FINAL REPORT

SHIELDALLOY METALLURGICAL CORPORATION

Newfield, New Jersey

April 1992

Remedial Investigation Technical Report

Submitted by:
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Project No. 7650-N51

PHASE I REMEDIAL INVESTIGATION REPORT

SHIELDALLOY METALLURGICAL CORPORATION

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EXECUTIVE SUMMARY

A Remedial Investigation was performed for Shieldalloy Metallurgical Corporation (SMC) at their Newfield, New Jersey facility by TRC Environmental Consultants, Inc. (TRC), as required under Administrative Consent Order (1988).

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. A site location map is provided in Figure ES-1.

PURPOSE

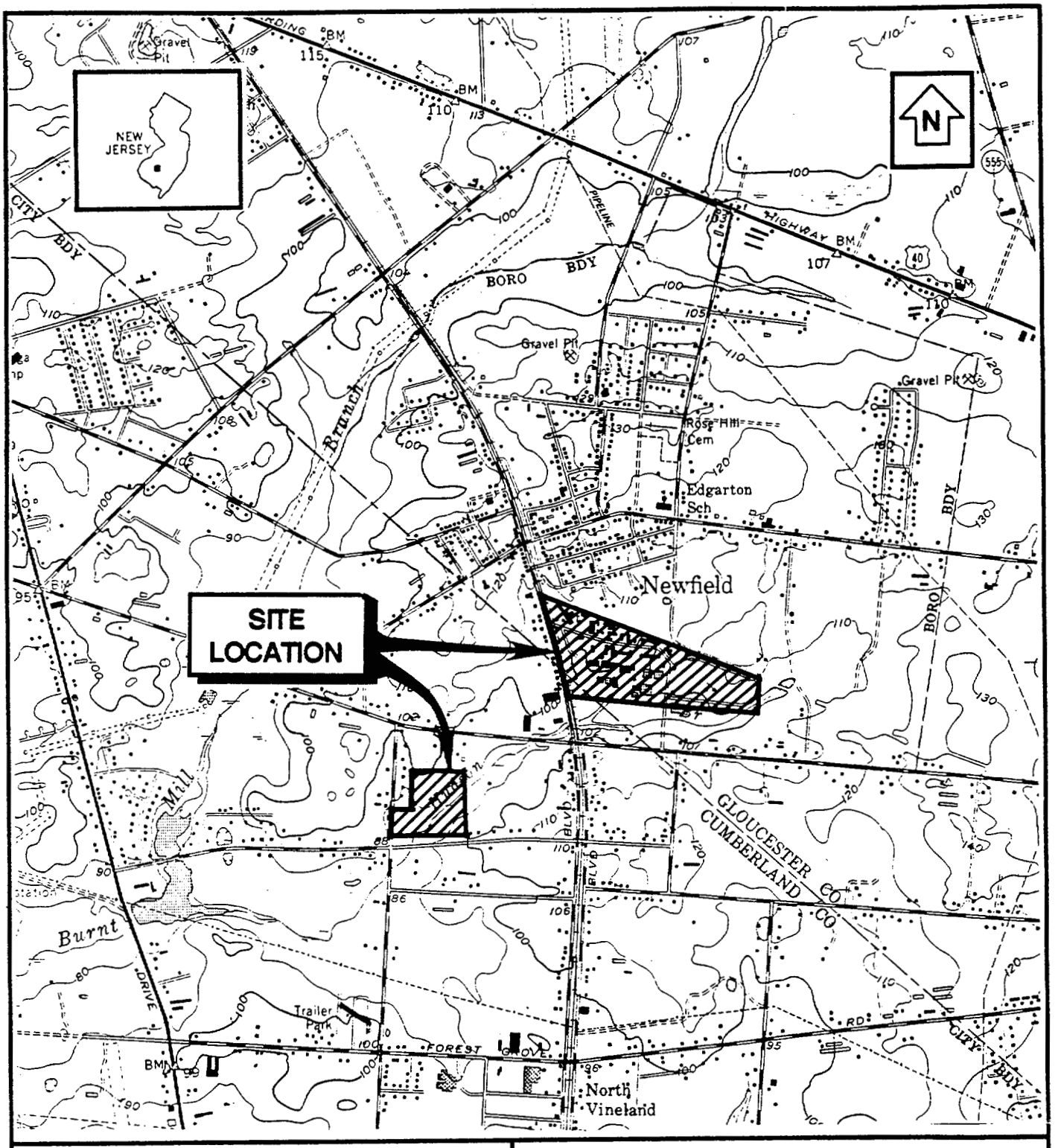
The purposes of the investigation were to: 1) investigate the physical characteristics of the site; 2) determine the nature and extent of contamination resulting from operations at SMC; and 3) to characterize environmental impact and potential health risks.

This report addresses physical characteristics of the site, and the nature and extent of contamination at and around the facility. Contaminant fate, transport mechanisms and a baseline risk assessment will be presented in a separate document. A detailed evaluation of fate and transport characteristics is required prior to fully defining the potential risks and environmental impacts posed by identified contaminants at the site.

HISTORY

SMC (formerly Shieldalloy Corporation) has been operating the 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 metal, slag and other by-products. Raw materials have included oxides of chromium, columbium (niobium), boron, vanadium, calcium, aluminum metal, strontium metal, zirconium metal, steel, iron, nickel, silicon, magnesium, manganese, chrome and fluoride salts. Specific areas of concern include By-Product Storage Area, wastewater lagoons, underground storage tanks for gasoline and diesel fuel, and a titanium metal degreasing operation which was in use from 1965 to 1967.

Previous investigations for SMC, conducted since 1971, have focused on ground water contamination, particularly with respect to chromium and volatile organic compounds (Roy F. Weston 1972, Woodward Clyde Consultants 1972 & 1974, Dan Raviv Associates, Inc. 1987, 1988 & 1989). As a result of these studies, ground water extraction wells have been located both on and to the southwest of the SMC facility. These recovery wells have been located to



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SCALE

FROM NEWFIELD, NJ 7 1/2' USGS
TOPOGRAPHIC MAP, 1953
PHOTOREVISED 1986

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SHIELDALLOY METALLURGICAL CORPORATION
NEWFIELD, NEW JERSEY

FIGURE ES-1.

SITE LOCATION MAP

hydraulically control further migration of the chromium plume. The ground water recovered from these wells is treated at an on-site treatment facility prior to discharge to the Hudson Branch. The Remedial Investigation process began in 1988 with the preparation of a site work plan. Comments from the New Jersey Department of Environmental Protection were incorporated into a final work plan in October 1990.

INVESTIGATION AREAS

The RI program was structured to investigate specific areas of former plant processes and associated materials storage areas. The four general areas that were studied in detail are summarized in Table ES-1 and are indicated on Figure ES-2. The individual areas are described below.

Manufacturing Area - *This area is 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* **Former Manpro-Vibra Degreasing Unit** *which was used to remove dirt, fines and grease from manufactured metals 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**; *the* **Department 102 Area**; *and the* **Chromium Button Storage Area.**

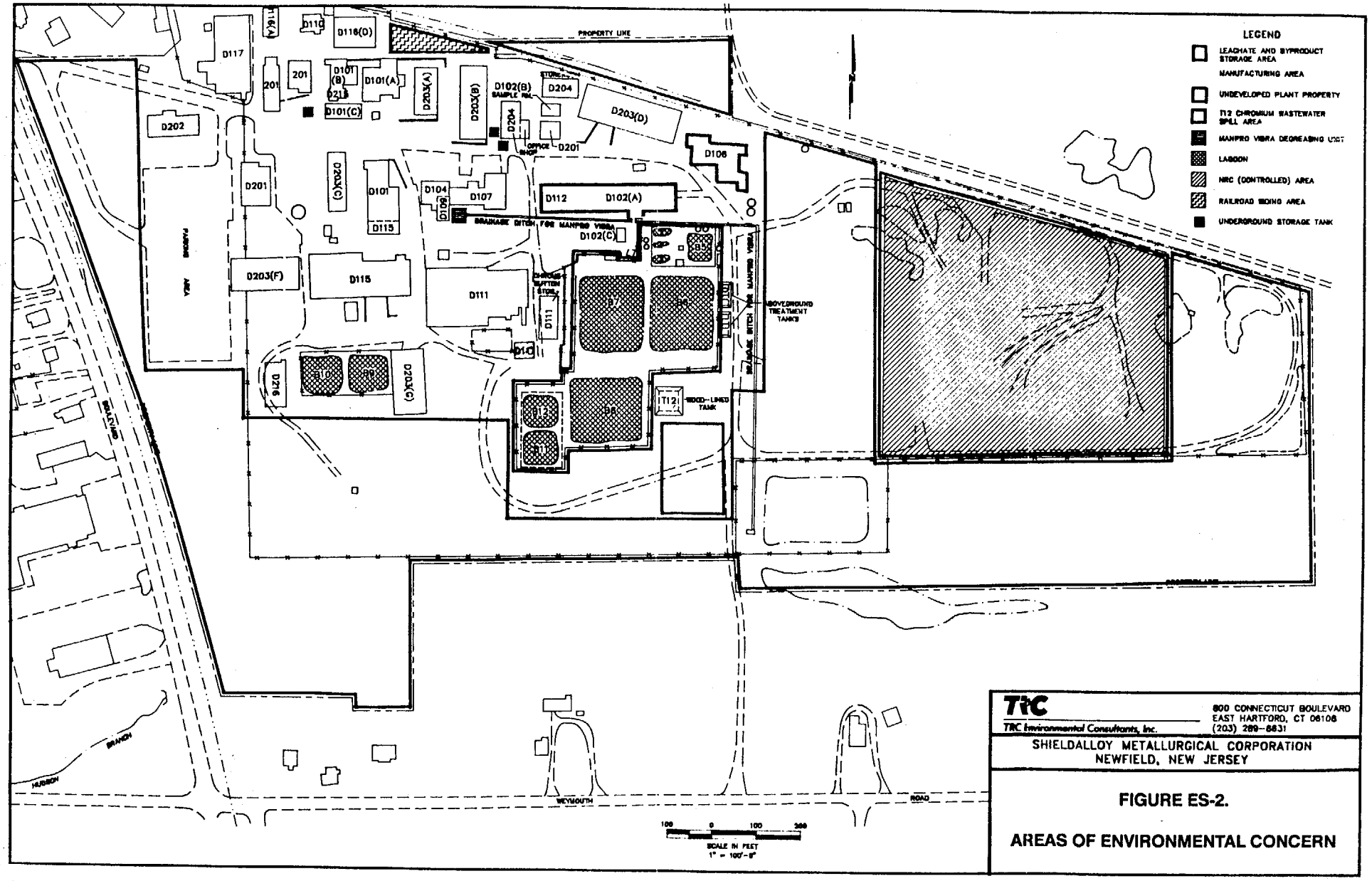
Undeveloped Plant Property - *This area is located along the southern plant property boundary and includes areas east of and adjacent to the Manufacturing Area. This area does not contain manufacturing buildings or offices. Specific areas of investigation within the Undeveloped Plant Property include the* **Former Material Storage Area, By-product Drum Storage Area, Former Chromium Button Storage Area, Tank T12 Area and Remaining Plant Property.** *The Tank T12 Area is 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 consists of nine lagoons located in the central portion of the facility. An unlined lagoon was used as an*

TABLE ES-1
SUMMARY OF INVESTIGATION AREAS
SHIELDALLOY METALLURGICAL CORPORATION

MANUFACTURING AREA	Former Manpro-Vibra Degreasing Unit Underground Storage Tank Area Railroad Siding Area Department 106 Area Department 102 Area Department 101(B) Area Chromium Button Storage Area
UNDEVELOPED PLANT PROPERTY	Former Material Storage Area By-product Drum Storage Area Former Chromium Button Storage Area Tank T12 Area Remaining Plant Property
BY-PRODUCT STORAGE AREA	Ferrovanadium Slag, Chromium Slag, Ferrocolumbium Slag, and Lime Pile
LAGOON AREA	Lagoons B1, B2, B3, B5, B6, B7, B8, B11, and B12



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NEWFIELD, NEW JERSEY

FIGURE ES-2.

AREAS OF ENVIRONMENTAL CONCERN

infiltration/percolation basin for disposal of untreated wastewaters in the 1960's. This lagoon was replaced by lined lagoons that received treated wastewater in 1971.

FIELD INVESTIGATION SCOPE

Key elements of the field investigation program are listed in Table ES-2. The primary goal of the field investigation program was to obtain data to:

* *Characterize the hydrogeologic regime in the study area, including hydraulic properties of overburden deposits;*
* *Characterize the type(s) of contamination present in the study area;*
* *Determine areal and vertical extent of contamination in the media sampled;*
* *Identify pathways of contaminant migration; and*
* *Characterize the nature and extent of contaminant migration.*

The field investigation activities were completed between October 1990 and April 1991.

A Radiological Characterization Study required for NRC license renewal has been conducted by ENSR. The purpose of this study is to determine the extent of radiological contamination at and around the facility. The results of the Radiological Characterization Study and radiological sampling and analyses from wells under the ACO will be included in appendices of the final report and will be considered in the risk assessment and Feasibility Study for the site.

SITE GEOLOGY AND HYDROLOGY

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. Inspection of the geologic boring logs compiled during the RI investigation indicates that generally the Cohansey Sand is composed of coarse sands and little to trace silt in the upper 40 feet, and generally 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. The results of the RI soil boring and monitoring well investigations indicate that no continuous semi-confining layer exists across the site. A semi-confining layer was detected in the

TABLE ES-2
FIELD INVESTIGATION PROGRAM SUMMARY
SHIELDALLOY METALLURGICAL CORPORATION

Field Reconnaissance *and* **Instrument Survey**

Mobilization

Sampling Grid *Layout*

Surface Soil Sampling *(64 samples)*

Test Pit Operations *(5 test pits located along former drainage ditch - 5 samples)*

Soil Gas Surveys - *used to locate 6 soil borings in former product storage areas*

Collection of one round of **surface water samples**, *including runoff samples, and one round of* **sediment samples**

Completion of 72 **soil borings** *across the site to characterize soil quality and geology above the water table*

Installation of **ground water monitoring wells** *to identify geologic and hydrogeologic conditions; 19 wells installed at 14 locations, including 7 deep and 12 shallow wells*

Collection of 2 rounds of **ground water samples** *from on-site and off-site newly installed and existing monitoring wells; initial round (52 monitoring wells sampled) characterized ground water quality and the second round (39 monitoring wells sampled) confirmed first round results and further defined the nature and extent of contamination*

Collection of 72 **air samples** *over the course of 12 air sampling events conducted during non-operational periods at the SMC facility*

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vicinity of monitoring wells SC12D, SC13D, and SC22D. The depth, thickness, and composition of the semi-confining layer differed at each monitoring well. For discussion purposes, the characteristics and extent of contamination in the upper (water table) and lower Cohansey Sands will be addressed separately, where appropriate.

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 toward the southwest. 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. 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).

FIELD INVESTIGATION SUMMARY

Volatile organic compounds and metals (inorganics) were the primary contaminants detected in environmental media at the SMC facility.

In evaluating detected contaminant levels, they were compared against available regulatory action levels. For soils and sediments, contaminant levels were compared to New Jersey Interim Soil Action Levels (referred to hereafter as action levels). For ground water samples, contaminant levels were compared to federal and New Jersey Maximum Contaminant Levels (MCLs). Surface water contaminant levels were compared to New Jersey Water Pollution Control Act (NJWPCA) Maximum Values of Protection of Aquatic Life (Freshwater) and federal MCLs. Air monitoring results were compared to federal Acceptable Ambient Levels (AALs).

It should be noted that "action levels" provide an initial means for the evaluation of contaminant levels and areas of potential concern. It is necessary to evaluate the detected contaminant levels and associated potential risks to human health and the environment with respect to site-specific land use conditions and exposure pathways. These activities will be conducted in a comprehensive baseline risk assessment, in accordance with NJDEP and USEPA guidance, and presented in a separate document.

For each environmental media sampled, a discussion of the contaminant types detected, the environmental distribution of

contaminants, and a comparison of detected levels to regulatory action levels is presented below.

Soil Samples - *Soil samples collected from surface soils, test pits and soil borings at the SMC facility primarily exhibit inorganic compounds. Volatile organic, semi-volatile organic, and PCB compounds were detected in soil samples but at levels which do not exceed New Jersey Interim Soil Action Levels. DDT was detected in three soil boring samples at levels of 26 parts per million (ppm), 31 ppm, and 37 ppm which exceed the New Jersey Interim Soil Action Level of 1 - 10 ppm for DDT.*

Inorganics were detected most frequently at levels exceeding New Jersey Interim Soil Action Levels. The presence of individual inorganic compounds is discussed below:

Beryllium *was detected 66 times in soil samples (53 times in near-surface soil samples) at levels exceeding the action level of 1 ppm. The maximum detected concentration of beryllium was 60.1 ppm, detected in a sample collected in the southwestern portion of the Undeveloped Plant Property, along the observed floodplain of the Hudson Branch. Other areas exhibiting elevated beryllium levels (with maximum detected level of beryllium noted) include the Lagoon Area (19.4 ppm), the Railroad Siding Area (20 ppm), and along the eastern and western sides of the By-products Storage Area (29.3 ppm and 22.5 ppm, respectively).*

Chromium *was detected at concentrations exceeding the action level of 100 ppm a total of 41 times (35 times in near-surface soil samples). The maximum detected concentration of total chromium was 5,870 ppm, detected in a sample collected in the southwestern portion of the Undeveloped Plant Property, along the observed floodplain of the Hudson Branch. Other areas exhibiting elevated total chromium levels (with maximum detected concentrations noted) include the Department 106 Area (2,280 ppm), the Department 102 Area (1,630 ppm), the Railroad Siding Area (260 ppm), and along the eastern and western sides of the By-products Storage Area (176 ppm and 473 ppm, respectively).*

Nickel *was detected at concentrations exceeding the action level of 100 ppm a total of 29 times (26 times in near-surface soil samples). The maximum detected concentration of nickel was 3,360 ppm, detected in a sample collected in the southwestern portion of the Undeveloped Plant Property, along the observed floodplain of the Hudson Branch. Other areas exhibiting elevated nickel levels (with maximum detected concentrations noted) include the Lagoon Area (912 ppm), the Railroad Siding Area (339 ppm), and along the eastern and western sides of the By-products Storage Area (530 ppm and 1,110 ppm, respectively).*

Vanadium *was detected at concentrations exceeding the action level of 100 ppm a total of 81 times (62 times in near-surface soil samples). The maximum detected concentration of vanadium was 12,100 ppm, detected in a sample collected in the southwestern portion of the Undeveloped Plant Property, along the observed floodplain of the Hudson Branch. Other areas exhibiting elevated vanadium levels (with maximum detected concentrations noted) include the Department 106 Area (1,190 ppm), the Lagoon Area (3,950 ppm), the Railroad Siding Area (4,110 ppm), the Tank T12 Area (1,810 ppm), and along the eastern and western sides of the By-products Storage Area (3,990 ppm and 4,750 ppm, respectively).*

In addition to these inorganics, several other metals were detected at levels exceeding action levels, although less frequently than those discussed above. These metals and the frequency with which they were detected at concentrations exceeding action levels include antimony (1 time), barium (6 times), lead (1 time), cadmium (1 time), and selenium (1 time). They were detected in the same areas (as identified above) in which other inorganics exceeded action levels.

The inorganic concentrations in soil samples were also compared to on-site background concentrations and published ranges (USEPA and USGS) of background concentrations for the United States. While detected inorganic levels generally exceeded on-site background concentrations, most levels were within the published national ranges of naturally occurring metals.

Surface Water Samples - *Surface water samples included five water samples collected from the Hudson Branch, as well as four runoff samples collected during a rainfall event from major drainage pathways (near their off-site discharge points). Volatile organic and semi-volatile organic compounds were detected in surface water samples, but at levels which do not exceed NJWPCA levels or federal MCLs. Pesticide/PCB compounds were not detected in surface water samples. As with the soil samples, inorganic contaminants were typically detected in surface water samples at levels exceeding regulatory action levels. Total chromium and lead levels (detected at maximum levels of 8,520 parts per billion [ppb] and 1,240 ppb, respectively) exceeded regulatory levels (50 ppb and 0.75 ppb, respectively) at seven sample locations each, beryllium (detected at a maximum level of 468 ppb) exceeded the regulatory level (5.3 ppb) at four sample locations, and nickel (detected at a maximum level of 618 ppb) exceeded the regulatory level (56 ppb) at three locations. The highest levels of inorganics were generally detected at runoff sample locations, with concentrations generally decreasing as a function of distance downstream of the SMC facility.*

Stream Sediment Samples - *Five sediment samples were collected from the Hudson Branch. Volatile organic, semi-volatile organic, and*

pesticide/PCB compounds were detected in the samples, but at levels which do not exceed action levels. Again, inorganic compounds were commonly detected at levels exceeding action levels. Beryllium, total chromium and vanadium action levels (1 ppm, 100 ppm, and 100 ppm, respectively) were exceeded in each of the sediment samples. Antimony was detected in four of the five samples at levels greater than the action level of 10 ppm. In general, the highest levels of inorganics were detected in sediment sample SD2, which was collected south of the lagoon areas on the SMC facility. While inorganic concentrations generally decreased with distance downgradient of the SMC facility, a slight increase was observed in the sediment sample collected at the most downgradient sampling point (SD5).

Ground Water Samples - *Two rounds of ground water sampling were conducted: the first in December 1990 and the second in April 1991. Sampling locations changed between sampling rounds, with 52 samples collected in the first round and 39 collected in the second round. In addition to the variations in the well locations sampled, the ground water extraction wells which are used for SMC's current ground water pump and treat system varied from one sampling round to the next. Prior to the December sampling event, SMC was pumping primarily from recovery wells IW2 and RW6S. On January 21, 1991, SMC modified the pumping strategy to increase the extraction of ground water from the lower Cohansey Sand, including ground water extraction at wells RIW2, RW6D and W9. The modified pumping program could be partially accountable for variations in detected contaminant concentrations at monitoring wells between sampling rounds. Specifically, the addition of ground water extraction at the location of recovery well W9 could impact the contaminant concentrations detected at wells A and SC22D.*

Volatile Organics - *Trichloroethene (TCE) was the volatile organic compound most commonly detected at levels exceeding MCLs. In the first round, the MCL 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) are detected in the general location of the Former Manpro-Vibra Degreasing Unit. Lower levels (5 to 55 ppb) are 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) and to the southwest, with a "hot spot" detected in the northeast corner of SMC's 7.5 acre parcel (330 ppb). 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).

Other volatile organics were detected at levels exceeding MCLs at a much lower frequency (1 to 4 times per sampling round), including 1,1-dichloroethene, 1,2-dichloroethene (total), benzene, toluene, and xylene. In both rounds, benzene, toluene and xylene were detected in well SC23S, which was 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, indicating their presence may be associated with laboratory contamination.

Semi-Volatile Organics - *No semi-volatile organic compounds were detected in either sampling round at concentrations exceeding MCLs.*

Pesticide/PCBs - *No pesticides/PCBs were detected in the first sampling round.*

Inorganics - *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 and lead were the inorganics most commonly detected above MCLs during the first sampling round, while total chromium and antimony were most commonly detected above MCLs during the second sampling round. The major anion and cation analysis indicated that chromium exists primarily in a trivalent state in the ground water. Although some variability was found, comparison of filtered and unfiltered ground water sample analyses indicated that soluble inorganics are present in the ground water, with metals 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.

Total Chromium - *During the first sampling round, total chromium was the inorganic most commonly detected at levels exceeding the New Jersey MCL (50 ppb). Hexavalent chromium was also commonly detected, although no MCL has been established for hexavalent chromium. Total chromium was detected in the upper Cohansey Sand beneath the Manufacturing Area at concentrations ranging to 20,800 ppb in the first round, with concentrations generally decreasing to the*

southwest. An elevated concentration (11,700 ppb) was detected in a well located near the pumping wells, southwest of the facility. Lesser concentrations (1,180 ppb and 368 ppb) were detected further southwest of the pumping wells. In the second round of sampling, total chromium in the upper Cohansey Sand was detected at a maximum level of 7,960 ppb beneath the Manufacturing Area, ranging to 5,190 ppb in the area of the pumping wells. Total chromium levels did not extend as far to the southwest as they did in the first sampling round.

In the lower Cohansey Sand, total chromium levels ranged to 108,000 ppb, detected at a well located just south of the Lagoon Area. Concentrations decreased to the southwest, generally mirroring the southwestern extent of total chromium in the upper Cohansey Sand in the first sampling round, although detected levels of total chromium in these areas were higher in the lower sands (12,600 ppb and 26,400 ppb compared to 1,180 and 368 ppb). In the second sampling round, the maximum total chromium level was again detected south of the Lagoon Area (62,000 ppb). The southwestern extent of total chromium also mirrored that identified in the shallow sands, with concentrations in the lower sands (12,600 ppb) exceeding those detected in the upper sands (956 ppb).

Hexavalent Chromium *- For hexavalent chromium in the upper Cohansey Sand, first round sampling results indicated the highest detected level (26,400 ppb) was located just west of the Lagoon Area, with a second area of elevated concentration (10,600 ppb) located west of the By-product Storage Area. The contaminant plume extends to the southwest, but not to the same extent as total chromium was detected during the same sampling round. During the second sampling round, detected hexavalent chromium levels decreased in the By-product Storage Area (2,100 ppb). The wells located west and southwest of the Lagoon Area (IWC2, Layne and K wells) exhibiting elevated hexavalent chromium levels (26,400 ppb, 19,900 ppb and 15,100 ppb, respectively) in the first sampling round were not resampled during the second round; however, a well adjacent to the Layne well (well B) exhibited only 1,600 ppb hexavalent chromium during the second round. Hexavalent chromium levels downgradient to the southwest remained relatively constant in the second round, with the maximum detected concentration (13,000 ppb) located in the area of extraction wells Layne and W9.*

Hexavalent chromium in the lower Cohansey Sand was detected at the highest level (60,900 ppb) in the southwestern portion of the Undeveloped Plant Property, with concentrations extending to the southwest and increasing slightly at a well located in the northeast portion of SMC's 7.5 acre parcel. The southwest extent of the plume generally agrees with the

extent of the total chromium plume determined during first round sampling. In the second round of sampling, the maximum level of hexavalent chromium (69,000 ppb) was detected south of the Lagoon Area, extending west and southwest, although not into SMC's 7.5 acre parcel. The extent of hexavalent chromium mirrors the extent of total chromium measured during the same sampling round.

Other Inorganics - *Lead was detected in ground water at levels exceeding the MCL (5 ppb) 16 times during the first sampling round and 10 times during the second sampling round. The highest level of lead (137 ppb) was detected at an upgradient shallow well location (W3S). Shallow wells in the northwestern portion of the facility, near the locations of the Railroad Siding Area and Underground Storage Tanks also exhibited relatively high levels of lead (49 to 84 ppb). MCLs were also exceeded in wells screened within the lower Cohansey Sand, with concentrations generally decreasing to the southwest for both the lower and upper sands. Second round results generally confirmed the lead levels detected in the first round.*

Antimony was detected in ground water at levels exceeding the MCL (10 ppb) 12 times during the first sampling round and 18 times during the second sampling round. During both sampling rounds, maximum levels (2,140 ppb and 1,340 ppb) were detected south of the Lagoon Area in well SC22D. A well located in the northeast portion of SMC's 7.5 acre parcel (IW2 - screened from 40 to 70 feet), which was sampled only during the first sampling round, exhibited 573 ppb antimony, indicating a potential "hot spot". A well located approximately 300 feet northeast of IW2, SC4D, exhibited antimony at 258 ppb during the first round and 272 ppb during the second round. Downgradient wells located to the southwest exhibited lesser concentrations of antimony (19 to 45.7 ppb), although these levels did exceed the MCL.

Other inorganics detected at levels exceeding their associated MCL at frequencies of 1 to 4 times per sampling round include arsenic, beryllium, cadmium, mercury, nickel, and selenium.

Included in the ground water investigation was the sampling of a monitoring well, SC23S, which had been installed downgradient of an inactive underground storage tank which previously held unleaded gasoline. The analytical data from monitoring well SC23S indicated that a discharge of fuel products had occurred. SMC notified NJDEP of the discharge and will submit Closure Plans for the three underground storage tanks at the facility in the near future. Upon NJDEP approval of the Closure Plans, closure activities will be initiated.

Air Samples - *A total of 72 air/dust samples were collected during twelve sampling events at the SMC facility. Titanium was the only metal species detected at a concentration exceeding federal Acceptable Ambient Levels (AALs), and it was detected at these levels at one sample location in only two (2) of twelve (12) sampling events. No site specific air criteria for metal species have been developed by NJDEP for the SMC facility.*

A review of the meteorological and chemical concentration data indicates variability in contaminant levels, which would be expected given the various meteorological conditions under which the monitoring occurred, as well as a relative consistency between the areas in which the highest particulate concentrations were detected and potential upgradient source areas, depending on the wind conditions on a particular day. Based on the air monitoring results, it is likely that particulate sources are not collocated and that particulate source locations are variable based on ongoing site operations (especially material storage activities within the By-products Storage Area).

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the Remedial Investigation, conclusions regarding the nature and extent of contamination and recommendations for additional studies can be made. However, a full evaluation of contaminant fate and transport mechanisms and potential impacts to human health and the environment will be presented in a separate document which will provide the basis for developing the work plan for additional investigations.

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

* *An area along the observed floodplain of 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); and*

* *Tank T12 Area (vanadium).*

Surface water sample 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 of the Hudson Branch. Sediment samples collected from the Hudson Branch also exhibit inorganics at levels exceeding soil action levels. While concentrations in surface water and sediment generally decrease with distance downstream from the SMC facility, a slight increase in sediment inorganic levels was observed at the sampling point located the greatest distance downstream. This may indicate other off-site sources are contributing to inorganic levels within the water and sediment of the Hudson Branch.

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 upper plume, extending 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 potentially indicates a separate contaminant source from that contributing to the elevated TCE levels detected beneath 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 Pile. 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 Pile 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 Pile and the Manufacturing Area, as well as in the area near the Underground Storage Tanks and Railroad Siding. 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.

Prior to proposing additional investigations at the SMC facility, an evaluation of contaminant fate and transport mechanisms and a health and environmental risk assessment will be conducted to quantitatively and qualitatively assess the impacts of detected contaminant levels on human health and the environment. This information must be considered to more effectively determine where additional environmental data is needed to adequately characterize the site. Based on the information available at this point in time, potential sampling objectives can be preliminarily identified, as follows:

* *Confirmation of increased contaminant levels at the downstream sediment sample location (SD5);*

* *Definition of ground water quality in the lower Cohansey Sand in the general area of the Former Manpro-Vibra Degreasing Unit by installing a deep monitoring well (SC20D);*

* *Definition of ground water quality in the area south of existing well SC22D by installing a deep monitoring well between SC22D and the Hudson Branch, to confirm the capture zone of the existing recovery well.*

This Remedial Investigation combined with the human health risk assessment will provide risk-based criteria for developing cleanup objectives. Subsequent to this work effort, a Feasibility Study will be performed to determine cost-effective remedial strategies for the SMC Newfield site.

1.0 INTRODUCTION

TRC Environmental Consultants, Inc. (TRC) has performed a Phase I Remedial Investigation (RI) at the Shieldalloy Metallurgical Corporation (SMC) facility, Newfield, New Jersey 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 investigation was performed for SMC as required under a New Jersey Department of Environmental Protection (NJDEP) Administrative Consent Order (ACO dated October 5, 1988), which sited the following New Jersey statutes: the Water Pollution Control Act, N.J.A.C. 58:10A-1 et seq., the Spill Compensaiton 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.

The purpose of the investigation was to investigate the physical characteristics of the site, as well as potential sources of contamination, determine the nature and extent of contamination and characterize potential health risk and environmental impact. The investigation is being conducted in two phases. This report presents the results of the Phase I RI investigation. The second phase of the RI will focus primarily on lagoon areas at the facility and will also address areas identified during the Phase I RI as requiring supplemental investigations.

Environmental investigation reports previously prepared for the SMC facility include:

- Final RI Work Plan for Shieldalloy Metallurgical Corporation, TRC, October 1990
- Second Ground Water Sampling Event Work Plan for Shieldalloy Metallurgical Corporation, TRC, April 1991
- Evaluation of Ground Water Pumping Effectiveness for Shieldalloy Metallurgical Corporation, Dan Ravin Associates, Inc. (DRAI), January 1991

- Summary of Geohydrologic Information Collected since January 1988 for Shieldalloy Metallurgical Corporation, DRAI, April 1990
- Radiological Survey of the Shieldalloy Corporation, Newfield, New Jersey, Oak Ridge Associated Universities (ORAU), July 1988
- Ground Water Remediation Alternatives for Shieldalloy Corporation, DRAI, January 1988
- Summary of Water Analyses for Inorganic Parameters for Shieldalloy Corporation, DRAI, February 1987
- Surface Water Contamination Study for Shieldalloy Corporation, Woodward-Clyde Consultants, March 1975
- Final Report - Phase II Ground Water Contamination Study for Shielalloy Corporation, Woodward-Clyde Consultants, March 1975
- Progress Report - Monitoring Well Program Ground Water Contamination Study, Woodward-Moorhouse & Associates, Inc., July 1974
- Hydrogeologic Investigation of Ground Water Contamination, Interim Report, Roy F. Weston, Inc. (Weston), February 1972

1.1 Overview of Phase I Remedial Investigation Report

The Phase I RI Report presents information concerning the physical characterization of the SMC site, summarizes data collected during Phase I of the site investigation, and presents an evaluation of chemical data, and conclusions regarding the extent of contamination at the site. The organization of the RI report is presented in a format consistent with the "Guidance for Conducting RI/FS Under CERCLA" (USEPA, 1988).

Section 1.0, Introduction, provides an overview of the Phase I Remedial Investigation (RI) Report, information on the site history, pertinent results of previous studies conducted at the SMC site, and a summary of the Phase I investigation activities conducted at the site.

Section 2.0, Site Investigation, presents information on the key environmental media that were investigated during the Phase I field activities. These environmental components include air, surface soil, surface

water and sediments, subsurface soils, and ground water. For each media investigated, the following information is presented:

- an investigation overview, including the sample types, number of samples, chemical analyses, and any deviations from the approved RI Work Plan (TRC, 1990);
- a summary of sampling point locations;
- a summary of field measurements and pertinent observations.

Section 3.0, Physical Characteristics - Site Assessment, presents information regarding the physical characterization of the site, based on the results of the Phase I site investigation. The assessment includes an evaluation of hydrologic, geologic, and hydrogeologic characteristics.

Section 4.0, Nature and Extent of Contamination, presents an evaluation of the chemical data gathered for each sample matrix, identification of potential contamination sources and the degree that contamination has affected the quality of soils, water and air.

Section 5.0, Summary and Conclusions, presents a synopsis of the nature and extent of contamination throughout the site, and preliminary recommendations for additional environmental investigations at the SMC facility.

Additional site characterization information will be presented in a separate document. This document will include an evaluation of the possible fate of contaminants in the environment and potential transport mechanisms affecting contaminant migration. It will also include a baseline Risk Assessment, which presents an evaluation of the potential health risks posed by contaminants detected at the SMC facility. The human health study will evaluate potential risks to potential receptors, including SMC personnel as well as potential residential exposures.

1.2 Site Background Information

This section provides information on the site characteristics, manufacturing operations and previous environmental investigations.

1.2.1 Site 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 farm lands which are located in Vineland, New Jersey, within Cumberland County. This 7.5 acre parcel is located approximately 2,000 feet southwest of the 60 acre parcel. Figure 1 shows the location of the site within the United States Geological Survey (USGS) 7.5 minute series topographic map of the Newfield, New Jersey Quadrangle.

The SMC Newfield property is bounded by a Conrail rail line to the west and to the north. Woods, residential homes, and small businesses are located east of the site. Hudson Branch, a tributary to Burnt Mill Branch, flows along the southern portion of the site, just north of residences on 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 2.

1.2.2 Operations and History

SMC (formerly Shieldalloy Corporation) has been operating at the Newfield, NJ facility since 1955. 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. The principal production processes currently

employed by SMC include aluminothermic and reduction smelting of ores, which produce purified metal, slags, and various other by-products, co-products, or other materials. Current products include aluminum master alloys, ferroalloys, crushing/grinding metal powders, and pressed metal powder briquettes. Raw materials currently used and stored at the facility include pyrochlore, columbium (niobium), ferroboron, aluminum oxide, titanium oxide, strontium oxide, zirconium oxide, dolomite lime, steel slag, lead, nickel, ferromanganese, silicon, fluoride salts, and oxides of vanadium. The raw materials are distributed to appropriate warehouse or departments upon arrival. In the past, some raw materials may have been stored throughout the plant. As a result of these current and past manufacturing processes, the facility has generated slag, dross, baghouse dust, and wastewaters. The products and by-products produced by SMC are presented in Table 1.

The SMC facility has grown as manufacturing operations were expanded and new products were manufactured. The expansion of operations required the construction of buildings to house these manufacturing processes. A chronological listing of the various structures built at the SMC facility since 1955 is presented in Table 2. Aerial photographs of the site are located in Appendix H of the RI Work Plan (TRC, 1990).

1.2.3 Previous Investigations

Environmental investigations at the SMC facility have been ongoing since 1972, when the first hydrologic investigation of the site was conducted. A summary of historic environmental investigation reports was previously presented in Section 1.0. Based on these environmental investigations, on-going interactions with and input from the New Jersey Department of Environmental Protection (NJDEP), and further review of historic site

operations, several areas of potential environmental concern at the facility have been identified. These areas, as identified in Figure 3, are described briefly below. These descriptions are followed by a summary of previous site investigations.

Manufacturing Area - This area is 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 Former Manpro-Vibra Degreasing Unit which was used to remove dirt, fines and grease from manufactured metals 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; the Department 102 Area; Department 101(B) Area; and the Chromium Button Storage Area.

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. Specific areas of investigation within the Undeveloped Plant Property include the Former Material Storage Area (which consists of two areas), By-Product Drum Storage Area, Tank T12 Area and Remaining Plant Property. The Tank T12 Area is 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 are overlaps with

an area referred to as the NRC (controlled) area. Due to the presence of naturally ocurring thorium and uranium in the raw material which SMC uses for ferrocolumbium, potions 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 consists of nine lagoons located in the central portion of the facility. An unlined lagoon was used as an infiltration/ percolation basin for disposal of untreated wastewaters in the 1960's. This lagoon was replaced by lined lagoons that received treated wastewater in 1971.

Three of these areas, specifically the Manpro-Vibra Degreasing Unit Area (located within the Manufacturing Area), the By-product Storage Area and the Lagoon Area, are of principal concern. They are discussed in more detail below.

Manpro-Vibra Degreasing Unit - A Manpro-Vibra Degreasing Unit operated at the facility from 1965 to 1967. This unit was used to remove dirt and fines as well as grease from the manufactured metals. The primary degreasing compound used was trichloroethene (TCE). TCE apparently was allowed to and vent volatilize to the atmosphere as well as be discharged periodically along with the system's outflow into a ditch system (TRC, 1990).

By-products Storage Area - The By-products Storage Area, which includes the NRC control zone, consists of slags and lime flume solids (baghouse dust). Some of these by-products contain low concentrations of radioactive isotopes. In previous investigations (ORAU, 1988), radioactive isotopes have been traced along runoff drainage pathways.

Lagoon Area - In 1963, SMC installed a combination wet and dry air emissions control system (SMC Department 102), sending untreated wastewater from the system to an unlined lagoon in the central portion of the property. In the mid-1960's, untreated process wastewater from a now abandoned chrome oxide (Cr_2O_3) production facility (SMC Department 106) was also sent to this lagoon. Ground

water quality beneath the lagoon was impacted as wastewater leaked through the lagoon bottom, contaminating the ground water with hexavalent and trivalent chromium, sodium, and resulting in high pH levels. In 1971, the unlined lagoon was replaced by a number of smaller, lined lagoons (as indicated in Figure 3) and the wastewater was treated (SMC Department 214) prior to discharge to the lagoons. The treatment process involved the conversion of hexavalent chromium to trivalent chromium, which subsequently combined with hydroxide (OH) to form chromic hydroxide ($Cr(OH)_3$). The chromic hydroxide then precipitated out of solution within the lined lagoons resulting in a hydroxide sludge. If these lined lagoons also leak, they may provide a continued source of chromium and associated contaminants to the ground water.

Additional areas targeted for investigation were the sites of three (3) underground storage tanks (USTs) that are located on the SMC facility. One of the three USTs which stored unleaded gasoline is no longer in service, while the other two USTs still store petroleum products. Each tank is made of steel and has been in place for over fifteen (15) years.

There have been a number of background surficial, hydraulic, and hydrogeologic investigations conducted at the SMC facility, which to some extent, have overlapped each other. A summary of all ground water monitoring, irrigation, and recovery wells installed prior to the current RI field investigation is presented in Table 3. The monitoring wells associated with each specific use and investigation are identified below.

The first hydrologic investigation at SMC was performed by Roy F. Weston, Inc. in 1972, in response to the detection of hexavalent chromium contamination in a newly installed Newfield municipal supply well. The municipal supply well was installed west of Building D117 and north of Building D202 (Figure 2). The supply well was drilled to provide water for SMC plant operations and therefore was never connected into the municipal distribution system (sealed). The Roy F. Weston investigation consisted of the installation of twelve (12) two-inch diameter monitoring wells (monitoring wells A through L) and one (1) six-inch diameter well (Layne Well, used as a recovery well). These wells were installed downgradient (southwest) of the

unlined lagoon. The wells were installed to determine the vertical and horizontal extent of hexavalent chromium contamination. An attempt was made to determine the effect of small silt and clay lenses on the downward migration of hexavalent chromium (Weston, 1972).

In 1973, Woodward-Moorehouse Associates, Inc. conducted a ground and surface water contamination study. They installed ten (10) monitoring wells (identified as "W" series monitoring wells), two of which were installed downgradient off SMC property. These monitoring wells were constructed mainly of four-inch diameter PVC and were located to define the extent of the contamination plume as well as to determine upgradient water quality . In addition to the "W" series of wells, five (5) two-inch wells, referred to as IWC wells, were installed as a single well cluster. The purpose of these wells was to establish water quality as a function of depth, and to be used as observation wells during a pump test to determine the hydrologic properties of the aquifer. The data developed from these wells, as well as a resistivity study of the area, resulted in the construction of the first ion exchange plant (SMC Department 214) to treat the chromium-contaminated ground water (Woodward-Moorehouse, 1974).

In 1983, Dan Raviv Associates, Inc. (DRAI) reviewed previous investigations including data SMC had collected through an in-house well sampling program. Based on this review it was determined that sampling data gaps existed. Therefore DRAI initiated a more intensive monitoring program and installed an additional nine (9) monitoring wells (the "SC", series of wells) and five (5) extraction wells (the "RW" and "RI" series of wells). Twelve (12) of these wells were drilled downgradient of the SMC property and were used to evaluate off-site ground water quality and the extent of the hexavalent chromium contamination plume. DRAI also installed upgradient wells

W3S and W3D to replace the Woodward-Moorehouse monitoring well W3 and to provide additional upgradient water quality information. In addition to sampling SMC monitoring wells, DRAI also surveyed the locations of domestic wells in the area. These domestic wells were sampled to provide additional water quality information. In January 1988, DRAI submitted a report to SMC and to the NJDEP entitled "Ground Water Remediation Alternatives". This report described the results of DRAI's four year investigation of ground water impacts and evaluated remedial alternatives for the SMC facility. The report modeled the contamination plume using the USGS numerical model MODFLOW and suggested a pumping schedule to control the hexavalent chromium contamination. The report also evaluated remediation technologies for hexavalent chromium contamination treatment.

In October 1988, NJDEP and SMC entered into an Administrative Consent Order (ACO). SMC was required to initiate the operation of a 400 gallon per minute (gpm) pump and treat system that would control the migration of hexavalent chromium and treat the chromium using ion-exchange technologies. A Remedial Investigation/Feasibility Study was also required under the order. SMC commenced operation of the pump and treat system in May 1989. SMC contracted with ENSR Consulting and Engineering (ENSR) to prepare a Remedial Investigation (RI) Work Plan that addressed ACO requirements (as stated in Appendix A of the ACO). The RI Work plan was to address the following objectives:

- Fully chracterize all waste and other materials which are, or may be the source(s) of pollution at the site;
- Fully determine the nature, type and physical states of soil, surface water and ground water pollution at and/or emanating from the site;
- Fully determine the horizontal and vertical extent of pollution at and/or emanating from the site;

- Fully determine migration paths of pollutants through air, soil, ground water, surface water and sediment;
- Fully determine impact of the pollution on human health and the environment; and
- Collect, present and discuss all data necessary to adequately support the development of a feasibility study and the selection of a remedial action alternative that will remediate the adverse impacts of the pollution on human health and the environment.

The RI Work Plan (TRC, 1990) was finalized by TRC Environmental Consultants, Inc. (TRC) in October 1990. The field investigation began in late October 1990.

The NRC license for the SMC facility expired in July 1985. SMC submitted a license renewal application in July 1985, which was revised in 1988. The NRC requires as part of their license renewal process a survey and field investigation to determine if any radioactive isotopes have migrated from the NRC control area. An initial survey was conducted by Oak Ridge Associated Universities (ORAU, 1988). The results of this survey indicated that radioactive isotopes had migrated from the NRC control area into the Hudson Branch sediments. In March 1991, ENSR conducted a radiological characterization survey at the SMC facility. The radiological characterization survey has not been completed but will be included in the final RI report as Appendix A.

1.3 Summary of Phase I Investigation Activities

The Phase I field investigation began on October 29, 1990 and was completed on April 17, 1991. During the field investigation the following activities were completed: surface soil sampling; surface water and sediment sampling; test pit sampling; soil boring sampling; monitoring well installation; and ground water sampling. A summary of field investigation activities, including dates of investigation, is provided below.

- Field Reconnaissance and Instrument Survey (Week of October 15, 1990)

- Mobilization and Sample Grid Layout (Week of October 22, 1990)

- Surface Soil Sampling - 64 samples (October 29-31, 1990)

- Test Pit Operations - 5 test pits located along the former Manpro-Vibra Degreasing Unit drainage ditch, including collection of 5 soil samples (October 29-30, 1990)

- Soil Gas Survey - used to locate 6 soil borings in former titanium product storage areas (October 31, 1990-November 1, 1990)

- Collection of one round of Surface Water Samples (5), Runoff Samples (4), and Sediment Samples (5) (October 31, 1990)

- Completion of 72 Soil Borings across the site to characterize soil quality and geology above the water table (November 6-16, 1990)

- Installation of Ground Water Monitoring Wells to identify geologic and hydrogeologic conditions; 19 wells installed at 14 locations, including 7 deep and 12 shallow wells (November 6-29, 1990)

- Collection of 2 rounds of Ground Water Samples from on-site and off-site newly installed and existing monitoring wells; initial round characterized ground water quality and the second round confirmed first round results and further defined nature and extent of contamination (December 19-22, 1990 and April 16-17, 1990)

- Collection of 72 Air Samples over the course of 12 air sampling events conducted during non-operational periods at the SMC facility (November 11, 1990-February 3, 1991)

2.0 SITE INVESTIGATION

This section provides a discussion of site investigation activities. A detailed description of all the field procedures used is presented in the RI Work Plan (TRC, 1990). As previously identified, the RI field investigation examined specific areas of the SMC facility, including the Undeveloped Plant Area, Manufacturing Area, and Lagoon & By-product Storage Area. Figure 3 indicates the boundaries of the major study areas and areas of concern.

The investigation of each environmental media is described herein. For each media sampled, a discussion of the purpose of the investigation, an overview of the investigation activities, identification of sample locations and a description of visual observations and field measurements made during the investigation activities are presented. All required laboratory analyses were performed by Weston Analytics of Lionville, PA, with the exception of the air samples which were analyzed by Environmental Testing & Technologies Inc. of Westmont, NJ. As part of the sampling protocol, 5% of the total number of samples from each matrix were submitted for expanded parameter list analysis. The location and elevation of the RI monitoring wells, soil borings, and test pits were surveyed by James M. Stewart, Inc. of Philadelphia, PA.

2.1 Surface Soil Investigation

The purpose of the surface soil investigation was to identify and define the nature and extent of contaminants at or near the ground surface across the Undeveloped Plant Area of the facility.

2.1.1 Overview of Investigation

A total of 64 surface soil samples were collected for analysis. One sample was collected from each sample location (RA-1 through RA-60 and RA-64;

see Figure 4), with the exception of locations RA-58, RA-59 and RA-60, where two samples were collected from each location. Surface soil samples RA-58, RA-59, and RA-60 are background samples (Figure 4) and were collected from the 6- to 12-inch and 18- to 24-inch intervals using decontaminated hand augers. The remaining surface soil samples were collected by digging, with a decontaminated spoon, to a depth of approximately six inches, and collecting the sample directly into sample jars.

All of the samples were analyzed for Target Analyte List (TAL) metals, boron, niobium, strontium, titanium, and hexavalent chromium. Samples collected from RA-34, RA-58, RA-59 and RA-60 were selected as part of the 5% of total soil samples required to be submitted for expanded parameter list analysis, and were also analyzed for Target Compound List (TCL) + 30 peaks and zirconium. See Tables 4a, 4b, 4c, and 4d for the constituent lists for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides/PCBs, and TAL metals, respectively.

2.1.2 Surface Soil Sample Locations

Figure 4 shows the grid and selected surface soil sampling locations across the Undeveloped Plant Area. The 200-foot grid system was laid out in accordance with the RI Work Plan (TRC, 1990), and samples were collected at the nodes of the grid system or as modified in the field. During field reconnaissance, several sample locations were found to be obstructed, effectively preventing sampling, and had to be relocated. These changes are acknowledged and approved in a letter to SMC from the NJDEP dated November 15, 1990 (NJDEP, 1990). Surface soil samples RA-41, RA-42 and RA-44 were located under slag piles on the western portion of the site and were relocated as follows: sample RA-41 was moved to a former drum storage area near the

ferrocolumbium high purity slag pile; RA-42 was moved to an area of stained soil where drums had formerly been stored; and RA-44 was located adjacent to the lime pile, where visible runoff of the material was observed. Surface soil samples RA-12 and RA-13 were located in areas of standing water, and were relocated 150 and 100 feet north of their original positions, respectively. Surface soil samples RA-25 and RA-36 were originally located in the middle of a ponded area of the Hudson Branch, and were relocated to the northern edge of the ponded area. SMC also requested additional samples be collected from the soils beneath Department 101(B), the location of a furnace that previously was used for chromium production). Due to the thickness of the concrete floor, and site limitations posed by a confined space, only one sample (RA-64) could be collected.

2.1.3 Field Measurements and Observations

Surface soil sample descriptions were noted and recorded in field notebooks. Table 5 summarizes the date and time of collection and the physical description for each surface soil sample collected.

The surface soil across the Undeveloped Plant Property is predominantly brown medium- to fine-grained sand. Finer-grained soils, such as silt, were found in greater abundance near the marsh and wetland areas adjacent to the Hudson Branch. The color of the soil in sample RA-30, located adjacent to Department 106 (see Figure 4), was found to have a slightly greenish tint. This may be attributable to the former chromium manufacturing processes that occurred in Department 106. No unusual odors were noted in any of the samples.

A more detailed description of the soils across the entire site can be found in Section 3.0, Physical Characteristics - Site Assessment.

2.2 Surface Water and Sediment Investigation

Sediment and surface water samples were collected to determine the presence, nature, and extent of sediment and surface water contamination of the Hudson Branch. The collection and analysis of sediment and surface water samples was considered important, since prior investigations have documented that ground water discharge is a significant source of recharge for the Hudson Branch. The collection of four (4) surface runoff samples was necessary to document the presence or absence of contamination in runoff from the SMC site and to evaluate potential subsequent impacts to the sediment/surface water quality of the Hudson Branch.

2.2.1 Overview of Investigation

Surface water and sediment samples were collected from five (5) downstream locations on the Hudson Branch on October 31, 1991. Surface water runoff samples were also collected from four (4) drainage pathways across the site during a precipitation event on December 4, 1990, to assess runoff water quality. In late November 1990, Weston Analytics informed TRC that the holding times for hexavalent chromium in the five (5) stream sediment samples had been exceeded. On December 5, 1990, TRC resampled the five (5) stream sediment locations and sent the samples to Weston Analytics to be analyzed for hexavalent chromium.

Three (3) surface water and sediment samples, that were collected from the Hudson Branch were analyzed for TAL metals, hexavalent chromium, VOCs, sulfate, fluoride and total cyanide. These samples included SW/SD-2, SW/SD-3, and SW/SD-5. The remaining two (2) Hudson Branch surface water and sediment samples, SW/SD-1 and SW/SD-4 were selected as part of the 5% of total samples submitted for expanded parameter list analysis and were analyzed for TCL+30,

TAL Metals, hexavalent chromium, sulfate, cyanide, fluoride, niobium (Nb), strontium (Sr), titanium (Ti), boron (B) and zirconium (Zr). All four (4) surface water runoff samples were also analyzed for the 5% expanded parameters list.

2.2.2 Sampling Locations

Surface water and sediment samples (SW1/SD1 through SW5/SD5) were collected from five (5) locations along the Hudson Branch. Four (4) surface runoff water samples (SW6 through SW9) were collected from major drainage pathways just before they left the SMC facility. The location of SW/SD-1 was moved to the edge of a ponded area located just south of the SMC facility due to the fact that the streambed was dry at the original proposed sample location. The actual sample locations are shown in Figure 5. The off-site sampling locations were not surveyed and, therefore, their positions on Figure 5 have been approximated. The rationale for each sampling location selected is provided in the RI Work Plan (TRC, 1990).

2.2.3 Field Measurements and Observations

The surface water, stream sediment and surface runoff samples were collected over a two month period. The initial surface water and stream sediment sampling event occurred on October 31, 1990. The NJDEP collected split samples from two (2) locations (SW/SD-1 and SW/SD-4). These samples were sent to NYTEST Environmental Inc. and were analyzed for the same parameters as the samples collected by TRC. In November 1990, it was discovered that holding times (24-hours) for the analysis of hexavalent chromium in sediment samples had been exceeded. On December 5, 1990, all of the stream sediment sample locations were resampled for hexavalent chromium

analysis. The surface runoff samples were collected on December 4, 1990 after an intense rainfall event.

Brief stream sediment soil descriptions are presented in Table 6. In general, all stream sediment samples were dark brown-black silt, some cobble and rock fragments, trace clay and fine sand. All sediment samples contained organic material (decaying leaves, grass and root structures). No noticeable contamination or sheen was detected at any sample location except at SW/SD-1. This sample had been relocated downstream from its proposed location because at that point the streambed was dry. The new location of SW/SD-1 was a swampy/marsh area filled with stagnant water. There was a swamp odor and a slight oily sheen on the water and sediment, the source of which is believed to be H_2SO_4 (marsh/swamp gas).

Temperature, pH, and conductivity measurements were taken for each surface water sample. These parameters are presented in Table 7. The reduction/oxidation potential (Eh) was not obtained for surface water due to problems calibrating the instrument (YSI Model 3560).

2.3 Test Pit Investigation

Test pits were excavated during the RI investigation to determine if plant runoff and the effluent from the Manpro-Vibra Degreasing Unit had contaminated soils in an old drainage ditch. The drainage ditch was backfilled and replaced with a 36" diameter corrugated steel culvert in the late 1960's. During operation of the Manpro-Vibra Degreasing Unit (1965-1967), effluent was discharged directly into this historic drainage ditch.

2.3.1 Overview of Investigation

The test pit investigation consisted of the excavation of five (5) test pits. Each of the test pits was 100 feet long and approximately four (4) feet

wide. The depths of the test pits varied in accordance with the RI Work Plan (TRC, 1990) requirement of excavating to a depth of two (2) feet below the existing culvert. The test pits were excavated parallel to the corrugated steel culvert and samples were collected from the base of each test pit which was two feet lower than the base of the culvert. Thus, the depths of test pits varied from five (5) feet to twelve (12) feet. A descriptive log of each test pit is provided in Appendix B.

One soil sample was collected from the bottom of each test pit. All test pit soil samples were analyzed for TCL VOC+10, TAL metals, cyanide, and hexavalent chromium, with the exception of SMC-TP02-01, which was selected for the 5% expanded analysis list and analyzed for TCL+30, boron, niobium, strontium, titanium and zirconium.

2.3.2 Test Pit Locations and Samples

The five (5) test pit locations are shown on Figure 6. Each test pit sample was collected from the center of the base of the test pit. The log for each test pit provides the depth at which each sample was collected within each test pit.

2.3.3 Field Measurements and Observations

All field measurements and observations made during the test pit investigation activities were recorded in a field notebook. No elevated VOCs were detected or visual signs of contamination observed in any test pit. The soil was screened using a Century 128 Organic Vapor Analyzer (OVA). All of the field measurements and observations are included on the test pit logs provided in Appendix B. Field measurements included OVA measurements, geological soil descriptions, and descriptions of possible contamination. A

summary of the test pit log field measurements and observations is presented in Table 8.

Photographs of test pits were taken during excavation activities. Upon completion of each test pit, the ends of the pit were staked and the pit backfilled. At the conclusion of the site investigation, the ends of each test pit were located for inclusion on the site base map.

2.4 Soil Boring Investigation

The purpose of the soil boring investigation was to evaluate potential subsurface soil contamination in the unsaturated zone across the entire site. Soil gas surveys supplemented the soil boring activities, and were used to site boring locations at two areas of the investigation.

2.4.1 Overview of Investigation

On October 31, 1990, soil gas investigations were conducted to evaluate the extent of subsurface contamination in two selected areas of the SMC site. From November 6, 1990 through November 14, 1990, a total of 72 borings were drilled to delineate soil contamination in the unsaturated zone across the site. The following subsections describe the soil gas and soil boring sampling strategies in more detail. The analytical parameters required for each boring sample were chosen to reflect the expected contamination at that location. In order to determine if unknown contaminants exist across the site, 5% of the soil boring samples were analyzed for the expanded parameter list, comprised of TCL+30, boron, niobium, strontium, titanium and zirconium.

2.4.1.1 Soil Gas Survey

Two (2) separate soil gas surveys were conducted at two former material storage areas at SMC. Their locations, referred to as Area A and Area B, are

presented in Figure 7. These areas are suspected of being potential sources of volatile organic contamination. Materials stored at Area A included drummed liquids (TCE) and solid wastes used in the degreasing operation and Area B stored titanium chips (prior to their being degreased). The purpose of the soil gas survey was to identify individual volatile organic compounds in the soil and ground water over the area of the grid. The soil gas technique allows for rapid analysis (real-time) of specific volatile organic compounds within the soil pore spaces as an indication of subsurface soil and ground water conditions. Many aromatic and halogenated compounds such as benzene, toluene, xylene, TCE and tetrachloroethene (PCE) are often associated with degreasing operations. Additionally, these compounds exhibit relatively high degrees of chemical stability in the environment and are volatile. When these compounds are present, they are generally effective soil gas indicator compounds for areas where residual degreasing materials may be present. The results of the soil gas surveys were to be used to determine the location of three (3) soil borings to be drilled at each former material storage area.

Although repeated attempts were made to drill soil gas holes at soil gas survey area A (near the slag piles, Figure 7), an impenetrable strata at a depth of eight to twelve inches prevented the drill from reaching a depth greater than one foot. Further attempts were made to advance the holes with a hand auger, but were not successful. Therefore, the soil gas investigation at Area A was abandoned and soil boring locations were selected based on historic information and site reconnaissance. All soil gas holes at Area B (near the pump shed, Figure 7) were successfully advanced to a depth of 30 inches.

2.4.1.2 Soil Borings

Changes from the approved Soil Boring Sampling Plan were required by conditions encountered and observations made in the field, and are discussed

in detail in Section 2.4.2. Changes in location were generally due to the presence of nearby overhead utility lines or surface conditions in the sampling area. These changes are referenced and approved in a letter to SMC from the NJDEP dated November 15, 1990 (NJDEP, 1990).

In most cases, continuous split spoon samples were collected at two-foot intervals to the ground water table. Two of the soil boring locations near lagoon B-8, borings SB-62 and SB-64, were inaccessible to drilling equipment and therefore the borings were advanced with hand augers to a depth of eight feet. Since all split spoon samples could potentially be submitted for chemical analysis, all split spoons were decontaminated according to procedures outlined in the Field and Laboratory QA/QC Plan (TRC, 1990).

Samples were collected to determine the presence, nature and extent of vadose zone (unsaturated) soil contamination near the surface and near the ground water table. The actual interval sampled for chemical analysis depended on the scheduled analytical parameters, number of samples to be analyzed from the boring, and headspace readings taken using an organic vapor analyzer (OVA) or a photoionization detector (HNu). See Work Plan Tables 4-1 through 4-4 for more detail (TRC, 1990).

2.4.2 Soil Boring Locations and Samples

Comprehensive subsurface soil investigations were conducted in the Undeveloped Plant Property, Lagoon and By-product Storage Areas, and, to a more limited extent, in the Manufacturing Area. Figure 3 shows the locations of each area.

2.4.2.1 Undeveloped Plant Property

Figure 7 illustrates the soil boring sample locations within the Undeveloped Plant Property. Specific areas investigated in the Undeveloped

Plant Property include the Former Material Storage Area, By-product Drum Storage Area, Former Chromium Button Storage Area, and Tank T-12 Area. Table 9 provides the boring numbers, intervals sampled and analyses performed for soil boring samples in these areas and in the remaining areas within the Undeveloped Plant Property.

Each area and the corresponding investigations are described below.

Former Material Storage Areas

Area A was formerly used to store drummed liquids and solid waste generated in the degreasing operation and Area B was primarily used to store titanium chips prior to their being degreased (see Figure 7). A soil gas survey was proposed in each of these areas to assist in locating borings SB-1 through SB-6. The soil gas investigation at Area A (near the slag piles) was abandoned due to an impenetrable layer at a shallow depth. The results of the survey from Area B did not identify any significant soil gas contamination or volatile "hot spots" in Area B. None of the target compounds were detected in any of the locations above the instrument detection limit of approximately 5 ppb. Further, no additional compound peaks were observed on the sample chromatographs (copies of the field chromatographs are presented in Appendix C).

The soil borings (SB-1 through SB-6) were distributed evenly across the center of both Area A and Area B in order to obtain representative results. Split spoon samples were collected from the surface to the water table. Each sample was screened for ambient temperature headspace (ATH) with an OVA and HNu. The one sample from each boring that had the highest OVA or HNu reading was submitted for Target Compound List (TCL) analyses of base/neutrals and volatile organics. In addition, the samples collected from SB-1 and SB-5 were

analyzed for TAL metals, boron, niobium, strontium, titanium, zirconium and TCL + 30 peaks.

By-Product Drum Storage Area

Three borings (SB-7 through SB-9) were advanced in the By-product Drum Storage Area to investigate unsaturated subsurface soils in this area (see Figure 7). This area is used to manage by-product materials of ferro-aluminum dross, furnace clean-out and chromium. Samples were collected for analysis from the surface interval (0 to 2 feet) and the interval just above the ground water table. All the samples were analyzed for TAL metals, boron, niobium, strontium, titanium and hexavalent chromium (zircon was also analyzed for at SB-8), with the exception of SB-7. At boring SB-7, the 0- to 2-foot sample was analyzed for the above listed metals while the 4- to 6-foot interval was additionally analyzed for TCL+30 peaks and zirconium. Soil boring locations were as outlined in the RI Work Plan (TRC, 1990) (see Table 9).

Former Chromium Button Storage Area

Three soil borings (SB-52 through SB-54) were advanced in the Former Chromium Button Storage area as indicated in Figure 7. Samples were collected for analysis from the surface interval (0 to 2 feet) and the fourth split spoon interval (6 to 8 feet). Samples were analyzed for TAL metals and hexavalent chromium. These borings were located to provide chemical characterization of subsurface unsaturated soils in this area. There were no changes in boring locations from those originally proposed in the RI Work Plan (TRC, 1990).

Tank T-12 Area

Two soil borings (SB-82 and SB-83) were advanced in this area to investigate potential soil contamination associated with a recent (May 1, 1990) spill of chromium wastewater from tank T-12. Samples were collected for analysis from the surface interval (0 to 2 feet) and the third split spoon interval (4 to 6 feet), and were analyzed for TAL metals and hexavalent chromium. There were no changes in boring locations from those originally proposed in the RI Work Plan (TRC, 1990).

Remaining Plant Property

A total of nineteen soil borings (SB-10 through SB-28) were advanced in the remaining areas of the Undeveloped Plant Property (see Table 9) to characterize unsaturated subsurface soils.

In general, samples from the surface interval (0 to 2 feet) and the interval just above the water table, to a maximum interval depth of 8 to 10 feet, were collected for analysis. A 0- to 0.5-foot surface soil sample was collected in place of the 0- to 2-foot sample interval at soil borings located next to surface soil grid nodes (SB-12, SB-16, SB-19 and SB-24). Three samples were collected at the location of boring SB-22 due to the increased depth to the ground water table (8 to 10 feet) encountered at this location.

Samples from each boring were analyzed for TAL metals and hexavalent chromium. In addition, the samples collected from the surface interval at SB-11 and SB-22 and the sample collected from the 2- to 4-foot interval at SB-11 were analyzed for sulfate, and the sample collected from the fourth interval (6 to 8 feet) was analyzed for boron, niobium, titanium, strontium, zirconium and sulfates. The fifth interval at SB-22 (8 to 10 feet) was analyzed for TCL + 30 only, while the fourth interval at SB-27 was analyzed

for TCL+30, TAL metals, boron, niobium, titanium, stratium, and zirconium (see Table 9, for other exceptions). This methodology was used to assure metals and volatile organics data were collected from consistent intervals across the site (i.e., metals samples collected no deeper than 8 feet and volatile organics samples collected just above the water table or from the zone that had the highest ambient temperature headspace).

Borings remained in the locations described in the RI Work Plan (TRC, 1990), with the exception of SB-11 (see Figure 7). This boring was not completed at its proposed location because of the existence of standing surface water. The location was moved southeast from its original position. The revised location of SB-11 is noted and approved in a letter sent to SMC from the NJDEP dated November 15, 1990 (NJDEP, 1990).

2.4.2.2 Manufacturing Areas

Figure 7 illustrates the soil boring sample locations within the manufacturing areas. Table 10 shows the boring numbers, intervals sampled and analyses performed for soil boring samples collected in the former Manpro-Vibra Degreasing Area, Departments 106 and 102, Underground Storage Tank Area, Railroad Siding Area, and Chromium Button Storage Area. Each area and corresponding investigation are described below.

Former Manpro-Vibra Degreasing Area

Five soil borings (SB-29, SB-40, and SB-44 through SB-46) were advanced in this area to assess the effects of effluent drainage from the degreasing system and from titanium chips that may have been stored in the area. Two samples were collected from each boring. Samples were collected for analysis in most cases from the surface interval (0 to 2 feet) and the interval two

feet above the ground water table. At boring SB-40, the first recoverable sample for analysis was from the second interval (2 to 4 feet), due to the presence of two feet of concrete over the soil surface. The second interval (2 to 4 feet) was also used for sample collection at boring SB-45 due to the presence of a slight petroleum odor beginning at a depth of two feet.

Samples were collected from the interval just above the water table from each boring except SB-44, where drilling was stopped at a depth of six feet because of very high OVA readings (>1000 ppm) and the presence of a natural gas odor. The second interval (2 to 4 feet) was the lower interval sampled at this boring location (see Table 10).

Most of the samples were analyzed for TCL volatile organics, TCL base/neutrals, TAL metals, and titanium. The sample collected from the lower interval at boring SB-40 was additionally analyzed for boron, niobium, strontium, zirconium, and hexavalent chromium.

As referenced in a letter from the NJDEP to SMC dated November 15, 1990 (NJDEP, 1990), soil boring SB-46 was relocated in front of the scrap steel storage shed just south of D-107, due to the presence of overhead power lines at the proposed boring location. The rest of the borings remained at their originally planned locations.

Department 106

Six soil borings (SB-30 through SB-35) were drilled around Department 106, the Former Chromium Oxide Production Facility. Boring intervals sampled for chemical analysis were the surface interval (0 to 2 feet) and the fourth interval (6 to 8 feet). Samples were analyzed for TAL metals, TCL PCBs and hexavalent chromium. The lower interval sampled at SB-32 was analyzed for TCL + 30 peaks, TAL metals, boron, niobium, strontium, titanium, zirconium and

hexavalent chromium (see Table 10). A duplicate sample, SB-94, was collected from the lower interval (6 to 8 feet) at SB-34 and analyzed for TCL PCBs, TAL metals and hexavalent chromium. With the exception of SB-35, borings were located as outlined in the RI Work Plan. Soil boring SB-35 was moved approximately 15 feet north to avoid overhead power lines at the original proposed location.

Department 102

A total of four soil borings (SB-36 through SB-39) were advanced around Department 102 (see Figure 7). Samples were collected for analysis from the soil surface (0 to 2 feet) and the fourth split spoon interval (6 to 8 feet). Each sample was analyzed for TAL metals and hexavalent chromium. The samples collected at soil boring SB-39 were also analyzed for boron, niobium, strontium, titanium and zirconium and from the lower interval for TCL+30 (see Table 10). Soil borings SB-74, SB-75 and SB-76 were not drilled during this investigation but will be included in the Phase II investigation. The actual boring locations (as drilled) were as specified in the RI Work Plan.

Underground Storage Tank Area

Five soil borings (SB-41, SB-42, SB-72, SB-73 and SB-84) were drilled in the Underground Storage Tank (UST) Area (see Figure 7). The sampling procedures described in the RI Work Plan (TRC, 1990) differed from those in the QA/QC plan for these areas. The Work Plan called for one sample to be collected from each of four borings at a depth of two feet above the water table. The QA/QC plan called for two samples from each of four borings; one each from the approximate levels of the top and the bottom of the tank. The actual sampling procedures were performed in accordance with the QA/QC plan

with some slight modifications (see Table 10). At soil boring locations SB-42 and SB-72, samples were collected from the first interval (0 to 2 feet) and the fourth interval (6 to 8 feet). Additional samples were collected at a depth of two (2) feet above the water table at borings SB-42 and SB-84. These samples were collected from the fifth sampling interval (8 to 10 feet). Boring locations were modified slightly due to the presence of overhead power lines (see Figure 7).

Samples were analyzed for TCL volatile organic compounds, TCL base/neutrals and total petroleum hydrocarbons. The fifth interval sample collected from SB-42 was additionally analyzed for TAL metals, boron, niobium, strontium, zirconium, titanium and hexavalent chromium and pesticide/PCBs. Pesticide/PCBs were also anlayzed for in Samples SB73-04 (6 to 8 feet) and SB84-05 (8 to 10 feet).

Railroad Siding Area

Three soil borings (SB-43, SB-47 and SB-48) were advanced in the Railroad Siding Area to assess the effects on soil quality of any potential spills resulting from the loading and unloading of packaged products (see Figure 7). Samples were collected for analysis from the first (0 to 2 feet) and fourth (6 to 8 feet) split spoon sample intervals, and were analyzed for TAL metals. The fourth sample interval (6 to 8 feet) at SB-47 was additionally sampled and analyzed for TCL+30 peaks, TAL metals, boron, niobium, strontium, titanium, zirconium and hexavalent chromium (see Table 10). Soil boring locations were as outlined in the RI Work Plan (TRC, 1990).

Chromium Button Storage Area

Three soil borings (SB-49 through SB-51) were advanced at locations surrounding the building presently used to store chromium buttons (see Figure

7). Two samples from each boring were analyzed for TAL metals and hexavalent chromium. Samples were collected from surface soils (0 to 2 feet) and from two (2) feet above the water table or at a maximum depth of 6 to 8 feet (see Table 10). Soil boring locations were as outlined in the RI Work Plan (TRC, 1990).

2.4.2.3 Lagoon & By-Products Storage Areas

Figure 7 illustrates the soil boring sample locations within the Lagoon & By-products Storage Area. Table 11 shows the boring numbers, intervals sampled and analyses performed for soil boring samples in these areas and in remaining areas within the Lagoon & By-Products Storage Area. Each area and the corresponding investigations are described below.

Lagoon Area

Eight (8) soil borings were advanced between and around lagoons B6, B7 and B8 (SB-55 through SB-57 and SB-60 through SB-64; see Figure 7). Two samples from each boring were analyzed for TAL metals and hexavalent chromium. In addition, the sample from the second split spoon interval (2 to 4 feet) at SB-60 and from the fourth split spoon interval (6 to 8 feet) at SB-55 were analyzed for TCL+30 peaks, boron, niobium, strontium, titanium and zirconium. Samples were collected from surface soils (0 to 2 feet) and from two (2) feet above the ground water table, with a maximum sample depth of 6 to 8 feet (see Table 11). Soil borings SB-62 and SB-64 were inaccessible with drill rigs; these borings were advanced using hand augers. Sample locations were as outlined in the RI Work Plan.

Soil borings intended to be advanced in and around lagoons B1, B2, B3, B5, B11 and B12 were not completed. Due to drilling rig accessibility

difficulties, these soils will be investigated after the lagoons are closed. Soil boring location SB-58 (located between B6 and B7) was also inaccessible. These proposed borings will be included in the Phase II investigation.

By-Products Storage Area

Five soil borings (SB-77 through SB-81) were advanced in the By-product Storage Area (see Figure 7). The purpose of these borings was to investigate the lateral and vertical extent of soil contamination around the By-product Storage Area. Soil borings were drilled in areas where materials presently are not being stored. Intervals sampled for chemical analysis were the 0- to 2-foot interval and the interval 2 feet above the water table, with a maximum sample depth of 6 to 8 feet. A 0- to 0.5-foot surface soil sample was collected in place of the 0- to 2-foot sample interval at the one soil boring, SB-24, located next to the surface soil grid node.

Soil boring locations were as outlined in the RI Work Plan with the exception of SB-81, which had to be relocated slightly west of its original position. A ferrocolumbium standard grade pile existed on top of the boring's original position. The relocation is referenced in the letter sent to SMC from the NJDEP dated November 15, 1990 (NJDEP, 1990).

2.4.3 Field Observations and Measurements

During the soil boring and soil gas investigations, all field measurements were recorded in field notebooks. Recorded field measurements include soil gas chromatogram printouts from injected standards and sample points (Appendix C), organic vapor measurements with an OVA or HNu read directly from split spoon samples, and headspace readings from samples potentially to be analyzed for volatile organic compounds. Observations recorded in field notebooks

included geological soil descriptions and evidence of possible contamination (i.e., discolored soils, unusual odors and visible waste products). All of the soil boring field measurements and observations (except headspace readings) are presented in the boring logs in Appendix D. Headspace readings from samples submitted for analysis are presented in Table 12.

2.5 Monitoring Well Installation

The purpose of this phase of the investigation was to install monitoring wells to monitor ground water quality and to evaluate the subsurface geology across the site.

2.5.1 Overview of Investigation

A total of nineteen (19) borings were drilled for the installation of monitoring wells. All monitoring well locations, except for locations SC5S, SC23S and SC24S, were either sited in the field during the October 26, 1990 Work Plan Modification Meeting (SC18 S/D, SC19 S/D, and SC21 S/D) or sited based on proposed locations provided on Figure 12 of the RI Work Plan (TRC, 1990). Monitoring wells SC5S and SC24S were added after the NJDEP expressed a concern about the integrity of existing monitoring well IW4 and the need for additional water elevation and water quality data in the northwest portion of SMC's 7.5 acre parcel (currently used as farmland) located in Vineland, NJ (November 19, 1990 site visit). During that meeting, SMC agreed to decommission monitoring well IW4 and install monitoring well SC5S adjacent to existing well SC5D, located approximately 20 feet south of IW4. Monitoring well SC24S was installed in the northwest portion of the 7.5 acre parcel, as requested by the NJDEP. Monitoring well SC23S was installed near the backfill of an underground storage tank (UST) located south of Building 201 (Figure

8). The purpose of this well was to determine the integrity of the UST (i.e, document any petroleum release) and to determine if an old furnace in Building D101(B) was a source of subsurface chromium contamination.

Continuous split spoon samples were collected at 2-foot intervals to the water table at each monitoring well location. Once the water table had been reached, split spoon samples were collected every 5 feet. The boring was extended until a confining layer was encountered or to a maximum depth of 80 feet. If a confining layer was not found, previous well logs were examined to determine the depth to which the boring would be double-cased (generally in the 70- to 80-foot range). At off-site monitoring well locations SC17D, SC18D, SC19D and SC21D, no confining layer was found. All of these deep wells were double-cased, except SC18D, since no confining layer was identified. An exemption for double casing this well was granted by the NJDEP during the November 19, 1990 site visit. At all on-site monitoring well locations, a semi-confining layer was detected at a depth of between 30 and 40 feet.

The borehole and well construction activities were performed according to the RI Work Plan (TRC, 1990), except as noted.

2.5.2 Monitoring Well Locations

The nineteen (19) monitoring well locations are shown on Figure 8. The details of each well boring and monitoring well are shown in Appendix E. A summary of well completion details is presented in Table 13.

2.5.3 Field Measurements and Observations

During the monitoring well investigation activities, all field measurements and observations were recorded in a field notebook. Recorded field measurements include organic vapor measurements made with an OVA.

Observations that were recorded include geologic soil descriptions and evidence of potential contamination (i.e., discolored soils, waste products, odor). A summary of the well development activities is presented in Table 14. All of the monitoring well boring field measurements and observations are presented in Appendix E.

2.6 Ground Water Investigation

The purpose of the ground water investigation was to characterize the extent and configuration of the hexavalent chromium contamination plume as well as confirm or deny the presence of other contaminants. Water elevation data collected during sampling was used to evaluate ground water flow directions and estimate flow velocity.

2.6.1 Overview of Investigation

Monitoring wells at the SMC site were sampled twice during the RI field activities. During the first sampling event, conducted December 17, 1990 through December 20, 1990, 51 monitoring wells were sampled. The purpose of the first ground water sampling event was to provide ground water data to assess the nature and extent of ground water contamination.

A total of 37 monitoring wells were sampled during the second ground water sampling event, conducted April 15, 1991 through April 17, 1991. The scope of the second sampling event was developed using the ground water data generated during the first sampling event, as well as data from SMC's in place sampling program. Inspection of all the data allowed for the deletion of 14 monitoring wells from the sampling program (see NJDEP approval letter dated April 15, 1991). The purpose of the second ground water sampling event was to further characterize the effect of the hexavalent chromium contamination in the ground water and to confirm the presence or absence of other contaminants.

During the first ground water sampling event, there were some minor modifications to the scope of work included in the RI Work Plan (TRC, 1990). Monitoring wells Mohan (S) and Mohan (D), both private wells, were not sampled. Historically, in conducting SMC's current in-house sampling program, sampling personnel have not been allowed entry to collect samples from the Mohan wells. Instead, sample bottles have been received, filled, and returned to SMC personnel. Due to the lack of maintenance of QA/QC protocols in the collection of such samples, and due to the lack of available well construction information for either well, the Mohan wells were not included in ground water sampling activities. Monitoring well IW3 also was not sampled because it was discovered that there was no protective cap on the well. Since monitoring well IW3 was exposed to the elements, the integrity of any sample collected from the well was considered questionable.

Each monitoring well was purged and sampled according to the methodology described in the RI Work Plan (TRC, 1990) and the Second Ground Water Sampling Event Work Plan (TRC, 1991). Tables 15 and 16 provide the analyte list for each monitoring well sample.

Since monitoring wells SC5S, SC23S, and SC24S were added during the RI field investigation, these wells were not included on the analyte list presented in the RI Work Plan (Table 4-8, TRC, 1990). Samples from monitoring wells SC5S and SC24S were analyzed for TCL VOC+10, TAL metals, sulfate, hexavalent chromium and cyanide during both sampling events. Monitoring well SC23S was analyzed for TCL VOC+10 and hexavalent chromium during the first sampling event and TCL VOC+10, TAL metals, sulfate, hexavalent chromium, and cyanide during the second sampling event.

2.6.2 Sampling Locations

The nineteen (19) on-site and off-site monitoring wells that were installed during the RI field investigation are identified on Figure 8. Locations and elevations of all of the RI field investigation monitoring wells were surveyed by James M. Stewart, Inc. At each monitoring well, the following elevations were determined: the top of the protective casing, top of the PVC well casing (TPVC), and the land surface adjacent to the well. The well location coordinates and elevations are presented in a table in Appendix F.

2.6.3 Field Measurements and Observations

Several field measurements were conducted as part of the ground water investigation at the SMC site. These measurements included downhole organic vapor (second sampling event only) and water level measurements at each well. The following parameters were determined for each ground water sample: pH, specific conductance, oxidation potential (Eh), and temperature. All field measurements and notable observations made during both ground water sampling events were recorded in a field notebook and are discussed below.

All observations concerning unusual appearance of the ground water were recorded in a field notebook during the development, purging, and sampling of each well. Immediately after each ground water sample was collected, pH, specific conductance, oxidation-reduction potential (Eh), and temperature of the sample were measured and recorded in a field notebook. These field measurements are also recorded in Tables 17 and 18. Prior to purging each monitoring well during both sampling events, the ground water level in each monitoring well was measured per the methodology presented in the RI Work Plan (TRC, 1990). All ground water level measurements are provided in Table 19.

The downhole OVA measurements for each well during the second sampling event are provided in Table 20.

2.7 Air Investigation

The purpose of the air investigation was to determine the impact that the By-product Storage Pile and other surface soils have on air quality when the SMC facility is non-operational, typically on Sundays.

2.7.1 Overview of Investigation

A total of five (5) air monitoring stations were installed on SMC property. All air monitoring stations were sited in the field during the October 26, 1990 Work Plan Modification Meeting. Air sampling was performed in an area located east of SMC's plant facility to assess fugitive air emissions from the soils and/or by-product piles.

Sampling was conducted on Sundays, midnight to midnight, in order to collect air samples when the facility was non-operational. The air monitoring investigation was conducted over a three month period in order to collect twelve (12) 24-hour composite samples. An on-site meteorological station was installed to provide wind direction/speed and precipitation data. If more than 0.01 inches of rain fell during the test, then the samples collected during that sample period were not analyzed and the test was repeated.

Details regarding pump types, calibration methods, and analytical methods, which were not specified in the RI Work Plan (TRC, 1990), are included in Appendix G.

2.7.2 Sampling Locations

The sampling sites for air monitoring reflect the overall shape of the site, the present manufacturing operations at the facility and prevailing

surface wind direction. Five (5) fixed-site sampling points were installed: AM1, the background station, was located in the southwest corner of the site near West Boulevard; AM2 and AM3 were both located north of the by-product/ dust storage pile; and AM4 and AM5 were both located south of the by-product/dust storage pile (see Figure 9). In addition a sixth sampler was installed and used to collect duplicate samples. This sampler was moved each week and run simultaneously with and adjacent to one of the five fixed air stations.

2.7.3 Field Measurements and Observations

During the air monitoring investigation activities, all field measurements were recorded on log paper or in a field notebook. Recorded field measurements included wind direction and speed, precipitation amounts, and volume of air that was sampled. The meteorological data is presented in Table 21 and the sampling data is presented in Section 3.6.4.

3.0 PHYSICAL CHARACTERISTICS - SITE ASSESSMENT

The SMC facility covers approximately 67.5 acres. Approximately 60 acres lie in Newfield, New Jersey, Gloucester County, and 7.5 acres lie in Vineland, New Jersey, Cumberland County (see Figure 2).

The following sections describe the physical characteristics of the site. A description of the surficial features in and around the site, surface water hydrology, regional and local geology, soils, hydrogeology, and assessments drawn from the evaluated field data are discussed in the sections that follow.

3.1 Surface Features and Land Use

The SMC property is bounded by a Conrail rail line to the west and to the north. Weymouth Road lies directly south of the site. Hudson Branch, a tributary to Burnt Mill Branch, runs along the southern portion of the site just north of Weymouth Road. A large portion of the facility is surrounded by a 10-foot steel wire fence.

The property surrounding SMC is used for a combination of residential and industrial purposes. To the north of the SMC facility are a number of Newfield municipal water supply wells. The former Newfield Municipal Landfill is adjacent to the northeast portion of the site. Two (2) businesses abut the northwest portion of the SMC property. The first, Courter Company, manufactures and stores cement castings. The second, Bondy Oil, stores and transports petroleum products. The western end of the SMC property abuts East Boulevard. The western side of East Boulevard is the site of six residences and the following businesses: Paladino Building Materials, Fisher and Porter (chemical products), and Andrew Glass. The SMC property is bordered to the south by residences located on Weymouth Road.

The land surrounding the 7.5 acres of farmland owned by SMC and located in Vineland, NJ is used primarily for residential and farming purposes.

The topography within the Newfield area is relatively flat. The SMC site is located on a slight topographic high, with the ground surface at the site generally sloping to the west-southwest, toward the Hudson Branch.

3.2 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 headwaters of the stream are supplied by discharging ground water. At its headwaters, the Hudson Branch is an intermittent stream due to seasonal fluctuations in the ground water table elevation (water table falls approximately 2 feet from late summer through mid-winter).

SMC has three (3) permitted outfalls into the Hudson Branch (Figure 2). Two (2) of the three (3) outfalls are not permitted. These outfalls (002 and 003) are discharge points from SMC's storm runoff system, while the third outfall (001) is permitted and discharges SMC facility water into the Hudson Branch. The average discharge from outfall 001 ranges from 50 to 250 gpm. Discharge from outfall 001 consists of city water (non-contact cooling water), treated ground water (water run through the air stripper and ion exchange columns), and supernatant from the wastewater treatment facility (chromium reduction/precipitation). Based on flow measurements of the outfalls and natural ground water discharge to the stream, the outfalls represent the major portion of the Hudson Branch's total flow in the vicinity of the SMC facility (DRAI, 1988b).

There is a small pond located near the SMC outfalls. The pond ranges from two to six feet deep. The Hudson Branch exits the pond area on the western side of the emergency access road located adjacent to outfall 001.

During precipitation events, runoff from the SMC site drains into the Hudson Branch. Due to the large drainage area at the SMC site, the runoff during precipitation events tends to cause the stream to overflow its banks and flood the marsh area at the southwest corner of the facility. This area is referred to later in this report as the observed floodplain of the Hudson Branch.

3.3 Geology

The following subsections describe both the regional and local geology at the SMC facility.

3.3.1 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.

3.3.2 Local Geology

Figure 10 shows the locations of the three (3) cross sections that describe the geology of the SMC site. These cross sections are presented in Figures 11, 12 and 13 and are referenced as A, B, and C, respectively. They were constructed from the boring logs of the wells installed during the RI field investigation. Well logs are located in Appendix E. Additional information was gathered from logs of wells installed during previous investigations at the site.

Review of the Geologic Map of New Jersey (Lewis and Kummel, 1950) indicates that the surficial materials of the site and 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 on the top of the cross sections as brown sands. Its thickness ranges from 0 feet in the vicinity of well SC-17D to 28 feet in the vicinity of well SC-12D.

Below the Bridgeton Formation exists approximately 120 feet of subsurface sediments consisting of variegated fine to coarse grained sands with some local silt and clay beds in a formation referred to as the Cohansey Sand. The Cohansey is a Miocene shallow marine and beach deposit, formed during alternating transgressive and regressive seas (USGS, 1984). Its color varies from tan to pink, orange, brown and red. Beneath the Cohansey are gray silts and clays belonging to the Kirkwood Formation, a Miocene mid-shelf to shallow marine deposit.

During the field investigation, subsurface samples were carefully logged to allow the identification of a semi-confining layer in the Cohansey Sand, if present. The results of the RI field investigation, however, indicate that there is no continuous semi-confining layer. This is clearly shown in the cross-sections presented in Figures 12 and 13. In the vicinity of SC12D, a gray clay layer six (6) feet thick was observed from 28 to 34 feet below the surface. A gray silt layer with the same thickness and depth was observed from the pilot boring for SC13D. West of these borings, from the pilot hole for SC22D, a very thin layer (4 inches) of silt and clay was observed 30 feet below the surface. No other silt and/or clay layers were observed in these borings until reaching a depth of 120 feet, where the presence of a gray silt and clay layer indicated the top of the Kirkwood Formation. Pilot holes drilled for the other deep wells west of SC22D also showed only one or two areas with very narrow silt or clay stringers (see Figures 11 and 13). The clay and clay stringers exist at different depths in each boring, and therefore do not appear to be continuous. Apparently, a clay wedge exists in the northeast portion of the site, narrowing to clay and silt stringers in the vicinity of SC22D. South and west of SC22D, the clay and silt stringers appear to be sporadic and discontinuous.

3.4 Soils

The SMC site is located on Atlas Sheet 38 of the Gloucester County Soil Survey. Five soil mapping units are identified by the Soil Conservation Service on this site. These units are Downer loamy sand, 0-5% slope (DoB); Aura sandy loam, 0-5% slope (ArB); Woodstown and Dragston sandy loams, 0-5% slope (WsB); Woodstown and Klej loamy sands, 0-5% slope; and Muck (Mu).

Downer soils, which are the most common across the site, have a grayish-brown plow layer over yellowish-brown, light sandy loam subsoil. The subsoil is underlain by sand or gravelly sand. These soils are low in organic matter and clay. The Aura soils are present along the eastern side of the site. They have a grayish-brown coarse to medium sandy loam or loamy sand surface layer. The upper subsoil is yellowish-brown and is generally sandy loam or loamy sand. The deeper subsoil is noticeably reddish and more clayey.

Woodstown and Dragston soils are present in a small area in the northeastern portion of the site. They have a dark grayish-brown to dark brown surface layer. The yellowish-brown subsoil generally contains loamy sand and gravel with occasional lenses of clay.

The Woodstown and Klej soils are similar to the Woodstown and Dragston soils, except that the Woodstown and Klej soils have a predominantly sandy subsoil, and they are present in a small area in the south-central portion of the site.

Muck consists of 1 to 3 feet of black to brown partially decomposed organic matter. It is generally very acidic, and is present in marshy areas adjacent to the Hudson Branch.

The general soil types identified by the Soil Conservation Service (SCS) were confirmed by the surface/subsurface soil exploration program.

3.5 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, 1971 (Water Resources of Gloucester County)). 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. The

Kirkwood Formation acts as a confining layer and restricts the downward flow of ground water from the Cohansey Sand. The thickness of the Cohansey Sand was found to range from 110 to 120 feet in the RI well borings.

The Cohansey Sand is composed of fine to coarse sand, with discontinuous layers of clay and zones of silt stringers. The grain size heterogeneities occur vertically, as demonstrated by the finer sized particles found lower in the stratigraphic profile. Grain size also varies laterally across the site. There is no consistent grain size pattern across the site, since the Cohansey Sand was deposited in a coastal environment.

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. Ground water movement is to the west-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 as Figures 14 through 17. The water level elevations obtained during the ground water sampling events in December 1990 and April 1991 are provided in Table 19.

Previous investigations (DRAI, 1988 and DRAI, 1990) concluded that the Cohansey Sand had two water producing zones separated by a 40- to 60-foot thick semi-confining layer consisting of thin sand and clay interbeds. This interpretation was based on well logs produced from drill cuttings. Logging stratigraphy using drilling cuttings can be difficult and may lead to incorrect interpretations of existing stratigraphy. Monitoring wells installed by others prior to the RI field investigation either were installed by mud rotary or were hydraulically jetted. The deep monitoring wells, installed by DRAI, were installed using mud rotary techniques. Mud rotary

drilling is based on the continuous circulation of drilling mud through the cutting head under pressure; the drilling mud lifts the drill cuttings up the side of the boring to the surface and into a mud tub. The cuttings are logged as they enter the mud tub. There are three problems logging stratigraphy with this method: 1) the depth of the cutting cannot be determined for logging; 2) when the drilling mud is thin or drilling encounters a coarse sand layer, no cuttings will be brought to the surface and the drilling mud could be mistaken for a clay layer, and 3) there is no way to determine the percentage of silt or to differentiate a silt layer from a clay layer. Therefore, stratigraphic information obtained from the installation of monitoring wells before the RI field investigation (pre-1990) was not used in the geologic interpretation of the site.

Data gathered from the present investigation does not support a two-aquifer system in the Cohansey Sand. Monitoring well borings installed during the RI field investigation detected thin, discontinuous silt and clay lenses in several areas. In the vicinity of SC12D, a gray clay layer six feet thick was observed from 28 to 34 feet below the surface. A gray silt layer with the same thickness and depth was observed from the pilot boring for SC13D. West of these borings, at the pilot hole for SC22D, a very thin layer (4 inches) of silt and clay was observed 30 feet below the surface. No other silt and/or clay layers were observed in these borings until a depth of 120 feet was reached, where the presence of a gray silt and clay layer indicated the top of the Kirkwood Formation.

Ground water flow directions in both the water table and the lower Cohansey Sand closely correspond with the general topography of the site. As presented in Table 19 and shown in Figures 14 and 16, 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 19 and shown in Figures 15 and 17, the lower Cohansey Sand piezometric surface again follows the Hudson Branch. The only irregularities noted on the lower Cohansey Sand piezometric contour maps were noted near the 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 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.

Downward vertical gradients were observed at most well clusters across the site (Table 22). The only areas where an upward gradient was detected during both measuring events were the IWC and W3 wells. Both of these monitoring wells are located on-site and were installed prior to the RI investigation. Since the upward gradients at these monitoring wells were measured at less than 0.002 ft/ft, their ability to impede contaminant migration is considered to be negligible.

During the April 1991 (second round) ground water elevation measurements, an upward gradient of 0.0019 ft/ft was also recorded at the location of the SC19 shallow and deep wells. This nested pair had a downward gradient of 0.0141 ft/ft during December 1990. A possible explanation for the change in vertical gradient is the influence of the Hudson Branch. Monitoring wells SC19S/D are located adjacent to the Hudson Branch. Autumn and early winter are periods of low precipitation, and the ground water table tends to be lower

than during the spring. This was found to be true for SC19D, but the water elevation did not change at SC19S.

Prior investigations have determined the hydraulic characteristics for the Cohansey Sand at the SMC site (DRAI, 1988). These investigations have determined separate transmissivities (T) and specific yield (Sy) values for both the shallow (water table) and deep (lower Cohansey Sand) ground water flow regimes. These values were averaged from four aquifer tests performed for SMC, as well as from two tests conducted during development of the Newfield supply well adjacent to the site (to the northwest). The following hydrologic parameters were calculated for the upper and lower Cohansey Sand respectively: T = 130,000 gpd/ft and Sy = 0.03 (upper) and T = 74,000 gpd/ft and Sy = 0.002 (lower). Across the site, vertical hydraulic conductivities of 0.006 to 3 gpd/ft^2 were calculated. The variation in vertical hydraulic conductivities indicates a high degree of variability in the connection between the upper and lower sands, and may also reflect differences in the length of screened interval as well as differences in the depth of screened intervals in the tested wells (DRAI, 1988). Utilizing the transmissivity value from the upper Cohansey Sand (as it will give a more conservative estimation of ground water velocities) presented above, as well as an estimate of the thickness of the aquifer, the hydraulic conductivity of the Cohansey Sand can be estimated.

$T = Kb$ converts to $K = T/b$

where T = Transmissivity (130,000 gpd/ft = 17380 ft/day) and
b = Saturated thickness (120 ft)

then K = Hydraulic Conductivity (145 ft/day)

The average linear ground water flow velocity can be calculated using the hydraulic conductivity calculated above, an estimated formation porosity and the hydraulic gradient across the site:

$$V = KL/n$$

where V = average linear ground water flow velocity (ft/day)

K = calculated hydraulic conductivity (145 ft/day)
L = hydraulic gradient, from Figure 15 (0.004 ft/ft)
n = estimated formation porosity (0.3 ft^3/ft^3)

Using the above formula and values, the average linear ground water flow velocity across the site is 2 ft/day. This is considered an order of magnitude estimate only. The actual flow velocity of contaminants in ground water is less than the ground water flow velocity due to absorption and dispersion effects within the aquifer matrix.

4.0 NATURE AND EXTENT OF CONTAMINATION

This section of the RI report provides the following information for each sample matrix: analytical results; significance relative to site background and published background ranges; significance of analytical results for specific compounds relative to New Jersey Department of Environmental Protection (NJDEP) and United States Environmental Protection (USEPA) Maximum Contaminant Levels (MCLs) and Proposed Maximum Contaminant Level Goal (MCLG) concentrations; and the identification of potential contaminant sources and the extent of contamination at the site. Interim NJDEP Soil Action Levels (referred hereafter as NJDEP Soil Action Levels) were used to evaluate all soil and sediment chemical data for VOCs, BNAs, pesticide/PCBs, and inorganics. The specific action levels used are defined in the summary tables which follow the analytical results.

This section is divided into the following subsections: Surface and Subsurface Soils; Surface Water and Stream Sediment; Ground Water; and Air. Each subsection contains summary tables of detected compounds that are used to demonstrate where contaminants were found and potential sources of that contamination. This is followed by comparisons of analyte concentrations observed in the sampled media to available standards and guidance values.

All samples were analyzed in accordance with USEPA Contract Laboratory Program (CLP) protocol for TCL organic and TAL inorganic analytes. Non TCL/TAL analyses (Cr^{+6}, Sr, Ti, etc.) were analyzed in accordance with EPA approved methods. All samples were analyzed by Weston Analytics Laboratory of Lionville, PA. A quality assurance review of the analytical data was made in accordance with NJDEP protocol presented in "Standard Operating Procedures for the Quality Assurance Data Validation of Analytical Deliverables, SOP NO. BEMQA 5.A.3", issue date April 16, 1990. The quality assurance review

concluded that the chemical data was of sufficient quality to be used in the RI report. Quality assurance summary sheets are presented in Appendix H. Copies of the laboratory chemical analysis data sheets for each sample matrix are presented in Appendices J through Q.

4.1 Surface and Subsurface Soils

In this section, a brief assessment of the Phase I soil sample analytical results is presented. Summary tables of all detected compounds, including concentrations of samples that exceeded the established NJDEP site are included. Where appropriate, a discussion of the investigation results that indicate a potential source or pattern of soil contamination or "hot spot" delineation is provided.

4.1.1 Assessment of Results

A total of 194 soil samples were collected across the site through several soil investigation techniques. The soil investigation techniques included surface soil sampling, test pit sampling, and soil boring sampling. A discussion of the sampling locations, the number of samples collected, and all field measurements and observations made during the soil sampling activities is presented in Section 2.0 of this report.

Tables 23 through 25 present a summary of the detected compounds in surface soil, test pit, and soil boring samples, respectively. Tables 26 through 28 present a summary of analytical results exceeding NJDEP Soil Action Levels for surface soil, test pit, and soil boring samples, respectively.

The SMC soil investigation divided the site into the following subsections: Undeveloped Plant Property; Manufacturing Area; and Lagoon & By-Products Storage Areas. The Undeveloped Plant Property was further divided

into the following areas: Former Material Storage Area; By-product Drum Storage Area; Former Chromium Button Storage Area; and Remaining Plant Property. The Manufacturing Area of the site was further divided into the following areas: Department 106 Area; Department 102 Area; Former Manpro-Vibra Degreasing Area; Underground Storage Tank Area; Railroad Siding Area; and Chromium Button Storage Area. The Lagoon & By-Products Storage Areas of the site were not sub-divided further.

4.1.1.1 Volatile Organic Compounds (VOCs)

Of the 194 soil samples collected for analyses, 57 soil samples were collected from 48 locations across the site and analyzed for TCL VOC+10. The results are presented in Tables 23a through 25a. The VOC analytical data is interpreted according to the depth and location at which each sample was collected. Methylene chloride and acetone were detected in all surface soil, test pit, and soil boring samples. These compounds are common laboratory contaminants and were present in laboratory blanks. All compounds that were detected within method blanks were evaluated during the quality assurance review (see Appendix H) according to the criteria required by the NJDEP SOP for Completion of Data Validation Report Forms and the Preparation of the Final Data Validation Report.

Undeveloped Plant Property

A total of twenty-four (24) soil samples were analyzed for TCL VOC+10 in the Undeveloped Plant Property. Of the twenty-four soil samples, seven (7) were surface soil samples, five (5) were test pit samples and twelve (12) were soil boring samples.

Seven (7) soil boring samples were collected for VOC analysis from the Former Material Storage Area. These boring locations were chosen as a result

of soil gas surveys. Excluding the common laboratory contaminants detected in laboratory blanks, trichloroethene (TCE), tetrachloroethene (PCE) and toluene were detected at soil boring SB01-02 at concentrations of 24 ppb, 4 J (estimated) ppb, and 2 J ppb, respectively.

One (1) soil boring sample was collected for VOC analysis from the By-products Drum Storage Area. TCE was the only VOC (excluding common laboratory contaminants) detected; it was found at soil boring SB07-03 at an estimated (J) concentration of 1 ppb.

Five (5) soil boring samples were collected for VOC analysis from the remaining areas. TCE was the only VOC (excluding common laboratory contaminants) detected; it was found at soil borings SB13-03 (8 ppb) and SB24-3 (3 J ppb).

One (1) soil sample was collected from each of the five (5) test pits. The test pits were excavated to investigate possible VOC contamination of a filled drainage ditch. No VOCs were detected in any of the test pit samples (excluding common laboratory contaminants).

Seven (7) surface soil samples were collected from four (4) locations to determine the background VOC concentrations. TCE was detected in four (4) of the seven (7) samples, PCE was detected in four (4) of the seven (7) samples, and toluene was detected in both samples collected at location RA58. All VOCs were detected at estimated (J) concentrations and these concentrations decreased with depth.

No soil samples collected in the Former Chromium Button Storage area were analyzed for VOCs.

None of the samples collected within the Undeveloped Plant Property exceeded a NJDEP Soil Action Level for a specific VOC or for total VOCs (1 ppm) (see Tables 26 through 28).

Manufacturing Area

No surface soil or test pit samples were collected within the Manufacturing Area. A total of twenty-two (22) soil boring samples were analyzed for TCL VOC+10 in the Manufacturing Area. Nineteen (19) of the twenty-two (22) soil samples were collected in the areas of the Former Manpro-Vibra Degreasing Operation and/or the Underground Storage Tanks (UST). The remaining three (3) samples were part of the 5% TCL+30 random soil sampling required by the RI Work Plan (TRC, 1990).

One (1) of the twelve (12) soil boring samples collected around Department 106 was analyzed for VOC+10. No VOCs were detected at SB32-4 (excluding common laboratory contaminants detected in laboratory blanks).

One (1) of the eight (8) soil boring samples collected around Department 102 was analyzed for VOC+10. TCE was the only VOC (excluding common laboratory contaminants) detected; it was found at soil boring SB39-04 at an estimated (J) concentration of 3 ppb.

Ten (10) soil boring samples were collected from five (5) borings around the Former Manpro-Vibra Degreasing Area and were analyzed for VOC+10. The following VOCs were detected in these soil boring samples (excluding common laboratory contaminants): carbon disulfide (SB44-01 and SB44-02), total 1,2-dichloroethene (SB40-02 and SB44-01), 2-butanone (SB29-01, SB45-02), and TCE (SB29-01, SB40-02, SB44-01, SB45-02). In addition, benzene, PCE, toluene, ethylbenzene, and total xylene were all found in SB44-01. The concentrations of the VOCs decrease vertically in the soil profile with depth. The highest concentrations of VOCs appear to be along the degreasing unit's former wastewater drainage ditch. Detected VOC concentrations are presented in Table 23a. The presence of BTX compounds (benzene, toluene and xylenes) in SB44-01 indicates a possible spill of petroleum hydrocarbons onto the surface soil; no BTX compounds were detected in the 2- to 4-foot sample.

A total of nine (9) soil boring samples were collected from five (5) soil boring locations in the Underground Storage Tank Area and analyzed for TCL VOC+10. The following VOCs (excluding common laboratory contaminants) were detected in the soil boring samples: TCE (SB42-01 and SB42-04), 1,1,1-trichloroethane (SB73-04), and PCE and toluene (SB42-01, SB72-01, and SB72-04). The only petroleum hydrocarbon compound detected was toluene, at estimated concentrations in borings SB42 and SB72 (Table 23a). The installation of monitoring well SC23S and subsequent sampling confirmed that the unleaded fuel underground storage tank around which these borings were installed had released petroleum hydrocarbons.

One (1) of the six (6) soil boring samples collected around the railroad siding was analyzed for VOC+10. No VOCs were detected in SB47-04 other than the common laboratory contaminants detected in laboratory blanks.

No soil boring samples were analyzed for TCL VOC+10 in the Chromium Button Storage Area.

No sample collected within the Manufacturing Area exceeded any NJDEP Soil Action Level for a specific VOC or for total VOCs (1 ppm) (see Tables 26 through 28).

Lagoon and By-Products Storage

A total of two (2) soil boring samples from the Lagoon Area and one (1) soil boring samples and one (1) surface soil sample from the By-products Storage Area were analyzed for TCL VOC+10. All of these samples were part of the 5% TCL+30 random soil sampling required in the RI Work Plan (TRC, 1990).

Two (2) of the sixteen (16) soil boring samples collected around Lagoons B6, B7, and B8 were analyzed for TCL VOC+10. No VOCs were detected in SB55-04 and SB60-02 other than common laboratory contaminants also detected in the laboratory blanks.

One (1) of the ten (10) soil borings and one (1) surface soil sample from the By-products Storage Area were analyzed for TCL VOC+10. The only VOC detected in a soil boring or surface soil sample (excluding common laboratory contaminants) was TCE in RA32-01.

The total concentration of volatile organic compounds in all samples was less than 10 ppb. No sample collected within the Lagoon and By-products Storage Area exceeded any NJDEP Soil Action Level for a specific VOC or for total VOCs (1 ppm) (see Tables 26 through 28).

4.1.1.2 Semi-Volatile Organic Compounds (SVOCs)

Of the 194 soil samples collected for analyses, 45 soil samples were collected from 37 locations across the site and analyzed for TCL semi-volatile organic compounds (SVOCs). The results are presented in Tables 23b through 25b. The SVOC analytical data is interpreted according to the depth at which the sample was collected and the sample location. Di-n-butylphthalate and bis(2-ethylhexyl) phthalate were detected in all surface soil, test pit, and most soil boring samples. These compounds are common laboratory and field contaminants and were present in laboratory blanks. Pyrene and benzo(b)-fluoranthene were also detected in laboratory blanks and in some soil borings. All the compounds detected in the laboratory method blanks were evaluated during the quality assurance review (see Appendix H) according to the criteria required by the NJDEP SOP for Completion of Data Validation Report Forms and the Preparation of the Final Data Validation Report.

Undeveloped Plant Property

A total of nineteen (19) soil samples were analyzed for TCL SVOCs in the Undeveloped Plant Property. Of the nineteen (19) soil samples, six (6) were

surface soil samples, one (1) was a test pit sample and twelve (12) were soil boring samples.

Six (6) soil boring samples were collected for SVOC analysis from the Former Material Storage Area. No SVOCs were detected in any soil boring other than common laboratory contaminants detected in laboratory blanks (Table 25b).

One (1) soil boring sample was collected for SVOC analysis from the By-products Drum Storage Area. No SVOCs were detected in the soil boring other than common laboratory contaminants detected in laboratory blanks (Table 25b).

Five (5) soil boring samples were collected for SVOC analysis from the remaining areas. The following SVOCs were detected in soil boring samples (excluding common laboratory and field contaminants): phenol (SB13-03 and SB20-04), 2,4-dichlorophenol (SB24-03), 2,4,5-trichlorophenol (SB24-03), and pentachlorophenol (SB13-03). All SVOC contaminants were detected at estimated (J) concentrations (Table 25b).

One (1) test pit sample, collected from one (TP02-01) of the five test pits, was analyzed for SVOCs. The following SVOCs were detected in the test pit sample (excluding common laboratory and field contaminants): fluoranthene and pyrene. All SVOC contaminants were detected at estimated (J) concentrations (Table 24b).

Six (6) surface soil samples from three (3) locations were collected to determine the background SVOC concentrations. The following SVOCs were detected in background surface soil samples (excluding common laboratory and field contaminants): pentachlorophenol (RA58-01, RA58-02, RA59-01 and RA59-02), and pyrene, chrysene and benzo(b)fluoranthene (RA58-01). All SVOC contaminants were detected at estimated (J) concentrations (Table 23b).

No soil samples collected in the Former Chromium Button Storage Area were analyzed for SVOCs.

No sample collected within the Undeveloped Plant Property exceeded any NJDEP Soil Action Level for a specific PAH, for carcinogenic PAHs (10 ppm) or for total PAHs (100 ppm) (see Tables 26 through 28).

Manufacturing Area

A total of twenty-two (22) soil boring samples were analyzed for SVOCs in the Manufacturing Area. Eighteen (18) of the twenty-two (22) soil samples were located in the Former Manpro-Vibra Degreasing Area or the Underground Storage Tanks (UST) Area. The remaining four (4) samples were part of the 5% TCL+30 random soil sampling required by the RI Work Plan (TRC, 1990).

One (1) of the twelve (12) soil boring samples collected around Department 106 was analyzed for SVOCs. No SVOCs were detected at SB32-4 (excluding common laboratory and field contaminants detected in laboratory blanks).

One (1) of the eight (8) soil boring samples collected around Department 102 was analyzed for SVOCs. The following SVOCs were detected at estimated (J) concentrations at soil boring SB39-04 (excluding common laboratory and field contaminants): 2,4-dichlorophenol, 2,4,5-trichlorophenol, and pyrene.

Ten (10) soil boring samples were collected from five (5) borings located around the Former Manpro-Vibra Degreasing Unit and analyzed for SVOCs. The following SVOCs were detected in soil boring samples (excluding common laboratory and field contaminants): phenol (SB40-02 and SB44-01), 2-chlorophenol (SB40- 02), benzoic acid (SB40-02 and SB44-01), naphthalene (SB44-01), 4-chloro-3-methylphenol (SB44-02), 2,4,5-trichlorophenol (SB40-02 and SB44-02), 4-nitrophenol (SB40-02 and SB44-01), 2,4-dinitrotoluene (SB44-01), pentachlorophenol (SB29-01, SB40-02, SB40-05, SB44-01, SB44-02, SB45-02, SB45-03, SB46-01, and SB46-04), phenanthrene (SB44-01, SB44-02, SB46-01 and SB46-04), anthracene (SB44-01), fluoranthene (SB29-01, SB40-05,

SB44-01, SB44-02, SB45-02, SB46-01 and SB46-04), pyrene (SB29-01), butylbenzylphthalate (SB44-01), benzo(a)anthracene (SB44-01, SB44-02, and SB46-04), and chrysene (SB44-01, SB44-02, and SB46-04). In addition, benzo(b)-fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, and benzo(g,h,i)perylene were all detected in boring SB-44-01. The highest concentrations of SVOCs appear to be along the Former Manpro-Vibra Degreasing Unit's former wastewater drainage ditch. Detected SVOC concentrations for the eighteen (18) samples from the Former Manpro-Vibra Degreasing Unit area are presented in Table 25b.

A total of nine (9) soil boring samples were collected from five (5) soil boring locations located around three (3) USTs and were analyzed for SVOCs. The following SVOCs were detected in soil boring samples (excluding common laboratory contaminants): benzoic acid (SB42-01), pentachlorophenol (SB41-01, SB42-04, and SB72-04), phenanthrene (SB41-02, SB42-04, SB72-01, SB72-04 and SB84-05), anthracene (SB72-04), fluoranthene (SB41-02, SB42-04, SB72-01, SB72-04, and SB84-05), pyrene (SB41-02, SB42-04, SB72-01, SB72-04, and SB84-05), benzo(a)anthracene (SB41-02, SB42-04, and SB72-04), chrysene (SB41-02, SB42-04, SB72-01, and SB72-04), benzo(b)fluoranthene (SB72-01 and SB72-04), and benzo(k)fluoranthene and benzo(a)pyrene (SB72-04). All SVOC contaminants were detected at estimated (J) concentrations (Table 25b).

One (1) of the six (6) soil boring samples collected in the Railroad Siding Area was analyzed for SVOCs. The following SVOCs were detected in soil boring sample SB47-04 (excluding common laboratory contaminants): 2,4-dichlorophenol and 2,4,5-trichlorophenol. All SVOC contaminants were detected at estimated (J) concentrations (Table 25b).

No soil boring samples were analyzed for SVOCs in the Chromium Button Storage Area.

No sample collected within the Manufacturing Area exceeded any NJDEP Soil Action Level for a specific PAH, for carcinogenic PAHs (10 ppm) or for total PAHs (100 ppm) (see Tables 26 through 28).

Lagoon and By-Products Storage

A total of two (2) soil boring samples in the Lagoon Area and one (1) soil boring samples and one (1) surface soil sample from the By-products Storage Area were analyzed for SVOCs. All of these samples were part of the 5% TCL+30 random soil sampling required in the RI Work Plan (TRC, 1990).

Two (2) of the sixteen (16) soil boring samples collected around Lagoons B6, B7, and B8 were analyzed for SVOCs. Pyrene and butylbenzylphthalate were detected in soil boring SB55-04. No SVOCs were detected in soil boring SB60-02 (excluding common laboratory contaminants). All SVOC contaminants were detected at estimated (J) concentrations (Table 25b).

One (1) of the ten (10) soil boring samples and one (1) surface soil sample from the By-products Storage Area were analyzed for SVOCs. No SVOCs were detected in the soil boring and surface soil samples (excluding common laboratory contaminants).

No sample collected within the Lagoon or By-products Storage Areas exceeded any NJDEP Soil Action Level for a specific PAH, for carcinogenic PAHs (10 ppm) or for total PAHs (100 ppm) (see Tables 26 through 28).

4.1.1.3 Pesticides/PCB Compounds

Of the 194 soil samples collected for analyses, 37 soil samples were collected from 30 locations across the site and analyzed for TCL Pesticides/ PCB compounds. The results are presented in Tables 23c through 25c. The Pesticide/PCB analytical data is interpreted according to the depth and location at which each sample was collected.

Undeveloped Plant Property

A total of sixteen (16) soil samples were analyzed for TCL Pesticides/PCBs in the Undeveloped Plant Property. Of the sixteen (16) soil samples, six (6) were surface soil samples, one (1) was a test pit sample and nine (9) were soil boring samples.

Two (2) soil boring samples were collected for Pesticide/PCB analysis from the Former Material Storage Area. No Pesticides/PCBs were detected in any soil boring sample (Table 25c).

One (1) soil boring sample was collected for Pesticide/PCB analysis from the By-products Drum Storage Area. The only Pesticide/PCB compound detected in soil boring SB07-03 was 4,4-DDT at an estimated (J) concentration (Table 25c).

Six (6) soil boring samples were collected for Pesticide/PCB analysis from the remaining areas. The only Pesticide/PCB compound detected in soil boring samples was 4,4-DDT (SB13-03, SB20-04, and SB22-05). The 4,4-DDT concentrations at SB20-04 and SB22-05 both exceeded the NJDEP Soil Action Level for DDT (1-10 ppm); at boring SB13-03, DDT was detected at an estimated (J) value (Table 25c).

One (1) test pit sample, collected from one of the five test pits, was analyzed for Pesticides/PCBs. No Pesticide/PCB compounds were detected in the test pit sample (Table 24c).

Six (6) surface soil samples from three (3) locations were collected to determine the background Pesticide/PCB concentrations. No Pesticide/PCB compounds were detected in the surface soil samples (Table 23c).

No soil samples collected in the Former Chromium Button Storage Area were analyzed for Pesticide/PCB compounds.

Two (2) soil boring samples within the Undeveloped Plant Property (SB20-04 and SB22-05) exceeded the NJDEP Soil Action Level for DDT of 1-10 ppm. No

other soil sample collected within the Undeveloped Plant Property exceeded any NJDEP Soil Action Level for a specific Pesticide/PCB or for total PCBs (5 ppm) (see Tables 26 through 28).

Manufacturing Area

A total of seventeen (17) soil boring samples were analyzed for Pesticides/ PCBs in the Manufacturing Area. Twelve (12) of the seventeen (17) soil samples investigated the soils around Department 106. The remaining four (4) samples were part of the 5% TCL+30 random soil sampling required by the RI Work Plan (TRC, 1990).

All twelve (12) soil boring samples collected around Department 106 were analyzed for PCB compounds and one (1) sample (SB32-04) was analyzed for pesticides. No pesticides were detected at soil boring SB32-04 and the only PCB compound detected was Aroclor-1254 (SB31-01, SB32-01, and SB33-01). No PCB compound exceeded a concentration of 0.130 ppm.

One (1) of the eight (8) soil boring samples collected around Department 102 was analyzed for Pesticide/PCB compounds. The only Pesticide/PCB compound detected at soil boring SB39-04 was 4,4-DDT (20 ppb) (Table 25c).

No soil samples were collected around the Former Manpro-Vibra Degreasing Unit for analysis for Pesticide/PCB compounds.

Three (3) soil boring samples were collected around the USTs and analyzed for Pesticides/PCBs. No pesticides were detected in soil boring SB42-02 and SB84-05 but the NJDEP Soil Action Level for 4,4-DDT was exceeded in SB73-04 (37,000 ppb). An estimated concentration of the PCB Aroclor-1260 (28 ppb) was detected in soil boring SB84-05 (Table 25c).

One (1) of the six (6) soil boring samples collected around the Railroad Siding Area was analyzed for Pesticides/PCBs. No pesticide/PCB compounds were detected in soil boring sample SB47-04 (Table 25c).

No soil boring samples were analyzed for Pesticide/PCB compounds in the Chromium Button Storage Area.

No sample collected within the Manufacturing Area exceeded any NJDEP Soil Action Level for a specific Pesticide/PCB or for Total PCBs (5 ppm) (see Tables 26 through 28).

Lagoon and By-Products Storage

A total of two (2) soil boring samples collected in the Lagoon Area and one (1) soil boring sample and one (1) surface soil sample from the By-products Storage Area were analyzed for Pesticide/PCB compounds. All of these samples were part of the 5% TCL+30 random soil sampling required in the RI Work Plan (TRC, 1990).

Two (2) of the sixteen (16) soil boring samples collected around Lagoons B6, B7, and B8 were analyzed for Pesticide/PCB compounds. No Pesticide/PCB compounds were detected in soil borings SB55-04 and SB60-02 (Table 25c).

One (1) of the ten (10) soil boring samples and one (1) surface soil sample from the By-Products Storage Area were analyzed for Pesticide/PCB compounds. No Pesticide/PCB compounds were detected in soil boring SB77-03; the PCB compounds Aroclor-1248 and Aroclor-1260 (1,900 ppb and 1,500 J ppb, respectively) were detected in surface soil sample RA34-01 (Tables 23c and 25c).

No sample collected within the Lagoon or By-products Storage Areas exceeded any NJDEP Soil Action Level for a specific Pesticide/PCB or for total PCBs (5 ppm) (see Tables 26 through 28).

4.1.1.4 Inorganic Compounds

Of the 194 soil samples collected for analyses, 190 soil samples were collected from 133 locations across the site and analyzed for inorganic

compounds and analytes. Inorganic compounds included in the analyses were TAL metals, sulfate, cyanide, hexavalent chromium, zirconium, titanium, boron, niobium and strontium. The results are presented in Tables 23d through 25d. The inorganic analytical data is interpreted according to the depth and location at which each sample was collected.

Undeveloped Plant Property

A total of 116 soil samples were analyzed for inorganics in the Undeveloped Plant Property. Of the 116 soil samples, 59 were surface soil samples, 5 were test pit samples and 52 were soil boring samples.

A total of six (6) surface soil samples and six (6) soil boring samples were collected for inorganic analysis from the Former Material Storage Area. The following inorganic compounds were identified at levels exceeding NJDEP Soil Action Levels: beryllium, chromium, nickel, and vanadium (Tables 26 and 28). An overall summary of inorganic analytical results is presented in Tables 23d through 25d.

A total of three (3) surface soil and eight (8) soil boring samples were collected for inorganic analysis from the By-products Drum Storage Area. The following inorganic compounds were identified at levels exceeding NJDEP Soil Action Levels: beryllium, chromium, nickel, and vanadium (Tables 26 and 28). An overall summary of inorganic analytical results is presented in Tables 23d through 25d.

A total of forty-four (44) surface soil samples and thirty-four (34) soil boring samples were collected for inorganic analysis from the Remaining Undeveloped Plant Property Areas. The following inorganic compounds were identified at levels exceeding NJDEP Soil Action Levels: barium, beryllium, chromium, lead, nickel, and vanadium (Tables 26 and 28). An overall summary of inorganic analytical results is presented in Tables 23d through 25d.

Five (5) test pit soil samples were analyzed for inorganic compounds. The following inorganic compounds were detected at levels exceeding NJDEP Soil Action Levels: antimony, beryllium, and vanadium (Table 27). An overall summary of inorganic analytical results is presented in Table 24d.

Six (6) surface soil samples from three (3) locations were collected to determine the background inorganic concentrations. The following inorganic compounds were detected at levels exceeding NJDEP Soil Action Levels: copper and mercury (Table 26). An overall summary of inorganic analytical results is presented in Table 23d.

A total of six (6) soil boring samples were collected in the Former Chromium Button Storage Area and analyzed for inorganic compounds. The following inorganic compounds were detected at levels exceeding NJDEP Soil Action Levels: beryllium, chromium, nickel, and vanadium (Table 28). An overall summary of inorganic analytical results is presented in Table 25d.

A total of four (4) soil boring samples were collected at the Tank T-12 Area and analyzed for inorganic compounds. No inorganic compounds were detected at levels exceeding NJDEP Soil Action Levels.

Manufacturing Area

A total of forty-two (42) soil samples were analyzed for inorganic compounds in the Manufacturing Area. A total of forty (40) soil boring samples, one (1) surface soil sample, and one (1) surface/subsurface sample were collected.

One (1) surface soil sample and twelve (12) soil boring samples were collected around Department 106 and analyzed for inorganic compounds. The following inorganic compounds were detected at levels exceeding NJDEP Soil Action Levels: beryllium, chromium, nickel, lead, and vanadium (Tables 26 and

28). An overall summary of inorganic analytical results is presented in Tables 23d and 25d.

Eight (8) soil boring samples collected around Department 102 were analyzed for inorganic compounds. The following inorganic compounds were detected at levels exceeding NJDEP Soil Action Levels: beryllium, chromium, nickel, lead, and vanadium (Table 28). An overall summary of inorganic analytical results is presented in Table 25d.

Ten (10) soil boring samples were collected from five (5) borings around the Former Manpro-Vibra Degreasing Unit and analyzed for inorganic compounds. The following inorganic compounds were detected at levels exceeding NJDEP Soil Action Levels: beryllium and vanadium (Table 28). An overall summary of inorganic analytical results is presented in Table 25d.

Two (2) of the eight (8) soil boring samples collected from around the Underground Storage Tank Area were analyzed for inorganic compounds. No inorganic compounds were detected at levels exceeding NJDEP Soil Action Levels (Table 28). An overall summary of inorganic analytical results is presented in Table 25d.

Six (6) soil boring samples were collected around the Railroad Siding Area and analyzed for inorganic compounds. The following inorganic compounds were detected at levels exceeding NJDEP Soil Action Levels: arsenic, chromium, selenium, and vanadium (Table 28). An overall summary of inorganic analytical results is presented in Table 25d.

One (1) surface/subsurface soil sample was collected under the furnace of Department 101(B). The sample was collected under the concrete at a depth of approximately fourteen (14) feet below ground surface. The sample was analyzed for TAL metals and hexavalent chromium only. The following inorganic compounds were detected at levels exceeding NJDEP Soil Action Levels:

arsenic, chromium, antimony, and selenium (Table 26). An overall summary of inorganic analytical results is presented in Table 23d.

Six (6) soil boring samples were analyzed for inorganic compounds in the Chromium Button Storage Area. The following inorganic compounds were detected at levels exceeding NJDEP Soil Action Levels: beryllium, chromium, nickel, and vanadium (Table 28). An overall summary of inorganic analytical results is presented in Table 25d.

Lagoon and By-Products Storage

A total of sixteen (16) soil boring samples in the Lagoon Area and ten (10) soil boring samples and four (4) surface soil sample from the By-products Storage Area were analyzed for inorganic compounds.

Sixteen (16) soil boring samples were collected around Lagoons B6, B7, and B8 and analyzed for inorganic compounds. The following inorganic compounds were detected at levels exceeding NJDEP Soil Action Levels: beryllium, chromium, nickel, and vanadium (Table 28). An overall summary of inorganic analytical results is presented in Table 25d.

Eighteen (18) soil boring samples and four (4) surface soil samples from the By-products Storage Area were analyzed for inorganic compounds. Five (5) of the ten (10) soil borings and all four (4) surface soil samples exceeded at least one (1) NJDEP Soil Action Level. The following inorganic compounds were detected at levels exceeding NJDEP Soil Action Levels: antimony, barium, beryllium, chromium, lead, nickel, and vanadium (Tables 26 and 28). An overall summary of inorganic analytical results is presented in Tables 23d and 25d.

4.1.1.5 Interpretation of Soil Contamination

This section discusses contamination patterns in surface and subsurface soils at the SMC facility. When possible, potential sources of the contaminants are discussed. The analysis is divided into the following sections: volatile organic compounds (VOCs); semi-volatile organic compounds (SVOCs); pesticides/PCBs; and inorganic compounds.

Volatile Organic Compounds (VOCs)

Inspection of surface soil, test pit and soil boring analytical data does not indicate any widespread VOC soil contamination. No soil sample collected and analyzed for VOCs exceeded any NJDEP Soil Action Level for a specific compound or for total VOCs (Tables 26 through 28).

Potential sources of VOC contamination were noted in two locations. The first location was a drainage ditch that ran from the Former Manpro-Vibra Degreaser Unit to the drainage ditch exposed during the test pit investigation. Volatile organic compounds were detected in all five boring locations at levels less than the associated Soil Action Levels. The boring that contained the highest concentrations as well as the greatest variety of VOCs was soil boring SB44 (Table 25a). This boring was advanced only four (4) feet due to a strong natural gas odor and the boring's proximity to an natural gas pipeline.

The second location was adjacent to the underground storage tank (UST) located near buildings D215 and 201. This UST, which contained unleaded fuel, is out of service but is still in-place in the ground. Soil samples from borings SB42 and SB72, located in the tank area, both exhibited low concentrations of benzene, toluene and xylene (less than Soil Action Levels). The subsequent analysis of ground water samples collected in monitoring well

SC23S (installed in soil boring SB42) confirmed the presence of petroleum hydrocarbons in the UST area.

No other areas of the SMC facility that were investigated as possible sources of VOC contamination had significant concentrations of VOC contaminants. The three (3) background surface soil samples (RA-58, RA-59, and RA-60 on Figure 4) all had estimated (J) concentrations of TCE and PCE. Since the areas to the north of the SMC facility are industrial, soils in that area may contain trace concentrations of VOCs.

Semi-Volatile Organic Compounds (SVOCs)

Inspection of surface soil, test pit and soil boring analytical data does not indicate any widespread SVOC soil contamination. No soil sample collected and analyzed for SVOCs exhibited contaminants at levels which exceeded any NJDEP Soil Action Level for a specific PAH compound, for carcinogenic PAHs, or for total PAHs (Tables 26 through 28). SVOCs were detected in soil samples from four of five borings located along a former drainage ditch that ran from the Manpro-Vibra Degreaser Unit to the drainage ditch exposed during the test pit investigation. The boring that contained the highest concentrations as well as the greatest variety of SVOCs was soil boring SB44 (Table 25b). This area of the site is currently covered by approximately eighteen (18) inches of reinforced concrete.

No other areas of the SMC facility that were investigated as possible sources of SVOC contamination exhibited significant concentrations of SVOCs. The three (3) background surface soil samples all had estimated concentrations of SVOC compounds. The highest concentrations and greatest variety of compounds were found in surface soil sample RA58. It should be noted that higher concentrations of SVOC compounds were detected in background soil sample RA58 than in most on-site soil samples.

Pesticides/PCBs

Inspection of surface soil, test pit and soil boring analytical data does not indicate any widespread pesticide/PCB soil contamination. Six (6) soil boring samples exceeded the NJDEP Soil Action Level for the pesticide 4,4-DDT and no soil samples exceeded the NJDEP Soil Action Level for the PCBs (Tables 26 through 28). The distribution of PCBs indicates that there is no widespread PCB contamination across the site, with PCBs confined to the area around Building 106 and to soils on the western side of the By-products Storage Area.

The distribution of the pesticide 4,4-DDT across the site is not surprising given the general widespread use of this chemical in the past. It is interesting to note that the depths of the three (3) soil boring samples (SB20-04, SB22-05, and SB73-04) at which the NJDEP Soil Action Level was exceeded were each greater than six (6) feet.

No other areas of the SMC facility that were investigated had significant concentrations of pesticide/PCB compounds. No pesticide/PCB compounds were detected in any of the three (3) background surface soil samples.

Inorganics

Inspection of surface soil, test pit and soil boring inorganic data indicates that a number of elements exceed NJDEP Soil Action Levels (Tables 26 through 28) and that they are migrating off-site. The individual inorganic elements of concern will be addressed separately in an attempt to determine sources as well as patterns of contamination.

Beryllium - Beryllium was found at concentrations in excess of the NJDEP Soil Action Level a total of sixty-six (66) times. It exceeded the Action Level forty-one (41) times in soil boring samples, twenty-two (22) times in

surface soil samples, and three (3) times in test pit samples. The analytical results of the surface soil samples and near-surface soil boring samples indicate that the NJDEP Soil Action Level for beryllium was exceeded in shallow samples 53 times, at locations across the site.

There are three (3) main areas of elevated beryllium levels: soils on the western side of the By-products Storage Pile, soils on the eastern side of the By-products Storage Pile, and within the floodplain (defined on the basis of visual observations as discussed in Section 3.2) of the Hudson Branch (RA12-13). The By-products Storage Pile, which is unprotected from the elements, appears to be the primary source of beryllium for the areas listed above. Beryllium concentrations have been mapped for surface soil and near-surface soil borings in Figure 18. The highest concentrations of beryllium were detected in the location of the observed Hudson Branch floodplain, indicating that beryllium has potentially migrated (precipitation runoff, wind transport, etc.) from the By-products Storage Pile. All other areas of the SMC property are of less concern, as these samples have lower beryllium concentrations and/or are covered by pavement or concrete.

The concentration of beryllium tends to decrease with depth. The elevated beryllium concentrations in the lower soil depths could be due to past site activities, such as reworking of the soil around the By-products Storage Pile. Based on the concentration patterns, it is unlikely that the concentrations noted are the result of beryllium leaching from the surface.

A comparison of site background concentrations, published United States average concentrations compiled by the USGS and EPA, and concentrations detected across the site is presented in Table 29. The majority of samples analyzed are within the EPA's range of naturally occurring beryllium.

Chromium - Chromium was detected at concentrations exceeding the NJDEP Soil Action Level a total of forty-one (41) times. It was exceeded twenty-three (23) times in soil boring samples and eighteen (18) times in surface soil samples. The analytical results of the surface soil and near-surface soil boring samples indicate that the NJDEP Soil Action Level for chromium was exceeded in shallow samples 35 times, at locations across the site.

There are five (5) main areas of elevated chromium levels: Building 106, the Railroad Siding Area, soils on the western side of the By-products Storage Pile, soils on the eastern side of the By-products Storage Pile, and within the observed floodplain of the Hudson Branch (RA12-13). Total chromium concentrations have been mapped for surface soil samples and near-surface soil boring samples in order to represent areas where the NJDEP Soil Action Level of 100 ppm for total chromium is exceeded (Figure 19). The two most contaminated areas are the observed floodplain (RA12) and the Building 106 Area (SB30), with both areas exhibiting greater than 2,000 ppm total chromium. Potential sources for the chromium contamination are the By-products Storage Pile (which appears to have affected soils east and west of the By-product Storage Pile as well as the observed Hudson Branch floodplain), Manufacturing Processes (Department 106 and Department 102), and storage/distribution areas (Railroad Siding and Lagoon Area).

Total chromium concentrations decrease with depth. Levels of chromium exceeded the NJDEP Soil Action Level of 100 ppm a total of six (6) times at depths below two feet. The chromium contamination detected at depth was found in the same locations as surficial chromium contamination.

A comparison of site background concentrations, published United States average concentrations compiled by the USGS and EPA, and concentrations

detected across the site is presented in Table 29. The majority of samples analyzed are within the EPA and USGS ranges of naturally occurring chromium.

Nickel - Nickel exceeded the NJDEP Soil Action Level a total of twenty-nine (29) times. The Action Level was exceeded eighteen (18) times in soil boring samples and eleven (11) times in surface soil samples. The results of the surface soil and near-surface soil boring samples indicate that the NJDEP Soil Action Level for nickel was exceeded in shallow samples 26 times, at locations across the site.

There are five (5) main areas of elevated nickel levels: Building 106, the Railroad Siding Area, soils on the western side of By-product Storage Pile, soils on the eastern side of the By-products Storage Pile, and within the observed floodplain of the Hudson Branch (RA12-14). The two most contaminated areas are within the observed floodplain (RA12) and along the eastern side of the By-products Storage Pile (SB56), with both areas exhibiting greater than 900 ppm nickel. Potential sources for the nickel contamination are the By-products Storage Pile (which may have affected soils east and west of the By-products Storage Pile as well as the observed floodplain), Manufacturing Processes (Department 106 and Department 102), and storage/distribution areas (Railroad Siding and Lagoon Area). Nickel concentrations have been mapped for surface soil samples and near-surface soil borings in Figure 20.

Nickel concentrations decrease with depth. Nickel levels exceeded the NJDEP Soil Action Level of 100 ppm a total of three (3) times at depths below two feet. The nickel contamination detected at depth was found in the same locations as surficial nickel contamination.

A comparison of site background concentrations, published United States average concentrations compiled by the USGS and EPA, and concentrations

detected across the site is presented in Table 29. The majority of samples analyzed are within the EPA and USGS ranges of naturally occurring nickel.

Vanadium - Vanadium exceeded the NJDEP Soil Action Level a total of eighty-one (81) times. It was exceeded fifty-one (51) times in soil boring samples, twenty-seven (27) times in surface soil samples, and three (3) times in test pit samples. The results of the surface soil and near-surface soil boring samples indicate that the NJDEP Soil Action Level for vanadium was exceeded in shallow samples 62 times, at locations across the site.

There are six (6) main areas of elevated vanadium levels: Building 106, the Railroad Siding Area, the Manpro-Vibra Degreasing wastewater ditch area, soils on the western side of the By-products Storage Pile, soils on the eastern side of the By-products Storage Pile, and within the observed floodplain of the Hudson Branch (RA12-13). Vanadium concentrations have been mapped for surface soil samples and near-surface soil borings in Figure 21. There are four areas across the site where vanadium concentrations exceed 3,000 ppm. These areas include the observed floodplain (RA12), the eastern side of the By-products Storage Pile (RA43), the Lagoon Area (SB56), and the Railroad Siding Area (SB47). Potential sources for the vanadium contamination are the By-products Storage Pile (which may have affected soils east and west of the By-products Storage Pile as well as within the floodplain), Manufacturing Processes (Manpro-Vibra Degreasing Unit and Department 102), and storage/distribution areas (Railroad Siding and Lagoon Area).

Total vanadium concentrations decrease with depth. Vanadium levels exceeded the NJDEP Soil Action Level of 100 ppm a total of sixteen (16) times at depths below two feet. The vanadium contamination detected at depth was found in the same locations as surficial vanadium contamination.

A comparison of site background concentrations, published United States average concentrations compiled by the USGS and EPA, and concentrations detected across the site is presented in Table 29. A large number of samples across the site exceeded the EPA and USGS range of naturally occurring vanadium.

Other Inorganics - A number of additional elements were detected at levels exceeding NJDEP Soil Action Levels across the site. These elements and their frequency of detection above Action Levels are as follows: antimony (1 time), barium (6 times), lead (1 time), cadmium (1 time), and selenium (1 time). Since these elements were not detected extensively across the site, they will not be addressed individually. They were detected in the same locations as noted previously for other inorganic constituents (near the By-Products Storage Area, the observed Hudson Branch floodplain, and the Manufacturing Area).

A comparison of site background concentrations, published United States average concentrations compiled by the USGS and EPA, and concentrations detected across the site is presented in Table 29. The majority of samples analyzed for the different elements were within the EPA and USGS ranges of naturally occurring background concentrations.

4.1.1.6 Surface and Subsurface Soil Summary

Soil samples collected from surface soils, test pits and soil borings at the SMC facility primarily exhibit inorganic compounds. Volatile organic, semi-volatile organic, and PCB compounds were detected in soil samples but at levels which do not exceed New Jersey Interim Soil Action Levels. DDT was detected in two soil boring samples at levels of 26 parts per million (ppm)

and 31 ppm, which exceed the New Jersey Interim Soil Action Level of 1 - 10 ppm for DDT.

Inorganics were detected most frequently at levels exceeding New Jersey Interim Soil Action Levels. The presence of individual inorganic compounds is discussed below:

Beryllium was detected 66 times in soil samples (53 times in near-surface soil samples) at levels exceeding the action level of 1 ppm. The maximum detected concentration of beryllium was 60.1 ppm, detected in a sample collected in the southwestern portion of the Undeveloped Plant Property, along the observed floodplain of the Hudson Branch. Other areas exhibiting elevated beryllium levels (with maximum detected level of beryllium noted) include the Lagoon Area (19.4 ppm), the Railroad Siding Area (20 ppm), and along the eastern and western sides of the By-products Storage Area (29.3 ppm and 22.5 ppm, respectively).

Chromium was detected at concentrations exceeding the action level of 100 ppm a total of 41 times (35 times in near-surface soil samples). The maximum detected concentration of total chromium was 5,870 ppm, detected in a sample collected in the southwestern portion of the Undeveloped Plant Property, along the observed floodplain of the Hudson Branch. Other areas exhibiting elevated total chromium levels (with maximum detected concentrations noted) include the Department 106 Area (2,280 ppm), the Department 102 Area (1,630 ppm), the Railroad Siding Area (260 ppm), and along the eastern and western sides of the By-products Storage Area (176 ppm and 473 ppm, respectively).

Nickel was detected at concentrations exceeding the action level of 100 ppm a total of 29 times (26 times in near-surface soil samples). The maximum detected concentration of nickel was 3,360 ppm, detected in a sample collected in the southwestern portion of the Undeveloped Plant Property, along the observed floodplain of the Hudson Branch. Other areas exhibiting elevated nickel levels (with maximum detected concentrations noted) include the Lagoon Area (912 ppm), the Railroad Siding Area (339 ppm), and along the eastern and western sides of the By-products Storage Area (530 ppm and 1,110 ppm, respectively).

Vanadium was detected at concentrations exceeding the action level of 100 ppm a total of 81 times (62 times in near-surface soil samples). The maximum detected concentration of vanadium was 12,100 ppm, detected in a sample collected in the southwestern portion of the Undeveloped Plant Property, along the observed floodplain of the Hudson Branch. Other areas exhibiting elevated vanadium levels (with maximum detected concentrations noted) include the Department 106 Area (1,190 ppm), the Lagoon Area (3,950 ppm), the Railroad Siding Area (4,110 ppm), the Tank T12 Area (1,810 ppm), and along the eastern and western sides of the By-products Storage Area (3,990 ppm and 4,750 ppm, respectively).

In addition to these inorganics, several other metals were detected at levels exceeding action levels, although less frequently than those discussed above. These metals and the frequency with which they were detected at concentrations exceeding action levels include antimony (1 time), barium (6 times), lead (1 time), cadmium (1 time), and selenium (1 time). They were detected in the same areas (as identified above) in which other inorganics exceeded action levels.

The inorganic concentrations in soil samples were also compared to on-site background concentrations and published ranges (USEPA and USGS) of background concentrations for the United States. While detected inorganic levels generally exceeded on-site background concentrations, most levels were within the published national ranges of naturally occurring metals.

4.2 Surface Water and Stream Sediment

In this section of the report, an assessment of the Phase I surface water and stream sediment sample analytical results is presented. Summary tables of all detected compounds within the stream sediment and surface water samples are presented in Tables 30 and 31. Summary tables of samples that exceeded established NJDEP and USEPA Action Levels for the stream sediments, and samples that exceeded the Maximum Values for the Protection of Aquatic Life (NJ Water Pollution Control Act) and the Safe Water Drinking Act MCL for the surface water and runoff water are presented in Tables 27 and 32, respectively. When applicable, a discussion of the investigation results that indicate a potential source or pattern of stream sediment or surface water contamination is included.

4.2.1 Assessment of Results

A total of five (5) surface water samples, four (4) runoff samples, and five (5) stream sediment samples were collected. A discussion of the sampling locations, the number of samples collected, and all field measurements and observations made during the stream and sediment sampling activities is presented in Section 2.0 of this report.

4.2.1.1 Volatile Organic Compound (VOC)

All surface water and stream sediment samples were analyzed for TCL VOC+10. The results are presented in Tables 30a and 31a. Methylene chloride and acetone were detected in all surface water and stream sediment samples. These compounds are common laboratory contaminants and were present in laboratory blanks.

Surface Water VOC Results

Volatile organic compounds were detected in only one (1) surface water sample (SW4). The following VOC contaminants were detected at estimated (J) concentrations: chloromethane (9 J ppb), 1,2-dichloroethene (2 J ppb), and trichloroethene (3 J ppb). Surface water sampling station SW4 is located adjacent to the toe of the hexavalent chromium ground water plume (Figure 5). Monitoring wells located upgradient of station SW4 also exhibited chlorinated VOCs (see Section 4.3.1). Therefore, a potential source of VOCs detected in the Hudson Branch is contaminated ground water. No volatile organic compound concentrations exceeded either the NJ Water Pollution Control Act (NJWPCA) or the Safe Drinking Water Act (SDWA) MCL values (Table 32).

Stream Sediment VOC Results

Volatile organic compounds were detected in all five (5) stream sediment samples. The following VOC contaminants were detected (some at estimated (J) concentrations): 1,2-dichloroethene (2 J ppb at SD3 and 5 J ppb at SD4), 2-butanone (72 ppb at SD1, 130 J ppb at SD2, 120 ppb at SD3, 55 ppb at SD4, and 69 ppb at SD5), and trichloroethene (7 ppb J at SD5).

The probable source of VOC contamination in the stream sediment samples is difficult to determine. The only VOC consistently detected in each of the sediment samples was 2-butanone. This compound is a frequent laboratory contaminant. The other VOC compounds were detected at off-site sample locations. The source of these contaminants could potentially be surface runoff sediments from other industrial facilities in the area. Two (2) of the detected VOC contaminants (2-butanone and 1,2-dichloroethene) had no associated NJDEP Soil Action Level. New Jersey has a Soil Action Level of 10 ppm for total VOC contaminants; no stream sediment sample exceeded any regulatory value (Table 27).

4.2.1.2 Semi-Volatile Organic Compounds (SVOCs)

All four (4) surface runoff water samples and two (2) of the surface water/stream sediment samples (SW1/SD1 and SW4/SD4) were analyzed for SVOCs. The results are presented in Tables 30b and 31b. Di-n-butylphthalate and bis(2-ethylhexyl)phthalate were detected in some surface water and stream sediment samples. These compounds were not considered representative of site contamination as they are common laboratory and field activity contaminants and were present in some laboratory blanks.

Surface Water SVOCs Results

No semi-volatile organic compounds other than di-n-butylphthalate and bis(2-ethylhexyl)phthalate were detected in any surface or runoff water samples. Therefore, no federal or New Jersey MCLs were exceeded.

Stream Sediment SVOCs Results

The following SVOCs were detected in the two stream sediment stations that were sampled (excluding di-n-butylphthalate and bis(2-ethylhexyl)phthalate): phenol (100 J ppb at SD1 and 520 J ppb at SD4), benzoic acid (1000 J ppb at SD1 and 3200 J ppb at SD4), pentachlorophenol (330 J ppb at SD1), phenanthrene (110 J ppb at SD4), fluoranthene (120 J ppb at SD1 and 210 J ppb at SD4), pyrene (130 J ppb at SD4), butylbenzlphthalate (140 J ppb at SD2), chrysene (140 J ppb at SD4), and benzo(b)fluoranthene (110 J ppb at SD4). The results are presented in Table 31b.

No SVOC contaminant was detected above NJDEP Soil Action Levels. New Jersey has a Soil Action Level of 10 ppm for total carcinogenic PAH and 100 ppm for total PAH contaminants; no stream sediment sample exceeded any regulatory value (Table 27).

The source of the SVOC contamination in the stream sediment is difficult to determine. Sediment sampling station SD1 was located as close to the source of the Hudson Branch as possible, while sediment sampling station SD4 was located adjacent to the toe of the hexavalent chromium ground water contamination plume (Figure 5). There are no known industrial activities on the eastern portion of the SMC property (current or historic) that would produce SVOC contaminated sediments. Possible sources of the detected SVOC contamination are the small industrial facilities located along Weymouth Road that are within the Hudson Branch discharge basin. SVOC contaminated soils

from these facilities could have migrated into the Hudson Branch during rainfall runoff events. The sediment at downstream sediment station SD4 could have been impacted by sediments from a number of industrial facilities that have access to the Hudson Branch.

4.2.1.3 Pesticide/PCB Compounds

All four (4) surface runoff water samples and two (2) surface water/stream sediment samples (SW1/SD1 and SW4/SD4) were analyzed for TCL Pesticides/PCB. The results are presented in Tables 28c and 29c.

Surface Water Pesticide/PCB

No Pesticide/PCB compounds were detected in any surface or runoff water samples. Therefore, no federal or New Jersey MCLs were exceeded.

Stream Sediment Pesticide/PCB

The following pesticide/PCB compounds were detected in the two stream sediment stations that were analyzed for pesticides/PCBs: 4,4-DDE (18 J ppb at SD1 and 11 J ppb at SD4), 4,4-DDD (5.3 J ppb at SD1 and 18 J ppb at SD4), 4,4-DDT (33 J ppb at SD1 and 28 J ppb at SD4), and Aroclor-1254 (160 J ppb at SD1 and 95 J ppb at SD4). The results are presented in Table 31c.

New Jersey has a Soil Action Level of 1-10 ppm for DDT and 5 ppm for total PCB contaminants; no stream sediment sample exceeded any regulatory value (Table 27).

The source of the Pesticide/PCB contamination in the stream sediment is difficult to determine. Sediment sampling station SD1 was located as close to the source of the Hudson Branch as possible, while sediment sampling station SD4 is located adjacent to the toe of the hexavalent chromium ground water contamination plume (Figure 5).

The area surrounding the SMC facility is a mixture of small industrial businesses, residences, and agricultural properties. Pesticides such as DDE, DDD, and DDT were commonly used from the early 1950's to the late 1960's. These compounds are known to be extremely persistent and their presence in stream sediment could be due to historic agricultural use.

The presence of the PCB compound Aroclor-1258 could be the result of runoff from the small industrial businesses in the Hudson Branch drainage basin or some other unknown contaminant source.

4.2.1.4 Inorganic Compounds

All surface water and stream sediment samples were analyzed for inorganic compounds. The results are presented in Tables 30d and 31d.

Surface Water Inorganic Results

Inorganic compounds were detected in all five (5) surface water samples and all four (4) runoff samples. The following inorganic contaminants were detected at concentrations that exceeded New Jersey Water Pollution Control Act (WPCA) or U.S. Safe Drinking Water Act (SDWA) criteria: antimony (SW1 and SW2), arsenic (SW7), beryllium (SW2, SW7, SW8, SW9), cadmium (SW2 and SW7), total chromium (SW2, SW3, SW4, SW7, and SW9), lead (SW7, SW8, SW9), mercury (SW2) and nickel (SW2, SW7, and SW9). A summary of analytical results which exceed Federal or New Jersey Criteria is presented in Table 32.

The criteria that the inorganic surface water analytical results are compared to are a combination of New Jersey criteria designed to protect aquatic organisms and the federal Safe Drinking Water Act MCLs for human health risk. The New Jersey WPCA criteria are extremely low (less than 1 ppb) for cadmium, lead, and mercury. Analytical detection limits for these inorganics exceeded the WPCA criteria.

The highest levels of inorganic contamination were in the runoff samples SW7, SW8, and SW9. The concentrations of inorganics at the downstream sampling stations decrease as a function of distance from the SMC facility. The following elements exceeded the SDWA MCLs: antimony, arsenic, total chromium, lead, mercury, and nickel. Most of these elements were detected in the surface runoff samples (SW6-SW9); this indicates that the SMC facility may be a source for these contaminants. As stated above, concentrations tend to decrease downstream, as is indicated in Table 30d.

Stream Sediment Inorganic Results

Inorganic compounds were detected in all five (5) stream sediment samples. The following inorganic contaminants were detected at concentrations that exceeded New Jersey Soil Action Levels: antimony (SD2, SD3, SD4, and SD5), beryllium (SD1, SD2, SD3, SD4, and SD5), barium (SD2), total chromium (SD1, SD2, SD3, SD4, and SD5), lead (SD1 and SD2), mercury (SD2 and SD5), selenium (SD1), vanadium (SD1, SD2, SD3, SD4, SD5), zinc (SD2), and nickel (SD2, SD3, and SD4). A summary of analytical results which exceed NJDEP Action Levels is presented in Table 27.

The highest levels of inorganic contamination were detected in stream sediment sample SD2. This sampling station was located directly south of SMC facility (Figure 5). The high concentrations may be due to sediment runoff from the site. The concentrations of inorganics at the downstream sampling stations generally decrease as a function of distance from the SMC facility. The relatively high concentrations of antimony, beryllium, and chromium at sediment sampling station SD5 are of some concern, as this is the sampling station located the farthest downstream. There are no industrial facilities between sampling stations SD4 and SD5. An additional sediment sample is

recommended at sampling station SD5 to be analyzed for the same inorganic parameters as the first round, to confirm the presence of these inorganics at the detected levels.

4.2.1.5 Surface Water and Stream Sediment Summary

Surface water samples included five water samples collected from the Hudson Branch, as well as four runoff samples collected during a rainfall event from major drainage pathways (near their off-site discharge points). Volatile organic and semi-volatile organic compounds were detected in surface water samples, but at levels which do not exceed NJWPCA levels or federal MCLs. Pesticide/PCB compounds were not detected in surface water samples. As with the soil samples, inorganic contaminants were typically detected in surface water samples at levels exceeding regulatory action levels. Total chromium and lead levels (detected at maximum levels of 8,520 parts per billion [ppb] and 1,240 ppb, respectively) exceeded regulatory levels (50 ppb and 0.75 ppb, respectively) at seven sample locations each, beryllium (detected at a maximum level of 468 ppb) exceeded the regulatory level (5.3 ppb) at four sample locations, and nickel (detected at a maximum level of 618 ppb) exceeded the regulatory level (56 ppb) at three locations. The highest levels of inorganics were generally detected at runoff sample locations, with concentrations generally decreasing as a function of distance downstream of the SMC facility.

Five sediment samples were collected from the Hudson Branch. Volatile organic, semi-volatile organic, and pesticide/PCB compounds were detected in the samples, but at levels which do not exceed action levels. Again, inorganic compounds were commonly detected at levels exceeding action levels. Beryllium, total chromium and vanadium action levels (1 ppm, 100 ppm, and 100

ppm, respectively) were exceeded in each of the sediment samples. Antimony was detected in four of the five samples at levels greater than the action level of 10 ppm. In general, the highest levels of inorganics were detected in sediment sample SD02, which was collected south of the lagoon areas on the SMC facility. While inorganic concentrations generally decreased with distance downgradient of the SMC facility, a slight increase was observed in the sediment sample collected at the most downgradient sampling point (SD05).

4.3 Ground Water

In this section of the report an assessment of the Phase I ground water sample analytical results from both the December 1990 and April 1991 sampling events are presented. A total of fifty-two (52) ground water samples were collected during the first sampling event and thirty-nine (39) were collected during the second sampling event. A discussion of the sampling locations, the number of samples collected, and all field measurements and observations made during both ground water sampling events is presented in Section 2.6 of this report.

Summaries of the compounds detected in each ground water sampling event are presented in Tables 33 and 34. Summaries of analytical results exceeding New Jersey or EPA MCL criteria for each sampling event are presented in Tables 35 and 36.

4.3.1 Volatile Organic Compounds (VOCs)

Forty-five (45) ground water samples during the first sampling event and thirty-three (33) during the second sampling event were analyzed for TCL VOC+10. The results are presented in Tables 33a and 34a. Methylene chloride and acetone were detected in the majority of ground water samples. These

compounds were detected in most of the laboratory blanks and were thereby either negated or qualified. They are not considered in this interpretation.

December 1990 Ground Water Sampling Event (VOCs)

Volatile organic compounds were detected (excluding methylene chloride and acetone) in twenty-seven (27) of the forty-five (45) monitoring wells sampled for VOC analysis. An inspection of Table 33a and Figures 22 and 23 (TCE concentration contour maps) indicates the presence of TCE contamination in both the upper and lower Cohansey Sands across the site. TCE has a federal MCL of 5 ppb and a New Jersey MCL of 1 ppb; the New Jersey MCL was exceeded at twenty-five (25) locations (Table 35).

In the upper Cohansey Sand, TCE is detected over an area trending northeast to southwest across the site. Concentrations range as high as 120 ppb, with the highest levels detected in the Manufacturing Area of the site. As seen in Figure 22, TCE contamination detected in the shallow monitoring wells is centered around monitoring well SC20S. Monitoring well SC20S was installed where the Former Manpro-Vibra Degreasing Unit operated.

Based on the slight downward hydraulic gradient observed at the site, and ground water flow direction to the southwest, concentrations of TCE would be expected to be greater in the lower Cohansey Sand downgradient of the observed contamination in the upper Cohansey Sand. This predicted fate of TCE in the lower Cohansey Sand is reflected somewhat in the observed TCE concentrations in the deep wells. However, several anomalies in TCE concentrations in the lower Cohansey Sand were observed. An elevated TCE concentration (70 ppb) was detected at monitoring well SC22D. The source of this observed contamination is unknown at this time. No TCE was detected in adjacent shallow wells (SC22S or D, located approximately 100 feet east of SC22D).

A second anomaly in TCE concentration in the lower Cohansey Sand is observed at the location of well SC5D, where TCE was detected at a level of 330 ppb. This was the highest concentration of TCE detected in the upper and lower Cohansey Sand during the first sampling event. The source of this contamination is unknown. Inspection of Figure 23 indicates that the TCE contamination in the lower Cohansey Sand may be coming from a source northwest of SMC's 7.5 acre parcel in Vineland, NJ (an off-site source).

The following additional VOCs were detected during the first ground water sampling event: 1,1-dichloroethene (SC6S, SC20S, and K; potential source - degreasing unit), total 1,2-dichloroethene (SC2D, SC4S, SC5D, SC6S, SC11S, SC20S, and IW2; potential source - degreasing unit), 2-butanone (SC6S and SC18S; source unknown; from NW), 1,1,1-trichloroethane (SC4S, SC6S, and SC20S; potential source - degreasing unit), and 4-methyl-2-pentanone (SC18S; source - unknown; from NW). See Table 33a for detected concentrations.

A petroleum hydrocarbon release was detected in an Underground Storage Tank (UST) near Building 201. Samples collected from monitoring wells SC23S (installed 10 feet downgradient of the UST) and H (approximately 150 feet downgradient of the UST) exhibited benzene (65 ppb at SC23S), toluene (2000 ppb at SC23S and 1 J ppb at H), ethylbenzene (240 ppb at SC23S), and total xylene (810 ppb at SC23S and 2 J ppb at H). SMC has notified the NJDEP of the release and will submit an Underground Storage Tank Closure Plan for all three (3) USTs.

April 1991 Ground Water Sampling Event (VOCs)

Volatile organic compounds were detected (excluding methylene chloride and aretone) in twenty-three (23) of the thirty-three (33) monitoring wells sampled for VOC analysis. Inspection of Table 32a and Figures 24 and 25 (TCE

concentration contour maps) confirms the presence of TCE contamination in both the upper and lower Cohansey Sands across the site. The New Jersey MCL was exceeded at sixteen (16) locations (Table 35).

During the April sampling round, TCE was detected in the upper Cohansey Sand, again centered over the Manufacturing Area and, specifically, over the location of well SC20S. The concentration of TCE detected at well SC20S increased from 120 ppb to 840 ppb between sampling rounds. This increase in detected contaminant level, coupled with the absence of data for wells K and IWC2 (which exhibited 110 ppb TCE and 69 ppb in the December sampling round respectively), and the low concentration of TCE (2 ppb) detected in well B (located approximately 250 feet southeast of well K), resulted in the development of TCE concentration contours which differed from those developed on the basis of the December ground water monitoring results (see Figures 22 and 24). The April 1990 results do not indicate a single TCE plume but, rather, that two separate plumes may exist. The concentration of TCE in monitoring well SC1S, the most downgradient well sampled for VOCs, remained constant between sampling rounds (5 J ppb in April versus 4 J ppb in December).

The TCE concentration contour map developed on the basis of April ground water monitoring results for the lower Cohansey Sand indicates increases in TCE concentrations and a slight shifting of the contours. The TCE concentration at monitoring well SC22D decreased from the December (70 ppb) to April (35 ppb) sampling rounds, while the TCE level in the vicinity of monitoring well A increased from 23 ppb to 120 ppb. The shift in TCE concentrations between the two (2) ground water sampling events may be the result of a change in the ground water pumping schedule which occurred on January 21, 1991. The pumping rate and frequency at recovery wells W9 and RW6D (both screened in the lower Cohansey Sand) were increased and the pumping

rate at recovery well RIW2 (screened in the upper Cohansey Sand) was decreased. The pumping schedule change was initiated based on recommendations from DRAI following evaluation of December 1990 pump test results (DRAI, 1991). The effect of the new pumping strategy is apparent upon inspection of the December 1990 lower Cohansey Sand piezometric surface contour map (Figure 15) and the April 1991 lower Cohansey Sand piezometric surface contour map (Figure 17). The lower Cohansey Sand piezometric surface around recovery wells W9 and RW6D shows an increase in hydraulic gradient between the December 1990 and April 1991 ground water sampling event. The increased hydraulic gradient identified during the April 1991 ground water sampling event at deep recovery wells W9 and RW6D may be the cause of the decreased concentration of TCE detected at monitoring well SC22D and the increased concentration of TCE detected at monitoring well A.

The anomaly in TCE concentration detected at well SC5D was confirmed during the second round of sampling. The concentration increased from 330 ppb in December to 430 ppb in the April sampling round.

The following additional VOCs were detected during the April 1991 sampling event: 1,1-dichloroethene (SC6S; potential source - degreasing unit), total 1,2-dichloroethene (SC4S, SC5D, SC6S, and SC20S; potential source - degreasing unit), 2-Butanone (SC14S; source unknown; from north), 1,1,1-trichloroethane (SC4S and SC6S; potential source - degreasing unit), benzene (SC5D, SC20S, and SC23S; potential source - on-site UST), 4-methyl-2-pentanone (SC18D; source unknown; from northeast), tetrachloroethene (SC14S, SC15S, SC19S, SC19D, SC21S, SC21D, and SC22D; source unknown; from northeast), toluene (SC21D and SC23S; potential source - on-site UST), ethylbenzene (SC23S; potential source - on-site UST), and xylene (SC21D and SC23S; potential source - on-site UST).

4.3.2 Semi-Volatile Organic Compounds (SVOCs)

Ten (10) ground water samples during the first sampling event and two (2) during the second sampling event were analyzed for TCL semi-volatile organic compounds. The results are presented in Tables 33b and 34b. Di-n-butylphalate and bis(2-ethylhexyl)phthalate were detected in the some of ground water samples. These compounds are common field and laboratory contaminants and are not considered in this interpretation.

December 1990 Ground Water Sampling Event SVOCs

Excluding di-n-butylphalate and bis(2-ethylhexyl)phthalate, the only SVOC detected during the first sampling event was phenol in monitoring well G1S at an estimated (J) concentration of 1 ppb. No SVOCs exceeded New Jersey or federal MCL criteria during the first sampling event (Table 33b).

April 1991 Ground Water Sampling Event SVOCs

No SVOC contaminants were detected during the second sampling event except the common field contaminant bis(2-ethylhexyl)phthalate, detected at estimated (J) concentrations (Table 34b).

4.3.3 Pesticide/PCB Compounds

Ten (10) ground water samples collected during the first sampling event and two (2) samples collected during the second sampling event were analyzed for TCL Pesticide/PCB compounds. The results are presented in Tables 33c and 34c.

December 1990 Ground Water Sampling Event Pesticide/PCBs

No pesticide/PCB compounds were detected in any monitoring well sampled during the first sampling event; therefore no pesticide/PCB compounds were detected at levels exceeding New Jersey or federal MCL criteria (Table 33c).

April 1991 Ground Water Sampling Event Pesticide/PCBs

Due to laboratory error, the two samples (SC14S and SC20S) submitted for pesticide/PCB analysis were not analyzed before the holding times had been exceeded.

4.3.4 Inorganic Compounds

Fifty-two (52) ground water samples during the first sampling event and thirty-nine (39) during the second sampling event were analyzed for inorganic compounds. The results are presented in Tables 33d and 34d. Filtered and unfiltered ground water samples were collected from each monitoring well during the first sampling event and analyzed for TAL metals. Additionally, samples collected from fifteen (15) monitoring wells were analyzed for major cations and major anions. The major cation/anion data was used in conjunction with the Eh and pH data collected during both ground water sampling events to determine the valence state of chromium across the site. The data indicates that chromium exists primarily in a trivalent state across the SMC site. The Eh and pH data collected during the two ground water sampling events (Tables 17 and 18) have been plotted on Figure 34. Figure 34 is an electrochemical equilibrium diagram. This diagram indicates the expected valence state of chromium at a specific Eh and pH. Eh and pH information is available for 85 samples during the two sampling events. In 74 samples, the Eh/pH conditions indicated Cr^{+3} stability, lying within the CrO_2 (chromate ion) stability range. The remaining 11 samples showed conditions indicating Cr^{+6} stability, conducive to the formation of the CrO_4^{2-} ion. Three locations, SC6S, SC10S, and SC22D, showed Cr^{+6} stability for both sampling events; SC13S indicated Cr^{+6} stability for the first sampling event while Wells B and H indicated Cr^{+6} stability during the second ground water sampling event. See Appendix I for the a more detailed description of the results of the Eh/pH investigation.

December 1990 Ground Water Sampling Event Inorganics

Inorganic compounds were detected in all fifty-two (52) of the sampled monitoring wells. At all monitoring wells, filtered and unfiltered samples were collected (Table 33d) and analyzed for TAL metals. The following elements were detected at concentrations which exceeded New Jersey or federal MCL criteria: arsenic (3 monitoring wells), beryllium (3 monitoring wells), cadmium (1 monitoring well), total chromium (21 monitoring wells), mercury (3 monitoring wells), nickel (3 monitoring wells), lead (21 monitoring wells), antimony (12 monitoring wells), and selenium (2 wells). See Table 35 for a summary of elements in ground water exceeding federal and New Jersey MCL criteria.

Total Chromium/Hexavalent Chromium - Figures 26, 27, 30 and 31 indicate the distribution of total chromium and hexavalent chromium within the upper and lower Cohansey Sands, respectively.

The upper Cohansey Sand total chromium contour map (Figure 26) and the upper Cohansey Sand hexavalent chromium contour map (Figure 30) are similar in shape. Based on the concentration contours, two (2) potential sources of chromium appear to be the Lagoon Area and the By-product Storage Area. The chromium contamination extends to the southwest to a point between monitoring wells SC3S and SC1S.

The concentrations of total chromium within the lower Cohansey Sand are of greater magnitude than those within the upper Cohansey Sand. The lower Cohansey Sand TCE contour map (December 1990, Figure 23) and the lower Cohansey Sand total chromium contour map (Figure 27) are extremely similar in appearance. Both contour maps have concentration highs at monitoring well SC22D (see Table 33d).

A potential source of the total chromium level (108,000 ppb) at monitoring well SC22D is difficult to determine. The chromium concentrations at two (2) lower Cohansey Sand monitoring wells, SC13D (12.5 ppb) and SC12D (non-detected), both located upgradient from SC22D, do not indicate an upgradient source of the contamination. The Lagoon Area is located directly north of monitoring well SC22D, but if this area was acting as the primary source, then shallow monitoring wells SC22S (84.6 ppb) and D (45.3 ppb) should also exhibit higher concentrations of total chromium. One possible explanation for the lack of chromium in the shallow wells could be that the localized six to seven-foot silty-clay layer observed in monitoring wells SC22D, SC13D, and SC12D extends to the north, toward the lagoons, thereby forcing the chromium contaminated ground water below the localized confining layer. However, if this were the case, ground water being pumped from recovery wells W9 and Layne should induce a hydraulic gradient away from monitoring well SC22D. The lower Cohansey Sand hexavalent chromium contour map (Figure 31) indicates that these recovery wells are controlling the hexavalent chromium contamination (none detected in SC22D), and in fact, that the lagoon area appears to be a potential source of hexavalent chromium contamination. Since the ratio of total chromium to hexavalent chromium concentrations at monitoring well SC22D is much greater than at monitoring well A (located near the recovery well) (see Table 33d), the total chromium contamination at monitoring well SC22D appears to come from an unidentified source other than the Lagoon Area.

Lead - Concentrations of lead exceeded the NJDEP MCL in the upper Cohansey Sand at four (4) general locations. The four (4) areas include the location of background well W3S, which is downgradient of the former Newfield Municipal

Landfill, the Underground Storage Tank Area (monitoring wells SC15S, H and L), the Manufacturing Area (monitoring well G1S), and the Lagoon Area (monitoring wells F and D). The highest concentration of lead detected in the upper Cohansey Sand was 137 ppb at upgradient monitoring well W3S. The other three on-site areas had maximum concentrations of 102 ppb (monitoring well F), 84 ppb (monitoring well SC15S), and 75 ppb (monitoring well G1S). Three (3) off-site monitoring wells exceeded the NJDEP MCL in the upper Cohansey Sand: SC1S (11.8 ppb), SC6S (8 ppb), and SC19S (13.9 ppb).

Areas on-site where concentrations of lead in the lower Cohansey Sand exceeded the NJDEP MCL include the Manufacturing Area (monitoring well G2D at 262 ppb), Lagoon Area (monitoring wells SC22D at 19.4 ppb and IWC5 at 41.2 ppb), an upgradient well (W3D-6.7 ppb) and the on-site recovery well area (monitoring well A at 92 ppb). Two (2) off-site areas where lead exceeded the MCL include an area southwest of the SMC facility, near an existing car wash (monitoring well SC6D at 5 ppb) and an area within the 7.5 acre farm property owned by SMC in Vineland (monitoring wells SC3D at 16.2 ppb and SC5D at 10.9 ppb).

Antimony - Concentrations of antimony exceeded the NJDEP MCL in the upper Cohansey Sand, at four (4) areas of the SMC facility and at one (1) off-site location. The four (4) on-site locations include the Lagoon Area (monitoring wells F - 41.7 ppb and IWC2 - 102 ppb), recovery well area (monitoring well K - 152 ppb), Manufacturing Area (monitoring well G1S - 61.2 ppb and L - 396 ppb), and the By-products Storage Area (monitoring well SC12S - 95.7 ppb). The one (1) off-site area was located southwest of the SMC facility, near an existing car wash (monitoring well SC6S - 235 ppb).

Concentrations of antimony exceeded the NJDEP MCL in the lower Cohansey Sand at two (2) areas of the SMC facility and at two (2) off-site locations.

The two (2) on-site locations include the Lagoon Area (monitoring wells SC22D - 2,140 ppb and IWC5 - 26.9 ppb) and the recovery well area (monitoring well A - 671 ppb). The two off-site areas include the car wash area referenced previously (monitoring wells SC6D - 339 ppb, SC10D - 88.1 ppb and SC17D - 24.8 ppb) and an area within the 7.5 acre farm property owned by SMC in Vineland (monitoring wells SC2D - 11.7 ppb, SC4D - 258 ppb, and IW2 - 573 ppb). Generally, the concentrations of antimony are higher in the lower Cohansey Sand than the upper Cohansey Sand. The concentrations of antimony appear to mirror the chromium contamination plume.

The other elements that exceeded federal or New Jersey MCLs (Table 35) appear to follow the same contamination patterns as the chromium contamination. Due to the previous identification of chromium and sulfate contamination in the Lagoon Area, a comparison of hexavalent chromium and sulfate concentrations was made (Figures 28 and 29) but no correlation between hexavalent chromium and sulfate concentrations were found.

Comparing filtered and unfiltered metal data was difficult as results were not consistent. Generally, the concentrations of metal species decreased in the filtered samples. However, in numerous samples, metals concentrations were higher in the filtered sample than in the unfiltered sample.

April 1991 Ground Water Sampling Event Inorganics

Inorganic compounds were detected in all thirty-nine (39) of the sampled monitoring wells. The following elements were detected at concentrations which exceeded New Jersey or federal MCL criteria: arsenic (3 monitoring wells), beryllium (4 monitoring wells), cadmium (1 monitoring well), total chromium (17 monitoring wells), mercury (3 monitoring wells), nickel (1 monitoring well), lead (10 monitoring wells), and antimony (16 monitoring

wells). See Table 36 for a summary of elements in ground water exceeding federal and New Jersey MCL criteria.

Total Chromium/Hexavalent Chromium - The concentration of total chromium in the shallow monitoring wells decreased between December 1990 and April 1991. Monitoring well L had a total chromium concentration of 20,800 ppb during the December sampling event and a total chromium concentration of 7,960 ppb during the April sampling event. The concentration of total chromium at monitoring well SC6S dropped from 11,700 ppb to 5,190 ppb over the two sampling events. Comparison of Figures 26 and 28 indicate that, while the basic shape of the chromium contamination plume did not change, there was a significant decrease in total chromium concentrations.

Based on the concentrations of total chromium in the deep monitoring wells, chromium appears to have migrated downgradient between the December and April sampling events. As clearly seen in Figures 27 and 29, the major area of total chromium migration is located between monitoring wells SC22D and SC6D. At monitoring well SC22D, the total chromium concentrations decreased from 108,000 ppb in December to 60,000 ppb in April, while at monitoring wells A and SC6D, the total chromium concentrations increased from 29,500 ppb to 50,000 ppb and 16,300 ppb to 21,000 ppb, respectively. The concentrations of total chromium within monitoring wells SC4D, SC5D, and SC1D, all located southwest of monitoring well SC6D, remained unchanged between the two (2) sampling events (non-detected at SC1D and SC5D, 12,600 ppb at SC4D).

The shift in total chromium concentrations between the two (2) ground water sampling events may be the result of a change in the ground water pumping schedule which was implemented by SMC on January 21, 1991. The pumping rate and pumping frequency were increased at recovery wells W9 and

RW6D (both screened in the lower Cohansey Sand) and the pumping rate at recovery well RIW2 (screened in the upper Cohansey Sand) was decreased. The pumping schedule change was initiated based on recommendations developed by DRAI following evaluation of December 1990 pump test results (DRAI, 1991). The effect of the new sampling strategy is apparent upon inspection of the December 1990 lower Cohansey Sand piezometric surface contour map (Figure 15) and the April 1991 lower Cohansey Sand piezometric surface contour map (Figure 17). The lower Cohansey Sand piezometric surface between recovery wells W9 and RW6D shows an increase in hydraulic gradient between the December 1990 and April 1991 ground water sampling events. The increased hydraulic gradient may be the cause of the decrease in total chromium concentration detected at monitoring well SC22D and the increase in concentration of total chromium at monitoring wells A and SC6D.

Figures 30 and 32 present the shallow monitoring well concentration contour maps for hexavalent chromium during the December and April sampling events. The difference in the appearance of the hexavalent chromium plume between the December and April sampling events can be partially attributed to changes in the monitoring program, as presented in the Second Ground Water Sampling Work Plan (TRC, 1991), and specifically to the absence of monitoring wells F, IWC2, and K in the April sampling event. Generally, the concentrations of hexavalent chromium across the site followed the same pattern as the total chromium, and generally decreased from the December to the April sampling events.

Figures 31 and 33 present the deep monitoring well concentration contour maps for hexavalent chromium during the December and April sampling events. The difference in the appearance of the hexavalent chromium plume between the December and April sampling event can be partially attributed to changes in

the monitoring program, specifically the absence of monitoring wells SC2D, IW2 and IWC5 in the April sampling event. Generally, the concentrations of hexavalent chromium across the site followed the same pattern as the total chromium, and appeared to decrease from the December to April sampling events.

Lead - Concentrations of lead exceeded the NJDEP MCL in the upper Cohansey Sand in three (3) general on-site areas. These areas include the Manufacturing Area (monitoring well H - 14.8 ppb), Underground Storage Tank Area (monitoring well L - 43.5 ppb), and the pumping area in the southwest portion of the facility (monitoring well B - 47.6 ppb). Off-site, lead was detected in the upper Cohansey Sand at levels exceeding the MCL west and southwest of the facility at monitoring wells SC6S (14.8 ppb) and SC17S (6.3 ppb).

In the lower Cohansey Sand, concentrations of lead exceeding the NJDEP MCL were detected in the Lagoon Area (monitoring well SC22D - 24.4 ppb) and in the recovery well area in the southwest portion of the facility (monitoring well A - 19.5 ppb). Off-site, lead was detected in the lower Cohansey Sand at concentrations exceeding the NJDEP MCL west of the facility (monitoring well SC17D - 5.7 ppb) and in the southwest portion of SMC's 7.5 acre parcel located in Vineland (monitoring well SC1D - 7.3 ppb).

Because fourteen (14) of the monitoring wells included in the December 1990 sampling round were not resampled in the April sampling round, direct comparisons between lead concentrations for the two sampling rounds cannot be made in all areas of the facility. Upgradient wells W3S and W3D were not resampled in April so the presence of lead levels exceeding MCLs was not confirmed. For the upper Cohansey Sand in on-site areas, lead levels decreased slightly between rounds, with the greatest change measured at

monitoring well SC15S (84 ppb to 2.1 ppb). Off-site, lead levels increased slightly at monitoring wells SC6S (8 ppb to 14.8 ppb) and SC17S (non-detectable to 6.3 ppb). In the lower Cohansey Sand, concentrations varied between sampling rounds, with no significant trends. The concentrations of lead in monitoring wells SC22D, SC17D and SC1D increased, while lead concentrations in monitoring wells A and SC5D decreased between sampling rounds.

Antimony - Concentrations of antimony exceeded the NJDEP MCL in the upper Cohansey Sand in three (3) general on-site areas. These areas include the recovery well area (monitoring well B - 68.2 ppb), the Manufacturing Area (monitoring wells L - 165 ppb and H - 59.3 ppb), and the By-products Storage Area (monitoring well SC12S - 82.3 ppb). Off-site, antimony was detected in the upper Cohansey Sand at levels exceeding the MCL southwest of the SMC facility (monitoring wells SC6S - 122 ppb and SC10S - 66.2 ppb) and in the southwest portion of SMC's 7.5 acre parcel located in Vineland (monitoring wells SC1S - 19 ppb, SC4S - 41.2 ppb, SC24S - 19.8 ppb and IW1 - 26.9 ppb).

In the lower Cohansey Sand, concentrations of antimony exceeding the NJDEP MCL were detected in the Lagoon Area (monitoring well SC22D - 1340 ppb) and in the recovery well area in the southwest portion of the facility (monitoring well A - 68.2 ppb). Off-site, antimony was detected in the lower Cohansey Sand at concentrations exceeding the NJDEP MCL southwest of the facility (monitoring wells SC6D - 465 ppb and SC10D - 66.2 ppb) and further to the southwest, in the area of SMC's 7.5 acre parcel located in Vineland (monitoring wells SC1D - 45.7 ppb and SC4D - 272 ppb).

Because fourteen (14) of the monitoring wells included in the December 1990 sampling round were not resampled in the April sampling round, direct

comparisons between antimony concentrations for the two sampling rounds cannot be made in all areas of the facility. For the upper Cohansey Sand in on-site areas, antimony levels generally decreased slightly between rounds, with the greatest change measured at monitoring well L (396 ppb to 165 ppb). Off-site, antimony levels southwest of the facility decreased at monitoring well SC6S (from 235 ppb to 122 ppb), and increased slightly at monitoring well SC10S (from non-detectable to 29.1 ppb). Further southwest, in the area of SMC's 7.5 acre parcel, levels of antimony increased from non-detectable levels to 19 ppb at SC1S and 41.2 ppb at SC4S. In the lower Cohansey Sand, concentrations varied between sampling rounds. On-site, antimony levels decreased in the Lagoon Area (monitoring well SC22D - 2,140 ppb to 1,340 ppb) and increased in the recovery well area (monitoring well A - 671 ppb to 1,130 ppb). Off-site, increases in antimony concentration were detected at monitoring wells SC6D (339 ppb to 465 ppb) and SC4D (258 ppb to 272 ppb). A decrease in antimony concentration was detected at monitoring well SC10D (88.1 ppb to 66.2 ppb), however.

The other elements that exceeded federal or New Jersey MCLs (Table 36) appear to follow the same contaminant patterns as the total chromium contamination.

4.3.5 Ground Water Sample Summary

Two rounds of ground water sampling were conducted: the first in December 1990 and the second in April 1991. Sampling locations changed between sampling rounds, with 52 samples collected in the first round and 39 collected in the second round. In addition to the variations in the well locations sampled, the ground water extraction wells which are used for SMC's current ground water pump and treat system varied from one sampling round to the

next. Prior to the December sampling event, SMC was pumping primarily from recovery wells IW2 and SC6D. On January 21, 1991, SMC modified the pumping strategy to increase the extraction of ground water from the lower Cohansey Sand, including ground water extraction at wells RW6D and W9 and modification of extraction rates at wells RIW2 and SC6D. The modified pumping program could be partially accountable for variations in detected contaminant concentrations at monitoring wells between sampling rounds. Specifically, the addition of ground water extraction at the location of recovery well W9 could impact the contaminant concentrations detected at wells A and SC22D.

Volatile Organics - Trichloroethene (TCE) was the volatile organic compound most commonly detected at levels exceeding MCLs. In the first round, the MCL 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) are detected in the general location of the Former Manpro-Vibra Degreasing Unit. Lower levels (5 to 55 ppb) are 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) and to the southwest, with a "hot spot" detected in the northeast corner of SMC's 7.5 acre parcel (330 ppb). 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).

Other volatile organics were detected at levels exceeding MCLs at a much lower frequency (1 to 4 times per sampling round), including 1,1-dichloroethene, 1,2-dichloroethene (total), benzene, toluene, and xylene. In both rounds, benzene, toluene and xylene were detected in well SC23S, which was 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, indicating their presence may be associated with laboratory contamination.

Semi-Volatile Organics - No semi-volatile organic compounds were detected in either sampling round at concentrations exceeding MCLs.

Pesticide/PCBs - No pesticides/PCBs were detected in the first sampling round.

Inorganics - 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 and lead were the inorganics most commonly detected above MCLs during the first sampling round, while total chromium and antimony were most commonly detected above MCLs during the second sampling round. The major anion and cation analysis indicated that chromium exists primarily in a trivalent state in the ground water. Although some variability was found, comparison of filtered and unfiltered ground water sample analyses indicated that soluble inorganics are present in the ground water, with metals 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.

Total Chromium - During the first sampling round, total chromium was the inorganic most commonly detected at levels exceeding the MCL (100 ppb). Hexavalent chromium was also commonly detected, although no MCL has been established for hexavalent chromium. Total chromium was detected in the upper Cohansey Sand beneath the Manufacturing Area at concentrations ranging to 20,800 ppb in the first round, with concentrations generally decreasing to the southwest. An elevated concentration (11,700 ppb) was detected in a well located near the pumping wells, southwest of the facility. Lesser concentrations (1,180 ppb and 368 ppb) were detected further southwest of the pumping wells. In the second round of sampling, total chromium in the upper Cohansey Sand was detected at a maximum level of 7,960 ppb beneath the Manufacturing Area, ranging to 5,190 ppb in the area of the pumping wells. Total chromium levels did not extend as far to the southwest as they did in the first sampling round.

In the lower Cohansey Sand, total chromium levels ranged to 108,000 ppb, detected at a well located just south of the Lagoon Area. Concentrations decreased to the southwest, generally mirroring the southwestern extent of total chromium in the upper Cohansey Sand in the first sampling round, although detected levels of total chromium in these areas were higher in the lower sands (12,600 ppb and 26,400 ppb compared to 1,180 and 368 ppb). In the second sampling round, the maximum total chromium level was again detected south of the Lagoon Area (62,000 ppb). The southwestern extent of total chromium also mirrored that identified in the shallow sands, with concentrations in the lower sands (12,600 ppb) exceeding those detected in the upper sands (956 ppb).

Hexavalent Chromium - For hexavalent chromium in the upper Cohansey Sand, first round sampling results indicated the highest detected level (26,400 ppb) was located just west of the Lagoon Area, with a second area of elevated concentration (10,600 ppb) located west of the By-product Storage Area. The contaminant plume extends to the

southwest, but not to the same extent as total chromium was detected during the same sampling round. During the second sampling round, detected hexavalent chromium levels decreased in the By-product Storage Area (2,100 ppb). The wells located west and southwest of the Lagoon Area (IWC2, Layne and K wells) exhibiting elevated hexavalent chromium levels (26,400 ppb, 19,900 ppb and 15,100 ppb, respectively) in the first sampling round were not resampled during the second round; however, a well adjacent to the Layne well (well B) exhibited only 1,600 ppb hexavalent chromium during the second round. Hexavalent chromium levels downgradient to the southwest remained relatively constant in the second round, with the maximum detected concentration (13,000 ppb) located in the area of the pumping wells.

Hexavalent chromium in the lower Cohansey Sand was detected at the highest level (60,900 ppb) in the southwestern portion of the Undeveloped Plant Property, with concentrations extending to the southwest and increasing slightly at a well located in the northeast portion of SMC's 7.5 acre parcel. The southwest extent of the plume generally agrees with the extent of the total chromium plume determined during first round sampling. In the second round of sampling, the maximum level of hexavalent chromium (69,000 ppb) was detected south of the Lagoon Area, extending west and southwest, although not into SMC's 7.5 acre parcel. The extent of hexavalent chromium mirrors the extent of total chromium measured during the same sampling round.

Other Inorganics - Lead was detected in ground water at levels exceeding the MCL (5 ppb) 16 times during the first sampling round and 10 times during the second sampling round. The highest level of lead (137 ppb) was detected at an upgradient shallow well location (W3S). Shallow wells in the northwestern portion of the facility, near the locations of the Railroad Siding Area and Underground Storage Tanks also exhibited relatively high levels of lead (49 to 84 ppb). MCLs were also exceeded in wells screened within the lower Cohansey Sand, with concentrations generally decreasing to the southwest for both the lower and upper sands. Second round results generally confirmed the lead levels detected in the first round.

Antimony was detected in ground water at levels exceeding the MCL (10 ppb) 12 times during the first sampling round and 18 times during the second sampling round. During both sampling rounds, maximum levels (2,140 ppb and 1,340 ppb) were detected south of the Lagoon Area in well SC22D. A well located in the northeast portion of SMC's 7.5 acre parcel (IW2 - screened from 40 to 70 feet), which was sampled only during the first sampling round, exhibited 573 ppb antimony, indicating a potential localized area of contamination. A well located approximately 300 feet northeast of IW2, SC4D, exhibited antimony at 258 ppb during the first round and 272 ppb during the second round. Downgradient wells located to the southwest exhibited lesser concentrations of antimony (19 to 45.7 ppb), although these levels did exceed the MCL.

Other inorganics detected at levels exceeding their associated MCL at frequencies of 1 to 4 times per sampling round include arsenic, beryllium, cadmium, mercury, nickel, and selenium.

4.4 Air

In this section of the report, an assessment of the Phase I background air/dust monitoring analytical results from the twelve (12) sampling events is presented. A total of seventy-two (72) air/dust samples were collected during the twelve (12) weeks of sampling. A discussion of the sampling locations, the number of samples collected, and all field measurements and observations made during air/dust sampling events are presented in Section 2.7 of this report.

A summary of the detected compounds in all twelve (12) air/dust sampling events is presented in Table 37. A summary of analytical results exceeding established federal Acceptable Ambient Levels (AALs) for each sampling station is presented in Table 38. Table 39 presents the AALs used in the assessment of the data and their associated references. A copy of the laboratory data package prepared by Environmental Testing & Technologies, Inc., along with TRC sampling protocol, is presented in Appendix G.

The only metal species that exceeded a federal AAL was titanium at air monitoring station AM-3 (Table 38). Federal criteria were used because the NJDEP has not assigned site specific air criteria for metal species to the SMC facility.

Examination of the meteorological and chemical concentration data yields a consistent description of contaminant dispersion in the vicinity of the SMC facility. When considering near field dispersion of contaminants utilizing this type of data, there are certain relationships which need to be kept in mind. At low wind speeds, wind direction is typically extremely variable. This variability tends to make the average wind speed less meaningful and the contaminant concentrations tend to be uniformly distributed among the different sampling locations. Higher wind speeds are characterized by a more

consistent direction and will produce relatively higher concentrations at sampling locations within a narrow directional arc. Additionally, while higher wind speeds may allow more efficient entrainment of contaminant particulates, the concentrations of contaminant particulates will become more dilute due to enhanced mixing. Therefore, even though the amount of contaminant particulates entrained is high, the concentrations detected near the source may be much lower. Conversely, at low wind speeds, there may not be enough energy to entrain or 'lift' the contaminant particulates, therefore, the contaminant particulate emission rates may be low. Since there is little transport or dilution, however, the concentrations detected near the source may be high.

Despite these various, sometimes opposing considerations, the SMC data shows remarkable consistency between the meteorological and contaminant particulate concentration data. The highest concentrations are generally noted at downwind sites and the contaminant particulate concentration data indicates that the source areas for the various pollutants may not be exactly collocated and may vary based on site use.

The results of the air sampling program are discussed by sampling event below. Any anomalies detected within the analytical or meteorological data during any sampling event are identified.

November 4, 1990 - This day was characterized by low wind speeds from the southwest. The concentration data shows relatively uniform concentrations at all air monitoring stations due to low wind speeds. All of the air monitoring stations (excluding the background station AM-1) registered a maximum value for at least one pollutant. Many of the contaminant concentrations were below the minimum detection level of the instrument.

November 11, 1990 - This day shows the highest wind speed of the entire test period, with the hourly average wind speed for the day at 10.8 mph from the west. Of the ten (10) contaminants presented in Table 37b, eight (8) were detected at levels above instrument threshold. Of these eight (8), air monitoring station AM-5 had the

highest concentrations of four (4) of the contaminants (Mn, Ni, V and Zn). Air monitoring station AM-5 is located directly southwest of the Manufacturing Area. The wind direction of the five (5) highest wind speed hours (9 AM, 10 AM, 11 AM, 1 PM and midnight) all came from north of west. Thus the data indicates that the By-products Storage Area may not be the primary source of many of the pollutants detected on this day.

November 17, 1990 - This day is characterized by moderate northerly winds. Only three (3) contaminants (Al, Ti and Zn) were detected at concentrations above the lowest detectable levels (LDL) presented in Table 37c. These very low levels do not merit in-depth discussion. It is interesting that air monitoring station AM-3, located in the northeast corner of the SMC facility and therefore upwind from the facility on this day, had higher zinc concentrations than any other air monitoring station.

November 25, 1990 - This day is characterized by a moderate wind that shifted direction from east to west over the course of the day, with the dominant direction being from the southwest. Three contaminants (Cr, Mn and Zn) were detected at concentrations above the LDL during this sampling event. Two (2) of these contaminants (Cr and Mn) had their highest concentrations at air monitoring station AM-3, which would be expected given southwest winds (Table 37d). Air monitoring station AM-5, which was not downwind during the sampling event, recorded the highest concentrations of zinc. The high zinc concentrations at air monitoring station AM-5 demonstrate how the mean directional statistics can be misleading, as localized meteorological circumstances can cause substantial 'meandering' about the mean flow.

December 2, 1990 - This day is characterized by light and variable winds. As expected for this type of meteorology, the four (4) contaminants detected above LDLs during this sampling event (Cr, Mn, Ti and Zn) all show maximum concentrations at different air monitoring stations (Table 37e).

December 9, 1990 - This was a day of light to moderate winds, whose direction varied from the northwest during the early hours to the southwest during the later hours of the day. Five (5) contaminants (Cr+6, Cr, Mn, Ti and Zn) were detected above the LDL during this sampling event. The highest concentrations of four (4) of these contaminants (Cr+6, Mn, Ti and Zn) were detected at air monitoring stations located on the northeast perimeter of the facility (AM-2 and AM-3). The highest concentration of chromium was detected at air monitoring station AM-5 (Table 37f). It should be noted that due to the irregular shape of the facility, north-northwest winds would traverse part of the Manufacturing Area before arriving at air monitoring station AM-2. This could potentially account for the detection of the highest concentrations of hexavalent chromium and titanium at air monitoring station AM-2 during this sampling event.

December 16, 1990 - This day was characterized by moderate to strong westerly winds. Seven (7) of the ten (10) analytes were detected at concentrations above the LDL during this sampling event (Table 37g).

The highest concentrations of chromium, copper, and manganese were detected at air monitoring stations AM-3 and AM-4, located on the eastern edge of the facility. It is notable that the highest concentration of titanium was detected at air monitoring station AM-1, which was located upwind of most of the facility during this sampling event. The highest concentrations of the remaining three (3) contaminants (Cr^{+6}, Al, and Zn) were detected at air monitoring stations AM-2 and AM-5, which were located downwind of a large portion of the Manufacturing Area during a substantial part of the day. These results indicate that the Manufacturing Area may be an additional source for these contaminants.

January 6, 1991 - This day was characterized by extremely light winds of variable direction. Six (6) contaminants (Cr^{+6}, Cr, Pb, Mn, Ti, and Zn) were detected above the LDL. The highest concentrations of five (5) contaminants (Cr^{+6}, Pb, Mn, Ti, and Zn) were detected at air monitoring station AM-3 (Table 37h). On this day, the detected titanium level at air monitoring station AM-3 (362 nanograms per cubic meter or ng/m^3) exceeded the federal AAL (100 ng/m^3). Since the light winds were generally westerly, the detection of contaminants at air monitoring station AM-3 indicates that the By-products Storage area may be the source for many of the contaminants detected on this day.

January 13, 1991 - This day was characterized by moderate wind speeds from the west and northwest. There were five (5) contaminants (Cr^{+6}, Al, Mn, Ti, and Zn) detected at concentrations above the LDL (Table 37i). The highest concentrations of two of the detected contaminants (Mn and Zn) were detected at air monitoring station AM-1. Air monitoring station AM-1 was located upwind of the Manufacturing Area during this sampling event and was not expected to be strongly impacted. The highest concentrations of aluminum and titanium were detected at air monitoring station AM-3, which was located downwind of the By-products Storage Area during this sampling event. Again on this day, the detected level of titanium at air monitoring station AM-3 (132 ng/m^3) exceeded the federal AAL (100 ng/m^3).

January 20, 1991 - This date shows wide ranges in both wind speed and direction. Four (4) contaminants (Cr+6, Mn, Ti and Zn) were detected at concentrations above the LDL. The highest contaminant concentrations were distributed among 3 air monitoring stations. The only air monitoring station that had more than one (1) maximum contaminant concentration was AM-4, where the highest levels of titanium and zinc were detected (Table 37j). This sort of wide spatial variance is expected given these meteorological conditions.

January 27, 1991 - This day is characterized by low to moderate wind speeds, with wind directions varying from the southeast to southwest. Four (4) contaminants (Cr+6, Mn, Ti and Zn) were detected at concentrations above the LDL. The highest concentrations of titanium and manganese were detected at air monitoring station AM-1 (Table 37k). The highest concentration of hexavalent chromium was detected at air monitoring station AM-2, which would be expected based on the dominant wind direction.

February 3, 1991 - This day was characterized by a wide range of wind speeds with directions varying from southeast to southwest. During this sampling event the only contaminant detected at a concentration above the LDL was titanium at air monitoring station AM-4 (Table 371).

In summary, the variance in the locations of measured contaminant concentrations cannot be entirely explained by meteorological data. It is likely that the sources of the various contaminants are not collocated and that contaminant source locations within the By-products Storage Area change as a result of the continuing disposal of operational by-products in this area. In other words, variations in the source areas within the By-products Storage Area occur depending on the frequency of storage activities, storage locations and the types of materials stored in the area, and could account for variations in the results of the monitoring program. Inspection of the data also indicates that the Manufacturing Area may be a source of some of the particulates detected in the air monitoring program. It should be emphasized, however, that titanium was the only analyte which was detected at levels exceeding AALs, and that these detections occurred in only two (2) of the twelve (12) sampling events.

4.5 Quality Assurance/Quality Control (QA/QC)

The RI Phase I analytical program included two (2) QA/QC controls to provide a check of sampling techniques (including equipment decontamination and sampling methodology) and laboratory analysis. The sampling technique QA/QC check involved the collection and analysis of field blanks and trip blanks. A field blank was collected for each day of sampling and for each matrix that was sampled. A trip blank was provided by the laboratory (Weston Analytics) for each sample cooler containing samples that were analyzed for TCL VOC+10. The laboratory (Weston Analytics) analytical data was checked by

a partial validation of the data as well as through the comparison of analytical results for split samples. At least one (1) split sample was collected in conjunction with the NJDEP for each sample matrix, and analyzed by Nytest Environmental, Inc. of Port Washington, NY (Nytest).

4.5.1 Field Blank Results

Field blanks were collected at a rate of one (1) per day per matrix over the investigation period. There were three (3) different matrices sampled during the RI Phase 1 field activities: a) soil, which includes surface soil, test pits, soil borings, and stream sediment; b) surface water; and c) ground water.

The purpose of collecting field blanks is to determine if any contaminants detected in the samples from the different environmental matrices are the result of the improper decontamination of sampling equipment or are due to sampling techniques. A field blank is collected by passing certified analyte-free laboratory water over the sampling device and collecting the water into sample bottles. The analytical results for all the field blanks are presented in Tables 40 and 41.

4.5.1.1 Volatile Organic Compounds (VOCs)

Eleven (11) field blanks were collected during the RI field activities from October through December 1990 and two (2) field blanks were collected during the April ground water sampling event. All field blanks were analyzed for TCL VOCs. The only VOC contaminants detected, excluding common laboratory contaminants methylene chloride and acetone, were chloroform, 1,1,1-trichloroethane, trichloroethene, toluene, and tetrachloroethene, all at estimated (J) concentrations (Tables 40a and 41a).

4.5.1.2 Semi-Volatile Organic Compounds (SVOCs)

Eight (8) field blanks were collected during the RI field activities from October through December 1990 and one (1) field blank was collected during the April ground water sampling event. All field blanks were analyzed for TCL SVOCs. The only SVOC contaminant detected in any field blank was pentachlorophenol, detected in FB-1108 at an estimated (J) concentration of 2 ppb and bis(2-ethylhexyl)phthalate, detected in FB1-041691 at an estimated (JB) concentration of 2 ppb (Tables 40b and 41b).

4.5.1.3 Pesticide/PCB

Nine (9) field blanks were collected during the RI field activities from October through December 1990 and were analyzed for TCL pesticide/PCBs. The only pesticide/PCB contaminant detected in any field blank was 4,4-DDT, detected in FB-1114 at an estimated (J) concentration of 0.091 ppb (Table 40c).

4.5.1.4 Inorganics

Thirteen (13) field blanks were collected during the RI field activities from October through December 1990 and two (2) field blanks were collected during the April ground water sampling event. All field blanks were analyzed for TAL metals and other inorganic contaminants. The following elements were detected in field blanks: calcium, copper, iron, lead, magnesium, manganese, mercury, selenium, sodium, vanadium, zinc, boron, silver, total chromium, hexavalent chromium, and silicon. The majority of the elements were detected in soil boring and surface soil field blank samples. The decontamination process includes a 10% nitric acid wash, which may be the source of the metal species detected in these field blanks. No element was detected at concentrations greater than 625 ppb, and most concentrations were less than 100 ppb (Tables 40d and 41d).

4.5.2 Trip Blanks

A trip blank is provided with the sample containers by the laboratory (Weston Analytics) to determine if contamination detected in water samples is the result of exposure to VOC contaminants after the sample was collected (during the sample transport period). Trip blanks can also provide an indication of potential sample container contamination. If upon analysis of a trip blank (analyzed for TCL VOC+10 only) a contaminant is detected, then all water samples sent in that cooler would be considered suspect for the compounds detected within the trip blank. The analytical results for all the trip blanks are presented in Tables 41 and 42.

Nineteen (19) trip blanks were analyzed for volatile organic compounds. The only VOC contaminants detected in all the trip blanks were the common laboratory contaminants methylene chloride and acetone. Examination of Table 42 indicates that the trip blanks associated with the ground water samples collected on December 19, 1990 contained the following non-laboratory contaminants, all at estimated (J) concentrations: 1,1-dichloroethane, chloroform, and 1,1,1-trichloroethane. The following monitoring well samples, collected on December 19, 1990, also exhibited those contaminants: SC4S (1,1,1-trichloroethane at 1 J ppb), and SC20S (1,1-dichloroethane at 1 J ppb, and 1,1,1-trichloroethane at 3 J ppb). Examination of Table 41a indicates that a trip blank associated with water samples collected on April 16, 1991 contained the non-laboratory contaminant toluene at an estimated (J) concentration (2 J ppb). No toluene was detected at any monitoring well samples on April 16, 1991.

Trip blanks are evaluated as if they are field samples unless they contain TCL or non-TCL compounds not attributable to method blank contamination. If TCL or non-TCL compounds are detected in trip blanks and not found in the method blanks then the trip blank is evaluated as a method blank.

The only VOCs detected in a monitoring well sample and a trip blank on the same day were 1,1,1-trichloroethane and 1,1-dichloroethane which were detected in monitoring well samples SC4S and SC20S at concentrations less than three (3) times the concentration of these analyte in the trip blanks. Therefore, the presence of 1,1,1-trichloroethane and 1,1-dichloroethane in the samples are negated due to introduced contamination by trip blank.

4.5.3 Quality Assurance Review

The quality assurance review, performed by TRC personnel, included a review of two (2) major areas. Guidance for the review came from the following specification packages provided by the State of New Jersey Department of Environmental Protection.

- SOP for Completion of Data Validation Report Forms and the Preparation of the Final Data Validation Report.
- SOP for Analytical Data Validation of TAL-Inorganics
- SOP for the Quality Assurance Data Validation of Analytical Deliverables - TCL - Organics.

The two areas of review centered around sample holding times and method blank contamination. Each sample delivery group (SDG) was reviewed for compliance in these two areas. Sample qualifiers were placed on data based on criteria established in the above named specification packages.

The qualification of common laboratory contaminants such as acetone, 2-butanone, methylene chloride, and phthalate esters was accomplished using NJDEPE guidelines. If the blank contains detectable levels of common laboratory contaminants (up to three times the CRQL), then the sample results should be considered as positive, but qualified, results only if the concentrations in the sample exceed three times the maximum amount detected in any blank. If the sample concentration of a common laboratory contaminant is

less than three times the blank concentration, then list the value as negated. If a common laboratory contaminant in the blank is greater than three times the CRQL, the blank and associated samples for the particular analyte must be rejected.

On the other hand, if the blank contains detectable levels of one or more organic or inorganic chemicals that are not considered by NJDEPE to be common laboratory contaminants and the levels are greater than the CRQL, the analyte is rejected in all samples. Whereas, if the concentration of a non-common laboratory contamination of the blank is less than the CRQL, then the sample results should be considered as positive results only if the concentrations in the sample exceed three times the maximum amount detected in any blank.

The results of the quality assurance review are presented in Appendix H. Each sample delivery group (SDG) has been assigned a numerical ID by the laboratory. The quality assurance review is organized by analytical fraction and SDG ID number, in ascending order. For each of the volatile and semi-volatile SDG's, a narrative reviewing the holding time exceedances and method blank contaminants is provided. A single narrative is provided for each of the inorganics, Pesticides and PCBs, and Chromium IV fractions, including all applicable SDGs.

The overall findings of the quality assurance review are satisfactory.

The qualifiers used in the review of volatile and semi-volatile fractions were added to the data summary tables and their definitions are listed below.

U - Indicates compound was analyzed for but not detected.
J - Indicates an estimated value. This flag is used to indicate that the concentration is quantitatively qualified and the final result reported by the laboratory is considered to be an estimated value.
B - This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable blank contamination and warns the user to take appropriate action.

R - This flag is used when data does not meet quality assurance criteria and is rejected.
N - Data is flagged as negated when the concentration of the sample is less than three times the concentration value of the analyte found in the method blank.

The qualifiers used in the review of the inorganic fraction were added to the data summary tables and their definitions are listed below.

B - A concentration qualifier entered by the laboratory if the reported value is less than the Contract Required Detection Limit (CRDL) but greater than the Instrument Detection Limit (IDL). If the analyte was analyzed for but not detected, a "U" must be entered.
J - When holding time is greater than the required time but less than or equal to a ten day buffer then all results are quantitatively qualified with a "J".
R - Data is rejected due to lack of compliance with quality assurance criteria.

4.5.4 New Jersey DEP Split Samples

The State of New Jersey DEP split samples with TRC for all sampled matrices during the RI Phase I field work. The following samples were split with the NJDEP: surface soil samples RA-33 and RA-34, stream sediment samples SD-01 and SD-04, soil boring sample SB-77, surface water samples SW-01 and SW-04, and ground water sample SC19S. All split samples were collected by TRC personnel under the supervision of a NJDEP field auditor. Once the sample was collected, the NJDEP field auditor took custody of the sample and arranged shipment to Nytest.

A comparison of the split sample data is presented in Tables 43 through 47. Overall the split sample data compare favorably between the Weston and Nytest laboratories. The only metal specie that varied consistently in concentration was hexavalent chromium. The concentrations of all other elements were within an order of magnitude of each other. Volatile and semi-volatile organic data, excluding common laboratory and field

contaminants, were more varied. In general, if a compound was detected in one laboratory but not in the other laboratory, the compound was detected at an estimated (J) concentration (Tables 43 through 47).

4.6 Hexavalent Chromium Soil Analysis

The methodology used by Weston Analytics Laboratory of Lionville, PA. (Weston) for the analysis of hexavalent chromium in soils was a 24-hour cold water extraction method based on ASTM D3987-81. Hexavalent chromium measurements were performed colorimetrically following SW-846 Method 7196 for both waters and soil extracts.

On December 4, 1991 the NJDEP selected thirteen (13) soil samples for preparation method comparison. The NJDEP required that the thirteen (13) soil samples be reanalyzed by Method 3060, which is an alkaline digestion extraction process. The analytical results and data comparison were submitted to the NJDEP on December 20, 1990.

In a letter dated January 8, 1991 (NJDEP, 1991a), the NJDEP rejected the initial analysis, since the alkaline digestion was not conducted concurrently with the water leach extraction. Weston re-analyzed the thirteen (13) soil samples performing both methodologies concurrently and submitted the results to the NJDEP on January 18, 1991. The method comparison results are presented below:

	Cr^{6+} (mg/kg)		
	Average	S.D.	Range
Alkaline Digestion	5.8	+/-7.4	0.62-24.8
Water Extraction	3.8	+/-9.2	0.14-33.6

Little correlation (r=0.1131) exists between the two preparation techniques. On average, the concentrations detected by the Alkaline Digestion method were 2 mg/kg higher than the Water Extraction method.

Recoveries of the matrix spike/matrix spike duplicate (MS/MSD) for water extracts were 81/80% and 78/64%. For alkaline digests, using the same samples, the MS/MSD recoveries were low, 33/31% and 39/88%. Duplicates, analyzed as a measure of precision for two samples, were 0%/25% relative percent difference (RPD) for the water extract and 23%/17% RPD for the alkaline digests.

Also analyzed with this group of samples were spiked blanks, taken through the extraction process for both methods. Two species of chromium were used for the spikes, trivalent and hexavalent. Trivalent chromium was used to determine if any preparation processes oxidized this chrome species to the hexavalent form. For the hexavalent chromium blank spikes, recoveries were 107/103% on the water extract and 99/99% on the alkaline digests. For the trivalent chromium blank, spike recoveries as CR^{6+} were 0.3/0% on the water extracts and 6/5% on the alkaline digests. Additionally soil samples were spiked with trivalent chromium. The recoveries, as CR^{6+}, were 3% on the water extract and 12% on the alkaline digests. Both of the Cr^{3+} spiked blanks and samples exhibited a positive bias for hexavalent chrome.

The NJDEP responded to the results of the method comparison re-analyses in a letter dated February 13, 1991 (NJDEP, 1991b). In this letter, the NJDEP requested that all soil samples collected during the RI be re-analyzed using the Alkaline Digestion Method. An agreement was reached between TRC and the NJDEP that only samples with total chromium results greater than or equal to 100 mg/kg (New Jersey Action Level for Total Chromium) need to be re-analyzed using Method 3060. There were fifty-three (53) soil samples that exceeded that criteria. The analytical data for the re-analyses are presented in Table 48, and the comparison statistics between the original analysis and reanalysis are presented below:

	Cr^{6+} (mg/kg)		
	Average	S.D.	Range
Alkaline Digestion	15.4	+/-28.1	0.2-569
Water Extraction	5.59	+/-78.1	0.1-201

A better correlation (r=0.9789) between the two preparation techniques was obtained with a larger data base. On average, the concentrations detected by the Alkaline Digestion method were 10 mg/kg higher than the Water Extraction method. Excluding the two highest detected concentrations, the ranges in concentration would be closer to the first method comparison results.

The ratio of hexavalent chromium to total chromium in the soil samples was calculated for both methods. The average total chromium concentration of the soil samples was 943 mg/kg. Based on the average total chromium results for these samples, the average sample contains 1.6% Cr^{6+} via alkaline digestion versus 0.6% for the water leach.

5.0 SUMMARY AND CONCLUSIONS

This section presents a brief summary of the findings of the RI investigation conducted at the SMC facility, focusing on the nature and extent of contamination, and data limitations and recommendations for future work. A summary of contaminant fate and transport, and risk assessment will be presented in a separate document that will specifically address those two issues.

5.1 Summary

SMC (formerly Shieldalloy Corporation) has been operating the 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 metal, slag and other by-products. Raw materials have included oxides of chromium, columbium (niobium), boron, vanadium, calcium, aluminum metal, strontium metal, zirconium metal, steel, iron, nickel, silicon, magnesium, manganese, chrome and fluoride salts. Specific areas of concern were wastewater lagoons, underground storage tanks for gasoline and diesel fuel, and a titanium metal degreasing operation in use from 1965 to 1967.

The RI investigation was comprised of the following field activities: surface soil sampling, surface water and stream sediment sampling, test pit excavation and sampling, soil gas survey, soil boring drilling and sampling, pilot hole drilling and monitoring well installation, and ground water sampling.

5.1.1 Nature and Extent of Contamination

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 have been detected at levels significantly exceeding soil action levels in these areas are listed below:

- An area along the observed floodplain of 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).

The stream sediment and surface water samples collected from the Hudson Branch were primarily contaminated with inorganics. Few VOCs, SVOCs, or pesticides/PCBs were detected in any surface water samples. VOCs, SVOCs, and pesticides/PCBs were detected in the stream sediments but at levels less than NJDEP Soil Action Levels. Their source could not be determined. 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. 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 observed floodplain of the Hudson Branch.

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 upper plume, extending 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 potentially indicates a separate contaminant source from that contributing to the elevated TCE levels detected beneath 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 Pile. 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 Pile 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 Pile and the Manufacturing Area, as well as in the area near the Underground Storage Tanks and Railroad Siding. 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.

5.2 Conclusions

The Shieldalloy Metallurgical Corporation has been manufacturing metal alloys at the Newfield, New Jersey facility since 1955. Manufacturing activities as well as the deposition of slags and other by-products have resulted in the presence of inorganically contaminated soils across the site. The analytical results indicate that contamination is present within the soil, sediment, surface water, and ground water. The contamination detected at SMC is primarily inorganic. The ground water also exhibits VOC contamination, and many detected constituents exceed federal and New Jersey standards and guidance levels.

5.2.1 Data Limitations and Recommendations for Future Work

As a result of the quality assurance review of the sample analytical packages, some of the data for a particular matrix or sample were rejected or qualified. Chemical data was rejected if the holding time for the analysis was exceeded. Chemical data was qualified according to the NJDEP SOP for Completion of Data Validation Report Forms and the Preparation of the Final Data Validation Report, as described in Appendix H.

Prior to proposing additional investigations at the SMC facility, an evaluation of contaminant fate and transport mechanisms and a health and environmental risk assessment will be conducted to quantitatively and qualitatively assess the impacts of detected contaminant levels on human health and the environment. This information must be considered to more effectively determine where additional environmental data is needed to adequately characterize the site. Based on the information available at this point in time, potential sampling objectives can be preliminarily identified, as follows:

- Confirmation of increased TCE, total chromium, and beryllium contamination levels at the downstream sediment sample location SD-5;

- Definition of ground water quality in the lower Cohansey Sand in the general area of the Former Manpro-Vibra Degreasing Unit by installing a deep monitoring well (SC20D) next to SC20S;

- Definition of ground water quality in the area south of existing well SC22D, to confirm the capture zone of the existing recovery well pumping system, by installing a deep monitoring well between well SC22D and the Hudson Branch.

This Remedial Investigation combined with the human health risk assessment will provide risk-based criteria for developing cleanup objectives. Subsequent to this work effort, a Feasibility Study will be performed to determine cost-effective remedial strategies for the SMC Newfield site.

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