 in indirect capital costs and $220,000 in annual operation and maintenance costs ($950,000 net present value). The present worth value of this alternative, including contingency, is estimated at $1,400,000. A detailed cost estimate is presented in Appendix A.

5.3.13 Alternative 3 - Discharge Option D2 - Discharge to Surface Water

5.3.13.1 Description

Option D2 involves the discharge of treated ground water to surface water, which in this case would be the Hudson Branch tributary of the Maurice River. Ground water would be discharged directly via the existing discharge pipe to existing Outfall 001. The discharge rate will be approximately 400 gallons per minute. Implementation of discharge to the surface water is expected to have little, if any, effect on the ground water extraction and treatment system. Proposed discharge to surface water permit conditions are presented in Table 3-4.

5.3.13.2 Criteria Assessment

Short-Term Effectiveness - Short-term risks to workers under this alternative are not expected to be significant since no construction is required. Maintenance of the system will require maintenance of the piping and discharge monitoring. No significant added risks to the adjacent community or the environment are anticipated.

Long-Term Effectiveness and Permanence - The long-term risks associated with discharge to surface water will be minimal, provided the treatment system is operating properly. Long-term operation and maintenance of the discharge piping is not expected to pose any major technical problems. Long-term monitoring of the discharge water quality will be required.

Implementability - The implementation of a discharge to surface water system is very good since it utilizes the existing discharge system. Maintenance of the system will be limited. Continued monitoring of the discharged water quality will be required. Administrative feasibility of discharging treated ground water to surface water depends on the treatment system's ability to meet surface water discharge criteria.

Reduction of Toxicity, Mobility or Volume Through Treatment - This alternative is not expected to significantly impact the extraction or treatment system; therefore, it has little impact on the toxicity, mobility or volume of contamination.

Compliance with ARARs - The water quality of the effluent from the treatment process will be required to meet the requirements of a discharge to surface water permit. Draft permit conditions were previously presented in Table 3-4.

Overall Protection of Human Health and the Environment - Option D2 would provide overall protection of human health and the environment when combined with ground water extraction and treatment. The long-term effectiveness and permanence of this option are expected to be good, due to its simplicity.

Cost - The major costs associated with Option D2 are the on-going maintenance and discharge monitoring costs associated its implementation. The overall estimated cost includes $210,000 in annual operation and maintenance costs ($890,000 net present value). The present worth value of this alternative, including contingency, is estimated at $1,100,000. A detailed cost estimate is presented in Appendix A.

5.3.14 Alternative 3 - Discharge Option D3 - Combined Discharge to Surface Water and Ground Water

5.3.14.1 Description

Option D3 involves the combined discharge of treated ground water to both the surface water and the ground water. The existing surface water discharge system would be utilized but construction of a discharge to ground water system would also be required. While this discharge option was not specifically modeled under the simulations presented in Appendix B, it could be considered to be a combination of discharge to surface water using the existing discharge system and discharge to ground water using recharge basins, similar to that evaluated under Simulation 5 in Appendix B. The discharge rate will be approximately 400 gallons per minute. Implementation of a combined discharge to surface water and ground water system could speed the flushing of ground water contamination downgradient of the reinjection system while also offering flexibility in terms of requiring less recharge capacity as well as the potential ability to maintain discharge to the surface water should shut-down of the reinjection system for maintenance be required. This alternative includes the installation of piezometers or monitoring wells near the recharge basins to provide monitoring of mounding effects.

5.3.14.2 Criteria Assessment

Short-Term Effectiveness - Short-term risks to workers under this alternative are not significant. Construction of a discharge to ground water system will be required but it will be in an area which has exhibited no contamination, thereby posing little environmental risks. Maintenance of the system will consist of discharge monitoring and maintenance of the ground water recharge system. No significant added short-term risks to the adjacent community or the environment are anticipated as a result of implementation.

Long-Term Effectiveness and Permanence - The long-term risks associated with a combined discharge to surface and ground water will be minimal, provided the treatment system is operating properly. Long-term operation and maintenance of the discharge system is not expected to pose any major technical problems, although there is a potential for clogging of the ground water recharge portion of the discharge system. Long-term monitoring of the discharge water quality will be required.

Implementability - The implementation of a combined discharge to both ground water and surface water requires installation of the associated ground water recharge and piping system. The administrative feasibility of discharging treated ground water to both the ground and surface water will be dependent on the treatment system's ability to meet both ground water discharge and surface water discharge effluent requirements.

Reduction of Toxicity, Mobility or Volume Through Treatment - The ground water recharge component of this discharge alternative may assist in the flushing of contamination towards the extraction wells; otherwise, it has little impact on the toxicity, mobility or volume of contamination.

Compliance with ARARs - The ground water quality of the effluent from the treatment process will have to meet the requirements of both ground water discharge and surface water discharge permits.

Overall Protection of Human Health and the Environment - Option D3 would provide overall protection of human health and the environment when combined with ground water extraction and treatment. The long-term effectiveness and permanence of this option are expected to be good, although the ground water recharge component of the alternative may require additional maintenance to prevent clogging.

Cost - The major costs associated with Option D3 are the capital costs associated with the installation of the discharge to ground water system and the long-term discharge monitoring costs. The overall estimated cost includes \$210,000 in direct capital costs, \$30,000 in indirect capital costs and \$250,000 in annual operation and maintenance costs (\$1,100,000 net present value). The present worth value of this alternative, including contingency, is estimated at \$1,600,000. A detailed cost estimate is presented in Appendix A.

5.4 Comparative Analysis of Alternatives

In this section, the strengths and weaknesses of the alternatives and technology options relative to one another are discussed for each of the analysis criteria. In each discussion, the alternative or option which provides the best overall performance in that category is discussed first, followed by the other alternatives discussed in the relative order in which they perform. These comparisons of alternatives are also presented in summary form in Tables 5-6 through 5-12.

In selecting the remedy for the site, overall protection of human health and the environment and compliance with ARARs (unless grounds for invoking a waiver are provided) are threshold criteria that must be satisfied by the selected alternative. For chemical-specific ARARs, compliance of treatment technologies with proposed surface water discharge criteria (TBCs) will be evaluated. Long-term effectiveness and permanence, reduction of toxicity, mobility or volume through treatment, short-term effectiveness, implementability and cost are primary balancing criteria, with the NCP placing special emphasis on long-term effectiveness and reduction of toxicity, mobility or volume through treatment. Community acceptance, to be determined at the end of the public comment period, and federal acceptance, to be determined on the basis of support agency comments, are modifying criteria that may have significant input in the final remedy selection.

The comparative analyses of the remedial alternatives and technology options for each of the evaluation criteria follow.

5.4.1 Short-Term Effectiveness

Those alternatives which provide short-term achievement of remedial response objectives while minimizing short-term risks and environmental impacts are considered to be the most effective with respect to this criterion. None of the three alternatives result in significant risks to remedial workers, the community or the environment as a result of implementation. Therefore, short-term achievement of remedial response objectives provides the main determination of short-term effectiveness.

Alternative 3, which provides initiation of an enhanced ground water extraction and treatment system with minimal associated risks and environmental impacts, is considered to offer the greatest short-term effectiveness. Alternative 2, which also provides ground water treatment but at a lower extraction and treatment rate, does not provide the same degree of short-term effectiveness as Alternative 3. Alternative 1, the no action alternative, is not effective in the short-term.

For the ground water extraction options of Alternative 3, Option E1, use of the existing extraction system, provides the greatest short-term effectiveness since it requires installation of only one extraction well and minimal piping, and therefore has limited short-term risks associated with its implementation. Implementation of Option E2 requires the installation of one deep and three shallow extraction wells and associated piping. Once operating, however, it would be more effective than Option E1 in meeting remedial response objectives because it would provide additional downgradient capture of shallow chromium-contaminated ground water as well as capture of contamination within a shorter time frame, closer to the potential contaminant source area(s).

For the organic treatment options of Alternative 3, all treatment options are expected to achieve remedial response objectives within comparable time frames. Option T2, air stripping, is expected to have the greatest short-term effectiveness. This option involves the use of an existing on-site treatment system; therefore few risks are posed by its implementation. Air stripping is followed by Option T3, carbon adsorption, a readily available treatment technology that could be quickly employed, and which results in no emissions on-site, thereby presenting minimal risks to remedial workers, the community and the environment. Option T4 will provide destruction of most contaminants but, because UV oxidation systems are not as widely available as carbon or air stripping units, short-term implementation may not be as good and potential technical problems may result when implemented.

For the inorganic treatment options of Alternative 3, none of the treatment options are expected to present unacceptable risks to remedial workers or the public. While Option T6, coagulation and flocculation, is more readily available than Option T7, membrane microfiltration, and Option T8, electrochemical treatment, it may not be as effective in the short-term achievement of remedial response objectives, based on initial treatability study reports. Of the supplemental treatment options evaluated under Option T8, ion exchange and modified electrochemical treatment are the most easily implemented and therefore would offer the greatest effectiveness in the short-term.

For the discharge options of Alternative 3, Option D2, discharge to surface water, has the greatest short-term effectiveness, due to its relative ease of implementation based on the existing discharge piping. It is followed by combined discharge to the surface water and ground water, Option D3, and discharge to ground water, Option D1, both of which require construction of a recharge system. None of the discharge options are expected to pose unacceptable risks to remedial workers or the surrounding community.

5.4.2 Long-Term Effectiveness and Permanence

The alternative which poses the least residual risk due to untreated waste or treatment residues, or the greatest capability for controlling these risks, is considered to provide the greatest long-term effectiveness and permanence.

Alternative 3 is considered to provide the greatest long-term effectiveness and permanence through the optimization of the ground water restoration program. This alternative minimizes residual risk within the shortest time frame by providing extraction, treatment and discharge of ground water.

Alternative 2 is less effective in the long-term since ground water extraction and treatment are provided at a reduced rate. Exposure risks are limited to some extent through the existence of a well restriction area downgradient of the facility. Long-term monitoring provides a means of continued evaluation of ground water quality.

Alternative 1 is the least effective alternative in the long-term since no ground water treatment is provided and no protection against potential exposures is provided, except through the existence of a well restriction area downgradient of the facility. A five-year review of this alternative choice would be required since contamination is not remediated.

For the ground water extraction options of Alternative 3, Option E2, modified ground water extraction, provides the greatest long-term effectiveness since it provides the greatest degree of capture of shallow and deep chromium-contaminated ground water as well as capture nearer to the potential contaminant source area(s). It is more likely to achieve ground water cleanup standards within a shorter time frame and thereby require less long-term management and maintenance.

For the organic treatment options of Alternative 3, Option T2, air stripping, is expected to have the greatest long-term effectiveness because it treats contaminated ground water on a continual basis, with no residual handling or potential for contaminant breakthrough. This option will treat both chlorinated and aromatic organic compounds. Option T3, carbon adsorption, is also expected to be effective in the long-term based on its demonstrated treatment efficiencies for the contaminants of concern. Residual risks are expected to be minimal based on the regeneration and thermal destruction of contaminants adsorbed to the carbon. Option T4, UV oxidation, also results in the destruction of chlorinated and aromatic compounds; however, it requires greater monitoring of the treatment process to ensure treatment is achieved.

For the inorganic treatment options, the greatest long-term effectiveness is offered by Option T8, electrochemical treatment, because it provides the greatest degree of contaminant level reduction within the wastestream (based on treatability studies). In combination with ion exchange, or potentially by itself with process modifications, it is expected to achieve proposed discharge to surface water permit conditions. Option T7, membrane microfiltration, is also expected to provide a significant degree of treatment although effluent levels may not be as low as those measured for Option T8. Option T6, coagulation and flocculation, is expected to provide the least degree of long-term effectiveness based on the minimal degree of treatability reportedly measured in treatability studies. All three of these options produce a residual sludge material which will require off-site disposal. Option T7 would provide the least amount of residual sludge because it requires no chemical addition. Both Options T7 and T8 may produce a sludge that is not classified as a hazardous waste, thereby resulting in lesser residual risks.

For the discharge options of Alternative 3, discharge to surface water, Option D2, has the greatest long-term effectiveness due to its relative ease of implementation and operation. Long-term management and maintenance would be minimal. It is followed by combined discharge to the surface water and ground water, Option D3, which offers flexibility in terms of operation due to its two discharge methods and which also could provide a degree of hydraulic control through ground water recharge. Option D1, discharge to ground water, also provides a degree of hydraulic control but its long-term effectiveness may be affected by potential operational problems. Additional site characterization would be required during conceptual design to confirm the ability of the proposed system to recharge ground water at the assumed recharge rates.

5.4.3 Implementability

Those alternatives which offer the greatest technical feasibility, administrative feasibility, and service and material availability are considered to be most implementable.

Alternative 1, the no action alternative, is the most implementable, involving no implementation activities other than a round of ground water monitoring prior to conducting a five-year review of the alternative.

Alternative 2 requires the continued operation of the existing ground water restoration system, and continued enforcement of the downgradient well restriction area. Because these features are currently in-place, implementability is very good.

Alternative 3 is the least implementable of the three alternatives but it is still relatively easy to implement, depending on the extraction, treatment and discharge options selected.

For the ground water extraction options of Alternative 3, Option E1, use of the existing extraction system, is the most implementable because it involves the use of existing extraction wells supplemented by only one additional well. Option E2 would require the installation of four extraction wells, but is still technically feasible to implement. The administrative feasibility of both Options E1 and Option E2 is expected to be good.

For the organic treatment options of Alternative 3, Option T2, air stripping is expected to be the most implementable treatment option since an existing air stripper is available on-site. Operation and maintenance requirements are limited to blower maintenance and discharge monitoring. Option T3, carbon adsorption, is second in terms of implementability. This technology is readily available and easily set-up and implemented. It has additional operation and maintenance requirements in that replacement and handling of the spent carbon is required. Option T4 is last in terms of implementability based on its more limited availability, operation and maintenance requirements (lamp replacement and cleaning and maintenance of hydrogen peroxide supply) and greater potential for implementation problems.

For the inorganic treatment options of Alternative 3, all options considered require the handling of a residual sludge material. Option T6, coagulation and flocculation, is the most easily implemented option based on the availability of unit treatment processes. Option T7, membrane microfiltration, and Option T8, electrochemical treatment, are not as widely available but will be more effective in meeting remedial response objectives. Of the supplemental treatment technologies evaluated in association with Option T8, ion exchange or electrochemical treatment system modification would be most easily implemented.

For the discharge options of Alternative 3, all discharge options will require compliance with regulatory requirements for the associated type of discharge (i.e., discharge to surface water, ground water, etc.). Discharge to surface water, Option D2, has the greatest implementability based on the existing surface water discharge system. Combined discharge to surface water and ground water, Option D3 and discharge to ground water, Option D1, are less technically implementable based on the significant flow rate which must be handled and demonstrated operational problems associated with reinjection systems.

5.4.4 Reduction of Toxicity, Mobility or Volume Through Treatment

Alternative 3 provides the greatest reduction of toxicity, mobility or volume through the optimization of a modified ground water restoration system. Alternative 2 also provides ground water restoration but not to the same degree as Alternative 3 because of the lower extraction rates and use of existing extraction wells. Alternative 1 does not provide any reduction in toxicity, mobility or volume through treatment.

For the ground water extraction options of Alternative 3, both options will provide a reduction of the mobility of contaminated ground water through containment via pumping. Option E2 will provide the greatest reduction in mobility by utilizing extraction wells optimally placed to provide capture of identified ground water contamination close to potential contaminant source area(s). Option E1 may not provide the same degree of contaminant capture using the existing extraction wells and may result in significant contaminant dispersion prior to extraction.

For the organic treatment options of Alternative 3, Option T3, carbon adsorption, and Option T4, UV oxidation, provide the greatest protection against the contaminants of concern, with the contaminants ultimately destroyed as a result of off-site thermal carbon regeneration or within the UV oxidation treatment process itself. Option T2, air stripping, is also expected to provide a significant reduction in contaminant toxicity. While the contaminants are not destroyed by the treatment process itself, the principal contaminants of concern are removed from the ground water and pose little residual risk due to natural attenuation.

For the inorganic treatment options of Alternative 3, all options produce an inorganic sludge requiring off-site disposal. Option T8, electrochemical treatment, is expected to provide the greatest reduction of toxicity by providing the greatest degree of removal of inorganic contamination from the extracted ground water (based on treatability studies). Greater contaminant removals could be achieved through modification of the electrochemical treatment system or through the provision of supplemental treatment such as ion exchange. Option T7, membrane microfiltration, is expected to be effective in the removal of inorganic contaminants currently fouling the operation of the existing ion exchange system and will require operation of the ion exchange system to meet toxicity reduction requirements. For Option T6, coagulation and flocculation, initial studies have indicated that it may not be effective in reducing the toxicity of inorganic contaminants sufficiently to meet discharge requirements.

The discharge options of Alternative 3 generally have no effect on the toxicity or volume of contaminated ground water, although they may provide some control over contaminant migration. Option D1, discharge to ground water, could potentially enhance the control of contaminant migration by flushing contaminants towards the extraction wells. Option D3, combined discharge to surface water and ground water, could also provide this effect. Option D2, discharge to surface water, would have little or no impact on contaminant mobility.

5.4.5 Compliance with ARARs

Those alternatives which offer the greatest overall compliance with potential chemical-specific, location-specific and action-specific ARARs are considered to offer the best performance under this criterion. The potential compliance of treatment systems with proposed discharge to surface water permit conditions, to be considered criteria (TBCs), is discussed. Location-specific ARARs potentially applicable to remedial actions at the SMC site include floodplain, wetland, and farmland protection requirements. These ARARs would apply to any alternatives or options which require construction within floodplain or wetland areas or which impact significant farmland areas. Construction activities associated with the remedial actions evaluated herein are not expected to impact historic or cultural features, although additional studies will be conducted at the SMC facility to further define the applicability of location-specific ARARs. A summary of potentially applicable ARARs was presented in Section 2.0.

It should also be noted that under certain cases, compliance with ARARs may be waived. These cases include situations where the alternative is an interim measure and will become part of a total remedial action that will attain ARARS, where compliance with the requirement will result in greater risk to human health or the environment than other alternatives, where compliance is technically unpracticable from an engineering perspective, or where the alternative will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, through use of another method or approach.

Alternative 3 will provide the greatest degree of compliance with ARARs. Depending on the extraction technology option chosen for this alternative, compliance with chemical-specific ARARs for ground water is expected to be achievable. Compliance with discharge to surface water TBCs may be more difficult and is dependent on the treatment technology. The remedial technology options are expected to comply with applicable action-specific ARARs, while construction activities will comply with location-specific ARARs.

Alternative 2 may not achieve chemical-specific ARARs for ground water or proposed discharge criteria based on the current ground water extraction rate and the operational problems historically associated with the existing treatment system.

Alternative 1 is not expected to provide compliance with chemical-specific ARARs due to the lack of ground water treatment. Action-specific and location-specific ARARs would not be applicable to this alternative since it involves no implementation activities.

For the ground water extraction options of Alternative 3, Option E2 is expected to provide capture of shallow and deep ground water contaminated with chromium at levels exceeding ARARs. Modification of the proposed extraction system may be required following completion of additional site investigations. Option E1 may not capture chromium-contaminated ground water in the vicinity of wells SC3S or SC26S. Location-specific ARARs governing construction activities are potentially applicable to well installation activities associated with both options. Both options will also comply with action-specific ARARs such as water allocation regulations and well installation permit requirements.

For the organic treatment options of Alternative 3, compliance with chemical-specific, location-specific and action-specific ARARs and TBCs is considered to be achievable for all treatment options. For Option T2, discharges from the air stripping unit would be in compliance with air discharge regulations. For Option T3, handling and treatment of the spent carbon would be conducted in compliance with the appropriate hazardous waste management regulations. Option T4 produces no treatment residuals which require handling. Construction of all treatment options would meet location-specific ARARs.

For the inorganic treatment options of Alternative 3, compliance with chemical-specific TBCs is considered to be most achievable for Option T8, electrochemical treatment, based on the reductions in contaminant levels achievable during treatability study testing. Modification of the electrochemical treatment system or supplemental treatment such as ion exchange would further ensure compliance with surface water discharge TBCs, although modification of the electrochemical treatment system may not provide sufficient removal of TDS. Option T7, membrane microfiltration, may also meet chemical-specific ARARs when operated in conjunction with the existing ion exchange system. Preliminary testing indicates that Option T6, coagulation and flocculation, may not be effective in meeting chemical-specific TBCs. Construction of any of the inorganic treatment systems would require compliance with location-specific ARARs and operation would be in compliance with applicable action-specific ARARs.

For discharge options, compliance with chemical-specific ARARs/TBCs is dependent on the final discharge criteria and the ability of the treatment technology to meet these criteria. With respect to location-specific ARARs, Option D2 would be least impacted since it uses an existing surface water discharge system. Options D1 and D3 would have to be designed in accordance with floodplain, wetland and farmland protection requirements. All discharge options would be required to meet associated discharge (action-specific) requirements.

5.4.6 Overall Protection of Human Health and the Environment

This criterion considers the previous criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs, and provides a final overall assessment of whether the alternative provides adequate protection of human health and the environment.

Alternative 3 provides the greatest overall protection of human health and the environment because it provides active restoration of contaminated ground water through an optimized extraction, treatment and discharge system. Alternative 2 provides some protection of human health through the continued operation of the existing pump and treat system, but the system is not designed and cannot be operated in a manner which provides optimum restoration of ground water quality. Alternative 1 provides no protection of human health and the environment from the continued migration of ground water contamination.

Because the ground water extraction, treatment and discharge options alone do not provide an overall response to ground water contamination, a discussion of overall protection to human health and the environment is not possible. In the following paragraphs, however, a discussion of the relative degree of protection to human health and the environment offered by each option is presented on a comparative basis.

For the ground water extraction options of Alternative 3, both options provide protection of human health and the environment through ground water extraction. Option E2, use of a modified extraction system, provides an increased degree of protection through use of additional wells to provide added capture of the contaminated ground water, including capture in the vicinity of potential source area(s).

For the organic treatment options of Alternative 3, Options T2 and T3 will both provide similar levels of protection to human health and the environment. Both options are effective in the short-term, long-term, and are expected to meet ARARs. Option T2, air stripping, provides a slight advantage over Option T3, carbon adsorption, and Option T4, UV oxidation, in that it utilizes an existing on-site treatment system proven for the treatment of chlorinated organics and requires minimal long-term maintenance. Option T4, UV oxidation, may be impacted in the short-term by lesser availability than air stripping or carbon adsorption systems and may be impacted in the long-term by increased maintenance requirements and potential technical problems.

For inorganic treatment options, Option T8, electrochemical treatment, is expected to provide the greatest degree of inorganic treatment and, therefore, is most protective of human health and the environment. By enhancing the treatment process or providing supplemental treatment, this option could provide an even greater degree of protectiveness. Option T7, membrane microfiltration, is expected to also provide a significant degree of protection to human health and the environment, although it may not achieve inorganic treatment levels as low as Option T8. Option T6, coagulation and flocculation, is expected to be the least effective inorganic treatment option.

Discharge Option D2 offers the greatest short-term effectiveness through the use of the existing discharge system and is effective in the long-term by having minimal operation and maintenance activities associated with its implementation. Options D1 and D3 are expected to offer greater potential hydraulic control through ground water reinjection but also have greater maintenance associated with their implementation.

5.4.7 Cost

A comprehensive analysis of present worth cost of the alternatives is presented below, followed by a cost sensitivity analysis.

5.4.7.1 Present Worth Comparative Analysis

Present worth costs are summarized in Table 5-12. The lowest cost alternative is Alternative 1, no action, at an estimated cost of $48,000 for conducting a round of ground water sampling prior to a five-year review. Continuation of existing actions, Alternative 2, is estimated to have a present worth cost of $6,700,000 over a period of five years. Alternative 3, modified ground water restoration, will be variable in cost, depending on the individual extraction, treatment and discharge options employed.

For the extraction options, Option E1, use of the existing extraction system, is slightly lower in cost than Option E2, use of a modified extraction system.

For the organic treatment options, Option T2, air stripping is significantly lower in cost, based on the use of the existing on-site air stripper. It is followed in order of increasing cost by carbon adsorption and UV oxidation.

For the inorganic treatment options, Option T8, electrochemical treatment, is the least costly treatment option even with the addition of supplemental treatment, followed by membrane microfiltration (Option T7) and coagulation and flocculation (Option T6).

For the discharge options, Option D2, discharge to surface water, is the least costly option due to the use of the existing discharge system. Option D1, discharge to ground water and Option D3, combined discharge to surface water and ground water follow in order of increasing cost. The inclusion of ground water monitoring costs in the discharge options accounts for the majority of the estimated costs.

5.4.7.2 Sensitivity Analysis

A sensitivity analysis was conducted to assess the effect that variations in specific assumptions made during alternative development and assessment could have on the total estimated remedial cost. The main uncertainty factor which is applicable to all three remedial alternatives and all extraction, treatment and discharge options is the uncertainty associated with the discount factor over the life of the remedy. The resultant impacts to remedial costs are summarized in Table 5-13.

The discount rate can vary from the 5% rate used in the cost evaluation. Alternatives with large O&M cost components can be significantly impacted by a variation in the discount rate. The sensitivity analysis has been conducted assuming a variation in the annual discount rate, with total present worth costs estimated for each alternative at annual discount rates of 3% and 10%. Estimated costs for Alternative 2 and inorganic treatment options T6 and T7 exhibit the greatest impacts due to variations in the discount rate.

5.5 Remedial Alternative Recommendation

Based on the comparative analysis conducted for the remedial alternatives undergoing detailed analysis in this FFS, implementation of Alternative 3 - Modified Ground Water Restoration is recommended. Under this alternative, the following extraction, treatment and discharge options are recommended for implementation:

- Option E2 - Modified Extraction System
- Option T2 - Air Stripping (optional)
- Option T8 - Electrochemical Treatment (with supplemental treatment as required to meet discharge permit conditions)
- Option D2 - Discharge to Surface Water

The alternative would consist of implementation of a modified ground water extraction system in which one deep and three shallow extraction wells would be installed to supplement the existing extraction system. This would allow for capture of shallow and deep chromium-contaminated ground water while also providing for the extraction of shallow chromium-contaminated ground water close to the potential source(s) of contamination. Ground water would be extracted at a rate of approximately 400 gpm, using the distribution of extraction rates previously defined in Section 5.3.5. Additional investigation is to be conducted in the vicinity of wells IW2 and SC26D. Additional ground water modeling will also be conducted during the design phase to evaluate the effects of using different modeling packages, parameters, and boundary conditions. The final design of the extraction, treatment and discharge system may be modified as a result of additional site analysis. Upon monitoring of extraction system operation, a variation in the proposed extraction rates may also be implemented to achieve the desired extraction results.

Electrochemical treatment provides for removal of inorganic contaminants, especially chromium, with preliminary studies indicating the achievement of much lower chromium effluent levels (generally less than 50 ppb) than the existing ion exchange system has been capable of achieving. The electrochemical system would be used as the sole inorganic treatment method if discharge limitations could be achieved. Proposed discharge to surface water permit conditions have been developed by NJDEPE. Compliance with these proposed permit conditions may be difficult without modification of the electrochemical treatment system or the provision of supplemental treatment using ion exchange. Further testing of these technologies would be required to determine if proposed permit conditions could consistently be achieved. While the degassing process in the electrochemical treatment system has the potential to provide removal of chlorinated organics from the contaminated ground water, use of the existing air stripper would ensure organic contaminant removals.

Discharge to surface water is the preferred method of treated ground water discharge, due to its ease of implementation and its successful operational history. Implementation of this discharge option will be critically dependent upon the treatment system's ability to achieve proposed discharge to surface water permit conditions developed by NJDEPE. If implementation of a discharge to ground water option was required on the basis of chemical-specific discharge conditions, additional studies would be required during the conceptual design stage to provide the appropriate design information.

The alternative also includes continued ground water monitoring to confirm the alternative's effectiveness in capturing the contaminated ground water. Because it is unlikely that the alternative will be successful in remediating the ground water within a five-year period to the point where unlimited use and unrestricted exposure to ground water are possible, the conduct of a five-year review of the remedial action decision has been assumed, in accordance with the requirements of the NCP.

Alternative 3 will provide the greatest degree of overall protection of human health and the environment and compliance with ARARs through the modification of the existing extraction and treatment system. It also is effective in the short-term and long-term and provides a significant reduction in contaminant toxicity, as well as in the mobility and volume of contaminated ground water. The options recommended for inclusion in the alternative are cost-effective. Implementation will require installation of additional extraction wells, but overall implementability is good.

By adding extraction wells as described, additional capture of ground water contamination as well as extraction of contaminated ground water close to potential contaminant source area(s) will enhance the operation of the existing extraction system. Human health and the environment will be protected by decreased dispersion of contaminants within the aquifer and an expected decrease in the overall remedial time frame. Based on the treatability study testing, the selected inorganic treatment system, electrochemical treatment, will provide much greater removals of chromium and other inorganics than that provided by the ion exchange system, and therefore will provide greater compliance with chemical-specific ARARs. The air stripper will provide supplemental treatment of organics, as needed. To achieve draft discharge to surface water permit conditions, the electrochemical treatment system will be modified or ion exchange will be employed as a polishing treatment, as necessary. Additional testing would be required to establish the best technology to meet these TBCs. The recommended discharge system is proven to operate efficiently and reliably; however its implementation relies upon the ability of the treatment system to achieve the proposed discharge to surface water permit conditions developed by NJDEPE for discharge into the Hudson Branch.

6.0 REFERENCES

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TABLES

TABLE 1-1

SUMMARY OF INVESTIGATION AREAS
SHIELDALLOY METALLURGICAL CORPORATION

<u>MANUFACTURING AREA</u>	Former Manpro-Vibra Degreasing Unit Underground Storage Tank Area Railroad Siding Area Department 106 Area Department 102 Area Chromium Button Storage Area
<u>UNDEVELOPED PLANT PROPERTY</u>	Former Material Storage Area By-product Drum Storage Area Former Chromium Button Storage Area Tank T12 Area Remaining Plant Property
<u>BY-PRODUCT STORAGE AREA</u>	Ferrovanadium Slag, Chromium Slag, Ferrocolumbium Slag, and Lime Pile
<u>LAGOON AREA</u>	Lagoons B1, B2, B3, B5, B6, B7, B8, B11, and B12

TABLE 1-2

EXISTING MONITORING WELL DATA SHEETS
SHIELDALLOY METALLURGICAL CORPORATION

WELL LOCATION	PERMIT NUMBER	DATE INSTALLED	TPVC (ft, msl)	HOLE DIAMETER	CASING TYPE/ DIAMETER	TOTAL DEPTH	SCREENED INTERVAL		CONDITION
ON-SITE WELLS									
A	51-142	1970	94.82	J	STEEL/2"	124	114-124	(D)	GOOD
B	51-143	1970	94.33	J	STEEL/2"	46	36-46	(S)	GOOD
C	51-144	1970	96.29	J	STEEL/2"	85	75-85	(NS)	GOOD
D	51-145	1970	99.42	J	STEEL/2"	47	37-47	(S)	GOOD
E	51-146	1970	98.92	J	STEEL/2"	48	38-48	(NS)	GOOD
F	51-147	1971	108.58	J	STEEL/2"	41	31-41	(S)	GOOD
G1S	51-148	1971	104.74	J	STEEL/2"	49	39-49	(S)	GOOD
G2D	51-149	1971	104.59	J	STEEL/2"	128	118-128	(D)	GOOD
H	51-150	1971	103.02	J	STEEL/2"	54	44-54	(S)	GOOD
I	51-151	1971	95.09	J	STEEL/2"	46	36-46	(NS)	GOOD
K	51-152	1971	99.18	J	STEEL/2"	46	36-46	(S)	GOOD
L	51-153	1971	103.51	J	STEEL/2"	52	42-52	(S)	GOOD
W1	-	1/29/74	98.60	8"	PVC/4"	122	18-23/38-43/58-63	(NS)	GOOD
							78-83/118-123		GOOD
W2	51-218	5/21/74	100.84	8"	PVC/4"	120	55-60/116-120	(D)	GOOD
W3S	31-25760	12/5/86	108.37	8"	PVC/4"	62	42-62	(S)	GOOD
W3D	31-25759	12/5/86	107.85	8"	PVC/4"	108	88-108	(D)	GOOD
W4	51-219	5/8/74	104.58	8"	PVC/4"	75	55-75	(D)	GOOD
W8	-	10/18/74	97.44	10"	PVC/6"	126	35-45/80-100	(NS)	GOOD
							115-126		GOOD
DW2	51-225	BEFORE 1970	110.92	-	STEEL/2"	94	-	(NS)	GOOD
DW4	51-226	BEFORE 1970	-	-	STEEL/2"	94	-	(NS)	GOOD
IWC1	51-220	1/74	98.13	J	STEEL/2"	20	15-20	(NS)	GOOD
IWC2	51-221	1/74	98.51	J	STEEL/2"	40	35-40	(S)	GOOD
IWC3	51-222	1/74	97.83	J	STEEL/2"	60	55-60	(NS)	GOOD
IWC4	51-223	1/74	98.61	J	STEEL/2"	80	75-80	(NS)	GOOD
IWC5	51-224	1/74	98.03	J	STEEL/2"	100	95-100	(D)	GOOD
SC7S	31-23366-0	7/31/85	107.41	8"	PVC/4"	30	15-30	(S)	GOOD
SC8S	31-23367-8	7/31/85	107.66	8"	PVC/4"	30	15-30	(S)	GOOD
SC9S	31-23368-6	8/1/85	96.23	8"	PVC/4"	30	15-30	(S)	GOOD
SC11S	31-29139-2	9/1/88	108.33	5"	PVC/2"	27	20-27	(S)	GOOD
SC12S	31-29140-6	9/2/88	104.76	5"	PVC/2"	25	15-25	(S)	GOOD
SC13S	31-29570-3	9/9/88	101.41	5"	PVC/2"	24.7	14.7-24.7	(S)	GOOD

NOTES: J = WELL WAS INSTALLED USING JETTING TECHNIQUE
- = NO DATA AVAILABLE
msl = FEET ABOVE MEAN SEA LEVEL
TPVC = TOP OF PVC CASING
WELL CONDITION WAS EVALUATED BY AGE, MATERIAL, AVAILABLE CONSTRUCTION INFORMATION AND VISUAL INSPECTION.
ON-SITE WELLS W2 AND SC11S WERE REPLACED IN DECEMBER 1991 AND JULY 1992, RESPECTIVELY; WELL LOGS ARE PRESENTED IN APPENDIX D.

(S) = CONSIDERED AS SHALLOW WELL IN ANALYSIS OF EXTENT OF CONTAMINATION
(D) = CONSIDERED AS DEEP WELL IN ANALYSIS OF EXTENT OF CONTAMINATION
- = NOT USED FOR ANALYSIS OF EXTENT OF CONTAMINATION
(NS) = NOT SAMPLED

TABLE 1–2 (CONTINUED)

EXISTING MONITORING WELL DATA SHEETS
SHIELD ALLOY METALLURGICAL CORPORATION

WELL LOCATION	PERMIT NUMBER	DATE INSTALLED	TPVC (ft, msl)	HOLE DIAMETER	CASING TYPE/ DIAMETER	TOTAL DEPTH	SCREENED INTERVAL		CONDITION
OFF–SITE WELLS									
IW1	–	4/5/83	90.33	–	PVC/6"	62'	32–62	(S)	GOOD
IW2	–	11/12/85	91.05	8"	PVC/6"	70'	40–70	(D)	GOOD
IW3	–	–	92.18	–	STEEL/4"	60'	–	(NS)	POOR
IW4	–	6/19/84	96.94	10"	PVC/5"	120'	40–65/105–130	(NS)	GOOD
SC1S	31–28825–1	6/22/88	87.26	8"	PVC/4"	55'	35–55	(S)	GOOD
SC1D	31–21619–6	5/30/84	90.90	5"	PVC/2"	115'	85–95/100–115	(D)	GOOD
SC2D	31–31620–0	6/1/84	90.62	5"	PVC/2"	115'	65–85/95–115	(D)	GOOD
SC3S	31–28914–2	6/8/88	90.32	8"	PVC/4"	55'	35–55	(S)	GOOD
SC3D	31–21621–8	6/6/84	88.90	5"	PVC/2"	108'	78–88/98–108	(D)	GOOD
SC4S	31–21689–7	6/7/84	93.65	5"	PVC/2"	45'	35–45	(S)	GOOD
SC4D	31–21690–1	6/8/84	92.64	5"	PVC/2"	120'	110–120	(D)	GOOD
SC5D	31–21876–8	6/12/84	97.00	5"	PVC/2"	120'	90–120	(D)	GOOD
SC6S	31–21691–5	6/21/84	94.62	5"	PVC/2"	75'	45–75	(S)	GOOD
SC6D	31–21878–4	6/26/84	94.38	12"	PVC/2"	125'	110–120	(D)	GOOD
SC10S	31–23369	11/11/85	95.38	8"	PVC/4"	55'	35–55	(S)	GOOD
SC10D	31–23370	11/12/85	95.72	8"	PVC/4"	125'	105–125	(D)	GOOD
RECOVERY WELLS									
LAYNE	51–154	1971	94.11	8"	STEEL/6"	47'	42–47	(S)	GOOD
W9	31–19648	10/17/82	94.43	12"	PVC/6"	130'	110–130	–	GOOD
RW6S	31–28710	6/16/88	92.70	14"	PVC/8"	75'	55–75	(S)	GOOD
RW6D	31–28711	8/5/88	93.08	14"	PVC/8"	125'	90–125	(D)	GOOD
RIW2	31–28712	8/2/88	91.52	14"	PVC/8"	75'	30–55	–	GOOD

NOTES:
J = WELL WAS INSTALLED USING JETTING TECHNIQUE
– = NO DATA AVAILABLE
msl = FEET ABOVE MEAN SEA LEVEL
TPVC = TOP OF PVC CASING
(S) = CONSIDERED AS A SHALLOW WELL IN ANALYSIS OF EXTENT OF CONTAMINATION
(D) = CONSIDERED AS A DEEP WELL IN ANALYSIS OF EXTENT OF CONTAMINATION
– = NOT USED FOR ANALYSIS OF EXTENT OF CONTAMINATION (LIMITED ANALYSIS)
(NS) = NOT SAMPLED
WELL CONDITION WAS EVALUATED BY AGE, MATERIAL, AVAILABLE CONSTRUCTION INFORMATION, AND VISUAL INSPECTION.
OFF–SITE WELLS SC–2D AND SC–3D WERE REPLACED IN JANUARY 1992; WELL LOGS ARE PRESENTED IN APPENDIX D.

TABLE 1-3

REMEDIAL INVESTIGATION PHASE I
MONITORING WELL DATA SHEET
SHIELDALLOY METALLURGICAL CORPORATION

WELL LOCATION	PERMIT NUMBER	DATE INSTALLED	TPVC (ft. msl)	HOLE DIAMETER	CASING TYPE/ DIAMETER	TOTAL DEPTH	DEPTH CASED	SCREENED INTERVAL	CONDITION
ON-SITE WELLS									
SC12D	3135226-0	11/28/90	103.19	12"	PVC/4"	140.0'	35.0'	126-136'	EXCELLENT
SC13D	3135227-8	11/29/90	101.99	12"	PVC/4"	140.5'	30.0'	127-137'	EXCELLENT
SC14S	3135215-4	11/15/90	108.38	8"	PVC/4"	27.0'	-	12-27'	EXCELLENT
SC15S	3135216-2	11/13/90	108.32	8"	PVC/4"	27.5'	-	12.5-27.5'	EXCELLENT
SC16S	3135217-5	11/14/90	108.05	8"	PVC/4"	27.0'	-	12-27'	EXCELLENT
SC20S	3135218-3	11/13/90	104.45	8"	PVC/4"	22.0'	-	7-22'	EXCELLENT
SC22S	3135219-7	11/14/90	99.65	8"	PVC/4"	18.0'	-	3-18'	EXCELLENT
SC22D	3135222-7	11/21/90	98.72	12"	PVC/4"	125.0'	41.0'	111-121'	EXCELLENT
SC23S	3135437-8	11/16/90	102.21	8"	PVC/4"	24.0'	-	9-24'	EXCELLENT
OFF-SITE WELLS									
SC5S	3135434-1	11/28/90	96.55	8"	PVC/4"	20.0'	-	5-20'	EXCELLENT
SC17S	3135229-4	11/19/90	109.26	8"	PVC/4"	28.0'	-	13-28'	EXCELLENT
SC17D	3135223-5	11/27/90	108.07	12"	PVC/4"	153.0'	85.0'	143-453'	EXCELLENT
SC18S	3135230-8	11/15/90	95.72	8"	PVC/4"	19.0'	-	4-19'	EXCELLENT
SC18D	3135228-6	11/20/90	96.01	8"	PVC/4"	130.0'	-	119-129'	EXCELLENT
SC19S	3135224-3	11/15/90	92.98	8"	PVC/4"	17.0'	-	2-17'	EXCELLENT
SC19D	3135221-9	11/26/90	92.03	12"	PVC/4"	133.0'	80.0'	120-130'	EXCELLENT
SC21S	3135225-1	11/15/90	92.64	8"	PVC/4"	18.0'	-	3-18'	EXCELLENT
SC21D	3135220-1	11/27/90	91.65	12"	PVC/4"	140.0'	82.0'	125-135'	EXCELLENT
SC24S	3135435-1	11/28/90	93.57	8"	PVC/4"	20.0'	-	5-20'	EXCELLENT

NOTES:

"-" = WELL WAS NOT CASED

msl = FEET ABOVE SEA LEVEL

TPVC = TOP OF PVC CASING

WELL CONDITION WAS EVALUATED BY AGE, MATERIAL, AVAILIABLE CONSTRUCTION INFORMATION, AND VISUAL INSPECTION.

TABLE 1-4

MONITORING WELL WATER ELEVATION DATA
SHIELDALLOY METALLURGICAL CORPORATION

MONITORING WELL LOCATION	TOP OF PVC ELEVATION (MSL)	WATER ELEVATION 12/90 (MSL)	WATER ELEVATION 4/15/91 (MSL) *	AMOUNT DIFFERENCE (ft)
A	94.82	86.32 (12/19)	86.78	0.46
B	94.33	N.D.	88.88	N.D.
C	96.29	N.D.	90.13	N.D.
D	99.42	90.38 (12/19)	91.63	1.25
E	98.92	N.D.	90.13	N.D.
F	108.58	91.30 (12/19)	92.48	1.18
G1S	104.74	91.16 (12/19)	N.D.	N.D.
G2D	104.59	88.77 (12/19)	N.D.	N.D.
H	103.02	90.18 (12/17)	91.59	1.41
I	95.09	N.D.	89.75	N.D.
K	99.18	88.94 (12/19)	89.84	0.90
L	102.14	89.84 (12/19)	90.84	1.00
W1	98.60	N.D.	90.94	N.D.
W2	100.84	92.64 (12/20)	93.36	0.72
W3S	108.37	91.43 (12/19)	92.79	1.36
W3D	107.85	91.44 (12/19)	92.80	1.36
W4	104.58	N.D.	90.22	N.D.
DW2	110.92	N.D.	93.41	N.D.
DW4	UNKNOWN	N.D.	(17.36)	N.D.
IW1	90.42	85.30 (12/19)	85.58	0.28
IW2	92.18	85.12 (12/18)	84.92	-0.20
IW3	91.05	85.19 (12/19)	85.39	0.20
IWC1	98.13	N.D.	90.96	N.D.
IWC2	98.51	90.05 (12/20)	90.97	0.92
IWC3	97.53	N.D.	91.09	N.D.
IWC4	98.61	N.D.	91.11	N.D.
IWC5	98.03	90.08 (12/20)	91.05	0.97
SC1S	87.26	83.36 (12/17)	83.98	0.62
SC1D	90.95	82.36 (12/17)	82.38	0.02
SC2D	90.72	85.47 (12/18)	85.47	0.00
SC3S	90.32	84.14 (12/17)	84.42	0.28
SC3D	88.90	84.16 (12/17)	84.56	0.40
SC4S	93.65	86.20 (12/19)	86.45	0.25
SC4D	92.64	84.67 (12/19)	85.09	0.42
SC5S	96.55	84.90 (12/18)	85.31	0.41
SC5D	97.00	83.78 (12/18)	84.18	0.40
SC6S	94.62	87.71 (12/17)	87.77	0.06
SC6D	94.38	86.46 (12/17)	86.90	0.44

TABLE 1–4 (CONTINUED)

MONITORING WELL WATER ELEVATION DATA
SHIELDALLOY METALLURGICAL CORPORATION

MONITORING WELL LOCATION	TOP OF PVC ELEVATION (MSL)	WATER ELEVATION 12/90 (MSL)	* WATER ELEVATION 4/15/91 (MSL)	AMOUNT DIFFERENCE (ft)
SC7S	107.41	N.D.	92.26	N.D
SC8S	107.66	N.D.	92.56	N.D.
SC9S	96.23	N.D.	89.97	N.D.
SC10S	95.38	88.10 (12/18)	88.39	0.29
SC10D	95.72	88.06 (12/18)	88.48	0.42
SC11S	108.33	91.94 (12/19)	93.35	1.41
SC12S	104.76	92.06 (12/20)	93.29	1.23
SC12D	103.19	91.29 (12/20)	92.55	1.26
SC13S	101.41	92.61 (12/20)	93.52	0.91
SC13D	101.99	90.92 (12/20)	92.25	1.33
SC14S	108.38	91.84 (12/20)	93.23	1.39
SC15S	108.32	90.42 (12/17)	91.55	1.13
SC16S	108.05	89.18 (12/17)	90.52	1.34
SC17S	109.26	88.75 (12/19)	89.49	0.74
SC17D	108.07	87.67 (12/19)	89.39	1.72
SC18S	95.72	86.38 (12/19)	86.82	0.44
SC18D	96.01	86.35 (12/19)	86.85	0.50
SC19S	92.98	86.78 (12/20)	86.78	–
SC19D	92.03	85.33 (12/18)	86.98	1.65
SC20S	104.45	90.52 (12/19)	91.65	1.13
SC21S	92.64	86.45 (12/18)	86.54	0.09
SC21D	91.65	85.03 (12/18)	86.26	1.23
SC22S	99.65	90.93 (12/20)	91.60	0.67
SC22D	98.72	89.80 (12/20)	91.15	1.35
SC23S	102.21	90.23 (12/17)	91.35	1.12
SC24S	93.57	83.53 (12/18)	84.35	0.82

NOTES:

N.D. = NO WATER LEVEL DATA WAS COLLECTED
UNKNOWN = THE ELEVATION OF THE WELL IS UNKNOWN
(17.36) = DEPTH FROM TOP OF PVC TO THE WATER TABLE
(12/17) = REFERS TO THE DATE WATER ELEVATION DATA WAS COLLECTED DURING THE FIRST SAMPLING EVENT.
* = ALL THE WATER ELEVATION DATA DURING THE SECOND SAMPLING EVENT WAS COLLECTED ON 4/15/91.

TABLE 2-1

PRELIMINARY IDENTIFICATION OF FEDERAL CHEMICAL-SPECIFIC ARARs AND TBCs

SHIELDALLOY METALLURGICAL CORPORATION

FEDERAL STATUTE	REGULATION/GUIDANCE	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Ground Water--			
Safe Drinking Water Act (40 CFR 141.11-.16 and 141.60 - .63)	Maximum Contaminant Levels (MCLs)	MCL's directly apply to "public water systems", defined as systems with at least 15 connections which service a minimum of 25 persons.	While ground water is not a current source of drinking water at the site, MCL's may be relevant and appropriate due to the presence of volatile organic and inorganic contaminants in ground water.
Safe Drinking Water Act (40 CFR 141.50-.52)	Maximum Contaminant Level Goals (MCLGs)	Non-enforcable health goals for public water supply systems, set at levels which result in no known or anticipated adverse health effects.	Ground water at SMC is not a current source of drinking water; therefore, MCLGs are not applicable, but may be relevant and appropriate. Non-zero MCLGs are to be used as remedial goals for current or potential sources of drinking water, per the NCP (40 CFR 300). Contaminant concentrations are compared to MCLGs to assess potential risks associated with ingestion of ground water.
Surface Water --			
Clean Water Act (40 CFR 121)	Ambient Water Quality Criteria (AWQC)	Non-enforceable guidelines established for the protection of human health and/or aquatic organisms.	TBC criteria which may affect remedial actions involving discharge to nearby Hudson Branch.
Clean Water Act (40 CFR 401.15)	Effluent Discharge Limitations	Regulates the discharge of contaminants from an industrial point source.	Potential ARARs for remedial alternatives involving discharge to nearby Hudson Branch.

TABLE 2-1 (Continued)

PRELIMINARY IDENTIFICATION OF FEDERAL CHEMICAL-SPECIFIC ARARs AND TBCs

SHIELDALLOY METALLURGICAL CORPORATION

FEDERAL STATUTE	REGULATION/GUIDANCE	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Air--			
Clean Air Act (40 CFR 50)	National Ambient Air Quality Stardards (NAAQS)	Establishes maximum concentrations for particulates and fugitive dust emissions.	Potential ARARs for alternatives involving remedial actions which impact ambient air.
Clean Air Act (40 CFR 60)	New Source Performance Standards (NSPS)	Establishes emissions limitations for new sources.	Potential ARARs for alternatives involving treatment actions which emit pollutants.
Clean Air Act (40 CFR 61)	Emissions Standards for Hazardous Air Pollutants (NESHAPS)	Establishes emissions limitations for hazardous air pollutants.	Potential ARARs for alternatives involving treatment actions which emit hazardous air pollutants.

TABLE 2-2
PRELIMINARY IDENTIFICATION OF STATE CHEMICAL-SPECIFIC ARARs AND TBCs
SHIELDALLOY METALLURGICAL CORPORATION

STATE STATUTE	REGULATION/GUIDANCE	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Ground Water --			
NJ Safe Drinking Water Act (NJAC 7:10 1.1-7.3)	NJ Maximum Contaminant Levels (NJMCLs)	NJMCLs directly apply to all "public water systems" in NJ. Adopted from National Regulations published by EPA (40 CFR 141).	While ground water is not a current source of drinking water at the site, NJMCLs may be relevant and appropriate due to the presence of volatile organic and inorganic contaminants in ground water.
NJ Ground Water Quality Standards (NJAC 7:9-6)	Ground Water Quality Criteria (GWQC)	Establishes ground water quality standards (i.e. organics, PCBs, pesticides, metals) for various classes of ground water.	Potential ARARs applicable to alternatives which involve discharge to ground water; classification of ground water is Class II based on background TDS levels.
NJ Proposed Ground Water Quality Standards (NJAC 7:9-6)	Proposed Ground Water Quality Standards	Proposes ground water quality standards (i.e. organics, PCBs, pesticides, metals) for various classes of ground water.	To-Be-Considered applicable to alternatives which involve discharge to ground water.
NJ Proposed Cleanup Standards for Contaminated Sites (NJAC 7:26D-4)	Proposed Ground Water Cleanup Standards	Proposes cleanup standards for VOCs, SVOCs, pesticieds/PCBs, and inorganics	To-Be-Considered criteria due to known contamination of ground water with VOCs and inorganics.
Surface Water --			
NJ Clean Water Act (NJAC 7:14A-1 et seq.)	NJPDES Water Quality Toxic Effluent Limitations	Establishes values for the determination of NJPDES permit toxic effluent limitations	Potential ARARs for alternatives which include discharges to surface waters.
NJ Clean Water Act (NJAC 7:9-4)	NJ Surface Water Quality Standards	Establishes water quality standards for various surface water classes.	Potential ARARs due to classification of Hudson Branch near site as FW2-NT. Will affect alternatives which include discharges to surface waters.

TABLE 2-2 (Continued)
PRELIMINARY IDENTIFICATION OF STATE CHEMICAL-SPECIFIC ARARs AND TBCs
SHIELDALLOY METALLURGICAL CORPORATION

STATE STATUTE	REGULATION/GUIDANCE	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Air --			
NJ Clean Air Act (NJAC 7:27-13)	NJ Ambient Air Quality Standards	Establishes maximum ambient levels for criteria pollutants.	Potential ARARs for alternatives involving treatment actions which emit criteria pollutants.
NJ Clean Air Act (NJAC 7:27-17)	Control and Prohibition of Air Pollution by Toxic Substances	Establishes emissions limitations for toxic substances.	Potential ARARs for alternatives involving treatment actions which emit toxic pollutants.

TABLE 2–3
PRELIMINARY IDENTIFICATION OF FEDERAL LOCATION–SPECIFIC ARARs AND TBCs
SHIELDALLOY METALLURGICAL CORPORATION

FEDERAL STATUTE	REGULATION/GUIDANCE	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Wetlands –– Executive Order 11990	Protection of Wetlands	Regulates activities conducted in a wetland area to minimize the destruction, loss or degradation of the wetlands.	Potential ARARs if a remedial action is proposed within a wetland area.
Wetlands Construction and Management Procedures (40 CFR 6, Appendix A)	Protection of Wetlands	Sets forth EPA policy for carrying out the provisions of Executive Order 11900 (see above).	Potential ARARs if a remedial action is proposed within a wetland area.
Clean Water Act, Section 404 (40 CFR 230; 33 CFR 320–330)	Prohibition of Wetland Filling	Prohibits the discharge of dredged or fill material to a wetland without a permit issued by the Corp of Engineers.	Potential ARARs if a remedial action is proposed within a wetland area.
Floodplains –– Executive Order 11988	Protection of Floodplains	Regulates activities conducted in a floodplain to minimize adverse affects to the floodplain and ensures that flood hazards have been considered.	Potential ARAR as site is located adjacent to the Hudson Branch.
Flood Disaster Protection Act of 1973	Disaster Prevention	Regulates development in flood prone areas under FEMA.	Potential ARAR as site is located adjacent to the Hudson Branch.
Water Resources Council Floodplain Management Guidelines (February 10, 1978)	Floodplain Management	Outlines decision–making process to be used in complying with Executive Order 11988	Potential TBC as site is located adjacent to the Hudson Branch.
USEPA Statement of Policy on Floodplains and Wetlands Assessments for CERCLA Actions	Protection of Floodplains and Wetlands	Mandates the preparation of wetlands and floodplains assessments as appriopriate for the CERCLA program.	Potential TBC as site is located adjacent to the Hudson Branch.

TABLE 2–3 (Continued)
PRELIMINARY IDENTIFICATION OF FEDERAL LOCATION–SPECIFIC ARARs AND TBCs
SHIELDALLOY METALLURGICAL CORPORATION

FEDERAL STATUTE	REGULATION/GUIDANCE	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Historic Places-- National Historic Preservation Act of 1966 (16 USC 470, et seq.)	Protection of Historic Places	Requires actions to take into account effects on properties included in or eligible for the National Register of Historic Places and minimizes harm to National Historic Landmarks.	Potential ARAR for activities which could impact historic places.
Farmlands-- Farmland Protection Policy Act (7 USC 4201 et seq.)	Protection of Significant/ Important Agricultural Lands	Requires evaluation of direct and indirect effects of actions on remaining farms and farm support sources.	Potential ARAR as local areas are designated as Prime Farmlands.

TABLE 2-4
PRELIMINARY IDENTIFICATION OF STATE LOCATION-SPECIFIC ARARs AND TBCs
SHIELDALLOY METALLURGICAL CORPORATION

STATE STATUTE	REGULATION/GUIDANCE	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Wetlands --			
NJ Freshwater Wetlands Protection Act (NJSA 13:9B)	Regulation of Activities In and Around Wetlands	Provides for classification of freshwater wetlands and establishes permit requirements for activities which impact freshwater wetlands.	Potential ARAR if a remedial action is proposed within a wetland area.
NJ Freshwater Wetlands Regulations (NJAC 7:7)	Rules Governing Implementation of Wetlands Protection Act	Regulates alteration or disturbance in and around freshwater wetland areas.	Potential ARAR if a remedial action is proposed within a wetland area.
Floodplains --			
Flood Hazard Area Control Act (NJSA 58:16A-50)	Protection of Floodplains	Regulates any land use in a flood hazard area to reduce risks due to flooding.	Potential ARAR as site is adjacent to the Hudson Branch.
Historic Areas --			
NJ Conservation Restriction and Historic Preservation Restriction Act (NJSA 13:8B-1)	Protection of Historic Places	Allows for the acquistion and enforcement of conservation restrictions and historic preservation restrictions by the NJDEPE at historic sites.	Potential ARAR for activities which could impact historic places.
Farmlands--			
Agricultural Retention and Development Act (NJSA 4:1C-11)	Protection of Farmlands	Authorizes the establishment of county agricultural development boards, who are required to develop agriculture retention and development programs and farmland preservation programs.	Potential ARAR for activities which could impact farmland areas.

TABLE 2–5
PRELIMINARY IDENTIFICATION OF FEDERAL ACTION–SPECIFIC ARARs AND TBCs
SHIELDALLOY METALLURGICAL CORPORATION

FEDERAL STATUTE	REGULATION/GUIDANCE	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
CERCLA (Title I Section 101,111)	National Contingency Plan (40 CFR 300)	Establishes funding and provisions for the cleanup of hazardous waste sites.	ARARs as the SMC site is included on the National Priorities List (Rank 47/1073).
Superfund Amendments and Reauthorization Act (42 U.S.C. 9601)	Cleanup Standards/ Response Action	Treatments must provide permanent reductions in volume, toxicity and mobility of wastes and satisfy ARARs.	ARARs as the SMC site is included on the National Priorities List (Rank 47/1073).
Hazardous and Solid Waste Amendments of 1984 (HSWA)	Land Disposal Restrictions	Prohibits placement of hazardous wastes in locations of vulnerable hydrogeology and lists certain wastes, which will be evaluated for prohibition by EPA under RCRA.	Potential ARARs which may limit the use of land disposal in remediating certain hazardous wastes.
Resource Conservation and Recovery Act (RCRA) (40 CFR 262)	Generator Requirements for Manifesting Waste for Off–Site Disposal	Standards for manifesting, making and recording off–site waste shipments for treatment/disposal.	Potential ARARs for alternatives which utilize an off–site treatment/disposal method for hazardous wastes.
RCRA (40 CFR 263)	Transporter Requirements for Off–Site disposal	Standards for transporters of hazardous waste materials.	Potential ARARs for alternatives which utilize an off–site treatment/disposal method for hazardous wastes.
RCRA (40 CFR 264 and 265)	Requirements for Hazardous Waste Treatment Facility Design and Operating Standards for Treatment and Disposal Systems	Outlines specifications and standards for design, operation, closure, and monitoring of performance for hazardous waste storage, traetment and disposal facilities.	Potential ARARs for alternatives which utilize a surface impoundment, waste pile, landfill, land treatment, incineration, or miscellaneous treatment units for on–site storage/disposal/treatment of hazardous wastes.
RCRA (40 CFR 268)	Land Disposal Restrictions	Identifies hazardous wastes that are restricted from land disposal and sets treatment standards for restricted wastes.	Potential ARARs which may limit the use of land disposal in remediating certain hazardous wastes.

TABLE 2–5 (continued)
PRELIMINARY IDENTIFICATION OF FEDERAL ACTION–SPECIFIC ARARs AND TBCs
SHIELDALLOY METALLURGICAL CORPORATION

FEDERAL STATUE	REGULATION/GUIDANCE	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Safe Drinking Water Act (40 CFR 144 and 146)	Underground Injection Control Requirements	Establishes the general requirements, technical criteria and standards for underground injection wells.	Potential ARAR for alternatives which utilize underground injection as a remedial method.
Clean Water Act (40 CFR 122–125)	National Pollutant Discharge Elimination System (NPDES) Permit Requirements	Permits contain applicable effluent standards (i.e., technology–based and/or water quality–based), monitoring requirements, and standards and special conditions for discharge.	ARARs for alternatives involving treatment methods which discharge effluents to area water bodies.
Clean Water Act (40 CFR 403)	Discharge to Publicly – Owned Treatment Works (POTW)	A national pretreatment program disigned to protect municipal wastewater treatment plants and the environment from damage that may occur when hazardous, toxic or other non–domestic wastes are discharged into a sewer system.	This regulation is applicable to alternatives in which waters are discharged to a POTW.
Clean Air Act (40 CFR 50)	National Ambient Air Quality Standards (NAAQS)– Particulates	Establishes maximum concentrations for particulates and fugitive dust emissions.	ARARs for alternatives involving treatment methods which impact ambient air (i.e. air stripping, etc.).
Clean Air Act (40 CFR 50)	New Source Performance Standards (NSPS)	Requires Best Available Control Technology (BACT) for new sources, and sets emissions limitations.	ARARs for alternatives involving treatment methods which impact ambient air (i.e. air stripping, etc.).
Clean Air Act (40 CFR 61)	Emissions Standards for Hazardous Pollutants (NESHAPS)	Establishes emissions limitations for hazardous air pollutants.	ARARs for alternatives involving treatment methods (i.e., air stripping, etc.) which result in emissions to the air.
Hazardous Materials Transportation Act (49 CFR 170, 171)	Rules for Transportation of Hazardous Materials	Procedures for packaging, labelling, manifesting, and off–site transport of hazardous materials.	ARARs for alternatives involving the off–site shipment of hazardous materials or waste.

TABLE 2–5 (continued)
PRELIMINARY IDENTIFICATION OF FEDERAL ACTION–SPECIFIC ARARs AND TBCs
SHIELDALLOY METALLURGICAL CORPORATION

FEDERAL STATUE	REGULATION/GUIDANCE	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Occupational Safety and Health Act (29 CFR 1904)	Recordkeeping, Reporting and Related Regulations	Outlines recordkeeping and reporting requirements.	ARARs for all contractors/ subcontractors involved in hazardous activities.
Occupational Safety and Health Act (29 CFR 1910)	General Industry Standards	Establishes requirement for 40–hour training and medical surveillance of hazardous waste workers.	ARARs for workers and the workplace throughout the implementation of hazardous activities.
Occupational Safety and Health Act (29 CFR 1926)	Safety and Health Standards	Regulations specify the type of safety equipment and procedures for site remediation/excavation.	ARARs for workers and the workplace throughout the implementation of hazardous activities.

TABLE 2-6
PRELIMINARY IDENTIFICATION OF STATE ACTION-SPECIFIC ARARs AND TBCs
SHIELDALLOY METALLURGICAL CORPORATION

STATE STATUTE	REGULATION/GUIDANCE	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
NJ Hazardous Waste Regulations (NJAC 7:26)	Permitting, Contingency Plans, Specifications for Treatment/Disposal Units	Requirements for permitting, emergency planning, and design of treatment/storage/disposal systems.	Potential ARARs for alternatives which involve the treatment, storage or disposal of hazardous wastes.
NJ Pollutant Discharge Elimination System (NJAC 7:14A-1.1 et seq.)	Permit/Discharge Requirements	Requires any discharger to land or water to obtain a permit pursuant to NJSA (58:10A-1).	ARARs for alternatives involving treatments which discharge effluents to surface or ground water.
	Treatment Works Approval Requirements	Rules concerning the installation of a facility for the collection or treatment of a pollutant.	ARARs for alternatives involving extraction and on-site treatment of ground water.
NJ Surface Water Regulations (NJAC 7:9-5.1)	Effluent Standards/ Treatment Requirements	Establishes effluent standards and treatment requirements for discharge of toxic effluent.	ARARs for alternatives involving treatments which discharge toxic pollutants to area water bodies.
NJ Air Pollution Control Regulations (NJAC 7:27-16)	Permits and Emissions Limitations for VOCs	Requires sources which emit VOCs be registered & permitted with the NJDEPE & meet design specifications.	ARARs for alternatives involving treatments which impact ambient air (e.g., air stripping).
NJ Air Pollution Control Regulations (NJAC 7:27-17)	Toxic Substance Emissions	Requirements for emissions control apparatus for sources of toxic emissions.	ARARs for alternatives involving treatments which impact ambient air (e.g., air stripping).
NJ Air Pollution Control Regulations (NJAC 7:27-12)	Emergency Situations	Requirement for standby plans to reduce emissions of air contaminants during an air pollution emergency.	ARARs for alternatives involving treatments which impact ambient air.
NJ Water Supply Management Act (NJAC 7:19)	General Water Supply Management Regulations	Requires NJDEPE approval for ground water withdrawals exceeding 100,000 gpd and for drilling and construction of new wells.	ARARs for alternatives involving installation of monitoring wells or installation and operation of ground water extraction wells.

TABLE 3-1
COMPARISON OF MAXIMUM DETECTED CONCENTRATIONS OF ORGANICS
TO FEDERAL AND STATE GROUND WATER APPLICABLE OR
RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)
SHIELDALLOY METALLURGICAL CORPORATION

Parameter	Maximum Detected Concentration (ppb)		Federal ARARS (ppb)		State ARARS (ppb)	
	Upper Cohansey	Lower Cohansey	MCL (1)	MCLG (2)	NJMCL (3)	GWQS (4)
VOLATILE ORGANICS						
Methylene Chloride	37	32			2	2
Acetone	170	160				700
Carbon Disulfide	2	2				
1,1-Dichloroethene	4	-	7	7	2	2
1,2-Dichloroethene (total)	270	25	70 (a) 100 (b)	70 (a) 100 (b)	10 (a) 10 (b)	10 (a) 100 (b)
2-Butanone	78	-				
1,1,1-Trichloroethane	9	-	200	200	26	30
Trichloroethene	840	430	5	0	1	1
Benzene	78	4	5	0	1	1
4-Methyl-2-pentanone	120	3				400
Toluene	4900	5	1000	1000		1000
Ethylbenzene	630	-	700	700		700
Xylene (total)	2100	3	10,000	10,000	44	40
Tetrachloroethene	4	3	5	0	1	1
SEMIVOLATILE ORGANICS						
Phenol	1	-				4000
Di-n-butylphthalate	-	1				
Bis(2-ethylhexyl)phthalate	6	-	6*	0*		30

[shaded] ARAR/TBC Exceeded

- Not Detected

(1) MCL - Maximum Contaminant Level. National Primary Drinking Water Regulations, Final Rule Amendments to SDWA, U.S. EPA, Effective July 1992. * Effective January 17, 1994.

(2) MCLG - Maximum Contaminant Level Goal, based on health considerations only, Final Rule Amendments to SDWA, U.S. EPA, Effective July 1992. * Effective January 17, 1994.

(3) Maximum Contaminant Level for Drinking Water; NJ Safe Drinking Water Act, NJAC 7:10-16.7

(4) Ground Water Quality Standards; based on Class II-A ground water; NJAC 7:9-6.1 et seq.

(a) cis-1,2-Dichloroethene

(b) trans-1,2-Dichloroethene

Note: Methylene chloride and acetone were commonly detected in laboratory blanks, trip blanks, and /or field blanks, indicating their presence may be associated with laboratory contamination.

TABLE 3-2
COMPARISON OF MAXIMUM DETECTED CONCENTRATIONS OF INORGANICS (UNFILTERED)
TO FEDERAL AND STATE GROUND WATER APPLICABLE OR
RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)
SHIELD ALLOY METALLURGICAL CORPORATION

Parameter	Maximum Detected Concentration (ppb)		Federal ARARS (ppb)		State ARARS (ppb)	
	Upper Cohansey	Lower Cohansey	MCL (1)	MCLG (2)	NJMCL (3)	GWQS (4)
INORGANICS						
Silver	30.3	14.3				
Aluminum	70,800	99,400				200
Arsenic	748	352	50		50	8
Barium	369	507	2000	2000	2000	2000
Beryllium	570	11.3	4*	4*		20
Calcium	116,000	32,900				
Cadmium	7.7	6	5	5	5	4
Cobalt	27.5	43.8				
Chromium (total)	20,800	102,000	100	100	100	100
Chromium (VI)	19,900	60,900				
Copper	130	74.4	1300**			1000
Cyanide	26,400	51,300	200*	200*		200
Iron	164,000	241,000				300
Mercury	15.9	13.8	2	2	2	2
Potassium	346,000	23,000				
Magnesium	40,800	7240				
Manganese	3690	946				50
Sodium	1,790,000	706,000				50000
Nickel	1090	20.2	100*	100*		100
Lead	137	262	15**			10
Antimony	573	2140	6*	6*		20
Selenium	12.9	420	50	50	50	50
Silicon	38,600	13,600				
Vanadium	128,000	2000				
Zinc	1130	3130				5000
Boron	17,600	699				
Strontium	152	318				
Titanium	149	325				
Bicarbonate	549,000	115,000				
Carbonate	1,180,000	-				
Chloride	1,380,000	30,200				250000
Fluoride	30,900	2400				2000
Nitrate	24,300	12,800	10,000	10,000	10,000	10000
Sulfate	4,630,000	388,000	Deferred	Deferred		250000

[shaded box] ARAR/TBC Exceeded

\- Not Detected

(1) MCL - Maximum Contaminant Level. National Primary Drinking Water Regulations, Final Rule Amendments to SDWA, U.S. EPA, Effective July 1992.

(2) MCLG - Maximum Contaminant Level Goal, *based on health considerations only, Final Rule Amendments to* SDWA, U.S. EPA, Effective July 1992.

(3) Maximum Contaminant Level for Drinking Water; NJ Safe Drinking Water Act,NJAC 7:10-16.7.

(4) Ground Water Quality Standards; based on Class II-A ground water; NJAC 7:9-6.1 et seq.

* Effective 1/17/94

** Action levels representative of drinking water quality at the tap, U.S. EPA, May 7, 1991

TABLE 3-3
COMPARISON OF MAXIMUM DETECTED CONCENTRATIONS OF INORGANICS (FILTERED)
TO FEDERAL AND STATE GROUND WATER APPLICABLE OR
RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)
SHIELDALLOY METALLURGICAL CORPORATION

Parameter	Maximum Detected Concentration (ppb)		Federal ARARS (ppb)		State ARARS (ppb)	
	Upper Cohansey	Lower Cohansey	MCL (1)	MCLG (2)	NJMCL (3)	GWQS (4)
INORGANICS						
Silver	20.8	11.5				
Aluminum	40,700	53,000				200
Arsenic	392	692	50		50	8
Barium	493	654	2000	2000	2000	2000
Beryllium	636	7.2	4*	4*		20
Calcium	111,000	12,100				
Cadmium	7.1	-	5	5	5	4
Cobalt	14.3	38.5				
Chromium (total)	11,700	108,000	100	100	100	100
Chromium (VI)	16,600	27,400				
Copper	32	57.1	1300**			1000
Cyanide	-	-	200*	200*		200
Iron	77,100	17,000				300
Mercury	1.3	12.2	2	2	2	2
Potassium	374,000	17,600				
Magnesium	39,300	6800				
Manganese	1160	257				50
Sodium	1,940,000	729,000				50000
Nickel	275	14.9	100*	100*		100
Lead	108	19.6	15**			10
Antimony	280	2300	6*	6*		20
Selenium	46.4	91	50	50	50	50
Silicon	4710	5490				
Vanadium	122,000	2080				
Zinc	897	153				5000
Boron	18,300	197				
Strontium	152	-				
Titanium	-	-				
Bicarbonate	-	-				
Carbonate	-	-				
Chloride	-	-				250000
Fluoride	-	-				2000
Nitrate	-	-	10,000	10,000	10,000	10000
Sulfate	-	-	Deferred	Deferred		250000

[shaded] ARAR/TBC Exceeded

- Not Detected

(1) MCL - Maximum Contaminant Level. National Primary Drinking Water Regulations, Final Rule Amendments to SDWA, U.S. EPA, Effective July 1992.

(2) MCLG - Maximum Contaminant Level Goal, based on health considerations only, Final Rule Amendments to SDWA, U.S. EPA, Effective July 1992.

(3) Maximum Contaminant Level for Drinking Water; NJ Safe Drinking Water Act, NJAC 7:10-16.7.

(4) Ground Water Quality Standards; based on Class II-A ground water; NJAC 7:9-6.1 et seq.

* Effective 1/17/94

** Action levels representative of drinking water quality at the tap, U.S. EPA, May 7, 1991

TABLE 3-4
COMPARISON OF MAXIMUM DETECTED CONCENTRATIONS OF CONTAMINANTS TO DRAFT STATE SURFACE WATER DISCHARGE PERMIT CONDITIONS (TO-BE-CONSIDERED)
SHIELDALLOY METALLURGICAL CORPORATION

Parameter	Maximum Detected in Ground Water Samples	Draft Discharge to Surface Water Permit Conditions (1)	
		Monthly Average	Daily Maximum
Flow (mgd)	---	NL	0.576
Chemical Oxygen Demand	NA	NL	NL
Total Dissolved Solids (mg/l)	NA	154	166
Total Dissolved Solids (kg/d)	NA	336	362
Total Suspended Solids (mg/l)	NA	NL	NL
Total Suspended Solids (kg/d)	NA	14	23
Oil & Grease (mg/l)	NA	---	10
Petroleum Hydrocarbons (mg/l)	NA	---	---
pH Range (s.u.)	4.42-12.1	5.0 - 9.0	5.0 - 9.0
Chromium (total) (ug/l)	108,000	---	5.8
Chromium (total) (kg/d)	---	---	0.013
Trichloroethene (ug/l)	840	1.07	2.14
Trichloroethene (kg/d)	---	0.0023	0.0047
Chronic Toxicity	NA	NOEC>82%(2)	NOEC>82%
Acute Toxicity	NA	---	---

(1) Draft Discharge to Surface Water Permit Conditions, March 1993.
(2) This limitation is equivalent to a maximum of 1.2 TUc's (chronic toxic units)

MGD – Million Gallons per Day
NL – Not Limited
s.u. – Standard units
NOEC – No Observable Effects Concentration
--- – Not Applicable
NA – Not Available

TABLE 3-5

RISK-BASED CLEANUP LEVELS FOR
SELECTED GROUND WATER CONTAMINANTS
SHIELDALLOY METALLURGICAL CORPORATION

PARAMETER	CALCULATED HAZARD INDEX RATIO (HI)[1]	CLEANUP LEVEL (ppb) BASED ON HI = 1.0	MAXIMUM DETECTED GROUND WATER CONCENTRATION (ppb)
Boron	5.0	3,000	17,600
Vanadium	500	260	128,000

(1) The worst-case hazard index ratios for the selected contaminants were established under the shallow gr water ingestion scenario for residential use (Scenario 3, Human Health and Environmental Health Eva TRC, 1992c.

TABLE 3-6
GROUND WATER REMEDIAL TECHNOLOGY SCREENING
FOCUSED FEASIBILITY STUDY
SHIELDALLOY METALLURGICAL CORPORATION

(Shaded) Screened on Technical Implementability

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS
NO ACTION	NONE	NOT APPLICABLE	No action.	Fulfills NCP requirement for consideration of no action alternative.
INSTITUTIONAL CONTROL	CONTINUED GROUND WATER MONITORING	NOT APPLICABLE	Continued ground water monitoring.	Monitors off-site contaminant migration.
	GROUND WATER USE RESTRICTIONS	LEGAL RESTRICTIONS	Legal restictions on ground water use in the contaminated area, (e.g. deed restrictions, well permit restrictions, etc.)	A portion of Vineland has been designated as an aquifer exclusion zone, requiring mandatory connection with public water systems and sealing of domestic and supply wells (See Figure 1-10). Extension of this zone may be protective of additional downgradient wells.
		ALTERNATE WATER SUPPLY (shaded)	Provision of alternate water supply to receptors impacted by ground water contamination.	No impacts to active private potable wells currently identified.
CONTAINMENT (shaded)	CAPPING (shaded)	VARIOUS (shaded)	Placement of engineered cap constructed of low permeability material over contaminated areas to limit infiltration and leaching of contaminants into ground water.	Technical implementability limited by existing land use.

TABLE 3-6 (Continued)
GROUND WATER REMEDIAL TECHNOLOGY SCREENING
FOCUSED FEASIBILITY STUDY
SHIELDALLOY METALLURGICAL CORPORATION

[shaded] Screened on Technical Implementability

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS
CONTAINMENT (Cont.) [shaded]	VERTICAL BARRIER [shaded]	SLURRY WALL [shaded]	Vertical trench is excavated under a soil/bentonite slurry and backfilled with a low permeability material.	Best for containing a limited area of shallow ground water contamination; barrier would have to be keyed into the Kirkwood Formation at an approximate depth of 120 feet, thereby limiting this option's technical implementability.
		SHEET PILING [shaded]	Sheet piling is driven into soil to form barrier wall.	Best for containing a limited area of shallow ground water contamination; technical implementability limited by depth to Kirkwood Formation.
	HORIZONTAL BARRIER [shaded]	VARIOUS [shaded]	Horizontal barrier is created beneath contaminated zone to prevent contaminant migration.	Technical implementability limited by existing depth of ground water contamination.
EXTRACTION/ TREATMENT/ DISCHARGE	EXTRACTION	EXISTING EXTRACTION WELLS	Existing extraction wells and pumping systems within the contaminant plume are operated for the collection of contaminated ground water.	Viable, proven technology.
		REVISED EXTRACTION WELL SYSTEM	New extraction wells located to optimize operation of existing pump and treat system.	Viable, proven technology.

TABLE 3-6 (Continued)
GROUND WATER REMEDIAL TECHNOLOGY SCREENING
FOCUSED FEASIBILITY STUDY
SHIELDALLOY METALLURGICAL CORPORATION

[shaded box] Screened on Technical Implementability

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS
EXTRACTION/ TREATMENT/ DISCHARGE (Cont.)	OFF-SITE TREATMENT (shaded)	POTW (shaded)	Extracted ground water discharged to local POTW for treatment.	No sanitary sewer locally available; typical POTW treatment processes designed to treat biologically degradable contaminants, not specifically for inorganics or chlorinated organics.
		RCRA FACILITY (shaded)	Extracted ground water discharged to licensed RCRA facility for treatment and/or disposal.	Volumes of ground water to be treated limit technical implementability.
	ON-SITE ORGANIC CONTAMINANT TREATMENT	BIOREACTOR (shaded)	Activated sludge process utilizes acclimated bacteria for aerobic degradation of contaminants.	Proven effective for aromatic organics, ineffective for chlorinated compounds; would not treat major contaminants of concern.
		PACT	Organic contaminants removed from ground water using powdered activated carbon combined with conventional biological treatment. Wet air oxidation used to regenerate the powdered activated carbon.	Applicable to organic contaminants, including aromatic hydrocarbons and chlorinated compounds.
		AIR STRIPPING	Transfer of volatile organic compounds to gaseous faction through mixing with large volumes of air in a packed column.	Applicable to volatile organic contaminants, including aromatic hydrocarbons and chlorinated compounds.
		STEAM STRIPPING	Similar to air stripping but the use of steam increases contaminant volatilization.	Applicable to volatile organic contaminants and organic contaminants not readily stripped in a regular air stripping system.

TABLE 3-6 (Continued)
GROUND WATER REMEDIAL TECHNOLOGY SCREENING
FOCUSED FEASIBILITY STUDY
SHIELDALLOY METALLURGICAL CORPORATION

[shaded] Screened on Technical Implementability

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS
EXTRACTION/ TREATMENT/ DISCHARGE (Cont.)	ON-SITE ORGANIC CONTAMINANT TREATMENT (Cont.)	CARBON ADSORPTION	Contaminants adsorbed to activated carbon by internal pores of carbon granules.	Applicable to organic contaminants, including aromatic hydrocarbons and chlorinated compounds.
		RESIN ADSORPTION	Similar to carbon adsorption but synthetic resins are used.	Can be effective for organic removal; easily combined with ion exchange.
		UV OXIDATION	An oxidizing agent such as hydrogen peroxide is mixed with the waste stream and exposed to ultraviolet light to oxidize contaminants.	Proven for treatment of chlorinated VOCs, semivolatiles & pesticides/PCBs in EPA SITE testing; ineffective in treating single-bonded organic compounds; inorganics may cause fouling.
		DEHALOGENATION [shaded]	Chemical agent is mixed with waste stream to remove halogen atoms from chlorinated hydrocarbons.	Primarily used for PCB transformer oils. Does not treat non-chlorinated hydrocarbons.
	ON-SITE INORGANIC CONTAMINANT TREATMENT	REVERSE OSMOSIS [shaded]	Removal of solutes from solution by a semi-permeable membrane under a high pressure gradient.	Used mainly for dissolved solids; metals and low level organics can cause clogging.
		ION EXCHANGE	Contaminants removed from aqueous phase by exchanging places with ions held by ion exchange material.	Effective for inorganics; existing on-site ground water treatment utilizes an ion exchange system.
		PRECIPITATION	Contaminants removed by decreasing solubility.	Applicable to inorganics.

TABLE 3-6 (Continued)
GROUND WATER REMEDIAL TECHNOLOGY SCREENING
FOCUSED FEASIBILITY STUDY
SHIELDALLOY METALLURGICAL CORPORATION

[shaded box] Screened on Technical Implementability

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS
EXTRACTION/ TREATMENT/ DISCHARGE (Cont.)	ON-SITE INORGANIC CONTAMINANT TREATMENT (Cont.)	COAGULATION AND FLOCCULATION	Addition of chemicals is used to enhance sedimentation of insoluble and colloidal heavy metal compounds.	Proven for heavy metals.
		MEMBRANE MICROFILTRATION	Solid particles removed from liquids using pressure filter.	SITE program technology; applicable to ground water contaminated with suspended heavy metals; filter opening size is smaller than that used in collecting filtered ground water samples; therefore, treatability studies would be required to determine effectiveness in removing detected inorganics.
		ELECTROCHEMICAL	Utilizes the oxidation/reduction properties of ferrous ions for removing heavy metals from aqueous solutions.	Proven for treatment of heavy metals.
	IN SITU TREATMENT (shaded)	BIODEGRADATION (shaded)	Stimulation of indigenous bacteria or introduced strains to degrade organics by means of nutrient addition.	Aromatic hydrocarbons require aerobic conditions while chlorinated compounds require anaerobic conditions; ineffective for inorganics.
	DISCHARGE	GROUND WATER	Treated water is reinjected into water table via wells or infiltration galleries.	1984 testing of an injection well was not successful due to high ground water table and presence of iron bacteria.
		SURFACE WATER	Treated water is discharged directly into surface water.	Potentially viable; discharge of treated water has historically been to the Hudson Branch under NJPDES permit NJ0004103.

TABLE 3-6 (Continued)
GROUND WATER REMEDIAL TECHNOLOGY SCREENING
FOCUSED FEASIBILITY STUDY
SHIELDALLOY METALLURGICAL CORPORATION

(shaded) Screened on Technical Implementability

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS
EXTRACTION/ TREATMENT/ DISCHARGE (Cont.)	DISCHARGE (Cont.)	COMBINED DISCHARGE	Effluent stream is partially discharged to ground water, partially discharged to surface water.	Potentially viable.
		SANITARY SEWER (shaded)	Treated water is discharged indirectly to surface water body via sanitary sewer and POTW.	No locally available sanitary sewers.

TABLE /
GROUND WATER PROCESS OPTION SCREENING
FOCUSED FEASIBILITY STUDY
SHIELDALLOY METALLURGICAL CORPORATION

* CHOSEN PROCESS OPTION

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION		EFFECTIVENESS	IMPLEMENTABILITY	COST
NO ACTION	NONE	NOT APPLICABLE	•	Not effective in prohibiting or monitoring contaminant migration.	No implementation required.	No cost.
INSTITUTIONAL CONTROL	CONTINUED GROUND WATER MONITORING	NOT APPLICABLE	•	Would provide means of monitoring off-site contaminant migration but provides no treatment.	Easily implemented.	Low capital; moderate O&M.
	GROUND WATER USE RESTRICTIONS	LEGAL RESTRICTIONS	•	Effective in limiting public ingestion of ground water contaminants, by eliminating use of potable wells in contaminated areas.	Requires proper legal authority.	Low capital.
EXTRACTION/ TREATMENT/ DISCHARGE	EXTRACTION	EXISTING EXTRACTION WELLS	•	Effective; best suited for steep hydraulic gradients and miscible contaminants.	Easily implemented; extraction wells already exist on-site.	Low to moderate capital; moderate O&M.
		REVISED EXTRACTION WELL SYSTEM	*	Effective; may optimize operation of pump and treat system.	Easily implemented.	Moderate capital; moderate O&M.
	ON-SITE ORGANIC CONTAMINANT TREATMENT	PACT	*	Effective for organic compounds, including chorinated organics; provides an extended residence time for more effective treatment.	Easily implemented; Limited number of venders.	High capital; moderate to high O&M.
		AIR STRIPPING	*	Generally effective for volatile organics, including contaminants of concern.	Readily implemented; air stripping column available on-site; may require treatment of off-gases.	Low capital; moderate O&M.
		STEAM STRIPPING		Treats hard-to-strip organic compounds; contaminants of concern are readily strippable without addition of steam.	Readily implemented; may require treatment of off-gases.	Moderate to high capital; moderate O&M.
		CARBON ADSORPTION	*	Effective for low solubility organics.	Readily implemented; requires on- or off-site regeneration of carbon.	Moderate capital; moderate O&M.
		RESIN ADSORPTION		Effective for organic removal.	Prior to implementation, identification of resin applicable to contaminants in ground water is required.	High capital; moderate O&M.
		UV OXIDATION	*	Effective for treatment of volatiles and semi-volatiles; no emissions or waste by-products produced.	Readily implemented.	High capital; moderate O&M.

TABLE 3-7 (Continued)
GROUND WATER PROCESS OPTION SCREENING
FOCUSED FEASIBILITY STUDY
SHIELDALLOY METALLURGICAL CORPORATION

* CHOSEN PROCESS OPTION

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
EXTRACTION/ TREATMENT/ DISCHARGE (Cont.)	ON-SITE INORGANIC CONTAMINANT TREATMENT	ION EXCHANGE •	Generally effective for inorganic removal, although existing system would require evaluation to deterination effectiveness of upgrading the system.	Readily implemented; existing ground water treatment system is an ion exchange system.	Low to moderate capital; moderate O&M.
		PRECIPITATION	Effective for inorganic removal; precipitate must be disposed of; would provide pretreatment prior to ion exchange.	Readily implemented.	Low to moderate capital; moderate O&M.
		COAGULATION AND FLOCCULATION •	Effective for inorganic removal, including removal of colloidal particles; resultant sludge must be disposed of; would provide pretreatment prior to ion exchange.	Readily implemented.	Low to moderate capital; moderate O&M.
		MEMBRANE MICROFILTRATION *	Effective in removing filterable heavy metals, based on pilot tests. Treatability studies required to determine effectiveness; would provide pretreatment prior to ion exchange.	Can be manufactured as a mobile system.	High capital; moderate to high O&M.
		ELECTROCHEMICAL •	Effective in producing metal hydroxide precipitates of inorganic species such as arsenic, cadmium, zinc and copper; precipitate must be disposed of; would provide pretreatment prior to ion exchange or stand-along treatment of inorganics.	Newly developing technology in terms of applications to contaminated ground water; available through a limited number of suppliers.	Moderate capital; moderate O&M.
	DISCHARGE	GROUND WATER •	Effective with permeable soils and relatively low flow rates; not as effective at high flow rates due to shallow depth to water table and high iron concentrations which can result in clogging.	Requires compliance with discharge criteria and construction of injection system.	Moderate capital; low to moderate O&M.
		SURFACE WATER *	Effective for discharge of treated ground water.	Readily implemented; discharge system already in-place; requires compliance with discharge criteria.	Low capital; low O&M.
		COMBINED DISCHARGE *	Limits impacts of high discharge rates on surface water body and may assist in speeding flushing of ground water contaminants.	Surface water discharge system in-place; reinjection system construction required; requires compliance with surface and ground water discharge criteria.	Moderate capital; low to moderate O&M.

TABLE 3-8

REPRESENTATIVE PROCESS OPTIONS
FOCUSED FEASIBILITY STUDY

SHIELDALLOY METALLURGICAL CORPORATION

TECHNOLOGY	PROCESS OPTION
No Action	Not applicable
Ground Water Monitoring	Not applicable
Ground Water Use Restrictions	Legal restrictions
Extraction	Existing extraction well system Revised extraction well system
On-Site Organic Contaminant Treatment:	Powdered Activated Carbon Treatment (PACT) Air stripping Carbon adsorption UV oxidation
On-Site Inorganic Contaminant Treatment:	Ion exchange Coagulation/filtration Membrane microfiltration Electrochemical treatment
Discharge	Ground water Surface water Combined discharge

TABLE 4-1

PRELIMINARY REMEDIAL ALTERNATIVE OPTION SUMMARY
FOCUSED FEASIBILITY STUDY

SHIELDALLOY METALLURGICAL CORPORATION

Alternative 1 - No Action

Alternative 2 - Continuation of existing actions

Alternative 3 - Modified ground water restoration

Extraction -		Option E1 - Existing extraction system
		Option E2 - Modified extraction system
Treatment -		
	Organic:	Option T1 - Powdered Activated Carbon Treatment
		Option T2 - Air stripping
		Option T3 - Carbon adsorption
		Option T4 - UV oxidation
	Inorganic:	Option T5 - Ion exchange
		Option T6 - Coagulation and flocculation
		Option T7 - Membrane microfiltration
		Option T8 - Electrochemical
Discharge -		Option D1 - Ground water
		Option D2 - Surface water
		Option D3 - Combined discharge

TABLE 4-2

PRELIMINARY REMEDIAL ALTERNATIVE COST ESTIMATES
FOCUSED FEASIBILITY STUDY

SHIELDALLOY METALLURGICAL CORPORATION

Alternative			Total Present Worth
Alternative 1 - No Action			$ 40,000
Alternative 2 - Continuation of existing actions			$ 7,000,000
Alternative 3 - Modified ground water restoration			
Extraction -	Option E1 - Existing extraction system		$ 150,000
	Option E2 - Modified extraction system		$ 200,000
Treatment -			
Organic:	Option T1 - PACT treatment		$ 5,000,000
	Option T2 - Air stripping		$ 90,000
	Option T3 - Carbon adsorption		$ 800,000
	Option T4 - UV oxidation		$ 3,000,000
Inorganic:	Option T5 - Ion exchange		Not Calculated
	Option T6 - Coagulation and flocculation		$11,000,000
	Option T7 - Membrane microfiltration		$ 9,000,000
	Option T8 - Electrochemical treatment		
		(without ion exchange)	$ 3,900,000
		(with ion exchange)	$ 6,500,000
Discharge -	Option D1 - Ground water		$ 1,300,000
	Option D2 - Surface water		$ 1,000,000
	Option D3 - Combined discharge		$ 1,500,000

TABLE 5-1

REMEDIAL ALTERNATIVES UNDERGOING DETAILED ANALYSIS
FOCUSED FEASIBILITY STUDY

SHIELDALLOY METALLURGICAL CORPORATION

Alternative 1 - No Action		
Alternative 2 - Continuation of existing actions		
Alternative 3 - Modified ground water restoration		
Extraction -		Option E1 - Existing extraction system Option E2 - Modified extraction system
Treatment -		
	Organic:	Option T2 - Air stripping Option T3 - Carbon adsorption Option T4 - UV oxidation
	Inorganic:	Option T6 - Coagulation and flocculation Option T7 - Membrane microfiltration Option T8 - Electrochemical
Discharge -		Option D1 - Ground water Option D2 - Surface water Option D3 - Combined discharge

TABLE 5–2

EXISTING MONITORING PROGRAM SUMMARY – ON–SITE WELLS
SHIELDALLOY METALLURGICAL CORPORATION

WELL LOCATION	SAMPLING FREQUENCY	ANALYSIS	REMARKS
ON–SITE WELLS			
A	Q	C,V,R	
B	Q	C,V	
F	Q	C	
K	Q	C,V	
L	Q	C	
W2 (R)	Q	C,R	Replaces W2
W4	A	C	
IWC1	A	C,V	
IWC2	Q	C,V	
IWC3	A	C,V	
IWC4	A	C,V	
IWC5	Q	C,V	
SC7S	Q	C	
SC8S	Q	C	
SC9S	Q	C,V	
SC11S (R)	Q	C,R	Replaces SC11S
SC12S	Q	C,R	
SC12D	Q	C	
SC13S	Q	C,R	
SC13D	Q	C	
SC14S	Q	C,R	
SC15S	A	C	
SC16S	A	C	
SC20S	A	C,V	
SC20D	A	C,V	
SC22S	Q	C,V	
SC22D	Q	C,V	
SC23S	Q	C,V	
SC25S	M	C	

NOTES:

SAMPLING FREQUENCY:
- M = MONTHLY
- Q = QUARTERLY
- A = ANNUALLY

ANALYSIS:
- C = TEMP., pH, Cr+6, Cr TOTAL, SO, Na
- V = VOC +15
- R = GROSS ALPHA

TABLE 5–3

EXISTING MONITORING PROGRAM SUMMARY – OFF–SITE WELLS, RECOVERY WELLS AND INFLUENT
SHIELDALLOY METALLURGICAL CORPORATION

WELL LOCATION	SAMPLING FREQUENCY	ANALYSIS	REMARKS
OFF–SITE WELLS			
SC1D	M	C	
	Q	V	
SC1S	M	C	
	Q	V	
SC2D (R)	M	C	Replaces SC2D
	Q	V	
SC3S	M	C	
	Q	V	
SC3D (R)	M	C	Replaces SC3D
	Q	V	
SC4D	A	C	
SC4S	A	C	
SC5D	M	C	
	Q	V	
SC5S	M	C	
	Q	V	
SC6D	Q	C,V	
SC6S	Q	C,V	
SC10D	M	C	
SC10S	M	C	
SC17D	A	C,V	
SC17S	A	C,V	
SC18D	A	C,V	
SC18S	A	C,V	
SC19D	Q	C,V	
SC19S	Q	C,V	
SC21D	Q	C,V	
SC21S	Q	C,V	
SC24S	M	C	
SC26D	Q	C,V	
IW1	M	C	
IW2	Q	C,V	
RECOVERY WELLS			
W9	M	C	
LAYNE	M	C	
RW6D	M	C	
RW6S	M	C	
RIW2	M	C	
PLANT INFLUENT	M	V	

NOTES:

SAMPLING FREQUENCY:
- M = MONTHLY
- Q = QUARTERLY
- A = ANNUALLY

ANALYSIS:
- C = TEMP., pH, Cr+6, Cr TOTAL, SO, Na
- V = VOC +15

TABLE 5-4

ASSUMED MONITORING PROGRAM (ALTERNATIVE 3) – ON-SITE WELLS
SHIELDALLOY METALLURGICAL CORPORATION

WELL LOCATION	SAMPLING FREQUENCY	ANALYSIS	REMARKS
ON-SITE WELLS			
A	Q	C,V,R	
B	Q	C,V	
F	Q	C	
K	Q	C,V	
L	Q	C	
W2 (R)	Q	C,R	Replaces W2
W4	A	C	
IWC1	A	C,V	
IWC2	Q	C,V	
IWC3	A	C,V	
IWC4	A	C,V	
IWC5	Q	C,V	
SC7S	Q	C	
SC8S	Q	C	
SC9S	Q	C,V	
SC11S (R)	Q	C,R	Replaces SC11S
SC12S	Q	C,R	
SC12D	Q	C	
SC13S	Q	C,R	
SC13D	Q	C	
SC14S	Q	C,R	
SC15S	A	C	
SC16S	A	C	
SC20S	A	C,V	
SC20D	A	C,V	
SC22S	Q	C,V	
SC22D	Q	C,V	
SC23S	Q	C,V	
SC25S	Q	C	

NOTES:

SAMPLING FREQUENCY:
- Q = QUARTERLY
- A = ANNUALLY

ANALYSIS:
- C = TEMP., pH, Cr+6, Cr TOTAL, SO, I
- V = VOC +15
- R = GROSS ALPHA

TABLE 5–5

ASSUMED MONITORING PROGRAM (ALTERNATIVE 3) – OFF–SITE WELLS, RECOVERY WELLS AND INFLUEN
SHIELDALLOY METALLURGICAL CORPORATION

WELL LOCATION	SAMPLING FREQUENCY	ANALYSIS	REMARKS
OFF–SITE WELLS			
SC1D	Q	C,V	
SC1S	Q	C,V	
SC2D (R)	Q	C,V	Replaces SC2D
SC3S	Q	C,V	
SC3D (R)	Q	C,V	Replaces SC3D
SC4D	A	C	
SC4S	A	C	
SC5D	Q	C,V	
SC5S	Q	C,V	
SC6D	Q	C,V	
SC6S	Q	C,V	
SC10D	Q	C	
SC10S	Q	C	
SC17D	A	C,V	
SC17S	A	C,V	
SC18D	A	C,V	
SC18S	A	C,V	
SC19D	Q	C,V	
SC19S	Q	C,V	
SC21D	Q	C,V	
SC21S	Q	C,V	
SC24S	Q	C,V	
SC26D	Q	C,V	
IW1	Q	C	
IW2	Q	C,V	
RECOVERY WELLS			
W9	Q	C	
LAYNE	Q	C	
RW6D	Q	C	
RW6S	Q	C	
RIW2	Q	C	
PLANT INFLUENT	M	V	

NOTES:

SAMPLING FREQUENCY:
- Q = QUARTERLY
- A = ANNUALLY
- M = MONTHLY

ANALYSIS:
- C = TEMP., pH, Cr+6, Cr TOTAL, SO, Na
- V = VOC +15

TABLE 5-6
COMPARISON AMONG GROUND WATER ALTERNATIVES
SHORT-TERM EFFECTIVENESS
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	DESCRIPTION
No action	No remedial activities conducted; Therefore, no short-term risks result; Remedial response objectives not achieved
Continuation of Existing Actions	Utilizes existing treatment system; Therefore, no short-term risks result
Modified Ground Water Restoration	Minimal short-term risks; Achieves remedial response objectives in shortest time frame
Extraction:	
Option E1 – Existing Extraction System	Requires minimal construction activities; Utilizes existing extraction wells and piping sytems; Therefore, no significant short-term risks associated with implementation
Option E2 – Modified Extraction System	Requires construction of additional extraction wells and installation of additional piping; Short-term risks are not expected to be significant; Expected to achieve remedial response objectives within a shorter time frame
Organic Treatment:	
Option T2 – Air Stripping	No significant short-term risks to the community or remedial workers anticipated; Utilizes an existing on-site treatment system; Effective in meeting remedial response objectives
Option T3 – Carbon Adsorption	Minimal short-term risks to community or remedial workers due to enclosed nature of treatment system and regeneration of spent carbon units; Treatment units are readily available; Effective in meeting remedial response objectives
Option T4 – UV Oxidation	Minimal short-term risks to the community due to destruction of contaminants; Process chemicals may pose short-term risks to remedial workers, depending on selected technology vendor; Potential additional risks associated with those UV treatment technologies which employ ozone in the treatment process; Treatment unit availability is improving; Effective in meeting remedial response objectives
Inorganic Treatment:	
Option T6 – Coagulation and Flocculation	Minimal short-term risks to the community; Requires handling of inorganic sludge; Treatment system readily available; May not be effective in meeting remedial response objectives
Option T7 – Membrane Microfiltration	Minimal short-term risks to community or remedial workers; Requires handling of sludge collected on membrane and periodic changes of the membrane; Effective in meeting remedial response objectives
Option T8 – Electrochemical	Minimal short-term risks to the community; Requires handling of inorganic sludge and replacement of electrodes in electrochemical cells; Effective in meeting remedial response objectives; Supplemental treatment technologies equally effective in the short-term although ion exchange and electrochemical treatment are most easily implemented

TABLE 5-6
COMPARISON AMONG GROUND WATER ALTERNATIVES
SHORT-TERM EFFECTIVENESS
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	DESCRIPTION
Discharge	
Option D1 – Ground Water	Minimal short-term risks to remedial workers, community and environment when combined with treatment; Requires construction of recharge system
Option D2 – Surface Water	Minimal short-term risks to remedial workers, community and environment when combined with treatment; Very easy to implement based on presence of existing discharge system
Option D3 – Combined Discharge to Surface Water and Ground Water	Minimal short-term risks to remedial workers, community and environment when combined with treatment; Requires construction of recharge system and use of existing surface water discharge system

TABLE 5-7
COMPARISON AMONG GROUND WATER ALTERNATIVES
LONG-TERM EFFECTIVENESS AND PERMANENCE
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	DESCRIPTION
No action	Existing site-related risks remain; Does not prevent contaminated ground water migration; Requires a five-year review
Continuation of Existing Actions	Existing system effective in minimizing the majority of contaminant migration beyond the identified plume area; Requires off-site disposal of brine solution and filter cake sludge, and long-term ground water monitoring; Exposures limited through existence of well restriction area
Modified Ground Water Restoration	Optimizes operation of ground water restoration program; Operation and maintenance requirements depend on selected options
Extraction:	
Option E1 - Existing Extraction System	Effective in implementing increased extraction rate but does not provide capture of contamination near potential source area(s)
Option E2 - Modified Extraction System	Provides greater control over contaminant plume; Removes contaminants closer to the potential contaminant source area(s)
Organic Treatment:	
Option T2 - Air Stripping	Effective in treating organic contaminants of concern from the wastestream; Requires minimal long-term maintenance of air stripper
Option T3 - Carbon Adsorption	Effective in treating both chlorinated and aromatic contaminants; Contaminants destroyed through thermal treatment; Requires periodic removal and regeneration of spent carbon
Option T4 - UV Oxidation	Effective in treating organic contaminants of concern; Contaminants destroyed by treatment process; Requires replacement of UV lamps and provision of hydrogen peroxide
Inorganic Treatment:	
Option T6 - Coagulation and Flocculation	May not be effective in treating colloidal contaminants, as indicated by preliminary testing; Requires hazardous waste characterization and disposal of residual sludge; Must be combined with ion exchange
Option T7 - Membrane Microfiltration	Effective in treating inorganic contaminants; Requires hazardous waste characterization and disposal of residual sludge, and replacement of membrane; Must be combined with ion exchange
Option T8 - Electrochemical	Effective in treating inorganic contaminants; Requires hazardous waste characterization and disposal of residual sludge; Provides greatest degree in contaminant reduction (based on treatability studies); With supplemental treatment, such as ion exchange, or by modifying the electrochemical treatment system, proposed discharge to surface water discharge permit conditions are expected to be achievable

TABLE 5–7
COMPARISON AMONG GROUND WATER ALTERNATIVES
LONG–TERM EFFECTIVENESS AND PERMANENCE
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	DESCRIPTION
Discharge	
Option D1 – Ground Water	Requires long–term maintenance of recharge system to prevent clogging; Requires regular monitoring of discharge quality and of effects of mounding on extraction system
Option D2 – Surface Water	Requires minimal long–term maintenance; Requires regular monitoring of discharge quality
Option D3 – Combined Discharge to Surface Water and Ground Water	Requires long–term maintenance of recharge system to prevent clogging of the ground water recharge portion of the discharge system; Requires regular monitoring of discharge quality and monitoring of recharge system to determine effects of mounding on extraction system

TABLE 5-8
COMPARISON AMONG GROUND WATER ALTERNATIVES
IMPLEMENTABILITY
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	TECHNICAL FEASIBILITY	ADMINISTRATIVE FEASIBILITY	SERVICE & MATERIAL AVAILABILITY
No action	Easily implemented; Does not limit implementation of future remedial actions	Requires five-year review	No equipment required except for five-year ground water monitoring event
Continuation of Existing Actions	Easily implemented; System already in place and operational; Does not limit implementation of future remedial actions	Continuation of current administrative requirements	Current suppliers of operation and maintenance equipment readily available
Modified Ground Water Restoration	See option descriptions below	See option descriptions below	See option descriptions below
Extraction:			
Option E1 – Existing Extraction System	Easily implemented based on use of existing extraction wells and one supplemental well; Does not limit implementation of future remedial actions	Continuation of current administrative requirements; Requires well installation permit	Suppliers of equipment and services are readily available
Option E2 – Modified Extraction System	Easily implemented but requires installation of additional wells; Does not limit implementation of future remedial actions	Requires well installation permits	Suppliers of equipment and services are readily available
Organic Treatment:			
Option T2 – Air Stripping	Easily implemented since the system already exists on-site; Expansion of system is fairly easy, if necessary	Administrative feasibility good based on system's historic use at site	Suppliers of equipment and services are readily available
Option T3 – Carbon Adsorption	Easily implemented; Requires set-up of an on-site carbon adsorption unit and replacement of carbon on a regular basis; Simplicity of unit allows for use of multiple units or subsequent additions of units, if necessary	Requires compliance with requirements of a treatment works permit	Requires regeneration of spent carbon; Suppliers of equipment and services are readily available
Option T4 – UV Oxidation	Fairly easily implemented; Requires set-up of an on-site UV oxidation system; Requires maintenance of chemical supplies and UV lamps	Requires compliance with requirements of a treatment works permit	Although previously considered an innovative technology, suppliers of equipment and services are becoming more readily available

TABLE 5–8
COMPARISON AMONG GROUND WATER ALTERNATIVES
IMPLEMENTABILITY
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	TECHNICAL FEASIBILITY	ADMINISTRATIVE FEASIBILITY	SERVICE & MATERIAL AVAILABILITY
Inorganic Treatment:			
Option T6 – Coagulation and Flocculation	Fairly easily implemented; Start–up could result in technical problems based on preliminary testing; Requires maintenance of chemical supplies and sludge disposal	Requires compliance with requirements of a treatment works permit	Requires disposal of residual sludge; Suppliers of equipment and services are readily available
Option T7 – Membrane Microfiltration	Fairly easily implemented; Does not limit implementation of future remedial actions; Requires construction of additional on–site facility	Requires compliance with requirements of a treatment works permit	Requires disposal of residual sludge and replacement of membrane; Suppliers of equipment and services are fairly readily available
Option T8 – Electrochemical	Fairly easily implemented, although construction of an additional on–site facility is required; Does not limit implementation of future remedial actions; Ion exchange or modification of electrochemical system are fairly easily implemented as supplemental treatment technology, if required	Requires compliance with requirements of a treatment works permit	Requires maintenance of electrochemical cells, chemical supplies, and sludge handling; Suppliers of equipment and services limited due to innovative nature of treatment option; Availability of ion exchange suppliers for supplemental treatment is good
Discharge			
Option D1 – Ground Water	Requires construction of an extensive recharge system	Requires compliance with discharge to ground water permit	Suppliers of equipment and services are readily available
Option D2 – Surface Water	Easily implemented since current system discharges to surface water	Requires compliance with surface water discharge criteria	Suppliers of equipment are readily available
Option D3 – Combined Discharge to Surface Water and Ground Water	Requires construction of an extensive recharge system	Requires compliance with discharge to ground water permit and surface water discharge criteria	Suppliers of equipment and services are readily available

TABLE 5-9
COMPARISON AMONG GROUND WATER ALTERNATIVES
REDUCTION OF TOXICITY (T), MOBILITY (M), OR VOLUME (V) THROUGH TREATMENT
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	DESCRIPTION
No action	No reductions of T,M or V of contaminated ground water; Potential risk of downgradient migration if existing system is shutdown
Continuation of Existing Actions	Reductions of T,M or V of contaminated ground water; Residual brine and sludge produced; May not effectively capture all identified ground water contamination
Modified Ground Water Restoration	Reductions of T, M, or V of contaminated ground water; Most effective in capturing contaminated ground water
Extraction:	
Option E1 – Existing Extraction System	M of contaminated ground water reduced through increased pumping using current extraction system and supplemental extraction well; T and V of contaminated ground water not reduced
Option E2 – Modified Extraction System	M of contaminated ground water reduced through increased pumping of a revised extraction system designed to optimize contaminant capture; T of contaminated ground water not reduced; V of contaminated ground water potentially reduced over long-term due to extraction near to potential source area(s)
Organic Treatment:	
Option T2 – Air Stripping	Reduces T of organic ground water contaminants through transfer of contaminants from aqueous to vapor phase; Contaminants undergo additional natural breakdown in atmosphere
Option T3 – Carbon Adsorption	Reduces T of organic ground water contaminants through adsorption of contaminants onto carbon and susequent destruction using thermal processes
Option T4 – UV Oxidation	Reduces T of organic ground water contaminants through oxidation processes without production of contaminant residuals
Inorganic Treatment:	
Option T6 – Coagulation and Flocculation	Initial studies indicate this option may not be effective in reducing T of inorganic ground water contamination; Residual sludge produced; Would have to be combined with current ion exchange treatment system
Option T7 – Membrane Microfiltration	Reduces T of undissolved inorganic ground water contamination; Would have to be combined with current ion exchange treatment system; Residual sludge produced
Option T8 – Electrochemical	Reduces T of inorganic ground water contamination; Residual sludge produced; Provides greatest degree of inorganic removal from ground water; If required to meet proposed discharge to surface water permit conditions, supplemental treatment such as ion exchange or modification of the electrochemical treatment system could provide even greater inorganic removals

TABLE 5-9
COMPARISON AMONG GROUND WATER ALTERNATIVES
REDUCTION OF TOXICITY (T), MOBILITY (M), OR VOLUME (V) THROUGH TREATMENT
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	DESCRIPTION
Discharge	
Option D1 – Ground Water	No significant effect on T or V of contaminated ground water; Recharged water could enhance the extraction system and minimize contaminant migration
Option D2 – Surface Water	No significant effect on T, M or V of contaminated ground water
Option D3 – Combined Discharge to Surface Water and Ground Water	No significant effect on T or V of contaminated ground water; Recharge to ground water could enhance the extraction system and minimize contaminant migration

TABLE 5-10
COMPARISON AMONG GROUND WATER ALTERNATIVES
COMPLIANCE WITH ARARs
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	CHEMICAL-SPECIFIC	LOCATION-SPECIFIC	ACTION-SPECIFIC
No action	ARARs/TBCs not attained for ground water	No construction required; not applicable	Remedial action undertaken; not applicable
Continuation of Existing Actions	Existing extraction and treatment system may not achieve ground water quality ARARs or discharge requirements	No construction required; not applicable	Must comply with requirements of a New Jersey treatment works permit and RCRA hazardous waste transport and treatment regulations
Modified Ground Water Restoration	ARARs/TBCs expected to be attained for ground water contaminants and treated water discharge	Construction activities required to comply with floodplain, wetlands, and farmland protection requirements	See options below for specific requirements
Extraction:			
Option E1 – Existing Extraction System	Provides for extraction of most ground water with contaminant levels which exceed ARARs	Construction of additional ground water extraction well must comply with floodplain, wetlands, and farmland protection requirements	Must comply with ground water allocation regulations
Option E2 – Modified Extraction System	Most effective in extracting ground water with contaminant levels which exceed ARARs closest to potential source area(s)	Construction of additional ground water extraction wells must comply with floodplain, wetlands, and farmland protection requirements	Must comply with well installation and ground water allocation regulations
Organic Treatment:			
Option T2 – Air Stripping	Discharge to surface water TBCs attained for volatile organic contaminants of concern	Using existing on-site treatment system; therefore, not applicable	Must comply with requirements of a New Jersey treatment works permit and air pollution discharge regulations
Option T3 – Carbon Adsorption	Discharge to surface water TBCs attained for volatile organic contaminants of concern	Construction of on-site treatment system may be required to comply with floodplain and wetland requirements	Must comply with requirements of a New Jersey treatment works permit and RCRA hazardous waste transport and treatment regulations
Option T4 – UV Oxidation	Discharge to surface water TBCs attained for volatile organic contaminants of concern	Construction of on-site treatment system may be required to comply with floodplain and wetland requirements	Must comply with requirements of a New Jersey treatment works permit

TABLE 5-10
COMPARISON AMONG GROUND WATER ALTERNATIVES
COMPLIANCE WITH ARARs
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	CHEMICAL-SPECIFIC	LOCATION-SPECIFIC	ACTION-SPECIFIC
Inorganic Treatment:			
Option T6 – Coagulation and Flocculation	Discharge to surface water TBCs are not expected to be attainable for inorganic contaminants of concern based on preliminary testing	Construction of on-site treatment system may be required to comply with floodplain and wetland requirements	Must comply with requirements of a New Jersey treatment works permit and hazardous waste characterization, transport and treatment regulations
Option T7 – Membrane Microfiltration	With additional ion exchange, discharge to surface water TBCs may be obtainable but treatability study testing would be required	Construction of on-site treatment system may be required to comply with floodplain and wetland requirements	Must comply with requirements of a New Jersey treatment works permit and hazardous waste characterization, transport and treatment regulations
Option T8 – Electrochemical	Discharge to surface water TBCs may be attained for inorganic contaminants of concern based on initial testing; modification of the electrochemical treatment system or provision of supplemental ion exchange may be required to consistently meet discharge requirements	Construction of on-site treatment system may be required to comply with floodplain and wetland requirements	Must comply with requirements of a New Jersey treatment works permit and hazardous waste characterization, transport and treatment regulations
Discharge			
Option D1 – Ground Water	Dependent on treatment system and requirements of discharge to ground water permit	Construction of recharge system must comply with floodplain, wetlands, and farmland protection requirements	Must comply with requirements of discharge to ground water permit
Option D2 – Surface Water	Dependent on treatment system and requirements of discharge to surface water permit	Operation of discharge system must comply with floodplain, wetlands and farmland protection requirements	Must comply with requirements of discharge to surface water permit
Option D3 – Combined Discharge to Surface Water and Ground Water	Dependent on treatment system and requirements of discharge to ground water and discharge to surface water permits	Construction of recharge system must comply with floodplain, wetlands, and farmland protection requirements	Must comply with requirements of discharge to ground water and discharge to surface water permits

TABLE 5-11
COMPARISON AMONG GROUND WATER ALTERNATIVES
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	DESCRIPTION
No action	Least protective alternative; Risk of additional downgradient contamination exists if current treatment system is shut down
Continuation of Existing Actions	Provides a degree of long-term protection of human health and the environment; Partially addresses potential risks associated with existing ground water contamination through ground water extraction and treatment
Modified Ground Water Restoration	Provides the greatest degree of long-term protection of human health and the environment through the optimization of the ground water extraction and treatment system
Extraction:	
Option E1 – Existing Extraction System	Protective of human health and the environment through ground water containment and extraction; May not provide efficient capture of all contaminated ground water
Option E2 – Modified Extraction System	Protective of human health and the environment through ground water containment and extraction; Maximizes capture of contaminated ground water through modification of existing extraction system; Provides for extraction of contaminated ground water closer to potential source area(s)
Organic Treatment:	
Option T2 – Air Stripping	Effective in long-term and short-term; Expected to meet chemical-specific discharge to surface water TBCs for VOCs; Contaminants are transferred from the aqueous phase to the vapor phase where they undergo natural attenuation
Option T3 – Carbon Adsorption	Effective in long-term and short-term; Expected to meet chemical-specific discharge to surface water TBCs for VOCs; Contaminants are thermally destroyed off-site
Option T4 – UV Oxidation	Effective in long-term and short-term; Expected to meet chemical-specific discharge to surface water TBCs for VOCs; Contaminants are chemically destroyed
Inorganic Treatment:	
Option T6 – Coagulation and Flocculation	Expected to provide some degree of protection of human health and the environment; Not expected to achieve discharge to surface water TBCs for inorganic compounds of concern; Sludge residual disposed of off-site
Option T7 – Membrane Microfiltration	Effective in long-term and short-term when combined with current ion exchange system; Expected to meet chemical-specific discharge to surface water TBCs for inorganics; Sludge residual disposed of off-site

TABLE 5-11
COMPARISON AMONG GROUND WATER ALTERNATIVES
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	DESCRIPTION
Inorganic Treatment (Cont.):	
Option T8 – Electrochemical	Effective in long-term and short-term; Expected to meet chemical specific discharge to surface water TBCs for inorganics, especially with the provision of supplemental ion exchange treatment, may possibly treat organic contaminants of concern; Sludge residual disposed of off-site
Discharge	
Option D1 – Ground Water	Protective of human health and the environment, provided treatment system meets discharge criteria; Provides added element of hydraulic control; Potential for significant maintenance requirements
Option D2 – Surface Water	Protective of human health and the environment, provided treatment system meets discharge criteria; Easily implemented with minimal maintenance required
Option D3 – Combined Discharge to Surface Water and Ground Water	Protective of human health and the environment, provided treatment system meets discharge criteria; Provides an added element of hydraulic control; May require added maintenance

TABLE 5-12
COMPARISON AMONG GROUND WATER ALTERNATIVES
COST
SHIELDALLOY METALLURGICAL CORPORATION

ACTION	TOTAL CAPITAL COST	ANNUAL O&M COST	PRESENT WORTH O&M COST (1)	TOTAL PRESENT WORTH (2)
No Action	–	–	$40,000	$48,000
Continuation of Existing Actions	–	$1,300,000	$5,600,000	$6,700,000
Modified Ground Water Restoration				
Extraction:				
Option E1 – Existing Extraction System	$25,000	$27,000	$110,000	$170,000
Option E2 – Modified Extraction System	$106,000	$27,000	$110,000	$260,000
Organic Treatment:				
Option T2 – Air Stripping	$23,000	$14,000	$59,000	$98,000
Option T3 – Carbon Adsorption	$290,000	$100,000	$440,000	$880,000
Option T4 – UV Oxidation	$860,000	$400,000	$1,700,000	$3,100,000
Inorganic Treatment:				
Option T6 – Coagulation and Flocculation (3)	$140,000	$2,300,000	$10,000,000	$12,000,000
Option T7 – Membrane Microfiltration (3)	$730,000	$1,600,000	$6,800,000	$9,000,000
Option T8 – Electrochemical (4)	$1,500,000	$500,000	$2,200,000	$4,400,000
Supplemental Ion Exchange Polishing	$150,000	$500,000	$2,200,000	$2,800,000
Modification of Electrochemical Treatment	$100,000	$140,000	$600,000	$840,000
Discharge:				
Option D1 – Ground Water	$240,000	$220,000	$900,000	$1,400,000
Option D2 – Surface Water	–	$210,000	$900,000	$1,100,000
Option D3 – Combination of Ground Water and Surface Water	$240,000	$250,000	$1,100,000	$1,600,000

(1) Based on 5% discount rate
(2) Includes 20% contingency on all components
(3) Includes ion exchange
(4) Costs presented for Supplemental Ion Exchange Polishing include capital costs associated with repiping of the treatment system and resin replacement and estimated operational costs associated with brine disposal
Costs presented for Modification of the Electrochemical Treatment System include capital costs for additional filtration and annual O&M costs for filtration and additional sludge disposal

TABLE 5–13
SENSITIVITY ANALYSIS SUMMARY
SHIELDALLOY METALLURGICAL CORPORATION

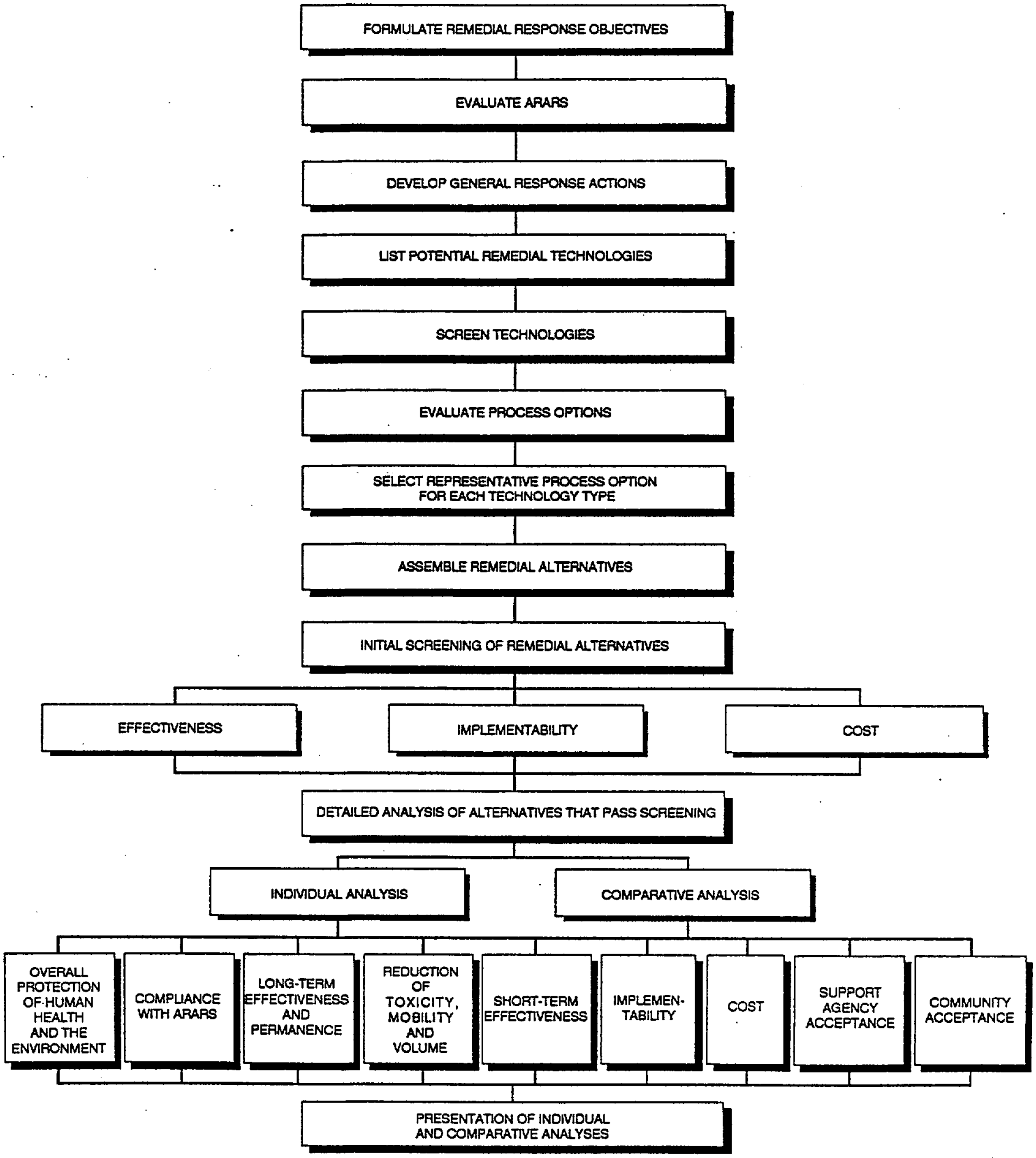
ALTERNATIVES/OPTIONS	DISCOUNT RATE = 3%	DISCOUNT RATE = 10%
<u>GROUND WATER ALTERNATIVES</u>		
ALTERNATIVE 1: NO ACTION	--	--
ALTERNATIVE 2: CONTINUATION OF EXISTING ACTIONS	$7,100,000	$5,900,000
ALTERNATIVE 3: MODIFIED GROUND WATER RESTORATION		
EXTRACTION		
OPTION E1 – EXISTING EXTRACTION SYSTEM	$180,000	$150,000
OPTION E2 – MODIFIED EXTRACTION SYSTEM	$270,000	$250,000
ORGANIC TREATMENT		
OPTION T2 – AIR STRIPPING	$100,000	$89,000
OPTION T3 – CARBON ADSORPTION	$910,000	$810,000
OPTION T4 – UV OXIDATION	$3,200,000	$2,800,000
INORGANIC TREATMENT		
OPTION T6 – COAGULATION AND FLOCCULATION	$13,000,000	$11,000,000
OPTION T7 – MEMBRANE MICROFILTRATION	$9,500,000	$8,000,000
OPTION T8 – ELECTROCHEMICAL TREATMENT	$4,500,000	$4,000,000
DISCHARGE		
OPTION D1 – DISCHARGE TO GROUND WATER	$1,500,000	$1,300,000
OPTION D2 – DISCHARGE TO SURFACE WATER	$1,100,000	$900,000
OPTION D3 – COMBINED DISCHARGE	$1,700,000	$1,400,000

TABLE 5-14
COMPARISON AMONG SUPPLEMENTAL TREATMENT TECHNOLOGIES
IN ACHIEVING COMPLIANCE WITH PROPOSED DISCHARGE TO SURFACE WATER PERMIT CONDITIONS
SHIELDALLOY METALLURGICAL CORPORATION

TECHNOLOGY	EFFECTIVENESS	IMPLEMENTABILITY	COST
Ion Exchange	Expected to attain both chromium and TDS proposed discharge to surface water permit conditions; initial treatability study testing supports this expectation; a resin may be identified which specifically targets chromium removal	Requires replacement of resin in existing ion exchange unit and tie-in of existing unit to electrochemical treatment system	Capital Costs: $150,000 Annual Operation and Maintenance: $500,000 Present Worth: $2,800,000
Reverse Osmosis	May attain chromium and TDS proposed discharge to surface water permit conditions; would require treatability study testing to verify treatability; not chemical-specific in terms of contaminant removal	Requires construction of new treatment system; requires determination of appropriate membrane type and system configuration for treatment of electrochemical effluent	Capital Costs: $1,000,000 Annual Operation and Maintenance: $300,000 Present Worth: $2,800,000
Microfiltration/Ultrafiltration	May attain chromium proposed discharge to surface water permit conditions; is not expected to attain proposed TDS permit conditions; would require treatability study testing to verify treatability; not chemical-specific in terms of contaminant removal	Requires contruction of new treatment system	Capital Costs: $700,000 to $1,000,000 Annual Operation and Maintenance: $100,000 to $500,000 Present Worth: $1,400,000 to $3,800,000
Electrochemical Treatment System Modification	Expected to attain chromium proposed discharge to surface water permit conditions; is not expected to attain proposed TDS permit conditions; treatability and operational studies confirm proposed chromium discharge conditions may be achievable; technology is specifically targeted to chromium removal	Requires modification of operation of existing treatment system; may require additional filtration capacity	Capital Costs: $100,000 Annual Operation and Maintenance: $140,000 Present Worth: $840,000

Note: Present Worth cost estimate includes operation over five years and 20% contingency

FIGURES



SOURCE: USEPA

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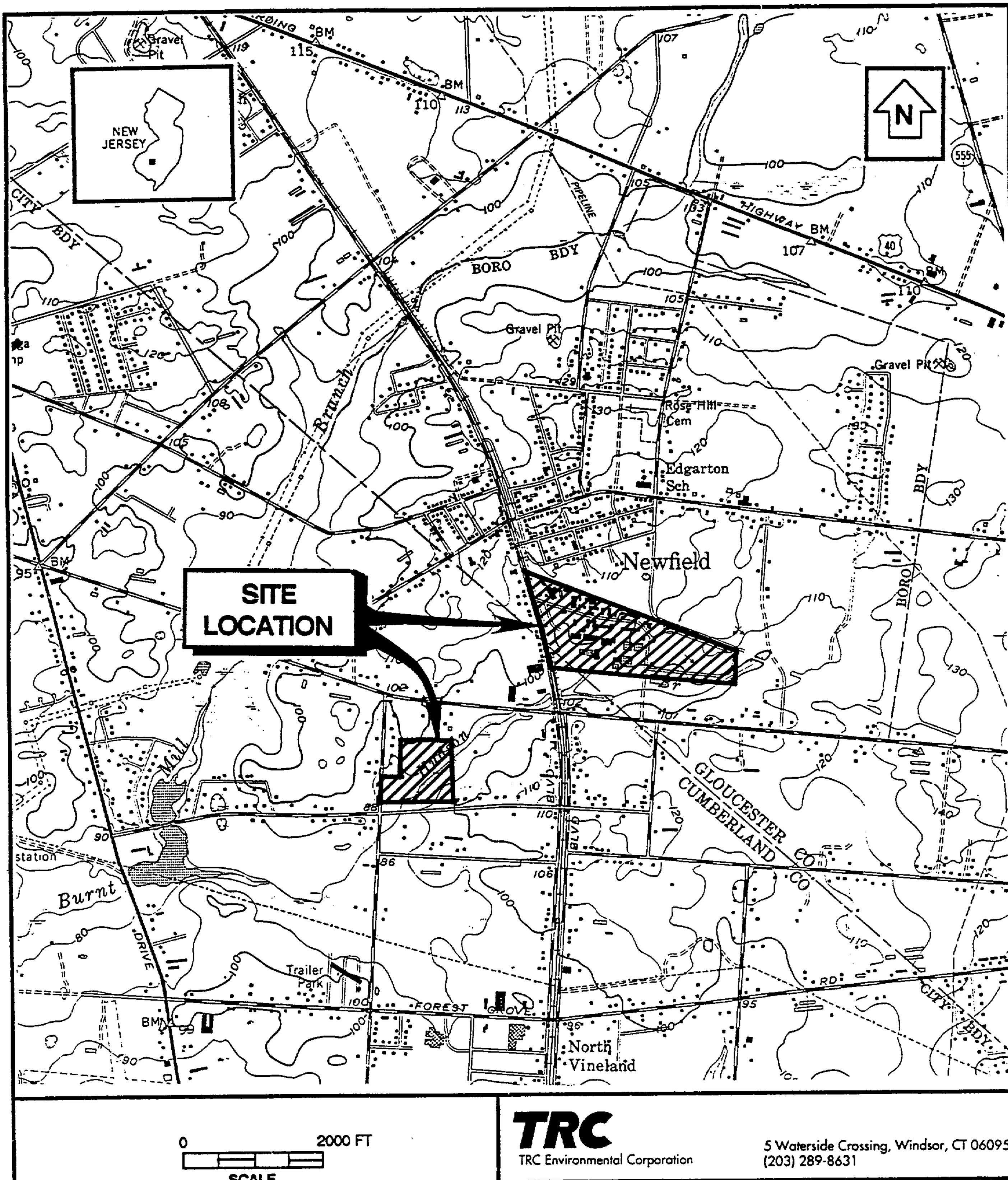
FIGURE 1-1.

FEASIBILITY STUDY APPROACH



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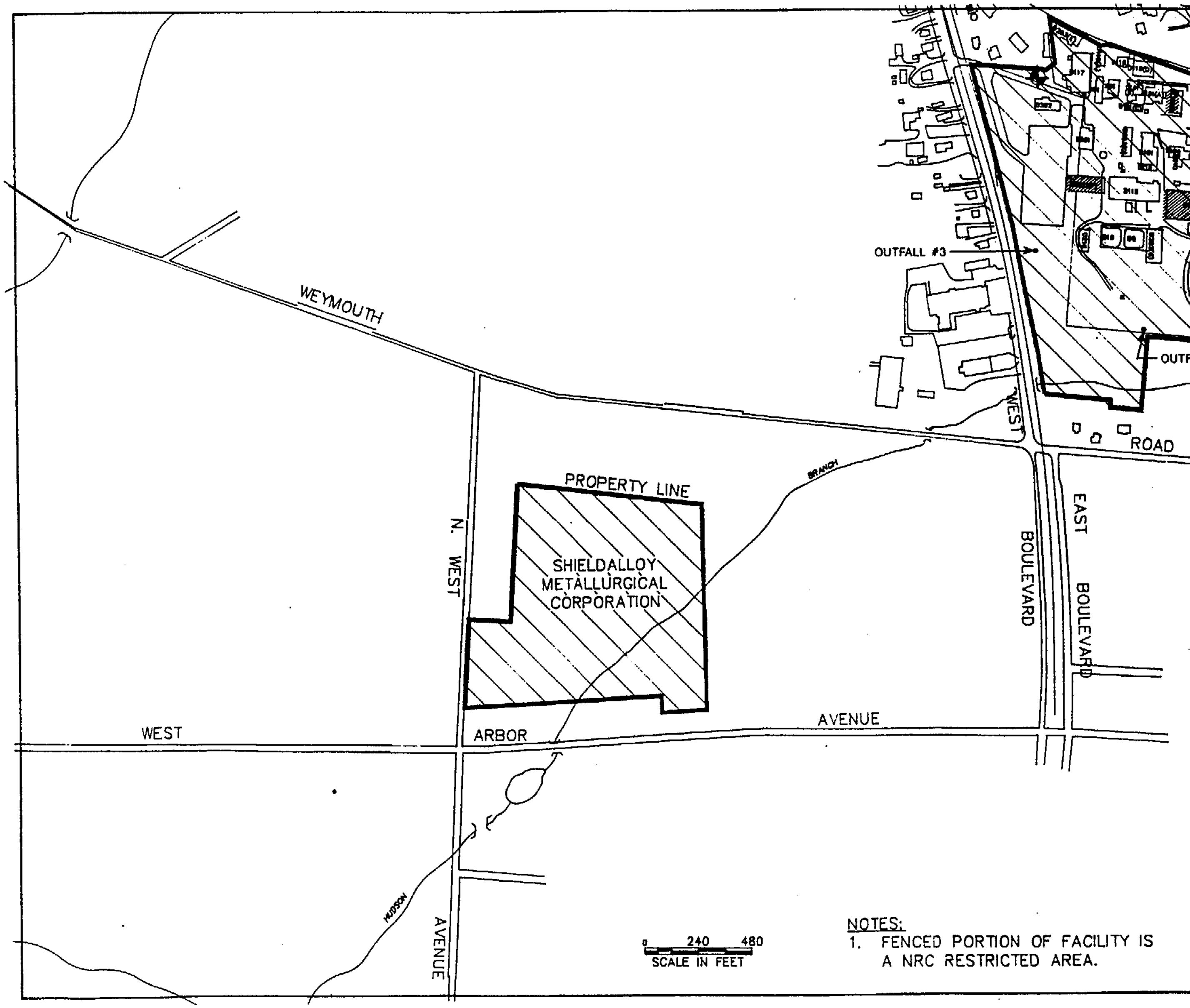
FROM NEWFIELD, NJ 7 1/2' USGS
TOPOGRAPHIC MAP, 1953
PHOTOREVISED 1986

FIGURE 1-2.

SITE LOCATION MAP



NOTES:
1. FENCED PORTION OF FACILITY IS A NRC RESTRICTED AREA.

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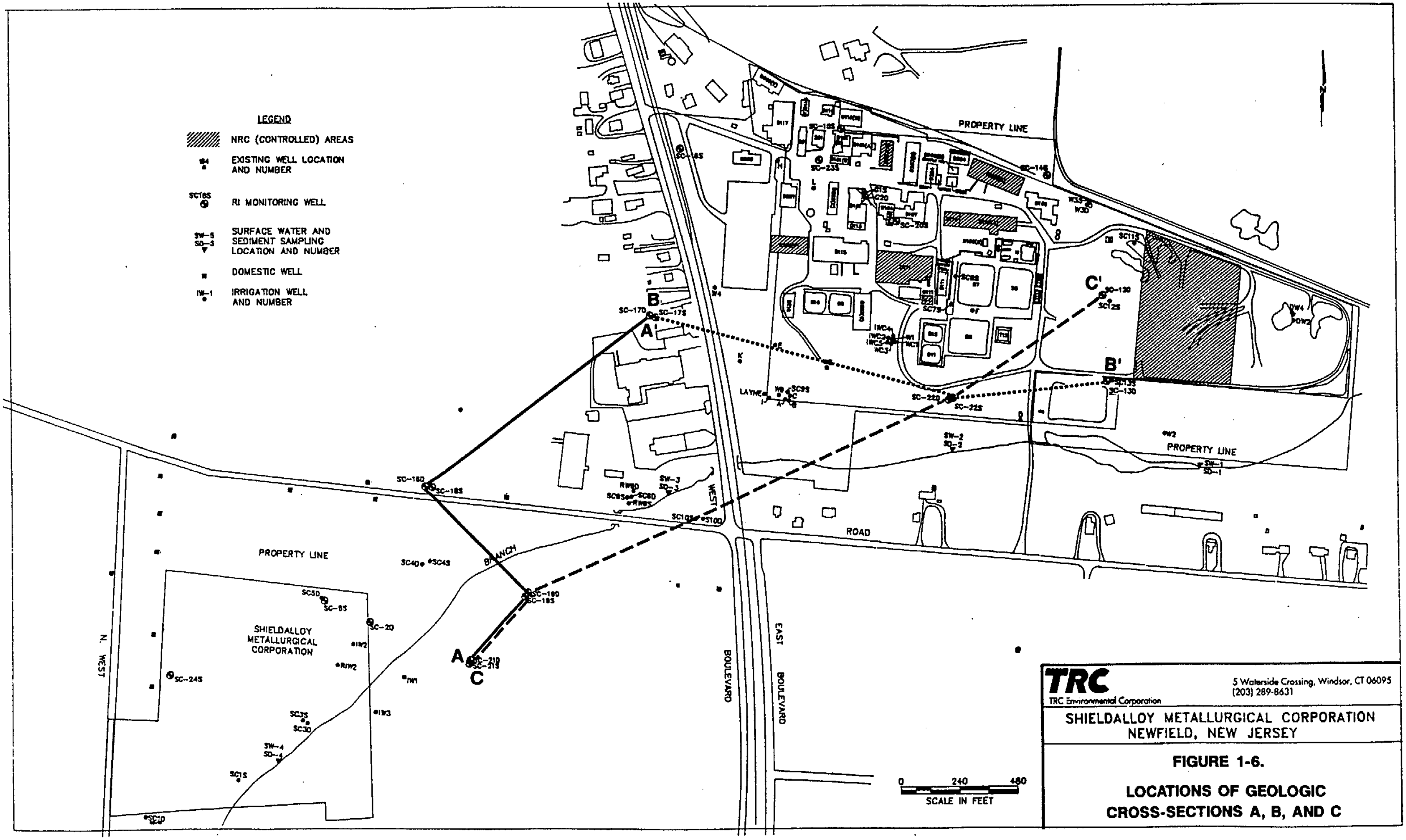
FIGURE 1-3.
SITE MAP



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NEWFIELD, NEW JERSEY

FIGURE 1-6.

LOCATIONS OF GEOLOGIC CROSS-SECTIONS A, B, AND C

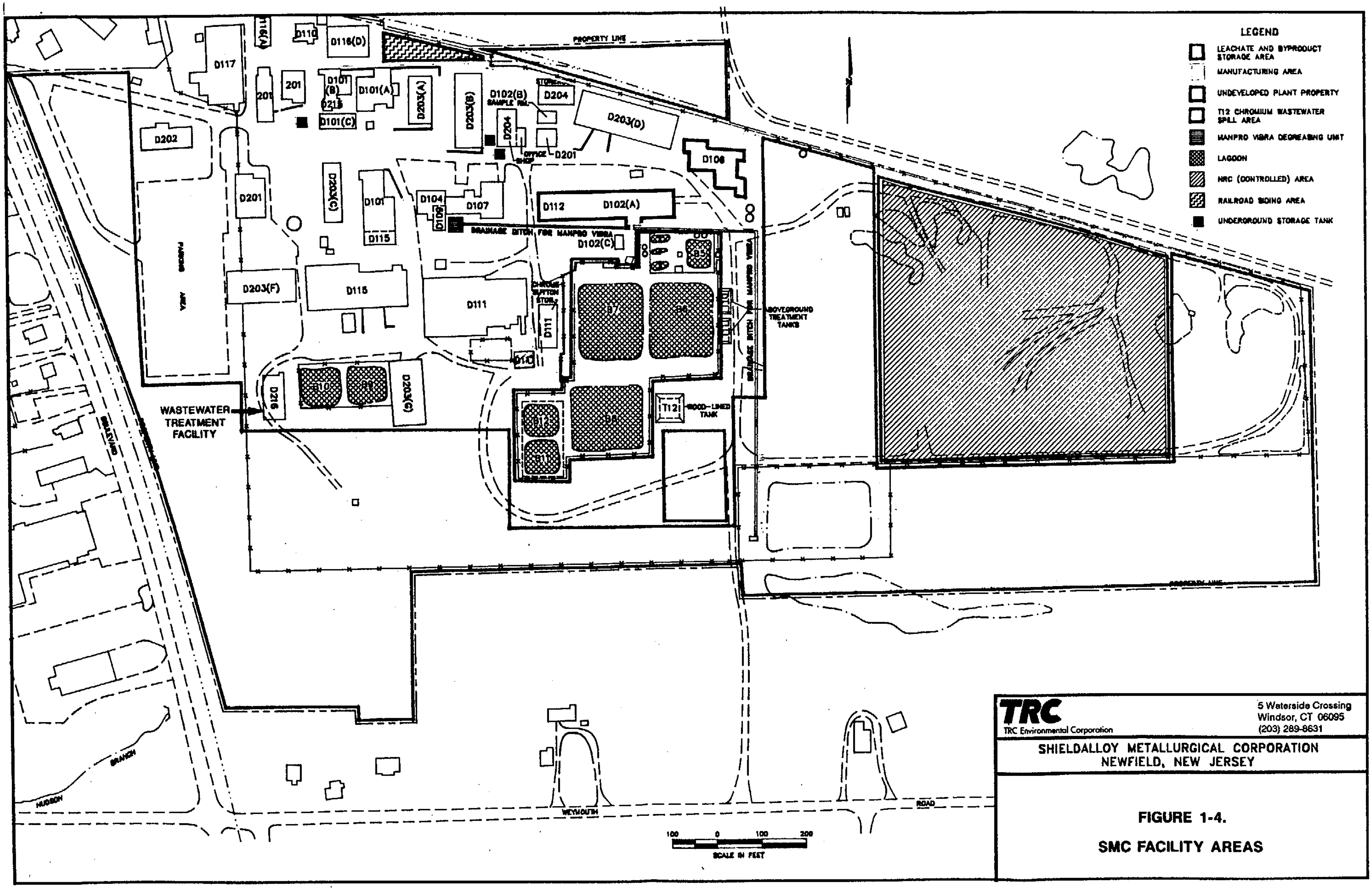

FIGURE 1-4.

SMC FACILITY AREAS

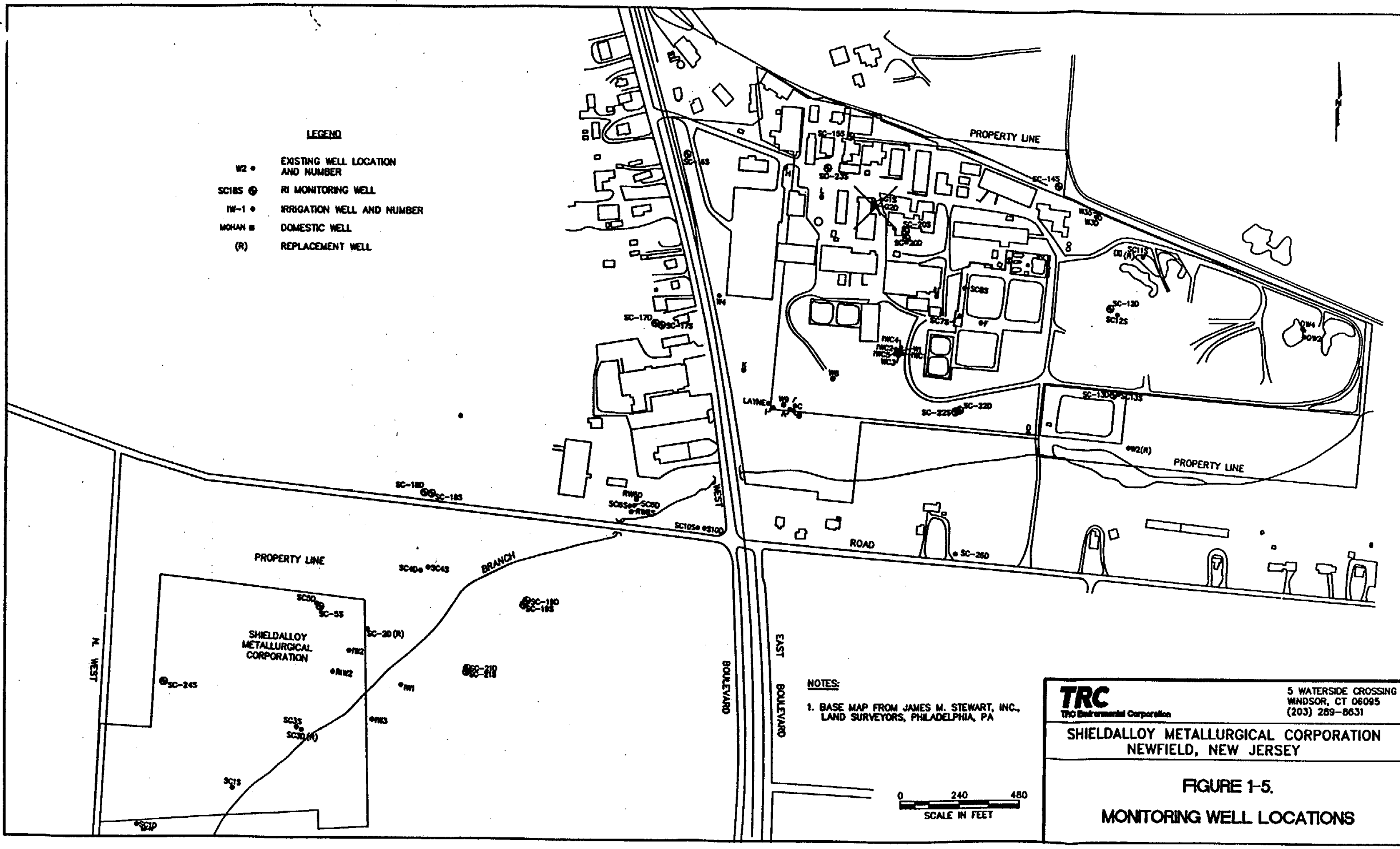

FIGURE 1-5.

MONITORING WELL LOCATIONS

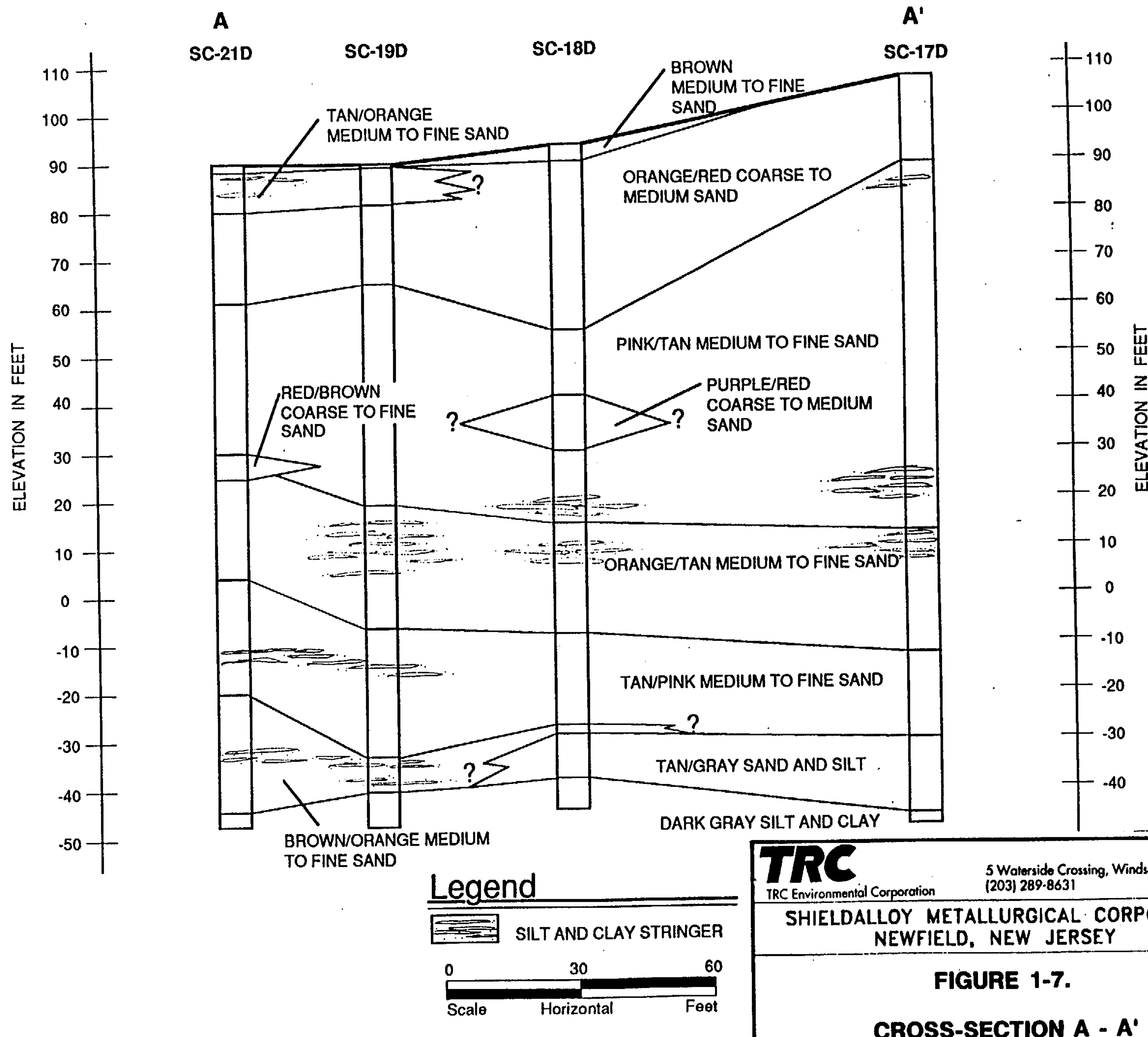

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FIGURE 1-7.

CROSS-SECTION A - A'

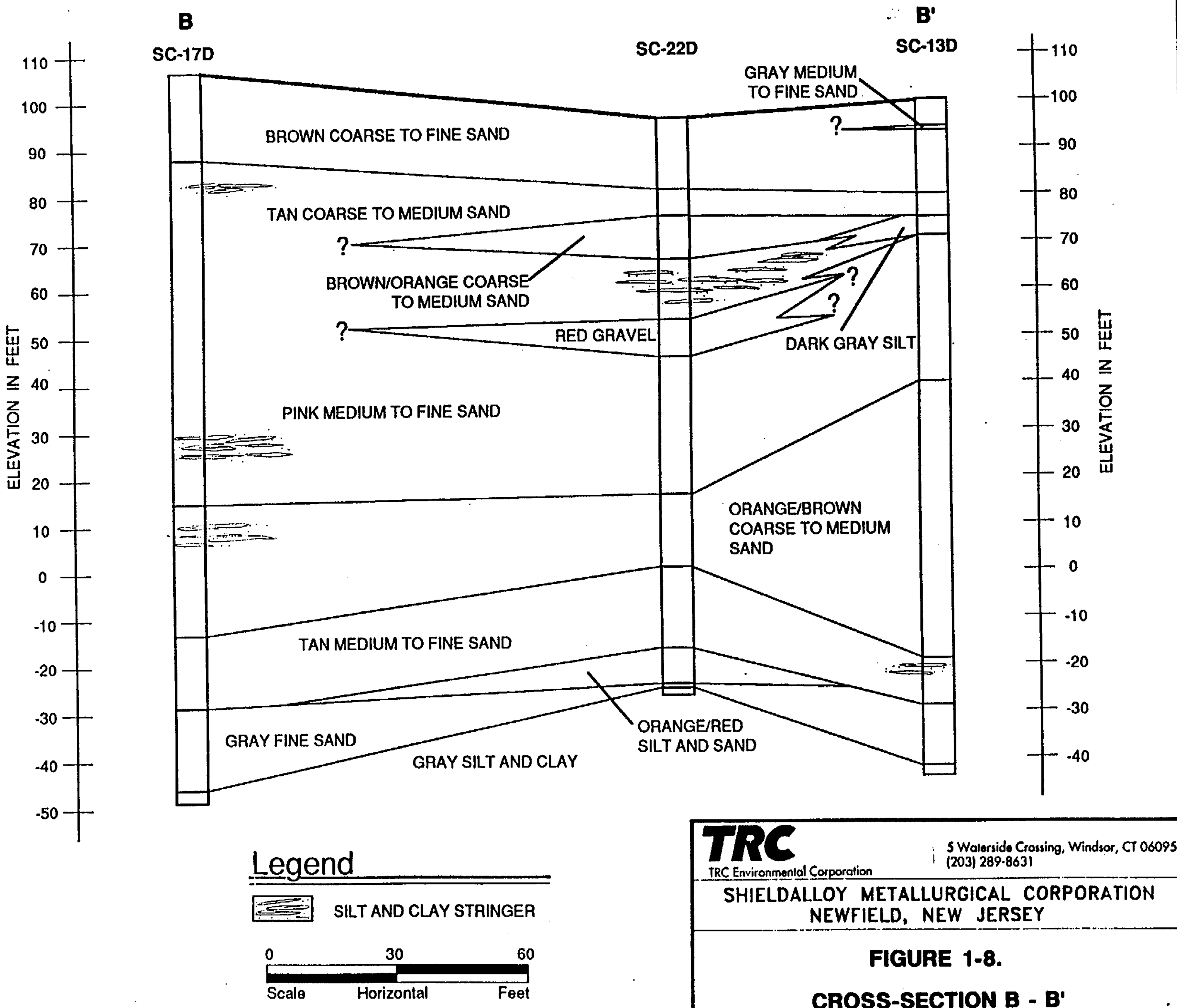

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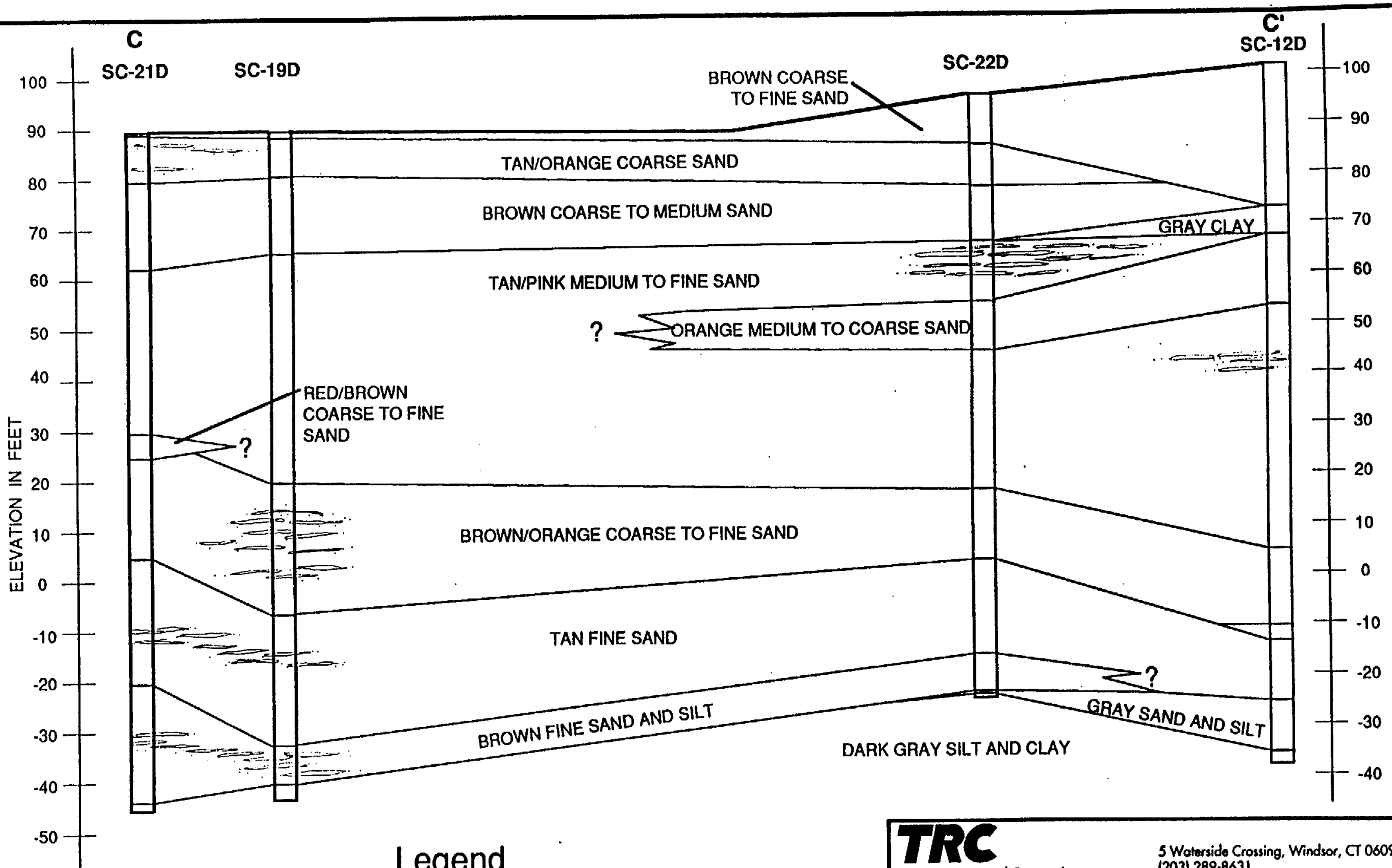
FIGURE 1-8.

CROSS-SECTION B - B'



Legend

SILT AND CLAY STRINGER

Scale: 0 — 30 — 60 Horizontal Feet

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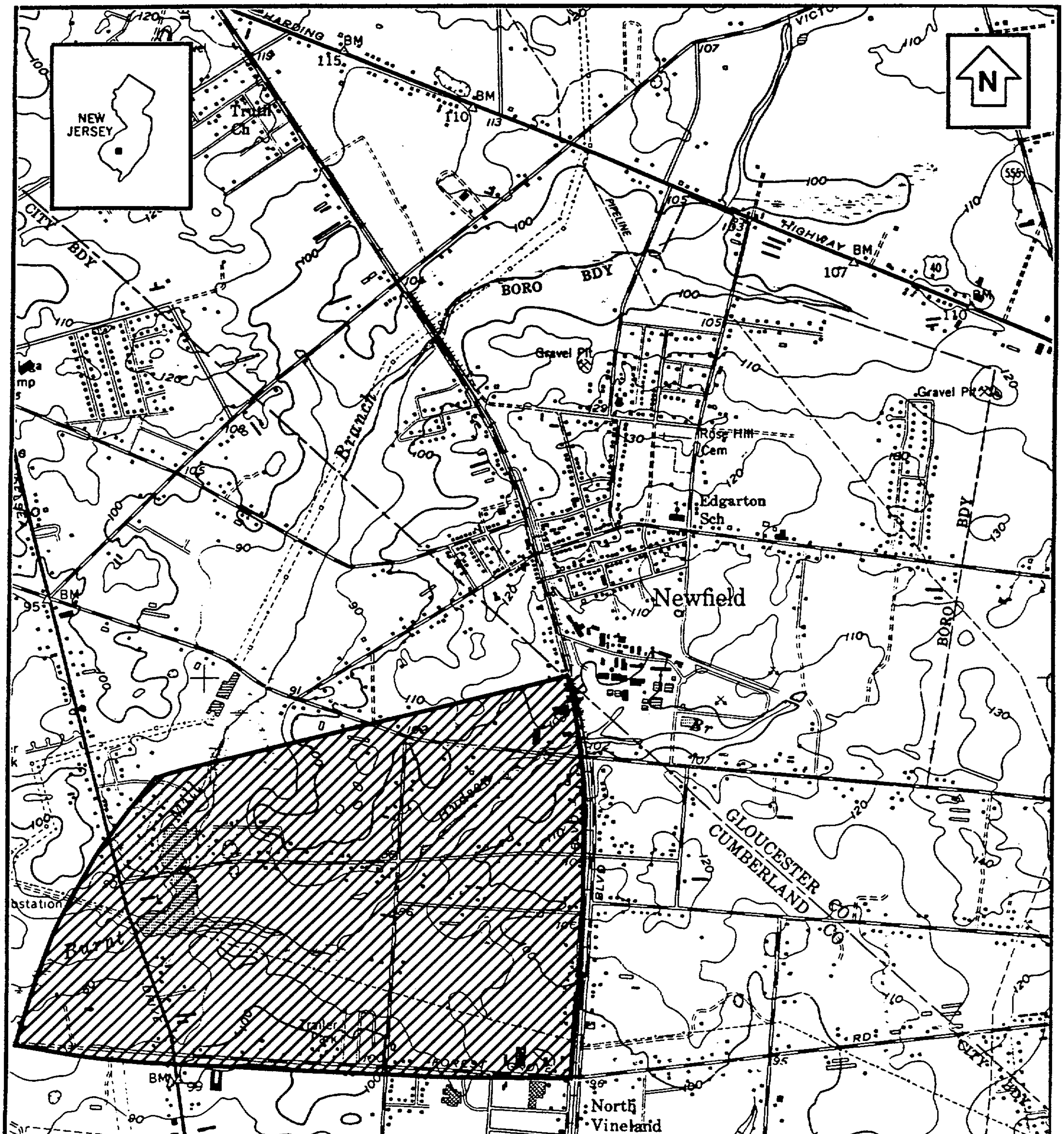
FIGURE 1-9.

CROSS-SECTION C - C'



0 2000 FT

SCALE

FROM NEWFIELD, NJ 7 1/2' USGS TOPOGRAPHIC MAP, 1953, PHOTOREVISED 1986

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FIGURE 1-10.

APPROXIMATE LOCATION OF VINELAND WELL RESTRICTION AREA

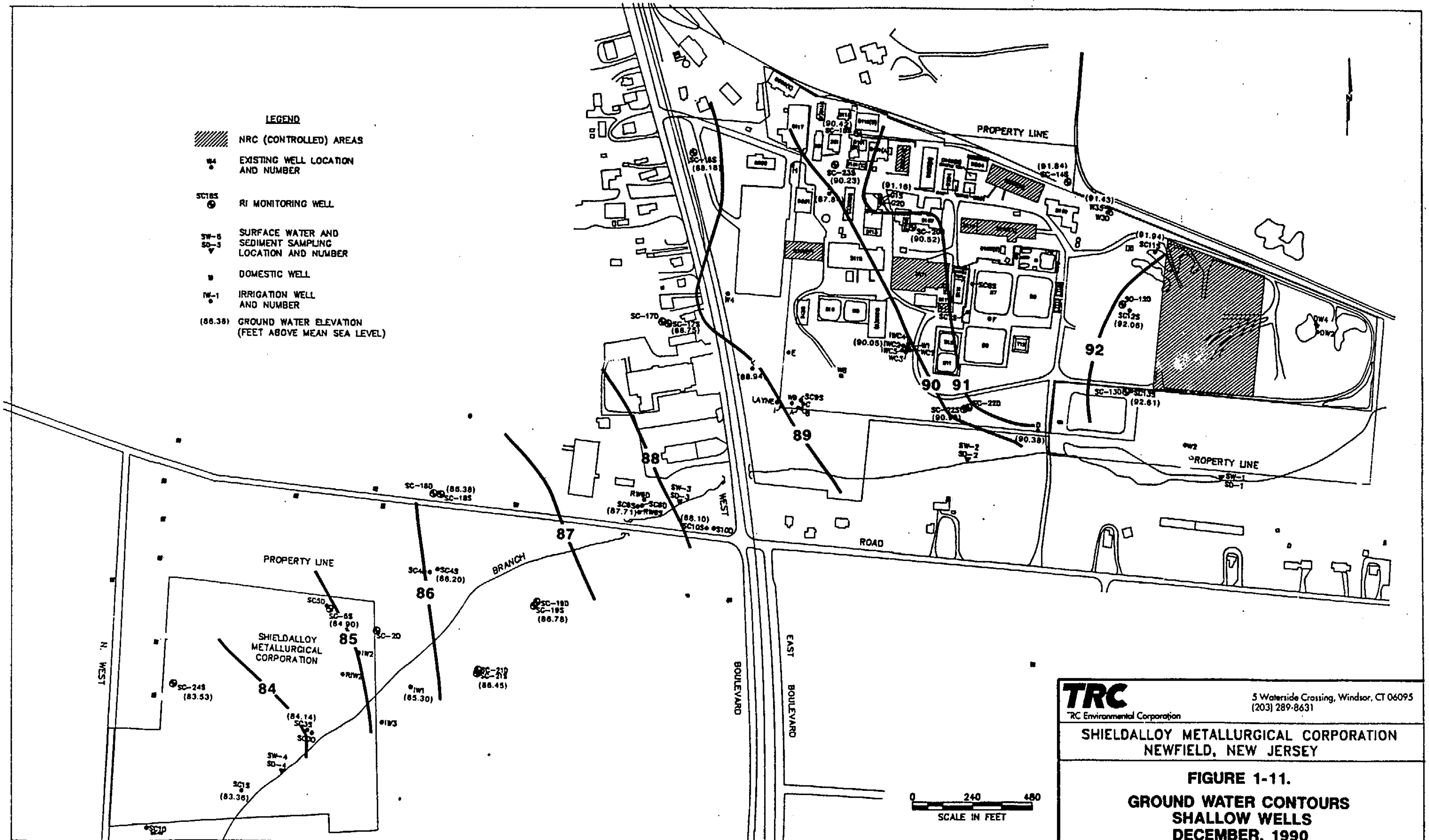

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FIGURE 1-11.
GROUND WATER CONTOURS
SHALLOW WELLS
DECEMBER, 1990

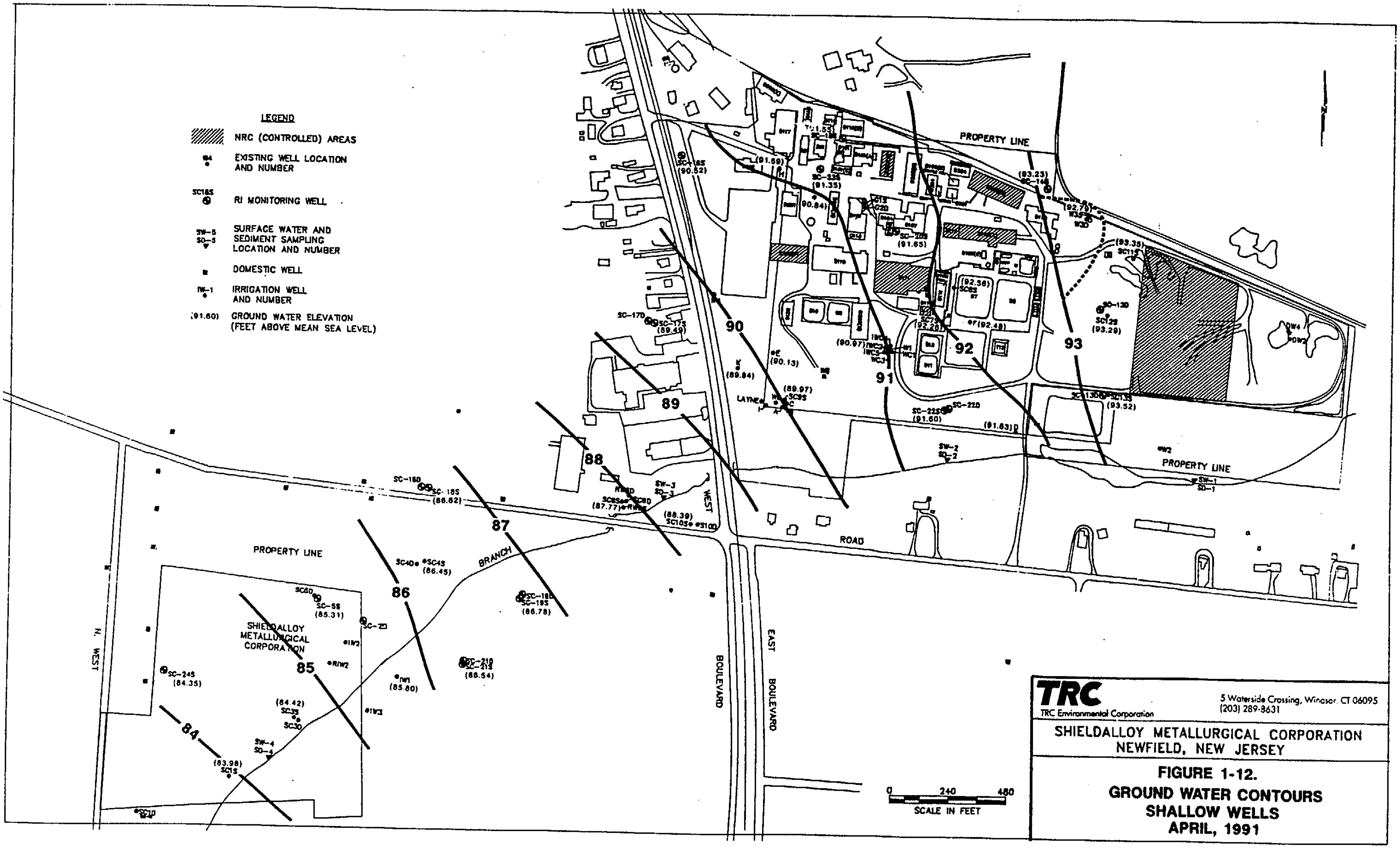

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FIGURE 1-12.
GROUND WATER CONTOURS
SHALLOW WELLS
APRIL, 1991

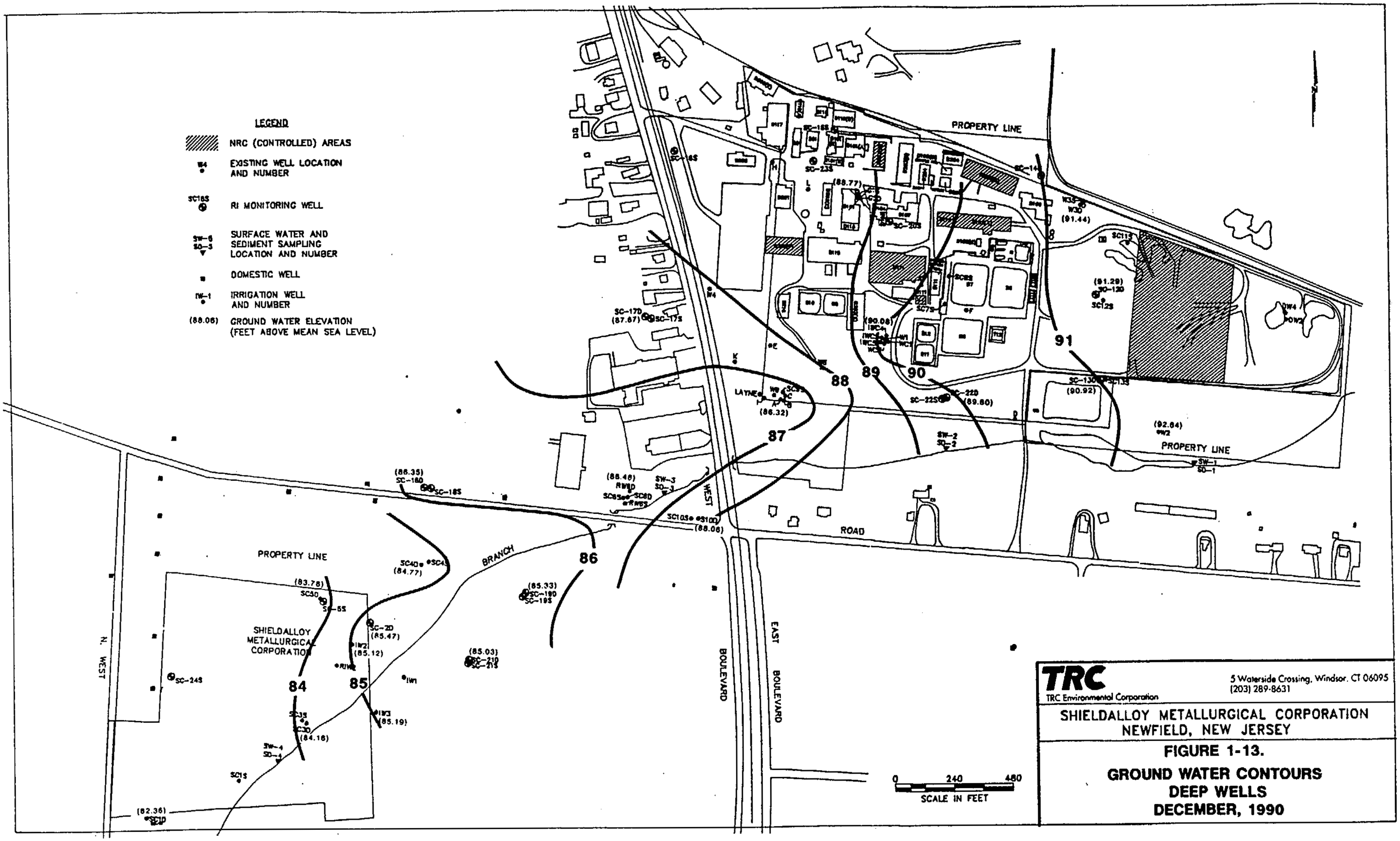
LEGEND
NRC (CONTROLLED) AREAS
EXISTING WELL LOCATION AND NUMBER
RI MONITORING WELL
SURFACE WATER AND SEDIMENT SAMPLING LOCATION AND NUMBER
DOMESTIC WELL
IRRIGATION WELL AND NUMBER
(88.06) GROUND WATER ELEVATION (FEET ABOVE MEAN SEA LEVEL)
PROPERTY LINE
SHIELDALLOY METALLURGICAL CORPORATION
BRANCH
ROAD
WEST BOULEVARD
EAST BOULEVARD
N. WEST
84
85
86
87
88
89
90
91
SCALE IN FEET
0
240
480
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FIGURE 1-13.
GROUND WATER CONTOURS
DEEP WELLS
DECEMBER, 1990

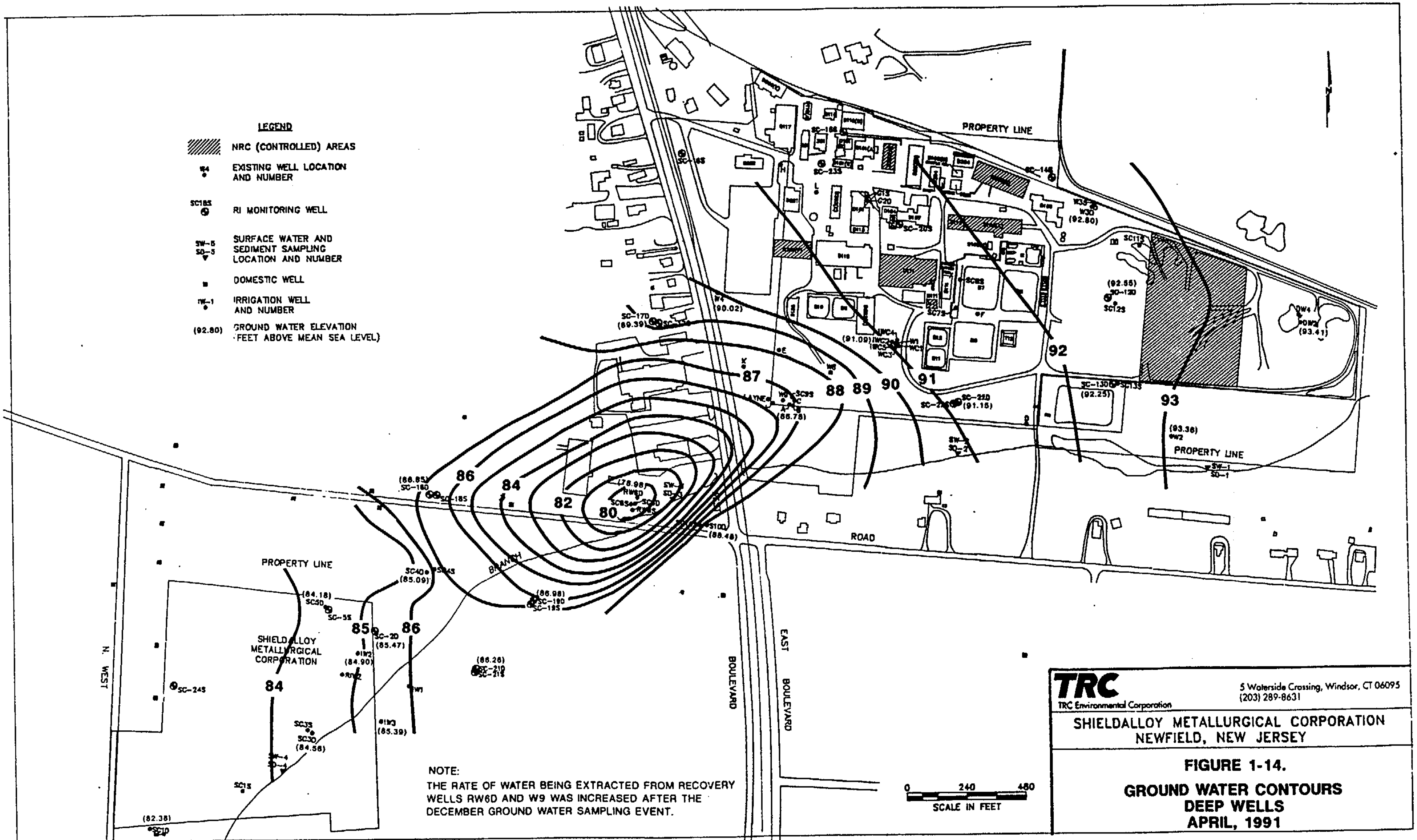
LEGEND
NRC (CONTROLLED) AREAS
EXISTING WELL LOCATION AND NUMBER
RI MONITORING WELL
SURFACE WATER AND SEDIMENT SAMPLING LOCATION AND NUMBER
DOMESTIC WELL
IRRIGATION WELL AND NUMBER
(92.80) GROUND WATER ELEVATION -FEET ABOVE MEAN SEA LEVEL)
PROPERTY LINE
ROAD
EAST BOULEVARD
BOULEVARD
N. WEST
BRANCH
SHIELDALLOY METALLURGICAL CORPORATION
80
82
84
85
86
87
88
89
90
91
92
93
NOTE:
THE RATE OF WATER BEING EXTRACTED FROM RECOVERY WELLS RW6D AND W9 WAS INCREASED AFTER THE DECEMBER GROUND WATER SAMPLING EVENT.
0 240 480
SCALE IN FEET
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FIGURE 1-14.
GROUND WATER CONTOURS
DEEP WELLS
APRIL, 1991

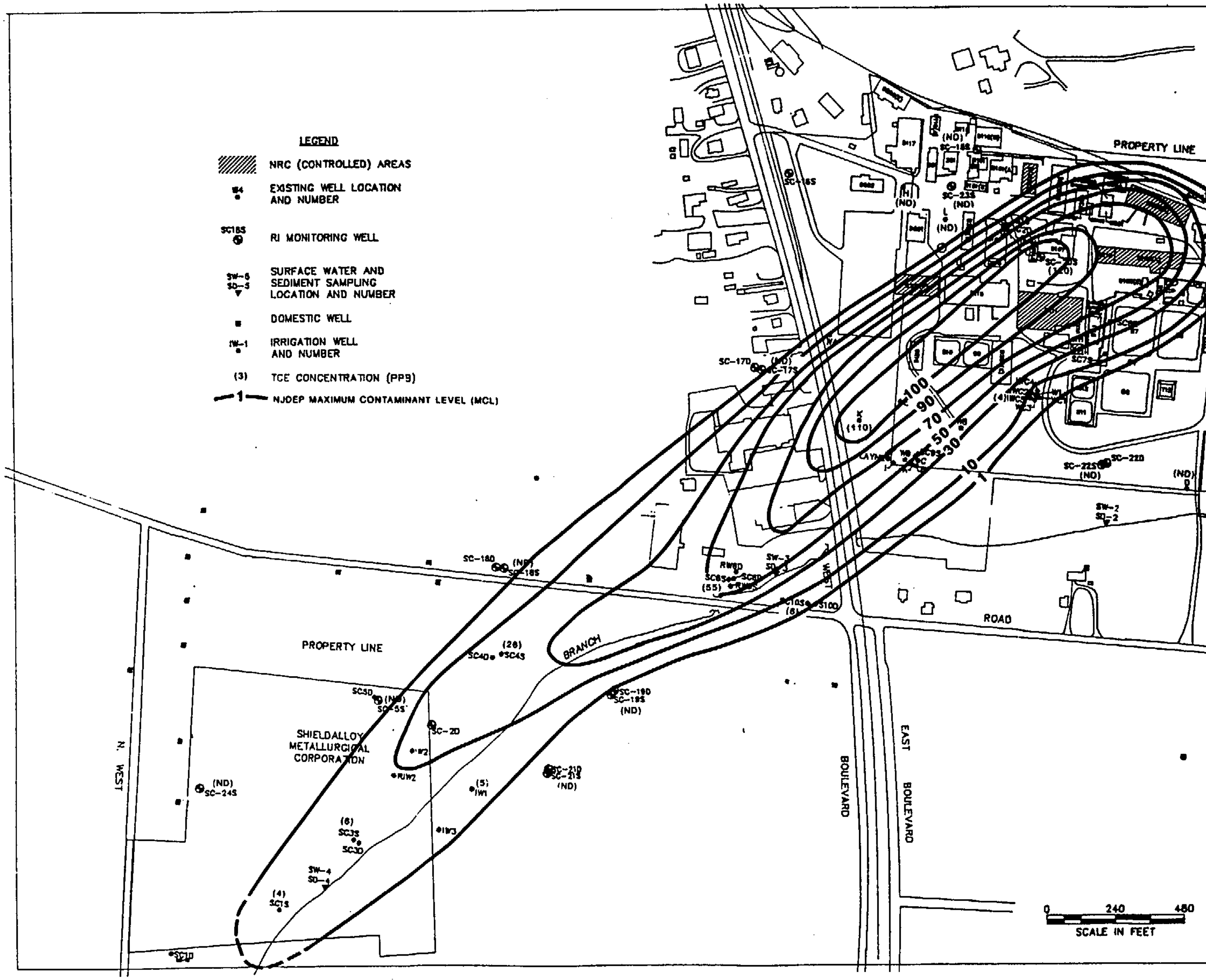

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FIGURE 3-1.
TCE CONCENTRATIONS (PPB)
SHALLOW WELLS
DECEMBER, 1990

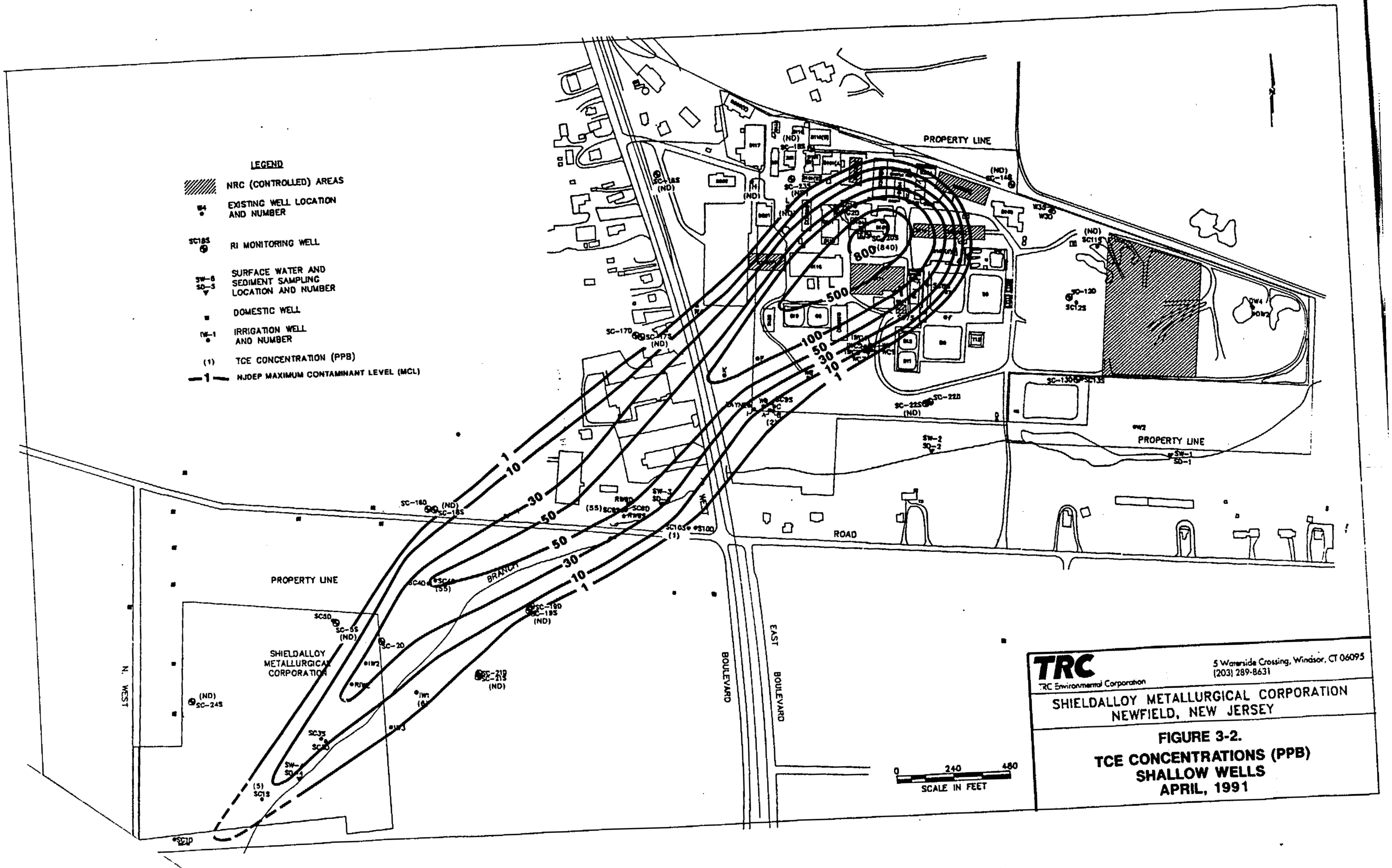

FIGURE 3-2.
TCE CONCENTRATIONS (PPB)
SHALLOW WELLS
APRIL, 1991

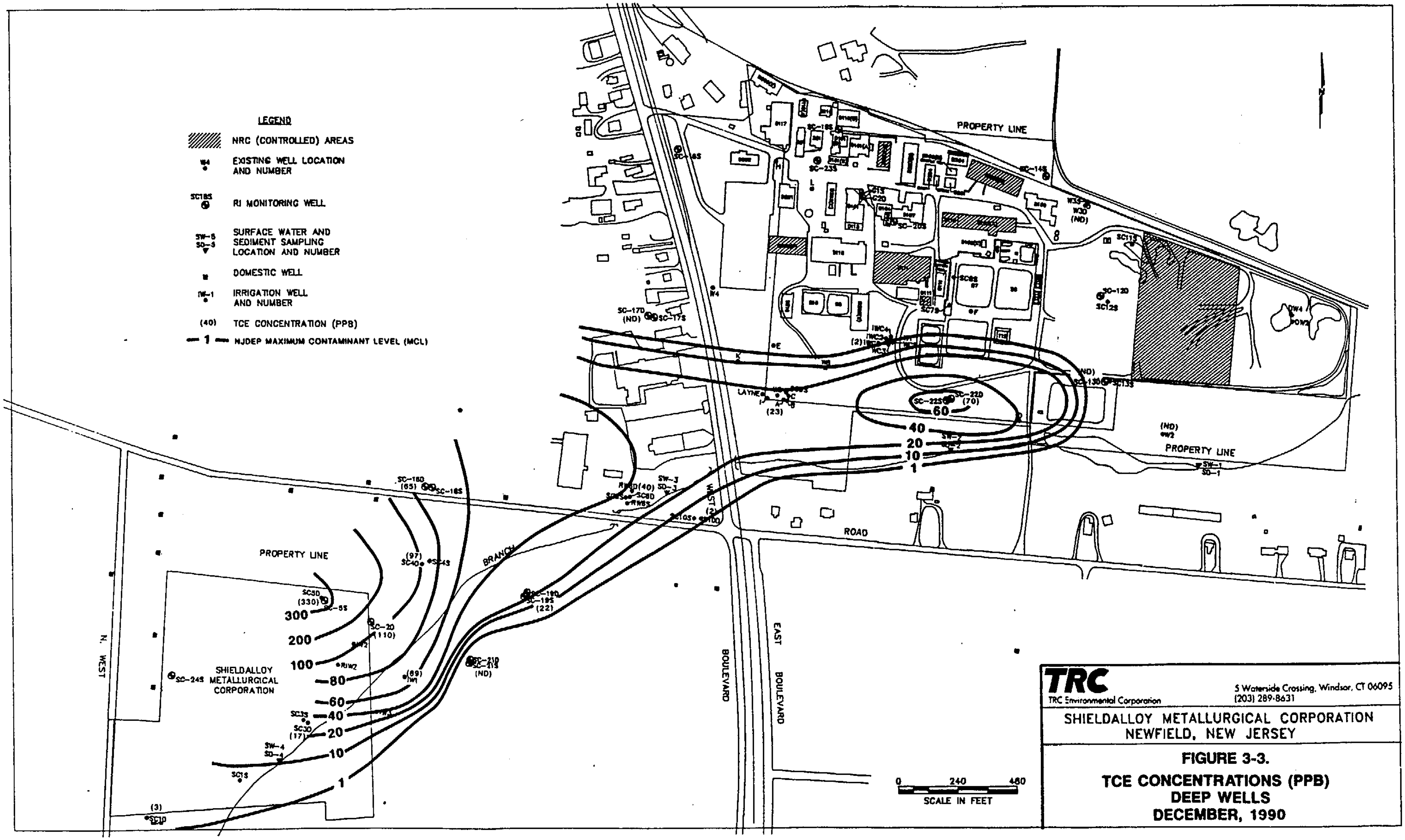

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FIGURE 3-3.
TCE CONCENTRATIONS (PPB)
DEEP WELLS
DECEMBER, 1990

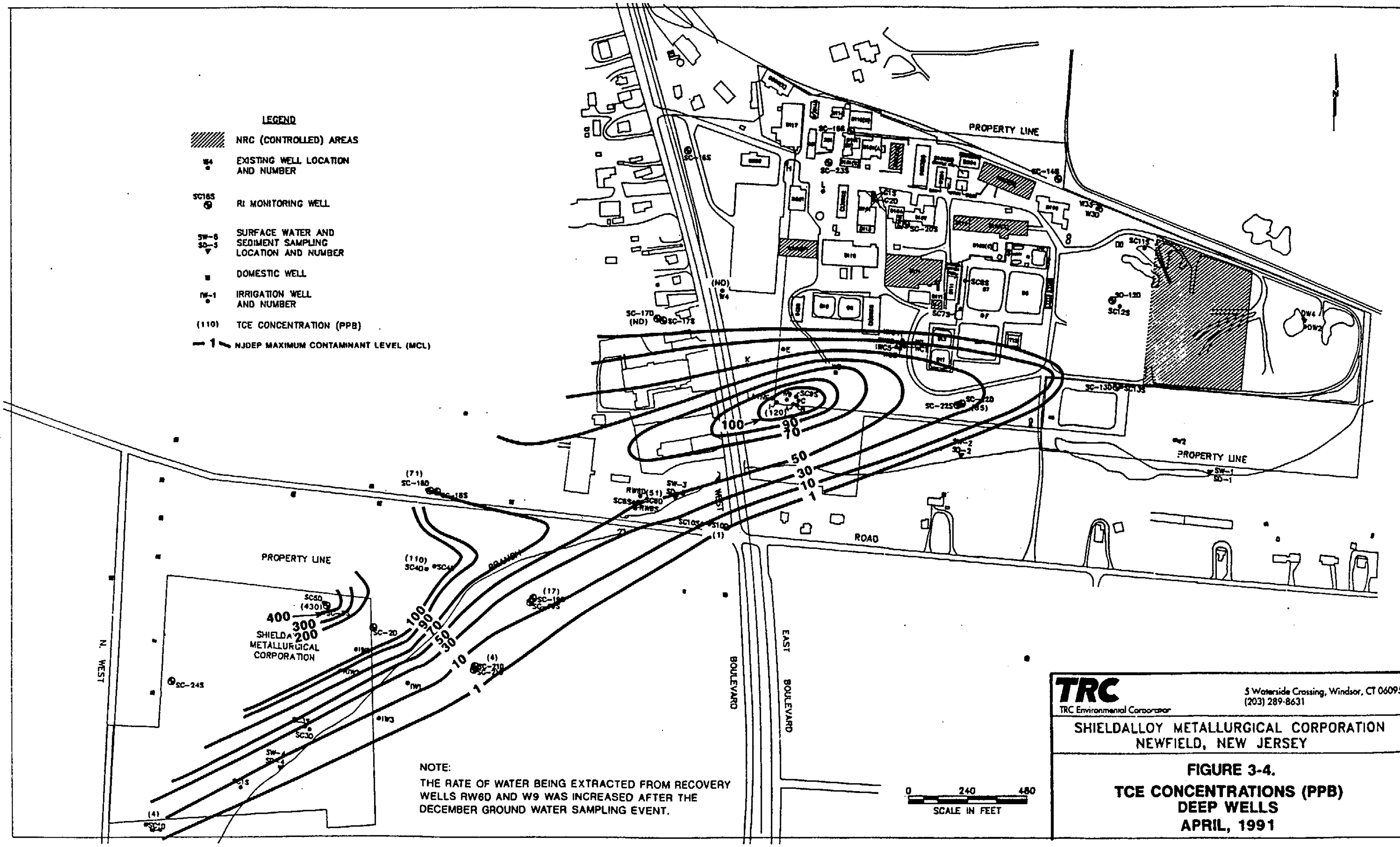

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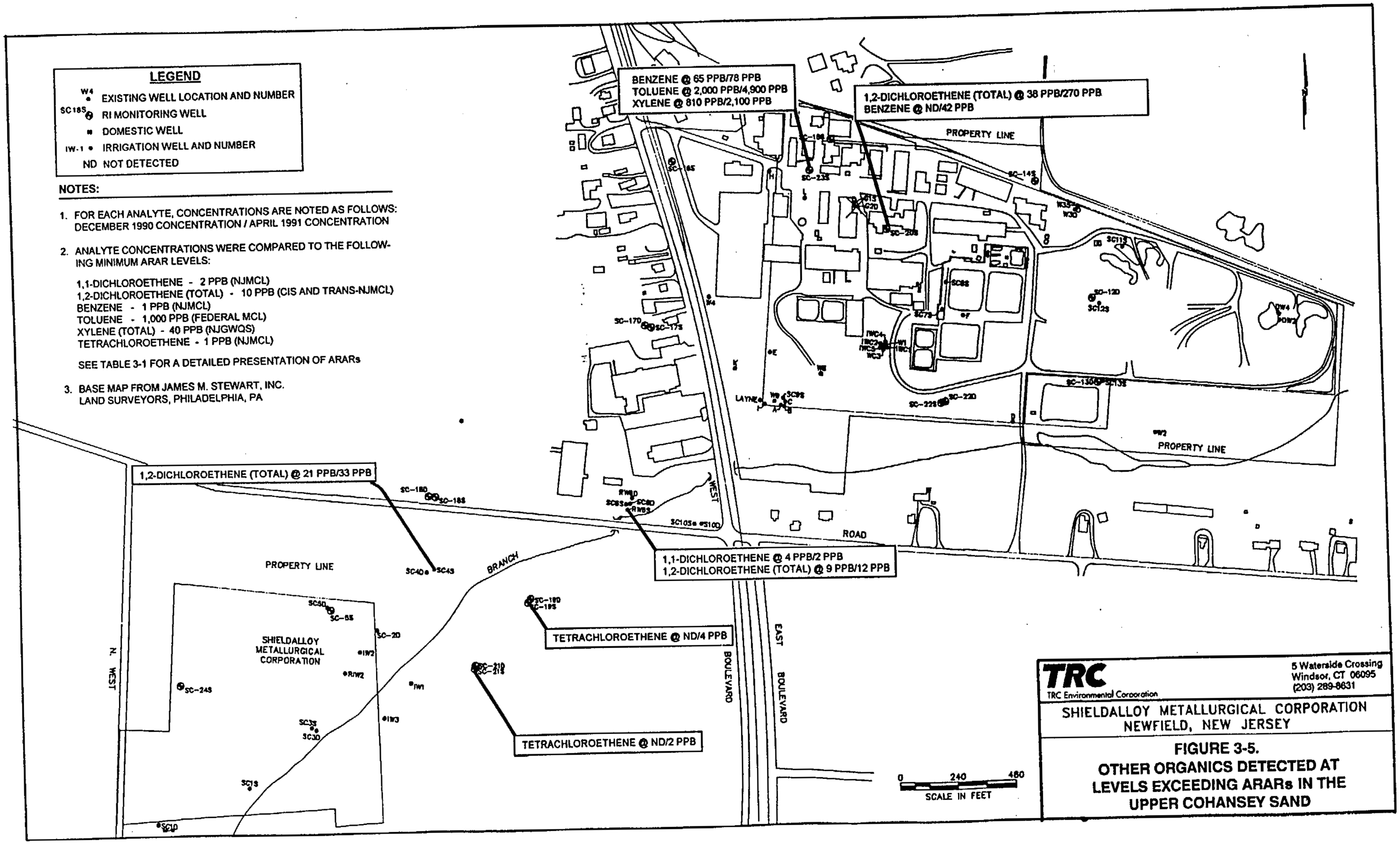
FIGURE 3-4.
TCE CONCENTRATIONS (PPB)
DEEP WELLS
APRIL, 1991



LEGEND
W4 • EXISTING WELL LOCATION AND NUMBER
SC18S RI MONITORING WELL
■ DOMESTIC WELL
IW-1 • IRRIGATION WELL AND NUMBER
ND NOT DETECTED
NOTES:
1. FOR EACH ANALYTE, CONCENTRATIONS ARE NOTED AS FOLLOWS: DECEMBER 1990 CONCENTRATION / APRIL 1991 CONCENTRATION
2. ANALYTE CONCENTRATIONS WERE COMPARED TO THE FOLLOWING MINIMUM ARAR LEVELS:
1,1-DICHLOROETHENE - 2 PPB (NJMCL)
1,2-DICHLOROETHENE (TOTAL) - 10 PPB (CIS AND TRANS-NJMCL)
BENZENE - 1 PPB (NJMCL)
TOLUENE - 1,000 PPB (FEDERAL MCL)
XYLENE (TOTAL) - 40 PPB (NJGWQS)
TETRACHLOROETHENE - 1 PPB (NJMCL)
SEE TABLE 3-1 FOR A DETAILED PRESENTATION OF ARARs
3. BASE MAP FROM JAMES M. STEWART, INC. LAND SURVEYORS, PHILADELPHIA, PA
BENZENE @ 65 PPB/78 PPB
TOLUENE @ 2,000 PPB/4,900 PPB
XYLENE @ 810 PPB/2,100 PPB
1,2-DICHLOROETHENE (TOTAL) @ 38 PPB/270 PPB
BENZENE @ ND/42 PPB
PROPERTY LINE
1,2-DICHLOROETHENE (TOTAL) @ 21 PPB/33 PPB
1,1-DICHLOROETHENE @ 4 PPB/2 PPB
1,2-DICHLOROETHENE (TOTAL) @ 9 PPB/12 PPB
TETRACHLOROETHENE @ ND/4 PPB
TETRACHLOROETHENE @ ND/2 PPB
ROAD
BRANCH
WEST BOULEVARD
EAST BOULEVARD
N. WEST
SHIELDALLOY METALLURGICAL CORPORATION
0 240 480
SCALE IN FEET
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FIGURE 3-5.
OTHER ORGANICS DETECTED AT LEVELS EXCEEDING ARARs IN THE UPPER COHANSEY SAND

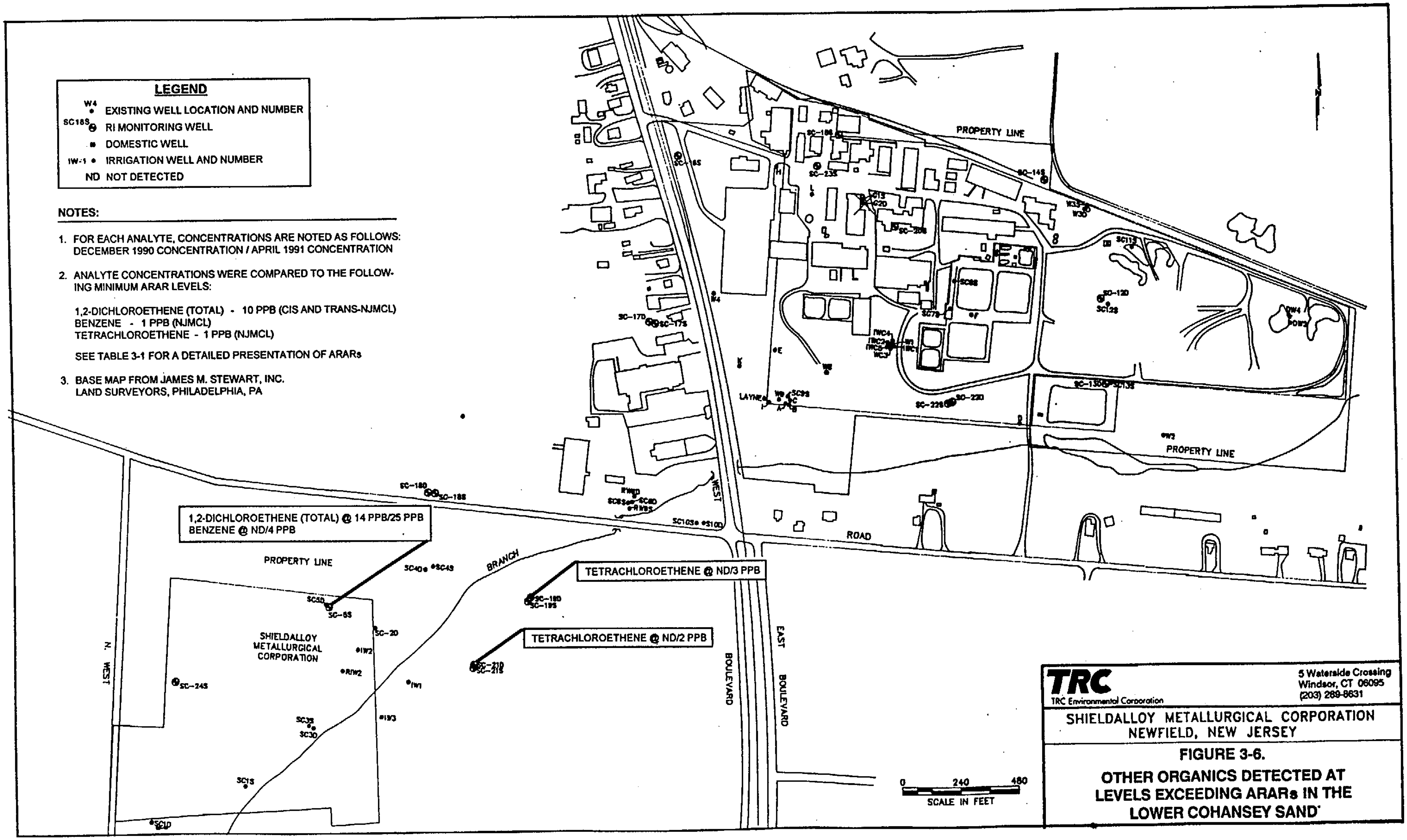

FIGURE 3-6.
OTHER ORGANICS DETECTED AT LEVELS EXCEEDING ARARs IN THE LOWER COHANSEY SAND

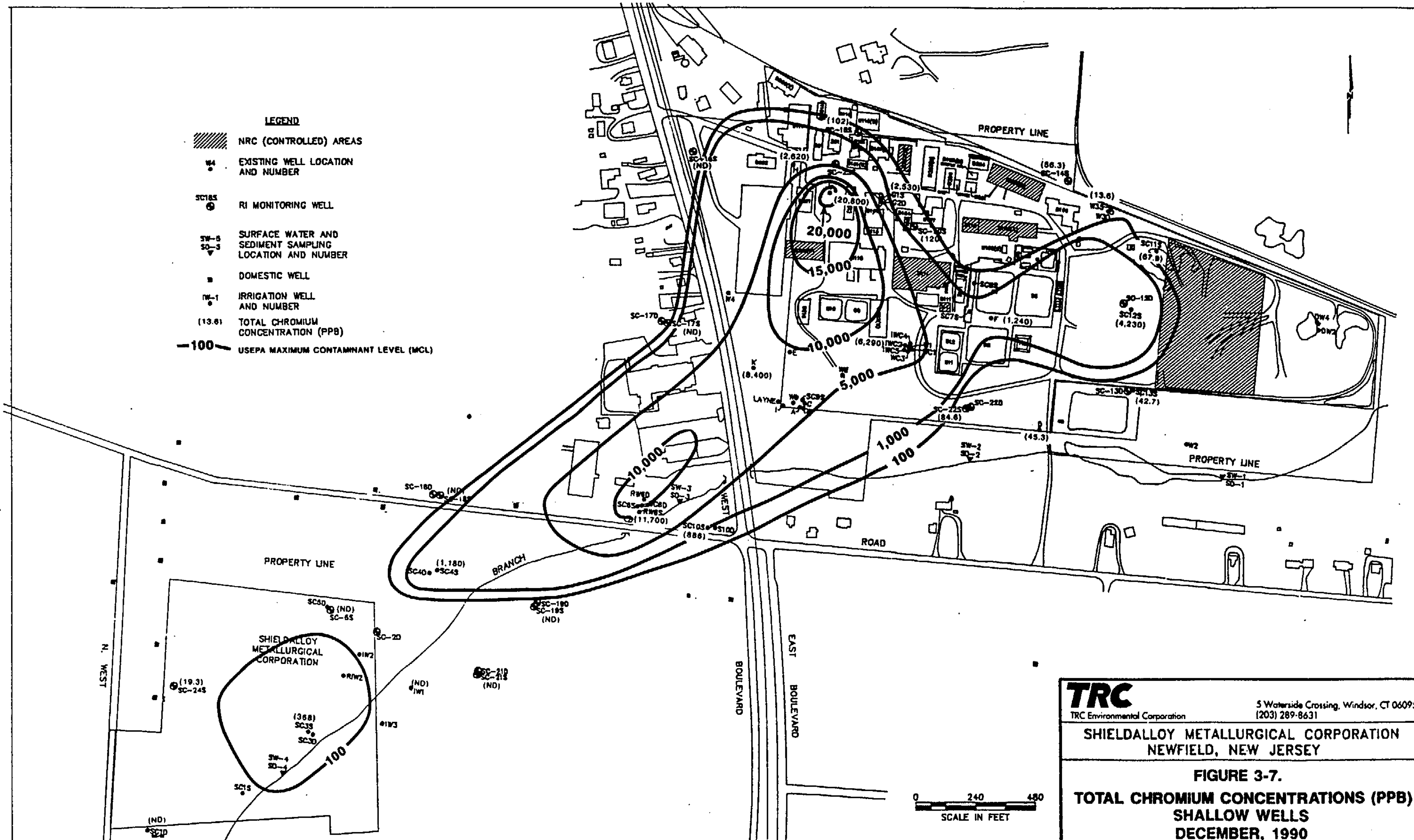

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FIGURE 3-7.
TOTAL CHROMIUM CONCENTRATIONS (PPB)
SHALLOW WELLS
DECEMBER, 1990

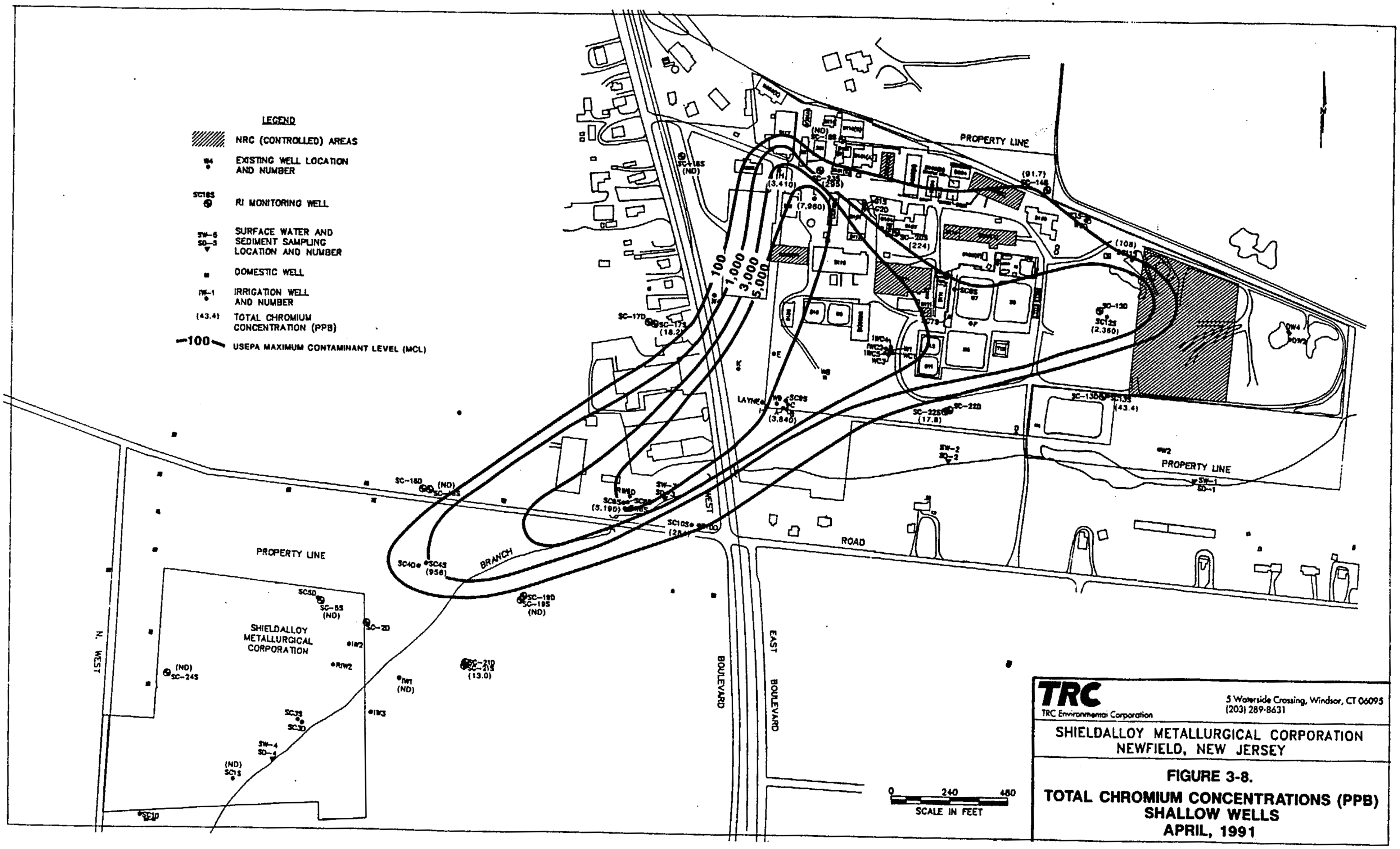

FIGURE 3-8.
TOTAL CHROMIUM CONCENTRATIONS (PPB)
SHALLOW WELLS
APRIL, 1991

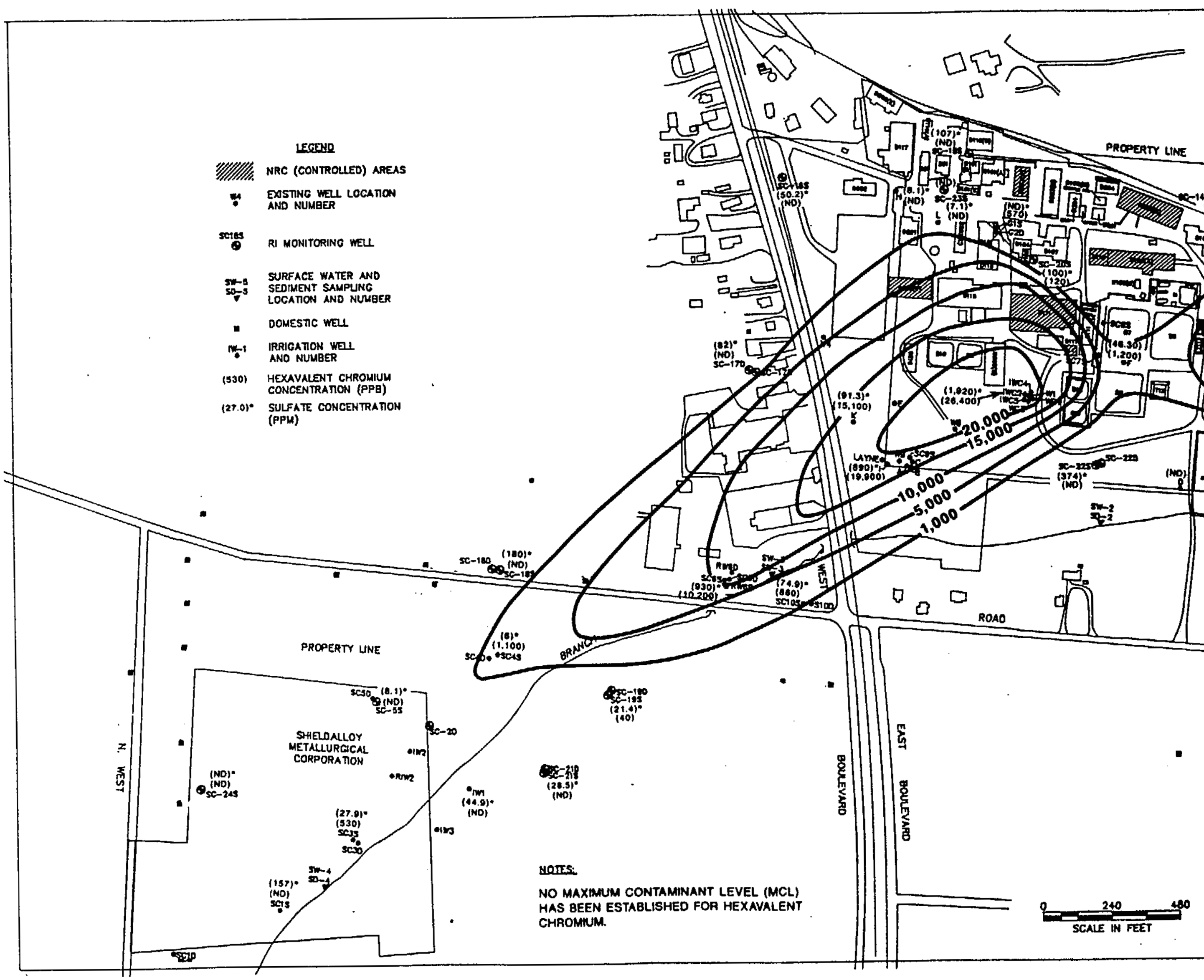

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FIGURE 3-9.
HEXAVALENT CHROMIUM CONCENTRATIONS (PPB) SHALLOW WELLS DECEMBER, 1990

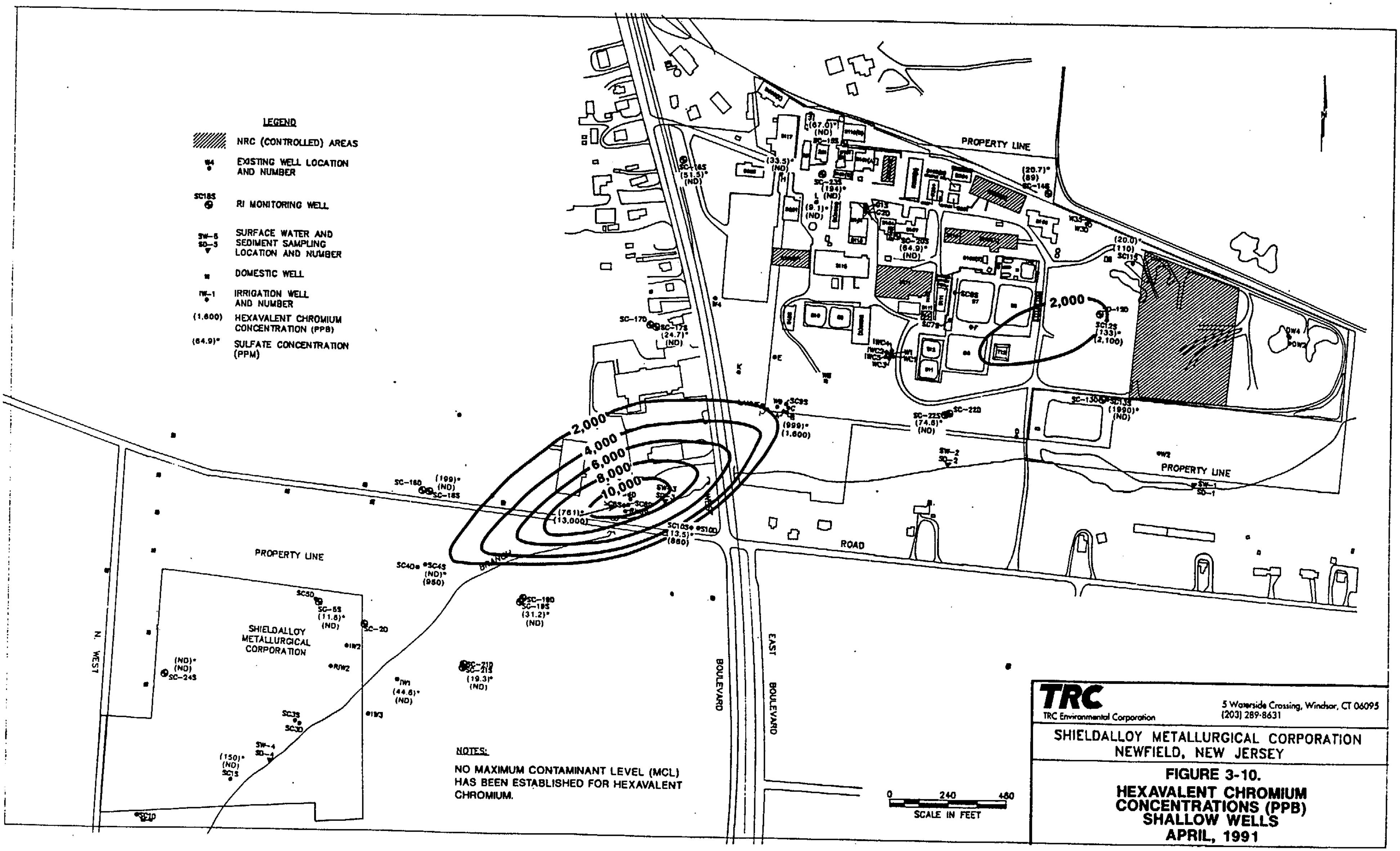

FIGURE 3-10.
HEXAVALENT CHROMIUM CONCENTRATIONS (PPB) SHALLOW WELLS APRIL, 1991

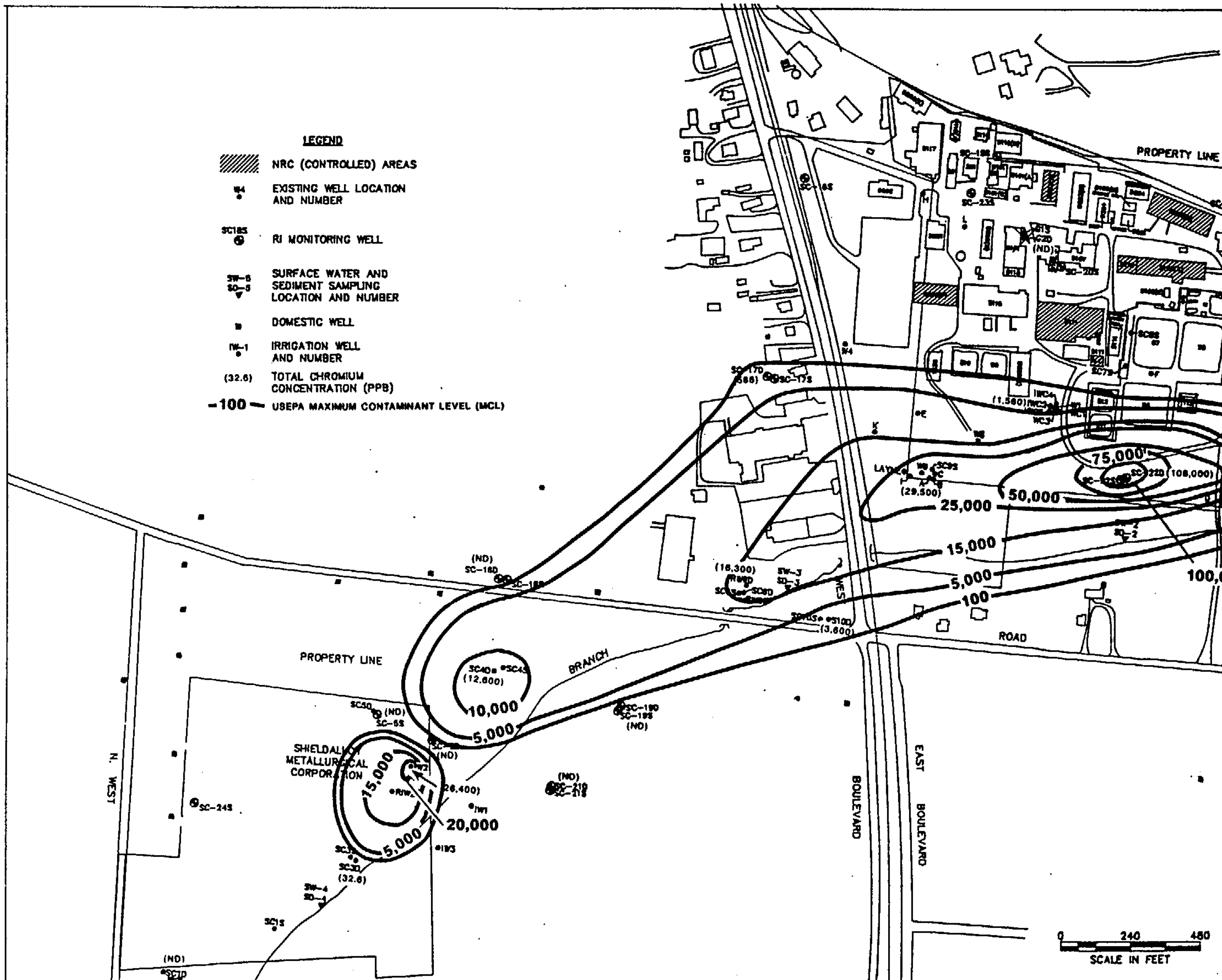

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FIGURE 3-11.
TOTAL CHROMIUM CONCENTRATIONS (PPB)
DEEP WELLS
DECEMBER, 1990

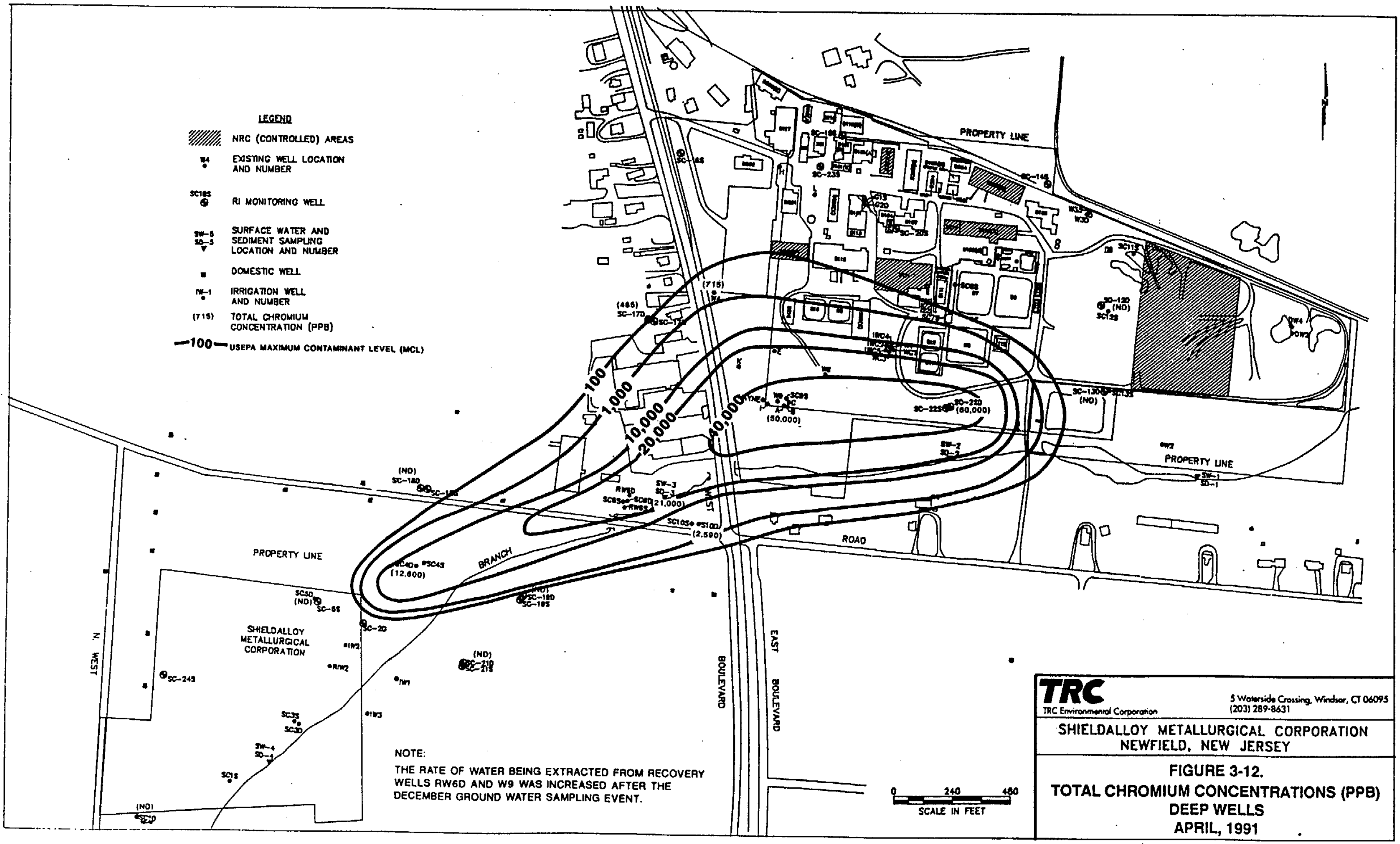

FIGURE 3-12.
TOTAL CHROMIUM CONCENTRATIONS (PPB)
DEEP WELLS
APRIL, 1991

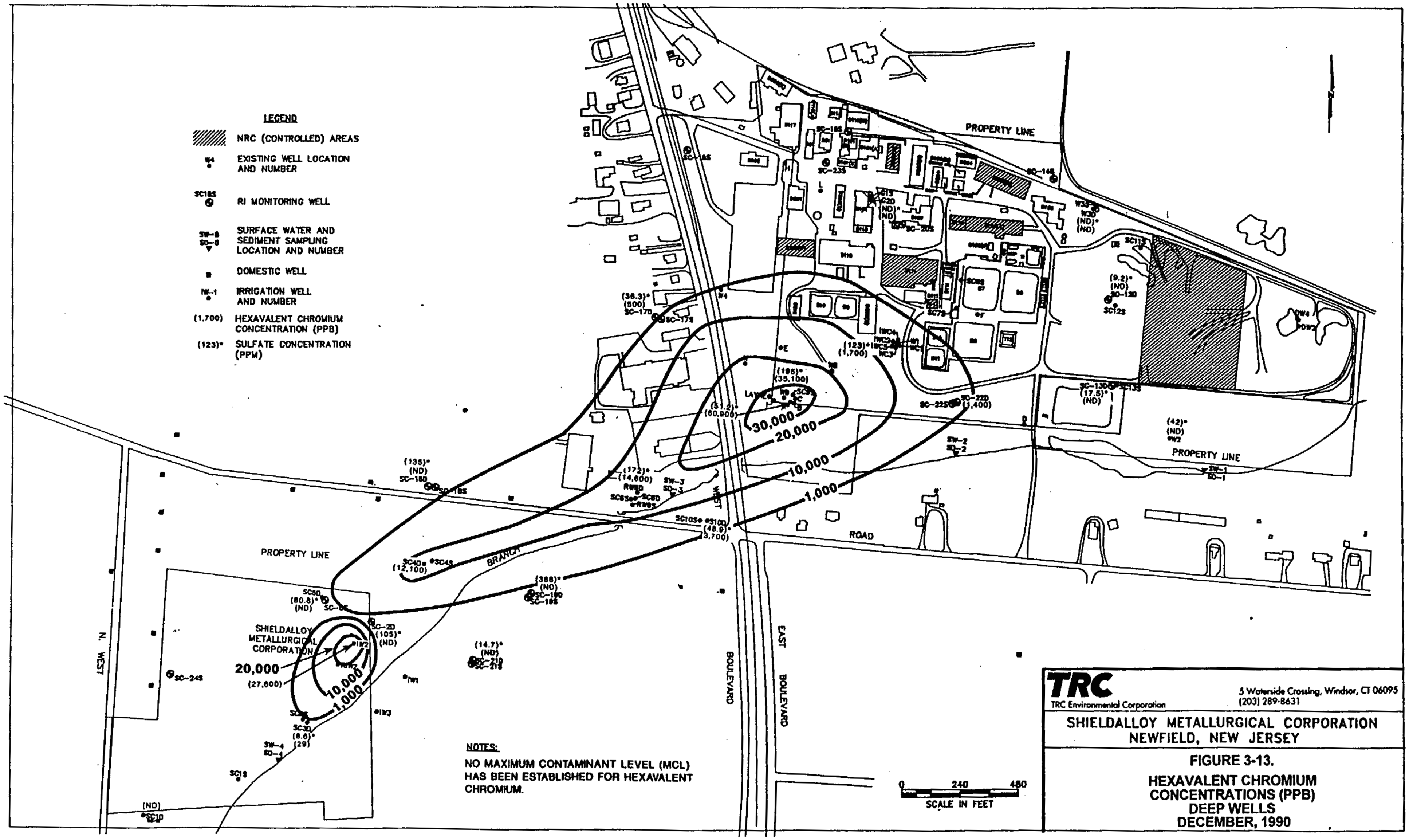

FIGURE 3-13.
HEXAVALENT CHROMIUM CONCENTRATIONS (PPB) DEEP WELLS DECEMBER, 1990

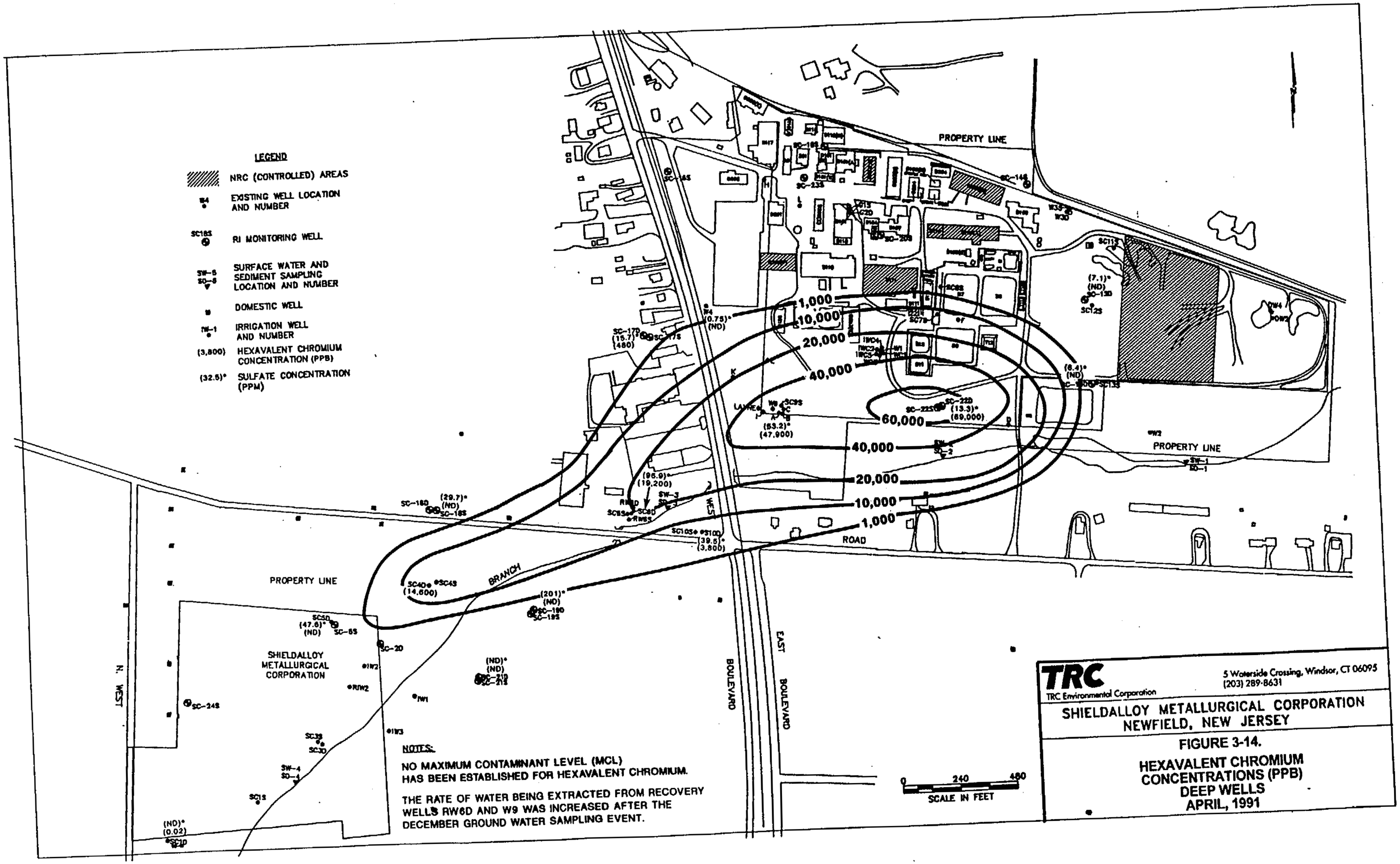
LEGEND
NRC (CONTROLLED) AREAS
EXISTING WELL LOCATION AND NUMBER
RI MONITORING WELL
SURFACE WATER AND SEDIMENT SAMPLING LOCATION AND NUMBER
DOMESTIC WELL
IRRIGATION WELL AND NUMBER
(3,800) HEXAVALENT CHROMIUM CONCENTRATION (PPB)
(32.5)* SULFATE CONCENTRATION (PPM)
PROPERTY LINE
1,000
10,000
20,000
40,000
60,000
ROAD
BRANCH
WEST BOULEVARD
EAST BOULEVARD
N. WEST
SHIELDALLOY METALLURGICAL CORPORATION
NOTES:
NO MAXIMUM CONTAMINANT LEVEL (MCL) HAS BEEN ESTABLISHED FOR HEXAVALENT CHROMIUM.
THE RATE OF WATER BEING EXTRACTED FROM RECOVERY WELLS RW6D AND W9 WAS INCREASED AFTER THE DECEMBER GROUND WATER SAMPLING EVENT.
0 240 480
SCALE IN FEET
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FIGURE 3-14.
HEXAVALENT CHROMIUM CONCENTRATIONS (PPB)
DEEP WELLS
APRIL, 1991

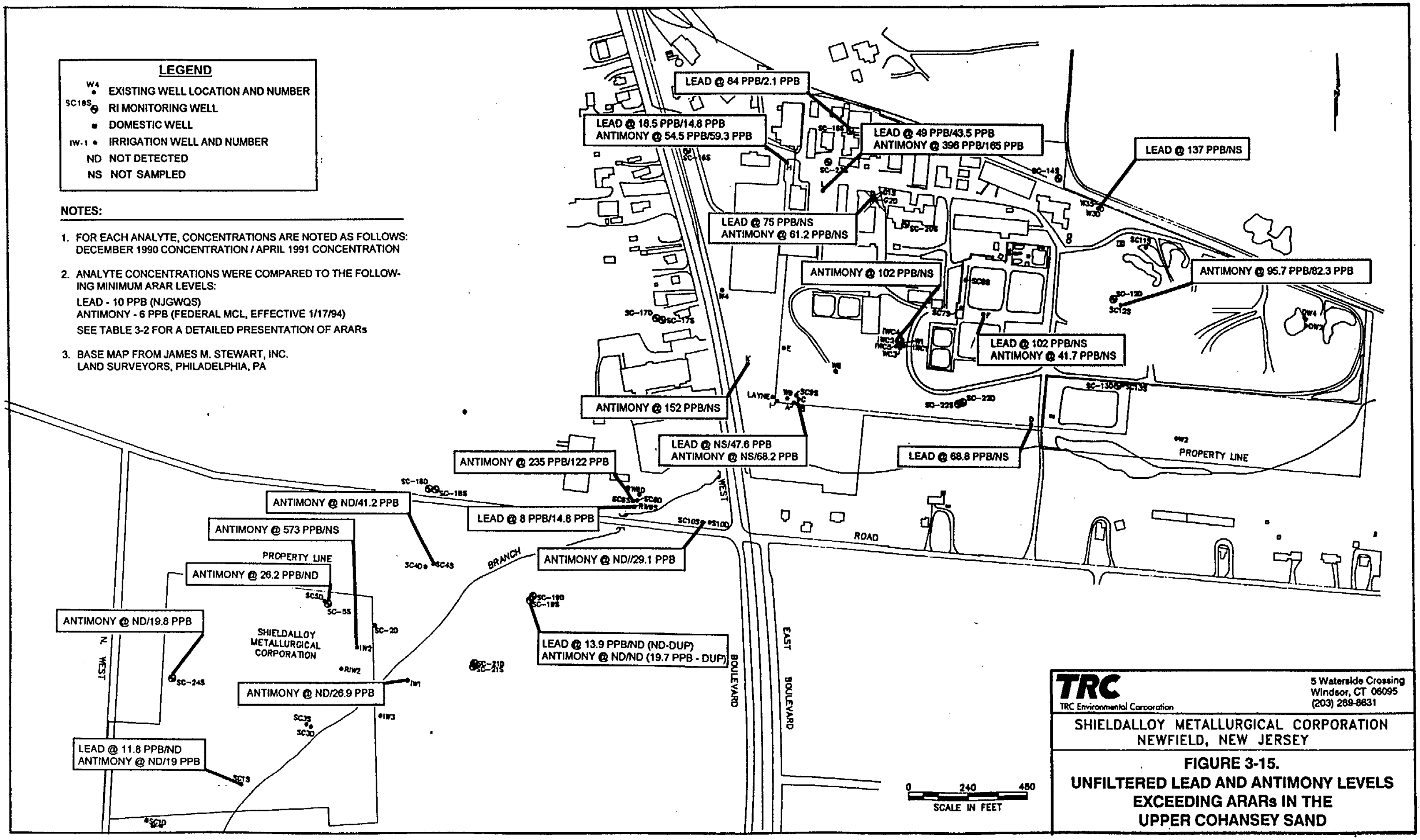

FIGURE 3-15.
UNFILTERED LEAD AND ANTIMONY LEVELS EXCEEDING ARARs IN THE UPPER COHANSEY SAND

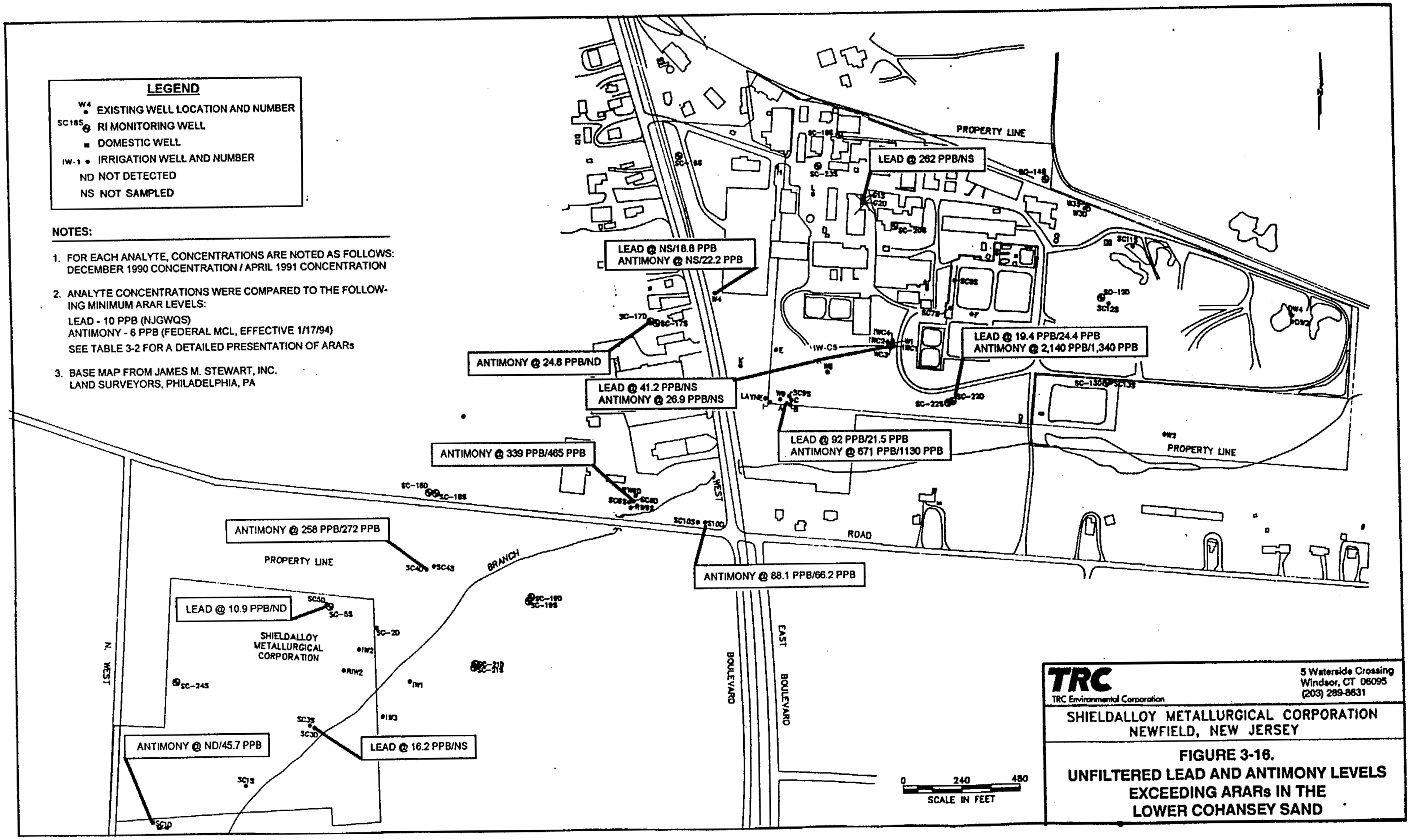

FIGURE 3-16.
UNFILTERED LEAD AND ANTIMONY LEVELS EXCEEDING ARARs IN THE LOWER COHANSEY SAND

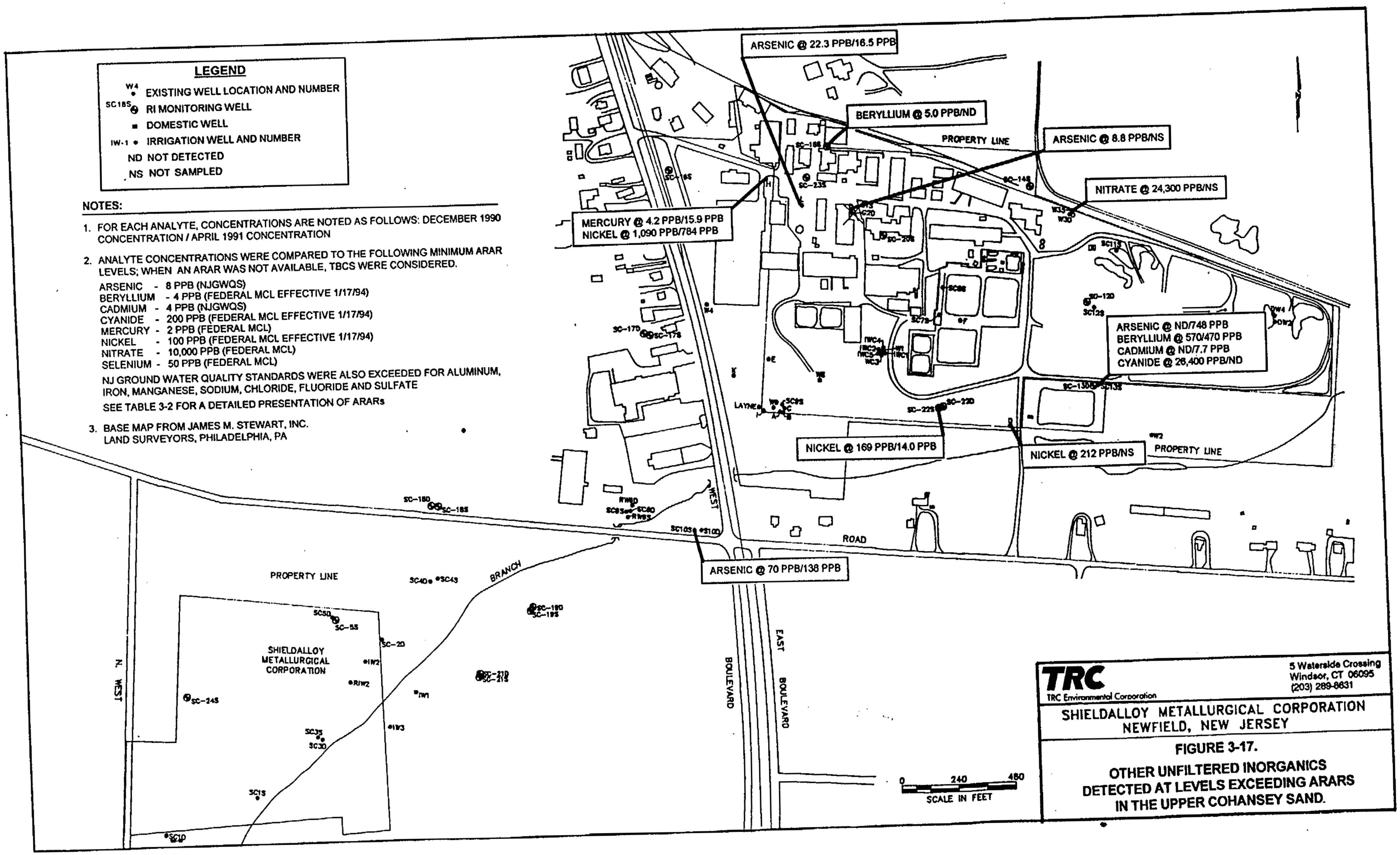

FIGURE 3-17.
OTHER UNFILTERED INORGANICS DETECTED AT LEVELS EXCEEDING ARARS IN THE UPPER COHANSEY SAND.

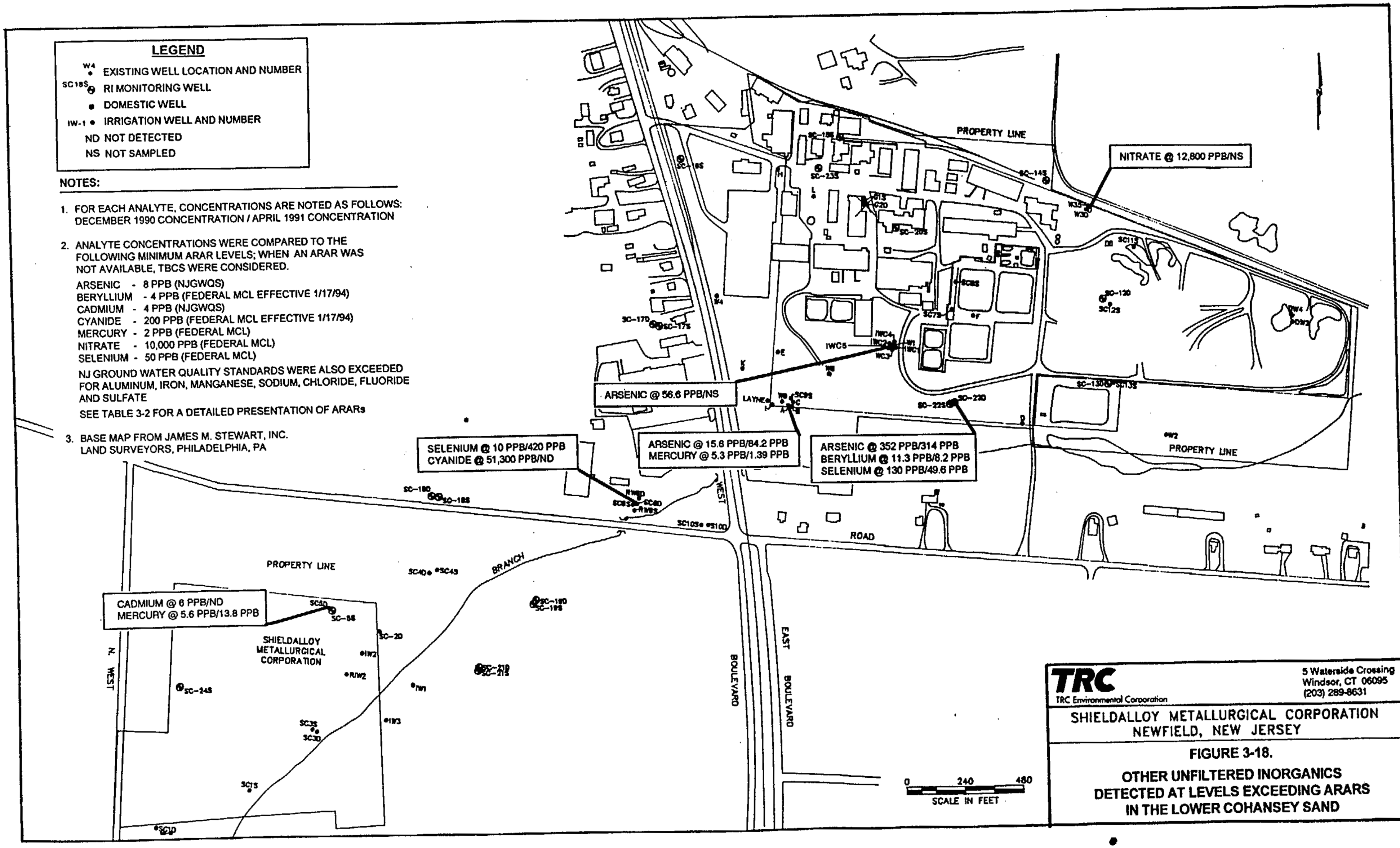

FIGURE 3-18.

OTHER UNFILTERED INORGANICS DETECTED AT LEVELS EXCEEDING ARARS IN THE LOWER COHANSEY SAND

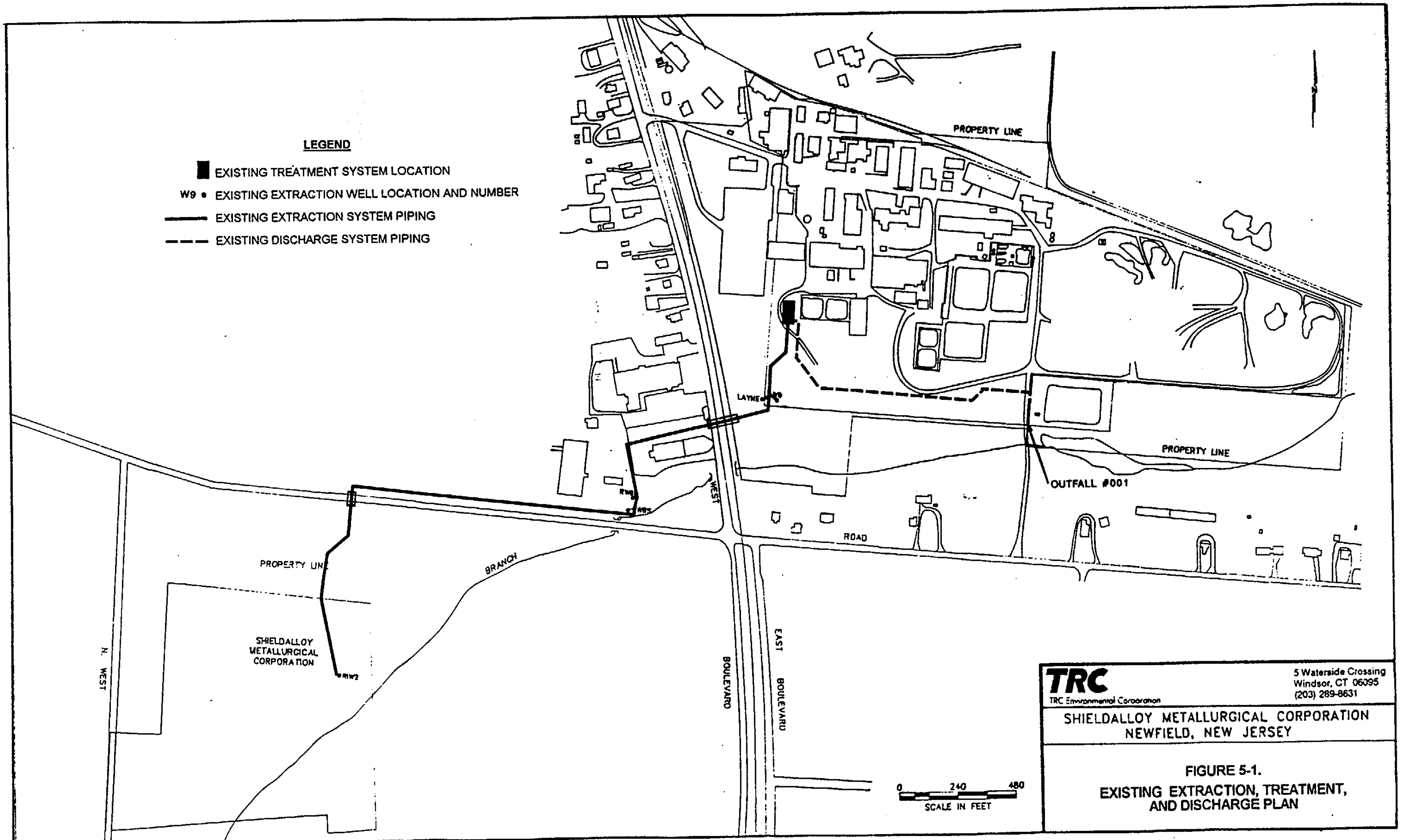

FIGURE 5-1.
EXISTING EXTRACTION, TREATMENT, AND DISCHARGE PLAN

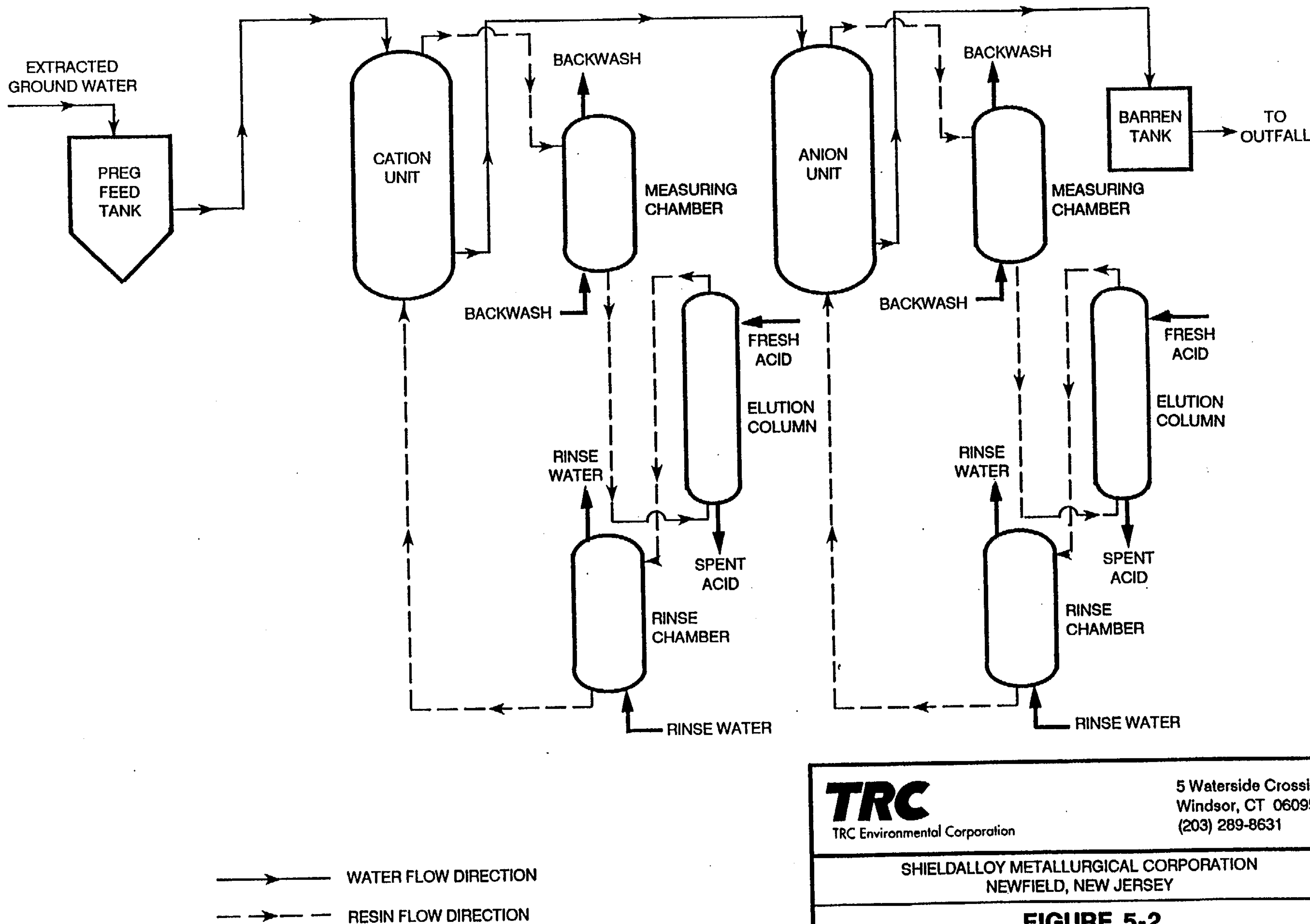

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FIGURE 5-2.
EXISTING ION EXCHANGE TREATMENT SYSTEM SCHEMATIC

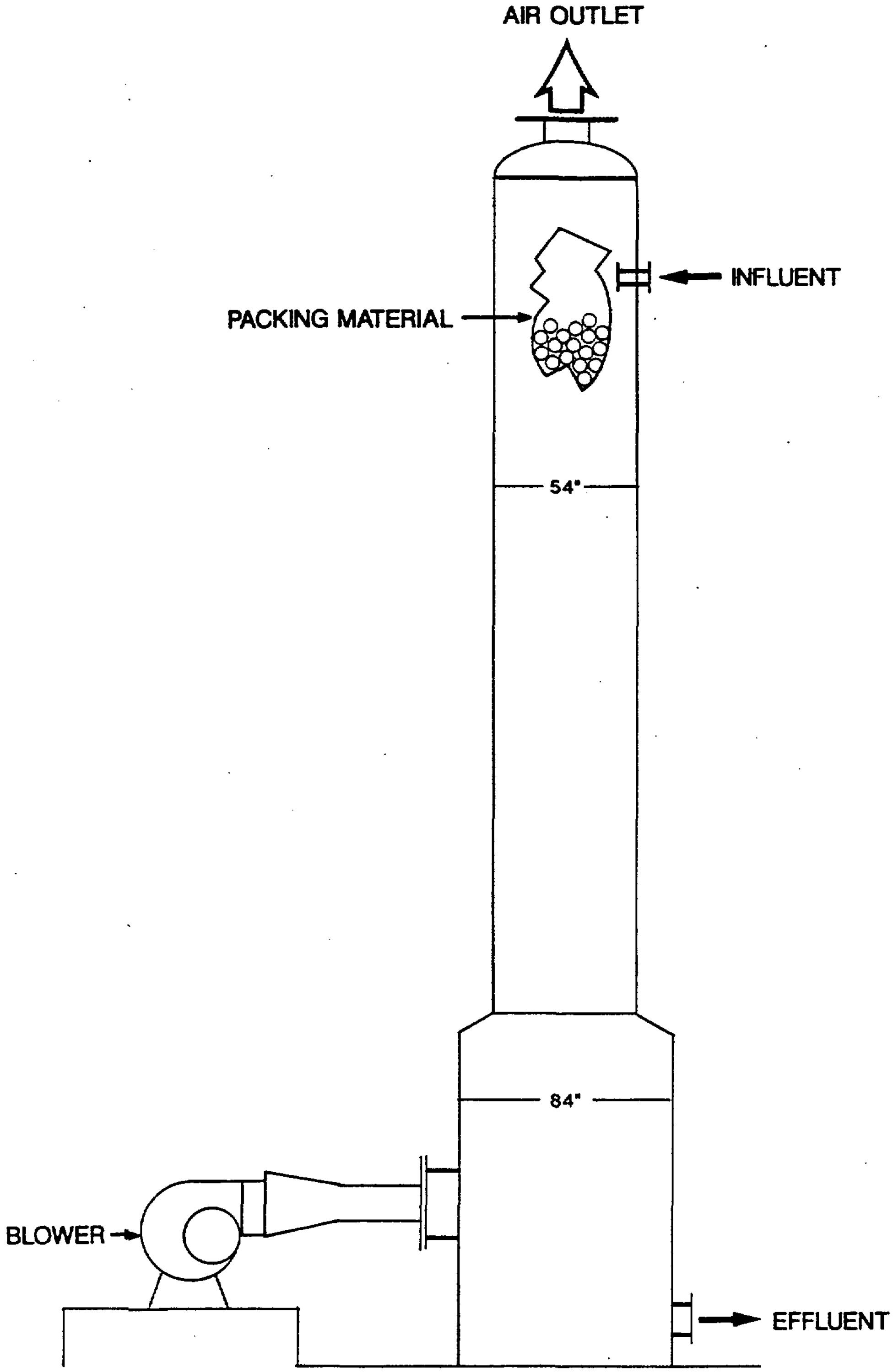

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FIGURE 5-3.

EXISTING AIR STRIPPING UNIT

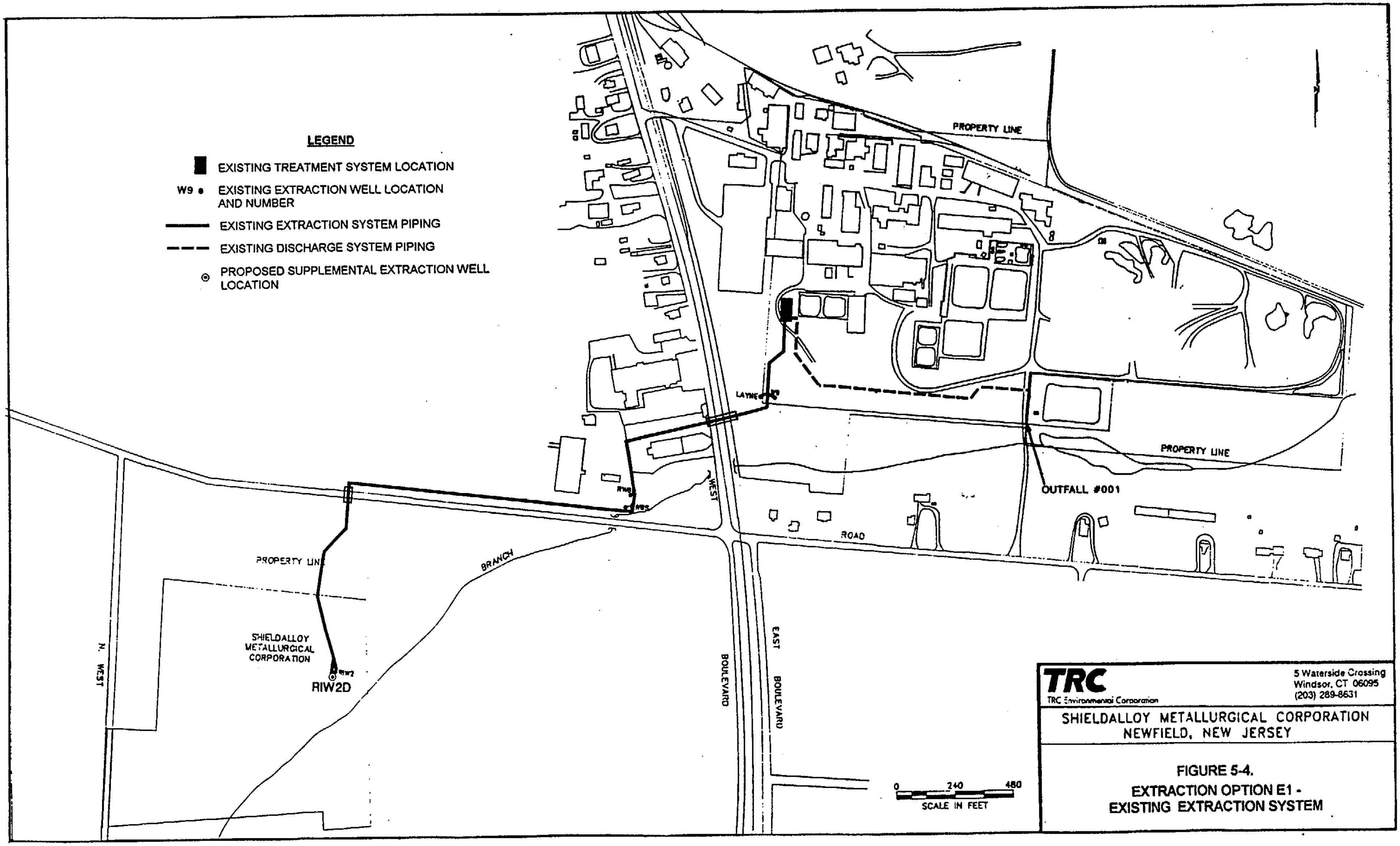

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FIGURE 5-4.
EXTRACTION OPTION E1 -
EXISTING EXTRACTION SYSTEM

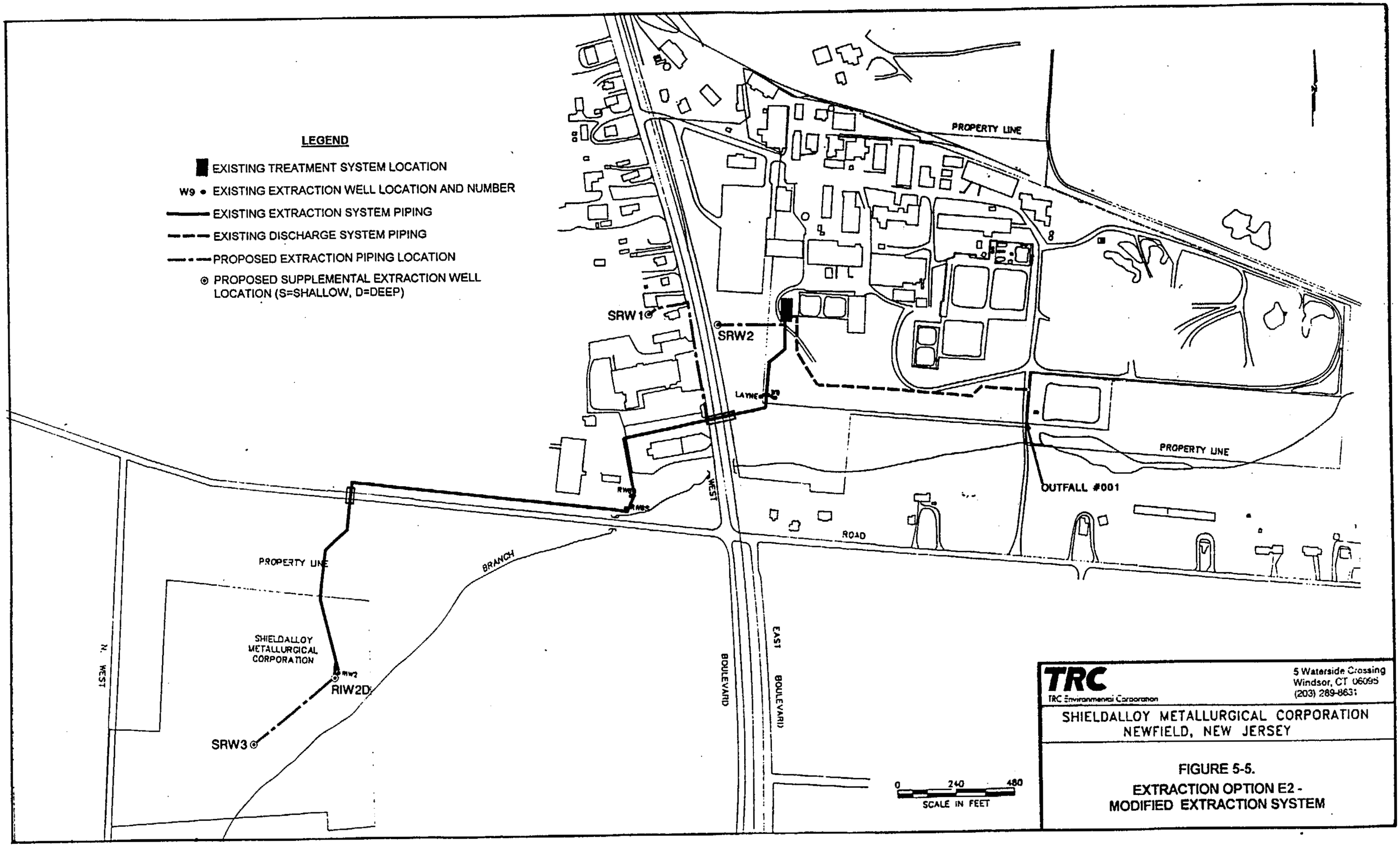

FIGURE 5-5.
EXTRACTION OPTION E2 -
MODIFIED EXTRACTION SYSTEM

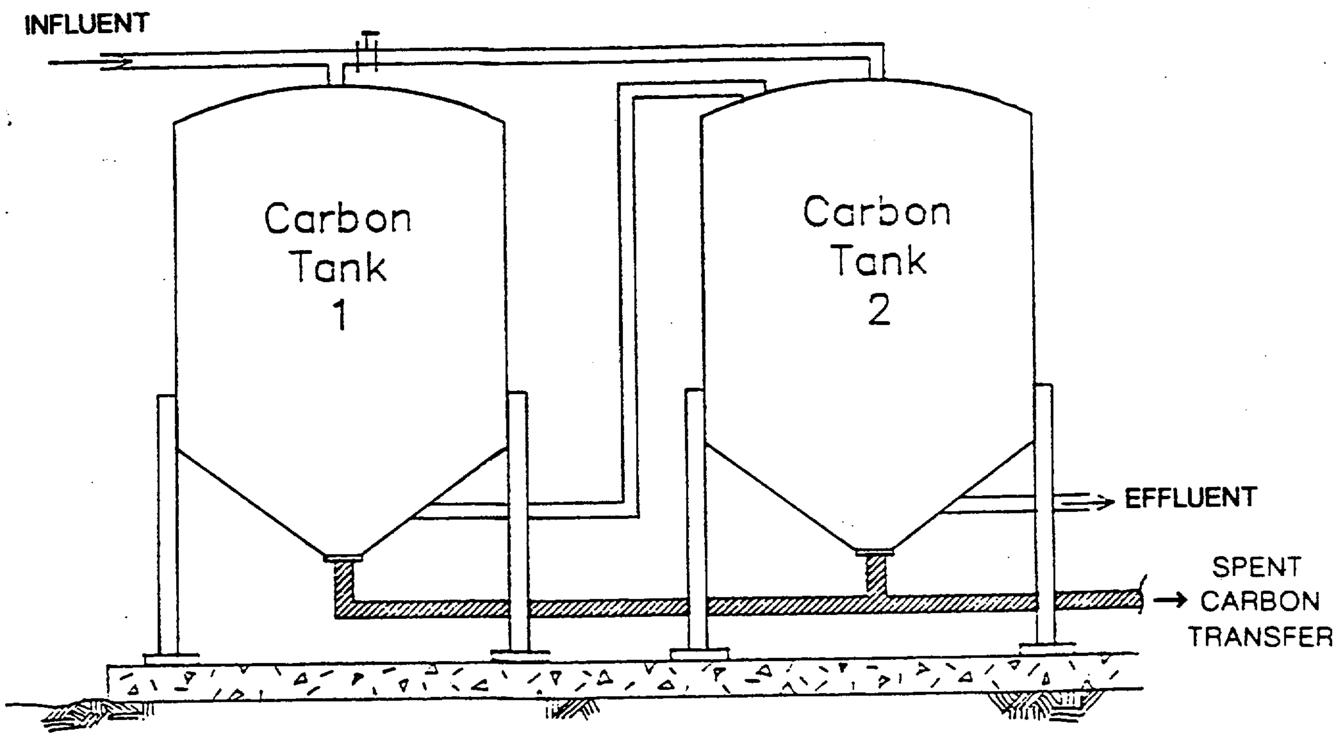

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FIGURE 5-6.

CARBON ADSORPTION SYSTEM

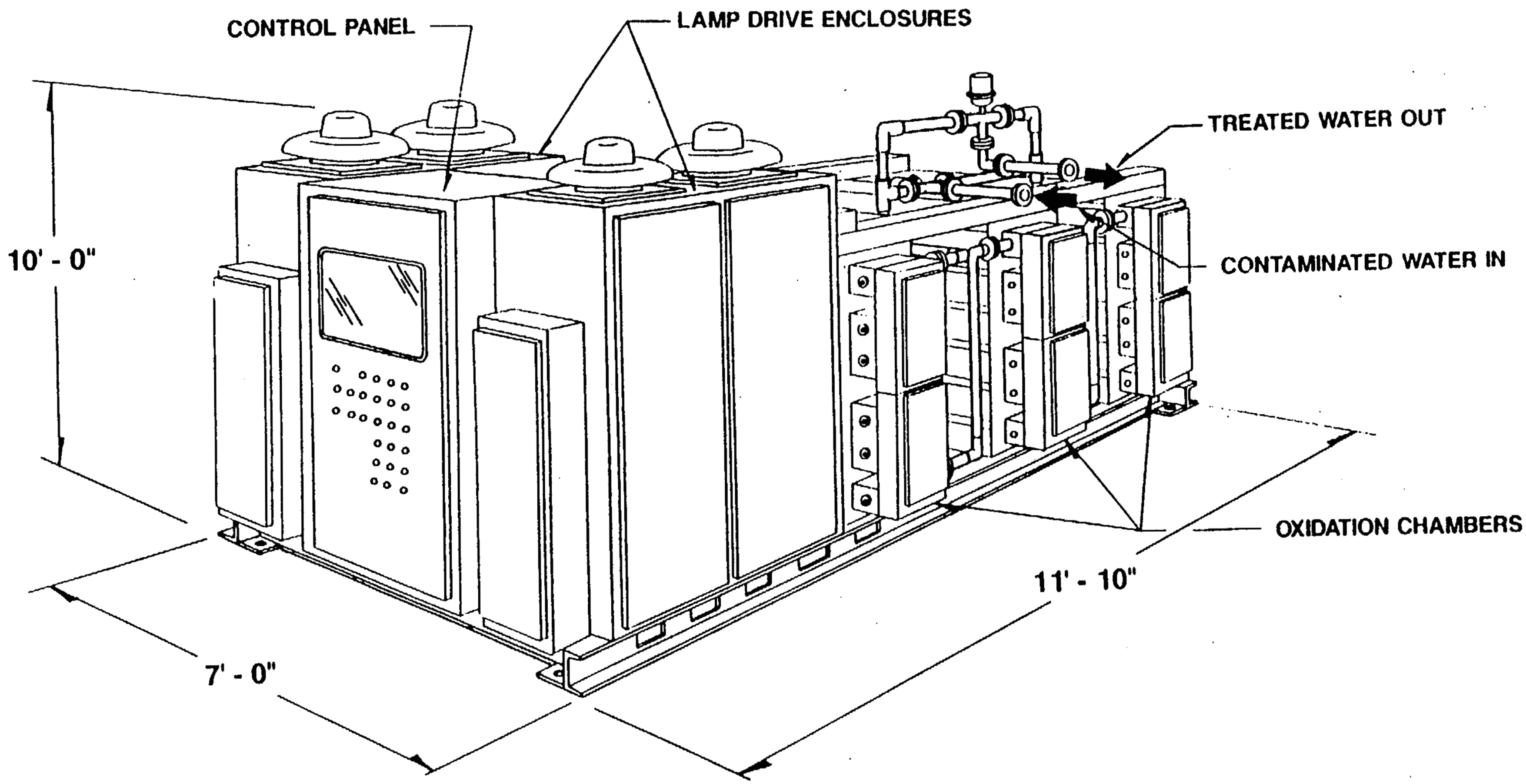

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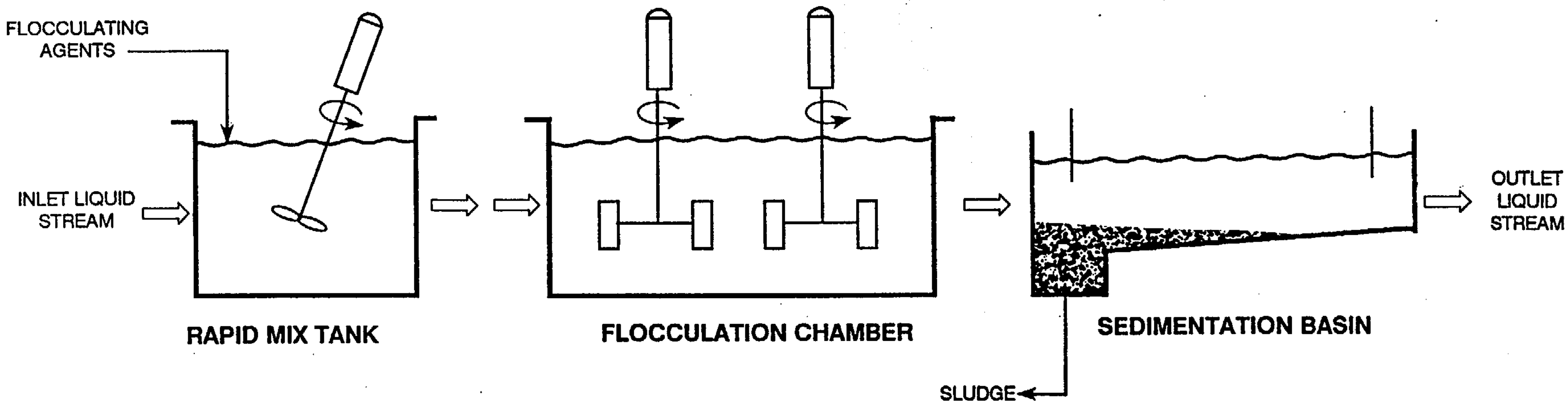
FIGURE 5-7.
UV OXIDATION UNIT



Source: De Renzo, 1978

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FIGURE 5-8.
COAGULATION AND FLOCCULATION SYSTEM

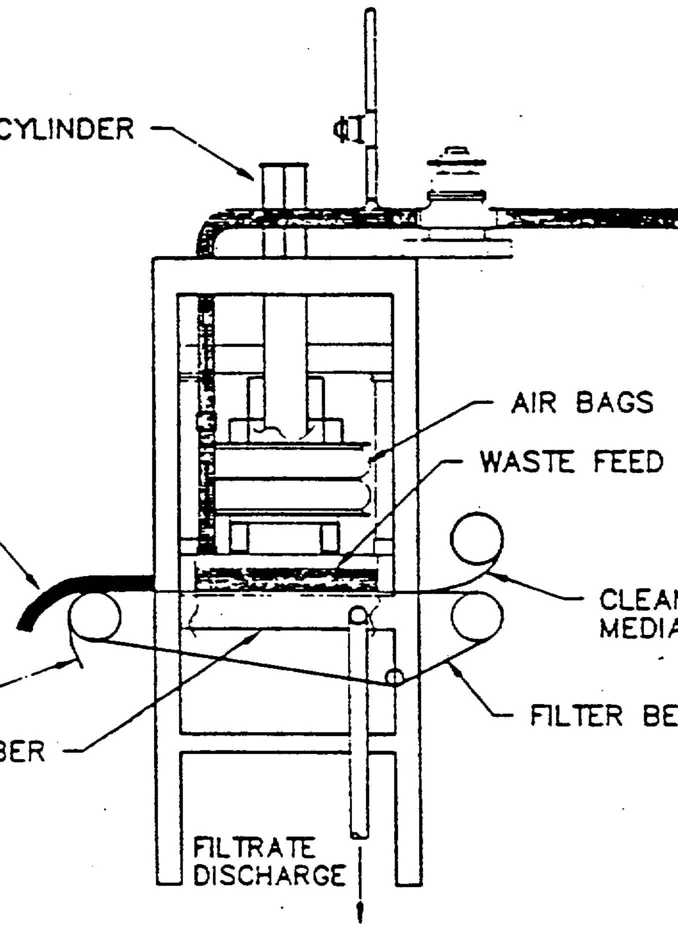

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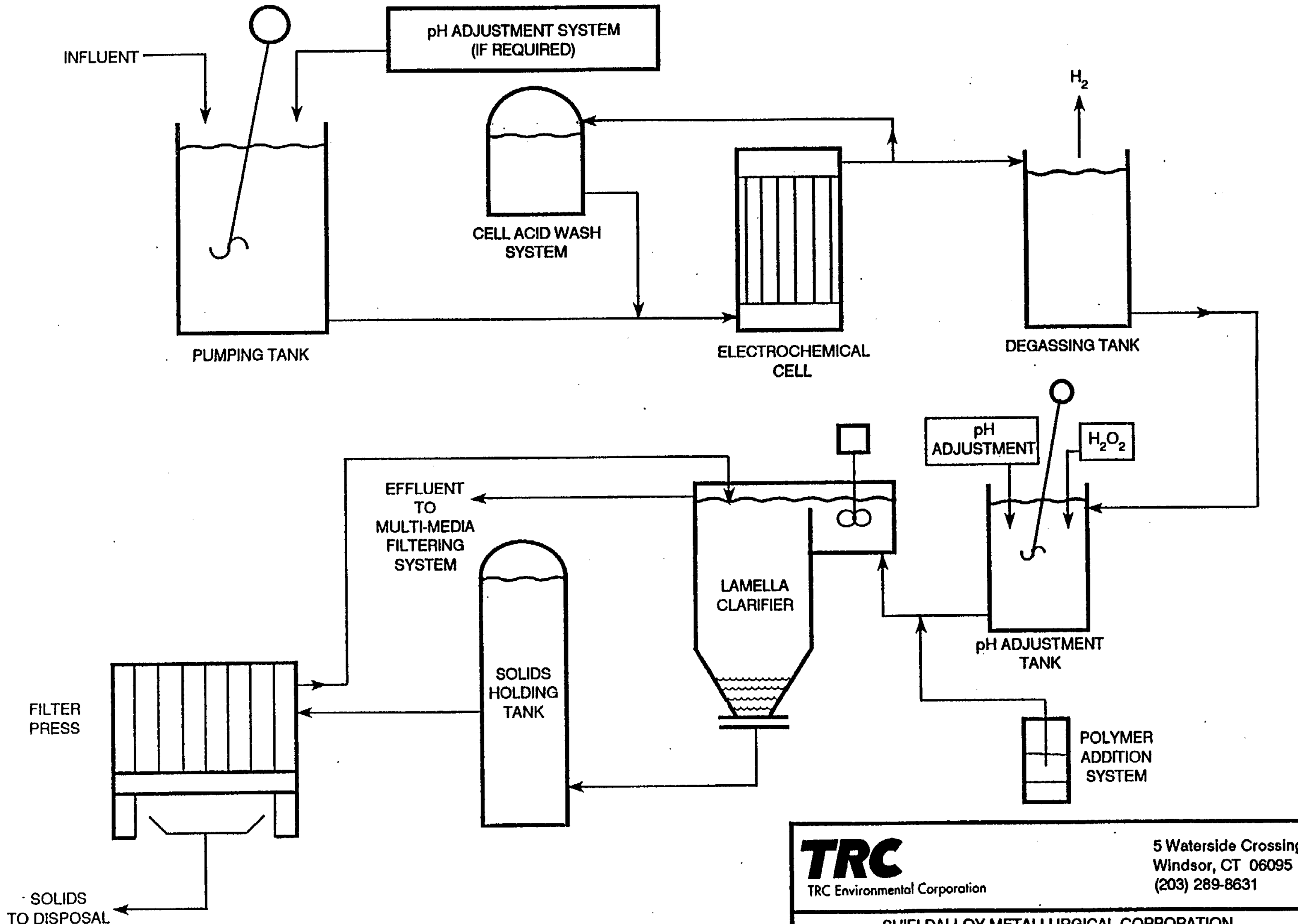
FIGURE 5-9.
DUPONT/OBERLIN MICROFILTRATION SYSTEM



SOURCE: ANDCO ENVIRONMENTAL PROCESSES, INC.

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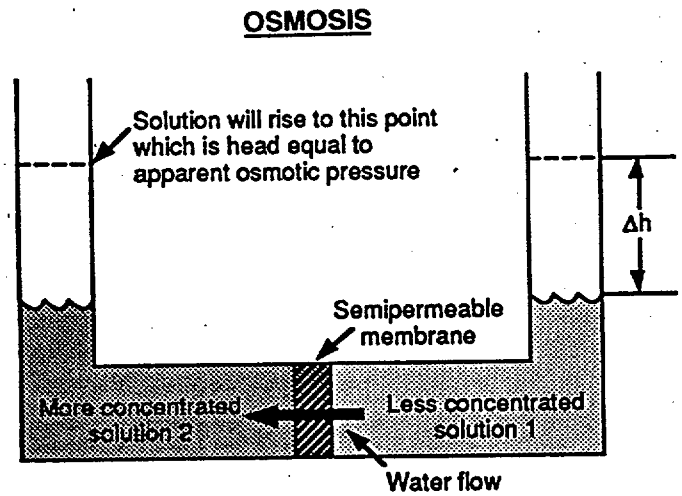
FIGURE 5-10.

ELECTROCHEMICAL REDUCTION SYSTEM



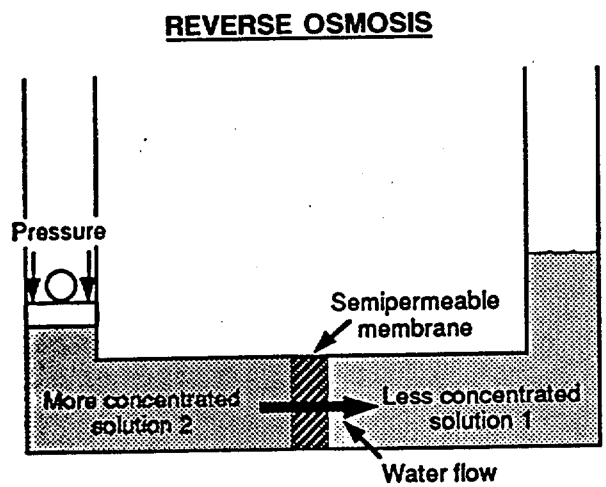


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FIGURE 5-11.

REVERSE OSMOSIS PROCESS DIAGRAM

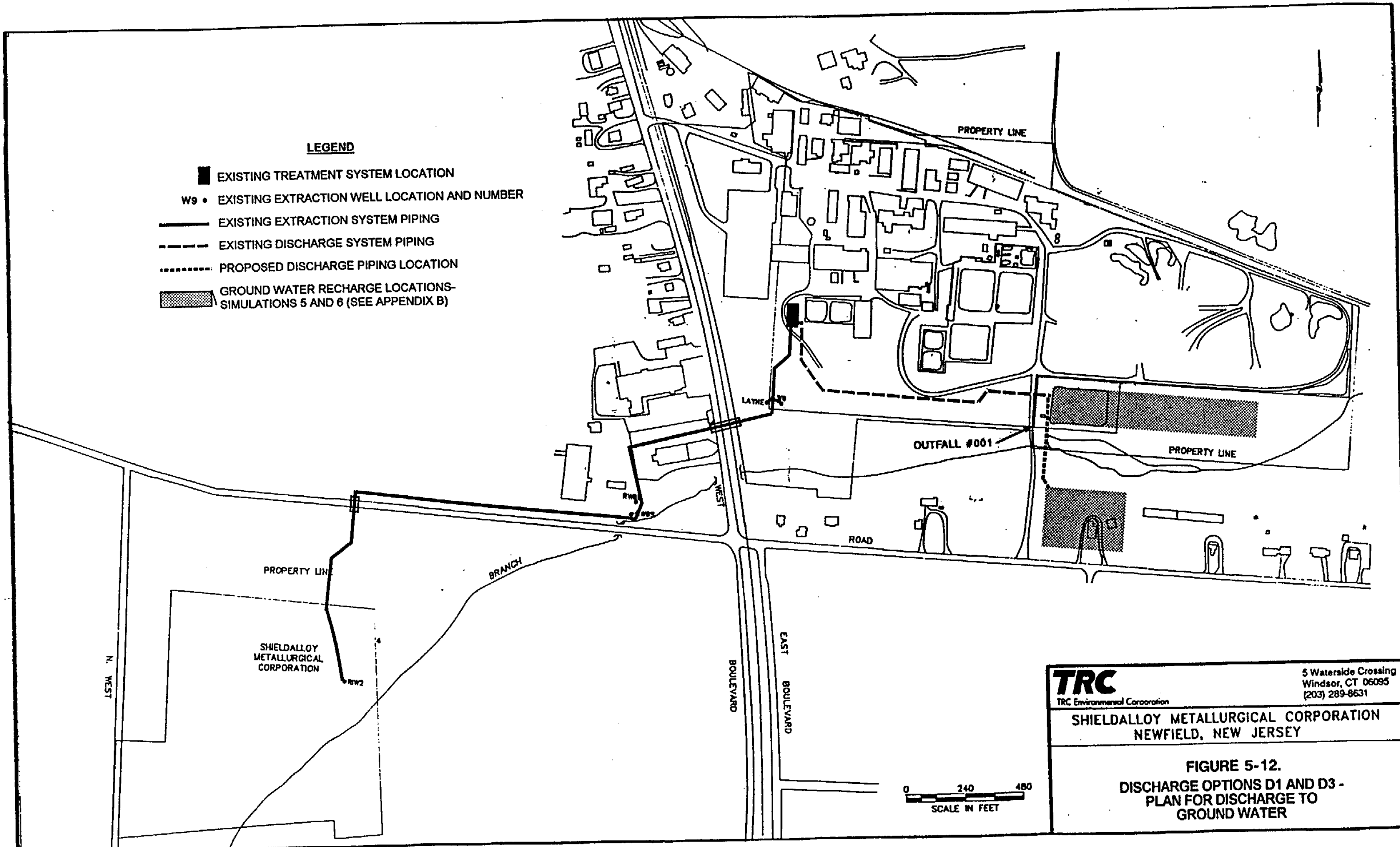

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FIGURE 5-12.
DISCHARGE OPTIONS D1 AND D3 - PLAN FOR DISCHARGE TO GROUND WATER

APPENDIX A

REMEDIAL COST ESTIMATES

Alternative 1
No Action
(Ground Water Monitoring at the End of Five Years)

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
TOTAL CAPITAL COSTS										$0.00
OPERATION AND MAINTENANCE COSTS										
Ground Water Monitoring (including trip blanks, field blanks and duplicate samples)										
– Sampling at end of 5 years	54	samples	$430.00	1992	6	1.000	$430.00	$23,220.00		$23,220.00
– Analysis:										
Cr+6, Cr (total), SO_4^-, Na	60	samples	$80.00	1992	6	1.000	$80.00	$4,800.00		$4,800.00
VOC+15	42	samples	$270.00	1992	6	1.000	$270.00	$11,340.00		$11,340.00
Gross Alpha	9	samples	$100.00	1992	6	1.000	$100.00	$900.00		$900.00
TOTAL NET PRESENT VALUE OF O & M										$40,260.00
SUBTOTAL COST										$40,260.00
CONTINGENCY (20%)										$8,052.00
TOTAL PRESENT VALUE COST FOR ALTERNATIVE 1										$48,312.00

(1) – Calculated based on 5% interest rate.

Alternative 2
Continuation of Existing Actions

Item	Quantity	Units	Unit Price	Basis year	Reference	Escalation	1992 Unit costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
TOTAL CAPITAL COSTS										$0.00
OPERATION AND MAINTENANCE COSTS										
Ground Water Extraction										
– Power Supply	8,760	hr	$0.42	1984	16	1.219	$0.51	$4,484.94	5	$19,415.33
Ground Water Treatment										
– Labor – Operation	8,760	man–hrs	$20.00	1987	10	1.148	$22.96	$201,129.60	5	$870,690.04
– Brine Transportation & Disposal	3,000,000	gal	$0.23	1992	11	1.000	$0.23	$690,000.00	5	$2,987,010.00
– Filter Cake Transportation	180	cy	$250.00	1992	11	1.000	$250.00	$45,000.00	5	$194,805.00
– Filter Cake Disposal	30	load	$3,000.00	1992	11	1.000	$3,000.00	$90,000.00	5	$389,610.00
– Discharge Sampling	1	year	$70,000.00	1992	11	1.000	$70,000.00	$70,000.00	5	$303,030.00
Ground Water and Influent Monitoring (including field blank, trip blank, and duplicate sample)										
– Annual Sampling	13	wells	$430.00	1992	6	1.000	$430.00	$5,590.00	5	$24,199.11
– Quarterly Sampling	116	wells	$430.00	1992	6	1.000	$430.00	$49,880.00	5	$215,930.52
– Monthly Sampling	144	wells	$430.00	1992	6	1.000	$430.00	$61,920.00	5	$268,051.68
– Analysis:										
Cr+6, Cr (total), SO_4^-, Na	370	samples	$80.00	1992	6	1.000	$80.00	$29,600.00	5	$128,138.40
VOC+15	171	samples	$270.00	1992	6	1.000	$270.00	$46,170.00	5	$199,869.93
Gross Alpha	36	samples	$100.00	1992	6	1.000	$100.00	$3,600.00	5	$15,584.40
ANNUAL O&M (1992 $)								$1,297,374.54		
TOTAL NET PRESENT VALUE OF O & M										$5,616,334.40
SUBTOTAL										$5,616,334.40
CONTINGENCY(20%)										$1,123,266.88
TOTAL PRESENT VALUE COST FOR ALTERNATIVE 2										$6,739,601.29

(1) – Calculated based on an assumed 5% interest rate.

Alternative 3 – Option E1
Existing Extraction Well System

Item	Quantity	Units	Unit Price	Basis Year	Ref.	Adj. Factor	1992 Unit costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS – DIRECT										
Ground Water Extraction										
–Well Construction and Materials										
(1 115–ft. deep overburden – 6")	1	ea	$14,900.00	1992	1	1.000	$14,900.00	$14,900.00		
–Health and Safety(17%)					17			$2,533.00		
–Submersible Pump, Installed										
(1 4–inch)	1	ea	$1,375.00	1992	5	1.000	$1,375.00	$1,375.00		
–Well Development	4	hrs	$175.00	1992	1	1.000	$175.00	$700.00		
–Well Permits	1	ea	$25.00	1992	1	1.000	$25.00	$25.00		
–Conveyance Piping and Appurtenances										
4" Cement Lined Ductile Iron	50	l.ft.	$11.55	1992	5	1.000	$11.55	$577.50		
Gate Valve	1	ea	$350.00	1992	5	1.000	$350.00	$350.00		
90° Elbows	3	ea	$120.00	1992	5	1.000	$120.00	$360.00		
Pressure Gauge	1	ea	$148.00	1991	9	1.046	$154.81	$154.81		
–Tap Existing Line	1	ea	$325.00	1992	5	1.000	$325.00	$325.00		
–Trenching	50	l.ft.	$14.15	1992	5	1.000	$14.15	$707.50		
–Bedding	11	cu. yd	$9.75	1991	9	1.046	$10.20	$112.18		
Direct Capital Cost Subtotal										$22,119.99
CAPITAL COSTS – INDIRECT										
Engineering and Design(11%)					2					$2,433.20
Legal and Administrative(3%)					2					$663.60
TOTAL CAPITAL COSTS										$25,216.79
OPERATION AND MAINTENANCE COSTS										
Extraction System O&M	1	ea	$22,000.00	1985	16	1.206	$26,532.00	$26,532.00	5	$114,857.03
ANNUAL O&M (1992 $)								$26,532.00		
TOTAL NET PRESENT VALUE OF O & M										$114,857.03

Alternative 3 – Option E1
Existing Extraction Well System
(Continued)

Item	Quantity	Units	Unit Price	Basis Year	Ref.	Adj. Factor	1992 Unit costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
SUBTOTAL										$140,073.82
CONTINGENCY(20%)										$28,014.76
TOTAL PRESENT VALUE COST FOR ALTERNATIVE 3 – OPTION E1										$168,088.58

(1) – Calculated based on 5% interest rate.

Alternative 3 – Option E2
Modified Extraction System

Item	Quantity	Units	Unit Price	Basis Year	Ref.	Adj. Factor	1992 Unit costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS – DIRECT										
Ground Water Extraction										
–Well Construction and Materials										
(1 115–ft. deep overburden – 6")	1	ea	$14,900.00	1992	1	1.000	$14,900.00	$14,900.00		
–Well Construction and Materials										
(3 50–ft. deep overburden – 8")	3	ea	$8,245.00	1992	1	1.000	$8,245.00	$24,735.00		
–Health and Safety(17%)					17			$2,533.00		
–Submersible Pump, Installed										
(1 4–inch)	1	ea	$1,375.00	1992	5	1.000	$1,375.00	$1,375.00		
(3 5–inch)	3	ea	$900.00	1992	6	1.000	$900.00	$2,700.00		
–Well Development	12	hrs	$175.00	1992	1	1.000	$175.00	$2,100.00		
–Well Permits	4	ea	$25.00	1992	1	1.000	$25.00	$100.00		
–Conveyance Piping and Appurtenances										
4" Cement Lined Ductile Iron	1300	l.ft.	$11.55	1992	5	1.000	$11.55	$15,015.00		
Gate Valves	4	ea	$350.00	1992	5	1.000	$350.00	$1,400.00		
90° Elbows	12	ea	$120.00	1992	5	1.000	$120.00	$1,440.00		
Pressure Gauge	4	ea	$148.00	1991	9	1.046	$154.81	$619.23		
–Tap Existing Line	4	ea	$325.00	1992	5	1.000	$325.00	$1,300.00		
–Trenching	1300	l.ft.	$14.15	1992	5	1.000	$14.15	$18,395.00		
–Bedding	300	cu. yd	$9.75	1991	9	1.046	$10.20	$3,059.55		
–Manholes	3	ea	$1,050.00	1992	5	1.000	$1,050.00	$3,150.00		
Direct Capital Cost Subtotal										$92,821.78
CAPITAL COSTS – INDIRECT										
Engineering and Design(11%)					2					$10,210.40
Legal and Administrative(3%)					2					$2,784.65
TOTAL CAPITAL COSTS										$105,816.83

Alternative 3 – Option E2
Modified Extraction System
(Continued)

Item	Quantity	Units	Unit Price	Basis Year	Ref.	Adj. Factor	1992 Unit costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
OPERATION AND MAINTENANCE COSTS										
Extraction System O&M	1	ea	$22,000.00	1985	16	1.206	$26,532.00	$26,532.00	5	$114,857.03
ANNUAL O&M (1992 $)								$26,532.00		
TOTAL NET PRESENT VALUE OF O & M										$114,857.03
SUBTOTAL										$220,673.86
CONTINGENCY(20%)										$44,134.77
TOTAL PRESENT VALUE COST FOR ALTERNATIVE 3 – OPTION E2										$264,808.63

(1) – Calculated based on 5% interest rate.

Alternative 3 – Option T2
Air Stripping

Item	Quantity Units	Unit Price	Basis year	Reference	Adjustment Factor	1992 Unit costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS – DIRECT									
Air Stripping System –Piping and Controls	1 L.S.	$20,000.00	1992	6	1.000	$20,000.00	$20,000.00		
Total Air Stripping System Costs									$20,000.00
Direct Capital Cost Subtotal									$20,000.00
CAPITAL COSTS – INDIRECT									
Engineering and Design(10%)				2					$2,000.00
Legal and Administrative(4%)				2					$800.00
TOTAL CAPITAL COSTS									$22,800.00
OPERATION AND MAINTENANCE COSTS									
Air Stripper O&M	1 year	$13,000.00	1991	9	1.046	$13,598.00	$13,598.00	5	$58,865.74
ANNUAL O&M (1992 $)							$13,598.00		
TOTAL NET PRESENT VALUE OF O & M									$58,865.74
SUBTOTAL									$81,665.74
CONTINGENCY(20%)									$16,333.15
TOTAL PRESENT VALUE COST FOR ALTERNATIVE 3 – OPTION T2									$97,998.89

(1) Calculated based on 5% interest rate.

Alternative 3 – Option T3
Carbon Adsorption

Item	Quantity Units	Unit Price	Basis year	Reference	Adjustment Factor	1992 Unit costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS – DIRECT									
Carbon Adsorption System									
–Carbon Treatment Unit	1 each	$185,000.00	1992	13	1.000	$185,000.00	$185,000.00		
–Accelerated Column Treatability Study Test	1 each	$15,000.00	1992	13	1.000	$15,000.00	$15,000.00		
Piping and Controls	1 L.S.	$20,000.00	1992	6	1.000	$20,000.00	$20,000.00		
Electrical Connection	1 L.S.	$20,000.00	1992	6	1.000	$20,000.00	$20,000.00		
Total Ground Water Treatment System Costs									$240,000.00
Direct Capital Cost Subtotal									$240,000.00
CAPITAL COSTS – INDIRECT									
Engineering and Design(15%)				2					$36,000.00
Legal and Administrative(5%)				2					$12,000.00
TOTAL CAPITAL COSTS									$288,000.00
OPERATION AND MAINTENANCE COSTS									
Spent Carbon Replacement	6 –20,000 lb	$17,000.00	1992	13	1.000	$17,000.00	$102,000.00	5	$441,558.00
ANNUAL O&M (1992 $)							$102,000.00		
TOTAL NET PRESENT VALUE OF O & M									$441,558.00
SUBTOTAL									$729,558.00
CONTINGENCY(20%)									$145,911.60
TOTAL PRESENT VALUE COST FOR OPTION T3									$875,469.60

(1) – Calculated based on 5% interest rate.

Alternative 3 – Option T4
UV Oxidation

Item	Quantity	Units	Unit Price	Basis year	Reference	Adjustment Factor	1992 Unit costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS – DIRECT										
UV Oxidation Treatment System										
–UV Oxidation Unit	1	each	$650,000.00	1992	14	1.000	$650,000.00	$650,000.00		
–Installation/Start–up	1	each	$15,000.00	1992	14	1.000	$15,000.00	$15,000.00		
–Piping and Controls	1	L.S.	$20,000.00	1992	6	1.000	$20,000.00	$20,000.00		
–Electrical Connection	1	L.S.	$20,000.00	1992	6	1.000	$20,000.00	$20,000.00		
Bench–Scale Testing and Reporting										
–Test Fee	1	each	$3,500.00	1992	14	1.000	$3,500.00	$3,500.00		
–Analytical (VOAs only)	20	samples	$300.00	1992	4	1.000	$300.00	$6,000.00		
Total UV Oxidation Treatment System Costs										$714,500.00
Direct Capital Cost Subtotal										$714,500.00
CAPITAL COSTS – INDIRECT										
Engineering and Design(15%)					2					$107,175.00
Legal and Administrative(5%)					2					$35,725.00
TOTAL CAPITAL COSTS										$857,400.00
OPERATION AND MAINTENANCE COSTS										
UV Oxidation O&M										
–UV Oxidation O&M Cost	1	year	$100,000.00	1992	14	1.000	$100,000.00	$100,000.00	5	$432,900.00
–UV Oxidation Power Supply	1	year	$300,000.00	1992	14	1.000	$300,000.00	$300,000.00	5	$1,298,700.00
ANNUAL O&M (1992 $)								$400,000.00		
TOTAL NET PRESENT VALUE OF O & M										$1,731,600.00
SUBTOTAL										$2,589,000.00
CONTINGENCY(20%)										$517,800.00
TOTAL PRESENT VALUE COST FOR OPTION T4										$3,106,800.00

(1) – Calculated based on 5% interest rate.

Alternative 3 – Option T6
Coagulation and Flocculation

Item	Quantity Units	Unit Price	Basis year	Reference	Adjustment Factor	1992 Unit costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS – DIRECT									
Coagulation and Flocculation System									
– Flocculator/Clarifier and Sludge Management	1 L.S.	$69,000.00	1987	10	1.148	$79,212.00	$79,212.00		
–Electrical Connection	1 L.S.	$20,000.00	1992	9	1.000	$20,000.00	$20,000.00		
–Piping and Controls	1 L.S.	$20,000.00	1992	9	1.000	$20,000.00	$20,000.00		
Total Coagulation and Flocculation Treatment System Costs									$119,212.00
Direct Capital Cost Subtotal									$119,212.00
CAPITAL COSTS – INDIRECT									
Engineering and Design(15%)				2					$17,881.80
Legal and Administrative(5%)				2					$5,960.60
TOTAL CAPITAL COSTS									$143,054.40
OPERATION AND MAINTENANCE COSTS									
Coagulation/Flocculation O&M	210,240 – 1,000 gal	$3.70	1987	10	1.148	$4.25	$893,015.42	5	$3,865,863.77
Ion Exchange O&M									
– Brine Transportation and Disposal	4,500,000 gal	$0.23	1992	11	1.000	$0.23	$1,035,000.00	5	$4,480,515.00
– Filter Cake Transportation	270 cy	$250.00	1992	11	1.000	$250.00	$67,500.00	5	$292,207.50
– Filter Cake Disposal	45 loads	$3,000.00	1992	11	1.000	$3,000.00	$135,000.00	5	$584,415.00
– Operator	8,760 man–hrs	$20.00	1987	10	1.148	$22.96	$201,129.60	5	$870,690.04
ANNUAL O&M (1992 $)							$2,331,645.02		
TOTAL NET PRESENT VALUE OF O & M									$10,093,691.31
SUBTOTAL									$10,236,745.71
CONTINGENCY(20%)									$2,047,349.14
TOTAL PRESENT VALUE COST FOR ALTERNATIVE 3 – OPTION T6									$12,284,094.85

(1) Calculated based on 5% interest rate.

Alternative 3 – Option T7
Microfiltration

Item	Quantity	Units	Unit Price	Basis year	Reference	Adjustment Factor	1992 Unit costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS – DIRECT										
Microfiltration System										
–Microfiltration System	1	L.S.	$450,000.00	1991	12	1.046	$470,700.00	$470,700.00		
–Electrical Connection	1	L.S.	$20,000.00	1992	9	1.000	$20,000.00	$20,000.00		
–Piping and Controls	1	L.S.	$20,000.00	1992	9	1.000	$20,000.00	$20,000.00		
–Treatment System Building	1	L.S.	$95,000.00	1992	11	1.000	$95,000.00	$95,000.00		
Direct Capital Cost Subtotal										$605,700.00
CAPITAL COSTS – INDIRECT										
Engineering and Design(15%)					2					$90,855.00
Legal and Administrative(5%)					2					$30,285.00
TOTAL CAPITAL COSTS										$726,840.00
OPERATION AND MAINTENANCE COSTS										
Microfiltration O&M	1	year	$129,000.00	1991	12	1.046	$134,934.00	$134,934.00	5	$584,129.29
Ion Exchange O&M										
– Brine Transportation and Disposal	4,500,000	gal	$0.23	1992	11	1.000	$0.23	$1,035,000.00	5	$4,480,515.00
– Filter Cake Transportation	270	cy	$250.00	1992	11	1.000	$250.00	$67,500.00	5	$292,207.50
– Filter Cake Disposal	45	loads	$3,000.00	1992	11	1.000	$3,000.00	$135,000.00	5	$584,415.00
– Operator	8,760	man–hrs	$20.00	1987	10	1.148	$22.96	$201,129.60	5	$870,690.04
ANNUAL O&M (1992 $)								$1,573,563.60		
TOTAL NET PRESENT VALUE OF O & M										$6,811,956.82
SUBTOTAL										$7,538,796.82
CONTINGENCY(20%)										$1,507,759.36
TOTAL PRESENT VALUE COST FOR ALTERNATIVE 3 – OPTION T7										$9,046,556.19

(1) Calculated based on 5% interest rate.

Alternative 3 – Option T8
Electrochemical Treatment

Item	Quantity	Units	Unit Price	Basis year	Reference	Adjustment Factor	1992 Unit costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS – DIRECT										
Electrochemical Treatment System										
–Electrochemical Treatment System	1	L.S.	$941,500.00	1991	7	1.046	$984,809.00	$984,809.00		
–Electrical Connection	1	L.S.	$20,000.00	1992	9	1.000	$20,000.00	$20,000.00		
–Piping and Controls	1	L.S.	$20,000.00	1992	9	1.000	$20,000.00	$20,000.00		
–Treatment System Building	1	L.S.	$190,000.00	1992	11	1.000	$190,000.00	$190,000.00		
Direct Capital Cost Subtotal										$1,214,809.00
CAPITAL COSTS – INDIRECT										
Engineering and Design (15%)					2					$182,221.35
Legal and Administrative (5%)					2					$60,740.45
TOTAL CAPITAL COSTS										$1,457,770.80
OPERATION AND MAINTENANCE COSTS										
Electrochemical O&M	1	yr	$288,000.00	1991	12	1.046	$301,248.00	$301,248.00	5	$1,304,102.59
Operator	8,760	man–hrs	$20.00	1987	10	1.148	$22.96	$201,129.60	5	$870,690.04
ANNUAL O&M (1992 $)								$502,377.60		
TOTAL NET PRESENT VALUE OF O & M										$2,174,792.63
SUBTOTAL										$3,632,563.43
CONTINGENCY (20%)										$726,512.69
TOTAL PRESENT VALUE COST FOR ALTERNATIVE 3 – OPTION T8										$4,359,076.12

(1) Calculated based on 5% interest rate.

Alternative 3 – Option T8
Electrochemical Treatment (with Ion Exchange)

Item	Quantity	Units	Unit Price	Basis year	Reference	Adjustment Factor	1992 Unit costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS – DIRECT										
Electrochemical Treatment System										
–Electrochemical Treatment System	1	L.S.	$941,500.00	1991	7	1.046	$984,809.00	$984,809.00		
–Electrical Connection	1	L.S.	$20,000.00	1992	9	1.000	$20,000.00	$20,000.00		
–Piping and Controls	1	L.S.	$20,000.00	1992	9	1.000	$20,000.00	$20,000.00		
–Treatment System Building	1	L.S.	$190,000.00	1992	11	1.000	$190,000.00	$190,000.00		
Direct Capital Cost Subtotal										$1,214,809.00
CAPITAL COSTS – INDIRECT										
Engineering and Design(15%)					2					$182,221.35
Legal and Administrative(5%)					2					$60,740.45
TOTAL CAPITAL COSTS										$1,457,770.80
OPERATION AND MAINTENANCE COSTS										
Electrochemical O&M	1	yr	$152,000.00	1991	12	1.046	$158,992.00	$158,992.00	5	$688,276.37
Ion Exchange O&M										
– Brine Transportation and Disposal	3,000,000	gal	$0.23	1992	11	1.000	$0.23	$690,000.00	5	$2,987,010.00
– Filter Cake Transportation	180	cy	$250.00	1992	11	1.000	$250.00	$45,000.00	5	$194,805.00
– Filter Cake Disposal	30	loads	$3,000.00	1992	11	1.000	$3,000.00	$90,000.00	5	$389,610.00
– Operator	8,760	man–hrs	$20.00	1987	10	1.148	$22.96	$201,129.60	5	$870,690.04
ANNUAL O&M (1992 $)								$1,185,121.60		
TOTAL NET PRESENT VALUE OF O & M										$5,130,391.41
SUBTOTAL										$6,588,162.21
CONTINGENCY(20%)										$1,317,632.44
TOTAL PRESENT VALUE COST FOR ALTERNATIVE 3 – OPTION T8										$7,905,794.65

(1) Calculated based on 5% interest rate.

Alternative 3 – Option D1
Discharge to Ground Water

Item	Quantity	Units	Unit Price	Basis year	Reference	Adjustment Factor	1992 Unit costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS – DIRECT										
Reinjection System										
–Reinjection System Excavation	24,300	cy	$7.10	1991	9	1.046	$7.43	$180,466.38		
–Scarification	164	msf	$3.87	1991	9	1.046	$4.05	$663.88		
–6" Schedule 40 PVC Pipe	420	l.ft.	$10.00	1992	5	1.000	$10.00	$4,200.00		
–Tap Existing Line	1	ea.	$700.00	1992	5	1.000	$700.00	$700.00		
–Trenching	420	l.ft.	$8.36	1992	5	1.000	$8.36	$3,511.20		
–Bedding	95	cy	$9.75	1991	9	1.046	$10.20	$968.86		
–Riprap	100	cy	$41.96	1991	9	1.046	$43.89	$4,389.02		
–12" PVC Manifold	50	l.ft.	$19.70	1991	9	1.046	$20.61	$1,030.31		
–Gate Valves	2	ea.	$545.00	1992	5	1.000	$545.00	$1,090.00		
Total Reinjection System Costs										$197,019.64
Piezometers/Monitoring Wells										
–Well Construction and Materials (6 50–ft shallow overburden – 4")	300	l.ft.	$30.00	1990	18	1.069	$32.07	$9,621.00		
–Protective Casings	6	ea.	$150.00	1990	18	1.069	$160.35	$962.10		
–Well Development	12	hrs.	$175.00	1992	1	1.000	$175.00	$2,100.00		
Total Piezometers/Monitoring Wells										$12,683.10
Direct Capital Cost Subtotal										$209,702.74
CAPITAL COSTS – INDIRECT										
Engineering and Design(11%)					2					$23,067.30
Legal and Administrative(3%)					2					$6,291.08
TOTAL CAPITAL COSTS										$239,061.12

Alternative 3 – Option D1
Discharge to Ground Water
(continued)

Item	Quantity Units	Unit Price	Basis year	Reference	Adjustment Factor	1992 Unit costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
OPERATION AND MAINTENANCE COSTS									
Discharge Sampling and Analysis	1 year	$70,000.00	1992	11	1.000	$70,000.00	$70,000.00	5	$303,030.00
Ground Water Monitoring (including field blank, trip blank, and duplicate samples)									
– Annual Sampling	13 wells	$430.00	1992	6	1.000	$430.00	$5,590.00	5	$24,199.11
– Quarterly Sampling	188 wells	$430.00	1992	6	1.000	$430.00	$80,840.00	5	$349,956.36
– Analysis:									
Cr+6, Cr (total), SO_4^-, Na	226 samples	$80.00	1992	6	1.000	$80.00	$18,080.00	5	$78,268.32
VOC+15	152 samples	$270.00	1992	6	1.000	$270.00	$41,040.00	5	$177,662.16
Gross Alpha	36 samples	$100.00	1992	6	1.000	$100.00	$3,600.00	5	$15,584.40
ANNUAL O&M (1992 $)							$219,150.00		
TOTAL NET PRESENT VALUE OF O&M									$948,700.35
SUBTOTAL									$1,187,761.47
CONTINGENCY(20%)									$237,552.29
TOTAL PRESENT VALUE COST FOR ALTERNATIVE 3 – OPTION D1									$1,425,313.77

(1) Calculated based on 5% interest rate.

Alternative 3 – Option D2
Discharge to Surface Water

Item	Quantity	Units	Unit Price	Basis year	Reference	Adjustment Factor	1992 Unit costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
TOTAL CAPITAL COSTS										$0.00
OPERATION AND MAINTENANCE COSTS										
Discharge Sampling and Analysis	1	year	$70,000.00	1992	11	1.000	$70,000.00	$70,000.00	5	$303,030.00
Ground Water Monitoring (including field blank, trip blank, and duplicate samples)										
– Annual Sampling	13	wells	$430.00	1992	6	1.000	$430.00	$5,590.00	5	$24,199.11
– Quarterly Sampling	164	wells	$430.00	1992	6	1.000	$430.00	$70,520.00	5	$305,281.08
– Analysis:										
Cr+6, Cr (total), SO_4^-, Na,	219	samples	$80.00	1992	6	1.000	$80.00	$17,520.00	5	$75,844.08
VOC+15	146	samples	$270.00	1992	6	1.000	$270.00	$39,420.00	5	$170,649.18
Gross Alpha	32	samples	$100.00	1992	6	1.000	$100.00	$3,200.00	5	$13,852.80
ANNUAL O&M (1992 $)								$206,250.00		
TOTAL NET PRESENT VALUE OF O&M										$892,856.25
SUBTOTAL										$892,856.25
CONTINGENCY(20%)										$178,571.25
TOTAL PRESENT VALUE COST FOR ALTERNATIVE 3 – OPTION D2										$1,071,427.50

(1) Calculated based on 5% interest rate.

Alternative 3 – Option D3
Combined Discharge to Ground Water and Surface Water

Item	Quantity Units	Unit Price	Basis year	Reference	Adjustment Factor	1992 Unit costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS – DIRECT									
Reinjection System									
–Reinjection System Excavation	24,300 cy	$7.10	1991	9	1.046	$7.43	$180,466.38		
–Scarification	164 msf	$3.87	1991	9	1.046	$4.05	$663.88		
–6" Schedule 40 PVC Pipe	420 l.ft.	$10.00	1992	5	1.000	$10.00	$4,200.00		
–Tap Existing Line	1 ea.	$700.00	1992	5	1.000	$700.00	$700.00		
–Trenching	420 l.ft.	$8.36	1992	5	1.000	$8.36	$3,511.20		
–Bedding	95 cy	$9.75	1991	9	1.046	$10.20	$968.86		
–Riprap	100 cy	$41.96	1991	9	1.046	$43.89	$4,389.02		
–12" PVC Manifold	50 l.ft.	$19.70	1991	9	1.046	$20.61	$1,030.31		
–Gate Valves	2 ea.	$545.00	1992	5	1.000	$545.00	$1,090.00		
Total Reinjection System Costs									$197,019.64
Piezometers/Monitoring Wells									
–Well Construction and Materials (6 50–ft shallow overburden – 4")	300 l.ft.	$30.00	1990	18	1.069	$32.07	$9,621.00		
–Protective Casings	6 ea.	$150.00	1990	18	1.069	$160.35	$962.10		
–Well Development	12 hrs.	$175.00	1992	1	1.000	$175.00	$2,100.00		
Total Piezometers/Monitoring Wells									$12,683.10
Direct Capital Cost Subtotal									$209,702.74
CAPITAL COSTS – INDIRECT									
Engineering and Design(11%)				2					$23,067.30
Legal and Administrative(3%)				2					$6,291.08
TOTAL CAPITAL COSTS									$239,061.12

Alternative 3 – Option D3
Combined Discharge to Ground Water and Surface Water
(Continued)

Item	Quantity Units	Unit Price	Basis year	Reference	Adjustment Factor	1992 Unit costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
OPERATION AND MAINTENANCE COSTS									
Discharge Sampling and Analysis	1 year	$105,000.00	1992	6	1.000	$105,000.00	$105,000.00	5	$454,545.00
Ground Water Monitoring *(including field blank, trip blank, and duplicate samples)*									
– Annual Sampling	13 wells	$430.00	1992	6	1.000	$430.00	$5,590.00	5	$24,199.11
– Quarterly Sampling	188 wells	$430.00	1992	6	1.000	$430.00	$80,840.00	5	$349,956.36
– Analysis:									
Cr+6, Cr (total), SO_4^-, Na	226 samples	$80.00	1992	6	1.000	$80.00	$18,080.00	5	$78,268.32
VOC+15	152 samples	$270.00	1992	6	1.000	$270.00	$41,040.00	5	$177,662.16
Gross Alpha	36 samples	$100.00	1992	6	1.000	$100.00	$3,600.00	5	$15,584.40
ANNUAL O&M (1992 $)							$254,150.00		
TOTAL NET PRESENT VALUE OF O&M									$1,100,215.35
SUBTOTAL									$1,339,276.47
CONTINGENCY(20%)									$267,855.29
TOTAL PRESENT VALUE COST FOR ALTERNATIVE 3 – OPTION D3									$1,607,131.77

(1) Calculated based on 5% interest rate.

COST REFERENCES

1) Empire Soils Investigations Inc., Division of Huntington; June 1992.

2) Remedial Action Costing Procedures Manual; JRB Associates; October 1987. EPA/600/8-87/049.

3) Clean Harbors; February 1991.

4) Weston Analytical Laboratories; 1992.

5) Means Site Work & Landscape Cost Data; 1992.

6) TRC Environmental Corporation; 1992.

7) Andco Environmental Processes; May 1991.

8) Andco Environmental Processes; April 1992.

9) TRC Environmental Corporation; 1991.

10) Metal/Cyanide Containing Wastes Treatment Technologies; Palmer et. al.; 1988.

11) Shieldalloy Metallurgical Corporation; 1992.

12) Shieldalloy Metallurgical Corporation; 1991.

13) Calgon Carbon Corporation; June 1992.

14) Zimpro Passavant; 1988.

15) Andco Environmental Processes; January 1992.

16) Remedial Action at Waste Disposal Sites; October 1985. EPA/625/6-85/006.

17) Compendium of Costs of Remedial Technologies at Hazardous Waste Sites; Environmental Law Institute; October 1987. EPA/600/2-87/087.

18) Empire Soils Investigations, Inc., November 1990.

APPENDIX B

GROUND WATER MODELING INFORMATION

APPENDIX B

GROUND WATER MODELING INFORMATION

Several ground water extraction and/or discharge options (as described in Section 5.3.3.1 of this report) were evaluated using the computer ground water flow model MODFLOW. These evaluations were conducted to support the ground water extraction analyses presented within this Focused Feasibility Study, with the goal of locating recovery wells and assigning pumping rates such that ground water contaminated at levels exceeding ARARs at and/or emanating from SMC could be captured and extracted for treatment within the SMC on-site ground water treatment facility. The main goal in the evaluation of extraction systems was to provide capture of chromium-contaminated ground water, including the chromium-contaminated ground water within the upper and lower Cohansey Sand aquifer, as presented in Figures 3-7 through 3-14, as well as contamination which has been identified in the vicinity of well SC-26D. Additional investigation will be conducted in the vicinity of deep well IW2 and in the vicinity of well SC-26D to further evaluate the extent of contamination in these areas and provide for its capture and remediation. A secondary goal of the modeled extraction systems was to provide capture of contaminated ground water close to potential source area(s) to prevent contaminant dispersion and diffusion in the downgradient portions of the aquifer while maintaining hydraulic control of outlying low-concentration contamination. Based on previous studies (see Section 4.2.3) and initial modeling runs, a minimum initial extraction rate of 400 gpm was assumed for these analyses (i.e., a lower extraction rate would not successfully capture the contaminated ground water). As discussed in Section 3.1.1, additional organic and inorganic contaminants have been identified in the downgradient portions of the upper and lower Cohansey Sands at levels exceeding ARARs, in some cases downgradient of existing extraction well RIW2. Some of these inorganics were detected in one round of ground water sampling only and their presence in the aquifer at levels greater than ARARs must be confirmed. Where possible, the modeled extraction systems were evaluated to determine their effectiveness in potentially capturing these contaminants.

Presented below is a description of the modeling procedure, including the model's assumptions and the input initial and boundary conditions.

MODFLOW (McDonald and Harbaugh, 1988) is a modular finite-difference ground water flow model which numerically simulates two- or three-dimensional flow in porous media. The model consists of a set of "packages", each of which includes a number of highly independent subroutines or "modules". Each package deals with a specific feature of the hydrologic flow system or a specific method of solving linear equations that describe the flow. Layers can be simulated as confined, unconfined, or a combination of both. Flow from external stresses, such as flow to and from riverbeds, wells and/or drains, areal recharge and evapotranspiration can also be simulated.

MODFLOW assumes the following: 1) the pumping wells in each layer fully penetrate that layer, and no water is stored in the well bores; 2) prior to pumping, the regional piezometric surface can be either horizontal or sloping; and 3) water is released instantaneously from storage by the compaction of the aquifer matrix and by the expansion of the water itself. MODFLOW can simulate unconfined conditions, where a portion of the water stored in the aquifer is released by dewatering of the aquifer.

The area encompassed by the model grid is shown in Figure B-1. The grid was configured with 16 columns and 35 rows with a uniform nodal spacing of 200 feet; the grid thus measured 3,200 feet by 7,000 feet, for a total simulation area of 22,400,000 ft^2 (514.2 acres). While under certain circumstances the spacing of node points with greater frequency around source areas and pumping wells can better define capture zones, a 200-foot node spacing was determined to be appropriate to this application because of the area to be modeled (over a mile and a quarter in length). In addition, the water level elevation data required to calibrate the use of a smaller grid spacing around the recovery wells is not available. At a smaller site with closer coverage of monitoring and pumping wells, a greater frequency of node points can be supported; however, at SMC this approach is impracticable. Another reason for using the 200-foot node spacing was associated with the methodology required to calibrate/verify the model and develop the various pumping scenarios. To develop the several pumping scenarios presented within this appendix, numerous (i.e. several hundred) computer simulations were conducted. The greater the number of nodes in the simulation, the longer the time required for parameter adjustment and simulation. A node spacing of 200 feet was considered to be optimum to provide coverage of the modeled area while also allowing flexibility in the development and optimization of various pumping scenarios for the purposes of this FFS.

To simulate the shallow and deep portions of the Cohansey Sand water table aquifer in the SMC site area, a two-layer simulation was used, with the shallow portion modeled as unconfined and the deep portion modeled as confined. The deep portion of the aquifer was designated as confined for modeling purposes because the transmissivity of the deep portion will remain constant with time, unlike the shallow portion, where water level fluctuations will increase or decrease the saturated thickness, and hence the transmissivity. The deep portion of the Cohansey Sand is not actually confined nor semi-confined (Section 3.5, RI Report (TRC, 1992)). Hydraulic communication between the layers was slightly restricted in the model, in order to simulate the downward vertical gradients typically observed at most shallow/deep well clusters across the site.

While the MODFLOW model can simulate flow from external stresses, including flow to and from riverbeds, areal recharge and evapotranspiration, these modules were not used in any of the model simulations. Use of these modules requires a great deal of specific data that was not collected as part of previous investigations, or requires numerous assumptions if support data is unavailable. Two of the modules (riverbed flow and evapotranspiration) would not be expected to greatly impact the area ground water flow. The Hudson Branch is a minor stream of small lateral extent and depth and does not act as major source or sink of ground water. The areal recharge module was not included as the necessary data on the amount and distribution of areal recharge within and outside of the SMC facility is not readily available. It should be noted that in using the basic MODFLOW module, the ground water contours were calibrated/verified for two specific seasons (April and October ground water contours).

The MODFLOW model assumes that all pumping wells fully penetrate each layer. In reality, this MODFLOW simulation was calibrated to existing pumping well screen intervals and thus simulates observed ground water elevation data.

As the modeled area of the aquifer is not bounded on any side by an impermeable boundary, constant-head boundaries were used around the modeled area, with the model boundaries extended outward as far as considered practical when taking into account the areal range of water level data points available. Limiting the outward extent of the model boundaries was particularly imperative in the northwest-southeast direction, due to the relatively narrow band of monitoring well water level data points. Extending the boundaries further outward would lead to a great deal of speculation regarding the input of initial heads around the model periphery, lowering confidence in the model's simulation of steady-state conditions and responses to aquifer stresses. By its nature, a constant head boundary is a recharge boundary; therefore, any boundary effect the constant heads may contribute would be expected to cause the model to err on the conservative side, acting to limit the areal extent of the modeled recovery well capture zones.

Model data sheets are provided within this Appendix, following this discussion and the associated figures. It should be noted that the MODFLOW output item "drawdown" is included in the model output regardless of whether or not a source or sink is simulated in the model. In the case of the steady-state calibration, the "drawdown" model output term quantifies only the change in hydraulic head between the initial input head value and the final equilibrium head calculated during the calibration. Also, the head change closure criterion used for all simulations was 0.001 feet.

As indicated in the data outputs, the simulations utilize only one time step. Since the model was calibrated/verified to monitoring events during two distinct seasons (April and October), no additional benefit was anticipated, in terms of representing the shallow and deep ground water response to the extraction scenarios, as a result of utilizing time steps for each of the four seasons. In addition, modeling seasonal fluctuations in ground water flow patterns was not possible because there was no other seasonal data available for use in calibrating the model. Therefore, the MODFLOW simulations were modeled for the average hydrologic condition.

MODEL CALIBRATION

For initial steady-state (non-stressed) calibration of each layer, initial head matrices, based on the average shallow and deep ground water contours for the nonpumping conditions existing on October 12, 1992 (Figures B-2 and B-3), were input for the two layers. For the shallow portion of the Cohansey Sand, the aquifer transmissivity was input as the product of the saturated thickness (initial head minus elevation of the aquifer bottom) and the hydraulic conductivity. For the deep portion, which would not be dewatered, the transmissivity was initially entered as a constant value for the entire aquifer. The initial shallow hydraulic conductivity value used was 215 ft/day, and the initial deep transmissivity value used was 5,000 ft^2/day. These values represent the average of the hydraulic conductivity and transmissivity values determined by TRC for the shallow and deep portions of the Cohansey Sand, respectively, using data from the pumping tests conducted for SMC by Dan Raviv Associates, Inc. (DRAI) in 1988 and 1989[1].

As mentioned in the previous section, constant-head boundaries were placed surrounding the modeled region to establish flow through the model. After each model run was conducted, the aquifer hydraulic conductivity and/or transmissivity values were adjusted as necessary at particular model nodes. Using this technique, an initial calibration was achieved for the non-pumping conditions which existed at the site on October 12, 1992. The steady-state calibration model output is included in this Appendix. Figures B-2 and B-3 show the results of the steady-state calibration process. Whenever possible, an attempt was made to use hydraulic conductivity and transmissivity values that were similar to the average values determined from the DRAI pump tests.

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[1] Previous investigations (DRAI, 1988 and DRAI, 1990) concluded that the Cohansey Sand has two water-producing zones separated by a 40- to 60-foot thick semi-confining layer. Consequently, DRAI's analyses of the 1988 and 1989 pump test data (DRAI, 4/20/90, Appendices C and D) included the evaluation of several monitoring wells' data using analysis methods for either confined (e.g., Jacob (Cooper and Jacob, 1946) or "distance-drawdown" (Driscoll, 1986)) or semi-confined (e.g., Hantush, 1960) aquifer conditions. Subsurface geologic data gathered from the monitoring well borings drilled during the RI field investigation (TRC, 1992) did not support the existence of a continuous semi-confining layer within the Cohansey Sand. A semi-confining layer was detected in the vicinity of monitoring wells SC12D, SD13D, and SC22D; its depth, thickness and composition differed between these monitoring wells. Therefore, the DRAI pump test data were reanalyzed by TRC using AQUIX123™ (Interpex Limited, 1988), an interactive analytical computer program, using the option for the curve-fitting method developed by Neuman (1975) for anisotropic unconfined aquifers with delayed gravity response. The reanalyzed pump test results were then used to determine initial model input hydraulic parameters, including transmissivity and specific yield, for the shallow and deep ground water layers.

MODEL VERIFICATION

Following the steady-state calibration, the model was twice verified to stressed aquifer conditions imposed by the operation of some or all of the SMC recovery wells upon the shallow and deep portions of the Cohansey Sand. This process was completed by calibrating the model to the ground water levels observed during two different periods of recovery well pumping. During the first period, April 13 to 15, 1992, recovery wells RIW2 (60 gpm), RW6D (83.5 gpm) and W9 (63 gpm) were operating. On October 14, 1992 during the second period, recovery wells Layne (48 gpm), RIW2 (115 gpm), RW6D (65 gpm), RW6S (26 gpm) and W9 (75 gpm) were operating. The model verification output for the two pumping events is included in this Appendix. Figures B-4, B-5, B-6 and B-7 indicate the results of the two-event verification process for the shallow and deep portions of the Cohansey Sand. The nodes representing the recovery wells were designated negative flux boundaries, and for each event the model was run for one day. Hydraulic conductivity and/or transmissivity values were further adjusted to provide agreement between the modeled contours and the water levels measured at the monitoring wells during the two pumping events. Due to apparent effects of stormwater infiltration from the Hudson Branch during the April 1992 observation event (Figure B-4), shallow ground water verification was not attempted for that monitoring event. At the time these model verification activities were conducted, no other complete shallow ground water data set which reflected pumping conditions was available for use in place of the April 1992 data.

Inspection of the ground water contour maps for both of the ground water extraction periods used for model verification (Figures B-4 through B-7), as well as for both of the RI ground water monitoring events (Figures 1-11 through 1-14) indicates that, for all four of these monitoring events, hydraulic control (as indicated by the establishment of an identifiable zone of capture) was not imposed upon any portion of the shallow ground water. With regard to the deep ground water, the simultaneous pumping of deep recovery wells W9 and RW6D appeared to provide effective capture of contaminated deep ground water migrating from SMC.

An additional observation is that recovery well RIW2, screened from 30 to 55 feet, appeared to influence the deep ground water during both the April 13-15, 1992 and October 14, 1992 pumping periods (Figures B-5 and B-7). The reason for this effect is not known; the RIW2 area lies approximately 1,500 feet inside the northern and eastern limits of the City of Vineland well restriction area. To allow for model verification to the apparently stressed deep ground water contours in the RIW2 area, the RIW2 extraction flux was divided evenly between the two model layers. This resulted in an acceptable match between the modeled and actual shallow and deep ground water contours in that area, for both model Verifications 1 and 2 (Figures B-4 through B-7). However, it must be emphasized that RIW2 should not be viewed as a shallow/deep recovery well. While the ground water level contours in Figures B-5 and B-7 imply the formation of a capture zone in the lower Cohansey Sand in the RIW2 area when that well is in operation, it is not viable to suggest that RIW2 imposes a zone of capture within the lower Cohansey Sand.

In light of the ARAR/TBC excesses for chromium in the deep ground water in the RIW2 area, the necessity of installing a deep extraction well at the RIW2 location should be considered. The following ground water extraction and/or discharge simulations assume the future presence of such a deep recovery well (for simplicity, referred to as RIW2 deep).

GROUND WATER EXTRACTION SIMULATIONS

After completing the two verification steps, several extraction wellfield configuration options were evaluated with respect to the goal of capturing ground water flow from areas which exhibit chromium contamination. The model outputs for the evaluated extraction scenarios are included in this Appendix. For each of the extraction scenarios, numerous evaluations were made to determine the optimum combination of extraction rates and well locations for that scenario. The resultant ground water contours, as indicated in Figures B-8 through B-21, were inspected to ensure that adequate capture was accomplished across the estimated area within each portion of the aquifer with ground water total chromium levels above ARARs. As mentioned previously, additional investigation is required in the vicinity of SC26D to further define the extent of chromium contamination in this area. Capture zones were limited to those portions of the flow regime where the water table/piezometric surface could be seen to be sloped toward an extraction well, so that ground water, flowing perpendicular to the piezometric contours, would likely be drawn into the extraction well. Therefore, the extraction well zones of capture did not include the entire zone of influence for each well. Efforts were made to provide capture of elevated contaminant areas at the nearest downgradient extraction well(s), to minimize the potential for mechanical dispersion and chemical diffusion of contaminants migrating with the bulk ground water flow from these zones. For all simulations, 25 gpm was considered the recovery rate lower limit for effective capture.

SIMULATION 1 - ALL EXISTING RECOVERY WELLS PLUS RIW2 DEEP PUMPING

For Simulation 1, the extraction rates at RIW2 deep and the five existing recovery wells were adjusted to provide the most efficient capture strategy, with a total continuous extraction rate of 400 gpm. The most optimal recovery well extraction rates under Simulation 1 consisted of the following:

RECOVERY WELL	EXTRACTION RATE (gpm)
Layne	95
RIW2	125
RIW2 deep	25
RW6D	25
RW6S	95
W9	35

The results of Simulation 1, presented in Figures B-8 and B-9, indicated that adequate capture would be provided for most of the shallow and deep contaminated ground water, to a distance of approximately 200 feet downgradient (southwest) of RIW2 in the shallow portion, and approximately 215 feet downgradient of RIW2 in the deep portion. The majority of shallow and deep ground water which exhibits inorganic and/or organic contamination at levels exceeding ARARs would lie within the shallow and/or deep downgradient capture limits imposed under Simulation 1. However, shallow chromium-contaminated ground water in the vicinity of SC3S would not be captured under this simulation. Also, the shallow ground water area including shallow monitoring wells H, L and SC23S, which exhibited elevated total chromium concentrations, would lie only within the capture zone of RIW2, located some 3,000 feet downgradient. Contaminated shallow ground water would be required to migrate an extensive distance from its source prior to capture, thereby resulting in potentially substantial contaminant dispersion and diffusion. Hydraulic control of these shallow ground water high total chromium areas closer to the potential source of the shallow ground water chromium contamination would provide for more efficient contaminated ground water extraction.

Deep monitoring well SC26D, located south of SMC, was installed after the completion of the RI; analysis of ground water samples from SC26D subsequent to its installation has indicated deep ground water contamination in the area of SC26D. The areal extent of contaminated deep ground water surrounding monitoring well SC26D has not been adequately delineated as of this report although additional investigation is planned in this area. For Simulation 1, it was not possible to include SC26D within the capture zone of any of deep recovery wells W9, RW6D or RIW2 deep. However, it appears that the area between SMC and SC26D would be hydraulically controlled, in terms of diverting and capturing deep ground water migrating from SMC toward SC26D. In that regard, further degradation of the deep ground water at SC26D would likely be minimized under Simulation 1.

SIMULATION 2 - ALL EXISTING RECOVERY WELLS PLUS RIW2 DEEP AND PROPOSED SHALLOW/DEEP RECOVERY WELL CLUSTER PUMPING

A scenario was developed featuring the installation of a shallow/deep recovery well cluster located approximately 1,000 feet downgradient (southwest) of RIW2. This cluster would be located at the southwestern corner of the 7.5-acre farmland parcel in Vineland, near SC1D (Figures B-10 and B-11). The recovery system would therefore be comprised of the five existing recovery wells plus RIW2 deep and the two proposed recovery wells (shallow well - SRW1; deep well - DRW1). Using this configuration, the continuous flow rates at the recovery wells were adjusted within a total 400 gpm extraction rate to provide the most optimal capture strategy.

The most optimal recovery well extraction rates under Simulation 2 consisted of the following:

RECOVERY WELL	EXTRACTION RATE (gpm)
Layne	75
RIW2	75
RIW2 deep	25
RW6D	25
RW6S	75
W9	25
SRW1	75
DRW1	25

The results of Simulation 2, presented in Figures B-10 and B-11, indicated that augmenting the existing recovery system with RIW2 deep and the proposed downgradient SRW1/DRW1 cluster would provide adequate capture of the majority of the shallow and most of the deep contaminated ground water, including shallow chromium-contaminated ground water in the vicinity of SC3S, to a distance of approximately 1000 feet downgradient (southwest) of RIW2 in the shallow and deep portions. However, the high total-chromium shallow ground water area including shallow monitoring wells H, L and SC23S would lie only within the capture zones of RIW2 and SRW1, located 3,000 and 4,000 feet downgradient, respectively. As with Simulation 1, extraction of this contaminated ground water via these extraction wells would potentially result in significant contaminant dispersion and diffusion. Hydraulic control of this contaminated ground water closer to its potential source area(s) would provide for more efficient ground water extraction.

For Simulation 2 it was not possible to include SC26D within the capture zone of any of deep recovery wells W9, RW6D, RIW2 deep or DRW1. However, it appears that the area between SMC and SC26D would be hydraulically controlled, in terms of diverting and capturing deep ground water migrating from SMC toward SC26D. Therefore, further degradation of the deep ground water at SC26D would likely be minimized under Simulation 2.

SIMULATION 3 - ALL EXISTING RECOVERY WELLS PLUS RIW2 DEEP PUMPING, TWO PROPOSED SHALLOW/DEEP INJECTION WELL CLUSTERS RECHARGING FOR SIX DAYS, ALL OFF SEVENTH DAY

A scenario was developed to determine whether the ground water extraction and treatment system could be shut off one day per week (e.g., for maintenance purposes) while maintaining hydraulic control of the contaminated ground water zones. This configuration featured the installation of two shallow/deep injection well clusters located approximately 850 and 1,000 feet downgradient (southwest) of RIW2 shallow/deep. These clusters would be located at the western edge of the 7.5-acre farmland parcel, along North West Street in Vineland (Figures B-12 through B-15). The recovery system would therefore be comprised of the five existing recovery wells plus RIW2 deep, two proposed shallow injection wells (SIW1 and SIW2) and two proposed deep injection wells (DIW1 and DIW2). Using this configuration, the continuous flow rates at the recovery and injection wells were adjusted within a total 400 gpm extraction rate, with the intent of providing the most optimal capture strategy while pumping, and establishing sufficient shallow and deep ground water mounding in the SC1D area to allow residual mounding to bar the migration of contaminated ground water past the downgradient capture limit during recovery system shut-off. A maximum injection capacity of 125 gpm per well was assumed, based on TRC's experience with the transmissive characteristics of the Cohansey Sand in southern New Jersey.

The most optimal well extraction/injection rates under Simulation 3 consisted of the following:

RECOVERY WELL	EXTRACTION RATE (gpm)
Layne	110
RIW2	80
RIW2 deep	50
RW6D	25
RW6S	110
W9	25

INJECTION WELL	INJECTION RATE (gpm)
SIW1	125
SIW2	125
DIW1	75
DIW2	75

The results of Simulation 3 after six days of system operation (Figures B-12 and B-13) indicated that augmenting the existing recovery system with RIW2 deep and the two shallow/deep injection well clusters would provide adequate capture during system operation of most of the shallow and deep contaminated ground water, to a distance of approximately 240 feet downgradient (southwest) of RIW2 in the shallow portion and approximately 760 feet downgradient of RIW2 in the deep portion. The majority of shallow and deep ground water which exhibits inorganic and/or organic contamination at levels exceeding ARARs would lie within the shallow and/or deep downgradient capture limits imposed under Simulation 3. However, the high total-chromium shallow ground water area including shallow monitoring wells H, L and SC23S would lie only within the capture zone of RIW2, located 3,000 downgradient. In addition, while the shallow/deep injection well clusters would help provide capture for contaminated shallow and deep ground water between RIW2 and the SC1D area, the injection mounds could laterally "push away" any contaminated ground water lying outside the capture zones. This could result in the potential spreading of contaminants to additional areas downgradient of the SMC facility.

For Simulation 3 after six days of system operation, it was not possible to include SC26D within the capture zone of any of deep recovery wells W9, RW6D or RIW2 deep. However, it appears that, at least during pumping periods, the area between SMC and SC26D would be hydraulically controlled, in terms of diverting and capturing deep ground water migrating from SMC toward SC26D. Therefore, further degradation of the deep ground water at SC26D would likely be minimized under Simulation 3.

The results of Simulation 3 after 24 hours of system shutdown (Figures B-14 and B-15) indicated that, after shutting off the recovery/injection system for 24 hours, residual mounding would remain in the deep ground water, but almost no residual mounding would remain in the shallow portion. This result is compatible with the typically high transmissivity of the upper

Cohansey Sand aquifer. It is possible that during the 24-hour system shutoff, contaminated ground water could migrate downgradient past the injection well area to the extent that a portion of the contaminant plume could be irretrievable upon resumption of the recovery/injection system.

Additional concerns should be noted regarding the use of shallow and deep injection wells which may place limits on their use at the SMC site. Historically, injection wells have had a much higher tendency to fail operationally than extraction wells (Driscoll, 1986). The consequences of water-chemistry problems, air entrainment and sand pumping are considerably more serious and common for injection wells. Clogging of screens is the most serious problem in injection well operation, and sand concentrations as low as 1 mg/l can clog injection wells within a short time. It should also be recognized that the maximum injection rates assumed for this evaluation may be high, particularly when taking into account the restrictions imposed by the limited (approximately seven feet) unsaturated zone available for the mounding pressure head in the SC1D area.

SIMULATION 4 - ALL EXISTING RECOVERY WELLS PLUS RIW2 DEEP AND TWO PROPOSED SHALLOW RECOVERY WELLS PUMPING

Simulations 1, 2 and 3 indicated that recovery well RIW2 could provide capture for high-level total chromium-contaminated shallow ground water in the vicinity of shallow monitoring wells H and SC23S. However, it is desirable to capture this shallow ground water closer to the SMC source area, to decrease the travel distance prior to capture and thus minimize the potential for contaminant dispersion and diffusion. For Simulation 4, a scenario was developed whereby two shallow recovery wells were added to the northwest of Layne (Figures B-16 and B-17); these two recovery wells, in combination with Layne, were located to provide capture of the contaminated shallow ground water in the western portion of SMC, as close to the source as possible. Shallow recovery well 1 (SRW1), approximately 565 feet northwest of Layne, would be located in the SC17S/SC17D area, and shallow recovery well 2 (SRW2), approximately 365 feet northwest of Layne, would be located on the SMC property, roughly midway between monitoring wells W4 and K.

The most optimal recovery well extraction rates under Simulation 4, based on a total extraction rate of 400 gpm, consisted of the following:

RECOVERY WELL	EXTRACTION RATE (gpm)
Layne	75
RIW2	80
RIW2 deep	25
RW6D	25
RW6S	25
W9	25
SRW1	75
SRW2	70

The results of Simulation 4, presented in Figures B-16 and B-17, indicated that adequate capture would be provided for most of the shallow and deep contaminated ground water to a distance of approximately 140 feet downgradient (southwest) of RIW2 in the shallow portion, and approximately 215 feet downgradient of RIW2 in the deep portion. The majority of shallow and deep ground water which exhibits inorganic and/or organic contamination at levels exceeding ARARs would lie within the shallow and/or deep downgradient capture limits imposed under Simulation 4, although shallow chromium-contaminated ground water in the vicinity of SC3S might not be captured under this simulation. In Figure B-16 (upper Cohansey Sand), one large, continuous capture zone is shown surrounding the SRW1/SRW2/Layne shallow recovery well group. The potential exists for some contaminated shallow ground water within this interpreted capture zone to elude capture by the SRW1/SRW2/Layne group by flowing between these wells. Therefore, the RIW2 pumping rate was adjusted until its capture zone enveloped the SRW1/SRW2/Layne capture zone. Any shallow ground water managing to flow past the SRW1/SRW2/Layne group would subsequently be captured further downgradient by RIW2. For Simulations 4, 5 and 6, shallow recovery well RW6S was pumped at 25 gpm, in order to recover shallow ground water in that area, where high total chromium concentrations were detected in the RI.

For Simulation 4, it was not possible to include SC26D within the capture zone of any of deep recovery wells W9, RW6D or RIW2 deep. However, it appears that the area between SMC and SC26D would be hydraulically controlled, in terms of diverting and capturing deep ground water migrating from SMC toward SC26D. In that regard, further degradation of the deep ground water at SC26D would likely be minimized under Simulation 4.

SIMULATION 4A - ALL EXISTING RECOVERY WELLS PLUS RIW2 DEEP AND THREE PROPOSED SHALLOW RECOVERY WELLS PUMPING

Simulation 4A was a modification to Simulation 4 which included an additional shallow recovery well, SRW3, located approximately midway between and to the northwest of shallow monitoring wells SC1S and SC3S (Figure 16A). Its function was to provide capture of shallow ground water in the vicinity of SC3S, where total chromium levels were found to exceed the MCL. The shallow recovery system, thus modified, would allow containment of this area of contaminated shallow ground water, as well as providing capture close to the source for the high-total chromium shallow ground water in the western portion of SMC. Shallow recovery wells SRW1 and SRW2 would be located as described for Simulation 4.

The most optimal recovery well extraction rates under Simulation 4A, based on a total extraction rate of 400 gpm, consisted of the following:

RECOVERY WELL	EXTRACTION RATE (gpm)
Layne	70
RIW2	40
RIW2 deep	25
RW6D	25
RW6S	25
W9	25
SRW1	70
SRW2	70
SRW3	50

The results of Simulation 4A, presented in Figures B-16A and B-17A, indicated that adequate capture would be provided for most of the shallow and deep contaminated ground water to a distance of approximately 450 feet downgradient (southwest) of RIW2 in the shallow portion, and approximately 215 feet downgradient of RIW2 in the deep portion. The majority of shallow and deep ground water which exhibits inorganic and/or organic contamination at levels exceeding ARARs would lie within the shallow and/or deep downgradient capture limits imposed under Simulation 4A. As in Simulation 4, the RIW2 pumping rate was adjusted until its capture zone enveloped the SRW1/SRW2/Layne capture zone.

For Simulation 4A, as in Simulation 4, it was not possible to include SC26D within the capture zone of any of deep recovery wells W9, RW6D or RIW2 deep. However, it appears that the area between SMC and SC26D would be hydraulically controlled, in terms of diverting and capturing deep ground water migrating from SMC toward SC26D. In that regard, further degradation of the deep ground water at SC26D would likely be minimized under Simulation 4A.

GROUND WATER EXTRACTION/DISCHARGE SIMULATIONS

Simulations 5 and 6 investigated on-site discharge of treated ground water utilizing open basins to recharge the shallow ground water. The extraction wellfield modeled in Simulation 4 was used in developing Simulations 5 and 6; however, if Simulation 4A were implemented, no significant impacts to the recharge evaluations of Simulations 5 and 6 would be expected. Additional testing would be required to define the feasibility of recharging treated ground water and the rate of recharge that is achievable at the SMC facility. For the purposes of this evaluation, the use of two recharge basins has been assumed for receiving discharge of treated ground water (Figures B-18 through B-21). One basin, approximately three acres in size and essentially an eastward extension of the existing thermal pond, is assumed to be capable of receiving treated water discharge at an approximate rate of 400 gpm for 4.5 days; the other basin, two acres in size and located on SMC-owned property along Weymouth Road in Newfield, is assumed to subsequently receive discharge for 3.0 days. Discharge of the treated ground water could be rotated between the two basins according to such a schedule.

The recharge basin locations were selected from available areas based on their positions relative to the area of shallow ground water total chromium contamination. At these two locations, shallow ground water mounding would be established outside the area of chromium-contaminated shallow ground water, to avoid the formation of a hydraulic barrier to the migration of the contaminants toward the shallow extraction wells. Instead, the establishment of shallow ground water mounds in these areas would result in increased hydraulic gradients between the mounds and the extraction wells, which could speed the flushing of shallow ground water contaminants downgradient of the mounds. A potential problem with this scenario is that the increased hydraulic gradients created by the mounds may necessitate increasing the extraction rates at the downgradient shallow recovery wells to maintain the capture zone size.

SIMULATION 5 - SIMULATION 4 PUMPING SCENARIO; 400 GPM SHALLOW RECHARGE ALTERNATING BETWEEN THERMAL POND AREA (4.5 DAYS) AND WEYMOUTH ROAD PROPERTY (3.0 DAYS)

For Simulation 5, all 400 gpm of the treated discharge was directed to the two large recharge basins discussed above. The results of Simulation 5 after 4.5 and 7.5 days are presented in Figures B-18 and B-19, respectively. Only the shallow ground water results are presented; the deep recovery well pumping rates simulated were the same as those for Simulation 4, and the shallow ground water mounding did not result in any discernable modeled hydraulic impact upon the deep ground water. Figures B-18 and B-19 indicate that adequate capture would be provided for most of the shallow contaminated ground water to a distance of approximately 150 feet downgradient (southwest) of RIW2 in the shallow portion, after both 4.5 and 7.5 days. The majority of shallow and deep ground water which exhibits inorganic and/or organic contamination at levels exceeding ARARs would lie within the shallow and/or deep downgradient capture limits imposed under Simulation 5. As in Simulation 4, the RIW2 pumping rate was adjusted until its capture zone enveloped the SRW1/SRW2/Layne capture zone.

For Simulation 5, as in Simulation 4, it was not possible to include SC26D within the capture zone of any of deep recovery wells W9, RW6D or RIW2 deep. However, it appears that the area between SMC and SC26D would be hydraulically controlled, in terms of diverting and capturing deep ground water migrating from SMC toward SC26D. In that regard, further degradation of the deep ground water at SC26D would likely be minimized under Simulation 5.

SIMULATION 6 - SIMULATION 4 PUMPING SCENARIO; 350 GPM SHALLOW RECHARGE ALTERNATING AS PER SIMULATION 5, 50 GPM SHALLOW RECHARGE AT LAGOONS B6, B7 AND B8

For Simulation 6, most of the treated discharge was directed to the two large recharge basins; in addition, a portion of the treated discharge was directed to SMC Lagoons B6, B7 and B8, assuming the lagoons have been closed in accordance with applicable regulations. The intent of discharging into the lagoons was to enhance the flushing of chromium in the shallow ground water downgradient of the lagoons. Recharge via the lagoons was adjusted so that the maximum amount of water could be discharged while avoiding the formation of a radial mound downgradient of the lagoons. The maximum recharge rate via the lagoons was determined to be 50 gpm. The remaining 350 gpm of treated discharge would be rotated between the recharge basins according to the schedule determined for Simulation 5.

The results of Simulation 6 after 4.5 and 7.5 days are presented in Figures B-20 and B-21, respectively. As in Simulation 5, the deep recovery well pumping rates simulated were the same as those for Simulation 4, and the shallow ground water mounding did not result in any discernable modeled hydraulic impact upon the deep ground water; therefore, only the shallow ground water results are presented. Figures B-20 and B-21 indicate that adequate capture would be provided for most of the shallow contaminated ground water to a distance of approximately 140 feet downgradient (southwest) of RIW2 in the shallow portion after 4.5 days, and approximately 150 feet downgradient of RIW2 after 7.5 days. The majority of shallow and deep ground water which exhibits inorganic and/or organic contamination at levels exceeding ARARs would lie within the shallow and/or deep downgradient capture limits imposed under Simulation 6. As in Simulations 4 and 5, the RIW2 pumping rate was adjusted until its capture zone enveloped the SRW1/SRW2/Layne capture zone.

For Simulation 6, as in Simulations 4 and 5, it was not possible to include SC26D within the capture zone of any of deep recovery wells W9, RW6D or RIW2 deep. However, it appears that the area between SMC and SC26D would be hydraulically controlled, in terms of diverting and capturing deep ground water migrating from SMC toward SC26D. In that regard, further degradation of the deep ground water at SC26D would likely be minimized under Simulation 6.

SENSITIVITY ANALYSES

The sensitivity of the calibrated and verified model was evaluated by changing the values for certain important boundary and initial conditions. The extent to which varying a parameter affected the simulated response was a measure of the sensitivity of the model to uncertainty in that aquifer characteristic. Using the input data set for model Simulation 4A, three input parameters, the total extraction flow rate, the hydraulic conductivity and the interlayer vertical leakage, were varied separately. The modeled results, in terms of the impacts on the upper and lower Cohansey Sand flow regimes and capture zones, were then evaluated.

SENSITIVITY ANALYSIS 1 - TOTAL EXTRACTION RATE = 440 GPM

The first sensitivity analysis examined the effect of raising the 400 gpm total design extraction rate by 10 percent, to 440 gpm. An additional 10 percent of extraction flow was added to each of the recovery wells proposed under Simulation 4A. The recovery well extraction rates for this analysis thus consisted of the following:

RECOVERY WELL	EXTRACTION RATE (gpm)
Layne	77
RIW2	44
RIW2 deep	27.5
RW6D	27.5
RW6S	27.5
W9	27.5
SRW1	77
SRW2	77
SRW3	55

The results of Sensitivity Analysis 1, presented in Figures B-22 and B-23, indicate that the Simulation 4A shallow and deep ground water capture zones would be minimally influenced by the additional 10 percent of extraction flow. The area of capture in the immediate vicinity of each recovery well broadened somewhat but, upgradient of the recovery wells, the widths of the capture zones did not increase. Increasing the extraction flow rate did not result in a change in the capture zone limit relative to deep monitoring well SC26D. The increase in the capture zones was limited by the high transmissivity of the Cohansey Sand.

SENSITIVITY ANALYSIS 2A - HYDRAULIC CONDUCTIVITY X 0.5
SENSITIVITY ANALYSIS 2B - HYDRAULIC CONDUCTIVITY X 2

Sensitivity Analysis 2 evaluated the effect of alternately halving (Analysis 2A) and doubling (Analysis 2B) the nodal hydraulic conductivity (Layer 1) or transmissivity (Layer 2) values. The results of Sensitivity Analysis 2A, presented in Figures B-24 and B-25, indicate that at half the hydraulic conductivity/transmissivity, the Simulation 4A shallow and deep ground water capture zones would be broadened, both in the immediate vicinity of each of the recovery wells as well as upgradient. While the shallow ground water capture zones determined from Simulation 4A reached a near-constant maximum width prior to their exiting the model at the upgradient edge, the shallow capture zones from Sensitivity Analysis 2A (Figure B-24) continue to broaden as they exit the modeled area. The results of Sensitivity Analysis 2B, presented in Figures B-26 and B-27, indicated that at double the hydraulic conductivity/transmissivity, the Simulation 4A shallow and deep ground water capture zones would be substantially diminished in lateral extent, and would reach their near-maximum width only a short distance upgradient from each recovery well. In the shallow ground water (Figure B-26), SRW1, SRW2 and

Layne do not appear to create a continuous zone of capture, allowing the possibility for throughflow between SRW2 and Layne. The capture zone imposed by shallow recovery well SRW3 would no longer envelop those created by SRW1, SRW2 and Layne. It can therefore be concluded from Sensitivity Analysis 2 that the model is very sensitive to changes made to the input hydraulic conductivity/transmissivity.

<u>SENSITIVITY ANALYSIS 3A - INTERLAYER VERTICAL LEAKAGE X 0.5</u>
<u>SENSITIVITY ANALYSIS 3B - INTERLAYER VERTICAL LEAKAGE X 2</u>

Sensitivity Analysis 3 evaluated the effect of alternately halving (Analysis 3A) and doubling (Analysis 3B) the model interlayer leakage value. The results of Sensitivity Analysis 3A, presented in Figures B-28 and B-29, indicate that at half the interlayer leakage, the Simulation 4A shallow and deep ground water capture zones would not be impacted.

The results of Sensitivity Analysis 3B, presented in Figures B-30 and B-31, indicate that at double the interlayer leakage the Simulation 4A shallow ground water capture zones would not be impacted, and the deep ground water capture zones would be only slightly diminished in lateral extent. Pumping from the deep ground water recovery wells would result in slightly less drawdown (i.e., tenths of a foot) in the deep ground water in the immediate vicinity of each well. It can therefore be concluded from Sensitivity Analysis 3 that the model is only slightly sensitive to changes made to the input interlayer vertical leakage; its impact upon the extent of the capture zones is substantially less than that of the model hydraulic conductivity/transmissivity.

SUMMARY OF SENSITIVITY ANALYSES

From the sensitivity analyses performed on the Simulation 4A data set, the following conclusions can be drawn. First, increasing the total extraction flow rate may slightly broaden the capture zone in the immediate vicinity of a well; however, owing to the high transmissivity of the Cohansey Sand, it does not produce a corresponding increase in the upgradient lateral extent of the capture zone. Second, the model appears to be highly sensitive to variations in the nodal hydraulic conductivity/transmissivity values. Wherever possible, the input hydraulic parameters were held close to the values determined by TRC from the DRAI 1988/89 pump test data. While a certain degree of error may be associated with the input hydraulic parameters, it is felt that the close matches produced from both the steady-state calibration and the two stressed-aquifer verifications provide support for the model input hydraulic data. Finally, the model appears to be only minimally sensitive to variations in the interlayer vertical leakage. This parameter was adjusted only during the model calibration, with no further adjustment required for subsequent verifications. This indicates that the simulated interlayer communication for the two-layer representation of the upper and lower Cohansey Sand is adequately quantified.

CONCLUSIONS

The computer models described herein were used for the purpose of modifying the design of the SMC ground water extraction system to provide more effective capture of contaminated ground water at and/or emanating from the site for treatment, and to provide a basis upon which to conduct a detailed evaluation of ground water extraction within the main body of this FFS. Based on the simulation results summarized above, Simulation 1, which utilizes the existing recovery wells to the greatest extent, and Simulation 4A, which implements the installation of new extraction wells, were selected for detailed analysis under Alternative 3. These scenarios optimize the extraction of chromium-contaminated ground water at an extraction rate of 400 gpm, and are presented as Ground Water Extraction Options E1 and E2 in Sections 5.3.4 and 5.3.5, respectively. The extent of chromium contamination in the vicinity of well SC26D and in the vicinity of well IW2 will be investigated further. Additional ground water modeling will be conducted during the design phase to evaluate the effects of using different modeling packages, parameters, and boundary conditions. The final location of recovery wells and determination of extraction rates required to control and capture ground water contamination at and/or emanating from the SMC facility will be refined as additional information is developed.

APPENDIX B - REFERENCES

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1                       U.S. GEOLOGICAL SURVEY MODULAR FINITE-DIFFERENCE GROUND-WATER MODEL
 SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     CALIBRATION TO STEADY-STATE CONDITIONS 10/12/92
   2 LAYERS        35 ROWS        16 COLUMNS
   1 STRESS PERIOD(S) IN SIMULATION
 MODEL TIME UNIT IS DAYS
0I/O UNITS:
 ELEMENT OF IUNIT:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
        I/O UNIT: 11  0  0  0  0  0  0  0 19  0  0 22  0  0  0  0  0  0  0  0  0  0  0  0
0BAS1 -- BASIC MODEL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT  1
 ARRAYS RHS AND BUFF WILL SHARE MEMORY.
 START HEAD WILL BE SAVED
    10699 ELEMENTS IN X ARRAY ARE USED BY BAS
    10699 ELEMENTS OF X ARRAY USED OUT OF  100000
0BCF1 -- BLOCK-CENTERED FLOW PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 11
 STEADY-STATE SIMULATION
      LAYER  AQUIFER TYPE
      -------------------
         1        1
         2        0
     1122 ELEMENTS IN X ARRAY ARE USED BY BCF
    11821 ELEMENTS OF X ARRAY USED OUT OF  100000
0SIP1 -- STRONGLY IMPLICIT PROCEDURE SOLUTION PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 19
 MAXIMUM OF  50 ITERATIONS ALLOWED FOR CLOSURE
  5 ITERATION PARAMETERS
     4685 ELEMENTS IN X ARRAY ARE USED BY SIP
    16506 ELEMENTS OF X ARRAY USED OUT OF  100000
1SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     CALIBRATION TO STEADY-STATE CONDITIONS 10/12/92
0
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BOUNDARY ARRAY FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
0 2	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 3	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 4	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 5	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 6	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 7	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 8	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 9	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
10	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
11	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
12	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 13	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 14	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 15	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 16	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 17	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 18	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 19	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 20	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 21	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 22	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 23	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 24	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 25	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 26	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 27	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 28	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 29	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 30	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 31	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 32	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 33	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 34	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 35	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

0

BOUNDARY ARRAY FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
0 2	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 3	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 4	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2

0 5	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 6	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 7	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 8	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 9	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 10	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 11	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 12	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 13	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 14	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 15	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 16	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 17	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 18	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 19	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 20	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 21	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 22	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 23	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 24	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 25	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 26	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 27	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 28	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 29	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 30	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 31	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 32	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 33	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 34	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 35	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2

0AQUIFER HEAD WILL BE SET TO 999.99 AT ALL NO-FLOW NODES (IBOUND=0).
0

INITIAL HEAD FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1 11	2 12	3 13	4 14	5 15	6 16	7	8	9	10
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90
	94.00	94.10	94.20	94.30	94.40	94.50				
0 2	92.40	92.60	92.70	92.80	92.90	93.00	93.20	93.30	93.40	93.50
	93.60	93.70	93.80	93.80	93.90	94.00				
0 3	92.00	92.20	92.30	92.40	92.50	92.70	92.80	92.90	93.00	93.10
	93.20	93.20	93.30	93.40	93.50	93.50				
0 4	91.60	91.80	91.90	92.00	92.20	92.30	92.40	92.50	92.60	92.70
	92.80	92.80	92.90	92.90	93.00	93.10				
0 5	91.20	91.40	91.50	91.60	91.80	91.90	92.00	92.10	92.20	92.30
	92.40	92.40	92.40	92.50	92.60	92.60				
0 6	90.70	90.90	91.00	91.20	91.40	91.50	91.60	91.70	91.80	91.90
	91.90	92.00	92.00	92.10	92.10	92.10				
0 7	90.20	90.40	90.60	90.70	90.90	91.00	91.10	91.20	91.30	91.40
	91.50	91.50	91.60	91.60	91.60	91.60				
0 8	89.70	89.90	90.10	90.30	90.40	90.50	90.60	90.70	90.80	90.90
	91.00	91.00	91.10	91.10	91.10	91.10				
0 9	89.40	89.50	89.70	89.80	90.00	90.10	90.20	90.30	90.30	90.40
	90.50	90.50	90.60	90.60	90.60	90.50				
0 10	89.00	89.20	89.30	89.40	89.50	89.60	89.70	89.80	89.90	89.90
	90.00	90.00	90.00	90.00	90.00	90.00				
0 11	88.70	88.80	88.90	89.00	89.10	89.20	89.30	89.40	89.40	89.50
	89.50	89.60	89.60	89.60	89.50	89.50				
0 12	88.30	88.40	88.60	88.70	88.80	88.90	88.90	89.00	89.00	89.10
	89.10	89.10	89.10	89.10	89.10	89.10				
0 13	88.00	88.10	88.20	88.30	88.40	88.50	88.60	88.60	88.70	88.70
	88.70	88.70	88.70	88.70	88.70	88.60				
0 14	87.70	87.80	87.90	88.00	88.10	88.10	88.20	88.20	88.30	88.30
	88.30	88.30	88.30	88.30	88.30	88.20				
0 15	87.50	87.60	87.60	87.70	87.70	87.80	87.80	87.90	87.90	87.90
	87.90	87.90	87.90	87.90	87.90	87.90				
0 16	87.30	87.30	87.30	87.30	87.40	87.40	87.50	87.50	87.50	87.60
	87.60	87.60	87.60	87.60	87.50	87.50				
0 17	87.00	86.90	87.00	87.00	87.00	87.10	87.10	87.20	87.20	87.20
	87.20	87.20	87.20	87.20	87.20	87.20				
0 18	86.50	86.50	86.60	86.60	86.70	86.70	86.80	86.80	86.80	86.80
	86.80	86.80	86.80	86.80	86.80	86.90				
0 19	86.00	86.10	86.20	86.30	86.40	86.40	86.40	86.50	86.50	86.50
	86.50	86.50	86.40	86.40	86.40	86.40				
0 20	85.60	85.70	85.80	85.90	86.00	86.00	86.00	86.10	86.10	86.10
	86.10	86.00	86.00	85.90	85.90	85.90				
0 21	85.10	85.20	85.30	85.40	85.50	85.50	85.60	85.60	85.60	85.60

Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
											85.50	85.50	85.40	85.30	85.20	85.10
0 22	84.70	84.80	84.90	84.90	85.00	85.00	85.00	85.10	85.00	85.00	85.00	84.90	84.80	84.70	84.60	84.50
23	84.20	84.30	84.40	84.50	84.50	84.50	84.50	84.50	84.50	84.50	84.40	84.40	84.30	84.20	84.00	83.80
0 24	83.80	83.90	84.00	84.00	84.00	84.10	84.10	84.00	84.00	84.00	83.90	83.80	83.80	83.60	83.40	83.30
0 25	83.50	83.50	83.50	83.60	83.60	83.60	83.60	83.60	83.50	83.50	83.40	83.30	83.20	83.10	82.90	82.80
0 26	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.00	83.00	82.90	82.80	82.70	82.60	82.40	82.30
0 27	82.70	82.70	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.50	82.40	82.40	82.20	82.10	82.00	81.90
0 28	82.20	82.20	82.20	82.20	82.20	82.20	82.20	82.10	82.10	82.00	82.00	81.90	81.80	81.70	81.50	81.40
0 29	81.80	81.80	81.80	81.80	81.70	81.70	81.70	81.70	81.60	81.60	81.50	81.40	81.30	81.20	81.10	81.00
0 30	81.30	81.30	81.30	81.30	81.30	81.30	81.30	81.20	81.20	81.10	81.10	81.00	80.90	80.80	80.70	80.60
0 31	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.70	80.70	80.60	80.50	80.40	80.30	80.30	80.20
0 32	80.30	80.40	80.40	80.40	80.40	80.40	80.40	80.30	80.30	80.20	80.20	80.10	80.00	79.90	79.80	79.70
0 33	79.90	79.90	79.90	80.00	80.00	80.00	79.90	79.90	79.90	79.80	79.70	79.70	79.60	79.50	79.40	79.30
0 34	79.40	79.40	79.50	79.50	79.50	79.50	79.50	79.50	79.50	79.40	79.30	79.20	79.10	79.00	78.90	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

0

INITIAL HEAD FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	92.10
0 2	90.90	91.00	91.10	91.10	91.20	91.30	91.40	91.40	91.50	91.50	91.60	91.60	91.70	91.70	91.80	91.80
0 3	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.20	91.20	91.30	91.30	91.30	91.40	91.40	91.40	91.40
0 4	90.40	90.50	90.50	90.60	90.70	90.70	90.80	90.90	90.90	91.00	91.00	91.00	91.10	91.10	91.10	91.10
5	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.70	90.70	90.70	90.70	90.70	90.70	90.70
0 6	89.80	89.90	90.00	90.00	90.10	90.20	90.20	90.30	90.30	90.30	90.40	90.40	90.40	90.40	90.40	90.30
0 7	89.50	89.60	89.70	89.80	89.80	89.90	89.90	90.00	90.00	90.00	90.10	90.10	90.10	90.10	90.00	90.00
0 8	89.20	89.30	89.40	89.50	89.50	89.60	89.60	89.70	89.70	89.70	89.70	89.70	89.70	89.70	89.70	89.70
0 9	89.00	89.10	89.10	89.20	89.30	89.30	89.30	89.40	89.40	89.40	89.40	89.40	89.40	89.40	89.30	89.30
0 10	88.70	88.80	88.90	88.90	89.00	89.00	89.00	89.10	89.10	89.10	89.10	89.10	89.00	89.00	89.00	89.00
0 11	88.50	88.60	88.60	88.60	88.70	88.70	88.70	88.80	88.80	88.80	88.70	88.70	88.70	88.70	88.60	88.50
0 12	88.30	88.30	88.30	88.40	88.40	88.40	88.50	88.50	88.50	88.40	88.40	88.40	88.40	88.30	88.20	88.10
0 13	88.10	88.10	88.10	88.10	88.10	88.10	88.20	88.20	88.20	88.10	88.10	88.10	88.00	88.00	87.90	87.80
0 14	87.80	87.80	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.80	87.80	87.70	87.70	87.60	87.60	87.50
0 15	87.50	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.60	87.50	87.40	87.30	87.30	87.20	87.20
0 16	87.10	87.10	87.20	87.20	87.30	87.30	87.30	87.30	87.20	87.20	87.10	87.00	87.00	86.90	86.90	86.90
0 17	86.80	86.80	86.80	86.90	86.90	86.90	86.90	86.80	86.80	86.80	86.70	86.70	86.60	86.60	86.50	86.50
0 18	86.40	86.40	86.50	86.50	86.50	86.50	86.40	86.40	86.40	86.40	86.30	86.30	86.20	86.20	86.20	86.20
0 19	86.10	86.10	86.10	86.10	86.10	86.00	86.00	86.00	86.00	85.90	85.90	85.90	85.80	85.80	85.80	85.80
0 20	85.70	85.80	85.80	85.70	85.70	85.60	85.60	85.60	85.60	85.50	85.50	85.50	85.40	85.40	85.40	85.40
0 21	85.30	85.30	85.30	85.30	85.30	85.20	85.20	85.20	85.10	85.10	85.10	85.10	85.00	85.00	85.00	85.00
0 22	84.90	84.90	84.90	84.90	84.80	84.80	84.80	84.80	84.70	84.70	84.70	84.60	84.60	84.60	84.60	84.50

Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 23	84.40	84.40	84.40	84.40	84.40	84.40	84.30	84.30	84.30	84.30	84.20	84.20	84.20	84.20	84.10	84.10
0 24	84.00	84.00	84.00	84.00	84.00	83.90	83.90	83.90	83.90	83.90	83.80	83.80	83.80	83.80	83.70	83.70
0 25	83.60	83.60	83.60	83.50	83.50	83.50	83.50	83.50	83.40	83.40	83.40	83.40	83.40	83.40	83.30	83.30
0 26	83.20	83.20	83.10	83.10	83.10	83.10	83.10	83.00	83.00	83.00	83.00	83.00	83.00	82.90	82.90	82.90
0 27	82.80	82.80	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.60	82.50	82.50	82.50	82.50	82.50	82.50
0 28	82.30	82.30	82.30	82.30	82.20	82.20	82.20	82.20	82.20	82.10	82.10	82.10	82.10	82.10	82.00	82.00
0 29	81.90	81.90	81.90	81.80	81.80	81.80	81.80	81.70	81.70	81.70	81.70	81.60	81.60	81.60	81.60	81.60
0 30	81.50	81.50	81.40	81.40	81.40	81.40	81.30	81.30	81.30	81.30	81.20	81.20	81.20	81.20	81.20	81.20
0 31	81.00	81.00	81.00	81.00	80.90	80.90	80.90	80.90	80.90	80.80	80.80	80.80	80.80	80.70	80.70	80.70
0 32	80.60	80.60	80.60	80.50	80.50	80.50	80.50	80.40	80.40	80.40	80.40	80.30	80.30	80.30	80.30	80.30
0 33	80.20	80.20	80.10	80.10	80.10	80.10	80.00	80.00	80.00	80.00	79.90	79.90	79.90	79.90	79.80	79.80
0 34	79.70	79.70	79.70	79.70	79.60	79.60	79.60	79.60	79.60	79.50	79.50	79.50	79.40	79.40	79.40	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

0HEAD PRINT FORMAT IS FORMAT NUMBER 4 DRAWDOWN PRINT FORMAT IS FORMAT NUMBER 9
0HEADS WILL BE SAVED ON UNIT 30 DRAWDOWNS WILL BE SAVED ON UNIT 40
0OUTPUT CONTROL IS SPECIFIED EVERY TIME STEP
0 COLUMN TO ROW ANISOTROPY = 1.000000
0 DELR = 200.0000
0 DELC = 200.0000
0

HYD. COND. ALONG ROWS FOR LAYER 1 WILL BE READ ON UNIT 11 USING FORMAT: (16F4.0)

Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0
0 2	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0
0 3	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0
0 4	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0
0 5	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0
0 6	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0	300.0
0 7	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0	300.0
0 8	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0
0 9	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0
0 10	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0
0 11	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 12	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 13	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 14	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 15	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 16	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 17	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 18	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 19	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 20	300.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	300.0
0 21	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0						

	150.0	150.0	175.0	175.0	175.0	300.0				
22	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	175.0	175.0	175.0	300.0				
23	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	175.0	175.0	175.0	300.0				
0 24	300.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	175.0	175.0	175.0	300.0				
0 25	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 26	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 27	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 28	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 29	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 30	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 31	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 32	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 33	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 34	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 35	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				

0 BOTTOM = 30.00000 FOR LAYER 1

0 VERT HYD COND /THICKNESS = .1000000E-02 FOR LAYER 1

0

TRANSMIS. ALONG ROWS FOR LAYER 2 WILL BE READ ON UNIT 11 USING FORMAT: (16F5.0)

	1 11	2 12	3 13	4 14	5 15	6 16	7	8	9	10
0 1	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.
	5000.	5000.	5000.	5000.	5000.	5000.				
0 2	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.
	5000.	5000.	5000.	5000.	5000.	5000.				
3	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.
	5000.	5000.	5000.	5000.	5000.	5000.				
4	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.
	5000.	5000.	5000.	5000.	5000.	5000.				
0 5	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.
	5000.	5000.	5000.	5000.	5000.	5000.				
0 6	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.
	5000.	5000.	5000.	5000.	5000.	5000.				
0 7	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.
	5000.	5000.	5000.	5000.	5000.	5000.				
0 8	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.
	5000.	5000.	5000.	5000.	5000.	5000.				
0 9	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.
	5000.	5000.	5000.	5000.	5000.	5000.				
0 10	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.
	5000.	5000.	5000.	5000.	5000.	5000.				
0 11	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.
	5000.	5000.	5000.	5000.	5000.	5000.				
0 12	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.
	5000.	5000.	5000.	5000.	5000.	5000.				
0 13	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.
	5000.	5000.	5000.	5000.	5000.	5000.				
0 14	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.
	5000.	5000.	5000.	5000.	5000.	5000.				
0 15	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.	5000.
	5000.	5000.	5000.	5000.	5000.	5000.				
0 16	5000.	5000.	5000.	5000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	5000.	5000.	5000.	5000.	5000.				
0 17	5000.	5000.	5000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	5000.	5000.	5000.	5000.	5000.				
0 18	5000.	5000.	5000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	5000.	5000.	5000.	5000.	5000.				
0 19	3000.	5000.	5000.	3000.	3000.	3000.	3000.	3000.	3300.	3000.
	3000.	5000.	5000.	5000.	5000.	5000.				
0 20	3000.	5000.	5000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	5000.	5000.	5000.	5000.	5000.				
0 21	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	5000.	5000.	5000.	5000.	5000.				

```
0 22    3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      5000.      5000.      5000.      5000.      5000.
0 23    3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      5000.      5000.      5000.      5000.      5000.
0 24    3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      5000.      5000.      5000.      5000.      5000.
0 25    5000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      5000.      5000.      5000.      5000.      5000.
0 26    5000.      3000.      3000.      3300.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      4000.      4000.      5000.      5000.      5000.
0 27    5000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      4000.      4000.      5000.      5000.      5000.
0 28    5000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      4000.      4000.      5000.      5000.      5000.
0 29    5000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      4000.      4000.      5000.      5000.      5000.
0 30    5000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      4000.      4000.      5000.      5000.      5000.
0 31    5000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      4000.      4000.      5000.      5000.      5000.
0 32    5000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      4000.      4000.      5000.      5000.      5000.
0 33    5000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      4000.      4000.      5000.      5000.      5000.
0 34    5000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      4000.      4000.      5000.      5000.      5000.
0 35    5000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      4000.      4000.      5000.      5000.      5000.
0

                                                               SOLUTION BY THE STRONGLY IMPLICIT PROCEDURE
                                                               -------------------------------------------
0                                                      MAXIMUM ITERATIONS ALLOWED FOR CLOSURE =        50
                                                                       ACCELERATION PARAMETER =      1.0000
                                                           HEAD CHANGE CRITERION FOR CLOSURE =     .10000E-02
                                                           SIP HEAD CHANGE PRINTOUT INTERVAL =         1
0                                                          CALCULATE ITERATION PARAMETERS FROM MODEL CALCULATED WSEED
1                                                         STRESS PERIOD NO.    1, LENGTH =   365.0000
                                                          ----------------------------------------------

                                                          NUMBER OF TIME STEPS =      1

                                                           MULTIPLIER FOR DELT =      1.000

                                                        INITIAL TIME STEP SIZE =   365.0000
0AVERAGE SEED =  .00187355
 MINIMUM SEED =  .00128278
0
    5 ITERATION PARAMETERS CALCULATED FROM AVERAGE SEED:

             .0000000E+00    .7919507E+00    .9567155E+00    .9909947E+00    .9981264E+00
0
     6 ITERATIONS FOR TIME STEP    1 IN STRESS PERIOD  1
0MAXIMUM HEAD CHANGE FOR EACH ITERATION:
0 HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL
 ------------------------------------------------------------------------------------------------------------------------------------
   .6174E-01 (  2, 13,  6)  -.1536E-01 (  2, 19,  4)  -.6745E-02 (  1,  6, 11)  -.4741E-02 (  2, 14, 10)  -.2386E-02 (  1, 12, 10)
   .6279E-03 (  1, 15, 12)
0
0HEAD/DRAWDOWN PRINTOUT FLAG = 1     TOTAL BUDGET PRINTOUT FLAG = 1     CELL-BY-CELL FLOW TERM FLAG = 0
0OUTPUT FLAGS FOR EACH LAYER:
          HEAD    DRAWDOWN  HEAD  DRAWDOWN
 LAYER  PRINTOUT  PRINTOUT  SAVE    SAVE
 ----------------------------------------
    1       1         1       1       1
    2       1         1       1       1
1                     HEAD IN LAYER  1 AT END OF TIME STEP  1 IN STRESS PERIOD  1
                  ---------------------------------------------------------------------

           1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          16
 ...................................................................................................................................
0  1    92.90   93.00   93.10   93.20   93.30   93.40   93.60   93.70   93.80   93.90   94.00   94.10   94.20   94.30   94.40
        94.50
0  2    92.40   92.56   92.69   92.80   92.92   93.04   93.17   93.29   93.39   93.49   93.58   93.67   93.76   93.84   93.92
        94.00
0  3    92.00   92.15   92.28   92.41   92.53   92.65   92.77   92.88   92.98   93.08   93.16   93.24   93.32   93.39   93.46
        93.50
0  4    91.60   91.75   91.89   92.02   92.15   92.27   92.39   92.49   92.59   92.68   92.75   92.82   92.88   92.94   93.01
        93.10
0  5    91.20   91.35   91.50   91.64   91.77   91.90   92.01   92.11   92.21   92.29   92.35   92.39   92.44   92.49   92.55
```

92.60

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
6	90.70	90.89	91.06	91.21	91.35	91.47	91.58	91.68	91.77	91.85	91.92	91.96	92.01	92.05	92.08	92.10
7	90.20	90.39	90.58	90.74	90.87	90.99	91.10	91.20	91.29	91.37	91.45	91.53	91.57	91.60	91.62	91.60
0 8	89.70	89.93	90.12	90.28	90.41	90.53	90.63	90.73	90.81	90.89	90.96	91.04	91.09	91.11	91.11	91.10
0 9	89.40	89.54	89.70	89.84	89.97	90.08	90.18	90.26	90.34	90.41	90.47	90.52	90.55	90.57	90.55	90.50
0 10	89.00	89.15	89.29	89.42	89.54	89.64	89.73	89.81	89.88	89.93	89.98	90.02	90.04	90.04	90.03	90.00
0 11	88.70	88.80	88.92	89.03	89.14	89.23	89.31	89.38	89.44	89.49	89.53	89.56	89.57	89.57	89.55	89.50
0 12	88.30	88.44	88.57	88.68	88.77	88.85	88.93	88.99	89.04	89.09	89.12	89.14	89.14	89.13	89.11	89.10
0 13	88.00	88.12	88.23	88.33	88.41	88.49	88.55	88.61	88.65	88.69	88.71	88.73	88.73	88.71	88.67	88.60
0 14	87.70	87.82	87.91	87.99	88.06	88.13	88.18	88.23	88.27	88.30	88.32	88.33	88.33	88.31	88.27	88.20
0 15	87.50	87.55	87.60	87.66	87.72	87.78	87.82	87.87	87.90	87.92	87.94	87.94	87.94	87.93	87.91	87.90
0 16	87.30	87.27	87.29	87.33	87.38	87.43	87.47	87.50	87.53	87.55	87.56	87.56	87.56	87.55	87.54	87.50
0 17	87.00	86.94	86.96	86.99	87.04	87.08	87.12	87.15	87.17	87.19	87.19	87.19	87.19	87.18	87.19	87.20
0 18	86.50	86.54	86.59	86.64	86.70	86.74	86.78	86.80	86.82	86.83	86.83	86.82	86.81	86.81	86.83	86.90
0 19	86.00	86.13	86.23	86.30	86.36	86.40	86.44	86.46	86.48	86.48	86.47	86.45	86.43	86.41	86.40	86.40
0 20	85.60	85.70	85.80	85.88	85.96	86.01	86.05	86.07	86.07	86.07	86.05	86.01	85.96	85.91	85.88	85.90
0 21	85.10	85.22	85.32	85.40	85.48	85.53	85.56	85.57	85.57	85.55	85.52	85.47	85.39	85.31	85.22	85.10
0 22	84.70	84.77	84.85	84.93	84.98	85.02	85.04	85.05	85.04	85.01	84.97	84.90	84.82	84.73	84.60	84.50
0 23	84.20	84.31	84.40	84.47	84.50	84.53	84.54	84.54	84.52	84.48	84.43	84.36	84.27	84.16	83.99	83.80
0 24	83.80	83.88	83.97	84.02	84.04	84.05	84.05	84.04	84.01	83.97	83.92	83.84	83.76	83.63	83.44	83.30
0 25	83.50	83.50	83.54	83.56	83.57	83.57	83.57	83.55	83.52	83.47	83.41	83.33	83.24	83.10	82.93	82.80
0 26	83.10	83.09	83.10	83.11	83.11	83.11	83.09	83.07	83.03	82.98	82.92	82.83	82.73	82.59	82.44	82.30
0 27	82.70	82.67	82.66	82.66	82.65	82.64	82.62	82.60	82.56	82.50	82.43	82.35	82.24	82.12	81.99	81.90
28	82.20	82.21	82.21	82.21	82.20	82.18	82.16	82.13	82.09	82.03	81.96	81.88	81.77	81.65	81.52	81.40
0 29	81.80	81.77	81.76	81.75	81.74	81.73	81.71	81.67	81.63	81.57	81.50	81.42	81.32	81.21	81.09	81.00
0 30	81.30	81.30	81.30	81.30	81.29	81.28	81.26	81.22	81.18	81.12	81.05	80.97	80.87	80.77	80.67	80.60
0 31	80.80	80.82	80.83	80.84	80.84	80.83	80.81	80.78	80.74	80.68	80.61	80.53	80.43	80.33	80.25	80.20
0 32	80.30	80.35	80.37	80.39	80.40	80.39	80.37	80.34	80.30	80.24	80.17	80.09	80.00	79.89	79.79	79.70
0 33	79.90	79.90	79.92	79.95	79.96	79.95	79.94	79.92	79.88	79.82	79.74	79.66	79.56	79.46	79.36	79.30
0 34	79.40	79.44	79.47	79.51	79.52	79.53	79.52	79.50	79.47	79.40	79.32	79.23	79.13	79.02	78.91	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

1 HEAD IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	92.10
0 2	90.90	90.97	91.05	91.14	91.22	91.28	91.35	91.43	91.50	91.54	91.60	91.63	91.68	91.71	91.76	91.80
0 3	90.60	90.71	90.80	90.88	90.95	91.02	91.08	91.15	91.21	91.26	91.30	91.34	91.37	91.39	91.41	91.40
0 4	90.40	90.46	90.53	90.61	90.68	90.74	90.80	90.86	90.91	90.96	91.00	91.03	91.05	91.07	91.08	91.10
0 5	90.10	90.18	90.25	90.33	90.40	90.46	90.52	90.57	90.62	90.65	90.68	90.71	90.72	90.73	90.72	90.70
0 6	89.80	89.89	89.97	90.04	90.11	90.17	90.22	90.27	90.31	90.34	90.37	90.38	90.39	90.39	90.36	90.30
0 7	89.50	89.60	89.68	89.76	89.82	89.88	89.93	89.97	90.00	90.03	90.05	90.06	90.06	90.05	90.03	90.00
0 8	89.20	89.32	89.40	89.47	89.53	89.58	89.63	89.66	89.69	89.71	89.72	89.73	89.72	89.71	89.70	

	89.70														
0 9	89.00	89.06	89.13	89.19	89.25	89.29	89.33	89.36	89.38	89.39	89.40	89.39	89.38	89.36	89.34
	89.30														
0 10	88.70	88.79	88.86	88.92	88.96	89.00	89.03	89.05	89.07	89.07	89.07	89.06	89.04	89.01	88.
	89.00														
0 11	88.50	88.55	88.60	88.64	88.68	88.71	88.74	88.75	88.76	88.76	88.74	88.72	88.69	88.65	88.59
	88.50														
0 12	88.30	88.32	88.34	88.37	88.40	88.43	88.44	88.45	88.45	88.44	88.42	88.39	88.35	88.29	88.22
	88.10														
0 13	88.10	88.07	88.07	88.10	88.12	88.14	88.16	88.16	88.15	88.14	88.10	88.06	88.01	87.96	87.89
	87.80														
0 14	87.80	87.78	87.79	87.82	87.85	87.87	87.88	87.88	87.86	87.84	87.79	87.73	87.68	87.62	87.56
	87.50														
0 15	87.50	87.48	87.49	87.53	87.58	87.60	87.61	87.60	87.58	87.55	87.49	87.40	87.34	87.29	87.24
	87.20														
0 16	87.10	87.14	87.17	87.22	87.25	87.26	87.27	87.26	87.23	87.19	87.12	87.03	86.98	86.94	86.91
	86.90														
0 17	86.80	86.80	86.82	86.86	86.86	86.86	86.85	86.83	86.80	86.76	86.71	86.65	86.61	86.58	86.54
	86.50														
0 18	86.40	86.44	86.45	86.46	86.46	86.45	86.43	86.41	86.38	86.35	86.30	86.26	86.23	86.20	86.19
	86.20														
0 19	86.10	86.10	86.10	86.08	86.06	86.04	86.02	86.00	85.97	85.94	85.90	85.86	85.84	85.82	85.80
	85.80														
0 20	85.70	85.75	85.75	85.70	85.66	85.63	85.61	85.59	85.56	85.53	85.49	85.46	85.43	85.42	85.40
	85.40														
0 21	85.30	85.34	85.34	85.28	85.25	85.22	85.19	85.17	85.14	85.11	85.08	85.05	85.03	85.00	84.99
	85.00														
0 22	84.90	84.89	84.87	84.85	84.82	84.79	84.77	84.75	84.72	84.69	84.66	84.63	84.61	84.58	84.55
	84.50														
0 23	84.40	84.43	84.42	84.41	84.39	84.37	84.34	84.32	84.30	84.27	84.24	84.22	84.20	84.17	84.14
	84.10														
0 24	84.00	84.00	83.99	83.97	83.96	83.94	83.91	83.89	83.87	83.85	83.83	83.81	83.79	83.76	83.73
	83.70														
0 25	83.60	83.58	83.56	83.54	83.52	83.51	83.48	83.46	83.44	83.42	83.41	83.41	83.39	83.35	83.32
	83.30														
0 26	83.20	83.17	83.14	83.12	83.10	83.08	83.05	83.03	83.01	82.99	82.98	82.98	82.96	82.92	82.91
	82.90														
0 27	82.80	82.75	82.72	82.70	82.67	82.64	82.62	82.60	82.58	82.56	82.54	82.53	82.51	82.49	82.48
	82.50														
0 28	82.30	82.30	82.28	82.26	82.24	82.21	82.19	82.17	82.15	82.12	82.10	82.08	82.07	82.05	82.03
	82.00														
0 29	81.90	81.88	81.85	81.83	81.80	81.78	81.76	81.73	81.71	81.69	81.67	81.64	81.63	81.61	81.60
	81.60														
0 30	81.50	81.45	81.42	81.39	81.37	81.35	81.32	81.30	81.28	81.25	81.23	81.21	81.19	81.18	81.17
	81.20														
0 31	81.00	81.00	80.98	80.96	80.94	80.91	80.89	80.87	80.85	80.82	80.80	80.77	80.75	80.73	80.
	80.70														
0 32	80.60	80.58	80.55	80.52	80.50	80.48	80.47	80.44	80.42	80.39	80.36	80.34	80.31	80.29	80.2
	80.30														
0 33	80.20	80.15	80.11	80.09	80.07	80.05	80.04	80.02	80.00	79.97	79.94	79.91	79.88	79.85	79.82
	79.80														
0 34	79.70	79.70	79.66	79.65	79.64	79.63	79.62	79.61	79.59	79.54	79.52	79.49	79.44	79.41	79.36
	79.30														
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90
	78.90														

0HEAD WILL BE SAVED ON UNIT 30 AT END OF TIME STEP 1, STRESS PERIOD 1

1 DRAWDOWN IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.04	.01	-.00	-.02	-.04	.03	.01	.01	.01	.02	.03	.04	-.04	-.02	.00
0 3	.00	.05	.02	-.01	-.03	.05	.03	.02	.02	.02	.04	-.04	-.02	.01	.04	.00
0 4	.00	.05	.01	-.02	.05	.03	.01	.01	.01	.02	.05	-.02	.02	-.04	-.01	.00
0 5	.00	.05	-.00	-.04	.03	.00	-.01	-.01	-.01	.01	.05	.01	-.04	.01	.05	.00
0 6	.00	.01	-.06	-.01	.05	.03	.02	.02	.03	.05	-.02	.04	-.01	.05	.02	.00
0 7	.00	.01	.02	-.04	.03	.01	-.00	.00	.01	.03	.05	-.03	.03	-.00	-.02	.00
0 8	.00	-.03	-.02	.02	-.01	-.03	-.03	-.03	-.01	.01	.04	-.04	.01	-.01	-.01	.00
0 9	.00	-.04	.00	-.04	.03	.02	.02	.04	-.04	-.01	.03	-.02	.05	.03	.05	.00
0 10	.00	.05	.01	-.02	-.04	-.04	-.03	-.01	.02	-.03	.02	-.02	-.04	-.04	-.03	.00
0 11	.00	.00	-.02	-.03	-.04	-.03	-.01	.02	-.04	.01	-.03	.04	.03	.03	-.05	.00
0 12	.00	-.04	.03	.02	.03	.05	-.03	.01	-.04	.01	-.02	-.04	-.04	-.03	-.01	.00
0 13	.00	-.02	-.03	-.03	-.01	.01	.05	-.01	.05	.01	-.01	-.03	-.03	-.01	.03	.00
0 14	.00	-.02	-.01	.01	.04	-.03	.02	-.03	.03	-.00	-.02	-.03	-.03	-.01	.03	.00
0 15	.00	.05	-.00	.04	-.02	.02	-.02	.03	.00	-.02	-.04	-.04	-.04	-.03	-.01	.00
0 16	.00	.03	.01	-.03	.02	-.03	.03	-.00	-.03	.05	.04	.04	.04	.05	-.04	.00
0 17	.00	-.04	.04	.01	-.04	.02	-.02	.05	.03	.01	.01	.01	.01	.02	.01	.00
0 18	.00	-.04	.01	-.04	.00	-.04	.02	-.00	-.02	-.03	-.03	-.02	-.01	-.01	-.03	.00
0 19	.00	-.03	-.03	.00	.04	-.00	-.04	.04	.02	.02	.03	.05	-.03	-.01	-.00	.00
0 20	.00	-.00	-.00	.02	.04	-.01	-.05	.03	.03	.03	.05	-.01	.04	-.01	.02	.00
0 21	.00	-.02	-.02	.00	.02	-.03	.04	.03	.03	.05	-.02	.03	.01	-.01	-.02	.00

0 22	.00	.03	.05	-.03	.02	-.02	-.04	.05	-.04	-.01	.03	-.00	-.02	-.03	-.00	.00
23	.00	-.01	.00	.03	-.00	-.03	-.04	-.04	-.02	.02	-.03	.04	.03	.04	.01	.00
24	.00	.02	.03	-.02	-.04	.05	.05	-.04	-.01	.03	-.02	-.04	.04	-.03	-.04	.00
25	.00	.00	-.04	.04	.03	.03	.03	.05	-.02	.03	-.01	-.03	-.04	-.00	-.03	.00
26	.00	.01	-.00	-.01	-.01	-.01	.01	.03	-.03	.02	-.02	-.03	-.03	.01	-.04	.00
0 27	.00	.03	.04	.04	.05	-.04	-.02	.00	.04	-.00	-.03	.05	-.04	-.02	.01	.00
0 28	.00	-.01	-.01	-.01	.00	.02	.04	-.03	.01	-.03	.04	.02	.03	.05	-.02	.00
0 29	.00	.03	.04	.05	-.04	-.03	-.01	.03	-.03	.03	-.00	-.02	-.02	-.01	.01	.00
0 30	.00	.00	.00	.00	.01	.02	.04	-.02	.02	-.02	.05	.03	.03	.03	.03	.00
0 31	.00	-.02	-.03	-.04	-.04	-.03	-.01	.02	-.04	.02	-.01	-.03	-.03	-.03	.05	.00
0 32	.00	.05	.03	.01	.00	.01	.03	-.04	-.00	-.04	.03	.01	.00	.01	.01	.00
0 33	.00	-.00	-.02	.05	.04	.05	-.04	-.02	.02	-.02	-.04	.04	.04	.04	.04	.00
0 34	.00	-.04	.03	-.01	-.02	-.03	-.02	-.00	.03	-.00	-.02	-.03	-.03	-.02	-.01	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

1 DRAWDOWN IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.03	.05	-.04	-.02	.02	.05	-.03	.00	-.04	.00	-.03	.02	-.01	.04	.00
0 3	.00	-.01	.00	.02	.05	-.02	.02	.05	-.01	.04	.00	-.04	.03	.01	-.01	.00
0 4	.00	.04	-.03	-.01	.02	-.04	-.00	.04	-.01	.04	.00	-.03	.05	.03	.02	.00
0 5	.00	.02	.05	-.03	.00	.04	-.02	.03	-.02	.05	.02	-.01	-.02	-.03	-.02	.00
0 6	.00	.01	.03	-.04	-.01	.03	-.02	.03	-.01	-.04	.03	.02	.01	.01	.04	.00
0 7	.00	.00	.02	.04	-.02	.02	-.03	.03	-.00	-.03	.05	.04	.04	.05	-.03	.00
0 8	.00	-.02	-.00	.03	-.03	.02	-.03	.04	.01	-.01	-.02	-.03	-.02	-.01	.00	.00
0 9	.00	.04	-.03	.01	.05	.01	-.03	.04	.02	.01	.00	.01	.02	.04	-.04	.00
0 10	.00	.01	.04	-.02	.04	.00	-.03	.05	.03	.03	.03	.04	-.04	-.01	.01	.00
0 11	.00	.05	.00	-.04	.02	-.01	-.04	.05	.04	.04	-.04	-.02	.01	.05	.01	.00
0 12	.00	-.02	-.04	.03	.00	-.03	.06	.05	.05	-.04	-.02	.01	.05	.01	-.02	.00
0 13	.00	.03	.03	.00	-.02	-.04	.04	.04	.05	-.04	-.00	.04	-.01	.04	.01	.00
0 14	.00	.02	.01	-.02	.05	.03	.02	.02	.04	-.04	.01	-.03	.02	-.02	.04	.00
0 15	.00	.02	.01	-.03	.02	-.00	-.01	-.00	.02	.05	.01	.00	-.04	.01	-.04	.00
0 16	.00	-.04	.03	-.02	.05	.04	.03	.04	-.03	.01	-.02	-.03	.02	-.04	-.01	.00
0 17	.00	.00	-.02	.04	.04	.05	.05	-.03	-.00	.04	-.01	.05	-.01	.02	-.04	.00
0 18	.00	-.04	.05	.04	.04	.05	-.03	-.01	.02	.05	-.00	.04	-.03	-.00	.01	.00
0 19	.00	.00	.00	.02	.04	-.04	-.02	.00	.03	-.04	.00	.04	-.04	-.02	-.00	.00
0 20	.00	.05	.05	.00	.04	-.03	-.01	.01	.04	-.03	.01	.04	-.03	-.02	-.00	.00
0 21	.00	-.04	-.04	.02	.05	-.02	.01	.03	-.04	-.01	.02	.05	-.03	-.00	.01	.00
0 22	.00	.01	.03	.05	-.02	.01	.03	.05	-.02	.01	.04	-.03	-.01	.02	.05	.00
0 23	.00	-.03	-.02	-.01	.01	.03	-.04	-.02	.00	.03	-.04	-.02	.00	.03	-.04	.00
0 24	.00	.00	.01	.03	.04	-.04	-.01	.01	.03	.05	-.03	-.01	.01	.04	-.03	.00
0 25	.00	.02	.04	-.04	-.02	-.01	.02	.04	-.04	-.02	-.01	-.01	.01	.05	-.02	.00
26	.00	.03	-.04	-.02	.00	.02	.05	-.03	-.01	.01	.02	.02	.04	-.02	-.01	.00
27	.00	.05	-.02	.00	.03	-.04	-.02	.00	.02	.04	-.04	-.03	-.01	.01	.02	.00
28	.00	-.00	.02	.04	-.04	-.01	.01	.03	.05	-.02	-.00	.02	.03	.05	-.03	.00
29	.00	.02	.05	-.03	-.00	.02	.04	-.03	-.01	.01	.03	-.04	-.03	-.01	-.00	.00
0 30	.00	.05	-.02	.01	.03	.05	-.02	-.00	.02	.05	-.03	-.01	.01	.02	.03	.00
0 31	.00	-.00	.02	.04	-.04	-.01	.01	.03	.05	-.02	.00	.03	.05	-.03	-.02	.00
0 32	.00	.02	.05	-.02	-.00	.02	.03	-.04	-.02	.01	.04	-.04	-.01	.01	.02	.00
0 33	.00	.05	-.01	.01	.03	.05	-.04	-.02	.00	.03	-.04	-.01	.02	.05	-.02	.00
0 34	.00	-.00	.04	.05	-.04	-.03	-.02	-.01	.01	-.04	-.02	.01	-.04	-.01	.04	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

0DRAWDOWN WILL BE SAVED ON UNIT 40 AT END OF TIME STEP 1, STRESS PERIOD 1

0

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 1

	CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
0				
	IN:		IN:	
	STORAGE =	.00000	STORAGE =	.00000
	CONSTANT HEAD =	.52090E+08	CONSTANT HEAD =	.14271E+06
0	TOTAL IN =	.52090E+08	TOTAL IN =	.14271E+06
0	OUT:		OUT:	
	STORAGE =	.00000	STORAGE =	.00000
	CONSTANT HEAD =	.52089E+08	CONSTANT HEAD =	.14271E+06
0	TOTAL OUT =	.52089E+08	TOTAL OUT =	.14271E+06
0	IN - OUT =	1328.0	IN - OUT =	3.6406
0	PERCENT DISCREPANCY =	.00	PERCENT DISCREPANCY =	.00

0

TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 1

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	.315360E+08	525600.	8760.00	365.000	.999316
STRESS PERIOD TIME	.315360E+08	525600.	8760.00	365.000	.999316
TOTAL SIMULATION TIME	.315360E+08	525600.	8760.00	365.000	.999316

1

1 U.S. GEOLOGICAL SURVEY MODULAR FINITE-DIFFERENCE GROUND-WATER MODEL
0SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION VERIFICATION 1 TO PUMPING CONDITIONS 4/13-15/92
2 LAYERS 35 ROWS 16 COLUMNS
1 STRESS PERIOD(S) IN SIMULATION
MODEL TIME UNIT IS DAYS
0I/O UNITS:
ELEMENT OF IUNIT: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
I/O UNIT: 11 12 0 0 0 0 0 0 19 0 0 22 0 0 0 0 0 0 0 0 0 0 0 0
0BAS1 -- BASIC MODEL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 1
ARRAYS RHS AND BUFF WILL SHARE MEMORY.
START HEAD WILL BE SAVED
10699 ELEMENTS IN X ARRAY ARE USED BY BAS
10699 ELEMENTS OF X ARRAY USED OUT OF 100000
0BCF1 -- BLOCK-CENTERED FLOW PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 11
STEADY-STATE SIMULATION

LAYER	AQUIFER TYPE
1	1
2	0

1122 ELEMENTS IN X ARRAY ARE USED BY BCF
11821 ELEMENTS OF X ARRAY USED OUT OF 100000
0WEL1 -- WELL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM 12
MAXIMUM OF 4 WELLS
16 ELEMENTS IN X ARRAY ARE USED FOR WELLS
11837 ELEMENTS OF X ARRAY USED OUT OF 100000
0SIP1 -- STRONGLY IMPLICIT PROCEDURE SOLUTION PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 19
MAXIMUM OF 50 ITERATIONS ALLOWED FOR CLOSURE
5 ITERATION PARAMETERS
4685 ELEMENTS IN X ARRAY ARE USED BY SIP
16522 ELEMENTS OF X ARRAY USED OUT OF 100000
1SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION VERIFICATION 1 TO PUMPING CONDITIONS 4/13-15/92
0

BOUNDARY ARRAY FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
0	2	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	3	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	4	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	5	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	6	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
	7	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
	8	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
	9	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	10	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	11	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	12	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	13	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	14	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	15	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	16	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	17	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	18	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	19	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	20	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	21	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	22	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	23	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	24	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	25	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	26	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	27	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	28	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	29	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	30	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	31	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	32	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	33	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	34	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	35	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

0

BOUNDARY ARRAY FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

0 1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
0 2	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 3	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 4	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 5	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 6	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 7	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 8	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 9	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 10	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 11	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 12	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 13	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 14	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 15	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 16	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 17	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 18	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 19	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 20	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 21	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 22	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 23	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 24	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 25	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 26	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 27	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 28	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 29	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 30	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 31	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 32	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 33	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 34	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 35	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2

0AQUIFER HEAD WILL BE SET TO 999.99 AT ALL NO-FLOW NODES (IBOUND=0).
0

INITIAL HEAD FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.60	92.70	92.80	92.90	93.00	93.20	93.30	93.40	93.50	93.60	93.70	93.80	93.80	93.90	94.00
0 3	92.00	92.20	92.30	92.40	92.50	92.70	92.80	92.90	93.00	93.10	93.20	93.20	93.30	93.40	93.50	93.50
0 4	91.60	91.80	91.90	92.00	92.20	92.30	92.40	92.50	92.60	92.70	92.80	92.80	92.90	92.90	93.00	93.10
0 5	91.20	91.40	91.50	91.60	91.80	91.90	92.00	92.10	92.20	92.30	92.40	92.40	92.40	92.50	92.60	92.60
0 6	90.70	90.90	91.00	91.20	91.40	91.50	91.60	91.70	91.80	91.90	91.90	92.00	92.00	92.10	92.10	92.10
0 7	90.20	90.40	90.60	90.70	90.90	91.00	91.10	91.20	91.30	91.40	91.50	91.50	91.60	91.60	91.60	91.60
0 8	89.70	89.90	90.10	90.30	90.40	90.50	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.10	91.10	91.10
0 9	89.40	89.50	89.70	89.80	90.00	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.60	90.50
0 10	89.00	89.20	89.30	89.40	89.50	89.60	89.70	89.80	89.90	89.90	90.00	90.00	90.00	90.00	90.00	90.00
0 11	88.70	88.80	88.90	89.00	89.10	89.20	89.30	89.40	89.40	89.50	89.50	89.60	89.60	89.60	89.50	89.50
0 12	88.30	88.40	88.60	88.70	88.80	88.90	88.90	89.00	89.00	89.10	89.10	89.10	89.10	89.10	89.10	89.10
0 13	88.00	88.10	88.20	88.30	88.40	88.50	88.60	88.60	88.70	88.70	88.70	88.70	88.70	88.70	88.70	88.60
0 14	87.70	87.80	87.90	88.00	88.10	88.10	88.20	88.20	88.30	88.30	88.30	88.30	88.30	88.30	88.30	88.20
0 15	87.50	87.60	87.60	87.70	87.70	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.90	87.90	87.90	87.90
0 16	87.30	87.30	87.30	87.30	87.40	87.40	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.50	87.50
0 17	87.00	86.90	87.00	87.00	87.00	87.10	87.10	87.20	87.20	87.20	87.20	87.20	87.20	87.20	87.20	87.20
0 18	86.50	86.50	86.60	86.60	86.70	86.70	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.90
0 19	86.00	86.10	86.20	86.30	86.40	86.40	86.40	86.50	86.50	86.50						

	86.50	86.50	86.40	86.40	86.40	86.40				
0 20	85.60	85.70	85.80	85.90	86.00	86.00	86.00	86.10	86.10	86.10
	86.10	86.00	86.00	85.90	85.90	85.90				
21	85.10	85.20	85.30	85.40	85.50	85.50	85.60	85.60	85.60	85.60
	85.50	85.50	85.40	85.30	85.20	85.10				
0 22	84.70	84.80	84.90	84.90	85.00	85.00	85.00	85.10	85.00	85.00
	85.00	84.90	84.80	84.70	84.60	84.50				
0 23	84.20	84.30	84.40	84.50	84.50	84.50	84.50	84.50	84.50	84.50
	84.40	84.40	84.30	84.20	84.00	83.80				
0 24	83.80	83.90	84.00	84.00	84.00	84.10	84.10	84.00	84.00	84.00
	83.90	83.80	83.80	83.60	83.40	83.30				
0 25	83.50	83.50	83.50	83.60	83.60	83.60	83.60	83.60	83.50	83.50
	83.40	83.30	83.20	83.10	82.90	82.80				
0 26	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.00	83.00
	82.90	82.80	82.70	82.60	82.40	82.30				
0 27	82.70	82.70	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.50
	82.40	82.40	82.20	82.10	82.00	81.90				
0 28	82.20	82.20	82.20	82.20	82.20	82.20	82.20	82.10	82.10	82.00
	82.00	81.90	81.80	81.70	81.50	81.40				
0 29	81.80	81.80	81.80	81.80	81.70	81.70	81.70	81.70	81.60	81.60
	81.50	81.40	81.30	81.20	81.10	81.00				
0 30	81.30	81.30	81.30	81.30	81.30	81.30	81.30	81.20	81.20	81.10
	81.10	81.00	80.90	80.80	80.70	80.60				
0 31	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.70	80.70
	80.60	80.50	80.40	80.30	80.30	80.20				
0 32	80.30	80.40	80.40	80.40	80.40	80.40	80.40	80.30	80.30	80.20
	80.20	80.10	80.00	79.90	79.80	79.70				
0 33	79.90	79.90	79.90	80.00	80.00	80.00	79.90	79.90	79.90	79.80
	79.70	79.70	79.60	79.50	79.40	79.30				
0 34	79.40	79.40	79.50	79.50	79.50	79.50	79.50	79.50	79.50	79.40
	79.30	79.20	79.10	79.00	78.90	78.80				
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00
	78.90	78.80	78.70	78.60	78.50	78.40				
0										

INITIAL HEAD FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1 11	2 12	3 13	4 14	5 15	6 16	7	8	9	10
0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80
	91.90	91.90	92.00	92.00	92.10	92.10				
2	90.90	91.00	91.10	91.10	91.20	91.30	91.40	91.40	91.50	91.50
	91.60	91.60	91.70	91.70	91.80	91.80				
3	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.20	91.20	91.30
	91.30	91.30	91.40	91.40	91.40	91.40				
0 4	90.40	90.50	90.50	90.60	90.70	90.70	90.80	90.90	90.90	91.00
	91.00	91.00	91.10	91.10	91.10	91.10				
0 5	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.70
	90.70	90.70	90.70	90.70	90.70	90.70				
0 6	89.80	89.90	90.00	90.00	90.10	90.20	90.20	90.30	90.30	90.30
	90.40	90.40	90.40	90.40	90.40	90.30				
0 7	89.50	89.60	89.70	89.80	89.80	89.90	89.90	90.00	90.00	90.00
	90.10	90.10	90.10	90.10	90.00	90.00				
0 8	89.20	89.30	89.40	89.50	89.50	89.60	89.60	89.70	89.70	89.70
	89.70	89.70	89.70	89.70	89.70	89.70				
0 9	89.00	89.10	89.10	89.20	89.30	89.30	89.30	89.40	89.40	89.40
	89.40	89.40	89.40	89.40	89.30	89.30				
0 10	88.70	88.80	88.90	88.90	89.00	89.00	89.00	89.10	89.10	89.10
	89.10	89.10	89.00	89.00	89.00	89.00				
0 11	88.50	88.60	88.60	88.60	88.70	88.70	88.70	88.80	88.80	88.80
	88.70	88.70	88.70	88.70	88.60	88.50				
0 12	88.30	88.30	88.30	88.40	88.40	88.40	88.50	88.50	88.50	88.40
	88.40	88.40	88.40	88.30	88.20	88.10				
0 13	88.10	88.10	88.10	88.10	88.10	88.10	88.20	88.20	88.20	88.10
	88.10	88.10	88.00	88.00	87.90	87.80				
0 14	87.80	87.80	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.80
	87.80	87.70	87.70	87.60	87.60	87.50				
0 15	87.50	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.60
	87.50	87.40	87.30	87.30	87.20	87.20				
0 16	87.10	87.10	87.20	87.20	87.30	87.30	87.30	87.30	87.20	87.20
	87.10	87.00	87.00	86.90	86.90	86.90				
0 17	86.80	86.80	86.80	86.90	86.90	86.90	86.90	86.80	86.80	86.80
	86.70	86.70	86.60	86.60	86.50	86.50				
0 18	86.40	86.40	86.50	86.50	86.50	86.50	86.40	86.40	86.40	86.40
	86.30	86.30	86.20	86.20	86.20	86.20				
0 19	86.10	86.10	86.10	86.10	86.10	86.00	86.00	86.00	86.00	85.90
	85.90	85.90	85.80	85.80	85.80	85.80				
0 20	85.70	85.80	85.80	85.70	85.70	85.60	85.60	85.60	85.60	85.50
	85.50	85.50	85.40	85.40	85.40	85.40				

0 21	85.30	85.30	85.30	85.30	85.30	85.20	85.20	85.20	85.10	85.10
	85.10	85.10	85.00	85.00	85.00	85.00				
0 22	84.90	84.90	84.90	84.90	84.80	84.80	84.80	84.80	84.70	84.70
	84.70	84.60	84.60	84.60	84.60	84.50				
0 23	84.40	84.40	84.40	84.40	84.40	84.40	84.30	84.30	84.30	84.30
	84.20	84.20	84.20	84.20	84.10	84.10				
0 24	84.00	84.00	84.00	84.00	84.00	83.90	83.90	83.90	83.90	83.90
	83.80	83.80	83.80	83.80	83.70	83.70				
0 25	83.60	83.60	83.60	83.50	83.50	83.50	83.50	83.50	83.40	83.40
	83.40	83.40	83.40	83.40	83.30	83.30				
0 26	83.20	83.20	83.10	83.10	83.10	83.10	83.10	83.00	83.00	83.00
	83.00	83.00	83.00	82.90	82.90	82.90				
0 27	82.80	82.80	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.60
	82.50	82.50	82.50	82.50	82.50	82.50				
0 28	82.30	82.30	82.30	82.30	82.20	82.20	82.20	82.20	82.20	82.10
	82.10	82.10	82.10	82.10	82.00	82.00				
0 29	81.90	81.90	81.90	81.80	81.80	81.80	81.80	81.70	81.70	81.70
	81.70	81.60	81.60	81.60	81.60	81.60				
0 30	81.50	81.50	81.40	81.40	81.40	81.40	81.30	81.30	81.30	81.30
	81.20	81.20	81.20	81.20	81.20	81.20				
0 31	81.00	81.00	81.00	81.00	80.90	80.90	80.90	80.90	80.90	80.80
	80.80	80.80	80.80	80.70	80.70	80.70				
0 32	80.60	80.60	80.60	80.50	80.50	80.50	80.50	80.40	80.40	80.40
	80.40	80.30	80.30	80.30	80.30	80.30				
0 33	80.20	80.20	80.10	80.10	80.10	80.10	80.00	80.00	80.00	80.00
	79.90	79.90	79.90	79.90	79.80	79.80				
0 34	79.70	79.70	79.70	79.70	79.60	79.60	79.60	79.60	79.60	79.50
	79.50	79.50	79.40	79.40	79.40	79.30				
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10
	79.10	79.10	79.00	79.00	78.90	78.90				

0HEAD PRINT FORMAT IS FORMAT NUMBER 4 DRAWDOWN PRINT FORMAT IS FORMAT NUMBER 9
0HEADS WILL BE SAVED ON UNIT 30 DRAWDOWNS WILL BE SAVED ON UNIT 40
0OUTPUT CONTROL IS SPECIFIED EVERY TIME STEP
0 COLUMN TO ROW ANISOTROPY = 1.000000
0 DELR = 200.0000
0 DELC = 200.0000
0

HYD. COND. ALONG ROWS FOR LAYER 1 WILL BE READ ON UNIT 11 USING FORMAT: (16F4.0)

	1 11	2 12	3 13	4 14	5 15	6 16	7	8	9	10
0 1	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 2	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 3	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 4	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 5	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 6	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 7	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 8	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	225.0	225.0	225.0	300.0				
0 9	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	225.0	225.0	225.0	300.0				
0 10	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	225.0	225.0	225.0	300.0				
0 11	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 12	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 13	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 14	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 15	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 16	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 17	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 18	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 19	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
											250.0	250.0	250.0	250.0	250.0	300.0
20	300.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	300.0
21	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 22	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 23	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 24	300.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 25	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 26	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 27	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 28	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 29	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 30	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 31	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 32	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 33	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 34	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 35	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0

0 BOTTOM = 30.00000 FOR LAYER 1

0 VERT HYD COND /THICKNESS = .1000000E-02 FOR LAYER 1

0

TRANSMIS. ALONG ROWS FOR LAYER 2 WILL BE READ ON UNIT 11 USING FORMAT: (16F5.0)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
2	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 3	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 4	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 5	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 6	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 7	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 8	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 9	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 10	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 11	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 12	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 13	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 14	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 15	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 16	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 17	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 18	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 19	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.

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0 20   4000.    4000.    4000.    4000.    4000.    4000.    1500.    1500.    1500.    4000.
       4000.    4000.    4000.    4000.    4000.    4000.
0 21   3000.    3000.    3000.    3000.    3000.    3000.    1500.    1500.    1500.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 22   3000.    3000.    3000.    3000.    3000.    3000.    1500.    1500.    1500.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 23   3000.    3000.    3000.    3000.    3000.    3000.    1500.    1500.    1500.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 24   3000.    3000.    3000.    3000.    3000.    3000.    1500.    1500.    1500.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 25   3000.    3000.    3000.    3000.    3000.    3000.    1500.    1500.    1500.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 26   3000.    3000.    3000.    3000.    3000.    3000.    1500.    1500.    1500.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 27   3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 28   3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 29   3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 30   3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 31   3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 32   3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 33   3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 34   3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 35   3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0

                                        SOLUTION BY THE STRONGLY IMPLICIT PROCEDURE
                                        -------------------------------------------
0                                 MAXIMUM ITERATIONS ALLOWED FOR CLOSURE =       50
                                                  ACCELERATION PARAMETER =     1.0000
                                     HEAD CHANGE CRITERION FOR CLOSURE =     .10000E-02
                                     SIP HEAD CHANGE PRINTOUT INTERVAL =        1
0                                    CALCULATE ITERATION PARAMETERS FROM MODEL CALCULATED WSEED
1                                   STRESS PERIOD NO.    1, LENGTH =    1.000000
                                    ----------------------------------------------

                                    NUMBER OF TIME STEPS =      1

                                     MULTIPLIER FOR DELT =      1.000

                                  INITIAL TIME STEP SIZE =    1.000000
0             4 WELLS
                                  LAYER     ROW     COL     STRESS RATE    WELL NO.
                                  ---------------------------------------------
                                    1       24       8      -5775.0          1
                                    2       13       8      -12128.          2
                                    2       17       8      -16075.          3
                                    2       24       8      -5775.0          4
0AVERAGE SEED =   .00187924
 MINIMUM SEED =   .00055600
0
    5 ITERATION PARAMETERS CALCULATED FROM AVERAGE SEED:

             .0000000E+00   .7917928E+00   .9566497E+00   .9909742E+00   .9981208E+00
0
    11 ITERATIONS FOR TIME STEP    1 IN STRESS PERIOD  1
0MAXIMUM HEAD CHANGE FOR EACH ITERATION:
0 HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL
 ------------------------------------------------------------------------------------------------------------------------------------
   -5.708     (  2, 13,  8)  -.7082      (  2, 12,  9)  -.5092      (  2, 14,  8)  -.3631      (  2, 15, 10)  -.5684E-01 (  2, 23,  9)
   -.1697E-01 (  2, 10,  8)   .1021E-01 (  2, 21,  6)   .1190E-01 (  2, 17,  8)   .3913E-02 (  2, 21, 11)   .1735E-02 (  2, 24,  9)
   -.5051E-03 (  2, 22, 10)
0
0HEAD/DRAWDOWN PRINTOUT FLAG = 1     TOTAL BUDGET PRINTOUT FLAG = 1     CELL-BY-CELL FLOW TERM FLAG = 0
0OUTPUT FLAGS FOR EACH LAYER:
          HEAD     DRAWDOWN  HEAD   DRAWDOWN
 LAYER  PRINTOUT  PRINTOUT  SAVE     SAVE
 ----------------------------------------
    1       1         1       1        1
    2       1         1       1        1
1                   HEAD IN LAYER  1 AT END OF TIME STEP  1 IN STRESS PERIOD  1
            -----------------------------------------------------------------------
```

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.55	92.67	92.78	92.88	93.00	93.14	93.25	93.36	93.46	93.56	93.66	93.75	93.84	93.92	94.00
0 3	92.00	92.13	92.26	92.37	92.47	92.58	92.70	92.82	92.92	93.02	93.11	93.21	93.30	93.38	93.45	93.50
0 4	91.60	91.73	91.85	91.97	92.07	92.17	92.28	92.39	92.49	92.58	92.67	92.77	92.85	92.92	93.00	93.10
0 5	91.20	91.33	91.46	91.58	91.68	91.77	91.87	91.97	92.06	92.15	92.23	92.32	92.40	92.46	92.53	92.60
0 6	90.70	90.87	91.02	91.14	91.25	91.34	91.43	91.53	91.62	91.71	91.78	91.87	91.95	92.01	92.06	92.10
0 7	90.20	90.37	90.53	90.67	90.78	90.88	90.98	91.07	91.16	91.24	91.32	91.41	91.50	91.56	91.60	91.60
0 8	89.70	89.91	90.08	90.21	90.32	90.42	90.52	90.61	90.70	90.78	90.85	90.93	91.01	91.06	91.09	91.10
0 9	89.40	89.52	89.65	89.78	89.88	89.98	90.08	90.16	90.24	90.31	90.38	90.43	90.49	90.52	90.53	90.50
0 10	89.00	89.13	89.25	89.35	89.45	89.55	89.64	89.72	89.79	89.86	89.90	89.94	89.98	90.00	90.01	90.00
0 11	88.70	88.77	88.87	88.96	89.05	89.14	89.22	89.29	89.36	89.41	89.45	89.49	89.51	89.53	89.52	89.50
0 12	88.30	88.42	88.51	88.60	88.67	88.74	88.80	88.87	88.93	88.98	89.03	89.06	89.08	89.09	89.09	89.10
0 13	88.00	88.09	88.17	88.24	88.30	88.35	88.40	88.45	88.51	88.56	88.61	88.64	88.66	88.67	88.65	88.60
0 14	87.70	87.79	87.85	87.90	87.93	87.97	88.01	88.05	88.10	88.15	88.20	88.23	88.25	88.26	88.25	88.20
0 15	87.50	87.52	87.54	87.56	87.58	87.59	87.61	87.65	87.69	87.74	87.80	87.84	87.86	87.88	87.88	87.90
0 16	87.30	87.24	87.22	87.23	87.24	87.24	87.26	87.28	87.32	87.36	87.42	87.45	87.48	87.50	87.51	87.50
0 17	87.00	86.91	86.89	86.89	86.90	86.91	86.93	86.95	86.98	87.01	87.05	87.08	87.10	87.13	87.16	87.20
0 18	86.50	86.51	86.53	86.55	86.57	86.58	86.60	86.62	86.64	86.67	86.69	86.71	86.73	86.76	86.80	86.90
0 19	86.00	86.10	86.16	86.20	86.23	86.25	86.27	86.29	86.31	86.32	86.33	86.34	86.35	86.36	86.38	86.40
0 20	85.60	85.67	85.74	85.79	85.83	85.86	85.87	85.89	85.90	85.91	85.91	85.90	85.88	85.86	85.86	85.90
0 21	85.10	85.19	85.26	85.30	85.34	85.36	85.37	85.37	85.38	85.38	85.38	85.35	85.31	85.26	85.20	85.10
22	84.70	84.74	84.79	84.83	84.84	84.84	84.83	84.81	84.82	84.82	84.82	84.79	84.74	84.67	84.58	84.50
23	84.20	84.28	84.34	84.37	84.36	84.33	84.28	84.23	84.26	84.28	84.27	84.24	84.19	84.10	83.97	83.80
0 24	83.80	83.85	83.90	83.91	83.88	83.84	83.75	83.55	83.71	83.75	83.75	83.72	83.67	83.57	83.42	83.30
0 25	83.50	83.47	83.48	83.46	83.43	83.38	83.32	83.24	83.26	83.27	83.25	83.22	83.16	83.05	82.91	82.80
0 26	83.10	83.07	83.05	83.02	82.99	82.94	82.90	82.85	82.83	82.81	82.78	82.73	82.65	82.55	82.42	82.30
0 27	82.70	82.65	82.62	82.58	82.55	82.51	82.47	82.43	82.40	82.36	82.32	82.26	82.18	82.08	81.97	81.90
0 28	82.20	82.20	82.17	82.14	82.11	82.08	82.04	82.00	81.96	81.92	81.86	81.80	81.72	81.62	81.51	81.40
0 29	81.80	81.76	81.73	81.70	81.67	81.64	81.61	81.57	81.53	81.48	81.42	81.35	81.27	81.18	81.08	81.00
0 30	81.30	81.29	81.27	81.26	81.24	81.21	81.18	81.14	81.10	81.05	80.99	80.92	80.84	80.75	80.66	80.60
0 31	80.80	80.81	80.82	80.81	80.80	80.78	80.75	80.72	80.68	80.62	80.56	80.49	80.40	80.32	80.24	80.20
0 32	80.30	80.34	80.36	80.37	80.36	80.35	80.33	80.30	80.26	80.20	80.14	80.06	79.97	79.88	79.79	79.70
0 33	79.90	79.90	79.91	79.93	79.94	79.93	79.92	79.89	79.85	79.79	79.72	79.64	79.55	79.45	79.36	79.30
0 34	79.40	79.44	79.46	79.50	79.51	79.51	79.51	79.49	79.46	79.39	79.31	79.22	79.12	79.02	78.91	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

1 HEAD IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	92.10
0 2	90.90	90.96	91.05	91.13	91.21	91.27	91.34	91.42	91.49	91.53	91.59	91.62	91.67	91.71	91.76	

	91.80														
0 3	90.60	90.70	90.78	90.86	90.93	91.00	91.07	91.14	91.19	91.24	91.28	91.31	91.35	91.38	91.40
	91.40														
0 4	90.40	90.45	90.51	90.58	90.65	90.72	90.79	90.85	90.90	90.94	90.97	90.99	91.02	91.04	91.
	91.10														
0 5	90.10	90.16	90.23	90.30	90.37	90.44	90.51	90.56	90.60	90.63	90.65	90.66	90.68	90.69	90.70
	90.70														
0 6	89.80	89.87	89.93	90.00	90.07	90.15	90.23	90.29	90.31	90.32	90.32	90.32	90.33	90.34	90.34
	90.30														
0 7	89.50	89.57	89.63	89.69	89.76	89.85	89.96	90.03	90.04	90.00	89.97	89.97	89.98	89.99	90.00
	90.00														
0 8	89.20	89.27	89.32	89.36	89.42	89.52	89.74	89.83	89.81	89.65	89.60	89.59	89.60	89.62	89.65
	89.70														
0 9	89.00	89.00	89.00	89.02	89.04	89.07	89.26	89.34	89.32	89.19	89.18	89.19	89.21	89.25	89.28
	89.30														
0 10	88.70	88.70	88.68	88.66	88.63	88.61	88.59	88.54	88.64	88.70	88.72	88.77	88.81	88.86	88.91
	89.00														
0 11	88.50	88.43	88.36	88.29	88.21	88.14	87.86	87.51	87.88	88.18	88.25	88.33	88.40	88.45	88.49
	88.50														
0 12	88.30	88.17	88.04	87.92	87.78	87.64	86.88	85.68	86.89	87.64	87.78	87.89	87.99	88.06	88.10
	88.10														
0 13	88.10	87.90	87.72	87.55	87.36	87.14	85.65	81.25	85.63	87.11	87.32	87.47	87.59	87.69	87.75
	87.80														
0 14	87.80	87.59	87.39	87.19	86.97	86.73	85.98	84.95	85.96	86.68	86.89	87.07	87.22	87.33	87.42
	87.50														
0 15	87.50	87.27	87.06	86.85	86.59	86.30	85.94	85.76	85.91	86.24	86.50	86.71	86.86	86.99	87.10
	87.20														
0 16	87.10	86.93	86.74	86.53	86.28	86.02	85.75	85.54	85.72	85.96	86.18	86.38	86.54	86.66	86.78
	86.90														
0 17	86.80	86.62	86.44	86.25	86.02	85.78	85.48	84.94	85.45	85.71	85.92	86.09	86.23	86.35	86.44
	86.50														
0 18	86.40	86.29	86.16	85.99	85.81	85.63	85.45	85.29	85.42	85.56	85.70	85.84	85.95	86.04	86.12
	86.20														
0 19	86.10	86.00	85.89	85.76	85.61	85.49	85.40	85.33	85.37	85.42	85.50	85.60	85.69	85.76	85.80
	85.80														
0 20	85.70	85.66	85.58	85.47	85.35	85.27	85.19	85.12	85.14	85.18	85.23	85.30	85.37	85.42	85.44
	85.40														
0 21	85.30	85.24	85.16	85.06	84.96	84.86	84.75	84.67	84.69	84.76	84.82	84.89	84.94	84.99	85.00
	85.00														
0 22	84.90	84.80	84.70	84.60	84.49	84.37	84.22	84.09	84.16	84.26	84.34	84.41	84.47	84.51	84.52
	84.50														
0 23	84.40	84.34	84.25	84.14	84.01	83.87	83.61	83.30	83.55	83.75	83.86	83.94	84.01	84.06	84.08
	84.10														
0 24	84.00	83.91	83.81	83.70	83.56	83.38	82.95	81.93	82.88	83.25	83.40	83.49	83.56	83.62	83.66
	83.70														
0 25	83.60	83.50	83.39	83.27	83.14	82.99	82.71	82.40	82.64	82.86	82.98	83.06	83.13	83.19	83.
	83.30														
0 26	83.20	83.09	82.98	82.87	82.74	82.61	82.42	82.28	82.35	82.49	82.58	82.65	82.72	82.77	82.
	82.90														
0 27	82.80	82.67	82.57	82.46	82.35	82.24	82.09	82.01	82.03	82.12	82.19	82.25	82.30	82.36	82.41
	82.50														
0 28	82.30	82.24	82.15	82.06	81.97	81.88	81.79	81.74	81.74	81.77	81.81	81.85	81.89	81.93	81.97
	82.00														
0 29	81.90	81.82	81.74	81.67	81.59	81.52	81.46	81.42	81.41	81.42	81.44	81.46	81.49	81.52	81.56
	81.60														
0 30	81.50	81.40	81.33	81.27	81.21	81.15	81.10	81.07	81.05	81.05	81.05	81.06	81.08	81.10	81.14
	81.20														
0 31	81.00	80.97	80.91	80.86	80.81	80.77	80.73	80.70	80.68	80.67	80.67	80.67	80.67	80.68	80.69
	80.70														
0 32	80.60	80.55	80.50	80.45	80.42	80.38	80.35	80.33	80.31	80.29	80.27	80.26	80.26	80.25	80.26
	80.30														
0 33	80.20	80.13	80.08	80.04	80.01	79.99	79.97	79.95	79.93	79.90	79.88	79.86	79.84	79.82	79.81
	79.80														
0 34	79.70	79.69	79.65	79.62	79.61	79.59	79.58	79.57	79.55	79.51	79.49	79.47	79.43	79.40	79.35
	79.30														
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90
	78.90														

0HEAD WILL BE SAVED ON UNIT 30 AT END OF TIME STEP 1, STRESS PERIOD 1

1 DRAWDOWN IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.05	.03	.02	.02	.00	.06	.05	.04	.04	.04	.04	.05	-.04	-.02	.00
0 3	.00	.07	.04	.03	.03	.12	.10	.08	.08	.08	.09	-.01	.00	.02	.05	.00
0 4	.00	.07	.05	.03	.13	.13	.12	.11	.11	.12	.13	.03	.05	-.02	.00	.00
0 5	.00	.07	.04	.02	.12	.13	.13	.13	.14	.15	.17	.08	.00	.04	.07	.00
0 6	.00	.03	-.02	.06	.15	.16	.17	.17	.18	.19	.12	.13	.05	.09	.04	.00
0 7	.00	.03	.07	.03	.12	.12	.12	.13	.14	.16	.18	.09	.10	.04	.00	.00
0 8	.00	-.01	.02	.09	.08	.08	.08	.09	.10	.12	.15	.07	.09	.04	.01	.00
0 9	.00	-.02	.05	.02	.12	.12	.12	.14	.06	.09	.12	.07	.11	.08	.07	.00

0 10	.00	.07	.05	.05	.05	.05	.06	.08	.11	.04	.10	.06	.02	-.00	-.01	.00
0 11	.00	.03	.03	.04	.05	.06	.08	.11	.04	.09	.05	.11	.09	.07	-.02	.00
12	.00	-.02	.09	.10	.13	.16	.10	.13	.07	.12	.07	.04	.02	.01	.01	.00
13	.00	.01	.03	.06	.10	.15	.20	.15	.19	.14	.09	.06	.04	.03	.05	.00
14	.00	.01	.05	.10	.17	.13	.19	.15	.20	.15	.10	.07	.05	.04	.05	.00
15	.00	.08	.06	.14	.12	.21	.19	.25	.21	.16	.10	.06	.04	.02	.02	.00
0 16	.00	.06	.08	.07	.16	.16	.24	.22	.18	.24	.18	.15	.12	.10	-.01	.00
0 17	.00	-.01	.11	.11	.10	.19	.17	.25	.22	.19	.15	.12	.10	.07	.04	.00
0 18	.00	-.01	.07	.05	.13	.12	.20	.18	.16	.13	.11	.09	.07	.04	-.00	.00
0 19	.00	-.00	.04	.10	.17	.15	.13	.21	.19	.18	.17	.16	.05	.04	.02	.00
0 20	.00	.03	.06	.11	.17	.14	.13	.21	.20	.19	.19	.10	.12	.04	.04	.00
0 21	.00	.01	.04	.10	.16	.14	.23	.23	.22	.22	.12	.15	.09	.04	.00	.00
0 22	.00	.06	.11	.07	.16	.16	.17	.29	.18	.18	.18	.11	.06	.03	.02	.00
0 23	.00	.02	.06	.13	.14	.17	.22	.27	.24	.22	.13	.16	.11	.10	.03	.00
0 24	.00	.05	.10	.09	.12	.26	.35	.45	.29	.25	.15	.08	.13	.03	-.02	.00
0 25	.00	.03	.02	.14	.17	.22	.28	.36	.24	.23	.15	.08	.04	.05	-.01	.00
0 26	.00	.03	.05	.08	.11	.16	.20	.25	.17	.19	.12	.07	.05	.05	-.02	.00
0 27	.00	.05	.08	.12	.15	.09	.13	.17	.20	.14	.08	.14	.02	.02	.03	.00
0 28	.00	.00	.03	.06	.09	.12	.16	.10	.14	.08	.14	.10	.08	.08	-.01	.00
0 29	.00	.04	.07	.10	.03	.06	.09	.13	.07	.12	.08	.05	.03	.02	.02	.00
0 30	.00	.01	.03	.04	.06	.09	.12	.06	.10	.05	.11	.08	.06	.05	.04	.00
0 31	.00	-.01	-.02	-.01	.00	.02	.05	.08	.02	.08	.04	.01	-.00	-.02	.06	.00
0 32	.00	.06	.04	.03	.04	.05	.07	.00	.04	-.00	.06	.04	.03	.02	.01	.00
0 33	.00	.00	-.01	.07	.06	.07	-.02	.01	.05	.01	-.02	.06	.05	.05	.04	.00
0 34	.00	-.04	.04	-.00	-.01	-.01	-.01	.01	.04	.01	-.01	-.02	-.02	-.02	-.01	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

1 DRAWDOWN IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.04	.05	-.03	-.01	.03	.06	-.02	.01	-.03	.01	-.02	.03	-.01	.04	.00
0 3	.00	.00	.02	.04	.07	-.00	.03	.06	.01	.06	.02	-.01	.05	.02	-.00	.00
0 4	.00	.05	-.01	.02	.05	-.02	.01	.05	.00	.06	.03	.01	.08	.06	.03	.00
0 5	.00	.04	.07	.00	.03	.06	-.01	.04	-.00	.07	.05	.04	.02	.01	-.00	.00
0 6	.00	.03	.07	.00	.03	.05	-.03	.01	-.01	-.02	.08	.08	.07	.06	.06	.00
0 7	.00	.03	.07	.11	.04	.05	-.06	-.03	-.04	.00	.13	.13	.12	.11	.00	.00
0 8	.00	.03	.08	.14	.08	.08	-.14	-.13	-.11	.05	.10	.11	.10	.08	.05	.00
0 9	.00	.10	.10	.18	.26	.23	.04	.06	.08	.21	.22	.21	.19	.15	.02	.00
0 10	.00	.10	.22	.24	.37	.39	.41	.56	.46	.40	.38	.33	.19	.14	.09	.00
0 11	.00	.17	.24	.31	.49	.56	.84	1.29	.92	.62	.45	.37	.30	.25	.11	.00
0 12	.00	.13	.26	.48	.62	.76	1.62	2.82	1.61	.76	.62	.51	.41	.24	.10	.00
0 13	.00	.20	.38	.55	.74	.96	2.55	6.95	2.57	.99	.78	.63	.41	.31	.15	.00
0 14	.00	.21	.41	.61	.93	1.17	1.92	2.95	1.94	1.12	.91	.63	.48	.27	.18	.00
15	.00	.23	.44	.65	1.01	1.30	1.66	1.84	1.69	1.36	1.00	.69	.44	.31	.10	.00
16	.00	.17	.46	.67	1.02	1.28	1.55	1.76	1.48	1.24	.92	.62	.46	.24	.12	.00
17	.00	.18	.36	.65	.88	1.12	1.42	1.86	1.35	1.09	.78	.61	.37	.25	.06	.00
0 18	.00	.11	.34	.51	.69	.87	.95	1.11	.98	.84	.60	.46	.25	.16	.08	.00
0 19	.00	.10	.21	.34	.49	.51	.60	.67	.63	.48	.40	.30	.11	.04	.00	.00
0 20	.00	.14	.22	.23	.35	.33	.41	.48	.46	.32	.27	.20	.03	-.02	-.04	.00
0 21	.00	.06	.14	.24	.34	.34	.45	.53	.41	.34	.28	.21	.06	.01	-.00	.00
0 22	.00	.10	.20	.30	.31	.43	.58	.71	.54	.44	.36	.19	.13	.09	.08	.00
0 23	.00	.06	.15	.26	.39	.53	.69	1.00	.75	.55	.34	.26	.19	.14	.02	.00
0 24	.00	.09	.19	.30	.44	.52	.95	1.97	1.02	.65	.40	.31	.24	.18	.04	.00
0 25	.00	.10	.21	.23	.36	.51	.79	1.10	.76	.54	.42	.34	.27	.21	.05	.00
0 26	.00	.11	.12	.23	.36	.49	.68	.72	.65	.51	.42	.35	.28	.13	.07	.00
0 27	.00	.13	.13	.24	.35	.36	.51	.59	.57	.48	.31	.25	.20	.14	.09	.00
0 28	.00	.06	.15	.24	.23	.32	.41	.46	.46	.33	.29	.25	.21	.17	.03	.00
0 29	.00	.08	.16	.13	.21	.28	.34	.28	.29	.28	.26	.14	.11	.08	.04	.00
0 30	.00	.10	.07	.13	.19	.25	.20	.23	.25	.25	.15	.14	.12	.10	.06	.00
0 31	.00	.03	.09	.14	.09	.13	.17	.20	.22	.13	.13	.13	.13	.02	.01	.00
0 32	.00	.05	.10	.05	.08	.12	.15	.07	.09	.11	.13	.04	.04	.05	.04	.00
0 33	.00	.07	.02	.06	.09	.11	.03	.05	.07	.10	.02	.04	.06	.08	-.01	.00
0 34	.00	.01	.05	.08	-.01	.01	.02	.03	.05	-.01	.01	.03	-.03	.00	.05	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

0DRAWDOWN WILL BE SAVED ON UNIT 40 AT END OF TIME STEP 1, STRESS PERIOD 1
0

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 1

	CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
	IN:		IN:	
	STORAGE =	.00000	STORAGE =	.00000
	CONSTANT HEAD =	.15868E+06	CONSTANT HEAD =	.15868E+06
	WELLS =	.00000	WELLS =	.00000
0	TOTAL IN =	.15868E+06	TOTAL IN =	.15868E+06
0	OUT:		OUT:	

```
                                 ----                                                                               ----
                              STORAGE =      .00000                                                             STORAGE =      .00000
                        CONSTANT HEAD =      .11891E+06                                                   CONSTANT HEAD =      .11891E+06
                                WELLS =      39753.                                                               WELLS =      39753.
0                           TOTAL OUT =      .15866E+06                                                       TOTAL OUT =      .15866E+06
0                            IN - OUT =      21.281                                                            IN - OUT =      21.281
0                PERCENT DISCREPANCY =                      .01                                  PERCENT DISCREPANCY =                      .01


0

         TIME SUMMARY AT END OF TIME STEP  1 IN STRESS PERIOD  1
                                SECONDS        MINUTES         HOURS          DAYS           YEARS
                            -----------------------------------------------------------------------------
      TIME STEP LENGTH          86400.0        1440.00        24.0000        1.00000        .273785E-02
    STRESS PERIOD TIME          86400.0        1440.00        24.0000        1.00000        .273785E-02
 TOTAL SIMULATION TIME          86400.0        1440.00        24.0000        1.00000        .273785E-02
1
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1                     U.S. GEOLOGICAL SURVEY MODULAR FINITE-DIFFERENCE GROUND-WATER MODEL
0SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     VERIFICATION 2 TO PUMPING CONDITIONS 10/14/92
    2 LAYERS          35 ROWS          16 COLUMNS
   1 STRESS PERIOD(S) IN SIMULATION
 ODEL TIME UNIT IS DAYS
 I/O UNITS:
 ELEMENT OF IUNIT:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
         I/O UNIT: 11 12  0  0  0  0  0  0 19  0  0 22  0  0  0  0  0  0  0  0  0  0  0  0
0BAS1 -- BASIC MODEL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT  1
 ARRAYS RHS AND BUFF WILL SHARE MEMORY.
 START HEAD WILL BE SAVED
    10699 ELEMENTS IN X ARRAY ARE USED BY BAS
    10699 ELEMENTS OF X ARRAY USED OUT OF  100000
0BCF1 -- BLOCK-CENTERED FLOW PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 11
 STEADY-STATE SIMULATION
      LAYER  AQUIFER TYPE
      -------------------
         1          1
         2          0
     1122 ELEMENTS IN X ARRAY ARE USED BY BCF
    11821 ELEMENTS OF X ARRAY USED OUT OF  100000
0WEL1 -- WELL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM 12
 MAXIMUM OF    6 WELLS
       24 ELEMENTS IN X ARRAY ARE USED FOR WELLS
    11845 ELEMENTS OF X ARRAY USED OUT OF  100000
0SIP1 -- STRONGLY IMPLICIT PROCEDURE SOLUTION PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 19
 MAXIMUM OF  50 ITERATIONS ALLOWED FOR CLOSURE
  5 ITERATION PARAMETERS
     4685 ELEMENTS IN X ARRAY ARE USED BY SIP
    16530 ELEMENTS OF X ARRAY USED OUT OF  100000
1SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     VERIFICATION 2 TO PUMPING CONDITIONS 10/14/92
0

                                          BOUNDARY ARRAY FOR LAYER  1 WILL BE READ ON UNIT  1 USING FORMAT: (16I3)
                                    ------------------------------------------------------------------------------

           1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16
 ..........................................................................
0  1      -1  -1  -1  -1  -1  -1  -1  -1  -1  -1  -1  -1  -1  -1  -1  -1
0  2      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0  3      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0  4      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0  5      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0  6      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
   7      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
   8      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
   9      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 10      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 11      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 12      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 13      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 14      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 15      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 16      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 17      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 18      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 19      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 20      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 21      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 22      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 23      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 24      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 25      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 26      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 27      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 28      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 29      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 30      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 31      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 32      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 33      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 34      -1   1   1   1   1   1   1   1   1   1   1   1   1   1   1  -1
0 35      -1  -1  -1  -1  -1  -1  -1  -1  -1  -1  -1  -1  -1  -1  -1  -1
0

                                          BOUNDARY ARRAY FOR LAYER  2 WILL BE READ ON UNIT  1 USING FORMAT: (16I3)
                                    ------------------------------------------------------------------------------

           1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16
 ..........................................................................
```

0	1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
0	2	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	3	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	4	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	5	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	6	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	7	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	8	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	9	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	10	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	11	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	12	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	13	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	14	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	15	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	16	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	17	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	18	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	19	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	20	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	21	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	22	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	23	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	24	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	25	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	26	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	27	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	28	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	29	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	30	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	31	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	32	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	33	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	34	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	35	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2

0AQUIFER HEAD WILL BE SET TO 999.99 AT ALL NO-FLOW NODES (IBOUND=0).
0

INITIAL HEAD FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1	2	3	4	5	6	7	8	9	10
	11	12	13	14	15	16				
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90
	94.00	94.10	94.20	94.30	94.40	94.50				
0 2	92.40	92.60	92.70	92.80	92.90	93.00	93.20	93.30	93.40	93.50
	93.60	93.70	93.80	93.80	93.90	94.00				
0 3	92.00	92.20	92.30	92.40	92.50	92.70	92.80	92.90	93.00	93.10
	93.20	93.20	93.30	93.40	93.50	93.50				
0 4	91.60	91.80	91.90	92.00	92.20	92.30	92.40	92.50	92.60	92.70
	92.80	92.80	92.90	92.90	93.00	93.10				
0 5	91.20	91.40	91.50	91.60	91.80	91.90	92.00	92.10	92.20	92.30
	92.40	92.40	92.40	92.50	92.60	92.60				
0 6	90.70	90.90	91.00	91.20	91.40	91.50	91.60	91.70	91.80	91.90
	91.90	92.00	92.00	92.10	92.10	92.10				
0 7	90.20	90.40	90.60	90.70	90.90	91.00	91.10	91.20	91.30	91.40
	91.50	91.50	91.60	91.60	91.60	91.60				
0 8	89.70	89.90	90.10	90.30	90.40	90.50	90.60	90.70	90.80	90.90
	91.00	91.00	91.10	91.10	91.10	91.10				
0 9	89.40	89.50	89.70	89.80	90.00	90.10	90.20	90.30	90.30	90.40
	90.50	90.50	90.60	90.60	90.60	90.50				
0 10	89.00	89.20	89.30	89.40	89.50	89.60	89.70	89.80	89.90	89.90
	90.00	90.00	90.00	90.00	90.00	90.00				
0 11	88.70	88.80	88.90	89.00	89.10	89.20	89.30	89.40	89.40	89.50
	89.50	89.60	89.60	89.60	89.50	89.50				
0 12	88.30	88.40	88.60	88.70	88.80	88.90	88.90	89.00	89.00	89.10
	89.10	89.10	89.10	89.10	89.10	89.10				
0 13	88.00	88.10	88.20	88.30	88.40	88.50	88.60	88.60	88.70	88.70
	88.70	88.70	88.70	88.70	88.70	88.60				
0 14	87.70	87.80	87.90	88.00	88.10	88.10	88.20	88.20	88.30	88.30
	88.30	88.30	88.30	88.30	88.30	88.20				
0 15	87.50	87.60	87.60	87.70	87.70	87.80	87.80	87.90	87.90	87.90
	87.90	87.90	87.90	87.90	87.90	87.90				
0 16	87.30	87.30	87.30	87.30	87.40	87.40	87.50	87.50	87.50	87.60
	87.60	87.60	87.60	87.60	87.50	87.50				
0 17	87.00	86.90	87.00	87.00	87.00	87.10	87.10	87.20	87.20	87.20
	87.20	87.20	87.20	87.20	87.20	87.20				
0 18	86.50	86.50	86.60	86.60	86.70	86.70	86.80	86.80	86.80	86.80
	86.80	86.80	86.80	86.80	86.80	86.90				
0 19	86.00	86.10	86.20	86.30	86.40	86.40	86.40	86.50	86.50	86.50

	86.50	86.50	86.40	86.40	86.40	86.40				
0 20	85.60	85.70	85.80	85.90	86.00	86.00	86.00	86.10	86.10	86.10
	86.10	86.00	86.00	85.90	85.90	85.90				
0 21	85.10	85.20	85.30	85.40	85.50	85.50	85.60	85.60	85.60	85.60
	85.50	85.50	85.40	85.30	85.20	85.10				
0 22	84.70	84.80	84.90	84.90	85.00	85.00	85.00	85.10	85.00	85.00
	85.00	84.90	84.80	84.70	84.60	84.50				
0 23	84.20	84.30	84.40	84.50	84.50	84.50	84.50	84.50	84.50	84.50
	84.40	84.40	84.30	84.20	84.00	83.80				
0 24	83.80	83.90	84.00	84.00	84.00	84.10	84.10	84.00	84.00	84.00
	83.90	83.80	83.80	83.60	83.40	83.30				
0 25	83.50	83.50	83.50	83.60	83.60	83.60	83.60	83.60	83.50	83.50
	83.40	83.30	83.20	83.10	82.90	82.80				
0 26	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.00	83.00
	82.90	82.80	82.70	82.60	82.40	82.30				
0 27	82.70	82.70	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.50
	82.40	82.40	82.20	82.10	82.00	81.90				
0 28	82.20	82.20	82.20	82.20	82.20	82.20	82.20	82.10	82.10	82.00
	82.00	81.90	81.80	81.70	81.50	81.40				
0 29	81.80	81.80	81.80	81.80	81.70	81.70	81.70	81.70	81.60	81.60
	81.50	81.40	81.30	81.20	81.10	81.00				
0 30	81.30	81.30	81.30	81.30	81.30	81.30	81.30	81.20	81.20	81.10
	81.10	81.00	80.90	80.80	80.70	80.60				
0 31	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.70	80.70
	80.60	80.50	80.40	80.30	80.30	80.20				
0 32	80.30	80.40	80.40	80.40	80.40	80.40	80.40	80.30	80.30	80.20
	80.20	80.10	80.00	79.90	79.80	79.70				
0 33	79.90	79.90	79.90	80.00	80.00	80.00	79.90	79.90	79.90	79.80
	79.70	79.70	79.60	79.50	79.40	79.30				
0 34	79.40	79.40	79.50	79.50	79.50	79.50	79.50	79.50	79.50	79.40
	79.30	79.20	79.10	79.00	78.90	78.80				
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00
	78.90	78.80	78.70	78.60	78.50	78.40				
0										

INITIAL HEAD FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1 11	2 12	3 13	4 14	5 15	6 16	7	8	9	10
0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80
	91.90	91.90	92.00	92.00	92.10	92.10				
0 2	90.90	91.00	91.10	91.10	91.20	91.30	91.40	91.40	91.50	91.50
	91.60	91.60	91.70	91.70	91.80	91.80				
0 3	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.20	91.20	91.30
	91.30	91.30	91.40	91.40	91.40	91.40				
0 4	90.40	90.50	90.50	90.60	90.70	90.70	90.80	90.90	90.90	91.00
	91.00	91.00	91.10	91.10	91.10	91.10				
0 5	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.70
	90.70	90.70	90.70	90.70	90.70	90.70				
0 6	89.80	89.90	90.00	90.00	90.10	90.20	90.20	90.30	90.30	90.30
	90.40	90.40	90.40	90.40	90.40	90.30				
0 7	89.50	89.60	89.70	89.80	89.80	89.90	89.90	90.00	90.00	90.00
	90.10	90.10	90.10	90.10	90.00	90.00				
0 8	89.20	89.30	89.40	89.50	89.50	89.60	89.60	89.70	89.70	89.70
	89.70	89.70	89.70	89.70	89.70	89.70				
0 9	89.00	89.10	89.10	89.20	89.30	89.30	89.30	89.40	89.40	89.40
	89.40	89.40	89.40	89.40	89.30	89.30				
0 10	88.70	88.80	88.90	88.90	89.00	89.00	89.00	89.10	89.10	89.10
	89.10	89.10	89.00	89.00	89.00	89.00				
0 11	88.50	88.60	88.60	88.60	88.70	88.70	88.70	88.80	88.80	88.80
	88.70	88.70	88.70	88.70	88.60	88.50				
0 12	88.30	88.30	88.30	88.40	88.40	88.40	88.50	88.50	88.50	88.40
	88.40	88.40	88.40	88.30	88.20	88.10				
0 13	88.10	88.10	88.10	88.10	88.10	88.10	88.20	88.20	88.20	88.10
	88.10	88.10	88.00	88.00	87.90	87.80				
0 14	87.80	87.80	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.80
	87.80	87.70	87.70	87.60	87.60	87.50				
0 15	87.50	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.60
	87.50	87.40	87.30	87.30	87.20	87.20				
0 16	87.10	87.10	87.20	87.20	87.30	87.30	87.30	87.30	87.20	87.20
	87.10	87.00	87.00	86.90	86.90	86.90				
0 17	86.80	86.80	86.80	86.90	86.90	86.90	86.90	86.80	86.80	86.80
	86.70	86.70	86.60	86.60	86.50	86.50				
0 18	86.40	86.40	86.50	86.50	86.50	86.50	86.40	86.40	86.40	86.40
	86.30	86.30	86.20	86.20	86.20	86.20				
0 19	86.10	86.10	86.10	86.10	86.10	86.00	86.00	86.00	86.00	85.90
	85.90	85.90	85.80	85.80	85.80	85.80				
0 20	85.70	85.80	85.80	85.70	85.70	85.60	85.60	85.60	85.60	85.50
	85.50	85.50	85.40	85.40	85.40	85.40				

0 21	85.30	85.30	85.30	85.30	85.30	85.20	85.20	85.20	85.10	85.10
	85.10	85.10	85.00	85.00	85.00	85.00				
0 22	84.90	84.90	84.90	84.90	84.80	84.80	84.80	84.80	84.70	84.70
	84.70	84.60	84.60	84.60	84.60	84.50				
0 23	84.40	84.40	84.40	84.40	84.40	84.40	84.30	84.30	84.30	84.30
	84.20	84.20	84.20	84.20	84.10	84.10				
0 24	84.00	84.00	84.00	84.00	84.00	83.90	83.90	83.90	83.90	83.90
	83.80	83.80	83.80	83.80	83.70	83.70				
0 25	83.60	83.60	83.60	83.50	83.50	83.50	83.50	83.50	83.40	83.40
	83.40	83.40	83.40	83.40	83.30	83.30				
0 26	83.20	83.20	83.10	83.10	83.10	83.10	83.10	83.00	83.00	83.00
	83.00	83.00	83.00	82.90	82.90	82.90				
0 27	82.80	82.80	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.60
	82.50	82.50	82.50	82.50	82.50	82.50				
0 28	82.30	82.30	82.30	82.30	82.20	82.20	82.20	82.20	82.20	82.10
	82.10	82.10	82.10	82.10	82.00	82.00				
0 29	81.90	81.90	81.90	81.80	81.80	81.80	81.80	81.70	81.70	81.70
	81.70	81.60	81.60	81.60	81.60	81.60				
0 30	81.50	81.50	81.40	81.40	81.40	81.40	81.30	81.30	81.30	81.30
	81.20	81.20	81.20	81.20	81.20	81.20				
0 31	81.00	81.00	81.00	81.00	80.90	80.90	80.90	80.90	80.90	80.80
	80.80	80.80	80.80	80.70	80.70	80.70				
0 32	80.60	80.60	80.60	80.50	80.50	80.50	80.50	80.40	80.40	80.40
	80.40	80.30	80.30	80.30	80.30	80.30				
0 33	80.20	80.20	80.10	80.10	80.10	80.10	80.00	80.00	80.00	80.00
	79.90	79.90	79.90	79.90	79.80	79.80				
0 34	79.70	79.70	79.70	79.70	79.60	79.60	79.60	79.60	79.60	79.50
	79.50	79.50	79.40	79.40	79.40	79.30				
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10
	79.10	79.10	79.00	79.00	78.90	78.90				

OHEAD PRINT FORMAT IS FORMAT NUMBER 4 DRAWDOWN PRINT FORMAT IS FORMAT NUMBER 9
OHEADS WILL BE SAVED ON UNIT 30 DRAWDOWNS WILL BE SAVED ON UNIT 40
OOUTPUT CONTROL IS SPECIFIED EVERY TIME STEP
0 COLUMN TO ROW ANISOTROPY = 1.000000
0 DELR = 200.0000
0 DELC = 200.0000
0

HYD. COND. ALONG ROWS FOR LAYER 1 WILL BE READ ON UNIT 11 USING FORMAT: (16F4.0)

	1	2	3	4	5	6	7	8	9	10
	11	12	13	14	15	16				
0 1	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 2	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 3	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 4	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 5	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 6	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 7	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 8	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	225.0	225.0	225.0	300.0				
0 9	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	225.0	225.0	225.0	300.0				
0 10	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	225.0	225.0	225.0	300.0				
0 11	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 12	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 13	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 14	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 15	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 16	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 17	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 18	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 19	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0

	250.0	250.0	250.0	250.0	250.0	300.0				
0 20	300.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0
	175.0	175.0	175.0	175.0	175.0	300.0				
21	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	175.0	175.0	175.0	300.0				
0 22	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	175.0	175.0	175.0	300.0				
0 23	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	175.0	175.0	175.0	300.0				
0 24	300.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	175.0	175.0	175.0	300.0				
0 25	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 26	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 27	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 28	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 29	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 30	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 31	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 32	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 33	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 34	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 35	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				

0 BOTTOM = 30.00000 FOR LAYER 1

0 VERT HYD COND /THICKNESS = .1000000E-02 FOR LAYER 1

0

TRANSMIS. ALONG ROWS FOR LAYER 2 WILL BE READ ON UNIT 11 USING FORMAT: (16F5.0)

	1 11	2 12	3 13	4 14	5 15	6 16	7	8	9	10
1	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
2	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 3	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 4	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 5	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 6	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 7	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 8	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 9	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 10	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 11	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 12	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 13	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 14	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 15	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 16	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 17	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 18	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 19	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.
	6000.	6000.	6000.	6000.	6000.	6000.				

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0 20    4000.       4000.       4000.       4000.       4000.       4000.       1500.       1500.       1500.       4000.
        4000.       4000.       4000.       4000.       4000.       4000.
0 21    3000.       3000.       3000.       3000.       3000.       3000.       1500.       1500.       1500.       3000.
        3000.       3000.       3000.       3000.       3000.       3000.
0 22    3000.       3000.       3000.       3000.       3000.       3000.       1500.       1500.       1500.       3000.
        3000.       3000.       3000.       3000.       3000.       3000.
0 23    3000.       3000.       3000.       3000.       3000.       3000.       1500.       1500.       1500.       3000.
        3000.       3000.       3000.       3000.       3000.       3000.
0 24    3000.       3000.       3000.       3000.       3000.       3000.       1500.       1500.       1500.       3000.
        3000.       3000.       3000.       3000.       3000.       3000.
0 25    3000.       3000.       3000.       3000.       3000.       3000.       1500.       1500.       1500.       3000.
        3000.       3000.       3000.       3000.       3000.       3000.
0 26    3000.       3000.       3000.       3000.       3000.       3000.       1500.       1500.       1500.       3000.
        3000.       3000.       3000.       3000.       3000.       3000.
0 27    3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.
        3000.       3000.       3000.       3000.       3000.       3000.
0 28    3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.
        3000.       3000.       3000.       3000.       3000.       3000.
0 29    3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.
        3000.       3000.       3000.       3000.       3000.       3000.
0 30    3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.
        3000.       3000.       3000.       3000.       3000.       3000.
0 31    3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.
        3000.       3000.       3000.       3000.       3000.       3000.
0 32    3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.
        3000.       3000.       3000.       3000.       3000.       3000.
0 33    3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.
        3000.       3000.       3000.       3000.       3000.       3000.
0 34    3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.
        3000.       3000.       3000.       3000.       3000.       3000.
0 35    3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.       3000.
        3000.       3000.       3000.       3000.       3000.       3000.
0

                                                             SOLUTION BY THE STRONGLY IMPLICIT PROCEDURE
                                                             -------------------------------------------
0                                                    MAXIMUM ITERATIONS ALLOWED FOR CLOSURE =       50
                                                                  ACCELERATION PARAMETER =     1.0000
                                                         HEAD CHANGE CRITERION FOR CLOSURE =    .10000E-02
                                                         SIP HEAD CHANGE PRINTOUT INTERVAL =       1
0                                                        CALCULATE ITERATION PARAMETERS FROM MODEL CALCULATED WSEED
1                                                       STRESS PERIOD NO.    1, LENGTH =   1.000000
                                                        ----------------------------------------------

                                                        NUMBER OF TIME STEPS =     1

                                                         MULTIPLIER FOR DELT =     1.000

                                                      INITIAL TIME STEP SIZE =   1.000000
0             6 WELLS
                                                     LAYER     ROW     COL     STRESS RATE   WELL NO.
                                                     --------------------------------------------
                                                       1        13      8      -9241.0          1
                                                       1        17      8      -5005.0          2
                                                       1        24      8      -11070.          3
                                                       2        13      8      -14439.          4
                                                       2        17      8      -12513.          5
                                                       2        24      8      -11070.          6
0AVERAGE SEED =   .00187924
 MINIMUM SEED =   .00055600
0
    5 ITERATION PARAMETERS CALCULATED FROM AVERAGE SEED:

             .0000000E+00   .7917928E+00   .9566497E+00   .9909742E+00   .9981208E+00
0
    11 ITERATIONS FOR TIME STEP    1 IN STRESS PERIOD   1
0MAXIMUM HEAD CHANGE FOR EACH ITERATION:
0 HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL
 ------------------------------------------------------------------------------------------------------------------------------------
   -6.775      (  2, 13,  8)  -.8171      (  2, 12,  9)  -.5029      (  2, 14,  8)  -.3867      (  2, 18,  9)  -.7183E-01 (  2, 23, 10)
   -.1809E-01 (  2,  9,  8)   .1107E-01 (  2, 21,  7)   .1159E-01 (  2, 17,  8)   .4755E-02 (  2, 21, 10)  -.1430E-02 (  2, 17,  7)
    .4733E-03 (  2,  9, 10)
0
0HEAD/DRAWDOWN PRINTOUT FLAG = 1     TOTAL BUDGET PRINTOUT FLAG = 1     CELL-BY-CELL FLOW TERM FLAG = 0
0OUTPUT FLAGS FOR EACH LAYER:
           HEAD    DRAWDOWN  HEAD  DRAWDOWN
 LAYER  PRINTOUT  PRINTOUT  SAVE    SAVE
 ----------------------------------------
    1        1         1      1       1
    2        1         1      1       1
1                   HEAD IN LAYER  1 AT END OF TIME STEP  1 IN STRESS PERIOD  1
```

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.55	92.67	92.78	92.88	92.99	93.13	93.24	93.35	93.45	93.55	93.65	93.75	93.83	93.92	94.00
0 3	92.00	92.13	92.25	92.36	92.46	92.57	92.69	92.80	92.90	93.00	93.10	93.20	93.29	93.37	93.45	93.50
0 4	91.60	91.72	91.84	91.95	92.05	92.15	92.26	92.36	92.46	92.56	92.65	92.75	92.84	92.91	93.00	93.10
0 5	91.20	91.32	91.45	91.56	91.65	91.74	91.84	91.93	92.03	92.12	92.20	92.29	92.38	92.45	92.52	92.60
0 6	90.70	90.86	91.00	91.12	91.21	91.29	91.39	91.48	91.57	91.66	91.74	91.83	91.92	91.99	92.05	92.10
0 7	90.20	90.36	90.51	90.63	90.73	90.82	90.91	91.00	91.09	91.18	91.27	91.37	91.47	91.54	91.59	91.60
0 8	89.70	89.89	90.05	90.16	90.26	90.35	90.44	90.53	90.61	90.70	90.78	90.87	90.97	91.04	91.08	91.10
0 9	89.40	89.50	89.62	89.72	89.80	89.89	89.97	90.05	90.13	90.21	90.29	90.36	90.44	90.49	90.51	90.50
0 10	89.00	89.10	89.20	89.28	89.35	89.43	89.50	89.57	89.65	89.73	89.80	89.86	89.92	89.96	89.99	90.00
0 11	88.70	88.74	88.81	88.87	88.93	88.98	89.03	89.08	89.16	89.25	89.32	89.38	89.44	89.48	89.50	89.50
0 12	88.30	88.39	88.45	88.50	88.53	88.55	88.55	88.55	88.67	88.79	88.88	88.94	89.00	89.04	89.07	89.10
0 13	88.00	88.06	88.10	88.13	88.14	88.13	88.08	87.92	88.18	88.34	88.44	88.51	88.57	88.61	88.62	88.60
0 14	87.70	87.75	87.77	87.78	87.77	87.75	87.72	87.70	87.81	87.93	88.03	88.10	88.16	88.20	88.22	88.20
0 15	87.50	87.48	87.46	87.44	87.42	87.38	87.35	87.36	87.43	87.52	87.63	87.70	87.76	87.81	87.85	87.90
0 16	87.30	87.20	87.15	87.11	87.08	87.03	87.00	86.99	87.06	87.15	87.24	87.32	87.38	87.44	87.48	87.50
0 17	87.00	86.88	86.81	86.78	86.74	86.71	86.67	86.60	86.72	86.80	86.88	86.95	87.01	87.07	87.13	87.20
0 18	86.50	86.48	86.45	86.43	86.41	86.39	86.37	86.36	86.41	86.47	86.53	86.58	86.63	86.69	86.77	86.90
0 19	86.00	86.07	86.09	86.09	86.08	86.07	86.06	86.06	86.09	86.13	86.18	86.22	86.25	86.30	86.35	86.40
0 20	85.60	85.64	85.67	85.68	85.69	85.68	85.67	85.67	85.69	85.72	85.75	85.78	85.78	85.80	85.83	85.90
21	85.10	85.16	85.19	85.20	85.21	85.19	85.17	85.16	85.17	85.20	85.22	85.23	85.22	85.20	85.17	85.10
22	84.70	84.71	84.72	84.72	84.70	84.66	84.61	84.57	84.59	84.63	84.66	84.67	84.65	84.62	84.56	84.50
0 23	84.20	84.25	84.27	84.27	84.21	84.14	84.03	83.93	84.00	84.07	84.11	84.12	84.10	84.05	83.94	83.80
0 24	83.80	83.83	83.84	83.81	83.74	83.63	83.46	83.09	83.41	83.54	83.59	83.60	83.59	83.52	83.40	83.30
0 25	83.50	83.45	83.42	83.37	83.30	83.20	83.08	82.96	83.02	83.08	83.11	83.11	83.08	83.01	82.89	82.80
0 26	83.10	83.05	83.00	82.94	82.87	82.79	82.71	82.65	82.64	82.65	82.65	82.63	82.58	82.51	82.41	82.30
0 27	82.70	82.63	82.57	82.51	82.45	82.39	82.33	82.28	82.25	82.23	82.21	82.17	82.12	82.04	81.96	81.90
0 28	82.20	82.18	82.14	82.09	82.03	81.98	81.93	81.88	81.85	81.81	81.78	81.73	81.67	81.59	81.50	81.40
0 29	81.80	81.75	81.70	81.65	81.61	81.57	81.52	81.48	81.44	81.40	81.35	81.30	81.23	81.15	81.07	81.00
0 30	81.30	81.28	81.25	81.22	81.19	81.15	81.11	81.07	81.03	80.99	80.93	80.87	80.80	80.73	80.65	80.60
0 31	80.80	80.80	80.80	80.78	80.76	80.74	80.70	80.67	80.63	80.58	80.52	80.45	80.38	80.30	80.23	80.20
0 32	80.30	80.34	80.35	80.35	80.34	80.32	80.30	80.26	80.22	80.17	80.11	80.04	79.96	79.87	79.78	79.70
0 33	79.90	79.90	79.91	79.92	79.92	79.91	79.89	79.87	79.83	79.77	79.70	79.62	79.53	79.44	79.35	79.30
0 34	79.40	79.44	79.46	79.50	79.51	79.50	79.49	79.48	79.45	79.38	79.30	79.21	79.12	79.01	78.91	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

1 HEAD IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	

92.10

0 2	90.90	90.96	91.05	91.13	91.21	91.26	91.34	91.42	91.49	91.53	91.58	91.62	91.67	91.70	91.7	91.80
0 3	90.60	90.70	90.78	90.86	90.93	91.00	91.06	91.13	91.19	91.23	91.27	91.31	91.35	91.38	91.	91.40
0 4	90.40	90.44	90.51	90.58	90.65	90.72	90.78	90.84	90.89	90.93	90.96	90.99	91.01	91.04	91.06	91.10
0 5	90.10	90.16	90.22	90.29	90.36	90.43	90.50	90.55	90.59	90.62	90.64	90.65	90.67	90.69	90.70	90.70
0 6	89.80	89.86	89.93	89.99	90.06	90.13	90.21	90.27	90.30	90.30	90.30	90.31	90.32	90.33	90.33	90.30
0 7	89.50	89.56	89.62	89.68	89.74	89.83	89.94	90.01	90.02	89.98	89.95	89.95	89.96	89.98	89.99	90.00
0 8	89.20	89.27	89.31	89.35	89.40	89.50	89.71	89.80	89.78	89.62	89.58	89.57	89.59	89.61	89.65	89.70
0 9	89.00	88.99	88.99	88.99	89.01	89.04	89.22	89.30	89.28	89.15	89.15	89.16	89.20	89.23	89.27	89.30
0 10	88.70	88.70	88.67	88.63	88.60	88.57	88.51	88.44	88.56	88.65	88.69	88.74	88.79	88.84	88.90	89.00
0 11	88.50	88.43	88.34	88.26	88.17	88.08	87.73	87.31	87.76	88.12	88.21	88.30	88.37	88.44	88.49	88.50
0 12	88.30	88.16	88.02	87.89	87.74	87.57	86.67	85.23	86.67	87.57	87.73	87.86	87.96	88.04	88.10	88.10
0 13	88.10	87.89	87.70	87.52	87.32	87.07	85.31	80.08	85.29	87.04	87.27	87.44	87.57	87.67	87.75	87.80
0 14	87.80	87.58	87.38	87.17	86.94	86.69	85.86	84.66	85.83	86.64	86.86	87.05	87.20	87.32	87.42	87.50
0 15	87.50	87.27	87.05	86.83	86.58	86.29	85.95	85.77	85.91	86.23	86.48	86.69	86.85	86.98	87.09	87.20
0 16	87.10	86.93	86.74	86.53	86.28	86.03	85.79	85.61	85.75	85.97	86.18	86.37	86.53	86.65	86.77	86.90
0 17	86.80	86.61	86.44	86.24	86.03	85.81	85.55	85.12	85.52	85.74	85.92	86.08	86.22	86.34	86.43	86.50
0 18	86.40	86.29	86.14	85.98	85.81	85.64	85.49	85.36	85.46	85.57	85.69	85.82	85.93	86.03	86.11	86.20
0 19	86.10	85.99	85.87	85.73	85.59	85.48	85.41	85.35	85.37	85.40	85.47	85.57	85.66	85.73	85.79	85.80
0 20	85.70	85.65	85.54	85.42	85.30	85.21	85.12	85.06	85.07	85.11	85.17	85.25	85.33	85.39	85.43	85.40
0 21	85.30	85.22	85.11	84.98	84.85	84.72	84.57	84.46	84.51	84.61	84.70	84.79	84.88	84.94	84.98	85.00
0 22	84.90	84.76	84.62	84.48	84.31	84.14	83.90	83.69	83.83	84.02	84.16	84.28	84.37	84.45	84.50	84.50
0 23	84.40	84.29	84.15	83.99	83.79	83.54	83.09	82.53	83.02	83.42	83.62	83.78	83.89	83.98	84.05	84.10
0 24	84.00	83.86	83.71	83.53	83.30	82.99	82.21	80.30	82.14	82.86	83.13	83.31	83.44	83.54	83.	83.70
0 25	83.60	83.45	83.29	83.11	82.90	82.64	82.18	81.62	82.10	82.51	82.72	82.88	83.01	83.11	83.2	83.30
0 26	83.20	83.04	82.88	82.72	82.54	82.34	82.06	81.85	81.99	82.21	82.36	82.49	82.60	82.70	82.79	82.90
0 27	82.80	82.63	82.48	82.34	82.18	82.02	81.84	81.75	81.78	81.90	82.01	82.11	82.20	82.29	82.38	82.50
0 28	82.30	82.20	82.08	81.96	81.84	81.71	81.61	81.54	81.55	81.60	81.67	81.74	81.81	81.88	81.95	82.00
0 29	81.90	81.79	81.69	81.58	81.48	81.39	81.32	81.27	81.26	81.28	81.32	81.36	81.42	81.47	81.53	81.60
0 30	81.50	81.38	81.29	81.20	81.12	81.05	80.99	80.96	80.94	80.94	80.96	80.99	81.02	81.06	81.12	81.20
0 31	81.00	80.95	80.88	80.81	80.75	80.70	80.65	80.62	80.60	80.59	80.60	80.61	80.62	80.65	80.68	80.70
0 32	80.60	80.54	80.47	80.42	80.37	80.33	80.29	80.27	80.25	80.23	80.23	80.22	80.22	80.23	80.25	80.30
0 33	80.20	80.12	80.06	80.02	79.98	79.96	79.93	79.91	79.89	79.87	79.85	79.84	79.82	79.81	79.80	79.80
0 34	79.70	79.69	79.64	79.61	79.59	79.58	79.57	79.55	79.53	79.49	79.47	79.46	79.42	79.39	79.35	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

0HEAD WILL BE SAVED ON UNIT 30 AT END OF TIME STEP 1, STRESS PERIOD 1

1 DRAWDOWN IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.05	.03	.02	.02	.01	.07	.06	.05	.05	.05	.05	.05	-.03	-.02	.00
0 3	.00	.07	.05	.04	.04	.13	.11	.10	.10	.10	.10	-.00	.01	.03	.05	.00
0 4	.00	.08	.06	.05	.15	.15	.14	.14	.14	.14	.15	.05	.06	-.01	.00	.00
0 5	.00	.08	.05	.04	.15	.16	.16	.17	.17	.18	.20	.11	.02	.05	.08	.00
0 6	.00	.04	.00	.08	.19	.21	.21	.22	.23	.24	.16	.17	.08	.11	.05	.00
0 7	.00	.04	.09	.07	.17	.18	.19	.20	.21	.22	.23	.13	.13	.06	.01	.00

0 8	.00	.01	.05	.14	.14	.15	.16	.17	.19	.20	.22	.13	.13	.06	.02	.00
0 9	.00	.00	.08	.08	.20	.21	.23	.25	.17	.19	.21	.14	.16	.11	.09	.00
10	.00	.10	.10	.12	.15	.17	.20	.23	.25	.17	.20	.14	.08	.04	.01	.00
11	.00	.06	.09	.13	.17	.22	.27	.32	.24	.25	.18	.22	.16	.12	-.00	.00
12	.00	.01	.15	.20	.27	.35	.35	.45	.33	.31	.22	.16	.10	.06	.03	.00
0 13	.00	.04	.10	.17	.26	.37	.52	.68	.52	.36	.26	.19	.13	.09	.08	.00
0 14	.00	.05	.13	.22	.33	.35	.48	.50	.49	.37	.27	.20	.14	.10	.08	.00
0 15	.00	.12	.14	.26	.28	.42	.45	.54	.47	.38	.27	.20	.14	.09	.05	.00
0 16	.00	.10	.15	.19	.32	.37	.50	.51	.44	.45	.36	.28	.22	.16	.02	.00
0 17	.00	.02	.19	.22	.26	.39	.43	.60	.48	.40	.32	.25	.19	.13	.07	.00
0 18	.00	.02	.15	.17	.29	.31	.43	.44	.39	.33	.27	.22	.17	.11	.03	.00
0 19	.00	.03	.11	.21	.32	.33	.34	.44	.41	.37	.32	.28	.15	.10	.05	.00
0 20	.00	.06	.13	.22	.31	.32	.33	.43	.41	.38	.35	.22	.22	.10	.07	.00
0 21	.00	.04	.11	.20	.29	.31	.43	.44	.43	.40	.28	.27	.18	.10	.03	.00
0 22	.00	.09	.18	.18	.30	.34	.39	.53	.41	.37	.34	.23	.15	.08	.04	.00
0 23	.00	.05	.13	.23	.29	.36	.47	.57	.50	.43	.29	.28	.20	.15	.06	.00
0 24	.00	.07	.16	.19	.26	.47	.64	.91	.59	.46	.31	.20	.21	.08	.00	.00
0 25	.00	.05	.08	.23	.30	.40	.52	.64	.48	.42	.29	.19	.12	.09	.01	.00
0 26	.00	.05	.10	.16	.23	.31	.39	.45	.36	.35	.25	.17	.12	.09	-.01	.00
0 27	.00	.07	.13	.19	.25	.21	.27	.32	.35	.27	.19	.23	.08	.06	.04	.00
0 28	.00	.02	.06	.11	.17	.22	.27	.22	.25	.19	.22	.17	.13	.11	.00	.00
0 29	.00	.05	.10	.15	.09	.13	.18	.22	.16	.20	.15	.10	.07	.05	.03	.00
0 30	.00	.02	.05	.08	.11	.15	.19	.13	.17	.11	.17	.13	.10	.07	.05	.00
0 31	.00	-.00	.00	.02	.04	.06	.10	.13	.07	.12	.08	.05	.02	.00	.07	.00
0 32	.00	.06	.05	.05	.06	.08	.10	.04	.08	.03	.09	.06	.04	.03	.02	.00
0 33	.00	.00	-.01	.08	.08	.09	.01	.03	.07	.03	.00	.08	.07	.06	.05	.00
0 34	.00	-.04	.04	.00	-.01	-.00	.01	.02	.05	.02	.00	-.01	-.02	-.01	-.01	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

1 DRAWDOWN IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.04	.05	-.03	-.01	.04	.06	-.02	.01	-.03	.02	-.02	.03	-.00	.04	.00
0 3	.00	.00	.02	.04	.07	.00	.04	.07	.01	.07	.03	-.01	.05	.02	-.00	.00
0 4	.00	.06	-.01	.02	.05	-.02	.02	.06	.01	.07	.04	.01	.09	.06	.04	.00
0 5	.00	.04	.08	.01	.04	.07	.00	.05	.01	.08	.06	.05	.03	.01	.00	.00
0 6	.00	.04	.07	.01	.04	.07	-.01	.03	.00	.00	.10	.09	.08	.07	.07	.00
0 7	.00	.04	.08	.12	.06	.07	-.04	-.01	-.02	.02	.15	.15	.14	.12	.01	.00
0 8	.00	.03	.09	.15	.10	.10	-.11	-.10	-.08	.08	.12	.13	.11	.09	.05	.00
0 9	.00	.11	.11	.21	.29	.26	.08	.10	.12	.25	.25	.24	.20	.17	.03	.00
0 10	.00	.10	.23	.27	.40	.43	.49	.66	.54	.45	.41	.36	.21	.16	.10	.00
0 11	.00	.17	.26	.34	.53	.62	.97	1.49	1.04	.68	.49	.40	.33	.26	.11	.00
0 12	.00	.14	.28	.51	.66	.83	1.83	3.27	1.83	.83	.67	.54	.44	.26	.10	.00
13	.00	.21	.40	.58	.78	1.03	2.89	8.12	2.91	1.06	.83	.66	.43	.33	.15	.00
14	.00	.22	.42	.63	.96	1.21	2.04	3.24	2.07	1.16	.94	.65	.50	.28	.18	.00
15	.00	.23	.45	.67	1.02	1.31	1.65	1.83	1.69	1.37	1.02	.71	.45	.32	.11	.00
0 16	.00	.17	.46	.67	1.02	1.27	1.51	1.69	1.45	1.23	.92	.63	.47	.25	.13	.00
0 17	.00	.19	.36	.66	.87	1.09	1.35	1.68	1.28	1.06	.78	.62	.38	.26	.07	.00
0 18	.00	.11	.36	.52	.69	.86	.91	1.04	.94	.83	.61	.48	.27	.17	.09	.00
0 19	.00	.11	.23	.37	.51	.52	.59	.65	.63	.50	.43	.33	.14	.07	.01	.00
0 20	.00	.15	.26	.28	.40	.39	.48	.54	.53	.39	.33	.25	.07	.01	-.03	.00
0 21	.00	.08	.19	.32	.45	.48	.63	.74	.59	.49	.40	.31	.12	.06	.02	.00
0 22	.00	.14	.28	.42	.49	.66	.90	1.11	.87	.68	.54	.32	.23	.15	.10	.00
0 23	.00	.11	.25	.41	.61	.86	1.21	1.77	1.28	.88	.58	.42	.31	.22	.05	.00
0 24	.00	.14	.29	.47	.70	.91	1.69	3.60	1.76	1.04	.67	.49	.36	.26	.08	.00
0 25	.00	.15	.31	.39	.60	.86	1.32	1.88	1.30	.89	.68	.52	.39	.29	.09	.00
0 26	.00	.16	.22	.38	.56	.76	1.04	1.15	1.01	.79	.64	.51	.40	.20	.11	.00
0 27	.00	.17	.22	.36	.52	.58	.76	.85	.82	.70	.49	.39	.30	.21	.12	.00
0 28	.00	.10	.22	.34	.36	.49	.59	.66	.65	.50	.43	.36	.29	.22	.05	.00
0 29	.00	.11	.21	.22	.32	.41	.48	.43	.44	.42	.38	.24	.18	.13	.07	.00
0 30	.00	.12	.11	.20	.28	.35	.31	.34	.36	.36	.24	.21	.18	.14	.08	.00
0 31	.00	.05	.12	.19	.15	.20	.25	.28	.30	.21	.20	.19	.18	.05	.02	.00
0 32	.00	.06	.13	.08	.13	.17	.21	.13	.15	.17	.17	.08	.08	.07	.05	.00
0 33	.00	.08	.04	.08	.12	.14	.07	.09	.11	.13	.05	.06	.08	.09	.00	.00
0 34	.00	.01	.06	.09	.01	.02	.03	.05	.07	.01	.03	.04	-.02	.01	.05	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

0DRAWDOWN WILL BE SAVED ON UNIT 40 AT END OF TIME STEP 1, STRESS PERIOD 1

0

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 1

0	CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
	IN:		IN:	
	---		---	
	STORAGE =	.00000	STORAGE =	.00000
	CONSTANT HEAD =	.17005E+06	CONSTANT HEAD =	.17005E+06
	WELLS =	.00000	WELLS =	.00000

```
0                         TOTAL IN =    .17005E+06
0                       OUT:
                        ----
                           STORAGE =    .00000
                     CONSTANT HEAD =    .10669E+06
                             WELLS =    63338.
0                        TOTAL OUT =    .17003E+06
0                         IN - OUT =    18.359
0              PERCENT DISCREPANCY =                  .01
```


```
                          TOTAL IN =    .17005E+06
                        OUT:
                        ----
                           STORAGE =    .00000
                     CONSTANT HEAD =    .10669E+06
                             WELLS =    63338.
                         TOTAL OUT =    .17003E+06
                          IN - OUT =    18.359
               PERCENT DISCREPANCY =                  .01
```


```
0

        TIME SUMMARY AT END OF TIME STEP  1 IN STRESS PERIOD  1
                             SECONDS       MINUTES       HOURS         DAYS          YEARS
                             -----------------------------------------------------------------
      TIME STEP LENGTH       86400.0       1440.00       24.0000       1.00000       .273785E-02
    STRESS PERIOD TIME       86400.0       1440.00       24.0000       1.00000       .273785E-02
 TOTAL SIMULATION TIME       86400.0       1440.00       24.0000       1.00000       .273785E-02
1
```

```
1                     U.S. GEOLOGICAL SURVEY MODULAR FINITE-DIFFERENCE GROUND-WATER MODEL
0SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     SIMULATION 1 - ALL WELLS PLUS RIW2 DEEP
    2 LAYERS        35 ROWS         16 COLUMNS
   1 STRESS PERIOD(S) IN SIMULATION
 MODEL TIME UNIT IS DAYS
0I/O UNITS:
 ELEMENT OF IUNIT:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
        I/O UNIT: 11 12  0  0  0  0  0  0 19  0  0 22  0  0  0  0  0  0  0  0  0  0  0  0
0BAS1 -- BASIC MODEL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT  1
 ARRAYS RHS AND BUFF WILL SHARE MEMORY.
 START HEAD WILL BE SAVED
    10699 ELEMENTS IN X ARRAY ARE USED BY BAS
    10699 ELEMENTS OF X ARRAY USED OUT OF  100000
0BCF1 -- BLOCK-CENTERED FLOW PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 11
 STEADY-STATE SIMULATION
      LAYER  AQUIFER TYPE
      -------------------
        1          1
        2          0
     1122 ELEMENTS IN X ARRAY ARE USED BY BCF
    11821 ELEMENTS OF X ARRAY USED OUT OF  100000
0WEL1 -- WELL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM 12
 MAXIMUM OF     6 WELLS
       24 ELEMENTS IN X ARRAY ARE USED FOR WELLS
    11845 ELEMENTS OF X ARRAY USED OUT OF  100000
0SIP1 -- STRONGLY IMPLICIT PROCEDURE SOLUTION PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 19
 MAXIMUM OF  50 ITERATIONS ALLOWED FOR CLOSURE
  5 ITERATION PARAMETERS
     4685 ELEMENTS IN X ARRAY ARE USED BY SIP
    16530 ELEMENTS OF X ARRAY USED OUT OF  100000
1SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     SIMULATION 1 - ALL WELLS PLUS RIW2 DEEP
0
```

BOUNDARY ARRAY FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
0 2	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 3	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 4	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 5	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 6	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 7	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 8	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 9	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 10	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 11	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 12	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 13	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 14	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 15	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 16	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 17	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 18	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 19	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 20	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 21	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 22	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 23	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 24	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 25	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 26	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 27	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 28	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 29	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 30	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 31	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 32	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 33	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 34	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 35	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

0

BOUNDARY ARRAY FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

0 1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
0 2	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 3	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 4	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 5	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 6	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 7	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 8	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 9	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 10	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 11	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 12	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 13	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 14	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 15	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 16	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 17	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 18	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 19	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 20	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 21	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 22	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 23	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 24	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 25	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 26	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 27	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 28	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 29	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 30	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 31	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 32	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 33	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 34	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 35	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2

0AQUIFER HEAD WILL BE SET TO 999.99 AT ALL NO-FLOW NODES (IBOUND=0).
0

INITIAL HEAD FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.60	92.70	92.80	92.90	93.00	93.20	93.30	93.40	93.50	93.60	93.70	93.80	93.80	93.90	94.00
0 3	92.00	92.20	92.30	92.40	92.50	92.70	92.80	92.90	93.00	93.10	93.20	93.20	93.30	93.40	93.50	93.50
0 4	91.60	91.80	91.90	92.00	92.20	92.30	92.40	92.50	92.60	92.70	92.80	92.80	92.90	92.90	93.00	93.10
0 5	91.20	91.40	91.50	91.60	91.80	91.90	92.00	92.10	92.20	92.30	92.40	92.40	92.40	92.50	92.60	92.60
0 6	90.70	90.90	91.00	91.20	91.40	91.50	91.60	91.70	91.80	91.90	91.90	92.00	92.00	92.10	92.10	92.10
0 7	90.20	90.40	90.60	90.70	90.90	91.00	91.10	91.20	91.30	91.40	91.50	91.50	91.60	91.60	91.60	91.60
0 8	89.70	89.90	90.10	90.30	90.40	90.50	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.10	91.10	91.10
0 9	89.40	89.50	89.70	89.80	90.00	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.60	90.50
0 10	89.00	89.20	89.30	89.40	89.50	89.60	89.70	89.80	89.90	89.90	90.00	90.00	90.00	90.00	90.00	90.00
0 11	88.70	88.80	88.90	89.00	89.10	89.20	89.30	89.40	89.40	89.50	89.50	89.60	89.60	89.60	89.50	89.50
0 12	88.30	88.40	88.60	88.70	88.80	88.90	88.90	89.00	89.00	89.10	89.10	89.10	89.10	89.10	89.10	89.10
0 13	88.00	88.10	88.20	88.30	88.40	88.50	88.60	88.60	88.70	88.70	88.70	88.70	88.70	88.70	88.70	88.60
0 14	87.70	87.80	87.90	88.00	88.10	88.10	88.20	88.20	88.30	88.30	88.30	88.30	88.30	88.30	88.30	88.20
0 15	87.50	87.60	87.60	87.70	87.70	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.90	87.90	87.90	87.90
0 16	87.30	87.30	87.30	87.30	87.40	87.40	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.50	87.50
0 17	87.00	86.90	87.00	87.00	87.00	87.10	87.10	87.20	87.20	87.20	87.20	87.20	87.20	87.20	87.20	87.20
0 18	86.50	86.50	86.60	86.60	86.70	86.70	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.90
0 19	86.00	86.10	86.20	86.30	86.40	86.40	86.40	86.50	86.50	86.50						

	86.50	86.50	86.40	86.40	86.40	86.40				
0 20	85.60	85.70	85.80	85.90	86.00	86.00	86.00	86.10	86.10	86.10
	86.10	86.00	86.00	85.90	85.90	85.90				
21	85.10	85.20	85.30	85.40	85.50	85.50	85.60	85.60	85.60	85.60
	85.50	85.50	85.40	85.30	85.20	85.10				
0 22	84.70	84.80	84.90	84.90	85.00	85.00	85.00	85.10	85.00	85.00
	85.00	84.90	84.80	84.70	84.60	84.50				
0 23	84.20	84.30	84.40	84.50	84.50	84.50	84.50	84.50	84.50	84.50
	84.40	84.40	84.30	84.20	84.00	83.80				
0 24	83.80	83.90	84.00	84.00	84.00	84.10	84.10	84.00	84.00	84.00
	83.90	83.80	83.80	83.60	83.40	83.30				
0 25	83.50	83.50	83.50	83.60	83.60	83.60	83.60	83.60	83.50	83.50
	83.40	83.30	83.20	83.10	82.90	82.80				
0 26	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.00	83.00
	82.90	82.80	82.70	82.60	82.40	82.30				
0 27	82.70	82.70	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.50
	82.40	82.40	82.20	82.10	82.00	81.90				
0 28	82.20	82.20	82.20	82.20	82.20	82.20	82.20	82.10	82.10	82.00
	82.00	81.90	81.80	81.70	81.50	81.40				
0 29	81.80	81.80	81.80	81.80	81.70	81.70	81.70	81.70	81.60	81.60
	81.50	81.40	81.30	81.20	81.10	81.00				
0 30	81.30	81.30	81.30	81.30	81.30	81.30	81.30	81.20	81.20	81.10
	81.10	81.00	80.90	80.80	80.70	80.60				
0 31	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.70	80.70
	80.60	80.50	80.40	80.30	80.30	80.20				
0 32	80.30	80.40	80.40	80.40	80.40	80.40	80.40	80.30	80.30	80.20
	80.20	80.10	80.00	79.90	79.80	79.70				
0 33	79.90	79.90	79.90	80.00	80.00	80.00	79.90	79.90	79.90	79.80
	79.70	79.70	79.60	79.50	79.40	79.30				
0 34	79.40	79.40	79.50	79.50	79.50	79.50	79.50	79.50	79.50	79.40
	79.30	79.20	79.10	79.00	78.90	78.80				
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00
	78.90	78.80	78.70	78.60	78.50	78.40				
0										

INITIAL HEAD FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1 11	2 12	3 13	4 14	5 15	6 16	7	8	9	10
0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80
	91.90	91.90	92.00	92.00	92.10	92.10				
2	90.90	91.00	91.10	91.10	91.20	91.30	91.40	91.40	91.50	91.50
	91.60	91.60	91.70	91.70	91.80	91.80				
3	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.20	91.20	91.30
	91.30	91.30	91.40	91.40	91.40	91.40				
0 4	90.40	90.50	90.50	90.60	90.70	90.70	90.80	90.90	90.90	91.00
	91.00	91.00	91.10	91.10	91.10	91.10				
0 5	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.70
	90.70	90.70	90.70	90.70	90.70	90.70				
0 6	89.80	89.90	90.00	90.00	90.10	90.20	90.20	90.30	90.30	90.30
	90.40	90.40	90.40	90.40	90.40	90.30				
0 7	89.50	89.60	89.70	89.80	89.80	89.90	89.90	90.00	90.00	90.00
	90.10	90.10	90.10	90.10	90.00	90.00				
0 8	89.20	89.30	89.40	89.50	89.50	89.60	89.60	89.70	89.70	89.70
	89.70	89.70	89.70	89.70	89.70	89.70				
0 9	89.00	89.10	89.10	89.20	89.30	89.30	89.30	89.40	89.40	89.40
	89.40	89.40	89.40	89.40	89.30	89.30				
0 10	88.70	88.80	88.90	88.90	89.00	89.00	89.00	89.10	89.10	89.10
	89.10	89.10	89.00	89.00	89.00	89.00				
0 11	88.50	88.60	88.60	88.60	88.70	88.70	88.70	88.80	88.80	88.80
	88.70	88.70	88.70	88.70	88.60	88.50				
0 12	88.30	88.30	88.30	88.40	88.40	88.40	88.50	88.50	88.50	88.40
	88.40	88.40	88.40	88.30	88.20	88.10				
0 13	88.10	88.10	88.10	88.10	88.10	88.10	88.20	88.20	88.20	88.10
	88.10	88.10	88.00	88.00	87.90	87.80				
0 14	87.80	87.80	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.80
	87.80	87.70	87.70	87.60	87.60	87.50				
0 15	87.50	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.60
	87.50	87.40	87.30	87.30	87.20	87.20				
0 16	87.10	87.10	87.20	87.20	87.30	87.30	87.30	87.30	87.20	87.20
	87.10	87.00	87.00	86.90	86.90	86.90				
0 17	86.80	86.80	86.80	86.90	86.90	86.90	86.90	86.80	86.80	86.80
	86.70	86.70	86.60	86.60	86.50	86.50				
0 18	86.40	86.40	86.50	86.50	86.50	86.50	86.40	86.40	86.40	86.40
	86.30	86.30	86.20	86.20	86.20	86.20				
0 19	86.10	86.10	86.10	86.10	86.10	86.00	86.00	86.00	86.00	85.90
	85.90	85.90	85.80	85.80	85.80	85.80				
0 20	85.70	85.80	85.80	85.70	85.70	85.60	85.60	85.60	85.60	85.50
	85.50	85.50	85.40	85.40	85.40	85.40				

0 21	85.30	85.30	85.30	85.30	85.30	85.20	85.20	85.20	85.10	85.10
	85.10	85.10	85.00	85.00	85.00	85.00				
0 22	84.90	84.90	84.90	84.90	84.80	84.80	84.80	84.80	84.70	84.70
	84.70	84.60	84.60	84.60	84.60	84.50				
0 23	84.40	84.40	84.40	84.40	84.40	84.40	84.30	84.30	84.30	84.30
	84.20	84.20	84.20	84.20	84.10	84.10				
0 24	84.00	84.00	84.00	84.00	84.00	83.90	83.90	83.90	83.90	83.90
	83.80	83.80	83.80	83.80	83.70	83.70				
0 25	83.60	83.60	83.60	83.50	83.50	83.50	83.50	83.50	83.40	83.40
	83.40	83.40	83.40	83.40	83.30	83.30				
0 26	83.20	83.20	83.10	83.10	83.10	83.10	83.10	83.00	83.00	83.00
	83.00	83.00	83.00	82.90	82.90	82.90				
0 27	82.80	82.80	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.60
	82.50	82.50	82.50	82.50	82.50	82.50				
0 28	82.30	82.30	82.30	82.30	82.20	82.20	82.20	82.20	82.20	82.10
	82.10	82.10	82.10	82.10	82.00	82.00				
0 29	81.90	81.90	81.90	81.80	81.80	81.80	81.80	81.70	81.70	81.70
	81.70	81.60	81.60	81.60	81.60	81.60				
0 30	81.50	81.50	81.40	81.40	81.40	81.40	81.30	81.30	81.30	81.30
	81.20	81.20	81.20	81.20	81.20	81.20				
0 31	81.00	81.00	81.00	81.00	80.90	80.90	80.90	80.90	80.90	80.80
	80.80	80.80	80.80	80.70	80.70	80.70				
0 32	80.60	80.60	80.60	80.50	80.50	80.50	80.50	80.40	80.40	80.40
	80.40	80.30	80.30	80.30	80.30	80.30				
0 33	80.20	80.20	80.10	80.10	80.10	80.10	80.00	80.00	80.00	80.00
	79.90	79.90	79.90	79.90	79.80	79.80				
0 34	79.70	79.70	79.70	79.70	79.60	79.60	79.60	79.60	79.60	79.50
	79.50	79.50	79.40	79.40	79.40	79.30				
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10
	79.10	79.10	79.00	79.00	78.90	78.90				

OHEAD PRINT FORMAT IS FORMAT NUMBER 4 DRAWDOWN PRINT FORMAT IS FORMAT NUMBER 9
OHEADS WILL BE SAVED ON UNIT 30 DRAWDOWNS WILL BE SAVED ON UNIT 40
OOUTPUT CONTROL IS SPECIFIED EVERY TIME STEP
0 COLUMN TO ROW ANISOTROPY = 1.000000
0 DELR = 200.0000
0 DELC = 200.0000
0

HYD. COND. ALONG ROWS FOR LAYER 1 WILL BE READ ON UNIT 11 USING FORMAT: (16F4.0)

	1 11	2 12	3 13	4 14	5 15	6 16	7	8	9	10
0 1	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 2	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 3	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 4	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 5	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 6	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 7	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 8	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	225.0	225.0	225.0	300.0				
0 9	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	225.0	225.0	225.0	300.0				
0 10	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	225.0	225.0	225.0	300.0				
0 11	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 12	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 13	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 14	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 15	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 16	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 17	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 18	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 19	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0

	250.0	250.0	250.0	250.0	250.0	300.0				
0 20	300.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0
	175.0	175.0	175.0	175.0	175.0	300.0				
21	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	175.0	175.0	175.0	300.0				
0 22	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	175.0	175.0	175.0	300.0				
0 23	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	175.0	175.0	175.0	300.0				
0 24	300.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	175.0	175.0	175.0	300.0				
0 25	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 26	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 27	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 28	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 29	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 30	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 31	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 32	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 33	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 34	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 35	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				

0 BOTTOM = 30.00000 FOR LAYER 1

0 VERT HYD COND /THICKNESS = .1000000E-02 FOR LAYER 1

0

TRANSMIS. ALONG ROWS FOR LAYER 2 WILL BE READ ON UNIT 11 USING FORMAT: (16F5.0)

	1 / 11	2 / 12	3 / 13	4 / 14	5 / 15	6 / 16	7	8	9	10
1	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
2	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 3	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 4	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 5	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 6	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 7	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 8	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 9	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 10	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 11	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 12	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 13	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 14	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 15	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 16	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 17	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 18	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 19	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.
	6000.	6000.	6000.	6000.	6000.	6000.				

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0 20   4000.    4000.    4000.    4000.    4000.    4000.    1500.    1500.    1500.    4000.
       4000.    4000.    4000.    4000.    4000.    4000.
0 21   3000.    3000.    3000.    3000.    3000.    3000.    1500.    1500.    1500.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 22   3000.    3000.    3000.    3000.    3000.    3000.    1500.    1500.    1500.    3000.
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0 23   3000.    3000.    3000.    3000.    3000.    3000.    1500.    1500.    1500.    3000.
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0 24   3000.    3000.    3000.    3000.    3000.    3000.    1500.    1500.    1500.    3000.
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0 25   3000.    3000.    3000.    3000.    3000.    3000.    1500.    1500.    1500.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 26   3000.    3000.    3000.    3000.    3000.    3000.    1500.    1500.    1500.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 27   3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 28   3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 29   3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 30   3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 31   3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 32   3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 33   3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 34   3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0 35   3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
       3000.    3000.    3000.    3000.    3000.    3000.
0

                                                     SOLUTION BY THE STRONGLY IMPLICIT PROCEDURE
                                                     -------------------------------------------
0                                           MAXIMUM ITERATIONS ALLOWED FOR CLOSURE =        50
                                                           ACCELERATION PARAMETER =      1.0000
                                                HEAD CHANGE CRITERION FOR CLOSURE =      .10000E-02
                                                SIP HEAD CHANGE PRINTOUT INTERVAL =        1
0                                               CALCULATE ITERATION PARAMETERS FROM MODEL CALCULATED WSEED
1                                              STRESS PERIOD NO.    1, LENGTH =   1.000000
                                               ---------------------------------------------

                                               NUMBER OF TIME STEPS =     1

                                                MULTIPLIER FOR DELT =     1.000

                                             INITIAL TIME STEP SIZE =   1.000000
0            6 WELLS
                                           LAYER    ROW    COL    STRESS RATE    WELL NO.
                                           ----------------------------------------------
                                             1       13      8     -18289.          1
                                             1       17      8     -18289.          2
                                             1       24      8     -24064.          3
                                             2       13      8     -6738.0          4
                                             2       17      8     -4813.0          5
                                             2       24      8     -4813.0          6
0AVERAGE SEED =  .00187924
 MINIMUM SEED =  .00055600
0
   5 ITERATION PARAMETERS CALCULATED FROM AVERAGE SEED:

        .0000000E+00   .7917928E+00   .9566497E+00   .9909742E+00   .9981208E+00
0
   11 ITERATIONS FOR TIME STEP   1 IN STRESS PERIOD   1
0MAXIMUM HEAD CHANGE FOR EACH ITERATION:
0 HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL
 ------------------------------------------------------------------------------------------------------------------------------------
  -3.222     (  2, 13,  8)  -.4210      (  2, 12,  9)  -.3255      (  1, 22,  8)  -.2819      (  1, 20,  8)  -.6267E-01 (  1, 23, 11)
  .9678E-02 (  2, 21,  7)   .8187E-02 (  1, 22,  9)   .6705E-02 (  1, 19,  8)   .4804E-02 (  1, 20,  9)   .1163E-02 (  1, 30,  7)
 -.2623E-03 (  2, 22, 10)
0
0HEAD/DRAWDOWN PRINTOUT FLAG = 1     TOTAL BUDGET PRINTOUT FLAG = 1     CELL-BY-CELL FLOW TERM FLAG = 0
0OUTPUT FLAGS FOR EACH LAYER:
           HEAD     DRAWDOWN  HEAD   DRAWDOWN
 LAYER  PRINTOUT  PRINTOUT  SAVE    SAVE
 ----------------------------------------
    1       1         1        1       1
    2       1         1        1       1
1                          HEAD IN LAYER   1 AT END OF TIME STEP   1 IN STRESS PERIOD   1
```

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.55	92.67	92.77	92.87	92.98	93.12	93.24	93.34	93.44	93.54	93.65	93.74	93.83	93.92	94.00
0 3	92.00	92.13	92.24	92.35	92.45	92.55	92.67	92.78	92.89	92.99	93.09	93.19	93.28	93.37	93.44	93.50
0 4	91.60	91.72	91.83	91.94	92.03	92.13	92.23	92.34	92.44	92.54	92.63	92.73	92.82	92.90	92.99	93.10
0 5	91.20	91.32	91.43	91.54	91.63	91.70	91.80	91.90	91.99	92.09	92.17	92.27	92.36	92.44	92.52	92.60
0 6	90.70	90.85	90.98	91.09	91.18	91.25	91.34	91.43	91.52	91.61	91.70	91.80	91.90	91.97	92.04	92.10
0 7	90.20	90.35	90.48	90.59	90.68	90.76	90.84	90.93	91.02	91.12	91.21	91.32	91.44	91.52	91.57	91.60
0 8	89.70	89.88	90.01	90.11	90.19	90.27	90.35	90.43	90.52	90.61	90.71	90.81	90.93	91.01	91.06	91.10
0 9	89.40	89.48	89.57	89.65	89.71	89.78	89.85	89.92	90.01	90.10	90.19	90.29	90.38	90.45	90.49	90.50
0 10	89.00	89.08	89.14	89.19	89.24	89.29	89.34	89.39	89.48	89.58	89.67	89.76	89.84	89.91	89.97	90.00
0 11	88.70	88.71	88.74	88.77	88.79	88.80	88.81	88.84	88.94	89.06	89.17	89.26	89.35	89.42	89.47	89.50
0 12	88.30	88.35	88.37	88.37	88.36	88.32	88.26	88.21	88.38	88.55	88.69	88.80	88.89	88.97	89.03	89.10
0 13	88.00	88.02	88.01	87.99	87.94	87.86	87.70	87.34	87.80	88.06	88.23	88.35	88.45	88.53	88.59	88.60
0 14	87.70	87.70	87.67	87.62	87.55	87.46	87.35	87.26	87.43	87.62	87.79	87.92	88.03	88.11	88.18	88.20
0 15	87.50	87.43	87.35	87.27	87.18	87.07	86.97	86.92	87.03	87.20	87.37	87.50	87.62	87.72	87.81	87.90
0 16	87.30	87.15	87.03	86.93	86.82	86.69	86.57	86.48	86.62	86.79	86.97	87.11	87.23	87.34	87.43	87.50
0 17	87.00	86.82	86.69	86.58	86.48	86.35	86.18	85.86	86.22	86.43	86.59	86.73	86.85	86.97	87.08	87.20
0 18	86.50	86.42	86.33	86.24	86.15	86.05	85.94	85.85	85.97	86.11	86.24	86.36	86.47	86.59	86.72	86.90
0 19	86.00	86.01	85.97	85.90	85.83	85.75	85.68	85.64	85.70	85.79	85.90	86.00	86.09	86.19	86.30	86.40
0 20	85.60	85.59	85.55	85.50	85.44	85.37	85.31	85.28	85.32	85.39	85.48	85.56	85.63	85.70	85.79	85.90
21	85.10	85.10	85.07	85.02	84.95	84.87	84.79	84.75	84.79	84.86	84.94	85.02	85.06	85.10	85.13	85.10
0 22	84.70	84.66	84.61	84.54	84.44	84.32	84.19	84.11	84.17	84.27	84.37	84.45	84.50	84.52	84.51	84.50
0 23	84.20	84.20	84.16	84.08	83.94	83.76	83.54	83.31	83.50	83.68	83.81	83.90	83.95	83.95	83.90	83.80
0 24	83.80	83.78	83.73	83.63	83.46	83.24	82.87	82.08	82.82	83.13	83.29	83.39	83.44	83.43	83.36	83.30
0 25	83.50	83.41	83.32	83.20	83.04	82.85	82.62	82.37	82.55	82.72	82.83	82.91	82.94	82.92	82.85	82.80
0 26	83.10	83.01	82.91	82.79	82.66	82.51	82.36	82.25	82.28	82.35	82.41	82.45	82.46	82.43	82.37	82.30
0 27	82.70	82.60	82.50	82.39	82.28	82.16	82.06	81.99	81.98	81.99	82.01	82.02	82.01	81.98	81.93	81.90
0 28	82.20	82.16	82.08	81.98	81.89	81.80	81.73	81.67	81.64	81.63	81.62	81.61	81.58	81.53	81.47	81.40
0 29	81.80	81.73	81.65	81.57	81.50	81.43	81.37	81.32	81.28	81.26	81.23	81.20	81.16	81.11	81.05	81.00
0 30	81.30	81.26	81.21	81.16	81.10	81.05	81.00	80.95	80.91	80.88	80.84	80.80	80.75	80.69	80.64	80.60
0 31	80.80	80.79	80.77	80.74	80.70	80.66	80.62	80.58	80.54	80.49	80.45	80.39	80.34	80.27	80.22	80.20
0 32	80.30	80.33	80.33	80.32	80.29	80.27	80.24	80.20	80.16	80.11	80.06	79.99	79.93	79.85	79.77	79.70
0 33	79.90	79.89	79.89	79.90	79.89	79.88	79.85	79.83	79.79	79.73	79.67	79.59	79.52	79.43	79.35	79.30
0 34	79.40	79.44	79.45	79.49	79.49	79.49	79.48	79.46	79.43	79.36	79.28	79.20	79.11	79.01	78.91	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

1 HEAD IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	

92.10

0 2	90.90	90.97	91.05	91.14	91.22	91.27	91.35	91.43	91.50	91.54	91.59	91.63	91.68	91.71	91.7	91.80
0 3	90.60	90.70	90.79	90.87	90.95	91.02	91.09	91.15	91.21	91.25	91.29	91.33	91.36	91.39	91.	91.40
0 4	90.40	90.45	90.52	90.60	90.67	90.75	90.81	90.87	90.92	90.96	90.99	91.01	91.04	91.05	91.07	91.10
0 5	90.10	90.17	90.24	90.32	90.39	90.47	90.54	90.60	90.64	90.66	90.68	90.69	90.70	90.71	90.71	90.70
0 6	89.80	89.88	89.95	90.03	90.11	90.19	90.27	90.33	90.36	90.36	90.36	90.36	90.36	90.36	90.35	90.30
0 7	89.50	89.58	89.66	89.73	89.81	89.91	90.02	90.09	90.10	90.06	90.03	90.02	90.02	90.02	90.01	90.00
0 8	89.20	89.29	89.36	89.42	89.49	89.60	89.81	89.90	89.88	89.73	89.68	89.66	89.66	89.66	89.67	89.70
0 9	89.00	89.02	89.06	89.09	89.13	89.18	89.37	89.47	89.44	89.31	89.29	89.29	89.29	89.30	89.30	89.30
0 10	88.70	88.74	88.75	88.76	88.76	88.77	88.79	88.79	88.85	88.87	88.88	88.89	88.91	88.92	88.94	89.00
0 11	88.50	88.48	88.45	88.42	88.39	88.36	88.21	88.03	88.25	88.42	88.46	88.49	88.52	88.53	88.53	88.50
0 12	88.30	88.22	88.16	88.09	88.02	87.93	87.51	86.84	87.52	87.96	88.03	88.09	88.13	88.15	88.15	88.10
0 13	88.10	87.96	87.85	87.75	87.65	87.52	86.66	84.20	86.66	87.51	87.63	87.71	87.76	87.80	87.81	87.80
0 14	87.80	87.67	87.55	87.43	87.30	87.15	86.69	86.10	86.67	87.12	87.25	87.34	87.41	87.46	87.48	87.50
0 15	87.50	87.36	87.23	87.11	86.96	86.79	86.56	86.45	86.54	86.74	86.90	87.00	87.08	87.13	87.16	87.20
0 16	87.10	87.02	86.92	86.81	86.68	86.55	86.41	86.32	86.39	86.50	86.61	86.70	86.76	86.81	86.85	86.90
0 17	86.80	86.71	86.62	86.53	86.43	86.33	86.21	86.04	86.19	86.28	86.35	86.41	86.46	86.49	86.51	86.50
0 18	86.40	86.38	86.33	86.27	86.20	86.13	86.08	86.02	86.05	86.08	86.11	86.14	86.17	86.18	86.19	86.20
0 19	86.10	86.08	86.05	86.01	85.96	85.94	85.95	85.92	85.91	85.88	85.87	85.88	85.89	85.89	85.86	85.80
0 20	85.70	85.73	85.72	85.68	85.65	85.63	85.61	85.58	85.57	85.55	85.54	85.54	85.55	85.54	85.50	85.40
0 21	85.30	85.30	85.27	85.23	85.18	85.13	85.05	84.99	85.00	85.04	85.06	85.08	85.09	85.08	85.05	85.00
0 22	84.90	84.84	84.79	84.73	84.65	84.57	84.45	84.34	84.39	84.47	84.52	84.56	84.58	84.58	84.56	84.50
0 23	84.40	84.37	84.31	84.24	84.14	84.02	83.80	83.53	83.73	83.91	84.00	84.05	84.09	84.11	84.11	84.10
0 24	84.00	83.94	83.86	83.77	83.65	83.49	83.12	82.26	83.06	83.38	83.50	83.57	83.63	83.66	83.	83.70
0 25	83.60	83.51	83.42	83.32	83.21	83.06	82.82	82.54	82.75	82.95	83.05	83.12	83.18	83.22	83.2	83.30
0 26	83.20	83.10	83.00	82.90	82.79	82.66	82.47	82.34	82.41	82.54	82.62	82.69	82.74	82.79	82.84	82.90
0 27	82.80	82.68	82.58	82.48	82.38	82.26	82.12	82.04	82.06	82.15	82.22	82.27	82.32	82.37	82.42	82.50
0 28	82.30	82.24	82.16	82.08	81.99	81.90	81.81	81.76	81.76	81.79	81.83	81.87	81.91	81.94	81.98	82.00
0 29	81.90	81.82	81.75	81.67	81.60	81.53	81.47	81.43	81.42	81.42	81.44	81.47	81.49	81.52	81.56	81.60
0 30	81.50	81.40	81.33	81.27	81.21	81.15	81.11	81.07	81.05	81.05	81.06	81.07	81.08	81.10	81.14	81.20
0 31	81.00	80.97	80.91	80.86	80.81	80.77	80.73	80.70	80.68	80.67	80.67	80.67	80.67	80.68	80.69	80.70
0 32	80.60	80.55	80.50	80.45	80.41	80.38	80.35	80.33	80.30	80.29	80.27	80.26	80.26	80.25	80.26	80.30
0 33	80.20	80.13	80.08	80.04	80.01	79.99	79.97	79.95	79.92	79.90	79.88	79.86	79.84	79.82	79.81	79.80
0 34	79.70	79.69	79.65	79.62	79.61	79.59	79.58	79.57	79.55	79.51	79.49	79.47	79.43	79.40	79.35	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

0HEAD WILL BE SAVED ON UNIT 30 AT END OF TIME STEP 1, STRESS PERIOD 1

1 DRAWDOWN IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.05	.03	.03	.03	.02	.08	.06	.06	.06	.06	.05	.06	-.03	-.02	.00
0 3	.00	.07	.06	.05	.05	.15	.13	.12	.11	.11	.11	.01	.02	.03	.06	.00
0 4	.00	.08	.07	.06	.17	.17	.17	.16	.16	.16	.17	.07	.08	-.00	.01	.00
0 5	.00	.08	.07	.06	.17	.20	.20	.20	.21	.21	.23	.13	.04	.06	.08	.00
0 6	.00	.05	.02	.11	.22	.25	.26	.27	.28	.29	.20	.20	.10	.13	.06	.00
0 7	.00	.05	.12	.11	.22	.24	.26	.27	.28	.28	.29	.18	.16	.08	.03	.00

0 8	.00	.02	.09	.19	.21	.23	.25	.27	.28	.29	.29	.19	.17	.09	.04	.00
9	.00	.02	.13	.15	.29	.32	.35	.38	.29	.30	.31	.21	.22	.15	.11	.00
10	.00	.12	.16	.21	.26	.31	.36	.41	.42	.32	.33	.24	.16	.09	.03	.00
11	.00	.09	.16	.23	.31	.40	.49	.56	.46	.44	.33	.34	.25	.18	.03	.00
12	.00	.05	.23	.33	.44	.58	.64	.79	.62	.55	.41	.30	.21	.13	.07	.00
0 13	.00	.08	.19	.31	.46	.64	.90	1.26	.90	.64	.47	.35	.25	.17	.11	.00
0 14	.00	.10	.23	.38	.55	.64	.85	.94	.87	.68	.51	.38	.27	.19	.12	.00
0 15	.00	.17	.25	.43	.52	.73	.83	.98	.87	.70	.53	.40	.28	.18	.09	.00
0 16	.00	.15	.27	.37	.58	.71	.93	1.02	.88	.81	.63	.49	.37	.26	.07	.00
0 17	.00	.08	.31	.42	.52	.75	.92	1.34	.98	.77	.61	.47	.35	.23	.12	.00
0 18	.00	.08	.27	.36	.55	.65	.86	.95	.83	.69	.56	.44	.33	.21	.08	.00
0 19	.00	.09	.23	.40	.57	.65	.72	.86	.80	.71	.60	.50	.31	.21	.10	.00
0 20	.00	.11	.25	.40	.56	.63	.69	.82	.78	.71	.62	.44	.37	.20	.11	.00
0 21	.00	.10	.23	.38	.55	.63	.81	.85	.81	.74	.56	.48	.34	.20	.07	.00
0 22	.00	.14	.29	.36	.56	.68	.81	.99	.83	.73	.63	.45	.30	.18	.09	.00
0 23	.00	.10	.24	.42	.56	.74	.96	1.19	1.00	.82	.59	.50	.35	.25	.10	.00
0 24	.00	.12	.27	.37	.54	.86	1.23	1.92	1.18	.87	.61	.41	.36	.17	.04	.00
0 25	.00	.09	.18	.40	.56	.75	.98	1.23	.95	.78	.57	.39	.26	.18	.05	.00
0 26	.00	.09	.19	.31	.44	.59	.74	.85	.72	.65	.49	.35	.24	.17	.03	.00
0 27	.00	.10	.20	.31	.42	.44	.54	.61	.62	.51	.39	.38	.19	.12	.07	.00
0 28	.00	.04	.12	.22	.31	.40	.47	.43	.46	.37	.38	.29	.22	.17	.03	.00
0 29	.00	.07	.15	.23	.20	.27	.33	.38	.32	.34	.27	.20	.14	.09	.05	.00
0 30	.00	.04	.09	.14	.20	.25	.30	.25	.29	.22	.26	.20	.15	.11	.06	.00
0 31	.00	.01	.03	.06	.10	.14	.18	.22	.16	.21	.15	.11	.06	.03	.08	.00
0 32	.00	.07	.07	.08	.11	.13	.16	.10	.14	.09	.14	.11	.07	.05	.03	.00
0 33	.00	.01	.01	.10	.11	.12	.05	.07	.11	.07	.03	.11	.08	.07	.05	.00
0 34	.00	-.04	.05	.01	.01	.01	.02	.04	.07	.04	.02	.00	-.01	-.01	-.01	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

1 DRAWDOWN IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.03	.05	-.04	-.02	.03	.05	-.03	.00	-.04	.01	-.03	.02	-.01	.04	.00
0 3	.00	-.00	.01	.03	.05	-.02	.01	.05	-.01	.05	.01	-.03	.04	.01	-.01	.00
0 4	.00	.05	-.02	.00	.03	-.05	-.01	.03	-.02	.04	.01	-.01	.06	.05	.03	.00
0 5	.00	.03	.06	-.02	.01	.03	-.04	.00	-.04	.04	.02	.01	-.00	-.01	-.01	.00
0 6	.00	.02	.05	-.03	-.01	.01	-.07	-.03	-.06	-.06	.04	.04	.04	.04	.05	.00
0 7	.00	.02	.04	.07	-.01	-.01	-.12	-.09	-.10	-.06	.07	.08	.08	.08	-.01	.00
0 8	.00	.01	.04	.08	.01	.00	-.21	-.20	-.18	-.03	.02	.04	.04	.04	.03	.00
0 9	.00	.08	.04	.11	.17	.12	-.07	-.07	-.04	.09	.11	.11	.11	.10	-.00	.00
0 10	.00	.06	.15	.14	.24	.23	.21	.31	.25	.23	.22	.21	.09	.08	.06	.00
0 11	.00	.12	.15	.18	.31	.34	.49	.77	.55	.38	.24	.21	.18	.17	.07	.00
12	.00	.08	.14	.31	.38	.47	.99	1.66	.98	.44	.37	.31	.27	.15	.05	.00
13	.00	.14	.25	.35	.45	.58	1.54	4.00	1.54	.59	.47	.39	.24	.20	.09	.00
14	.00	.13	.25	.37	.60	.75	1.21	1.80	1.23	.68	.55	.36	.29	.14	.12	.00
15	.00	.14	.27	.39	.64	.81	1.04	1.15	1.06	.86	.60	.40	.22	.17	.04	.00
0 16	.00	.08	.28	.39	.62	.75	.89	.98	.81	.70	.49	.30	.24	.09	.05	.00
0 17	.00	.09	.18	.37	.47	.57	.69	.76	.61	.52	.35	.29	.14	.11	-.01	.00
0 18	.00	.02	.17	.23	.30	.37	.32	.38	.35	.32	.19	.16	.03	.02	.01	.00
0 19	.00	.02	.05	.09	.14	.06	.05	.08	.09	.02	.03	.02	-.09	-.09	-.06	.00
0 20	.00	.07	.08	.02	.05	-.03	-.01	.02	.03	-.05	-.04	-.04	-.15	-.14	-.10	.00
0 21	.00	-.00	.03	.07	.12	.07	.15	.21	.10	.06	.04	.02	-.09	-.08	-.05	.00
0 22	.00	.06	.11	.17	.15	.23	.35	.46	.31	.23	.18	.04	.02	.02	.04	.00
0 23	.00	.03	.09	.16	.26	.38	.50	.77	.57	.39	.20	.15	.11	.09	-.01	.00
0 24	.00	.06	.14	.23	.35	.41	.78	1.64	.84	.52	.30	.23	.17	.14	.02	.00
0 25	.00	.09	.18	.18	.29	.44	.68	.96	.65	.45	.35	.28	.22	.18	.04	.00
0 26	.00	.10	.10	.20	.31	.44	.63	.66	.59	.46	.38	.31	.26	.11	.06	.00
0 27	.00	.12	.12	.22	.32	.34	.48	.56	.54	.45	.28	.23	.18	.13	.08	.00
0 28	.00	.06	.14	.22	.21	.30	.39	.44	.44	.31	.27	.23	.19	.16	.02	.00
0 29	.00	.08	.15	.13	.20	.27	.33	.27	.28	.28	.26	.13	.11	.08	.04	.00
0 30	.00	.10	.07	.13	.19	.25	.19	.23	.25	.25	.14	.13	.12	.10	.06	.00
0 31	.00	.03	.09	.14	.09	.13	.17	.20	.22	.13	.13	.13	.13	.02	.01	.00
0 32	.00	.05	.10	.05	.09	.12	.15	.07	.10	.11	.13	.04	.04	.05	.04	.00
0 33	.00	.07	.02	.06	.09	.11	.03	.05	.08	.10	.02	.04	.06	.08	-.01	.00
0 34	.00	.01	.05	.08	-.01	.01	.02	.03	.05	-.01	.01	.03	-.03	.00	.05	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

0DRAWDOWN WILL BE SAVED ON UNIT 40 AT END OF TIME STEP 1, STRESS PERIOD 1

0

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 1

0 CUMULATIVE VOLUMES L**3 RATES FOR THIS TIME STEP L**3/T

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	.00000	STORAGE =	.00000
CONSTANT HEAD =	.17336E+06	CONSTANT HEAD =	.17336E+06
WELLS =	.00000	WELLS =	.00000

```
0                TOTAL IN =    .17336E+06
0              OUT:
               ----
                  STORAGE =    .00000
            CONSTANT HEAD =    96341.
                    WELLS =    77006.
0               TOTAL OUT =    .17335E+06
0                IN - OUT =    9.2813
0     PERCENT DISCREPANCY =                 .01
```


```
                 TOTAL IN =    .17336E+06
               OUT:
               ----
                  STORAGE =    .00000
            CONSTANT HEAD =    96341.
                    WELLS =    77006.
                TOTAL OUT =    .17335E+06
                 IN - OUT =    9.2813
      PERCENT DISCREPANCY =                 .01
```


```
0

        TIME SUMMARY AT END OF TIME STEP  1 IN STRESS PERIOD  1
                                    SECONDS      MINUTES      HOURS        DAYS        YEARS
                                ------------------------------------------------------------------
        TIME STEP LENGTH            86400.0      1440.00     24.0000      1.00000     .273785E-02
      STRESS PERIOD TIME            86400.0      1440.00     24.0000      1.00000     .273785E-02
   TOTAL SIMULATION TIME            86400.0      1440.00     24.0000      1.00000     .273785E-02
1
```

```
1                    U.S. GEOLOGICAL SURVEY MODULAR FINITE-DIFFERENCE GROUND-WATER MODEL
0SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     SIMULATION 2 - ALL WELLS, RIW2 DEEP, NEW S/D
    2 LAYERS        35 ROWS        16 COLUMNS
   1 STRESS PERIOD(S) IN SIMULATION
 MODEL TIME UNIT IS DAYS
0I/O UNITS:
 ELEMENT OF IUNIT:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
         I/O UNIT: 11 12  0  0  0  0  0  0 19  0  0 22  0  0  0  0  0  0  0  0  0  0  0  0
0BAS1 -- BASIC MODEL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT  1
 ARRAYS RHS AND BUFF WILL SHARE MEMORY.
 START HEAD WILL BE SAVED
    10699 ELEMENTS IN X ARRAY ARE USED BY BAS
    10699 ELEMENTS OF X ARRAY USED OUT OF  100000
0BCF1 -- BLOCK-CENTERED FLOW PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 11
 STEADY-STATE SIMULATION
      LAYER  AQUIFER TYPE
      -------------------
         1          1
         2          0
     1122 ELEMENTS IN X ARRAY ARE USED BY BCF
    11821 ELEMENTS OF X ARRAY USED OUT OF  100000
0WEL1 -- WELL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM 12
 MAXIMUM OF    8 WELLS
       32 ELEMENTS IN X ARRAY ARE USED FOR WELLS
    11853 ELEMENTS OF X ARRAY USED OUT OF  100000
0SIP1 -- STRONGLY IMPLICIT PROCEDURE SOLUTION PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 19
 MAXIMUM OF  50 ITERATIONS ALLOWED FOR CLOSURE
  5 ITERATION PARAMETERS
     4685 ELEMENTS IN X ARRAY ARE USED BY SIP
    16538 ELEMENTS OF X ARRAY USED OUT OF  100000
1SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     SIMULATION 2 - ALL WELLS, RIW2 DEEP, NEW S/D
0
```

BOUNDARY ARRAY FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
0 2	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 3	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 4	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 5	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 6	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
7	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
8	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
9	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 10	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 11	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 12	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 13	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 14	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 15	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 16	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 17	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 18	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 19	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 20	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 21	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 22	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 23	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 24	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 25	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 26	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 27	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 28	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 29	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 30	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 31	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 32	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 33	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 34	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 35	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

0

BOUNDARY ARRAY FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

```
       1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16
 ..........................................................
```

0 1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
0 2	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 3	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 4	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 5	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 6	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 7	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 8	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 9	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 10	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 11	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 12	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 13	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 14	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 15	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 16	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 17	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 18	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 19	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 20	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 21	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 22	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 23	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 24	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 25	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 26	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 27	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 28	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 29	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 30	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 31	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 32	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 33	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 34	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 35	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2

0AQUIFER HEAD WILL BE SET TO 999.99 AT ALL NO-FLOW NODES (IBOUND=0).
0

INITIAL HEAD FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.60	92.70	92.80	92.90	93.00	93.20	93.30	93.40	93.50	93.60	93.70	93.80	93.80	93.90	94.00
0 3	92.00	92.20	92.30	92.40	92.50	92.70	92.80	92.90	93.00	93.10	93.20	93.20	93.30	93.40	93.50	93.50
0 4	91.60	91.80	91.90	92.00	92.20	92.30	92.40	92.50	92.60	92.70	92.80	92.80	92.90	92.90	93.00	93.10
0 5	91.20	91.40	91.50	91.60	91.80	91.90	92.00	92.10	92.20	92.30	92.40	92.40	92.40	92.50	92.60	92.60
0 6	90.70	90.90	91.00	91.20	91.40	91.50	91.60	91.70	91.80	91.90	91.90	92.00	92.00	92.10	92.10	92.10
0 7	90.20	90.40	90.60	90.70	90.90	91.00	91.10	91.20	91.30	91.40	91.50	91.50	91.60	91.60	91.60	91.60
0 8	89.70	89.90	90.10	90.30	90.40	90.50	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.10	91.10	91.10
0 9	89.40	89.50	89.70	89.80	90.00	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.60	90.50
0 10	89.00	89.20	89.30	89.40	89.50	89.60	89.70	89.80	89.90	89.90	90.00	90.00	90.00	90.00	90.00	90.00
0 11	88.70	88.80	88.90	89.00	89.10	89.20	89.30	89.40	89.40	89.50	89.50	89.60	89.60	89.60	89.50	89.50
0 12	88.30	88.40	88.60	88.70	88.80	88.90	88.90	89.00	89.00	89.10	89.10	89.10	89.10	89.10	89.10	89.10
0 13	88.00	88.10	88.20	88.30	88.40	88.50	88.60	88.60	88.70	88.70	88.70	88.70	88.70	88.70	88.70	88.60
0 14	87.70	87.80	87.90	88.00	88.10	88.10	88.20	88.20	88.30	88.30	88.30	88.30	88.30	88.30	88.30	88.20
0 15	87.50	87.60	87.60	87.70	87.70	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.90	87.90	87.90	87.90
0 16	87.30	87.30	87.30	87.30	87.40	87.40	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.50	87.50
0 17	87.00	86.90	87.00	87.00	87.00	87.10	87.10	87.20	87.20	87.20	87.20	87.20	87.20	87.20	87.20	87.20
0 18	86.50	86.50	86.60	86.60	86.70	86.70	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.90
0 19	86.00	86.10	86.20	86.30	86.40	86.40	86.40	86.50	86.50	86.50						

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
											86.50	86.50	86.40	86.40	86.40	86.40
0 20	85.60	85.70	85.80	85.90	86.00	86.00	86.00	86.10	86.10	86.10	86.10	86.00	86.00	85.90	85.90	85.90
21	85.10	85.20	85.30	85.40	85.50	85.50	85.60	85.60	85.60	85.60	85.50	85.50	85.40	85.30	85.20	85.10
0 22	84.70	84.80	84.90	84.90	85.00	85.00	85.00	85.10	85.00	85.00	85.00	84.90	84.80	84.70	84.60	84.50
0 23	84.20	84.30	84.40	84.50	84.50	84.50	84.50	84.50	84.50	84.50	84.40	84.40	84.30	84.20	84.00	83.80
0 24	83.80	83.90	84.00	84.00	84.00	84.10	84.10	84.00	84.00	84.00	83.90	83.80	83.80	83.60	83.40	83.30
0 25	83.50	83.50	83.50	83.60	83.60	83.60	83.60	83.60	83.50	83.50	83.40	83.30	83.20	83.10	82.90	82.80
0 26	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.00	83.00	82.90	82.80	82.70	82.60	82.40	82.30
0 27	82.70	82.70	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.50	82.40	82.40	82.20	82.10	82.00	81.90
0 28	82.20	82.20	82.20	82.20	82.20	82.20	82.20	82.10	82.10	82.00	82.00	81.90	81.80	81.70	81.50	81.40
0 29	81.80	81.80	81.80	81.80	81.70	81.70	81.70	81.70	81.60	81.60	81.50	81.40	81.30	81.20	81.10	81.00
0 30	81.30	81.30	81.30	81.30	81.30	81.30	81.30	81.20	81.20	81.10	81.10	81.00	80.90	80.80	80.70	80.60
0 31	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.70	80.70	80.60	80.50	80.40	80.30	80.30	80.20
0 32	80.30	80.40	80.40	80.40	80.40	80.40	80.40	80.30	80.30	80.20	80.20	80.10	80.00	79.90	79.80	79.70
0 33	79.90	79.90	79.90	80.00	80.00	80.00	79.90	79.90	79.90	79.80	79.70	79.70	79.60	79.50	79.40	79.30
0 34	79.40	79.40	79.50	79.50	79.50	79.50	79.50	79.50	79.50	79.40	79.30	79.20	79.10	79.00	78.90	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

0

INITIAL HEAD FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	92.10
0 2	90.90	91.00	91.10	91.10	91.20	91.30	91.40	91.40	91.50	91.50	91.60	91.60	91.70	91.70	91.80	91.80
3	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.20	91.20	91.30	91.30	91.30	91.40	91.40	91.40	91.40
0 4	90.40	90.50	90.50	90.60	90.70	90.70	90.80	90.90	90.90	91.00	91.00	91.00	91.10	91.10	91.10	91.10
0 5	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.70	90.70	90.70	90.70	90.70	90.70	90.70
0 6	89.80	89.90	90.00	90.00	90.10	90.20	90.20	90.30	90.30	90.30	90.40	90.40	90.40	90.40	90.40	90.30
0 7	89.50	89.60	89.70	89.80	89.80	89.90	89.90	90.00	90.00	90.00	90.10	90.10	90.10	90.10	90.00	90.00
0 8	89.20	89.30	89.40	89.50	89.50	89.60	89.60	89.70	89.70	89.70	89.70	89.70	89.70	89.70	89.70	89.70
0 9	89.00	89.10	89.10	89.20	89.30	89.30	89.30	89.40	89.40	89.40	89.40	89.40	89.40	89.40	89.30	89.30
0 10	88.70	88.80	88.90	88.90	89.00	89.00	89.00	89.10	89.10	89.10	89.10	89.10	89.00	89.00	89.00	89.00
0 11	88.50	88.60	88.60	88.60	88.70	88.70	88.70	88.80	88.80	88.80	88.70	88.70	88.70	88.70	88.60	88.50
0 12	88.30	88.30	88.30	88.40	88.40	88.40	88.50	88.50	88.50	88.40	88.40	88.40	88.40	88.30	88.20	88.10
0 13	88.10	88.10	88.10	88.10	88.10	88.10	88.20	88.20	88.20	88.10	88.10	88.10	88.00	88.00	87.90	87.80
0 14	87.80	87.80	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.80	87.80	87.70	87.70	87.60	87.60	87.50
0 15	87.50	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.60	87.50	87.40	87.30	87.30	87.20	87.20
0 16	87.10	87.10	87.20	87.20	87.30	87.30	87.30	87.30	87.20	87.20	87.10	87.00	87.00	86.90	86.90	86.90
0 17	86.80	86.80	86.80	86.90	86.90	86.90	86.90	86.80	86.80	86.80	86.70	86.70	86.60	86.60	86.50	86.50
0 18	86.40	86.40	86.50	86.50	86.50	86.50	86.40	86.40	86.40	86.40	86.30	86.30	86.20	86.20	86.20	86.20
0 19	86.10	86.10	86.10	86.10	86.10	86.00	86.00	86.00	86.00	85.90	85.90	85.90	85.80	85.80	85.80	85.80
0 20	85.70	85.80	85.80	85.70	85.70	85.60	85.60	85.60	85.60	85.50	85.50	85.50	85.40	85.40	85.40	85.40

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 21	85.30	85.30	85.30	85.30	85.30	85.20	85.20	85.20	85.10	85.10	85.10	85.10	85.00	85.00	85.00	85.00
0 22	84.90	84.90	84.90	84.90	84.80	84.80	84.80	84.80	84.70	84.70	84.70	84.60	84.60	84.60	84.60	84.50
0 23	84.40	84.40	84.40	84.40	84.40	84.40	84.30	84.30	84.30	84.30	84.20	84.20	84.20	84.20	84.10	84.10
0 24	84.00	84.00	84.00	84.00	84.00	83.90	83.90	83.90	83.90	83.90	83.80	83.80	83.80	83.80	83.70	83.70
0 25	83.60	83.60	83.60	83.50	83.50	83.50	83.50	83.50	83.40	83.40	83.40	83.40	83.40	83.40	83.30	83.30
0 26	83.20	83.20	83.10	83.10	83.10	83.10	83.10	83.00	83.00	83.00	83.00	83.00	83.00	82.90	82.90	82.90
0 27	82.80	82.80	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.60	82.50	82.50	82.50	82.50	82.50	82.50
0 28	82.30	82.30	82.30	82.30	82.20	82.20	82.20	82.20	82.20	82.10	82.10	82.10	82.10	82.10	82.00	82.00
0 29	81.90	81.90	81.90	81.80	81.80	81.80	81.80	81.70	81.70	81.70	81.70	81.60	81.60	81.60	81.60	81.60
0 30	81.50	81.50	81.40	81.40	81.40	81.40	81.30	81.30	81.30	81.30	81.20	81.20	81.20	81.20	81.20	81.20
0 31	81.00	81.00	81.00	81.00	80.90	80.90	80.90	80.90	80.90	80.80	80.80	80.80	80.80	80.70	80.70	80.70
0 32	80.60	80.60	80.60	80.50	80.50	80.50	80.50	80.40	80.40	80.40	80.40	80.30	80.30	80.30	80.30	80.30
0 33	80.20	80.20	80.10	80.10	80.10	80.10	80.00	80.00	80.00	80.00	79.90	79.90	79.90	79.90	79.80	79.80
0 34	79.70	79.70	79.70	79.70	79.60	79.60	79.60	79.60	79.60	79.50	79.50	79.50	79.40	79.40	79.40	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

0HEAD PRINT FORMAT IS FORMAT NUMBER 4 DRAWDOWN PRINT FORMAT IS FORMAT NUMBER 9
0HEADS WILL BE SAVED ON UNIT 30 DRAWDOWNS WILL BE SAVED ON UNIT 40
0OUTPUT CONTROL IS SPECIFIED EVERY TIME STEP
0 COLUMN TO ROW ANISOTROPY = 1.000000
0 DELR = 200.0000
0 DELC = 200.0000
0

HYD. COND. ALONG ROWS FOR LAYER 1 WILL BE READ ON UNIT 11 USING FORMAT: (16F4.0)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 2	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 3	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 4	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 5	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 6	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	300.0	300.0	300.0	300.0
0 7	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	300.0	300.0	300.0	300.0
0 8	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	225.0	225.0	225.0	300.0
0 9	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	225.0	225.0	225.0	300.0
0 10	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	225.0	225.0	225.0	300.0
0 11	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 12	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 13	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 14	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 15	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 16	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 17	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 18	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 19	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0						

Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
											250.0	250.0	250.0	250.0	250.0	300.0
0 20	300.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	300.0
21	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 22	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 23	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 24	300.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 25	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 26	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 27	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 28	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 29	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 30	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 31	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 32	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 33	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 34	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 35	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0

0 BOTTOM = 30.00000 FOR LAYER 1

0 VERT HYD COND /THICKNESS = .1000000E-02 FOR LAYER 1

0

TRANSMIS. ALONG ROWS FOR LAYER 2 WILL BE READ ON UNIT 11 USING FORMAT: (16F5.0)

Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
2	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 3	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 4	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 5	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 6	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 7	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 8	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 9	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 10	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 11	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 12	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 13	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 14	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 15	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 16	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 17	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 18	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 19	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.

```
0 20    4000.      4000.      4000.      4000.      4000.      4000.      1500.      1500.      1500.      4000.
        4000.      4000.      4000.      4000.      4000.      4000.
0 21    3000.      3000.      3000.      3000.      3000.      3000.      1500.      1500.      1500.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 22    3000.      3000.      3000.      3000.      3000.      3000.      1500.      1500.      1500.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 23    3000.      3000.      3000.      3000.      3000.      3000.      1500.      1500.      1500.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 24    3000.      3000.      3000.      3000.      3000.      3000.      1500.      1500.      1500.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 25    3000.      3000.      3000.      3000.      3000.      3000.      1500.      1500.      1500.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 26    3000.      3000.      3000.      3000.      3000.      3000.      1500.      1500.      1500.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 27    3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 28    3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 29    3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 30    3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 31    3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 32    3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 33    3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 34    3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 35    3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0

                                                        SOLUTION BY THE STRONGLY IMPLICIT PROCEDURE
                                                        -------------------------------------------
0                                               MAXIMUM ITERATIONS ALLOWED FOR CLOSURE =        50
                                                               ACCELERATION PARAMETER =      1.0000
                                                     HEAD CHANGE CRITERION FOR CLOSURE =     .10000E-02
                                                     SIP HEAD CHANGE PRINTOUT INTERVAL =        1
0                                                    CALCULATE ITERATION PARAMETERS FROM MODEL CALCULATED WSEED
1                                                   STRESS PERIOD NO.    1, LENGTH =    1.000000
                                                    ----------------------------------------------

                                                    NUMBER OF TIME STEPS =     1

                                                     MULTIPLIER FOR DELT =     1.000

                                                  INITIAL TIME STEP SIZE =   1.000000

0            8 WELLS
                                                LAYER    ROW    COL    STRESS RATE   WELL NO.
                                                ---------------------------------------------
                                                  1       13     8      -14439.         1
                                                  1       17     8      -14439.         2
                                                  1       24     8      -14439.         3
                                                  1       29     8      -14439.         4
                                                  2       13     8      -4813.0         5
                                                  2       17     8      -4813.0         6
                                                  2       24     8      -4813.0         7
                                                  2       29     8      -4813.0         8
0AVERAGE SEED =   .00187924
 MINIMUM SEED =   .00055600
0
    5 ITERATION PARAMETERS CALCULATED FROM AVERAGE SEED:

             .0000000E+00   .7917928E+00   .9566497E+00   .9909742E+00   .9981208E+00
0
    10 ITERATIONS FOR TIME STEP   1 IN STRESS PERIOD  1
0MAXIMUM HEAD CHANGE FOR EACH ITERATION:
0 HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL
 ---------------------------------------------------------------------------------------------------------------------------------
   -2.332      (  2, 13,  8)  -.3456      (  2, 14,  7)  -.3039      (  1, 26,  8)  -.2365      (  1, 21,  8)  -.5757E-01 (  1, 23,  9)
   .8438E-02 (  2, 21,  6)   .9331E-02 (  1, 24,  9)   .4786E-02 (  1, 24,  8)   .3998E-02 (  1, 24,  8)   .9121E-03 (  1, 18, 12)
0
0HEAD/DRAWDOWN PRINTOUT FLAG = 1     TOTAL BUDGET PRINTOUT FLAG = 1     CELL-BY-CELL FLOW TERM FLAG = 0
0OUTPUT FLAGS FOR EACH LAYER:
           HEAD     DRAWDOWN  HEAD  DRAWDOWN
 LAYER  PRINTOUT  PRINTOUT   SAVE    SAVE
 ----------------------------------------
    1       1          1        1       1
    2       1          1        1       1
```

1 HEAD IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.55	92.67	92.77	92.87	92.99	93.13	93.24	93.34	93.45	93.55	93.65	93.75	93.83	93.92	94.00
0 3	92.00	92.13	92.25	92.36	92.45	92.56	92.68	92.79	92.90	93.00	93.09	93.20	93.29	93.37	93.45	93.50
0 4	91.60	91.72	91.84	91.95	92.04	92.14	92.25	92.35	92.45	92.55	92.64	92.74	92.83	92.91	92.99	93.10
0 5	91.20	91.32	91.44	91.55	91.64	91.72	91.82	91.91	92.01	92.10	92.19	92.28	92.37	92.45	92.52	92.60
0 6	90.70	90.85	90.99	91.10	91.19	91.27	91.36	91.45	91.55	91.64	91.72	91.82	91.91	91.98	92.05	92.10
0 7	90.20	90.35	90.49	90.61	90.70	90.79	90.88	90.97	91.06	91.15	91.24	91.34	91.45	91.53	91.58	91.60
0 8	89.70	89.89	90.03	90.13	90.22	90.31	90.39	90.47	90.56	90.65	90.74	90.84	90.95	91.02	91.07	91.10
0 9	89.40	89.49	89.59	89.68	89.75	89.83	89.90	89.98	90.06	90.15	90.24	90.32	90.40	90.47	90.50	90.50
0 10	89.00	89.09	89.17	89.23	89.29	89.35	89.41	89.47	89.56	89.65	89.73	89.80	89.88	89.94	89.98	90.00
0 11	88.70	88.73	88.77	88.81	88.85	88.88	88.91	88.94	89.04	89.15	89.24	89.32	89.39	89.45	89.49	89.50
0 12	88.30	88.37	88.40	88.42	88.43	88.42	88.39	88.36	88.50	88.65	88.77	88.86	88.94	89.00	89.05	89.10
0 13	88.00	88.03	88.05	88.05	88.03	87.97	87.86	87.59	87.97	88.17	88.32	88.42	88.50	88.56	88.60	88.60
0 14	87.70	87.72	87.71	87.69	87.64	87.58	87.50	87.44	87.59	87.75	87.89	87.99	88.08	88.15	88.20	88.20
0 15	87.50	87.45	87.39	87.34	87.28	87.19	87.12	87.09	87.19	87.33	87.47	87.58	87.68	87.76	87.83	87.90
0 16	87.30	87.17	87.08	87.00	86.92	86.82	86.73	86.67	86.78	86.93	87.07	87.19	87.29	87.38	87.45	87.50
0 17	87.00	86.84	86.74	86.66	86.58	86.48	86.35	86.11	86.40	86.57	86.70	86.81	86.91	87.00	87.10	87.20
0 18	86.50	86.44	86.38	86.32	86.25	86.18	86.10	86.03	86.13	86.24	86.35	86.44	86.54	86.63	86.74	86.90
0 19	86.00	86.03	86.01	85.97	85.93	85.87	85.82	85.80	85.85	85.92	86.00	86.08	86.15	86.23	86.32	86.40
0 20	85.60	85.61	85.60	85.57	85.54	85.49	85.45	85.44	85.47	85.52	85.58	85.64	85.69	85.74	85.81	85.90
0 21	85.10	85.12	85.11	85.09	85.05	85.00	84.95	84.92	84.94	84.99	85.05	85.10	85.12	85.14	85.14	85.10
0 22	84.70	84.67	84.65	84.61	84.54	84.46	84.37	84.32	84.35	84.41	84.48	84.52	84.55	84.55	84.53	84.50
0 23	84.20	84.21	84.19	84.14	84.04	83.91	83.76	83.61	83.72	83.83	83.91	83.97	83.99	83.98	83.91	83.80
0 24	83.80	83.79	83.76	83.68	83.54	83.38	83.13	82.65	83.08	83.27	83.37	83.43	83.47	83.45	83.37	83.30
0 25	83.50	83.41	83.33	83.21	83.08	82.92	82.74	82.58	82.68	82.79	82.87	82.92	82.95	82.93	82.85	82.80
0 26	83.10	83.01	82.90	82.77	82.63	82.48	82.34	82.24	82.26	82.32	82.39	82.43	82.44	82.42	82.37	82.30
0 27	82.70	82.59	82.47	82.33	82.18	82.03	81.89	81.79	81.80	81.86	81.92	81.95	81.97	81.95	81.92	81.90
0 28	82.20	82.14	82.03	81.89	81.74	81.57	81.39	81.21	81.30	81.39	81.46	81.50	81.51	81.50	81.46	81.40
0 29	81.80	81.70	81.59	81.46	81.31	81.13	80.87	80.35	80.78	80.95	81.03	81.07	81.08	81.06	81.03	81.00
0 30	81.30	81.24	81.15	81.04	80.92	80.77	80.60	80.43	80.51	80.60	80.65	80.67	80.66	80.65	80.62	80.60
0 31	80.80	80.77	80.71	80.63	80.54	80.44	80.33	80.25	80.25	80.27	80.28	80.28	80.26	80.23	80.20	80.20
0 32	80.30	80.31	80.28	80.23	80.17	80.11	80.04	79.99	79.96	79.95	79.93	79.90	79.86	79.81	79.76	79.70
0 33	79.90	79.88	79.86	79.84	79.81	79.77	79.73	79.70	79.66	79.63	79.58	79.53	79.47	79.40	79.34	79.30
0 34	79.40	79.43	79.44	79.46	79.45	79.44	79.42	79.40	79.37	79.31	79.24	79.17	79.08	79.00	78.90	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

1 HEAD IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	92.10
0	2	90.90	90.97	91.05	91.14	91.22	91.28	91.35	91.43	91.50	91.54	91.60	91.63	91.68	91.71	91.	91.80
0	3	90.60	90.71	90.79	90.87	90.95	91.02	91.09	91.16	91.21	91.26	91.30	91.33	91.36	91.39	91.	91.40
0	4	90.40	90.45	90.53	90.60	90.68	90.75	90.82	90.88	90.93	90.97	91.00	91.02	91.04	91.06	91.07	91.10
0	5	90.10	90.17	90.25	90.33	90.40	90.48	90.55	90.61	90.65	90.67	90.69	90.70	90.71	90.72	90.71	90.70
0	6	89.80	89.88	89.96	90.04	90.12	90.21	90.29	90.35	90.38	90.38	90.38	90.37	90.37	90.37	90.35	90.30
0	7	89.50	89.59	89.67	89.74	89.83	89.93	90.04	90.11	90.12	90.08	90.05	90.04	90.03	90.03	90.02	90.00
0	8	89.20	89.30	89.37	89.44	89.51	89.62	89.83	89.92	89.91	89.76	89.71	89.68	89.68	89.67	89.68	89.70
0	9	89.00	89.03	89.07	89.12	89.16	89.21	89.41	89.51	89.48	89.34	89.32	89.31	89.31	89.31	89.31	89.30
0	10	88.70	88.75	88.77	88.79	88.80	88.81	88.86	88.88	88.92	88.92	88.92	88.92	88.93	88.94	88.95	89.00
0	11	88.50	88.49	88.47	88.46	88.44	88.41	88.32	88.21	88.37	88.48	88.51	88.53	88.54	88.55	88.54	88.50
0	12	88.30	88.24	88.18	88.13	88.07	88.01	87.70	87.23	87.72	88.04	88.09	88.14	88.16	88.17	88.16	88.10
0	13	88.10	87.97	87.88	87.79	87.71	87.60	86.98	85.21	86.98	87.60	87.69	87.75	87.80	87.82	87.82	87.80
0	14	87.80	87.68	87.57	87.47	87.35	87.22	86.85	86.40	86.83	87.19	87.31	87.39	87.44	87.48	87.49	87.50
0	15	87.50	87.37	87.26	87.15	87.01	86.85	86.63	86.53	86.61	86.81	86.95	87.04	87.11	87.15	87.17	87.20
0	16	87.10	87.03	86.94	86.84	86.73	86.60	86.47	86.38	86.45	86.55	86.65	86.73	86.79	86.82	86.85	86.90
0	17	86.80	86.72	86.64	86.56	86.47	86.37	86.26	86.09	86.24	86.32	86.39	86.44	86.48	86.50	86.51	86.50
0	18	86.40	86.39	86.34	86.29	86.23	86.17	86.12	86.06	86.09	86.11	86.14	86.17	86.19	86.20	86.19	86.20
0	19	86.10	86.09	86.06	86.02	85.98	85.97	85.98	85.96	85.95	85.91	85.89	85.90	85.90	85.89	85.87	85.80
0	20	85.70	85.74	85.72	85.69	85.66	85.64	85.63	85.60	85.59	85.57	85.55	85.55	85.55	85.54	85.50	85.40
0	21	85.30	85.30	85.27	85.23	85.18	85.13	85.05	84.99	85.00	85.04	85.06	85.08	85.08	85.08	85.05	85.00
0	22	84.90	84.83	84.77	84.71	84.63	84.55	84.42	84.31	84.36	84.44	84.50	84.54	84.56	84.57	84.56	84.50
0	23	84.40	84.36	84.29	84.20	84.09	83.96	83.74	83.47	83.68	83.85	83.94	84.01	84.06	84.09	84.	84.10
0	24	84.00	83.92	83.82	83.71	83.58	83.41	83.02	82.16	82.96	83.28	83.42	83.51	83.57	83.63	83.	83.70
0	25	83.60	83.49	83.37	83.24	83.10	82.93	82.66	82.37	82.59	82.81	82.93	83.03	83.11	83.18	83.24	83.30
0	26	83.20	83.06	82.93	82.79	82.64	82.47	82.23	82.08	82.16	82.35	82.47	82.57	82.66	82.74	82.81	82.90
0	27	82.80	82.64	82.50	82.35	82.19	82.01	81.78	81.67	81.72	81.89	82.02	82.13	82.22	82.30	82.39	82.50
0	28	82.30	82.19	82.07	81.92	81.76	81.58	81.38	81.22	81.32	81.47	81.60	81.70	81.79	81.87	81.94	82.00
0	29	81.90	81.78	81.65	81.51	81.36	81.18	80.94	80.49	80.88	81.07	81.20	81.29	81.37	81.45	81.52	81.60
0	30	81.50	81.36	81.24	81.12	80.99	80.85	80.69	80.55	80.64	80.74	80.83	80.90	80.97	81.03	81.10	81.20
0	31	81.00	80.93	80.83	80.74	80.63	80.53	80.43	80.37	80.38	80.43	80.48	80.53	80.57	80.62	80.66	80.70
0	32	80.60	80.52	80.44	80.36	80.28	80.21	80.14	80.10	80.10	80.11	80.13	80.16	80.18	80.21	80.24	80.30
0	33	80.20	80.11	80.04	79.98	79.92	79.88	79.84	79.81	79.79	79.79	79.79	79.79	79.79	79.79	79.79	79.80
0	34	79.70	79.68	79.63	79.59	79.56	79.54	79.52	79.50	79.49	79.45	79.44	79.43	79.40	79.38	79.34	79.30
0	35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

0HEAD WILL BE SAVED ON UNIT 30 AT END OF TIME STEP 1, STRESS PERIOD 1

1 DRAWDOWN IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0	2	.00	.05	.03	.03	.03	.01	.07	.06	.06	.05	.05	.05	.05	-.03	-.02	.00
0	3	.00	.07	.05	.04	.05	.14	.12	.11	.10	.10	.11	.00	.01	.03	.05	.00
0	4	.00	.08	.06	.05	.16	.16	.15	.15	.15	.15	.16	.06	.07	-.01	.01	.00
0	5	.00	.08	.06	.05	.16	.18	.18	.19	.19	.20	.21	.12	.03	.05	.08	.00
0	6	.00	.05	.01	.10	.21	.23	.24	.25	.25	.26	.18	.18	.09	.12	.05	.00

0 7	.00	.05	.11	.09	.20	.21	.22	.23	.24	.25	.26	.16	.15	.07	.02	.00
0 8	.00	.01	.07	.17	.18	.19	.21	.23	.24	.25	.26	.16	.15	.08	.03	.00
9	.00	.01	.11	.12	.25	.27	.30	.32	.24	.25	.26	.18	.20	.13	.10	.00
10	.00	.11	.13	.17	.21	.25	.29	.33	.34	.25	.27	.20	.12	.06	.02	.00
11	.00	.07	.13	.19	.25	.32	.39	.46	.36	.35	.26	.28	.21	.15	.01	.00
0 12	.00	.03	.20	.28	.37	.48	.51	.64	.50	.45	.33	.24	.16	.10	.05	.00
0 13	.00	.07	.15	.25	.37	.53	.74	1.01	.73	.53	.38	.28	.20	.14	.10	.00
0 14	.00	.08	.19	.31	.46	.52	.70	.76	.71	.55	.41	.31	.22	.15	.10	.00
0 15	.00	.15	.21	.36	.42	.61	.68	.81	.71	.57	.43	.32	.22	.14	.07	.00
0 16	.00	.13	.22	.30	.48	.58	.77	.83	.72	.67	.53	.41	.31	.22	.05	.00
0 17	.00	.06	.26	.34	.42	.62	.75	1.09	.80	.63	.50	.39	.29	.20	.10	.00
0 18	.00	.06	.22	.28	.45	.52	.70	.77	.67	.56	.45	.36	.26	.17	.06	.00
0 19	.00	.07	.19	.33	.47	.53	.58	.70	.65	.58	.50	.42	.25	.17	.08	.00
0 20	.00	.09	.20	.33	.46	.51	.55	.66	.63	.58	.52	.36	.31	.16	.09	.00
0 21	.00	.08	.19	.31	.45	.50	.65	.68	.66	.61	.45	.40	.28	.16	.06	.00
0 22	.00	.13	.25	.29	.46	.54	.63	.78	.65	.59	.52	.38	.25	.15	.07	.00
0 23	.00	.09	.21	.36	.46	.59	.74	.89	.78	.67	.49	.43	.31	.22	.09	.00
0 24	.00	.11	.24	.32	.46	.72	.97	1.35	.92	.73	.53	.37	.33	.15	.03	.00
0 25	.00	.09	.17	.39	.52	.68	.86	1.02	.82	.71	.53	.38	.25	.17	.05	.00
0 26	.00	.09	.20	.33	.47	.62	.76	.86	.74	.68	.51	.37	.26	.18	.03	.00
0 27	.00	.11	.23	.37	.52	.57	.71	.81	.80	.64	.48	.45	.23	.15	.08	.00
0 28	.00	.06	.17	.31	.46	.63	.81	.89	.80	.61	.54	.40	.29	.20	.04	.00
0 29	.00	.10	.21	.34	.39	.57	.83	1.35	.82	.65	.47	.33	.22	.14	.07	.00
0 30	.00	.06	.15	.26	.38	.53	.70	.77	.69	.50	.45	.33	.24	.15	.08	.00
0 31	.00	.03	.09	.17	.26	.36	.47	.55	.45	.43	.32	.22	.14	.07	.10	.00
0 32	.00	.09	.12	.17	.23	.29	.36	.31	.34	.25	.27	.20	.14	.09	.04	.00
0 33	.00	.02	.04	.16	.19	.23	.17	.20	.24	.17	.12	.17	.13	.10	.06	.00
0 34	.00	-.03	.06	.04	.05	.06	.08	.10	.13	.09	.06	.03	.02	.00	-.00	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

1 DRAWDOWN IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.03	.05	-.04	-.02	.02	.05	-.03	.00	-.04	.00	-.03	.02	-.01	.04	.00
0 3	.00	-.01	.01	.03	.05	-.02	.01	.04	-.01	.04	.00	-.03	.04	.01	-.01	.00
0 4	.00	.05	-.03	-.00	.02	-.05	-.02	.02	-.03	.03	.00	-.02	.06	.04	.03	.00
0 5	.00	.03	.05	-.03	-.00	.02	-.05	-.01	-.05	.03	.01	-.00	-.01	-.02	-.01	.00
0 6	.00	.02	.04	-.04	-.02	-.01	-.09	-.05	-.08	-.08	.02	.03	.03	.03	.05	.00
0 7	.00	.01	.03	.06	-.03	-.03	-.14	-.11	-.12	-.08	.05	.06	.07	.07	-.02	.00
0 8	.00	.00	.03	.06	-.01	-.02	-.23	-.22	-.21	-.06	-.01	.02	.02	.03	.02	.00
0 9	.00	.07	.03	.08	.14	.09	-.11	-.11	-.08	.06	.08	.09	.09	.09	-.01	.00
0 10	.00	.05	.13	.11	.20	.19	.14	.22	.18	.18	.18	.18	.07	.06	.05	.00
11	.00	.11	.13	.14	.26	.29	.38	.59	.43	.32	.19	.17	.16	.15	.06	.00
12	.00	.06	.12	.27	.33	.39	.80	1.27	.78	.36	.31	.26	.24	.13	.04	.00
13	.00	.13	.22	.31	.39	.50	1.22	2.99	1.22	.50	.41	.35	.20	.18	.08	.00
14	.00	.12	.23	.33	.55	.68	1.05	1.50	1.07	.61	.49	.31	.26	.12	.11	.00
0 15	.00	.13	.24	.35	.59	.75	.97	1.07	.99	.79	.55	.36	.19	.15	.03	.00
0 16	.00	.07	.26	.36	.57	.70	.83	.92	.75	.65	.45	.27	.21	.08	.05	.00
0 17	.00	.08	.16	.34	.43	.53	.64	.71	.56	.48	.31	.26	.12	.10	-.01	.00
0 18	.00	.01	.16	.21	.27	.33	.28	.34	.31	.29	.16	.13	.01	.00	.01	.00
0 19	.00	.01	.04	.08	.12	.03	.02	.04	.05	-.01	.01	.00	-.10	-.09	-.07	.00
0 20	.00	.06	.08	.01	.04	-.04	-.03	.00	.01	-.07	-.05	-.05	-.15	-.14	-.10	.00
0 21	.00	.00	.03	.07	.12	.07	.15	.21	.10	.06	.04	.02	-.08	-.08	-.05	.00
0 22	.00	.07	.13	.19	.17	.25	.38	.49	.34	.26	.20	.06	.04	.03	.04	.00
0 23	.00	.04	.11	.20	.31	.44	.56	.83	.62	.45	.26	.19	.14	.11	-.00	.00
0 24	.00	.08	.18	.29	.42	.49	.88	1.74	.94	.62	.38	.29	.23	.17	.03	.00
0 25	.00	.11	.23	.26	.40	.57	.84	1.13	.81	.59	.47	.37	.29	.22	.06	.00
0 26	.00	.14	.17	.31	.46	.63	.87	.92	.84	.65	.53	.43	.34	.16	.09	.00
0 27	.00	.16	.20	.35	.51	.59	.82	.93	.88	.71	.48	.37	.28	.20	.11	.00
0 28	.00	.11	.23	.38	.44	.62	.82	.98	.88	.63	.50	.40	.31	.23	.06	.00
0 29	.00	.12	.25	.29	.44	.62	.86	1.21	.82	.63	.50	.31	.23	.15	.08	.00
0 30	.00	.14	.16	.28	.41	.55	.61	.75	.66	.56	.37	.30	.23	.17	.10	.00
0 31	.00	.07	.17	.26	.27	.37	.47	.53	.52	.37	.32	.27	.23	.08	.04	.00
0 32	.00	.08	.16	.14	.22	.29	.36	.30	.30	.29	.27	.14	.12	.09	.06	.00
0 33	.00	.09	.06	.12	.18	.22	.16	.19	.21	.21	.11	.11	.11	.11	.01	.00
0 34	.00	.02	.07	.11	.04	.06	.08	.10	.11	.05	.06	.07	.00	.02	.06	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

0DRAWDOWN WILL BE SAVED ON UNIT 40 AT END OF TIME STEP 1, STRESS PERIOD 1

0

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 1

0

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	.00000	STORAGE =	.00000
CONSTANT HEAD =	.17020E+06	CONSTANT HEAD =	.17020E+06

```
                                    WELLS =      .00000                                                                          WELLS =      .00000
0                              TOTAL IN =      .17020E+06                                                                    TOTAL IN =      .17020E+06
0                             OUT:                                                                                          OUT:
                              ----                                                                                          ----
                                  STORAGE =      .00000                                                                        STORAGE =      .00000
                            CONSTANT HEAD =      93180.                                                                  CONSTANT HEAD =      93180.
                                    WELLS =      77008.                                                                          WELLS =      77008.
0                               TOTAL OUT =      .17019E+06                                                                  TOTAL OUT =      .17019E+06
0                                IN - OUT =      13.625                                                                       IN - OUT =      13.625
0                     PERCENT DISCREPANCY =                   .01                                                  PERCENT DISCREPANCY =                   .01


0

             TIME SUMMARY AT END OF TIME STEP  1 IN STRESS PERIOD  1
                            SECONDS        MINUTES          HOURS           DAYS          YEARS
                       -----------------------------------------------------------------------
      TIME STEP LENGTH      86400.0        1440.00        24.0000        1.00000    .273785E-02
    STRESS PERIOD TIME      86400.0        1440.00        24.0000        1.00000    .273785E-02
 TOTAL SIMULATION TIME      86400.0        1440.00        24.0000        1.00000    .273785E-02
1
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1                       U.S. GEOLOGICAL SURVEY MODULAR FINITE-DIFFERENCE GROUND-WATER MODEL
0SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     SIMULATION 3 - ALL WELLS, INJECTION, ON 6, OFF 1
    2 LAYERS          35 ROWS          16 COLUMNS
   3 STRESS PERIOD(S) IN SIMULATION
 MODEL TIME UNIT IS DAYS
0I/O UNITS:
 ELEMENT OF IUNIT:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
         I/O UNIT: 11 12  0  0  0  0  0  0 19  0  0 22  0  0  0  0  0  0  0  0  0  0  0  0
0BAS1 -- BASIC MODEL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT  1
 ARRAYS RHS AND BUFF WILL SHARE MEMORY.
 START HEAD WILL BE SAVED
    10699 ELEMENTS IN X ARRAY ARE USED BY BAS
    10699 ELEMENTS OF X ARRAY USED OUT OF  100000
0BCF1 -- BLOCK-CENTERED FLOW PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 11
 TRANSIENT SIMULATION
      LAYER  AQUIFER TYPE
      -------------------
         1         1
         2         0
     2242 ELEMENTS IN X ARRAY ARE USED BY BCF
    12941 ELEMENTS OF X ARRAY USED OUT OF  100000
0WEL1 -- WELL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM 12
 MAXIMUM OF   10 WELLS
       40 ELEMENTS IN X ARRAY ARE USED FOR WELLS
    12981 ELEMENTS OF X ARRAY USED OUT OF  100000
0SIP1 -- STRONGLY IMPLICIT PROCEDURE SOLUTION PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 19
 MAXIMUM OF  50 ITERATIONS ALLOWED FOR CLOSURE
  5 ITERATION PARAMETERS
     4685 ELEMENTS IN X ARRAY ARE USED BY SIP
    17666 ELEMENTS OF X ARRAY USED OUT OF  100000
1SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     SIMULATION 3 - ALL WELLS, INJECTION, ON 6, OFF 1
0
```

BOUNDARY ARRAY FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
0 2	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 3	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 4	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 5	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
6	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
7	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
8	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
9	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 10	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 11	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 12	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 13	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 14	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 15	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 16	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 17	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 18	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 19	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 20	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 21	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 22	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 23	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 24	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 25	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 26	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 27	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 28	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 29	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 30	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 31	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 32	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 33	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 34	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 35	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

0

BOUNDARY ARRAY FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

0	1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
0	2	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	3	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	4	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	5	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	6	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	7	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	8	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	9	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	10	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	11	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	12	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	13	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	14	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	15	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	16	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	17	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	18	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	19	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	20	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	21	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	22	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	23	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	24	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	25	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	26	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	27	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	28	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	29	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	30	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	31	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	32	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	33	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	34	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	35	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2

0AQUIFER HEAD WILL BE SET TO 999.99 AT ALL NO-FLOW NODES (IBOUND=0).
0

INITIAL HEAD FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.60	92.70	92.80	92.90	93.00	93.20	93.30	93.40	93.50	93.60	93.70	93.80	93.80	93.90	94.00
0 3	92.00	92.20	92.30	92.40	92.50	92.70	92.80	92.90	93.00	93.10	93.20	93.20	93.30	93.40	93.50	93.50
0 4	91.60	91.80	91.90	92.00	92.20	92.30	92.40	92.50	92.60	92.70	92.80	92.80	92.90	92.90	93.00	93.10
0 5	91.20	91.40	91.50	91.60	91.80	91.90	92.00	92.10	92.20	92.30	92.40	92.40	92.40	92.50	92.60	92.60
0 6	90.70	90.90	91.00	91.20	91.40	91.50	91.60	91.70	91.80	91.90	91.90	92.00	92.00	92.10	92.10	92.10
0 7	90.20	90.40	90.60	90.70	90.90	91.00	91.10	91.20	91.30	91.40	91.50	91.50	91.60	91.60	91.60	91.60
0 8	89.70	89.90	90.10	90.30	90.40	90.50	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.10	91.10	91.10
0 9	89.40	89.50	89.70	89.80	90.00	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.60	90.50
0 10	89.00	89.20	89.30	89.40	89.50	89.60	89.70	89.80	89.90	89.90	90.00	90.00	90.00	90.00	90.00	90.00
0 11	88.70	88.80	88.90	89.00	89.10	89.20	89.30	89.40	89.40	89.50	89.50	89.60	89.60	89.60	89.50	89.50
0 12	88.30	88.40	88.60	88.70	88.80	88.90	88.90	89.00	89.00	89.10	89.10	89.10	89.10	89.10	89.10	89.10
0 13	88.00	88.10	88.20	88.30	88.40	88.50	88.60	88.60	88.70	88.70	88.70	88.70	88.70	88.70	88.70	88.60
0 14	87.70	87.80	87.90	88.00	88.10	88.10	88.20	88.20	88.30	88.30	88.30	88.30	88.30	88.30	88.30	88.20
0 15	87.50	87.60	87.60	87.70	87.70	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.90	87.90	87.90	87.90
0 16	87.30	87.30	87.30	87.30	87.40	87.40	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.50	87.50
0 17	87.00	86.90	87.00	87.00	87.00	87.10	87.10	87.20	87.20	87.20	87.20	87.20	87.20	87.20	87.20	87.20
0 18	86.50	86.50	86.60	86.60	86.70	86.70	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.90
0 19	86.00	86.10	86.20	86.30	86.40	86.40	86.40	86.50	86.50	86.50						

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
											86.50	86.50	86.40	86.40	86.40	86.40
0 20	85.60	85.70	85.80	85.90	86.00	86.00	86.00	86.10	86.10	86.10	86.10	86.00	86.00	85.90	85.90	85.90
21	85.10	85.20	85.30	85.40	85.50	85.50	85.60	85.60	85.60	85.60	85.50	85.50	85.40	85.30	85.20	85.10
0 22	84.70	84.80	84.90	84.90	85.00	85.00	85.00	85.10	85.00	85.00	85.00	84.90	84.80	84.70	84.60	84.50
0 23	84.20	84.30	84.40	84.50	84.50	84.50	84.50	84.50	84.50	84.50	84.40	84.40	84.30	84.20	84.00	83.80
0 24	83.80	83.90	84.00	84.00	84.00	84.10	84.10	84.00	84.00	84.00	83.90	83.80	83.80	83.60	83.40	83.30
0 25	83.50	83.50	83.50	83.60	83.60	83.60	83.60	83.60	83.50	83.50	83.40	83.30	83.20	83.10	82.90	82.80
0 26	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.00	83.00	82.90	82.80	82.70	82.60	82.40	82.30
0 27	82.70	82.70	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.50	82.40	82.40	82.20	82.10	82.00	81.90
0 28	82.20	82.20	82.20	82.20	82.20	82.20	82.20	82.10	82.10	82.00	82.00	81.90	81.80	81.70	81.50	81.40
0 29	81.80	81.80	81.80	81.80	81.70	81.70	81.70	81.70	81.60	81.60	81.50	81.40	81.30	81.20	81.10	81.00
0 30	81.30	81.30	81.30	81.30	81.30	81.30	81.30	81.20	81.20	81.10	81.10	81.00	80.90	80.80	80.70	80.60
0 31	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.70	80.70	80.60	80.50	80.40	80.30	80.30	80.20
0 32	80.30	80.40	80.40	80.40	80.40	80.40	80.40	80.30	80.30	80.20	80.20	80.10	80.00	79.90	79.80	79.70
0 33	79.90	79.90	79.90	80.00	80.00	80.00	79.90	79.90	79.90	79.80	79.70	79.70	79.60	79.50	79.40	79.30
0 34	79.40	79.40	79.50	79.50	79.50	79.50	79.50	79.50	79.50	79.40	79.30	79.20	79.10	79.00	78.90	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40
0																

INITIAL HEAD FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	92.10
0 2	90.90	91.00	91.10	91.10	91.20	91.30	91.40	91.40	91.50	91.50	91.60	91.60	91.70	91.70	91.80	91.80
3	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.20	91.20	91.30	91.30	91.30	91.40	91.40	91.40	91.40
0 4	90.40	90.50	90.50	90.60	90.70	90.70	90.80	90.90	90.90	91.00	91.00	91.00	91.10	91.10	91.10	91.10
0 5	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.70	90.70	90.70	90.70	90.70	90.70	90.70
0 6	89.80	89.90	90.00	90.00	90.10	90.20	90.20	90.30	90.30	90.30	90.40	90.40	90.40	90.40	90.40	90.30
0 7	89.50	89.60	89.70	89.80	89.80	89.90	89.90	90.00	90.00	90.00	90.10	90.10	90.10	90.10	90.00	90.00
0 8	89.20	89.30	89.40	89.50	89.50	89.60	89.60	89.70	89.70	89.70	89.70	89.70	89.70	89.70	89.70	89.70
0 9	89.00	89.10	89.10	89.20	89.30	89.30	89.30	89.40	89.40	89.40	89.40	89.40	89.40	89.40	89.30	89.30
0 10	88.70	88.80	88.90	88.90	89.00	89.00	89.00	89.10	89.10	89.10	89.10	89.10	89.00	89.00	89.00	89.00
0 11	88.50	88.60	88.60	88.60	88.70	88.70	88.70	88.80	88.80	88.80	88.70	88.70	88.70	88.70	88.60	88.50
0 12	88.30	88.30	88.30	88.40	88.40	88.40	88.50	88.50	88.50	88.40	88.40	88.40	88.40	88.30	88.20	88.10
0 13	88.10	88.10	88.10	88.10	88.10	88.10	88.20	88.20	88.20	88.10	88.10	88.10	88.00	88.00	87.90	87.80
0 14	87.80	87.80	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.80	87.80	87.70	87.70	87.60	87.60	87.50
0 15	87.50	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.60	87.50	87.40	87.30	87.30	87.20	87.20
0 16	87.10	87.10	87.20	87.20	87.30	87.30	87.30	87.30	87.20	87.20	87.10	87.00	87.00	86.90	86.90	86.90
0 17	86.80	86.80	86.80	86.90	86.90	86.90	86.90	86.80	86.80	86.80	86.70	86.70	86.60	86.60	86.50	86.50
0 18	86.40	86.40	86.50	86.50	86.50	86.50	86.40	86.40	86.40	86.40	86.30	86.30	86.20	86.20	86.20	86.20
0 19	86.10	86.10	86.10	86.10	86.10	86.00	86.00	86.00	86.00	85.90	85.90	85.90	85.80	85.80	85.80	85.80
0 20	85.70	85.80	85.80	85.70	85.70	85.60	85.60	85.60	85.60	85.50	85.50	85.50	85.40	85.40	85.40	85.40

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 21	85.30	85.30	85.30	85.30	85.30	85.20	85.20	85.20	85.10	85.10	85.10	85.10	85.00	85.00	85.00	85.00
0 22	84.90	84.90	84.90	84.90	84.80	84.80	84.80	84.80	84.70	84.70	84.70	84.60	84.60	84.60	84.60	84.50
0 23	84.40	84.40	84.40	84.40	84.40	84.40	84.30	84.30	84.30	84.30	84.20	84.20	84.20	84.20	84.10	84.10
0 24	84.00	84.00	84.00	84.00	84.00	83.90	83.90	83.90	83.90	83.90	83.80	83.80	83.80	83.80	83.70	83.70
0 25	83.60	83.60	83.60	83.50	83.50	83.50	83.50	83.50	83.40	83.40	83.40	83.40	83.40	83.40	83.30	83.30
0 26	83.20	83.20	83.10	83.10	83.10	83.10	83.10	83.00	83.00	83.00	83.00	83.00	83.00	82.90	82.90	82.90
0 27	82.80	82.80	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.60	82.50	82.50	82.50	82.50	82.50	82.50
0 28	82.30	82.30	82.30	82.30	82.20	82.20	82.20	82.20	82.20	82.10	82.10	82.10	82.10	82.10	82.00	82.00
0 29	81.90	81.90	81.90	81.80	81.80	81.80	81.80	81.70	81.70	81.70	81.70	81.60	81.60	81.60	81.60	81.60
0 30	81.50	81.50	81.40	81.40	81.40	81.40	81.30	81.30	81.30	81.30	81.20	81.20	81.20	81.20	81.20	81.20
0 31	81.00	81.00	81.00	81.00	80.90	80.90	80.90	80.90	80.90	80.80	80.80	80.80	80.80	80.70	80.70	80.70
0 32	80.60	80.60	80.60	80.50	80.50	80.50	80.50	80.40	80.40	80.40	80.40	80.30	80.30	80.30	80.30	80.30
0 33	80.20	80.20	80.10	80.10	80.10	80.10	80.00	80.00	80.00	80.00	79.90	79.90	79.90	79.90	79.80	79.80
0 34	79.70	79.70	79.70	79.70	79.60	79.60	79.60	79.60	79.60	79.50	79.50	79.50	79.40	79.40	79.40	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

0HEAD PRINT FORMAT IS FORMAT NUMBER 4 DRAWDOWN PRINT FORMAT IS FORMAT NUMBER 9
0HEADS WILL BE SAVED ON UNIT 30 DRAWDOWNS WILL BE SAVED ON UNIT 40
0OUTPUT CONTROL IS SPECIFIED EVERY TIME STEP
0 COLUMN TO ROW ANISOTROPY = 1.000000
0 DELR = 200.0000
0 DELC = 200.0000
0 PRIMARY STORAGE COEF = .8360000E-01 FOR LAYER 1
0

HYD. COND. ALONG ROWS FOR LAYER 1 WILL BE READ ON UNIT 11 USING FORMAT: (16F4.0)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 2	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 3	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 4	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 5	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 6	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	300.0	300.0	300.0	300.0
0 7	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	300.0	300.0	300.0	300.0
0 8	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	225.0	225.0	225.0	300.0
0 9	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	225.0	225.0	225.0	300.0
0 10	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	225.0	225.0	225.0	300.0
0 11	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 12	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 13	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 14	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 15	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 16	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 17	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 18	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 19	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
20	300.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	300.0
21	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 22	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 23	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 24	300.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 25	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 26	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 27	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 28	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 29	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 30	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 31	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 32	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 33	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 34	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 35	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0

0 BOTTOM = 30.00000 FOR LAYER 1
0 VERT HYD COND /THICKNESS = .1000000E-02 FOR LAYER 1
0 PRIMARY STORAGE COEF = .1750000 FOR LAYER 2
0

TRANSMIS. ALONG ROWS FOR LAYER 2 WILL BE READ ON UNIT 11 USING FORMAT: (16F5.0)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 2	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 3	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 4	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 5	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 6	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 7	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 8	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 9	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 10	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 11	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 12	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 13	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 14	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 15	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 16	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 17	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 18	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.

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0 19    6000.    6000.    6000.    6000.    6000.    8000.    8000.    8000.    8000.    8000.
        6000.    6000.    6000.    6000.    6000.    6000.
0 20    4000.    4000.    4000.    4000.    4000.    4000.    1500.    1500.    1500.    4000.
        4000.    4000.    4000.    4000.    4000.    4000.
0 21    3000.    3000.    3000.    3000.    3000.    3000.    1500.    1500.    1500.    3000.
        3000.    3000.    3000.    3000.    3000.    3000.
0 22    3000.    3000.    3000.    3000.    3000.    3000.    1500.    1500.    1500.    3000.
        3000.    3000.    3000.    3000.    3000.    3000.
0 23    3000.    3000.    3000.    3000.    3000.    3000.    1500.    1500.    1500.    3000.
        3000.    3000.    3000.    3000.    3000.    3000.
0 24    3000.    3000.    3000.    3000.    3000.    3000.    1500.    1500.    1500.    3000.
        3000.    3000.    3000.    3000.    3000.    3000.
0 25    3000.    3000.    3000.    3000.    3000.    3000.    1500.    1500.    1500.    3000.
        3000.    3000.    3000.    3000.    3000.    3000.
0 26    3000.    3000.    3000.    3000.    3000.    3000.    1500.    1500.    1500.    3000.
        3000.    3000.    3000.    3000.    3000.    3000.
0 27    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
        3000.    3000.    3000.    3000.    3000.    3000.
0 28    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
        3000.    3000.    3000.    3000.    3000.    3000.
0 29    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
        3000.    3000.    3000.    3000.    3000.    3000.
0 30    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
        3000.    3000.    3000.    3000.    3000.    3000.
0 31    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
        3000.    3000.    3000.    3000.    3000.    3000.
0 32    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
        3000.    3000.    3000.    3000.    3000.    3000.
0 33    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
        3000.    3000.    3000.    3000.    3000.    3000.
0 34    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
        3000.    3000.    3000.    3000.    3000.    3000.
0 35    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.    3000.
        3000.    3000.    3000.    3000.    3000.    3000.
0

                                        SOLUTION BY THE STRONGLY IMPLICIT PROCEDURE
                                        -------------------------------------------
0                                 MAXIMUM ITERATIONS ALLOWED FOR CLOSURE =        50
                                                 ACCELERATION PARAMETER =     1.0000
                                     HEAD CHANGE CRITERION FOR CLOSURE =    .10000E-02
                                     SIP HEAD CHANGE PRINTOUT INTERVAL =         1
0                                    CALCULATE ITERATION PARAMETERS FROM MODEL CALCULATED WSEED
1                                   STRESS PERIOD NO.    1, LENGTH =    1825.000
                                    ---------------------------------------------

                                    NUMBER OF TIME STEPS =     1

                                     MULTIPLIER FOR DELT =     1.000

                                  INITIAL TIME STEP SIZE =   1825.000
0            10 WELLS
                                 LAYER     ROW     COL     STRESS RATE     WELL NO.
                                 --------------------------------------------------
                                   1        13      8       -21176.           1
                                   1        17      8       -21176.           2
                                   1        24      8       -15401.           3
                                   1        29      7        24064.           4
                                   1        29      8        24064.           5
                                   2        13      8       -4813.0           6
                                   2        17      8       -4813.0           7
                                   2        24      8       -9626.0           8
                                   2        29      7        14439.           9
                                   2        29      8        14439.          10
0AVERAGE SEED =   .00187924
 MINIMUM SEED =   .00055600
0
    5 ITERATION PARAMETERS CALCULATED FROM AVERAGE SEED:

             .0000000E+00    .7917928E+00    .9566497E+00    .9909742E+00    .9981208E+00
0
    11 ITERATIONS FOR TIME STEP    1 IN STRESS PERIOD   1
0MAXIMUM HEAD CHANGE FOR EACH ITERATION:
0 HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL
 ------------------------------------------------------------------------------------------------------------------------------------
   -2.330      (  2, 13,   8)   .9171      (  2, 30,   7)   .6796      (  2, 29,   7)   .3210      (  2, 27, 11)  -.7936E-01 (  2, 23, 13)
   .2625E-01 (  2, 21,   8)  -.2189E-01 (  2, 27, 11)   .1692E-01 (  2, 17,   9)   .8966E-02 (  2, 20, 12)   .3751E-02 (  2, 27,   8)
  -.8106E-03 (  2, 22, 12)
0
0HEAD/DRAWDOWN PRINTOUT FLAG = 1     TOTAL BUDGET PRINTOUT FLAG = 1     CELL-BY-CELL FLOW TERM FLAG = 0
0OUTPUT FLAGS FOR EACH LAYER:
```

LAYER	HEAD PRINTOUT	DRAWDOWN PRINTOUT	HEAD SAVE	DRAWDOWN SAVE
1	1	1	1	1
2	1	1	1	1

1 HEAD IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.55	92.67	92.77	92.87	92.98	93.12	93.24	93.34	93.44	93.54	93.65	93.74	93.83	93.92	94.00
0 3	92.00	92.13	92.24	92.35	92.45	92.55	92.67	92.78	92.89	92.99	93.09	93.19	93.28	93.37	93.44	93.50
0 4	91.60	91.72	91.83	91.94	92.03	92.13	92.23	92.34	92.44	92.53	92.63	92.73	92.82	92.90	92.99	93.10
0 5	91.20	91.32	91.43	91.54	91.62	91.70	91.80	91.89	91.99	92.08	92.17	92.27	92.36	92.44	92.52	92.60
0 6	90.70	90.85	90.98	91.08	91.17	91.25	91.33	91.42	91.52	91.61	91.70	91.80	91.89	91.97	92.04	92.10
0 7	90.20	90.35	90.48	90.59	90.67	90.75	90.84	90.93	91.02	91.11	91.21	91.32	91.43	91.51	91.57	91.60
0 8	89.70	89.88	90.01	90.11	90.19	90.26	90.34	90.42	90.51	90.61	90.70	90.81	90.92	91.01	91.06	91.10
0 9	89.40	89.48	89.57	89.64	89.71	89.77	89.83	89.91	89.99	90.09	90.19	90.28	90.37	90.45	90.49	90.50
0 10	89.00	89.07	89.14	89.19	89.23	89.28	89.32	89.38	89.46	89.57	89.66	89.75	89.84	89.91	89.97	90.00
0 11	88.70	88.71	88.74	88.76	88.77	88.78	88.79	88.81	88.92	89.05	89.16	89.26	89.35	89.42	89.47	89.50
0 12	88.30	88.35	88.37	88.36	88.35	88.30	88.23	88.15	88.34	88.53	88.68	88.79	88.89	88.97	89.03	89.10
0 13	88.00	88.02	88.01	87.98	87.93	87.84	87.66	87.23	87.76	88.04	88.22	88.35	88.45	88.53	88.59	88.60
0 14	87.70	87.71	87.68	87.62	87.55	87.45	87.32	87.22	87.41	87.62	87.79	87.92	88.03	88.12	88.18	88.20
0 15	87.50	87.43	87.36	87.28	87.19	87.07	86.96	86.91	87.03	87.21	87.39	87.52	87.64	87.73	87.82	87.90
0 16	87.30	87.16	87.05	86.95	86.85	86.72	86.58	86.48	86.64	86.82	87.00	87.14	87.26	87.36	87.44	87.50
0 17	87.00	86.83	86.72	86.63	86.52	86.40	86.21	85.84	86.25	86.48	86.65	86.78	86.89	86.99	87.10	87.20
18	86.50	86.44	86.37	86.30	86.22	86.13	86.02	85.93	86.05	86.20	86.33	86.44	86.53	86.63	86.74	86.90
0 19	86.00	86.04	86.03	85.99	85.94	85.88	85.81	85.78	85.84	85.93	86.02	86.10	86.18	86.25	86.33	86.40
0 20	85.60	85.63	85.64	85.62	85.60	85.56	85.52	85.51	85.54	85.60	85.66	85.71	85.74	85.78	85.82	85.90
0 21	85.10	85.16	85.19	85.20	85.19	85.16	85.12	85.10	85.12	85.16	85.20	85.22	85.22	85.20	85.17	85.10
0 22	84.70	84.73	84.76	84.78	84.77	84.73	84.67	84.62	84.65	84.70	84.72	84.73	84.70	84.65	84.57	84.50
0 23	84.20	84.29	84.36	84.39	84.37	84.31	84.20	84.07	84.17	84.24	84.27	84.25	84.20	84.11	83.97	83.80
0 24	83.80	83.89	83.98	84.02	84.01	83.95	83.76	83.27	83.70	83.83	83.85	83.81	83.74	83.62	83.44	83.30
0 25	83.50	83.53	83.61	83.67	83.71	83.70	83.61	83.47	83.52	83.54	83.49	83.40	83.29	83.13	82.94	82.80
0 26	83.10	83.15	83.25	83.35	83.45	83.52	83.53	83.47	83.40	83.29	83.17	83.02	82.86	82.67	82.47	82.30
0 27	82.70	82.76	82.88	83.04	83.21	83.39	83.52	83.49	83.30	83.07	82.86	82.65	82.44	82.23	82.03	81.90
0 28	82.20	82.33	82.49	82.71	82.97	83.30	83.68	83.65	83.22	82.84	82.53	82.27	82.03	81.80	81.58	81.40
0 29	81.80	81.89	82.07	82.32	82.65	83.17	84.23	84.21	83.10	82.53	82.15	81.86	81.61	81.37	81.16	81.00
0 30	81.30	81.42	81.60	81.84	82.12	82.48	82.88	82.86	82.41	82.01	81.68	81.41	81.16	80.93	80.74	80.60
0 31	80.80	80.93	81.10	81.30	81.52	81.74	81.91	81.89	81.67	81.41	81.15	80.91	80.69	80.48	80.30	80.20
0 32	80.30	80.43	80.58	80.74	80.90	81.03	81.11	81.09	80.97	80.79	80.60	80.40	80.20	80.01	79.84	79.70
0 33	79.90	79.96	80.06	80.18	80.28	80.36	80.40	80.39	80.31	80.18	80.03	79.87	79.71	79.54	79.40	79.30
0 34	79.40	79.47	79.54	79.63	79.69	79.73	79.74	79.73	79.68	79.58	79.46	79.34	79.20	79.07	78.93	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

1 HEAD IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	[illegible]	16
0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	92.10
0 2	90.90	90.97	91.05	91.14	91.22	91.28	91.35	91.43	91.50	91.54	91.60	91.63	91.68	91.71	91.76	91.80
0 3	90.60	90.71	90.79	90.87	90.95	91.02	91.09	91.16	91.21	91.26	91.30	91.33	91.36	91.39	91.41	91.40
0 4	90.40	90.45	90.53	90.60	90.68	90.75	90.82	90.88	90.93	90.97	91.00	91.02	91.04	91.06	91.07	91.10
0 5	90.10	90.17	90.25	90.33	90.40	90.48	90.55	90.61	90.65	90.67	90.69	90.70	90.71	90.72	90.71	90.70
0 6	89.80	89.88	89.96	90.04	90.12	90.21	90.29	90.35	90.37	90.38	90.38	90.37	90.37	90.37	90.35	90.30
0 7	89.50	89.59	89.67	89.74	89.83	89.93	90.04	90.11	90.12	90.08	90.05	90.04	90.03	90.03	90.02	90.00
0 8	89.20	89.30	89.37	89.44	89.51	89.62	89.83	89.92	89.91	89.76	89.71	89.69	89.68	89.68	89.68	89.70
0 9	89.00	89.03	89.07	89.12	89.16	89.22	89.41	89.51	89.48	89.35	89.32	89.31	89.31	89.31	89.31	89.30
0 10	88.70	88.75	88.77	88.79	88.80	88.82	88.86	88.88	88.92	88.92	88.92	88.93	88.93	88.94	88.95	89.00
0 11	88.50	·88.49	88.48	88.46	88.44	88.42	88.33	88.21	88.37	88.49	88.51	88.54	88.55	88.55	88.54	88.50
0 12	88.30	88.24	88.18	88.13	88.08	88.02	87.71	87.24	87.73	88.05	88.10	88.15	88.17	88.18	88.16	88.10
0 13	88.10	87.98	87.89	87.81	87.72	87.62	86.99	85.23	86.99	87.62	87.70	87.77	87.81	87.83	87.82	87.80
0 14	87.80	87.68	87.58	87.48	87.37	87.25	86.87	86.43	86.86	87.22	87.33	87.41	87.46	87.49	87.50	87.50
0 15	87.50	87.37	87.27	87.17	87.04	86.88	86.67	86.58	86.65	86.84	86.98	87.07	87.13	87.16	87.18	87.20
0 16	87.10	87.04	86.96	86.87	86.76	86.64	86.51	86.43	86.49	86.60	86.69	86.77	86.81	86.84	86.86	86.90
0 17	86.80	86.73	86.67	86.60	86.51	86.42	86.31	86.14	86.29	86.37	86.44	86.49	86.52	86.53	86.53	86.50
0 18	86.40	86.41	86.38	86.34	86.28	86.23	86.18	86.13	86.16	86.18	86.20	86.22	86.23	86.23	86.21	86.20
0 19	86.10	86.11	86.11	86.09	86.06	86.05	86.05	86.03	86.02	85.99	85.97	85.97	85.96	85.94	85.89	85.80
0 20	85.70	85.77	85.79	85.78	85.76	85.75	85.73	85.70	85.69	85.68	85.66	85.66	85.64	85.60	85.53	85.40
0 21	85.30	85.35	85.37	85.36	85.34	85.29	85.20	85.13	85.15	85.21	85.22	85.23	85.21	85.17	85	85.00
0 22	84.90	84.91	84.92	84.91	84.87	84.79	84.62	84.45	84.56	84.68	84.74	84.76	84.74	84.70	84.	84.50
0 23	84.40	84.47	84.50	84.50	84.44	84.31	83.98	83.51	83.90	84.19	84.29	84.32	84.31	84.26	84.19	84.10
0 24	84.00	84.07	84.12	84.14	84.09	83.94	83.34	81.70	83.24	83.78	83.91	83.94	83.91	83.85	83.78	83.70
0 25	83.60	83.69	83.78	83.84	83.86	83.80	83.52	83.07	83.39	83.60	83.63	83.60	83.54	83.47	83.38	83.30
0 26	83.20	83.32	83.46	83.59	83.71	83.79	83.79	83.66	83.59	83.51	83.42	83.31	83.20	83.09	82.99	82.90
0 27	82.80	82.95	83.14	83.35	83.60	83.87	84.10	84.06	83.78	83.47	83.23	83.02	82.85	82.71	82.59	82.50
0 28	82.30	82.54	82.79	83.09	83.47	83.99	84.60	84.57	83.93	83.39	83.00	82.71	82.49	82.31	82.16	82.00
0 29	81.90	82.14	82.40	82.74	83.22	84.03	85.74	85.72	83.99	83.16	82.67	82.33	82.09	81.90	81.74	81.60
0 30	81.50	81.70	81.95	82.25	82.66	83.20	83.82	83.80	83.16	82.60	82.19	81.88	81.64	81.46	81.31	81.20
0 31	81.00	81.22	81.43	81.68	81.97	82.28	82.55	82.53	82.25	81.91	81.61	81.36	81.15	80.99	80.84	80.70
0 32	80.60	80.74	80.90	81.07	81.26	81.44	81.56	81.55	81.40	81.20	80.99	80.80	80.64	80.50	80.38	80.30
0 33	80.20	80.26	80.35	80.45	80.56	80.65	80.71	80.70	80.62	80.49	80.36	80.23	80.10	79.99	79.89	79.80
0 34	79.70	79.76	79.78	79.83	79.87	79.92	79.94	79.93	79.89	79.80	79.73	79.65	79.56	79.48	79.39	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

0HEAD WILL BE SAVED ON UNIT 30 AT END OF TIME STEP 1, STRESS PERIOD 1

1 DRAWDOWN IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

0 2	.00	.05	.03	.03	.03	.02	.08	.06	.06	.06	.06	.05	.06	-.03	-.02	.00
0 3	.00	.07	.06	.05	.05	.15	.13	.12	.11	.11	.11	.01	.02	.03	.06	.00
4	.00	.08	.07	.06	.17	.17	.17	.16	.16	.17	.17	.07	.08	-.00	.01	.00
5	.00	.08	.07	.06	.18	.20	.20	.21	.21	.22	.23	.13	.04	.06	.08	.00
6	.00	.05	.02	.12	.23	.25	.27	.28	.28	.29	.20	.20	.11	.13	.06	.00
0 7	.00	.05	.12	.11	.23	.25	.26	.27	.28	.29	.29	.18	.17	.09	.03	.00
0 8	.00	.02	.09	.19	.21	.24	.26	.28	.29	.29	.30	.19	.18	.09	.04	.00
0 9	.00	.02	.13	.16	.29	.33	.37	.39	.31	.31	.31	.22	.23	.15	.11	.00
0 10	.00	.13	.16	.21	.27	.32	.38	.42	.44	.33	.34	.25	.16	.09	.03	.00
0 11	.00	.09	.16	.24	.33	.42	.51	.59	.48	.45	.34	.34	.25	.18	.03	.00
0 12	.00	.05	.23	.34	.45	.60	.67	.85	.66	.57	.42	.31	.21	.13	.07	.00
0 13	.00	.08	.19	.32	.47	.66	.94	1.37	.94	.66	.48	.35	.25	.17	.11	.00
0 14	.00	.09	.22	.38	.55	.65	.88	.98	.89	.68	.51	.38	.27	.18	.12	.00
0 15	.00	.17	.24	.42	.51	.73	.84	.99	.87	.69	.51	.38	.26	.17	.08	.00
0 16	.00	.14	.25	.35	.55	.68	.92	1.02	.86	.78	.60	.46	.34	.24	.06	.00
0 17	.00	.07	.28	.37	.48	.70	.89	1.36	.95	.72	.55	.42	.31	.21	.10	.00
0 18	.00	.06	.23	.30	.48	.57	.78	.87	.75	.60	.47	.36	.27	.17	.06	.00
0 19	.00	.06	.17	.31	.46	.52	.59	.72	.66	.57	.48	.40	.22	.15	.07	.00
0 20	.00	.07	.16	.28	.40	.44	.48	.59	.56	.50	.44	.29	.26	.12	.08	.00
0 21	.00	.04	.11	.20	.31	.34	.48	.50	.48	.44	.30	.28	.18	.10	.03	.00
0 22	.00	.07	.14	.12	.23	.27	.33	.48	.35	.30	.28	.17	.10	.05	.03	.00
0 23	.00	.01	.04	.11	.13	.19	.30	.43	.33	.26	.13	.15	.10	.09	.03	.00
0 24	.00	.01	.02	-.02	-.01	.15	.34	.73	.30	.17	.05	-.01	.06	-.02	-.04	.00
0 25	.00	-.03	-.11	-.07	-.11	-.10	-.01	.13	-.02	-.04	-.09	-.10	-.09	-.03	-.04	.00
0 26	.00	-.05	-.15	-.25	-.35	-.42	-.43	-.37	-.40	-.29	-.27	-.22	-.16	-.07	-.07	.00
0 27	.00	-.06	-.18	-.34	-.51	-.79	-.92	-.89	-.70	-.57	-.46	-.25	-.24	-.13	-.03	.00
0 28	.00	-.13	-.29	-.51	-.77	-1.10	-1.48	-1.55	-1.12	-.84	-.53	-.37	-.23	-.10	-.08	.00
0 29	.00	-.09	-.27	-.52	-.95	-1.47	-2.53	-2.51	-1.50	-.93	-.65	-.46	-.31	-.17	-.06	.00
0 30	.00	-.12	-.30	-.54	-.82	-1.18	-1.58	-1.66	-1.21	-.91	-.58	-.41	-.26	-.13	-.04	.00
0 31	.00	-.13	-.30	-.50	-.72	-.94	-1.11	-1.09	-.97	-.71	-.55	-.41	-.29	-.18	-.00	.00
0 32	.00	-.03	-.18	-.34	-.50	-.63	-.71	-.79	-.67	-.59	-.40	-.30	-.20	-.11	-.04	.00
0 33	.00	-.06	-.16	-.18	-.28	-.36	-.50	-.49	-.41	-.38	-.33	-.17	-.11	-.04	.00	.00
0 34	.00	-.07	-.04	-.13	-.19	-.23	-.24	-.23	-.18	-.18	-.16	-.14	-.10	-.07	-.03	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

1 DRAWDOWN IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.03	.05	-.04	-.02	.02	.05	-.03	.00	-.04	.00	-.03	.02	-.01	.04	.00
0 3	.00	-.01	.01	.03	.05	-.02	.01	.04	-.01	.04	.00	-.03	.04	.01	-.01	.00
0 4	.00	.05	-.03	-.00	.02	-.05	-.02	.02	-.03	.03	.00	-.02	.06	.04	.03	.00
0 5	.00	.03	.05	-.03	-.00	.02	-.05	-.01	-.05	.03	.01	-.00	-.01	-.02	-.01	.00
0 6	.00	.02	.04	-.04	-.02	-.01	-.09	-.05	-.07	-.08	.02	.03	.03	.03	.05	.00
7	.00	.01	.03	.06	-.03	-.03	-.14	-.11	-.12	-.08	.05	.06	.07	.07	-.02	.00
8	.00	.00	.03	.06	-.01	-.02	-.23	-.22	-.21	-.06	-.01	.01	.02	.02	.02	.00
9	.00	.07	.03	.08	.14	.08	-.11	-.11	-.08	.05	.08	.09	.09	.09	-.01	.00
0 10	.00	.05	.13	.11	.20	.18	.14	.22	.18	.18	.18	.17	.07	.06	.05	.00
0 11	.00	.11	.12	.14	.26	.28	.37	.59	.43	.31	.19	.16	.15	.15	.06	.00
0 12	.00	.06	.12	.27	.32	.38	.79	1.26	.77	.35	.30	.25	.23	.12	.04	.00
0 13	.00	.12	.21	.29	.38	.48	1.21	2.97	1.21	.48	.40	.33	.19	.17	.08	.00
0 14	.00	.12	.22	.32	.53	.65	1.03	1.47	1.04	.58	.47	.29	.24	.11	.10	.00
0 15	.00	.13	.23	.33	.56	.72	.93	1.02	.95	.76	.52	.33	.17	.14	.02	.00
0 16	.00	.06	.24	.33	.54	.66	.79	.87	.71	.60	.41	.23	.19	.06	.04	.00
0 17	.00	.07	.13	.30	.39	.48	.59	.66	.51	.43	.26	.21	.08	.07	-.03	.00
0 18	.00	-.01	.12	.16	.22	.27	.22	.27	.24	.22	.10	.08	-.03	-.03	-.01	.00
0 19	.00	-.01	-.01	.01	.04	-.05	-.05	-.03	-.02	-.09	-.07	-.07	-.16	-.14	-.09	.00
0 20	.00	.03	.01	-.08	-.06	-.15	-.13	-.10	-.09	-.18	-.16	-.16	-.24	-.20	-.13	.00
0 21	.00	-.05	-.07	-.06	-.04	-.09	.00	.07	-.05	-.11	-.12	-.13	-.21	-.17	-.10	.00
0 22	.00	-.01	-.02	-.01	-.07	.01	.18	.35	.14	.02	-.04	-.16	-.14	-.10	-.02	.00
0 23	.00	-.07	-.10	-.10	-.04	.09	.32	.79	.40	.11	-.09	-.12	-.11	-.06	-.09	.00
0 24	.00	-.07	-.12	-.14	-.09	-.04	.56	2.20	.66	.12	-.11	-.14	-.11	-.05	-.08	.00
0 25	.00	-.09	-.18	-.34	-.36	-.30	-.02	.43	.01	-.20	-.23	-.20	-.14	-.07	-.08	.00
0 26	.00	-.12	-.36	-.49	-.61	-.69	-.69	-.66	-.59	-.51	-.42	-.31	-.20	-.19	-.09	.00
0 27	.00	-.15	-.44	-.65	-.90	-1.27	-1.50	-1.46	-1.18	-.87	-.73	-.52	-.35	-.21	-.09	.00
0 28	.00	-.24	-.49	-.79	-1.27	-1.79	-2.40	-2.37	-1.73	-1.29	-.90	-.61	-.39	-.21	-.16	.00
0 29	.00	-.24	-.50	-.94	-1.42	-2.23	-3.94	-4.02	-2.29	-1.46	-.97	-.73	-.49	-.30	-.14	.00
0 30	.00	-.20	-.55	-.85	-1.26	-1.80	-2.52	-2.50	-1.86	-1.30	-.99	-.68	-.44	-.26	-.11	.00
0 31	.00	-.22	-.43	-.68	-1.07	-1.38	-1.65	-1.63	-1.35	-1.11	-.81	-.56	-.35	-.29	-.14	.00
0 32	.00	-.14	-.30	-.57	-.76	-.94	-1.06	-1.15	-1.00	-.80	-.59	-.50	-.34	-.20	-.08	.00
0 33	.00	-.06	-.25	-.35	-.46	-.55	-.71	-.70	-.62	-.49	-.46	-.33	-.20	-.09	-.09	.00
0 34	.00	-.06	-.08	-.13	-.27	-.32	-.34	-.33	-.29	-.30	-.23	-.15	-.16	-.08	.01	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

0DRAWDOWN WILL BE SAVED ON UNIT 40 AT END OF TIME STEP 1, STRESS PERIOD 1

0

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 1

0 CUMULATIVE VOLUMES L**3 RATES FOR THIS TIME STEP L**3/T

	IN:		
	STORAGE =	.68383E+06	
	CONSTANT HEAD =	.29053E+09	
	WELLS =	.14054E+09	
0	TOTAL IN =	.43175E+09	
0	OUT:		
	STORAGE =	.93761E+06	
	CONSTANT HEAD =	.29028E+09	
	WELLS =	.14053E+09	
0	TOTAL OUT =	.43176E+09	
0	IN - OUT =	-3136.0	
0	PERCENT DISCREPANCY =		.00

IN:		
STORAGE =	374.70	
CONSTANT HEAD =	.15920E+06	
WELLS =	77006.	
TOTAL IN =	.23658E+06	
OUT:		
STORAGE =	513.76	
CONSTANT HEAD =	.15906E+06	
WELLS =	77005.	
TOTAL OUT =	.23658E+06	
IN - OUT =	-1.7031	
PERCENT DISCREPANCY =		.00

0

TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 1

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	.157680E+09	.262800E+07	43800.0	1825.00	4.99658
STRESS PERIOD TIME	.157680E+09	.262800E+07	43800.0	1825.00	4.99658
TOTAL SIMULATION TIME	.157680E+09	.262800E+07	43800.0	1825.00	4.99658

1
1 STRESS PERIOD NO. 2, LENGTH = 6.000000

NUMBER OF TIME STEPS = 1

MULTIPLIER FOR DELT = 1.000

INITIAL TIME STEP SIZE = 6.000000

0REUSING WELLS FROM LAST STRESS PERIOD
0
3 ITERATIONS FOR TIME STEP 1 IN STRESS PERIOD 2
0MAXIMUM HEAD CHANGE FOR EACH ITERATION:

HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL
-.4470E-02	(2, 13, 8)	.1774E-02	(2, 29, 8)	-.5002E-03	(1, 15, 8)				

0
0HEAD/DRAWDOWN PRINTOUT FLAG = 1 TOTAL BUDGET PRINTOUT FLAG = 1 CELL-BY-CELL FLOW TERM FLAG = 0
REUSING PREVIOUS VALUES OF IOFLG
1 HEAD IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.55	92.67	92.77	92.87	92.98	93.12	93.24	93.34	93.44	93.54	93.65	93.74	93.83	93.92	94.00
0 3	92.00	92.13	92.24	92.35	92.45	92.55	92.67	92.78	92.89	92.99	93.09	93.19	93.28	93.37	93.44	93.50
0 4	91.60	91.72	91.83	91.94	92.03	92.13	92.23	92.34	92.44	92.53	92.63	92.73	92.82	92.90	92.99	93.10
0 5	91.20	91.32	91.43	91.54	91.62	91.70	91.80	91.89	91.99	92.08	92.17	92.27	92.36	92.44	92.52	92.60
0 6	90.70	90.85	90.98	91.08	91.17	91.25	91.33	91.42	91.52	91.61	91.70	91.80	91.89	91.97	92.04	92.10
0 7	90.20	90.35	90.48	90.59	90.67	90.75	90.84	90.93	91.02	91.11	91.21	91.32	91.43	91.51	91.57	91.60
0 8	89.70	89.88	90.01	90.11	90.19	90.26	90.34	90.42	90.51	90.61	90.70	90.81	90.92	91.01	91.06	91.10
0 9	89.40	89.48	89.57	89.64	89.71	89.77	89.83	89.91	89.99	90.09	90.19	90.28	90.37	90.45	90.49	90.50
0 10	89.00	89.07	89.14	89.19	89.23	89.28	89.32	89.38	89.46	89.57	89.66	89.75	89.84	89.91	89.97	90.00
0 11	88.70	88.71	88.74	88.76	88.77	88.78	88.78	88.81	88.92	89.05	89.16	89.26	89.35	89.42	89.47	89.50
0 12	88.30	88.35	88.37	88.36	88.34	88.30	88.22	88.15	88.34	88.53	88.68	88.79	88.89	88.97	89.03	89.10
0 13	88.00	88.02	88.01	87.98	87.93	87.84	87.65	87.23	87.75	88.04	88.22	88.35	88.45	88.53	88.59	88.60
0 14	87.70	87.71	87.68	87.62	87.55	87.45	87.32	87.22	87.40	87.61	87.79	87.92	88.03	88.12	88.18	88.20
0 15	87.50	87.43	87.36	87.28	87.19	87.07	86.96	86.91	87.03	87.21	87.38	87.52	87.64	87.73	87.82	87.90
0 16	87.30	87.16	87.05	86.95	86.85	86.71	86.58	86.48	86.64	86.82	87.00	87.14	87.26	87.36	87.44	

87.50

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 17	87.00	86.83	86.72	86.62	86.52	86.39	86.21	85.84	86.25	86.48	86.65	86.78	86.89	86.99	87.10	87.20
18	86.50	86.44	86.37	86.30	86.22	86.13	86.02	85.92	86.05	86.20	86.32	86.44	86.53	86.63	86.74	86.90
0 19	86.00	86.04	86.03	85.99	85.94	85.88	85.81	85.78	85.84	85.93	86.02	86.10	86.18	86.25	86.33	86.40
0 20	85.60	85.63	85.64	85.62	85.60	85.56	85.52	85.51	85.54	85.60	85.66	85.71	85.74	85.78	85.82	85.90
0 21	85.10	85.16	85.19	85.20	85.19	85.16	85.12	85.10	85.12	85.16	85.20	85.22	85.22	85.20	85.17	85.10
0 22	84.70	84.73	84.76	84.78	84.77	84.73	84.67	84.62	84.65	84.70	84.72	84.72	84.70	84.65	84.57	84.50
0 23	84.20	84.29	84.36	84.39	84.37	84.31	84.20	84.07	84.17	84.24	84.27	84.25	84.20	84.11	83.97	83.80
0 24	83.80	83.89	83.98	84.02	84.01	83.95	83.76	83.27	83.70	83.83	83.85	83.81	83.74	83.62	83.44	83.30
0 25	83.50	83.53	83.61	83.67	83.71	83.70	83.61	83.47	83.52	83.54	83.49	83.40	83.29	83.13	82.94	82.80
0 26	83.10	83.15	83.25	83.35	83.45	83.52	83.53	83.47	83.40	83.29	83.17	83.02	82.86	82.67	82.47	82.30
0 27	82.70	82.76	82.88	83.04	83.21	83.39	83.52	83.49	83.30	83.07	82.86	82.65	82.44	82.23	82.03	81.90
0 28	82.20	82.33	82.49	82.71	82.97	83.31	83.68	83.65	83.23	82.84	82.53	82.27	82.03	81.80	81.58	81.40
0 29	81.80	81.89	82.07	82.32	82.65	83.17	84.24	84.21	83.10	82.53	82.15	81.86	81.61	81.37	81.16	81.00
0 30	81.30	81.42	81.60	81.84	82.13	82.48	82.88	82.86	82.42	82.01	81.69	81.41	81.16	80.93	80.74	80.60
0 31	80.80	80.93	81.10	81.30	81.52	81.74	81.91	81.89	81.67	81.41	81.15	80.92	80.69	80.48	80.31	80.20
0 32	80.30	80.43	80.58	80.74	80.90	81.03	81.11	81.09	80.97	80.79	80.60	80.40	80.21	80.01	79.84	79.70
0 33	79.90	79.96	80.06	80.18	80.28	80.36	80.40	80.39	80.31	80.18	80.03	79.87	79.71	79.54	79.40	79.30
0 34	79.40	79.47	79.54	79.63	79.69	79.73	79.74	79.73	79.68	79.58	79.46	79.34	79.20	79.07	78.93	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

1 HEAD IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	92.10
2	90.90	90.97	91.05	91.14	91.22	91.28	91.35	91.43	91.50	91.54	91.60	91.63	91.68	91.71	91.76	91.80
0 3	90.60	90.71	90.79	90.87	90.95	91.02	91.09	91.16	91.21	91.26	91.30	91.33	91.36	91.39	91.41	91.40
0 4	90.40	90.45	90.53	90.60	90.68	90.75	90.82	90.88	90.93	90.97	91.00	91.02	91.04	91.06	91.07	91.10
0 5	90.10	90.17	90.25	90.33	90.40	90.48	90.55	90.61	90.65	90.67	90.69	90.70	90.71	90.72	90.71	90.70
0 6	89.80	89.88	89.96	90.04	90.12	90.21	90.29	90.35	90.38	90.38	90.38	90.37	90.37	90.37	90.35	90.30
0 7	89.50	89.59	89.67	89.74	89.83	89.93	90.04	90.11	90.12	90.08	90.05	90.04	90.03	90.03	90.02	90.00
0 8	89.20	89.30	89.37	89.44	89.51	89.62	89.83	89.92	89.91	89.76	89.71	89.69	89.68	89.68	89.68	89.70
0 9	89.00	89.03	89.07	89.12	89.16	89.22	89.41	89.51	89.48	89.35	89.32	89.31	89.31	89.31	89.31	89.30
0 10	88.70	88.75	88.77	88.79	88.80	88.82	88.86	88.88	88.92	88.92	88.92	88.93	88.93	88.94	88.95	89.00
0 11	88.50	88.49	88.48	88.46	88.44	88.42	88.33	88.21	88.37	88.49	88.51	88.54	88.55	88.55	88.54	88.50
0 12	88.30	88.24	88.18	88.13	88.08	88.02	87.71	87.23	87.73	88.05	88.10	88.15	88.17	88.18	88.16	88.10
0 13	88.10	87.98	87.89	87.81	87.72	87.62	86.99	85.22	86.99	87.61	87.70	87.77	87.81	87.83	87.82	87.80
0 14	87.80	87.68	87.58	87.48	87.37	87.25	86.87	86.42	86.86	87.22	87.33	87.41	87.46	87.49	87.50	87.50
0 15	87.50	87.37	87.27	87.17	87.04	86.88	86.67	86.57	86.65	86.84	86.98	87.07	87.13	87.16	87.18	87.20
0 16	87.10	87.04	86.96	86.87	86.76	86.64	86.51	86.43	86.49	86.60	86.69	86.77	86.81	86.84	86.86	86.90
0 17	86.80	86.73	86.67	86.60	86.51	86.42	86.31	86.14	86.29	86.37	86.44	86.49	86.52	86.53	86.53	86.50
0 18	86.40	86.40	86.38	86.34	86.28	86.23	86.18	86.13	86.15	86.18	86.20	86.22	86.23	86.23	86.21	86.20
0 19	86.10	86.11	86.11	86.08	86.06	86.05	86.05	86.03	86.02	85.99	85.97	85.97	85.96	85.94	85.89	

	85.80														
0 20	85.70	85.77	85.79	85.78	85.76	85.75	85.73	85.70	85.69	85.68	85.66	85.66	85.64	85.60	85.53
	85.40														
0 21	85.30	85.35	85.37	85.36	85.34	85.29	85.20	85.13	85.15	85.21	85.22	85.23	85.21	85.17	85.
	85.00														
0 22	84.90	84.91	84.93	84.91	84.87	84.79	84.62	84.45	84.56	84.68	84.74	84.76	84.74	84.70	84.62
	84.50														
0 23	84.40	84.47	84.50	84.50	84.45	84.31	83.97	83.51	83.90	84.19	84.29	84.32	84.31	84.26	84.19
	84.10														
0 24	84.00	84.07	84.12	84.14	84.10	83.94	83.34	81.70	83.24	83.78	83.91	83.94	83.91	83.85	83.78
	83.70														
0 25	83.60	83.69	83.78	83.84	83.86	83.80	83.53	83.07	83.39	83.60	83.63	83.61	83.54	83.47	83.38
	83.30														
0 26	83.20	83.32	83.46	83.59	83.71	83.79	83.80	83.66	83.60	83.51	83.42	83.31	83.20	83.09	82.99
	82.90														
0 27	82.80	82.95	83.14	83.35	83.60	83.87	84.11	84.06	83.78	83.48	83.23	83.02	82.85	82.71	82.59
	82.50														
0 28	82.30	82.54	82.79	83.09	83.48	84.00	84.60	84.58	83.93	83.39	83.00	82.71	82.49	82.31	82.16
	82.00														
0 29	81.90	82.14	82.40	82.74	83.23	84.04	85.75	85.73	83.99	83.16	82.67	82.34	82.09	81.90	81.74
	81.60														
0 30	81.50	81.70	81.95	82.26	82.66	83.20	83.82	83.81	83.16	82.61	82.19	81.88	81.64	81.46	81.31
	81.20														
0 31	81.00	81.22	81.44	81.68	81.97	82.29	82.55	82.54	82.25	81.92	81.61	81.36	81.16	80.99	80.84
	80.70														
0 32	80.60	80.74	80.90	81.07	81.26	81.44	81.56	81.55	81.40	81.20	80.99	80.80	80.64	80.50	80.38
	80.30														
0 33	80.20	80.26	80.35	80.45	80.56	80.66	80.71	80.70	80.62	80.49	80.36	80.23	80.10	79.99	79.89
	79.80														
0 34	79.70	79.76	79.78	79.83	79.87	79.92	79.94	79.93	79.89	79.80	79.73	79.65	79.56	79.48	79.39
	79.30														
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90
	78.90														

0HEAD WILL BE SAVED ON UNIT 30 AT END OF TIME STEP 1, STRESS PERIOD 2

1 DRAWDOWN IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.05	.03	.03	.03	.02	.08	.06	.06	.06	.06	.05	.06	-.03	-.02	.00
0 3	.00	.07	.06	.05	.05	.15	.13	.12	.11	.11	.11	.01	.02	.03	.06	.00
0 4	.00	.08	.07	.06	.17	.17	.17	.16	.16	.17	.17	.07	.08	-.00	.01	.00
0 5	.00	.08	.07	.06	.18	.20	.20	.21	.21	.22	.23	.13	.04	.06	.08	.00
0 6	.00	.05	.02	.12	.23	.25	.27	.28	.28	.29	.20	.20	.11	.13	.06	.00
0 7	.00	.05	.12	.11	.23	.25	.26	.27	.28	.29	.29	.18	.17	.09	.03	.00
0 8	.00	.02	.09	.19	.21	.24	.26	.28	.29	.29	.30	.19	.18	.09	.04	.00
0 9	.00	.02	.13	.16	.29	.33	.37	.39	.31	.31	.31	.22	.23	.15	.11	.00
0 10	.00	.13	.16	.21	.27	.32	.38	.42	.44	.33	.34	.25	.16	.09	.03	.00
0 11	.00	.09	.16	.24	.33	.42	.52	.59	.48	.45	.34	.34	.25	.18	.03	.00
0 12	.00	.05	.23	.34	.46	.60	.68	.85	.66	.57	.42	.31	.21	.13	.07	.00
0 13	.00	.08	.19	.32	.47	.66	.95	1.37	.95	.66	.48	.35	.25	.17	.11	.00
0 14	.00	.09	.22	.38	.55	.65	.88	.98	.90	.69	.51	.38	.27	.18	.12	.00
0 15	.00	.17	.24	.42	.51	.73	.84	.99	.87	.69	.52	.38	.26	.17	.08	.00
0 16	.00	.14	.25	.35	.55	.69	.92	1.02	.86	.78	.60	.46	.34	.24	.06	.00
0 17	.00	.07	.28	.38	.48	.71	.89	1.36	.95	.72	.55	.42	.31	.21	.10	.00
0 18	.00	.06	.23	.30	.48	.57	.78	.88	.75	.60	.48	.36	.27	.17	.06	.00
0 19	.00	.06	.17	.31	.46	.52	.59	.72	.66	.57	.48	.40	.22	.15	.07	.00
0 20	.00	.07	.16	.28	.40	.44	.48	.59	.56	.50	.44	.29	.26	.12	.08	.00
0 21	.00	.04	.11	.20	.31	.34	.48	.50	.48	.44	.30	.28	.18	.10	.03	.00
0 22	.00	.07	.14	.12	.23	.27	.33	.48	.35	.30	.28	.18	.10	.05	.03	.00
0 23	.00	.01	.04	.11	.13	.19	.30	.43	.33	.26	.13	.15	.10	.09	.03	.00
0 24	.00	.01	.02	-.02	-.01	.15	.34	.73	.30	.17	.05	-.01	.06	-.02	-.04	.00
0 25	.00	-.03	-.11	-.07	-.11	-.10	-.01	.13	-.02	-.04	-.09	-.10	-.09	-.03	-.04	.00
0 26	.00	-.05	-.15	-.25	-.35	-.42	-.43	-.37	-.40	-.29	-.27	-.22	-.16	-.07	-.07	.00
0 27	.00	-.06	-.18	-.34	-.51	-.79	-.92	-.89	-.70	-.57	-.46	-.25	-.24	-.13	-.03	.00
0 28	.00	-.13	-.29	-.51	-.77	-1.11	-1.48	-1.55	-1.13	-.84	-.53	-.37	-.23	-.10	-.08	.00
0 29	.00	-.09	-.27	-.52	-.95	-1.47	-2.54	-2.51	-1.50	-.93	-.65	-.46	-.31	-.17	-.06	.00
0 30	.00	-.12	-.30	-.54	-.83	-1.18	-1.58	-1.66	-1.22	-.91	-.59	-.41	-.26	-.13	-.04	.00
0 31	.00	-.13	-.30	-.50	-.72	-.94	-1.11	-1.09	-.97	-.71	-.55	-.42	-.29	-.18	-.01	.00
0 32	.00	-.03	-.18	-.34	-.50	-.63	-.71	-.79	-.67	-.59	-.40	-.30	-.21	-.11	-.04	.00
0 33	.00	-.06	-.16	-.18	-.28	-.36	-.50	-.49	-.41	-.38	-.33	-.17	-.11	-.04	.00	.00
0 34	.00	-.07	-.04	-.13	-.19	-.23	-.24	-.23	-.18	-.18	-.16	-.14	-.10	-.07	-.03	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

1 DRAWDOWN IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.03	.05	-.04	-.02	.02	.05	-.03	.00	-.04	.00	-.03	.02	-.01	.04	.00
0 3	.00	-.01	.01	.03	.05	-.02	.01	.04	-.01	.04	.00	-.03	.04	.01	-.01	.00

0 4	.00	.05	-.03	-.00	.02	-.05	-.02	.02	-.03	.03	.00	-.02	.06	.04	.03	.00
0 5	.00	.03	.05	-.03	-.00	.02	-.05	-.01	-.05	.03	.01	-.00	-.01	-.02	-.01	.00
6	.00	.02	.04	-.04	-.02	-.01	-.09	-.05	-.08	-.08	.02	.03	.03	.03	.05	.00
7	.00	.01	.03	.06	-.03	-.03	-.14	-.11	-.12	-.08	.05	.06	.07	.07	-.02	.00
8	.00	.00	.03	.06	-.01	-.02	-.23	-.22	-.21	-.06	-.01	.01	.02	.02	.02	.00
0 9	.00	.07	.03	.08	.14	.08	-.11	-.11	-.08	.05	.08	.09	.09	.09	-.01	.00
0 10	.00	.05	.13	.11	.20	.18	.14	.22	.18	.18	.18	.17	.07	.06	.05	.00
0 11	.00	.11	.12	.14	.26	.28	.37	.59	.43	.31	.19	.16	.15	.15	.06	.00
0 12	.00	.06	.12	.27	.32	.38	.79	1.27	.77	.35	.30	.25	.23	.12	.04	.00
0 13	.00	.12	.21	.29	.38	.48	1.21	2.98	1.21	.49	.40	.33	.19	.17	.08	.00
0 14	.00	.12	.22	.32	.53	.65	1.03	1.48	1.04	.58	.47	.29	.24	.11	.10	.00
0 15	.00	.13	.23	.33	.56	.72	.93	1.03	.95	.76	.52	.33	.17	.14	.02	.00
0 16	.00	.06	.24	.33	.54	.66	.79	.87	.71	.60	.41	.23	.19	.06	.04	.00
0 17	.00	.07	.13	.30	.39	.48	.59	.66	.51	.43	.26	.21	.08	.07	-.03	.00
0 18	.00	-.00	.12	.16	.22	.27	.22	.27	.25	.22	.10	.08	-.03	-.03	-.01	.00
0 19	.00	-.01	-.01	.02	.04	-.05	-.05	-.03	-.02	-.09	-.07	-.07	-.16	-.14	-.09	.00
0 20	.00	.03	.01	-.08	-.06	-.15	-.13	-.10	-.09	-.18	-.16	-.16	-.24	-.20	-.13	.00
0 21	.00	-.05	-.07	-.06	-.04	-.09	.00	.07	-.05	-.11	-.12	-.13	-.21	-.17	-.10	.00
0 22	.00	-.01	-.03	-.01	-.07	.01	.18	.35	.14	.02	-.04	-.16	-.14	-.10	-.02	.00
0 23	.00	-.07	-.10	-.10	-.05	.09	.33	.79	.40	.11	-.09	-.12	-.11	-.06	-.09	.00
0 24	.00	-.07	-.12	-.14	-.10	-.04	.56	2.20	.66	.12	-.11	-.14	-.11	-.05	-.08	.00
0 25	.00	-.09	-.18	-.34	-.36	-.30	-.03	.43	.01	-.20	-.23	-.21	-.14	-.07	-.08	.00
0 26	.00	-.12	-.36	-.49	-.61	-.69	-.70	-.66	-.60	-.51	-.42	-.31	-.20	-.19	-.09	.00
0 27	.00	-.15	-.44	-.65	-.90	-1.27	-1.51	-1.46	-1.18	-.88	-.73	-.52	-.35	-.21	-.09	.00
0 28	.00	-.24	-.49	-.79	-1.28	-1.80	-2.40	-2.38	-1.73	-1.29	-.90	-.61	-.39	-.21	-.16	.00
0 29	.00	-.24	-.50	-.94	-1.43	-2.24	-3.95	-4.03	-2.29	-1.46	-.97	-.74	-.49	-.30	-.14	.00
0 30	.00	-.20	-.55	-.86	-1.26	-1.80	-2.52	-2.51	-1.86	-1.31	-.99	-.68	-.44	-.26	-.11	.00
0 31	.00	-.22	-.44	-.68	-1.07	-1.39	-1.65	-1.64	-1.35	-1.12	-.81	-.56	-.36	-.29	-.14	.00
0 32	.00	-.14	-.30	-.57	-.76	-.94	-1.06	-1.15	-1.00	-.80	-.59	-.50	-.34	-.20	-.08	.00
0 33	.00	-.06	-.25	-.35	-.46	-.56	-.71	-.70	-.62	-.49	-.46	-.33	-.20	-.09	-.09	.00
0 34	.00	-.06	-.08	-.13	-.27	-.32	-.34	-.33	-.29	-.30	-.23	-.15	-.16	-.08	.01	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

0DRAWDOWN WILL BE SAVED ON UNIT 40 AT END OF TIME STEP 1, STRESS PERIOD 2

0

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 2

	CUMULATIVE VOLUMES	L**3		RATES FOR THIS TIME STEP	L**3/T	
0	IN:			IN:		
	STORAGE =	.68513E+06		STORAGE =	217.32	
	CONSTANT HEAD =	.29149E+09		CONSTANT HEAD =	.15924E+06	
	WELLS =	.14100E+09		WELLS =	77006.	
	TOTAL IN =	.43317E+09		TOTAL IN =	.23646E+06	
	OUT:			OUT:		
	STORAGE =	.93975E+06		STORAGE =	357.09	
	CONSTANT HEAD =	.29124E+09		CONSTANT HEAD =	.15913E+06	
	WELLS =	.14100E+09		WELLS =	77005.	
0	TOTAL OUT =	.43317E+09		TOTAL OUT =	.23649E+06	
0	IN - OUT =	-3296.0		IN - OUT =	-28.031	
0	PERCENT DISCREPANCY =		.00	PERCENT DISCREPANCY =		-.01

0

TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 2

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	518400.	8640.00	144.000	6.00000	.164271E-01
STRESS PERIOD TIME	518400.	8640.00	144.000	6.00000	.164271E-01
TOTAL SIMULATION TIME	.158198E+09	.263664E+07	43944.0	1831.00	5.01300

1

1 STRESS PERIOD NO. 3, LENGTH = 1.000000

NUMBER OF TIME STEPS = 1

MULTIPLIER FOR DELT = 1.000

INITIAL TIME STEP SIZE = 1.000000

0 10 WELLS

LAYER	ROW	COL	STRESS RATE	WELL NO.
1	13	8	.00000	1
1	17	8	.00000	2
1	24	8	.00000	3

1	29	7	.00000	4
1	29	8	.00000	5
2	13	8	.00000	6
2	17	8	.00000	7
2	24	8	.00000	8
2	29	7	.00000	9
2	29	8	.00000	10

0
5 ITERATIONS FOR TIME STEP 1 IN STRESS PERIOD 3
0MAXIMUM HEAD CHANGE FOR EACH ITERATION:

0 HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL
-1.138	(1, 29, 7)	-.2125	(1, 30, 7)	.3825E-01	(1, 15, 8)	.3986E-02	(1, 13, 11)	.5895E-03	(1, 27, 6)

0
0HEAD/DRAWDOWN PRINTOUT FLAG = 1 TOTAL BUDGET PRINTOUT FLAG = 1 CELL-BY-CELL FLOW TERM FLAG = 0
REUSING PREVIOUS VALUES OF IOFLG
1 HEAD IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 3

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.55	92.67	92.77	92.87	92.98	93.12	93.24	93.34	93.44	93.54	93.65	93.74	93.83	93.92	94.00
0 3	92.00	92.13	92.24	92.35	92.45	92.55	92.67	92.78	92.89	92.99	93.09	93.19	93.28	93.37	93.44	93.50
0 4	91.60	91.72	91.83	91.94	92.03	92.13	92.23	92.34	92.44	92.53	92.63	92.73	92.82	92.90	92.99	93.10
0 5	91.20	91.32	91.43	91.54	91.62	91.70	91.80	91.90	91.99	92.08	92.17	92.27	92.36	92.44	92.52	92.60
0 6	90.70	90.85	90.98	91.09	91.17	91.25	91.34	91.43	91.52	91.61	91.70	91.80	91.90	91.97	92.04	92.10
0 7	90.20	90.35	90.48	90.59	90.68	90.76	90.85	90.93	91.02	91.12	91.21	91.32	91.44	91.52	91.57	91.60
0 8	89.70	89.88	90.01	90.11	90.20	90.27	90.35	90.44	90.52	90.62	90.71	90.81	90.93	91.01	91.06	91.10
0 9	89.40	89.48	89.57	89.65	89.72	89.79	89.86	89.94	90.02	90.11	90.20	90.29	90.38	90.45	90.50	90.50
0 10	89.00	89.08	89.15	89.20	89.25	89.31	89.37	89.43	89.51	89.60	89.69	89.77	89.85	89.92	89.97	90.00
0 11	88.70	88.72	88.75	88.78	88.81	88.84	88.88	88.93	89.01	89.11	89.20	89.28	89.36	89.43	89.48	89.50
0 12	88.30	88.35	88.38	88.39	88.40	88.39	88.39	88.42	88.51	88.63	88.73	88.83	88.91	88.98	89.0[illegible]	89.10
0 13	88.00	88.02	88.03	88.02	88.00	87.96	87.93	87.93	88.03	88.16	88.29	88.39	88.47	88.54	88.[illegible]	88.60
0 14	87.70	87.71	87.70	87.66	87.62	87.57	87.52	87.52	87.61	87.73	87.86	87.96	88.06	88.13	88.19	88.20
0 15	87.50	87.44	87.38	87.32	87.26	87.18	87.13	87.13	87.20	87.32	87.45	87.56	87.66	87.75	87.82	87.90
0 16	87.30	87.17	87.07	86.99	86.92	86.84	86.78	86.77	86.84	86.94	87.07	87.18	87.28	87.37	87.45	87.50
0 17	87.00	86.84	86.74	86.66	86.59	86.53	86.47	86.45	86.52	86.61	86.72	86.82	86.91	87.01	87.10	87.20
0 18	86.50	86.45	86.39	86.34	86.28	86.23	86.19	86.18	86.23	86.30	86.39	86.47	86.55	86.64	86.75	86.90
0 19	86.00	86.05	86.04	86.02	85.98	85.95	85.92	85.92	85.95	86.00	86.07	86.13	86.19	86.26	86.33	86.40
0 20	85.60	85.63	85.65	85.64	85.64	85.61	85.59	85.59	85.61	85.65	85.69	85.73	85.75	85.78	85.83	85.90
0 21	85.10	85.16	85.20	85.21	85.22	85.20	85.18	85.17	85.18	85.21	85.23	85.24	85.23	85.21	85.17	85.10
0 22	84.70	84.73	84.77	84.80	84.80	84.78	84.74	84.72	84.73	84.74	84.75	84.74	84.71	84.65	84.57	84.50
0 23	84.20	84.29	84.36	84.40	84.40	84.37	84.33	84.28	84.29	84.30	84.30	84.27	84.21	84.11	83.97	83.80
0 24	83.80	83.89	83.98	84.03	84.04	84.02	83.96	83.88	83.90	83.91	83.88	83.82	83.74	83.62	83.44	83.30
0 25	83.50	83.53	83.61	83.67	83.71	83.72	83.69	83.64	83.62	83.57	83.50	83.41	83.30	83.13	82.94	82.80
0 26	83.10	83.15	83.24	83.33	83.42	83.47	83.49	83.45	83.38	83.28	83.16	83.01	82.85	82.67	82.47	82.30
0 27	82.70	82.75	82.86	83.00	83.13	83.25	83.31	83.28	83.16	83.00	82.82	82.63	82.43	82.23	82.03	81.90
0 28	82.20	82.32	82.46	82.64	82.83	83.01	83.14	83.12	82.93	82.70	82.47	82.24	82.02	81.79	81.58	81.40
0 29	81.80	81.88	82.04	82.24	82.45	82.69	82.90	82.88	82.62	82.34	82.07	81.82	81.59	81.36	81.16	81.00
0 30	81.30	81.41	81.57	81.77	81.97	82.18	82.32	82.30	82.11	81.86	81.61	81.37	81.15	80.93	80.73	80.60

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 31	80.80	80.92	81.08	81.25	81.42	81.57	81.67	81.64	81.51	81.32	81.10	80.89	80.68	80.48	80.30	80.20
32	80.30	80.43	80.57	80.71	80.84	80.95	81.00	80.98	80.89	80.74	80.56	80.38	80.20	80.01	79.84	79.70
33	79.90	79.96	80.06	80.17	80.26	80.32	80.35	80.34	80.27	80.15	80.01	79.86	79.70	79.54	79.39	79.30
0 34	79.40	79.47	79.54	79.62	79.68	79.71	79.72	79.71	79.67	79.57	79.46	79.33	79.20	79.07	78.93	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

1 HEAD IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 3

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	92.10
0 2	90.90	90.97	91.05	91.14	91.22	91.28	91.35	91.43	91.50	91.54	91.60	91.63	91.68	91.71	91.76	91.80
0 3	90.60	90.71	90.79	90.87	90.95	91.02	91.09	91.16	91.21	91.26	91.30	91.33	91.36	91.39	91.41	91.40
0 4	90.40	90.45	90.53	90.60	90.68	90.75	90.82	90.88	90.93	90.97	91.00	91.02	91.04	91.06	91.07	91.10
0 5	90.10	90.17	90.25	90.33	90.40	90.48	90.55	90.61	90.65	90.67	90.69	90.70	90.71	90.72	90.71	90.70
0 6	89.80	89.88	89.96	90.04	90.12	90.21	90.29	90.35	90.38	90.38	90.38	90.37	90.37	90.37	90.35	90.30
0 7	89.50	89.59	89.67	89.74	89.83	89.93	90.04	90.11	90.12	90.08	90.05	90.04	90.03	90.03	90.02	90.00
0 8	89.20	89.30	89.37	89.44	89.51	89.62	89.83	89.92	89.91	89.76	89.71	89.69	89.68	89.68	89.68	89.70
0 9	89.00	89.03	89.07	89.12	89.16	89.22	89.41	89.51	89.48	89.35	89.32	89.31	89.31	89.31	89.31	89.30
0 10	88.70	88.75	88.77	88.79	88.80	88.82	88.86	88.88	88.92	88.92	88.92	88.93	88.93	88.94	88.95	89.00
0 11	88.50	88.49	88.48	88.46	88.44	88.42	88.33	88.22	88.37	88.49	88.51	88.54	88.55	88.55	88.54	88.50
0 12	88.30	88.24	88.18	88.13	88.08	88.02	87.72	87.27	87.74	88.05	88.10	88.15	88.17	88.18	88.16	88.10
0 13	88.10	87.98	87.89	87.81	87.72	87.62	87.03	85.72	87.03	87.62	87.71	87.77	87.81	87.83	87.82	87.80
0 14	87.80	87.68	87.58	87.48	87.37	87.25	86.88	86.46	86.86	87.22	87.33	87.41	87.46	87.49	87.50	87.50
15	87.50	87.37	87.27	87.17	87.04	86.89	86.68	86.59	86.66	86.85	86.98	87.07	87.13	87.16	87.18	87.20
16	87.10	87.04	86.96	86.87	86.77	86.65	86.54	86.48	86.52	86.61	86.70	86.77	86.81	86.84	86.86	86.90
0 17	86.80	86.73	86.67	86.60	86.52	86.44	86.36	86.30	86.34	86.39	86.44	86.49	86.52	86.53	86.53	86.50
0 18	86.40	86.41	86.38	86.34	86.29	86.24	86.20	86.17	86.18	86.19	86.21	86.22	86.23	86.23	86.21	86.20
0 19	86.10	86.11	86.11	86.09	86.06	86.05	86.06	86.05	86.04	86.00	85.97	85.97	85.96	85.94	85.89	85.80
0 20	85.70	85.77	85.79	85.78	85.76	85.75	85.73	85.71	85.70	85.68	85.66	85.66	85.64	85.60	85.53	85.40
0 21	85.30	85.35	85.37	85.37	85.34	85.29	85.20	85.13	85.15	85.21	85.22	85.23	85.21	85.17	85.10	85.00
0 22	84.90	84.91	84.93	84.92	84.87	84.79	84.62	84.47	84.56	84.68	84.74	84.76	84.74	84.70	84.62	84.50
0 23	84.40	84.47	84.50	84.50	84.45	84.32	84.00	83.61	83.92	84.19	84.29	84.32	84.31	84.26	84.19	84.10
0 24	84.00	84.07	84.12	84.14	84.10	83.95	83.43	82.48	83.33	83.79	83.91	83.94	83.91	83.85	83.78	83.70
0 25	83.60	83.69	83.78	83.84	83.86	83.81	83.55	83.17	83.42	83.60	83.63	83.61	83.54	83.47	83.38	83.30
0 26	83.20	83.32	83.46	83.59	83.71	83.79	83.79	83.67	83.60	83.51	83.42	83.31	83.20	83.09	82.99	82.90
0 27	82.80	82.95	83.14	83.35	83.60	83.85	84.06	84.02	83.76	83.47	83.23	83.02	82.85	82.71	82.59	82.50
0 28	82.30	82.54	82.79	83.09	83.46	83.93	84.39	84.37	83.86	83.37	82.99	82.71	82.49	82.31	82.16	82.00
0 29	81.90	82.14	82.40	82.74	83.19	83.85	84.73	84.71	83.80	83.13	82.66	82.33	82.09	81.90	81.74	81.60
0 30	81.50	81.70	81.95	82.25	82.64	83.13	83.61	83.60	83.09	82.59	82.19	81.88	81.64	81.46	81.31	81.20
0 31	81.00	81.22	81.43	81.68	81.96	82.27	82.50	82.49	82.23	81.91	81.61	81.36	81.16	80.99	80.84	80.70
0 32	80.60	80.74	80.90	81.07	81.26	81.43	81.55	81.54	81.40	81.20	80.99	80.80	80.64	80.50	80.38	80.30
0 33	80.20	80.26	80.35	80.45	80.56	80.65	80.71	80.70	80.62	80.49	80.36	80.23	80.10	79.99	79.89	79.80

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 34	79.70	79.76	79.78	79.83	79.87	79.92	79.94	79.93	79.89	79.80	79.73	79.65	79.56	79.48	79.39	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78	78.90

0HEAD WILL BE SAVED ON UNIT 30 AT END OF TIME STEP 1, STRESS PERIOD 3

1 DRAWDOWN IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 3

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.05	.03	.03	.03	.02	.08	.06	.06	.06	.06	.05	.06	-.03	-.02	.00
0 3	.00	.07	.06	.05	.05	.15	.13	.12	.11	.11	.11	.01	.02	.03	.06	.00
0 4	.00	.08	.07	.06	.17	.17	.17	.16	.16	.17	.17	.07	.08	-.00	.01	.00
0 5	.00	.08	.07	.06	.18	.20	.20	.20	.21	.22	.23	.13	.04	.06	.08	.00
0 6	.00	.05	.02	.11	.23	.25	.26	.27	.28	.29	.20	.20	.10	.13	.06	.00
0 7	.00	.05	.12	.11	.22	.24	.25	.27	.28	.28	.29	.18	.16	.08	.03	.00
0 8	.00	.02	.09	.19	.20	.23	.25	.26	.28	.28	.29	.19	.17	.09	.04	.00
0 9	.00	.02	.13	.15	.28	.31	.34	.36	.28	.29	.30	.21	.22	.15	.10	.00
0 10	.00	.12	.15	.20	.25	.29	.33	.37	.39	.30	.31	.23	.15	.08	.03	.00
0 11	.00	.08	.15	.22	.29	.36	.42	.47	.39	.39	.30	.32	.24	.17	.02	.00
0 12	.00	.05	.22	.31	.40	.51	.51	.58	.49	.47	.37	.27	.19	.12	.06	.00
0 13	.00	.08	.17	.28	.40	.54	.67	.67	.67	.54	.41	.31	.23	.16	.11	.00
0 14	.00	.09	.20	.34	.48	.53	.68	.68	.69	.57	.44	.34	.24	.17	.11	.00
0 15	.00	.16	.22	.38	.44	.62	.67	.77	.70	.58	.45	.34	.24	.15	.08	.00
0 16	.00	.13	.23	.31	.48	.56	.72	.73	.66	.66	.53	.42	.32	.23	.05	.00
0 17	.00	.06	.26	.34	.41	.57	.63	.75	.68	.59	.48	.38	.29	.19	.10	.00
0 18	.00	.05	.21	.26	.42	.47	.61	.62	.57	.50	.41	.33	.25	.16	.05	.00
0 19	.00	.05	.16	.28	.42	.45	.48	.58	.55	.50	.43	.37	.21	.14	.07	.00
0 20	.00	.07	.15	.26	.36	.39	.41	.51	.49	.45	.41	.27	.25	.12	.07	.00
0 21	.00	.04	.10	.19	.28	.30	.42	.43	.42	.39	.27	.26	.17	.09	.03	.00
0 22	.00	.07	.13	.10	.20	.22	.26	.38	.27	.26	.25	.16	.09	.05	.03	.00
0 23	.00	.01	.04	.10	.10	.13	.17	.22	.21	.20	.10	.13	.09	.09	.03	.00
0 24	.00	.01	.02	-.03	-.04	.08	.14	.12	.10	.09	.02	-.02	.06	-.02	-.04	.00
0 25	.00	-.03	-.11	-.07	-.11	-.12	-.09	-.04	-.12	-.07	-.10	-.11	-.10	-.03	-.04	.00
0 26	.00	-.05	-.14	-.23	-.32	-.37	-.39	-.35	-.38	-.28	-.26	-.21	-.15	-.07	-.07	.00
0 27	.00	-.05	-.16	-.30	-.43	-.65	-.71	-.68	-.56	-.50	-.42	-.23	-.23	-.13	-.03	.00
0 28	.00	-.12	-.26	-.44	-.63	-.81	-.94	-1.02	-.83	-.70	-.47	-.34	-.22	-.09	-.08	.00
0 29	.00	-.08	-.24	-.44	-.75	-.99	-1.20	-1.18	-1.02	-.74	-.57	-.42	-.29	-.16	-.06	.00
0 30	.00	-.11	-.27	-.47	-.67	-.88	-1.02	-1.10	-.91	-.76	-.51	-.37	-.25	-.13	-.03	.00
0 31	.00	-.12	-.28	-.45	-.62	-.77	-.87	-.84	-.81	-.62	-.50	-.39	-.28	-.18	-.00	.00
0 32	.00	-.03	-.17	-.31	-.44	-.55	-.60	-.68	-.59	-.54	-.36	-.28	-.20	-.11	-.04	.00
0 33	.00	-.06	-.16	-.17	-.26	-.32	-.45	-.44	-.37	-.35	-.31	-.16	-.10	-.04	.01	.00
0 34	.00	-.07	-.04	-.12	-.18	-.21	-.22	-.21	-.17	-.17	-.16	-.13	-.10	-.07	-.03	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

1 DRAWDOWN IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 3

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.03	.05	-.04	-.02	.02	.05	-.03	.00	-.04	.00	-.03	.02	-.01	.04	.00
0 3	.00	-.01	.01	.03	.05	-.02	.01	.04	-.01	.04	.00	-.03	.04	.01	-.01	.00
0 4	.00	.05	-.03	-.00	.02	-.05	-.02	.02	-.03	.03	.00	-.02	.06	.04	.03	.00
0 5	.00	.03	.05	-.03	-.00	.02	-.05	-.01	-.05	.03	.01	-.00	-.01	-.02	-.01	.00
0 6	.00	.02	.04	-.04	-.02	-.01	-.09	-.05	-.08	-.08	.02	.03	.03	.03	.05	.00
0 7	.00	.01	.03	.06	-.03	-.03	-.14	-.11	-.12	-.08	.05	.06	.07	.07	-.02	.00
0 8	.00	.00	.03	.06	-.01	-.02	-.23	-.22	-.21	-.06	-.01	.01	.02	.02	.02	.00
0 9	.00	.07	.03	.08	.14	.08	-.11	-.11	-.08	.05	.08	.09	.09	.09	-.01	.00
0 10	.00	.05	.13	.11	.20	.18	.14	.22	.18	.18	.18	.17	.07	.06	.05	.00
0 11	.00	.11	.12	.14	.26	.28	.37	.58	.43	.31	.19	.16	.15	.15	.06	.00
0 12	.00	.06	.12	.27	.32	.38	.78	1.23	.76	.35	.30	.25	.23	.12	.04	.00
0 13	.00	.12	.21	.29	.38	.48	1.17	2.48	1.17	.48	.39	.33	.19	.17	.08	.00
0 14	.00	.12	.22	.32	.53	.65	1.02	1.44	1.04	.58	.47	.29	.24	.11	.10	.00
0 15	.00	.13	.23	.33	.56	.71	.92	1.01	.94	.75	.52	.33	.17	.14	.02	.00
0 16	.00	.06	.24	.33	.53	.65	.76	.82	.68	.59	.40	.23	.19	.06	.04	.00
0 17	.00	.07	.13	.30	.38	.46	.54	.50	.46	.41	.26	.21	.08	.07	-.03	.00
0 18	.00	-.01	.12	.16	.21	.26	.20	.23	.22	.21	.09	.08	-.03	-.03	-.01	.00
0 19	.00	-.01	-.01	.01	.04	-.05	-.06	-.05	-.04	-.10	-.07	-.07	-.16	-.14	-.09	.00
0 20	.00	.03	.01	-.08	-.06	-.15	-.13	-.11	-.10	-.18	-.16	-.16	-.24	-.20	-.13	.00
0 21	.00	-.05	-.07	-.07	-.04	-.09	.00	.07	-.05	-.11	-.12	-.13	-.21	-.17	-.10	.00
0 22	.00	-.01	-.03	-.02	-.07	.01	.18	.33	.14	.02	-.04	-.16	-.14	-.10	-.02	.00
0 23	.00	-.07	-.10	-.10	-.05	.08	.30	.69	.38	.11	-.09	-.12	-.11	-.06	-.09	.00
0 24	.00	-.07	-.12	-.14	-.10	-.05	.47	1.42	.57	.11	-.11	-.14	-.11	-.05	-.08	.00
0 25	.00	-.09	-.18	-.34	-.36	-.31	-.05	.33	-.02	-.20	-.23	-.21	-.14	-.07	-.08	.00
0 26	.00	-.12	-.36	-.49	-.61	-.69	-.69	-.67	-.60	-.51	-.42	-.31	-.20	-.19	-.09	.00
0 27	.00	-.15	-.44	-.65	-.90	-1.25	-1.46	-1.42	-1.16	-.87	-.73	-.52	-.35	-.21	-.09	.00
0 28	.00	-.24	-.49	-.79	-1.26	-1.73	-2.19	-2.17	-1.66	-1.27	-.89	-.61	-.39	-.21	-.16	.00
0 29	.00	-.24	-.50	-.94	-1.39	-2.05	-2.93	-3.01	-2.10	-1.43	-.96	-.73	-.49	-.30	-.14	.00
0 30	.00	-.20	-.55	-.85	-1.24	-1.73	-2.31	-2.30	-1.79	-1.29	-.99	-.68	-.44	-.26	-.11	.00
0 31	.00	-.22	-.43	-.68	-1.06	-1.37	-1.60	-1.59	-1.33	-1.11	-.81	-.56	-.36	-.29	-.14	.00
0 32	.00	-.14	-.30	-.57	-.76	-.93	-1.05	-1.14	-1.00	-.80	-.59	-.50	-.34	-.20	-.08	.00

```
0 33     .00  -.06  -.25  -.35  -.46  -.55  -.71  -.70  -.62  -.49  -.46  -.33  -.20  -.09  -.09   .00
0 34     .00  -.06  -.08  -.13  -.27  -.32  -.34  -.33  -.29  -.30  -.23  -.15  -.16  -.08   .01   .00
  35     .00   .00   .00   .00   .00   .00   .00   .00   .00   .00   .00   .00   .00   .00   .00   .00
 DRAWDOWN WILL BE SAVED ON UNIT 40 AT END OF TIME STEP  1, STRESS PERIOD  3


                              VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP  1 IN STRESS PERIOD  3
                              ---------------------------------------------------------------------------
0           CUMULATIVE VOLUMES      L**3                                   RATES FOR THIS TIME STEP      L**3/T
            ------------------                                             ------------------------

                  IN:                                                                IN:
                  ---                                                                ---
                    STORAGE =     .75449E+06                                           STORAGE =     69360.
              CONSTANT HEAD =     .29165E+09                                     CONSTANT HEAD =     .15785E+06
                      WELLS =     .14100E+09                                             WELLS =     .00000
0                  TOTAL IN =     .43340E+09                                          TOTAL IN =     .22721E+06
0                 OUT:                                                               OUT:
                  ----                                                               ----
                    STORAGE =     .10087E+07                                           STORAGE =     68950.
              CONSTANT HEAD =     .29140E+09                                     CONSTANT HEAD =     .15826E+06
                      WELLS =     .14100E+09                                             WELLS =     .00000
0                 TOTAL OUT =     .43340E+09                                         TOTAL OUT =     .22721E+06
0                  IN - OUT =    -3296.0                                              IN - OUT =    -4.4531
0      PERCENT DISCREPANCY =                   .00                         PERCENT DISCREPANCY =                  -.00


0


         TIME SUMMARY AT END OF TIME STEP  1 IN STRESS PERIOD  3
                                  SECONDS          MINUTES        HOURS          DAYS           YEARS
                              -----------------------------------------------------------------------------
         TIME STEP LENGTH        86400.0          1440.00        24.0000        1.00000        .273785E-02
       STRESS PERIOD TIME        86400.0          1440.00        24.0000        1.00000        .273785E-02
    TOTAL SIMULATION TIME        .158285E+09      .263808E+07    43968.0        1832.00        5.01574
1
```

```
1                             U.S. GEOLOGICAL SURVEY MODULAR FINITE-DIFFERENCE GROUND-WATER MODEL
0SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     SIMULATION 4 - ALL WELLS, RIW2 DEEP, 2 NEW S
     2 LAYERS          35 ROWS           16 COLUMNS
   1 STRESS PERIOD(S) IN SIMULATION
 MODEL TIME UNIT IS DAYS
0I/O UNITS:
 ELEMENT OF IUNIT:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
         I/O UNIT: 11 12  0  0  0  0  0  0 19  0  0 22  0  0  0  0  0  0  0  0  0  0  0  0
0BAS1 -- BASIC MODEL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT  1
 ARRAYS RHS AND BUFF WILL SHARE MEMORY.
 START HEAD WILL BE SAVED
    10699 ELEMENTS IN X ARRAY ARE USED BY BAS
    10699 ELEMENTS OF X ARRAY USED OUT OF  100000
0BCF1 -- BLOCK-CENTERED FLOW PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 11
 STEADY-STATE SIMULATION
       LAYER  AQUIFER TYPE
       ------------------
          1          1
          2          0
     1122 ELEMENTS IN X ARRAY ARE USED BY BCF
    11821 ELEMENTS OF X ARRAY USED OUT OF  100000
0WEL1 -- WELL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM 12
 MAXIMUM OF     8 WELLS
       32 ELEMENTS IN X ARRAY ARE USED FOR WELLS
    11853 ELEMENTS OF X ARRAY USED OUT OF  100000
0SIP1 -- STRONGLY IMPLICIT PROCEDURE SOLUTION PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 19
 MAXIMUM OF  50 ITERATIONS ALLOWED FOR CLOSURE
  5 ITERATION PARAMETERS
     4685 ELEMENTS IN X ARRAY ARE USED BY SIP
    16538 ELEMENTS OF X ARRAY USED OUT OF  100000
1SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     SIMULATION 4 - ALL WELLS, RIW2 DEEP, 2 NEW SHALL
0
```

BOUNDARY ARRAY FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
0 2	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 3	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 4	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 5	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 6	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 7	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 8	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 9	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 10	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 11	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 12	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 13	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 14	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 15	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 16	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 17	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 18	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 19	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 20	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 21	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 22	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 23	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 24	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 25	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 26	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 27	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 28	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 29	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 30	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 31	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 32	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 33	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 34	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 35	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

0

BOUNDARY ARRAY FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

0 1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
2	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
3	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
4	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
5	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 6	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 7	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 8	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 9	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 10	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 11	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 12	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 13	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 14	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 15	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 16	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 17	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 18	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 19	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 20	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 21	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 22	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 23	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 24	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 25	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 26	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 27	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 28	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 29	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 30	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 31	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 32	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 33	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 34	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 35	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2

0AQUIFER HEAD WILL BE SET TO 999.99 AT ALL NO-FLOW NODES (IBOUND=0).
0

INITIAL HEAD FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1 11	2 12	3 13	4 14	5 15	6 16	7	8	9	10
1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90
	94.00	94.10	94.20	94.30	94.40	94.50				
2	92.40	92.60	92.70	92.80	92.90	93.00	93.20	93.30	93.40	93.50
	93.60	93.70	93.80	93.80	93.90	94.00				
0 3	92.00	92.20	92.30	92.40	92.50	92.70	92.80	92.90	93.00	93.10
	93.20	93.20	93.30	93.40	93.50	93.50				
0 4	91.60	91.80	91.90	92.00	92.20	92.30	92.40	92.50	92.60	92.70
	92.80	92.80	92.90	92.90	93.00	93.10				
0 5	91.20	91.40	91.50	91.60	91.80	91.90	92.00	92.10	92.20	92.30
	92.40	92.40	92.40	92.50	92.60	92.60				
0 6	90.70	90.90	91.00	91.20	91.40	91.50	91.60	91.70	91.80	91.90
	91.90	92.00	92.00	92.10	92.10	92.10				
0 7	90.20	90.40	90.60	90.70	90.90	91.00	91.10	91.20	91.30	91.40
	91.50	91.50	91.60	91.60	91.60	91.60				
0 8	89.70	89.90	90.10	90.30	90.40	90.50	90.60	90.70	90.80	90.90
	91.00	91.00	91.10	91.10	91.10	91.10				
0 9	89.40	89.50	89.70	89.80	90.00	90.10	90.20	90.30	90.30	90.40
	90.50	90.50	90.60	90.60	90.60	90.50				
0 10	89.00	89.20	89.30	89.40	89.50	89.60	89.70	89.80	89.90	89.90
	90.00	90.00	90.00	90.00	90.00	90.00				
0 11	88.70	88.80	88.90	89.00	89.10	89.20	89.30	89.40	89.40	89.50
	89.50	89.60	89.60	89.60	89.50	89.50				
0 12	88.30	88.40	88.60	88.70	88.80	88.90	88.90	89.00	89.00	89.10
	89.10	89.10	89.10	89.10	89.10	89.10				
0 13	88.00	88.10	88.20	88.30	88.40	88.50	88.60	88.60	88.70	88.70
	88.70	88.70	88.70	88.70	88.70	88.60				
0 14	87.70	87.80	87.90	88.00	88.10	88.10	88.20	88.20	88.30	88.30
	88.30	88.30	88.30	88.30	88.30	88.20				
0 15	87.50	87.60	87.60	87.70	87.70	87.80	87.80	87.90	87.90	87.90
	87.90	87.90	87.90	87.90	87.90	87.90				
0 16	87.30	87.30	87.30	87.30	87.40	87.40	87.50	87.50	87.50	87.60
	87.60	87.60	87.60	87.60	87.50	87.50				
0 17	87.00	86.90	87.00	87.00	87.00	87.10	87.10	87.20	87.20	87.20
	87.20	87.20	87.20	87.20	87.20	87.20				
0 18	86.50	86.50	86.60	86.60	86.70	86.70	86.80	86.80	86.80	86.80
	86.80	86.80	86.80	86.80	86.80	86.90				
0 19	86.00	86.10	86.20	86.30	86.40	86.40	86.40	86.50	86.50	86.50

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
											86.50	86.50	86.40	86.40	86.40	86.40
0 20	85.60	85.70	85.80	85.90	86.00	86.00	86.00	86.10	86.10	86.10	86.10	86.00	86.00	85.90	85.90	85.90
0 21	85.10	85.20	85.30	85.40	85.50	85.50	85.60	85.60	85.60	85.60	85.50	85.50	85.40	85.30	85.20	85.10
0 22	84.70	84.80	84.90	84.90	85.00	85.00	85.00	85.10	85.00	85.00	85.00	84.90	84.80	84.70	84.60	84.50
0 23	84.20	84.30	84.40	84.50	84.50	84.50	84.50	84.50	84.50	84.50	84.40	84.40	84.30	84.20	84.00	83.80
0 24	83.80	83.90	84.00	84.00	84.00	84.10	84.10	84.00	84.00	84.00	83.90	83.80	83.80	83.60	83.40	83.30
0 25	83.50	83.50	83.50	83.60	83.60	83.60	83.60	83.60	83.50	83.50	83.40	83.30	83.20	83.10	82.90	82.80
0 26	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.00	83.00	82.90	82.80	82.70	82.60	82.40	82.30
0 27	82.70	82.70	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.50	82.40	82.40	82.20	82.10	82.00	81.90
0 28	82.20	82.20	82.20	82.20	82.20	82.20	82.20	82.10	82.10	82.00	82.00	81.90	81.80	81.70	81.50	81.40
0 29	81.80	81.80	81.80	81.80	81.70	81.70	81.70	81.70	81.60	81.60	81.50	81.40	81.30	81.20	81.10	81.00
0 30	81.30	81.30	81.30	81.30	81.30	81.30	81.30	81.20	81.20	81.10	81.10	81.00	80.90	80.80	80.70	80.60
0 31	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.70	80.70	80.60	80.50	80.40	80.30	80.30	80.20
0 32	80.30	80.40	80.40	80.40	80.40	80.40	80.40	80.30	80.30	80.20	80.20	80.10	80.00	79.90	79.80	79.70
0 33	79.90	79.90	79.90	80.00	80.00	80.00	79.90	79.90	79.90	79.80	79.70	79.70	79.60	79.50	79.40	79.30
0 34	79.40	79.40	79.50	79.50	79.50	79.50	79.50	79.50	79.50	79.40	79.30	79.20	79.10	79.00	78.90	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

0

INITIAL HEAD FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	92.10
0 2	90.90	91.00	91.10	91.10	91.20	91.30	91.40	91.40	91.50	91.50	91.60	91.60	91.70	91.70	91.80	91.80
0 3	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.20	91.20	91.30	91.30	91.30	91.40	91.40	91.40	91.40
0 4	90.40	90.50	90.50	90.60	90.70	90.70	90.80	90.90	90.90	91.00	91.00	91.00	91.10	91.10	91.10	91.10
0 5	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.70	90.70	90.70	90.70	90.70	90.70	90.70
0 6	89.80	89.90	90.00	90.00	90.10	90.20	90.20	90.30	90.30	90.30	90.40	90.40	90.40	90.40	90.40	90.30
0 7	89.50	89.60	89.70	89.80	89.80	89.90	89.90	90.00	90.00	90.00	90.10	90.10	90.10	90.10	90.00	90.00
0 8	89.20	89.30	89.40	89.50	89.50	89.60	89.60	89.70	89.70	89.70	89.70	89.70	89.70	89.70	89.70	89.70
0 9	89.00	89.10	89.10	89.20	89.30	89.30	89.30	89.40	89.40	89.40	89.40	89.40	89.40	89.40	89.30	89.30
0 10	88.70	88.80	88.90	88.90	89.00	89.00	89.00	89.10	89.10	89.10	89.10	89.10	89.00	89.00	89.00	89.00
0 11	88.50	88.60	88.60	88.60	88.70	88.70	88.70	88.80	88.80	88.80	88.70	88.70	88.70	88.70	88.60	88.50
0 12	88.30	88.30	88.30	88.40	88.40	88.40	88.50	88.50	88.50	88.40	88.40	88.40	88.40	88.30	88.20	88.10
0 13	88.10	88.10	88.10	88.10	88.10	88.10	88.20	88.20	88.20	88.10	88.10	88.10	88.00	88.00	87.90	87.80
0 14	87.80	87.80	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.80	87.80	87.70	87.70	87.60	87.60	87.50
0 15	87.50	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.60	87.50	87.40	87.30	87.30	87.20	87.20
0 16	87.10	87.10	87.20	87.20	87.30	87.30	87.30	87.30	87.20	87.20	87.10	87.00	87.00	86.90	86.90	86.90
0 17	86.80	86.80	86.80	86.90	86.90	86.90	86.90	86.80	86.80	86.80	86.70	86.70	86.60	86.60	86.50	86.50
0 18	86.40	86.40	86.50	86.50	86.50	86.50	86.40	86.40	86.40	86.40	86.30	86.30	86.20	86.20	86.20	86.20
0 19	86.10	86.10	86.10	86.10	86.10	86.00	86.00	86.00	86.00	85.90	85.90	85.90	85.80	85.80	85.80	85.80
0 20	85.70	85.80	85.80	85.70	85.70	85.60	85.60	85.60	85.60	85.50	85.50	85.50	85.40	85.40	85.40	85.40

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 21	85.30	85.30	85.30	85.30	85.30	85.20	85.20	85.20	85.10	85.10	85.10	85.10	85.00	85.00	85.00	85.00
22	84.90	84.90	84.90	84.90	84.80	84.80	84.80	84.80	84.70	84.70	84.70	84.60	84.60	84.60	84.60	84.50
23	84.40	84.40	84.40	84.40	84.40	84.40	84.30	84.30	84.30	84.30	84.20	84.20	84.20	84.20	84.10	84.10
0 24	84.00	84.00	84.00	84.00	84.00	83.90	83.90	83.90	83.90	83.90	83.80	83.80	83.80	83.80	83.70	83.70
0 25	83.60	83.60	83.60	83.50	83.50	83.50	83.50	83.50	83.40	83.40	83.40	83.40	83.40	83.40	83.30	83.30
0 26	83.20	83.20	83.10	83.10	83.10	83.10	83.10	83.00	83.00	83.00	83.00	83.00	83.00	82.90	82.90	82.90
0 27	82.80	82.80	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.60	82.50	82.50	82.50	82.50	82.50	82.50
0 28	82.30	82.30	82.30	82.30	82.20	82.20	82.20	82.20	82.20	82.10	82.10	82.10	82.10	82.10	82.00	82.00
0 29	81.90	81.90	81.90	81.80	81.80	81.80	81.80	81.70	81.70	81.70	81.70	81.60	81.60	81.60	81.60	81.60
0 30	81.50	81.50	81.40	81.40	81.40	81.40	81.30	81.30	81.30	81.30	81.20	81.20	81.20	81.20	81.20	81.20
0 31	81.00	81.00	81.00	81.00	80.90	80.90	80.90	80.90	80.90	80.80	80.80	80.80	80.80	80.70	80.70	80.70
0 32	80.60	80.60	80.60	80.50	80.50	80.50	80.50	80.40	80.40	80.40	80.40	80.30	80.30	80.30	80.30	80.30
0 33	80.20	80.20	80.10	80.10	80.10	80.10	80.00	80.00	80.00	80.00	79.90	79.90	79.90	79.90	79.80	79.80
0 34	79.70	79.70	79.70	79.70	79.60	79.60	79.60	79.60	79.60	79.50	79.50	79.50	79.40	79.40	79.40	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

0HEAD PRINT FORMAT IS FORMAT NUMBER 4 DRAWDOWN PRINT FORMAT IS FORMAT NUMBER 9
0HEADS WILL BE SAVED ON UNIT 30 DRAWDOWNS WILL BE SAVED ON UNIT 40
0OUTPUT CONTROL IS SPECIFIED EVERY TIME STEP
0 COLUMN TO ROW ANISOTROPY = 1.000000
0 DELR = 200.0000
0 DELC = 200.0000
0

HYD. COND. ALONG ROWS FOR LAYER 1 WILL BE READ ON UNIT 11 USING FORMAT: (16F4.0)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
2	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 3	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 4	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 5	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 6	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	300.0	300.0	300.0	300.0
0 7	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	300.0	300.0	300.0	300.0
0 8	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	225.0	225.0	225.0	300.0
0 9	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	225.0	225.0	225.0	300.0
0 10	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	225.0	225.0	225.0	300.0
0 11	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 12	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 13	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 14	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 15	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 16	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 17	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 18	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 19	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0						

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
											250.0	250.0	250.0	250.0	250.0	300.0
0 20	300.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	300.0
0 21	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 22	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 23	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 24	300.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 25	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 26	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 27	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 28	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 29	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 30	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 31	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 32	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 33	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 34	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 35	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0

0 BOTTOM = 30.00000 FOR LAYER 1

0 VERT HYD COND /THICKNESS = .1000000E-02 FOR LAYER 1

0

TRANSMIS. ALONG ROWS FOR LAYER 2 WILL BE READ ON UNIT 11 USING FORMAT: (16F5.0)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 2	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 3	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 4	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 5	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 6	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 7	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 8	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 9	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 10	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 11	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 12	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 13	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 14	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 15	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 16	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 17	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 18	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 19	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.

0 20	4000.	4000.	4000.	4000.	4000.	4000.	1500.	1500.	1500.	4000.
	4000.	4000.	4000.	4000.	4000.	4000.				
21	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
22	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 23	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 24	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 25	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 26	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 27	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 28	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 29	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 30	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 31	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 32	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 33	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 34	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 35	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				

0

SOLUTION BY THE STRONGLY IMPLICIT PROCEDURE

0

MAXIMUM ITERATIONS ALLOWED FOR CLOSURE = 50
ACCELERATION PARAMETER = 1.0000
HEAD CHANGE CRITERION FOR CLOSURE = .10000E-02
SIP HEAD CHANGE PRINTOUT INTERVAL = 1
CALCULATE ITERATION PARAMETERS FROM MODEL CALCULATED WSEED

0
1

STRESS PERIOD NO. 1, LENGTH = 1.000000

NUMBER OF TIME STEPS = 1

MULTIPLIER FOR DELT = 1.000

INITIAL TIME STEP SIZE = 1.000000

0 8 WELLS

LAYER	ROW	COL	STRESS RATE	WELL NO.
1	14	5	-14439.	1
1	13	6	-13476.	2
1	13	8	-14439.	3
1	17	8	-4813.0	4
1	24	8	-15401.	5
2	13	8	-4813.0	6
2	17	8	-4813.0	7
2	24	8	-4813.0	8

0AVERAGE SEED = .00187924
MINIMUM SEED = .00055600
0
5 ITERATION PARAMETERS CALCULATED FROM AVERAGE SEED:

.0000000E+00 .7917928E+00 .9566497E+00 .9909742E+00 .9981208E+00

0
10 ITERATIONS FOR TIME STEP 1 IN STRESS PERIOD 1
0MAXIMUM HEAD CHANGE FOR EACH ITERATION:

0 HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL
-2.333	(2, 13, 8)	-.3513	(2, 14, 7)	-.3455	(1, 14, 7)	-.2331	(1, 14, 9)	-.5808E-01	(1, 23, 10)
.8717E-02	(2, 21, 7)	.7580E-02	(1, 11, 9)	.5458E-02	(1, 14, 8)	.3392E-02	(1, 13, 7)	.8218E-03	(1, 22, 9)

0
0HEAD/DRAWDOWN PRINTOUT FLAG = 1 TOTAL BUDGET PRINTOUT FLAG = 1 CELL-BY-CELL FLOW TERM FLAG = 0
0OUTPUT FLAGS FOR EACH LAYER:

LAYER	HEAD PRINTOUT	DRAWDOWN PRINTOUT	HEAD SAVE	DRAWDOWN SAVE
1	1	1	1	1
2	1	1	1	1

1 HEAD IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.55	92.66	92.77	92.87	92.98	93.12	93.23	93.34	93.44	93.54	93.65	93.74	93.83	93.92	94.00
0 3	92.00	92.13	92.24	92.34	92.44	92.54	92.66	92.77	92.88	92.98	93.08	93.19	93.28	93.36	93.44	93.50
0 4	91.60	91.71	91.82	91.92	92.01	92.11	92.22	92.32	92.42	92.52	92.62	92.72	92.82	92.90	92.99	93.10
0 5	91.20	91.31	91.42	91.52	91.60	91.68	91.77	91.87	91.97	92.07	92.16	92.26	92.35	92.43	92.52	92.60
0 6	90.70	90.84	90.96	91.06	91.14	91.21	91.30	91.39	91.49	91.59	91.68	91.79	91.89	91.97	92.04	92.10
0 7	90.20	90.33	90.45	90.54	90.62	90.70	90.79	90.88	90.98	91.09	91.19	91.30	91.43	91.51	91.57	91.60
0 8	89.70	89.86	89.96	90.04	90.12	90.19	90.27	90.37	90.47	90.57	90.68	90.79	90.91	91.00	91.06	91.10
0 9	89.40	89.45	89.50	89.55	89.60	89.67	89.75	89.84	89.94	90.06	90.16	90.27	90.36	90.44	90.49	90.50
0 10	89.00	89.03	89.05	89.06	89.08	89.13	89.20	89.29	89.41	89.53	89.64	89.74	89.83	89.91	89.96	90.00
0 11	88.70	88.65	88.62	88.58	88.56	88.57	88.63	88.72	88.87	89.02	89.14	89.25	89.34	89.42	89.47	89.50
0 12	88.30	88.27	88.21	88.12	88.02	87.95	88.02	88.09	88.31	88.52	88.68	88.79	88.89	88.97	89.04	89.10
0 13	88.00	87.93	87.82	87.66	87.44	87.16	87.40	87.30	87.77	88.05	88.23	88.36	88.46	88.54	88.59	88.60
0 14	87.70	87.62	87.48	87.27	86.89	87.00	87.12	87.20	87.43	87.64	87.82	87.94	88.05	88.13	88.19	88.20
0 15	87.50	87.36	87.20	87.03	86.86	86.84	86.88	86.95	87.10	87.27	87.43	87.55	87.65	87.74	87.82	87.90
0 16	87.30	87.10	86.94	86.80	86.69	86.63	86.63	86.66	86.78	86.91	87.06	87.17	87.28	87.37	87.45	87.50
0 17	87.00	86.80	86.65	86.54	86.45	86.40	86.37	86.32	86.47	86.60	86.71	86.81	86.91	87.00	87.10	87.20
0 18	86.50	86.41	86.32	86.25	86.18	86.14	86.12	86.12	86.20	86.28	86.37	86.46	86.54	86.63	86.74	86.90
0 19	86.00	86.02	85.98	85.94	85.90	85.86	85.85	85.86	85.90	85.96	86.03	86.10	86.17	86.24	86.32	86.40
0 20	85.60	85.60	85.58	85.56	85.53	85.50	85.48	85.49	85.52	85.57	85.62	85.67	85.71	85.75	85.81	85.90
0 21	85.10	85.12	85.12	85.10	85.07	85.03	84.99	84.98	85.01	85.05	85.10	85.14	85.15	85.16	85.	85.10
0 22	84.70	84.68	84.66	84.63	84.58	84.51	84.44	84.39	84.43	84.49	84.54	84.58	84.59	84.57	84.54	84.50
0 23	84.20	84.23	84.22	84.19	84.10	83.99	83.85	83.70	83.82	83.93	84.00	84.04	84.04	84.01	83.93	83.80
0 24	83.80	83.81	83.80	83.74	83.64	83.49	83.25	82.75	83.21	83.40	83.48	83.52	83.53	83.49	83.38	83.30
0 25	83.50	83.43	83.39	83.31	83.21	83.08	82.92	82.76	82.86	82.96	83.01	83.04	83.03	82.98	82.87	82.80
0 26	83.10	83.04	82.97	82.89	82.80	82.70	82.60	82.52	82.52	82.55	82.57	82.57	82.54	82.48	82.39	82.30
0 27	82.70	82.62	82.55	82.47	82.39	82.31	82.24	82.18	82.16	82.15	82.15	82.12	82.08	82.02	81.95	81.90
0 28	82.20	82.17	82.12	82.05	81.99	81.92	81.86	81.82	81.78	81.76	81.73	81.69	81.64	81.57	81.49	81.40
0 29	81.80	81.74	81.68	81.63	81.58	81.52	81.48	81.43	81.39	81.35	81.31	81.27	81.21	81.14	81.06	81.00
0 30	81.30	81.27	81.24	81.20	81.16	81.12	81.08	81.04	81.00	80.95	80.90	80.85	80.79	80.72	80.65	80.60
0 31	80.80	80.80	80.79	80.77	80.74	80.71	80.68	80.64	80.60	80.55	80.50	80.44	80.37	80.29	80.23	80.20
0 32	80.30	80.33	80.34	80.34	80.33	80.31	80.28	80.25	80.20	80.15	80.09	80.02	79.95	79.86	79.78	79.70
0 33	79.90	79.89	79.90	79.91	79.91	79.90	79.88	79.85	79.82	79.76	79.69	79.61	79.53	79.44	79.35	79.30
0 34	79.40	79.44	79.46	79.49	79.50	79.50	79.49	79.47	79.44	79.37	79.29	79.21	79.11	79.01	78.91	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

1 HEAD IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	92.10
2	90.90	90.97	91.05	91.14	91.22	91.27	91.35	91.43	91.50	91.54	91.59	91.63	91.68	91.71	91.76	91.80
3	90.60	90.70	90.79	90.87	90.95	91.02	91.09	91.15	91.21	91.26	91.30	91.33	91.36	91.39	91.41	91.40
0 4	90.40	90.45	90.52	90.60	90.68	90.75	90.82	90.88	90.93	90.96	90.99	91.02	91.04	91.06	91.07	91.10
0 5	90.10	90.17	90.25	90.32	90.40	90.48	90.55	90.60	90.64	90.67	90.69	90.70	90.71	90.71	90.71	90.70
0 6	89.80	89.88	89.96	90.03	90.11	90.20	90.28	90.34	90.37	90.37	90.37	90.37	90.37	90.37	90.35	90.30
0 7	89.50	89.59	89.66	89.74	89.82	89.92	90.03	90.10	90.11	90.07	90.05	90.03	90.03	90.02	90.02	90.00
0 8	89.20	89.29	89.36	89.43	89.50	89.61	89.82	89.91	89.90	89.75	89.70	89.68	89.67	89.67	89.68	89.70
0 9	89.00	89.03	89.07	89.10	89.15	89.20	89.39	89.50	89.47	89.34	89.31	89.31	89.30	89.31	89.31	89.30
0 10	88.70	88.74	88.76	88.77	88.79	88.80	88.83	88.86	88.90	88.91	88.91	88.92	88.93	88.93	88.95	89.00
0 11	88.50	88.49	88.47	88.44	88.42	88.39	88.30	88.18	88.35	88.47	88.50	88.52	88.54	88.55	88.54	88.50
0 12	88.30	88.23	88.17	88.11	88.05	87.99	87.68	87.20	87.71	88.03	88.09	88.13	88.16	88.17	88.16	88.10
0 13	88.10	87.97	87.87	87.78	87.69	87.58	86.95	85.19	86.96	87.59	87.68	87.75	87.79	87.82	87.82	87.80
0 14	87.80	87.67	87.56	87.45	87.34	87.21	86.83	86.39	86.82	87.19	87.30	87.39	87.44	87.48	87.49	87.50
0 15	87.50	87.36	87.25	87.14	87.00	86.84	86.63	86.53	86.61	86.81	86.95	87.05	87.11	87.15	87.18	87.20
0 16	87.10	87.03	86.94	86.84	86.72	86.60	86.47	86.39	86.45	86.56	86.66	86.74	86.79	86.83	86.86	86.90
0 17	86.80	86.72	86.64	86.56	86.47	86.37	86.27	86.09	86.24	86.33	86.40	86.45	86.49	86.51	86.52	86.50
0 18	86.40	86.39	86.35	86.29	86.23	86.18	86.13	86.08	86.10	86.13	86.15	86.18	86.20	86.20	86.20	86.20
0 19	86.10	86.09	86.07	86.03	86.00	85.99	85.99	85.98	85.97	85.93	85.91	85.91	85.92	85.90	85.87	85.80
0 20	85.70	85.74	85.74	85.71	85.68	85.67	85.66	85.63	85.62	85.60	85.58	85.58	85.58	85.56	85.51	85.40
0 21	85.30	85.31	85.29	85.26	85.22	85.17	85.10	85.04	85.05	85.09	85.11	85.12	85.12	85.10	85.06	85.00
0 22	84.90	84.85	84.81	84.75	84.69	84.61	84.50	84.39	84.44	84.52	84.56	84.59	84.61	84.60	84.57	84.50
23	84.40	84.38	84.33	84.26	84.17	84.06	83.85	83.59	83.79	83.96	84.04	84.09	84.12	84.13	84.12	84.10
24	84.00	83.94	83.88	83.79	83.68	83.53	83.17	82.31	83.11	83.42	83.54	83.61	83.65	83.68	83.69	83.70
0 25	83.60	83.52	83.44	83.35	83.24	83.10	82.86	82.59	82.80	82.99	83.08	83.15	83.20	83.24	83.27	83.30
0 26	83.20	83.11	83.01	82.92	82.81	82.70	82.51	82.38	82.45	82.58	82.66	82.72	82.77	82.81	82.85	82.90
0 27	82.80	82.69	82.59	82.50	82.40	82.29	82.15	82.08	82.10	82.19	82.25	82.30	82.34	82.38	82.43	82.50
0 28	82.30	82.25	82.17	82.09	82.01	81.92	81.84	81.79	81.79	81.82	81.86	81.89	81.92	81.95	81.98	82.00
0 29	81.90	81.83	81.76	81.69	81.62	81.55	81.49	81.45	81.44	81.45	81.47	81.49	81.51	81.53	81.56	81.60
0 30	81.50	81.41	81.34	81.28	81.22	81.17	81.13	81.09	81.08	81.07	81.07	81.08	81.09	81.11	81.14	81.20
0 31	81.00	80.97	80.92	80.87	80.82	80.78	80.75	80.72	80.70	80.69	80.68	80.68	80.68	80.68	80.70	80.70
0 32	80.60	80.55	80.50	80.46	80.42	80.39	80.36	80.34	80.32	80.30	80.28	80.27	80.26	80.26	80.26	80.30
0 33	80.20	80.13	80.08	80.05	80.02	79.99	79.97	79.95	79.93	79.91	79.89	79.87	79.85	79.83	79.81	79.80
0 34	79.70	79.69	79.65	79.63	79.61	79.60	79.59	79.57	79.55	79.51	79.49	79.47	79.43	79.40	79.35	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

0HEAD WILL BE SAVED ON UNIT 30 AT END OF TIME STEP 1, STRESS PERIOD 1

1 DRAWDOWN IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.05	.04	.03	.03	.02	.08	.07	.06	.06	.06	.05	.06	-.03	-.02	.00
0 3	.00	.07	.06	.06	.06	.16	.14	.13	.12	.12	.12	.01	.02	.04	.06	.00
0 4	.00	.09	.08	.08	.19	.19	.18	.18	.18	.18	.18	.08	.08	-.00	.01	.00
0 5	.00	.09	.08	.08	.20	.22	.23	.23	.23	.23	.24	.14	.05	.07	.08	.00
0 6	.00	.06	.04	.14	.26	.29	.30	.31	.31	.31	.22	.21	.11	.13	.06	.00

0 7	.00	.07	.15	.16	.28	.30	.31	.32	.32	.31	.31	.20	.17	.09	.03	.00
0 8	.00	.04	.14	.26	.28	.31	.33	.33	.33	.33	.32	.21	.19	.10	.04	.00
0 9	.00	.05	.20	.25	.40	.43	.45	.46	.36	.34	.34	.23	.24	.16	.11	.00
0 10	.00	.17	.25	.34	.42	.47	.50	.51	.49	.37	.36	.26	.17	.09	.04	.00
0 11	.00	.15	.28	.42	.54	.63	.67	.68	.53	.48	.36	.35	.26	.18	.03	.00
0 12	.00	.13	.39	.58	.78	.95	.88	.91	.69	.58	.42	.31	.21	.13	.06	.00
0 13	.00	.17	.38	.64	.96	1.34	1.20	1.30	.93	.65	.47	.34	.24	.16	.11	.00
0 14	.00	.18	.42	.73	1.21	1.10	1.08	1.00	.87	.66	.48	.36	.25	.17	.11	.00
0 15	.00	.24	.40	.67	.84	.96	.92	.95	.80	.63	.47	.35	.25	.16	.08	.00
0 16	.00	.20	.36	.50	.71	.77	.87	.84	.72	.69	.54	.43	.32	.23	.05	.00
0 17	.00	.10	.35	.46	.55	.70	.73	.88	.73	.60	.49	.39	.29	.20	.10	.00
0 18	.00	.09	.28	.35	.52	.56	.68	.68	.60	.52	.43	.34	.26	.17	.06	.00
0 19	.00	.08	.22	.36	.50	.54	.55	.64	.60	.54	.47	.40	.23	.16	.08	.00
0 20	.00	.10	.22	.34	.47	.50	.52	.61	.58	.53	.48	.33	.29	.15	.09	.00
0 21	.00	.08	.18	.30	.43	.47	.61	.62	.59	.55	.40	.36	.25	.14	.05	.00
0 22	.00	.12	.24	.27	.42	.49	.56	.71	.57	.51	.46	.32	.21	.13	.06	.00
0 23	.00	.07	.18	.31	.40	.51	.65	.80	.68	.57	.40	.36	.26	.19	.07	.00
0 24	.00	.09	.20	.26	.36	.61	.85	1.25	.79	.60	.42	.28	.27	.11	.02	.00
0 25	.00	.07	.11	.29	.39	.52	.68	.84	.64	.54	.39	.26	.17	.12	.03	.00
0 26	.00	.06	.13	.21	.30	.40	.50	.58	.48	.45	.33	.23	.16	.12	.01	.00
0 27	.00	.08	.15	.23	.31	.29	.36	.42	.44	.35	.25	.28	.12	.08	.05	.00
0 28	.00	.03	.08	.15	.21	.28	.34	.28	.32	.24	.27	.21	.16	.13	.01	.00
0 29	.00	.06	.12	.17	.12	.18	.22	.27	.21	.25	.19	.13	.09	.06	.04	.00
0 30	.00	.03	.06	.10	.14	.18	.22	.16	.20	.15	.20	.15	.11	.08	.05	.00
0 31	.00	.00	.01	.03	.06	.09	.12	.16	.10	.15	.10	.06	.03	.01	.07	.00
0 32	.00	.07	.06	.06	.07	.10	.12	.05	.10	.05	.11	.08	.05	.04	.02	.00
0 33	.00	.01	-.00	.09	.09	.10	.02	.05	.08	.04	.01	.09	.07	.06	.05	.00
0 34	.00	-.04	.04	.01	-.00	.00	.01	.03	.06	.03	.01	-.01	-.01	-.01	-.01	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

1 DRAWDOWN IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.03	.05	-.04	-.02	.03	.05	-.03	.00	-.04	.01	-.03	.02	-.01	.04	.00
0 3	.00	-.00	.01	.03	.05	-.02	.01	.05	-.01	.04	.00	-.03	.04	.01	-.01	.00
0 4	.00	.05	-.02	-.00	.02	-.05	-.02	.02	-.03	.04	.01	-.02	.06	.04	.03	.00
0 5	.00	.03	.05	-.02	.00	.02	-.05	-.00	-.04	.03	.01	.00	-.01	-.01	-.01	.00
0 6	.00	.02	.04	-.03	-.01	.00	-.08	-.04	-.07	-.07	.03	.03	.03	.03	.05	.00
0 7	.00	.01	.04	.06	-.02	-.02	-.13	-.10	-.11	-.07	.05	.07	.07	.08	-.02	.00
0 8	.00	.01	.04	.07	-.00	-.01	-.22	-.21	-.20	-.05	.00	.02	.03	.03	.02	.00
0 9	.00	.07	.03	.10	.15	.10	-.09	-.10	-.07	.06	.09	.09	.10	.09	-.01	.00
0 10	.00	.06	.14	.13	.21	.20	.17	.24	.20	.19	.19	.18	.07	.07	.05	.00
0 11	.00	.11	.13	.16	.28	.31	.40	.62	.45	.33	.20	.18	.16	.15	.06	.00
0 12	.00	.07	.13	.29	.35	.41	.82	1.30	.79	.37	.31	.27	.24	.13	.04	.00
0 13	.00	.13	.23	.32	.41	.52	1.25	3.01	1.24	.51	.42	.35	.21	.18	.08	.00
0 14	.00	.13	.24	.35	.56	.69	1.07	1.51	1.08	.61	.50	.31	.26	.12	.11	.00
0 15	.00	.14	.25	.36	.60	.76	.97	1.07	.99	.79	.55	.35	.19	.15	.02	.00
0 16	.00	.07	.26	.36	.58	.70	.83	.91	.75	.64	.44	.26	.21	.07	.04	.00
0 17	.00	.08	.16	.34	.43	.53	.63	.71	.56	.47	.30	.25	.11	.09	-.02	.00
0 18	.00	.01	.15	.21	.27	.32	.27	.32	.30	.27	.15	.12	.00	-.00	.00	.00
0 19	.00	.01	.03	.07	.10	.01	.01	.02	.03	-.03	-.01	-.01	-.12	-.10	-.07	.00
0 20	.00	.06	.06	-.01	.02	-.07	-.06	-.03	-.02	-.10	-.08	-.08	-.18	-.16	-.11	.00
0 21	.00	-.01	.01	.04	.08	.03	.10	.16	.05	.01	-.01	-.02	-.12	-.10	-.06	.00
0 22	.00	.05	.09	.15	.11	.19	.30	.41	.26	.18	.14	.01	-.01	-.00	.03	.00
0 23	.00	.02	.07	.14	.23	.34	.45	.71	.51	.34	.16	.11	.08	.07	-.02	.00
0 24	.00	.06	.12	.21	.32	.37	.73	1.59	.79	.48	.26	.19	.15	.12	.01	.00
0 25	.00	.08	.16	.15	.26	.40	.64	.91	.60	.41	.32	.25	.20	.16	.03	.00
0 26	.00	.09	.09	.18	.29	.40	.59	.62	.55	.42	.34	.28	.23	.09	.05	.00
0 27	.00	.11	.11	.20	.30	.31	.45	.52	.50	.41	.25	.20	.16	.12	.07	.00
0 28	.00	.05	.13	.21	.19	.28	.36	.41	.41	.28	.24	.21	.18	.15	.02	.00
0 29	.00	.07	.14	.11	.18	.25	.31	.25	.26	.25	.23	.11	.09	.07	.04	.00
0 30	.00	.09	.06	.12	.18	.23	.17	.21	.22	.23	.13	.12	.11	.09	.06	.00
0 31	.00	.03	.08	.13	.08	.12	.15	.18	.20	.11	.12	.12	.12	.02	.00	.00
0 32	.00	.05	.10	.04	.08	.11	.14	.06	.08	.10	.12	.03	.04	.04	.04	.00
0 33	.00	.07	.02	.05	.08	.11	.03	.05	.07	.09	.01	.03	.05	.07	-.01	.00
0 34	.00	.01	.05	.07	-.01	.00	.01	.03	.05	-.01	.01	.03	-.03	.00	.05	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

0DRAWDOWN WILL BE SAVED ON UNIT 40 AT END OF TIME STEP 1, STRESS PERIOD 1
0

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 1

0 CUMULATIVE VOLUMES L**3 RATES FOR THIS TIME STEP L**3/T

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	.00000	STORAGE =	.00000
CONSTANT HEAD =	.17499E+06	CONSTANT HEAD =	.17499E+06

```
                WELLS =     .00000
0            TOTAL IN =     .17499E+06
          OUT:
          ----
              STORAGE =     .00000
        CONSTANT HEAD =     97972.
                WELLS =     77007.
0           TOTAL OUT =     .17498E+06
0            IN - OUT =     13.734
0 PERCENT DISCREPANCY =                .01
```


```
                WELLS =     .00000
             TOTAL IN =     .17499E+06
          OUT:
          ----
              STORAGE =     .00000
        CONSTANT HEAD =     97972.
                WELLS =     77007.
            TOTAL OUT =     .17498E+06
             IN - OUT =     13.734
  PERCENT DISCREPANCY =                .01
```


0

TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 1

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	86400.0	1440.00	24.0000	1.00000	.273785E-02
STRESS PERIOD TIME	86400.0	1440.00	24.0000	1.00000	.273785E-02
TOTAL SIMULATION TIME	86400.0	1440.00	24.0000	1.00000	.273785E-02

1

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1                                  U.S. GEOLOGICAL SURVEY MODULAR FINITE-DIFFERENCE GROUND-WATER MODEL
0SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     SIM 4A - ALL EXISTING WELLS, RIW2 DEEP, 3 NEW SHALLOW
    2 LAYERS          35 ROWS          16 COLUMNS
   1 STRESS PERIOD(S) IN SIMULATION
 MODEL TIME UNIT IS DAYS
0I/O UNITS:
 ELEMENT OF IUNIT:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
         I/O UNIT: 11 12  0  0  0  0  0  0 19  0  0 22  0  0  0  0  0  0  0  0  0  0  0  0
0BAS1 -- BASIC MODEL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT  1
 ARRAYS RHS AND BUFF WILL SHARE MEMORY.
 START HEAD WILL BE SAVED
    10699 ELEMENTS IN X ARRAY ARE USED BY BAS
    10699 ELEMENTS OF X ARRAY USED OUT OF  100000
0BCF1 -- BLOCK-CENTERED FLOW PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 11
 STEADY-STATE SIMULATION
      LAYER  AQUIFER TYPE
      -------------------
         1          1
         2          0
     1122 ELEMENTS IN X ARRAY ARE USED BY BCF
    11821 ELEMENTS OF X ARRAY USED OUT OF  100000
0WEL1 -- WELL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM 12
 MAXIMUM OF     9 WELLS
       36 ELEMENTS IN X ARRAY ARE USED FOR WELLS
    11857 ELEMENTS OF X ARRAY USED OUT OF  100000
0SIP1 -- STRONGLY IMPLICIT PROCEDURE SOLUTION PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 19
 MAXIMUM OF  50 ITERATIONS ALLOWED FOR CLOSURE
  5 ITERATION PARAMETERS
     4685 ELEMENTS IN X ARRAY ARE USED BY SIP
    16542 ELEMENTS OF X ARRAY USED OUT OF  100000
1SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     SIM 4A - ALL EXISTING WELLS, RIW2 DEEP, 3 NEW SHALLOW
0
```

BOUNDARY ARRAY FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
0	2	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	3	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	4	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	5	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	6	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	7	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	8	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	9	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	10	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	11	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	12	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	13	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	14	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	15	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	16	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	17	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	18	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	19	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	20	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	21	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	22	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	23	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	24	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	25	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	26	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	27	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	28	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	29	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	30	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	31	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	32	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	33	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	34	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	35	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

0

BOUNDARY ARRAY FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

0 1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
0 2	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
3	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
4	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
5	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 6	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 7	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 8	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 9	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 10	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 11	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 12	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 13	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 14	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 15	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 16	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 17	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 18	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 19	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 20	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 21	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 22	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 23	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 24	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 25	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 26	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 27	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 28	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 29	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 30	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 31	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 32	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 33	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 34	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 35	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2

0AQUIFER HEAD WILL BE SET TO 999.99 AT ALL NO-FLOW NODES (IBOUND=0).
0

INITIAL HEAD FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
2	92.40	92.60	92.70	92.80	92.90	93.00	93.20	93.30	93.40	93.50	93.60	93.70	93.80	93.80	93.90	94.00
0 3	92.00	92.20	92.30	92.40	92.50	92.70	92.80	92.90	93.00	93.10	93.20	93.20	93.30	93.40	93.50	93.50
0 4	91.60	91.80	91.90	92.00	92.20	92.30	92.40	92.50	92.60	92.70	92.80	92.80	92.90	92.90	93.00	93.10
0 5	91.20	91.40	91.50	91.60	91.80	91.90	92.00	92.10	92.20	92.30	92.40	92.40	92.40	92.50	92.60	92.60
0 6	90.70	90.90	91.00	91.20	91.40	91.50	91.60	91.70	91.80	91.90	91.90	92.00	92.00	92.10	92.10	92.10
0 7	90.20	90.40	90.60	90.70	90.90	91.00	91.10	91.20	91.30	91.40	91.50	91.50	91.60	91.60	91.60	91.60
0 8	89.70	89.90	90.10	90.30	90.40	90.50	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.10	91.10	91.10
0 9	89.40	89.50	89.70	89.80	90.00	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.60	90.50
0 10	89.00	89.20	89.30	89.40	89.50	89.60	89.70	89.80	89.90	89.90	90.00	90.00	90.00	90.00	90.00	90.00
0 11	88.70	88.80	88.90	89.00	89.10	89.20	89.30	89.40	89.40	89.50	89.50	89.60	89.60	89.60	89.50	89.50
0 12	88.30	88.40	88.60	88.70	88.80	88.90	88.90	89.00	89.00	89.10	89.10	89.10	89.10	89.10	89.10	89.10
0 13	88.00	88.10	88.20	88.30	88.40	88.50	88.60	88.60	88.70	88.70	88.70	88.70	88.70	88.70	88.70	88.60
0 14	87.70	87.80	87.90	88.00	88.10	88.10	88.20	88.20	88.30	88.30	88.30	88.30	88.30	88.30	88.30	88.20
0 15	87.50	87.60	87.60	87.70	87.70	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.90	87.90	87.90	87.90
0 16	87.30	87.30	87.30	87.30	87.40	87.40	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.50	87.50
0 17	87.00	86.90	87.00	87.00	87.00	87.10	87.10	87.20	87.20	87.20	87.20	87.20	87.20	87.20	87.20	87.20
0 18	86.50	86.50	86.60	86.60	86.70	86.70	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.90
0 19	86.00	86.10	86.20	86.30	86.40	86.40	86.40	86.50	86.50	86.50						

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
											86.50	86.50	86.40	86.40	86.40	86.40
0 20	85.60	85.70	85.80	85.90	86.00	86.00	86.00	86.10	86.10	86.10	86.10	86.00	86.00	85.90	85.90	85.90
0 21	85.10	85.20	85.30	85.40	85.50	85.50	85.60	85.60	85.60	85.60	85.50	85.50	85.40	85.30	85.20	85.10
0 22	84.70	84.80	84.90	84.90	85.00	85.00	85.00	85.10	85.00	85.00	85.00	84.90	84.80	84.70	84.60	84.50
0 23	84.20	84.30	84.40	84.50	84.50	84.50	84.50	84.50	84.50	84.50	84.40	84.40	84.30	84.20	84.00	83.80
0 24	83.80	83.90	84.00	84.00	84.00	84.10	84.10	84.00	84.00	84.00	83.90	83.80	83.80	83.60	83.40	83.30
0 25	83.50	83.50	83.50	83.60	83.60	83.60	83.60	83.60	83.50	83.50	83.40	83.30	83.20	83.10	82.90	82.80
0 26	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.00	83.00	82.90	82.80	82.70	82.60	82.40	82.30
0 27	82.70	82.70	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.50	82.40	82.40	82.20	82.10	82.00	81.90
0 28	82.20	82.20	82.20	82.20	82.20	82.20	82.20	82.10	82.10	82.00	82.00	81.90	81.80	81.70	81.50	81.40
0 29	81.80	81.80	81.80	81.80	81.70	81.70	81.70	81.70	81.60	81.60	81.50	81.40	81.30	81.20	81.10	81.00
0 30	81.30	81.30	81.30	81.30	81.30	81.30	81.30	81.20	81.20	81.10	81.10	81.00	80.90	80.80	80.70	80.60
0 31	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.70	80.70	80.60	80.50	80.40	80.30	80.30	80.20
0 32	80.30	80.40	80.40	80.40	80.40	80.40	80.40	80.30	80.30	80.20	80.20	80.10	80.00	79.90	79.80	79.70
0 33	79.90	79.90	79.90	80.00	80.00	80.00	79.90	79.90	79.90	79.80	79.70	79.70	79.60	79.50	79.40	79.30
0 34	79.40	79.40	79.50	79.50	79.50	79.50	79.50	79.50	79.50	79.40	79.30	79.20	79.10	79.00	78.90	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40
0																

INITIAL HEAD FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	92.10
0 2	90.90	91.00	91.10	91.10	91.20	91.30	91.40	91.40	91.50	91.50	91.60	91.60	91.70	91.70	91.80	91.80
0 3	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.20	91.20	91.30	91.30	91.30	91.40	91.40	91.40	91.40
0 4	90.40	90.50	90.50	90.60	90.70	90.70	90.80	90.90	90.90	91.00	91.00	91.00	91.10	91.10	91.10	91.10
0 5	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.70	90.70	90.70	90.70	90.70	90.70	90.70
0 6	89.80	89.90	90.00	90.00	90.10	90.20	90.20	90.30	90.30	90.30	90.40	90.40	90.40	90.40	90.40	90.30
0 7	89.50	89.60	89.70	89.80	89.80	89.90	89.90	90.00	90.00	90.00	90.10	90.10	90.10	90.10	90.00	90.00
0 8	89.20	89.30	89.40	89.50	89.50	89.60	89.60	89.70	89.70	89.70	89.70	89.70	89.70	89.70	89.70	89.70
0 9	89.00	89.10	89.10	89.20	89.30	89.30	89.30	89.40	89.40	89.40	89.40	89.40	89.40	89.40	89.30	89.30
0 10	88.70	88.80	88.90	88.90	89.00	89.00	89.00	89.10	89.10	89.10	89.10	89.10	89.00	89.00	89.00	89.00
0 11	88.50	88.60	88.60	88.60	88.70	88.70	88.70	88.80	88.80	88.80	88.70	88.70	88.70	88.70	88.60	88.50
0 12	88.30	88.30	88.30	88.40	88.40	88.40	88.50	88.50	88.50	88.40	88.40	88.40	88.40	88.30	88.20	88.10
0 13	88.10	88.10	88.10	88.10	88.10	88.10	88.20	88.20	88.20	88.10	88.10	88.10	88.00	88.00	87.90	87.80
0 14	87.80	87.80	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.80	87.80	87.70	87.70	87.60	87.60	87.50
0 15	87.50	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.60	87.50	87.40	87.30	87.30	87.20	87.20
0 16	87.10	87.10	87.20	87.20	87.30	87.30	87.30	87.30	87.20	87.20	87.10	87.00	87.00	86.90	86.90	86.90
0 17	86.80	86.80	86.80	86.90	86.90	86.90	86.90	86.80	86.80	86.80	86.70	86.70	86.60	86.60	86.50	86.50
0 18	86.40	86.40	86.50	86.50	86.50	86.50	86.40	86.40	86.40	86.40	86.30	86.30	86.20	86.20	86.20	86.20
0 19	86.10	86.10	86.10	86.10	86.10	86.00	86.00	86.00	86.00	85.90	85.90	85.90	85.80	85.80	85.80	85.80
0 20	85.70	85.80	85.80	85.70	85.70	85.60	85.60	85.60	85.60	85.50	85.50	85.50	85.40	85.40	85.40	85.40

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 21	85.30	85.30	85.30	85.30	85.30	85.20	85.20	85.20	85.10	85.10	85.10	85.10	85.00	85.00	85.00	85.00
22	84.90	84.90	84.90	84.90	84.80	84.80	84.80	84.80	84.70	84.70	84.70	84.60	84.60	84.60	84.60	84.50
23	84.40	84.40	84.40	84.40	84.40	84.40	84.30	84.30	84.30	84.30	84.20	84.20	84.20	84.20	84.10	84.10
0 24	84.00	84.00	84.00	84.00	84.00	83.90	83.90	83.90	83.90	83.90	83.80	83.80	83.80	83.80	83.70	83.70
0 25	83.60	83.60	83.60	83.50	83.50	83.50	83.50	83.50	83.40	83.40	83.40	83.40	83.40	83.40	83.30	83.30
0 26	83.20	83.20	83.10	83.10	83.10	83.10	83.10	83.00	83.00	83.00	83.00	83.00	83.00	82.90	82.90	82.90
0 27	82.80	82.80	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.60	82.50	82.50	82.50	82.50	82.50	82.50
0 28	82.30	82.30	82.30	82.30	82.20	82.20	82.20	82.20	82.20	82.10	82.10	82.10	82.10	82.10	82.00	82.00
0 29	81.90	81.90	81.90	81.80	81.80	81.80	81.80	81.70	81.70	81.70	81.70	81.60	81.60	81.60	81.60	81.60
0 30	81.50	81.50	81.40	81.40	81.40	81.40	81.30	81.30	81.30	81.30	81.20	81.20	81.20	81.20	81.20	81.20
0 31	81.00	81.00	81.00	81.00	80.90	80.90	80.90	80.90	80.90	80.80	80.80	80.80	80.80	80.70	80.70	80.70
0 32	80.60	80.60	80.60	80.50	80.50	80.50	80.50	80.40	80.40	80.40	80.40	80.30	80.30	80.30	80.30	80.30
0 33	80.20	80.20	80.10	80.10	80.10	80.10	80.00	80.00	80.00	80.00	79.90	79.90	79.90	79.90	79.80	79.80
0 34	79.70	79.70	79.70	79.70	79.60	79.60	79.60	79.60	79.60	79.50	79.50	79.50	79.40	79.40	79.40	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

0HEAD PRINT FORMAT IS FORMAT NUMBER 4 DRAWDOWN PRINT FORMAT IS FORMAT NUMBER 9
0HEADS WILL BE SAVED ON UNIT 30 DRAWDOWNS WILL BE SAVED ON UNIT 40
0OUTPUT CONTROL IS SPECIFIED EVERY TIME STEP
0 COLUMN TO ROW ANISOTROPY = 1.000000
0 DELR = 200.0000
0 DELC = 200.0000
0

HYD. COND. ALONG ROWS FOR LAYER 1 WILL BE READ ON UNIT 11 USING FORMAT: (16F4.0)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
2	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 3	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 4	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 5	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 6	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	300.0	300.0	300.0	300.0
0 7	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	300.0	300.0	300.0	300.0
0 8	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	225.0	225.0	225.0	300.0
0 9	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	225.0	225.0	225.0	300.0
0 10	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	225.0	225.0	225.0	300.0
0 11	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 12	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 13	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 14	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 15	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 16	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 17	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 18	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 19	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0						

	250.0	250.0	250.0	250.0	250.0	300.0				
0 20	300.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0
	175.0	175.0	175.0	175.0	175.0	300.0				
0 21	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	175.0	175.0	175.0	300.0				
0 22	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	175.0	175.0	175.0	300.0				
0 23	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	175.0	175.0	175.0	300.0				
0 24	300.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	175.0	175.0	175.0	300.0				
0 25	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 26	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 27	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 28	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 29	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 30	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 31	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 32	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 33	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 34	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 35	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				

0 BOTTOM = 30.00000 FOR LAYER 1
0 VERT HYD COND /THICKNESS = .1000000E-02 FOR LAYER 1
0

TRANSMIS. ALONG ROWS FOR LAYER 2 WILL BE READ ON UNIT 11 USING FORMAT: (16F5.0)

	1 / 11	2 / 12	3 / 13	4 / 14	5 / 15	6 / 16	7	8	9	10
0 1	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 2	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 3	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 4	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 5	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 6	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 7	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 8	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 9	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 10	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 11	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 12	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 13	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 14	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 15	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 16	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 17	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 18	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 19	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.
	6000.	6000.	6000.	6000.	6000.	6000.				

```
0 20   4000.     4000.     4000.     4000.     4000.     4000.     1500.     1500.     1500.     4000.
       4000.     4000.     4000.     4000.     4000.     4000.
  21   3000.     3000.     3000.     3000.     3000.     3000.     1500.     1500.     1500.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 22   3000.     3000.     3000.     3000.     3000.     3000.     1500.     1500.     1500.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 23   3000.     3000.     3000.     3000.     3000.     3000.     1500.     1500.     1500.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 24   3000.     3000.     3000.     3000.     3000.     3000.     1500.     1500.     1500.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 25   3000.     3000.     3000.     3000.     3000.     3000.     1500.     1500.     1500.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 26   3000.     3000.     3000.     3000.     3000.     3000.     1500.     1500.     1500.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 27   3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 28   3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 29   3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 30   3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 31   3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 32   3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 33   3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 34   3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 35   3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0

                                                       SOLUTION BY THE STRONGLY IMPLICIT PROCEDURE
                                                       -------------------------------------------
0                                               MAXIMUM ITERATIONS ALLOWED FOR CLOSURE =        50
                                                                ACCELERATION PARAMETER =      1.0000
                                                     HEAD CHANGE CRITERION FOR CLOSURE =      .10000E-02
                                                     SIP HEAD CHANGE PRINTOUT INTERVAL =        1
0                                                    CALCULATE ITERATION PARAMETERS FROM MODEL CALCULATED WSEED
1                                                   STRESS PERIOD NO.    1, LENGTH =    1.000000
                                                    ----------------------------------------------

                                                    NUMBER OF TIME STEPS =      1

                                                     MULTIPLIER FOR DELT =      1.000

                                                  INITIAL TIME STEP SIZE =   1.000000

0           9 WELLS
                                                LAYER     ROW     COL     STRESS RATE    WELL NO.
                                                ---------------------------------------------------
                                                  1       14       5      -13476.           1
                                                  1       13       6      -13476.           2
                                                  1       13       8      -13476.           3
                                                  1       17       8      -4813.0           4
                                                  1       24       8      -7701.0           5
                                                  1       26       8      -9626.0           6
                                                  2       13       8      -4813.0           7
                                                  2       17       8      -4813.0           8
                                                  2       24       8      -4813.0           9
0AVERAGE SEED =  .00187924
 MINIMUM SEED =  .00055600
0
    5 ITERATION PARAMETERS CALCULATED FROM AVERAGE SEED:

             .0000000E+00    .7917928E+00    .9566497E+00    .9909742E+00    .9981208E+00
0
    10 ITERATIONS FOR TIME STEP   1 IN STRESS PERIOD  1
0MAXIMUM HEAD CHANGE FOR EACH ITERATION:
0 HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL
 ----------------------------------------------------------------------------------------------------------------------------------
   -2.332     (  2, 13,  8)  -.3506      (  2, 14,  7)  -.3312      (  1, 14,  7)  -.2222      (  1, 14,  9)  -.6060E-01 (  1, 23, 10)
    .8787E-02 (  2, 21,  7)   .7268E-02 (  1, 11,  9)   .4748E-02 (  1, 14,  8)   .2975E-02 (  1, 20, 10)   .8014E-03 (  1, 22,  9)
0
0HEAD/DRAWDOWN PRINTOUT FLAG = 1     TOTAL BUDGET PRINTOUT FLAG = 1     CELL-BY-CELL FLOW TERM FLAG = 0
0OUTPUT FLAGS FOR EACH LAYER:
          HEAD    DRAWDOWN  HEAD   DRAWDOWN
 LAYER  PRINTOUT  PRINTOUT  SAVE     SAVE
 ----------------------------------------
    1       1         1       1        1
```

2 1 1 1 1
1 HEAD IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.55	92.66	92.77	92.87	92.98	93.12	93.23	93.34	93.44	93.54	93.65	93.74	93.83	93.92	94.00
0 3	92.00	92.13	92.24	92.34	92.44	92.54	92.66	92.77	92.88	92.98	93.08	93.19	93.28	93.36	93.44	93.50
0 4	91.60	91.72	91.83	91.93	92.02	92.11	92.22	92.32	92.42	92.52	92.62	92.73	92.82	92.90	92.99	93.10
0 5	91.20	91.31	91.42	91.52	91.60	91.68	91.78	91.88	91.97	92.07	92.16	92.26	92.35	92.44	92.52	92.60
0 6	90.70	90.84	90.96	91.06	91.14	91.22	91.30	91.40	91.50	91.60	91.69	91.79	91.89	91.97	92.04	92.10
0 7	90.20	90.33	90.45	90.55	90.63	90.71	90.80	90.89	90.99	91.09	91.20	91.31	91.43	91.51	91.57	91.60
0 8	89.70	89.86	89.97	90.05	90.12	90.20	90.29	90.38	90.48	90.59	90.69	90.80	90.92	91.00	91.06	91.10
0 9	89.40	89.45	89.51	89.56	89.62	89.68	89.76	89.85	89.96	90.07	90.17	90.27	90.37	90.44	90.49	90.50
0 10	89.00	89.04	89.06	89.07	89.10	89.15	89.22	89.31	89.43	89.55	89.65	89.75	89.84	89.91	89.97	90.00
0 11	88.70	88.66	88.63	88.60	88.58	88.59	88.65	88.75	88.89	89.04	89.16	89.26	89.35	89.42	89.48	89.50
0 12	88.30	88.28	88.22	88.14	88.05	87.98	88.05	88.13	88.35	88.54	88.70	88.81	88.90	88.98	89.04	89.10
0 13	88.00	87.94	87.84	87.69	87.48	87.20	87.45	87.36	87.81	88.08	88.25	88.37	88.47	88.54	88.59	88.60
0 14	87.70	87.63	87.50	87.30	86.94	87.04	87.16	87.24	87.46	87.67	87.84	87.96	88.06	88.14	88.19	88.20
0 15	87.50	87.37	87.22	87.06	86.90	86.87	86.91	86.99	87.13	87.29	87.45	87.57	87.67	87.75	87.83	87.90
0 16	87.30	87.11	86.95	86.82	86.72	86.66	86.66	86.69	86.81	86.94	87.08	87.19	87.29	87.38	87.45	87.50
0 17	87.00	86.80	86.66	86.56	86.48	86.43	86.40	86.35	86.50	86.62	86.73	86.83	86.92	87.01	87.11	87.20
0 18	86.50	86.42	86.34	86.26	86.21	86.17	86.15	86.15	86.22	86.31	86.39	86.47	86.56	86.64	86.75	86.90
0 19	86.00	86.02	86.00	85.95	85.92	85.89	85.88	85.89	85.93	85.99	86.06	86.12	86.18	86.25	86.33	86.40
0 20	85.60	85.61	85.59	85.57	85.55	85.53	85.52	85.52	85.55	85.60	85.64	85.69	85.72	85.76	85.8[illegible]	85.90
0 21	85.10	85.13	85.13	85.11	85.09	85.06	85.04	85.03	85.05	85.08	85.12	85.15	85.16	85.16	85.1[illegible]	85.10
0 22	84.70	84.68	84.67	84.65	84.60	84.55	84.49	84.46	84.48	84.53	84.56	84.59	84.59	84.58	84.54	84.50
0 23	84.20	84.23	84.22	84.19	84.12	84.03	83.92	83.83	83.89	83.96	84.02	84.04	84.05	84.01	83.93	83.80
0 24	83.80	83.81	83.80	83.74	83.64	83.51	83.34	83.05	83.29	83.41	83.48	83.52	83.53	83.48	83.38	83.30
0 25	83.50	83.43	83.38	83.29	83.17	83.04	82.86	82.68	82.80	82.91	82.98	83.01	83.02	82.97	82.87	82.80
0 26	83.10	83.03	82.95	82.85	82.74	82.59	82.39	82.02	82.32	82.44	82.51	82.53	82.52	82.47	82.39	82.30
0 27	82.70	82.61	82.53	82.43	82.32	82.20	82.07	81.93	81.99	82.04	82.07	82.07	82.05	82.00	81.94	81.90
0 28	82.20	82.16	82.09	82.01	81.92	81.83	81.73	81.66	81.65	81.66	81.66	81.64	81.61	81.55	81.48	81.40
0 29	81.80	81.73	81.66	81.59	81.52	81.45	81.38	81.33	81.29	81.27	81.25	81.22	81.18	81.12	81.06	81.00
0 30	81.30	81.27	81.22	81.17	81.11	81.06	81.01	80.96	80.92	80.89	80.85	80.81	80.76	80.70	80.64	80.60
0 31	80.80	80.79	80.77	80.74	80.71	80.67	80.63	80.59	80.55	80.50	80.46	80.41	80.35	80.28	80.22	80.20
0 32	80.30	80.33	80.33	80.32	80.30	80.27	80.24	80.21	80.17	80.12	80.06	80.00	79.93	79.85	79.78	79.70
0 33	79.90	79.89	79.90	79.90	79.89	79.88	79.86	79.83	79.79	79.74	79.67	79.60	79.52	79.43	79.35	79.30
0 34	79.40	79.44	79.46	79.49	79.49	79.49	79.48	79.46	79.43	79.36	79.29	79.20	79.11	79.01	78.91	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

1 HEAD IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	92.10
2	90.90	90.97	91.05	91.14	91.22	91.27	91.35	91.43	91.50	91.54	91.59	91.63	91.68	91.71	91.76	91.80
0 3	90.60	90.70	90.79	90.87	90.95	91.02	91.09	91.15	91.21	91.26	91.30	91.33	91.36	91.39	91.41	91.40
0 4	90.40	90.45	90.52	90.60	90.68	90.75	90.82	90.88	90.93	90.96	90.99	91.02	91.04	91.06	91.07	91.10
0 5	90.10	90.17	90.25	90.32	90.40	90.48	90.55	90.61	90.65	90.67	90.69	90.70	90.71	90.71	90.71	90.70
0 6	89.80	89.88	89.96	90.04	90.12	90.20	90.28	90.34	90.37	90.37	90.37	90.37	90.37	90.37	90.35	90.30
0 7	89.50	89.59	89.66	89.74	89.82	89.92	90.03	90.10	90.11	90.07	90.05	90.03	90.03	90.02	90.02	90.00
0 8	89.20	89.30	89.36	89.43	89.50	89.61	89.82	89.91	89.90	89.75	89.70	89.68	89.67	89.67	89.68	89.70
0 9	89.00	89.03	89.07	89.11	89.15	89.20	89.39	89.50	89.47	89.34	89.32	89.31	89.31	89.31	89.31	89.30
0 10	88.70	88.74	88.76	88.78	88.79	88.80	88.84	88.86	88.91	88.91	88.91	88.92	88.93	88.93	88.95	89.00
0 11	88.50	88.49	88.47	88.44	88.42	88.40	88.30	88.19	88.35	88.47	88.50	88.52	88.54	88.55	88.54	88.50
0 12	88.30	88.23	88.17	88.11	88.05	87.99	87.68	87.21	87.71	88.03	88.09	88.13	88.16	88.17	88.16	88.10
0 13	88.10	87.97	87.87	87.78	87.69	87.59	86.95	85.19	86.97	87.60	87.69	87.75	87.79	87.82	87.82	87.80
0 14	87.80	87.67	87.56	87.46	87.34	87.21	86.83	86.39	86.83	87.20	87.31	87.39	87.44	87.48	87.49	87.50
0 15	87.50	87.36	87.25	87.14	87.01	86.84	86.63	86.54	86.61	86.81	86.95	87.05	87.11	87.15	87.18	87.20
0 16	87.10	87.03	86.94	86.84	86.73	86.60	86.47	86.39	86.45	86.56	86.66	86.74	86.79	86.83	86.86	86.90
0 17	86.80	86.72	86.64	86.56	86.47	86.38	86.27	86.10	86.25	86.33	86.40	86.45	86.49	86.51	86.52	86.50
0 18	86.40	86.39	86.35	86.30	86.24	86.18	86.13	86.08	86.11	86.13	86.16	86.18	86.20	86.20	86.20	86.20
0 19	86.10	86.09	86.07	86.04	86.00	85.99	86.00	85.98	85.97	85.93	85.91	85.92	85.92	85.91	85.87	85.80
0 20	85.70	85.74	85.74	85.71	85.68	85.67	85.66	85.63	85.62	85.60	85.58	85.58	85.58	85.56	85.51	85.40
0 21	85.30	85.31	85.29	85.26	85.22	85.17	85.10	85.05	85.05	85.09	85.11	85.12	85.12	85.10	85.06	85.00
0 22	84.90	84.85	84.81	84.75	84.69	84.61	84.50	84.40	84.45	84.52	84.56	84.59	84.61	84.60	84.57	84.50
23	84.40	84.38	84.33	84.26	84.17	84.06	83.85	83.59	83.79	83.95	84.03	84.09	84.12	84.13	84.12	84.10
24	84.00	83.94	83.87	83.79	83.68	83.53	83.17	82.31	83.11	83.42	83.53	83.60	83.65	83.67	83.69	83.70
0 25	83.60	83.52	83.44	83.34	83.23	83.10	82.86	82.58	82.79	82.98	83.08	83.15	83.20	83.23	83.27	83.30
0 26	83.20	83.10	83.01	82.91	82.81	82.69	82.50	82.37	82.43	82.57	82.65	82.71	82.76	82.80	82.85	82.90
0 27	82.80	82.68	82.59	82.50	82.40	82.28	82.14	82.07	82.08	82.17	82.24	82.29	82.34	82.38	82.43	82.50
0 28	82.30	82.24	82.17	82.09	82.00	81.91	81.83	81.78	81.77	81.81	81.85	81.88	81.92	81.95	81.98	82.00
0 29	81.90	81.83	81.75	81.68	81.61	81.54	81.48	81.44	81.43	81.44	81.46	81.48	81.50	81.53	81.56	81.60
0 30	81.50	81.41	81.34	81.27	81.22	81.16	81.12	81.08	81.07	81.06	81.07	81.08	81.09	81.11	81.14	81.20
0 31	81.00	80.97	80.92	80.87	80.82	80.78	80.74	80.71	80.69	80.68	80.67	80.67	80.67	80.68	80.69	80.70
0 32	80.60	80.55	80.50	80.46	80.42	80.38	80.36	80.33	80.31	80.29	80.28	80.27	80.26	80.26	80.26	80.30
0 33	80.20	80.13	80.08	80.04	80.01	79.99	79.97	79.95	79.93	79.90	79.88	79.87	79.84	79.83	79.81	79.80
0 34	79.70	79.69	79.65	79.62	79.61	79.60	79.58	79.57	79.55	79.51	79.49	79.47	79.43	79.40	79.35	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

0HEAD WILL BE SAVED ON UNIT 30 AT END OF TIME STEP 1, STRESS PERIOD 1

1 DRAWDOWN IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.05	.04	.03	.03	.02	.08	.07	.06	.06	.06	.05	.06	-.03	-.02	.00
0 3	.00	.07	.06	.06	.06	.16	.14	.13	.12	.12	.12	.01	.02	.04	.06	.00
0 4	.00	.08	.07	.07	.18	.19	.18	.18	.18	.18	.18	.07	.08	-.00	.01	.00
0 5	.00	.09	.08	.08	.20	.22	.22	.22	.23	.23	.24	.14	.05	.06	.08	.00

0 6	.00	.06	.04	.14	.26	.28	.30	.30	.30	.30	.21	.21	.11	.13	.06	.00
0 7	.00	.07	.15	.15	.27	.29	.30	.31	.31	.31	.30	.19	.17	.09	.03	.00
0 8	.00	.04	.13	.25	.28	.30	.31	.32	.32	.31	.31	.20	.18	.10	.04	.00
0 9	.00	.05	.19	.24	.38	.42	.44	.45	.34	.33	.33	.23	.23	.16	.11	.00
0 10	.00	.16	.24	.33	.40	.45	.48	.49	.47	.35	.35	.25	.16	.09	.03	.00
0 11	.00	.14	.27	.40	.52	.61	.65	.65	.51	.46	.34	.34	.25	.18	.02	.00
0 12	.00	.12	.38	.56	.75	.92	.85	.87	.65	.56	.40	.29	.20	.12	.06	.00
0 13	.00	.16	.36	.61	.92	1.30	1.15	1.24	.89	.62	.45	.33	.23	.16	.11	.00
0 14	.00	.17	.40	.70	1.16	1.06	1.04	.96	.84	.63	.46	.34	.24	.16	.11	.00
0 15	.00	.23	.38	.64	.80	.93	.89	.91	.77	.61	.45	.33	.23	.15	.07	.00
0 16	.00	.19	.35	.48	.68	.74	.84	.81	.69	.66	.52	.41	.31	.22	.05	.00
0 17	.00	.10	.34	.44	.52	.67	.70	.85	.70	.58	.47	.37	.28	.19	.09	.00
0 18	.00	.08	.26	.34	.49	.53	.65	.65	.58	.49	.41	.33	.24	.16	.05	.00
0 19	.00	.08	.20	.35	.48	.51	.52	.61	.57	.51	.44	.38	.22	.15	.07	.00
0 20	.00	.09	.21	.33	.45	.47	.48	.58	.55	.50	.46	.31	.28	.14	.09	.00
0 21	.00	.07	.17	.29	.41	.44	.56	.57	.55	.52	.38	.35	.24	.14	.05	.00
0 22	.00	.12	.23	.25	.40	.45	.51	.64	.52	.47	.44	.31	.21	.12	.06	.00
0 23	.00	.07	.18	.31	.38	.47	.58	.67	.61	.54	.38	.36	.25	.19	.07	.00
0 24	.00	.09	.20	.26	.36	.59	.76	.95	.71	.59	.42	.28	.27	.12	.02	.00
0 25	.00	.07	.12	.31	.43	.56	.74	.92	.70	.59	.42	.29	.18	.13	.03	.00
0 26	.00	.07	.15	.25	.36	.51	.71	1.08	.68	.56	.39	.27	.18	.13	.01	.00
0 27	.00	.09	.17	.27	.38	.40	.53	.67	.61	.46	.33	.33	.15	.10	.06	.00
0 28	.00	.04	.11	.19	.28	.37	.47	.44	.45	.34	.34	.26	.19	.15	.02	.00
0 29	.00	.07	.14	.21	.18	.25	.32	.37	.31	.33	.25	.18	.12	.08	.04	.00
0 30	.00	.03	.08	.13	.19	.24	.29	.24	.28	.21	.25	.19	.14	.10	.06	.00
0 31	.00	.01	.03	.06	.09	.13	.17	.21	.15	.20	.14	.09	.05	.02	.08	.00
0 32	.00	.07	.07	.08	.10	.13	.16	.09	.13	.08	.14	.10	.07	.05	.02	.00
0 33	.00	.01	.00	.10	.11	.12	.04	.07	.11	.06	.03	.10	.08	.07	.05	.00
0 34	.00	-.04	.04	.01	.01	.01	.02	.04	.07	.04	.01	.00	-.01	-.01	-.01	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

1 DRAWDOWN IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.03	.05	-.04	-.02	.03	.05	-.03	.00	-.04	.01	-.03	.02	-.01	.04	.00
0 3	.00	-.00	.01	.03	.05	-.02	.01	.05	-.01	.04	.00	-.03	.04	.01	-.01	.00
0 4	.00	.05	-.02	-.00	.02	-.05	-.02	.02	-.03	.04	.01	-.02	.06	.04	.03	.00
0 5	.00	.03	.05	-.02	.00	.02	-.05	-.01	-.05	.03	.01	.00	-.01	-.01	-.01	.00
0 6	.00	.02	.04	-.04	-.02	.00	-.08	-.04	-.07	-.07	.03	.03	.03	.03	.05	.00
0 7	.00	.01	.04	.06	-.02	-.02	-.13	-.10	-.11	-.07	.05	.07	.07	.08	-.02	.00
0 8	.00	.00	.04	.07	-.00	-.01	-.22	-.21	-.20	-.05	.00	.02	.03	.03	.02	.00
0 9	.00	.07	.03	.09	.15	.10	-.09	-.10	-.07	.06	.08	.09	.09	.09	-.01	.00
0 10	.00	.06	.14	.12	.21	.20	.16	.24	.19	.19	.19	.18	.07	.07	.05	.00
0 11	.00	.11	.13	.16	.28	.30	.40	.61	.45	.33	.20	.17	.16	.15	.06	.00
0 12	.00	.07	.13	.29	.35	.41	.82	1.29	.79	.37	.31	.27	.24	.13	.04	.00
0 13	.00	.13	.23	.32	.41	.51	1.25	3.01	1.23	.50	.41	.35	.21	.18	.08	.00
0 14	.00	.13	.24	.34	.56	.69	1.07	1.51	1.07	.60	.49	.31	.26	.12	.11	.00
0 15	.00	.14	.25	.36	.59	.76	.97	1.06	.99	.79	.55	.35	.19	.15	.02	.00
0 16	.00	.07	.26	.36	.57	.70	.83	.91	.75	.64	.44	.26	.21	.07	.04	.00
0 17	.00	.08	.16	.34	.43	.52	.63	.70	.55	.47	.30	.25	.11	.09	-.02	.00
0 18	.00	.01	.15	.20	.26	.32	.27	.32	.29	.27	.14	.12	.00	-.00	.00	.00
0 19	.00	.01	.03	.06	.10	.01	.00	.02	.03	-.03	-.01	-.02	-.12	-.11	-.07	.00
0 20	.00	.06	.06	-.01	.02	-.07	-.06	-.03	-.02	-.10	-.08	-.08	-.18	-.16	-.11	.00
0 21	.00	-.01	.01	.04	.08	.03	.10	.15	.05	.01	-.01	-.02	-.12	-.10	-.06	.00
0 22	.00	.05	.09	.15	.11	.19	.30	.40	.25	.18	.14	.01	-.01	-.00	.03	.00
0 23	.00	.02	.07	.14	.23	.34	.45	.71	.51	.35	.17	.11	.08	.07	-.02	.00
0 24	.00	.06	.13	.21	.32	.37	.73	1.59	.79	.48	.27	.20	.15	.13	.01	.00
0 25	.00	.08	.16	.16	.27	.40	.64	.92	.61	.42	.32	.25	.20	.17	.03	.00
0 26	.00	.10	.09	.19	.29	.41	.60	.63	.57	.43	.35	.29	.24	.10	.05	.00
0 27	.00	.12	.11	.20	.30	.32	.46	.53	.52	.43	.26	.21	.16	.12	.07	.00
0 28	.00	.06	.13	.21	.20	.29	.37	.42	.43	.29	.25	.22	.18	.15	.02	.00
0 29	.00	.07	.15	.12	.19	.26	.32	.26	.27	.26	.24	.12	.10	.07	.04	.00
0 30	.00	.09	.06	.13	.18	.24	.18	.22	.23	.24	.13	.12	.11	.09	.06	.00
0 31	.00	.03	.08	.13	.08	.12	.16	.19	.21	.12	.13	.13	.13	.02	.01	.00
0 32	.00	.05	.10	.04	.08	.12	.14	.07	.09	.11	.12	.03	.04	.04	.04	.00
0 33	.00	.07	.02	.06	.09	.11	.03	.05	.07	.10	.02	.03	.06	.07	-.01	.00
0 34	.00	.01	.05	.08	-.01	.00	.02	.03	.05	-.01	.01	.03	-.03	.00	.05	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

0DRAWDOWN WILL BE SAVED ON UNIT 40 AT END OF TIME STEP 1, STRESS PERIOD 1
0

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 1

0 CUMULATIVE VOLUMES L**3 RATES FOR THIS TIME STEP L**3/T

IN:

STORAGE = .00000

IN:

STORAGE = .00000

```
          CONSTANT HEAD =    .17399E+06
                  WELLS =    .00000
               TOTAL IN =    .17399E+06
            OUT:
            ----
                STORAGE =    .00000
          CONSTANT HEAD =    96968.
                  WELLS =    77007.
0             TOTAL OUT =    .17398E+06
0              IN - OUT =    13.063
0  PERCENT DISCREPANCY =                    .01
```


```
          CONSTANT HEAD =    .17399E+06
                  WELLS =    .00000
               TOTAL IN =    .17399E+06
            OUT:
            ----
                STORAGE =    .00000
          CONSTANT HEAD =    96968.
                  WELLS =    77007.
              TOTAL OUT =    .17398E+06
               IN - OUT =    13.063
   PERCENT DISCREPANCY =                    .01
```


0

TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 1

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	86400.0	1440.00	24.0000	1.00000	.273785E-02
STRESS PERIOD TIME	86400.0	1440.00	24.0000	1.00000	.273785E-02
TOTAL SIMULATION TIME	86400.0	1440.00	24.0000	1.00000	.273785E-02

1

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1                     U.S. GEOLOGICAL SURVEY MODULAR FINITE-DIFFERENCE GROUND-WATER MODEL
`SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     SIMULATION 5 - SIM. 4 W/ ALTERNATING BASIN RECH.
   2 LAYERS        35 ROWS         16 COLUMNS
   3 STRESS PERIOD(S) IN SIMULATION
 MODEL TIME UNIT IS DAYS
0I/O UNITS:
 ELEMENT OF IUNIT:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
         I/O UNIT: 11 12  0  0  0  0  0 18 19  0  0 22  0  0  0  0  0  0  0  0  0  0  0  0
0BAS1 -- BASIC MODEL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT  1
 ARRAYS RHS AND BUFF WILL SHARE MEMORY.
 START HEAD WILL BE SAVED
    10699 ELEMENTS IN X ARRAY ARE USED BY BAS
    10699 ELEMENTS OF X ARRAY USED OUT OF  100000
0BCF1 -- BLOCK-CENTERED FLOW PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 11
 TRANSIENT SIMULATION
      LAYER  AQUIFER TYPE
      -------------------
         1         1
         2         0
     2242 ELEMENTS IN X ARRAY ARE USED BY BCF
    12941 ELEMENTS OF X ARRAY USED OUT OF  100000
0WEL1 -- WELL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM 12
 MAXIMUM OF    8 WELLS
       32 ELEMENTS IN X ARRAY ARE USED FOR WELLS
    12973 ELEMENTS OF X ARRAY USED OUT OF  100000
0RCH1 -- RECHARGE PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 18
 OPTION 1 -- RECHARGE TO TOP LAYER
      560 ELEMENTS OF X ARRAY USED FOR RECHARGE
    13533 ELEMENTS OF X ARRAY USED OUT OF  100000
0SIP1 -- STRONGLY IMPLICIT PROCEDURE SOLUTION PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 19
 MAXIMUM OF   50 ITERATIONS ALLOWED FOR CLOSURE
  5 ITERATION PARAMETERS
     4685 ELEMENTS IN X ARRAY ARE USED BY SIP
    18218 ELEMENTS OF X ARRAY USED OUT OF  100000
1SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     SIMULATION 5 - SIM. 4 W/ ALTERNATING BASIN RECH.
0
```

BOUNDARY ARRAY FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
2	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
3	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
4	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 5	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 6	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 7	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 8	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 9	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 10	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 11	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 12	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 13	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 14	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 15	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 16	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 17	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 18	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 19	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 20	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 21	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 22	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 23	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 24	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 25	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 26	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 27	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 28	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 29	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 30	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 31	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 32	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 33	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 34	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 35	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

0

BOUNDARY ARRAY FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
0 2	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 3	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 4	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 5	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 6	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 7	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 8	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 9	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 10	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 11	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 12	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 13	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 14	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 15	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 16	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 17	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 18	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 19	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 20	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 21	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 22	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 23	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 24	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 25	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 26	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 27	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 28	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 29	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 30	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 31	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 32	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 33	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 34	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 35	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2

0AQUIFER HEAD WILL BE SET TO 999.99 AT ALL NO-FLOW NODES (IBOUND=0).
0

INITIAL HEAD FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.60	92.70	92.80	92.90	93.00	93.20	93.30	93.40	93.50	93.60	93.70	93.80	93.80	93.90	94.00
0 3	92.00	92.20	92.30	92.40	92.50	92.70	92.80	92.90	93.00	93.10	93.20	93.20	93.30	93.40	93.50	93.50
0 4	91.60	91.80	91.90	92.00	92.20	92.30	92.40	92.50	92.60	92.70	92.80	92.80	92.90	92.90	93.00	93.10
0 5	91.20	91.40	91.50	91.60	91.80	91.90	92.00	92.10	92.20	92.30	92.40	92.40	92.40	92.50	92.60	92.60
0 6	90.70	90.90	91.00	91.20	91.40	91.50	91.60	91.70	91.80	91.90	91.90	92.00	92.00	92.10	92.10	92.10
0 7	90.20	90.40	90.60	90.70	90.90	91.00	91.10	91.20	91.30	91.40	91.50	91.50	91.60	91.60	91.60	91.60
0 8	89.70	89.90	90.10	90.30	90.40	90.50	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.10	91.10	91.10
0 9	89.40	89.50	89.70	89.80	90.00	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.60	90.50
0 10	89.00	89.20	89.30	89.40	89.50	89.60	89.70	89.80	89.90	89.90	90.00	90.00	90.00	90.00	90.00	90.00
0 11	88.70	88.80	88.90	89.00	89.10	89.20	89.30	89.40	89.40	89.50	89.50	89.60	89.60	89.60	89.50	89.50
0 12	88.30	88.40	88.60	88.70	88.80	88.90	88.90	89.00	89.00	89.10	89.10	89.10	89.10	89.10	89.10	89.10
0 13	88.00	88.10	88.20	88.30	88.40	88.50	88.60	88.60	88.70	88.70	88.70	88.70	88.70	88.70	88.70	88.60
0 14	87.70	87.80	87.90	88.00	88.10	88.10	88.20	88.20	88.30	88.30	88.30	88.30	88.30	88.30	88.30	88.20
0 15	87.50	87.60	87.60	87.70	87.70	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.90	87.90	87.90	87.90
0 16	87.30	87.30	87.30	87.30	87.40	87.40	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.50	87.50
0 17	87.00	86.90	87.00	87.00	87.00	87.10	87.10	87.20	87.20	87.20						

	87.20	87.20	87.20	87.20	87.20	87.20				
0 18	86.50	86.50	86.60	86.60	86.70	86.70	86.80	86.80	86.80	86.80
	86.80	86.80	86.80	86.80	86.80	86.90				
19	86.00	86.10	86.20	86.30	86.40	86.40	86.40	86.50	86.50	86.50
	86.50	86.50	86.40	86.40	86.40	86.40				
0 20	85.60	85.70	85.80	85.90	86.00	86.00	86.00	86.10	86.10	86.10
	86.10	86.00	86.00	85.90	85.90	85.90				
0 21	85.10	85.20	85.30	85.40	85.50	85.50	85.60	85.60	85.60	85.60
	85.50	85.50	85.40	85.30	85.20	85.10				
0 22	84.70	84.80	84.90	84.90	85.00	85.00	85.00	85.10	85.00	85.00
	85.00	84.90	84.80	84.70	84.60	84.50				
0 23	84.20	84.30	84.40	84.50	84.50	84.50	84.50	84.50	84.50	84.50
	84.40	84.40	84.30	84.20	84.00	83.80				
0 24	83.80	83.90	84.00	84.00	84.00	84.10	84.10	84.00	84.00	84.00
	83.90	83.80	83.80	83.60	83.40	83.30				
0 25	83.50	83.50	83.50	83.60	83.60	83.60	83.60	83.60	83.50	83.50
	83.40	83.30	83.20	83.10	82.90	82.80				
0 26	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.00	83.00
	82.90	82.80	82.70	82.60	82.40	82.30				
0 27	82.70	82.70	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.50
	82.40	82.40	82.20	82.10	82.00	81.90				
0 28	82.20	82.20	82.20	82.20	82.20	82.20	82.20	82.10	82.10	82.00
	82.00	81.90	81.80	81.70	81.50	81.40				
0 29	81.80	81.80	81.80	81.80	81.70	81.70	81.70	81.70	81.60	81.60
	81.50	81.40	81.30	81.20	81.10	81.00				
0 30	81.30	81.30	81.30	81.30	81.30	81.30	81.30	81.20	81.20	81.10
	81.10	81.00	80.90	80.80	80.70	80.60				
0 31	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.70	80.70
	80.60	80.50	80.40	80.30	80.30	80.20				
0 32	80.30	80.40	80.40	80.40	80.40	80.40	80.40	80.30	80.30	80.20
	80.20	80.10	80.00	79.90	79.80	79.70				
0 33	79.90	79.90	79.90	80.00	80.00	80.00	79.90	79.90	79.90	79.80
	79.70	79.70	79.60	79.50	79.40	79.30				
0 34	79.40	79.40	79.50	79.50	79.50	79.50	79.50	79.50	79.50	79.40
	79.30	79.20	79.10	79.00	78.90	78.80				
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00
	78.90	78.80	78.70	78.60	78.50	78.40				
0										

INITIAL HEAD FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1	2	3	4	5	6	7	8	9	10
	11	12	13	14	15	16				
1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80
	91.90	91.90	92.00	92.00	92.10	92.10				
0 2	90.90	91.00	91.10	91.10	91.20	91.30	91.40	91.40	91.50	91.50
	91.60	91.60	91.70	91.70	91.80	91.80				
0 3	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.20	91.20	91.30
	91.30	91.30	91.40	91.40	91.40	91.40				
0 4	90.40	90.50	90.50	90.60	90.70	90.70	90.80	90.90	90.90	91.00
	91.00	91.00	91.10	91.10	91.10	91.10				
0 5	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.70
	90.70	90.70	90.70	90.70	90.70	90.70				
0 6	89.80	89.90	90.00	90.00	90.10	90.20	90.20	90.30	90.30	90.30
	90.40	90.40	90.40	90.40	90.40	90.30				
0 7	89.50	89.60	89.70	89.80	89.80	89.90	89.90	90.00	90.00	90.00
	90.10	90.10	90.10	90.10	90.00	90.00				
0 8	89.20	89.30	89.40	89.50	89.50	89.60	89.60	89.70	89.70	89.70
	89.70	89.70	89.70	89.70	89.70	89.70				
0 9	89.00	89.10	89.10	89.20	89.30	89.30	89.30	89.40	89.40	89.40
	89.40	89.40	89.40	89.40	89.30	89.30				
0 10	88.70	88.80	88.90	88.90	89.00	89.00	89.00	89.10	89.10	89.10
	89.10	89.10	89.00	89.00	89.00	89.00				
0 11	88.50	88.60	88.60	88.60	88.70	88.70	88.70	88.80	88.80	88.80
	88.70	88.70	88.70	88.70	88.60	88.50				
0 12	88.30	88.30	88.30	88.40	88.40	88.40	88.50	88.50	88.50	88.40
	88.40	88.40	88.40	88.30	88.20	88.10				
0 13	88.10	88.10	88.10	88.10	88.10	88.10	88.20	88.20	88.20	88.10
	88.10	88.10	88.00	88.00	87.90	87.80				
0 14	87.80	87.80	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.80
	87.80	87.70	87.70	87.60	87.60	87.50				
0 15	87.50	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.60
	87.50	87.40	87.30	87.30	87.20	87.20				
0 16	87.10	87.10	87.20	87.20	87.30	87.30	87.30	87.30	87.20	87.20
	87.10	87.00	87.00	86.90	86.90	86.90				
0 17	86.80	86.80	86.80	86.90	86.90	86.90	86.90	86.80	86.80	86.80
	86.70	86.70	86.60	86.60	86.50	86.50				
0 18	86.40	86.40	86.50	86.50	86.50	86.50	86.40	86.40	86.40	86.40
	86.30	86.30	86.20	86.20	86.20	86.20				

0 19	86.10	86.10	86.10	86.10	86.10	86.00	86.00	86.00	86.00	85.90
	85.90	85.90	85.80	85.80	85.80	85.80				
0 20	85.70	85.80	85.80	85.70	85.70	85.60	85.60	85.60	85.60	85.50
	85.50	85.50	85.40	85.40	85.40	85.40				
0 21	85.30	85.30	85.30	85.30	85.30	85.20	85.20	85.20	85.10	85.10
	85.10	85.10	85.00	85.00	85.00	85.00				
0 22	84.90	84.90	84.90	84.90	84.80	84.80	84.80	84.80	84.70	84.70
	84.70	84.60	84.60	84.60	84.60	84.50				
0 23	84.40	84.40	84.40	84.40	84.40	84.40	84.30	84.30	84.30	84.30
	84.20	84.20	84.20	84.20	84.10	84.10				
0 24	84.00	84.00	84.00	84.00	84.00	83.90	83.90	83.90	83.90	83.90
	83.80	83.80	83.80	83.80	83.70	83.70				
0 25	83.60	83.60	83.60	83.50	83.50	83.50	83.50	83.50	83.40	83.40
	83.40	83.40	83.40	83.40	83.30	83.30				
0 26	83.20	83.20	83.10	83.10	83.10	83.10	83.10	83.00	83.00	83.00
	83.00	83.00	83.00	82.90	82.90	82.90				
0 27	82.80	82.80	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.60
	82.50	82.50	82.50	82.50	82.50	82.50				
0 28	82.30	82.30	82.30	82.30	82.20	82.20	82.20	82.20	82.20	82.10
	82.10	82.10	82.10	82.10	82.00	82.00				
0 29	81.90	81.90	81.90	81.80	81.80	81.80	81.80	81.70	81.70	81.70
	81.70	81.60	81.60	81.60	81.60	81.60				
0 30	81.50	81.50	81.40	81.40	81.40	81.40	81.30	81.30	81.30	81.30
	81.20	81.20	81.20	81.20	81.20	81.20				
0 31	81.00	81.00	81.00	81.00	80.90	80.90	80.90	80.90	80.90	80.80
	80.80	80.80	80.80	80.70	80.70	80.70				
0 32	80.60	80.60	80.60	80.50	80.50	80.50	80.50	80.40	80.40	80.40
	80.40	80.30	80.30	80.30	80.30	80.30				
0 33	80.20	80.20	80.10	80.10	80.10	80.10	80.00	80.00	80.00	80.00
	79.90	79.90	79.90	79.90	79.80	79.80				
0 34	79.70	79.70	79.70	79.70	79.60	79.60	79.60	79.60	79.60	79.50
	79.50	79.50	79.40	79.40	79.40	79.30				
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10
	79.10	79.10	79.00	79.00	78.90	78.90				

0HEAD PRINT FORMAT IS FORMAT NUMBER 4 DRAWDOWN PRINT FORMAT IS FORMAT NUMBER 9
0HEADS WILL BE SAVED ON UNIT 30 DRAWDOWNS WILL BE SAVED ON UNIT 40
0OUTPUT CONTROL IS SPECIFIED EVERY TIME STEP
0 COLUMN TO ROW ANISOTROPY = 1.000000
0 DELR = 200.0000
0 DELC = 200.0000
0 PRIMARY STORAGE COEF = .8360000E-01 FOR LAYER 1
0

HYD. COND. ALONG ROWS FOR LAYER 1 WILL BE READ ON UNIT 11 USING FORMAT: (16F4.0)

	1 / 11	2 / 12	3 / 13	4 / 14	5 / 15	6 / 16	7	8	9	10
0 1	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 2	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 3	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 4	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 5	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 6	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 7	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 8	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	225.0	225.0	225.0	300.0				
0 9	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	225.0	225.0	225.0	300.0				
0 10	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	225.0	225.0	225.0	300.0				
0 11	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 12	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 13	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 14	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 15	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 16	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
	250.0	250.0	250.0	250.0	250.0	300.0				

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 17	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
18	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
19	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 20	300.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	300.0
0 21	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 22	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 23	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 24	300.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 25	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 26	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 27	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 28	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 29	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 30	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 31	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 32	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 33	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 34	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 35	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0

0 BOTTOM = 30.00000 FOR LAYER 1
0 VERT HYD COND /THICKNESS = .1000000E-02 FOR LAYER 1
0 PRIMARY STORAGE COEF = .1750000 FOR LAYER 2
0

TRANSMIS. ALONG ROWS FOR LAYER 2 WILL BE READ ON UNIT 11 USING FORMAT: (16F5.0)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 2	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 3	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 4	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 5	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 6	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 7	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 8	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 9	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 10	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 11	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 12	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 13	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 14	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 15	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 16	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.

0 17	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 18	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 19	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 20	4000.	4000.	4000.	4000.	4000.	4000.	1500.	1500.	1500.	4000.
	4000.	4000.	4000.	4000.	4000.	4000.				
0 21	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 22	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 23	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 24	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 25	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 26	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 27	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 28	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 29	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 30	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 31	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 32	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 33	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 34	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 35	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				

0

SOLUTION BY THE STRONGLY IMPLICIT PROCEDURE

0

MAXIMUM ITERATIONS ALLOWED FOR CLOSURE = 50
ACCELERATION PARAMETER = 1.0000
HEAD CHANGE CRITERION FOR CLOSURE = .10000E-02
SIP HEAD CHANGE PRINTOUT INTERVAL = 1

0 CALCULATE ITERATION PARAMETERS FROM MODEL CALCULATED WSEED

1 STRESS PERIOD NO. 1, LENGTH = 1825.000

NUMBER OF TIME STEPS = 1

MULTIPLIER FOR DELT = 1.000

INITIAL TIME STEP SIZE = 1825.000

0 8 WELLS

LAYER	ROW	COL	STRESS RATE	WELL NO.
1	14	5	-14439.	1
1	13	6	-13476.	2
1	13	8	-14439.	3
1	17	8	-4813.0	4
1	24	8	-15401.	5
2	13	8	-4813.0	6
2	17	8	-4813.0	7
2	24	8	-4813.0	8

0

RECHARGE WILL BE READ ON UNIT 18 USING FORMAT: (16F5.2)

	1 / 11	2 / 12	3 / 13	4 / 14	5 / 15	6 / 16	7	8	9	10
0 1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	.0000	.0000	.0000	.0000	.0000	.0000				
0 2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	.0000	.0000	.0000	.0000	.0000	.0000				
0 3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	.0000	.0000	.0000	.0000	.0000	.0000				

0	4	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
	5	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
	6	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	7	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	8	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	9	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	10	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	11	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	12	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	13	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	14	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	15	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	16	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	17	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	18	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	19	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	20	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	21	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	22	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	23	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	24	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	25	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	26	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
	27	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	28	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	29	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	30	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	31	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	32	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	33	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	34	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				
0	35	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
		.0000	.0000	.0000	.0000	.0000	.0000				

0AVERAGE SEED = .00187924
MINIMUM SEED = .00055600
0
5 ITERATION PARAMETERS CALCULATED FROM AVERAGE SEED:

.0000000E+00 .7917928E+00 .9566497E+00 .9909742E+00 .9981208E+00

0
10 ITERATIONS FOR TIME STEP 1 IN STRESS PERIOD 1
0MAXIMUM HEAD CHANGE FOR EACH ITERATION:

0 HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL
-2.328	(2, 13, 8)	-.3493	(2, 14, 7)	-.3448	(1, 14, 7)	-.2319	(1, 14, 9)	-.5752E-01	(1, 23, 10)
.8549E-02	(2, 21, 7)	.7555E-02	(1, 11, 9)	.5426E-02	(1, 14, 8)	.3369E-02	(1, 13, 7)	.8121E-03	(1, 22, 9)

0
0HEAD/DRAWDOWN PRINTOUT FLAG = 1 TOTAL BUDGET PRINTOUT FLAG = 1 CELL-BY-CELL FLOW TERM FLAG = 0
0OUTPUT FLAGS FOR EACH LAYER:

LAYER	HEAD PRINTOUT	DRAWDOWN PRINTOUT	HEAD SAVE	DRAWDOWN SAVE

----
1 1 1 1 1
2 1 1 1 1

1 HEAD IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.55	92.66	92.77	92.87	92.98	93.12	93.23	93.34	93.44	93.54	93.65	93.74	93.83	93.92	94.00
0 3	92.00	92.13	92.24	92.34	92.44	92.54	92.66	92.77	92.88	92.98	93.08	93.19	93.28	93.36	93.44	93.50
0 4	91.60	91.71	91.82	91.92	92.01	92.11	92.22	92.32	92.42	92.52	92.62	92.72	92.82	92.90	92.99	93.10
0 5	91.20	91.31	91.42	91.52	91.60	91.68	91.77	91.87	91.97	92.07	92.16	92.26	92.35	92.43	92.52	92.60
0 6	90.70	90.84	90.96	91.06	91.14	91.21	91.30	91.39	91.49	91.59	91.68	91.79	91.89	91.97	92.04	92.10
0 7	90.20	90.33	90.45	90.54	90.63	90.70	90.79	90.88	90.98	91.09	91.19	91.30	91.43	91.51	91.57	91.60
0 8	89.70	89.86	89.96	90.05	90.12	90.19	90.27	90.37	90.47	90.58	90.68	90.79	90.91	91.00	91.06	91.10
0 9	89.40	89.45	89.50	89.56	89.61	89.67	89.75	89.84	89.95	90.06	90.16	90.27	90.36	90.44	90.49	90.50
0 10	89.00	89.03	89.05	89.06	89.08	89.13	89.20	89.29	89.41	89.54	89.64	89.74	89.83	89.91	89.96	90.00
0 11	88.70	88.65	88.62	88.58	88.56	88.57	88.63	88.72	88.87	89.02	89.15	89.25	89.34	89.42	89.47	89.50
0 12	88.30	88.27	88.21	88.12	88.02	87.95	88.02	88.09	88.32	88.52	88.68	88.80	88.89	88.97	89.04	89.10
0 13	88.00	87.93	87.82	87.66	87.44	87.16	87.40	87.30	87.78	88.05	88.23	88.36	88.46	88.54	88.59	88.60
0 14	87.70	87.62	87.48	87.27	86.89	87.00	87.12	87.20	87.43	87.65	87.82	87.94	88.05	88.13	88.19	88.20
0 15	87.50	87.36	87.20	87.03	86.86	86.84	86.88	86.95	87.10	87.27	87.43	87.55	87.66	87.74	87.82	87.90
0 16	87.30	87.10	86.94	86.80	86.69	86.63	86.63	86.66	86.78	86.92	87.06	87.18	87.28	87.37	87.45	87.50
0 17	87.00	86.80	86.65	86.54	86.45	86.40	86.37	86.32	86.47	86.60	86.71	86.82	86.91	87.00	87.10	87.20
0 18	86.50	86.41	86.32	86.25	86.19	86.14	86.12	86.13	86.20	86.28	86.37	86.46	86.55	86.63	86.74	86.90
0 19	86.00	86.02	85.99	85.94	85.90	85.87	85.85	85.86	85.90	85.97	86.04	86.11	86.17	86.24	86.	86.40
0 20	85.60	85.60	85.58	85.56	85.53	85.51	85.49	85.49	85.52	85.57	85.63	85.68	85.71	85.75	85.8[illegible]	85.90
0 21	85.10	85.13	85.12	85.10	85.07	85.03	85.00	84.98	85.01	85.05	85.10	85.14	85.15	85.16	85.15	85.10
0 22	84.70	84.68	84.67	84.64	84.58	84.51	84.44	84.39	84.43	84.49	84.55	84.58	84.59	84.58	84.54	84.50
0 23	84.20	84.23	84.22	84.19	84.10	83.99	83.85	83.71	83.82	83.93	84.00	84.04	84.05	84.01	83.93	83.80
0 24	83.80	83.81	83.80	83.74	83.64	83.49	83.26	82.75	83.21	83.40	83.49	83.53	83.53	83.49	83.39	83.30
0 25	83.50	83.43	83.39	83.31	83.21	83.08	82.93	82.77	82.87	82.96	83.02	83.04	83.03	82.98	82.88	82.80
0 26	83.10	83.04	82.97	82.89	82.80	82.70	82.60	82.52	82.53	82.55	82.57	82.57	82.54	82.48	82.40	82.30
0 27	82.70	82.62	82.55	82.47	82.39	82.32	82.24	82.19	82.16	82.16	82.15	82.12	82.08	82.02	81.95	81.90
0 28	82.20	82.17	82.12	82.05	81.99	81.92	81.87	81.82	81.78	81.76	81.73	81.69	81.64	81.57	81.49	81.40
0 29	81.80	81.74	81.68	81.63	81.58	81.53	81.48	81.43	81.39	81.36	81.32	81.27	81.21	81.14	81.07	81.00
0 30	81.30	81.27	81.24	81.20	81.16	81.12	81.08	81.04	81.00	80.95	80.91	80.85	80.79	80.72	80.65	80.60
0 31	80.80	80.80	80.79	80.77	80.74	80.71	80.68	80.64	80.60	80.55	80.50	80.44	80.37	80.29	80.23	80.20
0 32	80.30	80.33	80.34	80.34	80.33	80.31	80.28	80.25	80.20	80.15	80.09	80.02	79.95	79.86	79.78	79.70
0 33	79.90	79.89	79.90	79.91	79.91	79.90	79.88	79.85	79.82	79.76	79.69	79.61	79.53	79.44	79.35	79.30
0 34	79.40	79.44	79.46	79.49	79.50	79.50	79.49	79.47	79.44	79.37	79.29	79.21	79.11	79.01	78.91	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

1 HEAD IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	.15	16
1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	92.10
0 2	90.90	90.97	91.05	91.14	91.22	91.27	91.35	91.43	91.50	91.54	91.59	91.63	91.68	91.71	91.76	91.80
0 3	90.60	90.70	90.79	90.87	90.95	91.02	91.09	91.15	91.21	91.26	91.30	91.33	91.36	91.39	91.41	91.40
0 4	90.40	90.45	90.52	90.60	90.68	90.75	90.82	90.88	90.93	90.96	90.99	91.02	91.04	91.06	91.07	91.10
0 5	90.10	90.17	90.25	90.32	90.40	90.48	90.55	90.61	90.65	90.67	90.69	90.70	90.71	90.71	90.71	90.70
0 6	89.80	89.88	89.96	90.04	90.12	90.20	90.28	90.34	90.37	90.37	90.37	90.37	90.37	90.37	90.35	90.30
0 7	89.50	89.59	89.66	89.74	89.82	89.92	90.03	90.10	90.11	90.07	90.05	90.03	90.03	90.02	90.02	90.00
0 8	89.20	89.30	89.36	89.43	89.50	89.61	89.82	89.91	89.90	89.75	89.70	89.68	89.67	89.67	89.68	89.70
0 9	89.00	89.03	89.07	89.11	89.15	89.20	89.39	89.50	89.47	89.34	89.32	89.31	89.31	89.31	89.31	89.30
0 10	88.70	88.74	88.76	88.78	88.79	88.80	88.84	88.87	88.91	88.91	88.91	88.92	88.93	88.94	88.95	89.00
0 11	88.50	88.49	88.47	88.45	88.42	88.40	88.30	88.19	88.35	88.47	88.50	88.53	88.54	88.55	88.54	88.50
0 12	88.30	88.23	88.17	88.11	88.06	87.99	87.68	87.21	87.72	88.03	88.09	88.13	88.16	88.17	88.16	88.10
0 13	88.10	87.97	87.87	87.78	87.69	87.59	86.96	85.20	86.97	87.60	87.69	87.75	87.80	87.82	87.82	87.80
0 14	87.80	87.67	87.56	87.46	87.34	87.21	86.84	86.40	86.83	87.20	87.31	87.39	87.44	87.48	87.49	87.50
0 15	87.50	87.36	87.25	87.14	87.01	86.85	86.63	86.54	86.62	86.82	86.96	87.05	87.11	87.15	87.18	87.20
0 16	87.10	87.03	86.94	86.84	86.73	86.60	86.48	86.39	86.46	86.56	86.66	86.74	86.79	86.83	86.86	86.90
0 17	86.80	86.72	86.64	86.56	86.47	86.38	86.27	86.10	86.25	86.34	86.40	86.45	86.49	86.51	86.52	86.50
0 18	86.40	86.39	86.35	86.30	86.24	86.18	86.13	86.08	86.11	86.13	86.16	86.18	86.20	86.20	86.20	86.20
0 19	86.10	86.09	86.07	86.04	86.00	85.99	86.00	85.98	85.97	85.93	85.92	85.92	85.92	85.91	85.87	85.80
0 20	85.70	85.74	85.74	85.71	85.68	85.67	85.66	85.64	85.62	85.60	85.59	85.58	85.58	85.56	85.51	85.40
0 21	85.30	85.31	85.30	85.26	85.22	85.18	85.10	85.05	85.06	85.10	85.11	85.12	85.12	85.10	85.06	85.00
22	84.90	84.85	84.81	84.76	84.69	84.62	84.50	84.40	84.45	84.53	84.57	84.60	84.61	84.60	84.57	84.50
23	84.40	84.38	84.33	84.27	84.18	84.07	83.85	83.59	83.80	83.96	84.04	84.09	84.12	84.13	84.12	84.10
0 24	84.00	83.95	83.88	83.80	83.69	83.54	83.18	82.32	83.12	83.43	83.54	83.61	83.65	83.68	83.69	83.70
0 25	83.60	83.52	83.44	83.35	83.24	83.11	82.87	82.60	82.81	82.99	83.09	83.16	83.20	83.24	83.27	83.30
0 26	83.20	83.11	83.02	82.92	82.82	82.70	82.52	82.39	82.45	82.59	82.66	82.72	82.77	82.81	82.85	82.90
0 27	82.80	82.69	82.60	82.51	82.41	82.30	82.16	82.09	82.10	82.19	82.25	82.30	82.34	82.38	82.43	82.50
0 28	82.30	82.25	82.17	82.10	82.01	81.93	81.84	81.80	81.79	81.82	81.86	81.89	81.93	81.96	81.99	82.00
0 29	81.90	81.83	81.76	81.69	81.62	81.56	81.50	81.46	81.45	81.45	81.47	81.49	81.51	81.53	81.56	81.60
0 30	81.50	81.41	81.34	81.28	81.23	81.17	81.13	81.10	81.08	81.07	81.08	81.08	81.10	81.11	81.14	81.20
0 31	81.00	80.97	80.92	80.87	80.83	80.79	80.75	80.72	80.70	80.69	80.68	80.68	80.68	80.69	80.70	80.70
0 32	80.60	80.55	80.50	80.46	80.42	80.39	80.36	80.34	80.32	80.30	80.29	80.27	80.26	80.26	80.26	80.30
0 33	80.20	80.13	80.08	80.05	80.02	80.00	79.98	79.96	79.93	79.91	79.89	79.87	79.85	79.83	79.81	79.80
0 34	79.70	79.69	79.65	79.63	79.61	79.60	79.59	79.57	79.55	79.51	79.49	79.47	79.43	79.40	79.35	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

0HEAD WILL BE SAVED ON UNIT 30 AT END OF TIME STEP 1, STRESS PERIOD 1

1 DRAWDOWN IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.05	.04	.03	.03	.02	.08	.07	.06	.06	.06	.05	.06	-.03	-.02	.00
0 3	.00	.07	.06	.06	.06	.16	.14	.13	.12	.12	.12	.01	.02	.04	.06	.00

0 4	.00	.09	.08	.08	.19	.19	.18	.18	.18	.18	.18	.08	.08	-.00	.01	.00
0 5	.00	.09	.08	.08	.20	.22	.23	.23	.23	.23	.24	.14	.05	.07	.08	.00
0 6	.00	.06	.04	.14	.26	.29	.30	.31	.31	.31	.22	.21	.11	.13	.06	.00
0 7	.00	.07	.15	.16	.27	.30	.31	.32	.32	.31	.31	.20	.17	.09	.03	.00
0 8	.00	.04	.14	.25	.28	.31	.33	.33	.33	.32	.32	.21	.19	.10	.04	.00
0 9	.00	.05	.20	.24	.39	.43	.45	.46	.35	.34	.34	.23	.24	.16	.11	.00
0 10	.00	.17	.25	.34	.42	.47	.50	.51	.49	.36	.36	.26	.17	.09	.04	.00
0 11	.00	.15	.28	.42	.54	.63	.67	.68	.53	.48	.35	.35	.26	.18	.03	.00
0 12	.00	.13	.39	.58	.78	.95	.88	.91	.68	.58	.42	.30	.21	.13	.06	.00
0 13	.00	.17	.38	.64	.96	1.34	1.20	1.30	.92	.65	.47	.34	.24	.16	.11	.00
0 14	.00	.18	.42	.73	1.21	1.10	1.08	1.00	.87	.65	.48	.36	.25	.17	.11	.00
0 15	.00	.24	.40	.67	.84	.96	.92	.95	.80	.63	.47	.35	.24	.16	.08	.00
0 16	.00	.20	.36	.50	.71	.77	.87	.84	.72	.68	.54	.42	.32	.23	.05	.00
0 17	.00	.10	.35	.46	.55	.70	.73	.88	.73	.60	.49	.38	.29	.20	.10	.00
0 18	.00	.09	.28	.35	.51	.56	.68	.67	.60	.52	.43	.34	.25	.17	.06	.00
0 19	.00	.08	.21	.36	.50	.53	.55	.64	.60	.53	.46	.39	.23	.16	.08	.00
0 20	.00	.10	.22	.34	.47	.49	.51	.61	.58	.53	.47	.32	.29	.15	.09	.00
0 21	.00	.07	.18	.30	.43	.47	.60	.62	.59	.55	.40	.36	.25	.14	.05	.00
0 22	.00	.12	.23	.26	.42	.49	.56	.71	.57	.51	.45	.32	.21	.12	.06	.00
0 23	.00	.07	.18	.31	.40	.51	.65	.79	.68	.57	.40	.36	.25	.19	.07	.00
0 24	.00	.09	.20	.26	.36	.61	.84	1.25	.79	.60	.41	.27	.27	.11	.01	.00
0 25	.00	.07	.11	.29	.39	.52	.67	.83	.63	.54	.38	.26	.17	.12	.02	.00
0 26	.00	.06	.13	.21	.30	.40	.50	.58	.47	.45	.33	.23	.16	.12	.00	.00
0 27	.00	.08	.15	.23	.31	.28	.36	.41	.44	.34	.25	.28	.12	.08	.05	.00
0 28	.00	.03	.08	.15	.21	.28	.33	.28	.32	.24	.27	.21	.16	.13	.01	.00
0 29	.00	.06	.12	.17	.12	.17	.22	.27	.21	.24	.18	.13	.09	.06	.03	.00
0 30	.00	.03	.06	.10	.14	.18	.22	.16	.20	.15	.19	.15	.11	.08	.05	.00
0 31	.00	.00	.01	.03	.06	.09	.12	.16	.10	.15	.10	.06	.03	.01	.07	.00
0 32	.00	.07	.06	.06	.07	.09	.12	.05	.10	.05	.11	.08	.05	.04	.02	.00
0 33	.00	.01	-.00	.09	.09	.10	.02	.05	.08	.04	.01	.09	.07	.06	.05	.00
0 34	.00	-.04	.04	.01	-.00	.00	.01	.03	.06	.03	.01	-.01	-.01	-.01	-.01	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

1 DRAWDOWN IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.03	.05	-.04	-.02	.03	.05	-.03	.00	-.04	.01	-.03	.02	-.01	.04	.00
0 3	.00	-.00	.01	.03	.05	-.02	.01	.05	-.01	.04	.00	-.03	.04	.01	-.01	.00
0 4	.00	.05	-.02	-.00	.02	-.05	-.02	.02	-.03	.04	.01	-.02	.06	.04	.03	.00
0 5	.00	.03	.05	-.02	.00	.02	-.05	-.01	-.05	.03	.01	.00	-.01	-.01	-.01	.00
0 6	.00	.02	.04	-.04	-.02	.00	-.08	-.04	-.07	-.07	.03	.03	.03	.03	.05	.00
0 7	.00	.01	.04	.06	-.02	-.02	-.13	-.10	-.11	-.07	.05	.07	.07	.08	-.02	.00
0 8	.00	.00	.04	.07	-.00	-.01	-.22	-.21	-.20	-.05	.00	.02	.03	.03	.02	.00
0 9	.00	.07	.03	.09	.15	.10	-.09	-.10	-.07	.06	.08	.09	.09	.09	-.01	.00
0 10	.00	.06	.14	.12	.21	.20	.16	.23	.19	.19	.19	.18	.07	.06	.05	.00
0 11	.00	.11	.13	.15	.28	.30	.40	.61	.45	.33	.20	.17	.16	.15	.06	.00
0 12	.00	.07	.13	.29	.34	.41	.82	1.29	.78	.37	.31	.27	.24	.13	.04	.00
0 13	.00	.13	.23	.32	.41	.51	1.24	3.00	1.23	.50	.41	.35	.20	.18	.08	.00
0 14	.00	.13	.24	.34	.56	.69	1.06	1.50	1.07	.60	.49	.31	.26	.12	.11	.00
0 15	.00	.14	.25	.36	.59	.75	.97	1.06	.98	.78	.54	.35	.19	.15	.02	.00
0 16	.00	.07	.26	.36	.57	.70	.82	.91	.74	.64	.44	.26	.21	.07	.04	.00
0 17	.00	.08	.16	.34	.43	.52	.63	.70	.55	.46	.30	.25	.11	.09	-.02	.00
0 18	.00	.01	.15	.20	.26	.32	.27	.32	.29	.27	.14	.12	.00	-.00	.00	.00
0 19	.00	.01	.03	.06	.10	.01	.00	.02	.03	-.03	-.02	-.02	-.12	-.11	-.07	.00
0 20	.00	.06	.06	-.01	.02	-.07	-.06	-.04	-.02	-.10	-.09	-.08	-.18	-.16	-.11	.00
0 21	.00	-.01	.00	.04	.08	.02	.10	.15	.04	.00	-.01	-.02	-.12	-.10	-.06	.00
0 22	.00	.05	.09	.14	.11	.18	.30	.40	.25	.17	.13	.00	-.01	-.00	.03	.00
0 23	.00	.02	.07	.13	.22	.33	.45	.71	.50	.34	.16	.11	.08	.07	-.02	.00
0 24	.00	.05	.12	.20	.31	.36	.72	1.58	.78	.47	.26	.19	.15	.12	.01	.00
0 25	.00	.08	.16	.15	.26	.39	.63	.90	.59	.41	.31	.24	.20	.16	.03	.00
0 26	.00	.09	.08	.18	.28	.40	.58	.61	.55	.41	.34	.28	.23	.09	.05	.00
0 27	.00	.11	.10	.19	.29	.30	.44	.51	.50	.41	.25	.20	.16	.12	.07	.00
0 28	.00	.05	.13	.20	.19	.27	.36	.40	.41	.28	.24	.21	.17	.14	.01	.00
0 29	.00	.07	.14	.11	.18	.24	.30	.24	.25	.25	.23	.11	.09	.07	.04	.00
0 30	.00	.09	.06	.12	.17	.23	.17	.20	.22	.23	.12	.12	.10	.09	.06	.00
0 31	.00	.03	.08	.13	.07	.11	.15	.18	.20	.11	.12	.12	.12	.01	.00	.00
0 32	.00	.05	.10	.04	.08	.11	.14	.06	.08	.10	.11	.03	.04	.04	.04	.00
0 33	.00	.07	.02	.05	.08	.10	.02	.04	.07	.09	.01	.03	.05	.07	-.01	.00
0 34	.00	.01	.05	.07	-.01	.00	.01	.03	.05	-.01	.01	.03	-.03	.00	.05	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

0DRAWDOWN WILL BE SAVED ON UNIT 40 AT END OF TIME STEP 1, STRESS PERIOD 1
0

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 1

0 CUMULATIVE VOLUMES L**3 RATES FOR THIS TIME STEP L**3/T

IN: IN:

STORAGE = .10382E+07
CONSTANT HEAD = .31873E+09
WELLS = .00000
RECHARGE = .00000
0 TOTAL IN = .31977E+09
0 OUT:

STORAGE = 28668.
CONSTANT HEAD = .17918E+09
WELLS = .14054E+09
RECHARGE = .00000
0 TOTAL OUT = .31974E+09
0 IN - OUT = 24448.
0 PERCENT DISCREPANCY = .01

STORAGE = 568.87
CONSTANT HEAD = .17465E+06
WELLS = .00000
RECHARGE = .00000
TOTAL IN = .17521E+06
OUT:

STORAGE = 15.708
CONSTANT HEAD = 98179.
WELLS = 77007.
RECHARGE = .00000
TOTAL OUT = .17520E+06
IN - OUT = 13.391
PERCENT DISCREPANCY = .01

0

TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 1

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	.157680E+09	.262800E+07	43800.0	1825.00	4.99658
STRESS PERIOD TIME	.157680E+09	.262800E+07	43800.0	1825.00	4.99658
TOTAL SIMULATION TIME	.157680E+09	.262800E+07	43800.0	1825.00	4.99658

1
1 STRESS PERIOD NO. 2, LENGTH = 4.500000

NUMBER OF TIME STEPS = 1

MULTIPLIER FOR DELT = 1.000

INITIAL TIME STEP SIZE = 4.500000

0REUSING WELLS FROM LAST STRESS PERIOD
0

RECHARGE WILL BE READ ON UNIT 18 USING FORMAT: (16F5.2)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 4	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 5	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 6	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.6420	.0000	.0000	.0000
0 7	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.6420	.0000	.0000	.0000	.0000
0 8	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.6420	.0000	.0000	.0000	.0000	.0000
0 9	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 10	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 11	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 12	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 13	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 14	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 15	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 16	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 17	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 18	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000

0 19	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 20	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 21	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 22	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 23	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 24	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 25	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 26	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 27	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 28	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 29	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 30	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 31	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 32	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 33	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 34	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 35	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000

0

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     8 ITERATIONS FOR TIME STEP    1 IN STRESS PERIOD   2
0MAXIMUM HEAD CHANGE FOR EACH ITERATION:
0 HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL
 ----------------------------------------------------------------------------------------------------------------------------------
    .7503     (  1,  7, 12)   .4453     (  1,  7, 12)   .2131     (  1,  7, 11)   .5947E-01 (  1,  9,  8)   .1190E-01 (  1, 15, 12)
   -.2451E-02 (  1,  9,  7)  -.2399E-02 (  1, 11,  8)  -.8917E-03 (  1, 11,  7)
0
0HEAD/DRAWDOWN PRINTOUT FLAG = 1     TOTAL BUDGET PRINTOUT FLAG = 1     CELL-BY-CELL FLOW TERM FLAG = 0
 REUSING PREVIOUS VALUES OF IOFLG
1                          HEAD IN LAYER   1 AT END OF TIME STEP   1 IN STRESS PERIOD   2
```

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.55	92.67	92.78	92.89	93.01	93.16	93.28	93.40	93.52	93.64	93.74	93.83	93.90	93.95	94.00
0 3	92.00	92.13	92.25	92.37	92.48	92.60	92.74	92.88	93.02	93.16	93.29	93.40	93.48	93.51	93.52	93.50
0 4	91.60	91.73	91.85	91.96	92.07	92.19	92.34	92.49	92.64	92.81	92.96	93.10	93.17	93.16	93.12	93.10
0 5	91.20	91.32	91.45	91.56	91.67	91.79	91.93	92.10	92.28	92.48	92.69	92.87	92.97	92.84	92.71	92.60
0 6	90.70	90.85	90.99	91.11	91.23	91.34	91.49	91.67	91.89	92.16	92.46	92.76	92.99	92.54	92.29	92.10
0 7	90.20	90.35	90.49	90.61	90.72	90.85	91.01	91.21	91.46	91.81	92.25	92.73	92.36	92.06	91.82	91.60
0 8	89.70	89.87	90.00	90.11	90.22	90.34	90.50	90.70	90.97	91.37	92.06	91.84	91.65	91.46	91.27	91.10
0 9	89.40	89.46	89.54	89.62	89.70	89.81	89.95	90.14	90.37	90.66	90.95	90.96	90.89	90.78	90.65	90.50
0 10	89.00	89.05	89.08	89.12	89.17	89.26	89.38	89.54	89.74	89.96	90.13	90.20	90.20	90.15	90.08	90.00
0 11	88.70	88.67	88.65	88.64	88.63	88.67	88.77	88.92	89.12	89.32	89.47	89.55	89.59	89.59	89.56	89.50
0 12	88.30	88.29	88.24	88.16	88.08	88.03	88.13	88.24	88.50	88.73	88.90	89.00	89.06	89.09	89.09	89.10
0 13	88.00	87.94	87.84	87.70	87.49	87.23	87.49	87.41	87.91	88.20	88.38	88.50	88.58	88.62	88.63	88.60
0 14	87.70	87.63	87.50	87.30	86.93	87.05	87.19	87.28	87.52	87.75	87.92	88.04	88.13	88.19	88.21	88.20
0 15	87.50	87.37	87.22	87.06	86.89	86.88	86.93	87.01	87.17	87.34	87.50	87.62	87.71	87.78	87.84	87.90
0 16	87.30	87.11	86.95	86.82	86.71	86.66	86.67	86.71	86.83	86.97	87.11	87.22	87.32	87.40	87.46	87.50

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 17	87.00	86.80	86.66	86.55	86.47	86.42	86.40	86.36	86.51	86.63	86.75	86.85	86.94	87.02	87.11	87.20
18	86.50	86.42	86.33	86.26	86.20	86.16	86.14	86.15	86.22	86.31	86.40	86.48	86.56	86.65	86.75	86.90
0 19	86.00	86.02	85.99	85.95	85.91	85.88	85.87	85.88	85.92	85.99	86.06	86.12	86.19	86.25	86.33	86.40
0 20	85.60	85.60	85.59	85.56	85.54	85.52	85.50	85.50	85.54	85.58	85.64	85.69	85.72	85.76	85.82	85.90
0 21	85.10	85.13	85.12	85.10	85.08	85.04	85.00	84.99	85.02	85.06	85.11	85.15	85.16	85.16	85.15	85.10
0 22	84.70	84.68	84.67	84.64	84.59	84.52	84.45	84.40	84.44	84.50	84.55	84.59	84.59	84.58	84.54	84.50
0 23	84.20	84.23	84.22	84.19	84.11	83.99	83.85	83.71	83.83	83.93	84.01	84.04	84.05	84.01	83.93	83.80
0 24	83.80	83.81	83.80	83.75	83.64	83.50	83.26	82.75	83.21	83.40	83.49	83.53	83.54	83.49	83.39	83.30
0 25	83.50	83.43	83.39	83.31	83.21	83.08	82.93	82.77	82.87	82.96	83.02	83.04	83.04	82.98	82.88	82.80
0 26	83.10	83.04	82.97	82.89	82.80	82.70	82.60	82.52	82.53	82.56	82.57	82.57	82.55	82.48	82.40	82.30
0 27	82.70	82.62	82.55	82.47	82.39	82.32	82.24	82.19	82.16	82.16	82.15	82.12	82.08	82.02	81.95	81.90
0 28	82.20	82.17	82.12	82.05	81.99	81.92	81.87	81.82	81.78	81.76	81.73	81.69	81.64	81.57	81.49	81.40
0 29	81.80	81.74	81.68	81.63	81.58	81.53	81.48	81.43	81.39	81.36	81.32	81.27	81.21	81.14	81.07	81.00
0 30	81.30	81.27	81.24	81.20	81.16	81.12	81.08	81.04	81.00	80.95	80.91	80.85	80.79	80.72	80.65	80.60
0 31	80.80	80.80	80.79	80.77	80.74	80.71	80.68	80.64	80.60	80.55	80.50	80.44	80.37	80.29	80.23	80.20
0 32	80.30	80.33	80.34	80.34	80.33	80.31	80.28	80.25	80.20	80.15	80.09	80.02	79.95	79.86	79.78	79.70
0 33	79.90	79.89	79.90	79.91	79.91	79.90	79.88	79.86	79.82	79.76	79.69	79.61	79.53	79.44	79.35	79.30
0 34	79.40	79.44	79.46	79.49	79.50	79.50	79.49	79.47	79.44	79.37	79.29	79.21	79.11	79.01	78.91	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

1 HEAD IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	92.10
2	90.90	90.97	91.05	91.14	91.22	91.28	91.35	91.43	91.50	91.54	91.60	91.63	91.68	91.71	91.76	91.80
0 3	90.60	90.71	90.79	90.87	90.95	91.02	91.09	91.16	91.22	91.26	91.30	91.33	91.37	91.39	91.41	91.40
0 4	90.40	90.45	90.53	90.60	90.68	90.75	90.82	90.88	90.93	90.97	91.00	91.03	91.05	91.06	91.07	91.10
0 5	90.10	90.17	90.25	90.32	90.40	90.48	90.55	90.61	90.65	90.68	90.70	90.71	90.72	90.72	90.72	90.70
0 6	89.80	89.88	89.96	90.04	90.12	90.20	90.29	90.35	90.38	90.38	90.38	90.38	90.38	90.38	90.36	90.30
0 7	89.50	89.59	89.66	89.74	89.82	89.92	90.04	90.11	90.12	90.09	90.06	90.05	90.04	90.03	90.02	90.00
0 8	89.20	89.30	89.37	89.43	89.51	89.62	89.83	89.92	89.91	89.77	89.72	89.69	89.69	89.68	89.68	89.70
0 9	89.00	89.03	89.07	89.11	89.15	89.20	89.40	89.51	89.48	89.35	89.33	89.32	89.32	89.31	89.31	89.30
0 10	88.70	88.75	88.76	88.78	88.79	88.80	88.84	88.87	88.92	88.92	88.92	88.93	88.93	88.94	88.95	89.00
0 11	88.50	88.49	88.47	88.45	88.42	88.40	88.30	88.20	88.36	88.48	88.51	88.53	88.55	88.55	88.54	88.50
0 12	88.30	88.23	88.17	88.11	88.06	87.99	87.68	87.21	87.72	88.04	88.10	88.14	88.17	88.18	88.16	88.10
0 13	88.10	87.97	87.87	87.78	87.69	87.59	86.96	85.20	86.97	87.60	87.69	87.76	87.80	87.82	87.82	87.80
0 14	87.80	87.67	87.56	87.46	87.34	87.21	86.84	86.40	86.83	87.20	87.31	87.39	87.45	87.48	87.50	87.50
0 15	87.50	87.36	87.25	87.14	87.01	86.85	86.63	86.54	86.62	86.82	86.96	87.05	87.11	87.15	87.18	87.20
0 16	87.10	87.03	86.94	86.84	86.73	86.60	86.48	86.39	86.46	86.57	86.66	86.74	86.79	86.83	86.86	86.90
0 17	86.80	86.72	86.64	86.56	86.47	86.38	86.27	86.10	86.25	86.34	86.40	86.45	86.49	86.51	86.52	86.50
0 18	86.40	86.39	86.35	86.30	86.24	86.18	86.13	86.08	86.11	86.13	86.16	86.18	86.20	86.21	86.20	86.20
0 19	86.10	86.09	86.07	86.04	86.00	85.99	86.00	85.98	85.97	85.93	85.92	85.92	85.92	85.91	85.87	85.80

0 20	85.70	85.74	85.74	85.71	85.68	85.67	85.66	85.64	85.62	85.60	85.59	85.58	85.58	85.56	85.51	85.40
0 21	85.30	85.31	85.30	85.26	85.22	85.18	85.10	85.05	85.06	85.09	85.11	85.12	85.12	85.10	85.[illegible]	85.00
0 22	84.90	84.85	84.81	84.76	84.69	84.62	84.50	84.40	84.45	84.52	84.57	84.60	84.61	84.60	84.5[illegible]	84.50
0 23	84.40	84.38	84.33	84.27	84.18	84.06	83.85	83.59	83.79	83.96	84.04	84.09	84.12	84.13	84.12	84.10
0 24	84.00	83.95	83.88	83.80	83.69	83.54	83.18	82.32	83.11	83.43	83.54	83.61	83.65	83.68	83.69	83.70
0 25	83.60	83.52	83.44	83.35	83.24	83.11	82.87	82.60	82.81	82.99	83.09	83.16	83.20	83.24	83.27	83.30
0 26	83.20	83.11	83.02	82.92	82.82	82.70	82.52	82.39	82.45	82.59	82.66	82.72	82.77	82.81	82.85	82.90
0 27	82.80	82.69	82.60	82.51	82.41	82.30	82.16	82.09	82.10	82.19	82.25	82.30	82.34	82.38	82.43	82.50
0 28	82.30	82.25	82.17	82.10	82.01	81.93	81.84	81.80	81.79	81.82	81.86	81.89	81.92	81.96	81.99	82.00
0 29	81.90	81.83	81.76	81.69	81.62	81.55	81.50	81.46	81.45	81.45	81.47	81.49	81.51	81.53	81.56	81.60
0 30	81.50	81.41	81.34	81.28	81.23	81.17	81.13	81.10	81.08	81.07	81.08	81.08	81.10	81.11	81.14	81.20
0 31	81.00	80.97	80.92	80.87	80.83	80.79	80.75	80.72	80.70	80.69	80.68	80.68	80.68	80.69	80.70	80.70
0 32	80.60	80.55	80.50	80.46	80.42	80.39	80.36	80.34	80.32	80.30	80.29	80.27	80.26	80.26	80.26	80.30
0 33	80.20	80.13	80.08	80.05	80.02	80.00	79.98	79.96	79.93	79.91	79.89	79.87	79.85	79.83	79.81	79.80
0 34	79.70	79.69	79.65	79.63	79.61	79.60	79.59	79.57	79.55	79.51	79.49	79.47	79.43	79.40	79.35	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

0HEAD WILL BE SAVED ON UNIT 30 AT END OF TIME STEP 1, STRESS PERIOD 2

1 DRAWDOWN IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.05	.03	.02	.01	-.01	.04	.02	-.00	-.02	-.04	-.04	-.03	-.10	-.05	.00
0 3	.00	.07	.05	.03	.02	.10	.06	.02	-.02	-.06	-.09	-.20	-.18	-.11	-.02	.00
0 4	.00	.07	.05	.04	.13	.11	.06	.01	-.04	-.11	-.16	-.30	-.27	-.26	-.12	.00
0 5	.00	.08	.05	.04	.13	.11	.07	.00	-.08	-.18	-.29	-.47	-.57	-.34	-.11	.00
0 6	.00	.05	.01	.09	.17	.16	.11	.03	-.09	-.26	-.56	-.76	-.99	-.44	-.19	.00
0 7	.00	.05	.11	.09	.18	.15	.09	-.01	-.16	-.41	-.75	-1.23	-.76	-.46	-.22	.00
0 8	.00	.03	.10	.19	.18	.16	.10	.00	-.17	-.47	-1.06	-.84	-.55	-.36	-.17	.00
0 9	.00	.04	.16	.18	.30	.29	.25	.16	-.07	-.26	-.45	-.46	-.29	-.18	-.05	.00
0 10	.00	.15	.22	.28	.33	.34	.32	.26	.16	-.06	-.13	-.20	-.20	-.15	-.08	.00
0 11	.00	.13	.25	.36	.47	.53	.53	.48	.28	.18	.03	.05	.01	.01	-.06	.00
0 12	.00	.11	.36	.54	.72	.87	.77	.76	.50	.37	.20	.10	.04	.01	.01	.00
0 13	.00	.16	.36	.60	.91	1.27	1.11	1.19	.79	.50	.32	.20	.12	.08	.07	.00
0 14	.00	.17	.40	.70	1.17	1.05	1.01	.92	.78	.55	.38	.26	.17	.11	.09	.00
0 15	.00	.23	.38	.64	.81	.92	.87	.89	.73	.56	.40	.28	.19	.12	.06	.00
0 16	.00	.19	.35	.48	.69	.74	.83	.79	.67	.63	.49	.38	.28	.20	.04	.00
0 17	.00	.10	.34	.45	.53	.68	.70	.84	.69	.57	.45	.35	.26	.18	.09	.00
0 18	.00	.08	.27	.34	.50	.54	.66	.65	.58	.49	.40	.32	.24	.15	.05	.00
0 19	.00	.08	.21	.35	.49	.52	.53	.62	.58	.51	.44	.38	.21	.15	.07	.00
0 20	.00	.10	.21	.34	.46	.48	.50	.60	.56	.52	.46	.31	.28	.14	.08	.00
0 21	.00	.07	.18	.30	.42	.46	.60	.61	.58	.54	.39	.35	.24	.14	.05	.00
0 22	.00	.12	.23	.26	.41	.48	.55	.70	.56	.50	.45	.31	.21	.12	.06	.00
0 23	.00	.07	.18	.31	.39	.51	.65	.79	.67	.57	.39	.36	.25	.19	.07	.00
0 24	.00	.09	.20	.25	.36	.60	.84	1.25	.79	.60	.41	.27	.26	.11	.01	.00
0 25	.00	.07	.11	.29	.39	.52	.67	.83	.63	.54	.38	.26	.16	.12	.02	.00
0 26	.00	.06	.13	.21	.30	.40	.50	.58	.47	.44	.33	.23	.15	.12	.00	.00
0 27	.00	.08	.15	.23	.31	.28	.36	.41	.44	.34	.25	.28	.12	.08	.05	.00
0 28	.00	.03	.08	.15	.21	.28	.33	.28	.32	.24	.27	.21	.16	.13	.01	.00
0 29	.00	.06	.12	.17	.12	.17	.22	.27	.21	.24	.18	.13	.09	.06	.03	.00
0 30	.00	.03	.06	.10	.14	.18	.22	.16	.20	.15	.19	.15	.11	.08	.05	.00
0 31	.00	.00	.01	.03	.06	.09	.12	.16	.10	.15	.10	.06	.03	.01	.07	.00
0 32	.00	.07	.06	.06	.07	.09	.12	.05	.10	.05	.11	.08	.05	.04	.02	.00
0 33	.00	.01	-.00	.09	.09	.10	.02	.04	.08	.04	.01	.09	.07	.06	.05	.00
0 34	.00	-.04	.04	.01	-.00	.00	.01	.03	.06	.03	.01	-.01	-.01	-.01	-.01	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

1 DRAWDOWN IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.03	.05	-.04	-.02	.02	.05	-.03	.00	-.04	.00	-.03	.02	-.01	.04	.00
0 3	.00	-.01	.01	.03	.05	-.02	.01	.04	-.02	.04	-.00	-.03	.03	.01	-.01	.00
0 4	.00	.05	-.03	-.00	.02	-.05	-.02	.02	-.03	.03	.00	-.03	.05	.04	.03	.00

0 5	.00	.03	.05	-.02	-.00	.02	-.05	-.01	-.05	.02	.00	-.01	-.02	-.02	-.02	.00
6	.00	.02	.04	-.04	-.02	-.00	-.09	-.05	-.08	-.08	.02	.02	.02	.02	.04	.00
7	.00	.01	.04	.06	-.02	-.02	-.14	-.11	-.12	-.09	.04	.05	.06	.07	-.02	.00
8	.00	.00	.03	.07	-.01	-.02	-.23	-.22	-.21	-.07	-.02	.01	.01	.02	.02	.00
0 9	.00	.07	.03	.09	.15	.10	-.10	-.11	-.08	.05	.07	.08	.08	.09	-.01	.00
0 10	.00	.05	.14	.12	.21	.20	.16	.23	.18	.18	.18	.17	.07	.06	.05	.00
0 11	.00	.11	.13	.15	.28	.30	.40	.60	.44	.32	.19	.17	.15	.15	.06	.00
0 12	.00	.07	.13	.29	.34	.41	.82	1.29	.78	.36	.30	.26	.23	.12	.04	.00
0 13	.00	.13	.23	.32	.41	.51	1.24	3.00	1.23	.50	.41	.34	.20	.18	.08	.00
0 14	.00	.13	.24	.34	.56	.69	1.06	1.50	1.07	.60	.49	.31	.25	.12	.10	.00
0 15	.00	.14	.25	.36	.59	.75	.97	1.06	.98	.78	.54	.35	.19	.15	.02	.00
0 16	.00	.07	.26	.36	.57	.70	.82	.91	.74	.63	.44	.26	.21	.07	.04	.00
0 17	.00	.08	.16	.34	.43	.52	.63	.70	.55	.46	.30	.25	.11	.09	-.02	.00
0 18	.00	.01	.15	.20	.26	.32	.27	.32	.29	.27	.14	.12	.00	-.01	.00	.00
0 19	.00	.01	.03	.06	.10	.01	.00	.02	.03	-.03	-.02	-.02	-.12	-.11	-.07	.00
0 20	.00	.06	.06	-.01	.02	-.07	-.06	-.04	-.02	-.10	-.09	-.08	-.18	-.16	-.11	.00
0 21	.00	-.01	.00	.04	.08	.02	.10	.15	.04	.01	-.01	-.02	-.12	-.10	-.06	.00
0 22	.00	.05	.09	.14	.11	.18	.30	.40	.25	.18	.13	.00	-.01	-.00	.03	.00
0 23	.00	.02	.07	.13	.22	.34	.45	.71	.51	.34	.16	.11	.08	.07	-.02	.00
0 24	.00	.05	.12	.20	.31	.36	.72	1.58	.79	.47	.26	.19	.15	.12	.01	.00
0 25	.00	.08	.16	.15	.26	.39	.63	.90	.59	.41	.31	.24	.20	.16	.03	.00
0 26	.00	.09	.08	.18	.28	.40	.58	.61	.55	.41	.34	.28	.23	.09	.05	.00
0 27	.00	.11	.10	.19	.29	.30	.44	.51	.50	.41	.25	.20	.16	.12	.07	.00
0 28	.00	.05	.13	.20	.19	.27	.36	.40	.41	.28	.24	.21	.18	.14	.01	.00
0 29	.00	.07	.14	.11	.18	.25	.30	.24	.25	.25	.23	.11	.09	.07	.04	.00
0 30	.00	.09	.06	.12	.17	.23	.17	.20	.22	.23	.12	.12	.10	.09	.06	.00
0 31	.00	.03	.08	.13	.07	.11	.15	.18	.20	.11	.12	.12	.12	.01	.00	.00
0 32	.00	.05	.10	.04	.08	.11	.14	.06	.08	.10	.11	.03	.04	.04	.04	.00
0 33	.00	.07	.02	.05	.08	.10	.02	.04	.07	.09	.01	.03	.05	.07	-.01	.00
0 34	.00	.01	.05	.07	-.01	.00	.01	.03	.05	-.01	.01	.03	-.03	.00	.05	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

0DRAWDOWN WILL BE SAVED ON UNIT 40 AT END OF TIME STEP 1, STRESS PERIOD 2

0

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 2

	CUMULATIVE VOLUMES	L**3		RATES FOR THIS TIME STEP	L**3/T	
0	IN:			IN:		
	STORAGE =	.10387E+07		STORAGE =	112.94	
	CONSTANT HEAD =	.31941E+09		CONSTANT HEAD =	.15112E+06	
	WELLS =	.00000		WELLS =	.00000	
	RECHARGE =	.34668E+06		RECHARGE =	77040.	
	TOTAL IN =	.32079E+09		TOTAL IN =	.22827E+06	
0	OUT:			OUT:		
	STORAGE =	.17431E+06		STORAGE =	32365.	
	CONSTANT HEAD =	.17971E+09		CONSTANT HEAD =	.11892E+06	
	WELLS =	.14088E+09		WELLS =	77007.	
	RECHARGE =	.00000		RECHARGE =	.00000	
0	TOTAL OUT =	.32077E+09		TOTAL OUT =	.22830E+06	
0	IN - OUT =	24352.		IN - OUT =	-25.063	
0	PERCENT DISCREPANCY =		.01	PERCENT DISCREPANCY =		-.01

0

TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 2

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	388800.	6480.00	108.000	4.50000	.123203E-01
STRESS PERIOD TIME	388800.	6480.00	108.000	4.50000	.123203E-01
TOTAL SIMULATION TIME	.158069E+09	.263448E+07	43908.0	1829.50	5.00890

1

1 STRESS PERIOD NO. 3, LENGTH = 3.000000

NUMBER OF TIME STEPS = 1

MULTIPLIER FOR DELT = 1.000

INITIAL TIME STEP SIZE = 3.000000

0REUSING WELLS FROM LAST STRESS PERIOD

0

RECHARGE WILL BE READ ON UNIT 18 USING FORMAT: (16F5.2)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 4	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 5	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 6	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 7	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 8	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 9	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.9630	.9630	.0000	.0000
0 10	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 11	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 12	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 13	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 14	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 15	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 16	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 17	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 18	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 19	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 20	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 21	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 22	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 23	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 24	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 25	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 26	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 27	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 28	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 29	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 30	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 31	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 32	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 33	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 34	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 35	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000

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0
     7 ITERATIONS FOR TIME STEP   1 IN STRESS PERIOD   3
0MAXIMUM HEAD CHANGE FOR EACH ITERATION:
0 HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL
 ---------------------------------------------------------------------------------------------------------------------------------
    1.211     (  1,   9, 14)   .3090      (  1, 10, 13)   .6275E-01 (  1, 12, 14)   .2009E-01 (  1,   7, 12)  -.6820E-02 (  1,   9, 10)
  -.2350E-02 (  1,   7, 12)   .6791E-03 (  1, 11, 12)
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0
HEAD/DRAWDOWN PRINTOUT FLAG = 1   TOTAL BUDGET PRINTOUT FLAG = 1   CELL-BY-CELL FLOW TERM FLAG = 0
REUSING PREVIOUS VALUES OF IOFLG

HEAD IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 3

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.55	92.67	92.78	92.89	93.01	93.16	93.28	93.40	93.51	93.62	93.72	93.81	93.88	93.94	94.00
0 3	92.00	92.13	92.26	92.37	92.48	92.60	92.74	92.87	93.00	93.12	93.24	93.34	93.42	93.47	93.50	93.50
0 4	91.60	91.73	91.85	91.97	92.08	92.20	92.34	92.47	92.61	92.75	92.87	92.97	93.04	93.07	93.08	93.10
0 5	91.20	91.33	91.45	91.57	91.68	91.79	91.93	92.08	92.23	92.38	92.51	92.63	92.69	92.69	92.66	92.60
0 6	90.70	90.86	91.00	91.12	91.24	91.35	91.49	91.65	91.82	92.00	92.16	92.30	92.38	92.35	92.24	92.10
0 7	90.20	90.35	90.50	90.62	90.74	90.86	91.01	91.18	91.37	91.59	91.80	92.00	92.13	92.08	91.87	91.60
0 8	89.70	89.88	90.02	90.13	90.24	90.36	90.51	90.69	90.90	91.14	91.41	91.70	92.01	91.95	91.50	91.10
0 9	89.40	89.47	89.56	89.64	89.73	89.84	89.98	90.16	90.37	90.63	90.93	91.37	92.29	92.22	91.13	90.50
0 10	89.00	89.05	89.10	89.14	89.20	89.29	89.42	89.59	89.80	90.05	90.30	90.59	90.91	90.85	90.40	90.00
0 11	88.70	88.67	88.67	88.66	88.66	88.71	88.83	88.98	89.20	89.44	89.66	89.85	89.98	89.95	89.75	89.50
0 12	88.30	88.29	88.25	88.19	88.11	88.07	88.19	88.31	88.59	88.85	89.06	89.21	89.30	89.30	89.21	89.10
0 13	88.00	87.95	87.86	87.72	87.52	87.27	87.54	87.48	87.99	88.30	88.51	88.65	88.73	88.75	88.70	88.60
0 14	87.70	87.63	87.51	87.32	86.95	87.09	87.23	87.34	87.59	87.83	88.02	88.15	88.23	88.27	88.26	88.20
0 15	87.50	87.37	87.23	87.07	86.92	86.91	86.97	87.06	87.22	87.40	87.57	87.69	87.78	87.84	87.87	87.90
0 16	87.30	87.11	86.96	86.83	86.73	86.69	86.70	86.74	86.87	87.02	87.16	87.28	87.36	87.43	87.48	87.50
0 17	87.00	86.81	86.67	86.57	86.49	86.45	86.42	86.39	86.54	86.67	86.79	86.89	86.97	87.05	87.12	87.20
0 18	86.50	86.42	86.34	86.27	86.22	86.18	86.17	86.17	86.25	86.34	86.43	86.51	86.59	86.67	86.76	86.90
0 19	86.00	86.02	86.00	85.96	85.92	85.90	85.88	85.90	85.94	86.01	86.08	86.14	86.20	86.27	86.34	86.40
0 20	85.60	85.61	85.59	85.57	85.55	85.53	85.51	85.52	85.55	85.60	85.66	85.70	85.73	85.77	85.82	85.90
0 21	85.10	85.13	85.13	85.11	85.09	85.05	85.02	85.00	85.03	85.08	85.12	85.16	85.17	85.17	85.16	85.10
0 22	84.70	84.68	84.67	84.64	84.59	84.52	84.45	84.41	84.44	84.51	84.56	84.59	84.60	84.58	84.54	84.50
0 23	84.20	84.23	84.22	84.19	84.11	84.00	83.86	83.72	83.83	83.94	84.01	84.05	84.05	84.02	83.93	83.80
0 24	83.80	83.81	83.80	83.75	83.64	83.50	83.26	82.76	83.22	83.40	83.49	83.53	83.54	83.49	83.39	83.30
0 25	83.50	83.43	83.39	83.31	83.21	83.09	82.93	82.77	82.87	82.96	83.02	83.04	83.04	82.98	82.88	82.80
0 26	83.10	83.04	82.97	82.89	82.80	82.70	82.60	82.52	82.53	82.56	82.58	82.57	82.55	82.48	82.40	82.30
0 27	82.70	82.62	82.55	82.47	82.40	82.32	82.24	82.19	82.17	82.16	82.15	82.13	82.09	82.02	81.95	81.90
0 28	82.20	82.17	82.12	82.05	81.99	81.93	81.87	81.82	81.78	81.76	81.73	81.69	81.64	81.57	81.49	81.40
0 29	81.80	81.74	81.69	81.63	81.58	81.53	81.48	81.43	81.39	81.36	81.32	81.27	81.21	81.14	81.07	81.00
0 30	81.30	81.27	81.24	81.20	81.16	81.12	81.08	81.04	81.00	80.95	80.91	80.85	80.79	80.72	80.65	80.60
0 31	80.80	80.80	80.79	80.77	80.74	80.71	80.68	80.64	80.60	80.55	80.50	80.44	80.37	80.29	80.23	80.20
0 32	80.30	80.33	80.34	80.34	80.33	80.31	80.28	80.25	80.20	80.15	80.09	80.02	79.95	79.86	79.78	79.70
0 33	79.90	79.89	79.90	79.91	79.91	79.90	79.88	79.86	79.82	79.76	79.69	79.61	79.53	79.44	79.35	79.30
0 34	79.40	79.44	79.46	79.49	79.50	79.50	79.49	79.47	79.44	79.37	79.29	79.21	79.11	79.01	78.91	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

1 HEAD IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 3

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.	92.10
0 2	90.90	90.97	91.05	91.14	91.22	91.28	91.35	91.43	91.50	91.54	91.60	91.63	91.68	91.71	91.76	91.80
0 3	90.60	90.71	90.79	90.87	90.95	91.02	91.09	91.16	91.22	91.26	91.30	91.34	91.37	91.39	91.41	91.40
0 4	90.40	90.45	90.53	90.60	90.68	90.75	90.82	90.89	90.94	90.97	91.00	91.03	91.05	91.06	91.08	91.10
0 5	90.10	90.17	90.25	90.33	90.40	90.48	90.55	90.61	90.66	90.68	90.70	90.71	90.72	90.72	90.72	90.70
0 6	89.80	89.88	89.96	90.04	90.12	90.21	90.29	90.35	90.38	90.39	90.39	90.39	90.39	90.38	90.36	90.30
0 7	89.50	89.59	89.66	89.74	89.82	89.92	90.04	90.11	90.13	90.09	90.06	90.05	90.04	90.04	90.02	90.00
0 8	89.20	89.30	89.37	89.43	89.51	89.62	89.83	89.92	89.91	89.77	89.72	89.70	89.69	89.69	89.68	89.70
0 9	89.00	89.03	89.07	89.11	89.15	89.21	89.40	89.51	89.49	89.36	89.34	89.33	89.33	89.32	89.32	89.30
0 10	88.70	88.75	88.77	88.78	88.79	88.80	88.84	88.88	88.92	88.93	88.93	88.94	88.94	88.95	88.96	89.00
0 11	88.50	88.49	88.47	88.45	88.42	88.40	88.31	88.20	88.37	88.49	88.52	88.54	88.56	88.56	88.55	88.50
0 12	88.30	88.23	88.17	88.12	88.06	87.99	87.69	87.22	87.72	88.04	88.10	88.14	88.17	88.18	88.16	88.10
0 13	88.10	87.97	87.87	87.78	87.69	87.59	86.96	85.20	86.98	87.61	87.70	87.76	87.80	87.82	87.82	87.80
0 14	87.80	87.67	87.56	87.46	87.34	87.22	86.84	86.40	86.84	87.20	87.31	87.40	87.45	87.48	87.50	87.50
0 15	87.50	87.36	87.25	87.14	87.01	86.85	86.63	86.54	86.62	86.82	86.96	87.05	87.11	87.15	87.18	87.20
0 16	87.10	87.03	86.94	86.84	86.73	86.60	86.48	86.39	86.46	86.57	86.66	86.74	86.80	86.83	86.86	86.90
0 17	86.80	86.72	86.64	86.57	86.47	86.38	86.27	86.10	86.25	86.34	86.40	86.46	86.49	86.51	86.52	86.50
0 18	86.40	86.39	86.35	86.30	86.24	86.18	86.13	86.08	86.11	86.13	86.16	86.18	86.20	86.21	86.20	86.20
0 19	86.10	86.09	86.07	86.04	86.00	85.99	86.00	85.98	85.97	85.94	85.92	85.92	85.92	85.91	85.87	85.80
0 20	85.70	85.74	85.74	85.71	85.68	85.67	85.66	85.64	85.62	85.60	85.59	85.58	85.58	85.56	85.51	85.40
0 21	85.30	85.31	85.30	85.26	85.22	85.18	85.10	85.05	85.06	85.10	85.11	85.12	85.12	85.10	85.06	85.00
0 22	84.90	84.85	84.81	84.76	84.69	84.62	84.50	84.40	84.45	84.52	84.57	84.60	84.61	84.60	84.	84.50
0 23	84.40	84.38	84.33	84.27	84.18	84.06	83.85	83.59	83.79	83.96	84.04	84.09	84.12	84.13	84.[illegible]	84.10
0 24	84.00	83.95	83.88	83.80	83.69	83.54	83.18	82.32	83.11	83.43	83.54	83.61	83.65	83.68	83.69	83.70
0 25	83.60	83.52	83.44	83.35	83.24	83.11	82.87	82.60	82.81	82.99	83.09	83.16	83.20	83.24	83.27	83.30
0 26	83.20	83.11	83.02	82.92	82.82	82.70	82.51	82.39	82.45	82.59	82.66	82.72	82.77	82.81	82.85	82.90
0 27	82.80	82.69	82.60	82.51	82.41	82.30	82.16	82.09	82.10	82.19	82.25	82.30	82.34	82.38	82.43	82.50
0 28	82.30	82.25	82.17	82.10	82.01	81.93	81.84	81.79	81.79	81.82	81.86	81.89	81.92	81.96	81.99	82.00
0 29	81.90	81.83	81.76	81.69	81.62	81.55	81.50	81.46	81.45	81.45	81.47	81.49	81.51	81.53	81.56	81.60
0 30	81.50	81.41	81.34	81.28	81.23	81.17	81.13	81.10	81.08	81.07	81.08	81.08	81.10	81.11	81.14	81.20
0 31	81.00	80.97	80.92	80.87	80.83	80.79	80.75	80.72	80.70	80.69	80.68	80.68	80.68	80.69	80.70	80.70
0 32	80.60	80.55	80.50	80.46	80.42	80.39	80.36	80.34	80.32	80.30	80.29	80.27	80.26	80.26	80.26	80.30
0 33	80.20	80.13	80.08	80.05	80.02	80.00	79.97	79.96	79.93	79.91	79.89	79.87	79.85	79.83	79.81	79.80
0 34	79.70	79.69	79.65	79.63	79.61	79.60	79.59	79.57	79.55	79.51	79.49	79.47	79.43	79.40	79.35	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

0HEAD WILL BE SAVED ON UNIT 30 AT END OF TIME STEP 1, STRESS PERIOD 3

1 DRAWDOWN IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 3

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.05	.03	.02	.01	-.01	.04	.02	.00	-.01	-.02	-.02	-.01	-.08	-.04	.00
0 3	.00	.07	.04	.03	.02	.10	.06	.03	-.00	-.02	-.04	-.14	-.12	-.07	.00	.00

0 4	.00	.07	.05	.03	.12	.10	.06	.03	-.01	-.05	-.07	-.17	-.14	-.17	-.08	.00
5	.00	.07	.05	.03	.12	.11	.07	.02	-.03	-.08	-.11	-.23	-.29	-.19	-.06	.00
6	.00	.04	.00	.08	.16	.15	.11	.05	-.02	-.10	-.26	-.30	-.38	-.25	-.14	.00
7	.00	.05	.10	.08	.16	.14	.09	.02	-.07	-.19	-.30	-.50	-.53	-.48	-.27	.00
8	.00	.02	.08	.17	.16	.14	.09	.01	-.10	-.24	-.41	-.70	-.91	-.85	-.40	.00
0 9	.00	.03	.14	.16	.27	.26	.22	.14	-.07	-.23	-.43	-.87	-1.69	-1.62	-.53	.00
0 10	.00	.15	.20	.26	.30	.31	.28	.21	.10	-.15	-.30	-.59	-.91	-.85	-.40	.00
0 11	.00	.13	.23	.34	.44	.49	.47	.42	.20	.06	-.16	-.25	-.38	-.35	-.25	.00
0 12	.00	.11	.35	.51	.69	.83	.71	.69	.41	.25	.04	-.11	-.20	-.20	-.11	.00
0 13	.00	.15	.34	.58	.88	1.23	1.06	1.12	.71	.40	.19	.05	-.03	-.05	.00	.00
0 14	.00	.17	.39	.68	1.15	1.01	.97	.86	.71	.47	.28	.15	.07	.03	.04	.00
0 15	.00	.23	.37	.63	.78	.89	.83	.84	.68	.50	.33	.21	.12	.06	.03	.00
0 16	.00	.19	.34	.47	.67	.71	.80	.76	.63	.58	.44	.32	.24	.17	.02	.00
0 17	.00	.09	.33	.43	.51	.65	.68	.81	.66	.53	.41	.31	.23	.15	.08	.00
0 18	.00	.08	.26	.33	.48	.52	.63	.63	.55	.46	.37	.29	.21	.13	.04	.00
0 19	.00	.08	.20	.34	.48	.50	.52	.60	.56	.49	.42	.36	.20	.13	.06	.00
0 20	.00	.09	.21	.33	.45	.47	.49	.58	.55	.50	.44	.30	.27	.13	.08	.00
0 21	.00	.07	.17	.29	.41	.45	.58	.60	.57	.52	.38	.34	.23	.13	.04	.00
0 22	.00	.12	.23	.26	.41	.48	.55	.69	.56	.49	.44	.31	.20	.12	.06	.00
0 23	.00	.07	.18	.31	.39	.50	.64	.78	.67	.56	.39	.35	.25	.18	.07	.00
0 24	.00	.09	.20	.25	.36	.60	.84	1.24	.78	.60	.41	.27	.26	.11	.01	.00
0 25	.00	.07	.11	.29	.39	.51	.67	.83	.63	.54	.38	.26	.16	.12	.02	.00
0 26	.00	.06	.13	.21	.30	.40	.50	.58	.47	.44	.32	.23	.15	.12	.00	.00
0 27	.00	.08	.15	.23	.30	.28	.36	.41	.43	.34	.25	.27	.11	.08	.05	.00
0 28	.00	.03	.08	.15	.21	.27	.33	.28	.32	.24	.27	.21	.16	.13	.01	.00
0 29	.00	.06	.11	.17	.12	.17	.22	.27	.21	.24	.18	.13	.09	.06	.03	.00
0 30	.00	.03	.06	.10	.14	.18	.22	.16	.20	.15	.19	.15	.11	.08	.05	.00
0 31	.00	.00	.01	.03	.06	.09	.12	.16	.10	.15	.10	.06	.03	.01	.07	.00
0 32	.00	.07	.06	.06	.07	.09	.12	.05	.10	.05	.11	.08	.05	.04	.02	.00
0 33	.00	.01	-.00	.09	.09	.10	.02	.04	.08	.04	.01	.09	.07	.06	.05	.00
0 34	.00	-.04	.04	.01	-.00	.00	.01	.03	.06	.03	.01	-.01	-.01	-.01	-.01	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

1 DRAWDOWN IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 3

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.03	.05	-.04	-.02	.02	.05	-.03	.00	-.04	.00	-.03	.02	-.01	.04	.00
0 3	.00	-.01	.01	.03	.05	-.02	.01	.04	-.02	.04	-.00	-.04	.03	.01	-.01	.00
0 4	.00	.05	-.03	-.00	.02	-.05	-.02	.01	-.04	.03	-.00	-.03	.05	.04	.02	.00
0 5	.00	.03	.05	-.03	-.00	.02	-.05	-.01	-.06	.02	.00	-.01	-.02	-.02	-.02	.00
0 6	.00	.02	.04	-.04	-.02	-.01	-.09	-.05	-.08	-.09	.01	.01	.01	.02	.04	.00
0 7	.00	.01	.04	.06	-.02	-.02	-.14	-.11	-.13	-.09	.04	.05	.06	.06	-.02	.00
8	.00	.00	.03	.07	-.01	-.02	-.23	-.22	-.21	-.07	-.02	-.00	.01	.01	.02	.00
9	.00	.07	.03	.09	.15	.09	-.10	-.11	-.09	.04	.06	.07	.07	.08	-.02	.00
10	.00	.05	.13	.12	.21	.20	.16	.22	.18	.17	.17	.16	.06	.05	.04	.00
0 11	.00	.11	.13	.15	.28	.30	.39	.60	.43	.31	.18	.16	.14	.14	.05	.00
0 12	.00	.07	.13	.28	.34	.41	.81	1.28	.78	.36	.30	.26	.23	.12	.04	.00
0 13	.00	.13	.23	.32	.41	.51	1.24	3.00	1.22	.49	.40	.34	.20	.18	.08	.00
0 14	.00	.13	.24	.34	.56	.68	1.06	1.50	1.06	.60	.49	.30	.25	.12	.10	.00
0 15	.00	.14	.25	.36	.59	.75	.97	1.06	.98	.78	.54	.35	.19	.15	.02	.00
0 16	.00	.07	.26	.36	.57	.70	.82	.91	.74	.63	.44	.26	.20	.07	.04	.00
0 17	.00	.08	.16	.33	.43	.52	.63	.70	.55	.46	.30	.24	.11	.09	-.02	.00
0 18	.00	.01	.15	.20	.26	.32	.27	.32	.29	.27	.14	.12	.00	-.01	.00	.00
0 19	.00	.01	.03	.06	.10	.01	.00	.02	.03	-.04	-.02	-.02	-.12	-.11	-.07	.00
0 20	.00	.06	.06	-.01	.02	-.07	-.06	-.04	-.02	-.10	-.09	-.08	-.18	-.16	-.11	.00
0 21	.00	-.01	.00	.04	.08	.02	.10	.15	.04	.00	-.01	-.02	-.12	-.10	-.06	.00
0 22	.00	.05	.09	.14	.11	.18	.30	.40	.25	.18	.13	.00	-.01	-.00	.03	.00
0 23	.00	.02	.07	.13	.22	.34	.45	.71	.51	.34	.16	.11	.08	.07	-.02	.00
0 24	.00	.05	.12	.20	.31	.36	.72	1.58	.79	.47	.26	.19	.15	.12	.01	.00
0 25	.00	.08	.16	.15	.26	.39	.63	.90	.59	.41	.31	.24	.20	.16	.03	.00
0 26	.00	.09	.08	.18	.28	.40	.59	.61	.55	.41	.34	.28	.23	.09	.05	.00
0 27	.00	.11	.10	.19	.29	.30	.44	.51	.50	.41	.25	.20	.16	.12	.07	.00
0 28	.00	.05	.13	.20	.19	.27	.36	.41	.41	.28	.24	.21	.18	.14	.01	.00
0 29	.00	.07	.14	.11	.18	.25	.30	.24	.25	.25	.23	.11	.09	.07	.04	.00
0 30	.00	.09	.06	.12	.17	.23	.17	.20	.22	.23	.12	.12	.10	.09	.06	.00
0 31	.00	.03	.08	.13	.07	.11	.15	.18	.20	.11	.12	.12	.12	.01	.00	.00
0 32	.00	.05	.10	.04	.08	.11	.14	.06	.08	.10	.11	.03	.04	.04	.04	.00
0 33	.00	.07	.02	.05	.08	.10	.03	.04	.07	.09	.01	.03	.05	.07	-.01	.00
0 34	.00	.01	.05	.07	-.01	.00	.01	.03	.05	-.01	.01	.03	-.03	.00	.05	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

0DRAWDOWN WILL BE SAVED ON UNIT 40 AT END OF TIME STEP 1, STRESS PERIOD 3

0

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 3

0 CUMULATIVE VOLUMES L**3 RATES FOR THIS TIME STEP L**3/T

IN: IN:

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                     ---                                                                   ---
                STORAGE =    .10618E+07                                               STORAGE =    7699.9
          CONSTANT HEAD =    .31986E+09                                         CONSTANT HEAD =    .15144E+06
                  WELLS =    .00000                                                     WELLS =    .00000
               RECHARGE =    .57780E+06                                              RECHARGE =    77040.
0              TOTAL IN =    .32150E+09                                              TOTAL IN =    .23618E+06
0               OUT:                                                                  OUT:
                ----                                                                  ----
                STORAGE =    .22940E+06                                               STORAGE =    18363.
          CONSTANT HEAD =    .18013E+09                                         CONSTANT HEAD =    .14083E+06
                  WELLS =    .14112E+09                                                 WELLS =    77007.
               RECHARGE =    .00000                                                  RECHARGE =    .00000
0             TOTAL OUT =    .32148E+09                                             TOTAL OUT =    .23620E+06
0              IN - OUT =    24256.                                                  IN - OUT =   -17.547
0  PERCENT DISCREPANCY =                   .01                            PERCENT DISCREPANCY =                   -.01


0


         TIME SUMMARY AT END OF TIME STEP  1 IN STRESS PERIOD  3
                              SECONDS       MINUTES        HOURS          DAYS          YEARS
                         -----------------------------------------------------------------------
      TIME STEP LENGTH        259200.       4320.00        72.0000        3.00000       .821355E-02
    STRESS PERIOD TIME        259200.       4320.00        72.0000        3.00000       .821355E-02
 TOTAL SIMULATION TIME        .158328E+09   .263880E+07    43980.0        1832.50       5.01711
1
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1                         U.S. GEOLOGICAL SURVEY MODULAR FINITE-DIFFERENCE GROUND-WATER MODEL
0SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     SIMULATION 6 - SIM. 4 W/ LAGOONS, ALT BASIN REC
    2 LAYERS         35 ROWS         16 COLUMNS
   3 STRESS PERIOD(S) IN SIMULATION
 MODEL TIME UNIT IS DAYS
0I/O UNITS:
 ELEMENT OF IUNIT:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
       I/O UNIT: 11 12  0  0  0  0  0 18 19  0  0 22  0  0  0  0  0  0  0  0  0  0  0  0
0BAS1 -- BASIC MODEL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT  1
 ARRAYS RHS AND BUFF WILL SHARE MEMORY.
 START HEAD WILL BE SAVED
    10699 ELEMENTS IN X ARRAY ARE USED BY BAS
    10699 ELEMENTS OF X ARRAY USED OUT OF  100000
0BCF1 -- BLOCK-CENTERED FLOW PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 11
 TRANSIENT SIMULATION
      LAYER  AQUIFER TYPE
      -------------------
          1          1
          2          0
     2242 ELEMENTS IN X ARRAY ARE USED BY BCF
    12941 ELEMENTS OF X ARRAY USED OUT OF  100000
0WEL1 -- WELL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM 12
 MAXIMUM OF     8 WELLS
       32 ELEMENTS IN X ARRAY ARE USED FOR WELLS
    12973 ELEMENTS OF X ARRAY USED OUT OF  100000
0RCH1 -- RECHARGE PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 18
 OPTION 1 -- RECHARGE TO TOP LAYER
      560 ELEMENTS OF X ARRAY USED FOR RECHARGE
    13533 ELEMENTS OF X ARRAY USED OUT OF  100000
0SIP1 -- STRONGLY IMPLICIT PROCEDURE SOLUTION PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 19
 MAXIMUM OF  50 ITERATIONS ALLOWED FOR CLOSURE
  5 ITERATION PARAMETERS
     4685 ELEMENTS IN X ARRAY ARE USED BY SIP
    18218 ELEMENTS OF X ARRAY USED OUT OF  100000
1SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     SIMULATION 6 - SIM. 4 W/ LAGOONS, ALT BASIN REC
0
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BOUNDARY ARRAY FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
0 2	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
3	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
4	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 5	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 6	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 7	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 8	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 9	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 10	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 11	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 12	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 13	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 14	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 15	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 16	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 17	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 18	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 19	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 20	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 21	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 22	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 23	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 24	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 25	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 26	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 27	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 28	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 29	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 30	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 31	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 32	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 33	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 34	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 35	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

0

BOUNDARY ARRAY FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
0 2	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 3	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 4	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 5	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 6	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 7	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 8	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 9	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 10	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 11	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 12	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 13	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 14	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 15	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 16	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 17	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 18	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 19	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 20	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 21	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 22	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 23	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 24	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 25	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 26	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 27	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 28	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 29	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 30	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 31	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 32	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 33	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 34	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 35	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2

0AQUIFER HEAD WILL BE SET TO 999.99 AT ALL NO-FLOW NODES (IBOUND=0).
0

INITIAL HEAD FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.60	92.70	92.80	92.90	93.00	93.20	93.30	93.40	93.50	93.60	93.70	93.80	93.80	93.90	94.00
0 3	92.00	92.20	92.30	92.40	92.50	92.70	92.80	92.90	93.00	93.10	93.20	93.20	93.30	93.40	93.50	93.50
0 4	91.60	91.80	91.90	92.00	92.20	92.30	92.40	92.50	92.60	92.70	92.80	92.80	92.90	92.90	93.00	93.10
0 5	91.20	91.40	91.50	91.60	91.80	91.90	92.00	92.10	92.20	92.30	92.40	92.40	92.40	92.50	92.60	92.60
0 6	90.70	90.90	91.00	91.20	91.40	91.50	91.60	91.70	91.80	91.90	91.90	92.00	92.00	92.10	92.10	92.10
0 7	90.20	90.40	90.60	90.70	90.90	91.00	91.10	91.20	91.30	91.40	91.50	91.50	91.60	91.60	91.60	91.60
0 8	89.70	89.90	90.10	90.30	90.40	90.50	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.10	91.10	91.10
0 9	89.40	89.50	89.70	89.80	90.00	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.60	90.50
0 10	89.00	89.20	89.30	89.40	89.50	89.60	89.70	89.80	89.90	89.90	90.00	90.00	90.00	90.00	90.00	90.00
0 11	88.70	88.80	88.90	89.00	89.10	89.20	89.30	89.40	89.40	89.50	89.50	89.60	89.60	89.60	89.50	89.50
0 12	88.30	88.40	88.60	88.70	88.80	88.90	88.90	89.00	89.00	89.10	89.10	89.10	89.10	89.10	89.10	89.10
0 13	88.00	88.10	88.20	88.30	88.40	88.50	88.60	88.60	88.70	88.70	88.70	88.70	88.70	88.70	88.70	88.60
0 14	87.70	87.80	87.90	88.00	88.10	88.10	88.20	88.20	88.30	88.30	88.30	88.30	88.30	88.30	88.30	88.20
0 15	87.50	87.60	87.60	87.70	87.70	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.90	87.90	87.90	87.90
0 16	87.30	87.30	87.30	87.30	87.40	87.40	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.50	87.50
0 17	87.00	86.90	87.00	87.00	87.00	87.10	87.10	87.20	87.20	87.20						

	87.20	87.20	87.20	87.20	87.20	87.20				
18	86.50	86.50	86.60	86.60	86.70	86.70	86.80	86.80	86.80	86.80
	86.80	86.80	86.80	86.80	86.80	86.90				
19	86.00	86.10	86.20	86.30	86.40	86.40	86.40	86.50	86.50	86.50
	86.50	86.50	86.40	86.40	86.40	86.40				
0 20	85.60	85.70	85.80	85.90	86.00	86.00	86.00	86.10	86.10	86.10
	86.10	86.00	86.00	85.90	85.90	85.90				
0 21	85.10	85.20	85.30	85.40	85.50	85.50	85.60	85.60	85.60	85.60
	85.50	85.50	85.40	85.30	85.20	85.10				
0 22	84.70	84.80	84.90	84.90	85.00	85.00	85.00	85.10	85.00	85.00
	85.00	84.90	84.80	84.70	84.60	84.50				
0 23	84.20	84.30	84.40	84.50	84.50	84.50	84.50	84.50	84.50	84.50
	84.40	84.40	84.30	84.20	84.00	83.80				
0 24	83.80	83.90	84.00	84.00	84.00	84.10	84.10	84.00	84.00	84.00
	83.90	83.80	83.80	83.60	83.40	83.30				
0 25	83.50	83.50	83.50	83.60	83.60	83.60	83.60	83.60	83.50	83.50
	83.40	83.30	83.20	83.10	82.90	82.80				
0 26	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.00	83.00
	82.90	82.80	82.70	82.60	82.40	82.30				
0 27	82.70	82.70	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.50
	82.40	82.40	82.20	82.10	82.00	81.90				
0 28	82.20	82.20	82.20	82.20	82.20	82.20	82.20	82.10	82.10	82.00
	82.00	81.90	81.80	81.70	81.50	81.40				
0 29	81.80	81.80	81.80	81.80	81.70	81.70	81.70	81.70	81.60	81.60
	81.50	81.40	81.30	81.20	81.10	81.00				
0 30	81.30	81.30	81.30	81.30	81.30	81.30	81.30	81.20	81.20	81.10
	81.10	81.00	80.90	80.80	80.70	80.60				
0 31	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.70	80.70
	80.60	80.50	80.40	80.30	80.30	80.20				
0 32	80.30	80.40	80.40	80.40	80.40	80.40	80.40	80.30	80.30	80.20
	80.20	80.10	80.00	79.90	79.80	79.70				
0 33	79.90	79.90	79.90	80.00	80.00	80.00	79.90	79.90	79.90	79.80
	79.70	79.70	79.60	79.50	79.40	79.30				
0 34	79.40	79.40	79.50	79.50	79.50	79.50	79.50	79.50	79.50	79.40
	79.30	79.20	79.10	79.00	78.90	78.80				
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00
	78.90	78.80	78.70	78.60	78.50	78.40				
0										

INITIAL HEAD FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1	2	3	4	5	6	7	8	9	10
	11	12	13	14	15	16				
1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80
	91.90	91.90	92.00	92.00	92.10	92.10				
0 2	90.90	91.00	91.10	91.10	91.20	91.30	91.40	91.40	91.50	91.50
	91.60	91.60	91.70	91.70	91.80	91.80				
0 3	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.20	91.20	91.30
	91.30	91.30	91.40	91.40	91.40	91.40				
0 4	90.40	90.50	90.50	90.60	90.70	90.70	90.80	90.90	90.90	91.00
	91.00	91.00	91.10	91.10	91.10	91.10				
0 5	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.70
	90.70	90.70	90.70	90.70	90.70	90.70				
0 6	89.80	89.90	90.00	90.00	90.10	90.20	90.20	90.30	90.30	90.30
	90.40	90.40	90.40	90.40	90.40	90.30				
0 7	89.50	89.60	89.70	89.80	89.80	89.90	89.90	90.00	90.00	90.00
	90.10	90.10	90.10	90.10	90.00	90.00				
0 8	89.20	89.30	89.40	89.50	89.50	89.60	89.60	89.70	89.70	89.70
	89.70	89.70	89.70	89.70	89.70	89.70				
0 9	89.00	89.10	89.10	89.20	89.30	89.30	89.30	89.40	89.40	89.40
	89.40	89.40	89.40	89.40	89.30	89.30				
0 10	88.70	88.80	88.90	88.90	89.00	89.00	89.00	89.10	89.10	89.10
	89.10	89.10	89.00	89.00	89.00	89.00				
0 11	88.50	88.60	88.60	88.60	88.70	88.70	88.70	88.80	88.80	88.80
	88.70	88.70	88.70	88.70	88.60	88.50				
0 12	88.30	88.30	88.30	88.40	88.40	88.40	88.50	88.50	88.50	88.40
	88.40	88.40	88.40	88.30	88.20	88.10				
0 13	88.10	88.10	88.10	88.10	88.10	88.10	88.20	88.20	88.20	88.10
	88.10	88.10	88.00	88.00	87.90	87.80				
0 14	87.80	87.80	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.80
	87.80	87.70	87.70	87.60	87.60	87.50				
0 15	87.50	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.60
	87.50	87.40	87.30	87.30	87.20	87.20				
0 16	87.10	87.10	87.20	87.20	87.30	87.30	87.30	87.30	87.20	87.20
	87.10	87.00	87.00	86.90	86.90	86.90				
0 17	86.80	86.80	86.80	86.90	86.90	86.90	86.90	86.80	86.80	86.80
	86.70	86.70	86.60	86.60	86.50	86.50				
0 18	86.40	86.40	86.50	86.50	86.50	86.50	86.40	86.40	86.40	86.40
	86.30	86.30	86.20	86.20	86.20	86.20				

0 19	86.10	86.10	86.10	86.10	86.10	86.00	86.00	86.00	86.00	85.90
	85.90	85.90	85.80	85.80	85.80	85.80				
0 20	85.70	85.80	85.80	85.70	85.70	85.60	85.60	85.60	85.60	85.50
	85.50	85.50	85.40	85.40	85.40	85.40				
0 21	85.30	85.30	85.30	85.30	85.30	85.20	85.20	85.20	85.10	85.10
	85.10	85.10	85.00	85.00	85.00	85.00				
0 22	84.90	84.90	84.90	84.90	84.80	84.80	84.80	84.80	84.70	84.70
	84.70	84.60	84.60	84.60	84.60	84.50				
0 23	84.40	84.40	84.40	84.40	84.40	84.40	84.30	84.30	84.30	84.30
	84.20	84.20	84.20	84.20	84.10	84.10				
0 24	84.00	84.00	84.00	84.00	84.00	83.90	83.90	83.90	83.90	83.90
	83.80	83.80	83.80	83.80	83.70	83.70				
0 25	83.60	83.60	83.60	83.50	83.50	83.50	83.50	83.50	83.40	83.40
	83.40	83.40	83.40	83.40	83.30	83.30				
0 26	83.20	83.20	83.10	83.10	83.10	83.10	83.10	83.00	83.00	83.00
	83.00	83.00	83.00	82.90	82.90	82.90				
0 27	82.80	82.80	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.60
	82.50	82.50	82.50	82.50	82.50	82.50				
0 28	82.30	82.30	82.30	82.30	82.20	82.20	82.20	82.20	82.20	82.10
	82.10	82.10	82.10	82.10	82.00	82.00				
0 29	81.90	81.90	81.90	81.80	81.80	81.80	81.80	81.70	81.70	81.70
	81.70	81.60	81.60	81.60	81.60	81.60				
0 30	81.50	81.50	81.40	81.40	81.40	81.40	81.30	81.30	81.30	81.30
	81.20	81.20	81.20	81.20	81.20	81.20				
0 31	81.00	81.00	81.00	81.00	80.90	80.90	80.90	80.90	80.90	80.80
	80.80	80.80	80.80	80.70	80.70	80.70				
0 32	80.60	80.60	80.60	80.50	80.50	80.50	80.50	80.40	80.40	80.40
	80.40	80.30	80.30	80.30	80.30	80.30				
0 33	80.20	80.20	80.10	80.10	80.10	80.10	80.00	80.00	80.00	80.00
	79.90	79.90	79.90	79.90	79.80	79.80				
0 34	79.70	79.70	79.70	79.70	79.60	79.60	79.60	79.60	79.60	79.50
	79.50	79.50	79.40	79.40	79.40	79.30				
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10
	79.10	79.10	79.00	79.00	78.90	78.90				

0HEAD PRINT FORMAT IS FORMAT NUMBER 4 DRAWDOWN PRINT FORMAT IS FORMAT NUMBER 9
0HEADS WILL BE SAVED ON UNIT 30 DRAWDOWNS WILL BE SAVED ON UNIT 40
0OUTPUT CONTROL IS SPECIFIED EVERY TIME STEP
0 COLUMN TO ROW ANISOTROPY = 1.000000
0 DELR = 200.0000
0 DELC = 200.0000
0 PRIMARY STORAGE COEF = .8360000E-01 FOR LAYER 1
0

HYD. COND. ALONG ROWS FOR LAYER 1 WILL BE READ ON UNIT 11 USING FORMAT: (16F4.0)

	1 11	2 12	3 13	4 14	5 15	6 16	7	8	9	10
0 1	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 2	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 3	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 4	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 5	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 6	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 7	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 8	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	225.0	225.0	225.0	300.0				
0 9	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	225.0	225.0	225.0	300.0				
0 10	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	225.0	225.0	225.0	300.0				
0 11	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 12	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 13	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 14	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 15	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 16	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
	250.0	250.0	250.0	250.0	250.0	300.0				

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 17	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
18	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 19	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 20	300.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	300.0
0 21	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 22	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 23	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 24	300.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 25	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 26	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 27	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 28	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 29	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 30	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 31	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 32	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 33	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 34	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 35	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0

0 BOTTOM = 30.00000 FOR LAYER 1
0 VERT HYD COND /THICKNESS = .1000000E-02 FOR LAYER 1
0 PRIMARY STORAGE COEF = .1750000 FOR LAYER 2
0

TRANSMIS. ALONG ROWS FOR LAYER 2 WILL BE READ ON UNIT 11 USING FORMAT: (16F5.0)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 2	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 3	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 4	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 5	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 6	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 7	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 8	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 9	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 10	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 11	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 12	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 13	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 14	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 15	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 16	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 17	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 18	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 19	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 20	4000.	4000.	4000.	4000.	4000.	4000.	1500.	1500.	1500.	4000.	4000.	4000.	4000.	4000.	4000.	4000.
0 21	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 22	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 23	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 24	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 25	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 26	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 27	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 28	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 29	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 30	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 31	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 32	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 33	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 34	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 35	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.

0

SOLUTION BY THE STRONGLY IMPLICIT PROCEDURE

---

0 MAXIMUM ITERATIONS ALLOWED FOR CLOSURE = 50

ACCELERATION PARAMETER = 1.0000

HEAD CHANGE CRITERION FOR CLOSURE = .10000E-02

SIP HEAD CHANGE PRINTOUT INTERVAL = 1

0 CALCULATE ITERATION PARAMETERS FROM MODEL CALCULATED WSEED

1 STRESS PERIOD NO. 1, LENGTH = 1825.000

NUMBER OF TIME STEPS = 1

MULTIPLIER FOR DELT = 1.000

INITIAL TIME STEP SIZE = 1825.000

0 8 WELLS

LAYER	ROW	COL	STRESS RATE	WELL NO.
1	14	5	-14439.	1
1	13	6	-13476.	2
1	13	8	-14439.	3
1	17	8	-4813.0	4
1	24	8	-15401.	5
2	13	8	-4813.0	6
2	17	8	-4813.0	7
2	24	8	-4813.0	8

0

RECHARGE WILL BE READ ON UNIT 18 USING FORMAT: (16F5.2)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000

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0  4   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
   5   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0  6   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0  7   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0  8   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0  9   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 10   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 11   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 12   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 13   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 14   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 15   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 16   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 17   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 18   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 19   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 20   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 21   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 22   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 23   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 24   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 25   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
  26   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
  27   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 28   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 29   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 30   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 31   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 32   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 33   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 34   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0 35   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000   .0000
       .0000   .0000   .0000   .0000   .0000   .0000
0AVERAGE SEED =   .00187924
 MINIMUM SEED =   .00055600
0
    5 ITERATION PARAMETERS CALCULATED FROM AVERAGE SEED:

           .0000000E+00   .7917928E+00   .9566497E+00   .9909742E+00   .9981208E+00
0
    10 ITERATIONS FOR TIME STEP   1 IN STRESS PERIOD  1
0MAXIMUM HEAD CHANGE FOR EACH ITERATION:
0 HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL
 ------------------------------------------------------------------------------------------------------------------------------------
   -2.328     (  2, 13,  8)  -.3493     (  2, 14,  7)  -.3448     (  1, 14,  7)  -.2319     (  1, 14,  9)  -.5752E-01 (  1, 23, 10)
    .8549E-02 (  2, 21,  7)   .7555E-02 (  1, 11,  9)   .5426E-02 (  1, 14,  8)   .3369E-02 (  1, 13,  7)   .8121E-03 (  1, 22,  9)
0
0HEAD/DRAWDOWN PRINTOUT FLAG = 1     TOTAL BUDGET PRINTOUT FLAG = 1     CELL-BY-CELL FLOW TERM FLAG = 0
0OUTPUT FLAGS FOR EACH LAYER:
           HEAD     DRAWDOWN  HEAD   DRAWDOWN
 LAYER   PRINTOUT   PRINTOUT  SAVE     SAVE
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```
  1       1          1       1       1
  2       1          1       1       1
1                    HEAD IN LAYER   1 AT END OF TIME STEP  1 IN STRESS PERIOD  1
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	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.55	92.66	92.77	92.87	92.98	93.12	93.23	93.34	93.44	93.54	93.65	93.74	93.83	93.92	94.00
0 3	92.00	92.13	92.24	92.34	92.44	92.54	92.66	92.77	92.88	92.98	93.08	93.19	93.28	93.36	93.44	93.50
0 4	91.60	91.71	91.82	91.92	92.01	92.11	92.22	92.32	92.42	92.52	92.62	92.72	92.82	92.90	92.99	93.10
0 5	91.20	91.31	91.42	91.52	91.60	91.68	91.77	91.87	91.97	92.07	92.16	92.26	92.35	92.43	92.52	92.60
0 6	90.70	90.84	90.96	91.06	91.14	91.21	91.30	91.39	91.49	91.59	91.68	91.79	91.89	91.97	92.04	92.10
0 7	90.20	90.33	90.45	90.54	90.63	90.70	90.79	90.88	90.98	91.09	91.19	91.30	91.43	91.51	91.57	91.60
0 8	89.70	89.86	89.96	90.05	90.12	90.19	90.27	90.37	90.47	90.58	90.68	90.79	90.91	91.00	91.06	91.10
0 9	89.40	89.45	89.50	89.56	89.61	89.67	89.75	89.84	89.95	90.06	90.16	90.27	90.36	90.44	90.49	90.50
0 10	89.00	89.03	89.05	89.06	89.08	89.13	89.20	89.29	89.41	89.54	89.64	89.74	89.83	89.91	89.96	90.00
0 11	88.70	88.65	88.62	88.58	88.56	88.57	88.63	88.72	88.87	89.02	89.15	89.25	89.34	89.42	89.47	89.50
0 12	88.30	88.27	88.21	88.12	88.02	87.95	88.02	88.09	88.32	88.52	88.68	88.80	88.89	88.97	89.04	89.10
0 13	88.00	87.93	87.82	87.66	87.44	87.16	87.40	87.30	87.78	88.05	88.23	88.36	88.46	88.54	88.59	88.60
0 14	87.70	87.62	87.48	87.27	86.89	87.00	87.12	87.20	87.43	87.65	87.82	87.94	88.05	88.13	88.19	88.20
0 15	87.50	87.36	87.20	87.03	86.86	86.84	86.88	86.95	87.10	87.27	87.43	87.55	87.66	87.74	87.82	87.90
0 16	87.30	87.10	86.94	86.80	86.69	86.63	86.63	86.66	86.78	86.92	87.06	87.18	87.28	87.37	87.45	87.50
0 17	87.00	86.80	86.65	86.54	86.45	86.40	86.37	86.32	86.47	86.60	86.71	86.82	86.91	87.00	87.10	87.20
0 18	86.50	86.41	86.32	86.25	86.19	86.14	86.12	86.13	86.20	86.28	86.37	86.46	86.55	86.63	86.74	86.90
0 19	86.00	86.02	85.99	85.94	85.90	85.87	85.85	85.86	85.90	85.97	86.04	86.11	86.17	86.24	86.	86.40
0 20	85.60	85.60	85.58	85.56	85.53	85.51	85.49	85.49	85.52	85.57	85.63	85.68	85.71	85.75	85.[illegible]	85.90
0 21	85.10	85.13	85.12	85.10	85.07	85.03	85.00	84.98	85.01	85.05	85.10	85.14	85.15	85.16	85.15	85.10
0 22	84.70	84.68	84.67	84.64	84.58	84.51	84.44	84.39	84.43	84.49	84.55	84.58	84.59	84.58	84.54	84.50
0 23	84.20	84.23	84.22	84.19	84.10	83.99	83.85	83.71	83.82	83.93	84.00	84.04	84.05	84.01	83.93	83.80
0 24	83.80	83.81	83.80	83.74	83.64	83.49	83.26	82.75	83.21	83.40	83.49	83.53	83.53	83.49	83.39	83.30
0 25	83.50	83.43	83.39	83.31	83.21	83.08	82.93	82.77	82.87	82.96	83.02	83.04	83.03	82.98	82.88	82.80
0 26	83.10	83.04	82.97	82.89	82.80	82.70	82.60	82.52	82.53	82.55	82.57	82.57	82.54	82.48	82.40	82.30
0 27	82.70	82.62	82.55	82.47	82.39	82.32	82.24	82.19	82.16	82.16	82.15	82.12	82.08	82.02	81.95	81.90
0 28	82.20	82.17	82.12	82.05	81.99	81.92	81.87	81.82	81.78	81.76	81.73	81.69	81.64	81.57	81.49	81.40
0 29	81.80	81.74	81.68	81.63	81.58	81.53	81.48	81.43	81.39	81.36	81.32	81.27	81.21	81.14	81.07	81.00
0 30	81.30	81.27	81.24	81.20	81.16	81.12	81.08	81.04	81.00	80.95	80.91	80.85	80.79	80.72	80.65	80.60
0 31	80.80	80.80	80.79	80.77	80.74	80.71	80.68	80.64	80.60	80.55	80.50	80.44	80.37	80.29	80.23	80.20
0 32	80.30	80.33	80.34	80.34	80.33	80.31	80.28	80.25	80.20	80.15	80.09	80.02	79.95	79.86	79.78	79.70
0 33	79.90	79.89	79.90	79.91	79.91	79.90	79.88	79.85	79.82	79.76	79.69	79.61	79.53	79.44	79.35	79.30
0 34	79.40	79.44	79.46	79.49	79.50	79.50	79.49	79.47	79.44	79.37	79.29	79.21	79.11	79.01	78.91	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

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1                    HEAD IN LAYER   2 AT END OF TIME STEP  1 IN STRESS PERIOD  1
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	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	92.10
0 2	90.90	90.97	91.05	91.14	91.22	91.27	91.35	91.43	91.50	91.54	91.59	91.63	91.68	91.71	91.76	91.80
0 3	90.60	90.70	90.79	90.87	90.95	91.02	91.09	91.15	91.21	91.26	91.30	91.33	91.36	91.39	91.41	91.40
0 4	90.40	90.45	90.52	90.60	90.68	90.75	90.82	90.88	90.93	90.96	90.99	91.02	91.04	91.06	91.07	91.10
0 5	90.10	90.17	90.25	90.32	90.40	90.48	90.55	90.61	90.65	90.67	90.69	90.70	90.71	90.71	90.71	90.70
0 6	89.80	89.88	89.96	90.04	90.12	90.20	90.28	90.34	90.37	90.37	90.37	90.37	90.37	90.37	90.35	90.30
0 7	89.50	89.59	89.66	89.74	89.82	89.92	90.03	90.10	90.11	90.07	90.05	90.03	90.03	90.02	90.02	90.00
0 8	89.20	89.30	89.36	89.43	89.50	89.61	89.82	89.91	89.90	89.75	89.70	89.68	89.67	89.67	89.68	89.70
0 9	89.00	89.03	89.07	89.11	89.15	89.20	89.39	89.50	89.47	89.34	89.32	89.31	89.31	89.31	89.31	89.30
0 10	88.70	88.74	88.76	88.78	88.79	88.80	88.84	88.87	88.91	88.91	88.91	88.92	88.93	88.94	88.95	89.00
0 11	88.50	88.49	88.47	88.45	88.42	88.40	88.30	88.19	88.35	88.47	88.50	88.53	88.54	88.55	88.54	88.50
0 12	88.30	88.23	88.17	88.11	88.06	87.99	87.68	87.21	87.72	88.03	88.09	88.13	88.16	88.17	88.16	88.10
0 13	88.10	87.97	87.87	87.78	87.69	87.59	86.96	85.20	86.97	87.60	87.69	87.75	87.80	87.82	87.82	87.80
0 14	87.80	87.67	87.56	87.46	87.34	87.21	86.84	86.40	86.83	87.20	87.31	87.39	87.44	87.48	87.49	87.50
0 15	87.50	87.36	87.25	87.14	87.01	86.85	86.63	86.54	86.62	86.82	86.96	87.05	87.11	87.15	87.18	87.20
0 16	87.10	87.03	86.94	86.84	86.73	86.60	86.48	86.39	86.46	86.56	86.66	86.74	86.79	86.83	86.86	86.90
0 17	86.80	86.72	86.64	86.56	86.47	86.38	86.27	86.10	86.25	86.34	86.40	86.45	86.49	86.51	86.52	86.50
0 18	86.40	86.39	86.35	86.30	86.24	86.18	86.13	86.08	86.11	86.13	86.16	86.18	86.20	86.20	86.20	86.20
0 19	86.10	86.09	86.07	86.04	86.00	85.99	86.00	85.98	85.97	85.93	85.92	85.92	85.92	85.91	85.87	85.80
0 20	85.70	85.74	85.74	85.71	85.68	85.67	85.66	85.64	85.62	85.60	85.59	85.58	85.58	85.56	85.51	85.40
0 21	85.30	85.31	85.30	85.26	85.22	85.18	85.10	85.05	85.06	85.10	85.11	85.12	85.12	85.10	85.06	85.00
22	84.90	84.85	84.81	84.76	84.69	84.62	84.50	84.40	84.45	84.53	84.57	84.60	84.61	84.60	84.57	84.50
0 23	84.40	84.38	84.33	84.27	84.18	84.07	83.85	83.59	83.80	83.96	84.04	84.09	84.12	84.13	84.12	84.10
0 24	84.00	83.95	83.88	83.80	83.69	83.54	83.18	82.32	83.12	83.43	83.54	83.61	83.65	83.68	83.69	83.70
0 25	83.60	83.52	83.44	83.35	83.24	83.11	82.87	82.60	82.81	82.99	83.09	83.16	83.20	83.24	83.27	83.30
0 26	83.20	83.11	83.02	82.92	82.82	82.70	82.52	82.39	82.45	82.59	82.66	82.72	82.77	82.81	82.85	82.90
0 27	82.80	82.69	82.60	82.51	82.41	82.30	82.16	82.09	82.10	82.19	82.25	82.30	82.34	82.38	82.43	82.50
0 28	82.30	82.25	82.17	82.10	82.01	81.93	81.84	81.80	81.79	81.82	81.86	81.89	81.93	81.96	81.99	82.00
0 29	81.90	81.83	81.76	81.69	81.62	81.56	81.50	81.46	81.45	81.45	81.47	81.49	81.51	81.53	81.56	81.60
0 30	81.50	81.41	81.34	81.28	81.23	81.17	81.13	81.10	81.08	81.07	81.08	81.08	81.10	81.11	81.14	81.20
0 31	81.00	80.97	80.92	80.87	80.83	80.79	80.75	80.72	80.70	80.69	80.68	80.68	80.68	80.69	80.70	80.70
0 32	80.60	80.55	80.50	80.46	80.42	80.39	80.36	80.34	80.32	80.30	80.29	80.27	80.26	80.26	80.26	80.30
0 33	80.20	80.13	80.08	80.05	80.02	80.00	79.98	79.96	79.93	79.91	79.89	79.87	79.85	79.83	79.81	79.80
0 34	79.70	79.69	79.65	79.63	79.61	79.60	79.59	79.57	79.55	79.51	79.49	79.47	79.43	79.40	79.35	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

OHEAD WILL BE SAVED ON UNIT 30 AT END OF TIME STEP 1, STRESS PERIOD 1
1 DRAWDOWN IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.05	.04	.03	.03	.02	.08	.07	.06	.06	.06	.05	.06	-.03	-.02	.00
0 3	.00	.07	.06	.06	.06	.16	.14	.13	.12	.12	.12	.01	.02	.04	.06	.00

0 4	.00	.09	.08	.08	.19	.19	.18	.18	.18	.18	.18	.08	.08	-.00	.01	.00
0 5	.00	.09	.08	.08	.20	.22	.23	.23	.23	.23	.24	.14	.05	.07	.08	.00
0 6	.00	.06	.04	.14	.26	.29	.30	.31	.31	.31	.22	.21	.11	.13	.06	.00
0 7	.00	.07	.15	.16	.27	.30	.31	.32	.32	.31	.31	.20	.17	.09	.03	.00
0 8	.00	.04	.14	.25	.28	.31	.33	.33	.33	.32	.32	.21	.19	.10	.04	.00
0 9	.00	.05	.20	.24	.39	.43	.45	.46	.35	.34	.34	.23	.24	.16	.11	.00
0 10	.00	.17	.25	.34	.42	.47	.50	.51	.49	.36	.36	.26	.17	.09	.04	.00
0 11	.00	.15	.28	.42	.54	.63	.67	.68	.53	.48	.35	.35	.26	.18	.03	.00
0 12	.00	.13	.39	.58	.78	.95	.88	.91	.68	.58	.42	.30	.21	.13	.06	.00
0 13	.00	.17	.38	.64	.96	1.34	1.20	1.30	.92	.65	.47	.34	.24	.16	.11	.00
0 14	.00	.18	.42	.73	1.21	1.10	1.08	1.00	.87	.65	.48	.36	.25	.17	.11	.00
0 15	.00	.24	.40	.67	.84	.96	.92	.95	.80	.63	.47	.35	.24	.16	.08	.00
0 16	.00	.20	.36	.50	.71	.77	.87	.84	.72	.68	.54	.42	.32	.23	.05	.00
0 17	.00	.10	.35	.46	.55	.70	.73	.88	.73	.60	.49	.38	.29	.20	.10	.00
0 18	.00	.09	.28	.35	.51	.56	.68	.67	.60	.52	.43	.34	.25	.17	.06	.00
0 19	.00	.08	.21	.36	.50	.53	.55	.64	.60	.53	.46	.39	.23	.16	.08	.00
0 20	.00	.10	.22	.34	.47	.49	.51	.61	.58	.53	.47	.32	.29	.15	.09	.00
0 21	.00	.07	.18	.30	.43	.47	.60	.62	.59	.55	.40	.36	.25	.14	.05	.00
0 22	.00	.12	.23	.26	.42	.49	.56	.71	.57	.51	.45	.32	.21	.12	.06	.00
0 23	.00	.07	.18	.31	.40	.51	.65	.79	.68	.57	.40	.36	.25	.19	.07	.00
0 24	.00	.09	.20	.26	.36	.61	.84	1.25	.79	.60	.41	.27	.27	.11	.01	.00
0 25	.00	.07	.11	.29	.39	.52	.67	.83	.63	.54	.38	.26	.17	.12	.02	.00
0 26	.00	.06	.13	.21	.30	.40	.50	.58	.47	.45	.33	.23	.16	.12	.00	.00
0 27	.00	.08	.15	.23	.31	.28	.36	.41	.44	.34	.25	.28	.12	.08	.05	.00
0 28	.00	.03	.08	.15	.21	.28	.33	.28	.32	.24	.27	.21	.16	.13	.01	.00
0 29	.00	.06	.12	.17	.12	.17	.22	.27	.21	.24	.18	.13	.09	.06	.03	.00
0 30	.00	.03	.06	.10	.14	.18	.22	.16	.20	.15	.19	.15	.11	.08	.05	.00
0 31	.00	.00	.01	.03	.06	.09	.12	.16	.10	.15	.10	.06	.03	.01	.07	.00
0 32	.00	.07	.06	.06	.07	.09	.12	.05	.10	.05	.11	.08	.05	.04	.02	.00
0 33	.00	.01	-.00	.09	.09	.10	.02	.05	.08	.04	.01	.09	.07	.06	.05	.00
0 34	.00	-.04	.04	.01	-.00	.00	.01	.03	.06	.03	.01	-.01	-.01	-.01	-.01	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

1 DRAWDOWN IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.03	.05	-.04	-.02	.03	.05	-.03	.00	-.04	.01	-.03	.02	-.01	.04	.00
0 3	.00	-.00	.01	.03	.05	-.02	.01	.05	-.01	.04	.00	-.03	.04	.01	-.01	.00
0 4	.00	.05	-.02	-.00	.02	-.05	-.02	.02	-.03	.04	.01	-.02	.06	.04	.03	.00
0 5	.00	.03	.05	-.02	.00	.02	-.05	-.01	-.05	.03	.01	.00	-.01	-.01	-.01	.00
0 6	.00	.02	.04	-.04	-.02	.00	-.08	-.04	-.07	-.07	.03	.03	.03	.03	.05	.00
0 7	.00	.01	.04	.06	-.02	-.02	-.13	-.10	-.11	-.07	.05	.07	.07	.08	-.02	.00
0 8	.00	.00	.04	.07	-.00	-.01	-.22	-.21	-.20	-.05	.00	.02	.03	.03	.02	.00
0 9	.00	.07	.03	.09	.15	.10	-.09	-.10	-.07	.06	.08	.09	.09	.09	-.01	.00
0 10	.00	.06	.14	.12	.21	.20	.16	.23	.19	.19	.19	.18	.07	.06	.05	.00
0 11	.00	.11	.13	.15	.28	.30	.40	.61	.45	.33	.20	.17	.16	.15	.06	.00
0 12	.00	.07	.13	.29	.34	.41	.82	1.29	.78	.37	.31	.27	.24	.13	.04	.00
0 13	.00	.13	.23	.32	.41	.51	1.24	3.00	1.23	.50	.41	.35	.20	.18	.08	.00
0 14	.00	.13	.24	.34	.56	.69	1.06	1.50	1.07	.60	.49	.31	.26	.12	.11	.00
0 15	.00	.14	.25	.36	.59	.75	.97	1.06	.98	.78	.54	.35	.19	.15	.02	.00
0 16	.00	.07	.26	.36	.57	.70	.82	.91	.74	.64	.44	.26	.21	.07	.04	.00
0 17	.00	.08	.16	.34	.43	.52	.63	.70	.55	.46	.30	.25	.11	.09	-.02	.00
0 18	.00	.01	.15	.20	.26	.32	.27	.32	.29	.27	.14	.12	.00	-.00	.00	.00
0 19	.00	.01	.03	.06	.10	.01	.00	.02	.03	-.03	-.02	-.02	-.12	-.11	-.07	.00
0 20	.00	.06	.06	-.01	.02	-.07	-.06	-.04	-.02	-.10	-.09	-.08	-.18	-.16	-.11	.00
0 21	.00	-.01	.00	.04	.08	.02	.10	.15	.04	.00	-.01	-.02	-.12	-.10	-.06	.00
0 22	.00	.05	.09	.14	.11	.18	.30	.40	.25	.17	.13	.00	-.01	-.00	.03	.00
0 23	.00	.02	.07	.13	.22	.33	.45	.71	.50	.34	.16	.11	.08	.07	-.02	.00
0 24	.00	.05	.12	.20	.31	.36	.72	1.58	.78	.47	.26	.19	.15	.12	.01	.00
0 25	.00	.08	.16	.15	.26	.39	.63	.90	.59	.41	.31	.24	.20	.16	.03	.00
0 26	.00	.09	.08	.18	.28	.40	.58	.61	.55	.41	.34	.28	.23	.09	.05	.00
0 27	.00	.11	.10	.19	.29	.30	.44	.51	.50	.41	.25	.20	.16	.12	.07	.00
0 28	.00	.05	.13	.20	.19	.27	.36	.40	.41	.28	.24	.21	.17	.14	.01	.00
0 29	.00	.07	.14	.11	.18	.24	.30	.24	.25	.25	.23	.11	.09	.07	.04	.00
0 30	.00	.09	.06	.12	.17	.23	.17	.20	.22	.23	.12	.12	.10	.09	.06	.00
0 31	.00	.03	.08	.13	.07	.11	.15	.18	.20	.11	.12	.12	.12	.01	.00	.00
0 32	.00	.05	.10	.04	.08	.11	.14	.06	.08	.10	.11	.03	.04	.04	.04	.00
0 33	.00	.07	.02	.05	.08	.10	.02	.04	.07	.09	.01	.03	.05	.07	-.01	.00
0 34	.00	.01	.05	.07	-.01	.00	.01	.03	.05	-.01	.01	.03	-.03	.00	.05	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

0DRAWDOWN WILL BE SAVED ON UNIT 40 AT END OF TIME STEP 1, STRESS PERIOD 1
0

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 1

0 CUMULATIVE VOLUMES L**3 RATES FOR THIS TIME STEP L**3/T

IN: IN:

STORAGE =	.10382E+07
CONSTANT HEAD =	.31873E+09
WELLS =	.00000
RECHARGE =	.00000
0 TOTAL IN =	.31977E+09
0 OUT:	

STORAGE =	28668.
CONSTANT HEAD =	.17918E+09
WELLS =	.14054E+09
RECHARGE =	.00000
0 TOTAL OUT =	.31974E+09
0 IN - OUT =	24448.
0 PERCENT DISCREPANCY =	.01

STORAGE =	568.87
CONSTANT HEAD =	.17465E+06
WELLS =	.00000
RECHARGE =	.00000
TOTAL IN =	.17521E+06
OUT:	

STORAGE =	15.708
CONSTANT HEAD =	98179.
WELLS =	77007.
RECHARGE =	.00000
TOTAL OUT =	.17520E+06
IN - OUT =	13.391
PERCENT DISCREPANCY =	.01

0

TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 1

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	.157680E+09	.262800E+07	43800.0	1825.00	4.99658
STRESS PERIOD TIME	.157680E+09	.262800E+07	43800.0	1825.00	4.99658
TOTAL SIMULATION TIME	.157680E+09	.262800E+07	43800.0	1825.00	4.99658

1
1 STRESS PERIOD NO. 2, LENGTH = 4.500000

NUMBER OF TIME STEPS = 1

MULTIPLIER FOR DELT = 1.000

INITIAL TIME STEP SIZE = 4.500000

0REUSING WELLS FROM LAST STRESS PERIOD
0

RECHARGE WILL BE READ ON UNIT 18 USING FORMAT: (16F5.2)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 4	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 5	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 6	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.5610	.0000	.0000	.0000
0 7	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.5610	.0000	.0000	.0000	.0000
0 8	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.1200	.0000	.0000	.5610	.0000	.0000	.0000	.0000	.0000
0 9	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.1200	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 10	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 11	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 12	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 13	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 14	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 15	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 16	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 17	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 18	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 19	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 20	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 21	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 22	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 23	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 24	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 25	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 26	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 27	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 28	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 29	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 30	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 31	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 32	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 33	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 34	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 35	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000

0

8 ITERATIONS FOR TIME STEP 1 IN STRESS PERIOD 2

0MAXIMUM HEAD CHANGE FOR EACH ITERATION:

HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL
.6573	(1, 8, 11)	.4087	(1, 7, 12)	.2091	(1, 7, 10)	.5969E-01	(1, 10, 8)	.1132E-01	(1, 16, 12)
.2290E-02	(1, 12, 14)	-.2046E-02	(1, 11, 8)	-.8918E-03	(1, 11, 7)				

0

0HEAD/DRAWDOWN PRINTOUT FLAG = 1 TOTAL BUDGET PRINTOUT FLAG = 1 CELL-BY-CELL FLOW TERM FLAG = 0

REUSING PREVIOUS VALUES OF IOFLG

1 HEAD IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.55	92.67	92.78	92.89	93.01	93.16	93.29	93.40	93.52	93.63	93.74	93.82	93.89	93.95	94.00
0 3	92.00	92.13	92.26	92.37	92.48	92.61	92.75	92.89	93.02	93.15	93.27	93.38	93.46	93.50	93.51	93.50
0 4	91.60	91.73	91.85	91.97	92.08	92.20	92.35	92.50	92.65	92.80	92.94	93.07	93.14	93.13	93.11	93.10
0 5	91.20	91.33	91.46	91.58	91.69	91.81	91.96	92.12	92.29	92.47	92.65	92.82	92.91	92.80	92.69	92.60
0 6	90.70	90.86	91.00	91.13	91.25	91.37	91.54	91.72	91.92	92.15	92.41	92.67	92.88	92.48	92.27	92.10
0 7	90.20	90.35	90.50	90.63	90.75	90.90	91.08	91.30	91.52	91.81	92.18	92.59	92.27	92.01	91.80	91.60
0 8	89.70	89.88	90.02	90.14	90.25	90.40	90.61	90.91	91.09	91.39	91.96	91.76	91.59	91.42	91.25	91.10
0 9	89.40	89.47	89.56	89.64	89.74	89.87	90.05	90.29	90.58	90.72	90.93	90.93	90.86	90.76	90.64	90.50
0 10	89.00	89.05	89.10	89.14	89.20	89.30	89.45	89.64	89.84	90.01	90.14	90.19	90.18	90.14	90.07	90.00
0 11	88.70	88.67	88.66	88.65	88.66	88.71	88.82	88.97	89.17	89.35	89.48	89.55	89.58	89.58	89.55	89.50
0 12	88.30	88.29	88.25	88.18	88.10	88.06	88.17	88.28	88.53	88.75	88.91	89.01	89.06	89.09	89.09	89.10
0 13	88.00	87.95	87.85	87.71	87.51	87.25	87.51	87.44	87.93	88.21	88.39	88.50	88.58	88.62	88.63	88.60
0 14	87.70	87.63	87.50	87.30	86.94	87.07	87.20	87.30	87.54	87.76	87.93	88.05	88.13	88.19	88.21	88.20
0 15	87.50	87.37	87.22	87.06	86.90	86.89	86.94	87.02	87.18	87.35	87.51	87.62	87.71	87.79	87.84	87.90
0 16	87.30	87.11	86.96	86.82	86.72	86.67	86.67	86.71	86.83	86.97	87.11	87.23	87.32	87.40	87.46	87.50

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 17	87.00	86.80	86.66	86.56	86.48	86.43	86.40	86.36	86.51	86.64	86.75	86.85	86.94	87.03	87.11	87.20
18	86.50	86.42	86.33	86.26	86.20	86.17	86.15	86.15	86.23	86.31	86.40	86.49	86.57	86.65	86.75	86.90
0 19	86.00	86.02	85.99	85.95	85.91	85.88	85.87	85.88	85.93	85.99	86.06	86.12	86.19	86.25	86.33	86.40
0 20	85.60	85.60	85.59	85.56	85.54	85.52	85.50	85.51	85.54	85.59	85.64	85.69	85.72	85.76	85.82	85.90
0 21	85.10	85.13	85.12	85.10	85.08	85.04	85.01	84.99	85.02	85.07	85.11	85.15	85.16	85.16	85.15	85.10
0 22	84.70	84.68	84.67	84.64	84.59	84.52	84.45	84.40	84.44	84.50	84.55	84.59	84.59	84.58	84.54	84.50
0 23	84.20	84.23	84.22	84.19	84.11	84.00	83.85	83.71	83.83	83.93	84.01	84.04	84.05	84.01	83.93	83.80
0 24	83.80	83.81	83.80	83.75	83.64	83.50	83.26	82.75	83.21	83.40	83.49	83.53	83.54	83.49	83.39	83.30
0 25	83.50	83.43	83.39	83.31	83.21	83.08	82.93	82.77	82.87	82.96	83.02	83.04	83.04	82.98	82.88	82.80
0 26	83.10	83.04	82.97	82.89	82.80	82.70	82.60	82.52	82.53	82.56	82.57	82.57	82.55	82.48	82.40	82.30
0 27	82.70	82.62	82.55	82.47	82.39	82.32	82.24	82.19	82.16	82.16	82.15	82.13	82.08	82.02	81.95	81.90
0 28	82.20	82.17	82.12	82.05	81.99	81.93	81.87	81.82	81.78	81.76	81.73	81.69	81.64	81.57	81.49	81.40
0 29	81.80	81.74	81.68	81.63	81.58	81.53	81.48	81.43	81.39	81.36	81.32	81.27	81.21	81.14	81.07	81.00
0 30	81.30	81.27	81.24	81.20	81.16	81.12	81.08	81.04	81.00	80.95	80.91	80.85	80.79	80.72	80.65	80.60
0 31	80.80	80.80	80.79	80.77	80.74	80.71	80.68	80.64	80.60	80.55	80.50	80.44	80.37	80.29	80.23	80.20
0 32	80.30	80.33	80.34	80.34	80.33	80.31	80.28	80.25	80.20	80.15	80.09	80.02	79.95	79.86	79.78	79.70
0 33	79.90	79.89	79.90	79.91	79.91	79.90	79.88	79.86	79.82	79.76	79.69	79.61	79.53	79.44	79.35	79.30
0 34	79.40	79.44	79.46	79.49	79.50	79.50	79.49	79.47	79.44	79.37	79.29	79.21	79.11	79.01	78.91	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

1 HEAD IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	92.10
2	90.90	90.97	91.05	91.14	91.22	91.28	91.35	91.43	91.50	91.54	91.60	91.63	91.68	91.71	91.76	91.80
0 3	90.60	90.71	90.79	90.87	90.95	91.02	91.09	91.16	91.22	91.26	91.30	91.33	91.37	91.39	91.41	91.40
0 4	90.40	90.45	90.53	90.60	90.68	90.75	90.82	90.88	90.93	90.97	91.00	91.02	91.05	91.06	91.07	91.10
0 5	90.10	90.17	90.25	90.32	90.40	90.48	90.55	90.61	90.65	90.68	90.70	90.71	90.72	90.72	90.72	90.70
0 6	89.80	89.88	89.96	90.04	90.12	90.20	90.29	90.35	90.38	90.38	90.38	90.38	90.38	90.38	90.36	90.30
0 7	89.50	89.59	89.66	89.74	89.82	89.92	90.04	90.11	90.12	90.09	90.06	90.05	90.04	90.03	90.02	90.00
0 8	89.20	89.30	89.37	89.43	89.51	89.62	89.83	89.92	89.91	89.77	89.72	89.69	89.68	89.68	89.68	89.70
0 9	89.00	89.03	89.07	89.11	89.15	89.21	89.40	89.51	89.49	89.35	89.33	89.32	89.32	89.31	89.31	89.30
0 10	88.70	88.75	88.77	88.78	88.79	88.80	88.84	88.87	88.92	88.92	88.92	88.93	88.93	88.94	88.95	89.00
0 11	88.50	88.49	88.47	88.45	88.42	88.40	88.31	88.20	88.36	88.48	88.51	88.53	88.55	88.55	88.54	88.50
0 12	88.30	88.23	88.17	88.11	88.06	87.99	87.69	87.21	87.72	88.04	88.10	88.14	88.17	88.18	88.16	88.10
0 13	88.10	87.97	87.87	87.78	87.69	87.59	86.96	85.20	86.98	87.60	87.69	87.76	87.80	87.82	87.82	87.80
0 14	87.80	87.67	87.56	87.46	87.34	87.22	86.84	86.40	86.83	87.20	87.31	87.39	87.45	87.48	87.50	87.50
0 15	87.50	87.36	87.25	87.14	87.01	86.85	86.63	86.54	86.62	86.82	86.96	87.05	87.11	87.15	87.18	87.20
0 16	87.10	87.03	86.94	86.84	86.73	86.60	86.48	86.39	86.46	86.57	86.66	86.74	86.79	86.83	86.86	86.90
0 17	86.80	86.72	86.64	86.56	86.47	86.38	86.27	86.10	86.25	86.34	86.40	86.45	86.49	86.51	86.52	86.50
0 18	86.40	86.39	86.35	86.30	86.24	86.18	86.13	86.08	86.11	86.13	86.16	86.18	86.20	86.21	86.20	86.20
0 19	86.10	86.09	86.07	86.04	86.00	85.99	86.00	85.98	85.97	85.93	85.92	85.92	85.92	85.91	85.87	85.80

0 20	85.70	85.74	85.74	85.71	85.68	85.67	85.66	85.64	85.62	85.60	85.59	85.58	85.58	85.56	85.51	85.40
0 21	85.30	85.31	85.30	85.26	85.22	85.18	85.10	85.05	85.06	85.09	85.11	85.12	85.12	85.10	85.	85.00
0 22	84.90	84.85	84.81	84.76	84.69	84.62	84.50	84.40	84.45	84.52	84.57	84.60	84.61	84.60	84.[illegible]	84.50
0 23	84.40	84.38	84.33	84.27	84.18	84.06	83.85	83.59	83.79	83.96	84.04	84.09	84.12	84.13	84.12	84.10
0 24	84.00	83.95	83.88	83.80	83.69	83.54	83.18	82.32	83.11	83.43	83.54	83.61	83.65	83.68	83.69	83.70
0 25	83.60	83.52	83.44	83.35	83.24	83.11	82.87	82.60	82.81	82.99	83.09	83.16	83.20	83.24	83.27	83.30
0 26	83.20	83.11	83.02	82.92	82.82	82.70	82.52	82.39	82.45	82.59	82.66	82.72	82.77	82.81	82.85	82.90
0 27	82.80	82.69	82.60	82.51	82.41	82.30	82.16	82.09	82.10	82.19	82.25	82.30	82.34	82.38	82.43	82.50
0 28	82.30	82.25	82.17	82.10	82.01	81.93	81.84	81.80	81.79	81.82	81.86	81.89	81.92	81.96	81.99	82.00
0 29	81.90	81.83	81.76	81.69	81.62	81.55	81.50	81.46	81.45	81.45	81.47	81.49	81.51	81.53	81.56	81.60
0 30	81.50	81.41	81.34	81.28	81.23	81.17	81.13	81.10	81.08	81.07	81.08	81.08	81.10	81.11	81.14	81.20
0 31	81.00	80.97	80.92	80.87	80.83	80.79	80.75	80.72	80.70	80.69	80.68	80.68	80.68	80.69	80.70	80.70
0 32	80.60	80.55	80.50	80.46	80.42	80.39	80.36	80.34	80.32	80.30	80.29	80.27	80.26	80.26	80.26	80.30
0 33	80.20	80.13	80.08	80.05	80.02	80.00	79.98	79.96	79.93	79.91	79.89	79.87	79.85	79.83	79.81	79.80
0 34	79.70	79.69	79.65	79.63	79.61	79.60	79.59	79.57	79.55	79.51	79.49	79.47	79.43	79.40	79.35	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

0HEAD WILL BE SAVED ON UNIT 30 AT END OF TIME STEP 1, STRESS PERIOD 2

1 DRAWDOWN IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.05	.03	.02	.01	-.01	.04	.01	-.00	-.02	-.03	-.04	-.02	-.09	-.05	.00
0 3	.00	.07	.04	.03	.02	.09	.05	.01	-.02	-.05	-.07	-.18	-.16	-.10	-.01	.00
0 4	.00	.07	.05	.03	.12	.10	.05	.00	-.05	-.10	-.14	-.27	-.24	-.23	-.11	.00
0 5	.00	.07	.04	.02	.11	.09	.04	-.02	-.09	-.17	-.25	-.42	-.51	-.30	-.09	.00
0 6	.00	.04	-.00	.07	.15	.13	.06	-.02	-.12	-.25	-.51	-.67	-.88	-.38	-.17	.00
0 7	.00	.05	.10	.07	.15	.10	.02	-.10	-.22	-.41	-.68	-1.09	-.67	-.41	-.20	.00
0 8	.00	.02	.08	.16	.15	.10	-.01	-.21	-.29	-.49	-.96	-.76	-.49	-.32	-.15	.00
0 9	.00	.03	.14	.16	.26	.23	.15	.01	-.28	-.32	-.43	-.43	-.26	-.16	-.04	.00
0 10	.00	.15	.20	.26	.30	.30	.25	.16	.06	-.11	-.14	-.19	-.18	-.14	-.07	.00
0 11	.00	.13	.24	.35	.44	.49	.48	.43	.23	.15	.02	.05	.02	.02	-.05	.00
0 12	.00	.11	.35	.52	.70	.84	.73	.72	.47	.35	.19	.09	.04	.01	.01	.00
0 13	.00	.15	.35	.59	.89	1.25	1.09	1.16	.77	.49	.31	.20	.12	.08	.07	.00
0 14	.00	.17	.40	.70	1.16	1.03	1.00	.90	.76	.54	.37	.25	.17	.11	.09	.00
0 15	.00	.23	.38	.64	.80	.91	.86	.88	.72	.55	.39	.28	.19	.11	.06	.00
0 16	.00	.19	.34	.48	.68	.73	.83	.79	.67	.63	.49	.37	.28	.20	.04	.00
0 17	.00	.10	.34	.44	.52	.67	.70	.84	.69	.56	.45	.35	.26	.17	.09	.00
0 18	.00	.08	.27	.34	.50	.53	.65	.65	.57	.49	.40	.31	.23	.15	.05	.00
0 19	.00	.08	.21	.35	.49	.52	.53	.62	.57	.51	.44	.38	.21	.15	.07	.00
0 20	.00	.10	.21	.34	.46	.48	.50	.59	.56	.51	.46	.31	.28	.14	.08	.00
0 21	.00	.07	.18	.30	.42	.46	.59	.61	.58	.53	.39	.35	.24	.14	.05	.00
0 22	.00	.12	.23	.26	.41	.48	.55	.70	.56	.50	.45	.31	.21	.12	.06	.00
0 23	.00	.07	.18	.31	.39	.50	.65	.79	.67	.57	.39	.36	.25	.19	.07	.00
0 24	.00	.09	.20	.25	.36	.60	.84	1.25	.79	.60	.41	.27	.26	.11	.01	.00
0 25	.00	.07	.11	.29	.39	.52	.67	.83	.63	.54	.38	.26	.16	.12	.02	.00
0 26	.00	.06	.13	.21	.30	.40	.50	.58	.47	.44	.33	.23	.15	.12	.00	.00
0 27	.00	.08	.15	.23	.31	.28	.36	.41	.44	.34	.25	.27	.12	.08	.05	.00
0 28	.00	.03	.08	.15	.21	.27	.33	.28	.32	.24	.27	.21	.16	.13	.01	.00
0 29	.00	.06	.12	.17	.12	.17	.22	.27	.21	.24	.18	.13	.09	.06	.03	.00
0 30	.00	.03	.06	.10	.14	.18	.22	.16	.20	.15	.19	.15	.11	.08	.05	.00
0 31	.00	.00	.01	.03	.06	.09	.12	.16	.10	.15	.10	.06	.03	.01	.07	.00
0 32	.00	.07	.06	.06	.07	.09	.12	.05	.10	.05	.11	.08	.05	.04	.02	.00
0 33	.00	.01	-.00	.09	.09	.10	.02	.04	.08	.04	.01	.09	.07	.06	.05	.00
0 34	.00	-.04	.04	.01	-.00	.00	.01	.03	.06	.03	.01	-.01	-.01	-.01	-.01	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

1 DRAWDOWN IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.03	.05	-.04	-.02	.02	.05	-.03	.00	-.04	.00	-.03	.02	-.01	.04	.00
0 3	.00	-.01	.01	.03	.05	-.02	.01	.04	-.02	.04	.00	-.03	.03	.01	-.01	.00
0 4	.00	.05	-.03	-.00	.02	-.05	-.02	.02	-.03	.03	.00	-.02	.05	.04	.03	.00

0	5	.00	.03	.05	-.02	-.00	.02	-.05	-.01	-.05	.02	.00	-.01	-.02	-.02	-.02	.00
0	6	.00	.02	.04	-.04	-.02	-.00	-.09	-.05	-.08	-.08	.02	.02	.02	.02	.04	.00
0	7	.00	.01	.04	.06	-.02	-.02	-.14	-.11	-.12	-.09	.04	.05	.06	.07	-.02	.00
0	8	.00	.00	.03	.07	-.01	-.02	-.23	-.22	-.21	-.07	-.02	.01	.02	.02	.02	.00
0	9	.00	.07	.03	.09	.15	.09	-.10	-.11	-.09	.05	.07	.08	.08	.09	-.01	.00
0	10	.00	.05	.13	.12	.21	.20	.16	.23	.18	.18	.18	.17	.07	.06	.05	.00
0	11	.00	.11	.13	.15	.28	.30	.39	.60	.44	.32	.19	.17	.15	.15	.06	.00
0	12	.00	.07	.13	.29	.34	.41	.81	1.29	.78	.36	.30	.26	.23	.12	.04	.00
0	13	.00	.13	.23	.32	.41	.51	1.24	3.00	1.22	.50	.41	.34	.20	.18	.08	.00
0	14	.00	.13	.24	.34	.56	.68	1.06	1.50	1.07	.60	.49	.31	.25	.12	.10	.00
0	15	.00	.14	.25	.36	.59	.75	.97	1.06	.98	.78	.54	.35	.19	.15	.02	.00
0	16	.00	.07	.26	.36	.57	.70	.82	.91	.74	.63	.44	.26	.21	.07	.04	.00
0	17	.00	.08	.16	.34	.43	.52	.63	.70	.55	.46	.30	.25	.11	.09	-.02	.00
0	18	.00	.01	.15	.20	.26	.32	.27	.32	.29	.27	.14	.12	.00	-.01	.00	.00
0	19	.00	.01	.03	.06	.10	.01	.00	.02	.03	-.03	-.02	-.02	-.12	-.11	-.07	.00
0	20	.00	.06	.06	-.01	.02	-.07	-.06	-.04	-.02	-.10	-.09	-.08	-.18	-.16	-.11	.00
0	21	.00	-.01	.00	.04	.08	.02	.10	.15	.04	.01	-.01	-.02	-.12	-.10	-.06	.00
0	22	.00	.05	.09	.14	.11	.18	.30	.40	.25	.18	.13	.00	-.01	-.00	.03	.00
0	23	.00	.02	.07	.13	.22	.34	.45	.71	.51	.34	.16	.11	.08	.07	-.02	.00
0	24	.00	.05	.12	.20	.31	.36	.72	1.58	.79	.47	.26	.19	.15	.12	.01	.00
0	25	.00	.08	.16	.15	.26	.39	.63	.90	.59	.41	.31	.24	.20	.16	.03	.00
0	26	.00	.09	.08	.18	.28	.40	.58	.61	.55	.41	.34	.28	.23	.09	.05	.00
0	27	.00	.11	.10	.19	.29	.30	.44	.51	.50	.41	.25	.20	.16	.12	.07	.00
0	28	.00	.05	.13	.20	.19	.27	.36	.40	.41	.28	.24	.21	.18	.14	.01	.00
0	29	.00	.07	.14	.11	.18	.25	.30	.24	.25	.25	.23	.11	.09	.07	.04	.00
0	30	.00	.09	.06	.12	.17	.23	.17	.20	.22	.23	.12	.12	.10	.09	.06	.00
0	31	.00	.03	.08	.13	.07	.11	.15	.18	.20	.11	.12	.12	.12	.01	.00	.00
0	32	.00	.05	.10	.04	.08	.11	.14	.06	.08	.10	.11	.03	.04	.04	.04	.00
0	33	.00	.07	.02	.05	.08	.10	.02	.04	.07	.09	.01	.03	.05	.07	-.01	.00
0	34	.00	.01	.05	.07	-.01	.00	.01	.03	.05	-.01	.01	.03	-.03	.00	.05	.00
0	35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

0DRAWDOWN WILL BE SAVED ON UNIT 40 AT END OF TIME STEP 1, STRESS PERIOD 2

0

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 2

	CUMULATIVE VOLUMES	L**3		RATES FOR THIS TIME STEP	L**3/T
0					
	IN:			IN:	
	STORAGE =	.10387E+07		STORAGE =	104.60
	CONSTANT HEAD =	.31941E+09		CONSTANT HEAD =	.15111E+06
	WELLS =	.00000		WELLS =	.00000
	RECHARGE =	.34614E+06		RECHARGE =	76920.
	TOTAL IN =	.32079E+09		TOTAL IN =	.22813E+06
	OUT:			OUT:	
	STORAGE =	.18116E+06		STORAGE =	33887.
	CONSTANT HEAD =	.17970E+09		CONSTANT HEAD =	.11727E+06
	WELLS =	.14088E+09		WELLS =	77007.
	RECHARGE =	.00000		RECHARGE =	.00000
0	TOTAL OUT =	.32077E+09		TOTAL OUT =	.22816E+06
0	IN - OUT =	24384.		IN - OUT =	-24.938
0	PERCENT DISCREPANCY =	.01		PERCENT DISCREPANCY =	-.01

0

TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 2

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	388800.	6480.00	108.000	4.50000	.123203E-01
STRESS PERIOD TIME	388800.	6480.00	108.000	4.50000	.123203E-01
TOTAL SIMULATION TIME	.158069E+09	.263448E+07	43908.0	1829.50	5.00890

1

1 STRESS PERIOD NO. 3, LENGTH = 3.000000

NUMBER OF TIME STEPS = 1

MULTIPLIER FOR DELT = 1.000

INITIAL TIME STEP SIZE = 3.000000

0REUSING WELLS FROM LAST STRESS PERIOD

0

RECHARGE WILL BE READ ON UNIT 18 USING FORMAT: (16F5.2)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 4	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 5	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 6	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 7	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 8	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.1200	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 9	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.1200	.0000	.0000	.0000	.8420	.8420	.0000	.0000
0 10	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 11	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 12	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 13	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 14	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 15	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 16	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 17	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 18	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 19	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 20	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 21	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 22	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 23	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 24	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 25	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 26	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 27	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 28	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 29	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 30	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 31	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 32	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 33	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 34	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
0 35	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000

0

7 ITERATIONS FOR TIME STEP 1 IN STRESS PERIOD 3

0MAXIMUM HEAD CHANGE FOR EACH ITERATION:

HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL
1.061	(1, 9, 14)	.2748	(1, 10, 13)	.5879E-01	(1, 11, 13)	.1976E-01	(1, 7, 12)	-.6185E-02	(1, 9, 10)
-.2108E-02	(1, 7, 12)	.6134E-03	(1, 11, 12)						

0
HEAD/DRAWDOWN PRINTOUT FLAG = 1 TOTAL BUDGET PRINTOUT FLAG = 1 CELL-BY-CELL FLOW TERM FLAG = 0
REUSING PREVIOUS VALUES OF IOFLG

HEAD IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 3

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.55	92.68	92.79	92.89	93.01	93.16	93.29	93.40	93.51	93.62	93.72	93.80	93.88	93.94	94.00
0 3	92.00	92.14	92.26	92.38	92.49	92.62	92.76	92.89	93.01	93.13	93.24	93.34	93.41	93.46	93.49	93.50
0 4	91.60	91.73	91.86	91.98	92.10	92.22	92.36	92.50	92.63	92.76	92.87	92.97	93.03	93.06	93.08	93.10
0 5	91.20	91.33	91.47	91.59	91.71	91.83	91.97	92.12	92.26	92.40	92.51	92.61	92.67	92.68	92.65	92.60
0 6	90.70	90.86	91.02	91.15	91.28	91.40	91.56	91.72	91.88	92.03	92.16	92.28	92.35	92.32	92.23	92.10
0 7	90.20	90.36	90.52	90.65	90.79	90.94	91.11	91.31	91.47	91.64	91.81	91.97	92.08	92.03	91.84	91.60
0 8	89.70	89.89	90.04	90.16	90.29	90.45	90.65	90.94	91.06	91.22	91.42	91.66	91.92	91.86	91.46	91.10
0 9	89.40	89.48	89.58	89.68	89.78	89.92	90.11	90.34	90.61	90.73	90.94	91.31	92.10	92.02	91.06	90.50
0 10	89.00	89.06	89.12	89.18	89.25	89.36	89.52	89.71	89.93	90.12	90.31	90.55	90.82	90.76	90.36	90.00
0 11	88.70	88.68	88.68	88.69	88.70	88.77	88.90	89.06	89.28	89.49	89.67	89.83	89.94	89.91	89.73	89.50
0 12	88.30	88.30	88.27	88.21	88.14	88.11	88.24	88.36	88.63	88.88	89.07	89.20	89.28	89.28	89.20	89.10
0 13	88.00	87.95	87.87	87.74	87.55	87.30	87.58	87.51	88.02	88.32	88.52	88.65	88.72	88.74	88.69	88.60
0 14	87.70	87.64	87.52	87.33	86.97	87.11	87.26	87.36	87.61	87.85	88.03	88.15	88.23	88.26	88.25	88.20
0 15	87.50	87.38	87.24	87.08	86.93	86.92	86.98	87.07	87.23	87.41	87.58	87.70	87.78	87.83	87.87	87.90
0 16	87.30	87.12	86.97	86.84	86.74	86.70	86.71	86.76	86.88	87.02	87.17	87.28	87.37	87.43	87.48	87.50
0 17	87.00	86.81	86.67	86.57	86.50	86.45	86.43	86.39	86.55	86.68	86.79	86.89	86.97	87.05	87.12	87.20
0 18	86.50	86.42	86.34	86.27	86.22	86.19	86.17	86.18	86.26	86.34	86.43	86.51	86.59	86.67	86.76	86.90
19	86.00	86.03	86.00	85.96	85.93	85.90	85.89	85.90	85.95	86.01	86.08	86.15	86.21	86.27	86.34	86.40
0 20	85.60	85.61	85.59	85.57	85.56	85.53	85.52	85.52	85.56	85.61	85.66	85.71	85.73	85.77	85.82	85.90
0 21	85.10	85.13	85.13	85.11	85.09	85.05	85.02	85.01	85.03	85.08	85.13	85.16	85.17	85.17	85.16	85.10
0 22	84.70	84.68	84.67	84.64	84.59	84.53	84.45	84.41	84.45	84.51	84.56	84.59	84.60	84.58	84.54	84.50
0 23	84.20	84.23	84.22	84.19	84.11	84.00	83.86	83.72	83.83	83.94	84.01	84.05	84.05	84.02	83.93	83.80
0 24	83.80	83.81	83.80	83.75	83.64	83.50	83.26	82.76	83.22	83.41	83.49	83.53	83.54	83.49	83.39	83.30
0 25	83.50	83.43	83.39	83.31	83.21	83.09	82.93	82.77	82.87	82.96	83.02	83.04	83.04	82.98	82.88	82.80
0 26	83.10	83.04	82.97	82.89	82.80	82.70	82.60	82.52	82.53	82.56	82.58	82.57	82.55	82.48	82.40	82.30
0 27	82.70	82.62	82.55	82.47	82.40	82.32	82.24	82.19	82.17	82.16	82.15	82.13	82.09	82.02	81.95	81.90
0 28	82.20	82.17	82.12	82.05	81.99	81.93	81.87	81.82	81.78	81.76	81.73	81.69	81.64	81.57	81.49	81.40
0 29	81.80	81.74	81.69	81.63	81.58	81.53	81.48	81.43	81.39	81.36	81.32	81.27	81.21	81.14	81.07	81.00
0 30	81.30	81.27	81.24	81.20	81.16	81.12	81.08	81.04	81.00	80.95	80.91	80.85	80.79	80.72	80.65	80.60
0 31	80.80	80.80	80.79	80.77	80.74	80.71	80.68	80.64	80.60	80.55	80.50	80.44	80.37	80.29	80.23	80.20
0 32	80.30	80.33	80.34	80.34	80.33	80.31	80.28	80.25	80.21	80.15	80.09	80.02	79.95	79.86	79.78	79.70
0 33	79.90	79.89	79.90	79.91	79.91	79.90	79.88	79.86	79.82	79.76	79.69	79.61	79.53	79.44	79.35	79.30
0 34	79.40	79.44	79.46	79.49	79.50	79.50	79.49	79.47	79.44	79.37	79.29	79.21	79.11	79.01	78.91	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

1 HEAD IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 3

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92	92.10
0 2	90.90	90.97	91.05	91.14	91.22	91.28	91.35	91.43	91.50	91.54	91.60	91.63	91.68	91.71	91.76	91.80
0 3	90.60	90.71	90.79	90.87	90.95	91.02	91.09	91.16	91.22	91.26	91.30	91.34	91.37	91.39	91.41	91.40
0 4	90.40	90.45	90.53	90.60	90.68	90.75	90.82	90.89	90.94	90.97	91.00	91.03	91.05	91.06	91.08	91.10
0 5	90.10	90.17	90.25	90.33	90.40	90.48	90.55	90.61	90.66	90.68	90.70	90.71	90.72	90.72	90.72	90.70
0 6	89.80	89.88	89.96	90.04	90.12	90.21	90.29	90.35	90.38	90.39	90.39	90.39	90.38	90.38	90.36	90.30
0 7	89.50	89.59	89.67	89.74	89.83	89.93	90.04	90.11	90.13	90.09	90.06	90.05	90.04	90.04	90.02	90.00
0 8	89.20	89.30	89.37	89.43	89.51	89.62	89.83	89.93	89.91	89.77	89.72	89.70	89.69	89.69	89.68	89.70
0 9	89.00	89.03	89.07	89.11	89.16	89.21	89.40	89.51	89.49	89.36	89.34	89.33	89.33	89.32	89.32	89.30
0 10	88.70	88.75	88.77	88.78	88.79	88.81	88.85	88.88	88.93	88.93	88.93	88.94	88.94	88.95	88.95	89.00
0 11	88.50	88.49	88.47	88.45	88.43	88.40	88.31	88.20	88.37	88.49	88.52	88.54	88.56	88.56	88.55	88.50
0 12	88.30	88.23	88.17	88.12	88.06	88.00	87.69	87.22	87.72	88.04	88.10	88.14	88.17	88.18	88.16	88.10
0 13	88.10	87.97	87.87	87.79	87.69	87.59	86.96	85.20	86.98	87.61	87.70	87.76	87.80	87.82	87.82	87.80
0 14	87.80	87.67	87.56	87.46	87.34	87.22	86.84	86.40	86.84	87.20	87.31	87.40	87.45	87.48	87.50	87.50
0 15	87.50	87.36	87.25	87.14	87.01	86.85	86.63	86.54	86.62	86.82	86.96	87.05	87.11	87.15	87.18	87.20
0 16	87.10	87.03	86.94	86.84	86.73	86.60	86.48	86.39	86.46	86.57	86.67	86.74	86.80	86.83	86.86	86.90
0 17	86.80	86.72	86.64	86.57	86.47	86.38	86.27	86.10	86.25	86.34	86.40	86.46	86.49	86.51	86.52	86.50
0 18	86.40	86.39	86.35	86.30	86.24	86.18	86.13	86.08	86.11	86.13	86.16	86.18	86.20	86.21	86.20	86.20
0 19	86.10	86.09	86.07	86.04	86.00	85.99	86.00	85.98	85.97	85.94	85.92	85.92	85.92	85.91	85.87	85.80
0 20	85.70	85.74	85.74	85.71	85.68	85.67	85.66	85.64	85.62	85.60	85.59	85.58	85.58	85.56	85.51	85.40
0 21	85.30	85.31	85.30	85.26	85.22	85.18	85.10	85.05	85.06	85.10	85.11	85.12	85.12	85.10	85.06	85.00
0 22	84.90	84.85	84.81	84.76	84.69	84.62	84.50	84.40	84.45	84.52	84.57	84.60	84.61	84.60	84	84.50
0 23	84.40	84.38	84.33	84.27	84.18	84.06	83.85	83.59	83.79	83.96	84.04	84.09	84.12	84.13	84.	84.10
0 24	84.00	83.95	83.88	83.80	83.69	83.54	83.18	82.32	83.11	83.43	83.54	83.61	83.65	83.68	83.69	83.70
0 25	83.60	83.52	83.44	83.35	83.24	83.11	82.87	82.60	82.81	82.99	83.09	83.16	83.20	83.24	83.27	83.30
0 26	83.20	83.11	83.02	82.92	82.82	82.70	82.51	82.39	82.45	82.59	82.66	82.72	82.77	82.81	82.85	82.90
0 27	82.80	82.69	82.60	82.51	82.41	82.30	82.16	82.09	82.10	82.19	82.25	82.30	82.34	82.38	82.43	82.50
0 28	82.30	82.25	82.17	82.10	82.01	81.93	81.84	81.79	81.79	81.82	81.86	81.89	81.92	81.96	81.99	82.00
0 29	81.90	81.83	81.76	81.69	81.62	81.55	81.50	81.46	81.45	81.45	81.47	81.49	81.51	81.53	81.56	81.60
0 30	81.50	81.41	81.34	81.28	81.23	81.17	81.13	81.10	81.08	81.07	81.08	81.08	81.10	81.11	81.14	81.20
0 31	81.00	80.97	80.92	80.87	80.83	80.79	80.75	80.72	80.70	80.69	80.68	80.68	80.68	80.69	80.70	80.70
0 32	80.60	80.55	80.50	80.46	80.42	80.39	80.36	80.34	80.32	80.30	80.29	80.27	80.26	80.26	80.26	80.30
0 33	80.20	80.13	80.08	80.05	80.02	80.00	79.97	79.96	79.93	79.91	79.89	79.87	79.85	79.83	79.81	79.80
0 34	79.70	79.69	79.65	79.63	79.61	79.60	79.59	79.57	79.55	79.51	79.49	79.47	79.43	79.40	79.35	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

0HEAD WILL BE SAVED ON UNIT 30 AT END OF TIME STEP 1, STRESS PERIOD 3

1 DRAWDOWN IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 3

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.05	.02	.01	.01	-.01	.04	.01	-.00	-.01	-.02	-.02	-.00	-.08	-.04	.00
0 3	.00	.06	.04	.02	.01	.08	.04	.01	-.01	-.03	-.04	-.14	-.11	-.06	.01	.00

0 4	.00	.07	.04	.02	.10	.08	.04	.00	-.03	-.06	-.07	-.17	-.13	-.16	-.08	.00
0 5	.00	.07	.03	.01	.09	.07	.03	-.02	-.06	-.10	-.11	-.21	-.27	-.18	-.05	.00
6	.00	.04	-.02	.05	.12	.10	.04	-.02	-.08	-.13	-.26	-.28	-.35	-.22	-.13	.00
7	.00	.04	.08	.05	.11	.06	-.01	-.11	-.17	-.24	-.31	-.47	-.48	-.43	-.24	.00
0 8	.00	.01	.06	.14	.11	.05	-.05	-.24	-.26	-.32	-.42	-.66	-.82	-.76	-.36	.00
0 9	.00	.02	.12	.12	.22	.18	.09	-.04	-.31	-.33	-.44	-.81	-1.50	-1.42	-.46	.00
0 10	.00	.14	.18	.22	.25	.24	.18	.09	-.03	-.22	-.31	-.55	-.82	-.76	-.36	.00
0 11	.00	.12	.22	.31	.40	.43	.40	.34	.12	.01	-.17	-.23	-.34	-.31	-.23	.00
0 12	.00	.10	.33	.49	.66	.79	.66	.64	.37	.22	.03	-.10	-.18	-.18	-.10	.00
0 13	.00	.15	.33	.56	.85	1.20	1.02	1.09	.68	.38	.18	.05	-.02	-.04	.01	.00
0 14	.00	.16	.38	.67	1.13	.99	.94	.84	.69	.45	.27	.15	.07	.04	.05	.00
0 15	.00	.22	.36	.62	.77	.88	.82	.83	.67	.49	.32	.20	.12	.07	.03	.00
0 16	.00	.18	.33	.46	.66	.70	.79	.74	.62	.58	.43	.32	.23	.17	.02	.00
0 17	.00	.09	.33	.43	.50	.65	.67	.81	.65	.52	.41	.31	.23	.15	.08	.00
0 18	.00	.08	.26	.33	.48	.51	.63	.62	.54	.46	.37	.29	.21	.13	.04	.00
0 19	.00	.07	.20	.34	.47	.50	.51	.60	.55	.49	.42	.35	.19	.13	.06	.00
0 20	.00	.09	.21	.33	.44	.47	.48	.58	.54	.49	.44	.29	.27	.13	.08	.00
0 21	.00	.07	.17	.29	.41	.45	.58	.59	.57	.52	.37	.34	.23	.13	.04	.00
0 22	.00	.12	.23	.26	.41	.47	.55	.69	.55	.49	.44	.31	.20	.12	.06	.00
0 23	.00	.07	.18	.31	.39	.50	.64	.78	.67	.56	.39	.35	.25	.18	.07	.00
0 24	.00	.09	.20	.25	.36	.60	.84	1.24	.78	.59	.41	.27	.26	.11	.01	.00
0 25	.00	.07	.11	.29	.39	.51	.67	.83	.63	.54	.38	.26	.16	.12	.02	.00
0 26	.00	.06	.13	.21	.30	.40	.50	.58	.47	.44	.32	.23	.15	.12	.00	.00
0 27	.00	.08	.15	.23	.30	.28	.36	.41	.43	.34	.25	.27	.11	.08	.05	.00
0 28	.00	.03	.08	.15	.21	.27	.33	.28	.32	.24	.27	.21	.16	.13	.01	.00
0 29	.00	.06	.11	.17	.12	.17	.22	.27	.21	.24	.18	.13	.09	.06	.03	.00
0 30	.00	.03	.06	.10	.14	.18	.22	.16	.20	.15	.19	.15	.11	.08	.05	.00
0 31	.00	.00	.01	.03	.06	.09	.12	.16	.10	.15	.10	.06	.03	.01	.07	.00
0 32	.00	.07	.06	.06	.07	.09	.12	.05	.09	.05	.11	.08	.05	.04	.02	.00
0 33	.00	.01	-.00	.09	.09	.10	.02	.04	.08	.04	.01	.09	.07	.06	.05	.00
0 34	.00	-.04	.04	.01	-.00	.00	.01	.03	.06	.03	.01	-.01	-.01	-.01	-.01	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

1 DRAWDOWN IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 3

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.03	.05	-.04	-.02	.02	.05	-.03	-.00	-.04	.00	-.03	.02	-.01	.04	.00
0 3	.00	-.01	.01	.03	.05	-.02	.01	.04	-.02	.04	-.00	-.04	.03	.01	-.01	.00
0 4	.00	.05	-.03	-.00	.02	-.05	-.02	.01	-.04	.03	-.00	-.03	.05	.04	.02	.00
0 5	.00	.03	.05	-.03	-.00	.02	-.05	-.01	-.06	.02	.00	-.01	-.02	-.02	-.02	.00
0 6	.00	.02	.04	-.04	-.02	-.01	-.09	-.05	-.08	-.09	.01	.01	.02	.02	.04	.00
0 7	.00	.01	.03	.06	-.03	-.03	-.14	-.11	-.13	-.09	.04	.05	.06	.06	-.02	.00
8	.00	.00	.03	.07	-.01	-.02	-.23	-.23	-.21	-.07	-.02	.00	.01	.01	.02	.00
9	.00	.07	.03	.09	.14	.09	-.10	-.11	-.09	.04	.06	.07	.07	.08	-.02	.00
10	.00	.05	.13	.12	.21	.19	.15	.22	.17	.17	.17	.16	.06	.05	.05	.00
0 11	.00	.11	.13	.15	.27	.30	.39	.60	.43	.31	.18	.16	.14	.14	.05	.00
0 12	.00	.07	.13	.28	.34	.40	.81	1.28	.78	.36	.30	.26	.23	.12	.04	.00
0 13	.00	.13	.23	.31	.41	.51	1.24	3.00	1.22	.49	.40	.34	.20	.18	.08	.00
0 14	.00	.13	.24	.34	.56	.68	1.06	1.50	1.06	.60	.49	.30	.25	.12	.10	.00
0 15	.00	.14	.25	.36	.59	.75	.97	1.06	.98	.78	.54	.35	.19	.15	.02	.00
0 16	.00	.07	.26	.36	.57	.70	.82	.91	.74	.63	.43	.26	.20	.07	.04	.00
0 17	.00	.08	.16	.33	.43	.52	.63	.70	.55	.46	.30	.24	.11	.09	-.02	.00
0 18	.00	.01	.15	.20	.26	.32	.27	.32	.29	.27	.14	.12	.00	-.01	.00	.00
0 19	.00	.01	.03	.06	.10	.01	.00	.02	.03	-.04	-.02	-.02	-.12	-.11	-.07	.00
0 20	.00	.06	.06	-.01	.02	-.07	-.06	-.04	-.02	-.10	-.09	-.08	-.18	-.16	-.11	.00
0 21	.00	-.01	.00	.04	.08	.02	.10	.15	.04	.00	-.01	-.02	-.12	-.10	-.06	.00
0 22	.00	.05	.09	.14	.11	.18	.30	.40	.25	.18	.13	.00	-.01	-.00	.03	.00
0 23	.00	.02	.07	.13	.22	.34	.45	.71	.51	.34	.16	.11	.08	.07	-.02	.00
0 24	.00	.05	.12	.20	.31	.36	.72	1.58	.79	.47	.26	.19	.15	.12	.01	.00
0 25	.00	.08	.16	.15	.26	.39	.63	.90	.59	.41	.31	.24	.20	.16	.03	.00
0 26	.00	.09	.08	.18	.28	.40	.59	.61	.55	.41	.34	.28	.23	.09	.05	.00
0 27	.00	.11	.10	.19	.29	.30	.44	.51	.50	.41	.25	.20	.16	.12	.07	.00
0 28	.00	.05	.13	.20	.19	.27	.36	.41	.41	.28	.24	.21	.18	.14	.01	.00
0 29	.00	.07	.14	.11	.18	.25	.30	.24	.25	.25	.23	.11	.09	.07	.04	.00
0 30	.00	.09	.06	.12	.17	.23	.17	.20	.22	.23	.12	.12	.10	.09	.06	.00
0 31	.00	.03	.08	.13	.07	.11	.15	.18	.20	.11	.12	.12	.12	.01	.00	.00
0 32	.00	.05	.10	.04	.08	.11	.14	.06	.08	.10	.11	.03	.04	.04	.04	.00
0 33	.00	.07	.02	.05	.08	.10	.03	.04	.07	.09	.01	.03	.05	.07	-.01	.00
0 34	.00	.01	.05	.07	-.01	.00	.01	.03	.05	-.01	.01	.03	-.03	.00	.05	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

0DRAWDOWN WILL BE SAVED ON UNIT 40 AT END OF TIME STEP 1, STRESS PERIOD 3

0

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 3

0 CUMULATIVE VOLUMES L**3 RATES FOR THIS TIME STEP L**3/T

IN: IN:

```
                                ---                                                                         ---
                            STORAGE =        .10567E+07                                                 STORAGE =      6029.0
                      CONSTANT HEAD =        .31986E+09                                           CONSTANT HEAD =      .15058E+06
                              WELLS =        .00000                                                       WELLS =      .00000
                           RECHARGE =        .57702E+06                                                RECHARGE =      76960.
0                          TOTAL IN =        .32149E+09                                                TOTAL IN =      .23357E+06
0                         OUT:                                                                     OUT:
                          ----                                                                     ----
                            STORAGE =        .23762E+06                                                 STORAGE =      18820.
                      CONSTANT HEAD =        .18012E+09                                           CONSTANT HEAD =      .13776E+06
                              WELLS =        .14112E+09                                                   WELLS =      77007.
                           RECHARGE =        .00000                                                    RECHARGE =      .00000
0                         TOTAL OUT =        .32147E+09                                               TOTAL OUT =      .23359E+06
0                          IN - OUT =        24288.                                                    IN - OUT =      -17.703
0              PERCENT DISCREPANCY =                      .01                           PERCENT DISCREPANCY =                    -.01

0

         TIME SUMMARY AT END OF TIME STEP  1 IN STRESS PERIOD  3
                                 SECONDS         MINUTES          HOURS          DAYS           YEARS
                             -----------------------------------------------------------------------------
        TIME STEP LENGTH         259200.         4320.00          72.0000        3.00000        .821355E-02
      STRESS PERIOD TIME         259200.         4320.00          72.0000        3.00000        .821355E-02
   TOTAL SIMULATION TIME         .158328E+09     .263880E+07      43980.0        1832.50        5.01711
1
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1                                  U.S. GEOLOGICAL SURVEY MODULAR FINITE-DIFFERENCE GROUND-WATER MODEL
0SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     SENSIT ANAL, SIMULATION 4A: TOTAL FLOW = 440 GPM
    2 LAYERS          35 ROWS          16 COLUMNS
   1 STRESS PERIOD(S) IN SIMULATION
 MODEL TIME UNIT IS DAYS
0I/O UNITS:
 ELEMENT OF IUNIT:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
        I/O UNIT: 11 12  0  0  0  0  0  0 19  0  0 22  0  0  0  0  0  0  0  0  0  0  0  0
0BAS1 -- BASIC MODEL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT  1
 ARRAYS RHS AND BUFF WILL SHARE MEMORY.
 START HEAD WILL BE SAVED
    10699 ELEMENTS IN X ARRAY ARE USED BY BAS
    10699 ELEMENTS OF X ARRAY USED OUT OF  100000
0BCF1 -- BLOCK-CENTERED FLOW PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 11
 STEADY-STATE SIMULATION
      LAYER  AQUIFER TYPE
      -------------------
         1          1
         2          0
     1122 ELEMENTS IN X ARRAY ARE USED BY BCF
    11821 ELEMENTS OF X ARRAY USED OUT OF  100000
0WEL1 -- WELL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM 12
 MAXIMUM OF     9 WELLS
       36 ELEMENTS IN X ARRAY ARE USED FOR WELLS
    11857 ELEMENTS OF X ARRAY USED OUT OF  100000
0SIP1 -- STRONGLY IMPLICIT PROCEDURE SOLUTION PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 19
 MAXIMUM OF  50 ITERATIONS ALLOWED FOR CLOSURE
  5 ITERATION PARAMETERS
     4685 ELEMENTS IN X ARRAY ARE USED BY SIP
    16542 ELEMENTS OF X ARRAY USED OUT OF  100000
1SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     SENSIT ANAL, SIMULATION 4A: TOTAL FLOW = 440 GPM
0
```

BOUNDARY ARRAY FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
0 2	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 3	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 4	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 5	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 6	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
7	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
8	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
9	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 10	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 11	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 12	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 13	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 14	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 15	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 16	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 17	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 18	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 19	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 20	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 21	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 22	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 23	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 24	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 25	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 26	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 27	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 28	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 29	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 30	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 31	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 32	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 33	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 34	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 35	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

0

BOUNDARY ARRAY FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

0 1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
0 2	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 3	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 4	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 5	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 6	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 7	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 8	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 9	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 10	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 11	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 12	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 13	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 14	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 15	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 16	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 17	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 18	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 19	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 20	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 21	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 22	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 23	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 24	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 25	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 26	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 27	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 28	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 29	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 30	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 31	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 32	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 33	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 34	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 35	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2

0AQUIFER HEAD WILL BE SET TO 999.99 AT ALL NO-FLOW NODES (IBOUND=0).
0

INITIAL HEAD FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.60	92.70	92.80	92.90	93.00	93.20	93.30	93.40	93.50	93.60	93.70	93.80	93.80	93.90	94.00
0 3	92.00	92.20	92.30	92.40	92.50	92.70	92.80	92.90	93.00	93.10	93.20	93.20	93.30	93.40	93.50	93.50
0 4	91.60	91.80	91.90	92.00	92.20	92.30	92.40	92.50	92.60	92.70	92.80	92.80	92.90	92.90	93.00	93.10
0 5	91.20	91.40	91.50	91.60	91.80	91.90	92.00	92.10	92.20	92.30	92.40	92.40	92.40	92.50	92.60	92.60
0 6	90.70	90.90	91.00	91.20	91.40	91.50	91.60	91.70	91.80	91.90	91.90	92.00	92.00	92.10	92.10	92.10
0 7	90.20	90.40	90.60	90.70	90.90	91.00	91.10	91.20	91.30	91.40	91.50	91.50	91.60	91.60	91.60	91.60
0 8	89.70	89.90	90.10	90.30	90.40	90.50	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.10	91.10	91.10
0 9	89.40	89.50	89.70	89.80	90.00	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.60	90.50
0 10	89.00	89.20	89.30	89.40	89.50	89.60	89.70	89.80	89.90	89.90	90.00	90.00	90.00	90.00	90.00	90.00
0 11	88.70	88.80	88.90	89.00	89.10	89.20	89.30	89.40	89.40	89.50	89.50	89.60	89.60	89.60	89.50	89.50
0 12	88.30	88.40	88.60	88.70	88.80	88.90	88.90	89.00	89.00	89.10	89.10	89.10	89.10	89.10	89.10	89.10
0 13	88.00	88.10	88.20	88.30	88.40	88.50	88.60	88.60	88.70	88.70	88.70	88.70	88.70	88.70	88.70	88.60
0 14	87.70	87.80	87.90	88.00	88.10	88.10	88.20	88.20	88.30	88.30	88.30	88.30	88.30	88.30	88.30	88.20
0 15	87.50	87.60	87.60	87.70	87.70	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.90	87.90	87.90	87.90
0 16	87.30	87.30	87.30	87.30	87.40	87.40	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.50	87.50
0 17	87.00	86.90	87.00	87.00	87.00	87.10	87.10	87.20	87.20	87.20	87.20	87.20	87.20	87.20	87.20	87.20
0 18	86.50	86.50	86.60	86.60	86.70	86.70	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.90
0 19	86.00	86.10	86.20	86.30	86.40	86.40	86.40	86.50	86.50	86.50						

Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
											86.50	86.50	86.40	86.40	86.40	86.40
0 20	85.60	85.70	85.80	85.90	86.00	86.00	86.00	86.10	86.10	86.10	86.10	86.00	86.00	85.90	85.90	85.90
0 21	85.10	85.20	85.30	85.40	85.50	85.50	85.60	85.60	85.60	85.60	85.50	85.50	85.40	85.30	85.20	85.10
0 22	84.70	84.80	84.90	84.90	85.00	85.00	85.00	85.10	85.00	85.00	85.00	84.90	84.80	84.70	84.60	84.50
0 23	84.20	84.30	84.40	84.50	84.50	84.50	84.50	84.50	84.50	84.50	84.40	84.40	84.30	84.20	84.00	83.80
0 24	83.80	83.90	84.00	84.00	84.00	84.10	84.10	84.00	84.00	84.00	83.90	83.80	83.80	83.60	83.40	83.30
0 25	83.50	83.50	83.50	83.60	83.60	83.60	83.60	83.60	83.50	83.50	83.40	83.30	83.20	83.10	82.90	82.80
0 26	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.00	83.00	82.90	82.80	82.70	82.60	82.40	82.30
0 27	82.70	82.70	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.50	82.40	82.40	82.20	82.10	82.00	81.90
0 28	82.20	82.20	82.20	82.20	82.20	82.20	82.20	82.10	82.10	82.00	82.00	81.90	81.80	81.70	81.50	81.40
0 29	81.80	81.80	81.80	81.80	81.70	81.70	81.70	81.70	81.60	81.60	81.50	81.40	81.30	81.20	81.10	81.00
0 30	81.30	81.30	81.30	81.30	81.30	81.30	81.30	81.20	81.20	81.10	81.10	81.00	80.90	80.80	80.70	80.60
0 31	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.70	80.70	80.60	80.50	80.40	80.30	80.30	80.20
0 32	80.30	80.40	80.40	80.40	80.40	80.40	80.40	80.30	80.30	80.20	80.20	80.10	80.00	79.90	79.80	79.70
0 33	79.90	79.90	79.90	80.00	80.00	80.00	79.90	79.90	79.90	79.80	79.70	79.70	79.60	79.50	79.40	79.30
0 34	79.40	79.40	79.50	79.50	79.50	79.50	79.50	79.50	79.50	79.40	79.30	79.20	79.10	79.00	78.90	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

0

INITIAL HEAD FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	92.10
0 2	90.90	91.00	91.10	91.10	91.20	91.30	91.40	91.40	91.50	91.50	91.60	91.60	91.70	91.70	91.80	91.80
0 3	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.20	91.20	91.30	91.30	91.30	91.40	91.40	91.40	91.40
0 4	90.40	90.50	90.50	90.60	90.70	90.70	90.80	90.90	90.90	91.00	91.00	91.00	91.10	91.10	91.10	91.10
0 5	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.70	90.70	90.70	90.70	90.70	90.70	90.70
0 6	89.80	89.90	90.00	90.00	90.10	90.20	90.20	90.30	90.30	90.30	90.40	90.40	90.40	90.40	90.40	90.30
0 7	89.50	89.60	89.70	89.80	89.80	89.90	89.90	90.00	90.00	90.00	90.10	90.10	90.10	90.10	90.00	90.00
0 8	89.20	89.30	89.40	89.50	89.50	89.60	89.60	89.70	89.70	89.70	89.70	89.70	89.70	89.70	89.70	89.70
0 9	89.00	89.10	89.10	89.20	89.30	89.30	89.30	89.40	89.40	89.40	89.40	89.40	89.40	89.40	89.30	89.30
0 10	88.70	88.80	88.90	88.90	89.00	89.00	89.00	89.10	89.10	89.10	89.10	89.10	89.00	89.00	89.00	89.00
0 11	88.50	88.60	88.60	88.60	88.70	88.70	88.70	88.80	88.80	88.80	88.70	88.70	88.70	88.70	88.60	88.50
0 12	88.30	88.30	88.30	88.40	88.40	88.40	88.50	88.50	88.50	88.40	88.40	88.40	88.40	88.30	88.20	88.10
0 13	88.10	88.10	88.10	88.10	88.10	88.10	88.20	88.20	88.20	88.10	88.10	88.10	88.00	88.00	87.90	87.80
0 14	87.80	87.80	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.80	87.80	87.70	87.70	87.60	87.60	87.50
0 15	87.50	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.60	87.50	87.40	87.30	87.30	87.20	87.20
0 16	87.10	87.10	87.20	87.20	87.30	87.30	87.30	87.30	87.20	87.20	87.10	87.00	87.00	86.90	86.90	86.90
0 17	86.80	86.80	86.80	86.90	86.90	86.90	86.90	86.80	86.80	86.80	86.70	86.70	86.60	86.60	86.50	86.50
0 18	86.40	86.40	86.50	86.50	86.50	86.50	86.40	86.40	86.40	86.40	86.30	86.30	86.20	86.20	86.20	86.20
0 19	86.10	86.10	86.10	86.10	86.10	86.00	86.00	86.00	86.00	85.90	85.90	85.90	85.80	85.80	85.80	85.80
0 20	85.70	85.80	85.80	85.70	85.70	85.60	85.60	85.60	85.60	85.50	85.50	85.50	85.40	85.40	85.40	85.40

0 21	85.30	85.30	85.30	85.30	85.30	85.20	85.20	85.20	85.10	85.10
	85.10	85.10	85.00	85.00	85.00	85.00				
0 22	84.90	84.90	84.90	84.90	84.80	84.80	84.80	84.80	84.70	84.70
	84.70	84.60	84.60	84.60	84.60	84.50				
0 23	84.40	84.40	84.40	84.40	84.40	84.40	84.30	84.30	84.30	84.30
	84.20	84.20	84.20	84.20	84.10	84.10				
0 24	84.00	84.00	84.00	84.00	84.00	83.90	83.90	83.90	83.90	83.90
	83.80	83.80	83.80	83.80	83.70	83.70				
0 25	83.60	83.60	83.60	83.50	83.50	83.50	83.50	83.50	83.40	83.40
	83.40	83.40	83.40	83.40	83.30	83.30				
0 26	83.20	83.20	83.10	83.10	83.10	83.10	83.10	83.00	83.00	83.00
	83.00	83.00	83.00	82.90	82.90	82.90				
0 27	82.80	82.80	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.60
	82.50	82.50	82.50	82.50	82.50	82.50				
0 28	82.30	82.30	82.30	82.30	82.20	82.20	82.20	82.20	82.20	82.10
	82.10	82.10	82.10	82.10	82.00	82.00				
0 29	81.90	81.90	81.90	81.80	81.80	81.80	81.80	81.70	81.70	81.70
	81.70	81.60	81.60	81.60	81.60	81.60				
0 30	81.50	81.50	81.40	81.40	81.40	81.40	81.30	81.30	81.30	81.30
	81.20	81.20	81.20	81.20	81.20	81.20				
0 31	81.00	81.00	81.00	81.00	80.90	80.90	80.90	80.90	80.90	80.80
	80.80	80.80	80.80	80.70	80.70	80.70				
0 32	80.60	80.60	80.60	80.50	80.50	80.50	80.50	80.40	80.40	80.40
	80.40	80.30	80.30	80.30	80.30	80.30				
0 33	80.20	80.20	80.10	80.10	80.10	80.10	80.00	80.00	80.00	80.00
	79.90	79.90	79.90	79.90	79.80	79.80				
0 34	79.70	79.70	79.70	79.70	79.60	79.60	79.60	79.60	79.60	79.50
	79.50	79.50	79.40	79.40	79.40	79.30				
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10
	79.10	79.10	79.00	79.00	78.90	78.90				

0HEAD PRINT FORMAT IS FORMAT NUMBER 4 DRAWDOWN PRINT FORMAT IS FORMAT NUMBER 9
0HEADS WILL BE SAVED ON UNIT 30 DRAWDOWNS WILL BE SAVED ON UNIT 40
0OUTPUT CONTROL IS SPECIFIED EVERY TIME STEP
0 COLUMN TO ROW ANISOTROPY = 1.000000
0 DELR = 200.0000
0 DELC = 200.0000
0

HYD. COND. ALONG ROWS FOR LAYER 1 WILL BE READ ON UNIT 11 USING FORMAT: (16F4.0)

	1 11	2 12	3 13	4 14	5 15	6 16	7	8	9	10
0 1	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 2	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 3	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 4	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 5	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 6	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 7	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	300.0	300.0	300.0	300.0				
0 8	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	225.0	225.0	225.0	300.0				
0 9	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	225.0	225.0	225.0	300.0				
0 10	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0
	225.0	225.0	225.0	225.0	225.0	300.0				
0 11	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 12	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 13	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 14	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 15	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 16	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 17	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 18	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
	250.0	250.0	250.0	250.0	250.0	300.0				
0 19	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
											250.0	250.0	250.0	250.0	250.0	300.0
0 20	300.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	300.0
21	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 22	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 23	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 24	300.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 25	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 26	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 27	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 28	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 29	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 30	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 31	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 32	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 33	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 34	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 35	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0

0 BOTTOM = 30.00000 FOR LAYER 1

0 VERT HYD COND /THICKNESS = .1000000E-02 FOR LAYER 1

0

TRANSMIS. ALONG ROWS FOR LAYER 2 WILL BE READ ON UNIT 11 USING FORMAT: (16F5.0)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
2	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 3	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 4	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 5	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 6	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 7	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 8	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 9	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 10	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 11	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 12	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 13	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 14	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 15	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 16	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 17	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 18	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 19	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.

```
0 20    4000.      4000.      4000.      4000.      4000.      4000.      1500.      1500.      1500.      4000.
        4000.      4000.      4000.      4000.      4000.      4000.
0 21    3000.      3000.      3000.      3000.      3000.      3000.      1500.      1500.      1500.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 22    3000.      3000.      3000.      3000.      3000.      3000.      1500.      1500.      1500.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 23    3000.      3000.      3000.      3000.      3000.      3000.      1500.      1500.      1500.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 24    3000.      3000.      3000.      3000.      3000.      3000.      1500.      1500.      1500.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 25    3000.      3000.      3000.      3000.      3000.      3000.      1500.      1500.      1500.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 26    3000.      3000.      3000.      3000.      3000.      3000.      1500.      1500.      1500.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 27    3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 28    3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 29    3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 30    3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 31    3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 32    3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 33    3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 34    3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0 35    3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.      3000.
        3000.      3000.      3000.      3000.      3000.      3000.
0

                                                           SOLUTION BY THE STRONGLY IMPLICIT PROCEDURE
                                                           -------------------------------------------
0                                                  MAXIMUM ITERATIONS ALLOWED FOR CLOSURE =        50
                                                                  ACCELERATION PARAMETER =      1.0000
                                                       HEAD CHANGE CRITERION FOR CLOSURE =     .10000E-02
                                                       SIP HEAD CHANGE PRINTOUT INTERVAL =         1
0                                                      CALCULATE ITERATION PARAMETERS FROM MODEL CALCULATED WSEED
1                                                     STRESS PERIOD NO.    1, LENGTH =   1.000000
                                                      ----------------------------------------------

                                                      NUMBER OF TIME STEPS =      1

                                                       MULTIPLIER FOR DELT =      1.000

                                                    INITIAL TIME STEP SIZE =    1.000000

0              9 WELLS
                                                   LAYER    ROW    COL    STRESS RATE    WELL NO.
                                                   --------------------------------------------
                                                     1      14      5      -14824.          1
                                                     1      13      6      -14824.          2
                                                     1      13      8      -14824.          3
                                                     1      17      8      -5294.0          4
                                                     1      24      8      -8471.0          5
                                                     1      26      8      -10588.          6
                                                     2      13      8      -5294.0          7
                                                     2      17      8      -5294.0          8
                                                     2      24      8      -5294.0          9
0AVERAGE SEED =  .00187924
 MINIMUM SEED =  .00055600
0
    5 ITERATION PARAMETERS CALCULATED FROM AVERAGE SEED:

             .0000000E+00   .7917928E+00   .9566497E+00   .9909742E+00   .9981208E+00
0
    10 ITERATIONS FOR TIME STEP   1 IN STRESS PERIOD  1
0MAXIMUM HEAD CHANGE FOR EACH ITERATION:
0 HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL
 ------------------------------------------------------------------------------------------------------------------------------
   -2.556     (  2, 13,  8)  -.3714     (  2, 14,  7)  -.3609     (  1, 14,  7)  -.2421     (  1, 14,  9)  -.6619E-01 (  1, 23, 10)
    .9359E-02 (  2, 21,  7)   .7731E-02 (  1, 11,  9)   .5159E-02 (  1, 14,  8)   .3256E-02 (  1, 20, 10)   .8744E-03 (  1, 22,  9)
0
0HEAD/DRAWDOWN PRINTOUT FLAG = 1     TOTAL BUDGET PRINTOUT FLAG = 1     CELL-BY-CELL FLOW TERM FLAG = 0
0OUTPUT FLAGS FOR EACH LAYER:
          HEAD     DRAWDOWN  HEAD   DRAWDOWN
 LAYER  PRINTOUT  PRINTOUT   SAVE     SAVE
 ----------------------------------------
    1       1         1        1        1
```

1 2 1 1 1 1

1 HEAD IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.55	92.66	92.77	92.87	92.98	93.12	93.23	93.33	93.44	93.54	93.64	93.74	93.83	93.92	94.00
0 3	92.00	92.12	92.24	92.34	92.44	92.54	92.66	92.77	92.87	92.98	93.08	93.18	93.28	93.36	93.44	93.50
0 4	91.60	91.71	91.82	91.92	92.01	92.10	92.21	92.32	92.42	92.52	92.62	92.72	92.82	92.90	92.99	93.10
0 5	91.20	91.31	91.42	91.51	91.60	91.67	91.77	91.86	91.96	92.06	92.15	92.25	92.35	92.43	92.51	92.60
0 6	90.70	90.83	90.95	91.05	91.13	91.20	91.29	91.38	91.48	91.58	91.68	91.78	91.88	91.96	92.04	92.10
0 7	90.20	90.33	90.44	90.54	90.62	90.69	90.78	90.87	90.97	91.08	91.18	91.30	91.42	91.51	91.57	91.60
0 8	89.70	89.85	89.96	90.04	90.10	90.18	90.26	90.35	90.45	90.56	90.67	90.78	90.91	91.00	91.06	91.10
0 9	89.40	89.44	89.49	89.54	89.59	89.65	89.73	89.82	89.93	90.04	90.15	90.26	90.36	90.44	90.49	90.50
0 10	89.00	89.03	89.04	89.04	89.06	89.10	89.17	89.27	89.39	89.52	89.63	89.73	89.82	89.90	89.96	90.00
0 11	88.70	88.65	88.60	88.56	88.53	88.53	88.59	88.69	88.84	89.00	89.13	89.24	89.33	89.41	89.47	89.50
0 12	88.30	88.27	88.19	88.09	87.98	87.89	87.97	88.05	88.28	88.49	88.66	88.78	88.88	88.96	89.03	89.10
0 13	88.00	87.92	87.80	87.63	87.39	87.08	87.34	87.25	87.74	88.02	88.21	88.34	88.45	88.53	88.59	88.60
0 14	87.70	87.61	87.46	87.23	86.84	86.94	87.07	87.15	87.39	87.62	87.79	87.93	88.03	88.12	88.18	88.20
0 15	87.50	87.35	87.19	87.01	86.82	86.79	86.83	86.91	87.06	87.24	87.41	87.53	87.64	87.74	87.82	87.90
0 16	87.30	87.10	86.92	86.78	86.66	86.60	86.59	86.62	86.75	86.89	87.04	87.16	87.27	87.36	87.45	87.50
0 17	87.00	86.79	86.64	86.52	86.43	86.37	86.33	86.28	86.44	86.57	86.69	86.80	86.90	87.00	87.10	87.20
0 18	86.50	86.41	86.31	86.23	86.16	86.12	86.09	86.09	86.17	86.26	86.35	86.44	86.53	86.63	86.74	86.90
0 19	86.00	86.01	85.97	85.92	85.88	85.84	85.83	85.84	85.88	85.95	86.02	86.09	86.16	86.24	86.32	86.40
20	85.60	85.60	85.57	85.54	85.52	85.49	85.47	85.47	85.50	85.55	85.61	85.66	85.70	85.75	85.81	85.90
0 21	85.10	85.12	85.11	85.08	85.06	85.02	84.99	84.98	85.00	85.04	85.09	85.12	85.14	85.15	85.15	85.10
0 22	84.70	84.68	84.65	84.62	84.57	84.50	84.44	84.40	84.43	84.48	84.53	84.56	84.57	84.56	84.53	84.50
0 23	84.20	84.22	84.21	84.17	84.08	83.98	83.86	83.76	83.83	83.91	83.97	84.01	84.02	84.00	83.92	83.80
0 24	83.80	83.80	83.78	83.71	83.60	83.46	83.27	82.95	83.22	83.36	83.44	83.49	83.51	83.47	83.38	83.30
0 25	83.50	83.42	83.36	83.26	83.14	82.98	82.79	82.60	82.73	82.86	82.94	82.98	83.00	82.96	82.87	82.80
0 26	83.10	83.02	82.93	82.83	82.70	82.54	82.32	81.92	82.24	82.39	82.47	82.50	82.50	82.46	82.38	82.30
0 27	82.70	82.61	82.51	82.41	82.29	82.16	82.01	81.87	81.93	82.00	82.04	82.05	82.03	81.99	81.94	81.90
0 28	82.20	82.16	82.08	81.99	81.89	81.79	81.69	81.62	81.61	81.62	81.63	81.62	81.59	81.54	81.48	81.40
0 29	81.80	81.73	81.65	81.58	81.50	81.42	81.35	81.29	81.26	81.25	81.23	81.20	81.17	81.11	81.05	81.00
0 30	81.30	81.26	81.21	81.16	81.10	81.04	80.98	80.94	80.90	80.87	80.84	80.80	80.75	80.69	80.64	80.60
0 31	80.80	80.79	80.77	80.73	80.69	80.65	80.61	80.57	80.53	80.49	80.44	80.39	80.34	80.28	80.22	80.20
0 32	80.30	80.33	80.33	80.31	80.29	80.26	80.23	80.19	80.15	80.11	80.05	79.99	79.92	79.85	79.77	79.70
0 33	79.90	79.89	79.89	79.90	79.89	79.87	79.85	79.82	79.78	79.73	79.67	79.59	79.51	79.43	79.35	79.30
0 34	79.40	79.43	79.45	79.49	79.49	79.49	79.47	79.46	79.43	79.36	79.28	79.20	79.11	79.01	78.91	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

1 HEAD IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.[illegible]	92.10
0 2	90.90	90.97	91.05	91.14	91.22	91.27	91.35	91.43	91.50	91.54	91.59	91.63	91.68	91.71	9[illegible]	91.80
0 3	90.60	90.70	90.79	90.87	90.95	91.02	91.09	91.15	91.21	91.25	91.29	91.33	91.36	91.39	91.[illegible]	91.40
0 4	90.40	90.45	90.52	90.60	90.67	90.75	90.81	90.87	90.92	90.96	90.99	91.02	91.04	91.05	91.07	91.10
0 5	90.10	90.17	90.24	90.32	90.40	90.47	90.54	90.60	90.64	90.66	90.68	90.69	90.71	90.71	90.71	90.70
0 6	89.80	89.88	89.95	90.03	90.11	90.19	90.27	90.33	90.36	90.37	90.36	90.37	90.37	90.36	90.35	90.30
0 7	89.50	89.58	89.66	89.73	89.81	89.91	90.02	90.09	90.10	90.06	90.04	90.03	90.02	90.02	90.01	90.00
0 8	89.20	89.29	89.36	89.42	89.49	89.60	89.81	89.90	89.89	89.74	89.69	89.67	89.67	89.67	89.67	89.70
0 9	89.00	89.02	89.06	89.10	89.14	89.19	89.38	89.48	89.46	89.32	89.30	89.30	89.30	89.30	89.31	89.30
0 10	88.70	88.74	88.76	88.76	88.77	88.78	88.81	88.83	88.88	88.89	88.89	88.90	88.92	88.93	88.94	89.00
0 11	88.50	88.48	88.46	88.43	88.40	88.37	88.26	88.13	88.31	88.45	88.48	88.51	88.53	88.54	88.54	88.50
0 12	88.30	88.23	88.16	88.09	88.03	87.96	87.62	87.09	87.65	88.00	88.06	88.11	88.15	88.16	88.15	88.10
0 13	88.10	87.96	87.86	87.76	87.66	87.55	86.86	84.92	86.87	87.56	87.66	87.73	87.78	87.81	87.81	87.80
0 14	87.80	87.67	87.55	87.43	87.31	87.17	86.77	86.29	86.76	87.16	87.27	87.36	87.42	87.46	87.49	87.50
0 15	87.50	87.36	87.24	87.11	86.97	86.80	86.58	86.48	86.56	86.77	86.92	87.02	87.09	87.14	87.17	87.20
0 16	87.10	87.02	86.93	86.82	86.69	86.56	86.42	86.33	86.40	86.52	86.62	86.71	86.77	86.81	86.85	86.90
0 17	86.80	86.71	86.63	86.54	86.44	86.33	86.22	86.03	86.19	86.29	86.36	86.42	86.47	86.50	86.51	86.50
0 18	86.40	86.38	86.33	86.27	86.20	86.14	86.08	86.02	86.06	86.09	86.12	86.15	86.18	86.19	86.19	86.20
0 19	86.10	86.08	86.05	86.01	85.97	85.95	85.95	85.93	85.92	85.89	85.88	85.89	85.89	85.89	85.86	85.80
0 20	85.70	85.73	85.72	85.69	85.65	85.63	85.61	85.59	85.58	85.56	85.55	85.55	85.56	85.54	85.50	85.40
0 21	85.30	85.30	85.28	85.23	85.18	85.13	85.05	84.99	85.01	85.05	85.07	85.09	85.10	85.09	85.05	85.00
0 22	84.90	84.84	84.79	84.73	84.65	84.57	84.44	84.33	84.39	84.48	84.53	84.56	84.59	84.59	84.56	84.50
0 23	84.40	84.37	84.31	84.24	84.14	84.01	83.78	83.50	83.72	83.91	84.00	84.06	84.10	84.11	8[illegible]	84.10
0 24	84.00	83.94	83.86	83.76	83.65	83.48	83.08	82.15	83.02	83.37	83.49	83.57	83.63	83.66	83.[illegible]	83.70
0 25	83.60	83.51	83.42	83.32	83.20	83.05	82.79	82.50	82.73	82.93	83.04	83.12	83.18	83.22	83.26	83.30
0 26	83.20	83.10	83.00	82.89	82.78	82.65	82.45	82.32	82.39	82.53	82.62	82.69	82.74	82.79	82.84	82.90
0 27	82.80	82.68	82.58	82.48	82.37	82.25	82.11	82.03	82.05	82.14	82.21	82.27	82.32	82.37	82.42	82.50
0 28	82.30	82.24	82.16	82.07	81.98	81.89	81.80	81.75	81.75	81.78	81.82	81.87	81.90	81.94	81.98	82.00
0 29	81.90	81.82	81.74	81.67	81.59	81.52	81.46	81.42	81.41	81.42	81.44	81.46	81.49	81.52	81.56	81.60
0 30	81.50	81.40	81.33	81.27	81.20	81.15	81.10	81.07	81.05	81.05	81.05	81.06	81.08	81.10	81.14	81.20
0 31	81.00	80.97	80.91	80.86	80.81	80.76	80.73	80.70	80.68	80.67	80.66	80.66	80.67	80.68	80.69	80.70
0 32	80.60	80.55	80.50	80.45	80.41	80.38	80.35	80.32	80.30	80.28	80.27	80.26	80.25	80.25	80.26	80.30
0 33	80.20	80.13	80.08	80.04	80.01	79.99	79.96	79.94	79.92	79.90	79.88	79.86	79.84	79.82	79.81	79.80
0 34	79.70	79.69	79.65	79.62	79.61	79.59	79.58	79.57	79.55	79.51	79.49	79.47	79.43	79.40	79.35	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

0HEAD WILL BE SAVED ON UNIT 30 AT END OF TIME STEP 1, STRESS PERIOD 1

1 DRAWDOWN IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.05	.04	.03	.03	.02	.08	.07	.07	.06	.06	.06	.06	-.03	-.02	.00
0 3	.00	.08	.06	.06	.06	.16	.14	.13	.13	.12	.12	.02	.02	.04	.06	.00
0 4	.00	.09	.08	.08	.19	.20	.19	.18	.18	.18	.18	.08	.08	.00	.01	.00
0 5	.00	.09	.08	.09	.20	.23	.23	.24	.24	.24	.25	.15	.05	.07	.09	.00

0 6	.00	.07	.05	.15	.27	.30	.31	.32	.32	.32	.22	.22	.12	.14	.06	.00
0 7	.00	.07	.16	.16	.28	.31	.32	.33	.33	.32	.32	.20	.18	.09	.03	.00
0 8	.00	.05	.14	.26	.30	.32	.34	.35	.35	.34	.33	.22	.19	.10	.04	.00
0 9	.00	.06	.21	.26	.41	.45	.47	.48	.37	.36	.35	.24	.24	.16	.11	.00
0 10	.00	.17	.26	.36	.44	.50	.53	.53	.51	.38	.37	.27	.18	.10	.04	.00
0 11	.00	.15	.30	.44	.57	.67	.71	.71	.56	.50	.37	.36	.27	.19	.03	.00
0 12	.00	.13	.41	.61	.82	1.01	.93	.95	.72	.61	.44	.32	.22	.14	.07	.00
0 13	.00	.18	.40	.67	1.01	1.42	1.26	1.35	.96	.68	.49	.36	.25	.17	.11	.00
0 14	.00	.19	.44	.77	1.26	1.16	1.13	1.05	.91	.68	.51	.37	.27	.18	.12	.00
0 15	.00	.25	.41	.69	.88	1.01	.97	.99	.84	.66	.49	.37	.26	.16	.08	.00
0 16	.00	.20	.38	.52	.74	.80	.91	.88	.75	.71	.56	.44	.33	.24	.05	.00
0 17	.00	.11	.36	.48	.57	.73	.77	.92	.76	.63	.51	.40	.30	.20	.10	.00
0 18	.00	.09	.29	.37	.54	.58	.71	.71	.63	.54	.45	.36	.27	.17	.06	.00
0 19	.00	.09	.23	.38	.52	.56	.57	.66	.62	.55	.48	.41	.24	.16	.08	.00
0 20	.00	.10	.23	.36	.48	.51	.53	.63	.60	.55	.49	.34	.30	.15	.09	.00
0 21	.00	.08	.19	.32	.44	.48	.61	.62	.60	.56	.41	.38	.26	.15	.05	.00
0 22	.00	.12	.25	.28	.43	.50	.56	.70	.57	.52	.47	.34	.23	.14	.07	.00
0 23	.00	.08	.19	.33	.42	.52	.64	.74	.67	.59	.43	.39	.28	.20	.08	.00
0 24	.00	.10	.22	.29	.40	.64	.83	1.05	.78	.64	.46	.31	.29	.13	.02	.00
0 25	.00	.08	.14	.34	.46	.62	.81	1.00	.77	.64	.46	.32	.20	.14	.03	.00
0 26	.00	.08	.17	.27	.40	.56	.78	1.18	.76	.61	.43	.30	.20	.14	.02	.00
0 27	.00	.09	.19	.29	.41	.44	.59	.73	.67	.50	.36	.35	.17	.11	.06	.00
0 28	.00	.04	.12	.21	.31	.41	.51	.48	.49	.38	.37	.28	.21	.16	.02	.00
0 29	.00	.07	.15	.22	.20	.28	.35	.41	.34	.35	.27	.20	.13	.09	.05	.00
0 30	.00	.04	.09	.14	.20	.26	.32	.26	.30	.23	.26	.20	.15	.11	.06	.00
0 31	.00	.01	.03	.07	.11	.15	.19	.23	.17	.21	.16	.11	.06	.02	.08	.00
0 32	.00	.07	.07	.09	.11	.14	.17	.11	.15	.09	.15	.11	.08	.05	.03	.00
0 33	.00	.01	.01	.10	.11	.13	.05	.08	.12	.07	.03	.11	.09	.07	.05	.00
0 34	.00	-.03	.05	.01	.01	.01	.03	.04	.07	.04	.02	.00	-.01	-.01	-.01	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

1 DRAWDOWN IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.03	.05	-.04	-.02	.03	.05	-.03	.00	-.04	.01	-.03	.02	-.01	.04	.00
0 3	.00	-.00	.01	.03	.05	-.02	.01	.05	-.01	.05	.01	-.03	.04	.01	-.01	.00
0 4	.00	.05	-.02	.00	.03	-.05	-.01	.03	-.02	.04	.01	-.02	.06	.05	.03	.00
0 5	.00	.03	.06	-.02	.00	.03	-.04	.00	-.04	.04	.02	.01	-.01	-.01	-.01	.00
0 6	.00	.02	.05	-.03	-.01	.01	-.07	-.03	-.06	-.07	.04	.03	.03	.04	.05	.00
0 7	.00	.02	.04	.07	-.01	-.01	-.12	-.09	-.10	-.06	.06	.07	.08	.08	-.01	.00
0 8	.00	.01	.04	.08	.01	-.00	-.21	-.20	-.19	-.04	.01	.03	.03	.03	.03	.00
0 9	.00	.08	.04	.10	.16	.11	-.08	-.08	-.06	.08	.10	.10	.10	.10	-.01	.00
0 10	.00	.06	.14	.14	.23	.22	.19	.27	.22	.21	.21	.20	.08	.07	.06	.00
0 11	.00	.12	.14	.17	.30	.33	.44	.67	.49	.35	.22	.19	.17	.16	.06	.00
0 12	.00	.07	.14	.31	.37	.44	.88	1.41	.85	.40	.34	.29	.25	.14	.05	.00
0 13	.00	.14	.24	.34	.44	.55	1.34	3.28	1.33	.54	.44	.37	.22	.19	.09	.00
0 14	.00	.13	.25	.37	.59	.73	1.13	1.61	1.14	.64	.53	.34	.28	.14	.11	.00
0 15	.00	.14	.26	.39	.63	.80	1.02	1.12	1.04	.83	.58	.38	.21	.16	.03	.00
0 16	.00	.08	.27	.38	.61	.74	.88	.97	.80	.68	.48	.29	.23	.09	.05	.00
0 17	.00	.09	.17	.36	.46	.57	.68	.77	.61	.51	.34	.28	.13	.10	-.01	.00
0 18	.00	.02	.17	.23	.30	.36	.32	.38	.34	.31	.18	.15	.02	.01	.01	.00
0 19	.00	.02	.05	.09	.13	.05	.05	.07	.08	.01	.02	.01	-.09	-.09	-.06	.00
0 20	.00	.07	.08	.01	.05	-.03	-.01	.01	.02	-.06	-.05	-.05	-.16	-.14	-.10	.00
0 21	.00	-.00	.02	.07	.12	.07	.15	.21	.09	.05	.03	.01	-.10	-.09	-.05	.00
0 22	.00	.06	.11	.17	.15	.23	.36	.47	.31	.22	.17	.04	.01	.01	.04	.00
0 23	.00	.03	.09	.16	.26	.39	.52	.80	.58	.39	.20	.14	.10	.09	-.01	.00
0 24	.00	.06	.14	.24	.35	.42	.82	1.75	.88	.53	.31	.23	.17	.14	.02	.00
0 25	.00	.09	.18	.18	.30	.45	.71	1.00	.67	.47	.36	.28	.22	.18	.04	.00
0 26	.00	.10	.10	.21	.32	.45	.65	.68	.61	.47	.38	.31	.26	.11	.06	.00
0 27	.00	.12	.12	.22	.33	.35	.49	.57	.55	.46	.29	.23	.18	.13	.08	.00
0 28	.00	.06	.14	.23	.22	.31	.40	.45	.45	.32	.28	.23	.20	.16	.02	.00
0 29	.00	.08	.16	.13	.21	.28	.34	.28	.29	.28	.26	.14	.11	.08	.04	.00
0 30	.00	.10	.07	.13	.20	.25	.20	.23	.25	.25	.15	.14	.12	.10	.06	.00
0 31	.00	.03	.09	.14	.09	.14	.17	.20	.22	.13	.14	.14	.13	.02	.01	.00
0 32	.00	.05	.10	.05	.09	.12	.15	.08	.10	.12	.13	.04	.05	.05	.04	.00
0 33	.00	.07	.02	.06	.09	.11	.04	.06	.08	.10	.02	.04	.06	.08	-.01	.00
0 34	.00	.01	.05	.08	-.01	.01	.02	.03	.05	-.01	.01	.03	-.03	.00	.05	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

ODRAWDOWN WILL BE SAVED ON UNIT 40 AT END OF TIME STEP 1, STRESS PERIOD 1
0

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 1

0 CUMULATIVE VOLUMES L**3 RATES FOR THIS TIME STEP L**3/T

IN: IN:

STORAGE = .00000 STORAGE = .00000

```
                 CONSTANT HEAD =     .17909E+06
                         WELLS =     .00000
0                     TOTAL IN =     .17909E+06
0                   OUT:
                    ----
                       STORAGE =     .00000
                 CONSTANT HEAD =     94371.
                         WELLS =     84707.
0                    TOTAL OUT =     .17908E+06
0                     IN - OUT =     13.531
0        PERCENT DISCREPANCY =                 .01
```


```
                 CONSTANT HEAD =     .17909E+06
                         WELLS =     .00000
                      TOTAL IN =     .17909E+06
                    OUT:
                    ----
                       STORAGE =     .00000
                 CONSTANT HEAD =     94371.
                         WELLS =     84707.
                     TOTAL OUT =     .17908E+06
                      IN - OUT =     13.531
         PERCENT DISCREPANCY =                 .01
```


0

TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 1

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	86400.0	1440.00	24.0000	1.00000	.273785E-02
STRESS PERIOD TIME	86400.0	1440.00	24.0000	1.00000	.273785E-02
TOTAL SIMULATION TIME	86400.0	1440.00	24.0000	1.00000	.273785E-02

1

```
1                    U.S. GEOLOGICAL SURVEY MODULAR FINITE-DIFFERENCE GROUND-WATER MODEL
0SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     SENSIT ANAL, SIMULATION 4A: HYDRAULIC COND X 0.5
    2 LAYERS         35 ROWS         16 COLUMNS
   1 STRESS PERIOD(S) IN SIMULATION
 MODEL TIME UNIT IS DAYS
0I/O UNITS:
 ELEMENT OF IUNIT:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
         I/O UNIT: 11 12  0  0  0  0  0  0 19  0  0 22  0  0  0  0  0  0  0  0  0  0  0  0
0BAS1 -- BASIC MODEL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT  1
 ARRAYS RHS AND BUFF WILL SHARE MEMORY.
 START HEAD WILL BE SAVED
    10699 ELEMENTS IN X ARRAY ARE USED BY BAS
    10699 ELEMENTS OF X ARRAY USED OUT OF  100000
0BCF1 -- BLOCK-CENTERED FLOW PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 11
 STEADY-STATE SIMULATION
      LAYER  AQUIFER TYPE
      -------------------
        1         1
        2         0
     1122 ELEMENTS IN X ARRAY ARE USED BY BCF
    11821 ELEMENTS OF X ARRAY USED OUT OF  100000
0WEL1 -- WELL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM 12
 MAXIMUM OF    9 WELLS
       36 ELEMENTS IN X ARRAY ARE USED FOR WELLS
    11857 ELEMENTS OF X ARRAY USED OUT OF  100000
0SIP1 -- STRONGLY IMPLICIT PROCEDURE SOLUTION PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 19
 MAXIMUM OF  50 ITERATIONS ALLOWED FOR CLOSURE
  5 ITERATION PARAMETERS
     4685 ELEMENTS IN X ARRAY ARE USED BY SIP
    16542 ELEMENTS OF X ARRAY USED OUT OF  100000
1SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     SENSIT ANAL, SIMULATION 4A: HYDRAULIC COND X 0.5
0
```

BOUNDARY ARRAY FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
0 2	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 3	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 4	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 5	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 6	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
7	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
8	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 9	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 10	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 11	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 12	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 13	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 14	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 15	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 16	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 17	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 18	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 19	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 20	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 21	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 22	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 23	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 24	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 25	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 26	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 27	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 28	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 29	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 30	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 31	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 32	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 33	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 34	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 35	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

0

BOUNDARY ARRAY FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

0 1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
0 2	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 3	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 4	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 5	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 6	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 7	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 8	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 9	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 10	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 11	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 12	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 13	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 14	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 15	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 16	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 17	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 18	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 19	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 20	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 21	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 22	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 23	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 24	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 25	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 26	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 27	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 28	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 29	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 30	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 31	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 32	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 33	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 34	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 35	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2

0AQUIFER HEAD WILL BE SET TO 999.99 AT ALL NO-FLOW NODES (IBOUND=0).
0

INITIAL HEAD FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.60	92.70	92.80	92.90	93.00	93.20	93.30	93.40	93.50	93.60	93.70	93.80	93.80	93.90	94.00
0 3	92.00	92.20	92.30	92.40	92.50	92.70	92.80	92.90	93.00	93.10	93.20	93.20	93.30	93.40	93.50	93.50
0 4	91.60	91.80	91.90	92.00	92.20	92.30	92.40	92.50	92.60	92.70	92.80	92.80	92.90	92.90	93.00	93.10
0 5	91.20	91.40	91.50	91.60	91.80	91.90	92.00	92.10	92.20	92.30	92.40	92.40	92.40	92.50	92.60	92.60
0 6	90.70	90.90	91.00	91.20	91.40	91.50	91.60	91.70	91.80	91.90	91.90	92.00	92.00	92.10	92.10	92.10
0 7	90.20	90.40	90.60	90.70	90.90	91.00	91.10	91.20	91.30	91.40	91.50	91.50	91.60	91.60	91.60	91.60
0 8	89.70	89.90	90.10	90.30	90.40	90.50	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.10	91.10	91.10
0 9	89.40	89.50	89.70	89.80	90.00	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.60	90.50
0 10	89.00	89.20	89.30	89.40	89.50	89.60	89.70	89.80	89.90	89.90	90.00	90.00	90.00	90.00	90.00	90.00
0 11	88.70	88.80	88.90	89.00	89.10	89.20	89.30	89.40	89.40	89.50	89.50	89.60	89.60	89.60	89.50	89.50
0 12	88.30	88.40	88.60	88.70	88.80	88.90	88.90	89.00	89.00	89.10	89.10	89.10	89.10	89.10	89.10	89.10
0 13	88.00	88.10	88.20	88.30	88.40	88.50	88.60	88.60	88.70	88.70	88.70	88.70	88.70	88.70	88.70	88.60
0 14	87.70	87.80	87.90	88.00	88.10	88.10	88.20	88.20	88.30	88.30	88.30	88.30	88.30	88.30	88.30	88.20
0 15	87.50	87.60	87.60	87.70	87.70	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.90	87.90	87.90	87.90
0 16	87.30	87.30	87.30	87.30	87.40	87.40	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.50	87.50
0 17	87.00	86.90	87.00	87.00	87.00	87.10	87.10	87.20	87.20	87.20	87.20	87.20	87.20	87.20	87.20	87.20
0 18	86.50	86.50	86.60	86.60	86.70	86.70	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.90
0 19	86.00	86.10	86.20	86.30	86.40	86.40	86.40	86.50	86.50	86.50						

											86.50	86.50	86.40	86.40	86.40	86.40
0 20	85.60	85.70	85.80	85.90	86.00	86.00	86.00	86.10	86.10	86.10	86.10	86.00	86.00	85.90	85.90	85.90
21	85.10	85.20	85.30	85.40	85.50	85.50	85.60	85.60	85.60	85.60	85.50	85.50	85.40	85.30	85.20	85.10
0 22	84.70	84.80	84.90	84.90	85.00	85.00	85.00	85.10	85.00	85.00	85.00	84.90	84.80	84.70	84.60	84.50
0 23	84.20	84.30	84.40	84.50	84.50	84.50	84.50	84.50	84.50	84.50	84.40	84.40	84.30	84.20	84.00	83.80
0 24	83.80	83.90	84.00	84.00	84.00	84.10	84.10	84.00	84.00	84.00	83.90	83.80	83.80	83.60	83.40	83.30
0 25	83.50	83.50	83.50	83.60	83.60	83.60	83.60	83.60	83.50	83.50	83.40	83.30	83.20	83.10	82.90	82.80
0 26	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.00	83.00	82.90	82.80	82.70	82.60	82.40	82.30
0 27	82.70	82.70	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.50	82.40	82.40	82.20	82.10	82.00	81.90
0 28	82.20	82.20	82.20	82.20	82.20	82.20	82.20	82.10	82.10	82.00	82.00	81.90	81.80	81.70	81.50	81.40
0 29	81.80	81.80	81.80	81.80	81.70	81.70	81.70	81.70	81.60	81.60	81.50	81.40	81.30	81.20	81.10	81.00
0 30	81.30	81.30	81.30	81.30	81.30	81.30	81.30	81.20	81.20	81.10	81.10	81.00	80.90	80.80	80.70	80.60
0 31	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.70	80.70	80.60	80.50	80.40	80.30	80.30	80.20
0 32	80.30	80.40	80.40	80.40	80.40	80.40	80.40	80.30	80.30	80.20	80.20	80.10	80.00	79.90	79.80	79.70
0 33	79.90	79.90	79.90	80.00	80.00	80.00	79.90	79.90	79.90	79.80	79.70	79.70	79.60	79.50	79.40	79.30
0 34	79.40	79.40	79.50	79.50	79.50	79.50	79.50	79.50	79.50	79.40	79.30	79.20	79.10	79.00	78.90	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

0

INITIAL HEAD FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	92.10
0 2	90.90	91.00	91.10	91.10	91.20	91.30	91.40	91.40	91.50	91.50	91.60	91.60	91.70	91.70	91.80	91.80
3	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.20	91.20	91.30	91.30	91.30	91.40	91.40	91.40	91.40
0 4	90.40	90.50	90.50	90.60	90.70	90.70	90.80	90.90	90.90	91.00	91.00	91.00	91.10	91.10	91.10	91.10
0 5	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.70	90.70	90.70	90.70	90.70	90.70	90.70
0 6	89.80	89.90	90.00	90.00	90.10	90.20	90.20	90.30	90.30	90.30	90.40	90.40	90.40	90.40	90.40	90.30
0 7	89.50	89.60	89.70	89.80	89.80	89.90	89.90	90.00	90.00	90.00	90.10	90.10	90.10	90.10	90.00	90.00
0 8	89.20	89.30	89.40	89.50	89.50	89.60	89.60	89.70	89.70	89.70	89.70	89.70	89.70	89.70	89.70	89.70
0 9	89.00	89.10	89.10	89.20	89.30	89.30	89.30	89.40	89.40	89.40	89.40	89.40	89.40	89.40	89.30	89.30
0 10	88.70	88.80	88.90	88.90	89.00	89.00	89.00	89.10	89.10	89.10	89.10	89.10	89.00	89.00	89.00	89.00
0 11	88.50	88.60	88.60	88.60	88.70	88.70	88.70	88.80	88.80	88.80	88.70	88.70	88.70	88.70	88.60	88.50
0 12	88.30	88.30	88.30	88.40	88.40	88.40	88.50	88.50	88.50	88.40	88.40	88.40	88.40	88.30	88.20	88.10
0 13	88.10	88.10	88.10	88.10	88.10	88.10	88.20	88.20	88.20	88.10	88.10	88.10	88.00	88.00	87.90	87.80
0 14	87.80	87.80	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.80	87.80	87.70	87.70	87.60	87.60	87.50
0 15	87.50	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.60	87.50	87.40	87.30	87.30	87.20	87.20
0 16	87.10	87.10	87.20	87.20	87.30	87.30	87.30	87.30	87.20	87.20	87.10	87.00	87.00	86.90	86.90	86.90
0 17	86.80	86.80	86.80	86.90	86.90	86.90	86.90	86.80	86.80	86.80	86.70	86.70	86.60	86.60	86.50	86.50
0 18	86.40	86.40	86.50	86.50	86.50	86.50	86.40	86.40	86.40	86.40	86.30	86.30	86.20	86.20	86.20	86.20
0 19	86.10	86.10	86.10	86.10	86.10	86.00	86.00	86.00	86.00	85.90	85.90	85.90	85.80	85.80	85.80	85.80
0 20	85.70	85.80	85.80	85.70	85.70	85.60	85.60	85.60	85.60	85.50	85.50	85.50	85.40	85.40	85.40	85.40

0 21	85.30	85.30	85.30	85.30	85.30	85.20	85.20	85.20	85.10	85.10
	85.10	85.10	85.00	85.00	85.00	85.00				
0 22	84.90	84.90	84.90	84.90	84.80	84.80	84.80	84.80	84.70	84.70
	84.70	84.60	84.60	84.60	84.60	84.50				
0 23	84.40	84.40	84.40	84.40	84.40	84.40	84.30	84.30	84.30	84.30
	84.20	84.20	84.20	84.20	84.10	84.10				
0 24	84.00	84.00	84.00	84.00	84.00	83.90	83.90	83.90	83.90	83.90
	83.80	83.80	83.80	83.80	83.70	83.70				
0 25	83.60	83.60	83.60	83.50	83.50	83.50	83.50	83.50	83.40	83.40
	83.40	83.40	83.40	83.40	83.30	83.30				
0 26	83.20	83.20	83.10	83.10	83.10	83.10	83.10	83.00	83.00	83.00
	83.00	83.00	83.00	82.90	82.90	82.90				
0 27	82.80	82.80	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.60
	82.50	82.50	82.50	82.50	82.50	82.50				
0 28	82.30	82.30	82.30	82.30	82.20	82.20	82.20	82.20	82.20	82.10
	82.10	82.10	82.10	82.10	82.00	82.00				
0 29	81.90	81.90	81.90	81.80	81.80	81.80	81.80	81.70	81.70	81.70
	81.70	81.60	81.60	81.60	81.60	81.60				
0 30	81.50	81.50	81.40	81.40	81.40	81.40	81.30	81.30	81.30	81.30
	81.20	81.20	81.20	81.20	81.20	81.20				
0 31	81.00	81.00	81.00	81.00	80.90	80.90	80.90	80.90	80.90	80.80
	80.80	80.80	80.80	80.70	80.70	80.70				
0 32	80.60	80.60	80.60	80.50	80.50	80.50	80.50	80.40	80.40	80.40
	80.40	80.30	80.30	80.30	80.30	80.30				
0 33	80.20	80.20	80.10	80.10	80.10	80.10	80.00	80.00	80.00	80.00
	79.90	79.90	79.90	79.90	79.80	79.80				
0 34	79.70	79.70	79.70	79.70	79.60	79.60	79.60	79.60	79.60	79.50
	79.50	79.50	79.40	79.40	79.40	79.30				
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10
	79.10	79.10	79.00	79.00	78.90	78.90				

0HEAD PRINT FORMAT IS FORMAT NUMBER 4 DRAWDOWN PRINT FORMAT IS FORMAT NUMBER 9
0HEADS WILL BE SAVED ON UNIT 30 DRAWDOWNS WILL BE SAVED ON UNIT 40
0OUTPUT CONTROL IS SPECIFIED EVERY TIME STEP
0 COLUMN TO ROW ANISOTROPY = 1.000000
0 DELR = 200.0000
0 DELC = 200.0000
0

HYD. COND. ALONG ROWS FOR LAYER 1 WILL BE READ ON UNIT 11 USING FORMAT: (16F4.0)

	1 11	2 12	3 13	4 14	5 15	6 16	7	8	9	10
0 1	150.0	150.0	150.0	150.0	150.0	113.0	113.0	113.0	113.0	113.0
	113.0	113.0	150.0	150.0	150.0	150.0				
0 2	150.0	150.0	150.0	150.0	150.0	113.0	113.0	113.0	113.0	113.0
	113.0	113.0	150.0	150.0	150.0	150.0				
0 3	150.0	150.0	150.0	150.0	150.0	113.0	113.0	113.0	113.0	113.0
	113.0	113.0	150.0	150.0	150.0	150.0				
0 4	150.0	150.0	150.0	150.0	150.0	113.0	113.0	113.0	113.0	113.0
	113.0	113.0	150.0	150.0	150.0	150.0				
0 5	150.0	150.0	150.0	150.0	150.0	113.0	113.0	113.0	113.0	113.0
	113.0	113.0	150.0	150.0	150.0	150.0				
0 6	150.0	113.0	113.0	113.0	113.0	100.0	100.0	100.0	100.0	100.0
	113.0	113.0	150.0	150.0	150.0	150.0				
0 7	150.0	113.0	113.0	113.0	113.0	100.0	100.0	100.0	100.0	100.0
	113.0	113.0	150.0	150.0	150.0	150.0				
0 8	150.0	113.0	113.0	113.0	113.0	100.0	100.0	100.0	100.0	100.0
	113.0	113.0	113.0	113.0	113.0	150.0				
0 9	150.0	113.0	113.0	113.0	113.0	100.0	100.0	100.0	100.0	100.0
	113.0	113.0	113.0	113.0	113.0	150.0				
0 10	150.0	113.0	113.0	113.0	113.0	100.0	100.0	100.0	100.0	100.0
	113.0	113.0	113.0	113.0	113.0	150.0				
0 11	150.0	125.0	125.0	125.0	125.0	100.0	100.0	100.0	100.0	100.0
	125.0	125.0	125.0	125.0	125.0	150.0				
0 12	150.0	125.0	125.0	125.0	125.0	100.0	100.0	100.0	100.0	100.0
	125.0	125.0	125.0	125.0	125.0	150.0				
0 13	150.0	125.0	125.0	125.0	125.0	100.0	100.0	100.0	100.0	100.0
	125.0	125.0	125.0	125.0	125.0	150.0				
0 14	150.0	125.0	125.0	125.0	125.0	100.0	100.0	100.0	100.0	100.0
	125.0	125.0	125.0	125.0	125.0	150.0				
0 15	150.0	125.0	125.0	125.0	125.0	100.0	100.0	100.0	100.0	100.0
	125.0	125.0	125.0	125.0	125.0	150.0				
0 16	150.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0
	125.0	125.0	125.0	125.0	125.0	150.0				
0 17	150.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0
	125.0	125.0	125.0	125.0	125.0	150.0				
0 18	150.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0
	125.0	125.0	125.0	125.0	125.0	150.0				
0 19	150.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0

	125.0	125.0	125.0	125.0	125.0	150.0				
0 20	150.0	88.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00
	88.00	88.00	88.00	88.00	88.00	150.0				
21	150.0	88.00	88.00	88.00	75.00	75.00	75.00	75.00	75.00	75.00
	75.00	75.00	88.00	88.00	88.00	150.0				
0 22	150.0	88.00	88.00	88.00	75.00	75.00	75.00	75.00	75.00	75.00
	75.00	75.00	88.00	88.00	88.00	150.0				
0 23	150.0	88.00	88.00	88.00	75.00	75.00	75.00	75.00	75.00	75.00
	75.00	75.00	88.00	88.00	88.00	150.0				
0 24	150.0	88.00	88.00	88.00	75.00	75.00	75.00	75.00	75.00	75.00
	75.00	75.00	88.00	88.00	88.00	150.0				
0 25	150.0	100.0	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
	75.00	75.00	75.00	75.00	100.0	150.0				
0 26	150.0	100.0	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
	75.00	75.00	75.00	75.00	100.0	150.0				
0 27	150.0	100.0	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
	75.00	75.00	75.00	75.00	100.0	150.0				
0 28	150.0	100.0	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
	75.00	75.00	75.00	75.00	100.0	150.0				
0 29	150.0	100.0	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
	75.00	75.00	75.00	75.00	100.0	150.0				
0 30	150.0	100.0	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
	75.00	75.00	75.00	75.00	100.0	150.0				
0 31	150.0	100.0	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
	75.00	75.00	75.00	75.00	100.0	150.0				
0 32	150.0	100.0	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
	75.00	75.00	75.00	75.00	100.0	150.0				
0 33	150.0	100.0	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
	75.00	75.00	75.00	75.00	100.0	150.0				
0 34	150.0	100.0	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
	75.00	75.00	75.00	75.00	100.0	150.0				
0 35	150.0	100.0	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
	75.00	75.00	75.00	75.00	100.0	150.0				

0 BOTTOM = 30.00000 FOR LAYER 1

0 VERT HYD COND /THICKNESS = .1000000E-02 FOR LAYER 1

0

TRANSMIS. ALONG ROWS FOR LAYER 2 WILL BE READ ON UNIT 11 USING FORMAT: (16F5.0)

	1 11	2 12	3 13	4 14	5 15	6 16	7	8	9	10
1	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
2	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 3	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 4	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 5	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 6	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 7	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 8	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 9	3000.	3000.	3000.	3000.	3000.	3000.	350.0	350.0	350.0	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 10	3000.	3000.	3000.	3000.	3000.	3000.	350.0	350.0	350.0	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 11	3000.	3000.	3000.	3000.	3000.	3000.	350.0	350.0	350.0	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 12	3000.	3000.	3000.	3000.	3000.	3000.	350.0	350.0	350.0	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 13	3000.	3000.	3000.	3000.	3000.	3000.	350.0	350.0	350.0	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 14	3000.	3000.	3000.	3000.	3000.	3000.	350.0	350.0	350.0	3000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 15	3000.	3000.	3000.	3000.	3000.	4000.	4000.	4000.	4000.	4000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 16	3000.	3000.	3000.	3000.	3000.	4000.	4000.	4000.	4000.	4000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 17	3000.	3000.	3000.	3000.	3000.	4000.	4000.	4000.	4000.	4000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 18	3000.	3000.	3000.	3000.	3000.	4000.	4000.	4000.	4000.	4000.
	3000.	3000.	3000.	3000.	3000.	3000.				
0 19	3000.	3000.	3000.	3000.	3000.	4000.	4000.	4000.	4000.	4000.
	3000.	3000.	3000.	3000.	3000.	3000.				

0 20	2000.	2000.	2000.	2000.	2000.	2000.	750.0	750.0	750.0	2000.
	2000.	2000.	2000.	2000.	2000.	2000.				
0 21	1500.	1500.	1500.	1500.	1500.	1500.	750.0	750.0	750.0	1500.
	1500.	1500.	1500.	1500.	1500.	1500.				
0 22	1500.	1500.	1500.	1500.	1500.	1500.	750.0	750.0	750.0	1500.
	1500.	1500.	1500.	1500.	1500.	1500.				
0 23	1500.	1500.	1500.	1500.	1500.	1500.	750.0	750.0	750.0	1500.
	1500.	1500.	1500.	1500.	1500.	1500.				
0 24	1500.	1500.	1500.	1500.	1500.	1500.	750.0	750.0	750.0	1500.
	1500.	1500.	1500.	1500.	1500.	1500.				
0 25	1500.	1500.	1500.	1500.	1500.	1500.	750.0	750.0	750.0	1500.
	1500.	1500.	1500.	1500.	1500.	1500.				
0 26	1500.	1500.	1500.	1500.	1500.	1500.	750.0	750.0	750.0	1500.
	1500.	1500.	1500.	1500.	1500.	1500.				
0 27	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.
	1500.	1500.	1500.	1500.	1500.	1500.				
0 28	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.
	1500.	1500.	1500.	1500.	1500.	1500.				
0 29	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.
	1500.	1500.	1500.	1500.	1500.	1500.				
0 30	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.
	1500.	1500.	1500.	1500.	1500.	1500.				
0 31	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.
	1500.	1500.	1500.	1500.	1500.	1500.				
0 32	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.
	1500.	1500.	1500.	1500.	1500.	1500.				
0 33	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.
	1500.	1500.	1500.	1500.	1500.	1500.				
0 34	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.
	1500.	1500.	1500.	1500.	1500.	1500.				
0 35	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.
	1500.	1500.	1500.	1500.	1500.	1500.				

0

SOLUTION BY THE STRONGLY IMPLICIT PROCEDURE

0

MAXIMUM ITERATIONS ALLOWED FOR CLOSURE = 50
ACCELERATION PARAMETER = 1.0000
HEAD CHANGE CRITERION FOR CLOSURE = .10000E-02
SIP HEAD CHANGE PRINTOUT INTERVAL = 1

0

CALCULATE ITERATION PARAMETERS FROM MODEL CALCULATED WSEED

1

STRESS PERIOD NO. 1, LENGTH = 1.000000

NUMBER OF TIME STEPS = 1

MULTIPLIER FOR DELT = 1.000

INITIAL TIME STEP SIZE = 1.000000

0 9 WELLS

LAYER	ROW	COL	STRESS RATE	WELL NO.
1	14	5	-13476.	1
1	13	6	-13476.	2
1	13	8	-13476.	3
1	17	8	-4813.0	4
1	24	8	-7701.0	5
1	26	8	-9626.0	6
2	13	8	-4813.0	7
2	17	8	-4813.0	8
2	24	8	-4813.0	9

0AVERAGE SEED = .00194253
MINIMUM SEED = .00055362
0
5 ITERATION PARAMETERS CALCULATED FROM AVERAGE SEED:

.0000000E+00 .7900615E+00 .9559258E+00 .9907472E+00 .9980575E+00

0
11 ITERATIONS FOR TIME STEP 1 IN STRESS PERIOD 1
0MAXIMUM HEAD CHANGE FOR EACH ITERATION:

0 HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL
-4.456	(2, 13, 8)	-.5950	(1, 13, 6)	-.6296	(1, 14, 7)	-.4238	(1, 15, 8)	-.1201	(1, 23, 10)
.1354E-01	(2, 21, 7)	.1216E-01	(1, 23, 9)	.8511E-02	(1, 14, 8)	.5964E-02	(1, 21, 9)	.1579E-02	(1, 18, 12)
-.3491E-03	(2, 24, 8)								

0
0HEAD/DRAWDOWN PRINTOUT FLAG = 1 TOTAL BUDGET PRINTOUT FLAG = 1 CELL-BY-CELL FLOW TERM FLAG = 0
0OUTPUT FLAGS FOR EACH LAYER:

LAYER	HEAD PRINTOUT	DRAWDOWN PRINTOUT	HEAD SAVE	DRAWDOWN SAVE

1 1 1 1 1
2 1 1 1 1

HEAD IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.54	92.65	92.75	92.84	92.95	93.08	93.20	93.30	93.41	93.51	93.62	93.72	93.82	93.91	94.00
0 3	92.00	92.11	92.21	92.30	92.39	92.48	92.60	92.71	92.81	92.92	93.02	93.14	93.24	93.34	93.43	93.50
0 4	91.60	91.69	91.78	91.86	91.94	92.02	92.12	92.22	92.33	92.43	92.54	92.65	92.76	92.86	92.97	93.10
0 5	91.20	91.28	91.36	91.44	91.50	91.56	91.65	91.74	91.84	91.95	92.05	92.17	92.28	92.38	92.49	92.60
0 6	90.70	90.80	90.88	90.95	91.01	91.06	91.13	91.23	91.33	91.44	91.55	91.67	91.80	91.91	92.01	92.10
0 7	90.20	90.28	90.35	90.40	90.45	90.50	90.58	90.67	90.77	90.90	91.02	91.16	91.32	91.44	91.53	91.60
0 8	89.70	89.80	89.84	89.86	89.89	89.93	90.00	90.09	90.20	90.34	90.48	90.62	90.79	90.91	91.02	91.10
0 9	89.40	89.37	89.35	89.32	89.31	89.33	89.39	89.48	89.61	89.77	89.92	90.07	90.21	90.34	90.44	90.50
0 10	89.00	88.94	88.85	88.76	88.70	88.69	88.73	88.84	89.00	89.18	89.35	89.51	89.66	89.79	89.91	90.00
0 11	88.70	88.53	88.37	88.20	88.06	87.98	88.02	88.13	88.35	88.60	88.81	88.98	89.15	89.29	89.41	89.50
0 12	88.30	88.13	87.91	87.65	87.37	87.14	87.21	87.29	87.67	88.03	88.30	88.50	88.68	88.83	88.97	89.10
0 13	88.00	87.77	87.47	87.10	86.60	85.96	86.39	86.15	87.02	87.50	87.82	88.04	88.23	88.39	88.52	88.60
0 14	87.70	87.45	87.11	86.65	85.87	86.03	86.21	86.33	86.73	87.10	87.40	87.62	87.81	87.97	88.11	88.20
0 15	87.50	87.21	86.87	86.51	86.15	86.07	86.11	86.22	86.46	86.75	87.01	87.23	87.42	87.59	87.75	87.90
0 16	87.30	86.97	86.65	86.36	86.12	86.00	85.96	86.00	86.19	86.42	86.65	86.86	87.04	87.21	87.38	87.50
0 17	87.00	86.68	86.40	86.17	85.98	85.85	85.76	85.64	85.91	86.12	86.32	86.50	86.68	86.85	87.03	87.20
0 18	86.50	86.31	86.10	85.92	85.77	85.66	85.59	85.57	85.69	85.84	86.00	86.16	86.32	86.49	86.67	86.90
0 19	86.00	85.92	85.79	85.64	85.52	85.43	85.37	85.36	85.43	85.54	85.67	85.81	85.95	86.10	86.25	86.40
20	85.60	85.52	85.40	85.28	85.18	85.09	85.03	85.02	85.07	85.16	85.27	85.39	85.49	85.61	85.75	85.90
0 21	85.10	85.05	84.95	84.84	84.74	84.63	84.55	84.52	84.56	84.64	84.75	84.86	84.94	85.02	85.09	85.10
0 22	84.70	84.61	84.50	84.38	84.24	84.10	83.97	83.90	83.95	84.06	84.18	84.29	84.38	84.44	84.48	84.50
0 23	84.20	84.15	84.05	83.92	83.74	83.54	83.32	83.14	83.29	83.46	83.61	83.74	83.83	83.87	83.87	83.80
0 24	83.80	83.74	83.63	83.47	83.26	82.99	82.64	82.05	82.58	82.87	83.07	83.21	83.31	83.35	83.33	83.30
0 25	83.50	83.36	83.22	83.04	82.80	82.52	82.17	81.83	82.10	82.37	82.57	82.71	82.81	82.84	82.82	82.80
0 26	83.10	82.97	82.81	82.61	82.38	82.09	81.70	80.98	81.61	81.93	82.12	82.24	82.32	82.35	82.34	82.30
0 27	82.70	82.56	82.40	82.21	82.01	81.78	81.52	81.29	81.43	81.60	81.73	81.82	81.88	81.90	81.90	81.90
0 28	82.20	82.12	81.98	81.82	81.66	81.49	81.32	81.21	81.23	81.30	81.37	81.42	81.46	81.46	81.45	81.40
0 29	81.80	81.69	81.57	81.44	81.31	81.18	81.07	81.00	80.98	81.00	81.02	81.04	81.05	81.05	81.03	81.00
0 30	81.30	81.24	81.15	81.05	80.95	80.86	80.78	80.72	80.69	80.68	80.67	80.67	80.66	80.64	80.62	80.60
0 31	80.80	80.77	80.72	80.65	80.59	80.52	80.46	80.41	80.37	80.35	80.32	80.30	80.27	80.23	80.20	80.20
0 32	80.30	80.31	80.29	80.26	80.21	80.17	80.12	80.08	80.05	80.01	79.97	79.92	79.88	79.82	79.76	79.70
0 33	79.90	79.88	79.87	79.86	79.84	79.81	79.78	79.75	79.72	79.67	79.61	79.55	79.48	79.41	79.34	79.30
0 34	79.40	79.43	79.44	79.47	79.47	79.46	79.44	79.42	79.39	79.33	79.26	79.18	79.09	79.00	78.90	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

1 HEAD IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

16

0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92	92.10
0 2	90.90	90.98	91.07	91.15	91.24	91.29	91.37	91.45	91.52	91.56	91.62	91.65	91.70	91.73	91.	91.80
0 3	90.60	90.72	90.81	90.90	90.97	91.05	91.12	91.19	91.24	91.29	91.33	91.37	91.40	91.42	91.43	91.40
0 4	90.40	90.46	90.54	90.62	90.70	90.78	90.85	90.91	90.96	91.00	91.03	91.06	91.08	91.09	91.09	91.10
0 5	90.10	90.18	90.26	90.34	90.42	90.49	90.57	90.63	90.67	90.70	90.72	90.73	90.74	90.74	90.73	90.70
0 6	89.80	89.88	89.96	90.04	90.12	90.20	90.29	90.35	90.38	90.39	90.39	90.39	90.40	90.39	90.37	90.30
0 7	89.50	89.58	89.65	89.72	89.80	89.90	90.02	90.09	90.11	90.07	90.05	90.04	90.04	90.04	90.03	90.00
0 8	89.20	89.28	89.34	89.39	89.46	89.56	89.79	89.88	89.87	89.72	89.67	89.66	89.67	89.67	89.68	89.70
0 9	89.00	89.00	89.02	89.04	89.06	89.10	89.29	89.40	89.39	89.26	89.25	89.26	89.28	89.29	89.31	89.30
0 10	88.70	88.71	88.69	88.67	88.65	88.64	88.63	88.62	88.72	88.78	88.81	88.84	88.87	88.90	88.94	89.00
0 11	88.50	88.44	88.37	88.30	88.24	88.17	87.94	87.70	88.02	88.28	88.35	88.41	88.46	88.50	88.52	88.50
0 12	88.30	88.17	88.05	87.94	87.82	87.69	87.08	86.16	87.14	87.77	87.89	87.98	88.06	88.11	88.13	88.10
0 13	88.10	87.90	87.73	87.57	87.41	87.22	86.02	82.58	86.07	87.27	87.44	87.57	87.66	87.74	87.78	87.80
0 14	87.80	87.60	87.41	87.23	87.03	86.83	86.21	85.41	86.23	86.84	87.02	87.18	87.29	87.38	87.45	87.50
0 15	87.50	87.28	87.09	86.89	86.67	86.43	86.14	86.01	86.14	86.42	86.64	86.81	86.94	87.04	87.13	87.20
0 16	87.10	86.95	86.77	86.59	86.38	86.18	85.98	85.84	85.97	86.15	86.33	86.49	86.61	86.71	86.80	86.90
0 17	86.80	86.63	86.47	86.31	86.13	85.95	85.75	85.42	85.73	85.91	86.05	86.19	86.30	86.39	86.46	86.50
0 18	86.40	86.30	86.18	86.04	85.89	85.77	85.65	85.55	85.63	85.72	85.81	85.91	86.00	86.08	86.14	86.20
0 19	86.10	86.01	85.90	85.78	85.67	85.59	85.55	85.50	85.52	85.53	85.57	85.64	85.72	85.78	85.81	85.80
0 20	85.70	85.66	85.57	85.46	85.35	85.28	85.22	85.16	85.18	85.21	85.24	85.31	85.37	85.42	85.44	85.40
0 21	85.30	85.22	85.12	85.00	84.88	84.77	84.63	84.54	84.58	84.68	84.75	84.83	84.91	84.96	84.99	85.00
0 22	84.90	84.76	84.63	84.49	84.34	84.18	83.96	83.77	83.90	84.07	84.19	84.30	84.39	84.46	84.	84.50
0 23	84.40	84.29	84.15	83.99	83.80	83.58	83.17	82.68	83.10	83.45	83.64	83.78	83.89	83.98	84.	84.10
0 24	84.00	83.86	83.70	83.52	83.31	83.02	82.33	80.66	82.25	82.89	83.13	83.30	83.42	83.53	83.62	83.70
0 25	83.60	83.44	83.28	83.09	82.89	82.64	82.21	81.71	82.14	82.50	82.70	82.86	82.98	83.09	83.19	83.30
0 26	83.20	83.03	82.86	82.69	82.51	82.31	82.03	81.82	81.96	82.17	82.32	82.45	82.56	82.67	82.78	82.90
0 27	82.80	82.62	82.46	82.30	82.14	81.97	81.79	81.69	81.72	81.84	81.95	82.06	82.16	82.25	82.36	82.50
0 28	82.30	82.19	82.06	81.92	81.79	81.66	81.54	81.47	81.48	81.53	81.60	81.68	81.76	81.84	81.92	82.00
0 29	81.90	81.78	81.66	81.55	81.44	81.33	81.25	81.20	81.19	81.21	81.26	81.31	81.37	81.43	81.51	81.60
0 30	81.50	81.37	81.26	81.17	81.08	81.00	80.93	80.89	80.88	80.88	80.90	80.93	80.98	81.03	81.10	81.20
0 31	81.00	80.94	80.86	80.78	80.71	80.65	80.60	80.56	80.54	80.54	80.54	80.56	80.58	80.62	80.66	80.70
0 32	80.60	80.52	80.45	80.39	80.34	80.29	80.25	80.22	80.20	80.19	80.18	80.18	80.19	80.20	80.23	80.30
0 33	80.20	80.11	80.05	80.00	79.96	79.93	79.90	79.88	79.86	79.83	79.82	79.81	79.79	79.79	79.79	79.80
0 34	79.70	79.68	79.63	79.60	79.58	79.56	79.55	79.53	79.52	79.48	79.46	79.44	79.40	79.38	79.34	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

0HEAD WILL BE SAVED ON UNIT 30 AT END OF TIME STEP 1, STRESS PERIOD 1

1 DRAWDOWN IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.06	.05	.05	.06	.05	.12	.10	.10	.09	.09	.08	.08	-.02	-.01	.00
0 3	.00	.09	.09	.10	.11	.22	.20	.19	.19	.18	.18	.06	.06	.06	.07	.00
0 4	.00	.11	.12	.14	.26	.28	.28	.28	.27	.27	.26	.15	.14	.04	.03	.00

0 5	.00	.12	.14	.16	.30	.34	.35	.36	.36	.35	.35	.23	.12	.12	.11	.00
0 6	.00	.10	.12	.25	.39	.44	.47	.47	.47	.46	.35	.33	.20	.19	.09	.00
0 7	.00	.12	.25	.30	.45	.50	.52	.53	.53	.50	.48	.34	.28	.16	.07	.00
8	.00	.10	.26	.44	.51	.57	.60	.61	.60	.56	.52	.38	.31	.19	.08	.00
9	.00	.13	.35	.48	.69	.77	.81	.82	.69	.63	.58	.43	.39	.26	.16	.00
0 10	.00	.26	.45	.64	.80	.91	.97	.96	.90	.72	.65	.49	.34	.21	.09	.00
0 11	.00	.27	.53	.80	1.04	1.22	1.28	1.27	1.05	.90	.69	.62	.45	.31	.09	.00
0 12	.00	.27	.69	1.05	1.43	1.76	1.69	1.71	1.33	1.07	.80	.60	.42	.27	.13	.00
0 13	.00	.33	.73	1.20	1.80	2.54	2.21	2.45	1.68	1.20	.88	.66	.47	.31	.18	.00
0 14	.00	.35	.79	1.35	2.23	2.07	1.99	1.87	1.57	1.20	.90	.68	.49	.33	.19	.00
0 15	.00	.39	.73	1.19	1.55	1.73	1.69	1.68	1.44	1.15	.89	.67	.48	.31	.15	.00
0 16	.00	.33	.65	.94	1.28	1.40	1.54	1.50	1.31	1.18	.95	.74	.56	.39	.12	.00
0 17	.00	.22	.60	.83	1.02	1.25	1.34	1.56	1.29	1.08	.88	.70	.52	.35	.17	.00
0 18	.00	.19	.50	.68	.93	1.04	1.21	1.23	1.11	.96	.80	.64	.48	.31	.13	.00
0 19	.00	.18	.41	.66	.88	.97	1.03	1.14	1.07	.96	.83	.69	.45	.30	.15	.00
0 20	.00	.18	.40	.62	.82	.91	.97	1.08	1.03	.94	.83	.61	.51	.29	.15	.00
0 21	.00	.15	.35	.56	.76	.87	1.05	1.08	1.04	.96	.75	.64	.46	.28	.11	.00
0 22	.00	.19	.40	.52	.76	.90	1.03	1.20	1.05	.94	.82	.61	.42	.26	.12	.00
0 23	.00	.15	.35	.58	.76	.96	1.18	1.36	1.21	1.04	.79	.66	.47	.33	.13	.00
0 24	.00	.16	.37	.53	.74	1.11	1.46	1.95	1.42	1.13	.83	.59	.49	.25	.07	.00
0 25	.00	.14	.28	.56	.80	1.08	1.43	1.77	1.40	1.13	.83	.59	.39	.26	.08	.00
0 26	.00	.13	.29	.49	.72	1.01	1.40	2.12	1.39	1.07	.78	.56	.38	.25	.06	.00
0 27	.00	.14	.30	.49	.69	.82	1.08	1.31	1.17	.90	.67	.58	.32	.20	.10	.00
0 28	.00	.08	.22	.38	.54	.71	.88	.89	.87	.70	.63	.48	.34	.24	.05	.00
0 29	.00	.11	.23	.36	.39	.52	.63	.70	.62	.60	.48	.36	.25	.15	.07	.00
0 30	.00	.06	.15	.25	.35	.44	.52	.48	.51	.42	.43	.33	.24	.16	.08	.00
0 31	.00	.03	.08	.15	.21	.28	.34	.39	.33	.35	.28	.20	.13	.07	.10	.00
0 32	.00	.09	.11	.14	.19	.23	.28	.22	.25	.19	.23	.18	.12	.08	.04	.00
0 33	.00	.02	.03	.14	.16	.19	.12	.15	.18	.13	.09	.15	.12	.09	.06	.00
0 34	.00	-.03	.06	.03	.03	.04	.06	.08	.11	.07	.04	.02	.01	.00	-.00	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

1 DRAWDOWN IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.02	.03	-.05	-.04	.01	.03	-.05	-.02	-.06	-.02	-.05	-.00	-.03	.03	.00
0 3	.00	-.02	-.01	.00	.03	-.05	-.02	.01	-.04	.01	-.03	-.07	.00	-.02	-.03	.00
0 4	.00	.04	-.04	-.02	-.00	-.08	-.05	-.01	-.06	.00	-.03	-.06	.02	.01	.01	.00
0 5	.00	.02	.04	-.04	-.02	.01	-.07	-.03	-.07	.00	-.02	-.03	-.04	-.04	-.03	.00
0 6	.00	.02	.04	-.04	-.02	-.00	-.09	-.05	-.08	-.09	.01	.01	.00	.01	.03	.00
0 7	.00	.02	.05	.08	.00	.00	-.12	-.09	-.11	-.07	.05	.06	.06	.06	-.03	.00
0 8	.00	.02	.06	.11	.04	.04	-.19	-.18	-.17	-.02	.03	.04	.03	.03	.02	.00
0 9	.00	.10	.08	.16	.24	.20	.01	.00	.01	.14	.15	.14	.12	.11	-.01	.00
0 10	.00	.09	.21	.23	.35	.36	.37	.48	.38	.32	.29	.26	.13	.10	.06	.00
0 11	.00	.16	.23	.30	.46	.53	.76	1.10	.78	.52	.35	.29	.24	.20	.08	.00
0 12	.00	.13	.25	.46	.58	.71	1.42	2.34	1.36	.63	.51	.42	.34	.19	.07	.00
0 13	.00	.20	.37	.53	.69	.88	2.18	5.62	2.13	.83	.66	.53	.34	.26	.12	.00
0 14	.00	.20	.39	.57	.87	1.07	1.69	2.49	1.67	.96	.78	.52	.41	.22	.15	.00
0 15	.00	.22	.41	.61	.93	1.17	1.46	1.59	1.46	1.18	.86	.59	.36	.26	.07	.00
0 16	.00	.15	.43	.61	.92	1.12	1.32	1.46	1.23	1.05	.77	.51	.39	.19	.10	.00
0 17	.00	.17	.33	.59	.77	.95	1.15	1.38	1.07	.89	.65	.51	.30	.21	.04	.00
0 18	.00	.10	.32	.46	.61	.73	.75	.85	.77	.68	.49	.39	.20	.12	.06	.00
0 19	.00	.09	.20	.32	.43	.41	.45	.50	.48	.37	.33	.26	.08	.02	-.01	.00
0 20	.00	.14	.23	.24	.35	.32	.38	.44	.42	.29	.26	.19	.03	-.02	-.04	.00
0 21	.00	.08	.18	.30	.42	.43	.57	.66	.52	.42	.35	.27	.09	.04	.01	.00
0 22	.00	.14	.27	.41	.46	.62	.84	1.03	.80	.63	.51	.30	.21	.14	.10	.00
0 23	.00	.11	.25	.41	.60	.82	1.13	1.62	1.20	.85	.56	.42	.31	.22	.05	.00
0 24	.00	.14	.30	.48	.69	.88	1.57	3.24	1.65	1.01	.67	.50	.38	.27	.08	.00
0 25	.00	.16	.32	.41	.61	.86	1.29	1.79	1.26	.90	.70	.54	.42	.31	.11	.00
0 26	.00	.17	.24	.41	.59	.79	1.07	1.18	1.04	.83	.68	.55	.44	.23	.12	.00
0 27	.00	.18	.24	.40	.56	.63	.81	.91	.88	.76	.55	.44	.34	.25	.14	.00
0 28	.00	.11	.24	.38	.41	.54	.66	.73	.72	.57	.50	.42	.34	.26	.08	.00
0 29	.00	.12	.24	.25	.36	.47	.55	.50	.51	.49	.44	.29	.23	.17	.09	.00
0 30	.00	.13	.14	.23	.32	.40	.37	.41	.42	.42	.30	.27	.22	.17	.10	.00
0 31	.00	.06	.14	.22	.19	.25	.30	.34	.36	.26	.26	.24	.22	.08	.04	.00
0 32	.00	.08	.15	.11	.16	.21	.25	.18	.20	.21	.22	.12	.11	.10	.07	.00
0 33	.00	.09	.05	.10	.14	.17	.10	.12	.14	.17	.08	.09	.11	.11	.01	.00
0 34	.00	.02	.07	.10	.02	.04	.05	.07	.08	.02	.04	.06	-.00	.02	.06	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

ODRAWDOWN WILL BE SAVED ON UNIT 40 AT END OF TIME STEP 1, STRESS PERIOD 1
0

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 1

0 CUMULATIVE VOLUMES L**3 RATES FOR THIS TIME STEP L**3/T

IN: IN:

```
                    STORAGE =    .00000
              CONSTANT HEAD =    .11672E+06
                      WELLS =    .00000
0                  TOTAL IN =    .11672E+06
0                OUT:
                 ----
                    STORAGE =    .00000
              CONSTANT HEAD =    39707.
                      WELLS =    77007.
0                 TOTAL OUT =    .11671E+06
0                  IN - OUT =    6.0938
0      PERCENT DISCREPANCY =                 .01
```


```
                    STORAGE =    .00000
              CONSTANT HEAD =    .11672E+06
                      WELLS =    .00000
                   TOTAL IN =    .11672E+06
                 OUT:
                 ----
                    STORAGE =    .00000
              CONSTANT HEAD =    39707.
                      WELLS =    77007.
                  TOTAL OUT =    .11671E+06
                   IN - OUT =    6.0938
       PERCENT DISCREPANCY =                 .01
```


0

TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 1

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	86400.0	1440.00	24.0000	1.00000	.273785E-02
STRESS PERIOD TIME	86400.0	1440.00	24.0000	1.00000	.273785E-02
TOTAL SIMULATION TIME	86400.0	1440.00	24.0000	1.00000	.273785E-02

1

```
1                     U.S. GEOLOGICAL SURVEY MODULAR FINITE-DIFFERENCE GROUND-WATER MODEL
0SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     SENSIT ANAL, SIMULATION 4A: HYDRAULIC COND X 2
   2 LAYERS          35 ROWS         16 COLUMNS
   1 STRESS PERIOD(S) IN SIMULATION
 MODEL TIME UNIT IS DAYS
0I/O UNITS:
 ELEMENT OF IUNIT:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
         I/O UNIT: 11 12  0  0  0  0  0  0 19  0  0 22  0  0  0  0  0  0  0  0  0  0  0  0
0BAS1 -- BASIC MODEL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT  1
 ARRAYS RHS AND BUFF WILL SHARE MEMORY.
 START HEAD WILL BE SAVED
    10699 ELEMENTS IN X ARRAY ARE USED BY BAS
    10699 ELEMENTS OF X ARRAY USED OUT OF  100000
0BCF1 -- BLOCK-CENTERED FLOW PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 11
 STEADY-STATE SIMULATION
      LAYER  AQUIFER TYPE
      -------------------
         1         1
         2         0
     1122 ELEMENTS IN X ARRAY ARE USED BY BCF
    11821 ELEMENTS OF X ARRAY USED OUT OF  100000
0WEL1 -- WELL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM 12
 MAXIMUM OF     9 WELLS
       36 ELEMENTS IN X ARRAY ARE USED FOR WELLS
    11857 ELEMENTS OF X ARRAY USED OUT OF  100000
0SIP1 -- STRONGLY IMPLICIT PROCEDURE SOLUTION PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 19
 MAXIMUM OF  50 ITERATIONS ALLOWED FOR CLOSURE
  5 ITERATION PARAMETERS
     4685 ELEMENTS IN X ARRAY ARE USED BY SIP
    16542 ELEMENTS OF X ARRAY USED OUT OF  100000
1SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     SENSIT ANAL, SIMULATION 4A: HYDRAULIC COND X 2
0
```

BOUNDARY ARRAY FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
0 2	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 3	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 4	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 5	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 6	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
7	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
8	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
9	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 10	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 11	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 12	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 13	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 14	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 15	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 16	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 17	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 18	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 19	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 20	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 21	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 22	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 23	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 24	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 25	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 26	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 27	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 28	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 29	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 30	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 31	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 32	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 33	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 34	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 35	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

0

BOUNDARY ARRAY FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

0 1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
0 2	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 3	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 4	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 5	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 6	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 7	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 8	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 9	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 10	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 11	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 12	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 13	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 14	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 15	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 16	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 17	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 18	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 19	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 20	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 21	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 22	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 23	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 24	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 25	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 26	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 27	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 28	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 29	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 30	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 31	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 32	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 33	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 34	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 35	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2

0AQUIFER HEAD WILL BE SET TO 999.99 AT ALL NO-FLOW NODES (IBOUND=0).
0

INITIAL HEAD FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1	2	3	4	5	6	7	8	9	10
	11	12	13	14	15	16				
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90
	94.00	94.10	94.20	94.30	94.40	94.50				
0 2	92.40	92.60	92.70	92.80	92.90	93.00	93.20	93.30	93.40	93.50
	93.60	93.70	93.80	93.80	93.90	94.00				
0 3	92.00	92.20	92.30	92.40	92.50	92.70	92.80	92.90	93.00	93.10
	93.20	93.20	93.30	93.40	93.50	93.50				
0 4	91.60	91.80	91.90	92.00	92.20	92.30	92.40	92.50	92.60	92.70
	92.80	92.80	92.90	92.90	93.00	93.10				
0 5	91.20	91.40	91.50	91.60	91.80	91.90	92.00	92.10	92.20	92.30
	92.40	92.40	92.40	92.50	92.60	92.60				
0 6	90.70	90.90	91.00	91.20	91.40	91.50	91.60	91.70	91.80	91.90
	91.90	92.00	92.00	92.10	92.10	92.10				
0 7	90.20	90.40	90.60	90.70	90.90	91.00	91.10	91.20	91.30	91.40
	91.50	91.50	91.60	91.60	91.60	91.60				
0 8	89.70	89.90	90.10	90.30	90.40	90.50	90.60	90.70	90.80	90.90
	91.00	91.00	91.10	91.10	91.10	91.10				
0 9	89.40	89.50	89.70	89.80	90.00	90.10	90.20	90.30	90.30	90.40
	90.50	90.50	90.60	90.60	90.60	90.50				
0 10	89.00	89.20	89.30	89.40	89.50	89.60	89.70	89.80	89.90	89.90
	90.00	90.00	90.00	90.00	90.00	90.00				
0 11	88.70	88.80	88.90	89.00	89.10	89.20	89.30	89.40	89.40	89.50
	89.50	89.60	89.60	89.60	89.50	89.50				
0 12	88.30	88.40	88.60	88.70	88.80	88.90	88.90	89.00	89.00	89.10
	89.10	89.10	89.10	89.10	89.10	89.10				
0 13	88.00	88.10	88.20	88.30	88.40	88.50	88.60	88.60	88.70	88.70
	88.70	88.70	88.70	88.70	88.70	88.60				
0 14	87.70	87.80	87.90	88.00	88.10	88.10	88.20	88.20	88.30	88.30
	88.30	88.30	88.30	88.30	88.30	88.20				
0 15	87.50	87.60	87.60	87.70	87.70	87.80	87.80	87.90	87.90	87.90
	87.90	87.90	87.90	87.90	87.90	87.90				
0 16	87.30	87.30	87.30	87.30	87.40	87.40	87.50	87.50	87.50	87.60
	87.60	87.60	87.60	87.60	87.50	87.50				
0 17	87.00	86.90	87.00	87.00	87.00	87.10	87.10	87.20	87.20	87.20
	87.20	87.20	87.20	87.20	87.20	87.20				
0 18	86.50	86.50	86.60	86.60	86.70	86.70	86.80	86.80	86.80	86.80
	86.80	86.80	86.80	86.80	86.80	86.90				
0 19	86.00	86.10	86.20	86.30	86.40	86.40	86.40	86.50	86.50	86.50

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
											86.50	86.50	86.40	86.40	86.40	86.40
0 20	85.60	85.70	85.80	85.90	86.00	86.00	86.00	86.10	86.10	86.10	86.10	86.00	86.00	85.90	85.90	85.90
21	85.10	85.20	85.30	85.40	85.50	85.50	85.60	85.60	85.60	85.60	85.50	85.50	85.40	85.30	85.20	85.10
0 22	84.70	84.80	84.90	84.90	85.00	85.00	85.00	85.10	85.00	85.00	85.00	84.90	84.80	84.70	84.60	84.50
0 23	84.20	84.30	84.40	84.50	84.50	84.50	84.50	84.50	84.50	84.50	84.40	84.40	84.30	84.20	84.00	83.80
0 24	83.80	83.90	84.00	84.00	84.00	84.10	84.10	84.00	84.00	84.00	83.90	83.80	83.80	83.60	83.40	83.30
0 25	83.50	83.50	83.50	83.60	83.60	83.60	83.60	83.60	83.50	83.50	83.40	83.30	83.20	83.10	82.90	82.80
0 26	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.00	83.00	82.90	82.80	82.70	82.60	82.40	82.30
0 27	82.70	82.70	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.50	82.40	82.40	82.20	82.10	82.00	81.90
0 28	82.20	82.20	82.20	82.20	82.20	82.20	82.20	82.10	82.10	82.00	82.00	81.90	81.80	81.70	81.50	81.40
0 29	81.80	81.80	81.80	81.80	81.70	81.70	81.70	81.70	81.60	81.60	81.50	81.40	81.30	81.20	81.10	81.00
0 30	81.30	81.30	81.30	81.30	81.30	81.30	81.30	81.20	81.20	81.10	81.10	81.00	80.90	80.80	80.70	80.60
0 31	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.70	80.70	80.60	80.50	80.40	80.30	80.30	80.20
0 32	80.30	80.40	80.40	80.40	80.40	80.40	80.40	80.30	80.30	80.20	80.20	80.10	80.00	79.90	79.80	79.70
0 33	79.90	79.90	79.90	80.00	80.00	80.00	79.90	79.90	79.90	79.80	79.70	79.70	79.60	79.50	79.40	79.30
0 34	79.40	79.40	79.50	79.50	79.50	79.50	79.50	79.50	79.50	79.40	79.30	79.20	79.10	79.00	78.90	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40
0																

INITIAL HEAD FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	92.10
0 2	90.90	91.00	91.10	91.10	91.20	91.30	91.40	91.40	91.50	91.50	91.60	91.60	91.70	91.70	91.80	91.80
3	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.20	91.20	91.30	91.30	91.30	91.40	91.40	91.40	91.40
0 4	90.40	90.50	90.50	90.60	90.70	90.70	90.80	90.90	90.90	91.00	91.00	91.00	91.10	91.10	91.10	91.10
0 5	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.70	90.70	90.70	90.70	90.70	90.70	90.70
0 6	89.80	89.90	90.00	90.00	90.10	90.20	90.20	90.30	90.30	90.30	90.40	90.40	90.40	90.40	90.40	90.30
0 7	89.50	89.60	89.70	89.80	89.80	89.90	89.90	90.00	90.00	90.00	90.10	90.10	90.10	90.10	90.00	90.00
0 8	89.20	89.30	89.40	89.50	89.50	89.60	89.60	89.70	89.70	89.70	89.70	89.70	89.70	89.70	89.70	89.70
0 9	89.00	89.10	89.10	89.20	89.30	89.30	89.30	89.40	89.40	89.40	89.40	89.40	89.40	89.40	89.30	89.30
0 10	88.70	88.80	88.90	88.90	89.00	89.00	89.00	89.10	89.10	89.10	89.10	89.10	89.00	89.00	89.00	89.00
0 11	88.50	88.60	88.60	88.60	88.70	88.70	88.70	88.80	88.80	88.80	88.70	88.70	88.70	88.70	88.60	88.50
0 12	88.30	88.30	88.30	88.40	88.40	88.40	88.50	88.50	88.50	88.40	88.40	88.40	88.40	88.30	88.20	88.10
0 13	88.10	88.10	88.10	88.10	88.10	88.10	88.20	88.20	88.20	88.10	88.10	88.10	88.00	88.00	87.90	87.80
0 14	87.80	87.80	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.80	87.80	87.70	87.70	87.60	87.60	87.50
0 15	87.50	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.60	87.50	87.40	87.30	87.30	87.20	87.20
0 16	87.10	87.10	87.20	87.20	87.30	87.30	87.30	87.30	87.20	87.20	87.10	87.00	87.00	86.90	86.90	86.90
0 17	86.80	86.80	86.80	86.90	86.90	86.90	86.90	86.80	86.80	86.80	86.70	86.70	86.60	86.60	86.50	86.50
0 18	86.40	86.40	86.50	86.50	86.50	86.50	86.40	86.40	86.40	86.40	86.30	86.30	86.20	86.20	86.20	86.20
0 19	86.10	86.10	86.10	86.10	86.10	86.00	86.00	86.00	86.00	85.90	85.90	85.90	85.80	85.80	85.80	85.80
0 20	85.70	85.80	85.80	85.70	85.70	85.60	85.60	85.60	85.60	85.50	85.50	85.50	85.40	85.40	85.40	85.40

0 21	85.30	85.30	85.30	85.30	85.30	85.20	85.20	85.20	85.10	85.10
	85.10	85.10	85.00	85.00	85.00	85.00				
0 22	84.90	84.90	84.90	84.90	84.80	84.80	84.80	84.80	84.70	84.70
	84.70	84.60	84.60	84.60	84.60	84.50				
0 23	84.40	84.40	84.40	84.40	84.40	84.40	84.30	84.30	84.30	84.30
	84.20	84.20	84.20	84.20	84.10	84.10				
0 24	84.00	84.00	84.00	84.00	84.00	83.90	83.90	83.90	83.90	83.90
	83.80	83.80	83.80	83.80	83.70	83.70				
0 25	83.60	83.60	83.60	83.50	83.50	83.50	83.50	83.50	83.40	83.40
	83.40	83.40	83.40	83.40	83.30	83.30				
0 26	83.20	83.20	83.10	83.10	83.10	83.10	83.10	83.00	83.00	83.00
	83.00	83.00	83.00	82.90	82.90	82.90				
0 27	82.80	82.80	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.60
	82.50	82.50	82.50	82.50	82.50	82.50				
0 28	82.30	82.30	82.30	82.30	82.20	82.20	82.20	82.20	82.20	82.10
	82.10	82.10	82.10	82.10	82.00	82.00				
0 29	81.90	81.90	81.90	81.80	81.80	81.80	81.80	81.70	81.70	81.70
	81.70	81.60	81.60	81.60	81.60	81.60				
0 30	81.50	81.50	81.40	81.40	81.40	81.40	81.30	81.30	81.30	81.30
	81.20	81.20	81.20	81.20	81.20	81.20				
0 31	81.00	81.00	81.00	81.00	80.90	80.90	80.90	80.90	80.90	80.80
	80.80	80.80	80.80	80.70	80.70	80.70				
0 32	80.60	80.60	80.60	80.50	80.50	80.50	80.50	80.40	80.40	80.40
	80.40	80.30	80.30	80.30	80.30	80.30				
0 33	80.20	80.20	80.10	80.10	80.10	80.10	80.00	80.00	80.00	80.00
	79.90	79.90	79.90	79.90	79.80	79.80				
0 34	79.70	79.70	79.70	79.70	79.60	79.60	79.60	79.60	79.60	79.50
	79.50	79.50	79.40	79.40	79.40	79.30				
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10
	79.10	79.10	79.00	79.00	78.90	78.90				

0HEAD PRINT FORMAT IS FORMAT NUMBER 4 DRAWDOWN PRINT FORMAT IS FORMAT NUMBER 9
0HEADS WILL BE SAVED ON UNIT 30 DRAWDOWNS WILL BE SAVED ON UNIT 40
0OUTPUT CONTROL IS SPECIFIED EVERY TIME STEP
0 COLUMN TO ROW ANISOTROPY = 1.000000
0 DELR = 200.0000
0 DELC = 200.0000
0

HYD. COND. ALONG ROWS FOR LAYER 1 WILL BE READ ON UNIT 11 USING FORMAT: (16F4.0)

	1	2	3	4	5	6	7	8	9	10
	11	12	13	14	15	16				
0 1	600.0	600.0	600.0	600.0	600.0	450.0	450.0	450.0	450.0	450.0
	450.0	450.0	600.0	600.0	600.0	600.0				
0 2	600.0	600.0	600.0	600.0	600.0	450.0	450.0	450.0	450.0	450.0
	450.0	450.0	600.0	600.0	600.0	600.0				
0 3	600.0	600.0	600.0	600.0	600.0	450.0	450.0	450.0	450.0	450.0
	450.0	450.0	600.0	600.0	600.0	600.0				
0 4	600.0	600.0	600.0	600.0	600.0	450.0	450.0	450.0	450.0	450.0
	450.0	450.0	600.0	600.0	600.0	600.0				
0 5	600.0	600.0	600.0	600.0	600.0	450.0	450.0	450.0	450.0	450.0
	450.0	450.0	600.0	600.0	600.0	600.0				
0 6	600.0	450.0	450.0	450.0	450.0	400.0	400.0	400.0	400.0	400.0
	450.0	450.0	600.0	600.0	600.0	600.0				
0 7	600.0	450.0	450.0	450.0	450.0	400.0	400.0	400.0	400.0	400.0
	450.0	450.0	600.0	600.0	600.0	600.0				
0 8	600.0	450.0	450.0	450.0	450.0	400.0	400.0	400.0	400.0	400.0
	450.0	450.0	450.0	450.0	450.0	600.0				
0 9	600.0	450.0	450.0	450.0	450.0	400.0	400.0	400.0	400.0	400.0
	450.0	450.0	450.0	450.0	450.0	600.0				
0 10	600.0	450.0	450.0	450.0	450.0	400.0	400.0	400.0	400.0	400.0
	450.0	450.0	450.0	450.0	450.0	600.0				
0 11	600.0	500.0	500.0	500.0	500.0	400.0	400.0	400.0	400.0	400.0
	500.0	500.0	500.0	500.0	500.0	600.0				
0 12	600.0	500.0	500.0	500.0	500.0	400.0	400.0	400.0	400.0	400.0
	500.0	500.0	500.0	500.0	500.0	600.0				
0 13	600.0	500.0	500.0	500.0	500.0	400.0	400.0	400.0	400.0	400.0
	500.0	500.0	500.0	500.0	500.0	600.0				
0 14	600.0	500.0	500.0	500.0	500.0	400.0	400.0	400.0	400.0	400.0
	500.0	500.0	500.0	500.0	500.0	600.0				
0 15	600.0	500.0	500.0	500.0	500.0	400.0	400.0	400.0	400.0	400.0
	500.0	500.0	500.0	500.0	500.0	600.0				
0 16	600.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0
	500.0	500.0	500.0	500.0	500.0	600.0				
0 17	600.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0
	500.0	500.0	500.0	500.0	500.0	600.0				
0 18	600.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0
	500.0	500.0	500.0	500.0	500.0	600.0				
0 19	600.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0

Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
											500.0	500.0	500.0	500.0	500.0	600.0
0 20	600.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	600.0
21	600.0	350.0	350.0	350.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	350.0	350.0	350.0	600.0
0 22	600.0	350.0	350.0	350.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	350.0	350.0	350.0	600.0
0 23	600.0	350.0	350.0	350.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	350.0	350.0	350.0	600.0
0 24	600.0	350.0	350.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	350.0	350.0	350.0	600.0
0 25	600.0	400.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	400.0	600.0
0 26	600.0	400.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	400.0	600.0
0 27	600.0	400.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	400.0	600.0
0 28	600.0	400.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	400.0	600.0
0 29	600.0	400.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	400.0	600.0
0 30	600.0	400.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	400.0	600.0
0 31	600.0	400.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	400.0	600.0
0 32	600.0	400.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	400.0	600.0
0 33	600.0	400.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	400.0	600.0
0 34	600.0	400.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	400.0	600.0
0 35	600.0	400.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	400.0	600.0

0 BOTTOM = 30.00000 FOR LAYER 1
0 VERT HYD COND /THICKNESS = .1000000E-02 FOR LAYER 1
0

TRANSMIS. ALONG ROWS FOR LAYER 2 WILL BE READ ON UNIT 11 USING FORMAT: (16F5.0)

Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04
2	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04
0 3	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04
0 4	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04
0 5	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04
0 6	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04
0 7	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04
0 8	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04
0 9	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1400.	1400.	1400.	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04
0 10	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1400.	1400.	1400.	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04
0 11	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1400.	1400.	1400.	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04
0 12	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1400.	1400.	1400.	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04
0 13	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1400.	1400.	1400.	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04
0 14	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1400.	1400.	1400.	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04
0 15	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.6000E+04	1.6000E+04	1.6000E+04	1.6000E+04	1.6000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04
0 16	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.6000E+04	1.6000E+04	1.6000E+04	1.6000E+04	1.6000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04
0 17	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.6000E+04	1.6000E+04	1.6000E+04	1.6000E+04	1.6000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04
0 18	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.6000E+04	1.6000E+04	1.6000E+04	1.6000E+04	1.6000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04
0 19	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.6000E+04	1.6000E+04	1.6000E+04	1.6000E+04	1.6000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04

```
0 20  8000.   8000.   8000.   8000.   8000.   8000.   3000.   3000.   3000.   8000.
      8000.   8000.   8000.   8000.   8000.   8000.
0 21  6000.   6000.   6000.   6000.   6000.   6000.   3000.   3000.   3000.   6000.
      6000.   6000.   6000.   6000.   6000.   6000.
0 22  6000.   6000.   6000.   6000.   6000.   6000.   3000.   3000.   3000.   6000.
      6000.   6000.   6000.   6000.   6000.   6000.
0 23  6000.   6000.   6000.   6000.   6000.   6000.   3000.   3000.   3000.   6000.
      6000.   6000.   6000.   6000.   6000.   6000.
0 24  6000.   6000.   6000.   6000.   6000.   6000.   3000.   3000.   3000.   6000.
      6000.   6000.   6000.   6000.   6000.   6000.
0 25  6000.   6000.   6000.   6000.   6000.   6000.   3000.   3000.   3000.   6000.
      6000.   6000.   6000.   6000.   6000.   6000.
0 26  6000.   6000.   6000.   6000.   6000.   6000.   3000.   3000.   3000.   6000.
      6000.   6000.   6000.   6000.   6000.   6000.
0 27  6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.
      6000.   6000.   6000.   6000.   6000.   6000.
0 28  6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.
      6000.   6000.   6000.   6000.   6000.   6000.
0 29  6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.
      6000.   6000.   6000.   6000.   6000.   6000.
0 30  6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.
      6000.   6000.   6000.   6000.   6000.   6000.
0 31  6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.
      6000.   6000.   6000.   6000.   6000.   6000.
0 32  6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.
      6000.   6000.   6000.   6000.   6000.   6000.
0 33  6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.
      6000.   6000.   6000.   6000.   6000.   6000.
0 34  6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.
      6000.   6000.   6000.   6000.   6000.   6000.
0 35  6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.   6000.
      6000.   6000.   6000.   6000.   6000.   6000.
0

                                   SOLUTION BY THE STRONGLY IMPLICIT PROCEDURE
                                   -------------------------------------------
0                             MAXIMUM ITERATIONS ALLOWED FOR CLOSURE =        50
                                              ACCELERATION PARAMETER =     1.0000
                                   HEAD CHANGE CRITERION FOR CLOSURE =    .10000E-02
                                   SIP HEAD CHANGE PRINTOUT INTERVAL =        1
0                                  CALCULATE ITERATION PARAMETERS FROM MODEL CALCULATED WSEED
1                                 STRESS PERIOD NO.    1, LENGTH =   1.000000
                                  ----------------------------------------------

                                  NUMBER OF TIME STEPS =      1

                                   MULTIPLIER FOR DELT =     1.000

                                INITIAL TIME STEP SIZE =   1.000000
0          9 WELLS
                              LAYER    ROW   COL   STRESS RATE   WELL NO.
                              --------------------------------------------
                                1      14     5    -13476.           1
                                1      13     6    -13476.           2
                                1      13     8    -13476.           3
                                1      17     8    -4813.0           4
                                1      24     8    -7701.0           5
                                1      26     8    -9626.0           6
                                2      13     8    -4813.0           7
                                2      17     8    -4813.0           8
                                2      24     8    -4813.0           9
0AVERAGE SEED =  .00152628
 MINIMUM SEED =  .00055719
0
    5 ITERATION PARAMETERS CALCULATED FROM AVERAGE SEED:

             .0000000E+00   .8023446E+00   .9609323E+00   .9922780E+00   .9984737E+00
0
    10 ITERATIONS FOR TIME STEP    1 IN STRESS PERIOD   1
0MAXIMUM HEAD CHANGE FOR EACH ITERATION:
0 HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL
 ------------------------------------------------------------------------------------------------------------------------------------
   -1.241      (  2, 13,  8)  -.2603      (  2, 14,  7)  -.1856      (  1, 15,  8)  -.1173      (  1, 14,  9)  -.2752E-01 (  1, 23, 10)
    .7121E-02 (  2, 21,  6)   .5338E-02 (  2, 13, 11)   .3747E-02 (  2, 12, 10)   .1705E-02 (  1, 13,  7)  -.9633E-03 (  2, 11, 10)
0
0HEAD/DRAWDOWN PRINTOUT FLAG = 1     TOTAL BUDGET PRINTOUT FLAG = 1     CELL-BY-CELL FLOW TERM FLAG = 0
0OUTPUT FLAGS FOR EACH LAYER:
           HEAD     DRAWDOWN  HEAD   DRAWDOWN
 LAYER   PRINTOUT   PRINTOUT  SAVE     SAVE
 -----------------------------------------
    1        1          1        1        1
```

1 2 1 1 1 1

1 HEAD IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.55	92.67	92.78	92.88	92.99	93.14	93.25	93.36	93.46	93.56	93.66	93.75	93.84	93.92	94.00
0 3	92.00	92.13	92.26	92.37	92.47	92.58	92.70	92.81	92.92	93.02	93.11	93.21	93.30	93.38	93.45	93.50
0 4	91.60	91.73	91.85	91.96	92.06	92.16	92.27	92.38	92.48	92.57	92.67	92.76	92.85	92.92	93.00	93.10
0 5	91.20	91.33	91.45	91.56	91.66	91.74	91.85	91.95	92.04	92.14	92.22	92.31	92.39	92.46	92.53	92.60
0 6	90.70	90.86	91.00	91.12	91.22	91.30	91.40	91.49	91.59	91.68	91.76	91.85	91.94	92.00	92.06	92.10
0 7	90.20	90.36	90.51	90.63	90.73	90.82	90.92	91.01	91.11	91.20	91.29	91.38	91.49	91.55	91.59	91.60
0 8	89.70	89.89	90.04	90.15	90.25	90.34	90.44	90.53	90.62	90.72	90.80	90.89	90.99	91.05	91.08	91.10
0 9	89.40	89.49	89.60	89.69	89.78	89.86	89.96	90.05	90.14	90.23	90.31	90.38	90.45	90.50	90.52	90.50
0 10	89.00	89.09	89.17	89.24	89.30	89.38	89.47	89.56	89.65	89.74	89.82	89.88	89.94	89.98	90.00	90.00
0 11	88.70	88.72	88.77	88.80	88.84	88.90	88.98	89.07	89.17	89.27	89.34	89.41	89.46	89.49	89.51	89.50
0 12	88.30	88.36	88.39	88.39	88.39	88.40	88.48	88.55	88.69	88.81	88.90	88.97	89.02	89.05	89.08	89.10
0 13	88.00	88.02	88.02	87.99	87.92	87.82	87.97	87.97	88.21	88.37	88.47	88.54	88.59	88.62	88.63	88.60
0 14	87.70	87.72	87.69	87.62	87.47	87.55	87.64	87.70	87.84	87.96	88.06	88.13	88.19	88.22	88.23	88.20
0 15	87.50	87.45	87.40	87.34	87.28	87.28	87.32	87.37	87.46	87.57	87.67	87.74	87.79	87.83	87.87	87.90
0 16	87.30	87.18	87.11	87.05	87.02	87.00	87.01	87.04	87.12	87.20	87.29	87.36	87.42	87.46	87.49	87.50
0 17	87.00	86.87	86.80	86.76	86.73	86.72	86.72	86.71	86.80	86.87	86.94	87.00	87.05	87.09	87.14	87.20
0 18	86.50	86.48	86.45	86.44	86.43	86.43	86.43	86.45	86.49	86.54	86.59	86.63	86.68	86.72	86.79	86.90
0 19	86.00	86.07	86.10	86.11	86.12	86.13	86.14	86.15	86.18	86.22	86.25	86.28	86.30	86.33	86.36	86.40
20	85.60	85.65	85.69	85.72	85.74	85.75	85.76	85.78	85.79	85.82	85.83	85.84	85.83	85.83	85.85	85.90
21	85.10	85.17	85.22	85.25	85.27	85.28	85.28	85.28	85.30	85.31	85.31	85.30	85.27	85.24	85.18	85.10
0 22	84.70	84.72	84.76	84.78	84.78	84.77	84.76	84.74	84.75	84.76	84.76	84.74	84.70	84.65	84.57	84.50
0 23	84.20	84.27	84.31	84.33	84.30	84.27	84.22	84.18	84.20	84.22	84.22	84.20	84.16	84.08	83.96	83.80
0 24	83.80	83.84	83.88	83.87	83.83	83.77	83.69	83.54	83.65	83.69	83.69	83.67	83.64	83.55	83.41	83.30
0 25	83.50	83.46	83.45	83.42	83.37	83.30	83.21	83.11	83.15	83.18	83.19	83.17	83.13	83.03	82.90	82.80
0 26	83.10	83.06	83.02	82.98	82.92	82.84	82.73	82.54	82.67	82.71	82.71	82.68	82.62	82.53	82.41	82.30
0 27	82.70	82.64	82.59	82.54	82.48	82.42	82.34	82.26	82.26	82.26	82.25	82.21	82.14	82.06	81.96	81.90
0 28	82.20	82.19	82.15	82.10	82.06	82.00	81.94	81.89	81.86	81.84	81.80	81.75	81.69	81.60	81.50	81.40
0 29	81.80	81.75	81.71	81.67	81.63	81.58	81.54	81.49	81.46	81.42	81.37	81.31	81.24	81.16	81.07	81.00
0 30	81.30	81.28	81.26	81.23	81.20	81.16	81.13	81.09	81.05	81.00	80.95	80.88	80.81	80.73	80.65	80.60
0 31	80.80	80.81	80.80	80.79	80.77	80.75	80.71	80.68	80.64	80.59	80.53	80.46	80.39	80.30	80.23	80.20
0 32	80.30	80.34	80.35	80.35	80.34	80.33	80.30	80.27	80.23	80.18	80.11	80.04	79.96	79.87	79.78	79.70
0 33	79.90	79.90	79.91	79.92	79.92	79.91	79.90	79.87	79.83	79.77	79.70	79.62	79.54	79.44	79.35	79.30
0 34	79.40	79.44	79.46	79.50	79.51	79.51	79.50	79.48	79.45	79.38	79.30	79.21	79.12	79.01	78.91	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

1 HEAD IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.1	92.10
0 2	90.90	90.96	91.04	91.13	91.21	91.26	91.34	91.42	91.48	91.53	91.58	91.61	91.67	91.70	91	91.80
0 3	90.60	90.70	90.78	90.86	90.93	91.00	91.07	91.13	91.19	91.23	91.27	91.31	91.34	91.37	91.4	91.40
0 4	90.40	90.44	90.51	90.58	90.66	90.73	90.80	90.85	90.90	90.94	90.97	90.99	91.01	91.04	91.06	91.10
0 5	90.10	90.16	90.23	90.31	90.38	90.46	90.53	90.58	90.62	90.64	90.66	90.67	90.68	90.69	90.70	90.70
0 6	89.80	89.88	89.95	90.03	90.10	90.19	90.27	90.32	90.35	90.35	90.35	90.35	90.35	90.35	90.34	90.30
0 7	89.50	89.58	89.66	89.74	89.82	89.91	90.02	90.09	90.10	90.06	90.03	90.02	90.01	90.01	90.01	90.00
0 8	89.20	89.30	89.37	89.44	89.51	89.62	89.83	89.91	89.89	89.75	89.70	89.68	89.67	89.67	89.67	89.70
0 9	89.00	89.03	89.08	89.13	89.18	89.23	89.42	89.53	89.50	89.36	89.33	89.32	89.31	89.31	89.31	89.30
0 10	88.70	88.76	88.79	88.81	88.84	88.86	88.92	88.96	88.98	88.96	88.95	88.95	88.94	88.94	88.95	89.00
0 11	88.50	88.50	88.50	88.50	88.49	88.49	88.46	88.41	88.50	88.55	88.56	88.57	88.57	88.57	88.55	88.50
0 12	88.30	88.26	88.22	88.19	88.15	88.12	87.96	87.72	87.98	88.15	88.18	88.20	88.21	88.20	88.17	88.10
0 13	88.10	88.00	87.93	87.87	87.81	87.75	87.41	86.50	87.41	87.75	87.80	87.83	87.85	87.85	87.83	87.80
0 14	87.80	87.71	87.63	87.56	87.48	87.38	87.13	86.87	87.11	87.36	87.43	87.48	87.51	87.52	87.51	87.50
0 15	87.50	87.40	87.32	87.25	87.16	87.03	86.85	86.79	86.84	87.00	87.10	87.16	87.18	87.20	87.20	87.20
0 16	87.10	87.07	87.02	86.96	86.88	86.80	86.70	86.65	86.68	86.76	86.82	86.86	86.87	86.88	86.88	86.90
0 17	86.80	86.75	86.72	86.68	86.63	86.58	86.52	86.42	86.49	86.53	86.56	86.58	86.58	86.57	86.54	86.50
0 18	86.40	86.43	86.43	86.41	86.39	86.38	86.36	86.33	86.33	86.33	86.32	86.31	86.29	86.26	86.23	86.20
0 19	86.10	86.13	86.15	86.15	86.16	86.18	86.21	86.21	86.18	86.12	86.08	86.04	86.01	85.97	85.90	85.80
0 20	85.70	85.78	85.82	85.83	85.84	85.86	85.87	85.86	85.83	85.79	85.75	85.71	85.67	85.62	85.54	85.40
0 21	85.30	85.35	85.38	85.38	85.38	85.37	85.33	85.29	85.28	85.29	85.28	85.25	85.22	85.17	85.09	85.00
0 22	84.90	84.89	84.89	84.88	84.86	84.83	84.76	84.70	84.72	84.74	84.74	84.74	84.71	84.67	84.61	84.50
0 23	84.40	84.42	84.42	84.39	84.35	84.29	84.18	84.04	84.13	84.20	84.23	84.24	84.23	84.20	84	84.10
0 24	84.00	83.98	83.96	83.92	83.86	83.78	83.58	83.14	83.53	83.68	83.73	83.75	83.76	83.75	83.	83.70
0 25	83.60	83.56	83.52	83.46	83.40	83.32	83.17	83.01	83.11	83.21	83.26	83.29	83.30	83.30	83.30	83.30
0 26	83.20	83.14	83.08	83.02	82.95	82.87	82.72	82.63	82.66	82.76	82.81	82.84	82.86	82.87	82.88	82.90
0 27	82.80	82.72	82.65	82.59	82.52	82.43	82.30	82.24	82.25	82.33	82.38	82.40	82.42	82.44	82.46	82.50
0 28	82.30	82.27	82.22	82.16	82.10	82.03	81.96	81.92	81.91	81.94	81.96	81.98	81.99	82.00	82.01	82.00
0 29	81.90	81.85	81.80	81.74	81.69	81.64	81.59	81.56	81.54	81.54	81.55	81.56	81.57	81.58	81.59	81.60
0 30	81.50	81.43	81.37	81.33	81.28	81.24	81.20	81.17	81.16	81.15	81.14	81.14	81.14	81.15	81.16	81.20
0 31	81.00	80.98	80.95	80.91	80.87	80.84	80.80	80.78	80.76	80.75	80.73	80.73	80.72	80.71	80.71	80.70
0 32	80.60	80.56	80.52	80.49	80.46	80.43	80.40	80.38	80.36	80.34	80.32	80.31	80.29	80.28	80.28	80.30
0 33	80.20	80.14	80.09	80.06	80.04	80.02	80.00	79.98	79.96	79.94	79.91	79.89	79.87	79.84	79.82	79.80
0 34	79.70	79.70	79.66	79.64	79.62	79.61	79.60	79.59	79.57	79.53	79.51	79.48	79.44	79.41	79.36	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

0HEAD WILL BE SAVED ON UNIT 30 AT END OF TIME STEP 1, STRESS PERIOD 1

1 DRAWDOWN IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.05	.03	.02	.02	.01	.06	.05	.04	.04	.04	.04	.05	-.04	-.02	.00
0 3	.00	.07	.04	.03	.03	.12	.10	.09	.08	.08	.09	-.01	-.00	.02	.05	.00
0 4	.00	.07	.05	.04	.14	.14	.13	.12	.12	.13	.13	.04	.05	-.02	-.00	.00
0 5	.00	.07	.05	.04	.14	.16	.15	.15	.16	.16	.18	.09	.01	.04	.07	.00

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 6	.00	.04	.00	.08	.18	.20	.20	.21	.21	.22	.14	.15	.06	.10	.04	.00
0 7	.00	.04	.09	.07	.17	.18	.18	.19	.19	.20	.21	.12	.11	.05	.01	.00
0 8	.00	.01	.06	.15	.15	.16	.16	.17	.18	.18	.20	.11	.11	.05	.02	.00
9	.00	.01	.10	.11	.22	.24	.24	.25	.16	.17	.19	.12	.15	.10	.08	.00
10	.00	.11	.13	.16	.20	.22	.23	.24	.25	.16	.18	.12	.06	.02	.00	.00
0 11	.00	.08	.13	.20	.26	.30	.32	.33	.23	.23	.16	.19	.14	.11	-.01	.00
0 12	.00	.04	.21	.31	.41	.50	.42	.45	.31	.29	.20	.13	.08	.05	.02	.00
0 13	.00	.08	.18	.31	.48	.68	.63	.63	.49	.33	.23	.16	.11	.08	.07	.00
0 14	.00	.08	.21	.38	.63	.55	.56	.50	.46	.34	.24	.17	.11	.08	.07	.00
0 15	.00	.15	.20	.36	.42	.52	.48	.53	.44	.33	.23	.16	.11	.07	.03	.00
0 16	.00	.12	.19	.25	.38	.40	.49	.46	.38	.40	.31	.24	.18	.14	.01	.00
0 17	.00	.03	.20	.24	.27	.38	.38	.49	.40	.33	.26	.20	.15	.11	.06	.00
0 18	.00	.02	.15	.16	.27	.27	.37	.35	.31	.26	.21	.17	.12	.08	.01	.00
0 19	.00	.03	.10	.19	.28	.27	.26	.35	.32	.28	.25	.22	.10	.07	.04	.00
0 20	.00	.05	.11	.18	.26	.25	.24	.32	.31	.28	.27	.16	.17	.07	.05	.00
0 21	.00	.03	.08	.15	.23	.22	.32	.32	.30	.29	.19	.20	.13	.06	.02	.00
0 22	.00	.08	.14	.12	.22	.23	.24	.36	.25	.24	.24	.16	.10	.05	.03	.00
0 23	.00	.03	.09	.17	.20	.23	.28	.32	.30	.28	.18	.20	.14	.12	.04	.00
0 24	.00	.06	.12	.13	.17	.33	.41	.46	.35	.31	.21	.13	.16	.05	-.01	.00
0 25	.00	.04	.05	.18	.23	.30	.39	.49	.35	.32	.21	.13	.07	.07	.00	.00
0 26	.00	.04	.08	.12	.18	.26	.37	.56	.33	.29	.19	.12	.08	.07	-.01	.00
0 27	.00	.06	.11	.16	.22	.18	.26	.34	.34	.24	.15	.19	.06	.04	.04	.00
0 28	.00	.01	.05	.10	.14	.20	.26	.21	.24	.16	.20	.15	.11	.10	-.00	.00
0 29	.00	.05	.09	.13	.07	.12	.16	.21	.14	.18	.13	.09	.06	.04	.03	.00
0 30	.00	.02	.04	.07	.10	.14	.17	.11	.15	.10	.15	.12	.09	.07	.05	.00
0 31	.00	-.01	-.00	.01	.03	.05	.09	.12	.06	.11	.07	.04	.01	-.00	.07	.00
0 32	.00	.06	.05	.05	.06	.07	.10	.03	.07	.02	.09	.06	.04	.03	.02	.00
0 33	.00	.00	-.01	.08	.08	.09	.00	.03	.07	.03	-.00	.08	.06	.06	.05	.00
0 34	.00	-.04	.04	.00	-.01	-.01	.00	.02	.05	.02	.00	-.01	-.02	-.01	-.01	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

1 DRAWDOWN IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.04	.06	-.03	-.01	.04	.06	-.02	.02	-.03	.02	-.01	.03	.00	.05	.00
0 3	.00	.00	.02	.04	.07	.00	.03	.07	.01	.07	.03	-.01	.06	.03	.00	.00
0 4	.00	.06	-.01	.02	.04	-.03	.00	.05	-.00	.06	.03	.01	.09	.06	.04	.00
0 5	.00	.04	.07	-.01	.02	.04	-.03	.02	-.02	.06	.04	.03	.02	.01	.00	.00
0 6	.00	.02	.05	-.03	-.00	.01	-.07	-.02	-.05	-.05	.05	.05	.05	.05	.06	.00
0 7	.00	.02	.04	.06	-.02	-.01	-.12	-.09	-.10	-.06	.07	.08	.09	.09	-.01	.00
0 8	.00	.00	.03	.06	-.01	-.02	-.23	-.21	-.19	-.05	.00	.02	.03	.03	.03	.00
0 9	.00	.07	.02	.07	.12	.07	-.12	-.13	-.10	.04	.07	.08	.09	.09	-.01	.00
0 10	.00	.04	.11	.09	.16	.14	.08	.14	.12	.14	.15	.15	.06	.06	.05	.00
11	.00	.10	.10	.10	.21	.21	.24	.39	.30	.25	.14	.13	.13	.13	.05	.00
12	.00	.04	.08	.21	.25	.28	.54	.78	.52	.25	.22	.20	.19	.10	.03	.00
13	.00	.10	.17	.23	.29	.35	.79	1.70	.79	.35	.30	.27	.15	.15	.07	.00
0 14	.00	.09	.17	.24	.42	.52	.77	1.03	.79	.44	.37	.22	.19	.08	.09	.00
0 15	.00	.10	.18	.25	.44	.57	.75	.81	.76	.60	.40	.24	.12	.10	.00	.00
0 16	.00	.03	.18	.24	.42	.50	.60	.65	.52	.44	.28	.14	.13	.02	.02	.00
0 17	.00	.05	.08	.22	.27	.32	.38	.38	.31	.27	.14	.12	.02	.03	-.04	.00
0 18	.00	-.03	.07	.09	.11	.12	.04	.07	.07	.07	-.02	-.01	-.09	-.06	-.03	.00
0 19	.00	-.03	-.05	-.05	-.06	-.18	-.21	-.21	-.18	-.22	-.18	-.14	-.21	-.17	-.10	.00
0 20	.00	.02	-.02	-.13	-.14	-.26	-.27	-.26	-.23	-.29	-.25	-.21	-.27	-.22	-.14	.00
0 21	.00	-.05	-.08	-.08	-.08	-.17	-.13	-.09	-.18	-.19	-.18	-.15	-.22	-.17	-.09	.00
0 22	.00	.01	.01	.02	-.06	-.03	.04	.10	-.02	-.04	-.04	-.14	-.11	-.07	-.01	.00
0 23	.00	-.02	-.02	.01	.05	.11	.12	.26	.17	.10	-.03	-.04	-.03	.00	-.06	.00
0 24	.00	.02	.04	.08	.14	.12	.32	.76	.37	.22	.07	.05	.04	.05	-.03	.00
0 25	.00	.04	.08	.04	.10	.18	.33	.49	.29	.19	.14	.11	.10	.10	-.00	.00
0 26	.00	.06	.02	.08	.15	.23	.38	.37	.34	.24	.19	.16	.14	.03	.02	.00
0 27	.00	.08	.05	.11	.18	.17	.30	.36	.35	.27	.12	.10	.08	.06	.04	.00
0 28	.00	.03	.08	.14	.10	.17	.24	.28	.29	.16	.14	.12	.11	.10	-.01	.00
0 29	.00	.05	.10	.06	.11	.16	.21	.14	.16	.16	.15	.04	.03	.02	.01	.00
0 30	.00	.07	.03	.07	.12	.16	.10	.13	.14	.15	.06	.06	.06	.05	.04	.00
0 31	.00	.02	.05	.09	.03	.06	.10	.12	.14	.05	.07	.07	.08	-.01	-.01	.00
0 32	.00	.04	.08	.01	.04	.07	.10	.02	.04	.06	.08	-.01	.01	.02	.02	.00
0 33	.00	.06	.01	.04	.06	.08	-.00	.02	.04	.06	-.01	.01	.03	.06	-.02	.00
0 34	.00	.00	.04	.06	-.02	-.01	.00	.01	.03	-.03	-.01	.02	-.04	-.01	.04	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

0DRAWDOWN WILL BE SAVED ON UNIT 40 AT END OF TIME STEP 1, STRESS PERIOD 1

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VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 1

0 CUMULATIVE VOLUMES L**3 RATES FOR THIS TIME STEP L**3/T

CUMULATIVE VOLUMES L**3		RATES FOR THIS TIME STEP L**3/T	
IN:		IN:	
STORAGE =	.00000	STORAGE =	.00000

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                    CONSTANT HEAD =     .30457E+06
                            WELLS =     .00000
0                        TOTAL IN =     .30457E+06
0                       OUT:
                        ----
                          STORAGE =     .00000
                    CONSTANT HEAD =     .22754E+06
                            WELLS =     77007.
0                       TOTAL OUT =     .30454E+06
0                        IN - OUT =     23.719
0            PERCENT DISCREPANCY =                  .01
```


```
                    CONSTANT HEAD =     .30457E+06
                            WELLS =     .00000
                         TOTAL IN =     .30457E+06
                        OUT:
                        ----
                          STORAGE =     .00000
                    CONSTANT HEAD =     .22754E+06
                            WELLS =     77007.
                        TOTAL OUT =     .30454E+06
                         IN - OUT =     23.719
             PERCENT DISCREPANCY =                  .01
```


```
0


        TIME SUMMARY AT END OF TIME STEP  1 IN STRESS PERIOD  1
                             SECONDS      MINUTES      HOURS        DAYS         YEARS
                          -----------------------------------------------------------------
     TIME STEP LENGTH        86400.0      1440.00      24.0000      1.00000      .273785E-02
   STRESS PERIOD TIME        86400.0      1440.00      24.0000      1.00000      .273785E-02
 TOTAL SIMULATION TIME       86400.0      1440.00      24.0000      1.00000      .273785E-02
1
```

```
1                                   U.S. GEOLOGICAL SURVEY MODULAR FINITE-DIFFERENCE GROUND-WATER MODEL
0SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     SENSIT ANAL, SIMULATION 4A: VERT LEAKAGE X 0.5
    2 LAYERS         35 ROWS         16 COLUMNS
   1 STRESS PERIOD(S) IN SIMULATION
 ODEL TIME UNIT IS DAYS
 I/O UNITS:
 ELEMENT OF IUNIT:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
         I/O UNIT: 11 12  0  0  0  0  0  0 19  0  0 22  0  0  0  0  0  0  0  0  0  0  0  0
0BAS1 -- BASIC MODEL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT  1
 ARRAYS RHS AND BUFF WILL SHARE MEMORY.
 START HEAD WILL BE SAVED
    10699 ELEMENTS IN X ARRAY ARE USED BY BAS
    10699 ELEMENTS OF X ARRAY USED OUT OF  100000
0BCF1 -- BLOCK-CENTERED FLOW PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 11
 STEADY-STATE SIMULATION
       LAYER  AQUIFER TYPE
       -------------------
          1          1
          2          0
     1122 ELEMENTS IN X ARRAY ARE USED BY BCF
    11821 ELEMENTS OF X ARRAY USED OUT OF  100000
0WEL1 -- WELL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM 12
 MAXIMUM OF    9 WELLS
       36 ELEMENTS IN X ARRAY ARE USED FOR WELLS
    11857 ELEMENTS OF X ARRAY USED OUT OF  100000
0SIP1 -- STRONGLY IMPLICIT PROCEDURE SOLUTION PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 19
 MAXIMUM OF  50 ITERATIONS ALLOWED FOR CLOSURE
  5 ITERATION PARAMETERS
     4685 ELEMENTS IN X ARRAY ARE USED BY SIP
    16542 ELEMENTS OF X ARRAY USED OUT OF  100000
1SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION     SENSIT ANAL, SIMULATION 4A: VERT LEAKAGE X 0.5
0
```

BOUNDARY ARRAY FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
0	2	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	3	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	4	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	5	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	6	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
	7	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
	8	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
	9	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	10	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	11	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	12	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	13	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	14	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	15	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	16	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	17	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	18	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	19	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	20	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	21	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	22	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	23	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	24	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	25	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	26	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	27	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	28	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	29	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	30	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	31	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	32	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	33	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	34	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0	35	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

0

BOUNDARY ARRAY FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

```
           1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16
 ..................................................................
```

0	1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
0	2	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	3	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	4	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	5	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	6	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	7	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	8	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	9	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	10	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	11	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	12	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	13	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	14	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	15	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	16	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	17	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	18	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	19	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	20	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	21	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	22	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	23	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	24	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	25	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	26	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	27	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	28	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	29	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	30	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	31	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	32	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	33	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	34	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0	35	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2

0AQUIFER HEAD WILL BE SET TO 999.99 AT ALL NO-FLOW NODES (IBOUND=0).
0

INITIAL HEAD FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

		1 11	2 12	3 13	4 14	5 15	6 16	7	8	9	10
0	1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90
		94.00	94.10	94.20	94.30	94.40	94.50				
0	2	92.40	92.60	92.70	92.80	92.90	93.00	93.20	93.30	93.40	93.50
		93.60	93.70	93.80	93.80	93.90	94.00				
0	3	92.00	92.20	92.30	92.40	92.50	92.70	92.80	92.90	93.00	93.10
		93.20	93.20	93.30	93.40	93.50	93.50				
0	4	91.60	91.80	91.90	92.00	92.20	92.30	92.40	92.50	92.60	92.70
		92.80	92.80	92.90	92.90	93.00	93.10				
0	5	91.20	91.40	91.50	91.60	91.80	91.90	92.00	92.10	92.20	92.30
		92.40	92.40	92.40	92.50	92.60	92.60				
0	6	90.70	90.90	91.00	91.20	91.40	91.50	91.60	91.70	91.80	91.90
		91.90	92.00	92.00	92.10	92.10	92.10				
0	7	90.20	90.40	90.60	90.70	90.90	91.00	91.10	91.20	91.30	91.40
		91.50	91.50	91.60	91.60	91.60	91.60				
0	8	89.70	89.90	90.10	90.30	90.40	90.50	90.60	90.70	90.80	90.90
		91.00	91.00	91.10	91.10	91.10	91.10				
0	9	89.40	89.50	89.70	89.80	90.00	90.10	90.20	90.30	90.30	90.40
		90.50	90.50	90.60	90.60	90.60	90.50				
0	10	89.00	89.20	89.30	89.40	89.50	89.60	89.70	89.80	89.90	89.90
		90.00	90.00	90.00	90.00	90.00	90.00				
0	11	88.70	88.80	88.90	89.00	89.10	89.20	89.30	89.40	89.40	89.50
		89.50	89.60	89.60	89.60	89.50	89.50				
0	12	88.30	88.40	88.60	88.70	88.80	88.90	88.90	89.00	89.00	89.10
		89.10	89.10	89.10	89.10	89.10	89.10				
0	13	88.00	88.10	88.20	88.30	88.40	88.50	88.60	88.60	88.70	88.70
		88.70	88.70	88.70	88.70	88.70	88.60				
0	14	87.70	87.80	87.90	88.00	88.10	88.10	88.20	88.20	88.30	88.30
		88.30	88.30	88.30	88.30	88.30	88.20				
0	15	87.50	87.60	87.60	87.70	87.70	87.80	87.80	87.90	87.90	87.90
		87.90	87.90	87.90	87.90	87.90	87.90				
0	16	87.30	87.30	87.30	87.30	87.40	87.40	87.50	87.50	87.50	87.60
		87.60	87.60	87.60	87.60	87.50	87.50				
0	17	87.00	86.90	87.00	87.00	87.00	87.10	87.10	87.20	87.20	87.20
		87.20	87.20	87.20	87.20	87.20	87.20				
0	18	86.50	86.50	86.60	86.60	86.70	86.70	86.80	86.80	86.80	86.80
		86.80	86.80	86.80	86.80	86.80	86.90				
0	19	86.00	86.10	86.20	86.30	86.40	86.40	86.40	86.50	86.50	86.50

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
											86.50	86.50	86.40	86.40	86.40	86.40
0 20	85.60	85.70	85.80	85.90	86.00	86.00	86.00	86.10	86.10	86.10	86.10	86.00	86.00	85.90	85.90	85.90
21	85.10	85.20	85.30	85.40	85.50	85.50	85.60	85.60	85.60	85.60	85.50	85.50	85.40	85.30	85.20	85.10
0 22	84.70	84.80	84.90	84.90	85.00	85.00	85.00	85.10	85.00	85.00	85.00	84.90	84.80	84.70	84.60	84.50
0 23	84.20	84.30	84.40	84.50	84.50	84.50	84.50	84.50	84.50	84.50	84.40	84.40	84.30	84.20	84.00	83.80
0 24	83.80	83.90	84.00	84.00	84.00	84.10	84.10	84.00	84.00	84.00	83.90	83.80	83.80	83.60	83.40	83.30
0 25	83.50	83.50	83.50	83.60	83.60	83.60	83.60	83.60	83.50	83.50	83.40	83.30	83.20	83.10	82.90	82.80
0 26	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.00	83.00	82.90	82.80	82.70	82.60	82.40	82.30
0 27	82.70	82.70	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.50	82.40	82.40	82.20	82.10	82.00	81.90
0 28	82.20	82.20	82.20	82.20	82.20	82.20	82.20	82.10	82.10	82.00	82.00	81.90	81.80	81.70	81.50	81.40
0 29	81.80	81.80	81.80	81.80	81.70	81.70	81.70	81.70	81.60	81.60	81.50	81.40	81.30	81.20	81.10	81.00
0 30	81.30	81.30	81.30	81.30	81.30	81.30	81.30	81.20	81.20	81.10	81.10	81.00	80.90	80.80	80.70	80.60
0 31	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.70	80.70	80.60	80.50	80.40	80.30	80.30	80.20
0 32	80.30	80.40	80.40	80.40	80.40	80.40	80.40	80.30	80.30	80.20	80.20	80.10	80.00	79.90	79.80	79.70
0 33	79.90	79.90	79.90	80.00	80.00	80.00	79.90	79.90	79.90	79.80	79.70	79.70	79.60	79.50	79.40	79.30
0 34	79.40	79.40	79.50	79.50	79.50	79.50	79.50	79.50	79.50	79.40	79.30	79.20	79.10	79.00	78.90	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

0

INITIAL HEAD FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	92.10
0 2	90.90	91.00	91.10	91.10	91.20	91.30	91.40	91.40	91.50	91.50	91.60	91.60	91.70	91.70	91.80	91.80
3	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.20	91.20	91.30	91.30	91.30	91.40	91.40	91.40	91.40
0 4	90.40	90.50	90.50	90.60	90.70	90.70	90.80	90.90	90.90	91.00	91.00	91.00	91.10	91.10	91.10	91.10
0 5	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.70	90.70	90.70	90.70	90.70	90.70	90.70
0 6	89.80	89.90	90.00	90.00	90.10	90.20	90.20	90.30	90.30	90.30	90.40	90.40	90.40	90.40	90.40	90.30
0 7	89.50	89.60	89.70	89.80	89.80	89.90	89.90	90.00	90.00	90.00	90.10	90.10	90.10	90.10	90.00	90.00
0 8	89.20	89.30	89.40	89.50	89.50	89.60	89.60	89.70	89.70	89.70	89.70	89.70	89.70	89.70	89.70	89.70
0 9	89.00	89.10	89.10	89.20	89.30	89.30	89.30	89.40	89.40	89.40	89.40	89.40	89.40	89.40	89.30	89.30
0 10	88.70	88.80	88.90	88.90	89.00	89.00	89.00	89.10	89.10	89.10	89.10	89.10	89.00	89.00	89.00	89.00
0 11	88.50	88.60	88.60	88.60	88.70	88.70	88.70	88.80	88.80	88.80	88.70	88.70	88.70	88.70	88.60	88.50
0 12	88.30	88.30	88.30	88.40	88.40	88.40	88.50	88.50	88.50	88.40	88.40	88.40	88.40	88.30	88.20	88.10
0 13	88.10	88.10	88.10	88.10	88.10	88.10	88.20	88.20	88.20	88.10	88.10	88.10	88.00	88.00	87.90	87.80
0 14	87.80	87.80	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.80	87.80	87.70	87.70	87.60	87.60	87.50
0 15	87.50	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.60	87.50	87.40	87.30	87.30	87.20	87.20
0 16	87.10	87.10	87.20	87.20	87.30	87.30	87.30	87.30	87.20	87.20	87.10	87.00	87.00	86.90	86.90	86.90
0 17	86.80	86.80	86.80	86.90	86.90	86.90	86.90	86.80	86.80	86.80	86.70	86.70	86.60	86.60	86.50	86.50
0 18	86.40	86.40	86.50	86.50	86.50	86.50	86.40	86.40	86.40	86.40	86.30	86.30	86.20	86.20	86.20	86.20
0 19	86.10	86.10	86.10	86.10	86.10	86.00	86.00	86.00	86.00	85.90	85.90	85.90	85.80	85.80	85.80	85.80
0 20	85.70	85.80	85.80	85.70	85.70	85.60	85.60	85.60	85.60	85.50	85.50	85.50	85.40	85.40	85.40	85.40

0 21	85.30	85.30	85.30	85.30	85.30	85.20	85.20	85.20	85.10	85.10	85.10	85.10	85.00	85.00	85.00	85.00
0 22	84.90	84.90	84.90	84.90	84.80	84.80	84.80	84.80	84.70	84.70	84.70	84.60	84.60	84.60	84.60	84.50
0 23	84.40	84.40	84.40	84.40	84.40	84.40	84.30	84.30	84.30	84.30	84.20	84.20	84.20	84.20	84.10	84.10
0 24	84.00	84.00	84.00	84.00	84.00	83.90	83.90	83.90	83.90	83.90	83.80	83.80	83.80	83.80	83.70	83.70
0 25	83.60	83.60	83.60	83.50	83.50	83.50	83.50	83.50	83.40	83.40	83.40	83.40	83.40	83.40	83.30	83.30
0 26	83.20	83.20	83.10	83.10	83.10	83.10	83.10	83.00	83.00	83.00	83.00	83.00	83.00	82.90	82.90	82.90
0 27	82.80	82.80	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.60	82.50	82.50	82.50	82.50	82.50	82.50
0 28	82.30	82.30	82.30	82.30	82.20	82.20	82.20	82.20	82.20	82.10	82.10	82.10	82.10	82.10	82.00	82.00
0 29	81.90	81.90	81.90	81.80	81.80	81.80	81.80	81.70	81.70	81.70	81.70	81.60	81.60	81.60	81.60	81.60
0 30	81.50	81.50	81.40	81.40	81.40	81.40	81.30	81.30	81.30	81.30	81.20	81.20	81.20	81.20	81.20	81.20
0 31	81.00	81.00	81.00	81.00	80.90	80.90	80.90	80.90	80.90	80.80	80.80	80.80	80.80	80.70	80.70	80.70
0 32	80.60	80.60	80.60	80.50	80.50	80.50	80.50	80.40	80.40	80.40	80.40	80.30	80.30	80.30	80.30	80.30
0 33	80.20	80.20	80.10	80.10	80.10	80.10	80.00	80.00	80.00	80.00	79.90	79.90	79.90	79.90	79.80	79.80
0 34	79.70	79.70	79.70	79.70	79.60	79.60	79.60	79.60	79.60	79.50	79.50	79.50	79.40	79.40	79.40	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

0HEAD PRINT FORMAT IS FORMAT NUMBER 4 DRAWDOWN PRINT FORMAT IS FORMAT NUMBER 9
0HEADS WILL BE SAVED ON UNIT 30 DRAWDOWNS WILL BE SAVED ON UNIT 40
0OUTPUT CONTROL IS SPECIFIED EVERY TIME STEP
0 COLUMN TO ROW ANISOTROPY = 1.000000
0 DELR = 200.0000
0 DELC = 200.0000
0

HYD. COND. ALONG ROWS FOR LAYER 1 WILL BE READ ON UNIT 11 USING FORMAT: (16F4.0)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 2	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 3	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 4	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 5	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 6	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	300.0	300.0	300.0	300.0
0 7	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	300.0	300.0	300.0	300.0
0 8	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	225.0	225.0	225.0	300.0
0 9	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	225.0	225.0	225.0	300.0
0 10	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	225.0	225.0	225.0	300.0
0 11	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 12	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 13	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 14	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 15	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 16	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 17	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 18	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 19	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0						

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
											250.0	250.0	250.0	250.0	250.0	300.0
0 20	300.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	300.0
21	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 22	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 23	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 24	300.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	175.0	175.0	175.0	300.0
0 25	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 26	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 27	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 28	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 29	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 30	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 31	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 32	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 33	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 34	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0
0 35	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	300.0

0 BOTTOM = 30.00000 FOR LAYER 1

0 VERT HYD COND /THICKNESS = .5000000E-03 FOR LAYER 1

0

TRANSMIS. ALONG ROWS FOR LAYER 2 WILL BE READ ON UNIT 11 USING FORMAT: (16F5.0)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
2	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 3	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 4	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 5	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 6	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 7	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 8	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 9	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 10	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 11	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 12	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 13	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 14	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.	6000.	6000.	6000.	6000.	6000.	6000.
0 15	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 16	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 17	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 18	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.
0 19	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.	6000.	6000.	6000.	6000.	6000.	6000.

```
0 20   4000.     4000.     4000.     4000.     4000.     4000.     1500.     1500.     1500.     4000.
       4000.     4000.     4000.     4000.     4000.     4000.
0 21   3000.     3000.     3000.     3000.     3000.     3000.     1500.     1500.     1500.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 22   3000.     3000.     3000.     3000.     3000.     3000.     1500.     1500.     1500.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 23   3000.     3000.     3000.     3000.     3000.     3000.     1500.     1500.     1500.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 24   3000.     3000.     3000.     3000.     3000.     3000.     1500.     1500.     1500.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 25   3000.     3000.     3000.     3000.     3000.     3000.     1500.     1500.     1500.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 26   3000.     3000.     3000.     3000.     3000.     3000.     1500.     1500.     1500.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 27   3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 28   3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 29   3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 30   3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 31   3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 32   3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 33   3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 34   3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0 35   3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.     3000.
       3000.     3000.     3000.     3000.     3000.     3000.
0

                                                                SOLUTION BY THE STRONGLY IMPLICIT PROCEDURE
                                                                -------------------------------------------
0                                                       MAXIMUM ITERATIONS ALLOWED FOR CLOSURE =        50
                                                                       ACCELERATION PARAMETER =     1.0000
                                                             HEAD CHANGE CRITERION FOR CLOSURE =    .10000E-02
                                                             SIP HEAD CHANGE PRINTOUT INTERVAL =         1
0                                                            CALCULATE ITERATION PARAMETERS FROM MODEL CALCULATED WSEED
1                                                           STRESS PERIOD NO.    1, LENGTH =   1.000000
                                                            ----------------------------------------------

                                                            NUMBER OF TIME STEPS =     1

                                                             MULTIPLIER FOR DELT =     1.000

                                                          INITIAL TIME STEP SIZE =   1.000000
0             9 WELLS
                                                        LAYER     ROW     COL      STRESS RATE    WELL NO.
                                                        ---------------------------------------------
                                                          1        14      5        -13476.          1
                                                          1        13      6        -13476.          2
                                                          1        13      8        -13476.          3
                                                          1        17      8        -4813.0          4
                                                          1        24      8        -7701.0          5
                                                          1        26      8        -9626.0          6
                                                          2        13      8        -4813.0          7
                                                          2        17      8        -4813.0          8
                                                          2        24      8        -4813.0          9
0AVERAGE SEED =   .00152628
 MINIMUM SEED =   .00055719
0
    5 ITERATION PARAMETERS CALCULATED FROM AVERAGE SEED:

             .0000000E+00    .8023446E+00    .9609323E+00    .9922780E+00    .9984737E+00
0
    11 ITERATIONS FOR TIME STEP   1 IN STRESS PERIOD  1
0MAXIMUM HEAD CHANGE FOR EACH ITERATION:
0 HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL HEAD CHANGE LAYER,ROW,COL
 -------------------------------------------------------------------------------------------------------------------------------
   -2.368      (  2, 13,  8)  -.3658      (  2, 14,  7)  -.3371      (  1, 14,  7)  -.2153      (  1, 14,  9)  -.5164E-01 (  1, 23, 10)
    .9573E-02 (  2, 21,  7)   .8024E-02 (  1, 11, 10)   .5257E-02 (  2, 13, 10)   .2877E-02 (  1, 20, 10)  -.1124E-02 (  2, 11, 10)
   -.2869E-03 (  2, 25,  8)
0
0HEAD/DRAWDOWN PRINTOUT FLAG = 1     TOTAL BUDGET PRINTOUT FLAG = 1     CELL-BY-CELL FLOW TERM FLAG = 0
0OUTPUT FLAGS FOR EACH LAYER:
            HEAD     DRAWDOWN  HEAD   DRAWDOWN
 LAYER   PRINTOUT  PRINTOUT   SAVE    SAVE
 -----------------------------------------
```

1 1 1 1 1
2 1 1 1 1

HEAD IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.55	92.67	92.77	92.87	92.98	93.13	93.24	93.34	93.45	93.55	93.65	93.75	93.84	93.92	94.00
0 3	92.00	92.13	92.25	92.35	92.45	92.55	92.68	92.79	92.89	92.99	93.10	93.20	93.29	93.37	93.45	93.50
0 4	91.60	91.72	91.83	91.94	92.03	92.13	92.23	92.34	92.44	92.54	92.64	92.74	92.83	92.91	93.00	93.10
0 5	91.20	91.31	91.43	91.53	91.62	91.70	91.79	91.89	91.99	92.09	92.18	92.28	92.37	92.45	92.52	92.60
0 6	90.70	90.84	90.97	91.07	91.16	91.23	91.32	91.42	91.52	91.62	91.71	91.81	91.90	91.98	92.05	92.10
0 7	90.20	90.34	90.46	90.56	90.65	90.73	90.82	90.91	91.01	91.11	91.22	91.33	91.44	91.52	91.58	91.60
0 8	89.70	89.86	89.98	90.06	90.14	90.22	90.30	90.40	90.50	90.60	90.71	90.82	90.93	91.01	91.07	91.10
0 9	89.40	89.45	89.52	89.57	89.63	89.70	89.78	89.87	89.98	90.09	90.19	90.29	90.38	90.46	90.50	90.50
0 10	89.00	89.04	89.06	89.08	89.11	89.16	89.24	89.33	89.45	89.57	89.67	89.77	89.85	89.92	89.97	90.00
0 11	88.70	88.66	88.63	88.61	88.59	88.60	88.67	88.76	88.91	89.06	89.18	89.28	89.36	89.43	89.48	89.50
0 12	88.30	88.28	88.23	88.15	88.06	87.99	88.07	88.14	88.36	88.56	88.71	88.82	88.91	88.99	89.04	89.10
0 13	88.00	87.94	87.84	87.70	87.49	87.21	87.46	87.38	87.83	88.09	88.26	88.39	88.48	88.55	88.60	88.60
0 14	87.70	87.63	87.50	87.30	86.95	87.05	87.17	87.26	87.48	87.69	87.85	87.97	88.07	88.14	88.19	88.20
0 15	87.50	87.37	87.22	87.06	86.90	86.88	86.92	87.00	87.14	87.30	87.46	87.58	87.68	87.76	87.83	87.90
0 16	87.30	87.11	86.96	86.83	86.72	86.67	86.67	86.70	86.82	86.95	87.09	87.20	87.30	87.38	87.46	87.50
0 17	87.00	86.80	86.67	86.56	86.48	86.43	86.40	86.36	86.51	86.63	86.74	86.84	86.93	87.02	87.11	87.20
0 18	86.50	86.42	86.34	86.27	86.21	86.17	86.15	86.16	86.23	86.31	86.40	86.48	86.56	86.65	86.75	86.90
0 19	86.00	86.02	86.00	85.96	85.92	85.89	85.88	85.89	85.94	86.00	86.06	86.13	86.19	86.25	86.33	86.40
20	85.60	85.61	85.59	85.57	85.56	85.53	85.52	85.53	85.56	85.60	85.65	85.69	85.72	85.76	85.82	85.90
0 21	85.10	85.13	85.13	85.11	85.09	85.06	85.04	85.03	85.05	85.09	85.13	85.16	85.16	85.17	85.15	85.10
0 22	84.70	84.68	84.67	84.65	84.60	84.55	84.50	84.46	84.49	84.53	84.57	84.59	84.60	84.58	84.54	84.50
0 23	84.20	84.23	84.22	84.19	84.12	84.03	83.93	83.83	83.90	83.96	84.02	84.04	84.05	84.01	83.93	83.80
0 24	83.80	83.81	83.80	83.74	83.64	83.51	83.34	83.05	83.29	83.41	83.48	83.52	83.53	83.48	83.38	83.30
0 25	83.50	83.43	83.38	83.29	83.17	83.03	82.86	82.68	82.80	82.91	82.98	83.01	83.02	82.97	82.87	82.80
0 26	83.10	83.03	82.95	82.85	82.73	82.59	82.39	82.02	82.31	82.44	82.50	82.53	82.52	82.47	82.39	82.30
0 27	82.70	82.61	82.52	82.43	82.32	82.20	82.06	81.93	81.98	82.04	82.07	82.07	82.05	82.00	81.94	81.90
0 28	82.20	82.16	82.09	82.01	81.92	81.82	81.73	81.66	81.65	81.65	81.65	81.64	81.60	81.55	81.48	81.40
0 29	81.80	81.73	81.66	81.59	81.52	81.44	81.38	81.32	81.29	81.27	81.25	81.22	81.18	81.12	81.06	81.00
0 30	81.30	81.27	81.22	81.17	81.11	81.06	81.00	80.96	80.92	80.89	80.85	80.81	80.76	80.70	80.64	80.60
0 31	80.80	80.79	80.77	80.74	80.71	80.67	80.62	80.58	80.54	80.50	80.45	80.40	80.34	80.28	80.22	80.20
0 32	80.30	80.33	80.33	80.32	80.30	80.27	80.24	80.20	80.16	80.12	80.06	80.00	79.93	79.85	79.77	79.70
0 33	79.90	79.89	79.89	79.90	79.89	79.88	79.86	79.83	79.79	79.74	79.67	79.60	79.52	79.43	79.35	79.30
0 34	79.40	79.44	79.45	79.49	79.49	79.49	79.48	79.46	79.43	79.36	79.28	79.20	79.11	79.01	78.91	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

1 HEAD IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

																16
0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.	92.10
0 2	90.90	90.96	91.04	91.12	91.20	91.26	91.33	91.41	91.48	91.52	91.58	91.61	91.66	91.70	91.7	91.80
0 3	90.60	90.69	90.77	90.85	90.92	90.99	91.06	91.12	91.18	91.22	91.26	91.30	91.33	91.36	91.39	91.40
0 4	90.40	90.44	90.50	90.57	90.64	90.71	90.78	90.84	90.88	90.92	90.95	90.98	91.00	91.03	91.06	91.10
0 5	90.10	90.16	90.22	90.29	90.36	90.43	90.50	90.56	90.60	90.62	90.64	90.65	90.67	90.68	90.69	90.70
0 6	89.80	89.87	89.94	90.00	90.08	90.16	90.23	90.29	90.32	90.32	90.32	90.32	90.33	90.34	90.33	90.30
0 7	89.50	89.57	89.64	89.71	89.78	89.88	89.99	90.05	90.06	90.02	89.99	89.99	89.99	89.99	90.00	90.00
0 8	89.20	89.28	89.34	89.40	89.47	89.57	89.78	89.86	89.85	89.70	89.65	89.63	89.63	89.64	89.66	89.70
0 9	89.00	89.02	89.05	89.08	89.12	89.17	89.35	89.45	89.42	89.29	89.27	89.26	89.27	89.28	89.29	89.30
0 10	88.70	88.74	88.75	88.75	88.76	88.77	88.79	88.81	88.85	88.86	88.87	88.88	88.89	88.91	88.93	89.00
0 11	88.50	88.48	88.45	88.43	88.40	88.37	88.26	88.13	88.30	88.43	88.46	88.48	88.51	88.52	88.53	88.50
0 12	88.30	88.23	88.16	88.10	88.03	87.97	87.64	87.15	87.66	87.99	88.05	88.10	88.13	88.15	88.15	88.10
0 13	88.10	87.96	87.86	87.77	87.67	87.57	86.92	85.13	86.92	87.56	87.65	87.72	87.77	87.80	87.81	87.80
0 14	87.80	87.67	87.56	87.45	87.33	87.20	86.81	86.35	86.79	87.16	87.27	87.36	87.42	87.46	87.48	87.50
0 15	87.50	87.36	87.25	87.13	86.99	86.83	86.61	86.51	86.59	86.78	86.92	87.02	87.09	87.13	87.17	87.20
0 16	87.10	87.03	86.94	86.83	86.71	86.58	86.45	86.37	86.43	86.54	86.64	86.72	86.77	86.81	86.85	86.90
0 17	86.80	86.71	86.64	86.56	86.46	86.36	86.25	86.08	86.23	86.31	86.38	86.43	86.47	86.50	86.51	86.50
0 18	86.40	86.39	86.35	86.29	86.23	86.17	86.12	86.06	86.09	86.11	86.14	86.16	86.18	86.19	86.19	86.20
0 19	86.10	86.09	86.07	86.03	85.99	85.98	85.98	85.96	85.95	85.92	85.90	85.90	85.90	85.90	85.87	85.80
0 20	85.70	85.74	85.73	85.71	85.68	85.66	85.65	85.62	85.61	85.59	85.57	85.57	85.57	85.55	85.50	85.40
0 21	85.30	85.31	85.29	85.26	85.21	85.17	85.09	85.04	85.05	85.08	85.10	85.11	85.11	85.10	85.06	85.00
0 22	84.90	84.85	84.81	84.75	84.69	84.61	84.49	84.39	84.44	84.51	84.56	84.59	84.60	84.60	84.5	84.50
0 23	84.40	84.38	84.33	84.26	84.17	84.06	83.84	83.58	83.78	83.95	84.03	84.09	84.12	84.13	84.	84.10
0 24	84.00	83.94	83.88	83.79	83.68	83.53	83.17	82.31	83.10	83.42	83.54	83.61	83.65	83.68	83.69	83.70
0 25	83.60	83.52	83.44	83.35	83.24	83.10	82.86	82.59	82.80	82.99	83.08	83.15	83.20	83.24	83.27	83.30
0 26	83.20	83.11	83.01	82.92	82.81	82.69	82.50	82.38	82.44	82.58	82.66	82.72	82.77	82.81	82.85	82.90
0 27	82.80	82.69	82.59	82.50	82.40	82.29	82.15	82.08	82.09	82.19	82.25	82.30	82.35	82.39	82.43	82.50
0 28	82.30	82.25	82.17	82.09	82.01	81.92	81.84	81.79	81.79	81.82	81.86	81.90	81.93	81.96	81.99	82.00
0 29	81.90	81.83	81.76	81.69	81.62	81.55	81.49	81.45	81.44	81.45	81.47	81.49	81.52	81.54	81.57	81.60
0 30	81.50	81.41	81.34	81.28	81.22	81.17	81.13	81.09	81.08	81.07	81.08	81.09	81.10	81.12	81.15	81.20
0 31	81.00	80.97	80.92	80.87	80.83	80.78	80.75	80.72	80.70	80.69	80.69	80.68	80.69	80.69	80.70	80.70
0 32	80.60	80.55	80.50	80.46	80.43	80.39	80.36	80.34	80.32	80.30	80.29	80.28	80.27	80.27	80.27	80.30
0 33	80.20	80.13	80.08	80.05	80.02	80.00	79.98	79.96	79.94	79.91	79.89	79.87	79.85	79.83	79.81	79.80
0 34	79.70	79.70	79.65	79.63	79.61	79.60	79.59	79.57	79.56	79.52	79.50	79.47	79.43	79.40	79.35	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

0HEAD WILL BE SAVED ON UNIT 30 AT END OF TIME STEP 1, STRESS PERIOD 1

1 DRAWDOWN IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.05	.03	.03	.03	.02	.07	.06	.06	.05	.05	.05	.05	-.04	-.02	.00
0 3	.00	.07	.05	.05	.05	.15	.12	.11	.11	.11	.10	.00	.01	.03	.05	.00
0 4	.00	.08	.07	.06	.17	.17	.17	.16	.16	.16	.16	.06	.07	-.01	.00	.00

0 5	.00	.09	.07	.07	.18	.20	.21	.21	.21	.21	.22	.12	.03	.05	.08	.00
0 6	.00	.06	.03	.13	.24	.27	.28	.28	.28	.28	.19	.19	.10	.12	.05	.00
7	.00	.06	.14	.14	.25	.27	.28	.29	.29	.29	.28	.17	.16	.08	.02	.00
8	.00	.04	.12	.24	.26	.28	.30	.30	.30	.30	.29	.18	.17	.09	.03	.00
9	.00	.05	.18	.23	.37	.40	.42	.43	.32	.31	.31	.21	.22	.14	.10	.00
10	.00	.16	.24	.32	.39	.44	.46	.47	.45	.33	.33	.23	.15	.08	.03	.00
0 11	.00	.14	.27	.39	.51	.60	.63	.64	.49	.44	.32	.32	.24	.17	.02	.00
0 12	.00	.12	.37	.55	.74	.91	.83	.86	.64	.54	.39	.28	.19	.11	.06	.00
0 13	.00	.16	.36	.60	.91	1.29	1.14	1.22	.87	.61	.44	.31	.22	.15	.10	.00
0 14	.00	.17	.40	.70	1.15	1.05	1.03	.94	.82	.61	.45	.33	.23	.16	.11	.00
0 15	.00	.23	.38	.64	.80	.92	.88	.90	.76	.60	.44	.32	.22	.14	.07	.00
0 16	.00	.19	.34	.47	.68	.73	.83	.80	.68	.65	.51	.40	.30	.22	.04	.00
0 17	.00	.10	.33	.44	.52	.67	.70	.84	.69	.57	.46	.36	.27	.18	.09	.00
0 18	.00	.08	.26	.33	.49	.53	.65	.64	.57	.49	.40	.32	.24	.15	.05	.00
0 19	.00	.08	.20	.34	.48	.51	.52	.61	.56	.50	.44	.37	.21	.15	.07	.00
0 20	.00	.09	.21	.33	.44	.47	.48	.57	.54	.50	.45	.31	.28	.14	.08	.00
0 21	.00	.07	.17	.29	.41	.44	.56	.57	.55	.51	.37	.34	.24	.13	.05	.00
0 22	.00	.12	.23	.25	.40	.45	.50	.64	.51	.47	.43	.31	.20	.12	.06	.00
0 23	.00	.07	.18	.31	.38	.47	.57	.67	.60	.54	.38	.36	.25	.19	.07	.00
0 24	.00	.09	.20	.26	.36	.59	.76	.95	.71	.59	.42	.28	.27	.12	.02	.00
0 25	.00	.07	.12	.31	.43	.57	.74	.92	.70	.59	.42	.29	.18	.13	.03	.00
0 26	.00	.07	.15	.25	.37	.51	.71	1.08	.69	.56	.40	.27	.18	.13	.01	.00
0 27	.00	.09	.18	.27	.38	.40	.54	.67	.62	.46	.33	.33	.15	.10	.06	.00
0 28	.00	.04	.11	.19	.28	.38	.47	.44	.45	.35	.35	.26	.20	.15	.02	.00
0 29	.00	.07	.14	.21	.18	.26	.32	.38	.31	.33	.25	.18	.12	.08	.04	.00
0 30	.00	.03	.08	.13	.19	.24	.30	.24	.28	.21	.25	.19	.14	.10	.06	.00
0 31	.00	.01	.03	.06	.09	.13	.18	.22	.16	.20	.15	.10	.06	.02	.08	.00
0 32	.00	.07	.07	.08	.10	.13	.16	.10	.14	.08	.14	.10	.07	.05	.03	.00
0 33	.00	.01	.01	.10	.11	.12	.04	.07	.11	.06	.03	.10	.08	.07	.05	.00
0 34	.00	-.04	.05	.01	.01	.01	.02	.04	.07	.04	.02	.00	-.01	-.01	-.01	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

1 DRAWDOWN IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.04	.06	-.02	-.00	.04	.07	-.01	.02	-.02	.02	-.01	.04	.00	.05	.00
0 3	.00	.01	.03	.05	.08	.01	.04	.08	.02	.08	.04	.00	.07	.04	.01	.00
0 4	.00	.06	-.00	.03	.06	-.01	.02	.06	.02	.08	.05	.02	.10	.07	.04	.00
0 5	.00	.04	.08	.01	.04	.07	-.00	.04	.00	.08	.06	.05	.03	.02	.01	.00
0 6	.00	.03	.06	-.00	.02	.04	-.03	.01	-.02	-.02	.08	.08	.07	.06	.07	.00
0 7	.00	.03	.06	.09	.02	.02	-.09	-.05	-.06	-.02	.11	.11	.11	.11	.00	.00
0 8	.00	.02	.06	.10	.03	.03	-.18	-.16	-.15	.00	.05	.07	.07	.06	.04	.00
0 9	.00	.08	.05	.12	.18	.13	-.05	-.05	-.02	.11	.13	.14	.13	.12	.01	.00
10	.00	.06	.15	.15	.24	.23	.21	.29	.25	.24	.23	.22	.11	.09	.07	.00
11	.00	.12	.15	.17	.30	.33	.44	.67	.50	.37	.24	.22	.19	.18	.07	.00
12	.00	.07	.14	.30	.37	.43	.86	1.35	.84	.41	.35	.30	.27	.15	.05	.00
13	.00	.14	.24	.33	.43	.53	1.28	3.07	1.28	.54	.45	.38	.23	.20	.09	.00
0 14	.00	.13	.24	.35	.57	.70	1.09	1.55	1.11	.64	.53	.34	.28	.14	.12	.00
0 15	.00	.14	.25	.37	.61	.77	.99	1.09	1.01	.82	.58	.38	.21	.17	.03	.00
0 16	.00	.07	.26	.37	.59	.72	.85	.93	.77	.66	.46	.28	.23	.09	.05	.00
0 17	.00	.09	.16	.34	.44	.54	.65	.72	.57	.49	.32	.27	.13	.10	-.01	.00
0 18	.00	.01	.15	.21	.27	.33	.28	.34	.31	.29	.16	.14	.02	.01	.01	.00
0 19	.00	.01	.03	.07	.11	.02	.02	.04	.05	-.02	.00	.00	-.10	-.10	-.07	.00
0 20	.00	.06	.07	-.01	.02	-.06	-.05	-.02	-.01	-.09	-.07	-.07	-.17	-.15	-.10	.00
0 21	.00	-.01	.01	.04	.09	.03	.11	.16	.05	.02	.00	-.01	-.11	-.10	-.06	.00
0 22	.00	.05	.09	.15	.11	.19	.31	.41	.26	.19	.14	.01	-.00	.00	.03	.00
0 23	.00	.02	.07	.14	.23	.34	.46	.72	.52	.35	.17	.11	.08	.07	-.02	.00
0 24	.00	.06	.12	.21	.32	.37	.73	1.59	.80	.48	.26	.19	.15	.12	.01	.00
0 25	.00	.08	.16	.15	.26	.40	.64	.91	.60	.41	.32	.25	.20	.16	.03	.00
0 26	.00	.09	.09	.18	.29	.41	.60	.62	.56	.42	.34	.28	.23	.09	.05	.00
0 27	.00	.11	.11	.20	.30	.31	.45	.52	.51	.41	.25	.20	.15	.11	.07	.00
0 28	.00	.05	.13	.21	.19	.28	.36	.41	.41	.28	.24	.20	.17	.14	.01	.00
0 29	.00	.07	.14	.11	.18	.25	.31	.25	.26	.25	.23	.11	.08	.06	.03	.00
0 30	.00	.09	.06	.12	.18	.23	.17	.21	.22	.23	.12	.11	.10	.08	.05	.00
0 31	.00	.03	.08	.13	.07	.12	.15	.18	.20	.11	.11	.12	.11	.01	-.00	.00
0 32	.00	.05	.10	.04	.07	.11	.14	.06	.08	.10	.11	.02	.03	.03	.03	.00
0 33	.00	.07	.02	.05	.08	.10	.02	.04	.06	.09	.01	.03	.05	.07	-.01	.00
0 34	.00	.00	.05	.07	-.01	.00	.01	.03	.04	-.02	.00	.03	-.03	-.00	.05	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

ODRAWDOWN WILL BE SAVED ON UNIT 40 AT END OF TIME STEP 1, STRESS PERIOD 1

0

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 1

0 CUMULATIVE VOLUMES L**3 RATES FOR THIS TIME STEP L**3/T

IN: IN:

```
            STORAGE =      .00000                        STORAGE =      .00000
      CONSTANT HEAD =      .17312E+06              CONSTANT HEAD =      .17312E+06
              WELLS =      .00000                          WELLS =      .00000
0          TOTAL IN =      .17312E+06                   TOTAL IN =      .17312E+06
0     OUT:                                        OUT:
      ----                                        ----
            STORAGE =      .00000                        STORAGE =      .00000
      CONSTANT HEAD =      96105.                  CONSTANT HEAD =      96105.
              WELLS =      77007.                          WELLS =      77007.
0         TOTAL OUT =      .17311E+06                  TOTAL OUT =      .17311E+06
0          IN - OUT =      10.578                       IN - OUT =      10.578
0  PERCENT DISCREPANCY =              .01      PERCENT DISCREPANCY =              .01


0
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TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 1

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	86400.0	1440.00	24.0000	1.00000	.273785E-02
STRESS PERIOD TIME	86400.0	1440.00	24.0000	1.00000	.273785E-02
TOTAL SIMULATION TIME	86400.0	1440.00	24.0000	1.00000	.273785E-02

1

1 U.S. GEOLOGICAL SURVEY MODULAR FINITE-DIFFERENCE GROUND-WATER MODEL

0SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION SENSIT ANAL, SIMULATION 4A: VERT LEAKAGE X 2

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   2 LAYERS        35 ROWS        16 COLUMNS
  1 STRESS PERIOD(S) IN SIMULATION
 ODEL TIME UNIT IS DAYS
 I/O UNITS:
 ELEMENT OF IUNIT:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
         I/O UNIT: 11 12  0  0  0  0  0  0 19  0  0 22  0  0  0  0  0  0  0  0  0  0  0  0
0BAS1 -- BASIC MODEL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT  1
 ARRAYS RHS AND BUFF WILL SHARE MEMORY.
 START HEAD WILL BE SAVED
    10699 ELEMENTS IN X ARRAY ARE USED BY BAS
    10699 ELEMENTS OF X ARRAY USED OUT OF  100000
0BCF1 -- BLOCK-CENTERED FLOW PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 11
 STEADY-STATE SIMULATION
     LAYER  AQUIFER TYPE
     -------------------
        1          1
        2          0
     1122 ELEMENTS IN X ARRAY ARE USED BY BCF
    11821 ELEMENTS OF X ARRAY USED OUT OF  100000
0WEL1 -- WELL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM 12
 MAXIMUM OF     9 WELLS
       36 ELEMENTS IN X ARRAY ARE USED FOR WELLS
    11857 ELEMENTS OF X ARRAY USED OUT OF  100000
0SIP1 -- STRONGLY IMPLICIT PROCEDURE SOLUTION PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 19
 MAXIMUM OF  50 ITERATIONS ALLOWED FOR CLOSURE
  5 ITERATION PARAMETERS
     4685 ELEMENTS IN X ARRAY ARE USED BY SIP
    16542 ELEMENTS OF X ARRAY USED OUT OF  100000
```

1SHIELDALLOY METALLURGICAL CORPORATION FOCUSED FS - HYDROGEOLOGIC SIMULATION SENSIT ANAL, SIMULATION 4A: VERT LEAKAGE X 2

0

BOUNDARY ARRAY FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
0 2	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 3	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 4	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 5	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 6	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
7	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
8	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
9	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 10	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 11	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 12	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 13	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 14	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 15	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 16	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 17	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 18	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 19	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 20	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 21	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 22	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 23	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 24	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 25	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 26	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 27	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 28	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 29	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 30	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 31	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 32	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 33	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 34	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
0 35	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

0

BOUNDARY ARRAY FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16I3)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

0 1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
0 2	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 3	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 4	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 5	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 6	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 7	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 8	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 9	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 10	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 11	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 12	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 13	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 14	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 15	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 16	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 17	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 18	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 19	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 20	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 21	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 22	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 23	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 24	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 25	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 26	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 27	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 28	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 29	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 30	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 31	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 32	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 33	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 34	-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-2
0 35	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2

0AQUIFER HEAD WILL BE SET TO 999.99 AT ALL NO-FLOW NODES (IBOUND=0).
0

INITIAL HEAD FOR LAYER 1 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.60	92.70	92.80	92.90	93.00	93.20	93.30	93.40	93.50	93.60	93.70	93.80	93.80	93.90	94.00
0 3	92.00	92.20	92.30	92.40	92.50	92.70	92.80	92.90	93.00	93.10	93.20	93.20	93.30	93.40	93.50	93.50
0 4	91.60	91.80	91.90	92.00	92.20	92.30	92.40	92.50	92.60	92.70	92.80	92.80	92.90	92.90	93.00	93.10
0 5	91.20	91.40	91.50	91.60	91.80	91.90	92.00	92.10	92.20	92.30	92.40	92.40	92.40	92.50	92.60	92.60
0 6	90.70	90.90	91.00	91.20	91.40	91.50	91.60	91.70	91.80	91.90	91.90	92.00	92.00	92.10	92.10	92.10
0 7	90.20	90.40	90.60	90.70	90.90	91.00	91.10	91.20	91.30	91.40	91.50	91.50	91.60	91.60	91.60	91.60
0 8	89.70	89.90	90.10	90.30	90.40	90.50	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.10	91.10	91.10
0 9	89.40	89.50	89.70	89.80	90.00	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.60	90.50
0 10	89.00	89.20	89.30	89.40	89.50	89.60	89.70	89.80	89.90	89.90	90.00	90.00	90.00	90.00	90.00	90.00
0 11	88.70	88.80	88.90	89.00	89.10	89.20	89.30	89.40	89.40	89.50	89.50	89.60	89.60	89.60	89.50	89.50
0 12	88.30	88.40	88.60	88.70	88.80	88.90	88.90	89.00	89.00	89.10	89.10	89.10	89.10	89.10	89.10	89.10
0 13	88.00	88.10	88.20	88.30	88.40	88.50	88.60	88.60	88.70	88.70	88.70	88.70	88.70	88.70	88.70	88.60
0 14	87.70	87.80	87.90	88.00	88.10	88.10	88.20	88.20	88.30	88.30	88.30	88.30	88.30	88.30	88.30	88.20
0 15	87.50	87.60	87.60	87.70	87.70	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.90	87.90	87.90	87.90
0 16	87.30	87.30	87.30	87.30	87.40	87.40	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.50	87.50
0 17	87.00	86.90	87.00	87.00	87.00	87.10	87.10	87.20	87.20	87.20	87.20	87.20	87.20	87.20	87.20	87.20
0 18	86.50	86.50	86.60	86.60	86.70	86.70	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.80	86.90
0 19	86.00	86.10	86.20	86.30	86.40	86.40	86.40	86.50	86.50	86.50						

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
											86.50	86.50	86.40	86.40	86.40	86.40
0 20	85.60	85.70	85.80	85.90	86.00	86.00	86.00	86.10	86.10	86.10	86.10	86.00	86.00	85.90	85.90	85.90
21	85.10	85.20	85.30	85.40	85.50	85.50	85.60	85.60	85.60	85.60	85.50	85.50	85.40	85.30	85.20	85.10
0 22	84.70	84.80	84.90	84.90	85.00	85.00	85.00	85.10	85.00	85.00	85.00	84.90	84.80	84.70	84.60	84.50
0 23	84.20	84.30	84.40	84.50	84.50	84.50	84.50	84.50	84.50	84.50	84.40	84.40	84.30	84.20	84.00	83.80
0 24	83.80	83.90	84.00	84.00	84.00	84.10	84.10	84.00	84.00	84.00	83.90	83.80	83.80	83.60	83.40	83.30
0 25	83.50	83.50	83.50	83.60	83.60	83.60	83.60	83.60	83.50	83.50	83.40	83.30	83.20	83.10	82.90	82.80
0 26	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.10	83.00	83.00	82.90	82.80	82.70	82.60	82.40	82.30
0 27	82.70	82.70	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.50	82.40	82.40	82.20	82.10	82.00	81.90
0 28	82.20	82.20	82.20	82.20	82.20	82.20	82.20	82.10	82.10	82.00	82.00	81.90	81.80	81.70	81.50	81.40
0 29	81.80	81.80	81.80	81.80	81.70	81.70	81.70	81.70	81.60	81.60	81.50	81.40	81.30	81.20	81.10	81.00
0 30	81.30	81.30	81.30	81.30	81.30	81.30	81.30	81.20	81.20	81.10	81.10	81.00	80.90	80.80	80.70	80.60
0 31	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.80	80.70	80.70	80.60	80.50	80.40	80.30	80.30	80.20
0 32	80.30	80.40	80.40	80.40	80.40	80.40	80.40	80.30	80.30	80.20	80.20	80.10	80.00	79.90	79.80	79.70
0 33	79.90	79.90	79.90	80.00	80.00	80.00	79.90	79.90	79.90	79.80	79.70	79.70	79.60	79.50	79.40	79.30
0 34	79.40	79.40	79.50	79.50	79.50	79.50	79.50	79.50	79.50	79.40	79.30	79.20	79.10	79.00	78.90	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40
0																

INITIAL HEAD FOR LAYER 2 WILL BE READ ON UNIT 1 USING FORMAT: (16F5.1)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.10	92.10
0 2	90.90	91.00	91.10	91.10	91.20	91.30	91.40	91.40	91.50	91.50	91.60	91.60	91.70	91.70	91.80	91.80
3	90.60	90.70	90.80	90.90	91.00	91.00	91.10	91.20	91.20	91.30	91.30	91.30	91.40	91.40	91.40	91.40
0 4	90.40	90.50	90.50	90.60	90.70	90.70	90.80	90.90	90.90	91.00	91.00	91.00	91.10	91.10	91.10	91.10
0 5	90.10	90.20	90.30	90.30	90.40	90.50	90.50	90.60	90.60	90.70	90.70	90.70	90.70	90.70	90.70	90.70
0 6	89.80	89.90	90.00	90.00	90.10	90.20	90.20	90.30	90.30	90.30	90.40	90.40	90.40	90.40	90.40	90.30
0 7	89.50	89.60	89.70	89.80	89.80	89.90	89.90	90.00	90.00	90.00	90.10	90.10	90.10	90.10	90.00	90.00
0 8	89.20	89.30	89.40	89.50	89.50	89.60	89.60	89.70	89.70	89.70	89.70	89.70	89.70	89.70	89.70	89.70
0 9	89.00	89.10	89.10	89.20	89.30	89.30	89.30	89.40	89.40	89.40	89.40	89.40	89.40	89.40	89.30	89.30
0 10	88.70	88.80	88.90	88.90	89.00	89.00	89.00	89.10	89.10	89.10	89.10	89.10	89.00	89.00	89.00	89.00
0 11	88.50	88.60	88.60	88.60	88.70	88.70	88.70	88.80	88.80	88.80	88.70	88.70	88.70	88.70	88.60	88.50
0 12	88.30	88.30	88.30	88.40	88.40	88.40	88.50	88.50	88.50	88.40	88.40	88.40	88.40	88.30	88.20	88.10
0 13	88.10	88.10	88.10	88.10	88.10	88.10	88.20	88.20	88.20	88.10	88.10	88.10	88.00	88.00	87.90	87.80
0 14	87.80	87.80	87.80	87.80	87.90	87.90	87.90	87.90	87.90	87.80	87.80	87.70	87.70	87.60	87.60	87.50
0 15	87.50	87.50	87.50	87.50	87.60	87.60	87.60	87.60	87.60	87.60	87.50	87.40	87.30	87.30	87.20	87.20
0 16	87.10	87.10	87.20	87.20	87.30	87.30	87.30	87.30	87.20	87.20	87.10	87.00	87.00	86.90	86.90	86.90
0 17	86.80	86.80	86.80	86.90	86.90	86.90	86.90	86.80	86.80	86.80	86.70	86.70	86.60	86.60	86.50	86.50
0 18	86.40	86.40	86.50	86.50	86.50	86.50	86.40	86.40	86.40	86.40	86.30	86.30	86.20	86.20	86.20	86.20
0 19	86.10	86.10	86.10	86.10	86.10	86.00	86.00	86.00	86.00	85.90	85.90	85.90	85.80	85.80	85.80	85.80
0 20	85.70	85.80	85.80	85.70	85.70	85.60	85.60	85.60	85.60	85.50	85.50	85.50	85.40	85.40	85.40	85.40

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 21	85.30	85.30	85.30	85.30	85.30	85.20	85.20	85.20	85.10	85.10	85.10	85.10	85.00	85.00	85.00	85.00
0 22	84.90	84.90	84.90	84.90	84.80	84.80	84.80	84.80	84.70	84.70	84.70	84.60	84.60	84.60	84.60	84.50
0 23	84.40	84.40	84.40	84.40	84.40	84.40	84.30	84.30	84.30	84.30	84.20	84.20	84.20	84.20	84.10	84.10
0 24	84.00	84.00	84.00	84.00	84.00	83.90	83.90	83.90	83.90	83.90	83.80	83.80	83.80	83.80	83.70	83.70
0 25	83.60	83.60	83.60	83.50	83.50	83.50	83.50	83.50	83.40	83.40	83.40	83.40	83.40	83.40	83.30	83.30
0 26	83.20	83.20	83.10	83.10	83.10	83.10	83.10	83.00	83.00	83.00	83.00	83.00	83.00	82.90	82.90	82.90
0 27	82.80	82.80	82.70	82.70	82.70	82.60	82.60	82.60	82.60	82.60	82.50	82.50	82.50	82.50	82.50	82.50
0 28	82.30	82.30	82.30	82.30	82.20	82.20	82.20	82.20	82.20	82.10	82.10	82.10	82.10	82.10	82.00	82.00
0 29	81.90	81.90	81.90	81.80	81.80	81.80	81.80	81.70	81.70	81.70	81.70	81.60	81.60	81.60	81.60	81.60
0 30	81.50	81.50	81.40	81.40	81.40	81.40	81.30	81.30	81.30	81.30	81.20	81.20	81.20	81.20	81.20	81.20
0 31	81.00	81.00	81.00	81.00	80.90	80.90	80.90	80.90	80.90	80.80	80.80	80.80	80.80	80.70	80.70	80.70
0 32	80.60	80.60	80.60	80.50	80.50	80.50	80.50	80.40	80.40	80.40	80.40	80.30	80.30	80.30	80.30	80.30
0 33	80.20	80.20	80.10	80.10	80.10	80.10	80.00	80.00	80.00	80.00	79.90	79.90	79.90	79.90	79.80	79.80
0 34	79.70	79.70	79.70	79.70	79.60	79.60	79.60	79.60	79.60	79.50	79.50	79.50	79.40	79.40	79.40	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

0HEAD PRINT FORMAT IS FORMAT NUMBER 4 DRAWDOWN PRINT FORMAT IS FORMAT NUMBER 9
0HEADS WILL BE SAVED ON UNIT 30 DRAWDOWNS WILL BE SAVED ON UNIT 40
0OUTPUT CONTROL IS SPECIFIED EVERY TIME STEP
0 COLUMN TO ROW ANISOTROPY = 1.000000
0 DELR = 200.0000
0 DELC = 200.0000
0

HYD. COND. ALONG ROWS FOR LAYER 1 WILL BE READ ON UNIT 11 USING FORMAT: (16F4.0)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 2	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 3	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 4	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 5	300.0	300.0	300.0	300.0	300.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0
0 6	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	300.0	300.0	300.0	300.0
0 7	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	300.0	300.0	300.0	300.0
0 8	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	225.0	225.0	225.0	300.0
0 9	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	225.0	225.0	225.0	300.0
0 10	300.0	225.0	225.0	225.0	225.0	200.0	200.0	200.0	200.0	200.0	225.0	225.0	225.0	225.0	225.0	300.0
0 11	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 12	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 13	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 14	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 15	300.0	250.0	250.0	250.0	250.0	200.0	200.0	200.0	200.0	200.0	250.0	250.0	250.0	250.0	250.0	300.0
0 16	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 17	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 18	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	300.0
0 19	300.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0						

	1	2	3	4	5	6	7	8	9	10
	250.0	250.0	250.0	250.0	250.0	300.0				
0 20	300.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0
	175.0	175.0	175.0	175.0	175.0	300.0				
21	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	175.0	175.0	175.0	300.0				
0 22	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	175.0	175.0	175.0	300.0				
0 23	300.0	175.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	175.0	175.0	175.0	300.0				
0 24	300.0	175.0	175.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	175.0	175.0	175.0	300.0				
0 25	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 26	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 27	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 28	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 29	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 30	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 31	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 32	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 33	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 34	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				
0 35	300.0	200.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
	150.0	150.0	150.0	150.0	200.0	300.0				

0 BOTTOM = 30.00000 FOR LAYER 1

0 VERT HYD COND /THICKNESS = .2000000E-02 FOR LAYER 1

0

TRANSMIS. ALONG ROWS FOR LAYER 2 WILL BE READ ON UNIT 11 USING FORMAT: (16F5.0)

	1 11	2 12	3 13	4 14	5 15	6 16	7	8	9	10
0 1	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
2	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 3	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 4	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 5	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 6	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 7	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 8	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 9	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 10	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 11	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 12	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 13	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 14	6000.	6000.	6000.	6000.	6000.	6000.	700.0	700.0	700.0	6000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 15	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 16	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 17	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 18	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.
	6000.	6000.	6000.	6000.	6000.	6000.				
0 19	6000.	6000.	6000.	6000.	6000.	8000.	8000.	8000.	8000.	8000.
	6000.	6000.	6000.	6000.	6000.	6000.				

0 20	4000.	4000.	4000.	4000.	4000.	4000.	1500.	1500.	1500.	4000.	4000.	4000.	4000.	4000.	4000.	4000.
0 21	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 22	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 23	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 24	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 25	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 26	3000.	3000.	3000.	3000.	3000.	3000.	1500.	1500.	1500.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 27	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 28	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 29	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 30	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 31	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 32	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 33	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 34	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
0 35	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.

0

SOLUTION BY THE STRONGLY IMPLICIT PROCEDURE

0 MAXIMUM ITERATIONS ALLOWED FOR CLOSURE = 50
ACCELERATION PARAMETER = 1.0000
HEAD CHANGE CRITERION FOR CLOSURE = .10000E-02
SIP HEAD CHANGE PRINTOUT INTERVAL = 1
0 CALCULATE ITERATION PARAMETERS FROM MODEL CALCULATED WSEED
1 STRESS PERIOD NO. 1, LENGTH = 1.000000

NUMBER OF TIME STEPS = 1

MULTIPLIER FOR DELT = 1.000

INITIAL TIME STEP SIZE = 1.000000

0 9 WELLS

LAYER	ROW	COL	STRESS RATE	WELL NO.
1	14	5	-13476.	1
1	13	6	-13476.	2
1	13	8	-13476.	3
1	17	8	-4813.0	4
1	24	8	-7701.0	5
1	26	8	-9626.0	6
2	13	8	-4813.0	7
2	17	8	-4813.0	8
2	24	8	-4813.0	9

0AVERAGE SEED = .00194247
MINIMUM SEED = .00055362
0
5 ITERATION PARAMETERS CALCULATED FROM AVERAGE SEED:

.0000000E+00 .7900632E+00 .9559265E+00 .9907473E+00 .9980575E+00

0
10 ITERATIONS FOR TIME STEP 1 IN STRESS PERIOD 1
0MAXIMUM HEAD CHANGE FOR EACH ITERATION:

0 HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL	HEAD CHANGE	LAYER,ROW,COL
-2.265	(2, 13, 8)	-.3333	(2, 14, 7)	-.3358	(1, 14, 7)	-.2259	(1, 15, 8)	-.6263E-01	(1, 23, 10)
.7825E-02	(2, 21, 7)	.7094E-02	(1, 11, 9)	.4628E-02	(1, 14, 8)	.2974E-02	(1, 20, 10)	.7572E-03	(1, 22, 9)

0
0HEAD/DRAWDOWN PRINTOUT FLAG = 1 TOTAL BUDGET PRINTOUT FLAG = 1 CELL-BY-CELL FLOW TERM FLAG = 0
0OUTPUT FLAGS FOR EACH LAYER:

LAYER	HEAD PRINTOUT	DRAWDOWN PRINTOUT	HEAD SAVE	DRAWDOWN SAVE
1	1	1	1	1

1 2 1 1 1 1

1 HEAD IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	92.90	93.00	93.10	93.20	93.30	93.40	93.60	93.70	93.80	93.90	94.00	94.10	94.20	94.30	94.40	94.50
0 2	92.40	92.54	92.66	92.76	92.86	92.97	93.11	93.22	93.32	93.43	93.53	93.63	93.73	93.82	93.91	94.00
0 3	92.00	92.12	92.23	92.33	92.42	92.52	92.64	92.75	92.86	92.96	93.06	93.17	93.26	93.35	93.43	93.50
0 4	91.60	91.71	91.81	91.91	92.00	92.09	92.19	92.29	92.40	92.49	92.59	92.70	92.80	92.89	92.98	93.10
0 5	91.20	91.30	91.41	91.50	91.58	91.65	91.75	91.84	91.94	92.04	92.13	92.23	92.33	92.42	92.51	92.60
0 6	90.70	90.83	90.94	91.04	91.12	91.19	91.27	91.37	91.46	91.56	91.65	91.76	91.86	91.95	92.03	92.10
0 7	90.20	90.33	90.44	90.53	90.61	90.68	90.77	90.86	90.96	91.06	91.16	91.28	91.40	91.49	91.56	91.60
0 8	89.70	89.85	89.96	90.03	90.10	90.17	90.26	90.35	90.45	90.55	90.66	90.77	90.89	90.98	91.05	91.10
0 9	89.40	89.44	89.50	89.55	89.60	89.66	89.73	89.82	89.93	90.04	90.14	90.24	90.34	90.43	90.48	90.50
0 10	89.00	89.03	89.05	89.06	89.08	89.13	89.19	89.29	89.40	89.52	89.63	89.72	89.82	89.89	89.96	90.00
0 11	88.70	88.65	88.62	88.59	88.56	88.57	88.63	88.72	88.86	89.01	89.13	89.24	89.33	89.41	89.47	89.50
0 12	88.30	88.28	88.22	88.13	88.03	87.96	88.03	88.10	88.32	88.52	88.67	88.78	88.88	88.96	89.03	89.10
0 13	88.00	87.94	87.83	87.68	87.47	87.19	87.43	87.34	87.79	88.05	88.23	88.35	88.45	88.53	88.59	88.60
0 14	87.70	87.63	87.49	87.29	86.93	87.03	87.14	87.22	87.44	87.65	87.82	87.94	88.04	88.12	88.18	88.20
0 15	87.50	87.37	87.22	87.05	86.89	86.86	86.90	86.97	87.11	87.27	87.43	87.55	87.65	87.74	87.82	87.90
0 16	87.30	87.11	86.95	86.82	86.71	86.65	86.65	86.68	86.79	86.92	87.06	87.18	87.28	87.37	87.45	87.50
0 17	87.00	86.80	86.66	86.55	86.47	86.42	86.39	86.34	86.49	86.60	86.72	86.82	86.91	87.00	87.10	87.20
0 18	86.50	86.42	86.33	86.26	86.20	86.16	86.14	86.14	86.21	86.29	86.38	86.46	86.55	86.63	86.74	86.90
0 19	86.00	86.02	85.99	85.95	85.91	85.89	85.87	85.88	85.92	85.98	86.05	86.11	86.17	86.24	86.32	86.40
20	85.60	85.61	85.59	85.57	85.55	85.53	85.51	85.52	85.54	85.59	85.64	85.68	85.71	85.75	85.81	85.90
21	85.10	85.13	85.13	85.11	85.09	85.06	85.03	85.02	85.04	85.08	85.12	85.15	85.16	85.16	85.15	85.10
0 22	84.70	84.68	84.67	84.65	84.60	84.55	84.49	84.46	84.48	84.52	84.56	84.59	84.59	84.58	84.54	84.50
0 23	84.20	84.23	84.22	84.19	84.12	84.03	83.92	83.83	83.89	83.96	84.01	84.04	84.05	84.01	83.93	83.80
0 24	83.80	83.81	83.80	83.74	83.64	83.51	83.34	83.04	83.29	83.41	83.48	83.52	83.53	83.49	83.38	83.30
0 25	83.50	83.43	83.38	83.29	83.18	83.04	82.86	82.69	82.80	82.91	82.98	83.02	83.02	82.97	82.87	82.80
0 26	83.10	83.03	82.95	82.85	82.74	82.59	82.39	82.03	82.32	82.45	82.51	82.53	82.52	82.47	82.39	82.30
0 27	82.70	82.61	82.53	82.43	82.33	82.21	82.07	81.94	81.99	82.05	82.08	82.08	82.06	82.01	81.94	81.90
0 28	82.20	82.17	82.10	82.01	81.92	81.83	81.74	81.67	81.66	81.66	81.66	81.65	81.62	81.56	81.49	81.40
0 29	81.80	81.73	81.66	81.59	81.52	81.45	81.38	81.33	81.30	81.28	81.26	81.23	81.19	81.13	81.06	81.00
0 30	81.30	81.27	81.22	81.17	81.12	81.07	81.01	80.97	80.93	80.90	80.86	80.82	80.77	80.71	80.65	80.60
0 31	80.80	80.80	80.78	80.75	80.71	80.67	80.63	80.59	80.55	80.51	80.47	80.41	80.35	80.29	80.23	80.20
0 32	80.30	80.33	80.33	80.32	80.30	80.28	80.25	80.21	80.17	80.13	80.07	80.01	79.94	79.86	79.78	79.70
0 33	79.90	79.89	79.90	79.90	79.90	79.88	79.86	79.83	79.80	79.74	79.68	79.60	79.52	79.44	79.35	79.30
0 34	79.40	79.44	79.46	79.49	79.50	79.49	79.48	79.46	79.43	79.37	79.29	79.20	79.11	79.01	78.91	78.80
0 35	78.90	79.00	79.00	79.10	79.10	79.10	79.10	79.10	79.10	79.00	78.90	78.80	78.70	78.60	78.50	78.40

1 HEAD IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

0 1	91.20	91.20	91.30	91.40	91.50	91.50	91.60	91.70	91.80	91.80	91.90	91.90	92.00	92.00	92.1	92.10
0 2	90.90	90.98	91.07	91.16	91.25	91.31	91.38	91.46	91.53	91.58	91.63	91.66	91.71	91.73	91	91.80
0 3	90.60	90.72	90.82	90.91	91.00	91.07	91.14	91.21	91.27	91.32	91.36	91.39	91.41	91.43	91.43	91.40
0 4	90.40	90.47	90.56	90.65	90.74	90.81	90.89	90.95	91.00	91.04	91.07	91.09	91.10	91.11	91.10	91.10
0 5	90.10	90.19	90.29	90.38	90.46	90.55	90.62	90.69	90.73	90.76	90.77	90.78	90.78	90.77	90.74	90.70
0 6	89.80	89.90	90.00	90.09	90.18	90.27	90.36	90.43	90.46	90.46	90.46	90.45	90.44	90.42	90.38	90.30
0 7	89.50	89.61	89.70	89.79	89.88	89.99	90.11	90.19	90.20	90.16	90.13	90.12	90.10	90.08	90.05	90.00
0 8	89.20	89.31	89.40	89.48	89.56	89.68	89.90	90.00	89.99	89.84	89.79	89.76	89.74	89.73	89.71	89.70
0 9	89.00	89.04	89.09	89.15	89.20	89.26	89.46	89.58	89.56	89.42	89.40	89.38	89.37	89.36	89.34	89.30
0 10	88.70	88.76	88.79	88.81	88.83	88.85	88.90	88.95	89.00	88.99	88.99	88.99	88.99	88.98	88.97	89.00
0 11	88.50	88.50	88.49	88.47	88.45	88.44	88.36	88.27	88.44	88.55	88.57	88.59	88.60	88.59	88.57	88.50
0 12	88.30	88.24	88.19	88.13	88.08	88.02	87.74	87.30	87.80	88.10	88.16	88.19	88.21	88.21	88.18	88.10
0 13	88.10	87.98	87.88	87.80	87.71	87.61	87.01	85.29	87.05	87.66	87.75	87.81	87.84	87.85	87.84	87.80
0 14	87.80	87.68	87.57	87.47	87.36	87.24	86.87	86.45	86.89	87.25	87.36	87.44	87.49	87.51	87.51	87.50
0 15	87.50	87.37	87.26	87.15	87.02	86.87	86.66	86.57	86.65	86.86	87.00	87.09	87.15	87.18	87.19	87.20
0 16	87.10	87.03	86.95	86.85	86.74	86.62	86.50	86.42	86.49	86.60	86.70	86.78	86.83	86.85	86.87	86.90
0 17	86.80	86.72	86.65	86.57	86.49	86.40	86.29	86.12	86.28	86.37	86.43	86.48	86.52	86.53	86.53	86.50
0 18	86.40	86.39	86.35	86.30	86.25	86.20	86.15	86.10	86.13	86.16	86.18	86.21	86.22	86.22	86.21	86.20
0 19	86.10	86.09	86.07	86.04	86.01	86.00	86.01	86.00	85.99	85.96	85.94	85.94	85.94	85.92	85.88	85.80
0 20	85.70	85.74	85.74	85.71	85.69	85.68	85.67	85.65	85.64	85.62	85.60	85.60	85.59	85.57	85.51	85.40
0 21	85.30	85.31	85.29	85.26	85.22	85.18	85.11	85.06	85.07	85.10	85.12	85.13	85.13	85.11	85.07	85.00
0 22	84.90	84.85	84.80	84.75	84.69	84.62	84.50	84.40	84.45	84.53	84.57	84.60	84.61	84.60	84.57	84.50
0 23	84.40	84.38	84.33	84.26	84.17	84.06	83.85	83.59	83.79	83.96	84.04	84.09	84.12	84.13	84	84.10
0 24	84.00	83.94	83.87	83.79	83.68	83.53	83.17	82.32	83.11	83.42	83.53	83.60	83.64	83.67	83.	83.70
0 25	83.60	83.52	83.43	83.34	83.23	83.09	82.85	82.58	82.79	82.97	83.07	83.14	83.18	83.22	83.26	83.30
0 26	83.20	83.10	83.01	82.91	82.80	82.68	82.49	82.35	82.42	82.56	82.63	82.70	82.75	82.79	82.84	82.90
0 27	82.80	82.68	82.58	82.49	82.39	82.27	82.12	82.05	82.07	82.16	82.22	82.27	82.32	82.36	82.41	82.50
0 28	82.30	82.24	82.16	82.08	81.99	81.90	81.81	81.76	81.75	81.79	81.82	81.86	81.89	81.93	81.97	82.00
0 29	81.90	81.82	81.74	81.67	81.60	81.53	81.46	81.42	81.41	81.42	81.43	81.45	81.48	81.51	81.55	81.60
0 30	81.50	81.40	81.33	81.26	81.20	81.15	81.10	81.07	81.05	81.04	81.04	81.05	81.07	81.09	81.13	81.20
0 31	81.00	80.96	80.91	80.86	80.81	80.76	80.72	80.69	80.67	80.66	80.65	80.65	80.65	80.66	80.68	80.70
0 32	80.60	80.54	80.49	80.45	80.41	80.37	80.34	80.32	80.29	80.27	80.26	80.25	80.24	80.24	80.25	80.30
0 33	80.20	80.13	80.07	80.04	80.01	79.98	79.96	79.94	79.92	79.89	79.87	79.85	79.83	79.81	79.80	79.80
0 34	79.70	79.69	79.64	79.62	79.60	79.59	79.58	79.56	79.55	79.50	79.48	79.46	79.42	79.39	79.34	79.30
0 35	79.30	79.30	79.20	79.20	79.20	79.20	79.20	79.20	79.20	79.10	79.10	79.10	79.00	79.00	78.90	78.90

0HEAD WILL BE SAVED ON UNIT 30 AT END OF TIME STEP 1, STRESS PERIOD 1

1 DRAWDOWN IN LAYER 1 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.06	.04	.04	.04	.03	.09	.08	.08	.07	.07	.07	.07	-.02	-.01	.00
0 3	.00	.08	.07	.07	.08	.18	.16	.15	.14	.14	.14	.03	.04	.05	.07	.00
0 4	.00	.09	.09	.09	.20	.21	.21	.21	.20	.21	.21	.10	.10	.01	.02	.00
0 5	.00	.10	.09	.10	.22	.25	.25	.26	.26	.26	.27	.17	.07	.08	.09	.00

0 6	.00	.07	.06	.16	.28	.31	.33	.33	.34	.34	.25	.24	.14	.15	.07	.00
0 7	.00	.07	.16	.17	.29	.32	.33	.34	.34	.34	.34	.22	.20	.11	.04	.00
8	.00	.05	.14	.27	.30	.33	.34	.35	.35	.35	.34	.23	.21	.12	.05	.00
9	.00	.06	.20	.25	.40	.44	.47	.48	.37	.36	.36	.26	.26	.17	.12	.00
10	.00	.17	.25	.34	.42	.47	.51	.51	.50	.38	.37	.28	.18	.11	.04	.00
11	.00	.15	.28	.41	.54	.63	.67	.68	.54	.49	.37	.36	.27	.19	.03	.00
0 12	.00	.12	.38	.57	.77	.94	.87	.90	.68	.58	.43	.32	.22	.14	.07	.00
0 13	.00	.16	.37	.62	.93	1.31	1.17	1.26	.91	.65	.47	.35	.25	.17	.11	.00
0 14	.00	.17	.41	.71	1.17	1.07	1.06	.98	.86	.65	.48	.36	.26	.18	.12	.00
0 15	.00	.23	.38	.65	.81	.94	.90	.93	.79	.63	.47	.35	.25	.16	.08	.00
0 16	.00	.19	.35	.48	.69	.75	.85	.82	.71	.68	.54	.42	.32	.23	.05	.00
0 17	.00	.10	.34	.45	.53	.68	.71	.86	.71	.60	.48	.38	.29	.20	.10	.00
0 18	.00	.08	.27	.34	.50	.54	.66	.66	.59	.51	.42	.34	.25	.17	.06	.00
0 19	.00	.08	.21	.35	.49	.51	.53	.62	.58	.52	.45	.39	.23	.16	.08	.00
0 20	.00	.09	.21	.33	.45	.47	.49	.58	.56	.51	.46	.32	.29	.15	.09	.00
0 21	.00	.07	.17	.29	.41	.44	.57	.58	.56	.52	.38	.35	.24	.14	.05	.00
0 22	.00	.12	.23	.25	.40	.45	.51	.64	.52	.48	.44	.31	.21	.12	.06	.00
0 23	.00	.07	.18	.31	.38	.47	.58	.67	.61	.54	.39	.36	.25	.19	.07	.00
0 24	.00	.09	.20	.26	.36	.59	.76	.96	.71	.59	.42	.28	.27	.11	.02	.00
0 25	.00	.07	.12	.31	.42	.56	.74	.91	.70	.59	.42	.28	.18	.13	.03	.00
0 26	.00	.07	.15	.25	.36	.51	.71	1.07	.68	.55	.39	.27	.18	.13	.01	.00
0 27	.00	.09	.17	.27	.37	.39	.53	.66	.61	.45	.32	.32	.14	.09	.06	.00
0 28	.00	.03	.10	.19	.28	.37	.46	.43	.44	.34	.34	.25	.18	.14	.01	.00
0 29	.00	.07	.14	.21	.18	.25	.32	.37	.30	.32	.24	.17	.11	.07	.04	.00
0 30	.00	.03	.08	.13	.18	.23	.29	.23	.27	.20	.24	.18	.13	.09	.05	.00
0 31	.00	.00	.02	.05	.09	.13	.17	.21	.15	.19	.13	.09	.05	.01	.07	.00
0 32	.00	.07	.07	.08	.10	.12	.15	.09	.13	.07	.13	.09	.06	.04	.02	.00
0 33	.00	.01	.00	.10	.10	.12	.04	.07	.10	.06	.02	.10	.08	.06	.05	.00
0 34	.00	-.04	.04	.01	.00	.01	.02	.04	.07	.03	.01	-.00	-.01	-.01	-.01	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

1 DRAWDOWN IN LAYER 2 AT END OF TIME STEP 1 IN STRESS PERIOD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
0 2	.00	.02	.03	-.06	-.05	-.01	.02	-.06	-.03	-.08	-.03	-.06	-.01	-.03	.03	.00
0 3	.00	-.02	-.02	-.01	.00	-.07	-.04	-.01	-.07	-.02	-.06	-.09	-.01	-.03	-.03	.00
0 4	.00	.03	-.06	-.05	-.04	-.11	-.09	-.05	-.10	-.04	-.07	-.09	-.00	-.01	-.00	.00
0 5	.00	.01	.01	-.08	-.06	-.05	-.12	-.09	-.13	-.06	-.07	-.08	-.08	-.07	-.04	.00
0 6	.00	-.00	.00	-.09	-.08	-.07	-.16	-.13	-.16	-.16	-.06	-.05	-.04	-.02	.02	.00
0 7	.00	-.01	.00	.01	-.08	-.09	-.21	-.19	-.20	-.16	-.03	-.02	.00	.02	-.05	.00
0 8	.00	-.01	.00	.02	-.06	-.08	-.30	-.30	-.29	-.14	-.09	-.06	-.04	-.03	-.01	.00
0 9	.00	.06	.01	.05	.10	.04	-.16	-.18	-.16	-.02	.00	.02	.03	.04	-.04	.00
0 10	.00	.04	.11	.09	.17	.15	.10	.15	.10	.11	.11	.11	.01	.02	.03	.00
11	.00	.10	.11	.13	.25	.26	.34	.53	.36	.25	.13	.11	.10	.11	.03	.00
12	.00	.06	.11	.27	.32	.38	.76	1.20	.70	.30	.24	.21	.19	.09	.02	.00
13	.00	.12	.22	.30	.39	.49	1.19	2.91	1.15	.44	.35	.29	.16	.15	.06	.00
0 14	.00	.12	.23	.33	.54	.66	1.03	1.45	1.01	.55	.44	.26	.21	.09	.09	.00
0 15	.00	.13	.24	.35	.58	.73	.94	1.03	.95	.74	.50	.31	.15	.12	.01	.00
0 16	.00	.07	.25	.35	.56	.68	.80	.88	.71	.60	.40	.22	.17	.05	.03	.00
0 17	.00	.08	.15	.33	.41	.50	.61	.68	.52	.43	.27	.22	.08	.07	-.03	.00
0 18	.00	.01	.15	.20	.25	.30	.25	.30	.27	.24	.12	.09	-.02	-.02	-.01	.00
0 19	.00	.01	.03	.06	.09	-.00	-.01	.00	.01	-.06	-.04	-.04	-.14	-.12	-.08	.00
0 20	.00	.06	.06	-.01	.01	-.08	-.07	-.05	-.04	-.12	-.10	-.10	-.19	-.17	-.11	.00
0 21	.00	-.01	.01	.04	.08	.02	.09	.14	.03	-.00	-.02	-.03	-.13	-.11	-.07	.00
0 22	.00	.05	.10	.15	.11	.18	.30	.40	.25	.17	.13	.00	-.01	-.00	.03	.00
0 23	.00	.02	.07	.14	.23	.34	.45	.71	.51	.34	.16	.11	.08	.07	-.02	.00
0 24	.00	.06	.13	.21	.32	.37	.73	1.58	.79	.48	.27	.20	.16	.13	.02	.00
0 25	.00	.08	.17	.16	.27	.41	.65	.92	.61	.43	.33	.26	.22	.18	.04	.00
0 26	.00	.10	.09	.19	.30	.42	.61	.65	.58	.44	.37	.30	.25	.11	.06	.00
0 27	.00	.12	.12	.21	.31	.33	.48	.55	.53	.44	.28	.23	.18	.14	.09	.00
0 28	.00	.06	.14	.22	.21	.30	.39	.44	.45	.31	.28	.24	.21	.17	.03	.00
0 29	.00	.08	.16	.13	.20	.27	.34	.28	.29	.28	.27	.15	.12	.09	.05	.00
0 30	.00	.10	.07	.14	.20	.25	.20	.23	.25	.26	.16	.15	.13	.11	.07	.00
0 31	.00	.04	.09	.14	.09	.14	.18	.21	.23	.14	.15	.15	.15	.04	.02	.00
0 32	.00	.06	.11	.05	.09	.13	.16	.08	.11	.13	.14	.05	.06	.06	.05	.00
0 33	.00	.07	.03	.06	.09	.12	.04	.06	.08	.11	.03	.05	.07	.09	.00	.00
0 34	.00	.01	.06	.08	-.00	.01	.02	.04	.05	-.00	.02	.04	-.02	.01	.06	.00
0 35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

0DRAWDOWN WILL BE SAVED ON UNIT 40 AT END OF TIME STEP 1, STRESS PERIOD 1
0

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 1

0 CUMULATIVE VOLUMES L**3 RATES FOR THIS TIME STEP L**3/T

IN: IN:

STORAGE = .00000 STORAGE = .00000

CONSTANT HEAD = .17596E+06
WELLS = .00000
0 TOTAL IN = .17596E+06
0 OUT:

STORAGE = .00000
CONSTANT HEAD = 98941.
WELLS = 77007.
0 TOTAL OUT = .17595E+06
0 IN - OUT = 12.250
0 PERCENT DISCREPANCY = .01

CONSTANT HEAD = .17596E+06
WELLS = .00000
TOTAL IN = .17596E+06
OUT:

STORAGE = .00000
CONSTANT HEAD = 98941.
WELLS = 77007.
TOTAL OUT = .17595E+06
IN - OUT = 12.250
PERCENT DISCREPANCY = .01

0

TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 1

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	86400.0	1440.00	24.0000	1.00000	.273785E-02
STRESS PERIOD TIME	86400.0	1440.00	24.0000	1.00000	.273785E-02
TOTAL SIMULATION TIME	86400.0	1440.00	24.0000	1.00000	.273785E-02

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APPENDIX C

ASSESSMENT OF AIR STRIPPER EMISSIONS AND DISCHARGE REQUIREMENTS

APPENDIX C

ASSESSMENT OF AIR STRIPPER EMISSIONS AND DISCHARGE REQUIREMENTS

An assessment of volatile organic emissions from the air stripper system was conducted to evaluate the potential need for off-gas treatment in accordance with state and federal requirements. This evaluation assumes removal of the highest detected VOC concentrations based on three months' VOC data (June, July, and August, 1992) for extracted ground water at the SMC site (data summary tables are attached). During the three-month period, methylene chloride, 1,1-dichloroethene, 1,2-dichloroethene (total) and trichloroethene were the only VOCs detected. Methylene chloride was also detected in blank samples. Maximum detected levels for the three-month period are listed in Table C-1. Assuming 100% of the extracted contaminant is emitted into the air by the air stripper and that the extracted ground water is treated at an extraction rate of 400 gallons per minute, the maximum emission rate for each contaminant of concern was calculated. For trichloroethene, the maximum estimated emission rate is 0.018 lb/hour, which is less than the 0.1 lb/hr limitation specified under NJAC 7:27-17. Because the maximum detected concentrations for all other contaminants were less than that of trichloroethene, their maximum rates of emission (assuming 100% removal) would also be less than the 0.1 lb/hr limitation. Similarly, the total estimated emission rate falls well within limiting discharge values presented in 7:27-16.6. Therefore, this assessment indicates vapor phase treatment will not be required. However, further assessment of vapor phase treatment requirements may be required if monitoring of VOC inlet concentrations identifies significant increases in influent VOC levels.

TABLE C-1
ESTIMATED MAXIMUM VOLATILE ORGANIC COMPOUND VAPOR EMISSION RATES VS. STATE OF NEW JERSEY MAXIMUM EMISSION RATE STANDARDS
ALTERNATIVE 3 – TREATMENT OPTION T2 – AIR STRIPPING

NEW JERSEY VOLATILE ORGANIC SUBSTANCES				
COMPOUNDS	MAXIMUM INFLUENT CONCENTRATION[1] (ppb)	MAXIMUM INFLUENT CONCENTRATION[1] (lb/gal)[2]	MAXIMUM VAPOR EMISSION RATE[3] (lb/hr)	<0.1 lb/hr
Methylene Chloride	3.3	2.75×10^{-8}	0.00066	Y
1,1-Dichloroethene	1.2	1.00×10^{-8}	0.00024	Y
1,2-Dichloroethene (Total)	12	1.00×10^{-7}	0.0024	Y
Trichloroethene	74	6.17×10^{-7}	0.018	Y
Totals	90.5	7.55×10^{-7}	0.0213 (<0.1 lb/hr Tot. VOCs)	Y

[1] Maximum concentration of volatile organic compounds detected in monthly inlet samples collected from June to August 1992.

[2] 1 ppb (1µg/l) = 8.34×10^{-9} lb/gal

[3] Assuming 100% removal, 400 gpm (24,000 gal/hr)

Notes: – Under NJAC 7:27-17, the maximum vapor emission rate standard for individual volatile organic compounds is 0.1 lb.hr.
– Under NJAC 7:27-16.6, the maximum vapor emission rate standard for total volatile organic compounds is 0.1 lb/hr.

NATIONAL ENVIRONMENTAL TESTING, INC.
Thorofare Division
Report of Results

Client: SHIELD ALLOY
Sample ID: VOC INLET
% Moisture: N/A

Report NO: 92.1968
NET-Mid ID: 94324

Volatiles by GC/MS 624 AQ

Benzene	4.0	U	ug/L	1,1-Dichloroethene	1.0	J	ug/L
Bromodichloromethane	2.0	U	ug/L	total-1,2-Dichloroethene	12.		ug/L
Bromoform	5.0	U	ug/L	1,2-Dichloropropane	6.0	U	ug/L
Bromomethane	10.	U	ug/L	cis-1,3-Dichloropropene	5.0	U	ug/L
Carbon Tetrachloride	3.0	U	ug/L	trans-1,3-Dichloropropene	5.0	U	ug/L
Chlorobenzene	6.0	U	ug/L	Ethylbenzene	7.0	U	ug/L
Chloroethane	10.	U	ug/L	Methylene Chloride	3.3	B=13	ug/L
2-Chloroethylvinyl ether	10.	U	ug/L	1,1,2,2-Tetrachloroethane	7.0	U	ug/L
Chloroform	2.0	U	ug/L	Tetrachloroethene	4.0	U	ug/L
Chloromethane	10.	U	ug/L	Toluene	6.0	U	ug/L
Dibromochloromethane	3.0	U	ug/L	1,1,1-Trichloroethane	4.0	U	ug/L
1,3 & 1,4-Dichlorobenzene	10.	U	ug/L	1,1,2-Trichloroethane	5.0	U	ug/L
1,2-Dichlorobenzene	1.9	U	ug/L	Trichloroethene	74.		ug/L
1,1-Dichloroethane	5.0	U	ug/L	Trichlorofluoromethane	2.0	U	ug/L
1,2-Dichloroethane	3.0	U	ug/L	Vinyl Chloride	10.	U	ug/L

VALUE If the result is a value greater than or equal to the detection limit, the value is reported.

U Indicates compound was analyzed for but not detected (eg. 10U), based on necessary concentration/dilution. The number is the minimum attainable detection limit for the sample.

B This flag is used when the analyte is found in the blank as well as a sample. It indicates possible/probable contamination and warns the data user to take appropriate action.

J Indicates an estimated value. This flag is used when the data indicates the presence of a compound that meets identification criteria or the result is less than the specified detection limit. (e.g. If the limit of detection is 10 ug/L and a concentration of 3 ug/L is calculated, report as 3 J.)

NATIONAL ENVIRONMENTAL TESTING, INC.
Thorofare Division
Report of Results

Client: SHIELD ALLOY
Sample ID: INLET
% Moisture: N/A

Report NO: 92.2178
NET-Mid ID: 95628

Volatiles by GC/MS 624 AQ

Benzene	4.0	U	ug/L	1,1-Dichloroethene	1.2	J	ug/L
Bromodichloromethane	2.0	U	ug/L	total-1,2-Dichloroethene	9.8		ug/L
Bromoform	5.0	U	ug/L	1,2-Dichloropropane	6.0	U	ug/L
Bromomethane	10.	U	ug/L	cis-1,3-Dichloropropene	5.0	U	ug/L
Carbon Tetrachloride	3.0	U	ug/L	trans-1,3-Dichloropropene	5.0	U	ug/L
Chlorobenzene	6.0	U	ug/L	Ethylbenzene	7.0	U	ug/L
Chloroethane	10.	U	ug/L	Methylene Chloride	2.0	JB=4	ug/L
2-Chloroethylvinyl ether	10.	U	ug/L	1,1,2,2-Tetrachloroethane	7.0	U	ug/L
Chloroform	2.0	U	ug/L	Tetrachloroethene	2.6	J	ug/L
Chloromethane	10.	U	ug/L	Toluene	6.0	U	ug/L
Dibromochloromethane	3.0	U	ug/L	1,1,1-Trichloroethane	2.4	J	ug/L
1,3 & 1,4-Dichlorobenzene	10.	U	ug/L	1,1,2-Trichloroethane	5.0	U	ug/L
1,2-Dichlorobenzene	1.9	U	ug/L	Trichloroethene	68.		ug/L
1,1-Dichloroethane	5.0	U	ug/L	Trichlorofluoromethane	2.0	U	ug/L
1,2-Dichloroethane	3.0	U	ug/L	Vinyl Chloride	10.	U	ug/L
1,4-Dioxane	Not Present		ug/L	Ethylemine	Not Present		ug/L
Ethylene dibromide	Not Present		ug/L				

VALUE If the result is a value greater than or equal to the detection limit, the value is reported.

U Indicates compound was analyzed for but not detected (eg. 10U), based on necessary concentration/dilution. The number is the minimum attainable detection limit for the sample.

B This flag is used when the analyte is found in the blank as well as a sample. It indicates possible/probable contamination and warns the data user to take appropriate action.

J Indicates an estimated value. This flag is used when the data indicates the presence of a compound that meets identification criteria or the result is less than the specified detection limit. (e.g. If the limit of detection is 10 ug/L and a concentration of 3 ug/L is calculated, report as 3 J.)

NET ATLANTIC, INC.
Report of Results

Client: SHIELD ALLOY
Sample ID: INLET SAMPLE
% Moisture: N/A

Report NO: 92.1501
NET-Mid ID: 91022

Volatiles by GC/MS 624 AQ

Benzene	4.0	U	ug/L	1,1-Dichloroethene	1.2	J	ug/L
Bromodichloromethane	2.0	U	ug/L	total-1,2-Dichloroethene	2.0	U	ug/L
Bromoform	5.0	U	ug/L	1,2-Dichloropropane	6.0	U	ug/L
Bromomethane	10.	U	ug/L	cis-1,3-Dichloropropene	5.0	U	ug/L
Carbon Tetrachloride	3.0	U	ug/L	trans-1,3-Dichloropropene	5.0	U	ug/L
Chlorobenzene	6.0	U	ug/L	Ethylbenzene	7.0	U	ug/L
Chloroethane	10.	U	ug/L	Methylene Chloride	1.7	J(B=6)	ug/L
2-Chloroethylvinyl ether	10.	U	ug/L	1,1,2,2-Tetrachloroethane	7.0	U	ug/L
Chloroform	2.0	U	ug/L	Tetrachloroethene	2.6	J	ug/L
Chloromethane	10.	U	ug/L	Toluene	6.0	U	ug/L
Dibromochloromethane	3.0	U	ug/L	1,1,1-Trichloroethane	4.0	U	ug/L
1,2 & 1,4-Dichlorobenzene	10.	U	ug/L	1,1,2-Trichloroethane	5.0	U	ug/L
1,3-Dichlorobenzene	1.9	U	ug/L	Trichloroethene	71.		ug/L
1,1-Dichloroethane	5.0	U	ug/L	Trichlorofluoromethane	2.0	U	ug/L
1,2-Dichloroethane	3.0	U	ug/L	Vinyl Chloride	10.	U	ug/L
1,4-Dioxane	Not Present		ug/L	Ethylamine	Not Present		ug/L
Ethylene dibromide	Not Present		ug/L				

VALUE If the result is a value greater than or equal to the detection limit, the value is reported.

U Indicates compound was analyzed for but not detected (eg. 10U), based on necessary concentration/dilution. The number is the minimum attainable detection limit for the sample.

B This flag is used when the analyte is found in the blank as well as a sample. It indicates possible/probable contamination and warns the data user to take appropriate action.

J Indicates an estimated value. This flag is used when the data indicates the presence of a compound that meets identification criteria or the result is less than the specified detection limit. (e.g. If the limit of detection is 10 ug/L and a concentration of 3 ug/L is calculated, report as 3 J.)

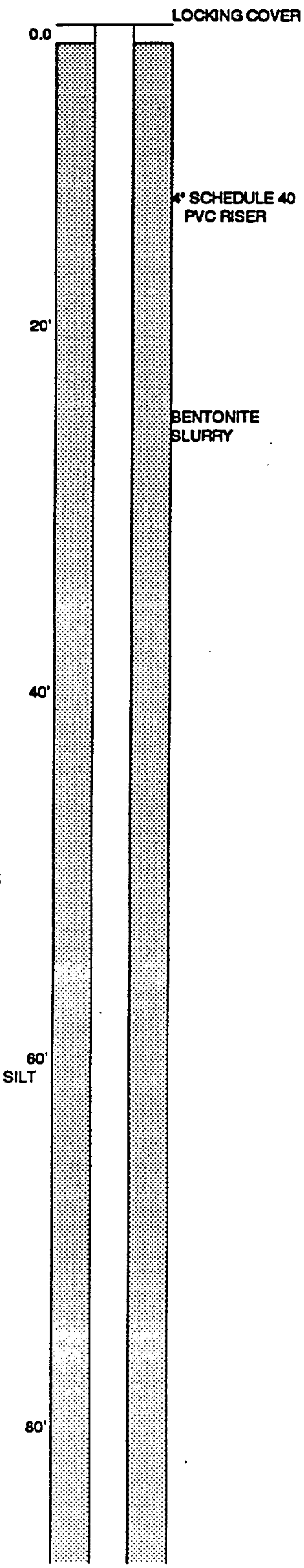
APPENDIX D

NEWLY INSTALLED MONITORING WELL LOGS

BORING NO.:	SC-2D (R)	CONTRACTOR:	UNI-TECH DRILLING	DATE STARTED:	1/2/92
PROJECT NO.:	7650-N51	DRILLERS:	CONOVER, JANDRAS	DATE COMPLETED:	1/3/92
PROJECT:	SHIELDALLOY	TRC INSPECTOR:	DRAKE	STATIC WATER LEVEL:	85.00 FT
CLIENT:	SMC	DRILLING METHOD:	MUD ROTARY	NJDEP PERMIT NUMBER:	31-38194
LOCATION:	NEWFIELD, NJ	GROUND ELEVATION:	90.62 FT		
BORING DEPTH:	127 FT	CASING ELEVATION:	92.70 FT		

DEPTH (FT)	BLOWS		SOIL DESCRIPTION
0 – 2	3 2	2 3	BROWN MEDIUM SAND, ORGANICS AT TOP OF SPOON
2–4	7 8	6 11	BROWN / ORANGE FINE TO MEDIUM GRAVEL, SOME SAND
4 – 6	10 41	27 47	TAN TO LIGHT BROWN SAME AS ABOVE. TIGHTLY PACKED
6 – 8	12 16	17 14	LIGHT BROWN MEDIUM SAND
10 – 12	8 18	15 19	ORANGE SILTY SAND, WET
12–14	15 23	15 22	0 – 14" TAN SILTY SAND; 14 – 24" ORANGE FINE SILTY SAND
20 – 22	7 14	8 18	ORANGE FINE–COARSE SAND, TRACE SILT RECOVERY = 10"
25 – 27	14 25	18 30	ORANGE/LIGHT BROWN MEDIUM COURSE SAND, TRACE SILT, RECOVERY = 12"
30 – 32	26 66	27 75	ORANGE / LIGHT BROWN FINR – MEDIUM SAND, SOME SILT. RECOVERY = 14"
35 – 37	30 100	56	LIGHT BROWN FINE – MEDIUM SILT. RECOVERY = 10"
40 – 42	42 100	66	ORANGE LIGHT BROWN FINE – MEDIUM SAND, TRACE SILT. RECOVERY = 1
50 – 52	30 75	52 75	0 – 3" RED & LIGHT BROWN LAYERS OF FINE–MEDIUM SAND, SOME SILT & CLAY; 3 – 15" ORANGE & RED LAYERS OF MEDIUM TO COURSE SAND, TRACE SILT. RECOVERY = 15"
55 – 57	39 60	40 75	RED FINE SAND, LITTLE SILT. RECOVERY = 14"
60 – 62	45 90	70 100/5"	RED FINE SAND, LITTLE SILT SILT & CLAY;3 – 15" ORANGE & RED LAYERS OF MEDIUM–COURSE SAND, TRACE SILT RECOVERY = 15"
65 – 67	33 100/4"	65	RED FINE SAND TRACE SILT RECOVERY = 10"
70 – 72	35 100/5"	50	LIGHT BROWN & RED LAYERS OF FINE SAND, SOME SILT RECOVERY = 13"
75 – 77	20 65	50 70	LIGHT BROWN & ORANGE LAYERS OF FINE SAND, TRACE SILT RECOVERY=11"
80 – 82	20 35	25 45	LIGHT BROWN FINE SAND WITH THIN WHITE SILT CLAY STRINGERS. RECOVERY = 8"
85 – 87	80 100/5"	105	LIGHT BROWN FINE SAND, TRACE SILT RECOVERY = 8"

WELL CONSTRUCTION



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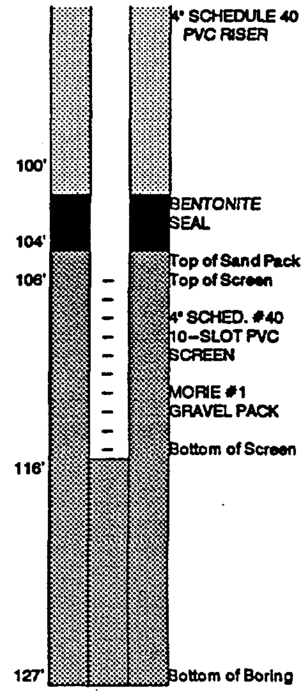
BORING NO.: SC-2D (R)
PROJECT NO.: 7650-N51

DEPTH (FT)	BLOWS		SOIL DESCRIPTION
90 – 92	20 15	27 22	LIGHT BROWN MEDIUM TO FINE SAND, TRACE SILT, RECOVERY = 9"
95 – 97	21 42	27 40	LIGHT BROWN FINE–MEDIUM SAND, SOME SILTY CLAY LAYERS RECOVERY = 11"
100–102	90	100/1.5"	LIGHT BROWN MEDIUM SAND TRACE SILT RECOVERY=19"
105–107	107	100/4"	SAME AS ABOVE RECOVERY=18"
110–112	125	100/2"	0 – 18" SAME AS ABOVE; 18–24" ORANGE MEDIUM SAND, SOME SILTY GRAY STRINGERS. RECOVERY = 24"
115–117	18 31	29 41	GRAY–BLACK FINE–MEDIUM SAND, SOME SILT, LITTLE CLAY. RECOVERY = 16"
117–119	15 22	18 33	GRAY/BLACK FINE–MEDIUM SAND, LITTLE SILT & CLAY RECOVERY = 6"; LARGE AMOUNTS OF WASH
119 – 121	13 20	19 29	GRAY/BLACK FINE–MEDIUM SAND, LITTLE SILT & CLAY RECOVERY = 6"
121 –123	14 70	35 54	SAME AS ABOVE RECOVERY = 3"
123 – 125	25 33	26 43	0–2" VARIED CLAY/SILT LAYERS; 2–4" MEDIUM–FINE SAND LITTLE SILT AND CLAY, ONE STRINGER OF SILT/CLAY; RECOVERY = 6"
125–127	17 19	23 25	FINE–MEDIUM SAND, LITTLE SILT AND CLAY RECOVERY = 5"
			END OF BORING = 127'

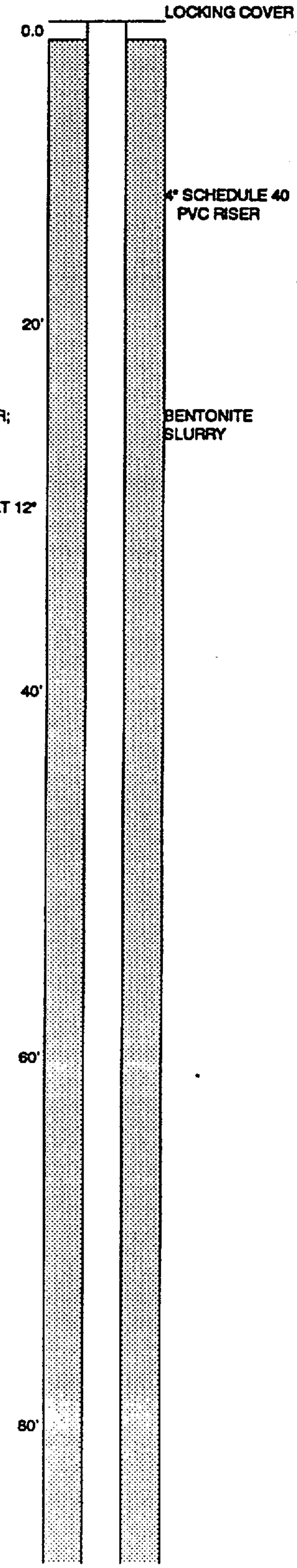
WELL CONSTRUCTION



BORING NO.:	SC-3D (R)	CONTRACTOR:	UNI-TECH DRILLING	DATE STARTED:	1/6/92
PROJECT NO.:	7650-N51	DRILLERS:	CONOVER, JANDRAS	DATE COMPLETED:	1/7/92
PROJECT:	SHIELDALLOY	TRC INSPECTOR:	DRAKE	STATIC WATER LEVEL:	86.01 FT
CLIENT:	SMC	DRILLING METHOD:	MUD ROTARY	NJDEP PERMIT NUMBER:	31-38195
LOCATION:	NEWFIELD, NJ	GROUND ELEVATION:	88.75 FT		
BORING DEPTH:	127 FT	CASING ELEVATION:	91.06 FT		

DEPTH (FT)	BLOWS	SOIL DESCRIPTION
0 – 2	4 2 3 4	0–6" BLACK ORGANICS; 6–20" BROWN/TAN MEDIUM–FINE SAND, LITTLE SILT, NO ODOR. WATER TABLE AT 2.5'. RECOVERY = 20".
5 – 7	12 18 30 31	BROWN/TAN MEDIUM–COURSE SAND, SOME FINE SAND AND GRAVEL, TRACE SILT, NO ODOR. RECOVERY = 12"
10 – 12	17 12 19 20	0–6" WASH; 6–14" BROWN/TAN MEDIUM–FINE SAND, LITTLE FINE GRAVEL, TRACE SILT, NO ODOR. RECOVERY = 14"
15–17	2 8 10 7	0 – 12" GRAY FINE SAND, SOME SILT; 12–19" RED/BROWN MEDIUM–COURSE SAND AND GRAVEL, TRACE SILT, NO ODOR. RECOVERY = 19"
20 – 22	10 16 25 28	0–2" WASH; 2–14" LAYERS OF WHITE AND TAN MEDIUM SAND AND FINE SAI TRACE SILT, NO ODOR. RECOVERY = 14"
25 – 27	16 25 34 40	0–6" LIGHT BROWN MEDIUM–COURSE SAND, SOME GRAVEL; 6–7" GRAVEL LAYER; 7–17" LIGHT ORANGE–BROWN MEDIUM–COURSE SAND, LITTLE GRAVEL AND FINE SAND, TRACE SILT. NO ODOR. RECOVERY = 17"
30 – 32	19 40 60 60	LIGHT BROWN MEDIUM–COURSE SAND, SOME FINE GRAVEL. COURSE GRAVEL AT 12" FINER SANDS AT BASE OF SPOON. NO ODOR. RECOVERY = 24"
35 – 37	25 40 40 43	0–15" LIGHT BROWN MEDIUM–COURSE SAND, LITTLE FINE SAND TRACE SILT; 15–24" WHITE MEDIUM SAND, LITTLE FINE SAND. RECOVERY = 24"
40 – 42	27 30 48 56	TAN MEDIUM–COURSE SAND, LITTLE FINE SAND, TRACE GRAVEL. RECOVERY = 18"
45 – 47	20 25 25 26	TAN MEDIUM–COURSE SAND, LITTLE FINE SAND, TRACE GRAVEL. RECOVERY = 19"
50 – 52	9 7 17 15	0–6" TAN–BROWN MEDIUM–FINE SAND, 8–14" RED–BROWN COURSE SAND, LITTLE FINE–MEDIUM SAND. RECOVERY = 14".
55 – 57	5 5 5 11	0–6" TAN–BROWN MEDIUM–FINE SAND, LITTLE SILT; 6–14" RED–BROWN MEDIUM–FINE SAND, LITTLE SILT. RECOVERY = 14"
60 – 62	42 56 83 67	TAN–BROWN MEDIUM SAND, LITTLE FINE SAND, TRACE SILT RECOVERY = 20"
65 – 67	13 13 37 45	TAN WITH PINK LAYERS;0–4" MEDIUM–COURSE SAND; 4–18" FINE SAND, LITTLE SILT. RECOVERY = 18"
70 – 72	40 54 100/5"	0–2" TAN MEDIUM–COURSE SAND; 2–12" TAN AND RED LAYERS OF FINE SAND LITTLE SILT, THIN WHITE FINE SAND NEAR BASE OF SPOON, RECOVERY = 18"
75 – 77	50 56 100/5"	0–6" WASH; 6–8" TAN MEDIUM FINE SAND, 8–18" LIGHT BROWN FINE SAND, LITTLE SILT, RECOVERY=18"
80 – 82	42 57 100/5"	0–6 TAN MEDIUM FINE SAND, 6–8" TAN FINE SAND, LITTLE SILT, RECOVERY = 8"
85 – 87	34 62 58 64	0–2" TAN MEDIUM–FINE SAND; 2–12" LIGHT BROWN FINE SAND, TRACE SILT, RECOVERY = 12"

WELL CONSTRUCTION



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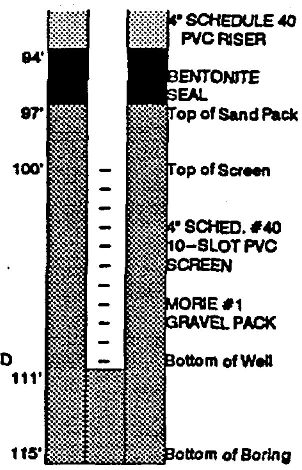
BORING NO.: SC–3D (R)
PROJECT NO.: 7650–N51

DEPTH (FT)	BLOWS		SOIL DESCRIPTION
90 – 92	34 58	62 64	0–6" TAN FINE–COURSE SAND, LITTLE GRAVEL; 6–12" BROWN–TAN FINE–MEDIUM SAND, LITTLE SILT, RECOVERY 12"
95 – 97	54 100/5"	59	0–10" TAN MEDIUM SAND;10–12" RED MEDIUM–COURSE SAND; 12–15" ORANGE–BROWN MEDIUM–COURSE SAND WIYH SILT STRINGERS. RECOVERY = 15"
100–102	25 35	32 26	0–3" TAN MEDIUM SAND, SOME COURSE SAND; 3–10" TAN–BROWN FINE M SAND WITH SILT STRINGERS, LITTLE SILT, RECOVERY = 10"
105–107	36 100/5"	45	0–14" TAN MEDIUM SAND, SOME COURSE SAND; 14–21" TAN–BROWN FINE–MEDIUM SAND, LITTLE GRAVEL AND SILT STRINGERS. RECOVERY = 21"
110–112	17 20	27 35	0–12" TAN MEDIUM SAND, SOME COURSE SAND; 12–24" VARIGATED MEDIUM SAND (TAN, RED, AND BROWN LAYERS) WITH SILT STRINGERS, SOME FINE SAND LITTLE SILT. RECOVERY = 24"
			END OF BORING = 115'

WELL CONSTRUCTION

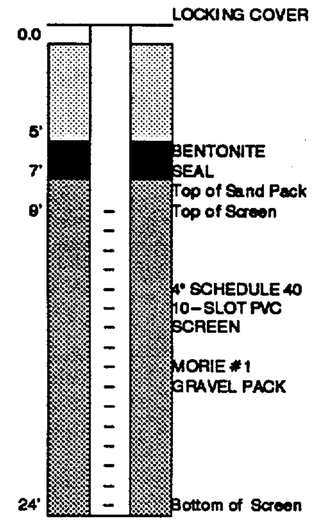


BORING NO.:	SC-11S (R)	CONTRACTOR:	UNI-TECH DRILLING	DATE STARTED:	7/1/92
PROJECT NO.:	7650-N51	DRILLERS:	FRECK	DATE COMPLETED:	7/1/92
PROJECT:	SHIELDALLOY	SMC INSPECTOR:	VALENTI	STATIC WATER LEVEL:	91.10 FT
CLIENT:	SMC	DRILLING METHOD:	MUD ROTARY	NJDEP PERMIT NUMBER:	31-39500
LOCATION:	NEWFIELD, NJ	GROUND ELEVATION:	106.91 FT		
BORING DEPTH:	24 FT	CASING ELEVATION:	108.12 FT		

DEPTH (FT)	BLOWS		SOIL DESCRIPTION
0 – 2			AUGERED TO 5'
5 – 7	3 6	4 7	ORANGE TO LIGHT BROWN SILTY SAND WITH GRAVEL
10 – 12	2 5	4 2	ORANGE–LIGHT BROWN SILTY SAND WITH GRAVEL
15 – 17	2 3	2 3	ORANGE–TAN GRAVEL
20 – 22	3 6	3 7	ORANGE–TAN GRAVEL

END OF BORING = 24'

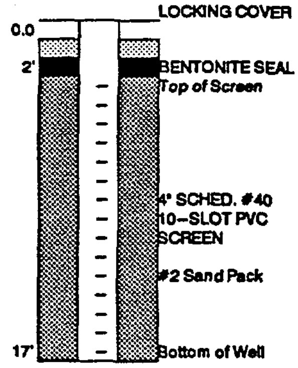
WELL CONSTRUCTION



BORING NO.:	SC-W2 (R)	CONTRACTOR:	UNI-TECH DRILLING	DATE STARTED:	12/20/91
PROJECT NO.:	*7650-N51*	*DRILLERS:*	CONOVER, EVANS	DATE COMPLETED:	12/20/91
PROJECT:	SHIELDALLOY	SMC INSPECTOR:	VALENTI	STATIC WATER LEVEL:	93.20 FT
CLIENT:	SMC	DRILLING METHOD:	MUD ROTARY	NJDEP PERMIT NUMBER:	
LOCATION:	NEWFIELD, NJ	GROUND ELEVATION:	95.66 FT		
BORING DEPTH:	17 FT	CASING ELEVATION:	97.96 FT		

DEPTH (FT)	BLOWS		SOIL DESCRIPTION
0 – 2	15	8	Light brown to light orange, GRAVEL, (0–.5'); light brown, sandy
	6	7	gravel, well rounded to subangular pebbles, (.5'–2')
2 – 4	4	7	Light brown to light orange SAND, medium to fine, water table at 2.5'
	15	13	
4 – 6	11	8	Light brown, SAND, fine
	6	10	
10 – 12	6	7	Light gray, SAND & GRAVEL, pebbles to 3/4", silty sand at 11'
	7	10	
15 – 17	5	7	Light brown, SAND & GRAVEL to 1/4", well graded and well rounded
	10	7	
			END OF BORING = 17'

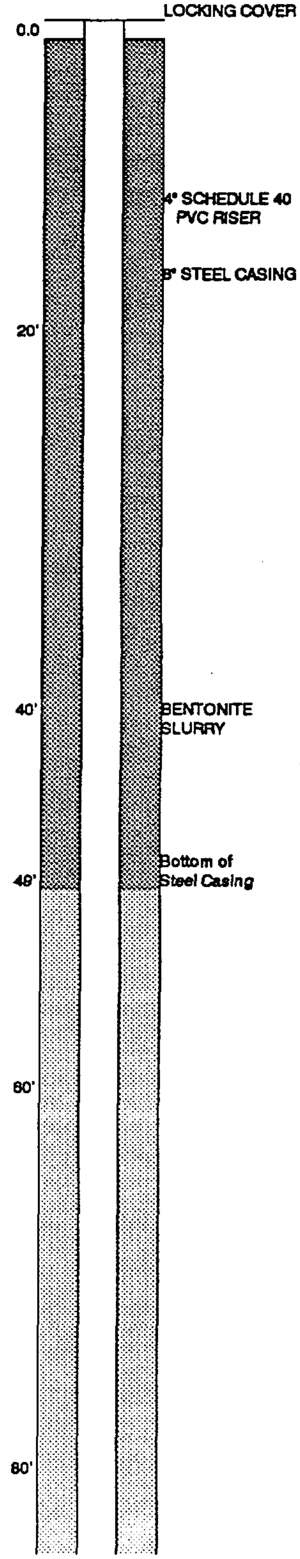
WELL CONSTRUCTION



BORING NO.:	SC-20D	CONTRACTOR:	UNI-TECH DRILLING	DATE STARTED:	1/8/92
PROJECT NO.:	7650-N51	DRILLERS:	CONOVER, JANDRAS	DATE COMPLETED:	1/10/92
PROJECT:	SHIELDALLOY	TRC INSPECTOR:	MULLEN	STATIC WATER LEVEL:	89.65 FT
CLIENT:	SMC	DRILLING METHOD:	MUD ROTARY	NJDEP PERMIT NUMBER:	31-38187
LOCATION:	NEWFIELD, NJ	GROUND ELEVATION:	101.55 FT		
BORING DEPTH:	139 FT	CASING ELEVATION:	104.53 FT		

DEPTH (FT)	BLOWS	SOIL DESCRIPTION
0 – 2		AUGERED TO 20' SEE LOG OF SC-20S FOR SOIL DESCRIPTION
5 – 7		
10 – 12		
15 – 17		
20 – 22	9 14 18 24	BROWN-ORANGE MEDIUM-COARSE SAND, TRACE FINE SAND. NO ODOR. RECOVERY=9"
25 – 27	23 25 37 37	0-7" WASH; 7-17" SAME AS ABOVE WITH TRACE FINE GRAVEL. NO ODOR. RECOVERY=17"
30 – 32	21 28 49 50	0-2" WASH; 2-13" BROWN ORANGE MEDIUM SAND, LITTLE FINE SAND, TRACE FINE GRAVEL; 13-15" BROWN-ORANGE FINE SAND. NO ODOR. RECOVERY=15"
35 – 37	16 22 50 39	0-2" WASH; 2-15" BROWN-ORANGE FINE TO MEDIUM SAND. NO ODOR. RECOVERY=15"
40 – 42	34 27 45 50	0-3" WASH; 3-15" SAME AS ABOVE RECOVERY=15"
45 – 47	17 29 39 50	0-6" BROWN-ORANGE FINE SAND; 6-12" BROWN-ORANGE FINE TO MEDIUM SAND. RECOVERY=12" STEEL CASING SET TO 49'
50 – 52	22 37 45 83	0-2" WASH; 2-4" BROWN-ORANGE SILT, SOME CLAY, LITTLE SAND; 4-21" BROWN-ORANGE MEDIUM SAND, LITTLE FINE SAND. RECOVERY=21"
55 – 57	49 65 70 65	BROWN-ORANGE FINE TO COARSE SAND, TRACE SILT. RECOVERY=12"
60 – 62	25 31 52 60	0-7" TAN MEDIUM SAND, LITTLE FINE SAND, TRACE FINE GRAVEL; 7-12" BROWN-ORANGE FINE TO MEDIUM SAND. RECOVERY=12"
65 – 67	43 43 49 53	VARIGATED TAN TO REDS MEDIUM SAND, SOME COARSE & FINE SAND, TRACE GRAVEL. RECOVERY=13"
70 – 72	14 22 45 56	SAME AS ABOVE EXCEPT SILT STRINGER IS LOCATED 4" DOWN FORM TOP OF SAMPLE. RECOVERY=12"
75 – 77	38 48 52 56	TAN FINE TO MEDIUM SAND; STRINGER OF FINE GRAVEL AT 4". RECOVERY=13"
80 – 82	42 48 100/5"	BROWN FINE SAND, LITTLE FINE GRAVEL. RECOVERY=12"
85 – 87	20 22 45 50	0-3" TAN CLAY, LITTLE SILT, TRACE FINE SAND, STIFF; 3-21" TAN TO RED FINE SAND WITH SILT/CLAY STRINGERS. RECOVERY=21"

WELL CONSTRUCTION



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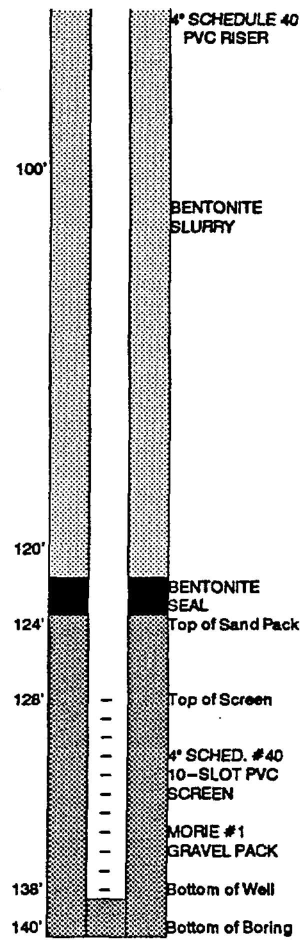
BORING NO.: SC-20D
PROJECT NO.: 7850-N51

DEPTH (FT)	BLOWS		SOIL DESCRIPTION
90 – 92	100/5"		LIGHT BROWN MEDIUM TO FINE SAND, TRACE SILT, RECOVERY = 6"
95 – 97	16 29	19 47	0–6" TAN FINE TO MEDIUM SAND, LITTLE COARSE SAND; 8–15" RED FINE TO MEDIUM SAND; LAYERS SEPARATED BY CLAY STRINGER. RECOVERY=15"
100–102	48 33	29 38	RED–BROWN FINE SAND WITH WHITE SILT AND CLAY STRINGERS. RECOVERY=19"
105–107	87	100/4"	0–2" SAME AS ABOVE; 2–8" TAN–PINK FINE TO MEDIUM SAND, TRACE SILT. RECOVERY=8"
110–112	100/4"		BROWN–ORANGE FINE TO MEDIUM SAND, TRACE SILT. RECOVERY=4"
115–117	91	100/4"	LIGHT TAN–BROWN MEDIUM SAND, LITTLE FINE SAND. RECOVERY=8"
120–122	22 26	20 13	TAN FINE SAND WITH RED LAMINATIONS, SOME SILT. RECOVERY=10"
125–127	53	133	BROWN–RED FINE SAND, LITTLE SILT. RECOVERY= 8"
130–132	25 33	24 32	SAME AS ABOVE. RED AT TOP TO TAN AT BOTTOM. RECOVERY=6"
137–139	29 28	24 34	DARK GRAY; 0–8" FINE SAND; 8–24" STIFF SILT & CLAY LAYERS, SOME TO LITTLE SAND AT BASE OF SPOON. RECOVERY=24"

WELL CONSTRUCTION

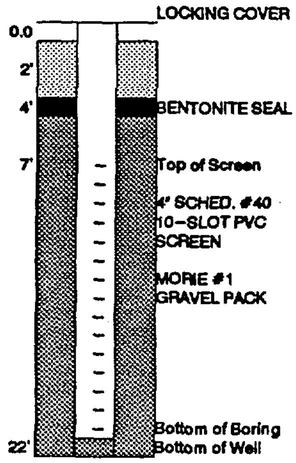


END OF BORING = 140'
6" STEEL CASING SET FROM 0 TO 49'

BORING NO.:	SC–W25S	CONTRACTOR:	UNI–TECH DRILLING	DATE STARTED:	12/23/91
PROJECT NO.:	7650–N51	DRILLERS:	CONOVER, EVANS	DATE COMPLETED:	12/23/91
PROJECT:	SHIELDALLOY	SMC INSPECTOR:	VALENTI	STATIC WATER LEVEL:	90.40 FT
CLIENT:	SMC	DRILLING METHOD:	MUD ROTARY	NJDEP PERMIT NUMBER:	
LOCATION:	NEWFIELD, NJ	GROUND ELEVATION:	99.60 FT		
BORING DEPTH:	22 FT	*CASING ELEVATION:*	*102.27 FT*		

DEPTH (FT)	BLOWS		SOIL DESCRIPTION
0 – 2	10	44	Gray, FILL, gravel, sand, and slag fragments
	20	14	
2 – 4	7	6	Light brown, SAND, gravel, pebbles to 1/2", damp
	7	6	
4 – 6	10	7	Same as above
	15	19	
6 – 8	18	16	Same as above
	17	16	
8 – 10	10	6	Saturated, water table at +/– 9'
	5	5	
15 – 17	6	6	Light brown to light orange, SAND & GRAVEL
	4	6	
20 – 22	2	2	Light brown to light orange, GRAVEL
			END OF BORING = 22 FT

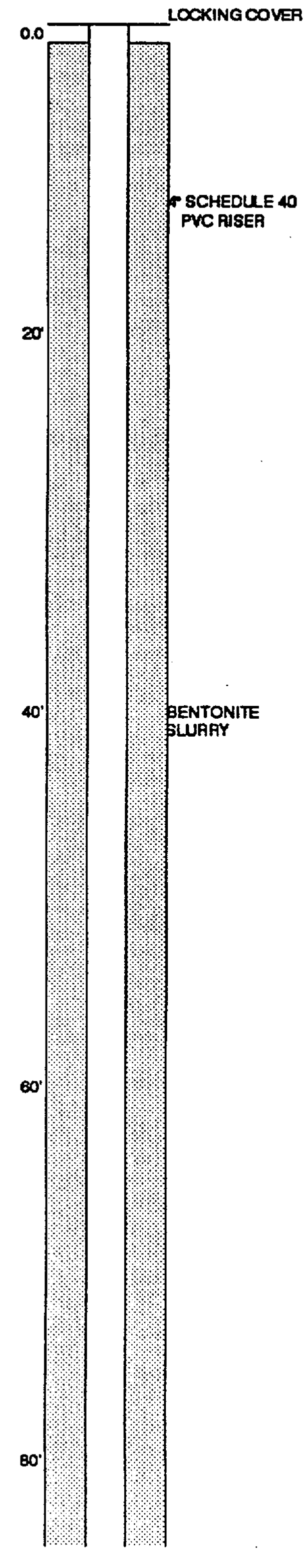
WELL CONSTRUCTION



BORING NO.:	SC-26D	CONTRACTOR:	UNI-TECH DRILLING	DATE STARTED:	7/09/92
PROJECT NO.:	7650-N51	DRILLERS:	FRECK, VISALLI	DATE COMPLETED:	7/08/92
PROJECT:	SHIELDALLOY	TRC INSPECTOR:	SMITH	STATIC WATER LEVEL:	88.40 FT
CLIENT:	SMC	DRILLING METHOD:	MUD ROTARY	NJDEP PERMIT NUMBER:	31-39512
LOCATION:	NEWFIELD, NJ	GROUND ELEVATION:	100.68 FT		
BORING DEPTH:	143 FT	CASING ELEVATION:	100.45 FT		

DEPTH (FT)	BLOWS		SOIL DESCRIPTION
0 – 2			
5 – 7	10 20	14 20	Brown, fine-medium SAND, trace silt, no odor, dry, 1.5' recovery
10 – 12	10 16	15 15	Same as above, 0.67' recovery
15 – 17	7 7	8 8	Same as above, 1' recovery
20 – 22	8 17	10 16	Brown, medium SAND, some fine sand, little silt, wet, no odor, 0.67' recovery
25 – 27	10 16	12 22	Same as above, 1' recovery
30 – 32	20 28	20 24	Brown, fine-medium SAND, little silt, no odor, wet, 1.2' recovery
35 – 37	37 41	38 51	Light, reddish-brown, fine-medium SAND, little silt, no odor, wet 1' recovery
40 – 42	48	54/6"	Same as above, 1' recovery
45 – 47	45	50/5"	Same as above, 0.5' recovery
50 – 52	20 42	28 30	Light brown, fine-medium SAND, little silt, no odor, wet, 1.2' recovery
55 – 57	20 50/4	39	Same as above, 1' recovery
60 – 62	30	50/5"	Same as above, 0.5' recovery
65 – 67	40	50/2"	Reddish-brown, same as above, 0.5' recovery
70 – 72	34 45	38 43	Same as above, 1.8' recovery
75 – 77	46	50/4"	Light brown, fine-medium SAND, little silt, no odor, wet, 0.67' recovery
80 – 82	38	50/5"	Same as above, 0.67' recovery
85 – 87	50/3		Same as above, 0.25' recovery

WELL CONSTRUCTION



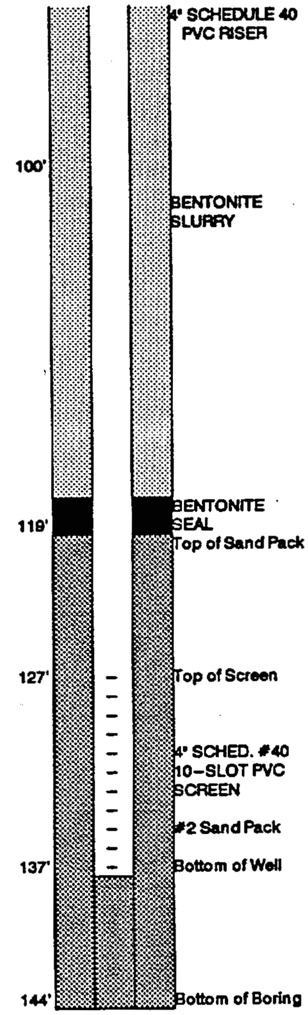
CONTINUED ON NEXT PAGE

BORING NO.: SC-26D
PROJECT NO.: 7650-N51

DEPTH (FT)	BLOWS		SOIL DESCRIPTION
95 – 97	42	50/3"	Brown, fine SAND and SILT, little medium sand, no odor, wet, 0.67' recovery
105–107	50/3		Same as above, 0.5' recovery
115–117	49	50/2"	Same as above, 1' recovery
120–122	25	50/3"	Light brown, reddish brown, fine–medium SAND, little silt, no odor, 1' recovery
125–127	48	50/4"	Light brown, fine–medium SAND, little silt, no odor, wet, 0.5' recovery
135–137	9 20	23 37	Same as above, 1' recovery
			Start of Clay Layer
145–147	9 1	9 47	Dark gray CLAY, little silt, dry, no odor, 2' recovery

END OF BORING = 144'

WELL CONSTRUCTION



APPENDIX E

FEASIBILITY ANALYSIS AND SUPPORTING INFORMATION

INORGANIC TREATMENT TO MEET PROPOSED DISCHARGE TO SURFACE WATER PERMIT CONDITIONS

APPENDIX E-1

FEASIBILITY ANALYSIS

APPENDIX E-1

FEASIBILITY ANALYSIS

INTRODUCTION

The objective of this appendix is to preliminarily evaluate the feasibility of removing chromium from the effluent of the electrochemical treatment system such that draft surface water discharge permit conditions for chromium removal can be achieved using commercially available technology and equipment.

Presently wastewater is treated in an electrochemical treatment system (described in Section 5.3.11) which effectively removes chromium from an influent concentration of approximately 10 to 30 parts per million (ppm) down to approximately 30 parts per billion (ppb) in the effluent. However, the proposed discharge to surface water permit conditions establish a daily allowable maximum level of 5.8 ppb total chromium and 166 ppm total dissolved solids (among other requirements). Following a brief discussion of the electrochemical treatment system as it exists at the SMC facility, treatment options for further reduction of chromium are presented and evaluated.

EXISTING CONDITIONS

Chromium contaminated ground water is treated at Shieldalloy's Newfield, New Jersey facility in an existing, permitted (Treatment Works Approval No. 88-1176-4-N), electrochemical wastewater treatment facility. Discharge from the treatment facility currently is to the Hudson Branch tributary to the Maurice River. The heavy metal treatment system is comprised of a number of unit operations including electrochemical precipitation, clarification, and filtering of sludge and treated effluent.

Influent ground water is directed to a 12,000 gallon influent tank (T-301). Effluent from tank T-301 is routed to a series of proprietary electrochemical precipitation cells. A series of five cells, each capable of processing a variable flow rate up to 130 gpm, produce ferrous ions [(Fe^{+2}) in the form of $Fe(OH)_2$] when a direct current is applied across iron sheet electrodes. The purpose of producing the ferrous ions is to reduce hexavalent chromium (Cr^{+6}) to the less toxic and more readily precipitated trivalent chromium (Cr^{+3}). A reaction illustrating the reduction of sodium chromate (Cr^{+6}) to chromium hydroxide (Cr^{+3}) is provided below:

$$NA_2CR_2O_7 + 6Fe(OH)_2 + 7H_2O \text{ -----> } 2CR(OH)_3 + 6Fe(OH)_3 + 2NaOH$$

The trivalent chromium-rich water is then routed to an 8,200-gallon fiberglass reinforced plastic (FRP) degassing tank (T-401), which allows removal of residual hydrogen gas produced as a byproduct of the reactions within the electrochemical cells. After the degassing tank, the water is routed to a 7,900-gallon pH adjustment/retention tank (T-601) equipped with a mixer. Adjustment of pH is accomplished in the retention tank by the addition of caustic to raise the pH to between 8.0 and 8.5. At this pH, ferrous ions will adsorb and coprecipitate the dissolved trivalent chromium [as chromium hydroxide $Cr(OH)_2$]. Hydrogen peroxide is also added at this point to facilitate oxidation of residual ferrous (Fe^{+2}) ions to the less soluble ferric (Fe^{+3}) ions, which subsequently precipitate as ferric hydroxide [$Fe(OH)_3$].

Water from the pH adjustment tank is discharged to a clarifier. A 3 to 10 part per million (ppm) solution of a high molecular weight anionic polymer is added to promote flocculation at this point. Sludge is removed from the cone of the clarifier and pumped to a plate-and-frame-style filter press. Sludge produced within the existing system has been tested and determined to be a non-hazardous waste.

Effluent from the clarifier is routed to a multi-media filtration system consisting of three parallel tanks, each approximately 880 gallons in volume and containing a mixture of anthracite, garnet, filter sand, and support media. This filtration system provides removal of particles down to 10 microns in size. From this point the effluent is routed to the existing on-site air stripper for treatment of volatile organics and then pumped to Outfall 001.

Effluent from the Andco system (approximately 400 gpm) is maintained at a pH of between 8.0 and 8.5, with a total chromium content of less than 0.030 mg/l. Typical operating data are provided in Table E-1. Typical operating parameters are also included in Appendix E-5 with the presentation of 24-hour test data.

POTENTIAL CHROMIUM TREATMENT TECHNIQUES

To determine treatment techniques which were potentially applicable to the polishing of the electrochemical treatment system effluent, the inorganic treatment technology and process option screening previously presented in Tables 3-6 and 3-7 of the FFS was reviewed. Supplemental information, such as that presented in Figure E-1, was also reviewed. Based on this review, three inorganic treatment technologies, as well as potential upgrading of the electrochemical treatment system, were selected as being worthy of further consideration as inorganic polishing technologies which may be effective in the reduction of total chromium from approximately 30 to 50 ppb down to 5.8 ppb. These treatment options include:

- Ion Exchange;
- Reverse Osmosis; and
- Ultrafiltration.

An evaluation of these treatment options as well as an evaluation of the upgrading of the electrochemical system are presented below.

Ion-Exchange Systems

The addition of an ion-exchange unit process may provide a means of polishing the electrochemical treatment system effluent to achieve the proposed chromium effluent limit. Ion exchange is a reversible chemical reaction between a solid resin and a fluid where undesirable cations (positively charged particles) or anions (negatively charged particles) are replaced with, or bound to, more desirable ionic groups contained within the resin. Following the exchange process the resin must be regenerated to achieve its original properties or replaced. The goal of the treatment process is to replace, or bind, undesirable chromium cations (primarily Cr^{+3}) such that the final effluent contains less than 5.8 ppb total chromium.

Ion-exchange resin suppliers which were contacted as part of this analysis indicate that two general approaches may be taken to reduce the total chromium content within an effluent stream. The first approach relies on a non-specific cation resin to remove chromium. Suppliers indicate that removal of chromium to a level of below 5.8 ppb may be achievable, but factors such as chromium speciation, pH, contact time, competing ionic species present within the wastestream and other factors would need to be evaluated through a bench- or pilot-scale test to verify its effectiveness. This will also remove other cations which may be present within the effluent stream, and may therefore provide removal of total dissolved solids (TDS) from the effluent. Available data suggest the presence of up to several hundred ppm TDS in the effluent.

The second approach would be to contact the effluent with a targeted ionic resin which would only remove chromium or other heavy metals. While information is limited, several ion-exchange resin vendors note that chelation resins are commercially available and may allow the targeted removal of chromium and other heavy metals from effluent. Chelation resins are designed to selectively remove particular groups of metals from a solution by binding the metallic ions to nonmetallic groups within the structure of the resin.

Treatability testing was conducted in April 1990 to evaluate the potential treatment of ground water initially using electrochemical treatment followed by ion exchange. The study was conducted by Andco ground water samples from the SMC facility. The ground water samples were treated using electrochemical treatment, multi-media filtration and ion exchange. Following thirty minutes of equilibration time, various stage effluent samples were collected. Tests were also run at electrochemical iron (Fe^{2+}) addition levels of 75 ppm, 150 ppm and 350 ppm. The initial untreated ground water sample contained 20.5 ppm chromium and 1,100 ppm TDS. At 150 and 350 ppm Fe^{2+}, post-multi-media filter chromium concentrations were less than 15 ppb and TDS ranged from 570 to 830 ppm. Reductions in both chromium (to less than 4 ppb) and TDS concentrations (to 270 to 350 ppm) were noted after treatment with the cation exchange resin. TDS continued to decrease (to 25 to 41 ppm) following treatment by the anion exchange resin; however chromium levels increased slightly (9 to 11 ppb). Additional samples were collected following treatment in the anion exchange resin after approximately 15 minutes to help understand how the test set-up performed over time. These samples both exhibited less than 4 ppb chrome with TDS ranging from 28 to 160 ppm. Therefore, existing treatability study testing indicates that achievement of chromium and TDS proposed surface water discharge limitations may be achievable using ion exchange as a polishing technology. Additional testing would be required to determine if a cation resin alone would provide sufficient treatment of TDS and chromium such that the existing system could be operated as a fixed-bed system with only cation resins used for removal. The treatability study report is included in Appendix E-2.

To implement ion exchange at the SMC facility, the existing system could potentially be retrofitted to provide secondary treatment, although the applicability of the existing equipment would be dependent on the selected resin and associated vendor. At a minimum, new ion exchange resin would have to be purchased and the existing system would have to be tied in to the electrochemical treatment unit. Available information indicates that the approximate cost for ion-exchange resins alone may be on the order of $80,000. Total capital costs are estimated to be around $150,000. The costs associated with operation and maintenance of the ion exchange system include the costs associated with brine disposal, and are estimated at approximately $500,000 annually, although they will be dependent on the frequency of resin regeneration.

The main advantage of using an ion-exchange resin to perform chrome polishing is the presence of existing ion-exchange equipment at SMC. Other advantages include the possibility of specifically targeting the removal of chromium, and the potential removal of TDS. A disadvantage associated with ion exchange is the production, handling and disposal of acidic waste streams produced by the resin regeneration process which are expected to require disposal as a hazardous waste. Also, the TDS may cause early fauling of the resins.

Given the number of different ion exchange resins that are available and the influence other influent parameters may have on the operation of the resin (e.g., TDS), further evaluation of specific resins is recommended prior to selection and/or initiation of bench/pilot scale testing programs. Vendor supplied ion-exchange literature is provided in Appendix E-2.

Reverse Osmosis Systems

Existing information suggests that addition of a reverse osmosis system to the effluent stream may achieve the required chromium reduction in the effluent. Osmosis is the spontaneous flow of solvent (e.g., water) from a dilute solution through a semi-permeable membrane (impurities or solute permeates at a much slower rate) to a more concentrated solution. A certain amount of potential energy exists between the solutions on either side of the membrane. Flow will occur from the solution with the higher potential energy level (the purer water, referred to as the dilute solution) to the solution with the lower potential energy level (the less pure water, referred to as the concentrated solution). Reverse osmosis (RO) is the application of sufficient pressure to the concentrated solution to overcome the osmotic pressure and force the net flow of water through the membrane toward the dilute phase. This allows the concentration of solute (impurities, ions, small molecules) to be built up on one side of the membrane while relatively pure water is transported through the membrane. The driving force for separation is the applied pressure gradient. The solution passes across the membrane, and the pressure forces only a percentage of the solvent through the membrane, while some of the initial solution, enriched in solutes, remains to be carried away via the turbulent flow maintained at the surface of the membrane. It is not a mechanical filtration mechanism, although dissolved organics are rejected primarily by a screening mechanism where rejection is a function of pore size, molecule size and molecule geometry. Certain organics may be enriched in the permeate due to preferential passage through the membrane. Osmosis and reverse osmosis process are depicted graphically in Figure 5-11.

The membranes used in RO are assembled into modules containing sheets (spiral wound), tubes or hollow fibers. The modules can be connected in series, in parallel, or a combination of the two. The most common RO membrane materials used are cellulose acetate and other polymers such as polyamides and polyether-polysulphones.

Similar to the non-selective ion exchange systems, RO systems are non-selective and would result in the removal of all ions and dissolved species greater than a certain particle size and containing a certain ionic charge. Operating conditions which affect the ability of reverse osmosis to achieve separation include:

- ionic charge of the separating species,
- pressure differential,
- the apparent or differential, osmotic pressure between the solutions, and
- the area and characteristics of the membrane.

In addition the presence of colloidal and organic matter can clog the membrane surface, thus reducing the available surface area for permeate flow. Overall membrane performance is affected by feed constituent concentrations, operating pressure and temperature, flow rate and pH. In general, flux and rejection data are not affected by changes in pH, but extreme pH values can limit the life of the membrane. The presence of low molecular weight, dissolved organics can present operational difficulties and may require pretreatment. Pretreatment techniques such as activated carbon adsorption may be required to extend service life.

Advantages of a RO polishing system would be that potential removal of chromium and TDS. In addition, once the systems are fabricated and installed, operational costs tend to be generally low due to the limited energy requirements of the pumping equipment.

Disadvantages of reverse osmosis membranes (cellulous acetate, aromatic polyamides, and thin film composites) are high capital cost, potential fouling problems, poor resistance to chlorine, and susceptibility to microbial attack. Operational upsets, pH changes and other conditions may limit the lifetime of the membrane. Reverse osmosis also produces a concentrated waste stream which would contain the separated chromium and other ionic species, and would most likely require off-site disposal/treatment as a hazardous waste.

Rough estimates indicate that design and construction of a reverse osmosis system for a 400 gpm process effluent may cost on the order of $1,000,000. Operation and maintenance costs, estimated at approximately $300,000 annually, will include membrane replacement, waste disposal and electricity costs. Prior to implementation, preliminary bench scale testing of the process to assess its applicability to the electrochemical treatment system effluent would be required. Vendor-supplied RO literature is provided in Appendix E-2.

Microfiltration/Ultrafiltration Systems

Available data suggests that precipitation and microfiltration or ultrafiltration of aqueous solutions may remove total chromium within the effluent to a level below 5.8 ppb. In general, filtration removes particles down to about 1 micron, whereas microfiltration may remove solids down to about 0.01 microns in diameter and ultrafiltration may be effective for particles as small as 0.001 microns in diameter. The basic driving force behind microfiltration is pressure. Microfiltration discriminates on the basis of molecular size, and shape and is used to physically remove particles and ions from solutions. This is a physical process where all matter larger than a certain size is unable to pass through the filtration system. Therefore, larger particles or ions are retained on the influent side of the filtration system, while filtered fluid is able to pass through the membrane.

Microfiltration essentially relies on chemical pretreatment in which precipitation is followed by a series of filtration steps which results in the non-selective removal of particles. Ultrafiltration systems are typically operated at pressures ranging from 10 to 100 psig, resulting in flow rates that are several orders of magnitude below conventional filtration processes, but with the retention of much smaller sized particles (10 to 200 angstroms). Ultrafiltration membranes are generally not defined by their pore sizes, but by the size or equivalent molecular weight of the particles excluded. Ultrafiltration membranes are reported as retaining species in the 300 to 300,000 molecular weight range. Therefore, ultrafiltration is not sufficient by itself to remove dissolved ionic species such as metal ions. However, both ultrafiltration and microfiltration are capable of effectively collecting colloidal metal suspensions following precipitation of dissolved metal ions. Available background information indicates that removal of chromium to less than 10 ppb may be achievable with this technology.

As with reverse osmosis membranes, ultrafiltration membrane systems can consist of tubular, hollow fiber, plate-type or spiral-wound units. Turbulent flow at the membrane surface can carry rejected solids back to the beginning of the system or, in the case of a plate system, the system can be operated cyclically, with accumulated solids discharged with each operating cycle. The residual filter cake requires off-site disposal.

Advantages to microfiltration systems are the generally lower pressures required for filtration as compared to RO systems, the generally wider selection of materials of construction from which filter membranes are fabricated, and the non-selective nature of the process where other undesirable materials may be removed from the waste stream. Disadvantages include the necessity of preceding the microfiltration system with a chemical precipitation system (such as that already employed by the electrochemical system), the inability of the system to treat dissolved inorganics, and the high initial design and capital cost to fabricate such a system. Also, an ultrafiltration system may have difficulty treating the flow rate at the SMC facility and, therefore, multiple units may be required. The largest available unit offered by DuPont/Oberlin, whose microfiltration system has been evaluated as a SITE technology (USEPA, 1991), is a 36-square foot unit. While the amount of water the system is able to treat is dependent on the concentration of contaminants, amount of filter aid used and the size of the unit, a treatment rate of 300 gallons per 20-minute cycle was assumed for conducting the economic analysis of the SITE demonstration, compared to the approximate treatment rate of 400 gallons per minute at the SMC facility.

Available rough estimates indicate that the approximate cost to design and build an ultrafiltration system for a 400 gpm process stream would be on the order of $700,000 to $1,000,000, while annual operation and maintenance costs can average $100,000 to $500,000. In the SITE demonstration economic analysis (USEPA, 1991), a 36-square foot treatment unit was estimated to have associated capital costs of $1,251,200 and annual O&M costs of $549,100.

Existing Electrochemical Treatment System Modifications

This option would involve modifying the existing Andco electrochemical precipitation system to meet the 5.8 ppb discharge limit for total chromium. A review of existing process data indicates that modification of process stream conditions may result in the attainment of the proposed chromium effluent limit. Background process data which support this position include results of a March 1990 bench scale and a May 1993 full-scale 24-hour operational test. Each of these tests is described below.

A bench-scale test conducted by Andco in March 1990 resulted in an effluent chromium concentration of 1.9 ppb when an 18-fold stoichiometric excess (20 ppm chromium, 350 ppm ferrous ions) of ferrous ions was maintained in the treatment system. Other bench-scale process conditions which helped to achieve the low chromium concentration within the effluent included the addition of a polyelectrolyte to aid floc formation and clarification. Results of the March 1990 bench-scale testing are provided in Appendix E-5.

A 24-hour, full-scale treatment test was conducted using existing process equipment on May 22, 1993. Process conditions for this test included an influent ground water flow rate of 401 gallons per minute (gpm) from the five extraction wells. This flow was increased by the addition of recycle streams to a total process flow rate of approximately 450 gpm. The influent chromium concentration was 10 ppm. Treatment was conducted at a five-fold excess of ferrous ions to chromium ions at a pH ranging from 7.6 to 7.9. Hourly samples of treated effluent were analyzed by SMC's internal laboratory, by a laboratory (E&E) contracted by Andco, the treatment system manufacturer, and an independent "referee" laboratory (National Environmental Testing, Inc.). Results of this analysis are summarized in Table E-2. Chromium was not detected in the samples analyzed by E&E and NET (each lab had a detection limit of 10 ug/l or ppb). Analyses conducted by SMC's laboratory exhibited total chromium levels ranging from non-detectable (less than 1.0 ppb) to 15.1 ppb. Process conditions and analytical results of the 24-hour pilot test are provided in Appendix E-5.

While variations in operational parameters (pump operation, cycle periods, etc.) have been used to optimize system operation, the reliability of operating the electrochemical system to consistently achieve a level of chromium in the effluent which is less than 5.8 ppb has not been demonstrated. When contacted regarding potential improvements to the system to lower chromium effluent levels on a consistent basis, the manufacturer indicated that achievement of treatment levels in the single part per billion range is not a normal operating requirement. While modification of the system can likely attain the desired effluent level (5.8 ppb total chromium) on a consistent basis, operating data (other than SMC's 24-hour test) are not available to verify removal rates below about 10 ppb. The basic reason for this data gap is that most chromium treatment processes are not required to treat to levels below about 50 ppb. Also, based on chromium's practical quantitation limit (PQL) of 10 ppb, standard water analyses run for other operating systems are typically not sensitive enough to detect such a level of treatment. The existing system is not expected to comply with proposed TDS surface water discharge permit conditions under normal operating procedures.

Advantages to utilizing the existing electrochemical precipitation system to attain the proposed chromium discharge to surface water permit conditions include; the presence of the process equipment on-site and on-line; the familiarity of SMC personnel with the existing equipment; the relatively low capital costs associated with any required modification of the existing system; and the documented performance of the system to achieve the proposed chromium limit under test conditions.

The major disadvantage is the anticipated increased consumption of iron electrodes necessary to achieve conditions suitable for removal of chromium to below 5.8 ppb. Increased electrode consumption would increase sludge generation. A series of preliminary calculations indicate that at present typical operating conditions (9 ppm hexavalent chromium, 45 ppm ferrous ion concentration, 450 gpm flow) a total of approximately 80 cubic feet of metal hydroxide sludge (30% weight percent solids) could be produced per day. If process conditions were modified to achieve a 15- to 20-fold stoichiometric excess of ferrous to chromium ion concentration, sludge generation would increase approximately three- to four-fold. Other factors which would change as a result of process stream modifications would be the increased consumption of the sacrificial iron electrodes, the increased need for hydrogen peroxide to oxidize residual ferrous ions, and increased power consumption required to produce the necessary ferrous ion concentration. Additional filtration capacity could also be required. Capital costs for system modification are estimated at approximately $100,000 for filtration improvements and annual operation and maintenance costs are estimated to be approximately $140,000, based on increased operating costs and additional sludge disposal.

In summary, modifications of the existing electrochemical treatment system would appear to be relatively easy to implement, and capital cost-effective in achieving the proposed chromium discharge to surface water permit condition. However, the long-term reliability of the system to consistently achieve this level is unknown at this time and the inability of the treatment system to achieve proposed TDS discharge to surface water permit conditions is a disadvantage.

PRELIMINARY SYSTEM EVALUATION

This section summarizes the results of a brief evaluation of each of the four identified treatment technologies on the basis of the following criteria:

- Effectiveness,
- Implementability, and
- Cost.

A summary of the comparative analysis is provided in Table E-3.

Effectiveness

Available background information indicates that each of the four treatment technologies may be effective in reducing the total chromium content of the effluent stream to below 5.8 ppb, depending on the type of separation process used and its associated applicability to the physical state of the chromium in the electrochemical system effluent. However, in general, treatability data for these additional systems which demonstrate chromium removal rates below 10 ppb are typically not available.

Of the four treatment technologies outlined above only modification of the Andco system and addition of a chelation ion exchange resin have the capability to selectively remove heavy metals such as chromium from the effluent. The Andco system is not expected to provide adequate removal of TDS to meet the proposed surface water discharge permit conditions. The effectiveness of the ion exchange system in providing primary treatment of the ground water was limited based on the presence of colloidal particles in the wastestream; the potential for fouling of the resins as a result of post-treating the electrochemical treatment system effluent is currently undefined. Preliminary treatability study testing indicates the system may be able to meet both chromium and TDS effluent conditions. The Andco system produces a non-hazardous waste while the ion exchange waste is expected to be hazardous.

The other two technologies, reverse osmosis and microfiltration/ ultrafiltration are non-specific in their removal capabilities. The microfiltration/ultrafiltration technology would not be effective in removing dissolved species. The reverse osmosis waste is expected to be hazardous while the microfiltration waste will require characterization to determine if it is hazardous.

Implementability

Implementability refers to the technical and administrative feasibility of implementing a remedy. Given the presence of the Andco treatment system at the site, and the available process equipment for ion-exchange present at the SMC facility, these two options are clearly more readily implemented than reverse osmosis and microfiltration systems. Initial treatability study testing of the Andco and ion exchange treatment systems has been completed. Design and pilot scale development of the reverse osmosis and microfiltration systems would likely take a longer time period as compared to modification of the Andco system or evaluation of alternate resin systems.

Cost

As noted within the descriptions of each of the four treatment technologies, capital and especially operations and maintenance costs may be quite variable for each system. However, the capital cost required for design and construction of either a microfiltration or reverse osmosis system is far greater than that required to either modify the existing electrochemical precipitation process or add an ion exchange unit process to the existing system. Therefore, selection of either the existing system modification or addition of an ion exchange system would be most cost-effective in the short-term. Long-term operational costs are more difficult to define based on existing data.

CONCLUSIONS

Based on the preliminary information presented above, it appears technically possible to achieve a total chromium content in the electrochemical treatment system effluent of less than 5.8 ppb using one of several technologies. The following two technologies offer the best combination of effectiveness, implementability and cost:

- Modification of the existing Andco Electrochemical Treatment Unit, and
- Ion Exchange.

Additional study through bech-scale or, in the case of electrochemical treatment, possible full-scale tests is recommended to further establish the best technology.

APPENDIX E - REFERENCES

Vendors:

Advanced Separations Technology, Lakeland, Florida.

Andco Environmental Processes, Inc., Amherst, New York.

Bio-Recovery Systems, Inc., 2001 Copper Avenue, Las Cruces, New Mexico

Osmonics, 5951 Clearwater Drive, Minnetonka, Minnesota.

Oberlin Filter Company, 404 Pilot Court, Waukesha, Wisconsin.

The Purolite Company, 150 Monument Road, Bala Cynwnyd, Pennsylvania.

Weston Analytics Division, 208 Welsh Pool Road, Lionville, Pennsylvania.

Other Sources of Information:

Applegate, L.E., 1984. "Membrane Separation Processes", Chemical Engineering, June 11, 1984.

Freeman, Harry M., Editor, 1989. Standard Handbook of Hazardous Waste Treatment and Disposal. McGraw-Hill Book Company, 1989.

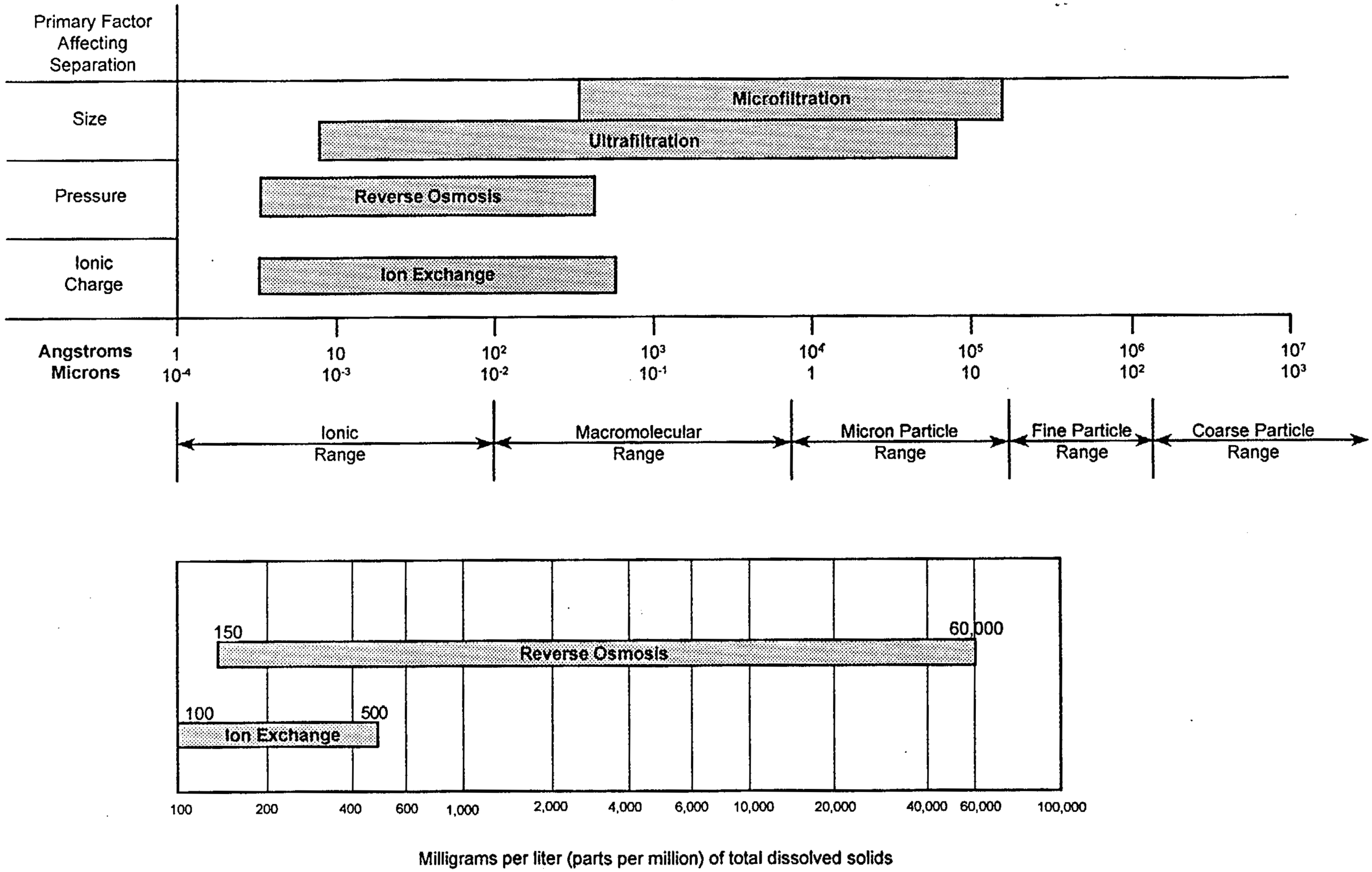
Palmer, S.A.K., et. al., 1988. Metal/Cyanide Containing Wastes; Treatment Technologies. Pollution Technology Review No. 158, Noyes Data Corporation.

Parekh, B.S., 1991. "Get Your Process Water to Come Clean", Chemical Engineering, January 1991.

USEPA, 1985. Handbook: Remedial Action at Waste Disposal Sites (Revised). EPA/625/6-85/006, October 1985.

USEPA, 1991. E.I. DuPont De Nemours & Company/Oberlin Filter Company Microfiltration Technology. EPA/540/A5-90/007; October 1991.

USEPA, 1992. The Superfund Innovative Technology Evaluation Program: Technology Profiles; Fifth Edition. EPA/540/R-92/077; November 1992.



SOURCE: METAL/CYANIDE CONTAINING WASTES; PALMER, ET AL, 1988

TRC
TRC Environmental Corporation
5 Waterside Crossing
Windsor, CT 06095
(203) 289-8631

SHIELDALLOY METALLURGICAL CORPORATION
NEWFIELD, NEW JERSEY

FIGURE E-1.

SEPARATION PROCESS COMPARISONS

TABLE E-1

TYPICAL OPERATING DATA
MAY 1993
ELECTROCHEMICAL TREATMENT SYSTEM
SHIELDALLOY METALLURGICAL CORPORATION

DATE	AVERAGE HOURLY FLOW	AVERAGE FLOW PER 24 HOURS
May 1, 1993	410	377
May 2, 1993	411	394
May 3, 1993	393	377
May 4, 1993	384	352
May 5, 1993	412	412
May 6, 1993	387	129
May 7, 1993	Off	Off
May 8, 1993	370	31
May 9, 1993	398	381
May 10, 1993	385	385
May 11, 1993	355	296
May 12, 1993	359	299
May 13, 1993	395	280
May 14, 1993	421	385
May 15, 1993	396	396
May 16, 1993	316	316
May 17, 1993	398	282
May 18, 1993	413	379
May 19, 1993	400	400
May 20, 1993	398	365
May 21, 1993	401	368
May 22, 1993	401	401
May 23, 1993	394	394
May 24, 1993	404	337
May 25, 1993	389	389
May 26, 1993	408	408
May 27, 1993	406	406
May 28, 1993	409	409
May 29, 1993	400	368
May 30, 1993	414	414
May 31, 1993	413	413
31-DAY HOURLY AVERAGE:	382 gpm	
31-DAY 24-HOUR AVERAGE:	352 gpm	

Note: *The average hourly flow represents the average flow over the hours the system is operating (i.e., does not consider downtime due to high tank alarms, etc.)*
The average 24-hour flow is the average flow over the 24-hour period, including downtime.

TABLE E-2
24-Hour Pilot Test Analytical Data
Total Chromium in Effluent

Sample ID	Time	Laboratory SMC (1)	Laboratory Andco (2)	Laboratory NET (3)
		Results – ug/l (ppb) Total Chromium		
5-21-93-4B	15:00	<1.0	<10	--
5-21-93-5B	16:00	3.4	<10	--
5-21-93-6B	17:00	<1.0	<10	--
5-21-93-7B	18:00	1.1	<10	<10
5-21-93-8B	19:00	<1.0	<10	--
5-21-93-9B	20:00	3.2	<10	--
5-21-93-10B	21:00	1.5	<10	--
5-21-93-11B	22:00	<1.0	<10	<10
5-21-93-12B	23:00	<1.0	<10	--
5-21-93-13B	23:59	<1.0	<10	--
5-22-93-3B	01:00	<1.0	<10	--
5-22-93-4B	02:00	3.8	<10	<10
5-22-93-5B	03:00	1.9	<10	--
5-22-93-6B	04:00	4.7	B	--
5-22-93-7B	05:00	<1.0	B	--
5-22-93-8B	06:00	3.1	<10	<10
5-22-93-9B	07:00	2.2	B	--
5-22-93-10B	08:00	<1.0	<10	--
5-22-93-11B	09:00	<1.0	<10	--
5-22-93-12B	10:00	1.3	<10	<10
5-22-93-13B	11:00	2.4	<10	--
5-22-93-14B	12:00	1.1	<10	--
5-22-93-15B	13:00	15.1	<10	--
5-22-93-16B	14:00	3.3	<10	<10
5-22-93-17B	15:00	1.7	<10	--

Notes:

1. Analyzed by SMC's Laboratory.
2. Analyzed by Andco's laboratory – Ecology and Environment.
3. Analyzed by National Environmental Testing, Inc. of Thorofare, N.J.
4. < Indicates that chromium was not reported above the detection limit.
5. -- Indicates not analyzed.
6. Sample broken prior to analysis.

TABLE E–3
COMPARISON AMONG SUPPLEMENTAL TREATMENT TECHNOLOGIES IN ACHIEVING COMPLIANCE WITH PROPOSED DISCHARGE TO SURFACE WATER PERMIT CONDITIONS
SHIELDALLOY METALLURGICAL CORPORATION

TECHNOLOGY	EFFECTIVENESS	IMPLEMENTABILITY	COST
Ion Exchange	Expected to attain both chromium and TDS proposed discharge to surface water permit conditions; initial treatability study testing supports this expectation; a resin may be identified which specifically targets chromium removal	Requires replacement of resin in existing ion exchange unit and tie–in of existing unit to electrochemical treatment system	Capital Costs: $150,000 Annual Operation and Maintenance: $500,000 Present Worth: $2,800,000
Reverse Osmosis	May attain chromium and TDS proposed discharge to surface water permit conditions; would require treatability study testing to verify treatability; not chemical–specific in terms of contaminant removal	Requires construction of new treatment system; requires determination of appropriate membrane type and system configuration for treatment of electrochemical effluent	Capital Costs: $1,000,000 Annual Operation and Maintenance: $300,000 Present Worth: $2,800,000
Microfiltration/Ultrafiltration	May attain chromium proposed discharge to surface water permit conditions; is not expected to attain proposed TDS permit conditions; would require treatability study testing to verify treatability; not chemical–specific in terms of contaminant removal	Requires contruction of new treatment system	Capital Costs: $700,000 to $1,000,000 Annual Operation and Maintenance: $100,000 to $500,000 Present Worth: $1,400,000 to $3,800,000
Electrochemical Treatment System Modification	Expected to attain chromium proposed discharge to surface water permit conditions; is not expected to attain proposed TDS permit conditions; treatability and operational studies confirm proposed chromium discharge conditions may be achievable; technology is specifically targeted to chromium removal	Requires modification of operation of existing treatment system; may require additional filtration capacity	Capital Costs: $100,000 Annual Operation and Maintenance: $140,000 Present Worth: $840,000

Note: Present Worth cost estimate includes operation over five years and 20% contingency

APPENDIX E-2

ION-EXCHANGE LITERATURE

April 1990 - Electrochemical/Multi-Media Filtration/ Ion Exchange Treatability Test Data

Results of the April 25, 1990 and April 27, 1990 Treatability Testing

Performed for:

Shieldalloy Metallurgical Corporation

Procedure:

1 - To a three-gallon sample, add ferrous iron by electrochemical generation.

2 - Using sulfuric acid, adjust pH to 8.0-8.5.

3 - Add 5 ppm (2 ppm active) Andco 3640 anionic polyelectrolyte and allow to settle.

4 - Decant solution to another container and add 2 ppm hydrogen peroxide.

5 - Next, begin pumping the sample through the Multi-Media Filtration/Ion Exchange System.

6 - Following thirty minutes of equilibration time, various stage effluents were collected.

7 - After approximately fifteen minutes, another final effluent sample was collected to help understand how the set-up performs over time.

Table 1

Description	pH	Chrome (T) mg/l	Fe mg/l	TDS mg/l
Untreated S-4-27-0	9.51	20.5	0.348	1100

Table 2.

Treatment Test #1

Fe^{+2} added (EC) = 75 ppm

Description	pH	Chrome (T) mg/l	Fe mg/l	TDS mg/l
Post Solids Sep S-4-27-1B	7.91	0.832	--	1000
Post Multi-Media S-4-27-1C	7.86	0.035	0.500	1000
Post (+)[1] Resin S-4-27-1D	1.97	0.012	--	68
Post (-)[2] Resin S-4-27-1E	10.45	< 0.004	--	50
Post (-)[2] Resin Plus 10-15 minutes S-4-27-1F	10.76	0.006	--	94

1 : (+) = Cation Exchange

2 : (-) = Anion Exchange

Table 3.

Treatment Test #2

Fe^{+2} added (EC) = 150 ppm

Description	pH	Chrome (T) mg/l	Fe mg/l	TDS mg/l
Post Solids Sep. S-4-27-2B	7.85	0.324	--	830
Post Multi-Media S-4-27-2C	7.77	<0.015	0.261	830
Post (+)[1] Resin S-4-27-2D	2.05	<0.004	--	350
Post (-)[2] Resin S-4-27-2E	9.45	0.009	--	25
Post (-)[2] Resin Plus 10-15 mins. S-4-27-2F	9.88	<0.004	--	160

1 : (+) = Cation Exchange

2 : (-) = Anion Exchange

Table 4.

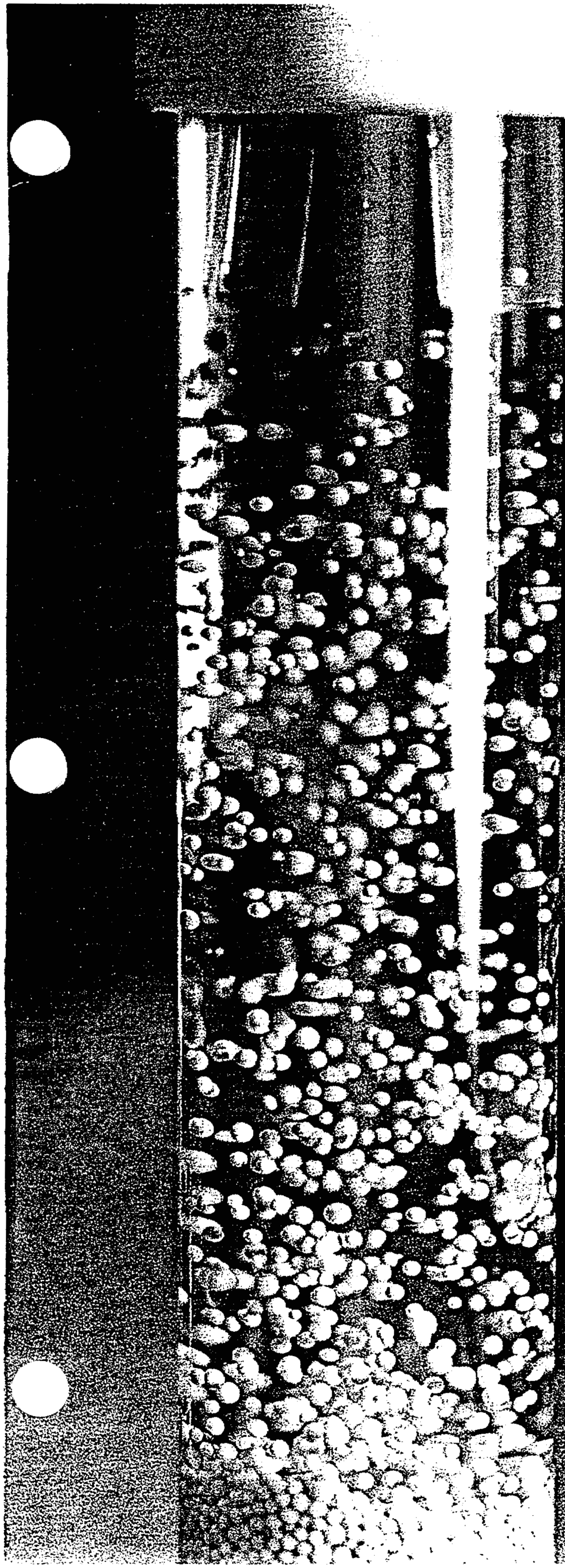
Treatment Test #3

Fe^{+2} added (EC) = 350 ppm

Description	pH	Chrome (T) mg/l	Fe mg/l	TDS mg/l
Post Solids Sep. S-4-27-3B	7.66	0.155	–	670
Post Multi-Media S-4-27-3C	7.57	<0.015	0.150	570
Post (+)[1] Resin S-4-27-3D	2.14	<0.004	–	270
Post (-)[2] Resin S-4-27-3E	10.24	0.011	–	41
Post (-)[2] Resin Plus 10-15 mins. S-4-27-3F	10.28	<0.004	–	28

1 : (+) = Cation Exchange

2 : (-) = Anion Exchange



Ten Reasons Why Bio-Recovery's Modular Point Source System™ is the Right Solution for Treatment of Heavy Metal Waste Streams.

It's called a "Point Source System" because its size allows it to be placed at the point where it's needed, removing heavy metals in solution through ion exchange – efficiently, economically and with greater flexibility than any other system.

BRS

BIO-RECOVERY SYSTEMS, INC.

Ten reasons why Point S

1. Compliance. Compliance with low metal effluent limits is possible day after day. Bio-Recovery's Point Source System™ is proven technology.

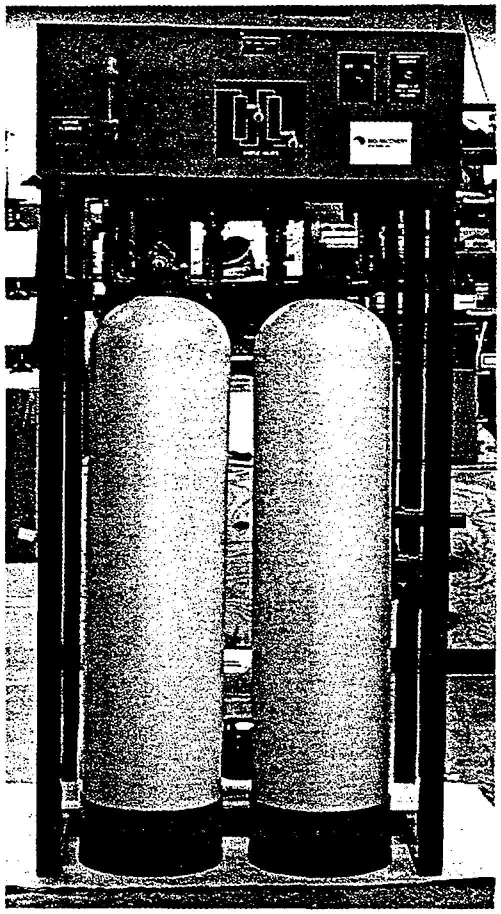
2. Ion exchange is less expensive. The price/performance value of ion exchange technology is superior to other technologies used to achieve low effluent limits.

In today's environmentally-aware world, where "toxic information" makes big headlines, Bio-Recovery is leading the way with safe, cost-effective solutions to your waste treatment needs.

3. Corporate liability can be reduced or eliminated. Conventional waste treatment systems frequently generate large quantities of toxic mixed metal sludge. Disposal of this sludge in a landfill exposes the generator to perpetual liability. Bio-Recovery's Point Source System™ reduces or eliminates sludge.

4. Metals can be recovered in a reusable concentrated form. Ion exchange can pull out heavy metals such as copper, nickel, chromium, cadmium, zinc, tin, lead, gold and silver in a concentrated form that can be reused or sold to other manufacturers. While conventional ion exchange systems can recover these metals, Bio-Recovery's selective ion exchange technology can recover these metals in a purer form and with higher efficiency.

5. Small and flexible Point Source Modules can work with your current centralized system or can stand on their own to handle your waste treatment needs. When you add a new manufacturing process it may upset the

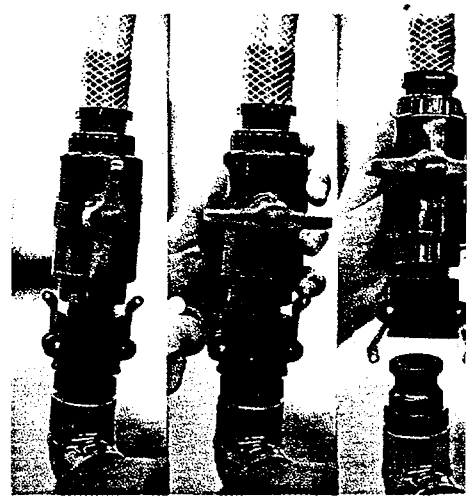


Bio-Recovery's PSR/PST™ Point Source Modules for removal of ionic impurities and heavy metals from solution.

chemistry of your centralized waste processing system. Or maybe your processing volume increases and you have a higher waste stream flow than your system can handle. The Bio-Recovery Point Source System™ is designed to supplement your current waste treatment system right at the source where the waste stream is generated.

If you don't have a waste treatment system, or if you need to replace your current waste treatment system with efficient, reliable state-of-the-art technology, our Point Source System™ is a cost-effective solution.

6. Quick-connect/disconnect system can speed and simplify operation. Changing canisters on other systems can be clumsy, time consuming and prone to spills of tox solutions. Our quick-connect/disconnect system saves you time and trouble.



Quick-connect/disconnect system.

7. Ion exchange columns can be easily regenerated for reuse. As the stream of contaminated liquid flows through the column, re beads pull the ions out of the solution. Wh the resin column is saturated, it is easily regenerated by treating the resin to release the contaminants so the column can be reused.

8. Long life and low maintenance are built in. You don't have to be a PhD to understand, operate and maintain our system. It's designed to work and keep working.

9. Large-system experience has been applied. Bio-Recovery has established itself as the technology leader by installin fully automatic, integrated wastewater treatment systems for the segregated treatment of industrial wastewaters.

urce is the right solution.

troduction of the Point Source System™ marks the application of our proven technology to the special needs of customers for point source treatment in:

- Heavy metal removal
- Water recycle
- Bath purification
- Pilot scale testing

10. A complete modular system allows a customized solution at off-the-shelf pricing. Each customer has different needs. That's why our Point Source System™ is designed to allow each customer to buy only the modules that are needed to solve his particular problem.

The modules are:

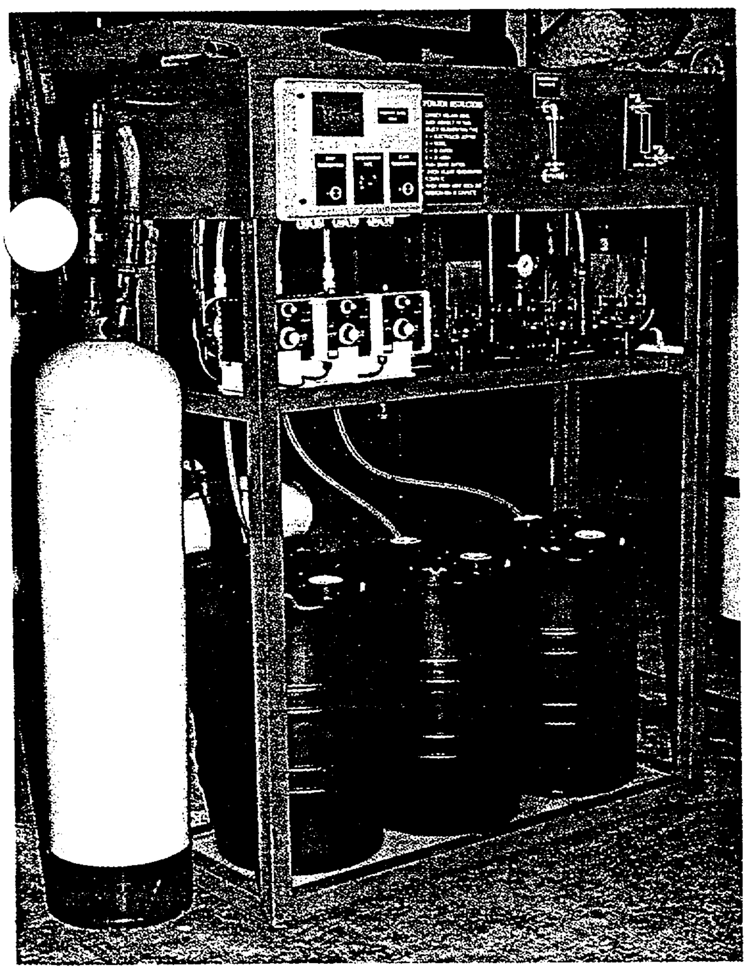
Point Source Recovery Module (PSR)™: This module removes essentially all ionic impurities to produce deionized water. Available for 2.5- and 5-gpm flow rates.

Point Source Treatment Module (PST)™: This module removes toxic heavy metals from wastewater, leaving non-hazardous ionic impurities, allowing treated water to be discharged or reused. Available for 2.5- and 5-gpm flow rates.

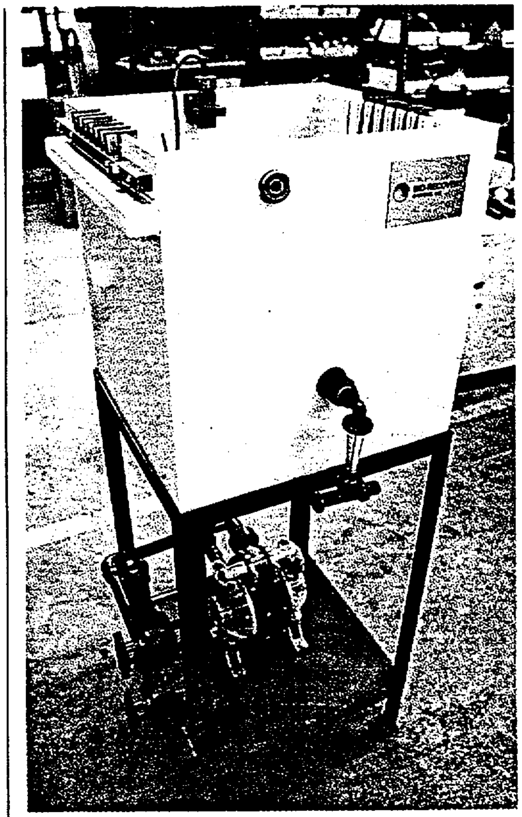
Regeneration Control Module (RC)™: This module automates the regeneration of the ion exchange columns, allowing their reuse. It contains the regeneration controller, plumbing, chemical storage tanks and pumps for regeneration of the PSR™ and PST™ columns.

Regeneration Tank Module (RT)™: This module consists of tanks used to hold the solutions generated by the RC™ module during regeneration.

Electrowinning Module (EW)™: This module converts the concentrated metal solution generated by the RC™ module into a nonhazardous metal form.



Bio-Recovery's Regeneration Control Module™ for automated regeneration of ion exchange columns.



Bio Recovery's Electrowinning Module™ converts concentrated metal solution into a nonhazardous metal form.

> ***"The BRS Point Source System has reduced our toxic sludge output by 65 percent. They've done a lot of good for such a small investment."***
>
> — *David Unger*
> *Environmental Engineering Manager*
> *Alternate Circuit Technology*
> *Ward Hill, Massachusetts*

Cover photo: Chromium ions being stripped from an ion exchange resin as part of a Bio-Recovery Feasibility Assessment Test.

Our business is to remove heavy metals from aqueous solutions.

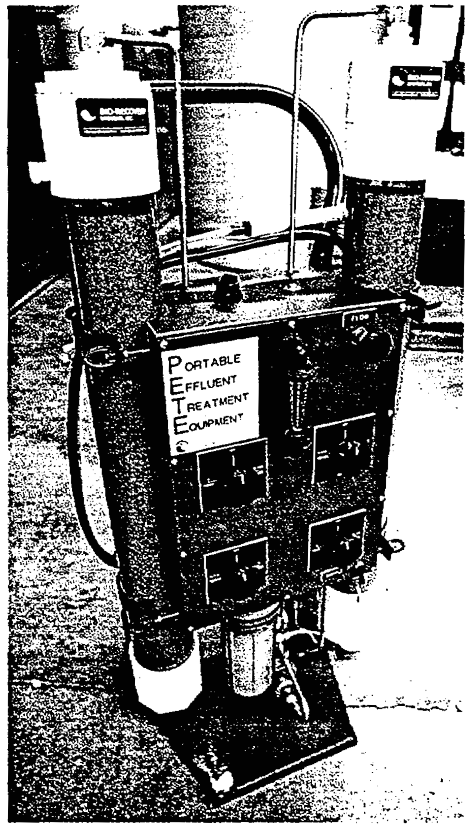
BRS

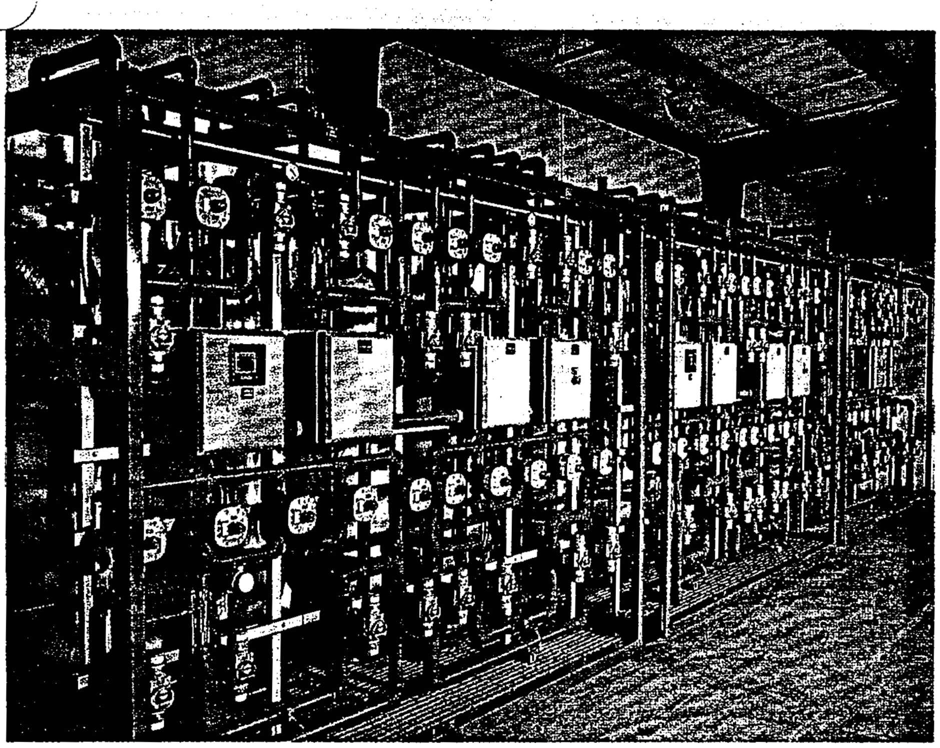
BIO-RECOVERY SYSTEMS, INC

2001 Copper Avenue
Las Cruces, NM 88005
(505) 523-0405
Fax (505) 523-1638

The Bio-Recovery Edge.

It takes more than state-of-the-art equipment to make a successful wastewater treatment system. It takes dedicated professionals with experience, know-how and research capabilities who are committed to your success. Bio-Recovery maintains this cutting edge in research and development at its corporate headquarters in New Mexico. A fully integrated laboratory and a complete fabrication facility guarantee the high quality and success you've come to expect from Bio-Recovery. From our flexible modular designs to our full-size centralized systems, Bio-Recovery is the right choice for your wastewater treatment needs.





Bio-Recovery can meet your needs for systems, including:

- Ion Exchange
- Deionized Water
- Reverse Osmosis
- Ultrafiltration

We solve your problems with:

- Discharge Compliance
- Water Reuse
- Bath Purification
- Incoming Water Treatment

PHOTOS FROM UPPER LEFT: Bio-Recovery chemist evaluates treatment performance during Feasibility Assessment Test. UPPER RIGHT: Portable Effluent Treatment Equipment (PETE)™ allows portable operation and small-scale pilot testing. LEFT: Fully automatic integrated wastewater treatment systems provide cost-effective environmental compliance.

BRS

BIO RECOVERY SYSTEMS, INC

2001 Copper Avenue
Las Cruces, NM 88005
(505) 523-0405
Fax (505) 523-1638

REMOVAL OF CHROMIUM FROM GROUNDWATERS TO DRINKING WATER STANDARDS

Provided by Bio-Recovery
Systems, Inc.

FEASIBILITY ASSESSMENT TESTING

I. OBJECTIVES

Client groundwaters are contaminated with chromium, the majority of which is hexavalent. Contaminated groundwaters must be pumped and treated so that the discharge meets drinking water limits for chromium. Maximum allowable levels of chromium are 50 parts per billion.

II. WATER CHARACTERISTICS

Contaminated groundwaters were found to have the following characteristic

Chemical	Concentration (ppm)
Total Dissolved Solids	207
Total Organic Carbon	24
Sulfate	37
Magnesium	9
Calcium	42
Total Alkalinity	99
pH	7.8
Chromium	0.35

III. CHROMIUM REMOVAL AND RECOVERY

Several different resins were initially tested for efficiency of chromium removal without pH adjustment of the waters. These tests are done by filling a small column with resin to a certain volume (termed a resin bed volume.) Then groundwaters are pumped through the resin at a specified flow rate and effluents from the column are collected. The effluent volume is measured and converted into resin bed volumes. For example, if the resin bed volume is 5 mL and 100 bed volumes of water were passed through the resin, this would translate into 500 mL of water which was treated. In this example, if all metal was bound to the resin during the passage of 100 bed volumes, then the metal would have been concentrated by a factor of 100. By the same token if in this example the resin bed volume had been 100 gallons, and 100 bed volumes were treated, this would correspond to treatment of 10,000 gallons of water. Thus the number of bed volumes of water which can be treated before effluents exceed discharge limits allows proper sizing of the treatment system for a specified flow rate.

One specific adsorbent showed excellent chromium removal from groundwaters adjusted to pH 4. The groundwater at pH 4.0 was loaded at a flow rate of 20 bed volumes per hour into a column (0.7 cm I.D.) containing a 5 mL bed volume of resin. Four bed volume fractions of effluent were collected and analyzed for chromium. Table 1 shows results of these analyses.

TABLE 1

Chromium Loading.
Influent chromium concentration was 0.35 ppm.

Effluent Bed Volume	Chromium Concentration in Effluent (ppm)
272	0.0026
528	0.0051
752	0.0052
880	0.0046
1008	0.0045
1136	0.0036
1200	0.0045

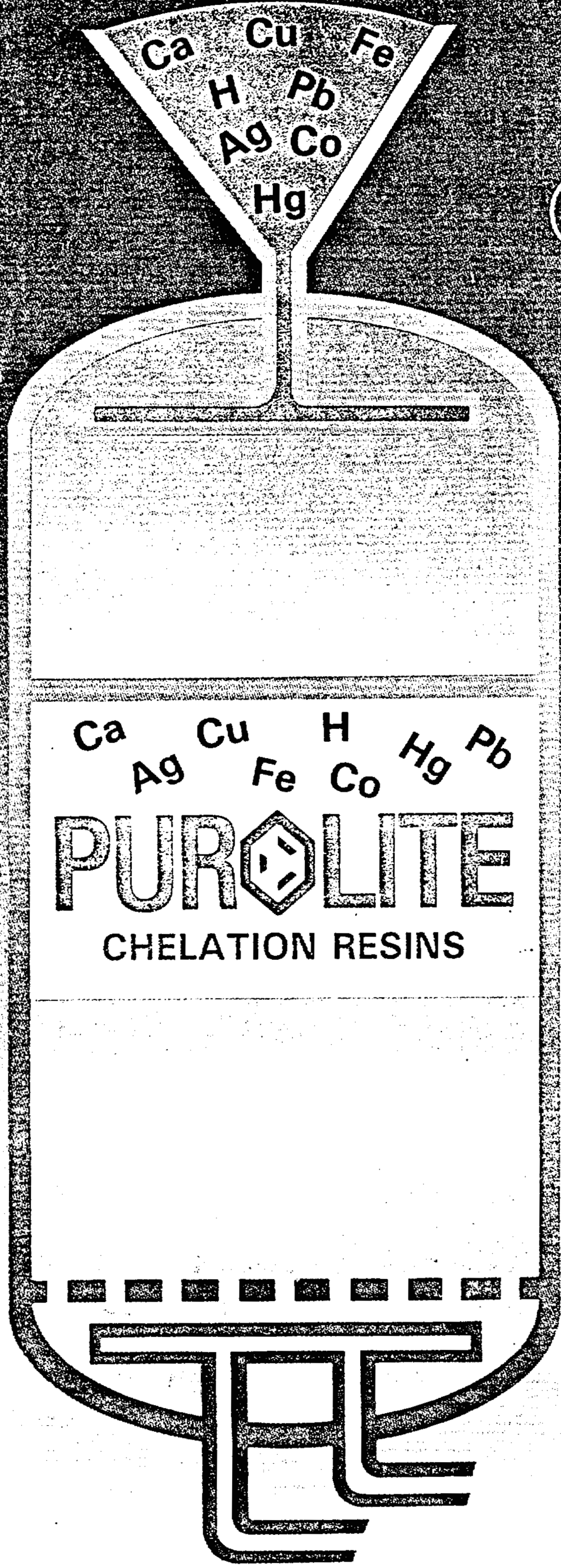
After the passage of 1200 bed volumes of the chromium-containing waters through the column, effluents were still below 5 parts per billion in chromium. At this point, flow through the column was stopped, and the column was stripped of chromium by the passage of 10 bed volumes of 2 M sodium hydroxide followed by 3 bed volumes of distilled water. Analysis of effluents showed that over 87 percent of the bound chromium was recovered in the first 4 bed volumes of the stripping solution. Total chromium recovery from all effluents was 96.9 percent.

The same column was again loaded with 1200 bed volumes of the chromium-containing waters as described above. Effluents from the column were consistently below 5 ppb. After passage of 1200 bed volumes the column was stripped again with similar results to those described above. The entire loading-stripping procedure was repeated yet a third time with similar results as those described above.

IV. CONCLUSIONS

It is clear that chromium can be removed from the contaminated groundwaters using ion-exchange resins so that treated waters contain chromium in the low part per billion level.

The column experiments were stopped in these experiments after the passage of 1200 bed volumes of waters through the columns. Based upon our past experience we predict that approximately 5000 to 6000 bed volumes of waters can be treated before the level of chromium in the effluents exceeds 50 ppb.



CHELATION SYSTEMS

PUROLITE
ION EXCHANGE RESINS

PUROLITE®
ION EXCHANGE RESINS

Chelation Systems

Technical Data

Section 1. INTRODUCTION

The removal of metals from process liquors is rapidly gaining in importance. The escalating costs of disposal of waste solutions, in order that they comply with increasingly tough regulation, have to be taken into account. Such costs have to be considered in conjunction with possible savings to be made from recovery.

Purolite offers a range of chelation resins which will selectively remove particular groups of metals from solution. After preliminary recovery by precipitation, on the one hand, or where plated metal objects have been given final rinses, on the other hand, these metals are usually present in waste solutions in concentrations of several parts per million. Such concentrations although low are found to be environmentally harmful in many cases.

The use of **Purolite Chelation Resins** for the purification of these waste aqueous streams to render them suitable for disposal through the domestic sewerage system, or direct disposal into suitable aquifers, affords a most suitable and economical means of treatment, which yields treated solutions containing almost undetectable (ppb) concentrations of the undesirable metals. The many-fold increase in concentration of the metals on the chelation resin makes possible the recovery of the metal for reprocessing or effective disposal in a less harmful form.

Modern industrial chemical processes often use sophisticated techniques which provide a more economical route to high quality products. One such process uses membrane cells for the electrolysis of brine to produce caustic soda and chlorine. The membrane cells require that the inlet brine contains less than 20ppb of calcium for efficient operation. **Purolite S-940** provides an ideal route to reduce calcium concentration in brine feed solutions from 1—15ppm, as found in conventionally purified solutions, to well within the required specification, for the smooth operation of this process.

As analytical techniques continue to improve, the study of the effect of trace levels of impurities on the economics of industrial processes is increasingly well understood. The very high selectivity of chelation resins means that these ion exchange resins will offer many further possibilities to remove harmful contaminants to provide solutions of the required purity.

Section II.

Resin Type	Functional Group	Matrix	Principal Applications
Purolite			
S-920	Thiouronium	Macroporous styrene-divinyl-benzene	Mercury and precious metals removal from aqueous solutions
S-930	Iminodiacetic	Macroporous styrene-divinyl-benzene	Effluent treatment, hydrometallurgy (Specific for heavy metals)
S-940	Aminophosphonic	Macroporous styrene-divinyl-benzene	Brine purification (Removal of calcium etc)
S-950	Aminophosphonic	Macroporous styrene-divinyl-benzene	Effluent treatment Hydrometallurgy

Contents

PUROLITE®
ION EXCHANGE RESINS

S-920
Macroporous Thiouronium Chelating Resin

(For the selective removal of mercury and precious metals from aqueous solutions)

Technical Data

Section III. **PRODUCT DESCRIPTION**

Purolite S-920 is a macroporous polystyrenic based chelating resin, with thiouronium groups designed for the selective removal of mercury and for the recovery of precious metals from the industrial effluents. The mercury, in particular, is strongly bound to the functional groups to form highly stable complexes, with high selective affinity compared with those of other heavy metals. These properties are largely unaffected by high chloride (or sulphate) content of the effluent. Effluent solutions which may typically contain 2—20ppm of mercury can be treated to reduce the concentration in solution to less than 0.005ppm. **Purolite S-920** can load up to 150g of mercury, or gold, or 60g approx. of platinum or palladium for each litre of resin, equivalent to 9.4, and 3.75 lb/ft^3 respectively. **Purolite S-920** is designed for the removal of low concentrations of soluble mercury salts from waste streams and for the recovery of precious metals from rinse waters in the galvanic and electronic industries. **Purolite S-920** is also used in hydrometallurgy for the separation of precious metals from acid liquors. Mercury and precious metals are so strongly held, and run lengths are so long (thousands of hours) that it is not normally considered economic to regenerate the resin for reuse, hence the resin is burnt to recover the loaded metals.

Purolite S-920 is more resistant to oxidation than many thiol based resins and contact with the atmosphere is not detrimental, however free chlorine and other strong oxidising agents may damage the resin and their removal from solution by filtering through activated carbon is recommended.

Typical Chemical & Physical Characteristics

Polymer Matrix Structure	Macroporous Styrene-divinylbenzene
Physical form & Appearance	Opaque Cream Spheres
Whole Bead Count	>95%
Functional Groups	Thiouronium
Ionic Form (as shipped)	H^+
Shipping Weight	740g/l (46 lb/ft^3)
Screen Size Range (British Standard Screen)	14-52 mesh, wet
Particle Size range	+1.2mm <5%, −0.3mm <1%
Moisture Retention, H^+ Form	48-54%
Reversible Swelling, ($H^+ \rightarrow Hg^{++}$)	< 5%
Specific Gravity, Moist H^+ Form	1.12
Specific Gravity, Moist Hg^{++} Form	1.40
Total Exchange Capacity, H^+ Form (wet, volumetric)	150g Hg/l
Max, Operating Temperature, H^+Form	80°C (176°F)
Operating *p*H Range	1—13

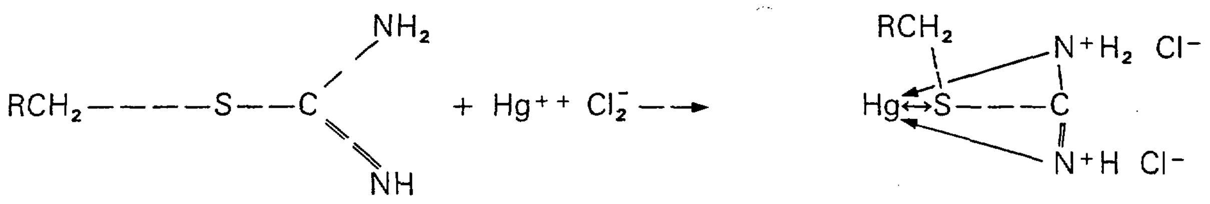
STANDARD OPERATING CONDITIONS

It is recommended that **Purolite S-920** is used in a two column, lead and trail system. In this way, maximum loading of the resin is achieved. When use is for mercury uptake, it is usual to pretreat the solution with lime neutralisation and to fully oxidise the metals and sulphites with H_2O_2. This is followed by flocculation with an inorganic polyelectrolite, sedimentation, sand and activated carbon filtration.

Recommended linear flow rate:	6-18 m/h
Minimum bed depth:	1000mm
Backwash flow rate:	4-8 m/h (see fig. 2), for 20 min.

PRINCIPLE OF REACTION

Mercury Removal



The mercury is strongly complexed by the sulphur and nitrogen groups. When the resin is well rinsed with water before use, the mercury salt as a whole is accommodated on the resin. In most instances the *p*H of the water to be treated will lie in the range of 3—10, which is generally very suitable for highest mercury uptake. *p*H may be reduced slightly by the mercury exchange (release of acid held by the weakly basic thiouronium groups).

In general **Purolite S-920** will complex precious metals when they are present as free cations. The free cation state is governed by the *p*H of the solution.

HYDRAULIC CHARACTERISTICS

The pressure drop (or headloss) across a properly classified bed of ion-exchange resin depends on the particle size distribution, bed depth, and voids volume of the exchange material, and on the flowrate and viscosity (and hence on the temperature) of the influent solution. Anything affecting any of these parameters, for example the presence of a particulate matter filtered out by the bed, abnormal compaction of the resin bed, or the incomplete classification of the bed will have an adverse effect, and result in an increased headloss.

Service flow rates from 10—30 bed volumes per hour, depending on the application, may be regarded as the normal range used on this resin. Typical pressure drop figures to be expected for ordinary aqueous solutions, are given in Fig. 1.

Fig. 1. PRESSURE DROP VS FLOW RATE

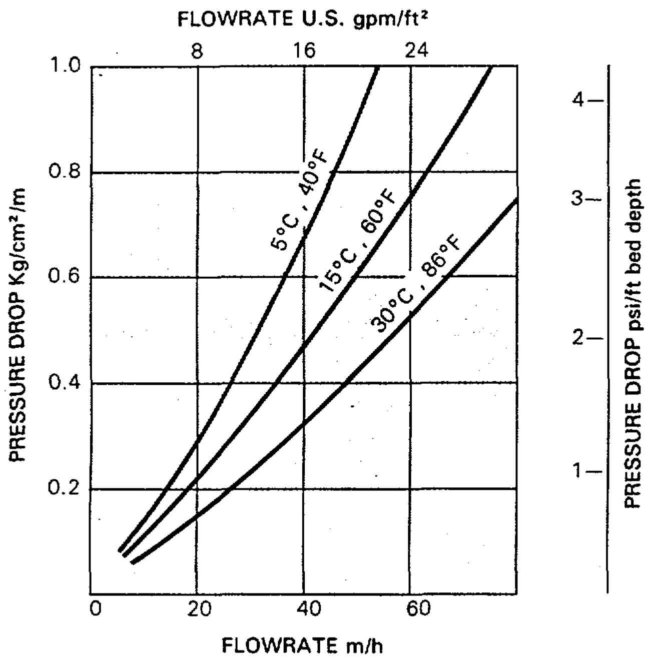
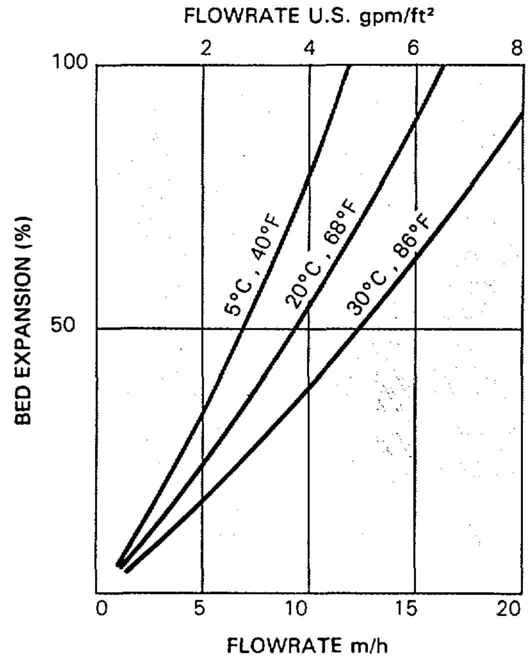


Fig. 2. BACKWASH EXPANSION (New resin)



During upflow backwash, the resin bed should be expanded in volume by between 50 and 75%, to clear the bed of bubbles and voids, and to classify the resin particles as much as possible, ensuring minimum resistance to flow. Bed expansion increases with flow rate and decreases with temperature, as shown in Fig. 2. This applies to unused resin. Since the resin is not regenerated, backwash at exhaustion is not required. Care should always be taken to avoid resin loss by over-expansion of the bed.

CONVERSION OF UNITS

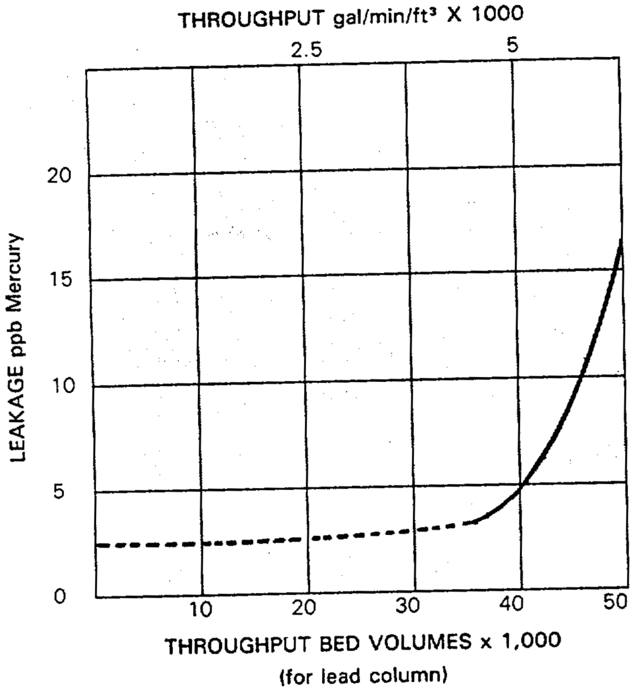
1 m/h (cubic metres per square metre per hour)	= 0.341	gpm./ft².
	= 0.409	U.S.gpm./ft².
1 Kg/cm²/m (Kilograms per square cm. per metre of bed)	= 4.33	psi/ft.
	= 1.03	atm./m.
	= 10	ft. H_2O/ft.

OPERATING PERFORMANCE

The operating capacity will be higher on the first cycle since both lead and trail columns will use new resin. This cycle will be complete when the lead column is saturated (that is when influent and effluent have reached equilibrium). The substantial leakage which occurs from the lead column towards the end of the cycle is of course taken out by the trail column. This uses capacity depending upon the conditions of operation. In subsequent runs the throughput obtained from the lead column will be reduced according to load previously taken up while the bed was in the trail position.

The Fig. 3. gives a typical exhaustion profile from the outlet of the trail column in terms of bed volumes throughput for the lead column. In a typical operation as shown the lead column is loaded with a total of 90g/l of mercury of which 70-85g/l may be loaded while the bed is in the lead position.

Fig. 3. OPERATING PROFILE: Typical from trail column



Inlet Mercury — 2ppm to Lead Column

Temperature	20°C
*p*H	8.0
Flow Rate	8BV/h

PUROLITE®
ION EXCHANGE RESINS

S-930
Macroporous Iminodiacetic Chelating Resin

(For the selective removal of heavy metals from aqueous solutions)

Technical Data

Section IV.

PRODUCT DESCRIPTION

Purolite S-930 is a macroporous polystyrenic based chelating resin, with iminodiacetic groups designed for the removal of cations of heavy metals from industrial effluents. These cations may be separated from high concentrations of univalent cations (typically sodium) and also from common divalent cations (such as calcium). Removal can be achieved both from weakly acidic and weakly basic solutions.

Purolite S-930 finds use in processes for extraction and recovery of metals from ores, galvanic plating solutions, pickling baths, and effluents even in the presence of alkaline earth metals (calcium and magnesium). Further important uses include the refining of the salt solutions of transition and precious metals and for the cleaning and purification of various organic or inorganic chemical products by removal of heavy metals contamination (usually from aqueous solution).

Typical Chemical & Physical Characteristics

Polymer Matrix Structure	Macroporous Styrene-divinylbenzene
Physical Form & Appearance	Opaque Beige Spheres
Whole Bead Count	>90%
Functional Groups	Iminodiacetic
Ionic Form (as shipped)	Na^+
Shipping Weight	750g/l (47lb./ft³)
Screen Size Range (British Standard Screen)	14-52 mesh, wet
Particle Size range	+1.2mm <2%, −0.3mm <1%
Moisture Retention, Na^+ Form	45-50%
Reversible Swelling, ($H^+ \rightarrow Na^+$)	< 25%
Specific Gravity, Moist Na^+ Form	1.17
Total Exchange Capacity, H^+ Form (wet, volumetric)	2.4 eq./l., min.
H^+ Form	77g of Cu^{++}/l., min.
Na^+ Form	1.9 eq./l., min.
Na^+ Form	62g of Cu^{++}/l., min.
Max, Operating Temperature, H^+Form	70°C (158°F)
*p*H Range (operating) H^+ Form	2—6
Na^+ Form	6—11

STANDARD OPERATING CONDITIONS

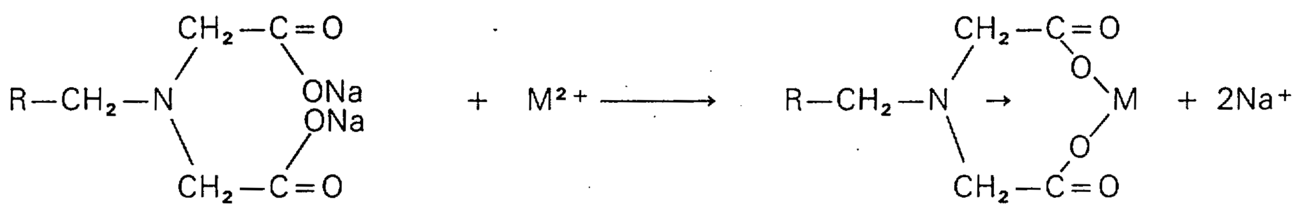
Purolite S-930 :—These operating conditions are given as a general example. However regeneration conditions and flow rates should be chosen for the particular application. For further recommendations please contact your local sales office.

Operation	**Rate**	**Solution**	**Minutes**	**Amount**
Service	8 — 16BV/h 1—2gpm/ft^3	For treatment		
Backwash	5—7m/h 2—3gpm/ft^2	Raw Water	5—20	1.5—6BV 10—35 gal/ft^3
Regeneration	3—4BV/h 0.4—0.5gpm/ft^3	Mineral Acids (2—3N)	30—60	140—200g/l HCl or 12.5—20lb/ft^3 200—320g/l H_2SO_4 8.5—12.5 lb/ft^3
Slow rinse	3—4BV/h 0.4—0.5gpm/ft^3	Raw Water	30—40	2—3BV 15—25gal/ft^3
Conversion to sodium form as required:—				
	3—4BV/h 0.4—0.5gpm/ft^3	N – 2N NaOH	40—60	120—160g/l 7.5—10lb/ft^3
Rinse	3—4BV/h 0.4—0.5gpm/ft^3	Soft or Demin Water	20—40	2—4BV 15—30gal/ft^3

Backwash expansion 75% (optimum)
Design rising space 100%
Minimum bed depth 1000mm
"gallons" refer to U.S. gallons = 3.785 Litres.

PRINCIPLE OF REACTION

The iminodiacetic functional groups, in either the sodium or the hydrogen form, will chelate heavy metals by ion attraction to the dicarboxylic functionality and electron donation from the nitrogen:



APPLICATIONS

Purolite S-930 is particularly suitable for the removal of heavy metals (as weakly acidic chelated complexes) which are held according to the following order of selectivity.
Cu>Ni>Zn>Co>Cd>Fe(II)>Mn>Ca
The macroporous resin structure ensures

excellent diffusion of ions thus affording efficient exhaustion and regeneration.
Recovery of heavy metals from effluents from the plating industry is achieved by concentration and is particularly useful where full demineralisation and recycling of the rinse water is not practised. The simplest case is where only one heavy metal is present, when volumes of rinse water are low, waste water fees may be low, and raw water has a low salt content.

Purolite S-930 can be used to reduce residual toxic heavy metals to below the maximum admissible concentration levels which are often far below those obtainable after precipitation reactions. It may also be used to remove similar residuals from demineralised rinse water circuits.

Purolite S-930 is also used to separate and concentrate heavy metals in hydrometallurgical processes (ore dressing and scrap recovery). It is particularly suitable where metals are present in low concentrations. Separation techniques may be carried out according to the order of selectivity given above. However changes in the sequence occur with change in *p*H and in the presence of certain anions (including higher concentrations of chloride and sulphate). The sequence given above is applicable for neutral and weakly acidic solutions.

OPERATING PERFORMANCE

The information below may be taken as a general guide. However, before any plant design is contemplated, the user should ascertain the exact operating performance under the proposed conditions of use, by way of column testing of the feed solution to be treated.
The operating capacity is a function of *p*H, and inlet concentration solution for each metal. Fig. 1 gives the exchange capacity obtainable when using the operating conditions given above, as a function of *p*H. This capacity is a function of ionic concentration, hence the multiplication factor given in fig. 2 should be applied.

Fig. 1. Exchange capacity for metals as a function of *p*H.

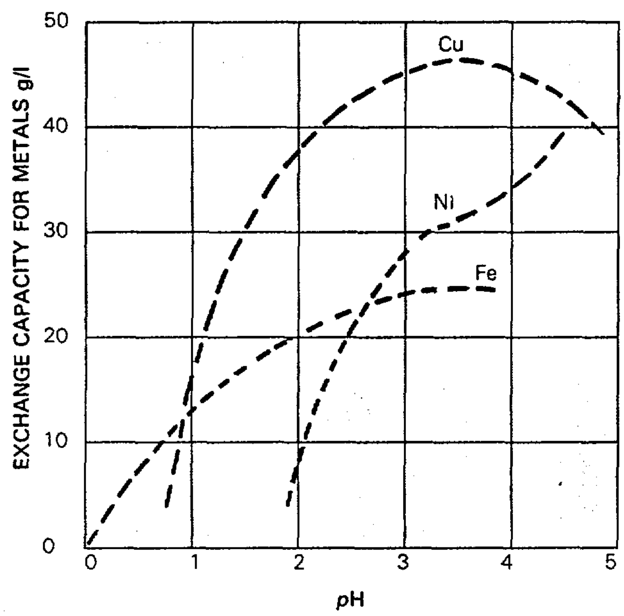
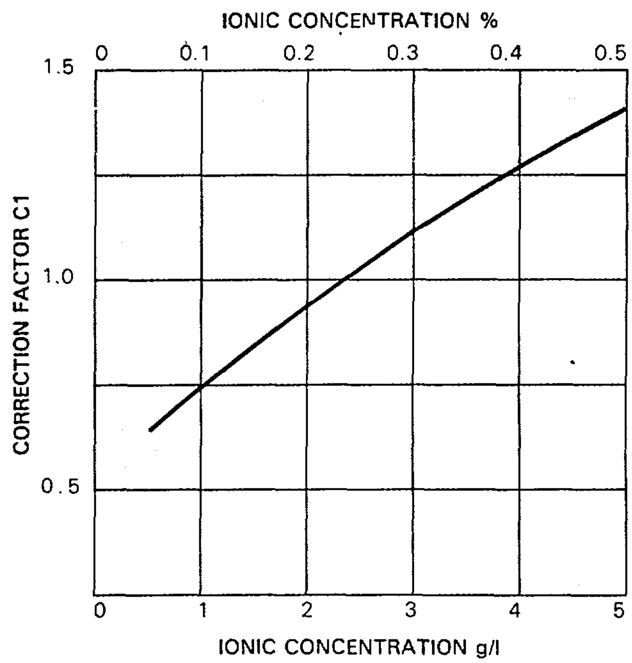


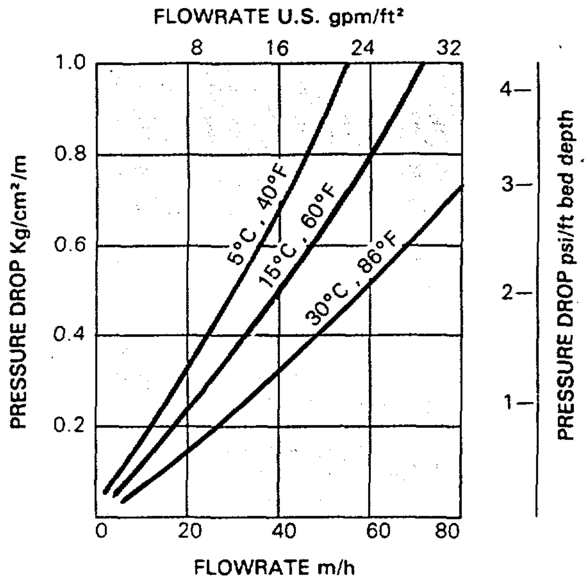
Fig. 2. Correction factor for ionic concentration



HYDRAULIC CHARACTERISTICS (General Applications)

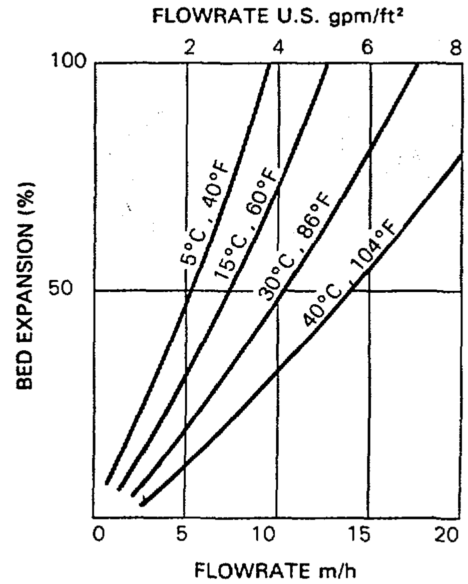
The pressure drop (or headloss) across a properly classified bed of ion-exchange resin depends on the particle size distribution, bed depth, and voids volume of the exchange material, and on the flow rate and viscosity (and hence on the temperature) of the influent solution. Anything affecting any of these parameters, for example the presence of particulate matter filtered out by the bed, abnormal compaction of the resin bed, or the incomplete classification of the bed will have an adverse effect, and result in an increased headloss. Service flow rates from 8—16 bed volumes per hour, 1—2gpm/ft³, depending on the application, may be regarded as the normal range used on this resin.

Fig. 3 PRESSURE DROP VS. FLOWRATE



Typical pressure drop figures to be expected for ordinary aqueous solutions, are given in fig. 3., below. This is applicable to the freshly regenerated H^+ Form. As the resin is converted to the metal form the pressure drop will decrease slightly.

Fig. 4 BACKWASH EXPANSION (Exhausted Form)



During upflow backwash, the resin bed should be expanded in volume by between 50 and 75%, in order to free it from any particulate matter from the influent solution, to clear the bed of bubbles and voids, and to reclassify the resin particles as much as possible, ensuring minimum resistance to flow. Bed expansion increases with flow rate and decreases with temperature, as shown in fig. 4, for a typical exhausted form of the resin. Care should always be taken to avoid resin loss by over-expansion of the bed.

CONVERSION OF UNITS

1 m/h (cubic metres per square metre per hour)	= 0.341	gpm./ft.²
	= 0.409	U.S. gpm./ft.²
1 Kg/cm.²/m (kilograms per square cm. per metre of bed)	= 4.33	psi./ft.
	= 1.03	atm./m.
	= 10	ft.H_2O/ft.

PUROLITE®
ION EXCHANGE RESINS

S-940
Macroporous Aminophosphonic Chelating Resin
(Especially for decalcification of brine solutions)

Technical Data

Section V. **PRODUCT DESCRIPTION**

Purolite S-940 is a chelating resin of macroporous structure, with a polystyrene matrix crosslinked with divinylbenzene (DVB) substituted with weakly acidic aminophosphonic active groups. This chemical structure facilitates the formation of complexes with metallic ions. The aminophosphonic chelating resins have a greater affinity for certain cations, and form more stable complexes with cations of low atomic mass metals than their iminodiacetic resin counterparts. Hence **Purolite S-940** is capable of fixing one or more specific cations from a larger range even from solutions which are highly concentrated.

Typical Physical, Chemical & Operating Characteristics

Polymer Matrix Structure	Macroporous Styrene-divinylbenzene
Physical Form & Appearance	Opaque Beige Spheres
Whole Bead Count	>95%
Functional Groups	$-CH_2NHCH_2PO_3$
Ionic Form (as shipped)	Na^+
Shipping Weight	740 g/l, (46 lb./ft³)
Screen Size Range	
British Standard Screen	18-36 mesh
U.S. Standard Screen	20-40 mesh
Particle Size Range	+0.85 mm <2%, −0.425 mm<2%
Moisture Retention Na^+ Form	60-65%
Reversible Swelling ($H^+ \rightarrow Na^+$) Max	45%
($H^+ \rightarrow Ca^{++}$) Max	20%
Specific Gravity Na^+ form	1.11
Total Exchange Capacity, (Na^+ Form)	20 g Ca/l (1.24 lb./ft.³) min at pH 9,5
Max, Operating Temperature °C (°F)	90°C (195°F)
Solubility	Insoluble in water, acids and bases, common solvents

NOTE: **Purolite S-940** is susceptible to oxidation. Hence direct treatment of brine solutions containing free chlorine should be avoided, for instance by preliminary reaction with sulphur dioxide, sulphite or, by use of a treatment with activated carbon. Brine solution can often contain significant concentrations of chlorates. In this case it is necessary to ensure that the displacement rinse prior to the acid regeneration is efficient, so as to avoid the formation of free chlorine from contact of chlorates in the brine solution with the regenerant acid.

OPERATING CONDITIONS

(Brine Purification)

Operation	Rate	Solution	Minutes	Amount (Temp)
Service	8—30BV/h 1—4gpm/ft³	Brine	*	* (at 60—90°C)
Brine Displacement	4 BV/h 0.5gpm/ft³	Soft water	60—90	4—6BV (room temp, RT) 30—45 gals /ft³
Backwash	8—12m/h 3—5 gpm/ft²	Soft water	30	— (RT)
Regeneration	2—6BV/h 0.25—0.75gpm/ft³	HCl (Normal)	30—60	100—150g/l (RT) 6.25—9.5 lb/ft³
Rinse	2—4BV/h 0.25—0.5gpm/ft³	Soft water	30—60	2BV(RT) 15gal/ft³
Sodium Conversion	2—4BV/h 0.25—0.5 gpm/ft³	NaOH (Normal)	30—60	80—150g/l (RT) 5—9.5 lb/ft³
Rinse	2—4BV/h 0.25—0.5 gpm/ft³	Soft water	30—60	2BV (RT) 15 gal/ft³

* Exhaustion time and volume of treated brine depend upon the operating conditions (see Figures 1—4) "gallons" refer to US gallons =3.785 litres

Purolite S-940 may also be used in the hydrogen form for heavy metals removal. The above operating conditions may be adapted as follows. The regeneration is carried out using HCl, as above (or 2N H_2SO_4 may also be used at 200—300g/l; 12.5-19lb/ft³). The sodium conversion is not necessary. Operation flow rates of 8—16 BV/h (1—2 gpm/ft³) may be used, and displacement prior to backwash eliminated or modified.

PRINCIPLES OF OPERATION

The capacity of this resin is dependent upon *p*H; it is able to operate in neutral, acidic or alkaline media, however the relative affinities for metals vary as a function of *p*H and ionic concentration, hence it is recommended that laboratory trials (column tests) are carried out to prove the process. The list of relative affinities will help serve as guide in such trials.

— Acidic *p*H

$Pb^{2+} > Cu^{2+} > U^{4+}$, Zn^{2+} , $Al^{3+} > Mg^{2+} > Sr^{2+}$, Ca^{2+} , Na^{+} , Ba^{2+}

— Alkaline *p*H

Cd^{2+} , Mg^{2+} ,$> Ca^{2+} > Sr^{2+}$, $Al^{3+} > Ba^{2+} \gg Na^{+}$, K^{+}

In the particular case of brine purification by softening the feed solution of chloralkali electrolysis cells, the characteristic reactions are described as follows:—

— Service

$$2RCH_2NH\ CH_2PO_3\ Na_2 + Ca^{2+} \rightarrow (RCH_2NH\ CH_2PO_3\ )_2\ CaNa_2 + 2\ Na^{+}$$

— Regeneration to H^{+} form

$$(RCH_2NH\ CH_2PO_3)_2\ CaNa_2 + 4HCl \rightarrow 2RCH_2NH\ CH_2PO_3\ H_2 + CaCl_2 + 2NaCl$$

— Conversion to sodium form

$$RCH_2NH\ CH_2PO_3H_2 + 2Na\ OH \rightarrow RCH_2NH\ CH_2PO_3Na_2 + 2H_2O$$

PRINCIPAL APPLICATION

The various applications of **Purolite S-940** are too numerous to cover individually in detail. Brine softening is the major application. Chlorine gas and alkali metal hydroxides are produced by the electrolysis of brine solutions in chlor-alkali cells. The industrial process has used three main types of these cells - mercury, diaphragm, and membrane electrolytic cells. The membrane cells are the most economic and are supported by the most sophisticated technology in their operation. All types need periodic maintenance as a result of the impurities in the brine, especially Ca and Mg. Membrane cells require the highest purity brine which should contain less than 20ppb calcium.

In this way it is possible to operate at a steady lower voltage, thus saving energy and increasing production.

Purification of brine (removal of divalent and trivalent cations) to the exacting standards required is achieved by using **Purolite S-940** which will remove the majority of contaminant metals, even under very difficult conditions: saturated salt (more than 300g/l of NaCl), alkaline *p*H, elevated temperature.

OPERATING PERFORMANCE

The operating capacity expressed in g Ca^{2+} per litre increases with:

— *p*H, optimum >9 (see fig. 1)

— influent calcium concentration, (see correction factor in fig. 2)

— temperature of feed, which is best maintained at above 60°C (see fig. 3)

— Reduction in flow rate, (see fig. 4)

10—20BV/h is recommended, though rates up to 30BV/h are feasible.

The permanent leakage obtained in treating brine using **Purolite S-940** is generally very low: for example < 50ppb for strontium and < 20ppb for calcium and magnesium, see fig. 5 and 6.

Fig. 1 CAPACITY FOR CALCIUM REMOVAL (as a function of *p*H)

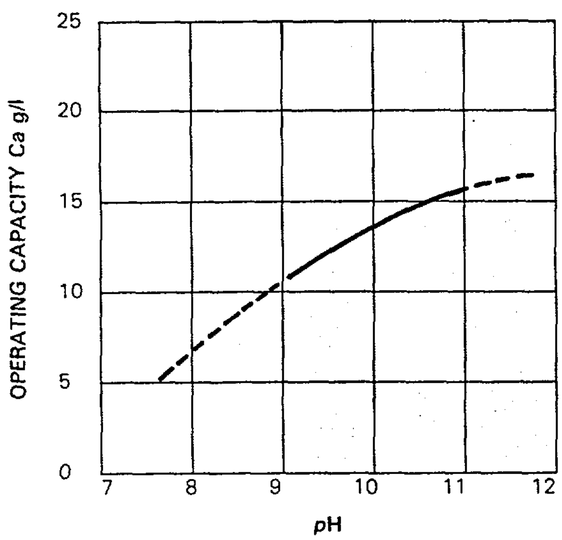


Fig. 2 CORRECTION FACTOR FOR INFLUENT CALCIUM CONCENTRATION

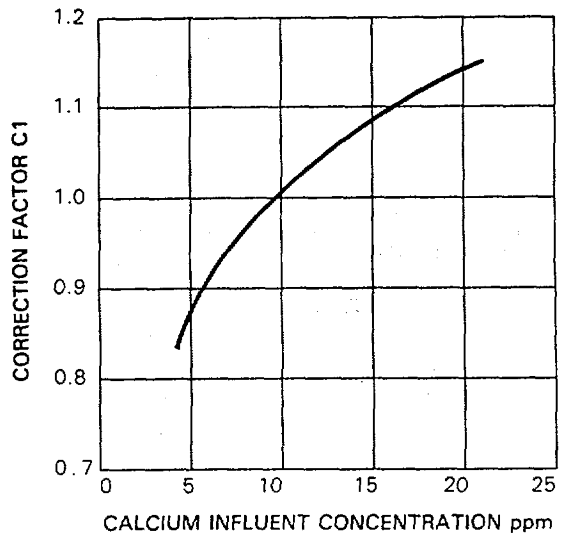


Fig. 3 CORRECTION FACTOR FOR TEMPERATURE

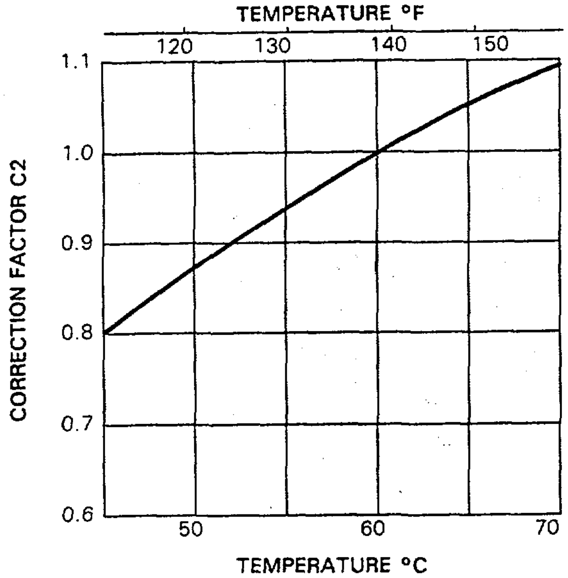


Fig. 4 CORRECTION FACTOR FOR FLOW RATE

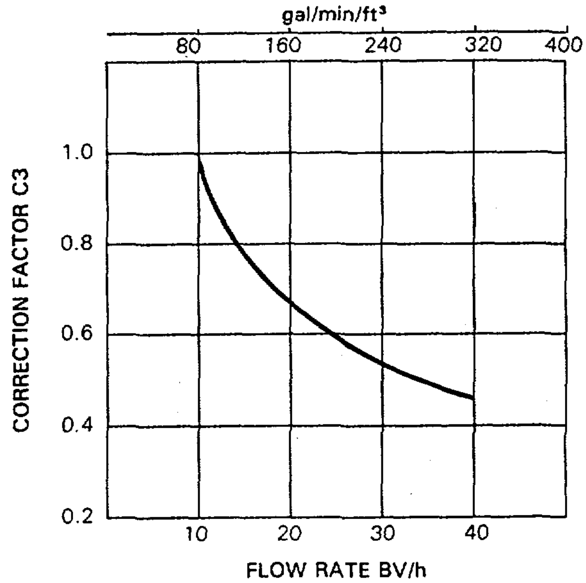


Fig. 5 TYPICAL LEAKAGE OF CALCIUM

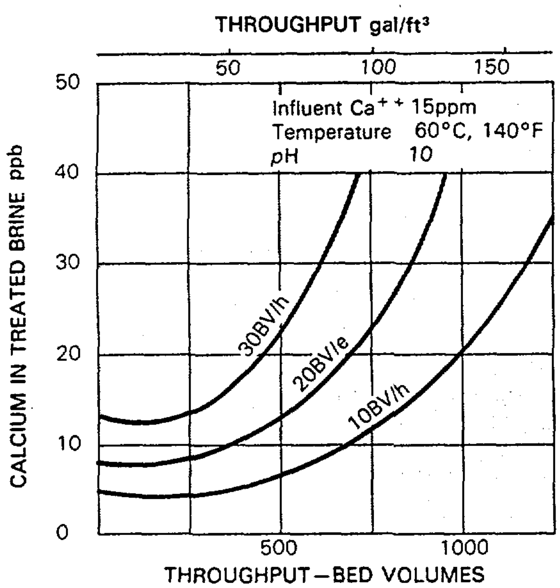
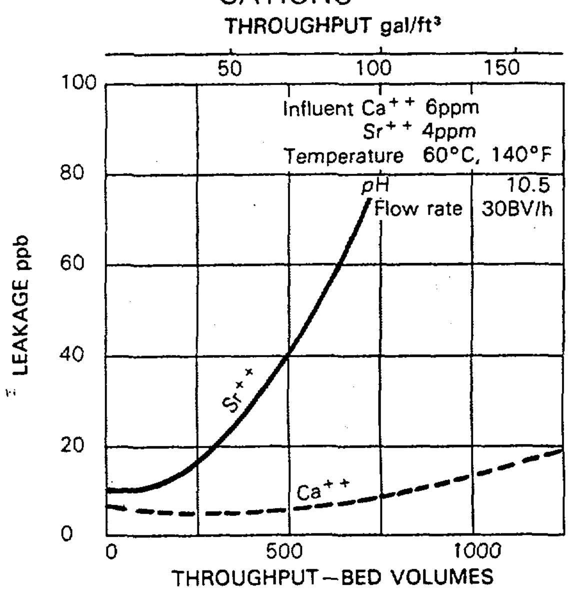


Fig. 6 TYPICAL LEAKAGE OF MIXED CATIONS



CHEMICAL AND PHYSICAL STABILITY

Purolite S-940 has been exhaustively tested to demonstrate that it will withstand temperatures above the maximum recommended limit of 90°C (194°F) in the presence of brine solutions at high ionic concentration (300g/l). It has also been shown that **Purolite S-940** is both chemically and physically stable to high concentrations of acid and alkali (20% of sulphuric acid and 20% of sodium hydroxide), which are stronger than would normally be used under the most severe conditions of operation. In tests for osmotic and physical stability using a specially developed rig* which incorporates mechanical stress and attrition, by pumping the resin against a retaining stainless steel mesh, the following results were typically obtained after 200 cycles of operation.

Resin	% Perfect	% Cracks	% Pieces	% Mis shapes
Purolite S-940	**97**	**1**	**1**	**1**
Purolite S-940 100 cycles	**96**	**0**	**2**	**1**
Purolite S-940 200 cycles	**95**	**0**	**4**	**1**

* Test Rig originally developed by the Scientific Services Division of the Electricity Generating Board.

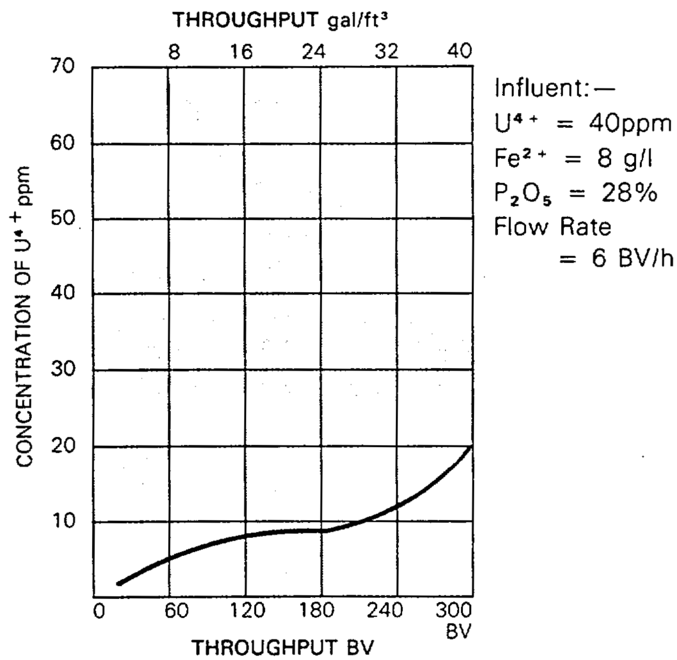
GENERAL APPLICATIONS

Purolite S-940 is also suitable for separation and recovery of heavy metals, including uranium.

— **Purolite S-940** has a high selectivity for heavy metals and transition metals, more particularly, lead, copper and zinc. The affinity for copper is higher than for zinc and hence it is possible to separate and concentrate these metals from a mixture in solution.

— **Purolite S-940** may be used to purify solutions. For example, lead can be removed from industrial waste streams etc...

Fig. 7 EXTRACTION OF URANIUM



HYDRAULIC CHARACTERISTICS

The pressure drop (or headloss) across a properly classified bed of ion-exchange resin depends on the particle size distribution, bed depth, and voids volume of the exchange material , and on the flowrate and viscosity (and hence on the temperature) of the influent solution. Anything affecting any of these parameters, for example the presence of particulate matter filtered out by the bed, abnormal compaction of the bed, or the incomplete classification of the bed will have an adverse effect, and result in an increased headloss.

Service flow rates from 10—30 bed volumes per hour depending on the application, may be regarded as the normal range used on this resin. Typical pressure drop figures to be expected for ordinary aqueous solutions, are given in fig. 8 below.

Fig. 8 PRESSURE DROP VS FLOWRATE

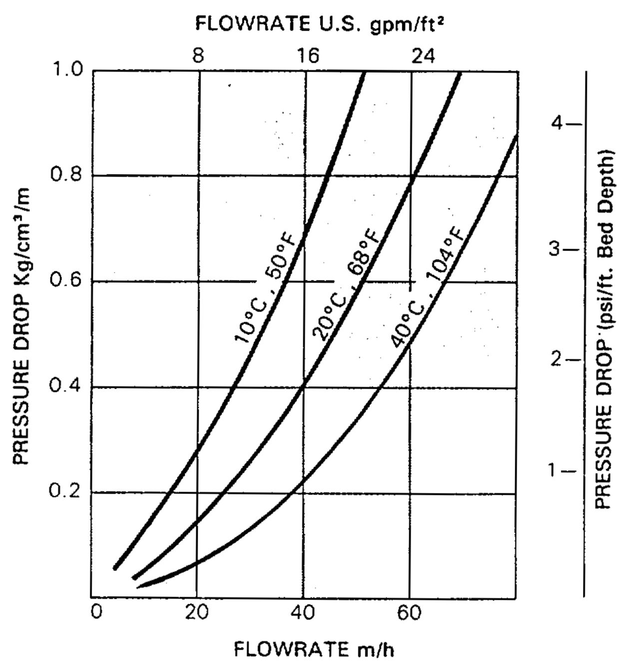
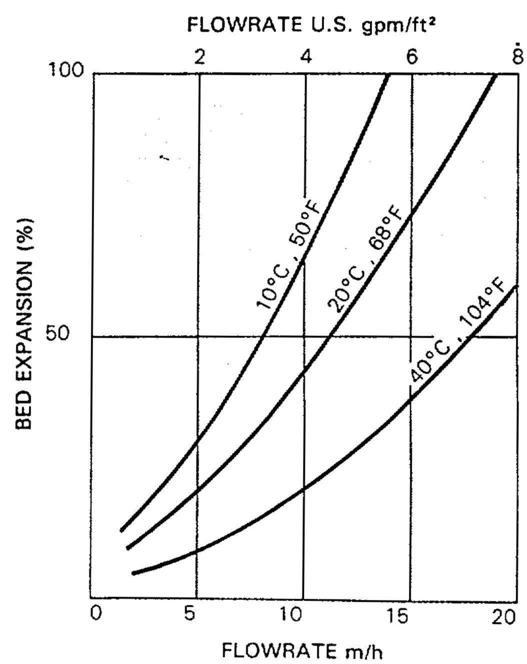


Fig. 9 BACKWASH EXPANSION
(Exhausted Forms)



During upflow backwash, the resin bed should be expanded in volume between 50 and 75%, in order to free it from any particulate matter from the influent solution, to clear the bed of bubbles and voids, and to reclassify the resin particles as much as possible, ensuring minimum resistance to flow. Bed expansion increases with flow rate and decreases with temperature, as shown in fig. 9 for a typical exhausted form of the resin. Care should always be taken to avoid resin loss by over-expansion of the bed.

Brine purification

PRESSURE DROP AND BACKWASH

The pressure drop across a bed of resin when brine (300g/l) is the influent solution is considerably higher than that for more dilute solutions hence the curves given below should be used, see fig. 10. The backwash expansion for the calcium form resin at the end of the brine purification is higher than that for the heavier metals, thus the curves in fig. 11 are applicable

Fig. 10 PRESSURE DROP VS FLOWRATE

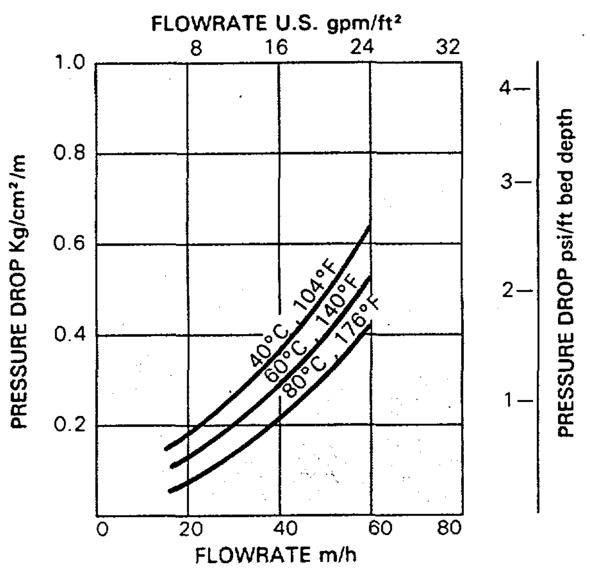
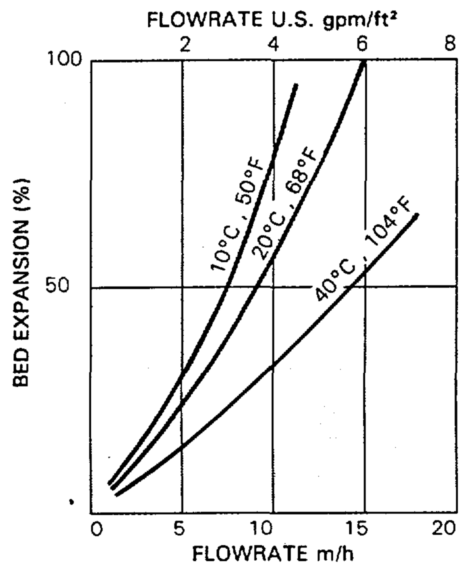


Fig. 11 BACKWASH EXPANSION



PUROLITE®
ION EXCHANGE RESINS

S-950
Macroporous Aminophosphonic Chelating Resin
(For the selective removal of toxic metals from aqueous solutions)

Technical Data

Section VI.

PRODUCT DESCRIPTION

Purolite S-950 is a macroporous aminophosphonic acid chelating resin, designed for the removal of cations of toxic metals such as lead, copper and zinc from industrial effluents at low *p*h. At somewhat higher *p*H values, calcium, magnesium and barium, as well as the toxic metals cadmium, nickel, and cobalt are strongly complexed and may be separated from quite high concentrations of univalent cations.

Unlike **Purolite S-930**, the well known iminodiacetic acid resin, which is selective for heavy metal ions, but not for common divalent ions (calcium and magnesium), **Purolite S-950** is more highly selective (under the appropriate conditions) for a range of both heavy metal and common divalent ions. Hence its use may be recommended where it is necessary to remove calcium or magnesium in order to avoid possible precipitation, or where its selectivity for a *particular range of metals offers advantages.*

Typical Chemical & Physical Characteristics

Polymer Matrix Structure	Macroporous Styrene-divinylbenzene
Physical Form & Appearance	Opaque light brown spheres
Whole Bead Count	>95%
Functional Groups	$RCH_2NHCH_2PO_3$
Ionic Form (as shipped)	Na^+
Shipping Weight g/l	740g/l (46(lb./ft^3))
Screen Size Range: British Standard Screen	14-52 mesh, wet
U.S. Standard Screen	16-50 mesh wet
Particle Size Range	+1.2mm <5%, −0.3mm <1%
Moisture Retention, Na^+ Form	60-65%
Reversible Swelling, ($H^+ \rightarrow Na^+$) Max.	45%
Specific Gravity, Moist Na^+ Form	1.13
Total Exchange Capacity, Na^+ Form (wet, volumetric)	2.0 meq./ml., min.
(dry weight)	5.5 meq./g., min.
Exchange Capacity (Na^+ Form)	24 g. Ca^{++}/l (1.5lb/ft^3)min at pH 9.5
Max, Operating Temperature, H^+Form	60°C (140°F)
Ca^{++} Form	90°C (195°F)
pH Range (operating), H^+ Form	2—6
Na^+ Form	6—11

APPLICATIONS

a) Extracting heavy metal ions from leach liquors, tailings runoff, or from industrial effluents. For example, lead may be removed from oil refinery waste liquors, solvents and aqueous wastes from the manufacture of paints and printing inks, or battery factory wastes.

b) Recovery of zinc from cooling-tower waters, etc. where it is used as a corrosion inhibitor.

c) Refining of metal salt solutions by selective removal of individual ions.

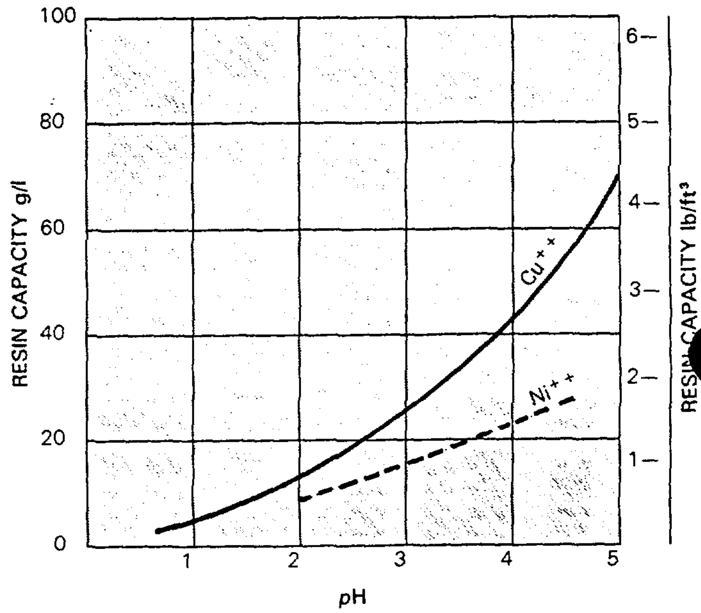
d) "Polishing" of aqueous organic and inorganic solutions for the removal of trace metals.

OPERATING PERFORMANCE

Before attempting to use **Purolite S-950** for any industrial application, it is strongly recommended that laboratory column tests are carried out on the solution which is to be treated, so as to determine the operating performance in terms of both treated solution quantity and quality once the chosen equilibrium cycle conditions have been established. This may take several cycles.

The curves for copper and nickel for **Purolite S-950** given in fig. 3 may serve as a guide to the maximum exchange capacity obtainable from a feed of 3g/l metal as a function of *p*H. In practice, lower capacities will usually be obtained, depending, depending upon regeneration level chosen, having regard to the leakage of metal acceptable.

Fig. 3 RESIN CAPACITY



Section VII.

COMMENTS

The **Purolite Chelation Resins** described in this bulletin are the result of continued development of ion exchange products designed for many industrial processes. Further modifications of these products already exist in accordance with **Purolite's** policy to provide their customers with the superior resins for specific industrial processes.

Chelation Resins and the associated systems, have already been shown to be indispensible for production of solutions of the high purity needed in special processes. The efficiency of removal of particular species ultimately depends upon the property of selectivity. However, the advantage of high selectivity has to be taken into account when considering how best to remove the concentrated metal from the collecting medium. In some cases resin destruction is economic and useful. In others, it is the change of stability of the chelation complex with the change in conditions between exhaustion and regeneration which ensures near perfect fixation and excellent removal on regeneration. Changes in pH and ionic concentration are often the best means to ensure efficiency in both parts of the cycle. The use of electrolytic processes for regeneration can also be considered, particularly for the electrodeposition of precious metals.

The need for chelation materials with specific properties tailor made to suit particular industrial processes is now a commercial reality.

The expertise of **Purolite** is available, to give recommendations both on specific uses of the chelation products described in this bulletin, and to provide modified products for evaluation.

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D145T/89

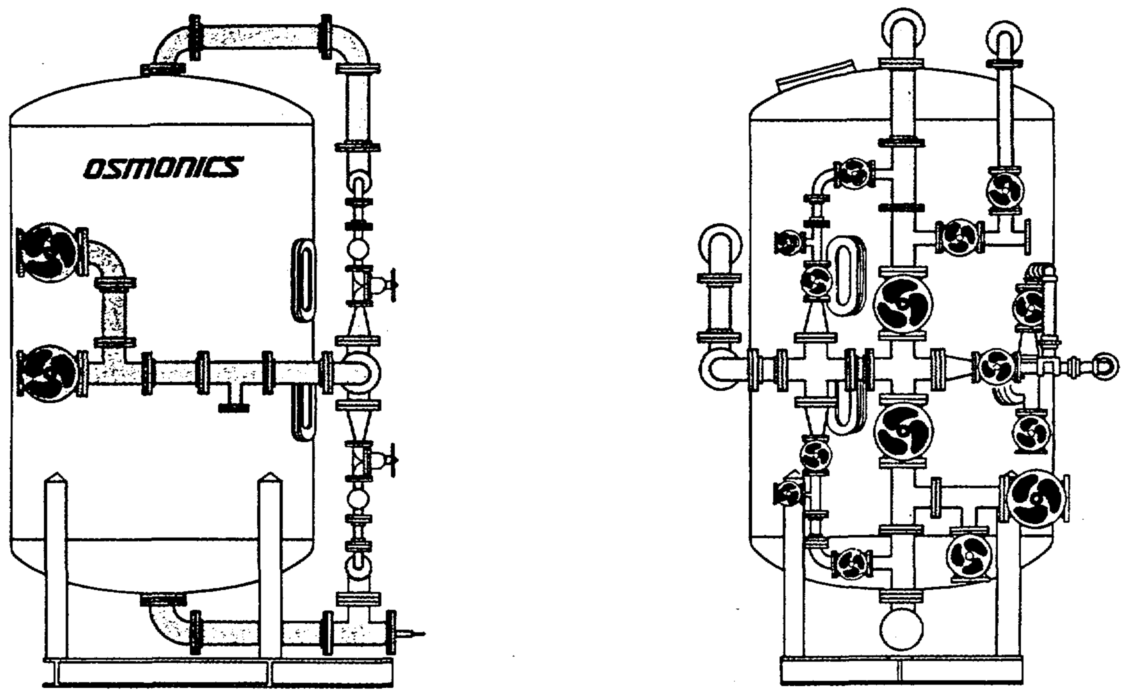
OSMONICS

Specialists in water purification worldwide

Mixed-Bed Deionizers

manual and automatic regeneration

PRODUCT BULLETIN



Manual Mixed-Bed Deionizer

Introduction

Osmonics manufactures packaged mixed-bed deionizers for applications that require a higher level of water quality than normally available from other types of DI equipment. Osmonics packaged mixed-beds are often placed downstream of reverse osmosis equipment to further treat RO product water. Primary mixed-bed units produce 1-16 megohm water. Then, polishing mixed-beds will raise the resistivity of the water to 16-18 megohms.

Standard packaged deionizers are supplied with either manual or automatic regeneration control systems. Automatic regeneration systems feature Programmable Logic Controller (PLC) panels to simplify maintenance and operation for plant personnel. Standard packaged mixed-bed DI units are skid mounted, fully assembled and include the necessary chemical tanks, piping and valves to begin immediate operation.

Tanks:
Built of ASTM-283 Steel. Have a working pressure of 100 psig (689 kPa). Hydrostatically tested at 150 psig (1034 kPa). Interiors are coated with 90 mil of cold sprayed plastisol. Exteriors are primed with epoxy and painted with high grade blue phenolic coating.

Pipes and Valves:
Pipes and valves having a diameter of less than 2.5 inches are PVC. Larger pipes and fittings are saran-lined cast iron. Manual units use handwheel operated valves with position indicators. Automatic valves are double action air actuated.

Distributors:
System distributes service and regenerate waters evenly over entire bed surface area. Laterals are wrapped with fine mesh saran screen to prevent loss of resin.

Resin:
Osmonics DI units can use resin supplied by any of the major manufacturers to meet any application. Resin beds are designed to maximize efficiency of chemical usage during regeneration.

Automatic Regeneration

Programmable Logic Controller (PLC) panels provide instant accurate data and maximum operational flexibility for automatic regeneration. The control panel is encased in a NEMA 12 enclosure. The front of the panel has an L.E.D. graphic display that describes each phase of regeneration and indicates which valves are open during each regeneration and service step. Additional data is supplied by readouts, including current program position (regeneration step), flow rate, time remaining, and the resistivity of the product water.

Contact Osmonics for information on Programmable Logic Controllers.

Manual Regeneration

Operator controls service and regeneration cycles. Resistivity meter continuously monitors water quality for operator. Osmonics provides complete instruction manuals. Standard instrumentation includes:

Service flow meter, air flow meter, inlet pressure gauge, outlet pressure gauge, air pressure regulator and filter, and acid and caustic sample points.

APPENDIX E-3

REVERSE OSMOSIS LITERATURE

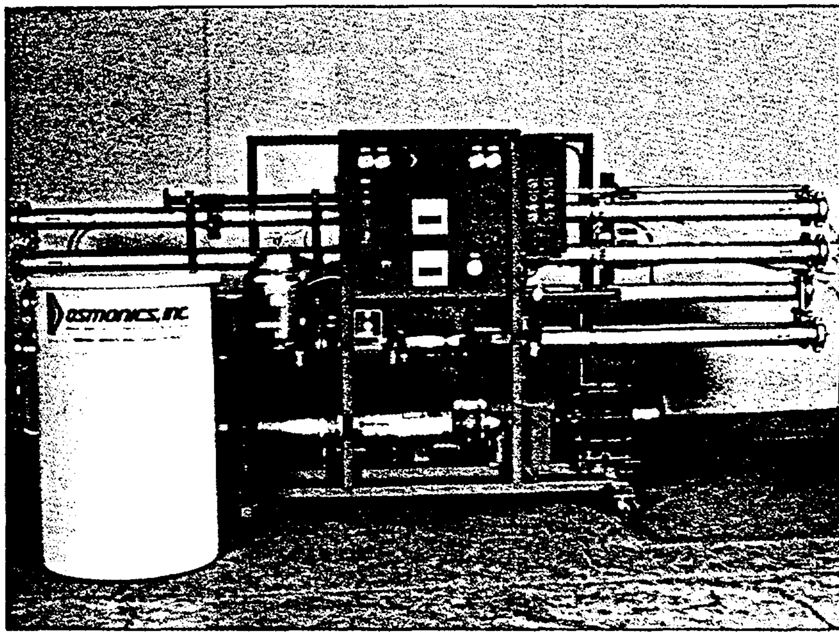
osmonics®

OSMO® 43CHF SERIES

REVERSE OSMOSIS FOR WATER PURIFICATION

OSMO 43CHF Series reverse osmosis (RO) machines are high capacity units designed to economically produce high purity water. Units operate at various pressures depending on the feed water and membrane type. The standard 43CHF design consists of horizontally mounted, side-entry stainless steel sepralator (membrane element) housings and a quiet TONKAFLO® multi-stage centrifugal pump mounted on a free-standing frame. Permeate and concentrate flow meters are standard on all machines. A sophisticated electrical system allows for an array of time delay alarm features and controls.

Osmonics is a registered medical device manufacturer. Each RO system is manufactured with the care used in the manufacture of machines for the medical market. Complete traceability by lot number of all critical raw materials and system components ensures quality in every RO unit. All basic components (multi-stage centrifugal pump, cartridge prefilters, sepralators, sepralator housings, electrical package) are manufactured by one company, Osmonics.



43CVF Models offer the same features as 43CHF models, except sepralator housings and pump are mounted vertically in a space-saving design. Maximum flow rates for 43CVF units are limited to those produced with 3 and 5 Hp pumps.

43CVF-K Units are attractive, enclosed versions of the compact 43CVF vertical models. They feature an aesthetic cover and are ideal for confined spaces or areas where noise reduction is critical. For 43CHF models with feed flow rates less than 20 gpm (4.5 m^3/hr).

- Osmonics' unique spiral-wound sepralators, which feature a turbulent flow design, are manufactured for each specific application.
- Side-entry stainless steel sepralator housings allow for easy sepralator installation and removal.
- All components in contact with permeate are stainless steel or inert plastic.
- TONKAFLO pump/motor are mounted on the base to enhance stability and to simplify service.
- All stainless steel welding is tungsten inert gas (TIG).
- In-line stainless steel thermometer.
- Cutout switch to protect against low flow and/or low inlet pressure to the pump.
- Thermal cutout switch is preset at 105°F (41°C) to prevent damaging the sepralators due to high temperatures.
- Tubular steel joints on upper portion of machine are welded angles to avoid open channels for water collection.
- Bolt pattern in frame base provided to allow for permanent mounting.
- Automatic inlet shut-off valve to prevent flow through the machine when it is shut down.
- Check valve in permeate lines to prevent backflow or siphoning into the permeate side of the machine.
- Prewired motor starter.
- On/off indicator light with separate alarm light.
- HYTREX® II 5-micron prefilter cartridges and housing.
- Panel-mounted pre- and post-filter pressure gauges.
- Panel-mounted permeate and concentrate flow meters for ease of reading.
- Panel-mounted concentrate valve with minimum flows preset at factory.
- Recycle control incorporating a fixed orifice design.
- Each housing has its own test port to allow for testing of permeate quality of each sepralator during operation.
- Each sepralator is performance tested prior to being loaded in the RO unit.
- Machine frame and panels coated with epoxy primer and phenolic overcoat paint for corrosion resistance.
- Complete quality testing with sepralators installed at our factory prior to shipment to ensure trouble-free start-up.
- Complete operating and instruction manual.

SPECIFICATIONS

OSMO ECONOMY MODELS (ECN) have all the features necessary for safe continuous production of high purity water. This assumes good quality typical feed water, adequate pretreatment and regular operator attention, each shift or daily. Not recommended for use if feed water pH is below 5.8 or with DI water.

OSMO DELUXE 316 STAINLESS STEEL MODELS (DLX 316SS) are specified when maximum material durability is required. All wetted components are 316 stainless steel or inert plastic.

OSMO DELUXE MODELS (DLX) contain several useful standard features that provide additional system safety and reliability. These features simplify system monitoring and data collection and ensure longest membrane life. pH limits are primarily membrane dependent. Additional items that are standard on DLX models include:

- Stainless steel or inert plastic wetted components.
- Complete pH buffer system including chemical feed pump mounted on the unit, injection ports and day tank for acid (CFS-10X).
- TONKAFLO pump with stainless steel construction.
- Auto flush system (AUF-24).
- Panel-mounted conductivity monitor (CM-671) with temperature compensation.

MATERIALS OF CONSTRUCTION

- Sepralator Housing: Stainless steel with injection molded glass-filled Noryl end caps.
- High Pressure Tubing: All wetted components stainless steel or inert plastic, tube fittings 316 stainless steel.
- Rigid Low Pressure Piping: PVC or stainless steel.
- Permeate Plumbing: Nylon tubing with polypropylene and PVC fittings.
- Inlet Plumbing: PVC.
- Prefilter: Filter housing with HYTREX II 5-micron cartridge filters installed on machine.
- Flow Meters: Acrylic rotometers for flow rates under 20 gpm (4.5 m^3/hr). Magnetic induced paddle wheel for flow rates over 20 gpm (4.5 m^3/hr).
- Concentrate Valve: 316 stainless steel.
- Pump: ECN machine - nickel plated cast iron castings, stainless steel shaft/shell with Noryl impellers. DLX machine - 316 stainless steel castings and shaft/shell with Noryl impellers.

MOTOR

Motors supplied are open drip proof (ODP) unless totally enclosed, fan cooled (TEFC) is specified. Voltages available are 208, 230 and 460 VAC, 60 Hz, three-phase and 380 VAC, 50 Hz, three-phase. Single-phase motors are available as an option. BE SURE TO SPECIFY ALL ELECTRICAL REQUIREMENTS WITH ORDER.

CONTROL CIRCUIT

110 VAC, 60 or 50 Hz, single phase. For 50 Hz operation, a transformer is included to transform 220 VAC, 50 Hz, single-phase to 110 VAC, 50 Hz, single-phase. For 60 Hz operation, a 110 VAC connection is required. The control circuit has a maximum rating of 3 amps.

	Feed Rate <20 gpm (<76 lpm)	**Feed Rate 20-50 gpm (76-189 lpm)**	**Feed Rate 51-100 gpm (193-379 lpm)**
Inlet (Feed)	1" FNPT	1-1/2" FNPT	2" FNPT
Concentrate	1" FNPT	1" FNPT	1-1/2" FNPT
Permeate (Pure Water)	1" FNPT	1-1/2" FNPT	2" FNPT

Permeate flow rates based on an inlet pressure of 30 psig (207 kPa). Maximum inlet pressure is 60 psig (413 kPa); minimum inlet pressure is 20 psig (138 kPa).

ORDERING INFORMATION

Three types of OSMO membranes are available in 43CHF reverse osmosis water purification machines. Specify model number, construction (ECN, DLX or DLX 316SS), recovery and electrical requirements with order. **OSMO-43CHF-SR4000-DLX** is an example of a complete model number.

MODEL #	RECOVERY	PERMEATE RATE		PUMP	DIMENSIONS			WEIGHT	
43CHF Series	%	gpd	(m^3/d)	Hp (kW)	Height in (cm)	Width in (cm)	Depth in (cm)	Net lbs (kgs)	Shipping lbs (kgs)
SR (Standard Rejection) Permeate Quality									
SR4000	60/75	4,030	(15.3)	5 (3.7)	72 (183)	92 (234)	34 (86)	423 (192)	662 (301)
SR8000	60/75	8,060	(30.5)	7.5 (5.6)	72 (183)	92 (234)	34 (86)	489 (222)	728 (331)
SR12K	60/75	12,100	(45.9)	10 (7.5)	72 (183)	92 (234)	34 (86)	555 (252)	794 (360)
SR16K	60/75	16,100	(61.0)	10 (7.5)	72 (183)	92 (234)	34 (86)	621 (282)	860 (390)
SR20K	60/75	20,800	(78.8)	10 (7.5)	72 (183)	131 (333)	34 (86)	996 (453)	1,174 (534)
SR30K	60/75	31,800	(120.5)	20 (14.9)	72 (183)	172 (437)	34 (86)	1,225 (557)	1,465 (666)
SR40K	60/75	41,200	(156.1)	20 (14.9)	72 (183)	172 (437)	34 (86)	1,420 (645)	1,570 (714)
SR50K	60/75	51,700	(195.9)	25 (18.7)	72 (183)	172 (437)	34 (86)	1,680 (764)	1,800 (818)
SR63K	60/75	63,000	(238.8)	30 (22.4)	72 (183)	154 (391)	54 (137)	2,100 (953)	2,350 (1,066)
SR70K	60/75	70,000	(265.3)	40 (29.8)	72 (183)	154 (391)	54 (137)	2,300 (1,045)	2,550 (1,159)
SR95K	60/75	95,000	(360.1)	50 (37.3)	72 (183)	154 (391)	54 (137)	2,550 (1,159)	2,800 (1,273)
SR120K	60/75	120,000	(454.8)	60 (44.7)	72 (183)	154 (391)	54 (137)	2,800 (1,273)	3,050 (1,386)
[illegible]									
HR3200	60/75	3,200	(12.1)	5 (3.7)	72 (183)	92 (234)	34 (86)	423 (192)	662 (301)
HR6400	60/75	6,400	(24.3)	5 (3.7)	72 (183)	92 (234)	34 (86)	489 (222)	728 (331)
HR9600	60/75	9,600	(36.4)	7.5 (5.6)	72 (183)	92 (234)	34 (86)	444 (252)	794 (361)
HR12K	60/75	12,800	(48.5)	10 (7.5)	72 (183)	92 (234)	34 (86)	621 (282)	860 (391)
HR14K	60/75	14,100	(53.4)	10 (7.5)	72 (183)	131 (333)	34 (86)	685 (311)	924 (420)
HR17K	60/75	17,300	(65.6)	10 (7.5)	72 (183)	131 (333)	34 (86)	716 (325)	926 (421)
HR22K	60/75	21,600	(81.9)	10 (7.5)	72 (183)	172 (437)	34 (86)	996 (453)	1,174 (534)
HR30K	60/75	30,400	(115.2)	20 (14.9)	72 (183)	172 (437)	34 (86)	1,520 (691)	1,690 (768)
HR40K	60/75	41,500	(157.3)	20 (14.9)	72 (183)	172 (437)	34 (86)	1,880 (855)	2,000 (909)
HR56K	60/75	56,000	(212.0)	30 (22.4)	72 (183)	154 (391)	54 (137)	2,380 (1,082)	2,500 (1,136)
HR75K	60/75	75,000	(284.3)	40 (29.8)	72 (183)	154 (391)	54 (137)	2,550 (1,159)	2,800 (1,273)
HR94K	60/75	94,000	(356.3)	40 (29.8)	72 (183)	154 (391)	54 (137)	2,800 (1,273)	3,050 (1,386)
HR113K	60/75	113,000	(428.3)	50 (37.3)	72 (183)	154 (391)	54 (137)	3,100 (1,409)	3,350 (1,523)
[illegible] Permeate Quality									
HR(PA)3600	60/75	3,600	(13.6)	5 (3.7)	72 (183)	92 (234)	34 (86)	433 (197)	672 (305)
HR(PA)7200	60/75	7,200	(27.3)	5 (3.7)	72 (183)	92 (234)	34 (86)	489 (222)	728 (331)
HR(PA)11K	60/75	11,000	(41.7)	5 (3.7)	72 (183)	92 (234)	34 (86)	499 (227)	738 (335)
HR(PA)14K	60/75	14,400	(54.6)	7.5 (5.6)	72 (183)	92 (234)	34 (86)	545 (248)	784 (356)
HR(PA)16K	60/75	16,200	(61.4)	7.5 (5.6)	72 (183)	131 (333)	34 (86)	555 (252)	794 (360)
HR(PA)21K	60/75	21,600	(81.9)	7.5 (5.6)	72 (183)	172 (437)	34 (86)	1,130 (514)	1,370 (623)
HR(PA)28K	60/75	28,800	(109.2)	7.5 (5.6)	72 (183)	172 (437)	34 (86)	1,250 (568)	1,515 (689)
HR(PA)40K	60/75	43,200	(163.7)	15 (11.2)	72 (183)	172 (437)	34 (86)	1,381 (628)	1,530 (695)
HR(PA)50K	60/75	51,800	(196.3)	15 (11.2)	72 (183)	172 (437)	34 (86)	1,680 (764)	1,800 (818)
HR(PA)66K	60/75	66,000	(250.1)	25 (18.6)	72 (183)	154 (391)	54 (137)	2,300 (1,045)	2,550 (1,159)
HR(PA)88K	60/75	88,000	(333.5)	30 (22.4)	72 (183)	154 (391)	54 (137)	2,550 (1,159)	2,800 (1,273)
HR(PA)110K	60/75	110,000	(416.9)	30 (22.4)	72 (183)	154 (391)	54 (137)	2,800 (1,273)	3,050 (1,386)

NOTE: Ordering information subject to change without notice. Please verify all specifications prior to ordering.

MEMBRANE TYPES & OPERATING PARAMETERS

CONTAMINANT REJECTION		SEPA-SR	SEPA-HR	SEPA-HR(PA)
Salt Rejection[1]		90-95%	93-97%	95-98%
Organic Rejection[2]		>250 MW	>200 MW	>150 MW
Bacteria Rejection		>99%	>99%	>99%
Pyrogen Rejection		>99%	>99%	>99%
Particle Rejection		>99%	>99%	>99%
FEED WATER SPECIFICATIONS				
Free Chlorine	(Min.)	0.2 ppm	0.2 ppm	0.0 ppm
	(Max.)	2.0 ppm	2.0 ppm	<0.1 ppm
SDI		<8	<8	<5

1. Assumes water with a typical mixture of monovalent and polyvalent salts.
2. Nominal cutoff point for rejection of saccharide-type molecules larger than the stated molecular weight (MW).

NOTES:

- Chlorine tolerance is pH dependent. Increased tolerance is likely where feed water pH is 7.0 or lower.
- Langlier Index as calculated on concentrate TDS must be a negative value.
- Operating Temperature, min. 35°F (2°C), max. 85°F (29°C). Optional high temperature designs are available. Permeate flow varies with temperature, contact factory. All capacities rated at 77°F (25°C).

PREPARATION

All machines are factory tested with sepralators installed and sanitized prior to shipment to ensure troublefree start-up in the field. A complete set of operating instructions and Quality Assurance data sheets are included. All units are shipped exworks, Minnetonka, Minnesota USA. Machines are crated for overland, air freight or containerized ocean freight. If you wish uncontainerized ocean freight, please specify.

Osmonics stocks a complete line of cleaning, sanitizing and pretreatment chemicals. Please order separately. Osmonics also offers all pre- and post-treatment equipment required for a complete operating ultrapure water system.

IMPORTANT NOTICE TO USER:

The following is made in lieu of all other warranties expressed or implied. Manufacturer's and Seller's only obligation shall be to issue credit against the purchase or replacement of the equipment proved to be defective in material or workmanship. Neither manufacturer nor seller shall be liable for any injury, loss or damage, direct or indirect, special or consequential, arising out of the use of, misuse, or the inability to use such product. The information contained herein is based on technical data and tests which we believe to be reliable and is intended for use by persons having technical skill at their discretion and risk. Since conditions of use are outside Osmonics' control, we can assume no liability whatsoever for results obtained or damages incurred through the application of the data presented. This information is not intended as a license to operate under, or a recommendation to infringe upon, any patent of Osmonics or others covering any material or use. The foregoing may not be altered except by a written agreement signed by officers of the manufacturer.

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P/N 47393

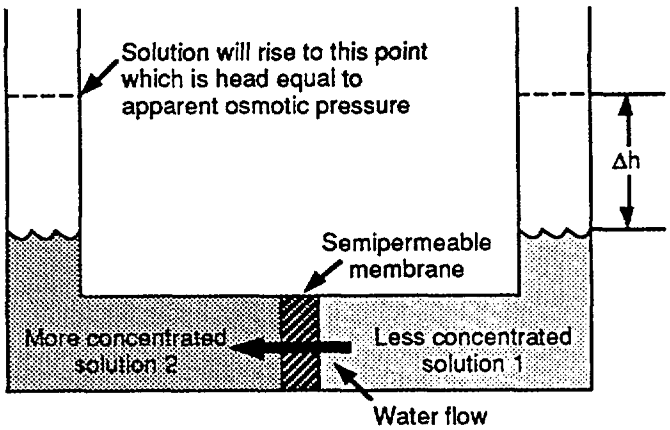
Engineering Memo #13

Re: **Fundamentals of OSMO® Systems**

From: **The Osmonics Engineering Department**

OSMO systems are designed to produce purified water by a process called reverse osmosis. An understanding of this process can best be gained by a review of the process of osmosis. A simple osmosis system is shown in Figure 1 below:

Figure 1 - Osmosis



Normal osmosis takes place when water passes from a less concentrated solution to a more concentrated solution through a semipermeable membrane. A semipermeable membrane will pass water molecules but will not pass a great percentage of the solute (i.e., dissolved material) – most of this material is rejected. The word most is emphasized because in practice there is no such thing as a perfect membrane.

A certain amount of potential energy exists between the two solutions on each side of the semipermeable membrane, with the more dilute solution exhibiting the higher potential energy level. Water, like everything else in nature, will flow from the solution with the higher potential energy level (dilute solution) to the solution with the lower potential energy level (more concentrated solution). The highest energy level for water is pure water; as solutes (i.e., impurities) are added, the water becomes less pure and the energy level of the water is reduced.

Due to this energy difference, water will flow from the less concentrated solution to the more concentrated solution until the system is in equilibrium. Equilibrium will be reached when the differential head, Δh is equivalent to the apparent, or differential, osmotic pressure. This state of equilibrium can be expressed as follows:

$$\Delta h = (\pi_2 - \pi_1) = (\Delta\pi) \qquad \text{(Eq. - 1)}$$

π_1 = Absolute osmotic pressure of less concentrated (higher energy) solution.

π_2 = Absolute osmotic pressure of more concentrated (lower energy) solution.

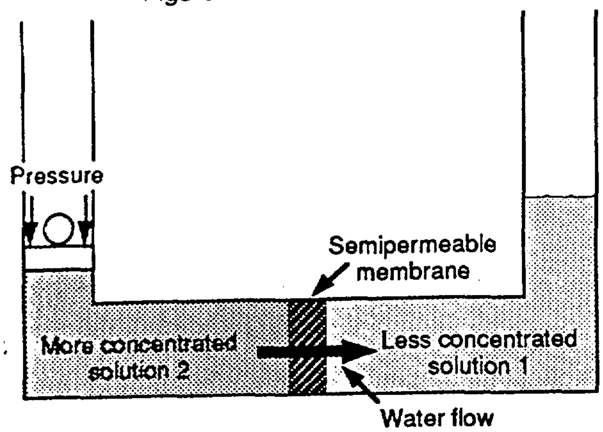
The absolute osmotic pressures, π_1 and π_2 of the solutions shown in Figures 1 and 2 are defined as the potential energy difference between any solution and pure water. Keep in mind the higher the purity, the higher the potential energy. Remember that extremely pure water has a very high potential energy level and is a very aggressive material.

Reverse osmosis can be defined as the separation of one component of a solution from another component by means of pressures exerted on a semipermeable membrane. Usually, RO is used for the separation of dissolved solids (solute) from water (solvent). Referring to Figure 2, the addition of pressure energy to the more concentrated solution will accomplish the same thing as the differential head, and it will stop the transport of water through the membrane when the head pressure equals the $\Delta\pi$ head. As more pressure is applied, the water will flow from the concentrated solution to the dilute solution, in effect, reversing normal osmotic flow. The addition of pressure has increased the energy level of the more concentrated solution above the energy level of the less concentrated solution. Water always flows from higher energy to lower energy. In this case, the flow will be from the more concentrated to the less concentrated. The rate of water transport is a function of:

1. The pressure applied.
2. The apparent, or differential, osmotic pressure between the solutions. (Differential osmotic pressure is the difference between the absolute osmotic pressures of the two solutions.)
3. Area and characteristics of the membrane.

4. The solution temperature.

Figure 2 - Reverse Osmosis

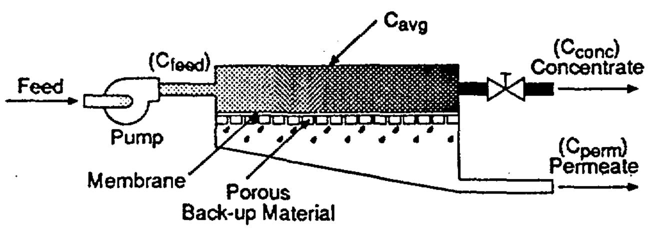


A reverse osmosis machine, regardless of size of complexity, can be conceptualized as the simple "black box" shown in Figure 3.

C_{feed} = Concentration of Feed
C_{perm} = Concentration of Permeate

C_{conc} = Concentration of Concentrate
C_{avg} = Average Concentration Over the Membrane

Figure 3



DEFINITION OF TERMINOLOGY

1. Total Dissolved Solids (TDS) The total organic and inorganic material dissolved in the water expressed as a concentration C (e.g. mg/L, ppm).

2. Feed. The solution which enters the system under pressure with solute concentration = C_{feed}. Example: C_{feed} = 150 mgL TDS

3. Permeate. The solution (usually purified water) which passes through the membrane and is collected for use. The solute concentration = C_{perm}.

4. Concentrate (brine, retentate). The solution which exits from the system which has not passed through the membrane. It is enriched in a particular rejected material. The solute concentration = C_{conc}.

5. Rejection. The percentage of dissolved material which does not pass through the membrane.

6. Passage. The percentage of dissolved material which does pass through the membrane.

7. Recovery. The ratio of permeate rate to feed rate:

$$\text{Recovery} = \frac{\text{Permeate Rate}}{\text{Feed Rate}} = \frac{(Q_{perm})}{(Q_{feed})} \quad \text{(Eq. - 2)}$$

8. Concentrate Concentration. The concentration of the concentrate stream, or blow-by, as it exits the machine. It is related to feed concentration and recovery as follows:

$$C_{conc} = \frac{C_{feed}}{(1 - \text{Recovery})} \quad \text{(Eq. - 3)}$$

(See Recovery example later in text.)

NOTE: This formula is based on the mass balance $(Q_{feed})\,C_{feed} = (Q_{conc})C_{conc} + (Q_{perm})C_{perm}$ and assumes that $C_{perm} = 0$. This is an over-simplification which assumes a "perfect" membrane. It works satisfactorily when the solute rejection is 95% or greater, but severely distorts the true system when solute rejections are less than 85%.

9. Average Concentration. *The average concentration* which the membrane is exposed to in the machine. It is calculated by averaging the C_{feed} and C_{conc}.

$$C_{avg} = \frac{C_{feed} + C_{conc}}{2} \quad \text{(Eq. - 4)}$$

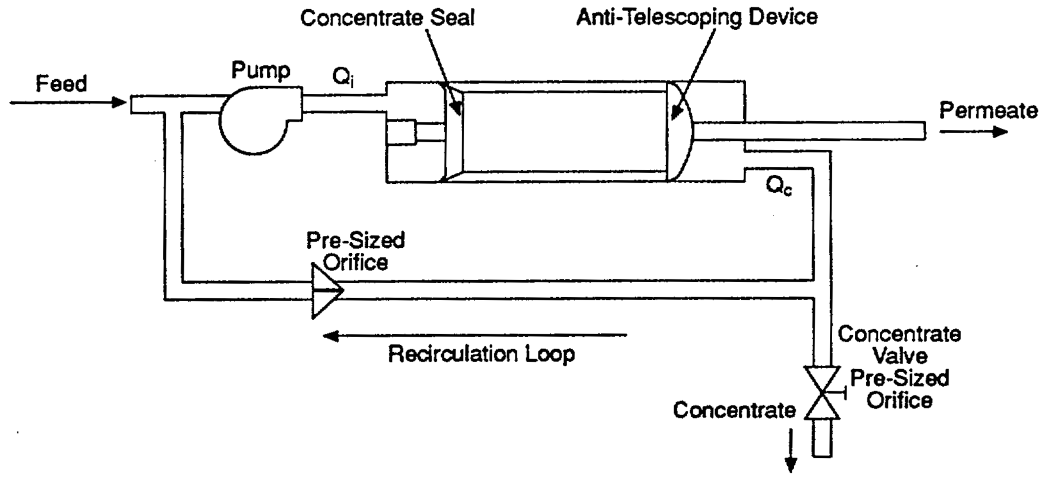
NOTE: Again, this is an over-simplification and has the same restrictions as the above equation. It tends to give a higher C_{avg} than what will actually occur and is therefore a conservative estimate.

Small OSMO systems operate at relatively low recovery, typically less than 50%. The cost of higher recoveries on small systems is not justifiable, especially when the permeate quality is considered. We design the systems to operate on a flow rate, Q_i, through the sepralator (membrane element), of about 5 gpm (19 Lpm) in order to create turbulent flow. The basic, once-through, recovery of a typical sepralator that produces 10 gph (39 Lph) of permeate flow is only:

$$\frac{10 \text{ gph}}{300 \text{ gph}} = 3\%$$

This low recovery is increased by recirculating a percentage of the concentrate Q_c, that has passed

Figure 4



over the sepralator (not through the membrane but over it) through an orifice restriction back to the pump, where it is mixed with the incoming feed solution. The amount that is recirculated is a function of the restriction in the orifice and the concentrate valve, which is an orifice-type valve that allows a predetermined amount of concentrate to flow at all times. (This is covered under Osmonics U.S. Patent #3,716,141. This apparatus is also patented in a number of foreign countries, notably Germany, Switzerland, Canada and Japan.)

We can also increase recovery by adding sepralators to the system, as we do in the larger units. Recovery is increased since each sepralator removes more permeate, adding to the total permeate rate without a corresponding increase in feed rate. In actual practice, both recirculation and the addition of sepralators is used to increase recovery. On some bigger systems, very little recirculation is necessary to achieve the recovery desired, and if recycle is not used, the quality of the permeate will be higher. All OSMO machines are manufactured so that Q_i can be increased if necessary to avoid fouling the sepralators.

For a given input feed rate, Q_{feed}, the permeate rate, Q_{perm}, obtained from a machine is a function of a number of interrelated factors. Among these are:

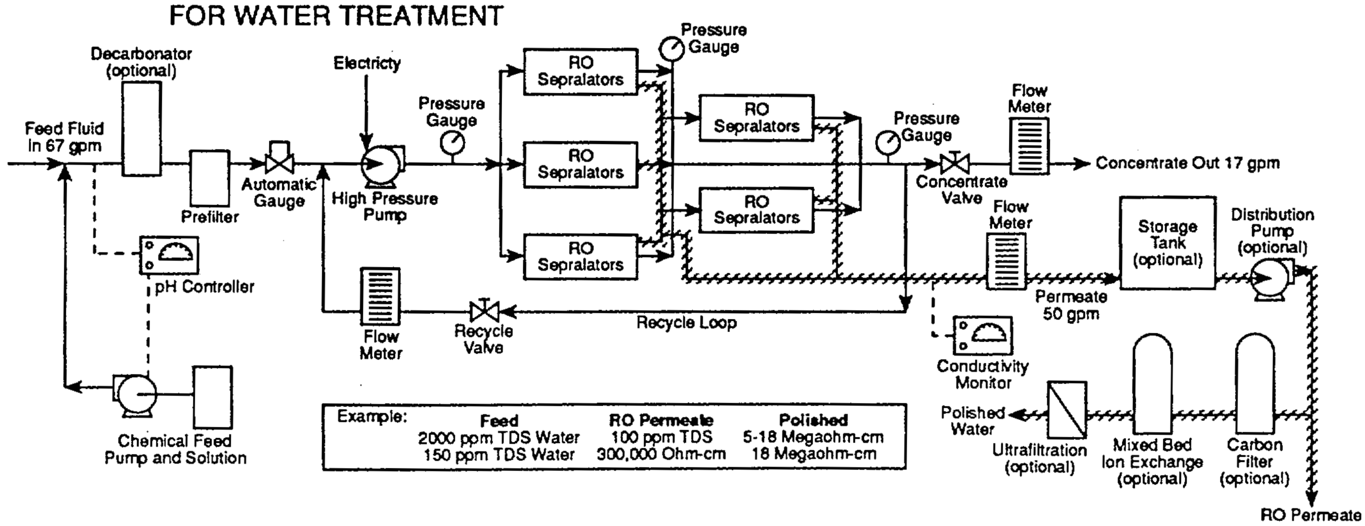
1. The number of sepralators used in the machine.
2. The type of membrane used.
3. The operating pressure.
4. The apparent osmotic pressure, $\Delta\pi$, of the solution in the machine, which is a function of average concentration and solute type.
5. The temperature of the solution.
6. The condition of the membrane.

To estimate the concentrate concentration (blow-by) in terms of feed concentration at any given recovery, use the following method:

$$\text{(A)} \quad C_{conc} = \frac{C_{feed}}{1 - \text{Recovery}} \qquad \text{(Eq. - 3)}$$

TYPICAL 50 GAL/MIN (189 Lpm)
OSMO REVERSE OSMOSIS SYSTEM
FOR WATER TREATMENT

Figure 5



EXAMPLE 1

Recovery = 80% = 0.80 using Eq. 4 we have:

C_{feed} = 500 ppm

$$C_{conc} = \frac{500}{1-0.80} = \frac{500}{0.20} = 5(500) = 2500 \text{ ppm}$$

To estimate the average concentration with a given feed concentration and concentrate concentration, use the following method:

(B) $$C_{avg} = \frac{C_{feed} + C_{conc}}{2}$$

C_{feed} = 500 ppm

C_{conc} = 2500 ppm

$$C_{avg} = \frac{500 + 2500}{2} = \frac{3000}{2} = 1500 \text{ ppm}$$

As mentioned previously, the process of reverse osmosis and the rejection of dissolved materials takes place under pressure, with the solution passing across the membrane, and only a percentage of the solvent passing through the membrane. This is not mechanical filtration such as you find in a cartridge filter where all of the solution passes through the filter media and some of the suspended material in the solution is caught by direct interception or inertial impaction on the filter media. Rather, the feed solution passes over the membrane, and pressure forces a percentage of the solvent (usually water) through the membrane, while some of the initial solution, enriched in solutes, remains to be carried away.

For most pure water applications where the input feed concentration is low (less than 1000 ppm) and we operate the machines at relatively low recoveries (typically 33% to 75%), the C_{avg} that we experience in the machine is low, resulting in an osmotic pressure that is a low percentage of the operating pressure.

- THE OSMOTIC PRESSURE FOR AN NaCl SOLUTION IS ABOUT 1 PSIG (0.069 BAR) PER 100 PPM TDS.

- THE OSMOTIC PRESSURE FOR AN Na_2SO_4 SOLUTION IS ABOUT 0.5 PSIG (0.034 BAR) PER 100 PPM TDS.

- IT IS BEST TO ASSUME THAT ALL YOUR TDS IS NaCl WHEN MAKING ESTIMATES IN ORDER TO BE SURE YOU HAVE NOT UNDERESTIMATED.

In the previous example, the 1500 ppm average concentration would represent about 15 psig (1.0 bar). This is a very low percentage of the typical 430 psig (29.6 bar) operating pressure for 43 Series machines, so it can be essentially neglected in our calculations. (See Page 2, #7.)

However, in a typical plating (metal reclamation) application, we do have higher concentrations in the feed, and we operate at relatively high recoveries. Therefore, we must take the resulting osmotic pressure into account because it becomes a large percentage of the operating pressure. Thus, it has a considerable effect on permeate rate for a given set of conditions.

EXAMPLE 2

Let us calculate the same parameters for a typical plating application:

(A) $$C_{conc} = \frac{C_{feed}}{1 - \text{Recovery}}$$ where: Recovery = 95% = 0.95

C_{feed} = 2500 ppm

$$C_{conc} = \frac{2500}{1 - 0.95} = \frac{2500}{0.05} = 20\,(2500) = 50{,}000 \text{ ppm}$$

(B) $$C_{avg} = \frac{C_{feed} + C_{conc}}{2}$$ where: C_{feed} = 2500 ppm

C_{conc} = 50,000 ppm

$$C_{avg} = \frac{2500 + 50{,}000}{2} = \frac{52{,}500}{2} = 26{,}250 \text{ ppm}$$

This average concentration will result in an osmotic pressure of approximately 260 psig (17.9 bar), assuming NaCl, and is a large percentage of the operating pressure, P_{op}. This must be taken into account when sizing machines.

TABLE 1

SOME SAMPLE OSMOTIC PRESSURES

NOTE: 1. Percent concentration times 10,000 is equivalent to ppm or mg/L.

2. One oz/gal is equivalent to 7500 mg/L.

3. Linear interpolation can be used to estimate intermediate concentrations.

SALTS:	Concentration	Osmotic Pressure	
Sodium Chloride (NaCl)	0.5%	55 psi	3.8 bar
	1.0%	125 psi	8.6 bar
	3.5%	410 psi	28.2 bar
Sodium Sulfate (Na_2SO_4)	2.0%	110 psi	7.6 bar
	5.0%	304 psi	20.9 bar
	10.0%	568 psi	39.1 bar

Calcium Chloride ($CaCl_2$)	1.0%	90 psi	6.2 bar
	3.5%	308 psi	21.2 bar
Copper Sulfate ($CuSO_4$)	2.0%	57 psi	3.9 bar
	5.0%	115 psi	7.9 bar
	10.0%	231 psi	15.9 bar

	Concentration	Osmotic Pressure	
ORGANICS:			
Sucrose MW 342	3.3%	36 psi	2.5 bar
	6.4%	73 psi	5.0 bar
	9.3%	110 psi	7.6 bar
	24.0%	350 psi	24.1 bar
	30.0%	500 psi	34.5 bar
	35.0%	645 psi	44.4 bar
Dextrose (glucose) MW 198	3.3%	62 psi	4.3 bar
	9.3%	190 psi	13.1 bar
	24.0%	605 psi	41.7 bar
	30.0%	863 psi	59.5 bar

For other organics, use the following ratio:

$$\frac{\text{MW of Sucrose}}{\text{MW of Organic}} \times \pi \text{ sucrose} = \pi \text{ organics}$$

USING OSMOTIC PRESSURE

When dealing with a solution which has a high osmotic pressure, the effect of $\Delta\pi$ becomes significant and the basic equation of reverse osmosis also becomes important. This equation is:

$$P_{eff} = P_{op} - \Delta\pi \qquad \text{(Eq. -5)}$$

where:

P_{op} = The operating pressure applied against the membrane

$\Delta\pi$ = The apparent osmotic pressure as discussed earlier

P_{eff} = The effective pressure available to force permeate through the membrane

When considering an application, the P_{eff} must be found in order to estimate the Q_{perm} that can be expected from a sepralator. The $Q_{perm,\,act}$ is the actual permeate rate for a particular system. Q_{perm} is the specified permeate rate when the effect of $\Delta\pi$ is negligible. To estimate:

$$Q_{perm,\,act} = \frac{P_{eff}}{P_{spec}} Q_{perm,\,spec} \qquad \text{(Eq. -6)}$$

where the P_{spec} is the pressure at which Q_{perm} is given. For PR and HR membranes, the $Q_{perm,\,spec}$ is given at P_{spec} = 400 psig (27.6 bar).

The next two examples will help to clarify the effect of $\Delta\pi$ and the method of calculating the expected permeate rate for a given sepralator.

EXAMPLE 3

Using Example 2, we found:

$\Delta\pi$ = 260 psi (17.9 bar)

If we are operating at an average pressure of 400 psig (27.6 bar) we have:

$P_{eff} = P_{op} - \Delta\pi$

P_{eff} = 400 psi (27.6 bar) - 260 psi (17.9 bar)

P_{eff} = 140 psi (9.6 bar)

To estimate the permeate rate for an OSMO-411T-ST10 sepralator we will use:

$$Q_{perm,\,act} = \frac{P_{eff}}{P_{spec}} Q_{perm,\,spec}$$

where:

$Q_{perm,\,spec}$ = 50 gph (189 Lph)

P_{spec} = 400 psig (27.6 bar)

P_{eff} = 140 psig (9.6 bar)

and therefore:

$$Q_{perm,\,act} = \frac{140 \text{ psig}}{400 \text{ psig}} (50 \text{ gph}) = 17.5 \text{ gph (66 Lph)}$$ per OSMO-411T-ST10 sepralator

In other words, we will get about 1/3 of the normal Q_{perm} from the sepralator due to the osmotic pressure effect. This OSMO machine will require three times the number of sepralators needed to produce the same amount of water as a water purification unit operating at lower recoveries.

EXAMPLE 4

Let us now look at a sugar application where both dextrose and sucrose are being concentrated. We will assume that the dextrose makes up 20% of the dissolved solids, DS, and sucrose makes up the remainder. Since over 99.9% of both dextrose and sucrose are rejected by the SEPA®ST10 membrane, our equations will be quite accurate.

Assume we start with a 2% sugar solution and want to remove 90% of the water. We have a required recovery of 90%. Using Equation 3 we have:

$$C_{conc} = \frac{2\%}{0.1} = 20\%$$

and Equation 4 gives:

$$C_{avg} = \frac{2\% + 20\%}{2} = 11\%\ DS$$

We know that 20% of the DS is dextrose and 80% is sucrose so we have:

Sucrose = 0.80 x 11% = 8.8% DS

Dextrose = 0.20 x 11% = 2.2% DS

With Table 1 we can estimate the osmotic pressure for the individual sugars. We have:

For Sucrose:	6.4% =	73 psi (5.0 bar)
	8.8% =	$\Delta\pi_{suc}$ psi
	9.3% =	110 psi (7.6 bar)

and using proportions:

$$\frac{\Delta\pi_{suc} - 73}{110 - 73} = \frac{8.8 - 6.4}{9.3 - 6.4}$$

$$\Delta\pi_{suc} - 73 = \frac{2.4}{2.9}(37)$$

$$\Delta\pi = 31.6 + 73 = 105 \text{ psi } (7.2 \text{ bar})$$

For Dextrose:	0% =	0 psi (0 bar)
	2.2% =	$\Delta\pi_{dex}$
	3.3% =	62 psi (4.3 bar)

and

$$\frac{\Delta\pi_{dex} - 0}{62 - 0} = \frac{2.2 - 0}{3.3 - 0}$$

$$\Delta\pi_{dex} = 41.4 \text{ psi or } 42 \text{ psi } (2.90 \text{ bar})$$

The osmotic pressure of different components of a solution are additive so the total osmotic pressure, $\Delta\pi_{tot}$, will be the sum of the $\Delta\pi$ of about 268 psi (18.5 bar). It will probably be best to operate at 500 psig (35.5 bar) in order to get more Q_{perm} per sepralator and yet keep membrane compaction as low as possible. Using P_{op} = 500 psig (34.5 bar), the average effective pressure is:

$$P_{eff} = 500 - 147 = 353 \text{ psi } (24.3 \text{ bar})$$

and the average Q_{perm} per sepralator for OSMO-411T-ST10 sepralators using Eq. 6 is:

$$PR_{act} = \frac{353}{400}(50) = 44 \text{ gph } (167 \text{ Lph}) \text{ per sepralator.}$$

Remember that this is an estimated Q_{perm} and that factors such as recycle rate, recovery, and tendency to foul can have strong effects on the actual operation, Q_{perm}. As a general rule, the P_{op} should be at least 100 psig (6.9 bar) greater than the $\Delta\pi$ of the concentrate. It is best to try to keep P_{op} at least 200 psig (13.8 bar) over the $\Delta\pi$ of the concentrate; however, compaction effects must be carefully weighed when P_{op} exceeds 500 psig (35.5 bar).

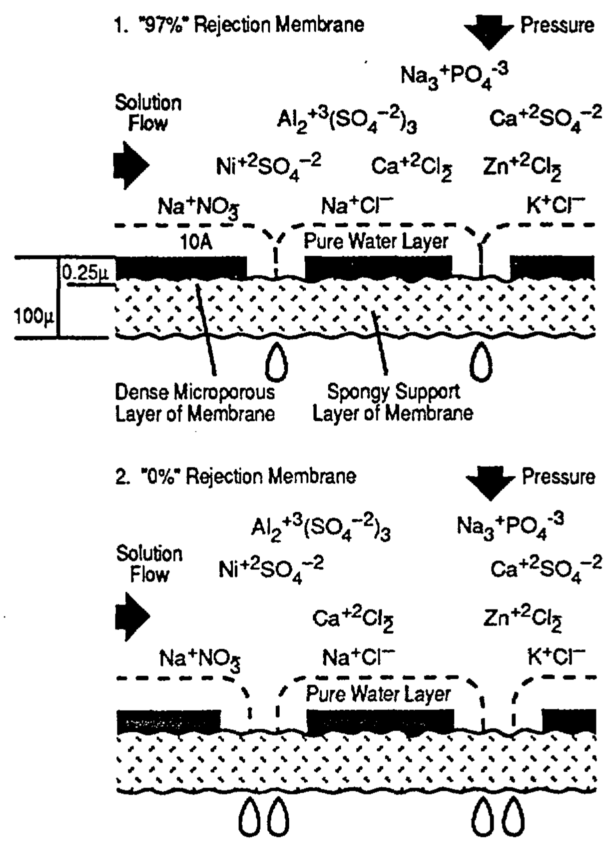
Another "rule of thumb" is that elements which have similar general properties will tend to have similar osmotic pressures for their salts. For example, nickel cadmium and copper are similar elements, are in close proximity in the periodic table, and the sulfate salts they form have nearly identical osmotic pressure concentration data.

To obtain $\Delta\pi$ for unknown solutions use a PES/OSMO unit as outlined in the "PES – Questions and Answers" Engineering Memo.

THERE ARE TWO FUNDAMENTAL MECHANISMS OF REJECTION AT WORK IN THE REVERSE OSMOSIS PROCESS.

1. Mechanism of Salt Rejection. Refer to Figure 6. The dissolved, ionized salts each carry an electrical charge the magnitude of which is a function of the valence and the "activity" of the ion. The ion is, in general, repelled away from the surface of the membrane to a degree proportional to its valence.

Figure 6



Higher valence ions are repelled farther than lower valence ions. The rejection of each ion by a membrane is a result of its valence. (Refer to Table 2.)

The repulsion of ions away from the membrane (dielectric effect) causes a very thin layer of pure water to form on the surface of the membrane, aided by the preferential sorption of pure water to the membrane surface, and the pressure on the solution forces some of the pure water molecules through the pores.

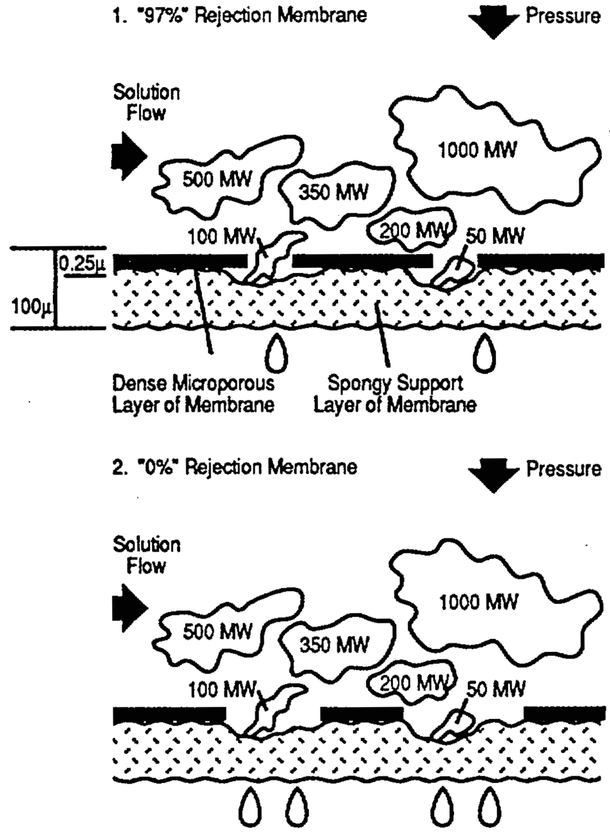
The ions are generally considered to be repulsed away from the surface of the membrane because of an electrostatic "di-pole" effect, similar to like poles of a pair of magnets, that is set up between the charged ion and the surface of the membrane by virtue of a "mirror" effect. In other words, the charge on the ion sets up or induces an equal and like charge on the membrane surface which, in turn, causes a force or repulsion to exist between the membrane and the charged ion. Due to this effect, the rejection of dissolved ionized salts by reverse osmosis can be considered as a physico-chemical or an electro-chemical interaction between the membrane and those constituents in the solution, and hence it can be considered to be chemically filtered.

2. Mechanism of Organic Rejection. Refer to Figure 7. Dissolved organics are rejected primarily by a screening or "sieving" mechanism (as are emulsed or suspended solids). The rejection of any given organic molecule is a function of membrane pore size, molecule size and the geometry of the molecule, (i.e., length to diameter ratio, etc). The size of an organic molecule is, in general, directly related to its molecular weight. There are exceptions; for example, a slightly ionized organic molecule will have a larger "apparent" size.

Referring to Table 2, we notice that some small organics may be enriched in the permeate due to preferential passage through the membrane. These molecules are actually adsorbed toward the membrane and because of their small size readily pass through the membrane faster than water.

It is sometimes desirable and necessary to be able to predict the quality of the permeate water one can expect, given a specific input feed analysis and recovery rate. (Permeate quality is, of course, a function of input feed concentration, average concentration in the machine and concentrate concentration).

Figure 7



In order to determine what concentration one can expect in the permeate of any given constituent in the feed, follow these steps:

1. At any stipulated recovery, calculate what the average concentration of a given constituent will be in the machine using Equation 3 and 4.

2. Refer to Table 2 for percent passage. For example, the passage of the cation sodium is given as 4%.

3. Take the average concentration figure from (1), multiply it by the passage figure from (2), and the result is the concentration of that constituent which will appear in the permeate.

EXAMPLE 5

a. Recovery = 80%

b. Na^+ = 100 ppm in feed

c. SEPA-HR

Using Eq. 3

1. $C_{conc} = \frac{C_{feed}}{(1 - \text{Recovery})} = \frac{100}{1 - 0.8} = \frac{100}{0.2}$

   $= 5(100) = 500$ ppm

Using Eq. 4

2. $C_{avg} = \frac{C_{feed} + C_{conc}}{2} = \frac{100 + 500}{2}$

   $= \frac{600}{2} = 300$ ppm

3. $C_{perm} = C_{avg}$ x passage*

   $C_{perm} = 300 \times 0.04 = 12$ ppm

   *From the Table for SEPA-HR membrane (Na has 96% rejection or 4% passage).

NOW:

4. For SEPA-SR membrane, the permeate concentration is:

   $C_{perm} = 300 \times 0.08 = 24$ ppm or double the permeate concentration with the SEPA-HR sepralator.

As you can see from the examples, passage is a more appropriate term than rejection. Passage is more useful in defining permeate quality. Keep in mind that the passages in Table 2 are given for the SEPA-HR membrane, and the SEPA-SR membrane passes about twice as much salt as the SEPA-HR does. Hence, the passage of the sulfate ion on the SEPA-HR membrane would be 0.01(1%) and the passage of the sulfate ion by the SEPA-SR membrane would be 0.02 (2%).

Another reason to think in terms of passage is that, while it appears to be a very small change from 99% rejection to 98% rejection, it is more accurate to describe the change as 1% passage to 2% passage, which is a 100% difference. This is a dramatic change which will cause the conductivity of the water to double.

MEMBRANE REJECTIONS:

Organics are rejected mainly on a size basis, with a cut-off between 100 and 200 molecular weight for the SEPA-HR or HR(PA) membranes. Compounds which react in water similarly to salts (i.e., they are partially ionized) but are organic in nature will still be rejected to some extent when the molecular weight is less than 100.

The SEPA-SR and PR membranes cut off around 250 and 300 MW respectively. The SR passes approximately twice as much salt and the PR about three times as much salt as the SEPA-HR membrane does.

Note: The following rejections are based on the average concentration for a membrane. If a system has 50% recovery, part of the membrane sees the feed concentration and part of the membrane sees a concentration that is double the feed concentration. Likewise, at 75% recovery the final concentration increases to 4 times the feed. For estimating purposes, take an average of the feed and the concentrate and use the average to figure the expected purity of the permeate.

TABLE 2

TYPICAL MEMBRANE REJECTIONS

SALTS

Name	Symbol	Percent Rejection	Percent Passage (Average)	Maximum Concentration Percent
CATIONS				
Sodium	Na^{+}	95-97	4	3-4
Calcium	CA^{+2}	96-98	3	*
Magnesium	Mg^{+2}	96-98	3	*
Potassium	K^{+1}	95-97	4	3-4
Iron	Fe^{+2}	98-99	2	*
Manganese	Mn^{+2}	98-99	2	*
Aluminum	Al^{+3}	99+	1	5-10
Ammonium	NH_4^{+1}	88-95	8	3-4
Copper	Cu^{+2}	98-99	1	8-10
Nickel	Ni^{+2}	98-99	1	10-12
Zinc	Zn^{+2}	98-99	1	10-12
Strontium	Sr^{+2}	96-99	3	-
Hardness	Ca and Mg	96-98	3	*
Cadmium	Cd^{+2}	96-98	3	8-10
Silver	Ag^{+1}	94-96	5	*
Mercury	Hg^{+2}	96-98	3	-
ANIONS				
Chloride	Cl^{-1}	95-97	4	3-4
Bicarbonate	HCO_3^{-1}	95-96	4	5-8
Sulfate	SO_4^{-2}	99+	1	8-12
Nitrate	NO_3^{-1}	93-96	6	3-4
Fluoride	F^{-1}	94-96	5	3-4
Silicate	SiO_2^{-2}	95-97	4	-
Phosphate	PO_4^{-3}	99+	1	10-14
Bromide	Br^{-1}	94-96	5	3-4
Borate	$B_4O_7^{-2}$	35-70**	-	-
Chromate	CrO_4^{-2}	90-98	6	8-12
Cyanide	CN^{-1}	90-95**	-	4-12
Sulfite	SO_3^{-2}	98-99	1	8-12
Thiosulfate	$S_2O_3^{-2}$	99+	1	10-14
Ferrocyanide	$Fe(CN)_6^{-3}$	99+	1	8-14

*Must watch for precipitation, other ion controls maximum concentration.
**Extremely dependent on pH; tends to be an exception to the rule.

The following are typical rejections of salts and organics using the OSMO-411-HR sepralator. As can be seen divalent ions tend to reject better than monovalent ions. If monovalent ions are combined with divalent ions, the rejection will be controlled by the divalent ion.

For estimating purposes, take an average of the feed and the concentrate and use this average concentration to figure the expected purity of the permeate.

Salts complexed with organics of large molecular weights will tend to act like the organics they are complexed with.

ORGANICS

	Molecular Weight	Percent Rejection	Maximum Concentration Percent
Sucrose sugar	342	100	25
Lactose sugar	360	100	25
Protein	10,000 Up	100	10-20
Glucose	198	99.9	25
Phenol	94	***	—
Acetic acid	60	***	—
Formaldehyde	30	***	—
Dyes	400 to 900	100	—
Biochemical Oxygen Demand	(BOD)	90-99	—
Chemical Oxygen Demand	(COD)	80-95	—
Urea	60	40-60	Reacts similar to a salt
Bacteria & virus	50,000-500,000	100	—
Pyrogen	1000-5000	100	-

***Permeate is enriched in material due to preferential passage through the membrane.

GASES, DISSOLVED

Carbon dioxide	CO_2	30-50%
Oxygen	O_2	Enriched in permeate
Chlorine	Cl_2	30-70%

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Paper #29

REVERSE OSMOSIS / ULTRAFILTRATION APPLICATION TO WATER REUSE AND MATERIAL RECLAMATION

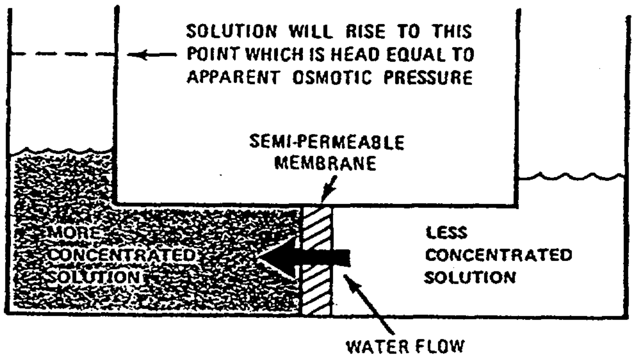
®

REVERSE OSMOSIS/ULTRAFILTRATION APPLICATION TO WATER REUSE AND MATERIAL RECLAMATION

By: D. Dean Spatz
President
Osmonics, Inc.
May 1, 1975

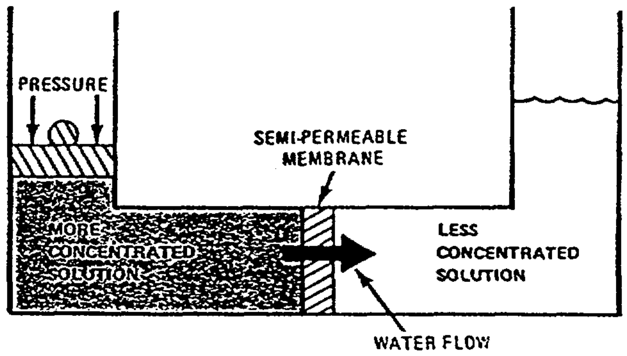
INTRODUCTION:

This paper is purposely short and none of the subjects are treated in depth in order to allow the reader to observe the overall breadth of reverse osmosis (RO) and ultrafiltration (UF) for water reuse and material reclamation from waste solutions. A few paragraphs are devoted to the difference between RO and UF. The technical aspects of how RO/UF works are reviewed. Examples of typical systems presently in operation for water reuse and material reclamation are discussed in the last half of the paper. The author has more complete papers on all of the subjects discussed in this paper. Please send a written request if you wish more detail on a particular subject.



OSMOSIS

FIGURE 1



REVERSE OSMOSIS

FIGURE 2

THE PROCESS:

The process of reverse osmosis is usually described by the two diagrams, Figure 1 and Figure 2. Figure 1 depicts osmosis where water flows through a semi-permeable membrane from a less concentrated solution (LCS) to a more concentrated solution (MCS). Figure 2 depicts what we call reverse osmosis. With reverse osmosis a pressure applied to the more concentrated solution (MCS) causes water to flow through the same semi-permeable membrane into the less concentrated solution (LCS). This explanation of RO seems to be a little like "black magic" and very few people realize that RO can be explained with conventional energy relationships.

It is important that energy be considered. RO/UF is a method of removing dissolved materials from a solution without a phase change. This is a substantial energy saving over an alternative such as evaporation which requires a phase change to separate the two components. It requires nearly 0.7 KW just to supply the vaporization energy to change the phase of one liter of water from liquid to vapor. On the other hand, an RO machine operating on a water reuse application requires 0.003 KW to purify one liter of water. With RO the temperature of the water is not increased and there is no heat pollution to be concerned about.

Figure 3 indicates a more technical way of describing osmosis and reverse osmosis. This figure is a diagram of relative energies. There has been no attempt at being quantitively correct. Without mechanical pumping energy, the highest energy state of water is pure water. As more impurities are added, the energy state decreases. A semi-permeable membrane can be placed at any point in this diagram to exclude the impurity and pass water. Refer to the "membrane A" line as an example. This is a membrane separating the LCS from the MCS. The water in the LCS has a higher energy state than the water in the MCS; therefore, the only available direction of water flow is from the LCS to the MCS. This is commonly called osmosis.

Referring to the "membrane B" line, indicating the same type membrane in a different location, the MCS has pumping energy added to it and the water in the MCS is now at a higher energy state than the water in the LCS. The only available direction of water flow is now from the MCS + pump energy to the LCS. This is commonly referred to as reverse osmosis.

Osmotic pressure or osmotic energy is important in reuse applications because many of the waste solutions are at high impurity concentrations. The higher impurity concentration requires more pumping energy to raise the MCS energy over the LCS energy. The energy required to raise the MCS energy up to the LCS energy is what is referred to as osmotic pressure or osmotic energy.

In RO/UF, pressure, usually supplied by a pump, must overcome the osmotic pressure before water can be forced through the membrane. Different impurities in waste solutions have different osmotic pressures so each individual impurity must be considered independently. Osmotic pressure increases with concentration of the impurity. Not all impurities increase the osmotic pressure at the same rate.

DEFINITION OF REVERSE OSMOSIS AND ULTRAFILTRATION:

This new field of membrane processing has established a distinction between RO and UF. Yet basically, the membrane that is used for RO is also used for UF. In membrane processing the impurities in a solution can be separated into ionic materials and non-ionic materials. Certain polar organics can be considered to be ionic.

The rejection or selective retention of ionic impurities by the membrane is based on the strength of the ionic charge. The ionic impurities are repelled by the membrane and are not allowed to pass through the membrane pore. Membranes that have pores of a sufficient size to reject ionic impurities are said to be RO membranes. RO has become generally accepted as the removal of ionic impurities from water by means of a membrane.

The rejection or selective retention of non-ionic impurities such as organics by the membrane is based on the size of the impurity compared to the pore size. Membranes that remove non-ionized impurities based on the size of the impurity are called UF membranes.

In this same example assume that the $CuSO_4$ waste is being produced at 1000 gal/hour. This means that RO removed 900 gallons of water per hour and the evaporator removed 75 gallons of water per hour. A 900 gph permeate rate RO for this application uses 27 Hp or 20.2 Kilowatts of energy per hour. The evaporator will evaporate 75 gph and use 622,000 Btu's or 180 Kilowatts of energy per hour. To do the entire job with the RO + evaporator the energy cost is 20.2 KW + 180 KW = 200.2 Kilowatts per hour.

If the $CuSO_4$ waste was handled entirely with evaporation, 975 gallons of water would be removed entirely with evaporation. This would require 8,100,000 Btu's per hour or 2350 Kilowatts of energy per hour.

The energy requirement using straight evaporation is 11.6 times the requirement for the RO/evaporation combination. The energy requirement per gallon to handle the waste is $2.35 per gal for evaporation and only $0.20 per gal for the RO/evaporation system.

WATER REUSE ONLY

With many waste solutions the value of the impurity is extremely low or it is very costly to segregate a valuable stream from others of little value. In these cases, the reuse of water is the only value received from the RO/UF unit. These applications are typically "end of pipe" type waste treatment. End of pipe treatment for water reuse should be implemented if:

Cost of Raw Water + Treatment Cost + Sewage Costs $>$ Cost of RO/UF Treatment

In many cases the only way one will meet the 1985 EPA Guidelines will be to use RO/UF after conventional waste treatment.

OSMO®5500-43-AB978 is first stage of a two stage "zero effluent" system supplied to a large mid-west manufacturer for a new plant. Total recovery on this system is 98%. End view shows proprietary S.S. pressure vessels and Osmonics unique manifolding. All connecting tubes have the same bend which allows easy replacement in the field. Plastic permeate lines with individual check valves are shown. Heat exchanger in foreground is integrally mounted. Note high pressure pump behind H.E. System has all standard "B Machine" controls except for pH. Capacity is 65 gpm permeate rate and size is 21' L x 4' W x 6' H. (February 1975)

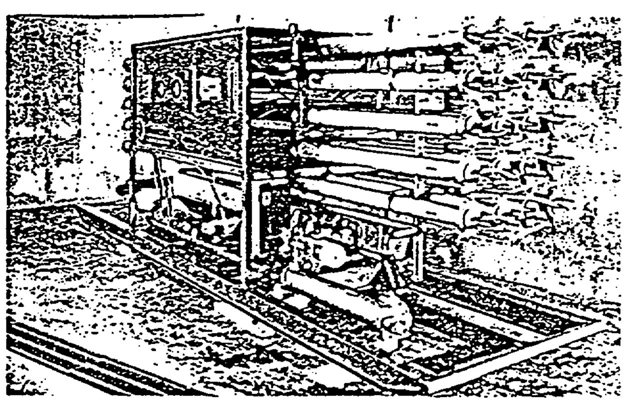


FIGURE 4

Figure 4, shows a typical RO machine used to recycle water after a conventional clarifier treatment of metal finishing waste. This is the second stage of a two stage RO system. Two stages were required because the customer required a maximum of 100 mg/l in the reused water and yet wanted a minimum concentrate flow. The overall percentage of waste water that is reused is 98%.

TWO STAGE METAL RECLAMATION SYSTEM. System has OSMO®-2750-43 SS978 (1st Stage) and OSMO-275-51-SS978 (2nd Stage) mounted on same skid. First stage recycles permeate to plating rinse tank at 790 gph while concentrate of 42 gph and approximately 60,000 mg/l TDS of nickel sulfamate is sent to a storage tank. When storage tank is full 2nd stage concentrates the nickel sulfamate further and returns the concentrate to the plate tank at approximately 7.8 gph and 300,000 mg/l. Panel has dual controls and each machine has its own complete set of instruments and controls. Stainless steel construction. (February 1975)

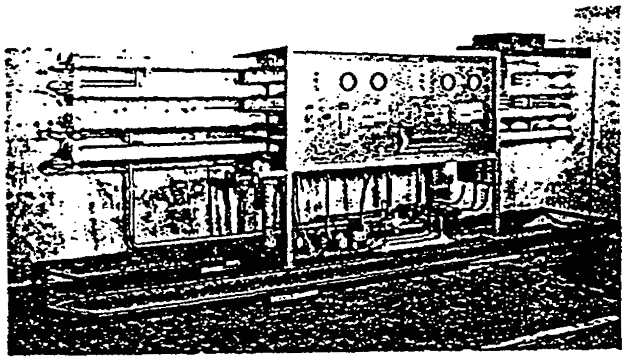
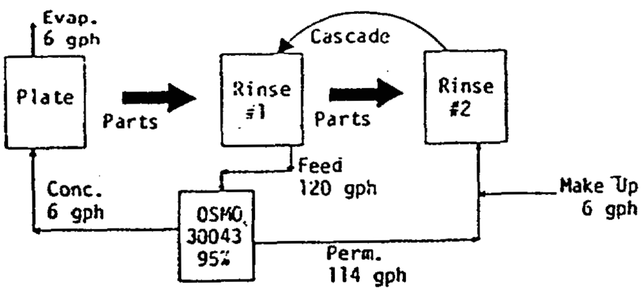


FIGURE 5

FIGURE 6



METAL RECLAMATION SYSTEM FOR NICKEL PLATING RINSE WATER

Figure 5 is a photograph of a typical METAL RECLAMATION SYSTEM. The system layout is shown in Figure 6. This system is set up to recycle the RO permeate back to the rinse and reuse the $NiSO_4$ and $NiCl_2$ as well as the expensive organic brighteners in the plating bath. This is typical of a situation where RO rejection of the salts is coupled with UF rejection of the brighteners to give paybacks on the initial cost of equipment of less than one year. Nickel plating is especially well suited for reuse because of the evaporation from the plating bath. In applications where there is little or no evaporation in the process, some means of water loss, such as evaporation, is usually required. The amount of water that should be evaporated is quite small, often only 3 gal/hour. Plating reuse applications other than nickel include chrome, copper and zinc plating baths.

An application that is similar to plating is the reclamation of silver from PHOTOGRAPHIC FIXER RINSE WATER. In this application the silver is not reused directly in the process. The silver is concentrated along with the sodium thiosulfate salts in the fixer rinse and then sold to a refiner.

Water soluble ELECTRO-DEPOSITION PAINT is reused in a similar fashion to the plating application. A UF unit operates on the paint and continuously removes water. This allows rinsing of the parts directly over the paint bath and eliminates waste treatment of the rinse. In this case, the reclamation of the valuable paint completely justifies the cost of the UF unit.

SOLUBLE OILS are very difficult to handle in conventional waste treatment. They are costly to break and require constant surveillance to be sure that the oil is breaking. By using RO or UF, depending on the molecular weight of the oil, the oil can be concentrated and reused. One application is in the textile industry where mineral oil is used to lubricate thread. This is an expensive oil and part of it is rinsed off with excess water. The RO/UF can then concentrate the rinse for reuse. The same system can be established for filtered cutting oils. Soluble cutting oils have been concentrated to 50% with RO/UF.

OSMO® -7930-16-SSOS3A Fractionation Machine for cheese whey. Uses OSMO ultrafiltration modules. Is constructed to 3A standards. System installed by Thomas Technical Services in Granton, Wisc. cheese plant. Handles 50,000 lb. of whey per hour to produce profitable milk replacer. (June 1974)

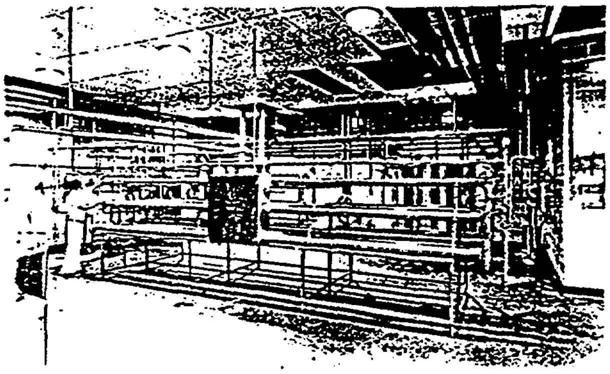


FIGURE 8

Right end of OSMO® Fractionation Machine showing the feed tubes as well as the permeate tubes and all stainless steel construction. (June 1974)

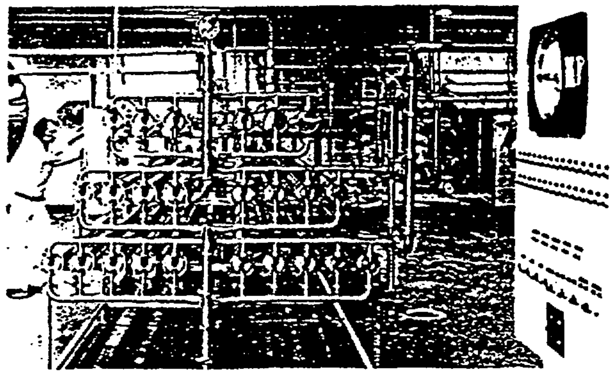


FIGURE 9

CONCLUSION:

The use of RO or UF for water reuse is dependent on the costs to reuse compared to the cost to process raw water and treat the waste. RO is the most economical method of meeting the E.P.A.'s 1985 "Zero Discharge" Guideline.

In order to reclaim material while reusing the water, the solution should be relatively pure. That is, it is best not to mix streams if material reclamation is contemplated. If material is reclaimed for reprocessing elsewhere, the system is easier to design. However, the cost savings are not as great as a system which reuses a material directly from the waste solution.

The optimum use of RO/UF in waste treatment is to reuse water as well as reusing material directly. A system where the reuse of material is contemplated must either have the entrance of no impurities into the system or there must be an available method (e.g. filtration, activated carbon) to remove impurities that do enter the system. Experience with over 100 RO/UF systems in operation, where water and material are reused, indicates that the material savings pay for the operating cost and initial capital cost in less than 18 months and often in less than 12 months.

- END -

APPENDIX E-4

MICROFILTRATION LITERATURE

National Environmental Technology Applications Corporation (412) 826-5511

NETAC

ENVIRONMENTAL PRODUCT PROFILES

Du Pont/Oberlin Membrane Microfiltration Process

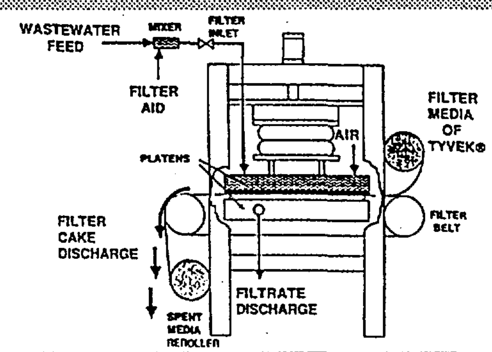
Process Description

▲ *Microfiltration*
▲ *Automatic Pressure Filter*

Reprinted from *Environmental Technology and Product Profiles*, a NETAC publication featuring innovative and emerging environmental technologies.

The Du Pont/Oberlin Membrane Microfiltration Process combines a unique filter medium (developed and commercialized by Du Pont) with an automatic pressure filter supplied by Oberlin Filter Company. The filter medium, designated as Tyvek® T-980, is a spun-bonded polyolefin material that can be used to remove 0.1-micron particulates from groundwater, wastewater, and other aqueous streams. Du Pont claims that the medium features superior filtration properties and longer life, and that it provides an alternative to microporous membranes, PTFE laminates, and various melt-blown media. The strength of the Tyvek® material allows it to be used in automatic pressure filters, thus allowing formulation of denser, dryer filter cakes. The process results in filter cakes containing 40 to 60% solids, and are said to provide a "dry-cake" alternative to conventional filter cartridges, cross-flow microfilters and ultrafilters. In certain instances, the system can replace the conventional three-stage metals treatment process of clarifier, underflow filter press, and overflow polishing sand filter. A schematic of the filter unit is provided in Figure 1.

FIGURE 1: PROCESS SCHEMATIC



Process Application

▲ *Groundwater*
▲ *Leachate*
▲ *Wastewater*

▲ *Metals*
▲ *Cyanides*
▲ *Particulate Matter*

▲ *Permanent/ Mobile*

The technology is most suitable for filtration of groundwater, leachate, wastewater, and other aqueous waste streams. Contaminants amenable to treatment include heavy metals and cyanides as well as other organic and inorganic material present as particulate matter of 0.1 microns or greater. Potential applications include treatment of industrial wastewaters, low-level radioactive wastes, plant equipment/floor washings, cyanide wastes, plant wastewaters containing heavy metals, and metals grinding wastes. Previous applications include treatment of effluent streams from electronics manufacturing facilities, a munitions plant, and a battery manufacturing plant. Table 1 provides performance data from an application using the system for direct filtration of a low-level radioactive plating waste generated at the Savannah River Plant, a U.S. Department of Energy facility producing specialty nuclear materials near Aiken, South Carolina. This application involved replacement of a clarifier, sand filter, and underflow filter press with the Du Pont/Oberlin system. The system can be furnished as part of a permanent installation or as a trailer-mounted system for on-site remediation activities such as lagoon cleanup or groundwater treatment.

TABLE 1: PERFORMANCE DATA

Parameter	Concentration (ppm) Influent	Effluent
Aluminum	127	0.95
Copper	2.0	< 0.1
Lead	1.6	0.2
Uranium	2.3	0.01
Zinc	0.5	< 0.1
TSS	687	1.4

Note: Results are based on use of the Du Pont/Oberlin Membrane Microfiltration Process to treat Savannah River Plant wastewater at a raw waste flow rate of 35,000 GPD.

VENDORS: Du Pont Engineering Department L1359 P.O. Box 6090 Newark, DE 19714-6090 (302) 366-3652
Oberlin Filter Company 404 Pilot Court Waukesha, WI 53188 (414) 547-4900

ENVIRONMENTAL PRODUCT PROFILES

Du Pont/Oberlin Membrane Microfiltration Process

Process Operation

- ▲ *Batch Operation*
- ▲ *Pretreatment*
- ▲ *Filter Platen*
- ▲ *Filter Chamber*
- ▲ *Pneumatic Controls*
- ▲ *Air Drying*

The filtration unit operates on a batch basis. Since the process is designed to remove solid particles, dissolved contaminants must first be converted to a particulate form using standard pretreatment operations (e.g., chemical precipitation, coagulation, flocculation, etc.). The automatic pressure filter apparatus consists of two compartments -- an upper compartment (filter platen) and lower compartment (filtrate chamber). These compartments are separated by Tyvek® filter fabric dispensed from a roll across the interface of the chambers. At the start of the filter cycle, pneumatic controls lower the filter platen against the filter chamber, thus forming a seal against the filter medium. Influent water is then pumped into the platen and through the filter medium, after which the filtered liquid is collected in the lower compartment and drained out. When the filter pressure reaches 30 to 50 psi (depending on the model), pressurized air is fed into the platen to dry the filter cake and medium. The filter platen is then pneumatically lifted and the filter cake is discharged by a conveyor belt (or by a conveyor motor which pulls the Tyvek® through), after which new filter fabric is automatically rolled into place and a new filtration cycle is started. The filter cake typically is disposed off site, while the filtrate is discharged in accordance with applicable regulations. The entire process can be controlled by a programmable logic controller. Filter aids, stabilizing agents, or flocculants can be added in-line, if required. Table 2 summarizes typical operating parameters.

TABLE 2: TYPICAL OPERATING PARAMETERS

Feed solids	10 to 5,000 mg/l
Flow rate	5 to 250 gpm
Operating pressure	30 to 50 psig
Required utilities	
Compressed air	40 SCFM @ 90 psig
Electricity	110V single-phase, 460V 3-phase
Domestic water	As required for wash down

Vendor Information

- ✓ ▲ *Bench*
- ✓ ▲ *Pilot*
- ✓ ▲ *Commercial*

Founded in 1802, Du Pont began manufacture of its Tyvek® series of polyolefins in 1970 and initially supplied the material for use in disposable garments, envelopes, and wrappings. Oberlin Filter Company, a division of Production Service Co., Inc., is a privately held company headquartered in Waukesha, Wisconsin. Oberlin and Du Pont have had a working relationship spanning 10 years, and introduced the DuPont/Oberlin Membrane Microfiltration Process in 1987. Since then, the technology has been applied to treat industrial effluents at over 14 locations and is now being refined for remedial applications. Applications to date include those listed in Table 3. The technology was demonstrated at the Palmerton Zinc Superfund site (Palmerton, Pennsylvania) under the U.S. EPA SITE Program. This demonstration, conducted in April and May 1990, evaluated treatment of about 3,000 gallons of groundwater containing dissolved zinc as well as copper, cadmium, lead, selenium, and maganese. Results from this evaluation will be published in the near future.

TABLE 3: SELECTED APPLICATIONS

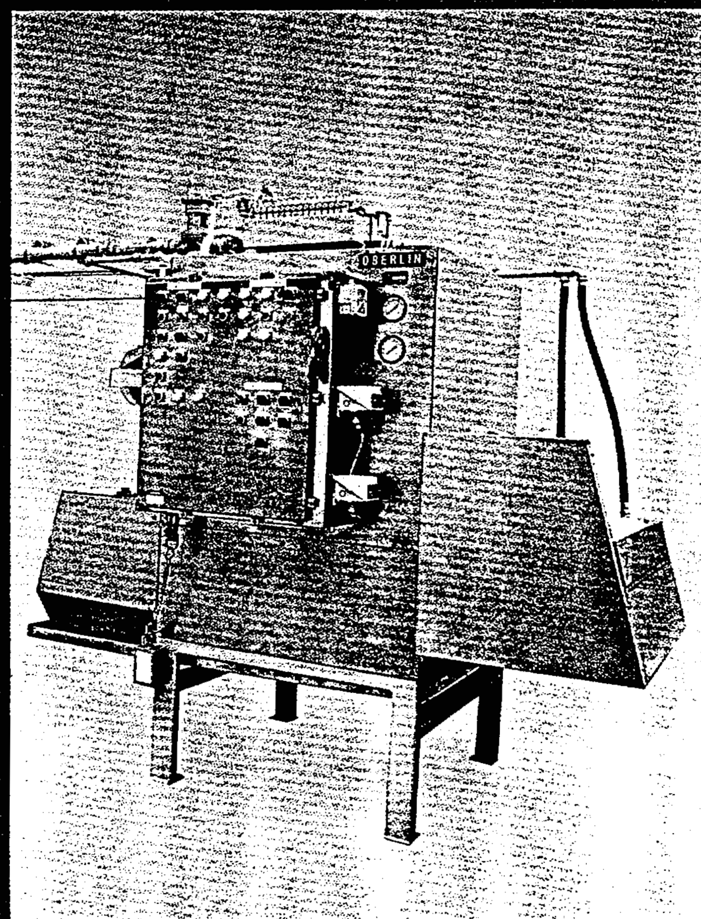
Date	Location	Flow (GPD)	Application
1985	CA	2,500	Removal of lead, cadmium, and barium from electronics manufacturing plant wastewater
1988	AR	7,000	Removal of copper, zinc, and lead from munitions plant wastewater
1989	TX	40,000	Removal of heavy metals from battery manufacturing plant wastewater
1991	TX	400,000	Removal of heavy metals from chemical plant acidic wastewater
1991	TX	30,000	Removal of lead from groundwater at a former lead manufacturing plant

OBERLIN PRESSURE FILTER

HIGH PERFORMANCE LIQUID FILTRATION

- COMPLETELY AUTOMATIC
- DRY CAKE DISCHARGE
- SOLIDS REMOVAL DOWN TO 0.5 MICRON PARTICLES
- VAPOR CONTAINMENT
- RECLEANABLE BELT OR DISPOSABLE MEDIA

LOW COST



OBERLIN FILTER COMPANY

OBERLIN

COMPLETELY AUTOMATIC OPERATION

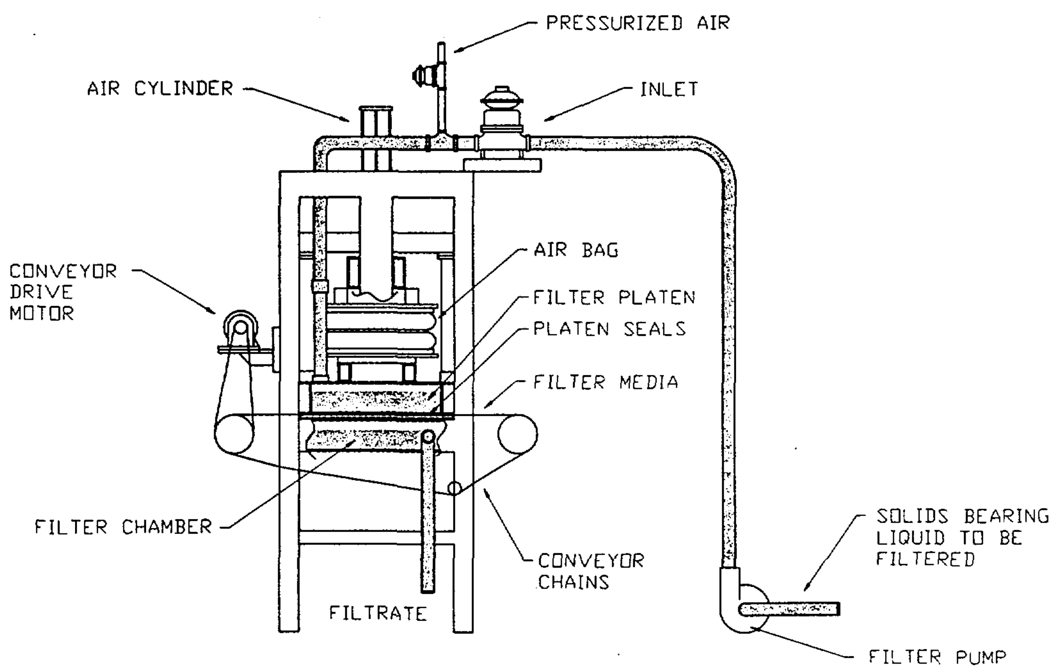
The OBERLIN PRESSURE FILTER has two compartments - an upper compartment or filter platen and a lower compartment or filter chamber. The platen moves while the chamber is fixed in place. The filter media lies between these two compartments.

At the beginning of a filtering cycle, pneumatic airbag(s) lower the filter platen against the filter chamber. Platen seals on the perimeter of the compartments form a liquid tight seal around the filter media. Solids bearing liquid is pumped into the platen and forced by the pump pressure through the filter media. The filtered liquid is collected in the lower compartment and drained out.

When the filter pressure reaches 30-50 psi (maximum, depending on the model), pressurized air is fed into the platen forcing the liquid through the filter cake and media. After the cake is dried (determined by backpressure and time elapsed), the platen is lifted by an air cylinder. The cake is then automatically discharged either by an endless conveyor belt or by simply pulling through the spent disposable media by a motor driven reroller. No hydraulics are used nor is there any mechanical squeezing.

After cake discharge the filter platen automatically descends and a new filtration cycle starts.

The filter area is the horizontal surface lying within the perimeter of the platen/filter chamber. The horizontal filter surface enables formation of thick filter cakes and easy precoating with filter aids such as Diatomaceous Earth (DE). Because of the horizontal surface prethickening is not required and small volume batches are easily filtered.

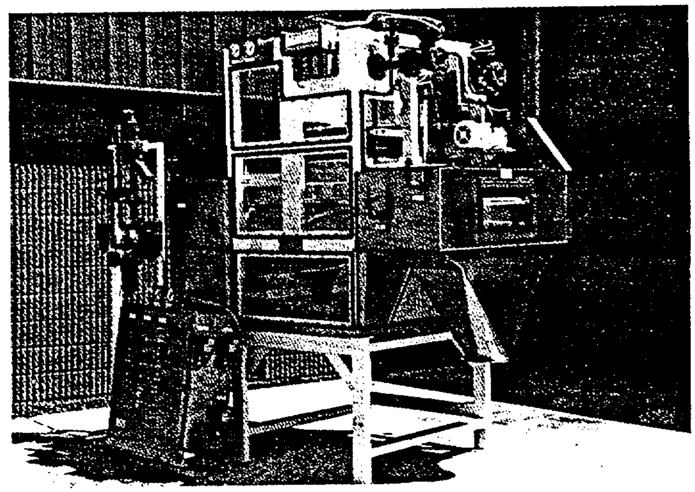


The filter structure is carbon steel. When required all wetted parts can be lined with 304/316 stainless steel or coated with Halar. Consult factory for special materials such as Titanium or Hastelloy C. The filter requires no special foundation. Electrical controls are based on either discrete relays and timers or programmable controllers. Explosion proofing is an option along with totally enclosed versions for vapor containment. Filter cakes can be washed and dried while inside the filter as part of an optional processing sequence.

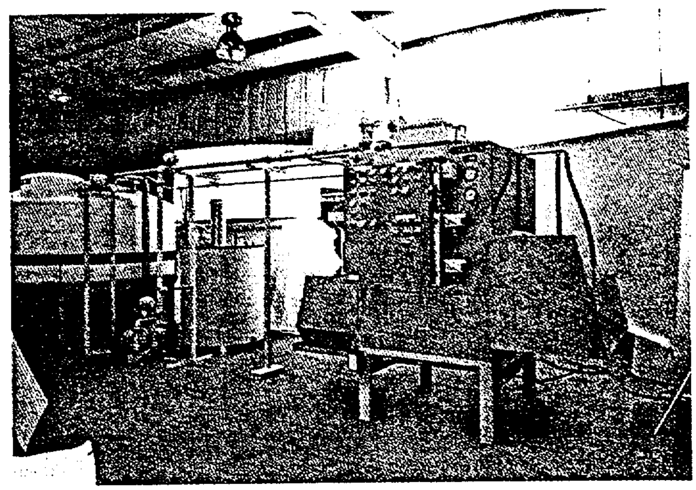
Complete systems available with automatic filter aid and polymer addition.

TYPICAL APPLICATIONS

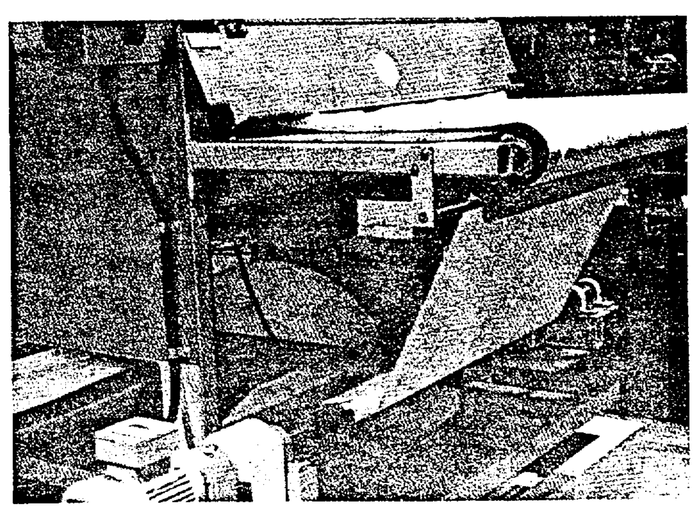
OPF7 used to filter low level radioactive waste dissolved in strong acid. Remote controls, explosion proof, complete vapor containment, cake washing features. Recleanable filter media. All wetted parts 316 SS.



OPF7 used to filter hazardous liquid waste. Washdown water from ceramic ball mills exceeds lead standards. Average particle size <1 micron. Using disposable TYVEK® filter media, filtrate meets 0.7 ppm lead standard and is discharged to sewer. Completely automatic diatomaceous earth and polymer injection system.



OPF7 used to filter oxamide from ammonium hydroxide. Methanol wash. Cake solids 75% by weight. TYVEK® disposable media used. All wetted parts 304 SS. Modified discharge - media rerolled which pulls cake out of filter. No conveyor used.



The OBERLIN PRESSURE FILTER has unique capabilities to meet the liquid filtration and dewatering requirements for chemical processes and hazardous waste.

- **30-50 PSI pressure differential** (depending on model) yields high quality filtrate since cake filtration can occur and high performance filter media such as TYVEK® can be used. Solids removal down to 0.6 micron particles with >93% retention using TYVEK® T980.
- **Completely automatic operation.** No operator required. Minimal exposure to hazardous material.
- **Dry cake discharge.** Pressurized air or inert gas will reduce moisture to a minimum. Simple belt discharge.
- **Versatility**
  - most commercially available disposable medias can be used.
  - recleanable belts can be used.
  - filter aid and polymer addition systems available.
  - filter cake wash available.
- **Easy access to filter chambers**
  - easy cleaning and maintenance.
- **Low operating costs**
  - high pressure differential uses disposable media efficiently.
  - recleanable filter belts inexpensive due to simple design.

SPECIFICATIONS

MODEL	FILTERING AREA (SQ. FT.)	LENGTH	WIDTH	HEIGHT (typical)	WEIGHT (lbs)	CAPACITY* lbs (dry wt.)/hr.
OPF-2	2.4	64″	33″	83″	1,300	125
OPF-4	4	78″	39 ½″	93″	2,000	200
OPF-7	7	97″	47″	96″	2,500	350
OPF-12	12	100″	67″	96″	4,000	600
OPF-24	24	145″	67″	96″	6,800	1,200
OPF-36	36	192″	67″	96″	10,000	1,800

* Nominal rates based on typical diatomaceous earth backwash slurry. Capacity will vary considerably depending on application. Cakes typically 50% solids (by wt.) for DE backwash type applications.

Filters available to rent for on-site testing. Factory lab support is standard.

Give us a call. We feel we have a truly unique, high performance filter to offer you at a price far below alternative approaches.

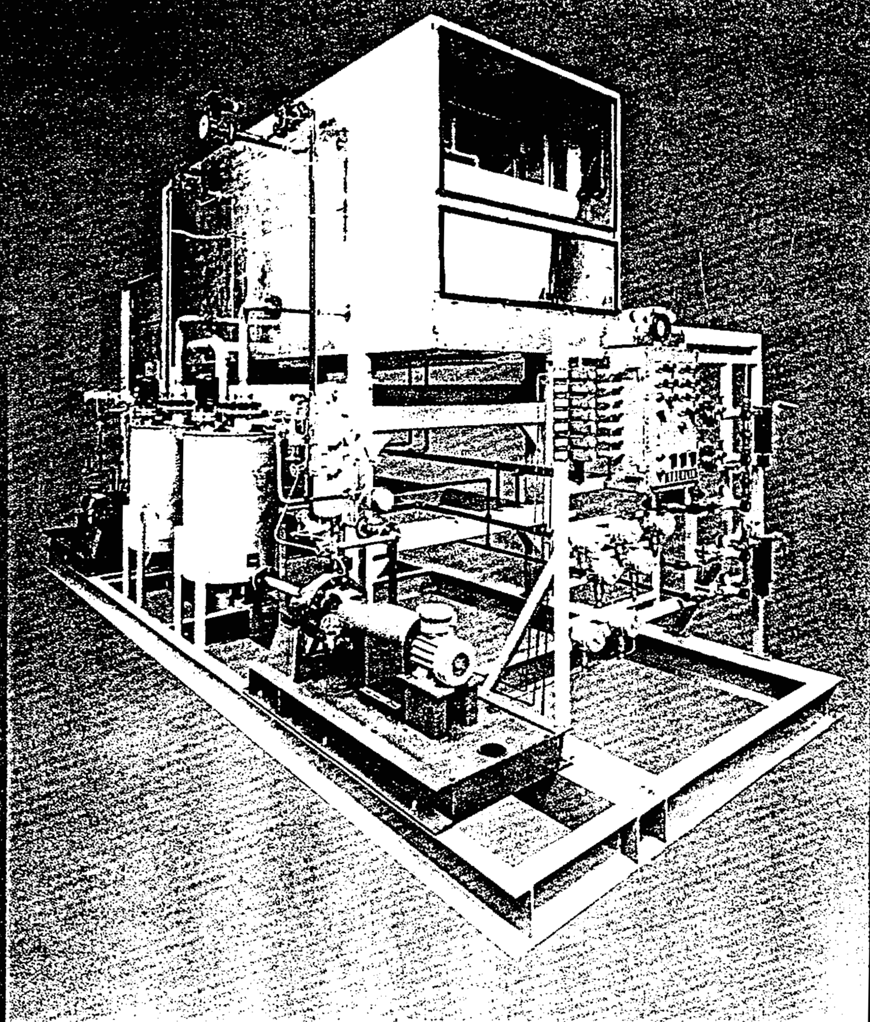
OBERLIN FILTER COMPANY
Division of Production Service Co. Inc.
404 Pilot Court
Waukesha, Wisconsin 53188
Phone: (414) 547-4900
Fax: (414) 547-0683

FOR MORE INFORMATION CONTACT

OBERLIN

TOP PERFORMANCE IN DEMANDING APPLICATIONS

36 ft. OBERLIN PRESSURE FILTER
Separating spent catalyst
from tertiary butyl alcohol
to allow recycling of TBA



Complete vapor containment with provisions for heating and insulation

Filtrate and recycle tanks included for this installation

API pumps with seal flushing required for this installation

TYVEK® filtration media shown

Complete electrical and pneumatic controls provided

Explosion proof

Installed outdoors at CPI company

All wetted parts 316 stainless steel

Skid mounted for ease in installation

United States
Environmental Protection
Agency

EPA/540/M5-90/007
February 1991

EPA

SITE
SUPERFUND INNOVATIVE TECHNOLOGY EVALUATION

Demonstration Bulletin

Membrane Microfiltration

E. I. DuPont de Nemours and Company, Inc.
Oberlin Filter Company

TECHNOLOGY DESCRIPTION: The DuPont/Oberlin microfiltration technology is a physical separation process that removes solid particles from liquid wastes. The process can filter particles that are submicron or larger in diameter. Pretreatment, such as chemical additions, will be required if dissolved contaminants are present in the liquid waste. The end microfiltration products are filtered solids, called filter cake, and filtered liquids, called filtrate.

The DuPont/Oberlin microfiltration system is transportable and requires little or no attention during operation. The system uses ‵erlin's automatic pressure filter and DuPont's special ,ınbonded olefin style filter material called Tyvek® T-980. The automatic pressure filter has two chambers—an upper chamber that feeds liquid waste under pressure through the Tyvek® and a lower chamber that collects the filtrate (Figure 1).

A typical microfiltration cycle consists of four steps: (1) initial filtration, (2) main filtration and cake forming, (3) cake drying, and (4) cake discharge. The process begins with liquid waste being pumped usually from a waste feed tank into the upper chamber. During the first minute of filtration, or the initial filtration step, the filtrate is usually recycled to the waste feed tank. During the main filtration step, solids accumulate on the Tyvek® and form a filter cake, while filtrate drains from the lower chamber to a filtrate collection tank. When the pressure in the upper chamber reaches a preset value (blowdown pressure), the waste feed valve closes and the cake drying step begins. Pressurized air (typically, 35 psig) is fed into the upper chamber to further dry the cake. After air breaks through the cake, drying continues for a preset time (blowdown time). During this step, any remaining liquids are forced through the Tyvek® and are recycled to the waste feed tank. Immediately following the cake drying step, the upper chamber is lifted, clean Tyvek® is drawn from a roll into the unit for the next cycle, and the filter cake is discharged.

WASTE APPLICABILITY: The combined DuPont/Oberlin microfiltration system has been applied to landfill leachate, groundwater containing cyanide, wastewaters containing uranium, and electroplating wastewaters containing heavy metals. The ‵echnology is best suited for treating wastes with solid concentra- ns less than 5,000 parts per million prior to pretreatment; .nerwise, cake capacity and handling become limiting factors.

DEMONSTRATION RESULTS: The DuPont/Oberlin microfiltration system was demonstrated at the Palmerton Zinc Superfund (PZS) site in Palmerton, Pennsylvania, over a 4-week period in April and May of 1990. During the demonstration, about 3,000 gallons of groundwater contaminated primarily with zinc from the PZS site were treated by the microfiltration system. The demonstration was carried out in four phases. Phases 1 and 2 involved nine runs each, and Phases 3 and 4 involved two runs each. Each run consisted of three cycles, as described above.

To evaluate the technology under different operating conditions, chemical operating parameters (precipitation pH and filter aid dose) and filter operating parameters (blowdown pressure and blowdown time) were varied in Phases 1 and 2, respectively. The precipitation pH was controlled by adding lime slurry to the untreated groundwater in the precipitation tank. A filter aid, ProFix, was added in-line prior to the microfiltration unit to improve the filtering characteristics of the precipitated solids. The filter operating parameters were set using the controls on the microfiltration unit. The operating conditions were varied as follows: pH, 8 to 10; ProFix dose, 6 to 14 g/L; blowdown pressure, 30 to 45 psig; and blowdown time, 0.5 to 3 minutes. Phase 3 runs were performed at optimum conditions, based on the results from Phases 1 and 2, to verify the reproducibility of the microfiltration system's performance. Phase 4 runs were performed to evaluate the reusability of the Tyvek® filter media.

Key findings from the technology demonstration are summarized below:

- The DuPont/Oberlin microfiltration system achieved the following: (1) zinc and total suspended solids (TSS) removal efficiencies ranged from 99.75 to 99.99 percent; and (2) the percent solids in the filter cake ranged from 30.5 to 47.1 percent. At the optimum conditions, shown in Table 1, the zinc and TSS removal efficiencies were about 99.95 percent; and the filter cake percent solids were about 41 percent.
- The treated groundwater (filtrate) met the applicable National Pollutant Discharge Elimination System (NPDES) standards, established for disposal into a local waterway, for metals and TSS at the 95 percent confidence level. However, the filtrate did not meet the NPDES standard for pH. The filtrate pH was typically 11.5, whereas the discharge standard is 6 to 9 pH units.
- The filter cake passed the paint filter liquid test (PFLT) in all runs. Also, a composite filter cake sample from the demonstration runs passed the extraction procedure (EP) toxicity and the toxicity characteristic leaching procedure (TCLP) tests.

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- ProFix contributed a significant portion (80 to 90 percent) of solids to the filter cake. The remaining solids were due to precipitated metals, TSS from the untreated groundwater, and any unreacted lime (from pH adjustment).
- The zinc and TSS removal efficiencies and the filter cake percent solids were unaffected by the repeated use (six cycles) of the Tyvek® filter media. This indicates that the Tyvek® media could be reused without adversely affecting the microfiltration system's performance.
- When operated in the automatic mode, the microfiltration system required little to no manual attention for several cycles.

A Technology Evaluation Report and an Application Analysis Report describing the complete demonstration will be available.

FOR FURTHER INFORMATION:

EPA Project Manager:
John F. Martin\U.S. EPA
Office of Research and Development
Risk Reduction Engineering Laboratory
26 West Martin Luther King Drive
Cincinnati, OH 45268
(513) 569-7758 (FTS: 684-7758)

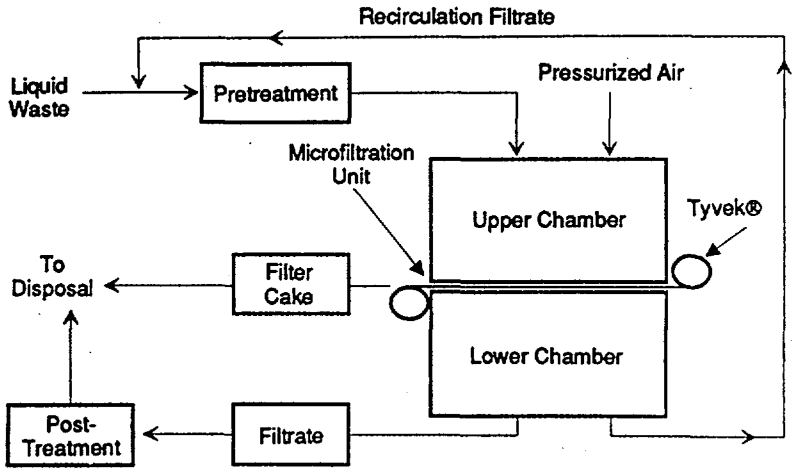

Figure 1. DuPont/Oberlin Microfiltration Process Diagram.

Table 1. Microfiltration System's Performance in Reproducibility Runs*

Run No.	Zinc in Untreated Groundwater, mg/L	Zinc in Filtrate, mg/L	Percent Zinc Removed	TSS in Influent to Microfiltration Unit, mg/L	TSS in Filtrate, mg/L	Percent TSS Removed	Percent Solids in Filter Cake
13	443.6	0.218	99.95	12,463	10.9	99.91	41.4
19	464.8	0.237	99.95	14,338	7.7	99.95	41.2
20	464.8	0.278	99.94	14,016	6.8	99.95	42.1

*Reproducibility runs were performed at Run 13 conditions: a precipitation pH of 9; a ProFix dose of approximately 12 g/L; a blowdown pressure of 38 psig; and a blowdown time of 0.5 minutes.

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Environmental Protection
Agency

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Cincinnati, OH 45268

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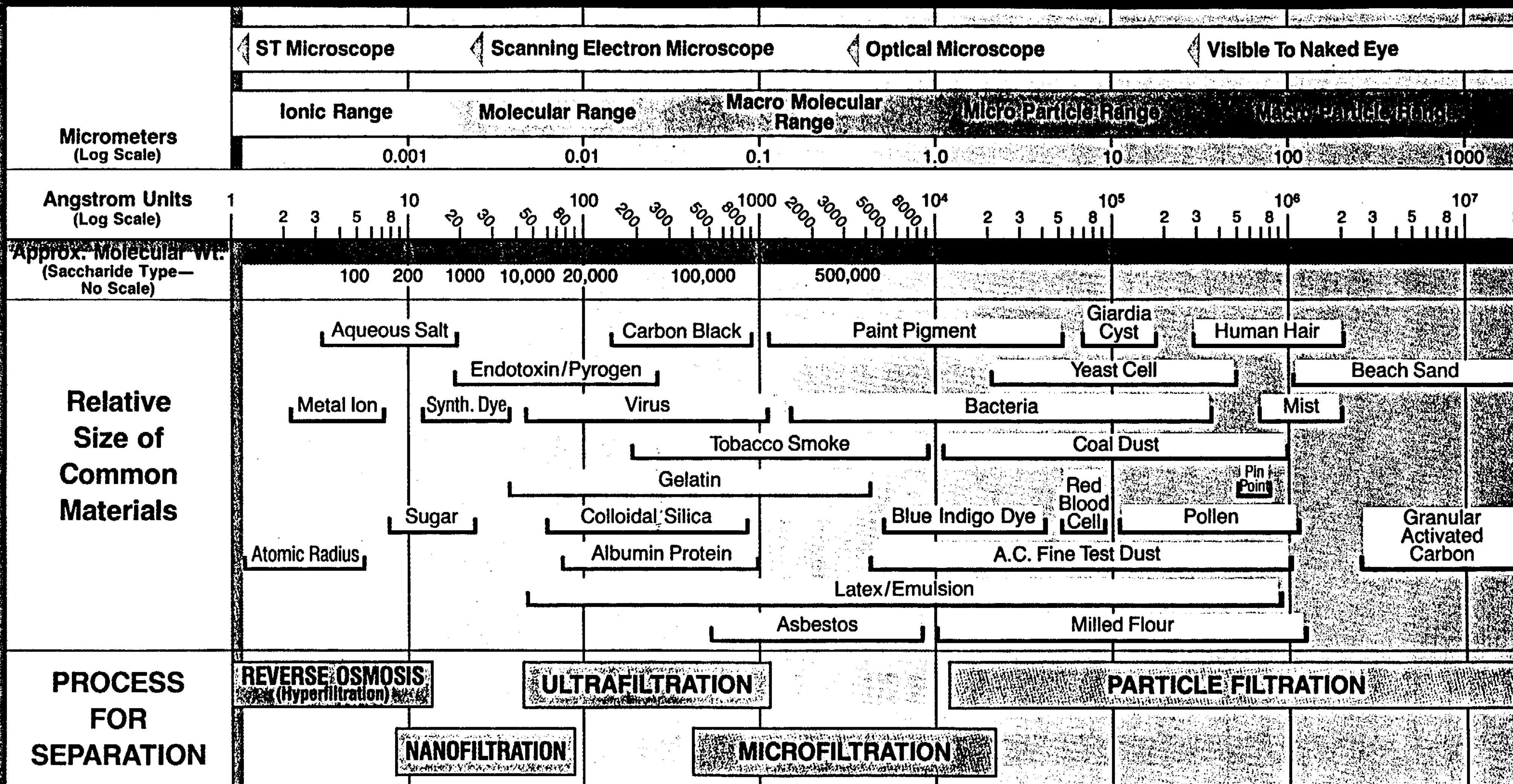
OSMONICS



Note: 1 Micron (1×10^{-6} Meters) ≈ 4×10^{-5} Inches (0.00004 Inches)
1 Angstrom Unit = 10^{-10} Meters = 10^{-4} Micrometers (Microns)

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Foster City, California

American Pump
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Vaponics, Inc.
Rockland, Massachusetts

Poretics Corp.
Livermore, California

Ghia, Inc./MACE Products
Upland, California

Ozone Research & Equipment Corp.
Phoenix, Arizona

Osmonics Asia/Pacific, Ltd.
Aqua Media of Asia, Ltd.
HONG KONG

Osmonics Europa, S.A./
Aqua Media International
Neuchatel, SWITZERLAND

Vaponics Thailand, Ltd.

SITE DEMONSTRATION OF MICROFILTRATION TECHNOLOGY FOR GROUNDWATER CONTAMINATED WITH METALS

John F. Martin
Risk Reduction Engineering Laboratory
U.S. Environmental Protection Agency
Cincinnati, Ohio 45268

Kirankumar Topudurti
Stanley Labunski
PRC Environmental Management, Inc.
Chicago, Illinois 60601

ABSTRACT

The Superfund Innovative Technology Evaluation (SITE) Program has as its major thrust the documentation of reliable performance and cost information for innovative alternative technologies so that they are developed, demonstrated, and made commercially available for the permanent cleanup of Superfund sites. Demonstration projects identify limitations of the technology, applicable wastes and waste media, potential operating problems, and the approximate cost of applying the technology.

A demonstration project was conducted with E.I. DuPont de Nemours & Company, Inc. and the Oberlin Filter Company to evaluate a microfiltration technology for removal of suspended solids from wastewater. The microfiltration system utilized DuPont's Tyvek® T-980 membrane filter media in conjunction with the Oberlin automatic pressure filter. The project was undertaken at the Palmerton Zinc Superfund site in April 1990 to evaluate the ability of the technology to remove zinc from the site's shallow groundwater. Pretreatment of the groundwater to precipitate dissolved zinc and other metals was included as part of the demonstration program. The treated filtrate indicated that the system removed precipitated zinc and other suspended solids at greater than 99.9%, and the filter cake produced during the study passed both the EP Toxicity test and the TCLP.

INTRODUCTION

Over the past few years, it has become increasingly evident that land disposal of hazardous wastes is at least only a temporary solution for much of the material present at Superfund sites. The need for more long-term, permanent treatment solutions as alternatives to land disposal has been stressed by recent legislation such as the Hazardous and Solid Waste Amendments of the Resource Conservation and Recovery Act (RCRA) as well as the Superfund Amendments and Reauthorization Act (SARA) of 1986. SARA directed the U.S. Environmental Protection Agency to establish an "Alternative or Innovative Treatment Technology Research and Demonstration Program," to identify promising technologies, assist with their evaluation, and promote the use of these technologies at Superfund sites. The Superfund Innovative

Technology Evaluation (SITE) Program resulted from that mandate.

The SITE Program is now in its sixth year of demonstrating technologies applicable to Superfund sites with 52 developers conducting 55 projects. The Program offers several advantages to participants, in addition both the Agency and technology developers benefit from the demonstrations. Primary benefits to developers include: experience gained from operating a commercial, field-scale process at a Superfund site; acquisition of valuable regulatory background; increased public awareness of the technology and its capabilities; and documentation of the applicability of the process to cleanup of hazardous waste sites.

Under the Demonstration Program, the developer and EPA participate in a joint venture to operate and evaluate a technology. In general, the developer is required to operate the technology at the selected location while EPA is primarily responsible for writing a demonstration plan, for all sampling and analytical operations, and for reporting and technology transfer activities.

Demonstrations at Federal or State Superfund sites (remedial or removal action sites), EPA test facilities, or at Federally owned sites are encouraged; however, if such sites are not available or not applicable, a developer's facility or a private site may be utilized. EPA is becoming increasingly flexible in the designation of appropriate sites as the Demonstration Program continues to evolve.

TECHNOLOGY DESCRIPTION

The demonstration project conducted by DuPont & Company, Inc., in conjunction with the Oberlin Filter Company, features a microfiltration system designed to remove solid particles from liquid wastes, forming a filter cake typically ranging from 30 to 50 percent solids. The filtration unit can be manufactured as an enclosed, trailer-mounted system, requiring little or no attention during operation. The system utilizes Oberlin's automatic pressure filter (APF) combined with DuPont's special Tyvek® T-980 filter media made of spun-bonded olefin. The Tyvek® material is a thin, durable fabric with openings of about one micron. During operation of the unit, it may be possible to get filtration down to the half-micron range or less. A microscopic view of standard Tyvek® material shows it to be only slightly porous, whereas the newer T-980 material has increased porosity and sub-micron filtration capability.

The APF, supplied by Oberlin, provides the support for pumping wastewater through the Tyvek® where solids accumulate to form a filter cake. Contaminated water is pumped across the filter fabric during the filtration cycle until build-up of a filter cake causes the feed pressure to rise to approximately 55 psig. At this point, the APF cuts the feed stream and switches to the cake dewatering cycle where air is blown through the filter cake to dry it prior to discharge. During the discharge cycle, the upper portion of the filter is raised and the filter cake is conveyed out of the filtration chamber on the used Tyvek® filter media as new material is drawn from the clean media roll into the filter chamber. The upper half of the filter then lowers, sealing the chamber above the Tyvek® for the next filtration cycle. The unit cycles through the complete operation automatically so that there is minimal worker exposure to hazardous materials.

The Oberlin APF is available in a variety of sizes from 2.4 square feet up to 36 square feet of filtering area. Similarly, Tyvek® filter media is produced in bulk rolls in several standard widths. The demonstration unit evaluated by the SITE Demonstration Program during the first three weeks of April 1990 was a 2.4-square foot, skid-mounted filter. Treatability tests conducted during July and October 1989, using groundwater from the demonstration site and a synthetic wastewater designed to simulate the groundwater, showed excellent performance by the filter in removing precipitated zinc and other suspended solids. In the July 1989 treatability test, on two separate groundwater runs with mean influent concentrations of 12,433 mg/l and 6,640 mg/l of TSS, the respective effluent concentrations of TSS were 44 mg/l and 23 mg/l.

DEMONSTRATION SITE

The microfiltration project was located at the Palmerton Zinc Superfund site in the Lehigh Valley of Pennsylvania. Contamination at the site resulted from smelting operations begun in 1889 by the New Jersey Zinc Company. In 1980 primary zinc smelting operations at the site were terminated, but secondary metal refining and processing operations continued under the ownership of the Zinc Corporation of America, a Division of Horsehead Industries, Inc.

The solid process waste or slag from the smelting operations has been disposed at the site since 1913, and by 1986 approximately 33 million tons of slag had accumulated in a pile nearly 2.5 miles long. Because of elevated levels of heavy metals in the surface water and groundwater of the Palmerton area, the slag pile site was included on EPA's National Priorities List of hazardous waste sites. Samples of the shallow groundwater at the site indicate that zinc is present at the highest levels (300-500 mg/l), while copper (0.02 mg/l), cadmium (1 mg/l), and selenium (0.05 mg/l) are present down to trace levels.

TECHNOLOGY EVALUATION

The demonstration was proposed to evaluate the overall ability of the DuPont/Oberlin treatment process to remove zinc from the groundwater at the Palmerton site. In order to accomplish this objective, field studies were designed to produce data relating to four primary aspects of the technology application:

1. Precipitation of metals from the groundwater with emphasis on zinc.

2. Filtration and dewatering of the metals precipitate.

3. Production of filtrate and filter cake to meet applicable disposal requirements.

4. Documentation of operating costs.

During Phase I of the demonstration program, operation of the APF remained unchanged while lime doses for metals precipitation, and ProFix (a filter aid material supplied by EnviroGuard, Inc.) doses for cake buildup and stabilization were varied. Nine separate runs (treatment batches) yielded data to indicate that optimum chemical addition rates were: lime addition to pH 9; ProFix addition at the rate of 12 grams per liter.

Optimum operating conditions for the APF were set during Phase II of the project. During the rest of the evaluation the chemical addition parameters were held constant. The two items varied during this phase were the pressure at which air was blown through the filter cake to dry it, and the length of time allowed for this function after all water was forced from the filter chamber and air broke through the filter cake. Taking into account the filtrate quality, the solids content of the cake, and the length of time (relating to the cost of treatment) for the drying cycle, the optimum operating conditions were set at a drying (blowdown) time of 0.5 minutes with 38 psig air.

Phase III provided two additional runs at the optimum operating conditions so that reproducibility of the treatment process could be evaluated. The influent zinc concentration in Phase II was reduced from 444 mg/l to 0.22 mg/l (99.95% removal), while in the two Phase III runs the zinc concentration was reduced from 465 mg/l to 0.24 and 0.28 mg/l (99.94 and 99.95% removal). Total suspended solids of 12,500 mg/l in the Phase II influent were reduced to 10.9 mg/l (99.91% removal), and TSS concentrations of 14,300 and 14,000 mg/l in the Phase III tests were lowered to 7.7 and 6.8 mg/l (indicating 99.95% removal).

Phase IV was designed to test the reusability of Tyvek® in the filter system. For this portion of the evaluation program, the filter media was rolled back into the APF following cake discharge. The same area of Tyvek was used for six filtration cycles with no apparent degradation or loss of filtering capacity.

Economic evaluation of the system will be reported in the Applications Analysis Report for this demonstration to be published in the Spring of 1991.

CONCLUSIONS

During optimum operating conditions the system removed zinc and TSS at a rate of 99.95%. Filter cake solids varied from approximately 30 to 47% with cake solids being 41% at optimum conditions for filtrate quality, chemical addition, and filter cycle time. The filtrate did meet applicable National Pollutant Discharge Elimination System (NPDES) permit limits for discharge to a local waterway for metals and TSS, (maximum daily discharge limits to Aquashicola Creek for zinc and TSS are 2.4 and 30 mg/l) but pH limits were consistently exceeded. The alkaline nature of the ProFix added to the feed stream to increase filtration capability consistently raised the effluent pH to 11.5, thereby violating the 6-9 limit. This condition is not critical, however, and can be mitigated by adding a pH adjustment step as a posttreatment option. The filter cake resulting from the process passed the paint filter liquids test for free liquids at all operating conditions, and a composite cake sample for the total demonstration successfully passed both the EP Toxicity and TCLP tests. A large scale system operating over a longer time might send the filter cake to a metals reclamation facility or a land disposal site.

APPENDIX E-5

ELECTROCHEMICAL TREATABILITY STUDIES AND OPERATING DATA

March 1990 - Bench-Scale Test Data

Andco Environmental Processes, Inc.
595 Commerce Drive, Amherst, NY 14150 (716) 691-2100/Telex 91-547

March 14, 1990

SHIELDALLOY CORPORATION
West Boulevard
Newfield, NJ 08344

Attention: Mr. Dave Smith

Subject: **Lab Report on Chrome Removal**

Dear Mr. Smith:

Six five-gallon groundwater samples (3 preserved, 3 unpreserved) were received on January 16, 1990. The results of the electrochemical (EC) treatability study are contained in this report.

<u>Sample Description:</u>

The deep yellow water samples were low in both turbidity and settleable particulate matter.

Upon receipt of the samples, hexavalent chromium and conductivity were measured. This data and sample designations are listed in Table 1.

<u>EC Treatment Procedure:</u>

The water samples were subjected to standard Andco electrochemical treatment tests. After determining the level of iron addition needed by evaluating untreated wastewater conditions, a known volume of sample was stirred and pH adjusted to between 7.0 and 9.0. Next, cold rolled steel electrodes were added and a specific amount of ferrous ion (Fe^{+2}) was generated in this mini-cell. Faraday's Law is used to determine generation time for a specific size sample at a known amperage. At pH >7.5, $Fe(OH)_2$ precipitates from solution and is capable of removing chrome by adsorption/coprecipitation processes. To allow hydrogen formed during EC treatment to dissipate, a ten minute degassing period is allowed. Following iron addition, pH adjustment is utilized to meet effluent requirements and also maintain pH close to the metal's point of minimum solubility. Andco 3640, an anionic polyelectrolyte, was added to assist floc formation and clarification. After thirty minutes of settling, the sample was filtered using Whatman filter paper.

Table 2 contains the treatability study designed in the Andco laboratory. All pH's of interest can also be found in this Table. Results obtained from analyses done at outside labs are located in Table 3.

Analyses:

Due to availability and turnaround time, two different analytical labs were utilized. Samples were sent to Ecology and Environment, Inc. (Lancaster, NY) and Alpha Analytical Laboratories, Inc. (Niagara Falls, NY). Past experience with them has shown that the results are reliable and can be used for comparison.

Conclusions:

The data in Table 3 indicates that chrome can be removed by Fe^{+2} addition and polymer (Andco 3640) assisted clarification. A substantial amount (350 ppm) of ferrous ion and pH adjustment, following iron generation to around 8.5, gave the best results. The range of 200 ppm Fe^{+2} (total chrome = 8 ppb) and 350 ppm Fe^{+2} (total chrome = 1.9 ppb) needs to be optimized. Optimization benefits include reduced sludge generation and sludge handling costs. If additional work is needed, we would be willing to help you optimize the treatment.

If you have any questions or comments, please feel free to contact Jack Reich or me at (716) 691-2100.

Sincerely yours,

ANDCO ENVIRONMENTAL PROCESSES, INC.

Michael D. Brewster

Michael D. Brewster
Research Chemist

MDB/cs

Table 1.

Andco I.D.	Client I.D.	Preserved	Conductivity umho	Cr^{+6} ppm
S-224-1	W-9	No	730	27.5
S-224-2	IW-2	No	1270	25.0
S-224-3	IW-2	Yes	–	–
S-224-4	SC6D	No	2560	32.5
S-224-5	SC6D	Yes	–	–
S-224-6	W-9	Yes	–	–

- Initial Cr^{+6} tests were done using a Hach Hexavalent Chromium Test Kit (Model CH-8).
- Conductivity and Cr^{+6} were not measured on the preserved samples since both would be altered when acidified.

Table 2.

Andco I.D.	pH initial	pH adj.	Fe^{+2} ppm	pH out	pH adj.
S-224-1A	8.74	7.86	100	9.97	7.83
S-224-1B	8.69	7.82	200	10.31	8.15
S-224-2A	7.36	7.50	100	9.56	7.55
S-224-2B	7.36	7.63	150	9.63	7.80
S-224-3A	1.23	7.61	100	9.31	8.17
S-224-3B[1]	1.23	7.32	200	9.57	8.52
S-224-4A	7.58	8.56	150	9.83	8.56
S-224-4B[1]	7.65	8.50	200	9.87	8.45
S-224-5A	1.26	8.49	100	9.85	8.45
S-224-5B	1.10	8.97	150	9.85	8.93
S-224-5C[1]	1.31	7.55	350	10.45	8.51
S-224-6A	1.23	8.61	150	10.05	–
S-224-6B[1]	1.23	8.58	200	10.42	–

1 Due to money restrictions, only four treated samples and two untreated (S-224-3 and S-224-4) were sent to an outside lab for analysis.

Table 3.

Andco I.D.	Fe^{+2} ppm	pH	Polymer ppm	Chromium Total ppb	Chromium Hex ppb
S-224-3	–	–	–	23,700	–
S-224-3B	200	8.52	5	8	–
S-224-4	–	–	–	–	17,500
S-224-4B	200	8.45	5	–	13
S-224-5C	350	8.51	5	1.9	–
S-224-6B	200	10.42	5	27	–

- pH data was relisted to show that pH adjustment (to around 8.5) prior to polymer addition needed. It is assumed that some chrome is returning to solution as the pH is increased.

May 1993 - Full-Scale Test Data

WELL INLET FLOWRATE

IW-2	113	GPM
SC6D	101	GPM
SC6S	97	GPM
LAYNE	49	GPM
W9	41	GPM
WELL TOTAL	401	GPM

IX INLET 427 GPM

PASSWORD - SECURITY MENU

Node Name [redacted]
Password to LOGON [redacted]
Password to LOGOFF [redacted]

Current Security Level 2
New password [redacted]
Current Owner PETE

Default
Security Level [redacted]

TREATMENT PARAMETERS

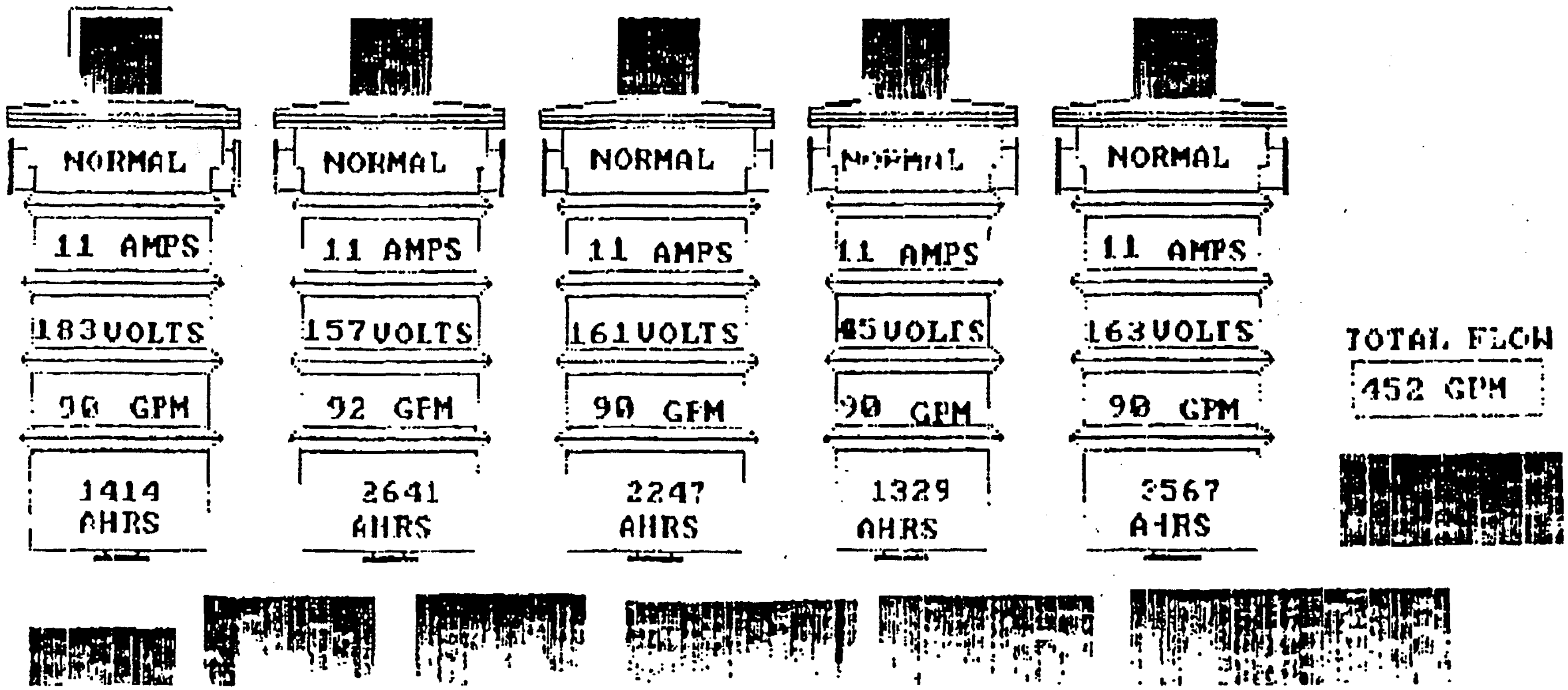
FLOWRATE	450	GPM
Cr^{+6} CONCENTRATION	10	PPM
TREATMENT RATIO (Fe/Cr)	50	RATIO x 10
CATIONIC POLYMER ADDITION	16	PPM x 10
ANIONIC POLYMER ADDITION	27	PPM x 10
pH HIGH CONTROL POINT	790	pH x 100
pH LOW CONTROL POINT	760	pH x 100

[redacted] [redacted] [redacted]

PASSWORD - SECURITY MENU

Node Name	[redacted]	Current Security Level	2
Password to LOGON	[redacted]	New password	[redacted]
Password to LOGOFF	[redacted]	Current Owner	PETE

ELECTROCHEMICAL CELLS



PASSWORD - SECURITY MENU

Node Name [redacted] Current Security Level 2
Password to LOGON [redacted] New password [redacted] Default
Password to LOGOFF [redacted] Current User PETE Security Level [redacted]

LMS

Order # 93-05-231
05/27/93 16:30

TEST RESULTS BY SAMPLE

Sample: 01A 5-21-93-2 ANDCO #4 COMP Collected: 05/21/93

Test Description	Result	Limit	Units	Analyzed	By
Cr+6 by Colormetric	5.86	0.01	ppm	05/26/93	KD

Sample: 02A 5-21-93-3 ANDCO #14 COMP Collected: 05/21/93

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	<1.0	1.0	ppb	05/26/93	KD
Cr+6 by Colormetric	<0.01	0.01	ppm	05/26/93	KD
Iron in Water, by ICP	0.01	0.01	ppm	05/26/93	GP
TDS by Gravimetric	700	0.01	ppm	05/26/93	KD

Sample: 03A 5-21-93-4B ANDCO #14 Collected: 05/21/93 15:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	<1.0	1.0	ppb	05/26/93	KD

Sample: 04A 5-21-93-5B ANDCO #14 Collected: 05/21/93 16:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	3.4	1.0	ppb	05/26/93	KD

Sample: 05A 5-21-93-6B ANDCO #14 Collected: 05/21/93 17:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	<1.0	1.0	ppb	05/26/93	KD

Sample: 06A 5-21-93-7B ANDCO #14 Collected: 05/21/93 18:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	1.1	1.0	ppb	05/26/93	KD

Sample: 07A 5-21-93-8B ANDCO #14 Collected: 05/21/93 19:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	<1.0	1.0	ppb	05/26/93	KD

Sample: 08A 5-21-93-9B ANDCO #14 Collected: 05/21/93 20:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	3.2	1.0	ppb	05/26/93	KD

Sample: 09A 5-21-93-10B ANDCO #14 Collected: 05/21/93 21:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	1.5	1.0	ppb	05/26/93	KD

Sample: 10A 5-21-93-11B ANDCO #14 Collected: 05/21/93 22:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	<1.0	1.0	ppb	05/26/93	KD

Sample: 11A 5-21-93-12B ANDCO #14 Collected: 05/21/93 23:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	<1.0	1.0	ppb	05/26/93	KD

Sample: 12A 5-21-93-13B ANDCO #14 Collected: 05/21/93 23:59

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	<1.0	1.0	ppb	05/26/93	KD

Sample: 13A 5-22-93-1 ANDCO #4 COMP Collected: 05/22/93

Test Description	Result	Limit	Units	Analyzed	By
Cr+6 by Colormetric	5.84	0.01	ppm	05/26/93	KD

Sample: 14A 5-22-93-2 ANDCO #14 COMP Collected: 05/22/93

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	1.4	1.0	ppb	05/26/93	KD
Cr+6 by Colormetric	<0.01	0.01	ppm	05/26/93	KD
Iron in Water, by ICP	0.02	0.01	ppm	05/26/93	GP
TDS by Gravimetric	700	0.01	ppm	05/26/93	KD

Sample: 15A 5-22-93-3B ANDCO #14 Collected: 05/22/93 01:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	<1.0	1.0	ppb	05/26/93	KD

Sample: 16A 5-22-93-4B ANDCO #14 Collected: 05/22/93 02:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	3.8	1.0	ppb	05/26/93	KD

Sample: 17A 5-22-93-5B ANDCO #14 Collected: 05/22/93 03:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	1.9	1.0	ppb	05/26/93	KD

Sample: 18A 5-22-93-6B ANDCO #14 Collected: 05/22/93 04:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	4.7	1.0	ppb	05/26/93	KD

Sample: 19A 5-22-93-7B ANDCO #14 Collected: 05/22/93 05:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	<1.0	1.0	ppb	05/26/93	KD

Sample: 20A 5-22-93-8B ANDCO #14 Collected: 05/22/93 06:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	3.1	1.0	ppb	05/26/93	KD

Sample: 21A 5-22-93-9B ANDCO #14 Collected: 05/22/93 07:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	2.2	1.0	ppb	05/26/93	KD

Sample: 22A 5-22-93-10B ANDCO #14 Collected: 05/22/93 08:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	<1.0	1.0	ppb	05/26/93	KD

Sample: 23A 5-22-93-11B ANDCO #14 Collected: 05/22/93 09:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	<1.0	1.0	ppb	05/26/93	KD

Sample: 24A 5-22-93-12B ANDCO #14 Collected: 05/22/93 10:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	1.3	1.0	ppb	05/26/93	KD

Sample: 25A 5-22-93-13B ANDCO #14 Collected: 05/22/93 11:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	2.4	1.0	ppb	05/26/93	KD

Sample: 26A 5-22-93-14B ANDCO #14 Collected: 05/22/93 12:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	1.1	1.0	ppb	05/26/93	KD

Sample: 27A 5-22-93-15B ANDCO #14 Collected: 05/22/93 13:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	15.1	1.0	ppb	05/26/93	KD

Sample: 28A 5-22-93-16B ANDCO #14 Collected: 05/22/93 14:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	3.3	1.0	ppb	05/26/93	KD

Sample: 29A 5-22-93-17B ANDCO #14 Collected: 05/22/93 15:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	1.7	1.0	ppb	05/26/93	KD

Sample: 30A 5-22-93-28 ANDCO #14 Collected: 05/22/93 22:00

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	5.8	1.0	ppb	05/26/93	KD
Cr+6 by Colormetric	<0.01	0.01	ppm	05/26/93	KD
Iron in Water, by ICP	0.05	0.01	ppm	05/26/93	GP
TDS by Gravimetric	700	0.01	ppm	05/26/93	KD

Sample: 31A 5-23-93-1 ANDCO #4 COMP Collected: 05/23/93

Test Description	Result	Limit	Units	Analyzed	By
Cr+6 by Colormetric	5.72	0.01	ppm	05/26/93	KD
pH by Wet Chemistry	7.82	0.10	pH	05/26/93	KD

Sample: 32A 5-23-93-2 ANDCO #14 COMP Collected: 05/23/93
Job: ANDCO ION EXCHANGE - NEW BLDG.

Test Description	Result	Limit	Units	Analyzed	By
Chromium by Graphite Furn	3.6	1.0	ppb	05/26/93	KD
Cr+6 by Colormetric	<0.01	0.01	ppm	05/26/93	KD
Iron in Water, by ICP	0.03	0.01	ppm	05/26/93	GP
TDS by Gravimetric	700	0.01	ppm	05/26/93	KD
TSS by Gravimetric	1	1	ppm	05/26/93	KD
pH by Wet Chemistry	8.18	0.10	pH	05/26/93	KD

Andco Environmental Processes, Inc.
595 Commerce Drive, Amherst, NY 14228 2380 (716) 691-2100/Fax (716) 691-2880

FAX

Date: June 4, 1993

Company: SHIELDALLOY METALLURGICAL

Attention: Dave Smith

Fax No: 609-697-9025

Location: Newfield, NJ

6 **pages incl. cover sheet**

From: Jack Reich

Subject: Sample Results

Andco Fax No. (716) 691-2880

Andco File No.

Message:

Dave,

Please review and call me. We used a detection limit of 10 ppb for all the analyses.

Sincerely,

Jack J. Reich

JOB NUMBER : 9301.066

Ecology and Environment, Inc.
SAMPLE TRACKING REPORT

SAMPLE NUMBER	CLIENT SAMPLE ID	DATE SAMPLED	DATE EXTRACTED	DATE ANALYZED
CHROMIUM T	(ICP)-WATER			
64772.01	SM-212-1	05/26/93	05/27/93	05/27/93
64773.01	SM-212-2	05/26/93	05/27/93	05/27/93
64774.01	SM-212-3	05/26/93	05/27/93	05/27/93
64775.01	SM-212-4	05/26/93	05/27/93	05/27/93
64776.01	SM-212-5	05/26/93	05/27/93	05/27/93
64777.01	SM-212-6	05/26/93	05/27/93	05/27/93
64778.01	SM-212-7	05/26/93	05/27/93	05/27/93
64779.01	SM-212-8	05/26/93	05/27/93	05/27/93
64780.01	SM-212-9	05/26/93	05/27/93	05/27/93
64781.01	SM-212-10	05/26/93	05/27/93	05/27/93
64782.01	SM-212-11	05/26/93	05/27/93	05/27/93
64783.01	SM-212-12	05/26/93	05/27/93	05/27/93
64784.01	SM-212-13	05/26/93	05/27/93	05/27/93
64785.01	SM-212-14	05/26/93	05/27/93	05/27/93
64786.01	SM-212-15	05/26/93	05/27/93	05/27/93
64787.01	SM-212-16	05/26/93	05/27/93	05/27/93
64788.01	SM-212-17	05/26/93	05/27/93	05/27/93
64789.01	SM-212-18	05/26/93	05/27/93	05/27/93
64790.01	SM-212-19	05/26/93	05/27/93	05/27/93
64791.01	SM-212-20	05/26/93	05/27/93	05/27/93
64792.01	SM-212-21	05/26/93	05/27/93	05/27/93
64793.01	SM-212-22	05/26/93	05/27/93	05/27/93

JOB NUMBER :9301.066
ELAP ID - 10486

Ecology and Environment, Inc.
Analytical Services Center

CLIENT : ANDCO ENVIRONMENTAL PROCESS INC.
MATRIX: WATER

SAMPLE ID LAB :EE-93-64772
SAMPLE ID CLIENT: SM-212-1

PARAMETER		RESULTS	Q	QNT. LIMIT	UNITS
Chromium Total	(ICP)	ND		10	UG/L

SAMPLE ID LAB :EE-93-64773
SAMPLE ID CLIENT: SM-212-2

PARAMETER		RESULTS	Q	QNT. LIMIT	UNITS
Chromium Total	(ICP)	ND		10	UG/L

SAMPLE ID LAB :EE-93-64774
SAMPLE ID CLIENT: SM-212-3

PARAMETER		RESULTS	Q	QNT. LIMIT	UNITS
Chromium Total	(ICP)	ND		10	UG/L

SAMPLE ID LAB :EE-93-64775
SAMPLE ID CLIENT: SM-212-4

PARAMETER		RESULTS	Q	QNT. LIMIT	UNITS
Chromium Total	(ICP)	ND		10	UG/L

SAMPLE ID LAB :EE-93-64776
SAMPLE ID CLIENT: SM-212-5

PARAMETER		RESULTS	Q	QNT. LIMIT	UNITS
Chromium Total	(ICP)	ND		10	UG/L

SAMPLE ID LAB :EE-93-64777
SAMPLE ID CLIENT: SM-212-6

PARAMETER		RESULTS	Q	QNT. LIMIT	UNITS
Chromium Total	(ICP)	ND		10	UG/L

QUALIFIERS: C = COMMENT
J = ESTIMATED VALUE
NA = NOT APPLICABLE
ND = NOT DETECTED

JOB NUMBER :9301.066
ELAP ID - 10486

Ecology and Environment, Inc.
Analytical Services Center

CLIENT : ANDCO ENVIRONMENTAL PROCESS INC.

MATRIX: WATER

SAMPLE ID LAB :EE-93-64778
SAMPLE ID CLIENT: SM-212-7

PARAMETER		RESULTS	Q	QNT. LIMIT	UNITS
Chromium Total	(ICP)	ND		10	UG/L

SAMPLE ID LAB :EE-93-64779
SAMPLE ID CLIENT: SM-212-8

PARAMETER		RESULTS	Q	QNT. LIMIT	UNITS
Chromium-Total	(ICP)	ND		10	UG/L

SAMPLE ID LAB :EE-93-64780
SAMPLE ID CLIENT: SM-212-9

PARAMETER		RESULTS	Q	QNT. LIMIT	UNITS
Chromium Total	(ICP)	ND		10	UG/L

SAMPLE ID LAB :EE-93-64781
SAMPLE ID CLIENT: SM-212-10

PARAMETER		RESULTS	Q	QNT. LIMIT	UNITS
Chromium Total	(ICP)	ND		10	UG/L

SAMPLE ID LAB :EE-93-64782
SAMPLE ID CLIENT: SM-212-11

PARAMETER		RESULTS	Q	QNT. LIMIT	UNITS
Chromium Total	(ICP)	ND		10	UG/L

SAMPLE ID LAB :EE-93-64783
SAMPLE ID CLIENT: SM-212-12

PARAMETER		RESULTS	Q	QNT. LIMIT	UNITS
Chromium Total	(ICP)	ND		10	UG/L

QUALIFIERS: C = COMMENT
J = ESTIMATED VALUE
NA = NOT APPLICABLE
ND = NOT DETECTED

JOB NUMBER :9301-066
ELAP ID - 10486

Ecology and Environment, Inc.
Analytical Services Center

CLIENT : ANDCO ENVIRONMENTAL PROCESS INC.
MATRIX: WATER

SAMPLE ID LAB :EE-93-64784
SAMPLE ID CLIENT: SM-212-13

PARAMETER		RESULTS	Q	QNT. LIMIT	UNITS
Chromium Total	(ICP)	ND		10	UG/L

SAMPLE ID LAB :EE-93-64785
SAMPLE ID CLIENT: SM-212-14

PARAMETER		RESULTS	Q	QNT. LIMIT	UNITS
Chromium Total	(ICP)	ND		10	UG/L

SAMPLE ID LAB :EE-93-64786
SAMPLE ID CLIENT: SM-212-15

PARAMETER		RESULTS	Q	QNT. LIMIT	UNITS
Chromium Total	(ICP)	ND		10	UG/L

SAMPLE ID LAB :EE-93-64787
SAMPLE ID CLIENT: SM-212-16

PARAMETER		RESULTS	Q	QNT. LIMIT	UNITS
Chromium Total	(ICP)	ND		10	UG/L

SAMPLE ID LAB :EE-93-64788
SAMPLE ID CLIENT: SM-212-17

PARAMETER		RESULTS	Q	QNT. LIMIT	UNITS
Chromium Total	(ICP)	ND		10	UG/L

SAMPLE ID LAB :EE-93-64789
SAMPLE ID CLIENT: SM-212-18

PARAMETER		RESULTS	Q	QNT. LIMIT	UNITS
Chromium Total	(ICP)	ND		10	UG/L

QUALIFIERS: C = COMMENT ND = NOT DETECTED
J = ESTIMATED VALUE
NA = NOT APPLICABLE

JOB NUMBER :9301.066
ELAP ID - 10486

Ecology and Environment, Inc.
Analytical Services Center

CLIENT : ANDCO ENVIRONMENTAL PROCESS INC.
MATRIX: WATER

SAMPLE ID LAB :EE-93-64790
SAMPLE ID CLIENT: SN-212-19

PARAMETER		RESULTS	Q	QNT. LIMIT	UNITS
Chromium Total	(ICP)	ND		10	UG/L

SAMPLE ID LAB :EE-93-64791
SAMPLE ID CLIENT: SN-212-20

PARAMETER		RESULTS	Q	QNT. LIMIT	UNITS
Chromium Total	(ICP)	ND		10	UG/L

SAMPLE ID LAB :EE-93-64792
SAMPLE ID CLIENT: SN-212-21

PARAMETER		RESULTS	Q	QNT. LIMIT	UNITS
Chromium Total	(ICP)	ND		10	UG/L

SAMPLE ID LAB :EE-93-64793
SAMPLE ID CLIENT: SN-212-22

PARAMETER		RESULTS	Q	QNT. LIMIT	UNITS
Chromium Total	(ICP)	ND		10	UG/L

SAMPLE ID LAB : METHOD BLANK

PARAMETER		RESULTS	Q	QNT. LIMIT	UNITS
Chromium Total	(ICP)	ND		10	UG/L

QUALIFIERS: C = COMMENT ND = NOT DETECTED
J = ESTIMATED VALUE
NA = NOT APPLICABLE

NET
NATIONAL ENVIRONMENTAL TESTING, INC.

Thorofare Division
100 Grove Road, P.O. Box 248
Thorofare, NJ 08086
Tel: (609) 848-3939
Fax: (609) 848-9195

REPORT NO: 93.01391
DATE: 06/03/1993

RECEIVED
JUN - 7 19??
DEPT. ENV. SERV.

Client
SHIELDALLOY METALLURGICAL
12 WEST BLVD
NEWFIELD, NJ 08344

Authorization
DAVID SMITH

Subject
Analytical results data package for samples submitted to National Environmental Testing, Inc. for chemical analysis. The following page lists all samples and the date they were received by the laboratory.

Procedure
Samples were analyzed in accordance with one or more of the procedures presented in the following:

USEPA Methods for Chemical Analysis of Water and Wastes(EPA-600/4-82-055).

Standard Methods for the Examination of Water and Wastewater. 16th Edition.

Federal Register volume 40 part 136.

Test Methods for Evaluating Solid Waste. (SW-846, Third Edition)

Approved by : National Environmental Testing, Inc Thorofare Division

Mary E. Pierce
Project Manager

Doug Weiler
Reports Manager

This report has been prepared in accordance with NJDEPE regulations governing laboratory performance and standards of performance N.J.A.C. 7:18.
NJ Laboratory Certification 08153

NATIONAL ENVIRONMENTAL TESTING, INC.

The following table identifies all samples submitted to NET for analysis.

Client: SHIELDALLOY METALLURGICAL Job No: 93.01391

NET ID	Client ID	Date Sampled	Date Received
114636	5-21-93-7C	05/21/1993	05/25/1993
114637	5-21-93-11C	05/21/1993	05/25/1993
114638	5-22-93-4C	05/22/1993	05/25/1993
114639	5-22-93-8C	05/22/1993	05/25/1993
114640	5-22-93-12C	05/22/1993	05/25/1993
114641	5-22-93-16C	05/22/1993	05/25/1993

Listed below are the current certifications that are held by NET, Inc. - Thorofare Division.

NJ Certification No: 08153
NY Certification No: 10867
PA Certification No: 68-212
SC Certification No: 94008
CT Certification No: PH-0784
TN Certification No: applied

MA Certification No: NJ119
DE Certification No: 08153(NJ)
MD Certification No: 173
VA Certification No: 00043
FL Certification No: pending
AL Certification No: applied

Definition of terms, abbreviations and flags that may be used in this report.

Flag/Term/Abbrev.	Definition
U	Compound was analyzed for but not detected. The laboratory has reported the method detection limit for the compound.
J	Compound was detected at a concentration below the method detection limit. These values are estimates.
B	Compound was detected in the method/extraction blank as well as the sample. The data user is warned of possible laboratory introduced contamination.
NA	Not Applicable
ND	Not Detected
NC	Not Calculable
NR	Not Requested or Not Reported
MDL	Method detection limit. Can be a limit specified by the method or a number determined by performing an MDL study.
LCS	Laboratory Control Sample
MS/MSD	Matrix Spike/Matrix Spike Duplicate
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
umhos	conductivity units; resistance is expressed in ohms.
NTU	Nephlometric Turbidity Units; used for turbidity.
col/3	Colonies per volume of sample analyzed; used for bacteriology.
deg C	degrees celcius
deg F	degrees fahrenheit
ug	microgram; there are 1000 ug in 1 mg.
mg	milligram; there are 1000 mg in 1 g.
g	gram; there are 1000 g in 1 Kg.
Kg	killogram
ul	microliter; there are 1000 ul in 1 ml.
ml	milliliter; there are 1000 ml in 1 liter.
L	liter
dw	Dry weight; indicates that the reported value has been corrected for percent solids.
ppm	Parts per million = mg/Kg, ug/g, mg/L, ug/ml; 1 ppm = 1000ppb
ppb	Parts per billion = ug/Kg, ug/L

NATIONAL ENVIRONMENTAL TESTING, INC.
Thorofare Division

REPORT OF ANALYSIS

Client: SHIELDALLOY METALLURGICAL
Job No: 93.01391

Sample No: 114636
Client Sample ID: 5-21-93-7C

Parameter		Results	Units
Hexavalent Chromium		<0.01	mg/L
pH		8.19	pH units
Solids, dissolved (TDS)		682	mg/L
Solids, suspended (TSS)		2	mg/L
Chromium (Cr)	200 ICP A	<0.01	mg/L
Iron (Fe)	200 ICP A	<0.05	mg/L

Sample No: 114637
Client Sample ID: 5-21-93-11C

Parameter		Results	Units
Hexavalent Chromium		<0.01	mg/L
pH		8.18	pH units
Solids, dissolved (TDS)		698	mg/L
Solids, suspended (TSS)		<1	mg/L
Chromium (Cr)	200 ICP A	<0.01	mg/L
Iron (Fe)	200 ICP A	<0.05	mg/L

Sample No: 114638
Client Sample ID: 5-22-93-4C

Parameter		Results	Units
Hexavalent Chromium		<0.01	mg/L
pH		8.12	pH units
Solids, dissolved (TDS)		652	mg/L
Solids, suspended (TSS)		<1	mg/L
Chromium (Cr)	200 ICP A	<0.01	mg/L
Iron (Fe)	200 ICP A	<0.05	mg/L

* Note that the pH and Hexavalent Chromium were run outside the prescribed holding time.

NATIONAL ENVIRONMENTAL TESTING, INC.
Thorofare Division

REPORT OF ANALYSIS

Client: SHIELDALLOY METALLURGICAL
Job No: 93.01391

Sample No: 114639
Client Sample ID: 5-22-93-8C

Parameter		Results	Units
Hexavalent Chromium		<0.01	mg/L
pH		8.06	pH units
Solids, dissolved (TDS)		680	mg/L
Solids, suspended (TSS)		<1	mg/L
Chromium (Cr)	200 ICP A	<0.01	mg/L
Iron (Fe)	200 ICP A	0.050	mg/L

Sample No: 114640
Client Sample ID: 5-22-93-12C

Parameter		Results	Units
Hexavalent Chromium		<0.01	mg/L
pH		8.21	pH units
Solids, dissolved (TDS)		670	mg/L
Solids, suspended (TSS)		<1	mg/L
Chromium (Cr)	200 ICP A	<0.01	mg/L
Iron (Fe)	200 ICP A	<0.05	mg/L

Sample No: 114641
Client Sample ID: 5-22-93-16C

Parameter		Results	Units
Hexavalent Chromium		<0.01	mg/L
pH		8.19	pH units
Solids, dissolved (TDS)		682	mg/L
Solids, suspended (TSS)		<1	mg/L
Chromium (Cr)	200 ICP A	<0.01	mg/L
Iron (Fe)	200 ICP A	<0.05	mg/L

* Note that the pH and Hexavalent Chromium were run outside the prescribed holding time.

NATIONAL ENVIRONMENTAL TESTING, INC.

CLIENT: SHIELDALLOY METALLURGICAL JOB NUMBER: 93.01391

NET ID	Client ID	Technician	Date Analyzed
Parameter: Hexavalent Chromium		**Method: SM 3500D**	
114636	5-21-93-7C	jhw	05/25/1993
114637	5-21-93-11C	jhw	05/25/1993
114638	5-22-93-4C	jhw	05/25/1993
114639	5-22-93-8C	jhw	05/25/1993
114640	5-22-93-12C	jhw	05/25/1993
114641	5-22-93-16C	jhw	05/25/1993
Parameter: pH		**Method: EPA 150.1**	
114636	5-21-93-7C	jhh	05/25/1993
114637	5-21-93-11C	jhh	05/25/1993
114638	5-22-93-4C	jhh	05/25/1993
114639	5-22-93-8C	jhh	05/25/1993
114640	5-22-93-12C	jhh	05/25/1993
114641	5-22-93-16C	jhh	05/25/1993
Parameter: Solids, dissolved (TDS)		**Method: EPA 160.1**	
114636	5-21-93-7C	mmm	05/26/1993
114637	5-21-93-11C	mmm	05/26/1993
114638	5-22-93-4C	mmm	05/26/1993
114639	5-22-93-8C	mmm	05/26/1993
114640	5-22-93-12C	mmm	05/26/1993
114641	5-22-93-16C	mmm	05/26/1993
Parameter: Solids, suspended (TSS)		**Method: EPA 160.2**	
114636	5-21-93-7C	pdg	05/26/1993
114637	5-21-93-11C	pdg	05/26/1993
114638	5-22-93-4C	pdg	05/26/1993
114639	5-22-93-8C	pdg	05/26/1993
114640	5-22-93-12C	pdg	05/26/1993
114641	5-22-93-16C	pdg	05/26/1993
Parameter: Chromium (Cr)	**200 ICP AQ**	**Method: EPA 200 ICP**	
114636	5-21-93-7C	jvs	06/02/1993
114637	5-21-93-11C	jvs	06/02/1993
114638	5-22-93-4C	jvs	06/02/1993
114639	5-22-93-8C	jvs	06/02/1993
114640	5-22-93-12C	jvs	06/02/1993
114641	5-22-93-16C	jvs	06/02/1993
Parameter: Iron (Fe)	**200 ICP AQ**	**Method: EPA 200 ICP**	
114636	5-21-93-7C	jvs	06/02/1993
114637	5-21-93-11C	jvs	06/02/1993
114638	5-22-93-4C	jvs	06/02/1993
114639	5-22-93-8C	jvs	06/02/1993
114640	5-22-93-12C	jvs	06/02/1993
114641	5-22-93-16C	jvs	06/02/1993

APPENDIX F

RESPONSES TO REGULATORY COMMENTS ON THE DRAFT FOCUSED FEASIBILITY STUDY

NJDEPE COMMENTS[1] ON THE DRAFT FOCUSED FEASIBILITY STUDY AND SHIELDALLOY METALLURGICAL CORPORATION RESPONSES

INTRODUCTION

Subsequent to the receipt of NJDEPE comments on the Draft Focused Feasibility Study, SMC prepared draft responses to those comments. A meeting was held on May 20, 1993 between representatives of SMC and NJDEPE to discuss the comments and responses. Comment responses and report text have been revised further in accordance with these discussions. The comments and revised responses follow.

It should also be noted that references to insertions to specific pages of the text refer to the pages as they were paginated within the Draft Focused Feasibility Study Report.

GENERAL COMMENTS

1. The DFFS was based primarily on findings of the RI. However, investigative activities have continued since the RI report was prepared. Specifically, additional monitoring wells SC20D, SC25S, and SC26D were installed and sampled. The latter well is located south of the SMC facility, along Weymouth Road. Reference is made to this well throughout the DFFS, although detailed information (well log, construction details, and analytic data) are not included. Both of the major contaminants of concern, chromium (Cr) and trichloroethene (TCE) were detected in this well. The TCE concentration is reportedly 12 ppb. The Cr concentration is not presented. These findings are of fundamental significance, as they indicate that the major contaminants in the deep portion of the aquifer extend outside previously determined boundaries. In fact, the southern boundary of the deep plume is not delineated. Additional discussion of this subject will be presented as Specific Comments, below.

<u>Response:</u> *Monitoring wells SC20D, SC25S, and SC26D were all installed after the RI Report was submitted for regulatory review. These monitoring wells were installed to address specific data gaps identified in the RI Report. Analytical data from these wells have been presented in the SMC Monthly Monitoring Report. Copies of these monitoring well logs have been included in Appendix D.*

The additional investigative activities were discussed in Sections 1.4 and 3.1.1 of the DFFS and were not ignored in the evaluation of ground water remediation options. The presence of TCE and chromium in well SC26D was discussed in Section 3.1.1, as well as the resultant conclusion that the limits of the extent of TCE and chromium contamination in this area extend beyond those previously presented. The level of chromium detected in well SC26D during the August 1992 sampling event (0.98 ppm and 1.13 ppm in a duplicate sample) has been provided in Section 3.1.1, where the last sentence of the first paragraph on page 3-8 has been revised to read as follows: Ground water monitoring of the toe of the chromium plume conducted since the preparation of

[1]Reference letter from Donna L. Gaffigan, Case Manager, NJDEPE to David R. Smith, Shieldalloy Metallurgical Corporation, dated March 17, 1993.

*the RI Report has indicated no significant change in the downgradient extent of either the shallow or deep total chromium or hexavalent chromium contamination with the exception of the identification of chromium **at a concentration of 0.98 ppm (1.13 ppm in a duplicate sample)** within newly installed well SC26D, located south of the SMC facility (SMC, 1992).*

As a result of discussions held at the May 20, 1993 project meeting (see Introduction), SMC agreed to meet with the NJDEPE site geologist to discuss the requirements for additional wells at the toe of the plume (in the vicinity of well IW2) as well as in the vicinity of well SC26D, with the intent of further delineating the extent of chromium contamination in these areas. Based on these future investigation activities, the evaluation of the extent of ground water contamination as well as the analysis of the optimal means for capturing and remediating the plume will be updated and revised, as necessary. This has been noted within the text of the report.

2. Reference is made throughout the DFFS to a new interpretation of the hydrogeology of the area since earlier investigations. Specifically, Dan Raviv Associates, Inc. (DRAI) considered an upper and a lower aquifer in the Cohansey Sand, with a 20 to 60 foot thick semi-confining layer between. The RI and DFFS refute this finding, and conclude that the Cohansey operates as a single water table aquifer, with discontinuous confining beds scattered throughout. However, both the discussion on contaminant distribution and proposed remedial extraction schemes continue to refer to the upper and lower Cohansey. Monitoring wells tend to be screened either in the very shallow portion of the aquifer (less than 20 feet) or very deep (greater than 100 feet). If the Cohansey in the vicinity of SMC does function as single unit, additional consideration of the middle portion may be warranted. The stratigraphy and detailed hydraulic properties of the system are not well understood.

<u>Response:</u> *As discussed in Section 3.5 of the RI report, the Cohansey Sand is composed of fine to coarse sand, with discontinuous layers of clay and zones of silt stringers. Grain size varies both vertically and laterally, which is consistent with deposition within a coastal environment. The Dan Raviv Associates, Inc. (DRAI) report described the Cohansey Sand as consisting of two water producing zones separated by a 40- to 60-foot thick semi-confining layer consisting of thin sand and clay interbeds. This description was based on well logs developed from drill cutting observations made during well construction using mud rotary techniques. As discussed in the RI, logging stratigraphy on this basis is difficult because the depth of the cutting cannot be determined, the geology can be mis-interpreted (e.g., when the drilling mud is thin or drilling encounters a coarse sand layer and no cuttings are brought to the surface, the drilling mud could be mis-interpreted as a clay layer), and there is no way to determine the percentage of silt or to differentiate a silt layer from a clay layer.*

Based on the typically continuous split-spoon sampling conducted by TRC during the RI soil borings, subsurface conditions were logged more accurately. Data gathered from the RI does not support the definition of a two-aquifer system in the Cohansey Sand at the SMC site. Thin, discontinuous silt and clay lenses were identified at several *locations, including in the vicinity of SC12D and SC13D (depth of 28 to 34 feet) and at the pilot hole for SC22D (4-inch layer at a depth of 30 feet).*

While it has been concluded that there is no semi-confining layer in the Cohansey Sand, this does not mean that the Cohansey Sand is considered as one unit. As stated in the FFS, for modeling purposes the Cohansey Sand has been divided into two units on the basis of hydrogeology to address the difference between the shallow and deep transmissivities observed from the pump test analysis. This interpretation has been confirmed by the strong correlation between the MODFLOW simulation and the actual ground water response to pumping during the two model verification monitoring events. This correlation supports the presented interpretation of the Cohansey Sands' upper and lower aquifer properties and does not indicate the need for additional definition of the stratigraphy and hydraulic properties of the system.

Discussions of the upper and lower Cohansey also allow for a presentation of the variation in contaminant distribution within the shallow portions of the aquifer as opposed to the deeper portions of the aquifer. This presentation supports the evaluation of pumping from various depths within the aquifer to capture contamination from the zones with the highest contaminant levels. While wells installed during the RI program tend to be screened within the shallow (less than 20 feet) or deep portions of the aquifer (greater than 100 feet - see Table 1-3 of the FFS), previously installed wells tend to be screened within the intermediate portion of the aquifer.

The response presented above has been incorporated into the text of the FFS (within Section 1.5.2 and Appendix B). In addition, a more detailed discussion of the vertical distribution of contamination has been incorporated into Section 3.1.1.

3. Based on material presented in the RI and the DFFS, the mechanisms of contaminant transport, for organic and inorganic contaminants, have not been fully determined. If the limits of contamination were known with certainty, and if the hydrogeology of the area were understood sufficiently to assure that whatever pumping scheme is adopted would capture all of the contaminants of concern, a complete understanding of the detailed mechanism of transport could be considered an unnecessary academic exercise. The recommended extraction scheme will probably capture most of the contaminants. However, there is sufficient uncertainty to warrant additional investigation. Additional discussion of this topic will be presented as Specific Comments, below.

<u>Response</u>: *The Conditional Approval for the Feasibility Study Work Plan stated that the ground water portion of the Remedial Investigation has been conditionally approved...... so the development of the remedial action can move forward. The purpose of the FFS is to identify and evaluate alternatives for mitigating ground water contamination at and/or emanating from the site, thereby minimizing potential impacts to human health or the environment. The major contaminants associated with the site, chromium and TCE, are addressed within the FFS based on currently available information. The recommended extraction scheme has been developed to capture or control the majority of contamination at and/or emanating from the site which was detected at levels exceeding ARARs/TBCs*

and/or risk-based cleanup levels. While additional investigation may be required in portions of the site (see the response to specific comments #22 and #26), SMC is confident that the FFS can meet the objectives of the study based on available information.

The extent of chromium contamination is well-defined with the exception of the area south of the SMC facility. The extent of chromium contamination in the lower Cohansey Sand in the vicinity of well IW2 also requires further definition. As presented in the response to specific comment #21, SMC is confident that the area of TCE contamination attributable to the SMC facility has also been defined, although additional investigation is appropriate, as noted above. This FFS has been focused on the capture and control of these contaminants. Total chromium has been used as an indicator of general ground water flow and contaminant dispersion from the site. Dissolved TCE would be expected to follow the same general subsurface flow pattern. The TCE plume does generally mirror the chromium plume in the upper and lower Cohansey Sands, with the exception of the increased levels of TCE contamination detected to the southwest of the facility, outside of the chromium plume. These anomalous results strongly indicate an additional source of TCE contamination. While SMC agrees to further investigate the extent of chromium contamination in the lower Cohansey Sand in the vicinity of IW2, the investigation of suspected off-site sources of TCE is not SMC's responsibility. Further study of these potential source areas, especially with respect to deep ground water quality, is of critical importance in achieving an overall understanding of the extent of organic ground water contamination in the Newfield/Vineland area; however, these issues are not critical in allowing SMC/NJDEPE to meet project goals, which include the development of a Proposed Plan and Record of Decision in support of a an optimum extraction and remediation system to address the contamination at and/or emanating from the SMC facility.

4. Reference is made throughout the DFFS to the 400 gpm design rate for the proposed extraction system. In only one of these references (Section 5.3.3.1, page 5-16) is it recognized that the 400 gpm rate may not be an absolute number. The use of this number as the recovery rate upper limit, for the final ground water remedy, is inappropriate. The 400 gpm requirement was based on the evaluation of the recovery system well configuration operated as an Interim Remedial Measure in 1988. It can not be considered the absolute maximum allowable pumping rate for the final ground water remedy. The installation of SC26D in 1992 extended the apparent scope of the contamination well beyond the apparent delineation in the RI. It now appears unlikely that 400 gpm will be sufficient to contain the full plume. With the addition of more recovery wells (as proposed in the DFFS) the overall volume of recovered ground water would be expected to increase. As such, the DFFS must evaluate which recovery rates will most efficiently remediate contaminated ground water while being protective of human health and the environment. SMC must provide comprehensive documentation supporting the selection of recovery rates deemed appropriate for the ground water final remedy.

   The Department advised SMC in previous meetings that the modified treatment system should have the capacity to handle increased flow when the final ground water remedy is implemented. Therefore, recovery rates should not be restricted to 400 gpm as a result of treatment system inadequacy.

Response: *Based on currently available information on the extent of contamination and based on the presented ground water modeling efforts, a 400 gpm pumping rate will provide capture or control of the contaminated ground water at and emanating from the SMC facility. An increased extraction rate has been evaluated within Appendix B, with no significant impacts to the overall efficiency of the extraction system observed. Because the extent of chromium contamination in the vicinity of well SC26D has not been defined, the relative effectiveness of ground water extraction scenarios which have various impacts on this area cannot be evaluated. However, the modeling output indicates that the recommended remedial alternative will, at a minimum, provide hydraulic control of the deep ground water contamination between SMC and SC26D, and therefore will prevent future contaminant migration in this direction. As documented in the FFS, the recommended remedial alternative provides protection to human health and the environment while efficiently remediating the ground water contamination, based on the currently existing information regarding the nature and extent of contamination.*

SMC has agreed additional investigation in the vicinity of SC26D and in the vicinity of deep well IW2 is required. Based on the results of additional investigations in these areas, the optimal ground water extraction system to remediate contamination in these areas will be reevaluated and refined. This has been noted at several places within the text, including the Conclusion Section of Appendix B.

5. In the Compliance with ARARs sections there are generalized references to the discharge to surface water (DSW) requirements. For example, it is stated that "the potential compliance of treatment systems with discharge requirements are qualitatively discussed since discharge requirements are not currently defined." (page 5-62), and that "Alternative 2 is expected to achieve historical surface water discharge limits,..." (page 5-13). This is not acceptable. The DFFS must include discussion of the chemical-specific concentrations, otherwise it is very difficult, if not impossible, to evaluate whether the treatment alternatives will be able to comply with the ARARs. The NJDEPE agrees that the final DSW requirements, i.e. ARARs, were not available at the time when the DFFS was completed, however, at the very least, the DFFS should have used the existing permit limits as points of comparison. Also, SMC was informally advised that the DSW limits would be much lower than the existing permit limits and that the DFFS must take that into account.

The DSW ARARs are defined in Attachment 1. These limits are identical to those which will appear in the draft DSW permit and are based on the Category I status of the Maurice River, into which the Hudson Branch flows.

Response: *At the time of preparation of the DFFS, it was known that the State was developing discharge to surface water permit limitations. Therefore, qualitative discussions of compliance with discharge requirements were considered to be appropriate based on the lack of specific information regarding the limits under development. Those qualitative discussions did consider the existing permit limits but, since it was expected that final permit requirements would be more stringent than the existing limitations (as noted in your comment), chemical-specific discussions were not provided.*

The draft DSW permit conditions attached to the comment letter are evaluated as to be To-Be-Considered requirements (TBCs) within the report (see Sections 3 and 5 and Table 3-4). NJDEPE has issued a draft permit for this discharge to surface water.

6. The recommended remedial alternative includes electrochemical treatment with an effluent concentration less than 30 ppb total chromium. The electrochemical treatment option was not adequately evaluated as an alternative with ion-exchange. The two systems together should allow treatment of the contaminated ground water to concentrations significantly less than 30 ppb total chromium, possibly approaching the discharge to surface water limit of 5.8 ppb. Therefore, the DFFS shall be revised to fully evaluate an alternative that includes a modified extraction system, air stripping, electrochemical treatment, ion-exchange polishing, and discharge to surface water.

Response: *To evaluate the effectiveness of electrochemical treatment, either through modification of the existing system or in concert with a separate polishing treatment process, in meeting the proposed 5.8 ppb discharge to surface water limit for chromium, a separate analysis is presented in Appendix E and summarized in Section 5.3.11.3. Based on the analysis presented there, electrochemical treatment may be able to achieve the proposed discharge conditions applicable to chromium without supplemental treatment. However, it should be emphasized that the ability to consistently attain such levels for this or any other treatment process cannot be defined without continuous operation of a treatment system. Furthermore, the ability of other treatment technologies to achieve chromium levels as low as 5.8 ppb is not well proven and the combination of these technologies with an electrochemical treatment system is also not well-defined. Therefore, there is a high degree of uncertainty associated with a review of the effectiveness of a combined treatment system. The effluent limits achievable by the electrochemical treatment system are still being refined based on continuing operations. Ion exchange, reverse osmosis and microfiltration/ultrafiltration are evaluated as supplemental treatment processes.*

Based on the separate presentation of extraction, treatment and discharge options within the detailed analysis of alternatives and the presentation of potential means of achieving the 5.8 ppb chromium TBC in Section 5.3.11.3 and Appendix E, an all-encompassing alternative as described in the comment has not been included. The method of presentation which is used allows for the final combination of all options determined to best meet the evaluation criteria.

7. Although the existing air stripper and ion exchange units can be used for polishing groundwater treated by other treatment technologies, the treatment capacity of these units may need to be re-evaluated for this application since they were originally designed for a different purpose (as primary treatment units).

Response: *The air stripper continues to function as a primary treatment unit for the treatment of organic contaminants. Its effectiveness in treating the organic contaminants of concern is not expected to vary. An evaluation of the expected air stripper emissions is presented in Appendix C. Based on this analysis, no emissions treatment is expected to be required. The air stripping system would be monitored during operation of confirm that* *a permit and emissions treatment are not required. See the responses to general comment #10 regarding air stripping and general comment #6 regarding the use of ion exchange.*

8. Reference is made to treatability studies and operating treatment data. However, no information is presented to allow independent evaluation of such studies or data. This information shall be included and presented in an appendix.

Response: *Treatability study data was provided with the Treatment Works Approval Application submitted in June 1992. A reference to this document has been added to the FFS in Section 5.3.11.1. Operating data are also presented in Appendix E.*

9. Flow schematic diagrams should be presented for all alternatives and options, not just the individual technologies.

Response: *To provide flexibility in the final recommendation of a comprehensive remedial alternative, the technologies associated with Alternative 3, Modified Ground Water Restoration, have been evaluated separately. This approach allows for the combination of those technologies determined to provide the greatest protection of human health and the environment and compliance with ARARs/TBCs within a comprehensive remedial alternative, and is a commonly requested and accepted approach to evaluating various technologies within a feasibility study. If every permutation of technology combinations was evaluated, the objective of a "focused feasibility study" would not be met. Flow schematic diagrams are provided for each of the individual technologies in accordance with this approach.*

10. The costs for air emissions control should be factored into the appropriate remedial alternatives and process options.

Response: *Historic operational monitoring of the air stripper supported the termination of the previously existing air permit. To evaluate the emissions which will potentially be generated by the air stripper at an operational rate of 400 gallons per minute, air emission calculations were conducted based on wastewater influent data and have been included as Appendix C to the report. Based on these calculations, both individual and total volatile organic emissions rates will be less than 0.1 lb/hr; therefore, no air emissions controls are anticipated to be required. Subsequently, costs of air emissions controls have not been added to the air stripping cost estimate.*

11. There appears to be a discrepancy in the inorganics data presented in the Tables section. Numerical values of maximum detected concentrations in filtered samples for barium, beryllium, potassium, sodium, selenium and boron in the Upper Cohansey aquifer and for arsenic, total chromium, sodium, antimony and vanadium in the Lower Cohansey aquifer are reported as being higher than corresponding values in unfiltered samples. This shall be explained.

Response: *Of the discrepancies noted in the comment above, the only filtered analytical results presented in the tables which were more than 10% greater than the unfiltered analytical results were those for barium and beryllium in the upper Cohansey and those for arsenic* *in the lower Cohansey. For most of these results, the maximum filtered and maximum unfiltered analytical results were detected in samples collected from the same well. In the case of selenium in the upper Cohansey Sand, the maximum filtered level was detected in well SC13S. Since the unfiltered sample for this well was not analyzed for selenium, a direct comparison of maximum filtered and unfiltered analytical results cannot be made for this compound. Field notes and CLP Form 1 information were reviewed and confirmed that the data presented within the RI Report, on which Tables 3-2 and 3-3 were based, was accurate with respect to the actual collection of samples and analysis data. As stated on page 3-7 of the DFFS, while some variability was found, an overall comparison of filtered and unfiltered ground water sample analyses indicates that soluble inorganics are present in the ground water, with inorganic concentrations in filtered samples typically at similar concentrations to those detected in unfiltered samples.*

The discussion presented above has been added to the text in Section 3.1.1.

Also refer to the response to specific comment #20.

12. SMC shall revise the MODFLOW ground water simulations in accordance with the Specific Comments, below. The revised simulations, and subsequent changes in interpretations, shall be included in the revised DFFS report.

Response: *Where appropriate the MODFLOW simulations have been modified to address specific comments. Please refer to specific comments #52 and #53 for comment responses.*

13. For the reasons discussed in General Comment No. 4, SMC shall evaluate pumping scenarios in excess of 400 gpm total volume. The recovery rates for the final system must achieve hydraulic capture of the entire ground water contaminant plume, and facilitate remediation of the plume. The MODFLOW ground water model will be used to determine the optimum locations and recovery rates for extraction wells.

Response: *An additional pumping scenario that exceeds 400 gpm total volume has been included, with its evaluation conducted as part of the sensitivity analysis. The recommended pumping scenario, as described within the FFS under extraction option E2, provides hydraulic control of the contaminants of concern. The increased pumping rate scenario does not greatly increase the zone of capture of the recovery wells, due to the high aquifer transmissivities. As presented in the response to specific comment #22, SMC acknowledges the need for additional investigation of the extent of contamination in the vicinity of wells IW2 and SC26D. Based on additional information to be gathered in these portions of the site, the recommended extraction scenario will be re-evaluated to verify its effectiveness in capturing contaminated ground water. This has been noted within the text; however, based on currently available information, the recommended extraction scenario has not been amended.*

14. SMC shall conduct a sensitivity analysis of the MODFLOW ground water model simulations and include the results in the revised DFFS report.

Response: *A sensitivity analysis has been included in Appendix B of the revised FFS. The following parameters were varied as part of the sensitivity analysis: hydraulic conductivity/ transmissivity (simulations of 2 times K and 0.5 times K were evaluated), interlayer vertical leakage (simulations of 2 times and 0.5 times interlayer vertical leakage were evaluated), and pumping rate (a 10 percent increase in the total pumping rate). Increasing the pumping rate and varying the interlayer vertical leakage had minimal effects on the modeling effort; by varying the hydraulic conductivity/transmissivity, the greatest impacts on the modeling results were observed.*

15. In numerous sections throughout the DFFS, it is stated that "the treatment process itself must comply with the substantive requirements of a ... permit." The phrase "substantive requirement" is generally reserved for discussions of permit equivalences. Be advised that it is the NJDEPE's policy that all NJDEPE-lead Superfund sites must obtain actual permits, not permit equivalences, for all permit-requiring remedial activities.

Response: *References to meeting the "substantive" requirements of a permit have been revised to simply state that the requirements of a permit will be met.*

16. The DFFS must be written to reflect reality. The electrochemical treatment unit has been built and is currently operating at the facility. Actual operational data shall be presented and discussed in the DFFS.

Response: *The FFS has been written to reflect and document the decision process which was used in the selection of a ground water treatment technology, as requested in the NJDEPE Conditional Approval of the Feasibility Study Work Plan dated August 17, 1992. As such, it is documenting past activities. However, given that the treatment system has been constructed and is operating, introductory discussions have been included in both the Executive Summary and in Section 1.0 of the report which provide the reader with an understanding of how previously conducted inorganic treatment system evaluations have been incorporated within the FFS. Existing operational data for the system have also been included in the report. SMC is encouraged that significant reductions in chromium concentrations are being achieved by the electrochemical treatment.*

SPECIFIC COMMENTS

1. Page iv, Executive Summary (also Page 1-7)
Please rephrase the rationale for installation of the four additional ground water extraction wells. The wells were installed to assist in hydraulically capturing and preventing further downgradient migration of SMC's ground water contamination plume.

Response: *The text on page iv has been revised to read: "Four additional ground water extraction wells were installed **to supplement the existing extraction well in capturing and preventing further downgradient migration of contaminated ground water, with the extracted ground water to be treated by** a new on-site ion exchange treatment system. Similarly, the text on page 1-7 has been revised to read:... to supplement the existing extraction well (Layne) **in capturing and preventing further downgradient migration of contaminated ground water. The ground water extracted from these recovery wells was treated within** a new on-site ion exchange treatment system..."*

2. Page v, Executive Summary (also Page 1-15)
Second Bullet: For the lower Cohansey Sand, please characterize the location where TCE was first detected as being "downgradient of the perceived source area for the TCE plume in the upper zone". Stating that TCE was first detected downgradient of the upper plume does not specify what plume (TCE or Cr) and may be interpreted to mean downgradient of the toe or end of the upper plume.

Response: *The text on page v and page 1-15 has been revised to read: "In the lower Cohansey Sand, TCE is first detected downgradient of the **suspected source area for the TCE plume in the upper zone (as referenced above), and** extends to the southwest.*

3. Page v, Executive Summary (also Page 1-16)
Last Bullet: Lead is stated to have been detected in an upgradient shallow well, near the underground storage tanks and the railroad siding. It must also be noted in this section that lead was detected in shallow monitoring well F at a concentration of 102 ug/l during the RI sampling.

Response: *The text has been revised to include a reference to this additional area where lead was detected at an elevated level. Specifically, the last bullet on page v and the corresponding sentence on page 1-16 have been revised to read: "...and Railroad Siding. **It was also detected in shallow monitoring well F at a concentration of 102 μg/l.**"*

4. Page vi, Executive Summary
The effects of TCE and other organics on the hazard assessment should be reported.

Response: *The one instance in which organics contribute significantly to the hazard assessment (for inhalation exposures under current residential use) has been noted. The text has been revised as follows: "...was the current residential use scenario, **under which both total cancer risks and the hazard index ratios exceeded the target risk levels. The major contributing factors to the calculation of cancer risk for this scenario are ingestion of***

arsenic and beryllium (in both the shallow and deep ground water) and inhalation of TCE (deep ground water only). *The text on page 1-18 has similarly been revised.*

5. Page vii, Executive Summary
The Remedial Response Objectives presented in Section 3.1.3 shall also be presented here.

Response: *The text has been revised. The partial sentence on top of page vii has been revised as follows: "current guidance criteria (TBCs)* ***or to risk-based cleanup levels which were developed as appropriate. On the basis of this evaluation, remedial action objectives were developed. They include the following:***

- ***Prevent exposure, due to ground water ingestion, to ground water contaminants attributable to the SMC facility which have been detected at levels exceeding acceptable ARARs/TBCs, as indicated in Tables 3-1 and 3-2 or acceptable risk-based cleanup levels;***

- ***Minimize migration of ground water contaminants; and***

- ***Remediate the ground water contamination attributable to the SMC facility to achieve ARARs/TBCs.***

General response actions which address the remedial response objectives were determined, *followed by the identification and screening...."*

Note that remedial response objectives have been revised in response to specific comment #25.

6. Page 1-5, Section 1.2 - Site History
This section should repeat what was stated in the last paragraph of page ii and top of page iii.

Response: *The text has been revised.*

7. Page 1-5, Section 1.3 - Previous Investigations
The initial discovery of ground water contamination at SMC in the Newfield municipal well. No mention is made concerning the depth of this former well, or the concentration of Cr or hexavalent chromium (Cr+6). Concentrations contours of total Cr in the shallow zone (Figures 3-7 and 3-8) show minimal concentrations near this area. There is no indication of Cr in the deep zone, or any Cr+6 in either zone presented in Figures 3-9 through 3-12. It is not clear whether this is the result of significant improvement of ground water quality in this portion of the aquifer in the past 20 years, or whether it reflects the lack of sampling in the area.

Response: *Based on current information, as presented in the RI Report and summarized in the FFS Report, it is agreed that there is a general lack of significant levels of chromium contamination in the vicinity of the former Newfield municipal well #3 (which was located in the northwest portion of the SMC facility and never was used to supply water to the Newfield water supply system). Municipal well #3 was drilled to a depth of 206 feet,* *screened from 129 to 149 feet in depth and was sealed in the early 1970's. TRC was unable to identify specific contaminant concentrations for this well. Shallow wells in the vicinity of its former location exhibited from non-detectable levels to 3.41 ppm of total chromium and non-detectable levels of hexavalent chromium during the RI sampling efforts. Downgradient deep wells exhibited from 485 to 715 ppb total chromium and from non-detectable to 500 ppb hexavalent chromium. Considering these results, combined with the fact that the Layne well has been used for ground water extraction since 1979 and has been supplemented by additional extraction wells since 1989, it is likely that ground water quality in the vicinity of the former Newfield municipal well #3 has improved as a result of active ground water remedial efforts. A discussion of changes in water quality in the vicinity of former Newfield municipal well #3 has been inserted in Section 3.1.1.*

8. <u>Page 1-7, Section 1.3 - Previous Investigations</u>
To accurately reflect the provisions of the ACO, the second sentence in the first full paragraph shall be changed to read: SMC was required to initiate operation of a 400 gpm ground water remediation system as an interim remedial measure and to conduct a comprehensive RI/FS.

<u>Response:</u> *The text has been revised as requested.*

9. <u>Page 1-9, Section 1.4 - Site Investigation Summary</u>
The second paragraph shall state the correct designations of the replacement wells (i.e SC2D(R)). SMC was required to correct the designations on several occasions prior to the preparation of the DFFS. Failure to correct the designations in the revised DFFS and in the monthly reports <u>WILL</u> result in the issuance of stipulated penalties.

<u>Response:</u> *The text has been revised as follows: "The following monitoring wells have been replaced,* ***with their replacement well designations noted: SC2D by SC2D(R), SC3D by SC3D(R) and SC11S by SC11S(R).*** *Well W2 was replaced with a shallow well, W2(R)." Tables 5-2 through 5-5 have likewise been revised. Figure 5-1 has also been revised to include replacement well locations. Other Section 3 and Section 5 figures which show well locations also show data gathered during the RI; therefore, they have not been revised since the data presented represent data collected at the former well locations.*

10. <u>Page 1-10, Section 1.5.1 - Surface Water Hydrology</u>
The hydraulic relationship between Hudson Branch and ground water has not been adequately addressed. It is stated that the stream is intermittent at its headwaters, with the supply being a combination of discharging ground water and storm water. However, in Appendix B, there is indication, based on shallow ground water contours from April 1992, that significant ground water recharge may occur during storms. As contaminants were found in the "wetland" (the southwest corner of the plant property) and in the sediment, this stream may have played a role in initial ground water contamination, and may continue to contribute. Furthermore, mounding in the shallow zone after heavy rain could severely disrupt ground water recovery from this zone.

<u>Response:</u> *In the vicinity of SMC, the Hudson Branch is primarily a gaining stream (obtains base water flow from ground water). Therefore, it is likely that contaminated ground water*

enters the Hudson Branch, although the exact volume of this discharge is unknown. SMC also discharges city water (non-contact cooling water) treated ground water and storm water into the Hudson Branch. Evaluation of the results of the RI surface water sampling and the subsequent 1991 ACO surface water sampling indicates that these discharges are not significantly impacting the water quality of the Hudson Branch.

During major storm events, the Hudson Branch can locally transform into a losing stream and, as a result, the ground water in the vicinity of Hudson Branch may become mounded. The impact of the ground water mounding on the ground water remediation system is minimal, because the mounding is of limited duration and of sporadic frequency. In addition, ground water mounding could act as a temporary barrier to the migration of contaminated ground water into the Hudson Branch as well as provide a driving force towards the recovery wells.

Sediment/surface soil samples from the southwest corner of the SMC facility showed relatively high concentrations of inorganic contamination. While elevated concentrations of inorganics were detected in the immediate vicinity of SMC, sediment samples collected further downstream were not significantly impacted. Therefore, migration of contaminated sediments by the Hudson Branch is not considered a major contaminant transport mechanism.

As appropriate, this response has been integrated into Sections 1.5.1 and 1.6 of the report.

11. Page 1-10, Section 1.5.1 - Surface Water Hydrology
The second paragraph of this section shall be revised to state that the discharge from Outfall 001 consists of city water (non-contact cooling water), treated ground water and treated storm water (from the areas in and around Departments 102 and 106). Also the paragraph shall include a discussion of the potential wetland associated with the Hudson Branch in and around the southwest corner of SMC's property.

Response: *The text has been revised to indicate that treated and untreated storm water are discharged from Outfall 001. As presented in the Ecological Assessment portion of the Risk Assessment Report (April 1992), there are no wetlands within the SMC facility indicated on the National Wetland Inventory Map. The following text will be added to the end of the first paragraph of Section 1.5.1: "**While the National Wetland Inventory Map identifies no wetlands on-site, a wetland area in association with the Hudson Branch is identified to the south of the site (TRC, 1992c).**" Also, reference the response to specific comment #19.*

12. Pages 1-10 thru 1-12, Section 1.5.2 - Geology
Three generalized cross-sections are presented (Figures 1-6 through 1-9), along generally parallel tracks from the eastern portion of the site, southwest, parallel to the Hudson Branch. The cross-sections are fairly typical of the Cohansey Sand, with interbedded sands, silts and clays. In general, they show fine sand and silt (10 to 20 feet) at the bottom of the section, overlain by progressively coarser units. The middle of the section is shown as interbedded units of coarse

to fine sand, medium to coarse sand, medium to fine sand, and gravel. A bed of clay, apparently less than 10 feet thick, is shown in the vicinity of SC12D, in the eastern part of the site.

As depicted on the cross-sections, there is no support for the earlier theory of a two aquifer system. Additional discussion on the topic is presented on page 45 of the RI. It is stated that older wells (pre-1990) were apparently logged from mud rotary cuttings, not from split spoon samples, and were not used to construct the cross-sections presented. It is implied that the reported 20 to 60 foot thick semi-confining zone originated from the older logs. With regard to defining the hydraulic characteristics of an aquifer, pumping test data are more accurate than lithologic logs, especially in a heterogenous formation such as the Cohansey. However, better definition of the clay lenses could help explain contaminant transport. A down-hole geophysical technique is available which could improve the understanding of the stratigraphy of the site. Natural gamma logging could preformed in cased wells, with either steel or PVC casings. Gamma logs could provide valuable data on the frequency and thickness of the clay beds in the formation.

<u>Response:</u> *As previously discussed in the response to General Comment #2, the Cohansey Sand is composed of fine to coarse sand, with discontinuous layers of clay and zones of silt stringers. Grain size varies both vertically and laterally, which is consistent with deposition within a coastal environment. Due to the variations in depth, thickness and horizontal extent of these discontinuous zones, any attempt to map these zones would be inconclusive at best. The local variability is significant only in terms of general trends with respect to hydrogeologic impacts. Small discontinuous silt layers will not greatly impact the regional ground water flow and provide no major separation between the upper and lower zones of the aquifer. The current well spacing and referenced cross-sections support an understanding of the major hydrogeologic units and an evaluation of appropriate remedial measures. Determination of the vertical extent of clay lenses within all of SMC's monitoring wells would not provide any additional information which would significantly improve the understanding of the site hydrogeology.*

The information included in this response has been integrated into Section 1.5.2 of the report.

13. <u>Page 1-12, Section 1.5.3 - Hydrogeology - Regional Hydrogeology</u>
As stated in the DFFS, the Kirkwood Formation underlies the Cohansey Sand. However, the upper part of the Kirkwood is not universally a confining layer. In general, the two formations function as a single unconfined aquifer, with local confining or semi-confining units. The borings used for construction of the cross-sections discussed above all show a few feet of penetration into a gray silt and clay. Since these sections cover only a portion of the site, and since the thickness and hydraulic conductivity of the silt and clay were not determined, the statement "The upper Kirkwood Formation acts as a confining layer and restricts the downward flow of ground water from the Cohansey Sand." is not supported.

<u>Response:</u> *The top of the Kirkwood Formation was encountered in all deep wells installed across the SMC site by TRC during the Phase I Remedial Investigation (TRC, April 1992). The*

upper ten (10) feet of the Kirkwood Formation was penetrated and was characterized, based on visual observations of split spoon samples, as a gray/black clay.

A review of previous investigations conducted at SMC indicate that well logs including the Layne Well encountered black clays at depths of 120 to 160 feet. During the initial SMC ground water investigation conducted by Roy F. Weston, Inc. in 1972, the Layne well was drilled to a depth of 170 feet below ground surface. Review of the Layne well's boring log indicates that a Gray Marl (clay) was encountered at a depth of 130 to 152 feet (22 feet of clay), with the Gray Marl underlain by a coarse gray sand (Kirkwood Formation). This coarse gray sand graded to medium gray sand after 15 feet, at which depth the boring was terminated and the boring grouted to its present depth of 47 feet below ground surface.

During the Phase II Groundwater Contamination Study conducted by Woodward-Moorehouse in 1974, well W1 was installed to a depth of 160 feet below ground surface. Well W1 encountered a 20-foot clay layer at 130 feet. The same gray sand as was identified in the Layne well boring was encountered from 150 - 160 feet. Woodward-Moorehouse installed monitoring well W1 and collected a ground water sample from the 160 foot interval. The sample was analyzed for Cr^{+6}, and the results indicated that Cr^{+6} concentration in the Kirkwood Formation is less than 0.01 mg/l. Well W1 was grouted to its present depth of 40 feet below ground surface.

The results of the two previous investigations along with the Phase I RI boring and well logs indicate that the clay layer is continuous across the Newfield area, thus preventing contaminant movement into the underlying aquifer system. Therefore, SMC believes that for the purposes of this investigation, the Kirkwood Formation (Gray Marl) acts as a confining layer and restricts the downward flow of ground water from the Cohansey Sands.

The information contained within this response has been integrated into Sections 1.5.2 and 1.5.3 of the report.

14. Pages 1-13 thru 1-14, Section 1.5.3 - Hydrogeology - Site-Specific

Ground water contours are presented for the shallow and deep wells. Measurements were made during the sampling episodes (December 1990 and April 1991). Data are presented in Table 1-4.

Contours based on the shallow wells appear to be unaffected by pumping. As drawn, they also appear to be unaffected by Hudson Branch. In reality, it is likely that equal elevation lines on the water table surface intersect the stream at an angle from each side, forming a "v" shape. The direction of the v is determined by the hydraulic relation between ground water and the stream.

Water elevations show a strong downward vertical gradient. For example, at clusters SC19D/S and SC21D/S, the vertical gradient in December 1990 is 1.45 and 1.42 feet, respectively. This gradient is likely due to pumping in the deep zone. The magnitude of the gradient suggests that either there may be a semi-confining unit between the deep and shallow zone, or the system has not reached equilibrium. This effect is more pronounced as depicted on the contours for April 1991. A deep depression is shown centered over the well cluster RW6S/D and SC6S/D.

The report states that a distortion in deep contours caused by pumping RIW2, screened at 55 feet, demonstrates hydraulic connection between deep and shallow zones. No comment is made concerning the lack of apparent connection between upper and lower zones discussed above in relation to the depression centered near RW6D. Any distortion observed in deep wells near RIW2 may just as likely be showing influence from RW6D.

The report states that:

> "The transmissivities (T) and specific yields (S_y) varied between the upper and lower Cohansey Sands. The transmissivity and specific yield of the lower Cohansey Sand, due to the smaller grain size sand and increased percentage of silt and clay, were lower than in the upper Cohansey Sand.

No reference is provided, but it is assumed that the T and S_y values referred to were those calculated by DRAI. Additional reference will be made to this subject relative to the ground water modeling section (Appendix B).

Response: *"V"-shaped contour lines were not presented because there is no site-specific hydrogeologic data available to support such a representation of the water table surface elevation contours. Furthermore, based on the topography of the site, it is unlikely that significant "V"'s exist in the water table surface elevation contours. Typically, a "V"-shaped water elevation contour is observed in areas of large topography changes, such as in steep valley walls.*

Strong downward vertical gradients were noted at well nests that were located near pumping centers or adjacent to the Hudson Branch (where proximity to the stream influences the shallow water table). In well nests located away from these areas, vertical gradients were of a much smaller magnitude. Proposing a semi-confining layer to explain these downward gradients, given the geologic logs of wells SC19 S/D and SC21 S/D and the deep ground water pumping at RW6D, does not appear to be warranted.

As clearly seen in Figures B-5 and B-7 of Appendix B, the pumping of RIW2 influences the deep ground water contours. The MODFLOW simulations are based on the aquifer characteristics calculated by TRC from the DRAI pump tests and were calibrated and verified to SMC deep monitoring well water levels. In addition, given the distance between RW6D and SC3D (over 1,000 feet) and the high transmissivities calculated for the lower Cohansey Sand, it is unlikely RW6D is impacting any deep monitoring wells downgradient of SC4D.

The discussion of transmissivity and specific yield values presented within Section 1.5.3 of the FFS report is general and, therefore, applies to both DRAI's interpretation and TRC's interpretation of transmissivity and specific yield. When conducting the ground water modeling, TRC recalculated transmissivity and specific yield values based on the

DRAI pump test information. The footnote on page B-3 of Appendix B has been clarified to reflect how these values were calculated by TRC. The text has been revised as follows: "....A semi-confining layer was detected in the vicinity of monitoring wells SC12D, SC13D, and SC22D; its depth, thickness and composition differed between these monitoring wells. ***Therefore, the DRAI pump test data were reanalyzed by TRC using AQUIX123™ (Interpex Limited, 1988), an interactive analytical computer program, using the option for the curve-fitting method developed by Neuman (1975) for anisotropic unconfined aquifers with delayed gravity response. The reanalyzed pump test results were then used to determine initial model input hydraulic parameters, including transmissivity and specific yield, for the shallow and deep ground water layers.*** *[END OF FOOTNOTE]*

15. <u>Page 1-15, Section 1.6 - Nature and Extent of Contamination</u>
Contaminants, organic and inorganic, have been found in the "wetland" (the southwest corner of the plant property) and sediment. There does not appear to have been any consideration given to the stream as a pathway to contaminant transport, especially in the shallow part of the aquifer. Not only might the stream have helped distribute contaminants to the southwest, but might be a continuing source of contaminants to the shallow system. SMC shall provide a discussion of this issue.

<u>*Response:*</u> *As discussed in the RI Report, stream and sediment sampling do not indicate that significant downstream migration of contamination is occurring. While contaminants, specifically inorganics, were detected at elevated levels in Hudson Branch water and sediment samples collected adjacent to the SMC facility, concentrations generally decreased as a function of distance downstream of the SMC facility. A sentence to this effect has been added to the text. Potential impacts of these contaminants on the shallow aquifer are further discussed in the response to Specific Comment #10 above.*

A discussion of this, as well as a discussion of surface water quality data gathered by DRAI have been included in Section 1.6 of the report.

16. <u>Page 1-17, Section 1.3 - Previous Investigations</u>
In August 1992, chrome was detected in well SC26D at a concentration of 980 ug/l. This well is located approximately 500 feet south of the SMC facility along Weymouth road. The DFFS selects wells SC22S, SC22D, SC13S, SC13D, W2, and D, as "being representative of current contamination to the south of the SMC site, in an area where residences are located outside of the well restriction area." Well D should have been sealed by now and should not be used for evaluation within the DFFS since future sampling is not possible. In addition, well SC26D is the only monitoring point located within the residential area to the south of the SMC site. Since the residential area is the focus of the evaluation, well SC26D is more representative of potential impact from the SMC site than the other specified wells. Well SC26D must be used in place of well D for remedial evaluation in this section.

<u>*Response:*</u> *The DFFS <u>does not</u> "select wells SC22S, SC22D, SC13S, SC13D, W2 and D as being representative of current contamination to the south of the SMC site...". As indicated in the first sentence of Section 1.7, this section summarizes the findings of the Human*

Health and Environmental Health Evaluation Report. Well SC26D was installed in July 1992 and, therefore, could not be addressed within the human health evaluation, which was submitted in April 1992. The text has been revised to reflect this, as presented in the response to specific comment #17 below. As discussed previously, this comment addresses the human health evaluation and not the FFS. Reference the General Comment Response which precedes specific comment response #6 above.

With respect to well D, well D has not yet been sealed but will be scheduled for closure within the next 30 days. This has been noted in Section 1.4 of the report.

17. <u>Page 1-17, Section 1.7 - Human Health and Ecological Evaluation</u>
This section describes a quantitative assessment of potential impacts of the SMC site to human health and the environment which was submitted by TRC as a separate document. However, a statement in this section is of concern:

> "The only scenario which evaluated exposures to contaminated ground water was the current residential use scenario. Data from monitoring wells SC22S SC22D, SC13S, W2 and D were selected as being representative of current contamination to the south of the SMC site, in an area where residences are located outside of the well restriction area. Under this scenario, risks associated with exposures to contaminants in the upper Cohansey Sands were evaluated separately from those associated with exposures to contaminants in the lower Cohansey Sands, because it is currently unknown whether private wells exist and, if they do exist, whether they have been screened within the shallow or deep portions of the Cohansey Sands."

The stated lack of knowledge related to domestic wells appears to be in conflict with a statement included on page 10 of the RI, which states that DRAI surveyed and sampled domestic wells in the area. The statement also conflict with the fact that a private well is known to exist in this area (Mohan Wells).

With the apparent finding of TCE and Cr in new well SC26D, it is important to discuss domestic water use south of the site.

<u>Response</u>: *The DRAI well survey, which was conducted prior to 1988, cannot be used to identify domestic wells in the area which are <u>still in use</u>. The well restriction area to the southwest of the site should restrict any potable ground water use in that area. City water is available south of the site. The Mohan well is located south of the site but is no longer in use. Per local ordinance, homeowners are required to tie into the city water supply where provided.*

The last paragraph of page 1-17 has been revised as follows, incorporating the changes made in response to specific comment #16, as well as changes made in response to this comment. Following the first sentence, the text has been revised as follows: ***"The well restriction area to the southwest of the site should restrict any potable ground water use in that area. However, residences are also located south of the site, outside of the well restriction area. While city water supply is available in this residential area, it has not***

***been confirmed that no potable use of ground water is occurring. Therefore, the Human Health Evaluation considered potential residential exposures to contaminated ground water in this area. At the time the Human Health Evaluation was conducted (i.e., prior to the installation of additional monitoring wells, as described in Section 1.4), data** from monitoring wells SC22S, SC22D, SC13S, SC13D, W2 and D were selected as being **representative of contamination to the south of the SMC site.** Under this **residential use** scenario, risks associated with exposures to contaminants in the upper Cohansey Sand were evaluated separately from those associated with exposures to contaminants in the lower Cohansey Sand, because, **if there are active potable wells in this area, it is unknown** whether they have been screened within the shallow or deep portions of the Cohansey Sand."*

18. Page 2-3, Section 2.1.2 - Potential NJ Chemical-Specific ARARs/TBCs

This section describes the ground water as Class II based on reported TDS levels of less than 500 ppm. It further discusses the proposed Ground Water Quality Criteria as TBCs. Be advised that the proposed Ground Water Quality Criteria (GWQC), N.J.A.C. 7:9-6.1 et seq., were promulgated on February 1, 1993 and shall be considered ARARs. The DFFS shall be revised to reflect that the ground water in the vicinity of SMC is classified as Class II, Ground Water for Potable Water Supply.

Also, for ground water, all references to New Jersey Ground Water Cleanup Standards must be omitted. The GWQS will now be used for cleanup levels.

Similar changes shall be made in Section 3.1.1 and Tables 3-1 through 3-3.

Response: *The text starting with the third sentence of Section 2.1.2 has been revised as follows: **"Ground water in the vicinity of the SMC site is classified as Class II."**[2] All remaining text associated with that paragraph has been deleted.*

Other text in Section 3.1.1 has been revised to reflect GWQS. Tables 2-2 and 3-1 through 3-3 have also been revised to reflect ground water quality standards rather than the previously proposed ground water cleanup standards. Similarly, where the ground water quality standards are more stringent than MCLs, they have been incorporated appropriately in Figures 3-5, 3-6, and 3-15 through 3-18.

19. Page 2-5, Section 2.2 - Potential Location-Specific ARARs/TBCs

The DFFS Report states that "no formal delineation of wetlands or floodplains and no cultural resources review of the SMC Newfield facility have been conducted." SMC shall conduct these activities as soon as possible to avoid unexpected difficulties.

Response: *These activities will be conducted by SMC in a timely fashion. The text of Section 2.2 has been revised to indicate these activities will be conducted.*

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[2] Nothing herein constitutes a waiver of SMC's right to petition for a change in classification pursuant to NJAC 7:9-6.10.

20. <u>Page 3-4, Section 3.1.1 - Distribution of Contamination and Comparison to ARARs/TBCs</u>
The statement is made that "The modified pumping program could be partially accountable for variations in detected contaminant concentrations at monitoring wells from one sampling round to the next, especially in the area of wells A and SC22D, which could be affected by ground water extraction at well W9." Such an explanation for well A, located near one of the pumping centers, is possible. It is much less likely for SC22D, which is hundreds of feet from the pumping center. Concentration differences at SC22D between the December 1990 and April 1991 samples do not seem unusually great. TCE and Cr concentrations (ppb) drop between the two events from 70 and 108,000 respectively to 35 and 62,000. A change of this magnitude is far more likely to result from minor differences in sampling technique, or random variation of concentrations in the ground water than pumping several hundred feet away.

A more useful exercise would have been presenting an explanation for the major differences in concentration in the deep zone at the far southwest part of the plume. No explanation is offered for the major change in concentration of total Cr in the deep wells noted between December 1990 and April 1991 (see Figures 3-11 and 3-12).

<u>Response:</u> *This comment contradicts specific comment #14, where the influence of well RW6D on deep wells near RIW2 (approximately 1,400 feet away) was inferred. In the case of wells SC22D and W9, which are approximately 700 feet apart, the potential for ground water extraction at well W9 to be <u>partially</u> accountable for variations in contaminant concentrations detected at well SC22D exists. This comment also contradicts general comment #11, where an explanation was requested for variations, typically of less than 10%, in filtered and unfiltered inorganic analytical results. If a 50% change in contaminant concentration is considered to be due to "minor differences in sampling technique or random variation of concentrations in ground water", then the majority of the variations in filtered and unfiltered inorganic sample concentrations noted in general comment #11 could be likewise explained.*

The "major differences" in total chromium concentrations in the deep zone at the far southwest part of the plume (see Figures 3-11 and 3-12 as well as Figures 3-13 and 3-14) do not actually reflect changes in the contaminant distribution but rather reflect changes in the wells which were sampled from one round to the next. In December 1990, well IW2 was sampled and exhibited 26,400 ppb total chromium while well SC4D exhibited 12,600 ppb total chromium. Well SC3D also exhibited total chromium at a concentration of 32.6 ppb. Surrounding wells SC1D, SC5D, SC18D, SC19D and SC21D all exhibited no detectable levels of total chromium. In the April 1991 sampling round, the suite of wells which were sampled changed from those sampled in December 1990, with an emphasis on sampling those wells near the outer fringes of the chromium plume. Again, wells SC1D, SC5D, SC18D, SC19D and SC21D exhibited no detectable levels of total chromium while well SC4D exhibited total chromium at 12,600 ppb. However, wells IW2 and SC3D were not resampled in this round. Therefore, the chromium concentrations could not be shown as extending into the area of these wells based on the lack of data in this area.

This explanation has been integrated into the introductory text following the first paragraph of Section 3.1.1.

21. Page 3-6, Section 3.1.1 - Distribution of Contamination and Comparison to ARARs/TBCs
As stated on page 3-6, the TCE "hot spot" observed at the northeast portion of the 7.5 acre property "...strongly suggests the likelihood of a separate contaminant source or sources...". The stated reasons are the "hot spot" is not in line with the Cr plume, and that if it were a "slug", upgradient wells would show increased contaminant levels also. This is an excellent example for the need to understand the detailed stratigraphy and hydraulics of an aquifer, and of the danger of using isopleth maps alone for the delineation of plumes. Examination of the isopleths for TCE for the shallow and deep systems shows an interesting phenomenon. The shallow plume originates on-site, and travels directly downgradient, to the 7.5 acre parcel. The deep plume is offset to the south, and appears to have migrated more easterly. Examination of the isopleths for the shallow/deep chromium plumes shows a similar pattern. However, the pattern strongly suggests that the plume has been split, probably by the distribution of clay lenses, with some traveling directly southwest in the shallow zone, and some "dropping off the edge" of a clay lens somewhere north of SC22D.

With regard to the TCE "hot spot", a slug could have followed the shallow route, and dropped to the lower zone southwest of the SMC site. Wells upgradient of the "spot" certainly do show elevated concentrations.

The danger of putting too much emphasis on isopleth maps is that it is difficult to keep in mind that they can only show concentrations where wells have been sampled. For example, the deep TCE contours (Figures 3-4 and 3-5) show a 1 ppb "boundary" on the south side of the plume. Now, with the discovery of 12 ppb TCE in SC22D, it is obvious that the previous boundary was present only because data points were lacking in critical areas.

Response: *An initial review of the TCE isopleth maps may seem to indicate an offset in the deep TCE plume to the south from the shallow plume location, however, this offset may be partially due to the lack of deep ground water data in the plant area (see the response to general comment #20). In December 1990, well G2D, the only deep well in the plant area, exhibited no TCE. Well G2D was not sampled in April 1991. Therefore, while TCE contamination in the deep wells could potentially extend to the northeast of the area shown in Figures 3-3 and 3-4, the lack of data in this area resulted in the interpretation of isopleths as presented in these figures.*

While the explanation offered by NJDEPE for TCE migration is a theoretically possible scenario, there is no existing data to support this interpretation. Rather, the available information more strongly suggests the interpretation offered in the RI report and reiterated here. The major points of this interpretation are as follows:

- *Ground water contamination would be expected to migrate in accordance with the regional ground water flow direction;*

- *While clay stringers were identified in the vicinity of wells SC12D, SC13D and SC22D, no continuous confining zone has been identified and no similar clay stringers of geologic significance were identified in other portions of the site;*

- *The chromium contamination migration pathway generally mirrors the TCE contamination migration pathway, with the exception of the TCE "hotspot" area near well SC5D. This increase in TCE levels strongly suggests the likelihood of a separate contaminant source or sources contributing to the levels of TCE other than the source at the SMC facility;*

- *As a result of on-going ground water extraction, the observed concentrations of TCE in well SC5D continue to increase, further suggesting an off-site source area of significantly higher concentrations, whereas concentrations in wells SC4D and SC2D remain relatively constant.*

- *The ground water in the general area around the SMC facility is known to be contaminated with VOCs, with at least three (3) additional identified potentially responsible parties (PRPs). The lack of deep wells at PRP sites represents a data gap which could definitively identify the presence of an off-site source; and*

- *Inspection of data presented in a suit against SMC (see PARS, August 1991) indicates that contamination at other properties includes PCE (which was not detected at SMC) as well as TCE. TCE is a known breakdown product of PCE, further suggesting an off-site source.*

Additional evaluation of the nature and extent of contamination in the southwestern part of the site will be possible following an additional investigation in this area, the scope of which will be determined by SMC, TRC and NJDEPE, per the project meeting of May 20, 1993.

This discussion has been incorporated into the text of Section 3.1.1.

The limitations of isopleth maps in interpreting the extent and movement of ground water contamination were considered in the interpretation of ground water contamination data.

22. Page 3-8, Section 3.1.1 - Distribution of Contamination and Comparison to ARARs/TBCs
On page 3-8, it is stated that: "Ground water monitoring of the toe of the chromium plume conducted since the preparation of the RI Report has indicated no significant change in the downgradient extent of either the shallow or deep total chromium or hexavalent chromium contamination with the exception of the identification of chromium within newly installed well SC26D..." It shall be stated that Cr was detected in monitoring well SC26D at a concentration of 980 ug/l during sampling in August 1992 and continues to be detected at similar concentrations. This well is located in a residential area south of both the SMC facility and the Hudson Branch. Previous to installation of well SC26D, ground water quality data in this area was extremely questionable due to the lack of quality assurance associated in sampling of residential wells (Mohan wells). The detection of Cr in SC26D is of great concern considering

the extent of the Cr plume in this area is basically undefined. The DFFS shall provide a comprehensive discussion regarding data gaps in this area, and specify how this concern will be addressed when evaluating appropriate remedial action.

Response: *The referenced sentence on page 3-8 has been revised per general comment #1. SMC agrees that additional investigation is required to further define the extent of contamination in the area of well SC26D. The following sentence has been appended to the first paragraph of page 3-8: **"Additional investigation is required to further define the extent of contamination in this area".** Also, reference the response to specific comment #26.*

23. Page 3-10, Section 3.1.1 - Distribution of Contamination and Comparison to ARARs/TBCs
a. The third sentence contains a typographical error. It should read "In Table 3-3, the filtered inorganic levels...".

b. The second paragraph states: "Based on the results of quarterly ground water monitoring sampling,... MCLs for radiological parameters have not been exceeded." Be advised that the Department has not agreed with this conclusion.

Response: *a. The text has been corrected as requested.*

b. While the Department's position is noted, SMC reiterates that, based on the results of quarterly ground water monitoring, MCLs for radiological parameters have not been exceeded.

24. Page 3-12, Section 3.1.2 - Risk-Based Considerations
The text states that the risk-based cleanup level for vanadium is 250 ppb, while Table 3-4 states it as 260 ppb. This discrepancy shall be resolved.

Response: *Table 3-4 is correct. The text has been revised to reflect the 260 ppb risk-based cleanup level for vanadium.*

25. Page 3-13, Section 3.1.3 - Remedial Response Objectives
The 400 gpm is the design rate for the ground water remediation system operated as an interim remedial measure, not a final remedy, therefore, this objective is not acceptable. The ion-exchange system and the current configuration of recovery wells was designed to capture chromium and sulfate only (DRAI 1988a). The Remedial Response Objectives shall be revised to state that the aquifer will be remediated to achieve ARARs/TBCs.

Response: *The remedial response objectives have been revised. Reference the response to specific comment #5.*

26. Page 3-13, Section 3.2 - General Response Actions
The first sentence of the second paragraph states "The first step in determining appropriate general response actions for a given media is an initial determination of the areas or volumes to which the general response actions may be applied." This step has yet to be completed at the

SMC site. The chromium, antimony, and volatile organic ground water plumes have not been fully delineated. The DFFS fails to discuss the implications of the missing data. It is possible to conduct additional field work during the design phase of the remedial action to fill the data gaps, however, no additional work is proposed or discussed.

Response: *The text has been revised as follows: "The extent of ground water contamination at the SMC facility and off-site of the facility, as defined by the Remedial Investigation, is indicated in Figures 3-1 through 3-18. As discussed previously in Section 3.1.1, the "hot spot" of TCE contamination identified in the northeast portion of SMC's 7.5 acre parcel strongly suggests the likelihood of a separate contaminant source or sources contributing to the elevated TCE levels in this portion of the site. In determining the extent of ground water requiring remediation, only contamination which is attributable to SMC, not from other potential sources, is considered.*

The installation of well SC26D to the south of the facility (see Figure 1-5 for the well location) subsequent to the RI has identified that the extent of TCE and chromium contamination extends in this direction. Additional plume delineation is required to confirm the extent of this contamination and to confirm or refute that SMC is the source of this contamination (especially the organic component).

Therefore, the areal extent of ground water requiring remediation in accordance with the remedial response objectives generally includes the area beneath the SMC facility, extending to the southwest towards SMC's off-site 7.5 acre parcel, with the extent of contamination to the south which requires remediation not well-defined at this point in time. Remedial alternatives will be developed to address ground water contamination within this general area, with the intent of providing at a minimum hydraulic control of the deep ground water between SMC and well SC26D, to the south of the site and with the goal of meeting the remedial response objectives (including ARARs) in this area. The installation of an additional deep well to further define the southerly extent of contamination can be conducted during the remedial design phase of the selected remedial action."

Other portions of the text have similarly been revised to maintain consistency within the report.

27. Page 3-13, Section 3.2 - General Response Actions

The last sentence of the second paragraph states "Remedial alternatives will be developed to address ground water contamination within this area while also meeting the 400 gpm remediation rate required under the 1988 ACO." As discussed in General Comment No. 4, the 400 gpm pumping rate may not be adequate to address the ground water contamination, therefore, this paragraph shall be revised.

Response: *The text has been revised as presented in the response to specific comment #26. The subsequent reference to the 400 gpm remediation rate has been deleted.*

28. Page 3-14 thru 3-22, Section 3.3.1 - Technology Screening

The procedure of the preliminary screening allows for the elimination of inappropriate or non-implemental technologies or technology process options without a comprehensive review or comparison. However, the text of the DFFS Report fails to present the results of the screening or the rationale for the elimination of a particular technology. The reader is referred to a table in the back of the document to ascertain the fate of each technology. While the information in Tables 3-5, 3-6, and 3-7 are well written, this presentation is backwards and very confusing for a public document. These tables should present a summary of the technology screening as explained in the text. SMC shall revise this section of the DFFS to include a brief technical explanation of each technology, along with a rationale for retaining or eliminating it from further consideration.

Also, it is not clear why capping was considered applicable for a groundwater remediation - even under the broad initial round of technology screening.

Response: *The brief technology descriptions provided in Section 3.3.1 and the process option screening description of Section 3.3.2 have been modified to include brief statements of the reasons for the screening of individual technologies and process options for the SMC site.*

As described in the technology description in Section 3.3.1, capping is potentially applicable as a means of minimizing continued degradation of ground water quality due to infiltration of precipitation and potential leaching of contamination from soil to the ground water. It is typically used in combination with ground water monitoring, ground water containment or ground water extraction

29. Page 3-22, Section 3.3.2 - Process Option Screening
The technology "groundwater use restrictions" is eliminated from further consideration according to Table 3-6, yet Table 3-7 includes it among other process options being considered for further review. This discrepancy shall be resolved.

Response: *Table 3-6 has been revised to indicate that ground water use restrictions have been selected as a chosen process option.*

30. Page 4-3, Section 4.1 - Development of Alternatives
The "interactions of other environmental media not playing a major role in alternatives selection for ground water treatment" needs to be further explained, particularly in light of the hydraulic relationship between the Hudson Branch and the ground water as discussed in Specific Comment No. 10.

Response: *The fourth sentence of Section 4.1 has been revised as follows: **"Only remediation of ground water will be addressed in this operable unit."** Refer to the comment response to specific comment #10.*

31. Page 4-5, Section 4.2.2.1 - Alternative 2 - Continuation of Existing Actions - Description
The first paragraph states that continuation of existing actions consists of continued protection of downgradient receptors through the existing ground water use restrictions. Monitoring well SC26D is located within a residential area outside of the well restriction area. Chromium was detected in this well at a concentration of 980 ug/l in August 1992 and continues to exhibit

similar concentrations. It must be stated in the DFFS that downgradient receptors are not completely protected under the existing action.

Response: *The first sentence of Section 4.2.2.1 has been revised as follows: "...ground water monitoring and **a continuation of** the existing ground water use restrictions." The last paragraph of this section (page 4-6) has been revised as follows: "potential exposures to ground water contamination. **The operation of extraction wells within the aquifer exclusion area provides further protection against potential exposures.** If determined to be necessary..." The text of the Effectiveness discussion in Section 4.2.2.2 has been revised as follows: "...existing well restriction area, **although potential receptors may be located outside the confines of the current restriction area.** Short-term and..."*

32. Page 4-7, Section 4.2.3.1 - Alternative 3 - Modified Ground Water Restoration - Description
It is stated that "Based on detailed design studies previously conducted (DRAI 1988, and DRAI 1991), modeling indicated that a pumping rate of 200 gpm would be sufficient to address ground water contamination, but that a total pumping rate of 400 gpm would ensure timely remediation of ground water. Therefore, the feasibility of significantly modifying the total design pumping rate will not be re-evaluated." The Department never agreed that a 200 gpm recovery rate was sufficient to address contamination. Chromium is intermittently detected in deep monitoring wells SC2D, SC3D, SC4D, and SC5D which are beyond the capture zone of the furthest downgradient deep recovery well, RW6D. Contamination is also consistently detected in monitoring well SC3S, which is beyond the capture zone of shallow recovery well RIW2. Further, Cr was detected in monitoring well SC26D at 980 ug/l, which is well beyond the capture zone of any of SMC's five recovery wells. There is enough data available to conclude that the present recovery well configuration and pumping rates are inadequate in addressing contamination. As previously stated in General Comment No. 4, the DFFS must evaluate the benefits of increased pumping rates (i.e. >400 gpm) to determine the most effective pumping configuration for the final remediation of ground water at the SMC site.

Response: *For the purposes of conducting the **preliminary** screening of alternatives, which is presented in this portion of the report, use of a 400 gpm extraction rate has been assumed. The text has been revised as follows: "...thereby allowing the remedial system to operate at **an optimum rate**, while achieving remediation goals... ...timely remediation of the ground water. **While additional information on the extent of ground water contamination has been developed subsequent to those studies, for preliminary screening purposes, a ground water extraction rate of 400 gpm will be assumed.** The main focus of development..." All subsequent references to "design" rate of 400 gpm will be revised to **"assumed"** rate of 400 gpm or to reference an optimum extraction rate. Further evaluation of the effectiveness of the assumed rate in capturing the contaminated ground water has been addressed within the detailed analysis of alternatives presented in Section 5 and Appendix B of the report. In Section 5, it is also noted that 400 gpm is an approximate rate that may be varied during design or actual system implementation to ensure achievement of desired results.*

Also refer to the response to general comment #4 regarding the potential impact of additional site investigations on the proposed extraction method.

*It should also be noted that well SC3S is located within the modeled capture zone of the ground water extraction component of the **recommended*** remedial alternative.

33. Page 4-9, Section 4.2.4.2 - Alternative 3 - Ground Water Extraction Option E1 - Existing Extraction System - Evaluation
It is stated that the proposed alternative "may not address contamination south of the SMC facility (per newly installed deep well SC26D)." The closest deep recovery well (W9) to monitoring well SC26D is over 900 feet away. Not one of the modeled pumping scenarios included this area within the capture zone of a recovery point. It must be stated that "it is very unlikely that contamination south of the SMC facility (per newly installed deep well SC26D) will be addressed by this alternative".

Response: *The text has been revised as follows: "...deep Cohansey Sands, although **it is very unlikely to** address contamination south of the SMC facility (per newly installed deep well SC26D)."*

It should be noted that the ground water extraction component of the recommended remedial alternative does provide hydraulic control of the deep ground water between SMC and well SC26D and additional investigation of this area will be conducted such that remedial response objectives can be achieved.

34. Page 4-10, Section 4.2.5.1 - Alternative 3, Ground Water Extraction Option E2 - Modified Extraction System - Description
It is stated that installation of one shallow and one deep well will be required to "optimize the extraction system". Page ES-viii and elsewhere throughout the DFFS Option E2 includes one deep and three shallow wells. This discrepancy shall be resolved.

Response: *This alternative option is undergoing **preliminary** screening in this section of the report; the detailed modeling effort which further defines the optimum extraction system has not yet been conducted at this point in the FFS. Therefore, installation of one shallow and one deep well is assumed for preliminary evaluation purposes. Page ES-viii describes the final option, developed on the basis of the modeling effort, as presented in Section 5. The text has been revised to reflect that additional definition of this option would occur during the detailed analysis, as follows: "...under Option E2. **If retained for detailed analysis, additional evaluation of the components (number of wells, well locations, extraction rates, etc.) required to optimize a ground water extraction system will be conducted as part of the detailed analysis.** As with..".*

35. Page 4-13, Section 4.2.7.2 - Alternative 3 - Groundwater Treatment Option T2 - Air Stripping - Evaluation
Air stripping systems often have to be combined with vapor phase carbon treatment in order to meet state air discharge regulations. However, there is limited discussion in the DFFS on the necessity to treat off-gases from the stripping tower. Based on the remedial cost estimates in Appendix A, it does not appear that the cost of a vapor phase carbon treatment unit has been factored into the calculations. This should not affect the ultimate recommendation for groundwater remediation; however, it must be addressed in the DFFS.

Response: *The effectiveness evaluation section of this* ***preliminary*** *analysis addresses the potential need for vapor-phase carbon treatment. However, based on historic operating parameters for the air stripper at the SMC facility, vapor-phase treatment is not required. Reference the response to general comment #10. Further analysis of the potential requirement of vapor-phase treatment has been addressed within the detailed analysis of alternatives presented in Chapter 5. The following text has been added to the end of the first full paragraph on page 5-26: "****While treatment of air emissions has historically not been required based on the treatment rate and VOC levels, potential emission rates are compared to regulatory levels on the basis of measured VOC influent levels and a 400 gallon per minute treatment rate in the calculations presented in Appendix C.****" Similarly, the remedial cost estimates presented in Appendix A are the detailed cost estimates conducted in association with the detailed alternative analysis of Chapter 5. Based on the detailed evaluation of the need for vapor-phase treatment presented in Chapter 5 (and newly created Appendix C), the cost of vapor-phase treatment has not been included in the detailed cost estimate because there is no indication that it will be required to meet air emission ARARs.*

36. Page 4-19, Section 4.2.13.2 - Alternative 3 - Ground Water Treatment Option T8 - Electrochemical Inorganic Removal - Evaluation
Electrochemical treatment is stated to be effective in treating cadmium, copper, chromium, arsenic, lead, and zinc. Antimony is a chemical of concern at the SMC site. It must be stated if this technology is effective in treating antimony.

Response: *This section, being the* ***preliminary*** *screening of alternatives, provides a summary of information readily available in technical literature. A reference to the specific publication which provided this information will be incorporated into the text. The referenced article only provides information on the effectiveness of the technology in treating the listed contaminants. Within the detailed analysis of this alternative option, as presented in Section 5.3.11.1, treatability study information provided by Andco which demonstrated that electrochemical treatment is effective in treating antimony is referenced.*

37. Page 4-27, Section 4.3.3 - Selection of Alternatives for Detailed Analysis - Cost
The last paragraph states that Option T8, electrochemical treatment, has the lowest cost without supplemental ion-exchange. For the reasons discussed in General Comment No. 6, the costs associated with Option T8 shall also include electrochemical treatment with ion-exchange.

Response: *The last paragraph of page 4-27 has been revised as follows: "...without treatment by ion exchange.* ***If supplemental ion exchange treatment is provided, the cost rises, with*** *Option T7, membrane microfiltration, and Option T6, coagulation and filtration, following in order of increasing cost."*

38. Page 5.9, Section 5.3.2.1 - Alternative 2 - Continuation of Existing Actions - Description
The top paragraph shall include a discussion of how and where the suspended solids are disposed, and how and where the dewatered sludge is stored prior to disposal.

Response: *The text at the top of page 5-9 has been revised as follows: "**From the transfer tank, the wastewater is discharged to a storage tank for off-site disposal.** This wastestream is referred to as "brine". The sludge from the separator is transferred to a sludge thickener and dewatered using a filter press. The dewatered sludge is **temporarily stored within super sacks or roll-off containers in a covered area with an impervious floor for a period of less than ninety days before being** disposed of off-site..." The text has been corrected to reflect the fact that no filtration for removal of suspended solids occurred after the supernatent entered the transfer tank.*

39. Page 5-9, Section 5.3.2.1 - Alternative 2 - Continuation of Existing Actions - Description
It shall be stated why the air stripper comes before the ion-exchange unit in the existing treatment train.

Response: *The air stripper was placed before the ion exchange unit to limit organic fouling of the resins. The text has been revised as follows: "...comes before the ion exchange treatment system **to prevent organic fouling of the ion exchange resins.**"*

40. Page 5-11, Section 5.3.2.2 - Alternative 2 - Continuation of Existing Actions - Criteria Assessment
It is stated that as a result of the 1991 study "The pumping rate and frequency at deep wells RW6D and W9 were increased and the recovery rate at shallow well RIW2 was decreased." These pumping rates, frequencies and recovery rates shall be provided.

Response: *The text will be revised as follows: "... in January 1991. **Ground water was extracted at increased rates from the deep extraction wells (50 to 60 gpm at W9 and 70 to 80 gpm at RW6D) and at a decreased rate at the shallow extraction well (65 to 85 gpm at RIW2).** The effects of..."*

41. Page 5-11, Section 5.3.2.2 - Alternative 2 - Continuation of Existing Actions - Criteria Assessment
Figures 1-11 and 1-12 represent ground water contours of shallow wells, not deep wells, as stated. Deep ground water contour maps are represented by Figures 1-13 and 1-14. This discrepancy shall be resolved.

Response: *The reference to the figure numbers has been corrected to read "Figures **1-13** and **1-14**".*

42. Page 5-12, Section 5.3.2.2 - Alternative 2 - Continuation of Existing Actions - Criteria Assessment
Under the heading Reduction of Toxicity, Mobility or Volume Through Treatment it is stated that the sludge is disposed at a land disposal facility. This paragraph shall state if the sludge is hazardous waste and if the sludge is disposed at a RCRA-permitted land disposal facility.

Response: *The text has been revised as follows: "The sludge is disposed of **as a D007 waste at a RCRA-permitted** land disposal facility."*

43. <u>Page 5-14, Section 5.3.3 - Alternative 3- Modified Ground Water Restoration - Description</u>
The last paragraph of this section referencing the Treatment Optimization Study is difficult to follow and should be explained better. The required flows and the effects of the equalization tanks requires elaboration.

<u>Response:</u> *The text has been revised, as follows: "...existing system to increase pumping efficiency be evaluated,* ***as previously described in Section 4.2.10. It had been determined that the existing treatment system's capacity was limited due to the high incoming solids loading and, therefore, the system was operated in a fixed bed mode, requiring periodic shutdowns for regeneration of the ion exchange columns. Flow equalization tanks would provide storage capacity to allow ground water extraction to continue during column regeneration periods. However, in order to take advantage of the added capacity, the treatment system would subsequently have to be operated at treatment rates higher than the optimum fixed bed treatment rates. Therefore, the use of equalization tanks or surge tanks to increase pumping efficiency would not have any effect on the existing system's inability to treat the water at a higher rate while still maintaining discharge limitations.*** *Based on ..."*

44. <u>Page 5-44, Section 5.3.11.1 - Alternative 3 - Ground Water Treatment Option T8 - Electrochemical Treatment - Description</u>
The last paragraph states the <u>bench</u> scale treatability studies showed that the "system would be capable of meeting a total chromium content (Cr+6 and Cr+3) of less than 0.03 ppm in the effluent based on the 400 gpm flow rate". The paragraph goes on to state that a pilot test was completed, however, the results of the pilot test were not discussed. The chromium content of the pilot test effluent shall be included in this section.

<u>Response:</u> *The text has been revised as follows: "...used to run the tests.* ***Most effluent samples exhibited less than 0.01 ppm Cr^{+6} and less than 0.05 ppm total chromium after treatment in the pilot test.*** *The electrochemical cells...presence of colloidal materials.* ***Some of the*** *pilot tests showed an increase in TDS following the electrochemical precipitation and TSS removal processes.* ***Therefore,*** *the ability of the...could not be confirmed.* ***Both bench-scale and pilot treatability study test results are presented in the Industrial Wastewater Treatment System Approval Application (TRC, 1992e)."***

Treatability study information is also provided in Appendix E, within the evaluation of inorganic treatment technologies' abilities to meet the proposed discharge to surface water permit conditions.

45. <u>Page 5-45, Section 5.3.11.2 - Alternative 3 - Ground Water Treatment Option T8 - Electrochemical Treatment -Criteria Evaluation</u>
This entire section shall be revised to include a discussion of electrochemical treatment in conjunction with ion-exchange. Please refer to General Comment No. <u>6</u>.

<u>Response:</u> *Refer to response to general comment #6.*

46. Page 5-47, Section 5.3.12.1 - Alternative 3 - Discharge Option D1 - Discharge to Ground Water - Description
This section describes a 2-acre parcel of SMC-owned property along Weymouth Road in Newfield and shows the location on Figure 5-11. This SMC-owned property shall also be shown of Figures 1-2, 1-3 and 1-4 at a minimum.

Response: *The general location of this parcel is shown on Figure 5-11. However, this parcel has historically been limited to residential use and is not pertinent to the overall RI/FS investigation of the SMC facility. Therefore, its location is not shown on Figures 1-2, 1-3 and 1-4.*

47. Page 5-48, Section 5.3.12.1 - Alternative 3 - Discharge Option D1 - Discharge to Ground Water -Description
The second paragraph discusses the modelling of the discharge of 350 gpm of treated ground water in lagoons B-6, B-7, and B-8. The implementability of the scenario is unclear. SMC shall describe in greater detail how this could be accomplished, recognizing that the lagoons are currently lined and filled with sludges and waste waters.

Response: *The text has been revised as follows: "Implementation of this scenario could be further evaluated pending future cleanup of the lagoons, which would be required before this option could be implemented."*

48. Page 5-54, Section 5.4 - Comparative Analysis of Alternatives
The second paragraph shall be modified to read: Community Acceptance, to be determined at the end of the public comment period, and federal acceptance,...".

Response: *The text has been revised as follows: "Community acceptance, to be determined at the end of the public comment period, and federal acceptance, to be determined on the basis of support agency comments." The last sentence on page 5-1 as well as the second to last sentence on page ix of the Executive Summary have been similarly revised with respect to federal acceptance.*

49. Tables 5-2 through 5-5
These tables shall be revised to state the correct designations of the replacement wells (i.e. SC2D(R)). SMC was required to correct the designations on several occasions prior to the preparation of the DFFS. Failure to correct the designations in the revised DFFS and in the monthly reports WILL result in the issuance of stipulated penalties.

Response: *Refer to response to specific comment #9.*

50. Table 5-12
The table shall include the cost of Option T8, electrochemical treatment, with ion-exchange.

Response: *Refer to response to general comment #6.*

51. Appendix A, Remedial Cost Estimates

For Alternative 3, Options D1 and D3, the $1090.00 for the two gate valves was not added into the costs. The tables shall be revised to reflect this and the DFFS revised where appropriate (i.e. page 5-13).

Response: *The cost estimate tables in Appendix A have been corrected. Due to the rounding of numbers that is done to reflect the relative accuracy goals for cost estimates within the FFS (i.e., +50 to -30 percent), the costs reported in Sections 5.3.12.2 and 5.3.14.2 for the discharge options involving discharge to ground water are not impacted by this correction.*

52. Appendix B, Ground Water Modeling Information

a. Page B-1, (third sentence)

The stated goals of the modeling are 1) to provide capture of Cr contaminated water at the 400 gpm design rate (based on Figures 3-7 through 3-14), and 2) to provide capture of contaminated water as close as possible to the sources, to minimize dispersion. As previously stated in Specific Comment No. 32, the ground water design extraction rate should not be limited to 400 gpm. The main goal of the modeling evaluation should be to determine the most efficient combination of recovery points and pumping rates which will effectively capture the entire contaminated ground water plume.

Response: *The introductory section to Appendix B has been revised to indicate that the purpose of the modeling effort was to develop a pumping scheme that would control and capture the contamination at and/or emanating from SMC. The modeling effort has been used to locate recovery wells and assign pumping rates to achieve this goal and to support the detailed ground water extraction analysis presented within the body of the FFS. A secondary goal of the proposed pumping scheme is to maximize the capture of the center of the plume while maintaining hydraulic control of outlying low-concentration contamination.*

b. Page B-2, (top paragraph)

The first paragraph on page B-2, describes the capabilities of the MODFLOW model. It is stated that the model can simulate flow from external stresses, such as flow to and from riverbeds, wells and/or drains, areal recharge and evapotranspiration. TRC did not use the packages which simulate riverbed flow, evapotranspiration, or areal recharge in any of the model simulations. Discussions of the capabilities of the model are irrelevant if the capabilities are not used. TRC could have used a less sophisticated model to achieve similar results. Although the MODFLOW program is an effective program and it use is preferred by the Department, the above referenced stresses should have been incorporated into the DFFS MODFLOW simulations. SMC shall incorporate packages 4 (river), 5 (evapotranspiration), and 8 (recharge), into the MODFLOW program and re-run the simulations. The results and revised portions of the DFFS document which discuss the results, should be included in the revised DFFS.

Also, MODFLOW assumes fully penetrating screens in pumping wells for each layer. The thickness of the layers used in the simulation are not presented. However, the screen lengths of the recovery wells do not approach the thickness of the formation. A more detailed discussion of the assumptions and their potential effect on the outcome shall be presented in the revised DFFS.

Response: *TRC did not use the riverbed flow, evapotranspiration, or areal recharge modules of MODFLOW as they were not needed to simulate SMC's ground water flow. Use of these modules requires a great deal of specific data that was not collected as part of previous investigations, or requires numerous assumptions without support data. In addition, two of the modules (riverbed flow and evapotranspiration) would not greatly impact the area ground water flow. The Hudson Branch is a minor stream of small lateral extent and depth and does not act as major source or sink of ground water. The areal recharge module was not included as the necessary data on the amount and distribution of areal recharge within and outside of the SMC facility is not available. It should be noted that in using the basic MODFLOW module, the ground water contours were calibrated/verified for two specific seasons. The MODFLOW simulation more than adequately reflected the April and October ground water contours. For the above-stated reasons, modification of the MODFLOW simulations to include the riverbed flow, evapotranspiration, or areal recharge modules is not warranted.*

While the MODFLOW model assumes that all pumping wells fully penetrate each layer, in reality this MODFLOW simulation was calibrated to existing pumping well screen intervals and thus successfully simulates observed ground water elevation data.

These discussions have been incorporated into the introductory section of Appendix B.

c. Page B-2, (bottom paragraph)
The grid for node spacing was uniformly set at 200 feet. The intent of the simulations should be to determine capture zones of recovery wells at specified pumping rates. This will assist in selecting the most efficient location and extraction rates for recovery wells. It is, therefore, beneficial to space nodes at a higher frequency around source areas and pumping wells to better define and refine calculations occurring within those areas. The rationale for the 200 foot grid spacing shall be provided.

Response: *A node spacing of 200 feet was selected because of the large area to be modeled. While under certain circumstances the spacing of node points with greater frequency around source areas and pumping wells can better define capture zones, this approach was not taken in this analysis for the following reasons: 1) The area to be modeled was over a mile and a quarter in length. Given this large area, a 200-foot node spacing was determined to be appropriate. In addition, the water level elevation data required to calibrate the use of a smaller grid spacing around the recovery wells was not available. At a smaller site with closer coverage of monitoring and pumping wells, a greater frequency of node points can be supported; however, at SMC this approach is impracticable. 2) The methodology required to calibrate/verify the model and develop the various pumping scenarios required that numerous (i.e. several hundred) computer simulations be conducted. The greater the number of nodes in the simulation, the longer the time required for parameter adjustment and simulation. A node spacing of 200 feet* *was considered to be optimum to provide coverage of the modeled area while also allowing flexibility in the development and optimization of various pumping scenarios within the FFS preparation time frame.*

This discussion has been incorporated into the introductory section of Appendix B.

d. Page B-4, (top paragraph)
TRC considered the modeled area to be unbounded on any side by an impermeable boundary and, therefore, used a constant head boundary around the modeled area. The use of this boundary, at such a close proximity to the site, constrains the model. As such, it becomes easier to calibrate the model to historical data, but subsequent simulations of aquifer responses may be distorted. Constant head boundary conditions will also reduce the sensitivity of the modeled system to changes in hydraulic conductivity. SMC shall review the use of a constant head boundary and/or expand the perimeter of the model area to reduce the effects of a constant head boundary on simulated flow within the study area.

Response: *The model boundaries were extended outward as far as considered practical when taking into account the areal range of water level data points available. Limiting the outward extent of the model boundaries was particularly imperative in the northwest-southeast direction, due to the relatively narrow band of monitoring well water level data points. Extending the boundaries further outward would lead to a great deal of speculation regarding the input of initial heads around the model periphery, lowering confidence in the model's simulation of steady-state conditions and responses to aquifer stresses. By its nature, constant head boundary is a recharge boundary; therefore, any boundary effect the constant heads may contribute would cause the model to err on the conservative side, acting to limit the areal extent of the recovery well capture zones.*

This discussion has been incorporated into the introductory section of Appendix B.

e. Page B-5, (top of page)
It is stated that shallow ground water was not verified for the April 1992, monitoring episode due to apparent effects of storm water infiltration from the Hudson Branch. As discussed in Specific Comment No. 52b, the river package and the areal recharge packages were not used in the MODFLOW simulations. TRC's concern that storm water infiltration would affect verification of the model further supports the need to utilize the available input packages for the simulations.

Response: *As discussed in the response to specific comment #52b, these modules were not used as insufficient input data were available. The aquifer simulations prepared by SMC for the FFS used values that reflect normal site conditions rather than extreme conditions such as heavy flooding.*

No other complete data set was available at the time the verification modeling was being conducted which could be used in place of the April 1992 shallow ground water contour data. This has been noted in the Model Verification section of Appendix B.

f. Page B-8, Simulation 1 (end of 2nd paragraph)
It is stated that further degradation of ground water may be minimized through hydraulic control of contaminated ground water migrating from the SMC site toward well SC26D. While this scenario may minimize further degradation, it does not address existing ground water contamination in this area which is well above New Jersey Ground Water Quality Standards. SMC shall propose additional remedial action to adequately address this area. Since ground water in this area is not captured under any of the simulated pumping scenarios, this comment is applicable to all of the proposed ground water remedies.

Response: *The FFS modeling effort was designed to devise a pumping scheme that would control and capture the contamination at and/or emanating from SMC, based on the information which was available at the time the modeling was conducted, and in support of the detailed ground water extraction analysis presented within the body of the FFS. SMC plans to further investigate the extent of chromium contamination in the vicinity of well SC26D and in the vicinity of well IW2. The final location of recovery wells and determination of extraction rates required to control and capture chromium contamination at and/or emanating from the SMC facility will be refined as additional information on the extent of contamination is developed.*

A discussion of the additional investigations and subsequent additional evaluation of the ground water extraction system has been added to the conclusions of Appendix B.

g. SMC shall conduct a sensitivity analysis on the MODFLOW ground water model simulations and include the results in the revised DFFS.

Response: *As discussed in the response to general comment #14, a sensitivity analysis has been conducted for the following aquifer parameters: hydraulic conductivity/transmissivity, interlayer vertical leakage, and total pumping rate. The results of these analyses have been presented and summarized in Appendix B.*

53. Model Output Data Sheets

a. Calibration to Steady State Conditions (1st data output)
What is the output labeled "Drawdown in Layer 1 at the End of Time Step 1 in Stress Period 1" (page 8) represent? Under steady state conditions, there should not be any pumping or drawdown present.

Response: *The MODFLOW output item "drawdown" is included in the model output regardless of whether or not a source or sink is simulated in the model. In the case of the steady-state calibration, the "drawdown" model output term quantifies only the change in hydraulic head between the initial input head value and the final equilibrium head calculated during the calibration.*

This information has been included in the introductory section of Appendix B.

b. Data Outputs
What is the head change criteria for closure for all simulations? The criteria shall be presented in the revised DFFS.

Response: *As presented in the model output data sheets, the head change closure criterion for all simulations is 1E-3 foot.*

This information has been included in the introductory section of Appendix B.

c. Data Outputs
The simulations only utilize one time step. This ignores variations in ground water elevations resulting from seasonal changes in climate. The simulations shall utilize four time steps which will represent ground water fluctuations attributable to winter, spring, summer, and fall.

Response: *Since the model was calibrated/verified to monitoring events during two distinct seasons (April and October), it is felt that no additional benefit would be gained, in terms of representing the shallow and deep ground water response to the extraction scenarios, by utilizing time steps for each of the four seasons. In addition, modeling seasonal fluctuations in ground water flow patterns was not possible because there is no other seasonal data available for use in calibrating the model. Therefore, the MODFLOW simulations were modeled for the average hydrologic condition.*

This information has been incorporated into the introductory section of Appendix B.

SUPPLEMENTAL NJDEPE COMMENTS[3] ON THE DRAFT FOCUSED FEASIBILITY STUDY AND SHIELDALLOY METALLURGICAL CORPORATION RESPONSES

A. The following are potential federal location-specific ARARs/TBCs that shall be added to the revised Focused Feasibility Study (FFS):

- Water Resources Council's February 10, 1978 Floodplain Management Guidelines
- USEPA's August 5, 1985 Statement of Policy on Floodplains and Wetland Assessments for CERCLA Actions

Response: *References to these ARARs/TBCs have been added to Table 2-3.*

B. General Comment No. 19 in the March 17 letter requires that SMC delineate any wetlands and floodplains. Be advised that wetland delineation and characterization can be accomplished easiest during the late spring, so planning for this task should begin now. In accordance with NJDEPE policy, the delineation shall follow the Federal Manual for Identifying and Delineating Jurisdictional Wetlands dated January 10, 1989. In addition, be advised that both the 100-year and the 500-year floodplains are of concern and shall be delineated.

Following delineation, wetlands and floodplains functional values assessments should be performed.

Upon completion, the results of the wetlands and floodplains delineations shall be submitted to the Department for review. The results of the delineations and the potential impacts to these resources shall be addressed in the revised FFS.

Response: *As noted in the response to specific comment #19, SMC will conduct these activities in a timely fashion. The results will be presented in an addendum to the Final FFS.*

C. General Comment No. 19 also requires that SMC conduct a cultural resources review. As a first step in dealing with possible cultural resources, SMC shall have a professional archaeologist perform a Stage IA cultural resources survey. Upon completion, the Stage IA report shall be submitted to the Department for review. The results and any impacts to cultural resources shall be addressed in the revised FFS.

Response: *As noted in the response to specific comment #19, SMC will conduct these activities in a timely fashion. The results will be presented in an addendum to the Final FFS.*

[3] Reference letter from Donna L. Gaffigan, Case Manager, NJDEPE to David R. Smith, Shieldalloy Metallurgical Corporation, dated April 27, 1993.

D. Since the Farmland Protection Policy Act is a potential federal location-specific ARAR/TBC, SMC shall identify and characterize these lands. The presence of contamination and the nature of the remedy shall be discussed in the revised FFS to identify potential impacts to these farmlands. Please contact the Soil Conservation Service for assistance.

<u>Response:</u> *As noted in Section 2.2 of the FFS, U.S. Department of Agriculture Maps for Gloucester and Cumberland Counties which identify prime farmland areas on the basis of soil survey information were received from the Soil Conservation Service and were reviewed in the preparation of the FFS. Further evaluation of potential impacts to significant agricultural lands will be presented within an addendum to the Final FFS.*