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SEP 27 2000

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Subject: Contract No. DE-AC13-96GJ87335 - *Final Site Observational Work Plan* for the  
Gunnison, Colorado, UMTRA Site

Dear Mr. Essig:

Enclosed are two copies of the *Final Site Observational Work Plan* for the Gunnison, Colorado, UMTRA site. This document is being provided as background information for your review of the Gunnison *Ground Water Compliance Action Plan*.

If you have any questions, please call me at (970) 248-7612.

Sincerely,

A handwritten signature in black ink, appearing to read "Donald R. Metzler", is written over the word "Sincerely,".

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Enclosures

cc w/o enclosure:  
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File GWGUN 1.1 (P. Taylor)

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**Final Site Observational Work Plan  
for the Gunnison, Colorado,  
UMTRA Project Site**

September 2000

Prepared by the  
U.S. Department of Energy  
Grand Junction Office



**UMTRA Ground Water Project**

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Grand Junction, Colorado

Project Number UGW-511-0010-02-000  
Document Number U0102400

Work Performed Under DOE Contract No. DE-AC13-96GJ87335

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## Acronyms and Abbreviations

ACL	alternate concentration limit
AEC	U.S. Atomic Energy Commission
AFO	amorphous ferric oxyhydroxide
ASTM	American Society of Testing Materials
BCF	bioaccumulation factors
bgs	below ground surface
BLRA	Baseline Risk Assessment
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	U.S. Code of Federal Regulations
cfs	cubic feet per second
cm	centimeter(s)
COC	constituents of concern
COPC	constituent(s) of potential concern
DOE	U.S. Department of Energy
EA	environmental assessment
EC	electrical conductivity
E-CPOC	ecological constituents of potential concern
EHPA	ethylhexyl phosphoric acid
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
ESL	Environmental Sciences Laboratory
FONSI	finding of no significant impact
FR	Federal Register
ft	foot (feet)
ft/day	foot (feet) per day
ft <sup>2</sup> /day	square feet per day
g	grams
gal	gallon(s)
gal/day	gallons per day
GCAP	Ground Water Compliance Action Plan
GJO	Grand Junction Office
gpm	gallons per minute
HCl	hydrochloric acid
HI	hazard index
HQ	hazard quotient
ICs	institutional controls
<i>K<sub>d</sub></i>	distribution coefficient
kg	kilogram(s)
kW-hr	kilowatts per hour
L	liter
L/s	liter(s) per second
lb	pounds
LTMP	Long-Term Management Plan
LTSP	Long-Term Surveillance Plan
MAP	management action process
MCL	maximum concentration limit

m	meter(s)
µg/L	micrograms per liter
µm	micrometer(s)
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mL	milliliter
mL/g	milliliters per gram
mL/min	milliliters per minute
mm	millimeter(s)
mV	millivolts
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NRC	U.S. Nuclear Regulatory Commission
O&M	operation and maintenance
ORNL	Oak Ridge National Laboratory
ORP	oxidation-reduction potential
pCi/g	picocuries per gram
pCi/L	picocuries per liter
PEIS	Programmatic Environmental Impact Statement
PVC	polyvinyl chloride
RAP	Remedial Action Plan
RBC	risk-based concentration
RO	reverse osmosis
ROD	record of decision
rpm	revolutions per minute
RRM	residual radioactive material
SDWA	Safe Drinking Water Act
SEE	Site Environmental Evaluation (database)
SOWP	Site Observational Work Plan
TAGR	Technical Approach to Ground Water Restoration
TDS	total dissolved solids
UCL <sub>95</sub>	95 percent upper confidence limit
UMTRA	Uranium Mill Tailings Remedial Action (Project)
UMTRCA	Uranium Mill Tailings Radiation Control Act
U.S.C.	United States Code
USGS	U.S. Geological Survey

## Executive Summary

Uranium ore was processed from 1958 through 1962 at the Gunnison site located 0.5 mile southwest of the City of Gunnison in Gunnison County, Colorado. Contaminated materials were removed from the millsite from 1992 through 1995 and stabilized in a disposal cell 6 miles east of Gunnison.

Ground water occurs under unconfined conditions in the alluvial aquifer (uppermost aquifer) with an average depth to the water table of 5 feet (ft). The alluvium is composed of poorly sorted sediments ranging from clay-sized material through gravel with cobbles and occasional boulders. The thickness of the alluvium ranges from 70 to 130 ft. Ground water in the alluvial aquifer generally flows to the southwest with an average gradient of 0.005. Hydraulic conductivity ranges from 100 to 170 ft/day. Ground water in the alluvial aquifer system is recharged by precipitation, flood irrigation of the pasture downgradient from the site, and irrigation of the golf course and residential areas southwest of the site. Ground water is discharged naturally to adjacent streams and by the gravel pit dewatering operations south of the site.

Ground water in the alluvial aquifer beneath and downgradient from the Gunnison site was contaminated by uranium processing activities. Uranium is the primary constituent of potential concern (COPC) in ground water because concentrations exceed 1.0 milligram per liter (mg/L) beneath the site and exceed the uranium maximum concentration limit (MCL) of 0.044 mg/L to approximately 1,000 ft downgradient from the site boundary beneath the adjacent gravel mining operation. Concentrations of uranium in ground water below the MCL, but above background, extend approximately 7,000 ft downgradient from the site boundary and have migrated beneath the Gunnison River just beyond the confluence with Tomichi Creek. The zone of contamination attenuates and migrates downward as it progresses laterally. Manganese is also a COPC in ground water with elevated concentrations beneath the site (there is no MCL for manganese). Manganese does not appear to be widespread in the aquifer and concentrations beneath the site are decreasing.

To achieve compliance with Subpart B of 40 CFR 192, the DOE proposed action is natural flushing in conjunction with institutional controls (IC) and continued monitoring. Ground water flow and transport modeling has predicted that site-related concentrations of uranium in ground water in the uppermost aquifer beneath and downgradient from the site will decrease to below the MCL within 100 years. ICs will be maintained and verified during the flushing period. This compliance strategy will be protective of human health and the environment.

ICs are in place on the former millsite through deed restrictions that became effective when the State of Colorado transferred ownership to Gunnison County in December 1999. The restrictions prohibit use of contaminated ground water and control excavation of contaminated soil. Gunnison County owns the water distribution system that provides drinking water to the entire area potentially affected by site-related contaminants. This system was funded by the U.S. Department of Energy (DOE) and the Colorado Department of Public Health and Environment (CDPHE) in 1994 to mitigate any risk associated with ingestion of contaminated ground water from the alluvial aquifer downgradient from the site. DOE is working with Gunnison County to formalize a requirement that all current and future residents in the area connect to the system. This requirement will become an enforceable administrative IC by means of a county ordinance. Any future water resource needs in the area will be regulated by Gunnison County.

There are no unacceptable risks to human health and the environment associated with current and projected conditions in the vicinity of the Gunnison site as long as ICs can be maintained. Current use of ground water at the Valco, Inc. operation presents no unacceptable risk. Consequently, the proposed compliance strategy of natural flushing in conjunction with institutional controls and continued monitoring will be protective of human health and the environment.

Monitoring of ground water and surface water will be implemented during the period of natural flushing to verify modeling results, ascertain that concentrations of uranium in ground water are decreasing, and ensure protection of human health and the environment. COPCs to be analyzed in ground water include uranium and manganese. General water quality indicators including alkalinity, conductivity, pH, total dissolved solids, sulfate, and temperature will also be determined during sampling. Monitoring will take place on an annual basis for the first 10 years (through 2010) and every 5 years thereafter until completion of natural flushing. At the end of 10 years an evaluation will be made in consultation with NRC and the State of Colorado to determine the need and timing for future monitoring at the site. Criteria for modifying or terminating the monitoring program will be decrease of uranium and manganese concentrations in ground water and continued protection of human health and the environment.

## 1.0 Introduction

### 1.1 Purpose and Scope

The Gunnison Uranium Mill Tailings Remedial Action (UMTRA) Project site is a former uranium-ore processing facility located approximately 0.5 mile southwest of the City of Gunnison in Gunnison County, Colorado (Figure 1-1). The site is situated on an alluvial terrace between the Gunnison River and Tomichi Creek.

The U.S. Department of Energy (DOE) completed surface remediation of abandoned uranium mill tailings and other contaminated surface residual radioactive material (RRM) associated with the former milling operation at the site by relocating the contaminated materials to a disposal cell approximately 6 miles east of the Gunnison processing site. Surface remedial action began in 1992 and was completed in 1995. The former processing site is currently covered and re-graded with clean fill material and re-seeded with range grasses.

DOE's goal is to implement a cost-effective ground water compliance strategy at the Gunnison processing site that is protective of human health and the environment. This Site Observational Work Plan (SOWP) documents the site-specific strategy that will allow DOE to comply with EPA ground water standards at the Gunnison site and provides a mechanism for stakeholder participation, review, and acceptance of the recommended remedial alternative. The SOWP is based on UMTRA Project programmatic documents mentioned in Section 1.2. After initial assessment of site characterization information, it was decided to use an abbreviated *Summary of Site Conditions and Work Plan* (DOE 1999f) instead of the traditional SOWP Rev. 0 because the magnitude of additional work required was thought to be relatively minor. This has expedited the process and led directly to this final version of the SOWP.

Compliance requirements for meeting the regulatory standards at the Gunnison site are presented in Section 2.0. Site background information, including physical setting, current water and land use, and an overview of the history of the former milling operations and surface remedial activities is reviewed in Section 3.0. A summary of 1999 field investigations is presented in Section 4.0. Site-specific characterization of the physical system and contaminant configuration are synthesized in the conceptual site model in Section 5.0. Assessment of human health and ecological risk is provided in Section 6.0. The process for selecting the ground water compliance strategy is presented in Section 7.0, along with information on institutional controls and monitoring activities.

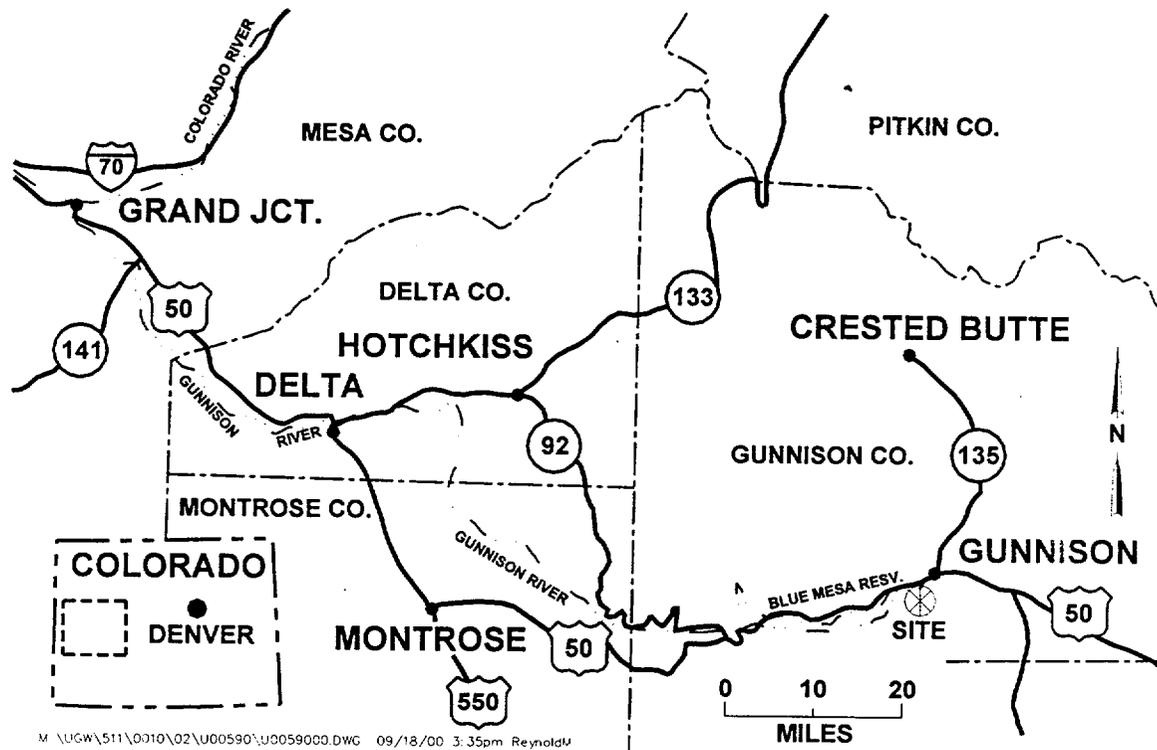


Figure 1-1. Gunnison Site Location Map

## 1.2 UMTRA Project Programmatic Documents

Programmatic documents that guide the SOWP include the *UMTRA Ground Water Management Action Process* (MAP) (DOE 1998), the *Final Programmatic Environmental Impact Statement for the Uranium Mill Tailings Remedial Action Ground Water Project* (PEIS) (DOE 1996b), and the *Technical Approach to Ground Water Restoration* (TAGR) (DOE 1993b). The MAP states the mission and objectives of the UMTRA Ground Water Project and provides a technical and management approach for conducting the project. The PEIS is the programmatic decision-making framework for conducting the UMTRA Ground Water Project. DOE will follow PEIS guidelines to assess the potential programmatic impacts of the Ground Water Project, to determine site-specific ground water compliance strategies, and to prepare site-specific environmental impact analyses more efficiently. Technical guidelines for conducting the ground water program are presented in the TAGR.

## 1.3 Relationship to Site-Specific Documents

The surface Remedial Action Plan (RAP) (DOE 1992b) provides early site characterization information. This information has been updated in developing this version of the SOWP to strengthen the conceptual site model. After a ground water compliance strategy is selected for the site, a Ground Water Compliance Action Plan (GCAP) will be prepared to document the remediation decision. The GCAP will be the concurrence document for compliance with Subpart B of 40 CFR Part 192 for the Gunnison uranium-ore processing site and will provide details of the required ground water monitoring program.

Subpart B of 40 CFR Part 192 for the Gunnison uranium-ore processing site and will provide details of the required ground water monitoring program.

A Baseline Risk Assessment (BLRA) (DOE 1996a) was prepared that identified potential public health and environmental risks at the site. Potential risks identified in the BLRA are considered and updated in this SOWP to ensure that the proposed compliance strategy is protective of human health and the environment.

After the proposed compliance strategy is identified in the SOWP and described in the GCAP, a site-specific National Environmental Policy Act (NEPA) document (e.g., an environmental assessment [EA]) will be prepared to determine any potential effects of implementing the proposed compliance strategy.

Since most of the contaminated materials and RRM were removed from the processing site and stabilized off site, the Long-Term Surveillance Plan (LTSP) required as part of the licensing agreement for disposal sites is not applicable. When DOE relocated RRM, the original processing site was cleaned up to meet EPA standards. The U.S. Nuclear Regulatory Commission (NRC) did not license the processing site or require an LTSP (Statements of Consideration for 10 CFR Part 40, April 30, 1992). In lieu of the LTSP, DOE will prepare a Long-Term Management Plan (LTMP), which will also contain the information on ground water monitoring and specify all other long-term surveillance activities and reporting requirements necessary for the site. The LTMP will be a stand-alone document to guide long-term surveillance activities at the Gunnison processing site.

Information for the SOWP is primarily derived from existing documents, the UMTRA Site Environmental Evaluation (SEE-UMTRA) database and from data in the UMTRA Project files. Local officials in the Gunnison area, along with regulatory entities, were consulted during preparation of this document.

End of current text

## 2.0 Regulatory Framework

A ground water compliance strategy is proposed for the Gunnison Site to achieve compliance with EPA ground water standards applicable to Title I UMTRA Project sites. This section identifies the requirements of the Uranium Mill Tailing Radiation Control Act (UMTRCA), the EPA ground water protection standards promulgated in 40 CFR Part 192, NEPA, and other regulations that are applicable to the UMTRA Ground Water Project.

### 2.1 Federal Regulations

#### 2.1.1 Uranium Mill Tailings Radiation Control Act

The U.S. Congress passed UMTRCA (42 U.S.C. §7901 *et seq.*) in 1978 in response to public concerns about the potential health hazards from long-term exposure to uranium mill tailings. UMTRCA authorized DOE to control, stabilize, and dispose of mill tailings and other contaminated materials at former uranium-ore processing sites.

UMTRCA has three titles that apply to uranium-ore processing sites. Title I designates 24 inactive processing sites to undergo remediation. Title I authorizes EPA to promulgate standards and mandates remedial action in accordance with those standards. This Title also directs remedial action to be selected and performed with the concurrence of the NRC in consultation with states and Indian tribes, authorizes DOE to enter into cooperative agreements with the affected states and Indian tribes, and directs NRC to license the disposal sites for long-term care. Title II applies to active uranium mills, and Title III applies to specific uranium mills in New Mexico. The UMTRA Ground Water Project has responsibility for administering only Title I of UMTRCA.

In 1988, Congress passed the Uranium Mill Tailings Remedial Action Amendments Act (42 U.S.C. 7901 *et seq.*) authorizing DOE to extend without limitation the time needed to complete ground water remediation at the processing sites.

#### 2.1.2 EPA Ground Water Standards

UMTRCA requires that EPA promulgate standards for protecting public health and the environment from hazardous constituents associated with processing uranium ore and the resulting RRM. On January 5, 1983, EPA published standards in 40 CFR Part 192 for the cleanup and disposal of RRM. The standards for ground water compliance were revised, and a final rule was published on January 11, 1995 (60 FR 2854), and codified in 40 CFR Part 192.

The standards in 40 CFR 192.02 (c)(1) require that the Secretary of Energy determine which of the constituents listed in Appendix I to Part 192 are present in or reasonably derived from RRM. Those standards also require the Secretary to determine the areal extent of ground water contamination by listed constituent. Section 5.0 of this document complies with these requirements and identifies the constituents of potential concern (COPC) at the Gunnison processing site.

The standards for cleanup address two ground water contamination scenarios. The first scenario addresses ground water contaminated as a result of RRM associated with disposal cells. Future protection of ground water at the disposal sites is being monitored as part of the Long-Term

**Surveillance and Maintenance Program.** The second scenario addresses ground water contaminated as a result of RRM in the uppermost aquifer at the former processing site. The UMTRA Ground Water Project addresses this ground water contamination and is regulated by Subparts B and C of 40 CFR Part 192.

#### 2.1.2.1 Subpart B: Cleanup Standards

The regulations allow the option of complying with four general standards. Three are numerical standards and are set forth in 40 CFR 192.02(c)(3) as follows:

*Background level*—Concentrations of constituents in the uppermost aquifer in an area that were not affected by ore-processing activities.

*Maximum Concentration Limit (MCL)*—EPA defined maximum concentrations for certain hazardous constituents in ground water and are specific to the UMTRA Project. The MCLs for inorganic constituents that apply to UMTRA Project sites are given in Table 1 to Subpart A of 40 CFR Part 192.

*Alternate Concentration Limit (ACL)*—An ACL may be applied to a hazardous constituent if it does not pose a substantial present or future risk to human health or the environment, as long as the limit is not exceeded. An ACL may be applied after considering options to achieve background levels and MCLs.

Subpart B of the EPA standards may also be met through natural flushing within an extended period not to exceed 100 years if (1) the concentration limits are projected to be satisfied at the end of this extended period, (2) institutional controls are in place which will effectively protect human health and the environment and satisfy beneficial uses of ground water during the extended period, and (3) the ground water is not currently and is not now projected to become a source for a public water system subject to provisions of the Safe Drinking Water Act during the extended period (40 CFR 192.12(c)(2)).

#### 2.1.2.2 Subpart C: Implementation

Subpart C provides guidance for implementing methods and procedures to reasonably ensure that standards of Subpart B are met. Subpart C requires that the standards are met on a site-specific basis using information gathered during characterization and monitoring. The plan for implementation must be stated in a site-specific GCAP and must contain a continued monitoring program, if necessary.

*Supplemental Standards*—DOE may, with NRC concurrence, apply a fourth option to contaminated ground water. Supplemental standards may be applied if any one of the following criteria is met as set forth in 40 CFR 192.21:

- (a) Remedial actions required to satisfy Subpart A or B would pose a clear and present risk of injury to workers or members of the public.
- (b) Remedial actions to satisfy the standards for land and ground water would directly produce health and environmental harm that is clearly excessive compared to the health and environmental benefits, now or in the future.

- (c) The estimated cost of remedial action is unreasonably high relative to the long-term benefits, and the RRM does not pose a clear present or future hazard.
- (d) The cost of remedial action for cleanup of a building is clearly unreasonably high relative to the benefits.
- (e) There is no known remedial action.
- (f) The restoration of ground water quality is technically impractical from an engineering perspective.
- (g) The ground water is considered of limited use and meets the criteria of §192.11(e).
- (h) Radionuclides other than radium-226 and its decay products are present in sufficient quantity and concentration to constitute a significant hazard from RRM.

### 2.1.3 Cooperative Agreements

UMTRCA requires that compliance with ground water standards be accomplished with the full participation of the states and Indian tribes on whose lands uranium mill tailings (RRM) are located. Section 103(a) of UMTRCA directs DOE to enter into cooperative agreements for remedial actions with the states and tribes. DOE has a cooperative agreement with the State of Colorado that covers ground water activities at the Gunnison Site.

### 2.1.4 National Environmental Policy Act

The UMTRA Project is a major federal action that is subject to the requirements of NEPA. DOE NEPA regulations are codified in 10 CFR Part 1021, "National Environmental Policy Act Implementing Procedures." Pursuant to NEPA, DOE finalized a PEIS (DOE 1996b) for the UMTRA Ground Water Project to analyze potential effects of implementing the alternatives for ground water compliance at the UMTRA Project processing sites. A Record of Decision (ROD) was published in April 1997 in which DOE's preferred alternative was selected based on the information available at the time. This ROD gave DOE the option of implementing one or a combination of the following compliance strategies:

- No ground water remediation
- Natural flushing
- Active ground water remediation

A Gunnison site-specific EA will be prepared to recommend the preferred remediation alternative and to address all environmental issues associated with the selected alternative.

### 2.1.5 Other Federal Regulations

In addition to EPA ground water standards and requirements of NEPA, DOE must comply with presidential executive orders, such as those related to pollution prevention and environmental justice, that may be relevant to the work being performed. Other federal regulations include those that require protection of wetlands and floodplains, threatened and endangered species, and cultural resources.

## 2.2 DOE Orders

A number of environmental, health and safety, and administrative DOE orders apply to the work being conducted under the UMTRA Ground Water Project. DOE orders prescribe the manner in which DOE will comply with federal and state laws, regulations, and guidance, and will conduct operations that are not prescribed by law. DOE guidance for complying with federal, state, and tribal environmental regulations is provided in the DOE Order 5400.1 series, which is partially superseded by DOE Order 231.1. DOE Order 5400.5 requires public protection from radiation hazards. DOE guidance for NEPA compliance is provided in DOE Order 451.1, and specific guidance pertaining to EAs is provided in *Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements* (DOE 1993a).

## 2.3 State Regulations

DOE must comply with state regulations where federal authority has been delegated to the State of Colorado. These include compliance with Colorado permits required for monitor wells (drilling, completing, and decommissioning), water discharge, and waste management.

## 3.0 Site Description

The Gunnison processing site has been investigated by DOE since 1983 (DOE 1992b and 1996a). Ground water conditions have been characterized by installing monitor wells on site, upgradient, and downgradient from the site. Monitor wells have been clustered at a number of locations to characterize the alluvium and site-related contamination in ground water at different depths. Most of the monitor wells still exist and have recently been sampled to provide information for this document. Additional information on the geology of the area, uranium deposition, and uranium processing at the Gunnison site are available from the literature (see reference list).

### 3.1 Physical Setting and Climate

The Gunnison site is on a 61.5-acre tract of land between the Gunnison River and Tomichi Creek, just southwest of the Gunnison city limits, Gunnison County, Colorado (Plate 1 and Figure 3-1). The site was backfilled with clean soil and graded after surface remediation and is currently covered with native grasses. The elevation at the site is approximately 7,635 feet (ft), and surrounding mountains rise above 12,000 ft. Higher elevations in the area are forested on the north and east sides, and lower elevations on the south and west sides are covered with brush and grass.

Gunnison receives an average annual precipitation of 10.5 inches (maximum precipitation in July and August) and an annual average snowfall of 54 inches. Winds blow predominately from the west and northwest. Average monthly temperatures range from a low of 9 °F in January to a high of 62 °F in July.

### 3.2 Land and Water Use

#### 3.2.1 Land Use

The former uranium-ore processing site was previously owned by private companies and later acquired by the State of Colorado, who then deeded the property to Gunnison County in December 1999 (Appendix I). A fence surrounds most of the site, except in the southeast corner, where it is readily accessible to the public. Eleven DOE monitor wells remain on the site (Figure 3-2). The site is not currently being used except for a small fenced storage yard near the south end maintained by Gunnison County. The existing fenced area does not include all of the original site. The north part of the site has already been deeded to Gunnison County for expansion of the airport and is behind the airport fence (Plate 1).

The site is bordered on the north and east by Gold Basin Road (County Road 38) and the Gunnison County Airport. An active gravel-mining operation owned by Valco, Inc. bounds the site to the south. Commercial and residential property bounds the site to the west. Valco, Inc. also owns most of the large pasture area southwest of the processing site, which is currently being used for livestock grazing and crop growing. This property will eventually be mined for gravel or developed as a residential area. The Dos Rios subdivision and golf course is west and southwest of the site and began development approximately 20 years ago along the North and South Forks of the Gunnison River. The subdivision is still under development.

The Gunnison County Public Works Department is interested in developing a portion of the site for maintenance shops, offices, and yard space to store snow removal and other equipment. Other future uses are under consideration. The deed restrictions (Appendix I) prohibit use of contaminated ground water and control excavation of contaminated soil beneath the site. The Gunnison County land-use planning procedures and resolutions will control potential development of the site and adjacent land.

### 3.2.2 Ground Water Use

There is no current use of alluvial ground water beneath the former processing site. Any potential future use of ground water offsite will be subject to Gunnison County institutional controls.

In the past, ground water from the alluvial aquifer has been the principal source of water for drinking and domestic use in the vicinity of the processing site. Numerous private domestic wells in the shallow alluvial aquifer have been used by residents and homeowners in the Dos Rios subdivision and area surrounding the site for drinking, irrigation, and livestock water. These wells are generally less than 30 ft in depth.

Results of ground water sampling downgradient from the former processing site during July through October 1990 indicated that 22 domestic wells contained concentrations of uranium, manganese, cadmium, and lead-210 (a decay product of uranium) in excess of background levels. Most of these wells were located in the Dos Rios subdivision and screened in the shallow alluvial aquifer. Since the elevated levels were related to uranium processing activities at the site, DOE assumed responsibility and began supplying bottled water to those residences in August 1990. DOE also investigated funding a permanent water supply system for this area (DOE 1991). An environmental assessment was prepared for the provision of the proposed water supply system and a Finding of No Significant Impact (FONSI) was issued in 1991 (DOE 1991). Construction of the water supply system occurred from 1992 to 1994, and approximately 5 miles of pipeline, mostly within the Dos Rios subdivision, was constructed at a cost of \$6 million. Per the cooperative agreement, DOE supplied 90 percent of the funding and the State of Colorado provided the remainder. By July 1994, most residents had hooked up to the alternate water supply system and the facility was turned over to the Gunnison County Public Works Department as the Dos Rios Water and Sanitation District (DOE 1996a). Water is taken from the west side of the Gunnison River just south of U.S. Highway 50 into the 350 gallons per minute (gpm) water treatment plant, and then stored in a 250,000 gallon water storage tank located just north of U.S. Highway 50. The water distribution system extends from U.S. Highway 50 on the north, toward Tomichi Creek on the south, from Gold Basin Road on the east, to Que Quay Lane on the west (Figure 3-3). There are currently 568 hookups to the water system (information from Gunnison County 1999). According to the Director of the Gunnison County Public Works Department, the water system has the capacity for expansion to cover any anticipated growth in the vicinity.

Existing domestic wells in the area downgradient from the processing site are no longer used as a source of drinking water, but ground water from the wells is used for irrigation and livestock watering. Ground water in selected domestic wells in the Dos Rios "buffer zone" has been monitored since 1990 to assess ground water quality and to ensure protection of human health and the environment in the area downgradient from the site (DOE 1995). The buffer zone monitor well network consists of four domestic irrigation wells (455, 468, 472, and 600), and six domestic buffer zone wells (469, 665, 667, 680, 683, and 685) (Figure 3-2 and Plate 1). Analytes

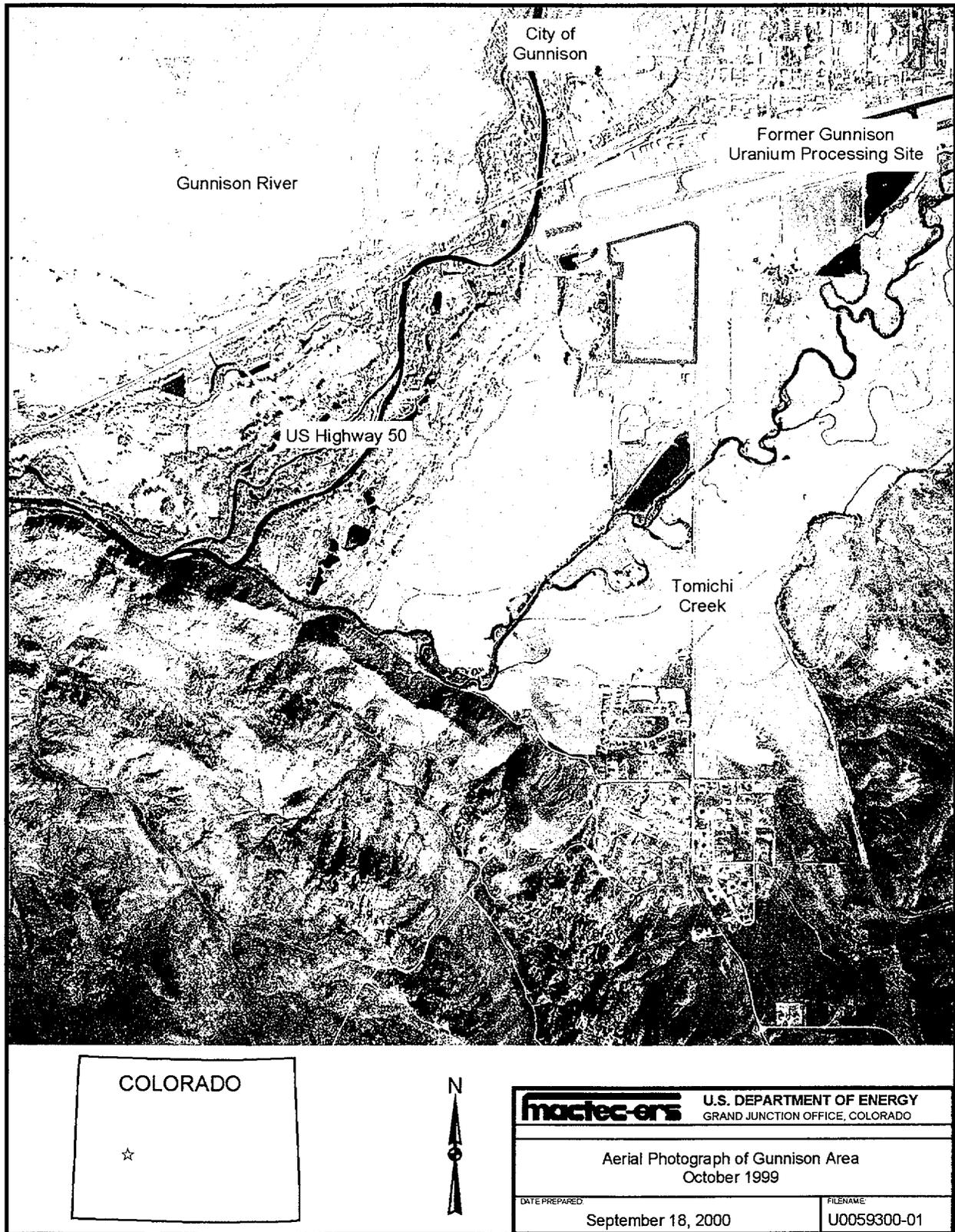


Figure 3-1. Aerial Photograph of Gunnison Area, October 1999

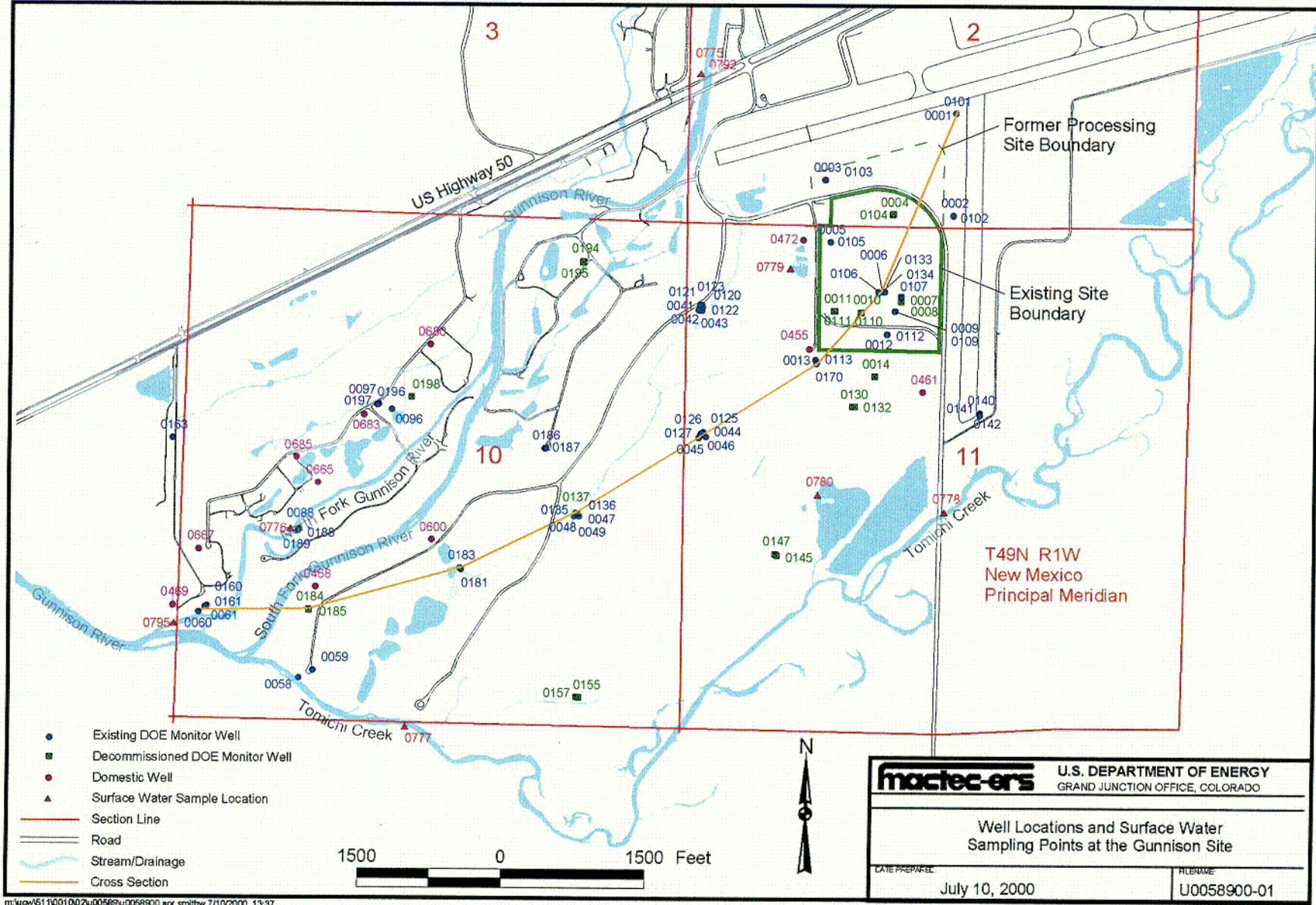


Figure 3-2. Well Locations and Surface Water Sampling Points at the Gunnison Site

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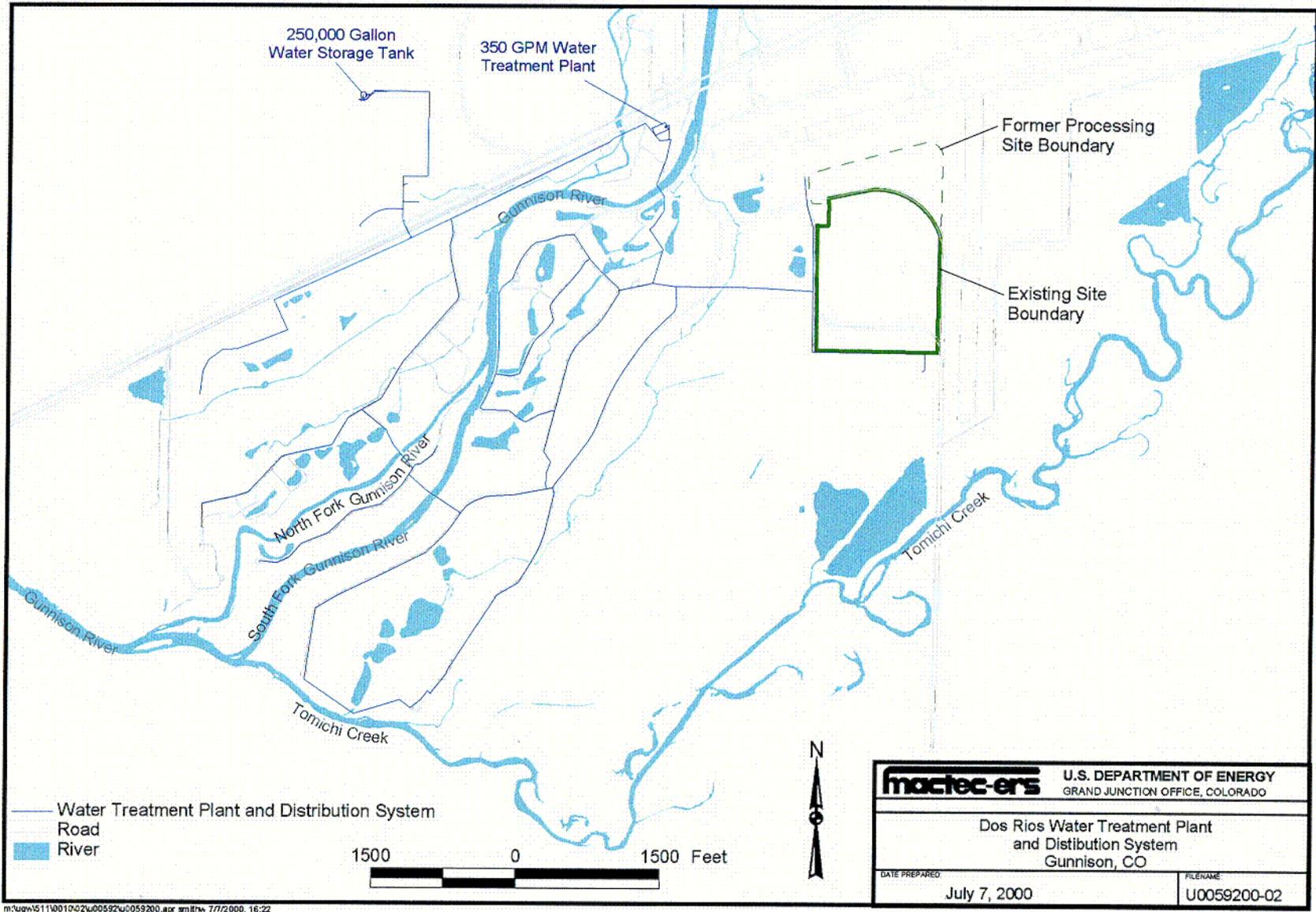


Figure 3-3. Dos Rios Water Treatment Plant and Distribution System, Gunnison, Colorado

CO2

evaluated include uranium in all of the wells and a full suite of constituents in one of the wells (468). The UMTRA Project MCL for uranium is 0.044 milligrams per liter (mg/L), and background uranium levels in alluvial ground water range from 0.003 to 0.009 mg/L. Action levels for uranium in ground water established by the Colorado Department of Public Health and Environment (CDPHE) are 0.020 mg/L in the domestic buffer zone wells and 0.200 mg/L in the domestic irrigation wells. Results of the buffer zone sampling since 1990 have shown concentrations of uranium consistently well below the CDPHE action levels for the domestic buffer zone and domestic irrigation wells. Concentrations of uranium have also been below the MCL of 0.044 mg/L (with the exception of well 600). The trends in uranium concentrations in the domestic wells have been consistently decreasing with time. There have been no notable trends or variations that would suggest the potential for significant changes in the ground water quality that could impact human health or the environment. Based on these results there is no reason for this monitoring to continue, since concentrations of uranium in ground water are in compliance with the UMTRA Project standards in 40 CFR 192.02(c)(3)(i) and have been consistently below the action levels established by CDPHE since the inception of monitoring. It has been recommended that monitoring of ground water in the buffer zone be discontinued.

Valco, Inc. pumps substantial amounts of ground water during their excavation de-watering operations from May through August. The water is discharged into ponds at the south edge of their property.

The City of Gunnison obtains potable water from nine wells in the alluvial aquifer east of the Gunnison River from 0.5 to 1.5 miles north (upgradient) of the Gunnison processing site.

There are no permanent surface water features on the former processing site. Surface water from the nearby streams and ditches is used for irrigation and stock watering. Water from the Gunnison River is diverted to flood-irrigate the pasture southwest of the site from May through September. The Dos Rios golf course west and southwest of site irrigates properties using water from the Gunnison River. Based on surface water sampling to date, there is no indication of any site-related contamination in surface water in the area.

### 3.3 History of Operations

Uranium was discovered in 1954 along the Los Ochos fault near Cochetopa Pass approximately 25 miles southeast of Gunnison, and ore was produced from 1955 until early 1962. Approximately 486,000 tons of ore were produced from the main Los Ochos area that averaged 0.14 percent uranium oxide ( $U_3O_8$ ) during the life of the mines (Chenoweth 1980).

The Gunnison mill was constructed in 1957, mainly as a result of the high grade ore from the Los Ochos claims, and began production in February 1958 (Merritt 1971) (Figure 3-4 and Figure 3-5). The Gunnison Mining Company operated the mill during most of its active life. In December 1961, the Gunnison Mining Company merged with Kermac Nuclear Fuels Corporation, a wholly owned subsidiary of Kerr-McGee Oil Industries, and operated until April 1962 when the mill closed (DOE 1981).

The mill produced uranium for sale to the U.S. Atomic Energy Commission (AEC) and was operated with a feed rate of 200 tons per day for its 4-year life (Merritt 1971). Ore was hauled in by truck from the mining areas. Processing consisted of grinding the ore to minus 65-mesh and acid leaching with sodium chlorate and sulfuric acid for 15 hours at 25 °C. After leaching, the

solution and solids were separated by a four-stage countercurrent classifier and thickener circuit. Washed solids were then sent to the tailings. The pregnant solution was treated with EHPA solvent extraction using a five-stage circuit to remove uranium from the solution. A sodium carbonate solution was then used to strip uranium from the solvent and the entire slurry was passed through a filter press to strip iron residues precipitated during this stage of the process. The clarified pregnant solution was acidified with sulfuric acid to a pH of 2.5 to decompose carbonates and precipitate uranium. Magnesium oxide was added to complete precipitation of the yellow cake (Merritt 1971). During its 4-year lifetime the mill processed approximately 540,000 dry tons of ore that averaged 0.14 percent uranium oxide (Merritt 1971).

Colorado Ventures, Inc., a group of Grand Junction, Colorado, businessmen, purchased the mill in 1964. Fences were established and access was limited according to Colorado regulations. Gunnison County was deeded a 3.5-acre strip along the northern edge of the property for airport use (DOE 1981). Before 1973, tailings were moved to one area west and southwest of the former mill buildings that occupied an area of approximately 1,180 ft by 1,440 ft, or 39 acres, with a maximum height of 13 ft (DOE 1981). In 1973 the property was purchased by C.A. Decker and N.M. Bishop of Denver, who leased the property to Solution Engineering Company of Alice, Texas (DOE 1981).

### 3.4 Surface Remediation

By the mid 1970s, all tailings were moved to a rectangular area of approximately 35 acres, and the milling operation, former ore storage area, and miscellaneous areas occupied about 16 acres. The buildings remaining were a water tower, large metal building, and office buildings (Figure 3-4). During the 1980s, the tailings pile was contoured, covered with material excavated at the adjacent gravel pit, seeded with grasses in accordance with plans approved by the CDPHE. Vegetation was well established on the pile after a few years of irrigation.

Contaminated materials consisted of approximately 450,000 cubic yards of tailings; 214,000 cubic yards of contaminated soil from the ore storage, millsite, subpile, and other areas; 25,300 cubic yards of windblown materials; 10,500 cubic yards of rubble; and 10,000 cubic yards of contaminated materials from vicinity properties. During 1991 all structures remaining at the site were demolished and materials were stored on site for final disposition (DOE 1992b).

From 1992 to 1995 most of the RRM and other contaminated materials were transported to a permanent disposal cell located approximately 6 miles east of Gunnison and 0.4 mile south of the county solid waste landfill (DOE 1997). The disposal site consists of approximately 29 acres of land. The disposal cell was constructed on an excavated surface and has an engineered cover.

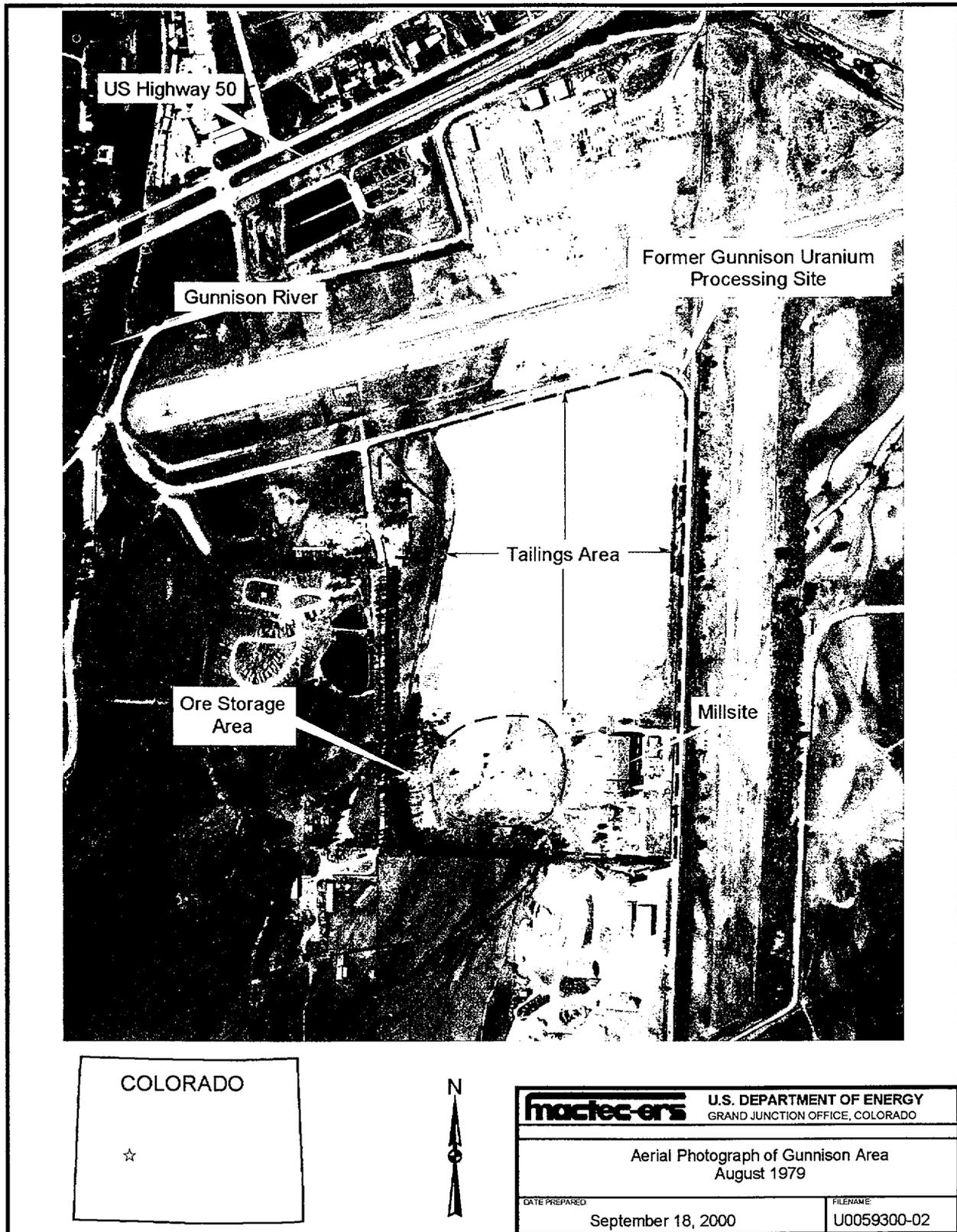
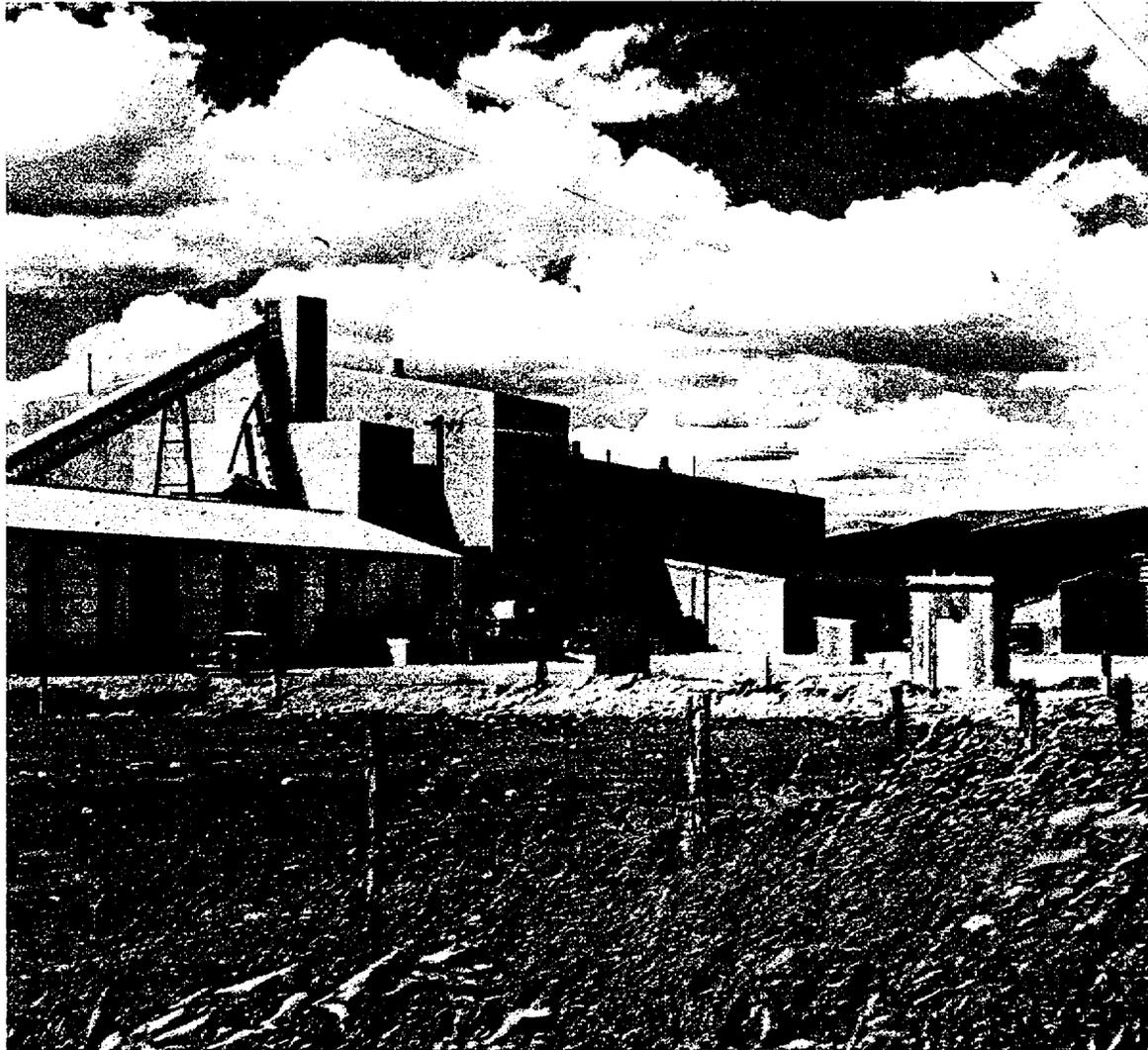


Figure 3-4. Aerial Photograph of the Gunnison Area, August 1979



Photograph of the Gunnison Millsite  
Circa 1957

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*Figure 3-5. Photograph of the Gunnison Millsite (1957)*

## 4.0 Summary of 1999 Field Investigations

Existing characterization data for the Gunnison processing site are presented in the RAP (DOE 1992b) and the BLRA (DOE 1996a). An evaluation of existing data at the Gunnison processing site indicated that additional investigation was needed to complete the SOWP and select the strategy for compliance with EPA ground water protection standards (DOE 1999f). Additional investigation was needed to further define hydraulic parameters of the alluvial aquifer that would be used in ground water flow and transport modeling. This field work included installation of pumping and observation wells at three locations downgradient from the site for aquifer pumping tests. Other work included subpile soil sampling and analysis to evaluate potential residual source term beneath the site, determination of distribution coefficients, collection and analysis of ground water samples from monitor wells and domestic wells downgradient from the processing site, and sediment sampling to characterize biotransformations occurring at the site, which would enable prediction of natural bioremediation under field conditions. Results of these investigations, along with more recent water quality analytical data, are presented in this section.

### 4.1 Ground Water Monitor Well Installation

To facilitate aquifer pumping tests downgradient from the former processing site, additional monitor wells were installed adjacent to existing monitor wells in three locations (Figure 4-1 and Table 4-1). Wells were drilled using the SONIC drilling method, which enabled collection of continuous samples through the entire interval drilled. All new monitor wells were installed within 50 ft of the existing monitor wells to minimize the extent of surface disturbance. Wells were installed in the middle portion of the aquifer to more accurately represent conditions and also to test the zone where contaminants seem to be migrating.

### 4.2 Aquifer Pumping Tests

Aquifer tests were performed at three locations (using wells 041, 044, and 047 as pumping wells) to determine hydraulic parameters of the alluvial aquifer. During each test, water level data were collected from the pumping wells and nearby observation wells. Only the data collected from those wells screened over the same depths as the pumping wells were analyzed for parameter estimation. Prior to the aquifer tests, step tests were conducted on each of the pumping wells to determine the optimal pumping rate at each location.

These aquifer tests were conducted during November and December 1999. As a result of equipment failure, more than one test was completed at each of the three locations. Pumping rates ranged from 35 to 60 gpm, and the length the pumping phase ranged from 8 to over 72 hours. Because of the equipment failure, recovery data were collected from only half the tests.

Data were analyzed using a number of different analytical methods. The pumping wells are generally screened from 30 to 60 ft below ground surface within an aquifer that is up to 120 ft thick. As a result, the Neuman Method for Partially Penetrating Wells in an Unconfined Aquifer (Neuman 1974) provided the analytical solution that best represents the conditions under which these data were collected.

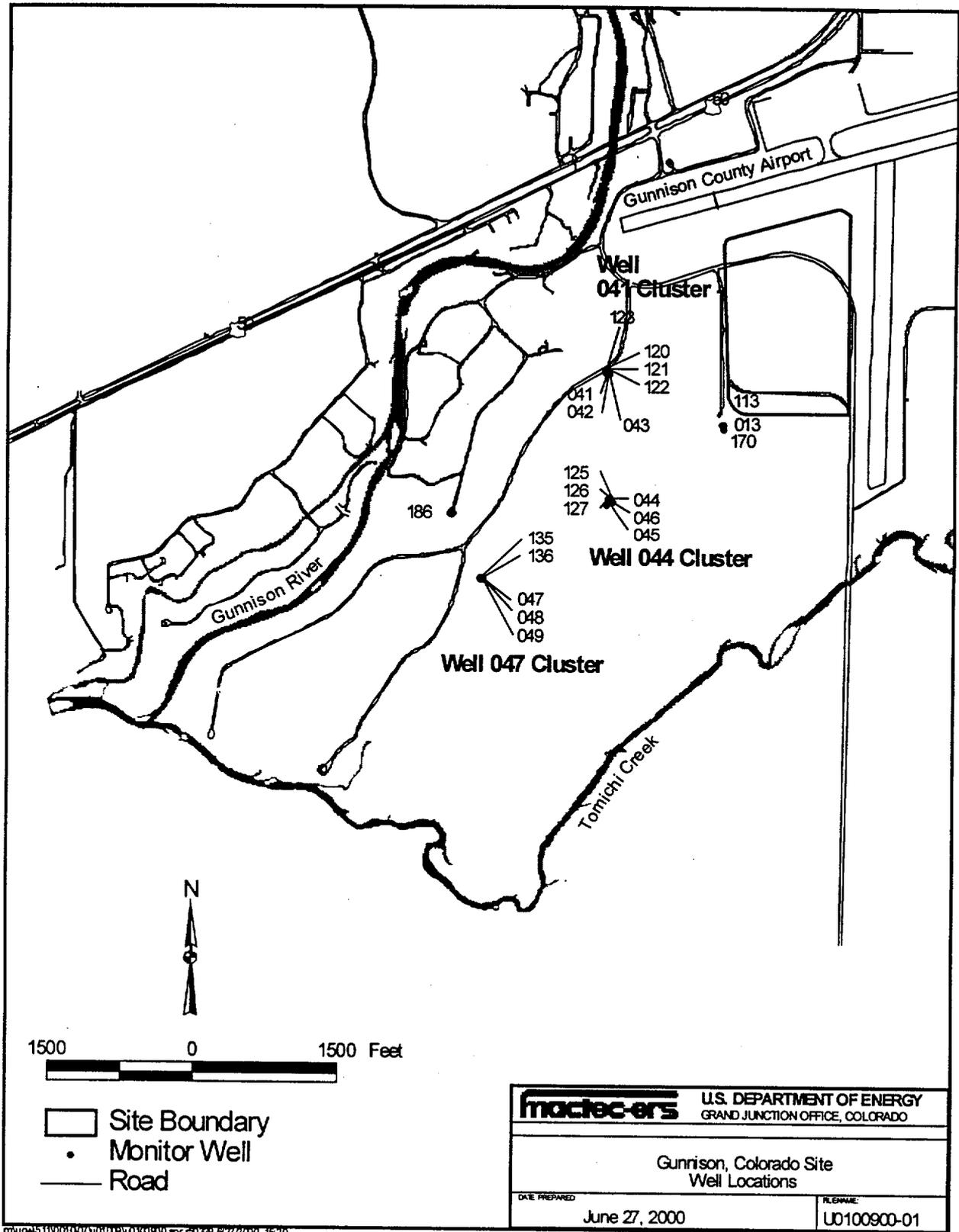


Figure 4-1. Well Location Map at the Gunnison Site

Table 4-1. Gunnison Well Cluster Construction Information

Cluster	Well No.	Dia. (in)	Installation Date	Screen Interval (ft BGS)	r (ft)	Static Elevation of Ground Water (ft MSL) <sup>a</sup>	Observation or Pumping Well
041	041	6	Nov 99	31.0 – 60.4	-	7629.28	pumping
	042	2	Nov 99	43.8 – 53.3	26.8	7629.16	observation
	043	2	Nov 99	43.8 – 53.5	36.6	7629.28	observation
	120	2	Dec 84	18.5 – 23.5	43.9	7632.88	observation
	121	2	Dec 84	93.3 – 98.3	12.4	7627.51	observation
	122	2	Dec 84	78.1 – 83.1	32.0	7627.38	observation
	123	2	Jan 85	53.2 – 58.2	30.8	7629.14	observation
044	044	6	Nov 99	31.1 – 60.5	-	7623.47	pumping
	045	2	Nov 99	40.9 – 50.5	56.8	7623.29	observation
	046	2	Nov 99	40.7 – 50.2	40.9	7623.77	observation
	125	2	Dec 84	18.8 – 23.8	23.3	7624.39	observation
	126	2	Jan 85	53.2 – 58.2	16.4	7623.30	observation
	127	2	Dec 84	94.3 – 99.3	20.4	7622.73	observation
047	047	6	Nov 99	30.8 – 60.2	-	7618.54	pumping
	048	2	Nov 99	41.2 – 50.7	27.2	7618.51	observation
	049	2	Nov 99	40.6 – 50.1	42.1	7618.56	observation
	135	2	Dec 84	16.3 – 21.3	16.4	7619.91	observation
	136	2	Jan 85	53.2 – 58.2	17.3	7618.55	observation

<sup>a</sup>water levels measured between November 17 and November 22, 1999

- Dia. = well diameter
- r = distance to pumping well
- MSL = mean sea level
- BGS = below ground surface
- in. = inches
- ft = feet

Data collected from the pumping phase of the on-site tests suggest that transmissivity ranges from 406 to 3,172 square feet per day (ft<sup>2</sup>/day), with a specific yield range of 0.016 to 0.664. Based on a saturated thickness of 30 ft (the screened interval of the pumping wells), the hydraulic conductivity ranges from 13.5 to 105.7 ft/day (Table 4-2).

Table 4-2. Measured Hydraulic Conductivity

	Location			
	Well 041	Well 044	Well 047	City Well #10
K range (ft/day)	13.5 – 20.3	42.6 – 105.7	55.8 – 67.9	103 – 171
K geomean (ft/day)	17.1	61.2	61.6	131.7

Additional aquifer test data were obtained from the City of Gunnison, which conducted tests following the installation of a production well in October 1999. This well is located north of the site but is considered to be within a portion of the alluvial aquifer that is representative of site conditions. Analyses of data from tests conducted on production well 10 (at flow rates up to 421 gpm) indicate a transmissivity range of 6,164 to 10,262 ft<sup>2</sup>/day. Dividing this range by

60 (this well is screened over the bottom 60 ft of the aquifer) results in an estimated hydraulic conductivity ranging from 103 to 171 ft/day (Table 4-2).

The data collected from the on-site tests indicate that steady state may have been achieved during the testing periods at each of the three locations, possibly the result of an inability to adequately stress the aquifer at a high enough flow rate. Based on this assumption, the conductivity range generated from the production well tests may be more representative because of the higher flow rates used to conduct the tests.

All data associated with the aquifer tests are contained in Appendix G. Appendix G also presents an interpretation of the data collected from the aquifer tests performed both on site and by the City of Gunnison.

### 4.3 Subpile Soil Sampling

During the surface cleanup from 1992 to 1995, contaminated material above the water table and one foot below the water table was removed. Figure 4-2 and Figure 4-3 show that leaching from the tailings pile caused a rusty coloration in the underlying sediments. Gravel was partly coated with ferric oxyhydroxides. Contamination of subpile soils was the subject of a previous study (DOE 1994), which concluded that the subpile soils were likely to be a continuing source of ground water contamination. Details of the remedial action are provided in the Final Completion Report (DOE 1997).

During remediation, high thorium-230 concentrations were detected in sediments below the water table. Supplemental standards were applied for thorium-230 left in place, because only material 1 ft below the water table was removed. Appendix I of the final completion report for the Gunnison site (DOE 1997) mentions that a site-specific cleanup protocol was developed in which soil with a high clay content ("select fill") was to be placed at the bottom of the excavation as a radon barrier. Figure 4-4 shows the soil verification plan from the final completion report, including the locations of the subpile soil sampling. Figure 4-5 and Figure 4-6 show the select fill shortly after remediation in 1995, and Figure 4-7 and Figure 4-8 show the fill during excavation in November 1999. Soil verification data are provided in Appendix I of the completion report. Forty-one locations (each location is an area 30 ft × 30 ft) did not receive a select fill (DOE 1997).

The first goal of this investigation was to determine if residual contamination is left onsite. Soil samples were collected on the former millsite November 2-9, 1999. Acid leaching was performed in the Grand Junction Office (GJO) Environmental Sciences Laboratory (ESL) in January 2000. Seventeen soil samples and 11 water samples were analyzed. A second goal of this study was to estimate the concentrations of uranium in ground water that have flowed through contaminated subpile soils. Therefore, natural ground water was used as the leaching solution in two column experiments conducted in April 2000. A summary of the study is presented below; more details are presented in the contaminants in subpile soils report (DOE 2000a).



*Figure 4-2. Excavated Millsite During Surface Remediation (1994?) (View 1)*



*Figure 4-3. Excavated Millsite During Surface Remediation (1994?) (View 2)*

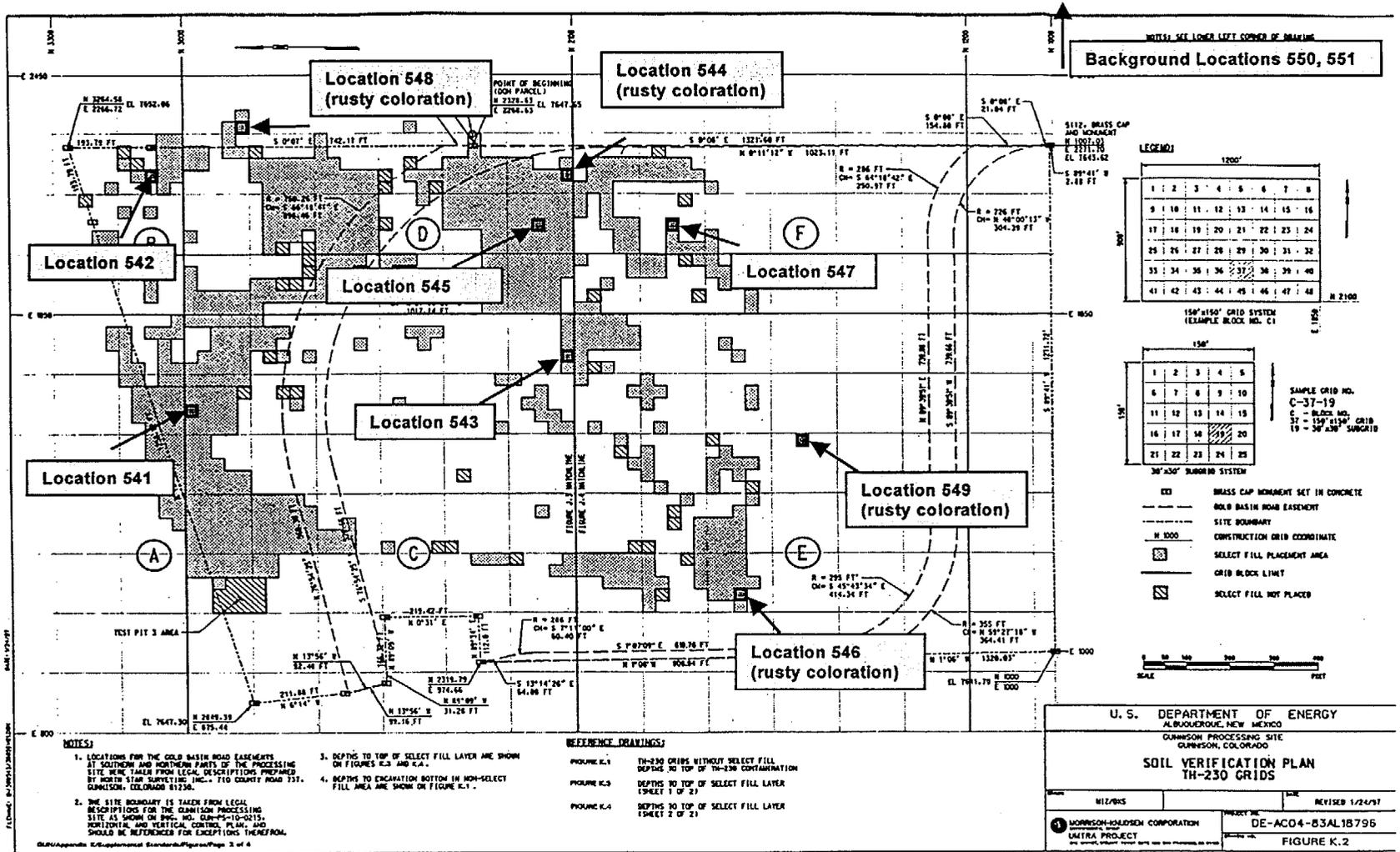


Figure 4-4. Sampling Locations and Coloration of Samples Posted on Soil Verification Plan

Note: (DOE 1997); gray shaded grids (30 x 30 ft) received select fill, diagonal shaded grids did not receive select fill

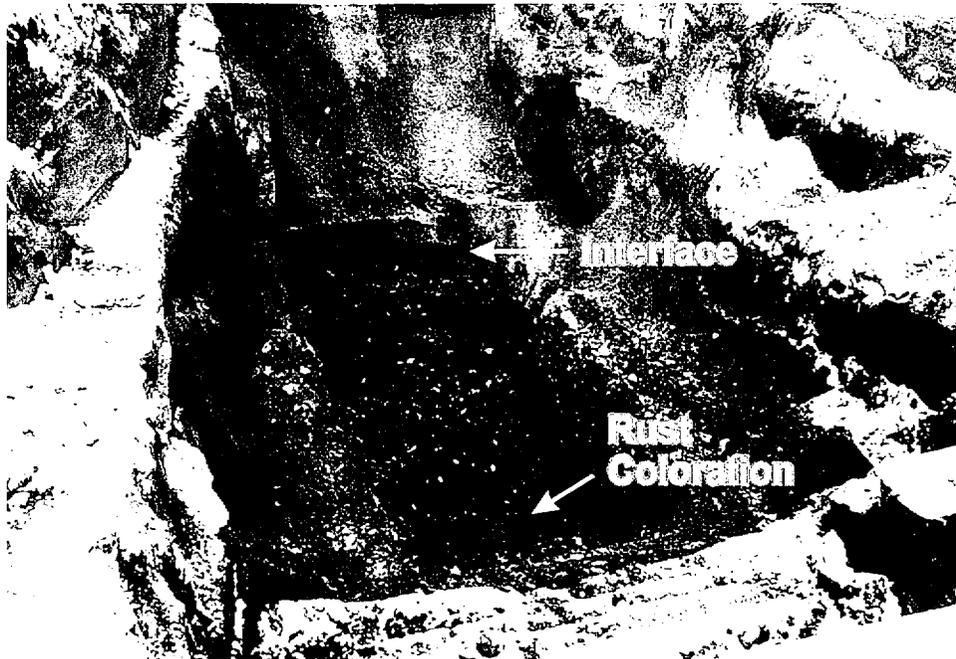


Figure 4-5. Excavation Shortly After Surface Remediation (1995) (View 1)

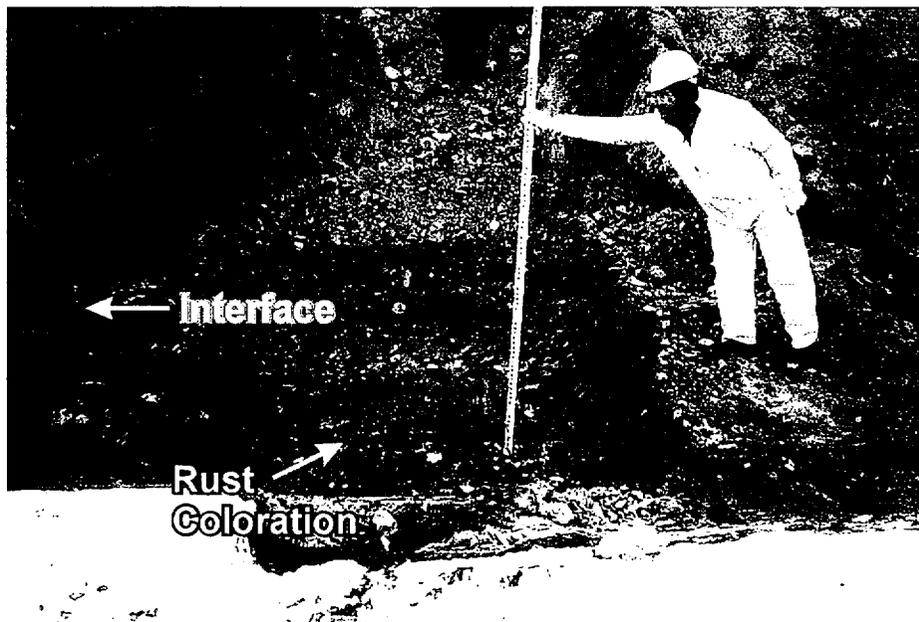


Figure 4-6. Excavation Shortly After Surface Remediation (1995) (View 2)  
- Note: rusty coloration of sediment below the select fill



*Figure 4-7. Excavation on the Millsite in November 1999 (View 1)  
- Note: high clay content select fill material*



*Figure 4-8. Excavation on the Millsite in November 1999 (View 2)  
- Note: the select fill appears as a distinct layer in the test pits*

### 4.3.1 Methods

Sediment samples were collected at eight locations where thorium-230 activity was highest, as indicated in the completion report. Table 4-3 lists the grid ID, and the thorium-230 activity as well as the top of select fill and the top of thorium. The grid ID refers to the survey during construction (Figure 4-4). One sample was collected at the former ore storage area at the south side of the former millsite. Two background samples were collected east of the unpaved runway. The ID from the construction grid was used to determine the location in the field before excavation. Surveyors staked locations in the field and surveyed the locations by Global Positioning System after sampling. Location 544 had to be moved about 25 ft east because the original point was under the pavement of the road.

Table 4-3. Sampling Locations and Soil Survey Information

Location	Grid ID	Bulk Th-230 pCi/g	Top of Select Fill (ft/bgs)	Top of Thorium Cont. (ft/bgs)
541	C-07-03	491	6-7	8-10
542	B-43-12	291	4	8
543	C-48-23	523	5	8
544	D-43-22	498	3	4.5
545	D-35-15	368	1-2.5	2
546	E-20-12	270	3	4
547	F-10-13	341	4	6-7
<b>Locations that did not receive select fill</b>				
548	D-04-21	1,068	n./a.	4.5
<b>Ore storage area</b>				
549	E-31-23	n./a.	n./a.	n./a.
<b>Background area</b>				
550	n./a.	n./a.	n./a.	n./a.
551	n./a.	n./a.	n./a.	n./a.

n./a. = no data available  
pCi/g = picocuries per gram

Soil samples were collected using a backhoe. Test pits were dug to the water table and soil samples were taken below the select fill directly from the backhoe bucket. Ground water samples were taken at the bottom of the pit (Figure 4-9). At background locations 550 and 551, soil samples were taken approximately 0.5 ft above the water table. During the sampling the excavated material was separated into three piles: topsoil, select fill, and material below the select fill (Figure 4-10). The material was backfilled in the reverse order of excavation.

Soil samples were placed in plastic ziplock bags and transported to the ESL. Water samples were filtered and kept on ice. The soil samples were placed in aluminum pie plates, open to the air, until they were visibly dry (about 5 days). To aid the drying process, the samples were frequently disaggregated by crushing lightly by hand. Large sticks, rootlets, and pebbles were removed by hand. Dried samples were sieved to less than 2 millimeters (mm).

Two grams of each sample was divided equally and placed in two 50-milliliter (mL) plastic centrifuge tubes, and 50 mL of 5-percent (v/v) HCl was poured into each tube. The tubes were agitated end over end for 4 hours. The samples were centrifuged for 45 minutes at

2,500 revolutions per minute (rpm) and decanted. The sediment was then leached again with 5-percent HCl following the same procedure. The supernatants were decanted into a 200-mL volumetric flask and filled to volume with 5-percent HCl. They were then filtered through a 0.45 micrometer ( $\mu\text{m}$ ) filter and submitted to the GJO Analytical Chemistry Laboratory for analysis of uranium, sulfate, iron, and manganese. Because the samples were HCl solutions, no additional preservation was used. Samples were kept at less than 4 °C prior to analysis.

Two samples with the highest uranium concentrations in the leaching tests were selected for a column experiment. The setup of the experiment is shown in Figure 4-11. This study used a procedure similar to ESL standard column test procedure CB(CT-1) (DOE 1999b). Columns (2-inch diameter) were constructed from clear acrylic. Nylon cloth filters sandwiched between two perforated plastic discs were placed at the bottom and top of the column. The sediment column was 18 inches in length. Natural ground water was pumped with a peristaltic pump set at 0.8 milliliters per minute (mL/min) from bottom to top through the column. Effluent was collected in a flask using a Gilson fraction collector.

Natural ground water from monitoring well 002 was used for the column experiment. Samples were collected March 15 and April 11, 2000. Concentrations of uranium, pH, electrical conductivity, oxidation-reduction potential (ORP), and alkalinity were measured in the ESL soon after sample collection using the procedures in the *Environmental Sciences Laboratory Procedures Manual* (DOE 1999b). Samples of the effluents were preserved and analyzed for uranium, iron, and manganese. The ground water sampling data and analytical methods are provided in DOE 2000a.

#### 4.3.2 Results

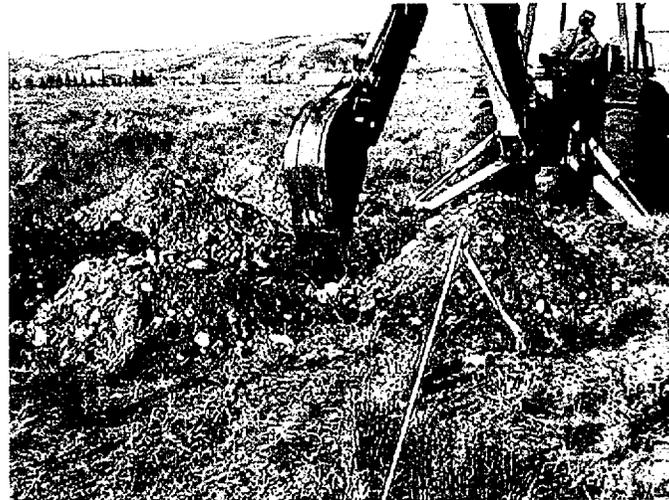
Sampling locations and the spatial distribution of uranium concentrations in soil and ground water are shown in Figure 4-12. Concentrations of constituents leached from the soils are provided in Table 4-4. Results of the column experiments are provided in Figure 4-13.

Background concentrations of uranium in soil and ground water are about 0.22 milligrams per kilogram (mg/kg) and 0.006 mg/L, respectively (Table 4-4). The two highest uranium concentrations in subpile soils were measured at location 545 at a depth of 8 ft and at location 546 at a depth of 9 ft. The concentrations were 81.4 mg/kg and 86.2 mg/kg, respectively. The uranium concentration in ground water is 1.3 mg/L at location 545 and 0.031 mg/L at location 546. Uranium concentrations in soil at other locations ranged from 0.39 mg/kg at location 548 near the northeast corner of the former millsite to 40.1 mg/kg near the center of the site at location 543. The uranium concentrations in soil at the former ore storage area, which is in the south part of the former millsite near location 549, average 3.76 mg/kg. There is no trend in uranium concentration with depth. Uranium concentrations increase with depth at location 544, whereas at location 543 no variation was observed, and concentrations decrease with depth at location 541 (Figure 4-12). Because surface remediation disturbed the original stratigraphy, the distribution of concentrations might be random in the subsurface today.

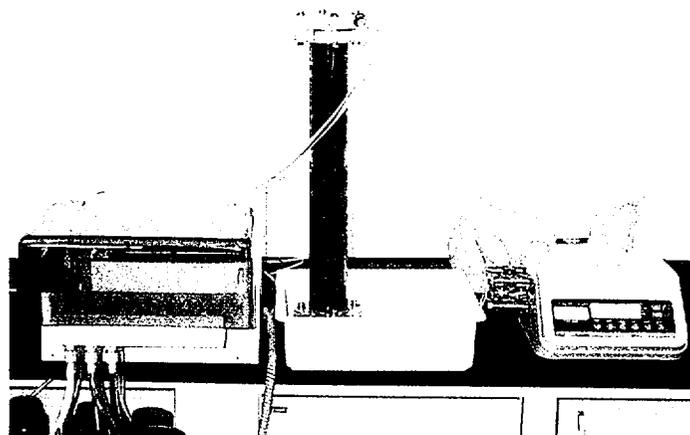
The initial uranium concentration in the effluent of column 545 was about 1.50 mg/L and reached a maximum of 1.67 mg/L after about 30 pore volumes (Figure 4-13). The uranium concentration in ground water at location 545 was as high as 1.21 mg/L and was comparable to



*Figure 4-9. Excavation on the Millsite in November 1999 (View 3)  
Note: Sediment and water samples were taken from the backhoe bucket*



*Figure 4-10. Excavation on the Millsite in November 1999 (View 4)  
Note: Excavated material was separated in different piles and backfilled in the same order*



*Figure 4-11. Setup of Column Experiment  
Note: source tank and peristaltic pump (right), column filled with subpile soil (middle)  
fraction collector (left)*

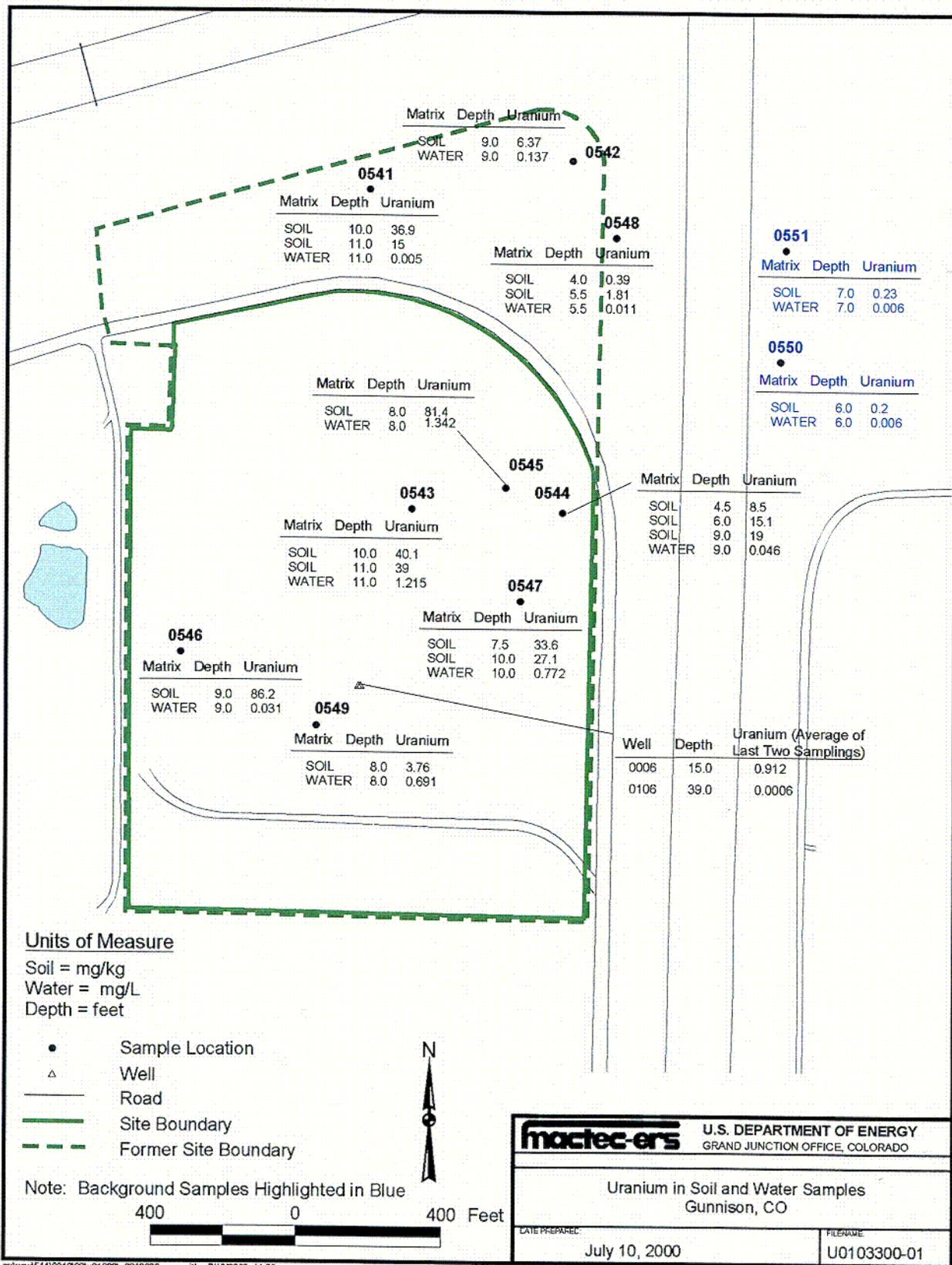


Figure 4-12. Uranium in Soil and Water Samples Gunnison, Colorado

C03

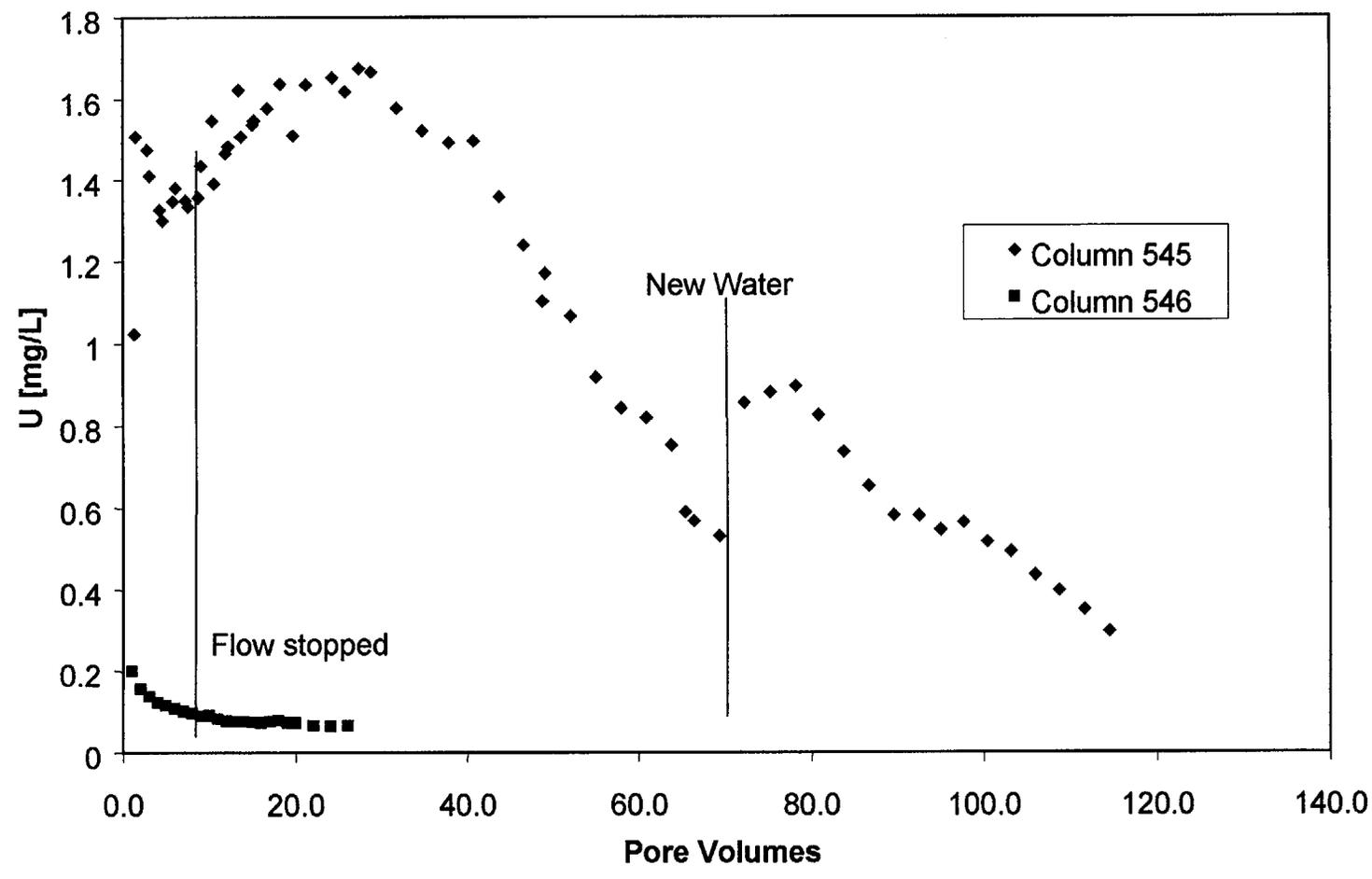


Figure 4-13. Uranium Concentration in Effluents from Column Experiments

Table 4-4. Element Concentrations in Subpile Soils and Uranium Concentration in Ground Water

Location	Depth ft bgs	Iron mg/kg	Manganese mg/kg	Sulfate mg/kg	Uranium mg/kg	Uranium in Ground Water mg/L
541	10	13,200	62.0	3,880	36.9	n./a.
	11	4,840	156	7,490	15.0	0.005
542	9	3,850	60.3	6,940	6.37	0.137
543	10	4,570	55.5	44,300	40.1	1.215
	11	3,700	68.5	61,900	39.0	n./a.
544	4.5	3,990	14.1	8,820	8.5	n./a.
	6	8,130	25.9	7,000	15.1	n./a.
	9	7,790	48.7	5,090	19.0	0.046
545	8	3,510	21.0	5,230	81.4	1.342
546	9	5,700	85.3	3,810	86.2	0.031
547	7.5	2,160	130	14,600	33.6	
	10	1,750	24.0	8,010	27.1	0.772
548	4	1,540	187	2,600	0.39	n./a.
	5.5	7,600	35.9	2,700	1.81	0.011
549	8	4,030	793	21,300	3.76	0.691
<b>Background Locations</b>						
550	6	1,390	60.3	4,150	0.20	0.006
551	7	1,850	42.1	1,720	0.23	0.006

n./a. no data available

bgs: below ground surface

the concentrations of the column effluent. Refilling the source tank with fresh ground water after 70 pore volumes caused an increase in effluent uranium concentrations for a short time. When the column 545 experiment was discontinued after 115 pore volumes, uranium concentration in the effluent had decreased to 0.296 mg/L. The effluent from column 546 had lower uranium concentrations than those from column 545 despite having similar concentrations of uranium in soils (Table 4-4). The first outflow of column 546 contained 0.2 mg/L (Figure 4-13). After 26 pore volumes the uranium concentration had decreased to 0.067 mg/L, which is comparable to the ground water concentration of 0.031 mg/L at field location 546.

Mass balances for uranium for the column experiment were calculated. Although samples 545 and 546 contain the same amount of uranium, they showed different behavior during leaching with natural ground water. Based on the initial and final uranium concentrations in the soils, 36.9 percent of the uranium inventory of column 545 was leached after 115 pore volumes and just 9.4 percent of the uranium inventory of column 546 was leached after 26 pore volumes (Figure 4-14). Although a different number of pore volumes was exchanged in both columns, the effluent concentrations (Figure 4-13) indicate that the soils release uranium at different rates.

The iron concentration in background soil samples is between 1,400 and 1,900 mg/kg. Rusty coloration of the soil samples was noted at locations 544, 546, 548, and 549. Figure 4-15 shows the sandy material and gravel coated with ferric oxyhydroxides. In samples from location 548 the colored material appears as a distinct layer above the water table (Figure 4-16). The iron concentration at location 544 at 6 ft below the surface is 8,190 mg/kg. The layer at location 548 contained 7,600 mg/kg iron. The highest iron concentration of 13,200 mg/kg was detected at location 541 at a depth of 10 ft below the surface where no coloration was noted. Iron concentrations in the effluent of the column experiment were below the detection limit of 0.1 mg/L. The fact that iron concentrations in the soil before and after the column experiment

were similar suggests that the ferric iron present will not be dissolved. Iron concentrations in ground water on site are low in shallow well 006 (screen depth 8 to 13 ft below surface). Higher iron concentrations in the ground water were detected at co-located well 106, which is screened from 32 to 37 ft.

Manganese concentrations in the background soil samples were 42.1 and 60.3 mg/kg (Table 4-4). Most of the subpile soils contain manganese in the same concentration range. The highest manganese concentration of 793 mg/kg was detected at the former ore storage area at location 549. Manganese concentrations in the subpile soils at locations 541 and 548 range from 156 to 187 mg/kg. Although manganese and iron can both form oxyhydroxides that can adsorb uranium, high manganese concentrations in soil or ground water are not associated with elevated uranium concentrations at the Gunnison site. As with iron, manganese concentrations in the effluent of the column experiment were below the detection limit of 0.1 mg/L. The shallow ground water at the millsite contains little manganese, whereas higher concentrations are present in deeper on-site wells such as 106, 109, and 112, which are screened from 32 to 45 ft.

Results of this investigation showed that uranium concentrations in subpile soils at the Gunnison site are up to 400 times higher than background. Because samples were taken at locations where thorium-230 concentrations were highest according to the completion report, no conclusion about the spatial distribution and volume of contaminated soil can be drawn.

The column experiments, conducted with the soils having the highest uranium content, showed that natural ground water can leach uranium over a long period of time. The uranium concentrations in the column effluent were comparable to the current concentrations in on-site ground water, which suggests that the subpile soils at the Gunnison site are contributing to ground water contamination.

#### 4.4 Distribution Coefficient

As contaminated ground water migrates through soil and rock, contamination is distributed between the solid and liquid phases. This phenomenon causes the contamination to travel at a slower rate than the average ground water velocity. Chemical processes that retard the contaminant plume can include adsorption, absorption, mineral precipitation, diffusion into immobile porosity, attachment to microbes, and transfer to vapor phases. It is generally not possible to differentiate among these processes. However, a bulk parameter ( $Kd$ ) has been used with some success to model the retardation of contamination for many aquifer systems. Most numerical ground water models use the  $Kd$  concept in simulations of contaminant transport. Site-specific  $Kd$  values are approximated from  $Rd$  values that are empirically determined. A laboratory study was conducted to determine  $Rd$  values for the alluvial system at the Gunnison site. A summary of the study is presented below; more details are presented in the determination of distribution ratios report (DOE 2000b).

##### 4.4.1 Definitions and Calculations

$Rd$  is defined as the concentration of a constituent associated with the solid fraction divided by the concentration in the aqueous phase:

$$Rd = \frac{(\text{mass of solute sorbed per unit mass of solids})}{(\text{mass of solute per volume of solution})} \quad (1)$$

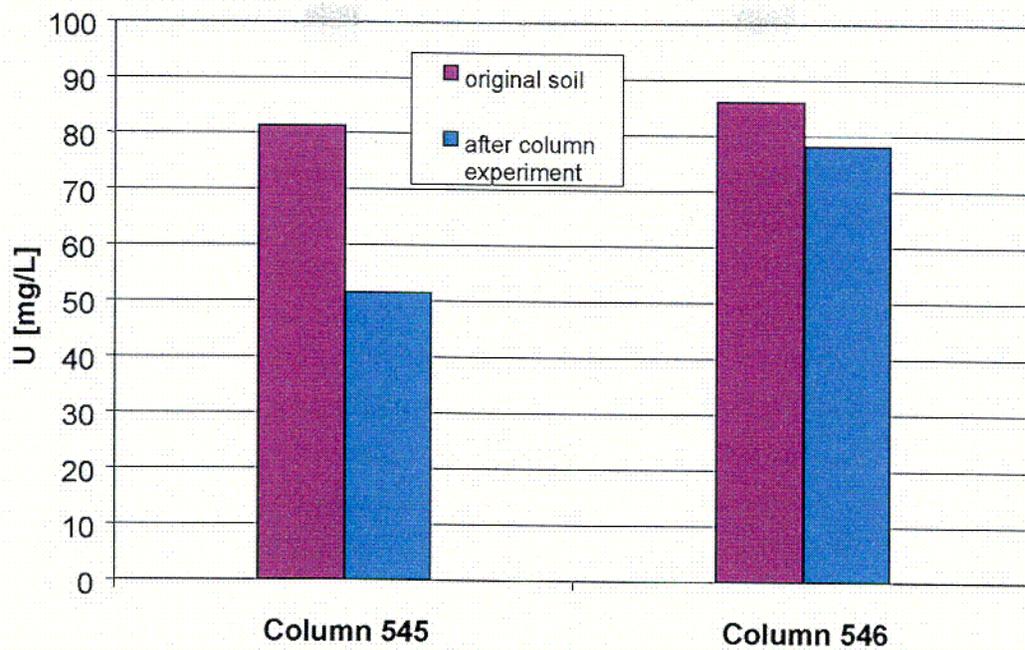
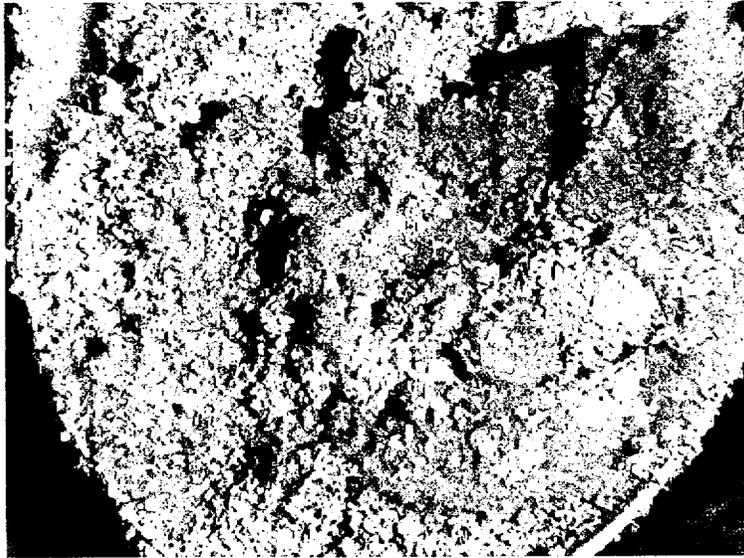
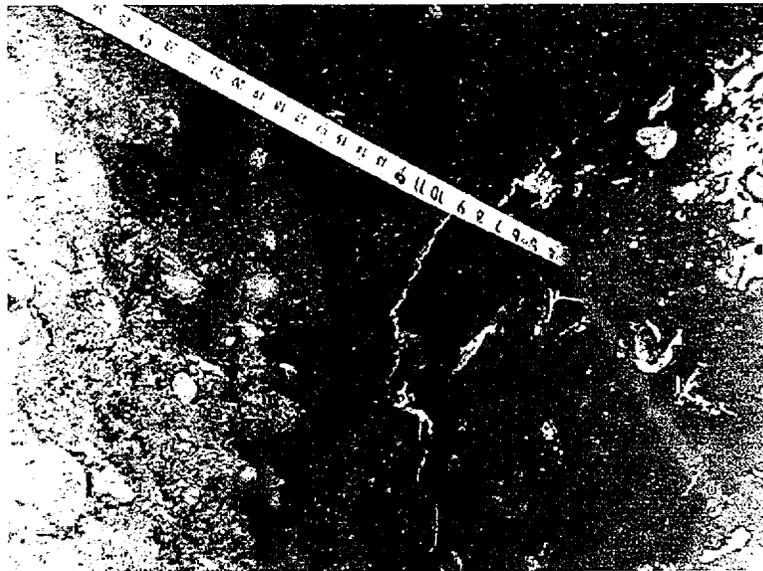


Figure 4-14. Uranium Concentration in Soils Before and After Column Leaching

CO4



*Figure 4-15. Rusty Coloration of Subpile Soils Caused by Ferric Oxyhydroxides (Location 544)*



*Figure 4-16. Rusty Colored Sediment at Location 544*

$Rd$  values are calculated from experimental data as

$$Rd = \frac{(A - B)V}{M_s B} \quad (2)$$

where

- $Rd$  = distribution ratio in milliliters per gram (mL/g),
- $A$  = initial concentration of the constituent in mg/L,
- $B$  = final concentration of the constituent (mg/L),
- $V$  = volume of solution (mL), and
- $M_s$  = mass of soil used in grams (g)

$Kd$  is numerically equivalent to  $Rd$  if the system is at equilibrium and  $Rd$  is constant over the range of conditions being considered. If  $Rd$  is constant over a large range of contaminant concentrations, it is said to be linear because a plot of aqueous concentration against solid-phase concentration forms a straight line on an arithmetic plot.  $Rd$  data are often displayed on log-log concentration plots. A linear arithmetic plot of  $Rd$  (referred to as a linear isotherm because temperature is held constant) is also linear on a log-log plot. The slope of a linear isotherm is unity on a log-log plot. At elevated concentrations of a constituent,  $Rd$  often varies with the aqueous concentration. In this case, the isotherm is said to be nonlinear and cannot be accurately represented by  $Kd$ .

The distribution of grain size influences the effect that sediment has on retarding migration of contaminants by sorption. For example, sediment that has a high proportion of fines will usually have a high  $Rd$  value compared with a mineralogically similar but coarser grained sediment. The increase in sorption is due to a higher proportion of sorbent phases, such as clay minerals and iron oxyhydroxides, and a greater surface area.

Fine-grained splits are commonly used in the laboratory to determine  $Rd$  values. The finer grain sizes are easier to work with and require smaller equipment. Because more contaminant is sorbed to finer grained sediment, the analysis is more sensitive and has lower detection limits than would be possible using the coarser grained fractions. However, the results are biased toward elevated values of  $Rd$ . The laboratory-derived  $Rd$  values should be adjusted to account for actual grain-size distributions in the aquifer.

Grain-size distribution data can be used to adjust the laboratory-derived values of  $Rd$  to the coarse-grained alluvial aquifer (DOE 1999d and 1999e). Values of  $Rd$  can be adjusted according to:

$$Rd_{adj} = Rd_{(<2 \text{ mm})} \times f \quad (3)$$

where

- $Rd_{adj}$  = adjusted  $Rd$  values,
- $Rd_{(<2 \text{ mm})}$  = laboratory  $Rd$  measured on the less-than-2-mm fraction, and
- $f$  = weight fraction of sediment that is less than 2 mm (from sieve analysis).

Use of this method assumes that there is no sorption on the greater-than-2-mm fraction. This is a reasonable method for estimating distribution coefficients for input into contaminant transport models.

#### 4.4.2 Selection of Samples and Solution Composition

Core from the alluvial aquifer was sampled from location 043 which is outside the main plume area and considered to be background (Figure 3-2). The lithology at this background location is similar to that in the contaminated aquifer. Background-area core was used instead of core from the contaminated area because of the difficulty in interpreting results from contaminated cores (DOE 2000b). Distribution ratios were determined on samples from two depths: 29 to 31 ft (referred to as 30 ft) and 52 to 57 ft (referred to as 54 ft).

Initially,  $Rd$  values were determined using a solution made in the laboratory that contained concentrations of major ions similar to those present in the aquifer ground water. This synthetic ground water, however, had considerably less dissolved carbonate than actual ground water. Because it was difficult to prepare synthetic ground water with carbonate concentrations similar to actual ground water, a sample of ground water was collected from well 0002 at the site and used for the  $Rd$  determinations. Because  $Rd$  determinations using actual ground water are believed to be more representative of site conditions, they are presented in this section. The results using the synthetic ground water are included in the ESL report (DOE 2000b).

#### 4.4.3 Methods

$Rd$  data were collected using ESL Procedure CB(BE-3) (DOE 1999b), which follows an American Society for Testing and Materials (ASTM) procedure for batch-type experiments (ASTM 1993). A representative portion of sample was air dried at room temperature. The samples were sieved to less than 10 mesh (2 mm). Uranium is the only contaminant tested and was added to the ground water at a concentration of 1.0 mg/L, which is near the upper limit of contaminant concentrations detected in ground water samples at the Gunnison site. Sulfate is also a contaminant of concern at the site; however, sulfate is present in such high concentrations that distribution coefficients are not applicable for determining transport. Sulfate is considered to be mobile (conserved) in modeling studies.

A five-point isotherm was determined for each of the two samples. The appropriate mass of core sample (1, 2.5, 5, 10, 20, or 40 g) was placed in a 125-mL Nalge bottle with 100 mL of ground water. Samples were rotated end over end at 8 rpm for 24 hours, centrifuged at 3,000 rpm, then vacuum filtered through a 0.45- $\mu$ m filter. Samples were analyzed for uranium by kinetic phosphorescent spectroscopy using ESL procedure AP(U-2) (DOE 1999b).

#### 4.4.4 Results and Discussion

The results of the  $Rd$  determinations are presented in Figure 4-17. The colored lines on the diagram show the position of theoretical linear isotherms for  $Rd$  values of 1, 10, 20, and 30 mL/g. Isotherms will behave ideally only if chemical conditions such as pH are similar among the experiments. Values of pH, alkalinity, conductivity, temperature, and oxidation-reduction potential remained fairly constant in all experiments.

The isotherm for the deep (54 ft) ground water sample is reasonably linear, except for two points with the highest dissolved uranium concentrations (Figure 4-17). The results for these two points are sensitive to small analytical errors for either the sample solution or the parent solution. Therefore, these two points were not used.  $Rd$  values for the other four points ranged from 3.94 to 5.47 mL/g and averaged 4.73 mL/g. For the same reason, the  $Rd$  value for the highest

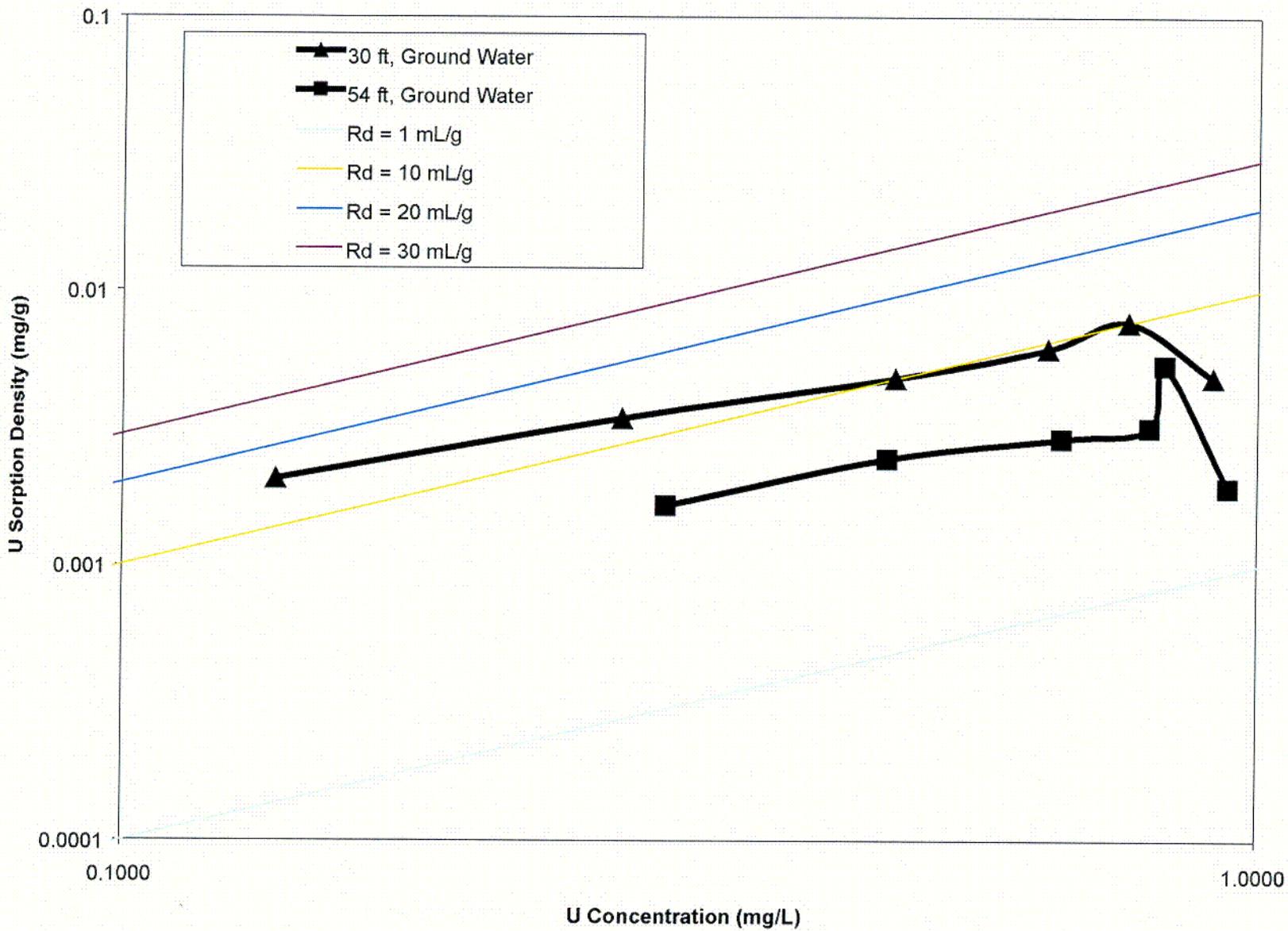


Figure 4-17. Results of Rd Determinations at the Gunnison Site

C05

dissolved uranium point on the shallow (30 ft) ground water sample was rejected (Figure 4-17). The other five points are reasonably linear with  $Rd$  values that ranged from 9.43 to 15.11 mL/g, and an average  $Rd$  value of 11.40 mL/g.

Uranium  $Rd$  values measured for samples from other UMTRA Project sites are lower than those for samples from the Gunnison site (Table 4-5). The lower values could indicate a different mineralogical composition of the sediments or could result from a variation in ground water chemistry. Uranium forms strong aqueous complexes with carbonate that favor partitioning to the dissolved phase. The lower carbonate concentrations (which are directly related to the alkalinity) in the Gunnison ground water samples favor partitioning to the sediment and may have resulted in higher  $Rd$  values.

Table 4-5. Mean Distribution Ratios ( $Rd$ ) for Uranium From Gunnison Compared With Other UMTRA Project Sites

Site	Formation	Alkalinity (mg/L of CaCO <sub>3</sub> )	$Rd$ (mL/g)
Gunnison	Qal (30 ft)	208	11.40
Gunnison	Qal (54 ft)	208	4.73
Shiprock	Weathered Km	231	1.59 <sup>a</sup>
Shiprock	Unweathered Km	231	2.13 <sup>a</sup>
Shiprock	Qal (floodplain)	1,036	0.54 <sup>a</sup>
New Rifle	Qal	500	0.7 <sup>b</sup>
Old Rifle	Qal	377	0.5 <sup>c</sup>
Old Rifle	Wasatch claystone	377	1.3 <sup>c</sup>
Grand Junction	Qal	260	2.15 <sup>d</sup>

Note: All samples were sieved to less than 2 mm.

Qal = Quaternary alluvium; Km = Cretaceous Mancos Shale

<sup>a</sup>DOE (1999a)

<sup>b</sup>DOE (1999d)

<sup>c</sup>DOE (1999e)

<sup>d</sup>DOE (1999c)

The  $Rd$  value for the aquifer can be estimated from the less-than-2-mm fraction by normalizing it to the grain size distribution in the aquifer and assuming that the larger fractions are not adsorptive (DOE 2000b). The alluvial aquifer at Gunnison is composed of clay-sized material through gravel with cobbles and occasional boulders (DOE 2000b). The two samples used for the  $Rd$  study contained 46 and 36 percent of the less-than-2-mm fraction (Table 4-6). The maximum particle diameter represented in the core was limited to the core diameter of 4 inches. By use of equation (1), the measured  $Rd$  values were adjusted to account for the proportion of less-than-2-mm material in the sample (Table 4-7).

The chemical and physical properties of alluvial aquifers typically vary substantially both vertically and horizontally. The distribution of the properties is rarely known due to the high cost of completely characterizing the aquifer. For this reason, it is common to apply parameters such as  $Kd$  uniformly over the entire aquifer to make estimates of contaminant transport.

Table 4-6. Grain Size Distribution of the Gunnison Samples

Sample Number	Size Fraction	Weight (g)	Weight Fraction
Well 0043 at 30 ft	> 2 mm	430	0.54
	< 2 mm	373	0.46
Well 0043 at 54 ft	> 2 mm	613	0.64
	< 2 mm	345	0.36

Table 4-7. Mean Distribution Ratios (Rd) for Uranium From Gunnison Adjusted for Grain Size

Formation	Unadjusted Rd (mL/g)	Adjusted Rd (mL/g)
Qal (30 ft)	11.40	5.24
Qal (54 ft)	4.73	1.70
Average		3.47

Qal = Quaternary alluvium

While this approach is not likely to accurately predict all details of contaminant migration, it provides a rough estimate of the trends and can help in making remediation decisions. The single *Rd* value that is most representative of the alluvial aquifer for Gunnison is an average of the two adjusted values (3.47 mL/g) measured using actual ground water.

## 4.5 Ecological Investigation

In general, the goal of ecological field investigations under the UMTRA Project is to acquire data to determine if site-related contamination may adversely affect ecological receptors (flora and fauna). Data needs include species composition, ecological interactions, contaminated media, contaminant concentrations, and exposure pathways. This section summarizes the data collected and identifies any additional data needs. Section 6.0 of this document evaluates the data and draws conclusions as to the level of risk presented by site-related contamination to receptors. A preliminary risk assessment was completed in 1990 that specifically addressed human health. However, the first Ecological Risk Assessment (ERA) was documented in the BLRA (DOE 1996a).

Because UMTRCA does not specify ERA protocol, the UMTRA Ground Water Project adopted the EPA 1992 risk assessment guidance as a best management practice. The BLRA preceded EPA 1998 risk assessment guidelines. The data and subsequent evaluation (Section 6.0) were developed to support a risk-based compliance strategy that is protective of the environment.

### 4.5.1 Abiotic Sampling and Analysis

Characterization (sampling and analysis) of ground water was conducted to determine if concentrations of site-related contaminants exceed background or MCLs established in 40 CFR 192. If ground water concentrations exceeded background levels, then the constituent was retained and evaluated for potential ecological risks. Table 3.1 of the BLRA summarizes the characterization results for key constituents. Section 3.3 and Table 3.2 of the 1996 BLRA identified ecological constituents of potential concern (E-COPCs) for those contaminants that, on average, exceeded background ground water concentrations. They are ammonium, calcium, cadmium, cobalt, iron, lead-210, magnesium, manganese, nickel, polonium-210, potassium, silica, sodium, strontium, sulfate, thorium-230, uranium, and zinc.

These contaminants became the focus for analysis in contaminated media. Because soils were remediated to standards in 40 CFR 192 under the surface remediation program, both soils and air are eliminated as contaminated media. However, ground water does present a possible exposure route. The primary concern is the possibility that contaminated ground water may be hydraulically connected to surface water, thereby creating the potential to contaminate adjacent streams, rivers, or ponds. Because the Gunnison River, Tomichi Creek, a campground pond, and Valco ponds are close to the ground water contamination, they are included for evaluation (Figure 3-2). Therefore, ground water, surface waters, and associated sediments are the media that will be the focus for purposes of the ERA. These media were selected because both direct and indirect pathways to ecological receptors are possible.

Ground water data were used to determine E-COPCs for terrestrial receptors. Surface water and sediment sampling was conducted for determining E-COPCs for primarily aquatic receptors. This section summarizes data collection efforts reported in Sections 3.0 and 7.0 of the BLRA.

On the basis of the identified E-COPCs, surface water sampling locations were established in the Gunnison River, Tomichi Creek, a campground pond, and the Valco pond. Table 4-8 identifies surface water sampling locations for the E-COPCs as shown on Figure 3-2. Filtered surfaced water samples were collected at four locations from 1989 through 1993 and at one location from 1989 through 1995. Unfiltered samples were collected at locations 775, 776, 778, and 779 in October 1990. Locations 775-778 were not sampled after the 1993 sampling event. Location 779 continued to be sampled until October 1995.

*Table 4-8. Summary of Surface Water Sampling Addressed in the BLRA*

Location No.	Medium	Location	Purpose/Sampling Period
775	Surface water	Gunnison River	Background concentrations (upstream) 1989-1993
776	Surface water	Gunnison River	COPC concentrations (downstream) 1989-1993
777	Surface water	Tomichi Creek	COPC concentrations (downstream) 1989-1993
778	Surface water	Tomichi Creek	Background concentrations (upstream) 1989-1993
779	Surface water	Campground pond	COPC concentrations (pond) 1989-1995

Surface sampling locations 780, 792, and 795 (Table 4-9) were not included within the scope of the BLRA but are included here to comprehensively evaluate potential risks.

*Table 4-9. Summary of Surface Water Sampling Locations Not Addressed in the BLRA*

Location No.	Medium	Location	Purpose/Sampling Period
780	Surface water	Valco pond	Evidence of ground water COPCs influencing pond water. 1990-1995
792	Surface water	Gunnison River	Background concentrations (upstream from location 775) 1997-Present
795	Surface water	Gunnison / Tomichi Creek confluence	COPC concentrations (downstream from location 776) 1997-Present

Location 780 was sampled annually from 1990 to 1995. Locations 792 and 795 have been sampled annually from 1997 to the present. No explanation was found in site documentation as to the rationale for exclusion of location 780 data in the BLRA, nor for the addition of locations 792 and 795 in 1997. It is assumed that the latter two locations were established because the original Gunnison River locations (775 and 776) could not be located or confirmed in the field, and no data had been collected from these locations since 1993. Table 4-10 summarizes those E-COPCs that were found to be above background for all surface water sampling locations. If no X appears in a box, the contaminant concentration did not exceed background concentrations.

Table 4-10. Summary of Downstream or Pond Surface Water Sampling Results That Exceeded Surface Water Background Concentrations (based on average concentration)

E-COPC	776 <sup>a</sup>	777 <sup>b</sup>	779 <sup>c</sup>	780 <sup>d</sup>	795 <sup>e</sup>
Ammonium					
Calcium		X		X	
Cadmium					
Cobalt				X	
Iron			X		
Lead-210					
Magnesium		X		X	
Manganese				X	
Nickel					
Polonium-210					
Potassium				X	
Silica	X				Note <sup>f</sup>
Sodium				X	
Strontium					
Sulfate		X		X	
Thorium-230					
Uranium				X	
Zinc			X		

<sup>a</sup>Results compared to background at location 775

<sup>b</sup>Results compared to background at location 778

<sup>c</sup>Results compared to background at location 775 and 778

<sup>d</sup>Results compared to background at location 792

<sup>e</sup>Results compared to background at location 792

<sup>f</sup>Silica was not sampled for at this location.

Sediment samples were collected in 1993 at locations 775 through 779. The BLRA states that only manganese, molybdenum, uranium, and zinc were sampled; however, no rationale is provided as to why these constituents were selected. It is assumed these metals were identified as a potential concern. No documented sediment sampling for E-COPCs was conducted at locations 780, 792, or 795. Table 4-11 summarizes the sediment sample results.

Table 4-11. Summary of Sediment Sampling Results That Exceeded Background Sediment Concentrations

E-COPC	776	777	779
Manganese		X	
Molybdenum			
Uranium		X	
Zinc		X	

#### 4.5.2 Biotic Sampling and Analysis

There is no information in the BLRA or site documents addressing chemical analysis of plants. This may be due to the lack of evidence that plants are in contact with either contaminated ground water or surface water.

Chemical analyses of fish tissue samples were conducted for fish that were caught from the Gunnison River, Tomichi Creek, and the campground pond. The purpose of the analyses was to determine any potential human health risks as a result of fish ingestion. No screening level assessment for ecological risks was addressed in the BLRA. It is assumed that data collected at that time did not support the need for further assessment. No biotic sampling was conducted in the Valco pond, which is known to contain fish populations and is used for sport fishing.

#### 4.6 Water Quality Sampling

Routine water quality sampling was performed in October 1999 and included 41 DOE monitor wells and two surface water locations. Results are included in the SEE-UMTRA database, and selected parameters are provided in Appendices D, E, and F. Complete water quality data are on a CD attached to this document.

The "buffer zone" domestic wells were also sampled in October 1999 according to the Water Sampling and Analysis Plan (DOE 1995). Results were well below action levels prescribed by CDPHE.

#### 4.7 Bioremediation Sampling

Sediment sampling at several locations was performed for the Natural and Accelerated Bioremediation Research field effort. The objective of this sampling was to characterize biotransformations occurring at the site which would enable predictions of natural bioremediation under field conditions. Backhoe samples were taken adjacent to the wells that were installed for the aquifer pumping tests at three locations downgradient from the former processing site and from one location in the southwest part of the site. Samples were also taken from several intervals during drilling of one of the wells. Sample recovery was good because the SONIC drilling method captures a 3½-inch core of the material penetrated. Ground water samples were also collected from the well. The vicinity of monitor well 136 was of particular interest because sulfate reduction had been observed there.

Ground water was also analyzed on site during the aquifer pumping tests in wells 044 and 047 to assess changes in water quality over time while pumping the wells (DOE 2000c). Ground water chemistry parameters included uranium, nitrate/nitrite, ammonium, sulfate, alkalinity, conductivity, pH, and ORP. Overall, concentrations of all constituents remained reasonably constant during both pumping tests. Water chemistry was similar between the two wells, but well 047 was somewhat higher in sulfate concentration and lower in ORP. Apparently there was little chemical stratification over the depth range that was affected by the pumping tests.

End of current text

## 5.0 Conceptual Site Model

The conceptual site model is based on the existing characterization information and will be used to determine site conditions, fate and transport of contaminants, evaluate the potential for risk to human health and the environment, assess manageable uncertainties, and determine the compliance strategy for ground water protection at the site.

### 5.1 Hydrogeology

#### 5.1.1 Geologic Setting

The Gunnison processing site is located on the northern margin of the San Juan Mountains (that formed during the Laramie orogenic event) and in the eastern edge of the West Elk volcanic field of Tertiary age. Widespread recent floodplain and terrace deposits (referred to as alluvium) associated with the Gunnison River and Tomichi Creek underlie the Gunnison processing site and surrounding area (Figure 5-1). The alluvium is complex and is composed of poorly sorted sediments ranging from clay-sized material through gravel with cobbles and occasional boulders and generally becomes more clayey with depth. The alluvium ranges from 72 ft to greater than 130 ft in thickness and extends beyond the bottom of most of the wells installed by DOE (Figure 5-2). Underlying the alluvium is a discontinuous unit of unknown extent and thickness identified as the Brushy Basin Member of the Jurassic Morrison Formation. This formation is not a significant water-bearing unit and is considered the lower confining unit of the alluvial aquifer. Lithology from this unit penetrated in deeper wells is a soft to moderately hard shale. The formation is composed of low-permeability shale that separates the overlying alluvium from the deeper units.

#### 5.1.2 Hydrologic System

##### 5.1.2.1 Alluvial Aquifer

Ground water occurs under unconfined conditions in the alluvial aquifer beneath and downgradient from the Gunnison site. Much of the information regarding the alluvial aquifer is derived from water level data collected from the network of monitoring wells located in the vicinity of the site. At five locations (the 013/113 cluster, 145/147 cluster, 096/196/197 cluster, 088/188/189 cluster, and 061/160/161 cluster), water levels collected from wells screened over different zones of the alluvial aquifer have been continuously monitored by dataloggers since October 1994. Across the site, the depth to the top of the water table ranges from approximately 2 to 11 ft. The ground water elevations generally peak in the spring and summer months and may fluctuate more than 10 ft over the course of a year (Figure 5-3).

Vertical ground water gradients within the alluvial aquifer are generally downward. As shown in Figure 5-3, at each of the five locations the higher ground water surface elevations are generally associated with the wells screened over the shallow portion of the aquifer, followed by the elevations measured in the wells screened over deeper zones of the aquifer. At various times during the year, the vertical gradients in the past have changed from downward to upward, as exhibited by the 096/196/197 cluster.

The general ground water flow direction is toward the southwest at an average horizontal gradient of 0.005. Figure 5-4 shows the average ground water flow direction based on May 1999

data. There appears to be minimal difference between the various depths within the aquifer; the deeper zones exhibit a similar ground water flow direction and gradient.

The Valco, Inc. gravel pit operation to the south influences the ground water flow regime in the immediate vicinity of the site. From mid-May through August the excavation is dewatered by pumping 2,000 to 4,000 gpm on a continual basis, with all water discharged into an adjacent pond. This dewatering activity creates a steeper ground water gradient in the vicinity of the excavation and tends to create a ground water mound to the south.

Hydraulic conductivity estimates range from 103 to 171 ft/day for the alluvial aquifer (Appendix G Calculation Set U0082900). Based on a ground water gradient of 0.005 and an estimated effective porosity of 0.27, the average linear ground water velocity ranges from 1.9 to 3.2 ft/day.

#### 5.1.2.2 Surface Water Interaction

Both Tomichi Creek and the South Fork of the Gunnison River significantly influence the alluvial aquifer. Daily mean streamflow data in cubic feet per second (cfs) are available from the U.S. Geological Survey (USGS) gaging stations located on the Gunnison River north of the site (station 09114500) and on Tomichi Creek south of the site (station 09119000). As shown in Figure 5-5, there is a correlation between the ground water elevation and the Gunnison River and Tomichi Creek streamflow. As a general rule, the well clusters located adjacent to the Gunnison River respond more quickly to fluctuations in the river stage.

#### 5.1.2.3 Aquifer Recharge/Discharge

The Gunnison River and Tomichi Creek are the main recharge sources for the alluvial aquifer. Other sources include flood irrigation during the late spring to late summer on the pasture area southwest (downgradient) of the site, and irrigation of the golf course, which applies up to 200,000 gallons per day (gal/day) during the spring and summer months to the area west of the site. Snowmelt and precipitation infiltration also recharge the alluvial aquifer to a lesser extent.

The ground water surface elevation and streamflow data suggest that the high ground water elevations measured in the summer and fall and the lower elevations in the winter and early spring are influenced by the Gunnison River and Tomichi Creek stages. Figure 5-6 shows the ground water temperature variations plotted with water table fluctuation from October 1998 through January 2000. Sitewide, ground water temperatures range from 2 to 14 °C (36 to 57 °F) over the course of 1 year. This range of temperature suggests alluvial aquifer recharge as a function of surface water. As the figure shows, there is a lag of approximately 3 to 4 months between the maximum ground water level (May through June) and the maximum temperature (September through October).

Discharge from the shallow zone (less than 20 ft below ground surface [bgs]) of the alluvial aquifer is to the Gunnison River and Tomichi Creek at various times of the year. Transpiration from the irrigated pasture downgradient of the site also provides discharge from the aquifer.

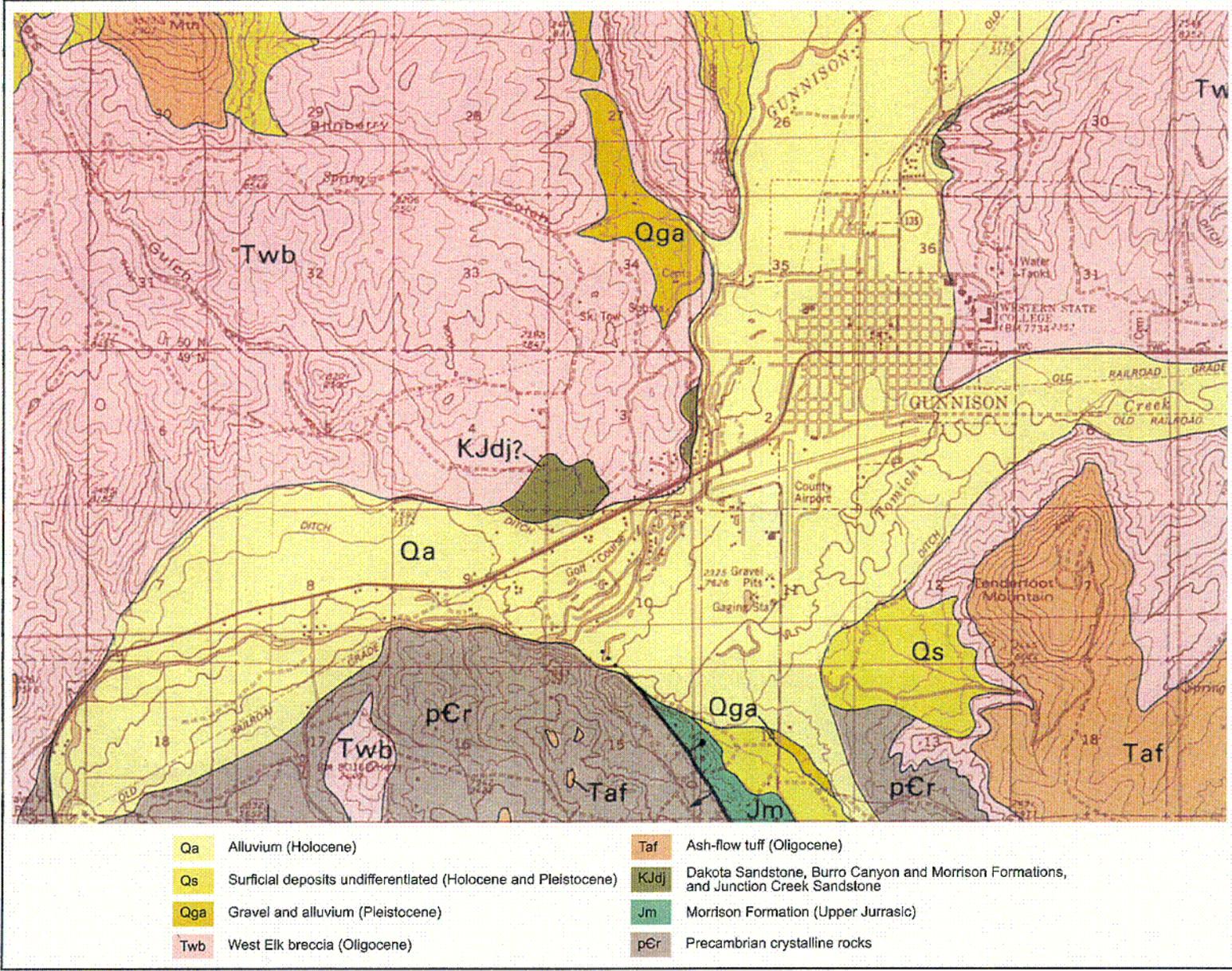


Figure 5-1. Geologic Map of the Gunnison, Colorado, Area

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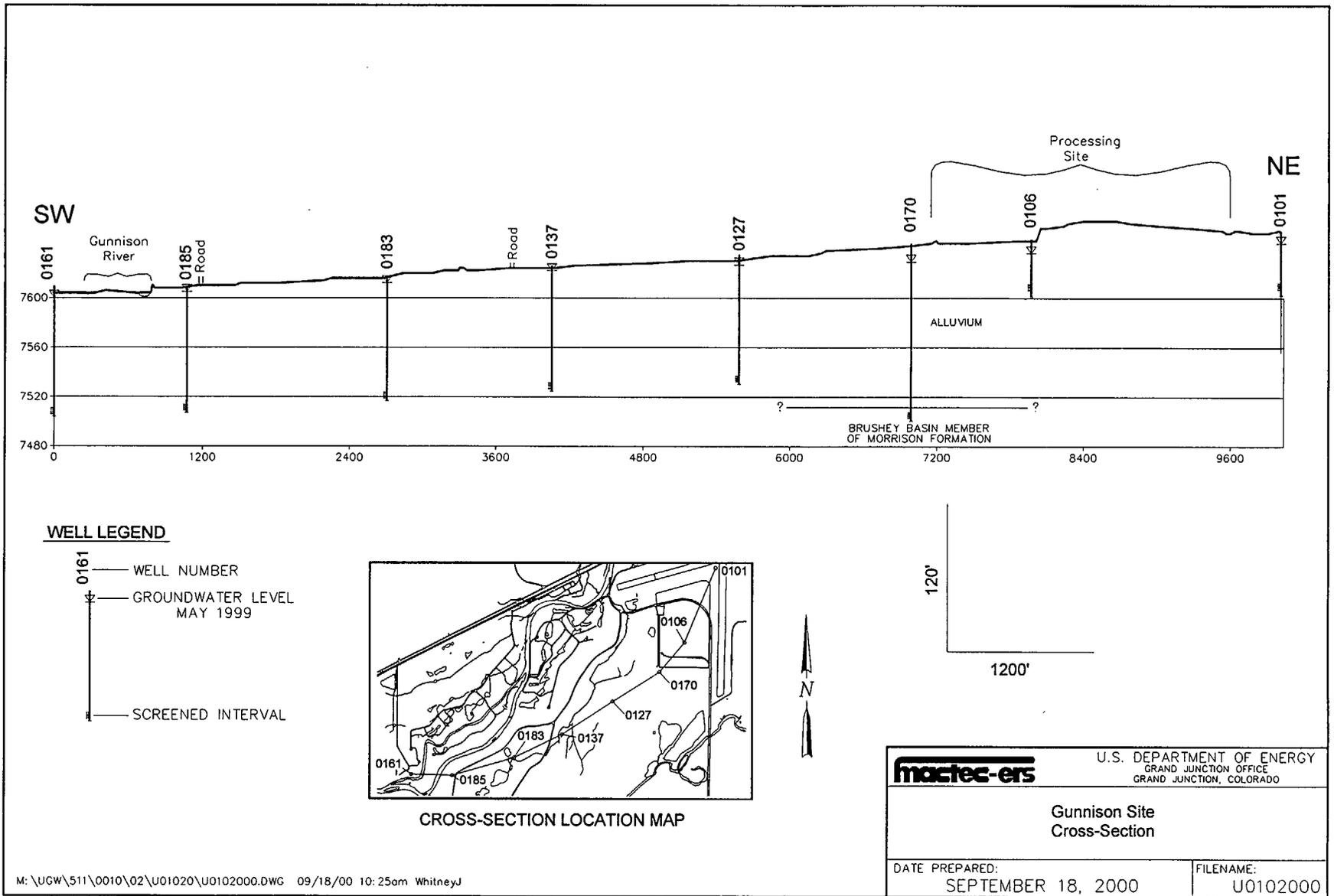


Figure 5-2. Cross Section of the Gunnison Site, Colorado

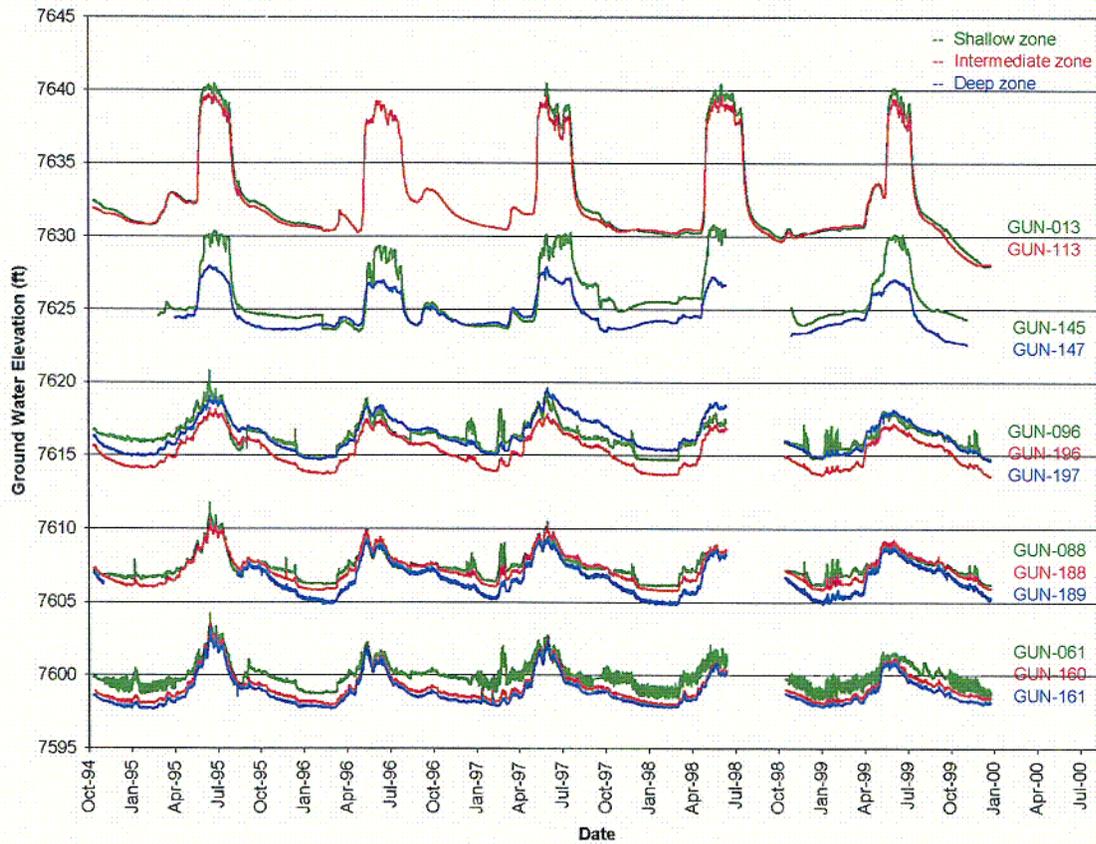


Figure 5-3. Ground Water Elevations in Different Zones of the Alluvial Aquifer

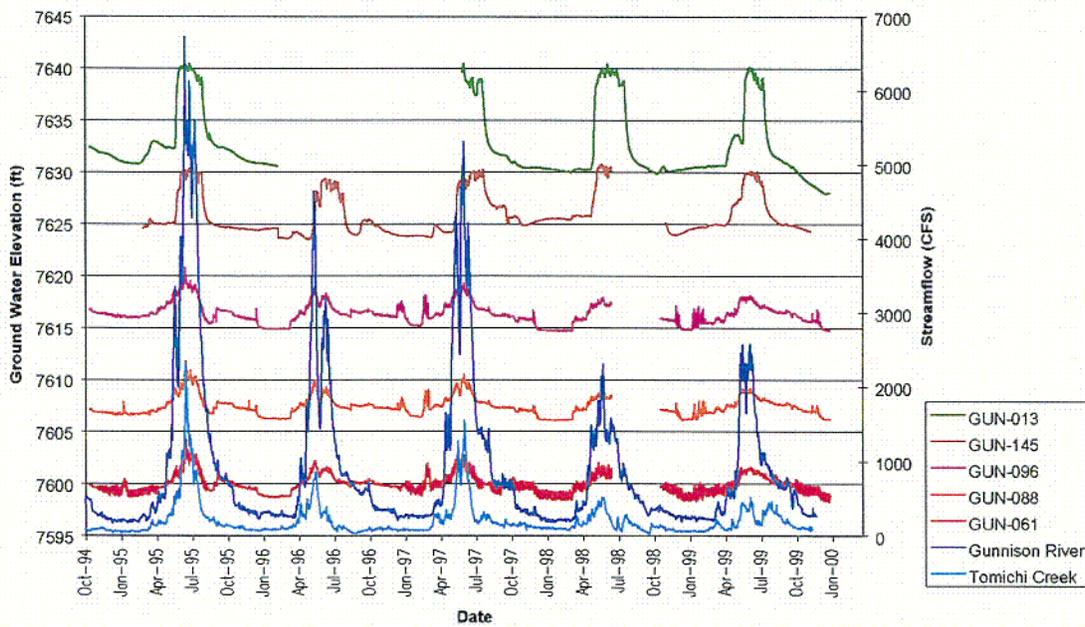
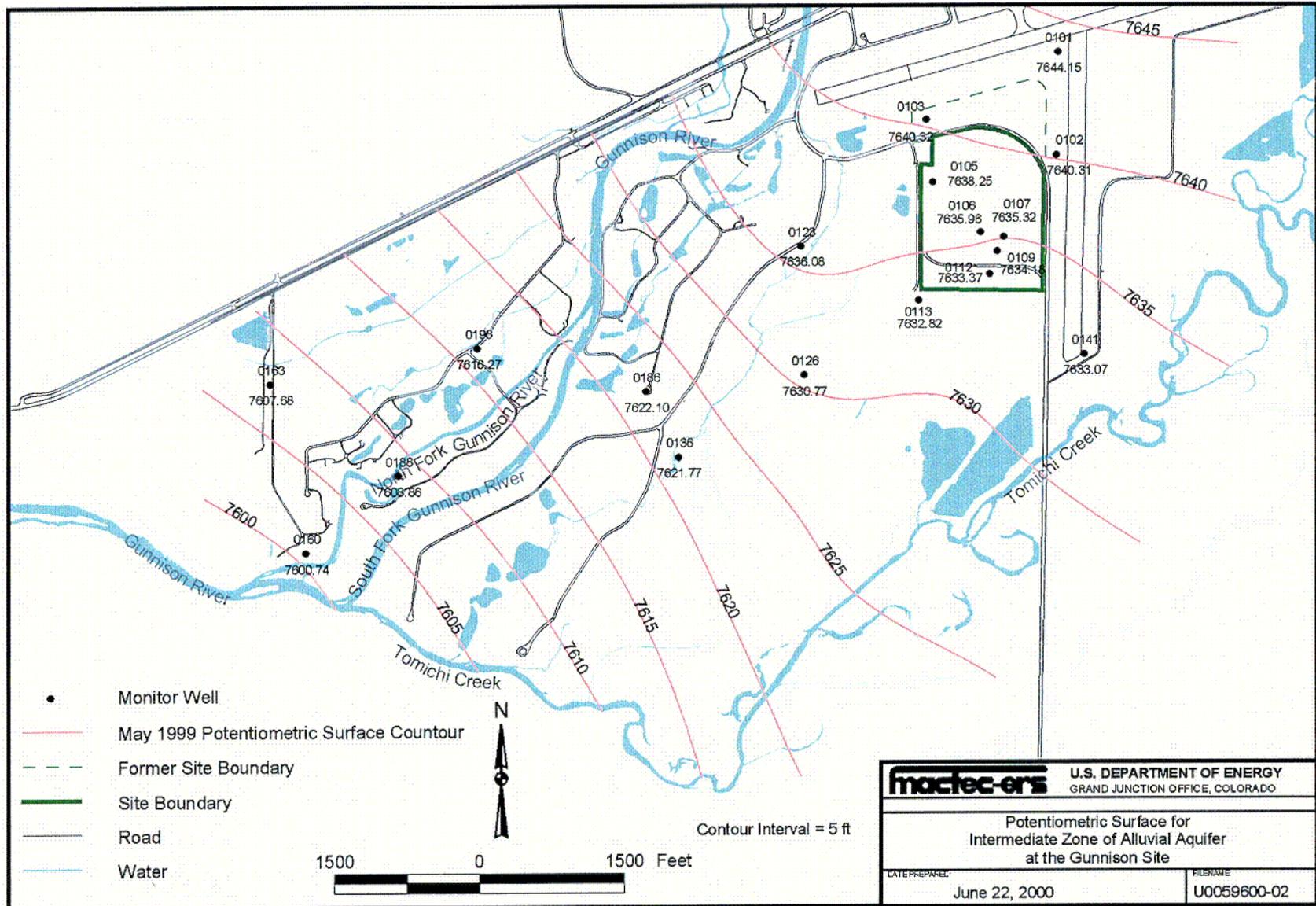


Figure 5-5. Ground Water Elevations in the Shallow Zone of the Alluvial Aquifer and Streamflow in the Gunnison River and Tomichi Creek

C07



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Figure 5-4. Potentiometric Surface for Intermediate Zone of Alluvial Aquifer at the Gunnison Site

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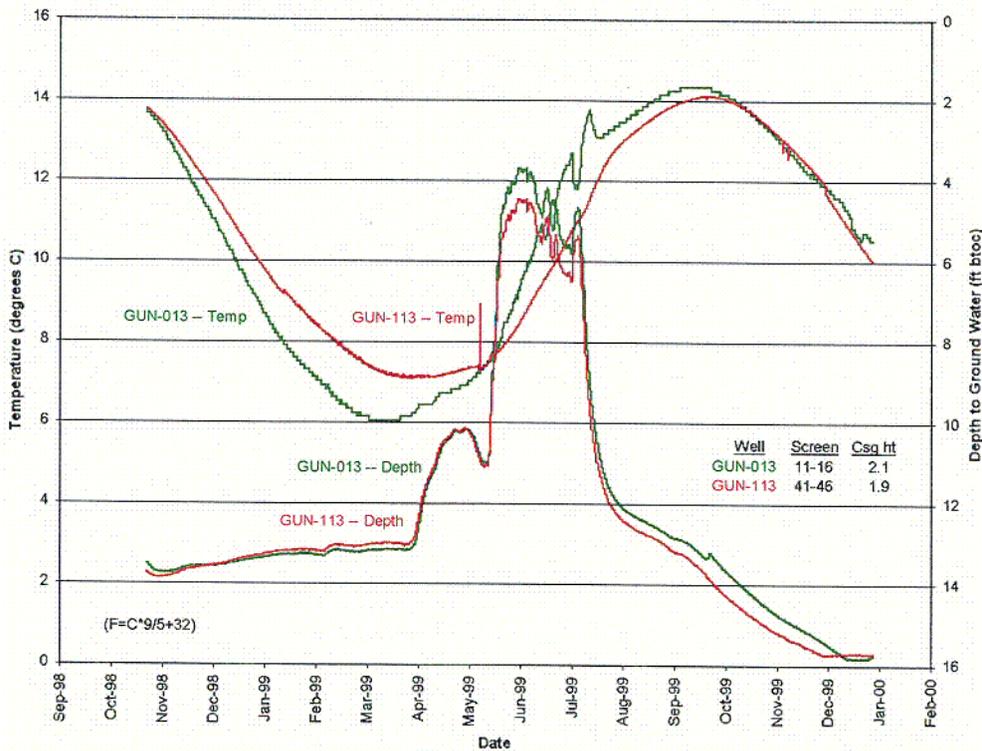


Figure 5-6. Ground Water Temperature and Depth at the Gunnison Site

## 5.2 Geochemistry

DOE collected ground water, surface water, and soil data at the Gunnison site from 1985 to 1999. Data from those sampling events were used to assess the geochemical condition at the Gunnison site. Data are available in the SEE-UMTRA database and locations of recent and abandoned wells are shown on Plate 1. A summary of recent surface and ground water sample analyses from 1997 to 1999 is presented in Appendix D. The more extensive and comprehensive data set is presented in Appendices E and F (CD-ROM format) attached to this document.

Data used to assess the current ground water quality were from the two most recent routine sampling events in May and October 1999. Because the seasonal water table fluctuation of approximately 10 ft might affect concentrations of elements in the ground water, an average value for both sampling events was used to evaluate the ground water quality. If no data for the two most recent sampling events were available, the last available data set was used to assess the water quality.

C09

### 5.2.1 Surface Water Quality

Surface water is present in the Gunnison River and Tomichi Creek as well as in ponds at the Valco, Inc. gravel pit and the KOA campground near the former millsite. Surface water samples were taken in May and October 1999 from the Gunnison River at sampling point 792 upgradient and at sampling point 795 downgradient of the millsite. Table 5-1 summarizes the surface water quality for the Gunnison site for selected constituents.

Table 5-1. Summary of Surface Water Quality at the Gunnison Site

Analyte <sup>a</sup>	Sampling Point					
	792 <sup>b</sup>	795 <sup>b</sup>	778 <sup>c</sup>	777 <sup>c</sup>	779 <sup>d</sup>	780 <sup>e</sup>
	Gunnison River		Tomichi Creek			
	Near Hwy 50 Bridge	Near well 188	Gold Basin Road Bridge	End of Fairway Lane	KOA Pond	Valco Pond
Cadmium	< 0.001	< 0.001	< 0.001	< 0.001		
Magnesium	4.9	5.0	10.4	11.3	13.3	20.9
Manganese	0.009	0.015	0.05	0.05	< 0.01	0.03
Nitrate	0.20	0.19	1	3.5	n./a.	n./a.
Selenium	< 0.001	< 0.001	0.005	0.005	n./a.	n./a.
Sulfate	12.9	12.6	17	24	17.2	181
Radium-226 and -228 <sup>f</sup>	1.09	1.10	n./a.	n./a.	n./a.	n./a.
Iron	0.025	0.029	0.1	0.05	0.03	0.03
Uranium	< 0.001	< 0.001	0.003	0.003	0.02	0.052
Vanadium	n./a.	n./a.	0.01	0.01	n./a.	n./a.

<sup>a</sup>Concentrations in mg/L except radium in pCi/L

<sup>b</sup>currently sampled May/Oct 99

<sup>c</sup>last sampled 8/30/89

<sup>d</sup>last sampled 10/9/95

<sup>e</sup>last sampled 5/10/95

<sup>f</sup>combined Radium-226 and -228

n./a. no data available

Surface water quality is generally good. The average pH in the Gunnison River is 7.5; average total dissolved solids (TDS) concentration is 105 mg/L, and alkalinity as CaCO<sub>3</sub> averages 75 mg/L. Uranium concentrations and metal concentrations in the stream water are low. An analysis from 1995 from a pit on Valco, Inc. property showed uranium concentrations above 0.044 mg/L.

### 5.2.2 Ground Water Quality

Ground water pH at the Gunnison site averages 7.3 and ranges between 5.2 and 8.5. Only location 170 had an exceptionally high pH of 11.3. TDS concentrations range from 110 to 2,280 mg/L. Highest concentrations were detected in ground water beneath the millsite. The geochemical conditions are intermediate to oxidizing, and the ORP ranges from -214 to 276 millivolts (mV). Major ions in the ground water are calcium and magnesium. The alkalinity averages 200 mg/L CaCO<sub>3</sub> but can be as high as 1,075 mg/L CaCO<sub>3</sub> on the west side of the Gunnison River. The ground water beneath and downgradient of the millsite is dominated by sulfate.

### 5.2.2.1 Background Ground Water Quality

Background ground water quality is defined as the quality of water in portions of the aquifer that were unaffected by milling activity. Wells 001, 101, 002, and 102 are upgradient of the millsite and represent background ground water quality at the Gunnison site. Table 5-2 lists geochemical parameters such as pH, ORP, and TDS as well as constituents commonly present at uranium mill tailings sites. The average pH in the background wells is 7.3, alkalinity is 215 mg/L CaCO<sub>3</sub>, and TDS is 312 mg/L. The ground water is dominated by calcium. The BLRA (DOE 1996a) identified uranium, sulfate, and manganese as the COPCs at the Gunnison site.

Table 5-2. Background Concentrations of Constituents in Ground Water at the Gunnison Site

Analyte <sup>a</sup>	UMTRA MCL	Background <sup>b</sup>	Range
Cadmium	0.01	< 0.001	< 0.001 – 0.002
Iron		0.18	0.006 – 10.3
Magnesium		15.7	5.58 – 59.3
Manganese		0.03	< 0.001 – 18.6
Nitrate	44	4.4	< 0.01 – 6.38
Radium-226 and -228 <sup>c</sup>		0.92	0.52 – 3.03
Selenium	0.01	< 0.001	< 0.001 – 0.004
Sulfate		20.0	11.6 – 1810
Uranium	0.044	0.003	< 0.001 – 0.95
pH		7.3	5.2 – 11.3
ORP (mV)		14	-214 – 276
TDS		312	110 – 2280

data: average May/October 1999

<sup>a</sup>Concentrations in mg/L except radium in pCi/L

<sup>b</sup>average from well 001, 101, 002, 102

<sup>c</sup>combined <sup>226</sup>Ra + <sup>228</sup>Ra

### 5.2.2.2 Fate and Transport of COPCs

Some constituents are readily transported by ground water, whereas others are strongly partitioned on immobile solid mineral phases. The rate of contaminant migration and the concentration in the ground water are controlled by the biogeochemical nature of the aquifer.

Manganese mobility is related to the ORP of a soil or sediment. Manganese forms oxide minerals under oxidizing conditions and is soluble under more reducing conditions. Therefore, the more oxidized a sediment is, the more likely it is to have higher concentrations of manganese. Manganese occurs in the 2+ and 4+ oxidation states at the Gunnison site. In the dissolved state, it is present mainly as Mn<sup>2+</sup> ion. Its redox chemistry is similar to that of iron. Manganese will also partition to sediment by substituting for calcium in calcite. The concentrations of manganese in ground water samples from the Gunnison site range from < 0.001 mg/L to 18.6 mg/L.

In alluvial ground water, dissolved sulfur occurs mainly as the unassociated sulfate ion (SO<sub>4</sub><sup>2-</sup>). The precipitation of gypsum (CaSO<sub>4</sub>) or sodium sulfate (Na<sub>2</sub>SO<sub>4</sub>) can partition significant amounts of sulfate into the solid phase. The concentrations of sulfate in solution will remain high even in the presence of these minerals. Much of the concentration gradient in ground water is caused by mixing with other ground water and dispersion. Under reducing conditions brought

about by microbial stimulation, sulfate can form sulfide that precipitates heavy metals and arsenic. Sulfate concentrations at the Gunnison site are as high as 1,800 mg/L.

Most naturally occurring uranium is either in the uranyl (6+) or the uranous (4+) oxidation state. The uranyl form is predominant in oxidized ground water. The uranyl ion forms strong aqueous complexes with carbonate, and uranyl bicarbonate [ $\text{UO}_2(\text{CO}_3)_2^{2-}$ ] is a dominant mobile species. Uranium adsorbs to ferric oxyhydroxide and clay minerals in soils and rocks. Under reducing conditions, uranium precipitates as uraninite ( $\text{UO}_2$ ), which has a low solubility. The reduction is catalyzed by microbial activity. Uranium concentrations in ground water samples at the millsite and downgradient exceed the UMTRA Project MCL of 0.044 mg/L.

### 5.2.2.3 Areal Extent of Ground Water Contamination

The spatial distribution of contamination is shown on plume maps for uranium, sulfate, and manganese in Figure 5-7, Figure 5-8, and Figure 5-9, respectively. The two most recent data sets were used to prepare the maps. Average uranium concentration from the May and October 1999 sampling was calculated for each well. Because wells with different depths are clustered at the Gunnison site, the maximum average concentration for each cluster was used for the calculation and is posted on the map. Contours were calculated using the kriging method. Because of insufficient data points southwest of the millsite, the contour lines were adjusted manually.

Maximum concentrations for uranium (0.912 mg/L), sulfate (1,295 mg/L) and manganese (17.75 mg/L) were detected in ground water at the millsite. Elevated concentrations are only present in shallow wells up to 30 ft in depth. The ground water flow from northeast to southwest forms a kidney-shaped plume area. The uranium plume in Figure 5-7 was extended to include well 183. Although a continuous plume area could not be inferred from the limited data between the millsite and monitor well 183, it was assumed that the concentration extends into the deeper part of the aquifer. Time series and a three dimensional model presented later show the westward extension of the plume.

A three dimensional graphic was used to visualize the movement of the uranium plume over time (Figure 5-10). Average uranium concentrations in ground water for the years 1990, 1995, and 1999 were used as input parameters for the kriging calculation. Areas where the concentrations exceed the MCL of 0.044 mg/L are colored yellow, orange, or red. A cut-off of 0.025 mg/L above background was chosen to distinguish uncontaminated from contaminated ground water. Figure 5-11 shows the uranium plume without the green coloration to show the higher contamination in the deeper part of the aquifer. Varying sampling frequency and data gaps can affect the shape of the plume; for example, the separated areas of contamination in the subsurface in 1990 as well as the separated areas in Figure 5-11 are artifacts resulting from data gaps. The main area of ground water contamination is the shallow ground water close to the millsite. The contamination moves farther downgradient toward the river. Flood irrigation of the pastures downgradient from the millsite might cause a downward gradient trend and might cause the contamination to be found in deeper wells. Figure 5-12 shows the extent of the uranium contamination greater than 0.02 mg/L for the years 1990, 1995, and 1999. The overlaid figures show that the plume migrated farther downgradient in the last 5 years.

Figure 5-13 through Figure 5-19 show the uranium, sulfate, and manganese concentrations over time for various locations. The time frame of the surface remediation is marked on the charts.

Figure 5–13 shows the concentrations in ground water at the millsite. Uranium concentrations in the shallow wells have been relatively constant over the past 10 years at about 1 mg/L. Even after completion of the surface remediation, uranium concentrations on site have not decreased considerably. Sulfate is present in the shallow wells as well as the deeper wells on site. Sulfate concentrations in ground water on site decrease slightly, as do the manganese concentrations. Manganese is predominant in the deeper wells, probably because of lower redox conditions causing a greater mobility of the element.

Well cluster 013, 113, and 170 is located downgradient just beyond the southwest boundary of the millsite. The time-concentration plots in Figure 5–14 illustrate that the surface remediation disturbed the geochemical conditions in the ground water. After surface remediation was completed the uranium concentrations decreased significantly and are currently below the MCL for wells 13 and 170. Well 113 is screened between 41 and 46 ft, and although concentrations are above the MCL, the trend shows a decrease through time. Manganese and sulfate concentrations show a similar decreasing trend.

Well cluster 125, 126, and 127 is located in the pasture about 1,500 ft downgradient of the millsite. Uranium concentrations in all three wells are currently below the MCL and continue to decrease (Figure 5–15). Higher uranium and sulfate concentrations are in well 127, the deepest well at that location (screened from 94 to 99 ft bgs).

Wells 181 and 183 are farther downgradient from the millsite. Well 183 is screened between 93 and 98 ft and shows increasing uranium concentrations (Figure 5–16) before and after surface remediation. Concentrations are currently as high as 0.05 mg/L. This well was included in the uranium plume map (Figure 5–7) because it showed elevated concentrations above the MCL for the last 10 years. The uranium contamination is present in the deeper part of the aquifer. Sulfate concentrations increased slightly over the last few years and are currently as high as 300 mg/L.

Wells 88, 188, and 189 between the north and the south fork of Gunnison River and the well cluster 60, 160, and 161 at the confluence of Gunnison River and Tomichi Creek show increasing uranium concentrations (Figure 5–17 and Figure 5–18). In both clusters the intermediate wells 160 and 188 are screened between 50 and 60 ft bgs. Uranium concentrations in well 188 are currently as high as 0.0045 mg/L. Sulfate concentrations in wells 188 and 189 have reached a plateau of 150 mg/L and 240 mg/L, respectively. Sulfate concentrations in wells 160 and 161 west of the river are still relatively low but are increasing.

Figure 5–19 shows the concentrations for uranium, sulfate, and manganese over time for wells 126, 186, and 196, which are screened between 53 and 58 ft bgs and are almost in a line from east to west across the Gunnison River. Uranium concentrations in well 126 vary between 0.015 mg/L and 0.06 mg/L, whereas concentrations in well 186 decrease slightly and have been below the MCL for the last 5 years. Ground water in well 196 has uranium concentrations comparable to background. From 1984 to 1997, sulfate concentrations in well 126 decreased from 900 mg/L to 47 mg/L but vary between 30 and 400 mg/L currently. Manganese concentrations have been below 0.3 mg/L for the last 16 years. Farther downgradient in well 196 uranium and sulfate concentrations remained low. In general, manganese concentrations in ground water west of the Gunnison River remained between 2 and 3 mg/L. If manganese in ground water at well 196 was mill related it might be residual contamination or from a different source. Ground water in well 163, which is located farther downgradient from well 196, has had low manganese concentrations for the last 15 years. This suggests that there might be another

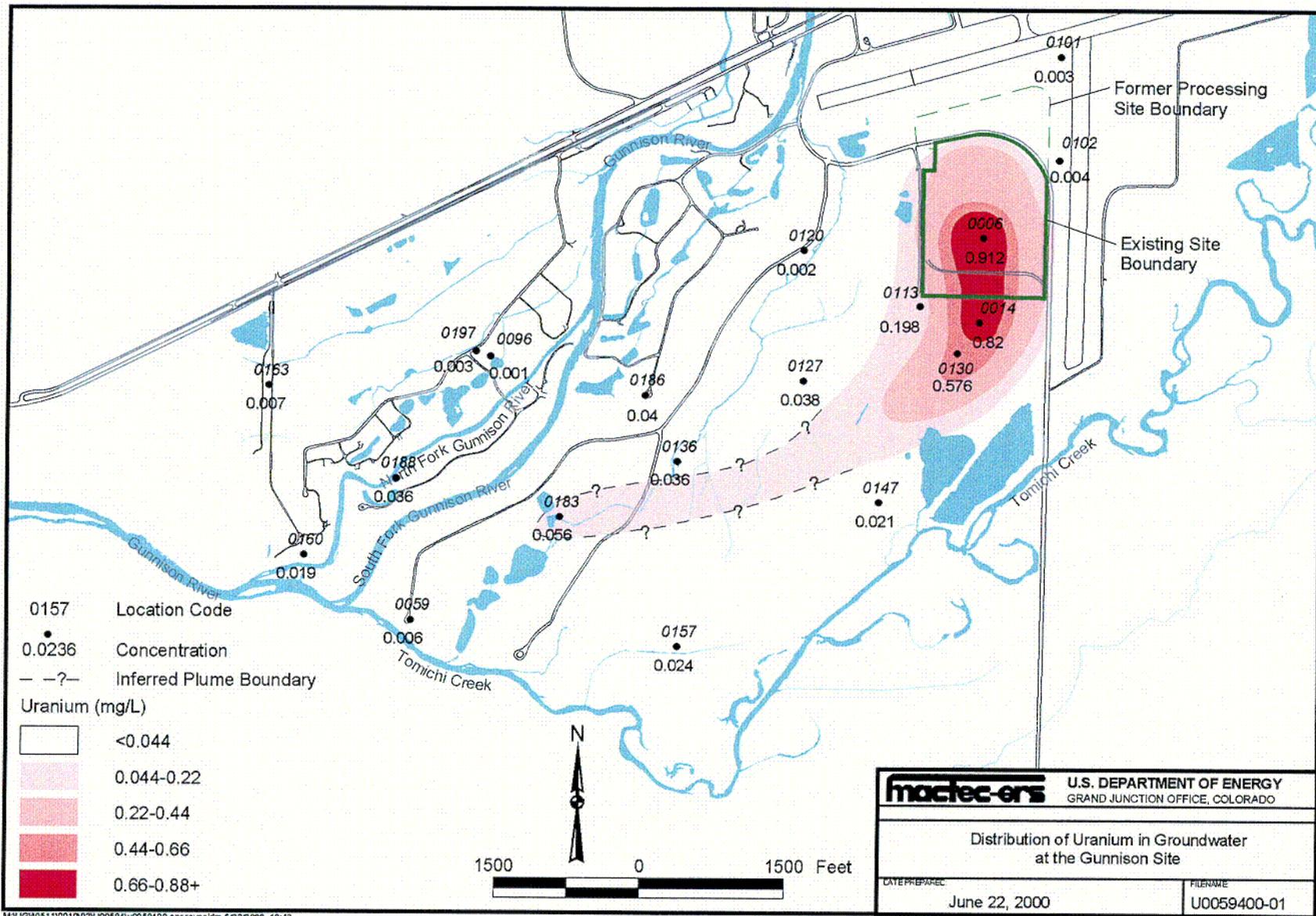
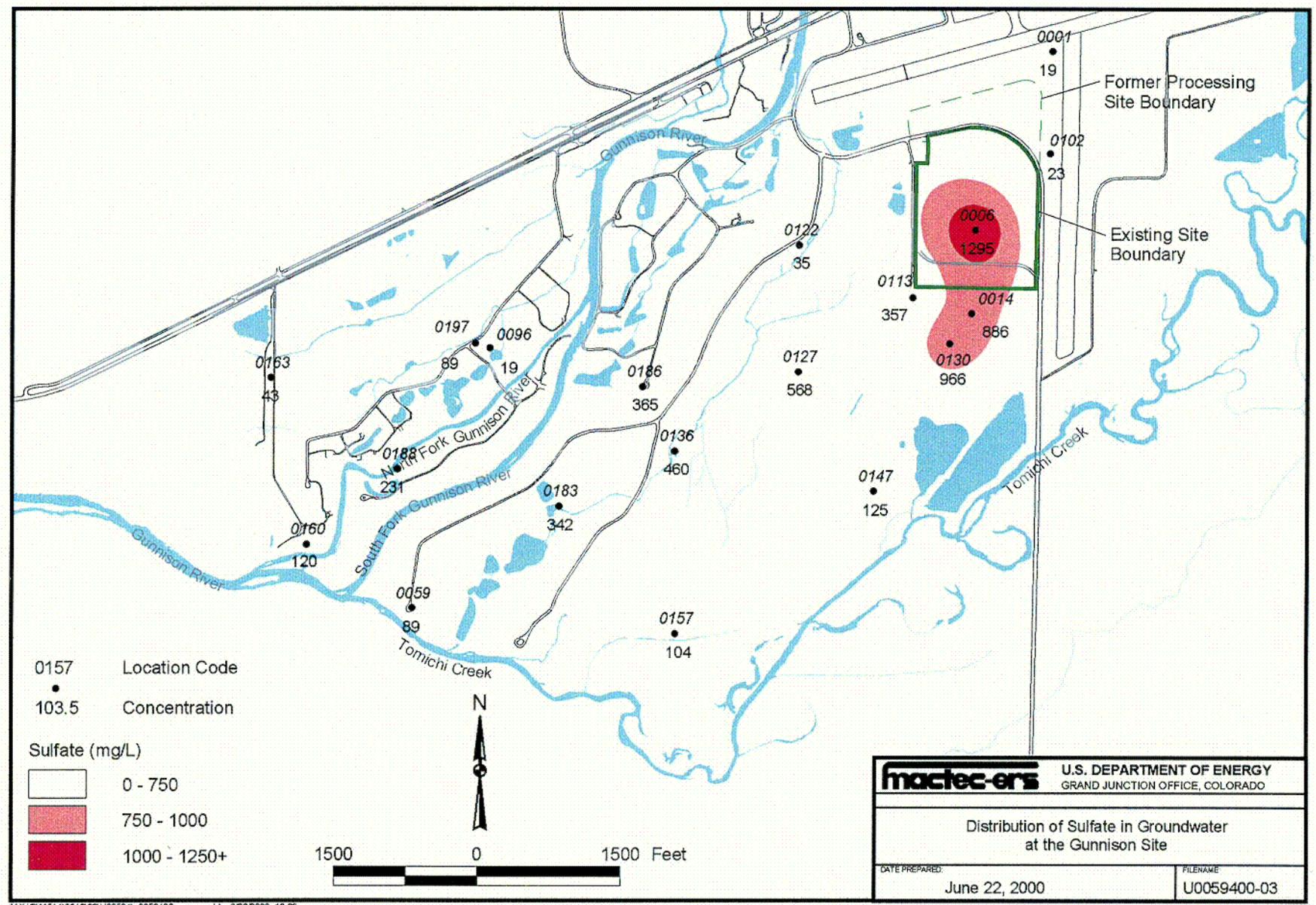


Figure 5-7. Distribution of Uranium in Ground Water at the Gunnison Site

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Figure 5-8. Distribution of Sulfate in Ground Water at the Gunnison Site

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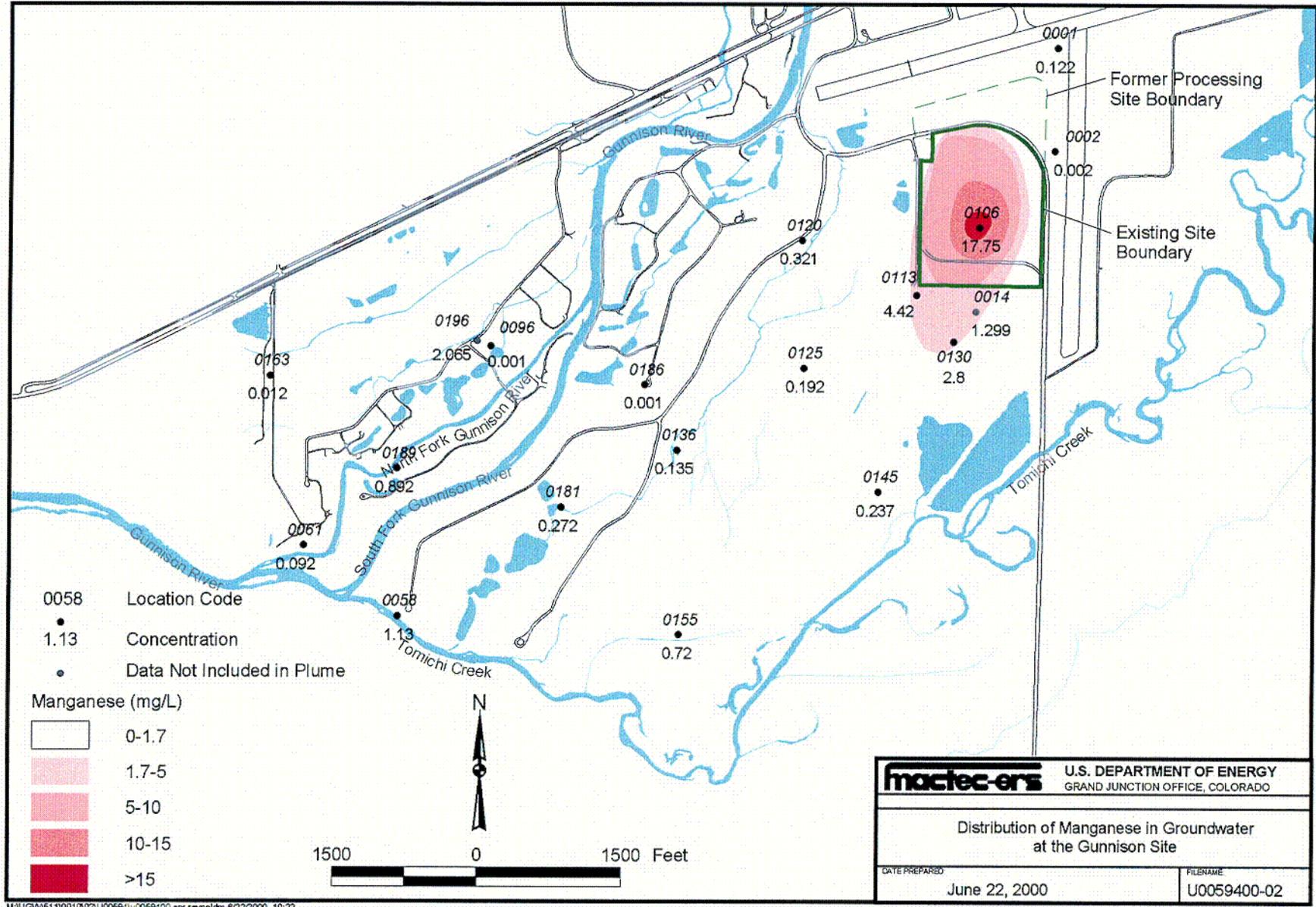


Figure 5-9. Distribution of Manganese in Ground Water at the Gunnison Site

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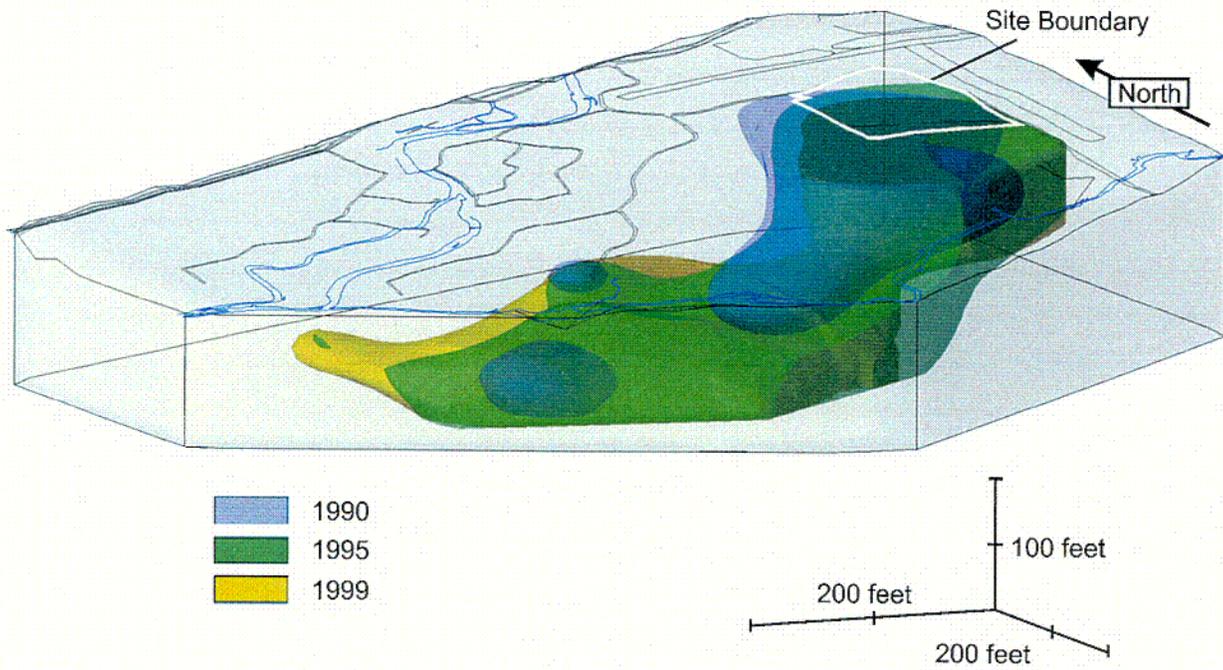


Figure 5-10. Migration of Uranium Plume in the Subsurface Over Time

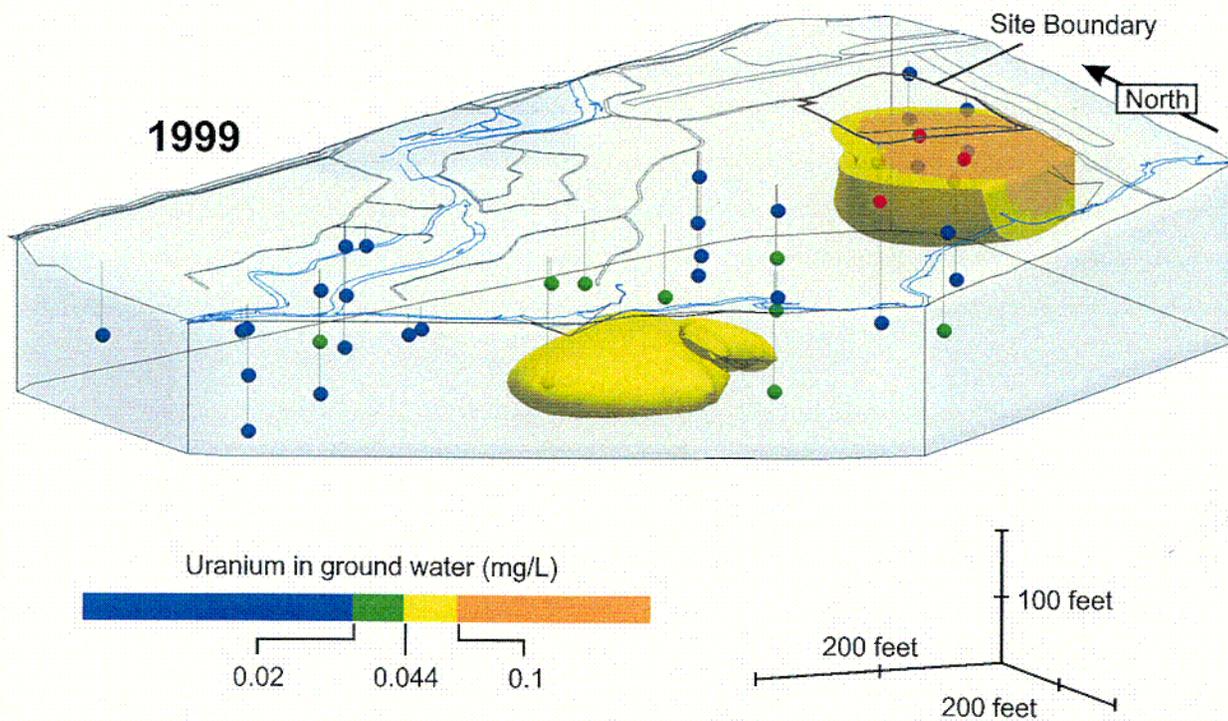
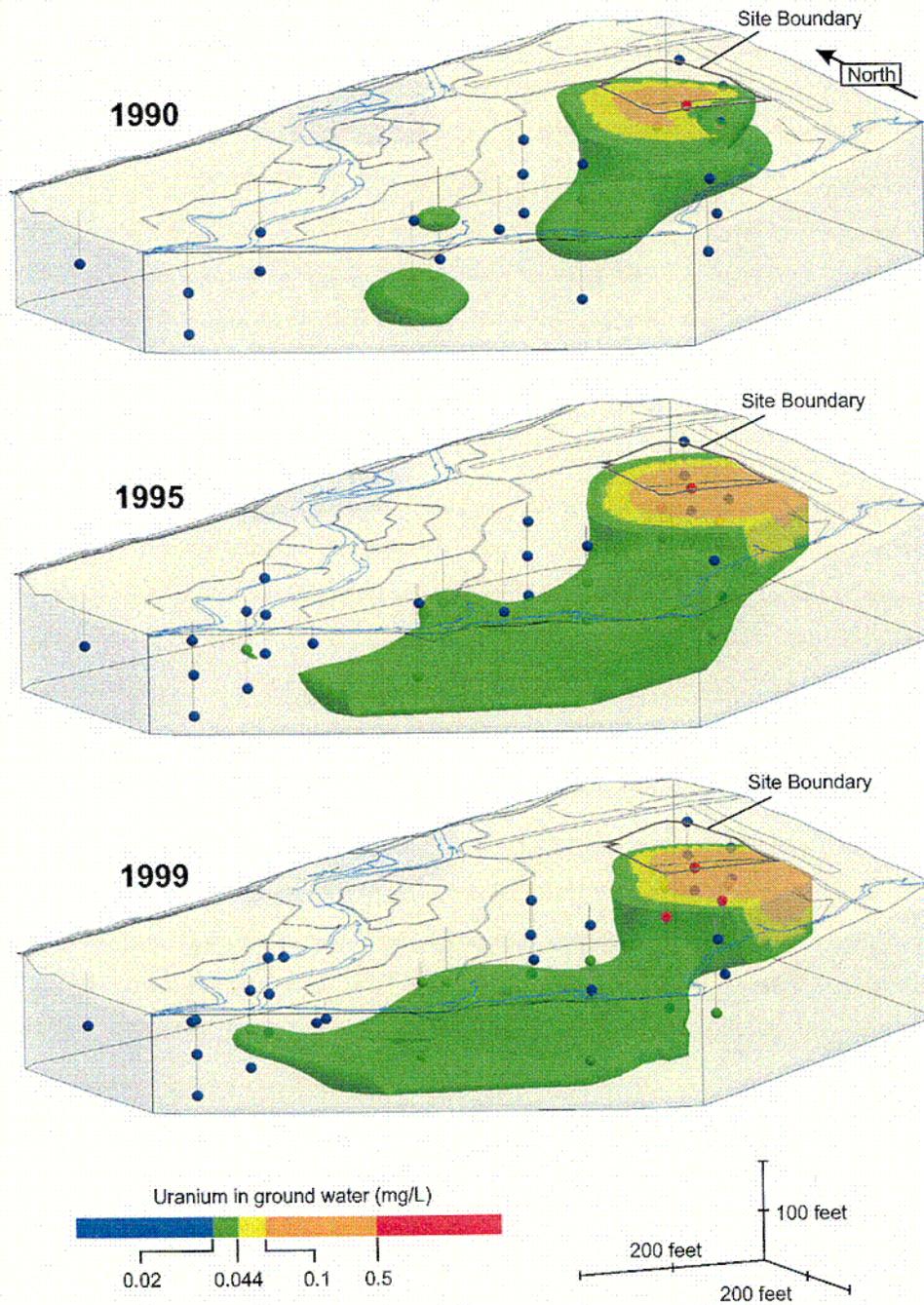


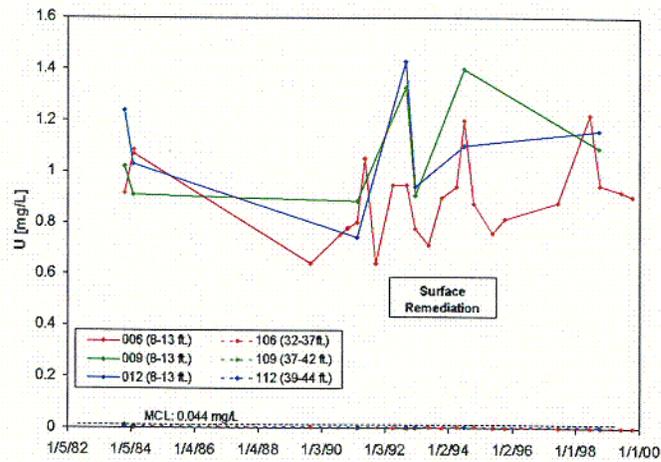
Figure 5-11. Uranium Concentrations >0.044 mg/L in Ground Water in 1999

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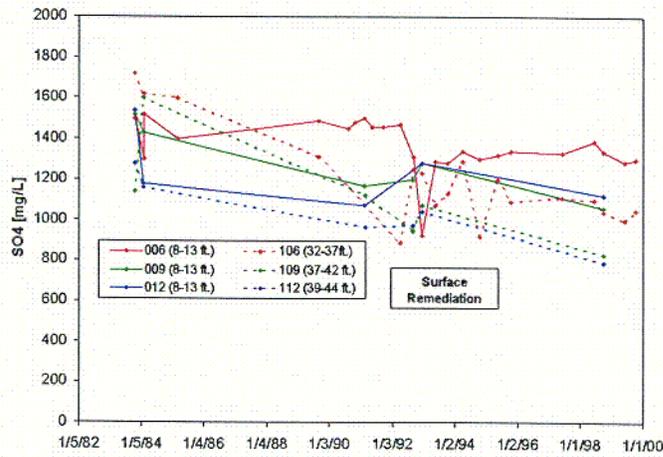


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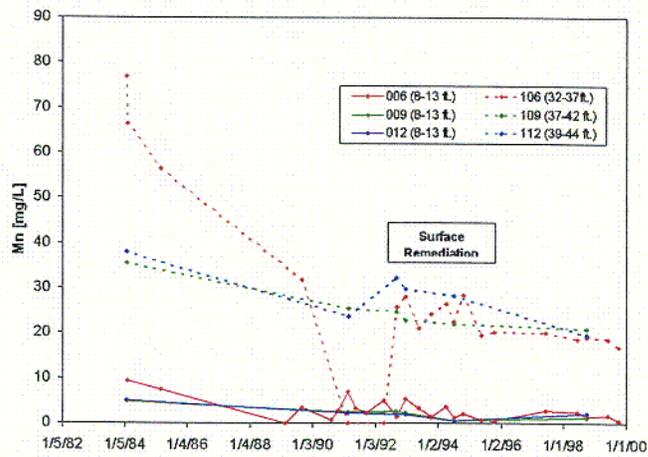
Figure 5-12. Extent of Uranium Concentrations >0.02 mg/L in Ground Water in 1990, 1995, and 1999



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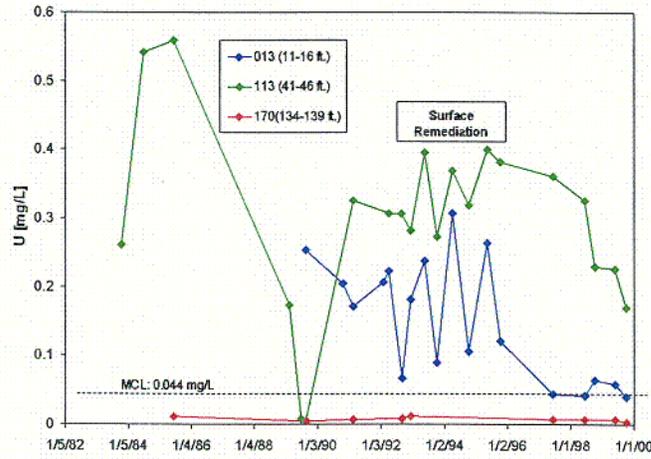
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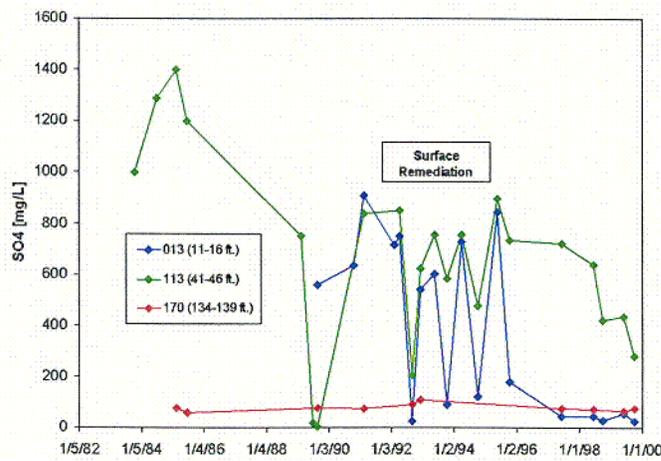
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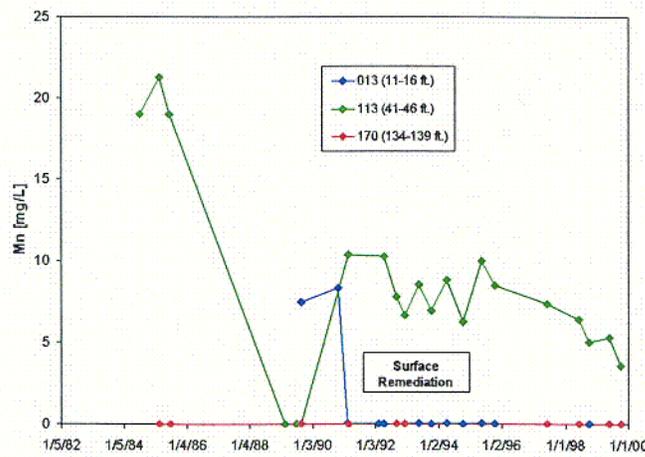
Figure 5-13. Ground Water Concentrations Over Time at the Millsite



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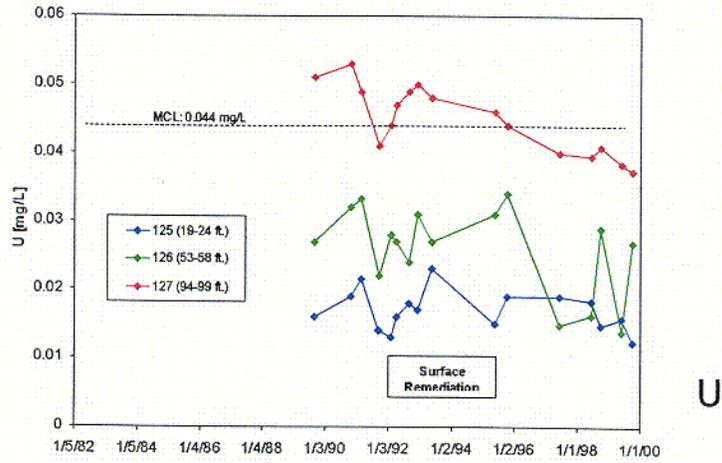
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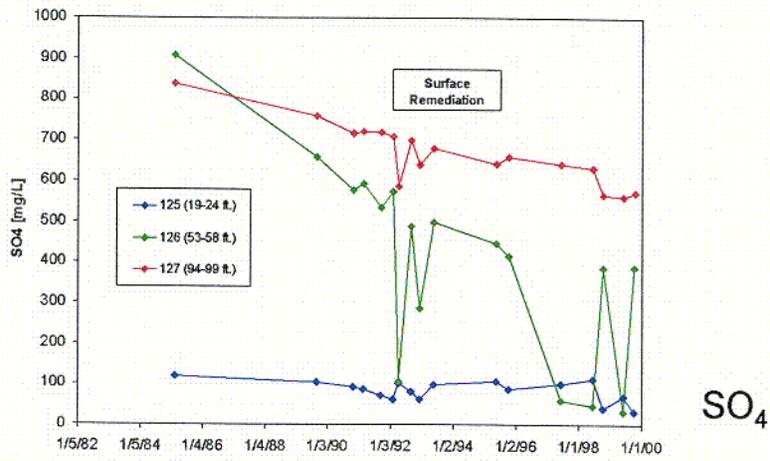
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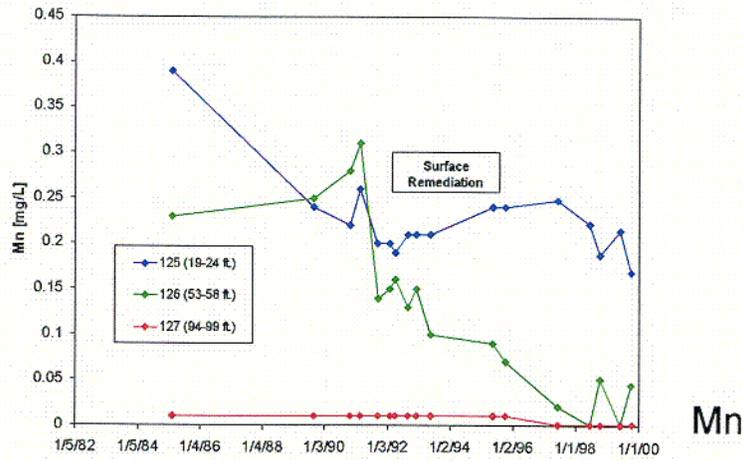
Figure 5-14. Ground Water Concentrations Over Time at Well Cluster 013, 113, and 170



U



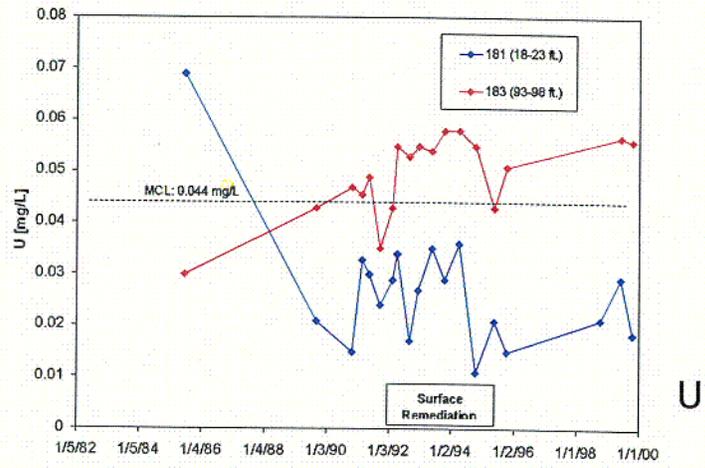
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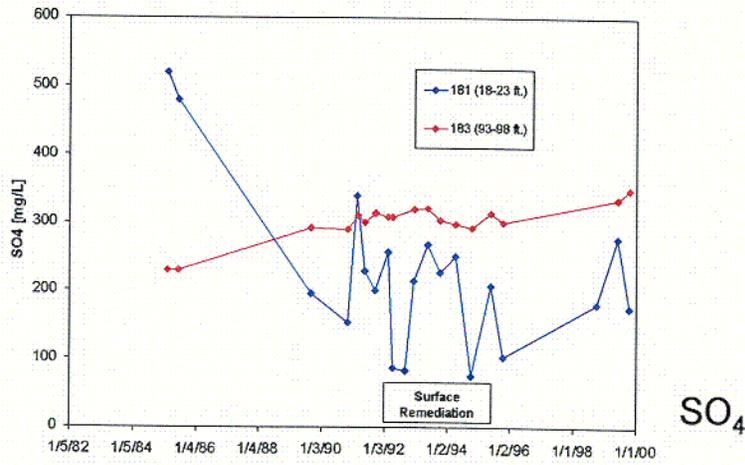
Mn

C17

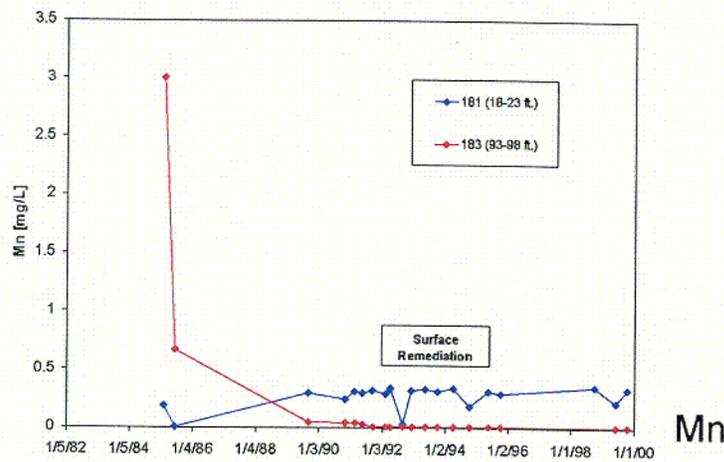
Figure 5-15. Ground Water Concentrations Over Time at Well Cluster 125, 126, and 127



U



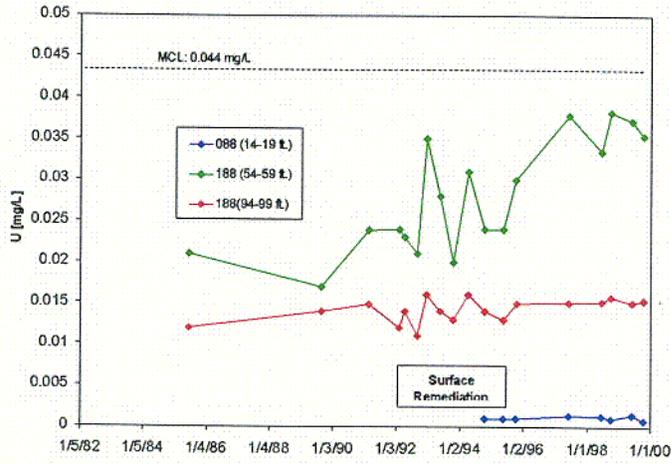
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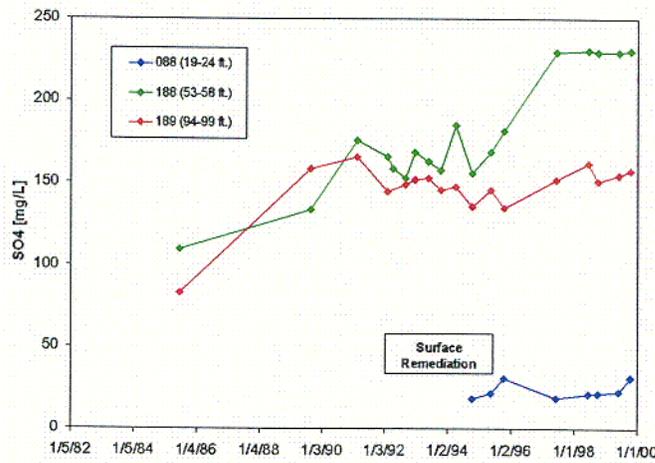
Mn

C18

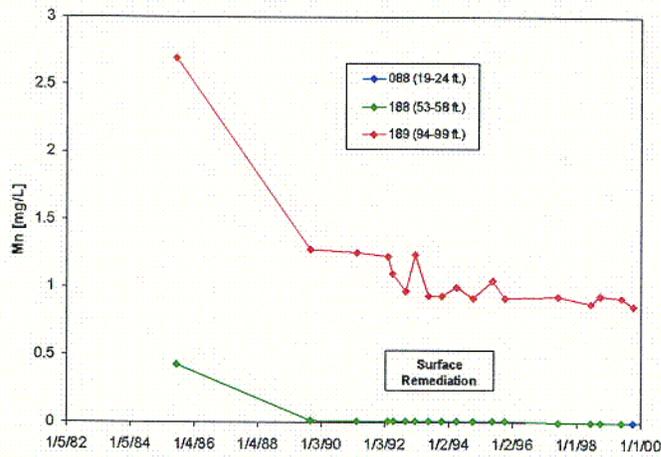
Figure 5-16. Ground Water Concentrations Over Time at Well Cluster 181, 183



U



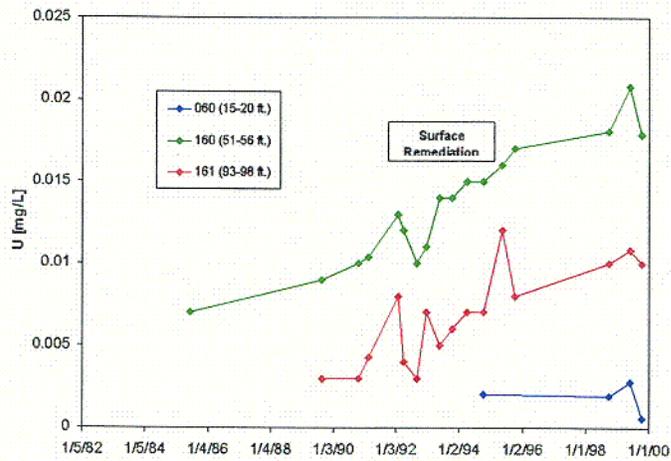
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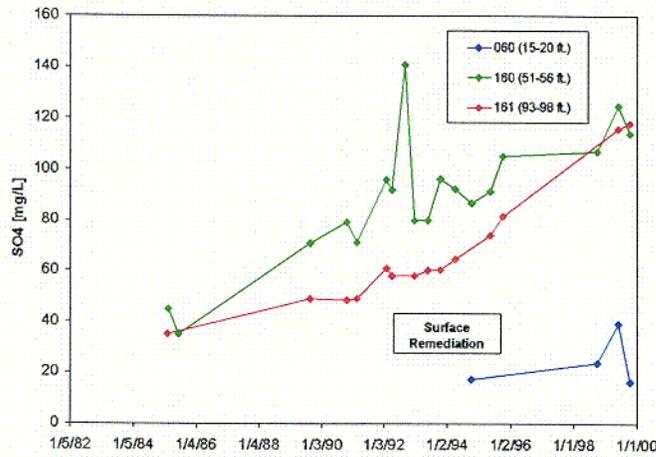
Mn

219

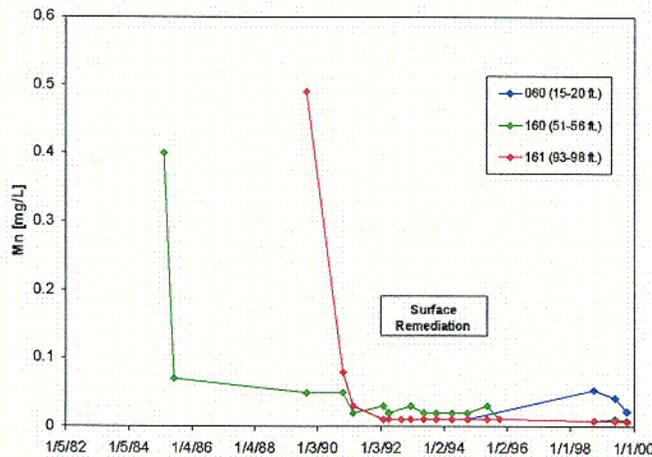
Figure 5-17. Ground Water Concentrations Over Time at Well Cluster 088, 188, and 189



U



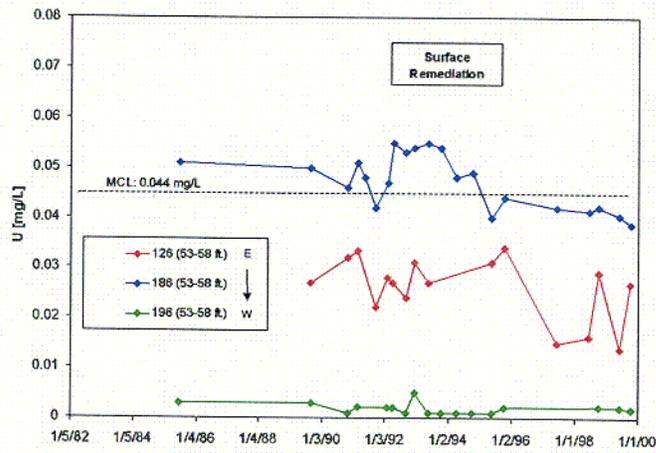
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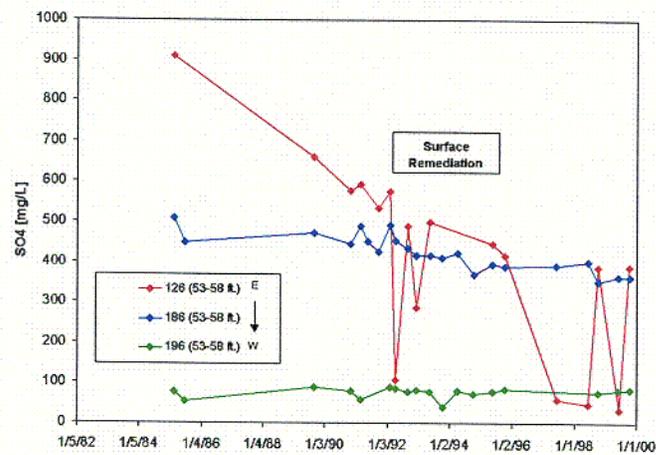
Mn

c20

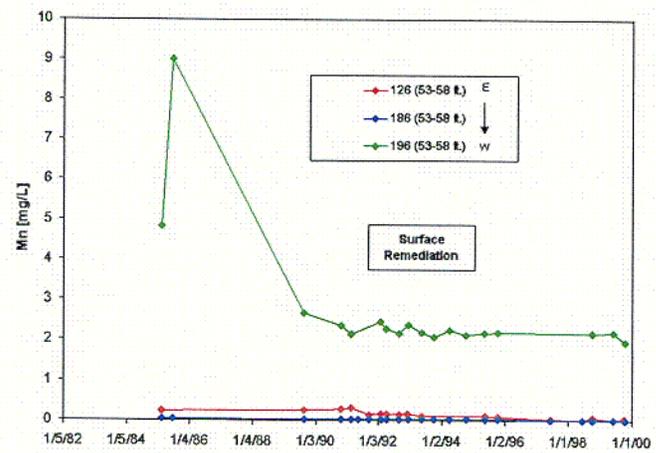
Figure 5-18. Ground Water Concentrations Over Time at Well Cluster 060, 160, and 161



U



SO<sub>4</sub>



Mn

C21

Figure 5-19. Ground Water Concentrations Over Time at Well Cluster 126, 186, and 196

source for manganese which is not mill related. The redox conditions in all three wells are similar and the average ORP ranges from -15 mV to 48 mV.

### 5.2.3 Summary of Geochemical Conditions

The results of the subpile soils investigation and the *K<sub>d</sub>* study were presented in Sections 4.3 and 4.4. Uranium concentrations in subpile soils at the Gunnison millsite are up to 400 times higher than background concentrations. Due to the limited number of samples and the sampling technique, no conclusions about the spatial distribution of uranium at the former millsite can be drawn. Samples 545 and 546 represent two different types of contaminated soil. Although both types contain the same uranium inventory, leaching with ground water caused sample 545 to release uranium constantly over a long period of time, whereas sample 546 released less uranium and concentrations in the effluent were close to the MCL after a short time. Ground water at on-site monitoring wells have had uranium concentrations of about 1 mg/L for several years (Figure 5-13). This indicates that soils similar to sample 545, which release uranium over a long period of time, might be the most common type of soil present on site.

The distribution coefficient for uranium at the Gunnison site was determined to be between 1.70 and 5.24 mL/g. A *K<sub>d</sub>* value of 3.47 was used for modeling, which is high compared to values used at other UMTRA sites.

### 5.2.4 Ground Water Flow and Transport Modeling

A ground water flow and transport model was developed to evaluate if natural processes will reduce site-related uranium concentrations to regulatory levels in the alluvial aquifer within 100 years. Three different versions of the model were developed and employed to address conditions in the vicinity of the site. A steady state flow and steady state transport model was used as the basis for the other two models. A steady state stochastic flow and steady state stochastic transport model was used to quantify the uncertainty in flow and transport parameters. A transient flow and transient transport model was used to address the seasonal nature of several parameters, including the high and low flow periods in the Gunnison River and Tomichi Creek (natural phenomena) and the Valco, Inc. sand and gravel operation (man-caused phenomena). Based on modeling results, natural flushing appears to be an acceptable compliance strategy that allows natural processes to reduce the ground water contaminants to below the MCL within 100 years.

The existing ground water flow pattern at the Gunnison site was modeled using the MODFLOW software package (McDonald and Harbaugh 1988), a multi-layered, three-dimensional hydrologic flow model published by the USGS. Output from the flow model was used as input to MT3DMS (Zheng 1999) and MT3D (Zheng 1990), different versions of a modular three-dimensional transport model to simulate advection, dispersion, and chemical reactions of contaminants in the ground water system. The distribution coefficient (*K<sub>d</sub>*) was identified as the most sensitive input parameter. Dewatering activities of the Valco, Inc. sand and gravel operation have a significant effect on the ground water flow patterns in this area of the alluvial aquifer during the months of operation. In general, this activity seems to enhance the natural flushing of uranium by drawing ground water and accelerating the migration of the plume beneath the site toward the dewatering pit. In addition, the ground water mound created by the overflow pond pushes ground water downgradient, which tends to disperse and dilute contaminant concentration to a greater extent than natural flushing alone. Therefore, the steady state flow and steady state

transport was modeled with the dewatering activity. The steady state stochastic flow and steady state stochastic transport was also modeled with the dewatering activities. The transient flow and transient transport was modeled with an average  $Kd = 3.47$  mL/g (see Section 4.4).

Details regarding the model construction, steady state calibration, steady state stochastic parameters, and transient state parameters are presented in Appendix H. The codes used are fully described in the references cited and have been verified, benchmarked, and approved for use by most government and regulatory agencies. A summary of the modeling results is presented in the following sections.

#### 5.2.4.1 Steady State Model

Predicted uranium concentrations in ground water after 100 years are presented in Figure 5–20. The simulation predicts the maximum concentration will decrease to 0.036627 mg/L. This value is below the cleanup standard of 0.044 mg/L.

#### 5.2.4.2 Steady State Stochastic Model

Similar results are predicted by the steady state stochastic modeling. Figure 5–21 presents the results at 100 years. Maximum average concentrations are below the standard at 0.031574 mg/L. The stochastic simulations predict that at 100 years there is a low probability (28%) that the maximum concentration will be greater than the proposed standard over a small area of the alluvial aquifer (Figure 5–22).

#### 5.2.4.3 Transient Model

Transient simulations were modeled with an average  $Kd$  of 3.47 mL/g. Results of these simulations indicate that the maximum concentration will decrease to 0.043996 mg/L in 100 years, which is just below at the UMTRA Project standard of 0.044 mg/L (Figure 5–23).

### 5.3 Ecology

The flora and fauna of the Gunnison millsite and surrounding area were investigated between 1984 and 1992. The *Environmental Assessment of Remedial Action at the Gunnison Uranium Mill Tailings Site Near Gunnison, Colorado* (DOE 1992a) documents the results of the investigations and lists the potential ecological receptors, including threatened or endangered species. An Endangered Species Act Section 7 consultation with the U.S. Fish and Wildlife Service concerning surface remediation resulted in a “may affect” determination in the biological opinion (letter from USFWS, December 11, 1990) for one threatened or endangered species. This determination was based on depletion of river water that may affect the razorback sucker. No determination was made at that time concerning the effects of site-related contaminants on ecological receptors.

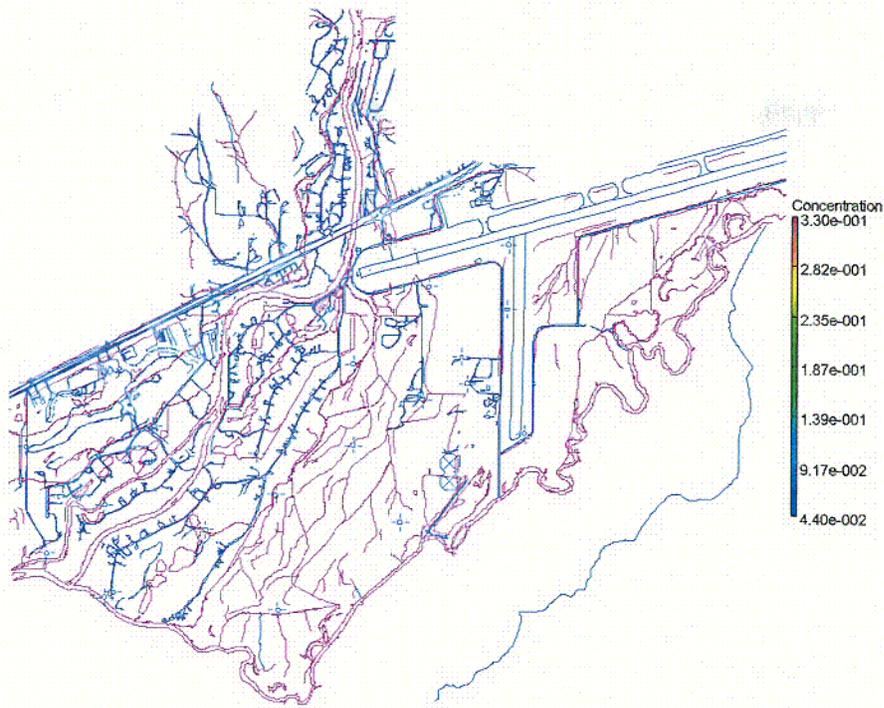
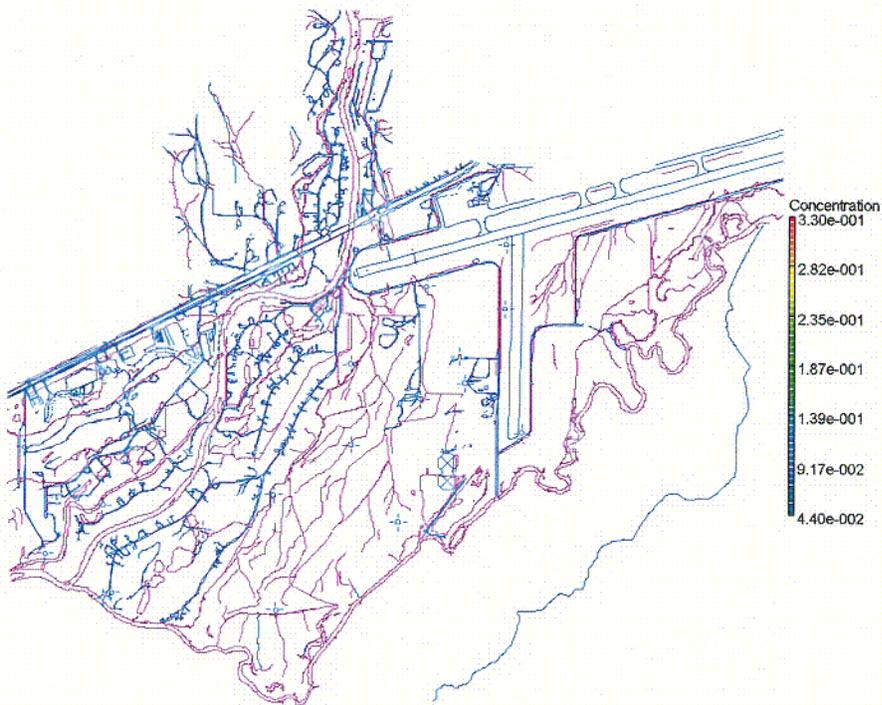


Figure 5-20. Predicted Steady State Uranium Concentration at 100 Years



C22

Figure 5-21. Predicted Stochastic Uranium Concentration at 100 Years (100 simulations)

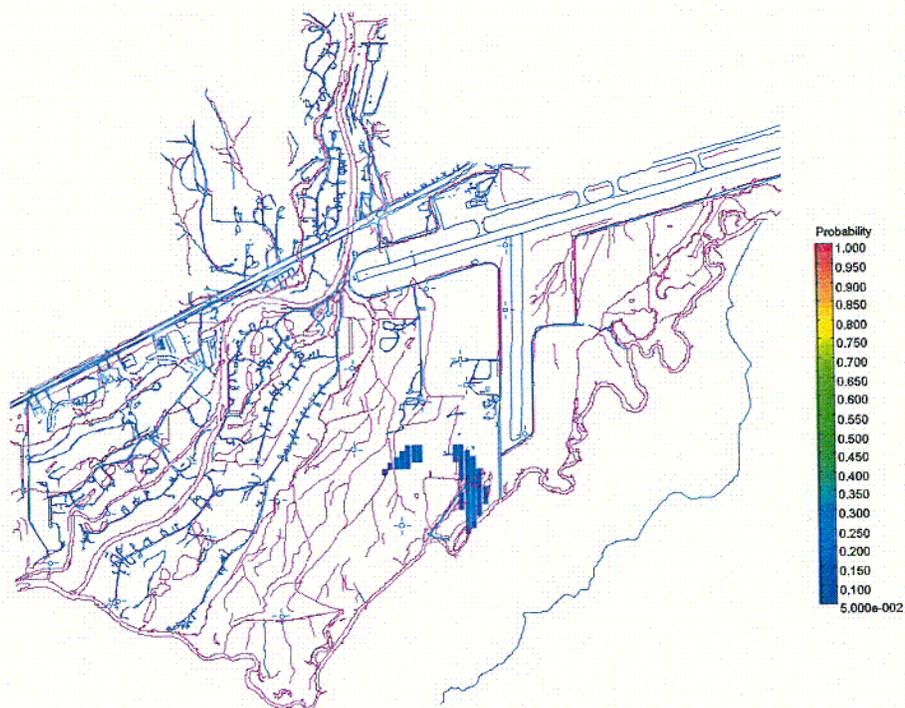


Figure 5-22. Probability of Uranium Concentration Exceeding the UMTRA 0.044 Standard at 100 Years (100 simulations)

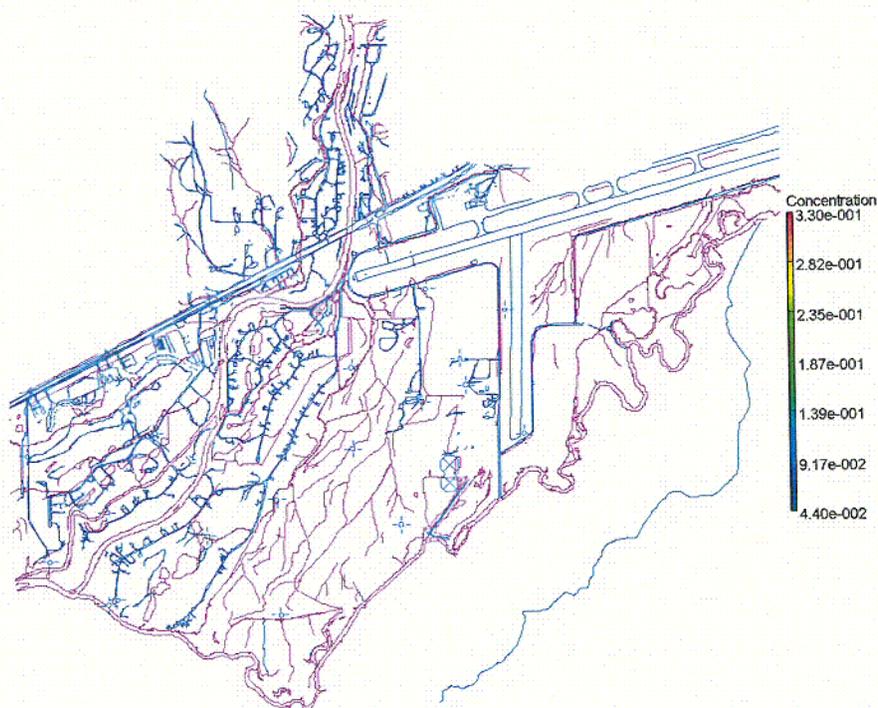


Figure 5-23. Predicted Transient Uranium Concentration at 100 Years

## 6.0 Risk Assessment

### 6.1 Human Health Risk Assessment

A BLRA (DOE 1996a) was previously prepared for the Gunnison site according to methods provided in the PEIS (DOE 1996b). Much of the data used in that risk analysis were collected before completion of surface remediation (data for characterizing the contaminant plume were collected from 1990 to 1993). Since that time, additional data have been collected and many contaminants have shown significant changes (mainly decreases) in concentration since completion of the original BLRA. This necessitates a reevaluation of COPC identification and assessment of associated risks. The intent of this BLRA update is to use those earlier results and conclusions as a starting point from which to evaluate the more recent data.

#### 6.1.1 Summary of 1996 BLRA

The 1996 BLRA identified 19 constituents associated with the Gunnison site as being present at levels statistically above background concentrations for the area. This initial list was screened to first eliminate constituents with concentrations within nutritional ranges and then to eliminate contaminants of low toxicity and high dietary ranges. These two steps eliminated five constituents each, resulting in the following COPC list: cadmium, cobalt, iron, lead-210, manganese, polonium-210, sulfate, thorium-230, and uranium. These contaminants were retained for further risk analysis.

A number of potential routes of exposure were evaluated: (1) ingestion of ground water as drinking water in a residential setting, (2) dermal contact with ground water while bathing, (3) ingestion of garden produce irrigated with ground water, (4) ingestion of milk/meat from livestock watered with ground water, and (6) ingestion of fish from the Gunnison river and Tomichi Creek. Results indicated that adverse toxic responses from exposure to contaminants from routes other than drinking water would not be expected. Therefore, it was determined that ingesting ground water as drinking water would be the primary contributor to total exposure. Consequently, the use of ground water as drinking water in a residential setting was evaluated probabilistically. For additional information on other potential exposure routes and for the probabilistic methodology, see the BLRA (DOE 1996a).

Results of the BLRA showed that the most severe noncarcinogenic health effects could occur from the manganese and iron content of the water and to a lesser extent from sulfate concentrations present. Although some questions exist regarding the toxicity of uranium, it was also recommended for retention as a noncarcinogenic COPC. Carcinogenic risks calculated for uranium exceeded the upper bound of EPA's acceptable risk range of  $1 \times 10^{-4}$ .

#### 6.1.2 BLRA Update

This BLRA update uses the COPC list from the original BLRA as a starting point to evaluate current data. Table 6-1 lists the COPCs identified in the 1996 BLRA, along with a summary of historical plume data (1989 to 1993; from the 1996 BLRA) and current (1998 and 1999) plume data. Background data (1995 to 1998) are also included. Plume data include on-site and immediately off-site wells that can reasonably be assumed to be influenced by site activities. Table 6-1 lists wells used for both plume and background calculations.

Table 6-1. Gunnison Site—Data Summary

Contaminant	FOD	Minimum mg/L	Maximum mg/L	Mean mg/L	MCL mg/L	RBC mg/L	% exceeding benchmark <sup>a</sup>
Iron						11N	
Background	2/16	0.004	0.869	n/a			0%
Current Plume	18/30	0.003	4.73	0.58			0%
Historical Plume	4/4	49	91	66			
Manganese						1.7N	
Background	3/16	0.001	0.457	n/a			
Current Plume	20/30	0.0008	19.1	3.51			
Historical Plume	15/15	0.05	7	3.5			
Sulfate					n/a	n/a	
Background	16/16	16.4	25.8	20.775			
Current Plume	30/30	19.2	1390	539			
Historical Plume	4/4	1470	1590	1540			
Uranium					0.044		
Background	16/16	0.0022	0.0058	0.003			
Current Plume	26/30	0.0002	1.22	0.296			
Historical Plume	4/4	1.2	1.6	1.4			

Alluvial background wells: 001, 002, 101, 102, 140, 141, 142 (1998-99 data)

Current plume wells: 006, 013, 014, 106, 113, 130, 132, 170 (1998-1999 data)

Historical plume wells: 133 & 134 for Fe, SO<sub>4</sub>, U (1989-93 data); 106, 109, 110-112 for Mn (1989-93 data)

<sup>a</sup>Benchmark = MCL, if available; RBC used if no MCL

For mean calculations, values for samples below detection set at one-half the detection limit

RBC = risk-based concentration

C = carcinogenic risk

N = noncarcinogenic risk

FOD = frequency of detection

The risk-based concentration (RBC) presented in Table 6-1 for a given contaminant represents a concentration in drinking water that would be protective of human health provided that:

- A residential exposure scenario is appropriate.
- Ingestion of contaminated drinking water is the only exposure pathway.
- The contaminant contributes nearly all of the health risk.
- EPA's risk level of  $1 \times 10^{-6}$  for carcinogens and a hazard index (HI) of 1 for noncarcinogens is appropriate.

If any of these assumptions is *not* true, contaminant levels at or below the RBC cannot be assumed to be protective. For example, if multiple contaminants are present in drinking water, a single contaminant may be below its RBC but still be a significant contributor to the total risk posed by drinking the water. However, if an RBC is exceeded, it is an indication that further evaluation of the contaminant is warranted. RBCs are intended for use in screening-level evaluations.

Because the historical plume data are limited, data trends over time are not well defined. It does appear that iron concentrations have greatly decreased, as current concentrations are much less than historical values. It also appears that sulfate concentrations may have declined from

historical levels. However, maximum values of manganese and uranium are higher than those reported for the historical plume, though mean values for uranium are lower.

Because manganese and uranium have shown no clear decline in concentration over historical values and because they are elevated over background, they are retained as COPCs for quantitative risk analysis in this BLRA update. Iron is also carried through the risk calculations; though concentrations have apparently declined significantly, they are still elevated above background levels.

No MCL or risk-based levels have been established for sulfate in drinking water. The secondary drinking water standard for sulfate is 250 mg/L, based on considerations of taste and smell. Average on-site sulfate concentrations exceed this unenforceable standard. A recent report by EPA (EPA 1999) indicates that levels of sulfate in drinking water up to 1,500 mg/L may result in no adverse health effects. All concentrations in plume wells have dropped below this value and have remained there for the past 2 years. Based on the lack of toxicity data, sulfate is not carried through the quantitative risk calculations presented in this section. It is not expected that sulfate concentrations in site-related ground water would result in adverse health effects if used for drinking water. Therefore, sulfate can be eliminated from further consideration as a COPC.

#### 6.1.2.1 Risk Assessment Methodology

The original BLRA considered several potential routes of exposure to contaminants and eliminated all but one — ingestion of ground water in a residential setting—as insignificant. However, that BLRA did not consider industrial exposure to contaminants in the Valco, Inc. gravel pit pond or risks associated with ingestion of fish from the Valco pond. Therefore, the ground water ingestion pathway, industrial exposure pathway, and fish ingestion pathway are evaluated in this BLRA update. The risks associated with residential use of ground water as drinking water are hypothetical. Because water is drawn from an alternative water source, this pathway is currently incomplete.

Risk calculations presented here follow EPA's *Risk Assessment Guidance for Superfund Methodology* (EPA 1989a), which involves determining a single-point estimate for excess cancer risk from current or potential carcinogenic exposures and a hazard quotient (HQ, or ratio of exposure intake to an acceptable intake) for noncarcinogenic exposures. It is assumed that the receptors for ground water are residents who use alluvial ground water as their primary source of drinking water. This is an unlikely scenario because of current land use in the vicinity of the site and because of the alternate water supply in place downgradient of the site but is consistent with the scenario evaluated in the original BLRA. Receptors for surface water are workers at the Valco facility, and receptors for fish ingestion are recreational fishermen.

The 1996 BLRA calculated noncarcinogenic risks using a probabilistic approach. Essentially, this means that instead of using a single value for each parameter required in the risk calculations (e.g., ground water concentrations, body weight, frequency of exposure), a range of values with a given probability distribution was used. By performing numerous iterations of the standard risk calculations, with a value selected at random from each parameter distribution, a range of exposures and associated risks results. The 1996 BLRA results were based on children as the most sensitive receptor population.

In this update, which uses point-exposure doses, single values are used for each parameter required in the risk calculations. Calculations to determine contaminant intakes use standard exposure factors for the adult population (EPA 1989b). Maximum, mean, and UCL<sub>95</sub> (the 95 percent upper confidence limit on the mean) contaminant concentrations were all used in risk calculations for ground water to provide a range of risk values, from highly conservative to average. Although the use of adult exposure data is probably less conservative than use of the exposure data for children, use of maximum and UCL<sub>95</sub> ground water concentrations and point-exposure dose calculations is probably more conservative; the net effect is to produce comparably conservative results. For purposes of making risk management decisions, results of both risk assessment methodologies are usable and each has its advantages and limitations. For the occupational exposure scenario, the maximum concentrations from a well near the Valco pond were used in calculations to provide a worst-case scenario. The fish ingestion scenario used maximum concentrations detected historically in the Valco pond.

The same methodology was used to calculate carcinogenic risks for this BLRA update as was used in the original BLRA (i.e., receptors are adults with exposure averaged over 70 years). For all risk calculations, benchmarks for acceptable contaminant intakes (e.g., reference doses, slope factors) are best available data from standard EPA sources (e.g., Integrated Risk Information System, Region III Risk-Based Concentration Table).

Risks were calculated for adults assuming a residential drinking water scenario to provide a worst-case estimate. The only potentially real exposure to ground water is at the Valco, Inc. property where ground water is present in a pond created by the gravel mining operation. Risks were calculated for potential incidental exposure to this water in an industrial setting and for ingestion of fish raised in the pond.

#### 6.1.2.2 Results

Results of the risk calculations are included in Table 6-2, Table 6-3, and Table 6-4. The following major observations are based on the results of the residential exposure scenario:

- Contributions of iron to overall risks are insignificant.
- Manganese and uranium are generally comparable in terms of their respective contributions to noncarcinogenic risk.
- All concentrations used for uranium in risk calculations result in carcinogenic risks exceeding EPA's acceptable risk range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$ .

Based on the results of the residential exposure scenario, only uranium and manganese were evaluated for the industrial exposure and fishing scenarios. For the industrial scenario it was assumed that the only exposure pathway was dermal exposure. The assumptions used in the calculations are highly conservative because they assume continuous contact with contaminated water throughout the entire work day for each work day of the year. Concentrations used were the maximum detected in ground water to provide a conservative estimate of risk. The results show that noncarcinogenic risks are negligible and carcinogenic risks are below the lower end of EPA's acceptable risk range. Therefore, contact with contaminated ground water at the Valco gravel-mining operation is not expected to pose any current or future unacceptable risks to workers.

**Table 6-2. Intake/Risk Calculation Spreadsheet (Ground Water Ingestion Pathway)  
(1998 and 1999 Data)**

<b>Noncarcinogens – Ground Water Ingestion Only (adults)</b>										
Contaminant		CW	IR	EF	ED	BW	AT	Intake	RfD <sup>b</sup>	HQ
Iron	max	4.73	2	350	30	70	10,950	0.129589	0.3	0.43
	UCL95	1.009	2	350	30	70	10,950	0.027644	0.3	0.09
	mean	0.582	2	350	30	70	10,950	0.015945	0.3	0.05
Manganese	max	19.1	2	350	30	70	10,950	0.523288	0.047	11.13
	UCL95	5.719	2	350	30	70	10,950	0.156685	0.047	3.33
	mean	3.51	2	350	30	70	10,950	0.096164	0.047	2.05
Uranium	max	1.22	2	350	30	70	10,950	0.033425	0.003	11.14
	UCL95	0.43	2	350	30	70	10,950	0.011781	0.003	3.93
	mean	0.296	2	350	30	70	10,950	0.00811	0.003	2.70
									HI-max =	22.71
									HI-95=	7.35
									HI-mean=	4.80
<b>Carcinogens – Ground Water Ingestion Only (Adults)</b>										
Contaminant		CW	IR	EF	ED	BW	AT	Intake	SF <sup>b</sup>	Risk
U234+238 <sup>c</sup>	max	837	2	350	30	na	na	1.76E+07	4.36E-11	7.66E-04
	UCL95	295	2	350	30	na	na	6.19E+06	4.36E-11	2.70E-04
	mean	203	2	350	30	na	na	4.26E+06	4.36E-11	1.86E-04

<sup>a</sup>All exposure factors are from EPA 1989b

<sup>b</sup>Data are mainly from EPA's Integrated Risk Information System (IRIS); other values are from EPA Region III Risk-Based Concentration Table

<sup>c</sup>assumes 1 mg U = 686 pCi of U234 + U238; SF used is average of U234 and U238

$$\text{Intake} = \frac{\text{CW} \times \text{IR} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

where<sup>a</sup>:

Intake is in (mg/kg-day)

CW = chemical concentration in water (mg/L); site-specific

IR = ingestion rate (L/day); 2 L/day adult; default

ED = exposure duration (years); 30 yr for adult; default

EF = exposure frequency (day/yr); 350 days/yr; default

BW = body weight (kg); 70 kg adult; default

AT = averaging time; ED x 365 day/yr non-carc.

Hazard Quotient (HQ) = Intake/Reference Dose (RfD)

Table 6-3. Gunnison—Ingestion of Fish from Valco Pond

Fish Ingestion - Noncarcinogens											
Contaminant	CF	FI	IR	EF	ED	BW	AT	Intake	RfD <sup>b</sup>	HQ	
Uranium	BCF=1	0.075	0.5	0.054	350	30	70	10,950	2.77E-05	0.003	0.01
	BCF=55	4.125	0.5	0.054	350	30	70	10,950	0.001526	0.003	0.51
									HI=		
Fish Ingestion - Carcinogens											
Contaminant	CF	FI	IR	EF	ED	BW	AT	Intake	SF <sup>b</sup>	Risk	
U234+238 <sup>c</sup>	BCF=1	51	0.5	0.054	350	30	na	na	1.46E+04	4.36E-11	6.36E-07
	BCF=55	2,830	0.5	0.054	350	30	na	na	8.02E+05	4.36E-11	3.50E-05

<sup>a</sup>All exposure factors are from EPA 1989b

<sup>b</sup>Data are from EPA's Integrated Risk Information System (IRIS); other values are from EPA Region III Risk-Based Concentration Table

<sup>c</sup>assumes 1 mg U = 686 pCi of U234 + U238; SF used is average of U234 and U238

$$\text{Intake} = \frac{\text{CF} \times \text{IR} \times \text{FI} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

where<sup>a</sup>:

Intake is in (mg/kg-day)

- FI = fraction of contaminated fish ingested
- CF = concentration of contaminant in fish (=BCF X water concentration -- maximum concentration detected in pond is 0.075 mg/L U)
- ED = exposure duration (years); 30 yrs for adult; default
- EF = exposure frequency (day/yr); 350 days/yr; default
- BW = body weight (kg); 70 kg adult; default
- AT = averaging time; ED x 365 day/yr non-carc.
- IR = Fish ingestion rate-based on average consumption of 2 8oz portions per week (0.054 kg per day for an adult)

Table 6-4. Gunnison—Incidental Exposure—Dermal Exposure Pathway

Contaminant	Cw-max <sup>a</sup> mg/L	Sa cm <sup>2</sup>	Pc cm/h	Cf L/cm <sup>3</sup>	ET h/day	EF day/yr	ED yr	BW kg	AT day	Intake absorbed mg/kg- day	RfD mg/kg- day	HQ mg/kg- day
<b>Noncarcinogenic</b>												
Uranium	1.22	312	0.001	0.001	8	250	30	70	2555	0.00013	0.003	0.042565
Manganese	19.1	312	0.001	0.001	8	250	30	70	2555	0.00200	0.047	0.042536
<b>Carcinogenic</b>											<b>Slope Factor</b>	<b>Risk</b>
Uranium (pCi/L)	836.92	312	0.001	0.001	8	250	30	na	na	15667.14	4.36E- 11	6.83E-07

<sup>a</sup>Based on 1998 & 1999 data; maximum detected at any location in ground water  
 Surface area (Sa) is for a man's arms and hands; EPA 1989  
 Pc (dermal permeability constant) assumes absorption is the same as water  
 Cf Conversion factor  
 ET Exposure time - assumes length of work day  
 ED Exposure duration - 30 years  
 EF Exposure frequency - assumes 5 days a week for 50 weeks  
 BW Body weight; default for adult  
 AT Averaging time - 365 days x ED  
 Carcinogenic risks calculated assuming 1 mg U = 686 pCi of U234 + U238

na = not applicable  
 Hazard Quotient (HQ) = Intake/Reference Dose (RfD)  
 Risk = Intake x Slope Factor (SF)

Noncarcinogenic intakes = Cw x Sa x Pc x Cf x ET x EF x ED/BW x AT  
 Carcinogenic intakes = Cw x Sa x Pc x Cf x ET x EF x ED

Exposure factors and default values from EPA 1989  
 Toxicological data are mainly from EPA's Integrated Risk Information System (IRIS); other values are from EPA Region III Risk Based Concentration Table  
 Carcinogenic risks for uranium assumes 1 mg U = 686 pCi of U234 + U238; SF is average of U234 and U238

For the fish ingestion scenario, risks were not calculated for manganese because manganese values in the pond have remained below EPA's 0.1 mg/L ambient water quality criterion for manganese based human consumption of aquatic organisms. Assumptions used for calculated risks based on uranium bioaccumulation in fish are conservative. These assumptions include ingestion of a pound of fish a week for the entire year, that exposure occurs for 30 years, that half of the consumed fish are contaminated, and that fish have been exposed to the highest levels of contamination detected at the pond.

Two bioaccumulation factors (BCF) for uranium were used: 1 and 55. This was the range of BCFs cited based on a study of uranium in the Baltic Sea (obtained over the Internet). The BCF used in BLRAs for other UMTRA Project ground water sites is 2. Regardless of the BCF used, both carcinogenic and noncarcinogenic risks associated with fish consumption are low. Noncarcinogenic risks are below the acceptable HQ of 1, and carcinogenic risks are lower than or within EPA's acceptable risk range.

**6.1.3 Summary and Recommendations**

Site-related activities have resulted in elevated concentrations of iron, manganese, sulfate, and uranium in the alluvial ground water at and near the site. For a residential setting, concentrations

of uranium and manganese are high enough to pose unacceptable noncarcinogenic (manganese and uranium) and carcinogenic (uranium) risks through regular ingestion of ground water as the primary source of drinking water. Concentrations of iron, though exceeding background, pose little risk through ground water ingestion. Quantitative risks were not calculated for sulfate due to lack of acceptable toxicity data; however, recent EPA studies (EPA 1999) suggest that site-related concentrations are within the range at which no adverse effects are expected. No unacceptable risks are expected in an occupational setting (Valco pond) through the most likely exposure route—dermal contact of ground water with the skin. Risks associated with ingestion of fish from the Valco pond, even using highly conservative assumptions, are acceptable.

In terms of development of a compliance strategy for the site, it will be necessary to demonstrate that no residential drinking water wells will be installed into the alluvial ground water in areas of elevated concentrations until levels of manganese and uranium in the aquifer have decreased to acceptable levels. For uranium, this acceptable level is probably the UMTRA Project standard of 0.044 mg/L. An acceptable human health risk-based level for manganese is 1.7 mg/L, though the Colorado agricultural standard for manganese is much lower at 0.2 mg/L. Locally elevated levels of manganese, unrelated to site activities, have been detected in the ground water in some off-site locations. Uses of ground water for other than drinking water purposes (e.g., use in watering gardens, industrial purposes) is permissible given current contaminant levels.

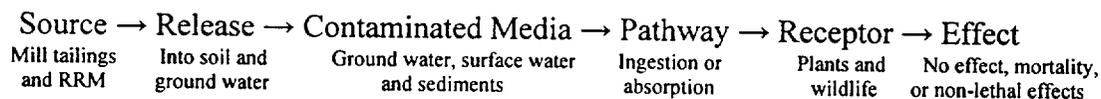
Current iron and sulfate concentrations are not expected to result in adverse human health effects. No restrictions on ground water use based on these constituents are expected based on concerns for human health.

## 6.2 Ecological Risk Assessment

The purpose of an ERA is to evaluate the likelihood that adverse ecological effects are occurring or may occur as a result of exposure to contamination or other stressors (EPA 1992). In this case the key stressor being evaluated is chemical contamination. Predicting the effects of chemicals on ecological receptors is extremely complicated due to variable interactions and influences within an ecosystem. To a great extent ecological risk assessment is an emerging science. Little data exist for most chemicals and their effects on ecological receptors. Therefore, attempting to integrate and evaluate individual and synergistic chemical effects with other stressors (predation, drought, disease, etc.) is problematic.

Generally speaking, for ecological risks to occur now or in the future there must be a source, and a pathway must exist for exposure of ecological receptors to contaminated ground water. The simplified ecological risk scenario gives a generalized overview of the ERA process.

### Contamination



The following sections provide a summary of the BLRA and evaluation of potential risks based on a review of all relevant data.

## 6.2.1 Summary of 1996 BLRA

A screening-level assessment of ecological risks at the site evaluated potential pathways, receptors, and potential adverse effects related to ground water, surface waters, and associated sediments. The results were documented the BLRA (DOE 1996a). No other contaminated media and subsequent pathways or effects were addressed in the BLRA. This section summarizes the BLRA findings and evaluates any data collected since the BLRA. Concentrations of ecological COPCs (E-COPC) in ground water, surface water, and sediments were compared to toxicity standards and guidelines (if available) for various ecological receptors.

### 6.2.1.1 Ecological Constituents of Potential Concern

Constituents in the alluvial aquifer were included in the list of E-COPCs if on-site ground water concentrations statistically exceeded background ground water concentrations. Background ground water quality was defined as the quality of ground water in areas not affected by milling operations. Water quality in ground water wells upgradient of the Gunnison site were considered representative of background conditions.

Eighteen constituents were identified as E-COPCs for further evaluation. They are ammonium, calcium, cadmium, cobalt, iron, lead-210, magnesium, manganese, nickel, polonium-210, potassium, silica, sodium, strontium, sulfate, thorium-230, uranium, and zinc. The BLRA (Section 7.3) states that there were 19, however bromide should have been excluded (BLRA Section 3.3).

#### *Potential Risks Associated with Ground Water*

All 18 E-COPCs were evaluated to determine risks associated with ground water. Based on shallow depth to contaminated ground water at the site, it is possible that some plants could intercept ground water. The methodology and parameters used to estimate root uptake and plant tissue concentrations are presented in Table 7.2 of the BLRA. Phreatophytes, including cottonwood and willow, are plants that have the potential to root into the shallow ground water. These plants inhabit the Gunnison millsite area. The BLRA attempted to evaluate the potential for phytotoxic effects by comparing estimates of contaminant concentrations in plant tissues with published values that have been shown to result in phytotoxicity. Plant tissue concentrations were estimated using soil-to-plant concentration factors. No soil reference data were available for the site. Soil concentrations were estimated by multiplying ground water concentration by a soil/water distribution coefficient ( $K_d$ ) (ORNL 1984). Because phytotoxicity comparison data are unavailable for 11 of the 18 COPCs, the BLRA concluded that it was not possible to evaluate whether estimated tissue concentration could adversely affect plants. However, the results indicated that concentrations did not exceed phytotoxicity standards for several of the constituents.

The BLRA also evaluated animals feeding on plants and animals that were exposed to ground water, and stated that only a limited number of constituents have the potential to magnify in the food chain. Based on the areal extent of contamination versus animals' feeding ranges it was concluded that the potential for the ground water E-COPCs to represent a hazard via food chain transfer is probably low.

To evaluate the potential impact on wildlife using contaminated ground water in a livestock pond (i.e., animals drinking from the pond or fish stocked in the pond), the BLRA compared mean ground water concentrations of the COPC with available water quality criteria. The mean ground water concentrations for iron and manganese exceeded the comparison water quality values, indicating that the water would be unacceptable for aquatic organisms. No comparison water quality values were available for 13 of the ground water COPCs.

The BLRA evaluated the impact of hypothetical use of ground water for irrigating agricultural crops. The mean ground water concentrations for cobalt, iron, and manganese exceed the comparison criteria (EPA 1972). No comparison criteria were available for 12 of the COPCs. The BLRA concluded that using the alluvial ground water near the site as a continuous source of irrigation water could result in deleterious effects to crops, primarily due to elevated concentrations of cobalt, iron, and manganese.

*Potential Risks Associated with Surface Water*

If concentrations in downstream or pond samples exceeded the reference (background) concentrations, the E-COPC was retained for surface water evaluation. E-COPCs in the ponds were determined by comparing concentrations with those detected at the upstream locations in the river and creek. Surface water samples were collected from upstream and downstream locations for both the Gunnison River and Tomichi Creek and from the campground pond. If a constituent was not detected or the downstream concentration was less than or equal to the upstream location, it was eliminated as an E-COPC. The Valco pond (location 780) was not evaluated in the BLRA. Table 6-5 summarizes the E-COPCs for surface waters in the BLRA.

*Table 6-5. Summary of Locations Where E-COPC Concentrations Exceeded Background Surface Water Concentrations*

E-COPC	Gunnison River (776)	Tomichi Creek (777)	Campground Pond (779)
Calcium		X	
Iron			X
Magnesium		X	
Silica	X		
Sulfate		X	
Zinc			X

X = background was exceeded

The comparison of surface water data collected from the Gunnison River at the upstream location to the downstream location indicated that most of the constituents did not exceed background concentrations. This suggests that ground water discharge to the river has not affected water quality. Silica was eliminated as an E-COPC because it is not a site-related constituent.

For Tomichi Creek, sulfate was the only COPC identified because it slightly exceeded upstream concentrations. Calcium and magnesium were eliminated because they only slightly exceeded background and are not considered site-related constituents. The sulfate concentration was approximately 30 percent higher downstream than upstream of the site. Because of the limited data available, the significance of this increase above background is not known. However, based on available information, the sulfate concentrations are not anticipated to result in adverse ecological effects.

Two E-COPCs (iron and zinc) were identified in water collected from the campground pond. A comparison of the surface water data with available water quality values indicated that the concentrations of iron and zinc are below the state standards. This suggests that iron and zinc would not represent a hazard to aquatic life in the campground pond.

Fish muscle tissue analyses were conducted on fish samples from the Gunnison River, Tomichi Creek, and the campground pond. Based on available data and literature information, no evidence suggests that bioaccumulation is a concern or that COPCs would cause adverse effects to the fish at the levels observed.

#### *Potential Risks Associated with Sediments*

Sampling was conducted for four primary constituents—manganese, molybdenum, uranium, and zinc—for sediment evaluation in June 1993 at the same locations as surface water samples. The BLRA stated that there were no state or federal sediment quality criteria at that time. However, the National Oceanic and Atmospheric Administration (NOAA) did have an effects-based sediment quality value for zinc. Table 6–6 summarizes the sediment sampling results for the downstream locations in the Gunnison River and Tomichi Creek and the campground pond. This summarizes Table 7.4 from the BLRA.

*Table 6–6. Summary of Locations Where Constituents Concentrations Exceeded Background Sediment Concentrations*

E-COPC	Gunnison River (776)	Tomichi Creek (777)	Campground Pond (779)
Manganese		X	
Molybdenum			
Uranium		X	
Zinc	X	X	

X = background was exceed

Zinc concentrations upstream and downstream in the Gunnison River were below the NOAA value of 120 mg/kg. Therefore, the Gunnison River sediment data evaluation suggests that the site is not a notable release source for sediment-bound metals to the river.

In Tomichi Creek manganese, uranium, and zinc were all higher at the downstream location than at the upstream location. The detected concentrations of zinc, both upstream and downstream, are below the NOAA comparison values for sediment (120 mg/kg). The BLRA concludes that it is not possible to evaluate whether manganese and uranium concentrations represent potential hazards to ecological receptors because of the lack of benchmark sediment quality values for these constituents. However, the NOAA lowest threshold effects level (TEL) for manganese is established at 630 mg/kg, which is well above analyzed concentrations.

The sediment concentrations of all four constituents from the campground pond were less than the concentrations detected at the upstream locations in both the Gunnison River and Tomichi Creek. Site-related contamination has not affected the sediment quality in the campground pond.

## *Summary*

Section 7.6 of the BLRA identified limitations of the ERA based on limited data and lack of standards and reference values. The BLRA concluded that ground water would not pose a threat to plants. However, ground water would not be suitable for continuous use for irrigation, primarily due to cobalt, iron, and manganese. The potential for ground water to adversely affect the food chain is low. There is no evidence that site-related constituents are adversely affecting surface waters. The BLRA also concluded that limited data existed to determine if elevated COPC concentrations in sediment were site-related or from another source.

### 6.2.1.2 Ecological Receptors

This section summarizes information on ecological receptors that are potentially exposed to ecological COPCs (DOE 1996a, Section 7.2). The information was derived from various qualitative surveys and observations.

#### *Flora*

Plant communities on the site include desert shrub, shrub wetland, and emergent wetland vegetation types. Big sagebrush is the most common shrub species in the desert shrub community and grows scattered or in clumps (TAC 1989). Rabbitbrush is present with grasses and herbs dominating the understory. Small narrowleaf cottonwood is common to the area as well.

#### *Terrestrial Fauna*

No reptiles or amphibians were observed during brief wildlife surveys; however, seven species, including short-horned lizard, eastern fence lizard, and bullsnake would be expected at the site. (DOE 1992a, Section 7.2.2). Amphibians common in wetland areas are species such as the leopard frog, boreal chorus frog, and tiger salamander. Lizard species such as the short-horned lizard and the sagebrush lizard may occur in the sagebrush and dry rocky areas (DOE 1992a, Section 7.2.2).

A total of 43 species of birds have been observed during various site surveys (DOE 1992a, Section 7.2.2). The western meadowlark, red-wing blackbird, yellow warbler, and robin were common nesting species at and near the site. Wetland species such as red-wing blackbirds, waterfowl, and shorebirds were common in the irrigated pastures. The sage thrasher, sage grouse, green-tailed towhee, and various species of sparrows are common nesting species in the sagebrush habitat.

A total of 25 species of mammals may occur at the processing site. Muskrat sign was observed in the wetland areas. Other species expected to occur are the desert cottontail and striped skunk. Mammals typical of the irrigated wetland habitat that would be expected in the area include the masked shrew, western jumping mouse, and muskrat. Prairie dogs were observed in 1990.

#### *Threatened and Endangered Species*

Two endangered bird species, the bald eagle and the whooping crane, may occur near the site. Of the five federally listed fish species in Colorado, only the Colorado pikeminnow occurs in the

Gunnison River. However, it is not found in the Gunnison area. Five federal candidate species occur in the Gunnison area; bird species are the white-faced ibis, long-billed curlew, and snowy plover. Plant species include the skiff milkvetch and Gunnison milkvetch.

### *Aquatic Organisms*

The Gunnison River, Tomichi Creek, and the campground pond were sampled in 1993. Stonefly (*Plecoptera*) nymphs, caddis fly larvae (*Trichoptera*), and fly larvae (*Diptera*), were observed. Brook trout, rainbow trout, and German brown trout were caught in the Gunnison River and Tomichi Creek. Several other fish species are known to occur in the Gunnison River and Tomichi Creek, including kokonee and cutthroat trout, speckled dace, flannelmouth sucker, and a bluehead-flannelmouth sucker hybrid.

## 6.2.2 BLRA Update

Data from location 780 (Valco, Inc. Pond) was not included in the 1996 BLRA. Since 1996, two additional locations (792 and 795) were established to monitor for site-related constituents in the Gunnison River. This section will focus on the data from these locations for purposes of updating the BLRA. If no new data were collected, or if there was no change in the trend of the data, the constituent is not discussed further in this section.

Ecological risk assessment is a process that evaluates the likelihood that adverse ecological effects are occurring or may occur as a result of exposure to one or more stressors (EPA 1992). A stressor is any physical, chemical, or biological entity that can induce an adverse ecological response.

The purpose of this risk assessment is to identify and characterize adverse effects, if any, on the ecosystem at the Gunnison site. For ecological risks to occur at the site, pathways must exist for exposure of biological receptors to biotic and abiotic media contaminated by ground water. Screening-level assessments of ecological risks at the site, as documented in the BLRA, evaluated COPCs, potential pathways, receptors, and adverse effects (DOE 1996a).

This ERA is based on relevant components of the EPA guidance provided in the "Guidelines for Ecological Risk Assessment" (EPA 1998) and the *Framework for Ecological Risk Assessment* (EPA 1992).

### 6.2.2.1 Risk Assessment Methodology

The ERA contains three main components: (1) problem formulation, (2) analysis, and (3) risk characterization. A tiered approach to the risk assessment process was followed with the possibility of proceeding to a quantitative risk assessment pending the outcome of the data review. A discussion of the problem formulation component is presented in the following sections. A risk assessment model for the Gunnison site is shown in Figure 6-1. Following an evaluation of the ecological data, the risk assessment process may or may not be followed by the analysis phase. Depending on the outcome of the analysis phase, risk characterization may not be necessary for this screening-level assessment. For some risk assessments, risk characterization may not be necessary based on the levels and types of contaminants.

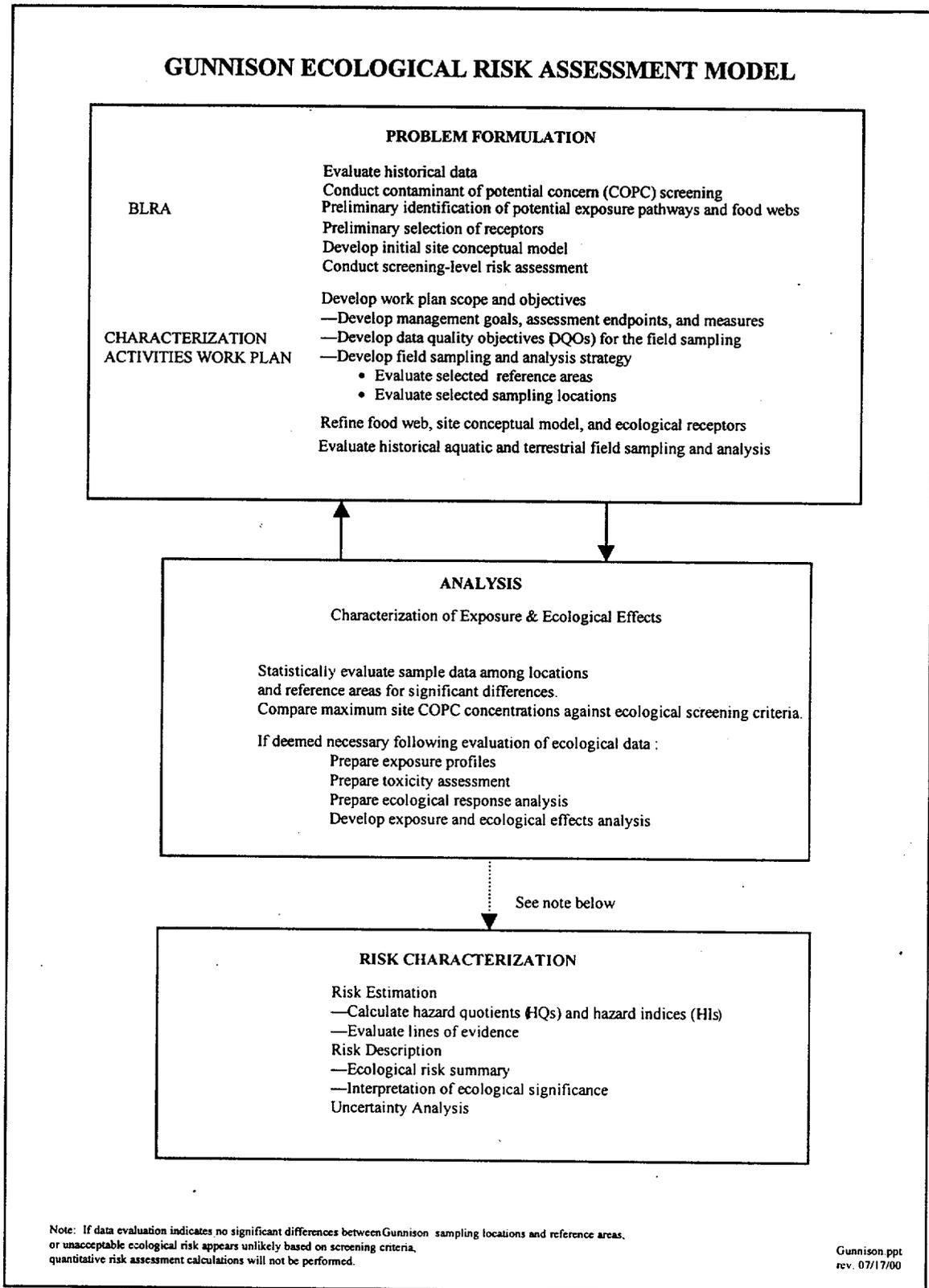


Figure 6-1. Ecological Risk Model for the Gunnison Colorado, UMTRA Site

### 6.2.2.2 Problem Formulation

In the problem formulation phase, the need for a risk assessment is identified, and the scope of the problem is defined. Evaluation of available data helps to develop site conceptual models, food webs, risk hypotheses, endpoints, and measures. The principal product from these activities is the analysis plan, which may include activities for new data collection as well as how existing data will be used to complete the risk assessment. The problem formulation phase typically requires the greatest effort, and the success of the risk assessment depends on a thorough and technically defensible planning process.

The problem formulation phase in the risk assessment process was represented in part by the BLRA (DOE 1996a), which was a screening-level risk assessment. The primary input to this phase is the integration of available information. Historical analytical data for the Gunnison site were reviewed to determine if concentrations of analytes in ground water, surface water, and sediment might pose an ecological risk. Other input included information gathered on the Gunnison geologic setting, ground water hydrology, geochemistry, and ecological habitat. Since the BLRA, additional abiotic samples (surface water only) have been collected at Gunnison and at upgradient reference areas, and these data were incorporated into the risk assessment process.

For this version of the BLRA update, data evaluation is limited to analytical data obtained from the GJO Analytical Chemistry Laboratory. All data gathered specifically for the ERA, which includes 1997 through 1999, have been examined for draft update.

### 6.2.2.3 Ecological Constituents of Potential Concern

E-COPCs were defined in the BLRA as those constituents that exceeded background concentrations for ground water, surface waters, and sediments. Those E-COPCs were further evaluated in the BLRA, and those constituents that were below benchmarks or were not site related were eliminated from further consideration. Table 6-7 summarizes the final BLRA E-COPCs by media and incorporates data results from the Valco pond (780) and the new Gunnison River downstream location (795). The table does not include E-COPCs for which there were no standards or benchmarks. Manganese, molybdenum, uranium, and zinc were the only analytes for sediment evaluation and were sampled for only at locations 776, 777, and 779.

*Table 6-7. Summary of Ground Water, Surface Water, and Sediment Locations Where Constituents are Retained for Further Evaluation*

E-COPCs	Ground Water	Surface Water				Sediments	
		Gunnison River		Tomichi Creek	Campground Pond		Valco, Inc. Pond
		776	795	777	779	780	Location
Calcium						X	NA
Cobalt	X					X	NA
Iron	X						NA
Magnesium						X	NA
Manganese	X					X	Tomichi Creek
Potassium						X	NA
Sodium						X	NA
Sulfate						X <sup>a</sup>	NA
Uranium						X	Tomichi Creek

<sup>a</sup>Based on secondary SDWA standard (aesthetics only)—not enforceable.

NA = Not analyzed, X = Retained for further evaluation

Cobalt, iron, and manganese were retained as ground water E-COPCs in the BLRA because the mean concentrations in ground water exceeded irrigation standards protective of plants. The assumption was made that the ground water could be pumped to the surface and used for irrigation or as a water supply for surface impoundment for fish or wildlife watering.

All surface water constituents in the Gunnison River, Tomichi Creek, and campground pond were eliminated as COPCs in the BLRA. However, the Valco pond was not evaluated. Data had been collected at the Valco pond from 1990 through 1995 and were compared to background data (location 792) from the Gunnison River (upstream). There is evidence that contaminated ground water is influencing the Valco pond. The eight constituents identified as exceeding background in the Gunnison River are calcium, cobalt, magnesium, manganese, potassium, sodium, sulfate, and uranium. Calcium, magnesium, potassium, and sodium are eliminated as COPCs because they are not site-related constituents; manganese, sulfate, and uranium were retained for further consideration. Manganese is below the Colorado aquatic life water quality value (1.0 mg/L) and is therefore eliminated. Although sulfate is elevated above background, its average concentration (107 mg/L) is well below the secondary drinking water standard (250 mg/L) considered protective of human health. Sulfate concentrations fluctuated significantly during the 1990–1995 sampling period; the highest concentration was 206 mg/L in 1990. While there are no surface water standards for uranium, the average concentration of 0.038 mg/L is below the UMTRA ground water standard of 0.044 mg/L (equivalent to 30 pCi/L), which is considered protective of human health in drinking water. Therefore, sulfate and uranium are also eliminated as E-COPCs.

#### 6.2.2.4 Ecological Conceptual Site Model

Conceptual models for ERAs are developed from information about stressors, potential exposure, and predicted effects on an ecological entity (the assessment endpoint). Conceptual models consist of two principal components (EPA 1998):

- A set of risk hypotheses that provide descriptions of predicted relationships among stressor, exposure, and assessment endpoint response, along with the rationale for their selection.
- A diagram that illustrates the relationships presented in the risk hypotheses.

#### *Risk Hypothesis Proposed for the Gunnison Site*

Contamination could result in contaminant exposure directly or indirectly to wildlife and plant receptors that use or inhabit the site through three primary media: ground water, surface water, and sediments. Process waters have moved southwest of the millsite, but there are no indications that ecological receptors are being exposed directly to ground water. On the basis of the BLRA, there is a low probability that ground water is influencing the Gunnison River, Tomichi Creek, or the campground surface waters. However, there is evidence that site-related contamination is influencing the Valco pond. Therefore, the Valco pond is the focus for potential exposure of ecological receptors to surface water.

Because the stressors are chemical contaminants, the Gunnison site risk hypothesis is considered a stressor-initiated risk hypothesis. However, no apparent ecological effects have been observed that would provide a cause-and-effect relationship.

As part of the initial problem formulation in the BLRA, a generalized site conceptual model was developed for the Gunnison site (Figure 6-2).

#### 6.2.2.5 Ecological Food Web

Ecological receptors that could potentially be exposed to E-COPCs were identified in the BLRA (DOE 1996a) and included terrestrial and aquatic species. A food web for the Gunnison site (Figure 6-3) illustrates the significant dietary interactions between the terrestrial and aquatic receptors.

The food web also depicts the major trophic-level interactions and shows nutrient flow and transfer of matter and energy through these levels. It was developed from the species lists and consideration of the exposure pathways. The food web diagram was used to portray potential routes of COPCs from the ground water to biotic species at various trophic levels, with receptor species being components of this food web.

The terrestrial receptor categories include

- Omnivores, carnivores – include fox, coyote, and raccoon
- Herbivores – include mule deer, cottontail, and some mice and vole species
- Vegetation – includes phreatophytes near riparian areas such as narrowleaf cottonwood
- Terrestrial invertebrates – include soil fauna

The aquatic receptor categories include

- Avian species – include great blue heron, geese, ducks, and some passerine birds
- Herbivores – include muskrat
- Vertebrates – include amphibians, reptiles, and fish
- Plants – include phreatophytes such as narrowleaf cottonwood cattail, bulrush, willow, and common reed
- Invertebrates – include benthic invertebrates

Only complete exposure pathways are quantitatively and qualitatively evaluated in an ERA. To be conservative, the following media and potential exposure pathways were considered for evaluation:

- Surface water—ingestion and direct contact
- Sediment—ingestion and direct contact
- Dietary—ingestion of forage or prey, as appropriate, by receptor
- Ground Water—ingestion (if ground water is pumped to the surface)

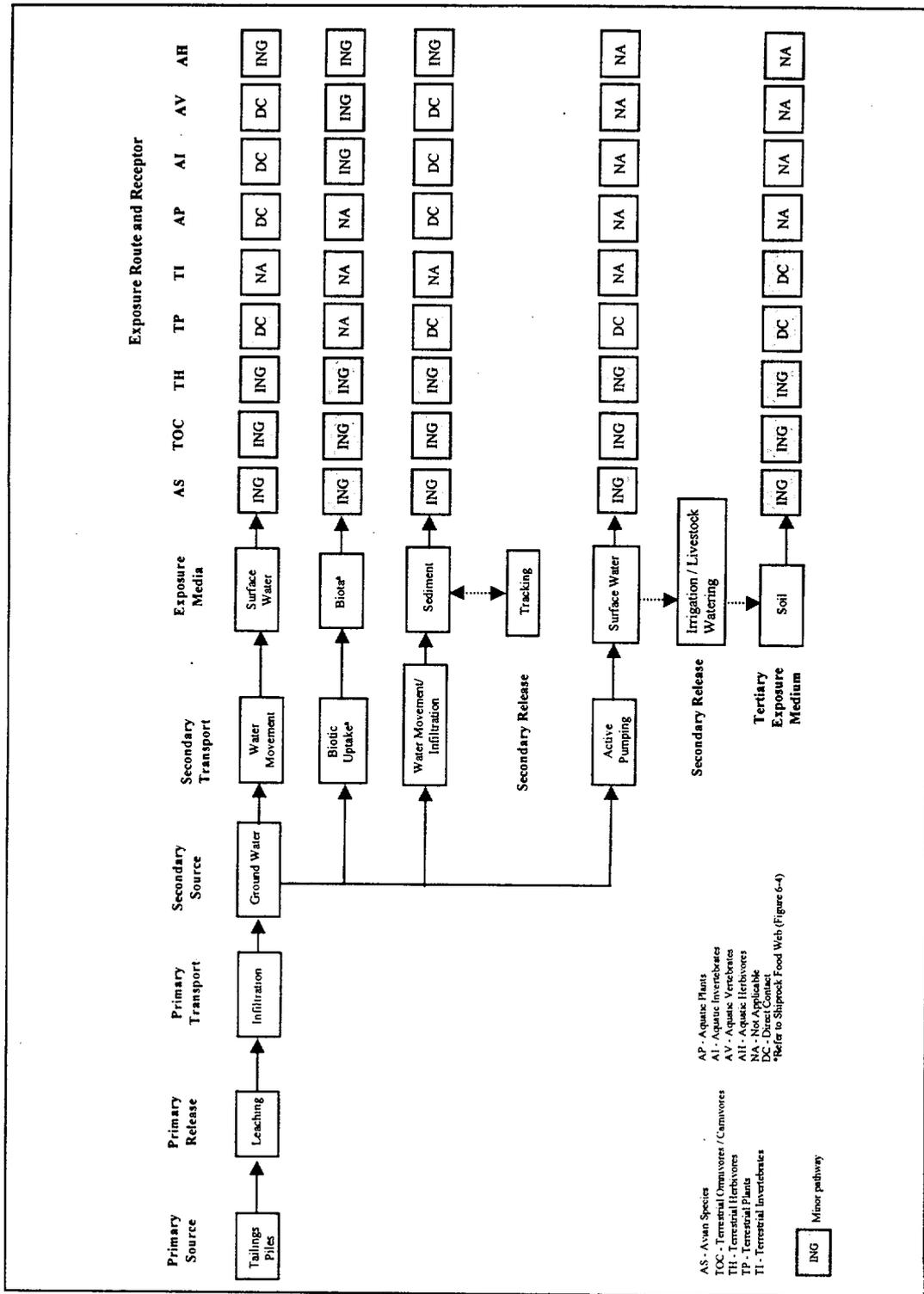


Figure 6-2. Gunnison Site Conceptual Model

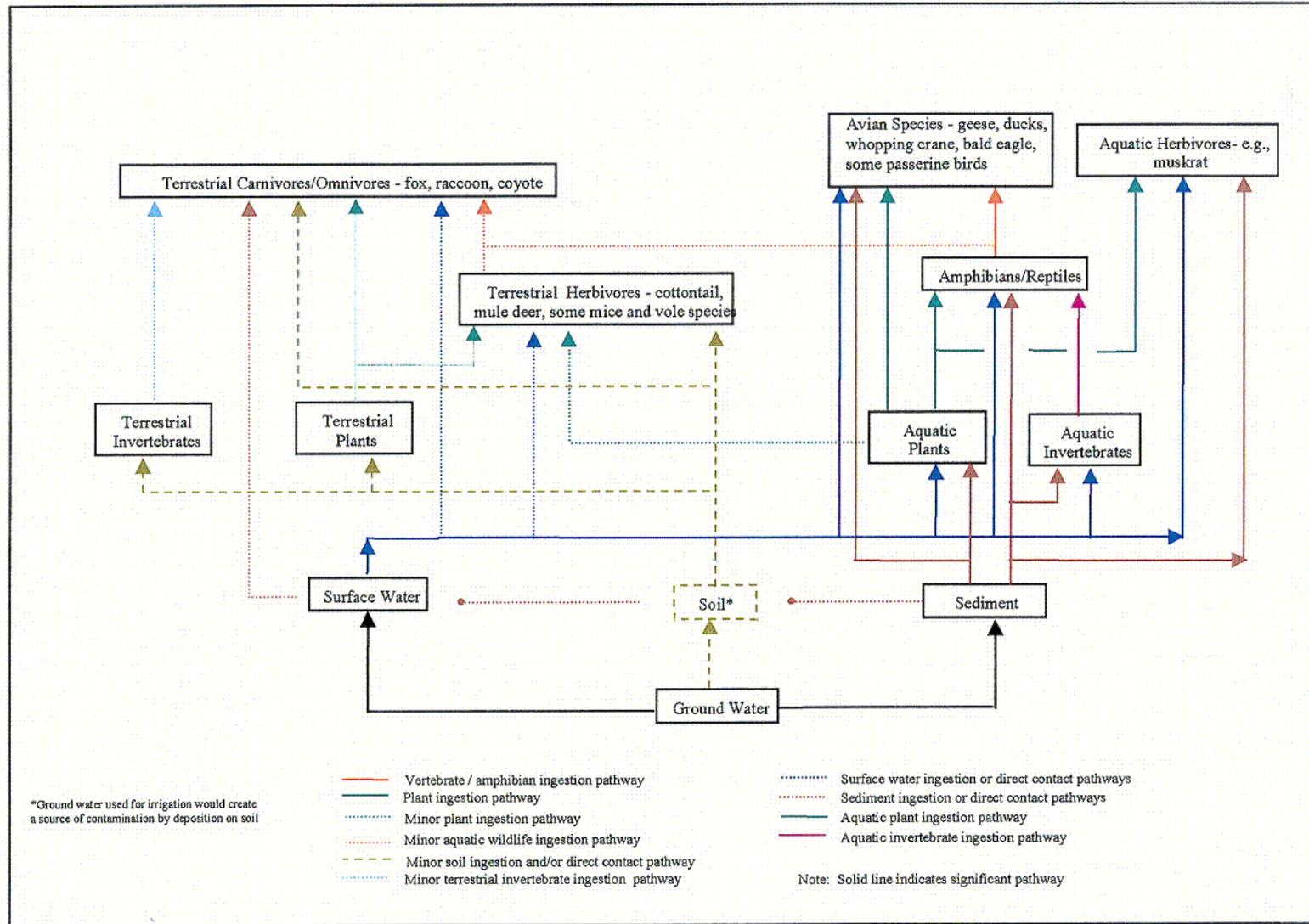


Figure 6-3. Generalized Food Web for Gunnison Ecological Receptors

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Because the contaminants associated with the Gunnison site are inorganics, dermal absorption pathways have not been included in this screening assessment. Dust inhalation is also excluded from this preliminary assessment, as it is considered a minor exposure pathway relative to soil or sediment ingestion, and the contaminated soils have been removed.

The pathways that are subsequently addressed in further detail were divided into current and future hypothetical exposure scenarios.

#### 6.2.2.6 Current Exposure Scenario

The terrestrial ecology of the Gunnison site is influenced by moderate annual precipitation, a rural setting and primarily irrigated pasture land for cattle. Tree cover in the area is limited and occurs primarily in riparian areas near the Gunnison River and Tomichi Creek.

The majority of undeveloped land is used for irrigated pasture for cattle. Wildlife are not restricted from any portion of the former millsite or the area under which mill-related contamination is present. Because the contaminated soils and tailings have been removed, contaminated soils do not represent a complete exposure pathway.

The surface water associated with the ecological habitats at Gunnison consists of the Gunnison River, Tomichi Creek, the campground pond, and the Valco pond. Herbivores grazing on vegetation could be exposed to contaminants through bio-uptake from the underlying aquifer and subsequent transfer into the plant roots and aboveground growth. Larger herbivores prefer to browse on leafy material; smaller mammals and birds seek plant seeds and roots. However, because most of the area is irrigated with water directly from the Gunnison River, this scenario is unlikely. There is no evidence that riparian habitats associated with the Gunnison River and Tomichi Creek are influenced by elevated levels of contamination associated with the millsite.

Terrestrial receptors such as deer, fox, coyotes, skunks, raccoons, and rodents likely use the riparian corridor for food items and as a drinking water source. Consequently, there is also a potential to be exposed to contaminated sediments. However, these terrestrial receptors typically do not spend most of their time in riparian or aquatic areas, and most have home ranges that extend well outside the area influenced by site-related contamination.

Aquatic receptors including fish, reptiles, and amphibians whose habitat includes areas influenced by site-related contamination have the potential to ingest contaminated sediment, surface water, and riparian vegetation. Aquatic wildlife species, including fish, muskrat, and beaver, have the potential for the greatest exposures. Higher trophic receptors such as coyotes, eagles, and hawks may in turn feed on small mammals or birds that have ingested contaminated food items. Aquatic avian species, including the bald eagle, whooping crane, ducks, and geese, are frequent visitors to the area surface waters and represent ecological receptors with exposure potential. Aquatic invertebrates, amphibians, reptiles, and fish are also in direct contact with potentially contaminated sediment and surface water. These receptors can also serve as prey for eagles, whooping cranes, and other wildlife.

#### 6.2.2.7 Future Hypothetical Exposure Scenario

Ground water could possibly be pumped and used for pasture irrigation, wildlife habitat, or industrial uses. If this were to occur a source of contaminated water would be made available for

surface water ingestion, direct contact with terrestrial vegetation, and deposition of ground water and surface water on the soil. The soil would then represent an additional source medium for ingestion and direct contact. Large-scale irrigation with ground water is not considered a likely future pathway because the Gunnison River is the main source of irrigation water in this area. As long as there is the possibility of pumping ground water for agricultural purposes, it is assumed that the potential exists for these exposure pathways.

### 6.2.3 Summary and Recommendations

#### 6.2.3.1 Ground Water Medium

The BLRA concluded that using site-related contaminated ground water as a continuous source of irrigation water could result in deleterious effects to crops, primarily due to elevated concentrations of cobalt, iron, and manganese. Concentrations of these constituents exceed EPA irrigation standards for plant protection. This conclusion was based on the assumption that ground water would be pumped to the surface and used for irrigation, or for a surface impoundment for fish or wildlife. However, this exposure pathway does not present a significant concern because most riparian plants in the area are tapping water directly from the Gunnison River and Tomichi Creek, and pasture grasses are being irrigated with water from the Gunnison River. Therefore, herbivores that may consume vegetation in the area have limited exposure potential. Likewise, the opportunity for bioaccumulation and biomagnification to higher trophic levels in the food chain is very limited, and significant adverse effects are unlikely.

#### 6.2.3.2 Surface Water Medium

All E-COPCs for the Gunnison River, Tomichi Creek, and the campground pond were eliminated for various reasons. Of greater significance were concentrations in the Valco pond, which were not evaluated in the BLRA. Several Valco pond constituents that exceeded background were evaluated in BLRA Section 6.2.4. All were eliminated because they were not site-related or were below available benchmarks or standards. It was assumed that if concentrations were below human health standards (in the absence of ecological benchmarks), that ecological receptors would not be adversely affected.

#### 6.2.3.3 Sediment Medium

The BLRA results indicated that it is not possible to evaluate whether manganese and uranium concentrations present in sediment represent potential hazards to ecological receptors because of the lack of sediment quality values for these constituents. Because manganese is below the NOAA TEL, only uranium concentrations are of concern. Because the whooping crane, an endangered species, and other wildlife use this area occasionally, it is recommended that uranium be monitored annually for the next 3 to 5 years.

As a result of reviewing the BLRA and evaluating data that was not subject to the BLRA, it appears that there are no significant adverse effects to ecological receptors as a result of site-related constituents. This conclusion is based on available sampling data and with the understanding that there are numerous limitations as to eco-toxicological benchmarks, synergistic effects, and the contribution of chemical stressors within the Gunnison site ecosystem.

## 7.0 Ground Water Compliance Strategy

The framework defined in the final PEIS for the UMTRA Ground Water Project governs selection of the final strategy to achieve compliance with the EPA ground water cleanup standards (DOE 1996b). Stakeholder review and acceptance of the final PEIS is documented and supported by the Record of Decision (April 1997). This section presents the selection process used to determine the ground water compliance strategy for the former Gunnison processing site along with a proposed implementation plan for institutional controls and ground water monitoring.

The proposed compliance strategy will be presented in detail in the GCAP, which will be the NRC concurrence document for Subpart B of 40 CFR 192. NEPA issues and environmental concerns will be addressed in the Environmental Assessment (EA) (in progress).

### 7.1 Compliance Strategy Selection Process

The PEIS framework used to determine the appropriate ground water compliance strategy for the Gunnison site is summarized in the flow chart provided in Figure 7-1. The process involved evaluating conditions at the Gunnison site and proposing a compliance strategy for ground water cleanup that is protective of human health and the environment and meets the regulatory requirements in subpart B of 40 CFR 192 for Title I sites. A step-by-step approach is followed until one or a combination of the three general compliance strategies is selected. The three compliance strategies are:

- **No remediation**—Compliance with the EPA ground water protection standards would be met without altering the ground water or cleaning it up in any way. This strategy could be applied for those constituents at or below background levels or MCLs, or for those constituents above background levels or MCLs that qualify for an ACL or supplemental standards.
- **Natural flushing**—Allows natural ground water movement and geochemical processes to decrease contaminant concentrations to regulatory limits within a period of 100 years. The natural flushing strategy could be applied at a site if ground water compliance can be achieved in 100 years or less, where effective monitoring and institutional controls can be maintained, and where the ground water is not currently and is not projected to become a source for a public water system.
- **Active ground water remediation**—Requires application of engineered ground water remediation methods such as gradient manipulation, ground water extraction and treatment, and in situ ground water treatment to achieve compliance with the standards.

### 7.2 Gunnison Compliance Strategy

To achieve compliance with Subpart B of 40 CFR 192, the DOE proposed action is natural flushing in conjunction with institutional controls (IC) and continued monitoring. Ground water flow and transport modeling has predicted that site-related concentrations of uranium in ground water in the uppermost aquifer beneath and downgradient from the site will decrease to below the maximum concentration limit (MCL) within 100 years (Section 5.2.4 and Appendix H). ICs

will be maintained and verified during the flushing period. This compliance strategy will be protective of human health and the environment. This proposed action has been determined by applying the compliance strategy selection framework from the PEIS, consisting of several evaluative steps that are discussed below (Figure 7-1).

### 7.2.1 Assessment of Environmental Data

The first step in the decision process was an assessment of both historical and new environmental data collected to characterize hydrogeological conditions and the extent of ground water contamination related to uranium processing activities at the site. Ground water occurs under unconfined conditions in the alluvial aquifer (uppermost aquifer) with an average depth to the water table of 5 ft. The alluvium is composed of poorly sorted sediments ranging from clay-sized material through gravel with cobbles and occasional boulders. The thickness of the alluvium ranges from 70 to 130 ft. Ground water in the alluvial aquifer generally flows to the southwest with an average gradient of 0.005. Hydraulic conductivity ranges from 100 to 170 ft/day. Ground water in the alluvial aquifer system is recharged by precipitation, flood irrigation of the pasture downgradient from the site, and irrigation of the golf course and residential areas southwest of the site. Ground water is discharged naturally to adjacent streams and by the gravel pit dewatering operations south of the site.

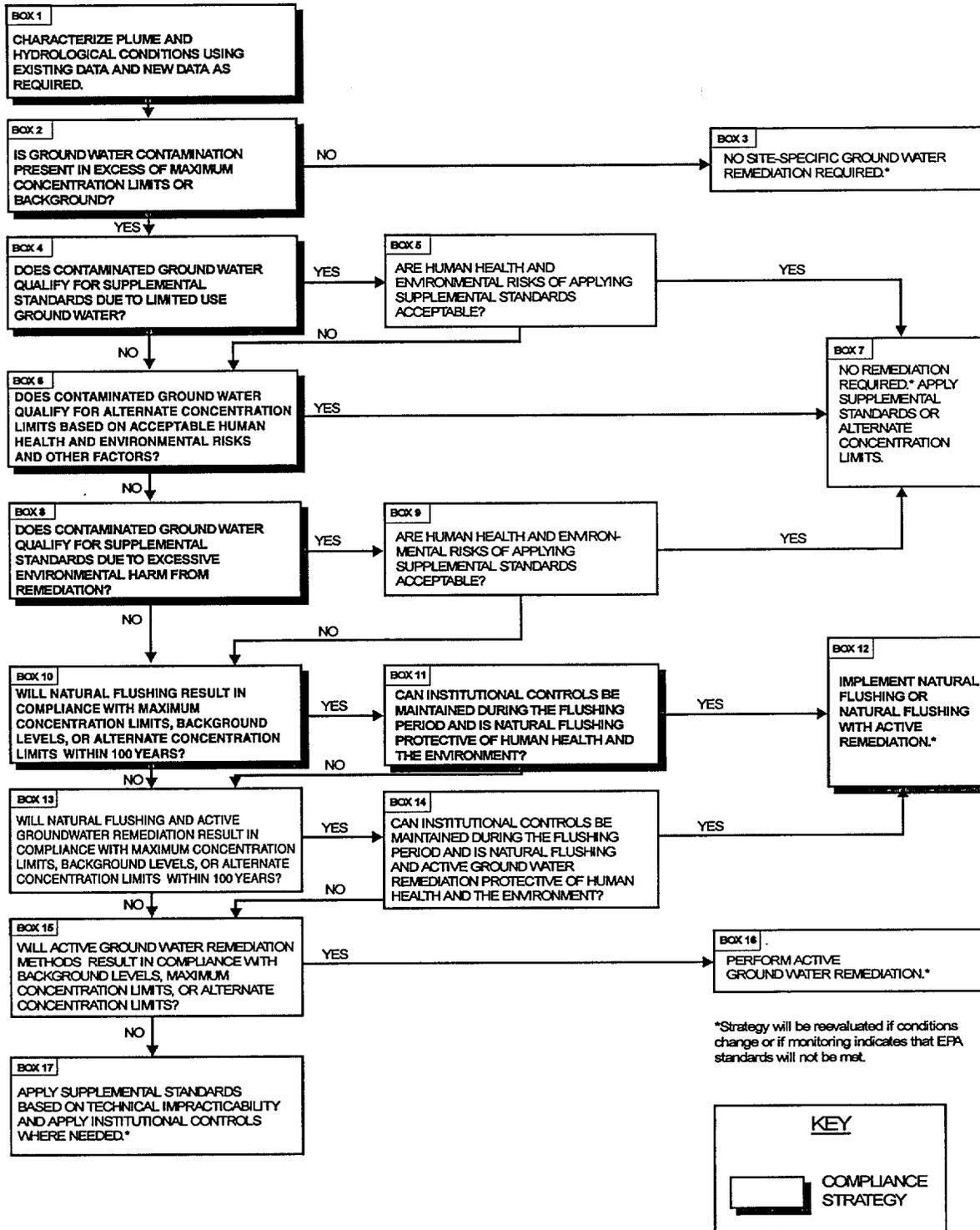
### 7.2.2 Ground Water Contaminants

Ground water in the alluvial aquifer beneath and downgradient from the Gunnison site was contaminated by uranium processing activities. Residual radioactive material (RRM) beneath the site was cleaned up to just below the water table with some contaminated material left in place. Clean fill was placed above these areas to prevent radiation from emanating to the surface. Uranium is the primary COPC in ground water because concentrations exceed 1.0 mg/L beneath the site and exceed the uranium MCL of 0.044 mg/L to approximately 1,000 ft downgradient from the site boundary beneath the adjacent gravel mining operation (Figure 5-6). Concentrations of uranium in ground water below the MCL, but above background, extend approximately 7,000 ft downgradient from the site boundary and have migrated beneath the Gunnison River just beyond the confluence with Tomichi Creek. The zone of contamination attenuates and migrates downward as it progresses laterally. Manganese is also a COPC in ground water with concentrations up to 19 mg/L beneath the site (Figure 5-8). There is no MCL for manganese, but an acceptable human health risk-based level is 1.7 mg/L. Manganese does not appear to be widespread in the aquifer and concentrations beneath the site are decreasing.

### 7.2.3 Applicability of Natural Flushing

Ground water flow and contaminant transport modeling indicates that uranium will naturally flush to concentrations below the MCL in the aquifer system beneath and downgradient from the site within 100 years. Results of the modeling are presented in Section 5.2.4 and Appendix H. Only uranium was modeled as it appears to be most representative and wide-spread of site-related contamination in ground water.

Transient flow and transport modeling was used to address the seasonal nature of several parameters, including the high and low flow periods of the Gunnison River and Tomichi Creek and the dewatering activities of the adjacent Valco, Inc. gravel mining operation. Results of the transient simulations indicate that the maximum concentration of uranium in ground water will



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Figure 7-1. Compliance Strategy

decrease to below 0.044 mg/L in 100 years. Steady state stochastic flow and transport modeling was used to quantify the uncertainty in flow and transport parameters. Results of the stochastic simulations predict that the maximum concentration of uranium in ground water will decrease to 0.032 mg/L after 100 years with a low probability (28 percent) that the standard will be exceeded over a small area of the alluvial aquifer south of the site.

#### 7.2.4 Institutional Controls

ICs are restrictions that effectively protect public health and the environment by limiting access to a contaminated medium—alluvial ground water at the Gunnison site. ICs typically depend on an administrative legal action, such as zoning, ordinances, and laws to ensure that protection is effective and enforceable. For the UMTRA Ground Water Project, ICs reduce exposure to contaminated ground water or reduce health risks by (1) preventing intrusion into contaminated ground water or (2) restricting access to or use of contaminated ground water for unacceptable purposes. The EPA standards require that ICs (1) have a high degree of permanence, (2) protect human health and the environment, (3) satisfy beneficial uses of ground water, (4) are enforceable by administrative or judicial branches of government entities, and (5) can be effectively maintained and verified. The EPA standards permit the use of ICs at sites where natural flushing will return the ground water to regulatory levels within 100 years.

##### 7.2.4.1 On-site ICs

ICs are in place at the former millsite through deed restrictions that became effective when the State of Colorado transferred ownership to Gunnison County in December 1999. The restrictions prohibit use of contaminated ground water and control excavation of contaminated soil. The deed contains the following language:

“Grantee (Gunnison county) covenants ... (ii) not to use ground water from the site for any purpose, and not to construct wells or any means of exposing ground water to the surface unless prior written approval for such use is given by the Grantor (Colorado Department of Public Health and Environment) and the U.S. Department of Energy.”

This language follows with the deed and ensures that any future landowner is subject to the same restrictions. This language fulfills the requirements for degree of permanence and enforceability by government entities. The site is within the service area of the Dos Rios water system, so future users have a source of domestic water available.

##### 7.2.4.2 Off-site ICs

Results of ground water sampling downgradient from the former processing site from July through October 1990 indicated that 22 domestic wells contained concentrations of uranium and manganese in excess of background levels. Most of these wells were located in the Dos Rios subdivision and screened in the shallow alluvial aquifer. Since the elevated levels were related to uranium processing activities at the site, DOE began supplying bottled water to those residences in August 1990. DOE also investigated funding a permanent water supply system for this area (DOE 1991). Construction of the water supply system occurred from 1992 to 1994, and approximately 5 miles of pipeline, mostly within the Dos Rios subdivision, was constructed at a cost in excess of \$6 million. DOE supplied 90 percent of the funding and the State of Colorado supplied the remainder. By July 1994, most residents had hooked up to the alternate water supply

system, and the facility was turned over to the Gunnison County Public Works Department (DOE 1996a). Water is taken from the west side of the Gunnison River just south of U.S. Highway 50 into the 350 gpm water treatment plant, and then stored in a 250,000 gallon water storage tank located just north of U.S. Highway 50. The water distribution system extends from U.S. Highway 50 on the north, toward Tomichi Creek on the south, from Gold Basin Road on the east, to Que Quay Lane on the west (Figure 3-3). According to the Director of the Gunnison County Public Works Department, the water system has the capacity for expansion to cover any anticipated growth in demand in the vicinity.

Recent investigations with the State Engineer's Office (well permits), the Gunnison County Planning Department, and contact with local businesses have provided no evidence of anyone using the alluvial aquifer for domestic purposes. All businesses and residences within a suggested IC boundary are connected with the Dos Rios water system (Figure 7-2). DOE is working with Gunnison County to develop an IC program to ensure implementation of an administrative mechanism that can be enforced, verified, and maintained. The mechanism under consideration is a Gunnison County ordinance within an IC boundary that will prohibit using untreated ground water for drinking water purposes.

### **7.2.5 Human Health and Environmental Risk**

There are no unacceptable risks to human health and the environment associated with current and projected conditions in the vicinity of the Gunnison site as long as ICs can be maintained (see Section 6.0). Current use of ground water at the Valco, Inc. operation presents no unacceptable risk. Consequently, the proposed compliance strategy of natural flushing in conjunction with institutional controls and continued monitoring will be protective of human health and the environment.

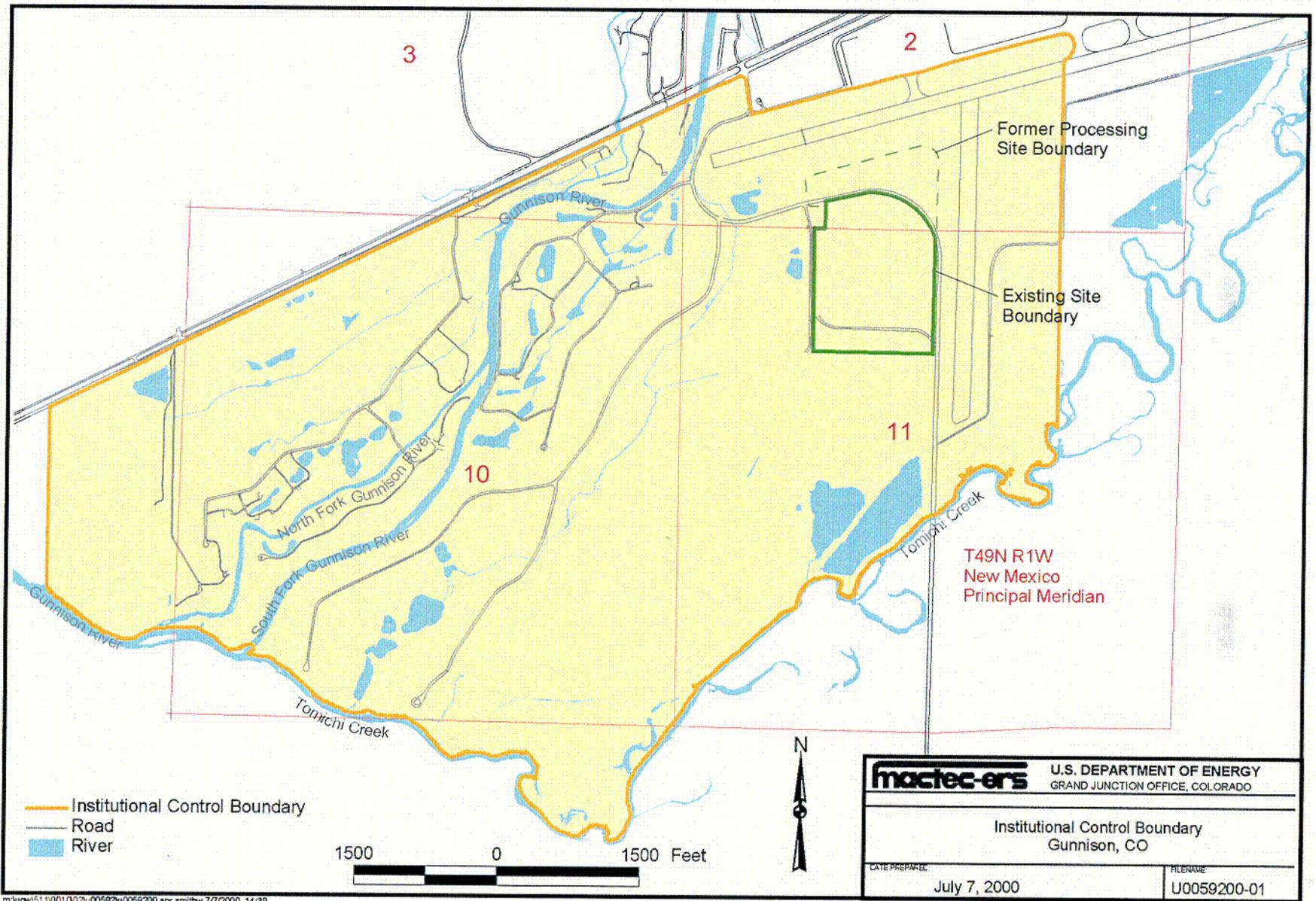
## **7.3 Implementation**

Implementation of the proposed compliance strategy includes ICs and continued monitoring of ground water and surface water.

### **7.3.1 Institutional Controls**

Gunnison County owns the water distribution system that provides drinking water to the entire area potentially affected by site-related contaminants. DOE is working with Gunnison County to formalize a requirement that all current and future residents in the area connect to the system. This requirement will become an enforceable administrative IC by means of a county ordinance. Any future water resource needs in the area will be regulated by Gunnison County.

The need for and duration of ICs depends on the compliance strategy selected for a site, the level of risk to humans and the environment, and existing site conditions. Movement of contaminated ground water may require restrictions over an extended period of time. As risks decrease over time, so should the need for ICs. Therefore, to ensure protection of human health and the environment, and to satisfy requirements for beneficial uses of the water, it is important that the effectiveness of ICs be verified and modified as necessary.



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Figure 7-2. Institutional Control Boundary, Gunnison, Colorado

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### 7.3.2 Monitoring

Monitoring of ground water and surface water will be implemented during the period of natural flushing to verify modeling results, ascertain that concentrations of uranium and manganese in ground water are decreasing, and ensure protection of human health and the environment (Figure 3-2 and Table 7-1). Ground water in the shallow zone of the alluvial aquifer will be sampled on-site in monitor wells 006 and 012 which have the highest concentration of uranium ("hot spot"). Ground water in the intermediate zone at these two locations will also be monitored in offset monitor wells 106 and 112 to verify that uranium concentration remains below background levels at this depth in the aquifer. Ground water in the shallow and intermediate zones in monitor wells 013 and 113, just off the southwest corner of the site, will be sampled. Concentration of uranium in both wells is decreasing with higher concentration in well 113 indicating that contamination is migrating deeper into the aquifer as it goes downgradient. Monitor wells 126 and 127 are 1,500-ft downgradient from the site and are just beyond the area where uranium concentration is above the MCL. Concentration of uranium is higher in the deeper zone of the aquifer, and is decreasing with time in both intervals. Concentration of uranium is above the MCL in monitor well 183 and is still increasing, indicating migration of the plume through this area. Concentration of uranium in monitor wells 160 and 161 is below the MCL, but is still increasing, again indicating migration of the contaminant plume through this area. Monitoring ground water at these locations will provide adequate information to assess the effectiveness of natural flushing, and to ensure that concentrations of uranium do not significantly increase downgradient to the point of potentially impacting human health and the environment. Concentrations of manganese in these areas are generally decreasing with time. Surface water locations have been selected to verify that uranium concentrations remain very low in the Gunnison River and Tomichi Creek and to track concentrations in the gravel pit on the Valco, Inc. property south of the site.

COPCs to be analyzed in ground water include uranium and manganese. The MCL for uranium is 0.044 mg/L and an acceptable human health risk-based level for manganese is 1.7 mg/L. General water quality indicators including alkalinity, conductivity, pH, total dissolved solids, sulfate, and temperature will also be determined during sampling. Statistical methods for evaluation of ground water and surface water monitoring data will be used as appropriate to assess variations in concentrations of COPCs over time. Results of monitoring will be compiled periodically and reports will be available to regulators.

Monitoring will take place on an annual basis for the first 10 years (through 2010) and every 5 years thereafter until completion of natural flushing. At the end of 10 years an evaluation will be made in consultation with NRC and the State of Colorado to determine the need and timing for future monitoring at the site. Criteria for modifying or terminating the monitoring program will be decrease of uranium and manganese concentrations in ground water and continued protection of human health and the environment. If it is determined that the natural flushing strategy is not progressing as predicted, reevaluation of the compliance strategy will be conducted.

Monitor wells not required as part of the monitoring network will be abandoned according to applicable State of Colorado regulations and UMTRA Project procedures. Abandonment will be done by the LTSM Program.

Table 7-1. Ground Water and Surface Water Monitoring, Gunnison, Colorado, Site

Monitor Well	Aquifer Zone	Screened Interval	Location	Rationale (Uranium)
<b>Ground Water</b>				
GUN-006	Shallow	10-15	On-site	"Hot spot"
GUN-106	Intermediate	34-39	On-site	Background
GUN-012	Shallow	10-15	On-site	"Hot spot"
GUN-112	Intermediate	40-45	On-site	Background
GUN-013	Shallow	11-16	Just off-site	Above MCL
GUN-113	Intermediate	41-46	Just off-site	Above MCL
GUN-126	Intermediate	54-59	Downgradient	Below MCL
GUN-127	Deep	94-99	Downgradient	Below MCL
GUN-183	Deep	93-98	Beneath golf course	Above MCL
GUN-160	Intermediate	51-56	West of Gunnison River	Above background
GUN-161	Deep	93-98	West of Gunnison River	Above background
<b>Surface Water</b>				
GUN-777			Tomichi Creek	Background
GUN-780			Valco, Inc. gravel pit	Above MCL
GUN-792			Gunnison River	Background
GUN-795			Gunnison River	Background

## 8.0 References

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- 40 CFR 192, “Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings,” U.S. Environmental Protection Agency.
- 60 FR 2854, “Groundwater Standards for Remedial Actions at Inactive Uranium Processing Sites,” final rule, U.S. Environmental Protection Agency.
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## **Appendix A**

### **Summary of Monitor Well Information**

MONITOR WELL REPORT FOR GUNNISON  
 REPORT DATE: 7/10/2000 2:56 pm

LOCATION CODE	INSTALL DATE	NORTH COORD. (FT STATE-PLANE)	EAST COORD. (FT STATE-PLANE)	GROUND ELEV. (FT NGVD)	BORE HOLE DEPTH (FT BLS)	BORE HOLE DIA. (INCHES)	TOP OF CASING ELEV. (FT NGVD)	WELL DEPTH (FT BLS)	CASING DIAMETER (INCHES)	TOP OF SCREEN DEPTH (FT BLS)	SCREEN LENGTH	ZONE OF COMPL.	STATUS
001	09/1983	258100.51	1588241.49	7653.90	20.0	6.875	7653.87	18.00	2.0	8.0	5.00	AL	Active
002	09/1983	257024.23	1588219.26	7646.93	20.0	6.875	7649.26	20.00	2.0	10.0	5.00	AL	Active
003	09/1983	257392.74	1586894.41	7647.95	20.0	6.875	7649.69	20.00	2.0	10.0	5.00	AL	Active
004	09/1983	257028.86	1587595.19	7662.42	40.0	6.875	7664.41	40.00	2.0	30.0	5.00	AL	Abandoned
005	09/1983	256740.29	1586946.30	7644.40	20.0	6.875	7645.66	20.00	2.0	10.0	5.00	AL	Active
006	09/1983	256218.08	1587452.00	7645.10	20.0	6.875	7647.19	20.00	2.0	10.0	5.00	AL	Active
007	09/1983	256170.13	1587683.40	7644.20	21.0	6.875	7646.21	21.00	2.0	11.0	5.00	AL	Abandoned
008	09/1983	256117.28	1587685.95	7643.92	50.0	12.875	7645.41	50.00	8.0	30.0	20.00	AL	Abandoned
009	09/1983	256016.92	1587625.87	7644.01	20.0	6.875	7645.38	20.00	2.0	10.0	5.00	AL	Active
010	09/1983	256007.65	1587265.30	7643.95	18.0	6.875	7645.90	18.00	2.0	8.0	5.00	AL	Abandoned
011	09/1983	256019.15	1586999.27	7642.65	20.0	6.875	7644.45	20.00	2.0	10.0	5.00	AL	Abandoned
012	09/1983	255777.22	1587543.59	7643.25	20.0	6.875	7645.46	20.00	2.0	10.0	5.00	AL	Active
013	09/1983	255507.42	1586799.22	7641.70	21.0	6.875	7643.75	21.00	2.0	11.0	5.00	AL	Active
014	09/1983	255338.81	1587416.46	7642.11	20.0	6.875	7644.07	20.00	2.0	10.0	5.00	AL	Abandoned
041	11/1999	256046.62	1585590.42	7635.75	63.3	10.0	7637.63	63.23	6.0	30.6	30.00	AL	Active
042	11/1999	256023.46	1585576.81	7635.51	58.0	6.0	7637.33	56.50	2.0	43.6	10.00	AL	Active
043	11/1999	256020.09	1585615.72	7635.77	58.0	6.0	7637.72	56.50	2.0	43.6	10.00	AL	Active
044	11/1999	254721.26	1585635.05	7631.03	64.0	10.0	7632.10	63.36	6.0	30.7	30.00	AL	Active
045	11/1999	254682.40	1585593.58	7631.08	54.0	6.0	7632.98	53.67	2.0	40.8	10.00	AL	Active
046	11/1999	254695.45	1585666.69	7630.80	53.5	6.0	7632.82	53.19	2.0	40.5	10.00	AL	Active
047	11/1999	253874.11	1584319.59	7623.52	63.1	10.0	7625.25	63.06	6.0	30.4	30.00	AL	Active

LOCATION CODE	INSTALL DATE	NORTH COORD. (FT STATE-PLANE)	EAST COORD. (FT STATE-PLANE)	GROUND ELEV. (FT NGVD)	BORE HOLE DEPTH (FT BLS)	BORE HOLE DIA. (INCHES)	TOP OF CASING ELEV. (FT NGVD)	WELL DEPTH (FT BLS)	CASING DIAMETER (INCHES)	TOP OF SCREEN DEPTH (FT BLS)	SCREEN LENGTH	ZONE OF COMPL.	STATUS
048	11/1999	253851.98	1584304.37	7623.53	54.0	6.0	7625.38	53.76	2.0	41.0	10.00	AL	Active
049	11/1999	253852.63	1584355.92	7624.31	53.3	6.0	7626.04	53.30	2.0	40.4	10.00	AL	Active
058	09/1994	252153.90	1581442.53	7603.99	19.8	7.3	7606.72	19.80	4.0	14.8	5.00	AL	Active
059	09/1994	252236.85	1581587.06	7605.91	20.0	7.3	7606.15	20.00	4.0	15.0	5.00	AL	Active
060	09/1994	252837.34	1580397.87	7603.07	20.0	7.3	7605.33	20.00	4.0	15.0	5.00	AL	Active
061	09/1994	252891.00	1580461.67	7603.54	20.0	7.3	7605.00	20.00	4.0	15.0	5.00	AL	Active
088	09/1994	253713.63	1581439.69	7611.42	19.0	7.3	7613.72	19.00	4.0	14.0	5.00	AL	Active
096	09/1994	254974.22	1582392.12	7620.02	20.0	7.3	7621.06	20.00	4.0	15.0	5.00	AL	Active
097	09/1994	255024.96	1582247.89	7619.36	20.0	7.3	7618.92	20.00	4.0	15.0	5.00	AL	Active
101	09/1983	258095.02	1588241.42	7653.67	51.5	6.875	7653.32	51.50	2.0	41.5	5.00	AL	Active
102	09/1983	257024.54	1588225.86	7647.28	52.0	6.875	7649.21	52.00	2.0	42.0	5.00	AL	Active
103	09/1983	257393.91	1586887.73	7647.81	50.0	6.875	7649.58	50.00	2.0	40.0	5.00	AL	Active
104	09/1983	257039.75	1587596.08	7662.48	70.0	6.25	7664.49	70.00	2.0	60.0	5.00	AL	Abandoned
105	09/1983	256740.29	1586950.86	7644.56	52.0	6.875	7646.11	52.00	2.0	42.0	5.00	AL	Active
106	09/1983	256218.18	1587446.91	7645.18	55.0	6.875	7647.30	44.00	2.0	34.0	5.00	AL	Active
107	09/1983	256172.24	1587685.37	7644.87	53.0	6.875	7646.37	53.00	2.0	43.0	5.00	AL	Active
109	09/1983	256018.25	1587620.33	7644.05	60.0	6.875	7645.10	55.00	2.0	45.0	5.00	AL	Active
110	09/1983	256007.34	1587271.40	7644.02	48.5	6.875	7645.81	48.50	2.0	38.5	5.00	AL	Abandoned
111	09/1983	256021.50	1586991.21	7642.60	52.0	6.875	7644.52	52.00	2.0	42.0	5.00	AL	Abandoned
112	09/1983	255775.92	1587539.05	7643.21	50.0	6.875	7644.84	50.00	2.0	40.0	5.00	AL	Active
113	09/1983	255506.47	1586804.77	7641.91	51.0	6.875	7643.83	51.00	2.0	41.0	5.00	AL	Active
120	12/1984	256083.08	1585613.81	7635.84	41.0	6.0	7638.70	24.70	2.0	17.7	5.00	AL	Active
121	12/1984	256056.77	1585596.20	7635.77	102.5	6.0	7637.82	100.00	2.0	93.0	5.00	AL	Active

LOCATION CODE	INSTALL DATE	NORTH COORD. (FT STATE-PLANE)	EAST COORD. (FT STATE-PLANE)	GROUND ELEV. (FT NGVD)	BORE HOLE DEPTH (FT BLS)	BORE HOLE DIA. (INCHES)	TOP OF CASING ELEV. (FT NGVD)	WELL DEPTH (FT BLS)	CASING DIAMETER (INCHES)	TOP OF SCREEN DEPTH (FT BLS)	SCREEN LENGTH	ZONE OF COMPL.	STATUS
122	12/1984	256060.07	1585618.71	7635.64	100.0	6.0	7638.10	85.00	2.0	78.0	5.00	AL	Active
123	01/1985	256076.12	1585597.11	7635.78	61.0	6.0	7638.81	61.00	2.0	53.0	5.00	AL	Active
125	12/1984	254744.48	1585636.79	7631.35	24.8	6.0	7633.52	24.80	2.0	17.8	5.00	AL	Active
126	01/1985	254734.80	1585625.45	7631.36	61.0	6.0	7634.14	61.00	2.0	54.0	5.00	AL	Active
127	12/1984	254726.25	1585615.09	7631.34	103.0	6.0	7634.64	101.00	2.0	94.0	5.00	AL	Active
130	12/1984	255019.87	1587194.27	7639.63	26.0	6.0	7641.48	25.00	2.0	18.0	5.00	AL	Abandoned
132	12/1984	255020.19	1587215.38	7639.74	100.5	6.0	7641.57	100.50	2.0	93.5	5.00	AL	Abandoned
133	01/1985	256218.42	1587503.53	7645.49	21.0	6.0	7646.98	21.00	2.0	14.0	5.00	AL	Active
134	01/1985	256225.16	1587510.23	7645.57	21.0	6.0	7646.72	21.00	2.0	14.0	5.00	AL	Active
135	12/1984	253890.71	1584319.55	7623.60	25.0	6.0	7627.03	25.00	2.0	18.0	5.00	AL	Active
136	01/1985	253889.25	1584328.12	7623.36	61.0	6.0	7626.24	60.00	2.0	53.0	5.00	AL	Active
137	12/1984	253892.78	1584335.26	7624.59	112.0	6.0	7626.11	100.00	2.0	93.0	5.00	AL	Abandoned
140	01/1985	254960.89	1588515.12	7639.70	26.0	6.0	7641.76	25.00	2.0	18.0	5.00	AL	Active
141	01/1985	254947.13	1588514.59	7639.56	61.0	6.0	7641.80	60.00	2.0	53.0	5.00	AL	Active
142	01/1985	254932.05	1588514.43	7639.46	100.0	6.0	7641.40	98.50	2.0	91.5	5.00	AL	Active
145	01/1985	253454.31	1586418.89	7630.76	27.0	6.0	7632.53	25.00	2.0	18.0	5.00	AL	Abandoned
147	01/1985	253468.09	1586403.14	7630.69	101.0	6.0	7632.64	100.00	2.0	93.0	5.00	AL	Abandoned
155	01/1985	251961.57	1584356.92	7618.87	27.0	6.0	7620.70	25.00	2.0	18.0	5.00	AL	Abandoned
157	01/1985	251969.16	1584335.35	7618.84	101.0	6.0	7620.55	97.00	2.0	90.0	5.00	AL	Abandoned
160	12/1984	252904.45	1580481.68	7603.74	75.0	6.0	7604.39	58.00	2.0	51.0	5.00	AL	Active
161	11/1984	252893.50	1580474.64	7603.64	100.0	6.0	7605.63	100.00	2.0	93.0	5.00	AL	Active
163	12/1984	254663.11	1580111.40	7611.08	61.0	6.0	7613.21	61.00	2.0	54.0	5.00	AL	Active

LOCATION CODE	INSTALL DATE	NORTH COORD. (FT STATE- PLANE)	EAST COORD. (FT STATE- PLANE)	GROUND ELEV. (FT NGVD)	BORE HOLE DEPTH (FT BLS)	BORE HOLE DIA. (INCHES)	TOP OF CASING ELEV. (FT NGVD)	WELL DEPTH (FT BLS)	CASING DIAMETER (INCHES)	TOP OF SCREEN DEPTH (FT BLS)	SCREEN LENGTH	ZONE OF COMPL.	STATUS
170	11/1984	255467.63	1586810.48	7641.72	141.0	6.25	7643.92	141.00	2.0	134.0	5.00	AL	Active
181	01/1985	253295.41	1583128.56	7616.86	28.0	6.0	7619.07	25.00	2.0	18.0	5.00	AL	Active
183	01/1985	253309.56	1583115.95	7616.66	101.0	6.0	7617.82	100.00	2.0	93.0	5.00	AL	Active
184	01/1985	252870.39	1581543.66	7606.88	61.0	6.0	7608.76	60.00	2.0	53.0	5.00	AL	Abandoned
185	01/1985	252862.76	1581545.42	7606.95	101.0	6.0	7608.87	100.00	2.0	93.0	5.00	AL	Abandoned
186	01/1985	254571.86	1583989.44	7625.34	61.0	6.0	7627.21	60.00	2.0	53.0	5.00	AL	Active
187	01/1985	254570.46	1583996.53	7625.40	101.0	6.0	7627.01	100.00	2.0	93.0	5.00	AL	Active
188	01/1985	253701.31	1581431.99	7611.61	61.0	6.0	7613.65	60.00	2.0	53.0	5.00	AL	Active
189	01/1985	253692.52	1581428.10	7611.88	101.0	6.0	7613.56	100.00	2.0	93.0	5.00	AL	Active
194	01/1985	256532.59	1584375.31	7634.43	94.0	6.0	7636.26	83.00	2.0	76.0	5.00	AL	Abandoned
195	01/1985	256521.09	1584369.50	7634.22	60.0	6.0	7636.41	60.00	2.0	53.0	5.00	AL	Abandoned
196	01/1985	255029.30	1582252.99	7619.82	60.0	6.0	7621.72	60.00	2.0	53.0	5.00	AL	Active
197	01/1985	255022.91	1582240.62	7619.88	100.0	6.0	7621.70	100.00	2.0	93.0	5.00	AL	Active
198	01/1985	255102.89	1582594.52	7620.00	72.0	6.0	-	67.50	2.0	60.5	5.00	AL	Abandoned

ZONES OF COMPLETION:  
AL ALLUVIUM

**Appendix B**

**Monitor Well Logs (CD-ROM)**

## **Appendix C**

### **Ground Water Elevations (CD-ROM)**

## **Appendix D**

### **Summary of Ground Water Quality (1997–1999)**

Summary of Ground Water Quality (1997 - 1999)

Site Code	Location Code	Date Sampled	Alk mg/L	EC umhos/cm	ORP mV	TDS mg/L	pH s.u.	Ca mg/L	Cd mg/L	Cl mg/L	Fe mg/L	K mg/L	Mg mg/L
GUN01	0001	05/27/1999	220	478	-70	313	7.06	76.9	<0.001	26.4	0.582	2.51	14.9
		10/12/1999	224	467	-95	330	7.12	80.5	<0.0003	47	0.869	3.11	15
GUN01	0002	06/10/1998	215	566	97	~325	7.18	78.7	<0.001	25.9	<0.003	2.29	15.4
		09/25/1998	233	---	60	368	6.86	84.1	<0.001	26	<0.004	2.76	16.1
		05/27/1999	211	552	189	315	7.01	78.8	<0.001	22.3	<0.006	2.39	15.5
		10/12/1999	237	592	38	328	7.42	81.3	<0.0003	35.1	<0.009	2.55	15.8
GUN01	0003	09/25/1998	203	---	49	298	7.08	66.2	<0.001	3.46	0.0199	2.36	12.2
GUN01	0006	06/04/1997	129	2510	31	2300	6.38	574	<0.001	22.1	2.74	4.99	24.9
		06/10/1998	260	2370	92	~2330	6.71	586	<0.001	25.3	4.73	4.28	20
		09/30/1998	260	2540	123	2380	6.56	643	0.0016	20.9	0.164	5.77	27.4
		06/01/1999	247	2460	34	~2160	6.54	611	<0.001	28.7	2.94	4.85	26.1
		10/06/1999	264	2420	35	2280	6.96	585	0.0004	19.4	0.053	5.12	23.3
GUN01	0009	09/24/1998	188	2310	-1	2260	6.19	611	<0.001	51.9	3.72	4.09	19.1
GUN01	0012	09/24/1998	244	2480	-14	2300	6.50	625	<0.001	54.7	6.33	5.2	21.3
GUN01	0013	06/04/1997	171	477	37	260	7.17	68.4	<0.001	3.04	<0.001	2.8	9.67
		06/09/1998	158	411	72	250	7.29	63.9	<0.001	1.49	<0.003	2.3	7.82
		09/29/1998	245	422	84	268	7.29	89.7	<0.001	2.4	<0.004	2.48	9.38
		05/26/1999	227	582	251	225	6.99	100	<0.001	3.86	<0.006	2.3	12.5
		10/05/1999	253	519	4	290	7.22	86.6	<0.0003	3.28	<0.009	2.34	10.9
GUN01	0014	06/05/1997	236	1773	190	1500	6.91	383	<0.001	18.4	<0.001	3.88	27.8
		06/09/1998	199	1102	86	1060	6.65	258	<0.001	20	<0.003	3.02	17.2
		09/24/1998	203	1808	72	1450	6.26	357	<0.001	21.7	0.0575	4.5	24.5
		05/28/1999	204	2070	91	1780	6.56	463	<0.001	44.9	0.0742	3.81	30.3
		10/06/1999	226	1852	20	1470	6.96	390	<0.0003	27.1	0.0415	4.28	25.3

Summary of Ground Water Quality (1997 - 1999)

Site Code	Location Code	Date Sampled	Mn mg/L	NO <sub>3</sub> mg/L	Na mg/L	Po-210 pCi/L	Ra-226 pCi/L	Ra-228 pCi/L	SO <sub>4</sub> mg/L	Se mg/L	U mg/L
GUN01	0001	05/27/1999	0.0736	2.02	11.7	<0.26	<0.14	<0.78	19.7	<0.001	0.0025
		10/12/1999	0.17	2.38	12.3	<0.06	<0.14	<0.93	18.1	<0.0001	~0.0023
GUN01	0002	06/10/1998	<0.001	4.93	9.68	<0.11	<0.14	<0.56	22.7	---	0.0028
		09/25/1998	0.0068	5.72	11.6	0.14	0.19	<0.7	20.8	<0.001	0.0031
		05/27/1999	<0.001	4.56	9.76	<0.14	0.09	<0.43	20.3	<0.001	0.0025
		10/12/1999	0.0019	6.38	11.2	<0.08	0.15	<0.82	21.1	0.0002	~0.0022
GUN01	0003	09/25/1998	0.0085	3.03	5.36	<0.14	0.16	<0.69	17.4	<0.001	0.0232
GUN01	0006	06/04/1997	2.85	0.38	12.8	<0.19	0.09	<0.9	1330	---	0.88
		06/10/1998	2.38	<0.143	11	<0.06	<0.16	<0.63	1390	---	1.22
		09/30/1998	1.43	0.83	14.9	<0.07	<0.11	<0.56	1340	<0.001	0.947
		06/01/1999	1.83	0.541	12.9	<0.1	<0.16	<0.93	1290	<0.001	0.921
		10/06/1999	0.557	0.428	12.5	<0.09	<0.13	<0.74	~1300	<0.0001	0.903
GUN01	0009	09/24/1998	1.28	2.67	13.8	<0.06	0.16	<0.73	1060	<0.001	1.09
GUN01	0012	09/24/1998	2.16	1.04	15.5	<0.05	<0.11	<0.69	1120	<0.001	1.16
GUN01	0013	06/04/1997	<0.001	6.33	4.1	<0.15	0.14	<0.7	43.7	---	0.0439
		06/09/1998	<0.001	1.06	4.39	<0.11	<0.15	<0.6	42.2	---	0.0417
		09/29/1998	<0.001	1.06	5.79	<0.08	<0.12	<0.78	28.9	<0.001	0.0647
		05/26/1999	<0.001	3.85	4.22	<0.22	<0.14	<0.83	53.8	<0.001	0.0582
		10/05/1999	<0.0008	0.234	4.54	<0.06	<0.12	<0.71	24.9	<0.0001	0.04
GUN01	0014	06/05/1997	0.594	6.98	11.4	<0.22	0.06	<0.7	801	---	0.62
		06/09/1998	0.173	2.21	8.81	<0.12	<0.15	<0.61	549	---	0.494
		09/24/1998	0.0159	0.922	11.9	<0.11	<0.11	<0.68	732	<0.001	0.608
		05/28/1999	2.53	1.39	12.3	0.12	<0.15	<0.86	959	<0.001	0.947
		10/06/1999	0.068	0.638	12.6	<0.07	<0.12	<0.7	813	<0.0001	0.692

Summary of Ground Water Quality (1997 - 1999)

Site Code	Location Code	Date Sampled	Alk mg/L	EC umhos/cm	ORP mV	TDS mg/L	pH s.u.	Ca mg/L	Cd mg/L	Cl mg/L	Fe mg/L	K mg/L	Mg mg/L
GUN01	0058	06/04/1997	210	580	168	358	7.02	84.7	<0.001	9.02	0.0041	2.02	19.2
		06/11/1998	199	530	100	~315	6.90	73.1	<0.001	6.72	0.0259	1.82	15.2
		06/11/1998	---	---	---	~317	---	73	<0.001	6.94	0.0271	1.81	15.2
		09/28/1998	205	554	78	~303	6.69	81.8	<0.001	5.77	0.0512	2.31	16.8
		05/26/1999	144	502	77	467	6.81	73.9	<0.001	10.9	<0.0507	1.81	15.5
		10/11/1999	209	507	-24	305	6.89	71.5	<0.0003	4.98	0.0348	1.99	14.4
GUN01	0059	06/04/1997	243	761	223	502	7.15	116	<0.001	5.37	<0.001	2.42	26
		06/10/1998	217	697	92	~432	6.93	101	<0.001	8.08	<0.003	1.79	20.7
		09/29/1998	203	619	101	380	6.59	92.7	<0.001	5.17	0.0119	2.08	18.6
		05/26/1999	195	620	77	383	6.87	93.6	<0.001	6.11	<0.0215	1.8	19.5
		10/11/1999	209	539	-8	325	6.81	77.8	<0.0003	5.06	<0.009	1.81	15.6
GUN01	0060	10/02/1998	133	289	44	137	6.63	39.9	<0.001	1.56	<0.004	1.24	8.23
		05/26/1999	114	338	84	198	6.90	47.3	<0.001	1.88	<0.006	1.11	9.95
		10/13/1999	125	234	12	113	7.18	31.1	<0.0003	0.801	<0.009	1.03	6.24
GUN01	0061	10/01/1998	118	300	36	152	6.95	40.1	<0.001	1.61	<0.004	1.29	8.27
		05/26/1999	107	337	73	208	6.96	48.2	<0.001	<5.24	<0.007	1.13	10.2
		10/13/1999	107	238	24	120	7.00	31.2	<0.0003	0.852	<0.009	1.04	6.27
GUN01	0088	06/03/1997	108	245	9	137	7.10	31.1	<0.001	1.41	<0.001	1	6.99
		06/11/1998	95	249	37	~133	6.87	32.6	<0.001	1.05	<0.003	0.908	6.66
		09/29/1998	111	262	36	135	7.01	35.7	<0.001	0.882	<0.004	1.15	7.24
		05/27/1999	78	236	-17	155	7.08	37	<0.001	2.01	<0.006	0.96	7.65
		05/27/1999	---	---	---	155	---	37.2	<0.001	1.74	<0.0077	0.991	7.71
		10/08/1999	108	293	21	137	7.06	39.6	<0.0003	1.54	<0.009	1.06	7.91
GUN01	0096	10/02/1998	107	253	36	130	6.69	34.3	<0.001	0.816	<0.004	1.02	7.18
		05/26/1999	97	243	276	150	6.66	33.3	<0.001	1.16	<0.006	0.78	7
		10/12/1999	144	253	15	135	6.91	33.6	<0.0003	1	<0.009	0.9	6.88

Summary of Ground Water Quality (1997 - 1999)

Site Code	Location Code	Date Sampled	Mn mg/L	NO <sub>3</sub> mg/L	Na mg/L	Po-210 pCi/L	Ra-226 pCi/L	Ra-228 pCi/L	SO <sub>4</sub> mg/L	Se mg/L	U mg/L
GUN01	0058	06/04/1997	0.757	0.0228	6.67	<0.12	<0.1	<1.2	80.2	---	0.0071
		06/11/1998	1.07	<0.0286	6.3	0.14	<0.12	<0.49	61.9	---	0.0061
		06/11/1998	1.06	<0.0226	6.28	<0.14	<0.13	<0.51	61.9	---	0.006
		09/28/1998	1.21	1.44	8.13	<0.12	0.13	<0.79	69.6	<0.001	0.0061
		05/26/1999	1.09	<0.01	5.97	<0.14	<0.15	<0.84	63.3	<0.001	0.0052
		10/11/1999	1.17	0.49	6.41	<0.09	<0.13	<0.85	62.3	<0.0001	-0.0048
GUN01	0059	06/04/1997	0.219	0.33	7.39	<0.2	0.14	<0.7	159	---	0.0209
		06/10/1998	0.92	<0.0708	6.58	<0.13	<0.13	<0.5	125	---	0.008
		09/29/1998	0.809	0.775	6.69	<0.08	0.23	<0.79	100	<0.001	0.0063
		05/26/1999	0.846	0.0619	6.32	<0.16	<0.15	<0.83	98.4	<0.001	0.0067
		10/11/1999	0.671	0.2	6.49	<0.13	<0.12	<0.8	79.2	<0.0001	-0.0044
GUN01	0060	10/02/1998	0.0532	0.219	3.19	<0.07	<0.12	<0.62	23.6	<0.001	0.0019
		05/26/1999	0.042	0.0275	3.52	<0.09	<0.16	<0.88	39.1	<0.001	0.0028
		10/13/1999	0.0222	<0.0295	3.45	<0.12	<0.14	<0.88	16.2	<0.0001	0.0006
GUN01	0061	10/01/1998	0.107	0.338	4.64	<0.08	<0.11	<0.58	26.8	<0.001	0.002
		05/26/1999	0.119	0.0476	4.3	<0.17	<0.13	<0.79	---	<0.001	0.0031
		10/13/1999	0.0645	0.0671	3.47	<0.19	<0.13	<0.86	17.5	<0.0001	0.0007
GUN01	0088	06/03/1997	<0.001	0.376	3.66	<0.17	0.06	<0.7	18.5	---	0.0013
		06/11/1998	<0.001	0.42	3.6	<0.09	<0.12	<0.5	21.3	---	0.0012
		09/29/1998	<0.001	0.473	3.84	<0.08	<0.13	<0.9	21.8	<0.001	0.001
		05/27/1999	<0.001	0.453	3.4	<0.08	<0.15	<0.85	22.5	<0.001	0.0014
		05/27/1999	<0.001	0.462	3.51	<0.12	<0.15	<0.85	22.8	<0.001	0.0014
		10/08/1999	<0.0019	<0.0313	4.05	<0.1	<0.13	<0.86	31	<0.0001	-0.0008
GUN01	0096	10/02/1998	<0.001	0.358	4.83	<0.09	<0.11	<0.57	15.9	<0.001	<0.001
		05/26/1999	<0.001	0.237	3.28	<0.25	<0.15	<0.85	18.9	<0.001	0.0011
		10/12/1999	0.0011	0.0858	3.67	<0.07	<0.15	<0.95	18.8	<0.0001	-0.0011

Summary of Ground Water Quality (1997 - 1999)

Site Code	Location Code	Date Sampled	Alk mg/L	EC umhos/cm	ORP mV	TDS mg/L	pH s.u.	Ca mg/L	Cd mg/L	Cl mg/L	Fe mg/L	K mg/L	Mg mg/L
GUN01	0097	10/01/1998	117	236	45	130	6.96	32.5	<0.001	0.605	<0.004	1.14	6.49
		05/27/1999	82	223	175	132	6.77	31	<0.001	1.04	<0.006	0.867	6.35
		05/27/1999	---	---	---	143	---	31.2	<0.001	1.02	<0.0068	0.914	6.37
		10/12/1999	94	212	41	110	6.96	28.7	<0.0003	0.671	<0.009	0.95	5.58
GUN01	0101	05/27/1999	209	494	203	277	7.40	70.2	<0.001	20.6	<0.006	2.15	14.9
		10/12/1999	194	474	-65	250	7.60	63.5	<0.0003	19.7	<0.009	1.97	13.6
GUN01	0102	06/10/1998	243	599	79	~337	7.41	85.2	<0.001	21.5	<0.003	1.69	17.9
		09/25/1998	278	---	34	355	7.28	87.3	<0.001	21.8	<0.004	1.84	18.1
		05/27/1999	240	597	-43	365	7.13	86.2	<0.001	20.1	<0.006	1.75	18.1
		10/12/1999	236	572	-40	323	7.72	84.4	<0.0003	18	<0.009	1.6	17.4
GUN01	0103	09/25/1998	203	---	-38	308	6.92	67.8	<0.001	4.28	0.0119	2.05	14.6
GUN01	0106	06/04/1997	35	---	29	1760	5.28	399	0.0012	21.3	2.77	3.72	31.2
		06/04/1997	---	---	---	1760	---	403	0.0011	21.3	2.81	3.73	31.4
		06/10/1998	40	1857	84	~1720	5.62	375	0.0014	25.8	2.57	3.36	27.3
		06/10/1998	---	---	---	~1730	---	387	0.001	25.7	2.64	3.46	28.2
		09/30/1998	38	1938	48	1700	5.34	406	0.0021	23.4	2.21	3.74	28.9
		06/01/1999	37	1901	-103	~1700	5.23	401	0.0014	28.4	2.32	3.72	28.8
		10/06/1999	22	1884	12	1720	5.43	393	0.0018	27	1.89	3.46	26.3
GUN01	0107	09/24/1998	86	829	-41	727	5.85	131	0.0012	27.4	0.0842	2.43	25.2
GUN01	0109	09/24/1998	70	1735	-34	253	5.73	285	<0.001	35.6	0.17	3.18	46.2
GUN01	0112	09/24/1998	82	1622	-55	1420	5.88	285	0.0186	35.5	0.0885	3	38.6
GUN01	0113	06/05/1997	204	1584	138	1320	6.72	319	<0.001	9.7	0.0772	3.26	29.3
		06/09/1998	208	1032	85	1160	6.59	276	<0.001	9.5	0.0588	2.82	24.3
		09/29/1998	195	992	60	867	6.57	213	<0.001	5.5	0.063	2.6	19.4
		05/26/1999	196	1184	16	235	6.51	215	<0.001	6.39	0.126	2.69	20.9
		10/05/1999	182	895	23	632	6.74	159	<0.0003	4.16	<0.072	2.33	14.3

Summary of Ground Water Quality (1997 - 1999)

Site Code	Location Code	Date Sampled	Mn mg/L	NO <sub>3</sub> mg/L	Na mg/L	Po-210 pCi/L	Ra-226 pCi/L	Ra-228 pCi/L	SO <sub>4</sub> mg/L	Se mg/L	U mg/L
GUN01	0097	10/01/1998	<0.001	0.509	2.92	<0.09	<0.12	<0.62	12.4	<0.001	0.001
		05/27/1999	<0.001	0.898	3.18	<0.33	<0.15	<0.86	16.2	<0.001	<0.001
		05/27/1999	<0.001	0.898	2.98	<0.25	<0.14	<0.84	16.2	<0.001	<0.001
		10/12/1999	0.0011	0.196	3.11	<0.05	<0.12	<0.81	13.6	<0.0001	~0.0003
GUN01	0101	05/27/1999	0.0031	3.85	5.87	<0.16	<0.15	<0.87	17.7	<0.001	0.0036
		10/12/1999	<0.0018	4.5	5.74	<0.05	<0.13	<0.81	17.5	<0.0001	~0.0031
GUN01	0102	06/10/1998	<0.001	5.67	6.95	<0.06	<0.13	<0.51	23.6	---	0.0043
		09/25/1998	0.001	6.11	8.62	<0.1	<0.11	<0.72	21.7	<0.001	0.0043
		05/27/1999	<0.001	5.71	6.54	<0.17	<0.14	<0.84	23.2	<0.001	0.004
		10/12/1999	0.0008	5.78	7	<0.07	<0.13	<0.82	22.5	<0.0001	~0.0035
GUN01	0103	09/25/1998	1.5	3.6	12	<0.07	<0.11	<0.72	36.3	<0.001	0.0074
GUN01	0106	06/04/1997	20	0.0327	19.9	<0.18	0.05	<1	1110	---	<0.001
		06/04/1997	20.3	<0.029	20.2	<0.2	0.11	<0.8	1110	---	<0.001
		06/10/1998	18.6	<0.0936	18.6	<0.05	<0.16	<0.65	1100	---	<0.001
		06/10/1998	18.1	<0.0621	19.1	<0.07	<0.14	<0.58	1080	---	<0.001
		09/30/1998	19.1	0.39	20.9	<0.06	<0.11	<0.57	1040	<0.001	<0.001
		06/01/1999	18.6	0.077	19.3	<0.1	<0.15	<0.88	1000	<0.001	<0.001
		10/06/1999	16.9	<0.0419	18.4	<0.05	<0.13	<0.77	~1050	<0.0001	<0.0002
GUN01	0107	09/24/1998	9.99	1.16	26.6	<0.07	<0.11	<0.7	316	<0.001	0.004
GUN01	0109	09/24/1998	20.9	0.351	29.5	<0.05	<0.15	<0.97	827	<0.001	0.0021
GUN01	0112	09/24/1998	19.5	1.1	28.4	<0.09	<0.11	<0.68	790	<0.001	0.0045
GUN01	0113	06/05/1997	7.37	0.0254	16.1	<0.17	<0.04	<0.8	721	---	0.361
		06/09/1998	6.43	<0.0863	14.8	<0.09	<0.14	<0.55	639	---	0.326
		09/29/1998	5.01	0.42	13.7	<0.12	<0.11	<0.73	422	<0.001	0.229
		05/26/1999	5.29	0.0264	14.6	<0.14	<0.14	<0.82	436	<0.001	0.226
		10/05/1999	3.55	<0.0157	12.1	<0.06	<0.13	<0.73	278	<0.0001	0.17

Summary of Ground Water Quality (1997 - 1999)

Site Code	Location Code	Date Sampled	Alk mg/L	EC umhos/cm	ORP mV	TDS mg/L	pH s.u.	Ca mg/L	Cd mg/L	Cl mg/L	Fe mg/L	K mg/L	Mg mg/L
GUN01	0120	06/11/1998	178	370	35	~227	7.44	54.6	<0.001	4.41	<0.003	2.61	10.4
		06/11/1998	---	---	---	~220	---	58.9	<0.001	4.45	0.0106	2.58	10.8
		09/29/1998	188	384	99	215	7.74	55.7	<0.001	5.8	0.0164	3.22	10.4
		05/28/1999	136	299	36	193	8.11	43.7	<0.001	2.19	<0.0226	2.38	7.97
		10/07/1999	149	375	89	237	7.67	53.5	<0.0003	6.87	0.01	2.64	9.72
GUN01	0121	06/11/1998	249	525	-139	~340	7.20	76.1	<0.001	4.18	0.388	4.21	14.8
		09/29/1998	156	372	9	233	7.82	67.9	<0.001	3.78	0.255	4.31	13.6
		05/28/1999	157	396	-125	247	7.67	64	<0.001	4	0.135	4.33	12.6
		10/07/1999	117	309	-96	150	8.51	40.5	<0.0003	3.79	<0.009	3.16	8.81
GUN01	0122	06/04/1997	286	798	106	467	6.74	118	<0.001	4.17	0.259	8.77	21.9
		06/11/1998	404	755	-50	~438	6.81	117	<0.001	4.5	0.212	8.07	19.9
		09/29/1998	410	824	108	452	6.81	122	<0.001	4.13	0.0985	8.23	20.9
		05/28/1999	395	838	1	485	6.72	126	<0.001	4.27	0.287	8.81	21.5
		10/07/1999	409	819	8	455	7.00	118	<0.0003	4.32	0.311	8.09	19.7
GUN01	0123	06/11/1998	164	384	60	~225	6.86	55.7	<0.001	3.75	<0.003	2.33	10.5
		09/29/1998	199	426	58	210	7.18	62.1	<0.001	6.2	0.0411	2.78	11.9
		05/28/1999	142	335	108	205	6.75	48.2	<0.001	<2.98	<0.0087	2.1	9.04
		10/07/1999	175	409	0	230	7.00	57.2	<0.0003	8.13	<0.009	2.44	10.8
GUN01	0125	06/05/1997	208	634	90	2900	7.16	87.1	<0.001	5.16	<0.001	2.42	20.1
		06/10/1998	216	638	112	~385	7.14	82.5	<0.001	5.52	<0.003	3.43	17.4
		10/01/1998	229	523	66	302	7.14	72.7	<0.001	3.92	<0.004	2.33	15
		06/02/1999	212	575	109	~345	6.89	82.6	<0.001	4.96	<0.013	2.26	17.3
		10/06/1999	225	492	18	235	7.34	70.7	<0.0003	4.44	<0.009	2.24	14.1
		10/06/1999	---	---	---	252	---	69.7	<0.0003	4.38	<0.009	2.21	14

Summary of Ground Water Quality (1997 - 1999)

Site Code	Location Code	Date Sampled	Mn mg/L	NO <sub>3</sub> mg/L	Na mg/L	Po-210 pCi/L	Ra-226 pCi/L	Ra-228 pCi/L	SO <sub>4</sub> mg/L	Se mg/L	U mg/L
GUN01	0120	06/11/1998	0.384	<0.245	6.03	<0.13	<0.14	<0.57	24.7	---	0.0028
		06/11/1998	0.49	<0.241	7.45	<0.1	<0.14	<0.58	24.8	---	0.0029
		09/29/1998	0.411	1.13	7.73	<0.08	0.12	<0.78	20.7	<0.001	0.0024
		05/28/1999	0.247	0.0951	5.16	<0.21	<0.15	<0.86	19.1	<0.001	0.0015
		10/07/1999	0.394	<0.01	6.39	<0.08	<0.12	<0.74	18	<0.0001	0.0016
GUN01	0121	06/11/1998	0.0998	<0.0312	13.5	<0.1	0.14	<0.53	34.1	---	0.0027
		09/29/1998	0.093	1.34	14.3	<0.06	0.57	<0.76	30.6	<0.001	0.002
		05/28/1999	0.0788	0.134	13.4	<0.16	0.58	<0.81	30.1	<0.001	0.0015
		10/07/1999	0.0358	<0.0387	9.3	<0.08	0.51	<0.71	28.1	<0.0001	0.0008
GUN01	0122	06/04/1997	0.142	0.0317	23.3	<0.13	0.2	<0.4	35.3	---	<0.001
		06/11/1998	0.143	<0.011	21.7	<0.06	<0.13	<0.52	37.4	---	0.0011
		09/29/1998	0.114	1.32	22.3	<0.06	0.34	<0.75	35	<0.001	0.0011
		05/28/1999	0.141	0.0775	23.4	<0.12	<0.14	<0.85	35.7	<0.001	<0.001
		10/07/1999	0.123	<0.0161	22.6	<0.08	<0.12	<0.73	35.1	<0.0001	0.0003
GUN01	0123	06/11/1998	0.186	<0.0489	5.59	<0.12	<0.13	<0.53	27.7	---	0.0022
		09/29/1998	0.0476	0.793	5.64	<0.08	0.17	<0.76	17.6	<0.001	0.0027
		05/28/1999	0.191	0.0455	4.44	<0.17	<0.15	<0.86	24.4	<0.001	<0.001
		10/07/1999	0.377	<0.0213	5.34	<0.07	<0.12	<0.73	16.1	<0.0001	0.0015
GUN01	0125	06/05/1997	0.248	0.0522	15.4	<0.1	0.09	<0.7	101	---	0.019
		06/10/1998	0.222	<0.0773	14	<0.13	<0.16	<0.63	112	---	0.0183
		10/01/1998	0.188	0.326	12.3	<0.09	<0.18	<0.88	40.8	<0.001	0.0147
		06/02/1999	0.215	0.144	13.8	0.11	<0.14	<0.86	70.1	<0.001	0.0158
		10/06/1999	0.169	<0.0631	10.7	<0.07	<0.14	<0.81	33.5	<0.0001	0.0123
		10/06/1999	0.166	<0.0492	10.6	<0.07	<0.12	<0.75	34.1	<0.0001	0.0119

Summary of Ground Water Quality (1997 - 1999)

Site Code	Location Code	Date Sampled	Alk mg/L	EC umhos/cm	ORP mV	TDS mg/L	pH s.u.	Ca mg/L	Cd mg/L	Cl mg/L	Fe mg/L	K mg/L	Mg mg/L
GUN01	0126	06/05/1997	231	543	91	322	7.17	76.9	<0.001	4.01	0.0177	3.32	15.8
		06/10/1998	208	523	101	~293	7.26	73.8	<0.001	4.48	<0.003	2.59	13.4
		10/01/1998	259	1217	52	870	6.92	181	<0.001	5.66	0.0198	3.35	40.8
		06/02/1999	199	478	114	~282	6.94	73.5	<0.001	4.07	<0.0064	2.68	13.5
		10/06/1999	257	949	-55	808	7.16	170	<0.0003	6.43	0.015	3.06	37.8
GUN01	0127	06/05/1997	251	1533	100	1270	7.14	259	<0.001	5.65	<0.001	2.93	66.5
		06/10/1998	258	1532	107	~1190	7.26	254	<0.001	5.92	<0.003	2.92	59.9
		10/01/1998	260	1515	78	1190	7.20	252	<0.001	5.25	<0.004	2.72	59.3
		06/02/1999	260	1509	98	~1180	7.00	253	<0.001	6	<0.0123	2.78	59.3
		10/07/1999	273	1389	51	1120	7.34	229	<0.0003	5.98	<0.009	2.46	53.1
		10/07/1999	---	---	---	1080	---	228	<0.0003	5.94	<0.009	2.46	52.5
GUN01	0130	06/03/1997	230	1422	27	1110	6.81	272	<0.001	9.92	0.008	3.15	26
		06/09/1998	178	447	78	375	6.98	102	<0.001	2.84	<0.003	2.08	8.44
		09/24/1998	213	942	66	570	6.52	179	<0.001	7.12	<0.004	3.12	15.5
		05/28/1999	229	2060	115	1810	6.47	451	<0.001	40.3	<0.022	3.57	43.4
		10/06/1999	---	153	72	---	7.64	---	---	---	---	---	---
GUN01	0132	06/03/1997	172	455	-5	280	7.51	64.2	<0.001	3.38	0.0288	1.94	15.3
		06/03/1997	---	---	---	275	---	62.3	<0.001	3.38	<0.001	1.87	14.9
		06/09/1998	172	369	81	270	7.61	58.9	<0.001	2.62	<0.003	1.74	12.9
		09/24/1998	168	400	21	270	7.73	59.4	<0.001	2.53	<0.004	1.93	12.9
		09/24/1998	---	---	---	262	---	54.9	<0.001	2.53	0.32	1.85	11.9
		05/28/1999	180	393	73	240	7.67	57.7	<0.001	2.42	<0.006	1.87	12.8
		10/06/1999	157	315	50	198	7.79	53.7	<0.0003	2.5	<0.009	1.67	11.6
GUN01	0133	09/24/1998	290	2610	68	2460	6.34	674	0.0125	24.2	3.99	6.32	23.9

Summary of Ground Water Quality (1997 - 1999)

Site Code	Location Code	Date Sampled	Mn mg/L	NO <sub>3</sub> mg/L	Na mg/L	Po-210 pCi/L	Ra-226 pCi/L	Ra-228 pCi/L	SO <sub>4</sub> mg/L	Se mg/L	U mg/L
GUN01	0126	06/05/1997	0.0212	0.121	6.81	<0.15	0.15	<0.8	59	---	0.0149
		06/10/1998	<0.001	<0.107	7.19	<0.09	<0.15	<0.6	47.3	---	0.0162
		10/01/1998	0.0508	0.655	24.1	<0.07	<0.12	<0.61	387	<0.001	0.0289
		06/02/1999	<0.001	0.216	7	<0.1	<0.14	<0.82	33.3	<0.001	0.0138
		10/06/1999	0.0454	<0.032	24.3	<0.07	<0.13	<0.78	389	<0.0001	0.0268
GUN01	0127	06/05/1997	<0.001	1.27	10	<0.11	0.06	<0.7	642	---	0.04
		06/10/1998	<0.001	1.27	10	<0.07	<0.15	<0.61	632	---	0.0395
		10/01/1998	<0.001	2.23	10.7	<0.07	<0.13	<0.62	567	<0.001	0.0409
		06/02/1999	<0.001	1.3	10.6	<0.1	<0.13	<0.81	563	<0.001	0.0383
		10/07/1999	0.0017	1.42	9.26	<0.06	<0.14	<0.83	573	<0.0001	0.0373
		10/07/1999	0.0015	1.39	8.96	<0.07	<0.13	<0.81	574	<0.0001	0.0381
GUN01	0130	06/03/1997	0.0078	9.71	8.08	0.17	0.12	<0.7	557	---	0.337
		06/09/1998	0.003	1.56	5.54	<0.09	<0.14	<0.56	124	---	0.125
		09/24/1998	0.0215	1.17	9.16	0.11	0.19	<0.68	282	<0.001	0.252
		05/28/1999	2.8	0.58	16.7	<0.11	<0.16	<0.96	966	<0.001	0.576
		10/06/1999	---	---	---	---	---	---	---	---	---
GUN01	0132	06/03/1997	<0.001	2.76	5.25	<0.11	0.07	<0.7	41.2	---	0.0057
		06/03/1997	<0.001	2.76	5.09	<0.21	0.2	<0.8	40.9	---	0.0057
		06/09/1998	<0.001	2.84	4.88	<0.09	<0.15	<0.59	35.3	---	0.0054
		09/24/1998	<0.001	3.53	5.27	<0.07	<0.11	<0.68	20.1	<0.001	0.0038
		09/24/1998	0.0031	4.16	4.98	<0.08	<0.1	<0.66	20.1	<0.001	0.0035
		05/28/1999	<0.001	2.82	4.74	<0.11	<0.15	<0.86	20.8	<0.001	0.0063
		10/06/1999	0.0009	2.76	5.01	<0.09	<0.13	<0.76	19.2	<0.0001	0.0027
GUN01	0133	09/24/1998	3.35	0.455	15.2	<0.07	<0.11	<0.68	1380	<0.001	2.19

Summary of Ground Water Quality (1997 - 1999)

Site Code	Location Code	Date Sampled	Alk mg/L	EC umhos/cm	ORP mV	TDS mg/L	pH s.u.	Ca mg/L	Cd mg/L	Cl mg/L	Fe mg/L	K mg/L	Mg mg/L
GUN01	0135	09/30/1998	248	532	32	287	6.97	74.8	<0.001	3.04	0.266	2.09	14.1
GUN01	0136	06/06/1997	1520	6840	-118	665	12.08	167	<0.001	3.96	<0.001	5.19	15.4
		06/11/1998	299	836	-174	~1050	9.61	227	<0.001	5.02	0.522	3.12	51
		09/30/1998	159	1061	-38	738	7.25	149	<0.001	4.15	0.0623	3.48	49.3
		05/28/1999	---	1243	-164	1000	7.47	204	<0.001	6.56	<0.0246	4.2	57.3
		10/08/1999	228	1066	-73	720	7.80	146	<0.0003	4.44	<0.009	4.06	42.7
GUN01	0140	09/28/1998	228	451	87	~297	7.15	76.5	<0.001	10.7	<0.004	2.41	16.4
GUN01	0141	09/28/1998	203	454	78	~237	7.89	67.6	<0.001	4.1	<0.004	1.87	14.7
		09/28/1998	---	---	---	~245	---	66.3	<0.001	3.99	<0.004	1.84	14.1
GUN01	0142	09/28/1998	169	397	73	~232	7.86	56.2	<0.001	2.69	<0.004	1.85	12.2
GUN01	0145	06/04/1997	234	579	34	352	7.10	87.6	<0.001	4.81	<0.001	2.71	17.2
		06/09/1998	189	557	55	358	7.01	83.8	<0.001	5.99	<0.003	2.48	14.6
		09/24/1998	257	522	71	325	7.24	80.3	<0.001	1.69	<0.004	3.06	13.9
		06/02/1999	162	598	147	~375	6.95	94	<0.001	7.65	<0.006	2.73	15.9
		10/07/1999	244	516	73	285	7.33	118	<0.0003	3.35	<0.009	4.23	20.4
GUN01	0147	06/04/1997	211	738	19	500	7.39	107	<0.001	3.49	<0.001	3.01	24.9
		06/09/1998	209	686	57	475	7.34	102	<0.001	3.48	<0.003	2.75	21.7
		09/24/1998	209	700	-4	460	7.35	99.8	<0.001	3.11	0.0074	2.89	21.1
		06/02/1999	212	567	141	~413	7.25	100	<0.001	3.79	<0.006	2.95	21.6
		10/07/1999	218	656	32	417	7.63	95.3	<0.0003	3.47	<0.009	2.57	20.2

Summary of Ground Water Quality (1997 - 1999)

Site Code	Location Code	Date Sampled	Mn mg/L	NO <sub>3</sub> mg/L	Na mg/L	Po-210 pCi/L	Ra-226 pCi/L	Ra-228 pCi/L	SO <sub>4</sub> mg/L	Se mg/L	U mg/L
GUN01	0135	09/30/1998	3.62	0.442	7.31	<0.08	0.18	<0.76	26.7	<0.001	0.0023
GUN01	0136	06/06/1997	<0.001	0.344	9.79	<0.16	0.46	<1.1	393	---	<0.001
		06/11/1998	0.29	0.666	9.69	<0.1	0.38	<0.53	531	---	0.0437
		09/30/1998	0.0993	0.432	10.4	<0.05	0.24	<0.8	404	<0.001	0.0363
		05/28/1999	0.183	4.36	14.1	0.28	<0.39	<2.19	489	0.0041	0.044
		10/08/1999	0.0878	0.305	9.97	<0.07	0.51	<0.75	431	<0.0001	~0.0287
GUN01	0140	09/28/1998	0.457	2.3	7.47	<0.1	<0.12	<0.79	25.8	<0.001	0.0058
GUN01	0141	09/28/1998	<0.001	2.26	5.07	<0.11	<0.12	<0.77	20.6	<0.001	0.005
		09/28/1998	<0.001	2.92	4.4	<0.1	<0.12	<0.77	20.7	<0.001	0.0051
GUN01	0142	09/28/1998	<0.001	3.43	6.73	<0.07	<0.12	<0.8	16.4	<0.001	0.0031
GUN01	0145	06/04/1997	0.157	0.472	4.53	<0.16	0.14	<0.4	70.3	---	0.0123
		06/09/1998	0.151	<0.0958	5.29	<0.12	<0.15	<0.57	79.7	---	0.01
		09/24/1998	0.136	0.212	6.53	<0.09	0.15	<0.69	11.3	<0.001	0.0086
		06/02/1999	0.25	0.0708	5.83	<0.1	<0.14	<0.83	120	<0.001	0.009
		10/07/1999	0.223	<0.0133	9.3	<0.09	<0.12	<0.73	28.6	<0.0001	0.0081
GUN01	0147	06/04/1997	<0.001	1.71	8.68	<0.19	0.06	<0.7	161	---	0.0263
		06/09/1998	<0.001	1.75	8.4	<0.08	<0.14	<0.56	138	---	0.0222
		09/24/1998	<0.001	1.92	8.94	<0.07	<0.1	<0.65	128	<0.001	0.0253
		06/02/1999	<0.001	1.76	8.34	<0.07	<0.14	<0.86	121	<0.001	0.0209
		10/07/1999	<0.0012	1.41	7.68	<0.06	<0.12	<0.74	129	<0.0001	0.0213

Summary of Ground Water Quality (1997 - 1999)

Site Code	Location Code	Date Sampled	Alk mg/L	EC umhos/cm	ORP mV	TDS mg/L	pH s.u.	Ca mg/L	Cd mg/L	Cl mg/L	Fe mg/L	K mg/L	Mg mg/L
GUN01	0155	06/05/1997	217	---	26	295	7.02	72.3	<0.001	2.72	0.0023	2.2	15
		09/30/1998	311	575	42	307	7.34	90.5	<0.001	1.95	0.0113	2.7	16.7
		06/02/1999	238	517	62	~295	6.98	81.8	<0.001	2.72	<0.0124	2	15.3
		10/07/1999	264	515	30	285	7.21	79.9	<0.0003	1.87	0.0139	2.24	14.3
GUN01	0157	06/05/1997	78	237	35	135	8.42	15.6	<0.001	2.3	<0.001	5.49	11.9
		06/02/1999	208	625	75	~380	7.34	87.9	<0.001	3.96	<0.0077	3.39	21.5
		10/07/1999	238	614	11	380	7.63	83.6	<0.0003	3.6	<0.009	3.1	20.4
GUN01	0160	10/01/1998	251	776	73	455	6.53	99.5	<0.001	16.9	<0.004	6.16	17.5
		05/26/1999	234	771	110	492	6.59	106	<0.001	16	<0.006	6.05	19.2
		10/13/1999	256	761	69	470	6.58	98.3	<0.0003	18	<0.009	5.85	16.9
GUN01	0161	10/01/1998	223	731	72	435	6.50	83.6	<0.001	0.292	0.0193	7.44	13.8
		05/26/1999	211	733	105	460	6.69	90.1	<0.001	20.1	<0.0307	7.82	14.9
		10/13/1999	230	727	68	437	6.58	85.1	<0.0003	19.8	<0.009	7.08	13.9
GUN01	0163	06/11/1998	222	557	95	~325	6.43	80.6	<0.001	5.07	<0.003	2.94	14.7
		10/02/1998	244	556	74	333	6.52	80.4	<0.001	4.36	<0.004	3.12	14.6
		05/26/1999	234	563	93	340	6.35	87.5	<0.001	4.96	<0.006	3.3	16.1
		10/13/1999	247	473	34	313	6.22	81.1	<0.0003	4.13	<0.009	2.83	14.6
GUN01	0170	06/05/1997	195	496	134	305	8.46	74.3	<0.001	3.9	<0.001	2.61	17.6
		06/09/1998	169	481	98	308	8.49	65.1	<0.001	3.43	<0.003	2.1	17.2
		05/26/1999	164	475	102	382	8.03	65.7	<0.001	3.85	<0.006	2.06	17.6
		10/06/1999	522	514	-111	160	11.28	40.8	<0.0003	3.71	<0.009	2.97	20.7
GUN01	0181	10/01/1998	231	802	61	550	6.87	124	<0.001	5.48	<0.004	2.07	25.7
		05/26/1999	249	1011	159	---	6.87	159	<0.001	5.04	<0.006	2.07	34.8
		10/12/1999	230	757	52	492	6.86	114	<0.0003	5.7	<0.009	1.91	23.7
GUN01	0183	05/26/1999	295	1203	140	348	6.35	186	<0.001	9.96	0.0193	7.9	32.7
		10/12/1999	321	1168	-74	838	6.46	175	<0.0003	9.25	<0.009	7.3	30

Summary of Ground Water Quality (1997 - 1999)

Site Code	Location Code	Date Sampled	Mn mg/L	NO <sub>3</sub> mg/L	Na mg/L	Po-210 pCi/L	Ra-226 pCi/L	Ra-228 pCi/L	SO <sub>4</sub> mg/L	Se mg/L	U mg/L
GUN01	0155	06/05/1997	0.6	<0.0291	4.23	<0.19	0.14	<0.8	23.9	---	0.0037
		09/30/1998	0.917	0.328	5.72	0.17	0.25	<0.76	9.76	<0.001	0.004
		06/02/1999	0.701	0.0824	4.81	0.18	<0.13	<0.78	24.5	<0.001	0.0036
		10/07/1999	0.738	<0.0231	5.07	0.19	<0.11	<0.71	11.6	<0.0001	0.0032
GUN01	0157	06/05/1997	<0.001	<0.0314	6.41	<0.16	0.2	<0.4	18.3	---	<0.001
		06/02/1999	0.0025	1.14	10.8	<0.1	0.21	<0.79	101	<0.001	0.0274
		10/07/1999	0.0276	1.34	10.5	<0.09	0.19	<0.73	106	<0.0001	0.0198
GUN01	0160	10/01/1998	0.0076	1.33	28	0.19	<0.11	<0.57	107	<0.001	0.0181
		05/26/1999	0.0107	0.946	27.2	<0.12	<0.15	<0.9	125	<0.001	0.0208
		10/13/1999	0.0079	1.01	31.4	<0.22	<0.14	<0.87	114	0.0002	0.0179
GUN01	0161	10/01/1998	0.0085	1.42	38.7	<0.13	<0.12	<0.59	1.97	<0.001	0.01
		05/26/1999	0.0079	1.1	40.8	<0.18	<0.15	<0.88	116	<0.001	0.0108
		10/13/1999	0.0064	1.1	39.5	<0.2	<0.14	<0.89	118	0.0006	0.01
GUN01	0163	06/11/1998	0.0123	0.897	8.82	<0.18	<0.14	<0.56	43.8	---	0.007
		10/02/1998	0.0131	1.11	9.4	<0.13	<0.11	<0.6	36.2	<0.001	0.0061
		05/26/1999	0.0148	0.893	9.48	<0.12	<0.15	<0.86	44.5	<0.001	0.0073
		10/13/1999	0.01	0.881	9.14	<0.18	<0.13	<0.86	41.7	0.0002	0.0065
GUN01	0170	06/05/1997	<0.001	2.88	5.54	<0.15	0.08	<0.7	72.6	---	0.0074
		06/09/1998	<0.001	2.8	5.2	<0.12	<0.15	<0.6	71.8	---	0.0071
		05/26/1999	0.001	2.79	4.36	<0.36	<0.14	<0.77	64.9	<0.001	0.0068
		10/06/1999	0.001	2.42	5.98	<0.07	0.14	<0.8	75	<0.0001	0.0032
GUN01	0181	10/01/1998	0.352	1.12	7.33	<0.07	<0.12	<0.58	181	<0.001	0.0212
		05/26/1999	0.214	0.299	7.09	<0.26	<0.13	<0.76	277	<0.001	0.0293
		10/12/1999	0.329	0.21	7.65	<0.06	<0.14	<0.92	175	<0.0001	~0.0184
GUN01	0183	05/26/1999	0.0046	1.08	32.2	<0.28	<0.14	<0.78	335	<0.001	0.0567
		10/12/1999	0.0038	1.11	32	<0.24	<0.16	2.87	349	<0.0001	~0.056

Summary of Ground Water Quality (1997 - 1999)

Site Code	Location Code	Date Sampled	Alk mg/L	EC umhos/cm	ORP mV	TDS mg/L	pH s.u.	Ca mg/L	Cd mg/L	Cl mg/L	Fe mg/L	K mg/L	Mg mg/L
GUN01	0186	06/04/1997	263	1206	4	875	7.18	190	<0.001	4.91	<0.001	2.25	43.2
		06/11/1998	265	1042	130	~863	6.98	194	<0.001	5.16	<0.003	2.15	41.3
		09/30/1998	265	1175	63	828	7.45	192	<0.001	4.43	<0.004	2.16	40.9
		05/27/1999	264	1142	91	838	7.32	195	<0.001	4.98	<0.006	2.29	42
		10/12/1999	245	1089	5	810	7.29	175	<0.0003	4.76	<0.009	1.95	37
		10/12/1999	---	---	---	813	---	175	<0.0003	4.71	<0.009	2	37.4
		06/03/1997	220	903	23	607	7.00	133	<0.001	11.3	0.0072	2.75	29
GUN01	0188	06/11/1998	198	861	49	~577	6.96	126	<0.001	10.6	<0.003	2.49	25.7
		09/29/1998	220	897	-12	582	7.10	137	<0.001	10.3	<0.004	2.67	27.7
		05/27/1999	222	881	31	592	6.98	141	<0.001	10.4	<0.0079	2.85	29.2
		10/08/1999	212	866	-50	595	7.27	132	<0.0003	10.2	<0.009	2.42	26.6
		06/05/1997	881	224	-5	1400	6.19	240	<0.001	93.3	6.16	35.9	29.4
GUN01	0189	06/11/1998	915	2120	92	~1410	6.35	243	<0.001	95.4	5.79	33.6	27.7
		09/29/1998	925	2180	8	1390	6.20	248	<0.001	95	6.63	34.5	28.5
		05/27/1999	975	2210	78	1390	6.24	250	<0.001	95.2	6.5	34.8	28.7
		10/08/1999	925	2140	-20	1360	6.30	234	<0.0003	96.2	5.84	32.4	26.8
		10/01/1998	1079	1997	58	1280	6.01	339	<0.001	7.35	8.82	34	29.5
GUN01	0196	05/27/1999	1092	2050	-13	1330	5.91	354	<0.001	8.46	10.3	34.6	30.1
		10/12/1999	1065	1990	-17	1290	5.93	326	<0.0003	8.5	9.78	30.6	26.9
		10/01/1998	1020	1926	41	1210	6.06	300	<0.001	13	8.12	30.9	25.8
GUN01	0197	05/27/1999	972	1677	-84	1240	5.91	323	<0.001	14.3	8.5	33	27.6
		10/12/1999	995	1880	-28	1220	5.94	299	<0.0003	14.6	8.08	29.5	25.1

Summary of Ground Water Quality (1997 - 1999)

Site Code	Location Code	Date Sampled	Mn mg/L	NO <sub>3</sub> mg/L	Na mg/L	Po-210 pCi/L	Ra-226 pCi/L	Ra-228 pCi/L	SO <sub>4</sub> mg/L	Se mg/L	U mg/L
GUN01	0186	06/04/1997	<0.001	0.351	6.82	0.31	<0.04	<0.7	392	---	0.042
		06/11/1998	<0.001	0.357	7.04	<0.07	<0.14	<0.58	402	---	0.0414
		09/30/1998	<0.001	0.614	6.84	<0.07	<0.11	<0.73	353	<0.001	0.0421
		05/27/1999	<0.001	0.33	7.05	<0.11	<0.13	<0.79	364	<0.001	0.0404
		10/12/1999	0.0009	0.4	7.11	<0.08	<0.14	<0.89	365	<0.0001	~0.0387
		10/12/1999	0.001	0.35	7.03	<0.07	<0.12	<0.77	362	<0.0001	~0.0383
GUN01	0188	06/03/1997	<0.001	0.814	8.06	0.44	0.11	<0.6	230	---	0.0379
		06/11/1998	<0.001	0.805	7.34	<0.12	<0.12	<0.49	231	---	0.0335
		09/29/1998	<0.001	0.979	8.3	<0.07	<0.11	<0.76	230	<0.001	0.0383
		05/27/1999	<0.001	0.76	8.09	<0.08	<0.16	<0.9	230	<0.001	0.0372
		10/08/1999	<0.0054	0.737	7.83	<0.08	<0.13	<0.82	231	<0.0001	~0.0354
GUN01	0189	06/05/1997	0.932	<0.0202	222	<0.22	0.86	0.5	152	---	0.0151
		06/11/1998	0.882	<0.0309	208	<0.27	0.59	0.52	162	---	0.0152
		09/29/1998	0.936	0.34	212	0.33	0.9	<0.77	151	<0.001	0.0157
		05/27/1999	0.921	<0.01	214	<0.1	0.63	1	155	<0.001	0.0151
		10/08/1999	0.862	<0.01	206	0.15	0.57	<0.81	158	<0.0001	~0.0154
GUN01	0196	10/01/1998	2.17	0.641	79.9	<0.09	<0.12	0.57	75.6	<0.001	0.0022
		05/27/1999	2.19	0.126	80.9	<0.26	0.17	<0.8	80.5	<0.001	0.0021
		10/12/1999	1.94	0.132	75.6	<0.04	0.22	<0.93	83.7	<0.0001	~0.0017
GUN01	0197	10/01/1998	1.7	0.42	84.3	<0.13	1.58	1.9	81.2	<0.001	0.0029
		05/27/1999	1.78	0.0777	89	<0.24	1.38	1.28	86.9	<0.001	0.0028
		10/12/1999	1.65	0.0379	84.8	<0.05	1.28	1.08	90.2	<0.0001	~0.0024

Summary of Ground Water Quality (1997 - 1999)

Site Code	Location Code	Date Sampled	Alk mg/L	EC umhos/cm	ORP mV	TDS mg/L	pH s.u.	Ca mg/L	Cd mg/L	Cl mg/L	Fe mg/L	K mg/L	Mg mg/L
GUN01	0455	06/02/1997	189	455	136	---	7.23	---	---	---	---	---	---
		10/02/1997	221	593	-75	---	7.14	---	---	---	---	---	---
		06/08/1998	188	485	103	---	6.96	---	---	---	---	---	---
		10/06/1999	91	228	111	---	7.30	---	---	---	---	---	---
GUN01	0461	06/08/1998	99	249	96	---	7.83	---	---	---	---	---	
GUN01	0468	06/02/1997	216	576	218	525	7.50	118	<0.0011	6.04	8.02	2.48	24.5
		06/08/1998	196	693	22	450	7.33	98.7	<0.0011	4.65	12.7	2.39	20.2
		10/11/1999	239	737	-214	465	7.12	109	<0.0003	5.29	8.35	2.38	22.3
GUN01	0469	06/02/1997	103	265	81	---	6.93	---	---	---	---	---	---
		10/01/1997	119	277	36	---	6.82	---	---	---	---	---	---
		06/08/1998	96	352	138	---	7.20	---	---	---	---	---	---
		10/06/1999	101	257	72	---	6.68	---	---	---	---	---	---
GUN01	0472	06/02/1997	59	470	221	---	7.12	---	---	---	---	---	---
		10/02/1997	202	439	127	---	7.26	---	---	---	---	---	---
		06/08/1998	185	482	105	---	7.03	---	---	---	---	---	---
		10/06/1999	182	460	111	---	6.83	---	---	---	---	---	---
GUN01	0665	06/02/1997	107	276	77	---	7.29	---	---	---	---	---	---
		10/01/1997	113	212	121	---	6.95	---	---	---	---	---	---
		06/08/1998	106	272	146	---	7.26	---	---	---	---	---	---
		10/06/1999	110	237	65	---	6.60	---	---	---	---	---	---
GUN01	0667	06/02/1997	79	197	201	---	6.83	---	---	---	---	---	---
		10/01/1997	74	207	108	---	6.90	---	---	---	---	---	---
		06/08/1998	85	220	123	---	6.98	---	---	---	---	---	---
		10/06/1999	80	324	133	---	6.76	---	---	---	---	---	---

Summary of Ground Water Quality (1997 - 1999)

Site Code	Location Code	Date Sampled	Mn mg/L	NO <sub>3</sub> mg/L	Na mg/L	Po-210 pCi/L	Ra-226 pCi/L	Ra-228 pCi/L	SO <sub>4</sub> mg/L	Se mg/L	U mg/L
GUN01	0455	06/02/1997	---	---	---	---	---	---	---	---	0.029
		10/02/1997	---	---	---	---	---	---	---	---	0.022
		06/08/1998	---	---	---	---	---	---	---	---	0.0287
		10/06/1999	---	---	---	---	---	---	---	---	0.0032
GUN01	0461	06/08/1998	---	---	---	---	---	---	---	<0.0011	
GUN01	0468	06/02/1997	0.215	0.284	10.5	<0.14	0.09	<0.8	177	---	0.0183
		06/08/1998	0.18	<0.316	8.7	<0.09	<0.15	<0.59	143	---	0.0175
		10/11/1999	0.188	0.273	9.77	<0.07	<0.12	<0.79	158	<0.0001	0.0155
GUN01	0469	06/02/1997	---	---	---	---	---	---	---	---	0.0014
		10/01/1997	---	---	---	---	---	---	---	---	0.002
		06/08/1998	---	---	---	---	---	---	---	---	0.0021
		10/06/1999	---	---	---	---	---	---	---	---	0.001
GUN01	0472	06/02/1997	---	---	---	---	---	---	---	---	0.0138
		10/02/1997	---	---	---	---	---	---	---	---	0.0117
		06/08/1998	---	---	---	---	---	---	---	---	0.0115
		10/06/1999	---	---	---	---	---	---	---	---	0.0138
GUN01	0665	06/02/1997	---	---	---	---	---	---	---	---	0.0011
		10/01/1997	---	---	---	---	---	---	---	---	0.0017
		06/08/1998	---	---	---	---	---	---	---	---	0.0024
		10/06/1999	---	---	---	---	---	---	---	---	0.0011
GUN01	0667	06/02/1997	---	---	---	---	---	---	---	---	<0.0011
		10/01/1997	---	---	---	---	---	---	---	---	<0.0011
		06/08/1998	---	---	---	---	---	---	---	---	<0.0011
		10/06/1999	---	---	---	---	---	---	---	---	<0.0002

Summary of Ground Water Quality (1997 - 1999)

Site Code	Location Code	Date Sampled	Alk mg/L	EC umhos/cm	ORP mV	TDS mg/L	pH s.u.	Ca mg/L	Cd mg/L	Cl mg/L	Fe mg/L	K mg/L	Mg mg/L
GUN01	0680	06/02/1997	98	242	82	---	7.21	---	---	---	---	---	---
		10/02/1997	103	234	137	---	7.67	---	---	---	---	---	---
		06/08/1998	84	233	124	---	7.26	---	---	---	---	---	---
		10/06/1999	90	239	103	---	6.73	---	---	---	---	---	---
GUN01	0683	06/02/1997	108	300	108	---	7.27	---	---	---	---	---	---
		06/02/1997	---	---	---	---	---	---	---	---	---	---	---
		10/01/1997	117	265	109	---	7.24	---	---	---	---	---	---
		06/08/1998	99	281	128	---	6.82	---	---	---	---	---	---
		10/06/1999	87	225	106	---	6.96	---	---	---	---	---	---
		10/06/1999	---	---	---	---	---	---	---	---	---	---	---
GUN01	0685	06/02/1997	109	272	85	---	7.21	---	---	---	---	---	---
		10/01/1997	106	255	87	---	7.13	---	---	---	---	---	---
		06/08/1998	113	273	130	---	7.56	---	---	---	---	---	---
		10/06/1999	90	217	81	---	6.59	---	---	---	---	---	---

Summary of Ground Water Quality (1997 - 1999)

Site Code	Location Code	Date Sampled	Mn mg/L	NO <sub>3</sub> mg/L	Na mg/L	Po-210 pCi/L	Ra-226 pCi/L	Ra-228 pCi/L	SO <sub>4</sub> mg/L	Se mg/L	U mg/L
GUN01	0680	06/02/1997	---	---	---	---	---	---	---	---	0.0014
		10/02/1997	---	---	---	---	---	---	---	---	0.0015
		06/08/1998	---	---	---	---	---	---	---	---	0.0012
		10/06/1999	---	---	---	---	---	---	---	---	0.0008
GUN01	0683	06/02/1997	---	---	---	---	---	---	---	---	0.0018
		06/02/1997	---	---	---	---	---	---	---	---	0.0018
		10/01/1997	---	---	---	---	---	---	---	---	0.0018
		06/08/1998	---	---	---	---	---	---	---	---	0.0032
		10/06/1999	---	---	---	---	---	---	---	---	0.0005
		10/06/1999	---	---	---	---	---	---	---	---	<0.0002
GUN01	0685	06/02/1997	---	---	---	---	---	---	---	---	0.0019
		10/01/1997	---	---	---	---	---	---	---	---	0.0021
		06/08/1998	---	---	---	---	---	---	---	---	0.002
		10/06/1999	---	---	---	---	---	---	---	---	0.0005

## **Appendix E**

### **Ground Water Analytical Results (CD-ROM)**

**Appendix F**

**Surface Water Analytical Results (CD-ROM)**

## **Appendix G**

### **Aquifer Pumping Test Calculation**

## Technical Task Cover Sheet

**Discipline:** Hydrogeology

**Project:**

UMTRA Ground Water

**Site:**

Gunnison, Colorado

**Subject:**

Gunnison Aquifer Test Data Analyses

**Sources of Data:**

Cooper, H.H. and C.E. Jacob, 1946. A Generalized Graphical Method for Evaluating Formation Constants and Summarizing Well Field History, Am. Geophys. Union Trans., Vol. 27, pp. 526-534.

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Waterloo Hydrogeologic, Inc., and Röhrich, T. no date. User's Manual for AquiferTest.

Task Order No. [MAC00-05]

File Index No. [GWGUN13.2]

Proj. No. 341418003

Calc. No. U0082900

Supersedes Calc. No. NA

Calculated by	Date	Checked by	Date	Approved by	Date	DOE Concurrence (if required)	Date
<i>R. Hill</i>	7/13/00	<i>David Keating</i>	7/13/00	<i>[Signature]</i>	13 July 2000		



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## **Appendices**

**Appendix A—Step Test Data and Plots for Wells 041, 044, and 047**

**Appendix B—Well 041 Aquifer Test Data and Plots**

**Appendix C—Well 044 Aquifer Test Data and Plots**

**Appendix D—Well 047 Aquifer Test Data and Plots**

**Appendix E—City of Gunnison Production Well Aquifer Test Data and Plots**

## 1.0 Introduction

Aquifer tests were completed at the Gunnison UMTRA Project site to collect the hydrogeologic data necessary to characterize the alluvial aquifer. These data were collected to further define the hydraulic parameters of the alluvial aquifer which will be used in ground water flow and transport modeling. Analyses of these data provide a range of transmissivity, hydraulic conductivity, and specific yield estimates for the alluvial aquifer.

Aquifer tests were conducted during November and December 1999 using newly installed wells 041, 044, and 047 as the pumping wells and surrounding wells as the observation wells. Each pumping well is screened within the alluvium downgradient from the site. The alluvial aquifer consists of gravelly sand and is up to 120 ft thick in the vicinity of the site. Locations of each well cluster are shown on Figure 1. To determine if the ground water chemistry changes after prolonged pumping, discharge samples were collected and analyzed from wells 044 and 047.

## 2.0 Test Procedures

This section provides the procedures that were used to analyze the data collected during the step tests and the aquifer tests. In addition, the procedures used to analyze the discharge water samples are also discussed.

### 2.1 Step Tests

Once the wells were installed and developed, a step test was completed on each of the three newly installed pumping wells to determine the sustainable pumping rate and specific capacity. Each test consisted of monitoring the drawdown in the pumping well at three or four different pumping rates, with each step lasting a minimum of 60 minutes or until the drawdown inside the pumping well stabilized.

Drawdown and pumping rate data were used to determine the specific capacity of the pumping wells using the software AquiferTest (Waterloo Hydrogeologic, Inc., Version 2.5.2). The specific capacity of a well is its yield per unit of drawdown, usually expressed as gallons per minute per foot (gpm/ft), which can be also expressed as  $\text{ft}^2/\text{min}$  after converting the pumping rate from gpm to cubic feet per min ( $\text{ft}^3/\text{min}$ ).

### 2.2 Aquifer Tests

Aquifer tests were conducted to determine the transmissivity, hydraulic conductivity, and specific yield of the alluvial aquifer. These tests were completed at each of the new pumping wells using the sustainable pumping rate previously determined by the step test data. Water levels were monitored in the pumping wells and nearby observation wells prior to and during the aquifer test period and during the recovery test period, using both transducers connected to dataloggers and manually (using an electrical sounder). All water generated from each aquifer test was discharged 300 ft from the pumping well.

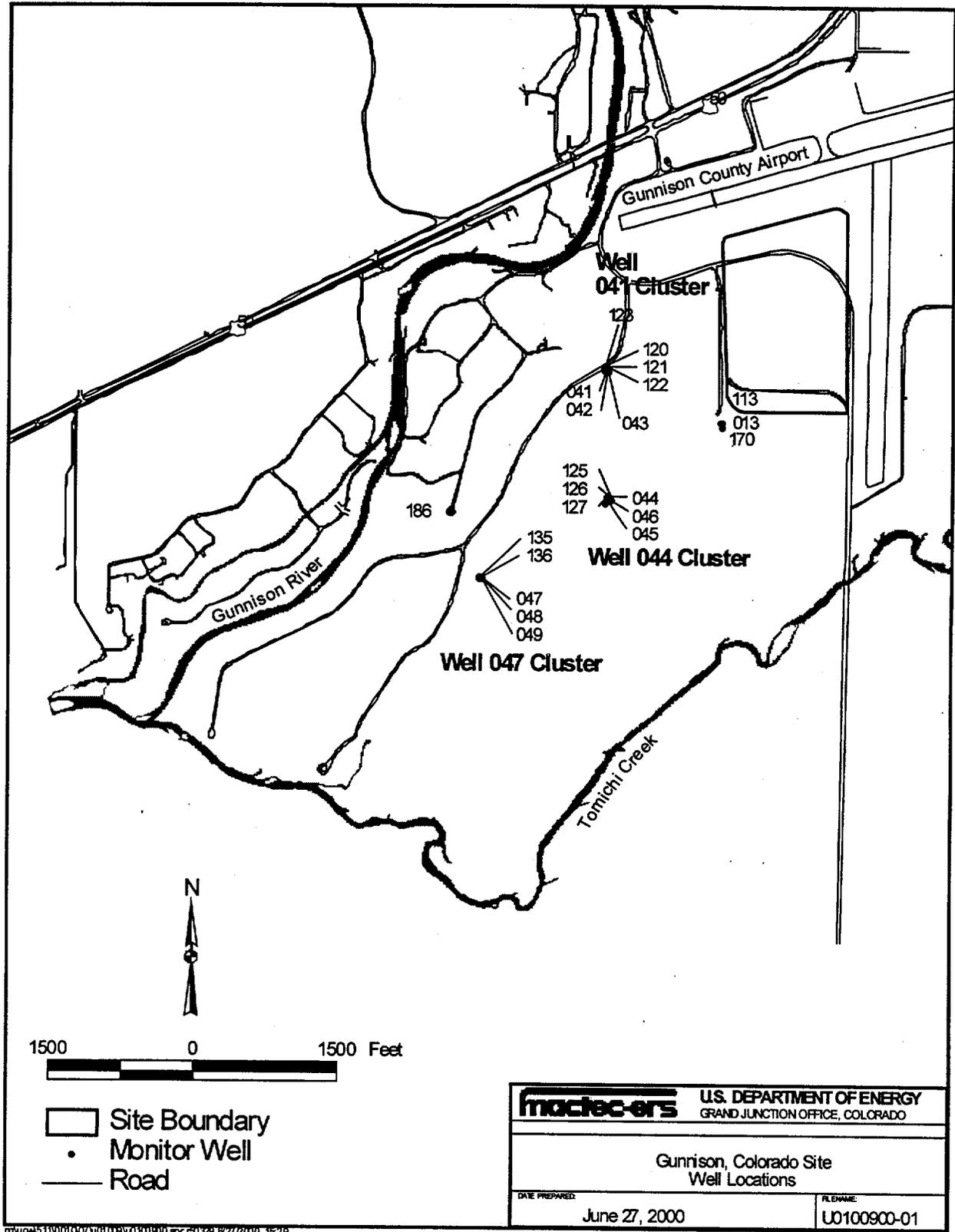


Figure 1. Well Location Map

Table 1 lists each testing location and the well construction details associated with the pumping wells and nearby observation wells.

Table 1. Gunnison Well Cluster Construction Information

Cluster	Well No.	Dia. (in)	Installation Date	Screen Interval (ft BGS)	r (ft)	Static Elevation of Ground Water (ft MSL) <sup>a</sup>	Observation or Pumping Well
041	041	6	Nov 99	31.0 – 60.4	-	7629.28	pumping
	042	2	Nov 99	43.8 – 53.3	26.8	7629.16	observation
	043	2	Nov 99	43.8 – 53.5	36.6	7629.28	observation
	120	2	Dec 84	18.5 – 23.5	43.9	7632.88	observation
	121	2	Dec 84	93.3 – 98.3	12.4	7627.51	observation
	122	2	Dec 84	78.1 – 83.1	32.0	7627.38	observation
	123	2	Jan 85	53.2 – 58.2	30.8	7629.14	observation
044	044	6	Nov 99	31.1 – 60.5	-	7623.47	pumping
	045	2	Nov 99	40.9 – 50.5	56.8	7623.29	observation
	046	2	Nov 99	40.7 – 50.2	40.9	7623.77	observation
	125	2	Dec 84	18.8 – 23.8	23.3	7624.39	observation
	126	2	Jan 85	53.2 – 58.2	16.4	7623.30	observation
	127	2	Dec 84	94.3 – 99.3	20.4	7622.73	observation
047	047	6	Nov 99	30.8 – 60.2	-	7618.54	pumping
	048	2	Nov 99	41.2 – 50.7	27.2	7618.51	observation
	049	2	Nov 99	40.6 – 50.1	42.1	7618.56	observation
	135	2	Dec 84	16.3 – 21.3	16.4	7619.91	observation
	136	2	Jan 85	53.2 – 58.2	17.3	7618.55	observation

<sup>a</sup>water levels measured between November 17 and November 22, 1999

Dia. = well diameter

r = distance to pumping well

MSL = mean sea level

BGS = below ground surface

in. = inches

ft = feet

Drawdown and residual drawdown data collected during the aquifer tests were analyzed using the software packages AquiferTest (Waterloo Hydrogeologic, Inc., Version 2.52) and AquiferWin32 (Environmental Simulations, Inc., Version 2.17). These software packages allow the user to analyze the data with a number of different analytical methods. Because the alluvial aquifer is unconfined, the drawdown data collected from observation wells during the pumping period of the tests were analyzed using the Theis Method modified for an unconfined aquifer (Theis 1935), the Neuman Method for Unconfined Aquifers with Partial Penetrating Wells (Neuman 1974), and the Cooper and Jacob Method modified for an unconfined aquifer (Cooper and Jacob 1946). Specific yield estimates were calculated using the Neuman Method (Neuman 1974). The data collected from the observation wells and pumping wells during the recovery phase of the aquifer tests were analyzed using the Theis Recovery Method (Kruseman and DeRidder 1991).

In addition to analyzing the data collected from the 041, 044, and 047 aquifer tests, aquifer test data collected by a consultant to the City of Gunnison (as part of the installation of new Production Wells) were also analyzed.

## 2.3 Discharge Samples

During the aquifer tests conducted at 044 and 047 locations (starting December 1, 1999, and November 20, 1999, respectively), samples of the discharge water were collected to determine if the water chemistry of the alluvial aquifer changed over the course of the test. The pH, temperature, and specific conductance of the discharge water were monitored throughout the test. Samples were collected and analyzed for uranium, nitrate, nitrite, ammonia, and sulfate at a mobile laboratory during the testing period. Details of the analysis associated with each constituent are provided in the ESL report *Expedited Site Characterization of the Ground Water Chemistry During Two Pumping Tests November 20 through December 2, 1999* (ESL-RPT-2000-2).

## 3.0 Results

This section presents the results obtained from the analysis of data collected during the step tests and aquifer tests.

### 3.1 Step Tests

The results from the step tests completed on wells 041, 044, and 047 will be discussed in Sections 3.1.1, 3.1.2, and 3.1.3, respectively.

#### 3.1.1 Well 041 Step Test

A step test on well 041 was completed on November 18, 1999. Figure 2 is a graphical representation of the drawdown data collected from the pumping well and observation wells 042 and 043 during the test. A flow rate (Q) of 10 gallons per minute (gpm) was chosen for the initial step, which resulted in only 2.3 ft of drawdown in the pumping well after 60 minutes. The rate was increased to 20 gpm for 60 minutes (which caused a total drawdown of 8.6 ft in the pumping well) and to 30 gpm for another hour (which resulted in 20.9 ft of drawdown). For the final step, the pumping rate was set to 40 gpm. At this rate, after 60 minutes there was 45.3 ft of drawdown in the pumping well.

Subsequent aquifer tests conducted at this location generated 19.6 ft of drawdown in well 041 at a pumping rate of 35 gpm over a time period of approximately 19 hours, and 22.9 ft of drawdown at a pumping rate of 38 gpm over 72.25 hours. After review of the data, it was apparent that the well may have become more efficient during the aquifer testing (i.e., the well was further developed during the testing periods). As a result, a second step test was completed on December 1, 1999, to compare the results from the initial step test.

During this second step test (Figure 3), drawdowns of 12.9 ft and 22.6 ft were measured in pumping well 041 at flow rates of 30 and 40 gpm, respectively. The third step was initially run at a flow rate of 55 gpm. After less than 5 minutes of pumping at that rate, it was apparent that the flow rate was too high to sustain. The rate was eventually reduced to 45 gpm, which created 48.8 ft of drawdown in the pumping well. Only a 5 gpm increase in the flow rate resulted in 26.2 ft of added drawdown.

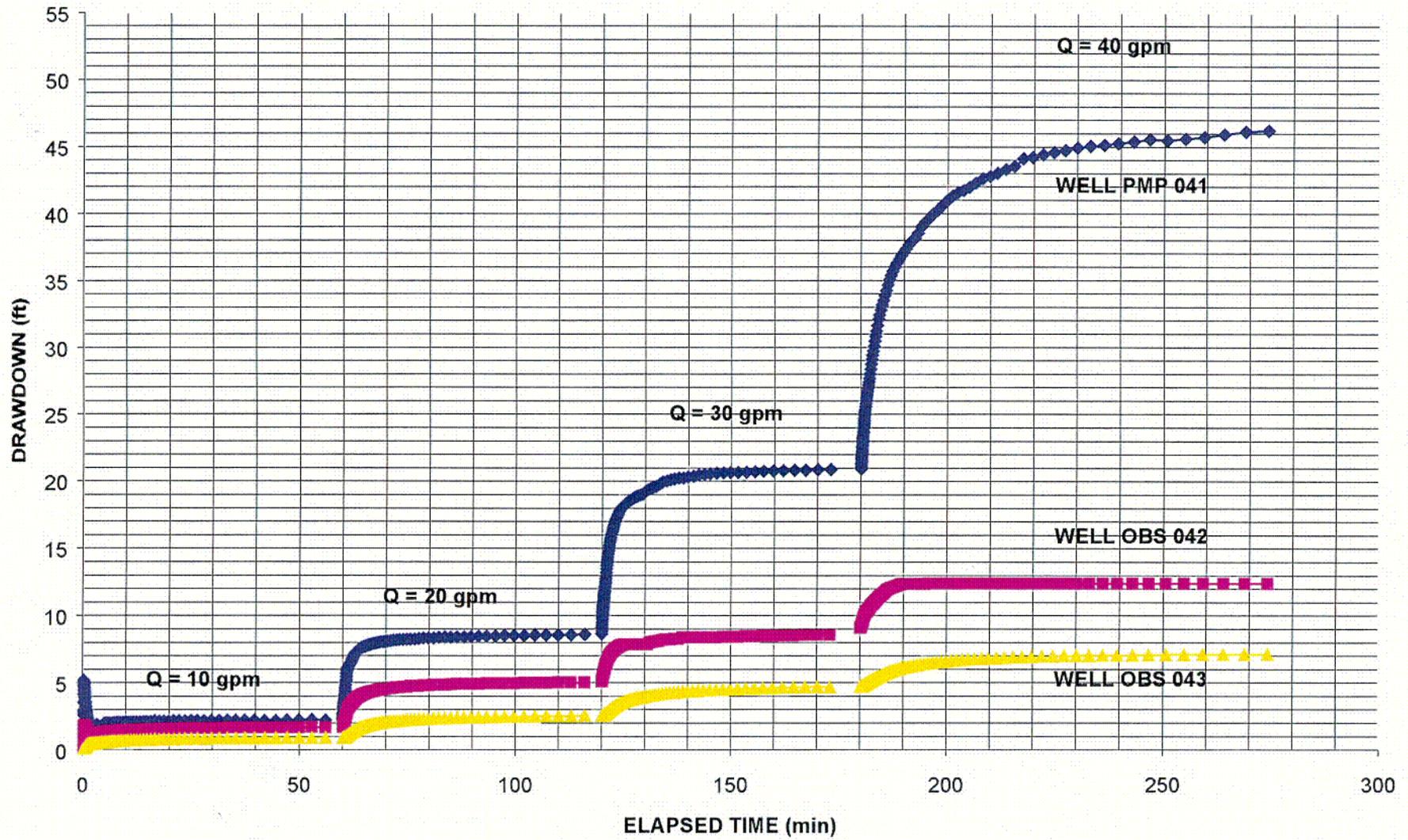


Figure 2. Well 041 Step Test 1 Data

C26

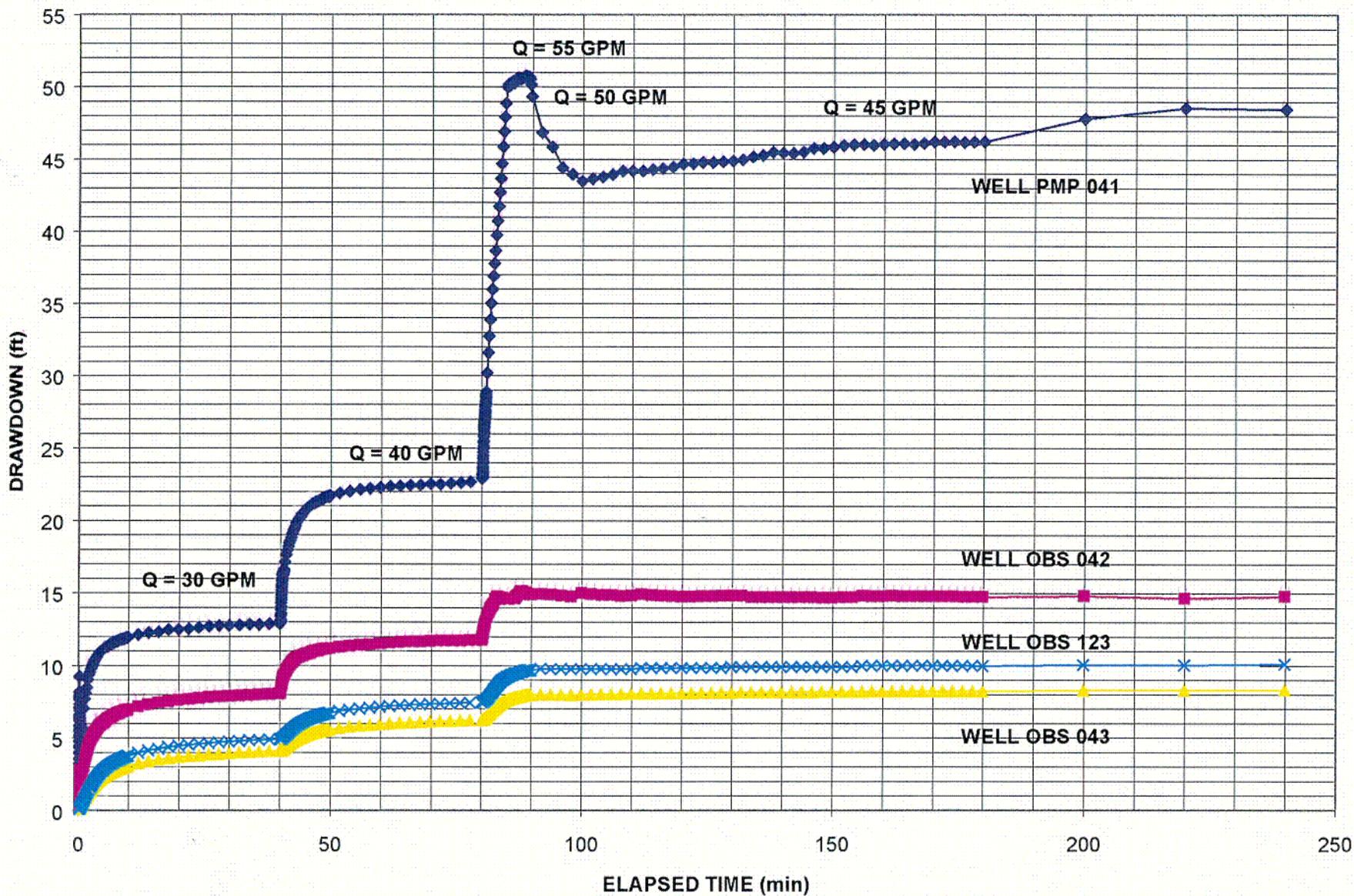


Figure 3. Well 041 Step Test 2 Data

C27

Analysis of the data collected during the first step test resulted in a specific capacity of 0.22 square feet per minute ( $\text{ft}^2/\text{min}$ ) for flow rates between 10 and 30 gpm, and a reduced specific capacity of 0.06  $\text{ft}^2/\text{min}$  for flow rates between 30 and 40 gpm. The specific capacity decreases with increased drawdown (Driscoll 1986). Based on the data from the second test, the specific capacity for flow rates between 30 and 40 gpm increased to 0.13  $\text{ft}^2/\text{min}$ . The computer-generated plots, and drawdown data collected from the datalogger are contained in Appendix A.

### 3.1.2 Well 044 Step Test

A step test on well 044 was completed on November 30, 1999. Figure 4 shows the drawdown data collected during the test. Flow rates of 20 gpm for 40 minutes and 40 gpm for 55 minutes resulted in 5.1 and 21.3 ft of drawdown measured in the pumping well, respectively. The flow rate was then increased to 55 gpm. After 15 minutes, the water level inside the pumping well was close to the intake of the submersible pump. The flow was reduced to 50 gpm, which created 42.3 ft of drawdown after 80 minutes of pumping.

Subsequent to this step test, an aquifer test was started on December 1, 1999. After approximately 41 hours of pumping at 50 gpm, there was 38.9 ft of drawdown measured in pumping well 044. Due to the discrepancy between the drawdown observed in the step test and the aquifer test, a second step test was conducted to confirm if the additional pumping during the aquifer test actually further developed the pumping well. A second step test was completed on December 7, 1999 (Figure 5). Flow rates of 52, 60, and 61 gpm resulted in drawdowns within the pumping well of 26.2, 38.2, and 45.5 ft, respectively. The 52 gpm step lasted 75 minutes, the 60 gpm step lasted 60 minutes, and the final step at 61 gpm lasted 40 minutes.

Analysis of the data collected from the first step test indicated the specific capacity for flow rates from 20 to 40 gpm was 0.17  $\text{ft}^2/\text{min}$ , and decreased to 0.06  $\text{ft}^2/\text{min}$  for flows greater than 40 gpm. The subsequent step test data indicated the specific capacity at the higher flow rates increased to 0.09  $\text{ft}^2/\text{min}$  (the second test did not include steps with flow rates lower than 50 gpm). The computer-generated plots and drawdown data collected from the data logger are included in Appendix A.

### 3.1.3 Well 047 Step Test

The step test for well 047 was completed on November 20, 1999. Each step for this test lasted 40 minutes. During the initial step, the flow rate was set at 20 gpm and resulted in 3.9 ft of drawdown in the pumping well. Three additional steps were made at 35, 50, and 60 gpm, which resulted in 9.4, 19.8, and 32.6 ft of drawdown in the pumping well, respectively (Figure 6).

Analysis of the data collected during this step test indicated the specific capacity for flow rates below 40 gpm was 0.36  $\text{ft}^2/\text{min}$ , while flow rates above 40 gpm result in a specific capacity of 0.12  $\text{ft}^2/\text{min}$ . The computer-generated plots and drawdown data collected from the data logger are also included in Appendix A.

### 3.2 Aquifer Tests

The results obtained from the data collected during the aquifer tests completed at wells 041, 044, and 047 will be discussed in Sections 3.2.1, 3.2.2, and 3.2.3, respectively. Section 3.2.4 contains the results obtained from the aquifer tests conducted by the City of Gunnison on Production Well #7 and #10.

#### 3.2.1 Well 041 Aquifer Test

An aquifer test was started on November 19, 1999, pumping 35 gpm from well 041. Drawdown data were collected from the pumping well and observation wells 042, 043, 120, 121, 122, and 123. Figure 7 is a cross-section showing well completions at this location. Observation wells 042, 043, and 123 are all screened within the same interval as the pumping well.

Unfortunately, below zero temperatures created problems for equipment exposed to the cold overnight. The generator running the pump unexpectedly shut down after only approximately 19 hours. As a result, there was no recovery data collected for this test. However, the data collected during the pumping phase of the test were used to determine the aquifer parameters.

A subsequent aquifer test was started on November 20, 1999. This second test ran for a total of 72.25 hours (4,335 minutes). During this time, a total of 165,074 gallons of ground water were removed from well 041, at an average rate of 38.1 gpm. A recovery test was started on November 23, 1999, after the pumping phase was completed.

A shorter aquifer test was completed on December 2, 1999. During the 8 hour test, 21,452 gallons were removed from pumping well 041, at an average pumping rate of 44.7 gpm. A recovery test was run overnight after the pumping phase was completed. Table 2 lists the drawdown measured in the pumping well and each observation well for the three tests completed at this location.

Table 2. Total Drawdown for Well 041 Aquifer Tests

		Test No.	041 Test 1	041 Test 2	041 Test 3
		Q (gpm)	35	38	45
Well	r (ft)	Scrn Inv (ft bgs)	s (ft)	s (ft)	s (ft)
Pmp 041	NA	31.0 - 60.4	19.56	22.95	48.83
Obs 042	26.8	43.8 - 53.3	10.6	11.12	14.6
Obs 043	36.6	43.8 - 53.5	5.7	6.2	8.14
Obs 120	43.9	18.5 - 23.5	0.28	0.33	0.31
Obs 121	12.4	93.3 - 98.8	0.96	1.01	1.08
Obs 122	32	78.1 - 83.1	1.03	1.12	1.24
Obs 123	30.8	53.2 - 58.2	6.82	7.43	10.01

Q = Pumping Rate  
 r = Distance to Pumping Well  
 Scrn Inv = Screened Interval (ft below ground surface [ft BGS])  
 s = Drawdown  
 Pmp = Pumping Well  
 Obs = Observation Well

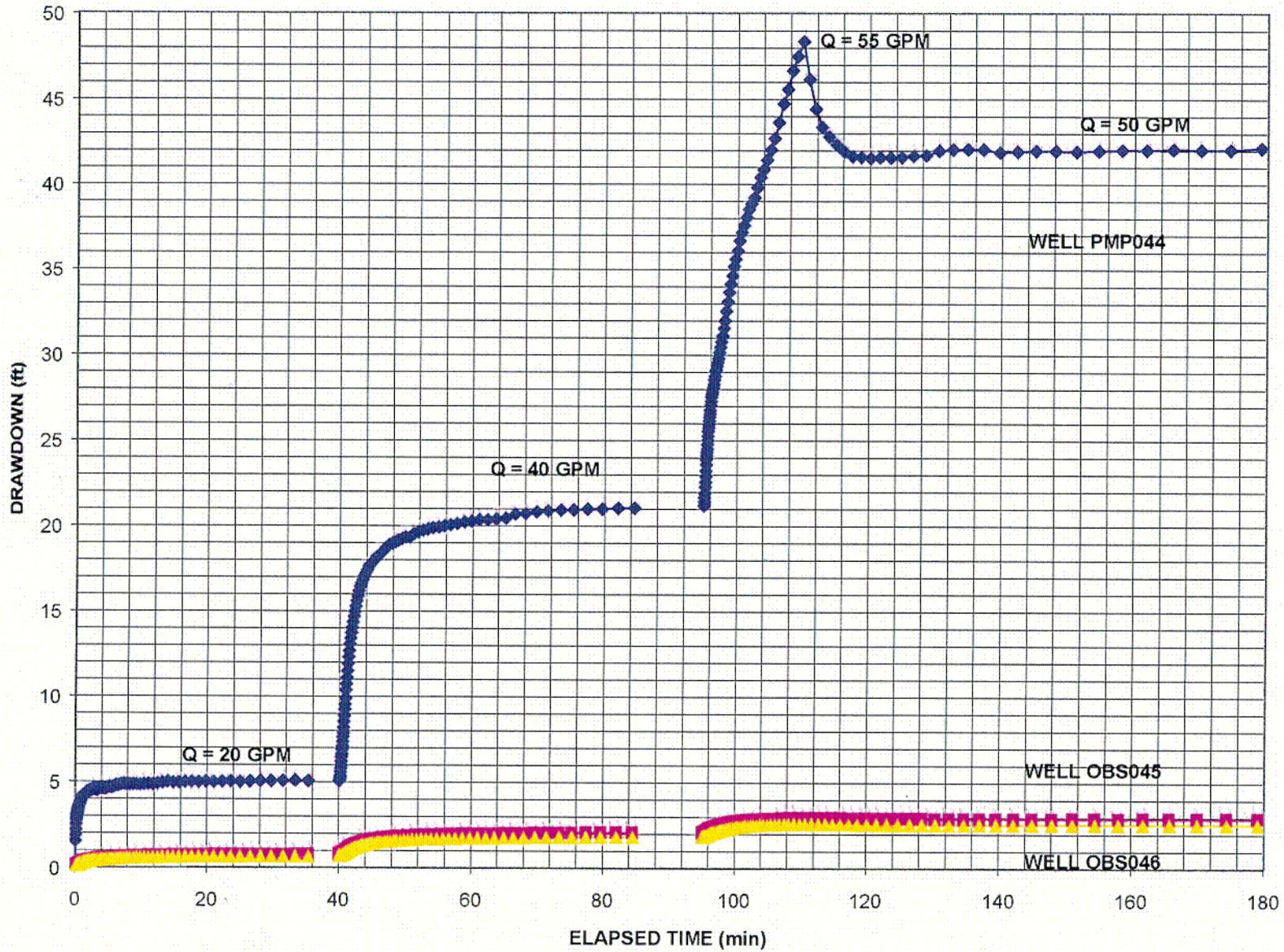


Figure 4. Well 044 Step Test 1 Data

C28

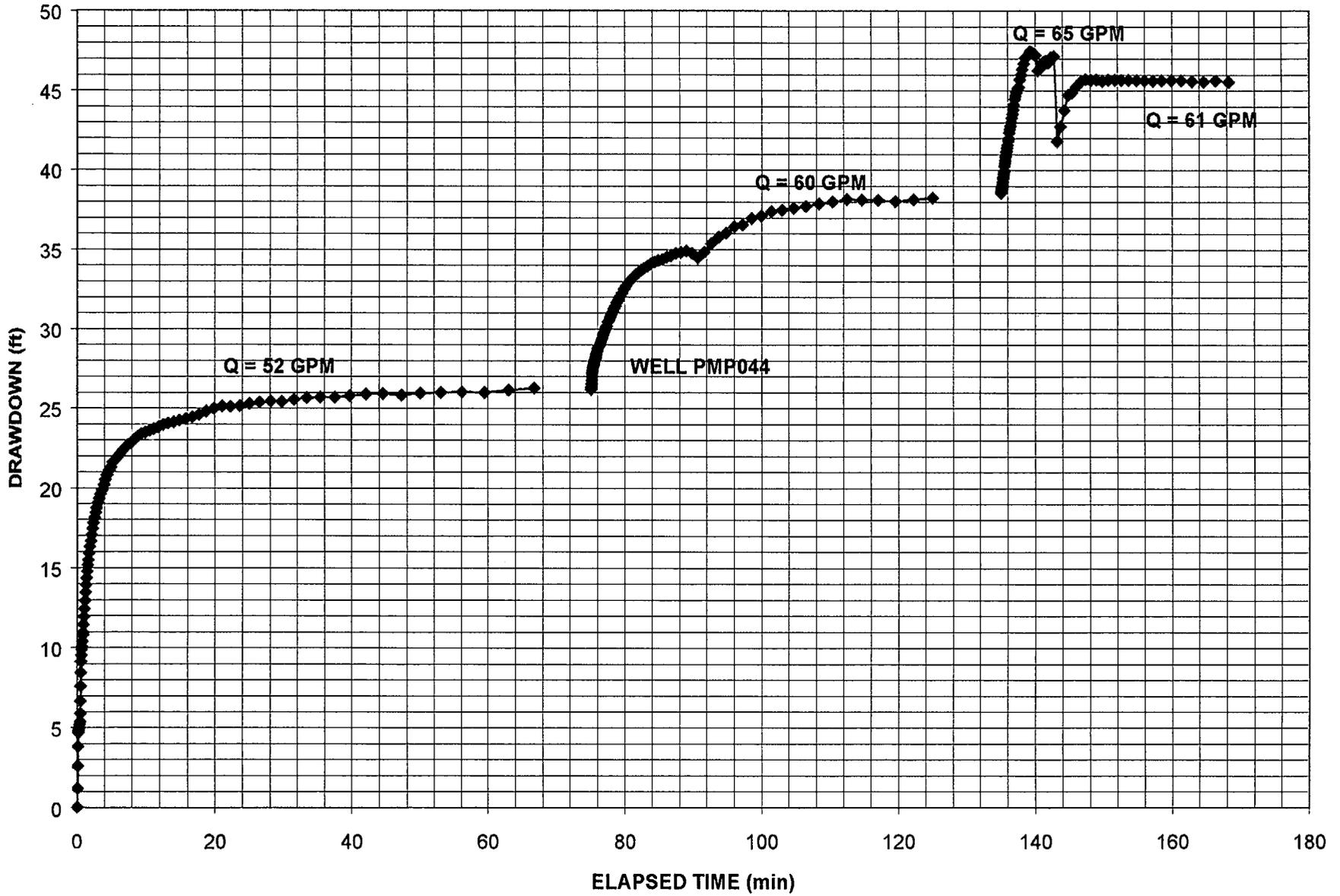


Figure 5. Well 044 Step Test 2 Data

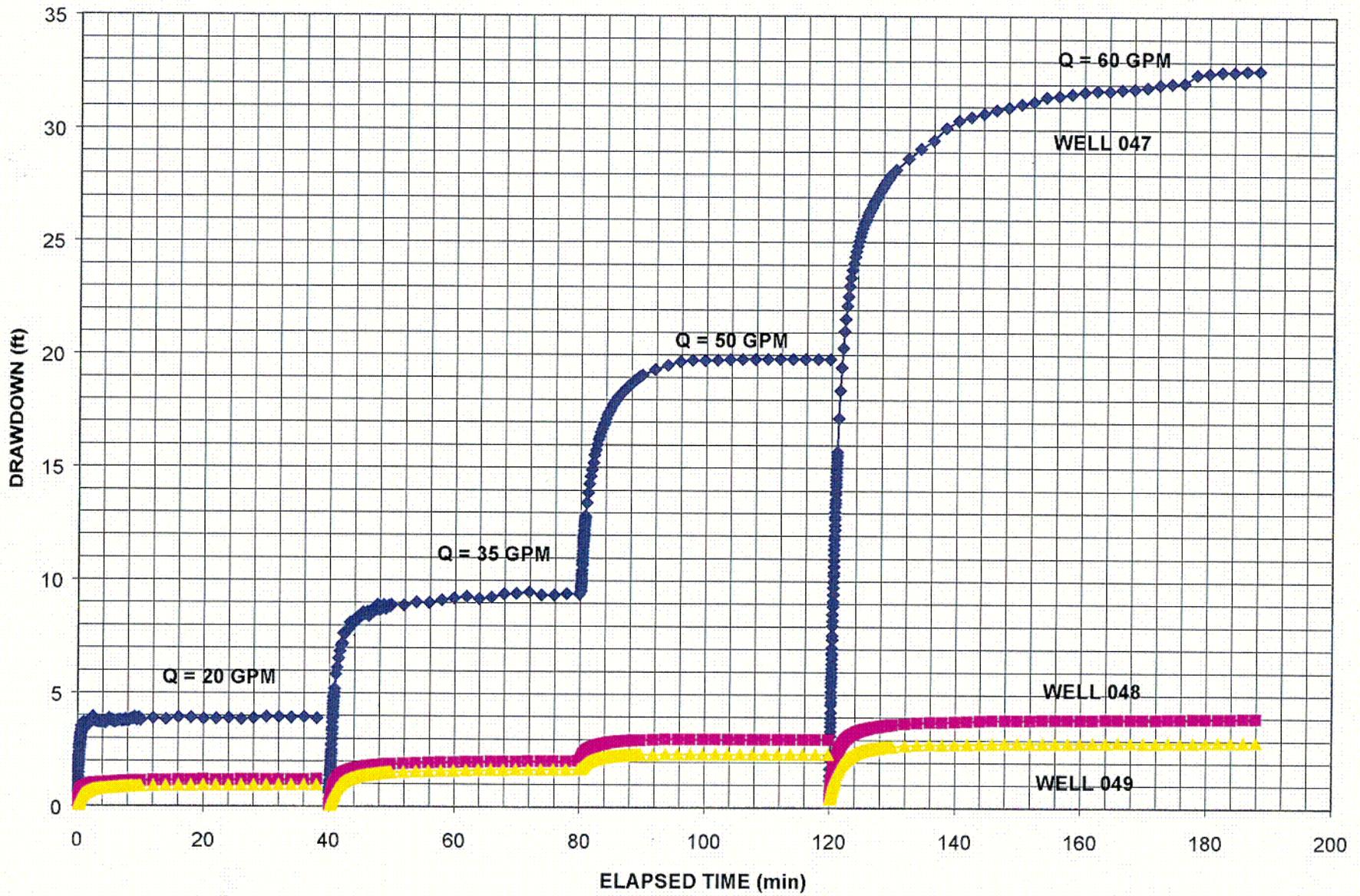


Figure 6. Well 047 Step Test Data

C29

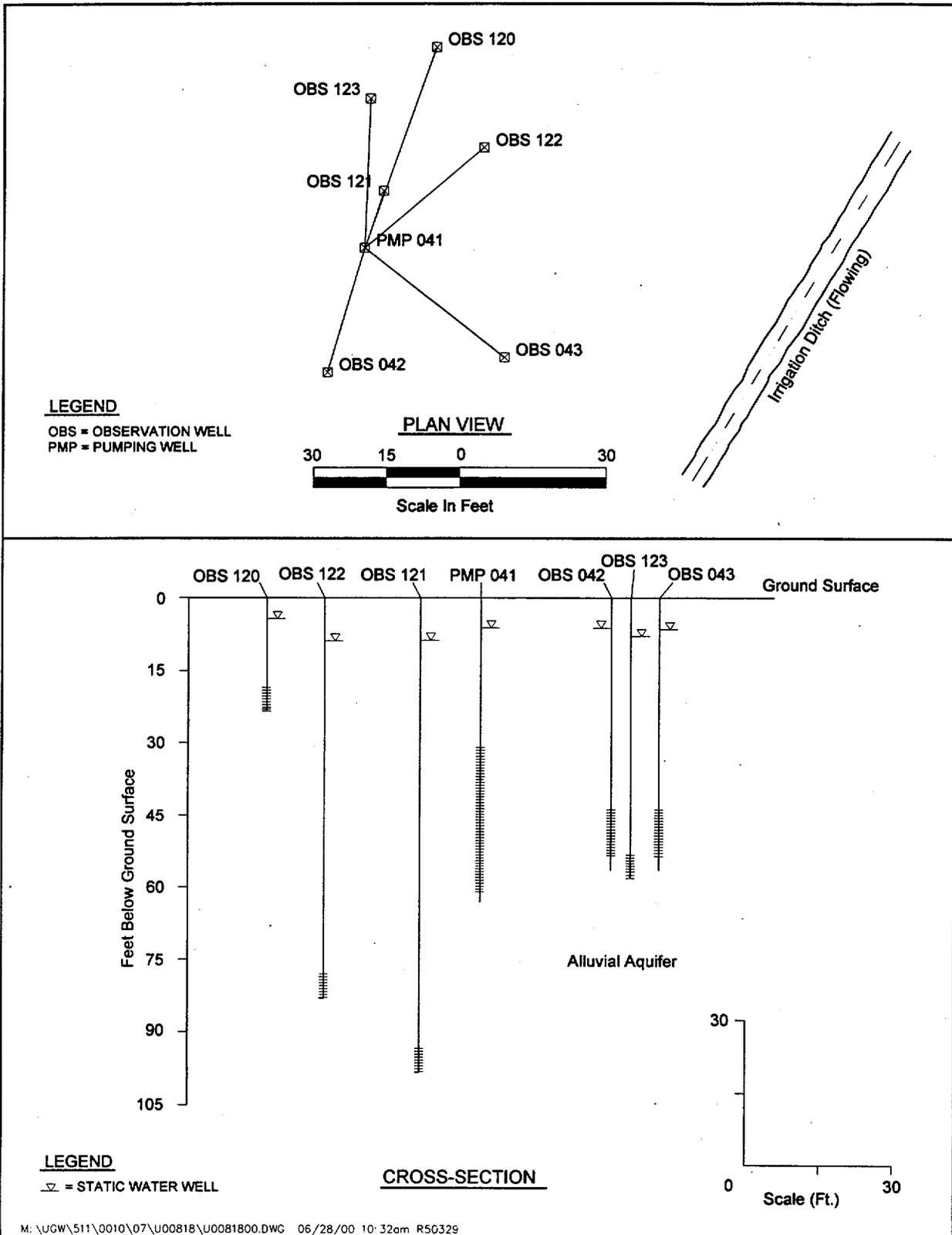


Figure 7. Well 041 Cluster Map and Cross Section

**Calculation No. U0082900**

To determine if the data from the previously installed observation wells is representative (wells 120, 121, 122, and 123), "response" tests were performed on each observation well. For each test, a slug of water was added to the well, and the response as the water level returned to static was monitored. Wells in which the water level returned to static rather quickly (within 5 minutes) are considered to provide a representative response during the aquifer test. These tests indicated that for each observation well the water level returned to static within 5 minutes, suggesting the drawdown measured in each observation was not influenced by poor well efficiency.

Since wells 042, 043, and 123 are screened approximately within the same interval as the pumping well (i.e., they are screened in the approximate same interval from where water was being withdrawn), drawdown data from only these observation wells were analyzed. Table 3 contains the transmissivity results based on the data collected during the three tests from observation wells 042, 043, and 123. Plots used for the analyses and the drawdown data collected during the tests are contained within Appendix B.

*Table 3. 041 Aquifer Test Transmissivity Results (ft<sup>2</sup>/day)*

Test No	Data Source	Test	Analytical Method				
			Theis T(ft <sup>2</sup> /d)	C-J T(ft <sup>2</sup> /d)	Neuman T(ft <sup>2</sup> /d)	Theis Rec T(ft <sup>2</sup> /d)	Neuman Sy
041 Test 1	Obs 042	AQ	301.0	361.4	516.7	NA	.016
	Obs 123	AQ	267.8	315.4	472.5	NA	.062
	Obs 043	AQ	424.8	423.4	608.9	NA	.049
041 Test 2	Obs 042	AQ	292.3	352.8	551.5	NA	.059
	Obs 123	AQ	231.8	325.4	488	NA	.381
	Obs 043	AQ	260.6	414.7	608.7	NA	.359
	Obs 042	REC	NA	NA	NA	325.4	NA
	Obs 123	REC	NA	NA	NA	319.7	NA
	Obs 043	REC	NA	NA	NA	394.6	NA
	Pmp 041	REC	NA	NA	NA	302.4	NA
041 Test 3	Obs 042	AQ	305.3	338.4	495.5	NA	.400
	Obs 123	AQ	216	301	405.9	NA	.500
	Obs 043	AQ	305.3	375.8	508.4	NA	.500
	Obs 042	REC	NA	NA	NA	178.6	NA
	Obs 123	REC	NA	NA	NA	216	NA
	Obs 043	REC	NA	NA	NA	302.4	NA
	Pmp 041	REC	NA	NA	NA	74.7	NA

- OBS = Observation Well
- PMP = Pumping Well
- AQ = Aquifer Test
- REC = Recovery Test
- NA = Not applicable
- Theis = Theis Method
- C-J = Cooper Jacob Method
- Neuman = Neuman Method for Partially Penetrating Wells in Unconfined Aquifers
- Theis Rec = Theis Recovery Method
- T = Transmissivity (ft<sup>2</sup>/day)
- Sy = Specific yield

As the plots in Appendix B show for the Theis Unconfined Analysis, the drawdown data collected from each of these observation wells falls below the Theis curve shortly (generally within 20 minutes) after the beginning of each test. Such a response from the drawdown data suggests that the aquifer is either: a) being influenced by a nearby recharge source (such as the flowing [at the time of the tests] irrigation ditch located to the southeast of the pumping well), or b) the pumping rate/well design is not sufficient to appropriately stress the aquifer, resulting in a steady-state condition.

### 3.2.2 Well 044 Aquifer Test

An aquifer test was started on November 30, 1999, pumping 50 gpm from well 044. Drawdown data were collected from the pumping well and observation wells 045, 046, 125, 126, and 127. Figure 8 is a cross-section of this well cluster. Observation wells 045, 046, and 126 are all screened within the same screened interval of the pumping well.

Similar to the problems encountered during the 041 tests, the generator shut off unexpectedly after only 41 hours. As a result, no recovery data were collected from this initial test. A subsequent test was conducted starting on December 7, 1999. This test lasted only 15.5 hours with an initial pumping rate of 60 gpm. However, after 70 minutes of pumping, it was apparent that this pumping rate could not be maintained overnight. The pumping rate was lowered to 58 gpm for the remainder of the test. Recovery test data were collected after this second aquifer test.

Table 4 presents the results of the 044 Test 1 discharge water chemical analyses. These results indicate the constituents remained reasonably constant during the pumping phase time period. A more complete discussion is included in the ESL report *Expedited Site Characterization of the Ground Water Chemistry During Two Pumping Tests November 20 through December 2, 1999* (ESL-RPT-2000-2).

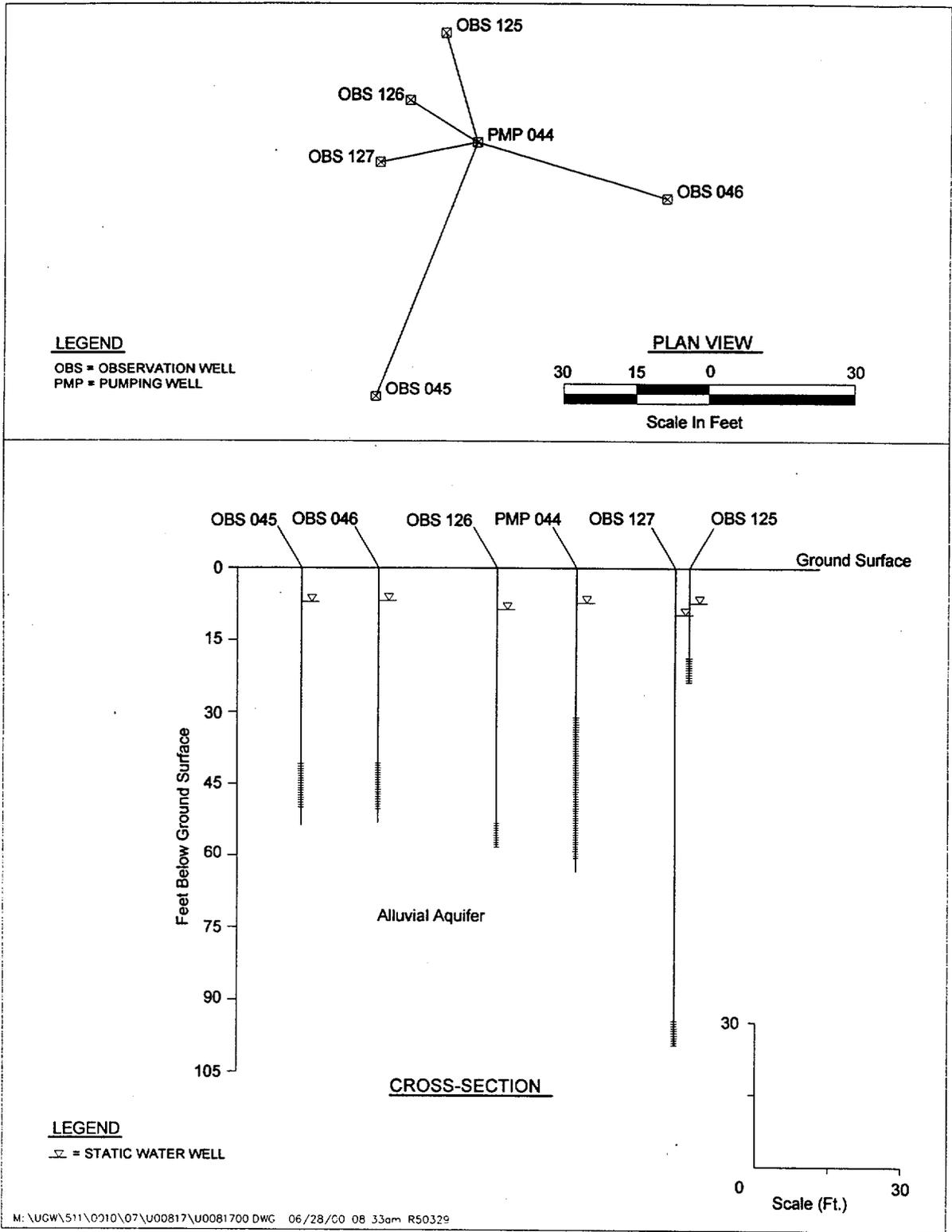


Figure 8. Well 044 Cluster Map and Cross Section

Table 4. Results of Discharge Sampling from Well 044 Aquifer Test 1, November, 1999.

Sample	Cum Vol. (Gal.)	pH	ORP	Cond (ATC)	Temp (°C)	ALK	SO <sub>4</sub> (mg/L)	NO <sub>3</sub> (mg/L)	NO <sub>2</sub> (µg/L)	NH <sub>3</sub> (µg/L)	U (µg/L)
GUN044 @ 1 min	50	6.68	60	616	8.4	230	50	3.4	19	40	15
GUN044 @ 2 min	100	6.29	57	689	8.4	210	80	3.2	37	40	16
GUN044 @ 3 min	150	6.62	53	708	8.6	240	120	2	60	120	18
GUN044 @ 4 min	200	6.68	51	729	8.6	230	150	3.5	26	70	18
GUN044 @ 5 min	250	6.73	47	742	8.5	220	140	3.6	21	60	20
GUN044 @ 15 min	750	6.84	32	776	8.6	210	165	3.9	17	110	19
GUN044 @ 30 min	1,500	6.84	21	790	8.5	220	180	3.5	15	40	19
GUN044 @ 60 min	3,000	7.03	101	796	8.8	230	175	5.6	22	40	19
GUN044 @ 90 min	4,500	6.97	64	802	8.8	230	175	4.9	10	40	19
GUN044 @ 120 min	6,000	6.93	45	805	8.8	230	190	3.6	13	70	20
GUN044 @ 240 min	12,000	6.96	38	815	8.9	243	190	8.2	18	40	18
GUN044 @ 360 min	18,000	7.01	26	735	8.8	256	160	4.6	12	40	15
GUN044 @ 480 min	24,000	6.88	12	837	8.6	233	200	6.8	12	40	17
GUN044 @ 24 hrs	72,000	6.64	116	839	8.7	245	150	7.5	22	40	19
GUN044 @ 28 hrs	84,000	6.7	108	846	8.7	250	180	8.1	31	40	18
GUN044 @ 32 hrs	96,000	6.96	90	860	8.6	232	160	7	17	40	19
NOTES: Water parameters (pH, ORP, Cond., Temp.) were measured (unfiltered) at the well with a calibrated YSI 3500 using a flow cell.											
All other analyses were performed on water filtered through a 0.45µm flow-through filter.											
The pump test was halted 12/03/99 ~0200. The last sample taken was the 32 hour sample. The generator supplying power to the pump quit working sometime overnight and the rate meter froze.											
Spreadsheet has been checked for accuracy in transcription.											
Bold = values are less than detection											

Table 5 lists the drawdown measured in the pumping well and each observation well for the two tests completed at this location.

Table 5. Total Drawdown for the Well 044 Aquifer Tests

		Test No.	044 Test 1	044 Test 2
		Q (gpm)	50	60 / 58
Well	r (ft)	Scrn Inv (ft bgs)	s (ft)	s (ft)
PMP 044	NA	31.1 - 60.5	38.89	44.1
OBS 045	56.8	40.9 - 50.5	2.87	3.08
OBS 046	40.9	40.7 - 50.2	2.48	2.66
OBS 125	23.3	18.8 - 23.8	0.58	0.74
OBS 126	16.4	53.2 - 58.2	2.56	2.8
OBS 127	20.4	94.3 - 99.3	0.47	0.54

Q = Pumping Rate  
r = Distance to Pumping Well  
Scrn Inv = Screened Interval (ft below ground surface [ft BGS])  
s = Drawdown  
Pmp = Pumping Well  
Obs = Observation Well

As shown in Table 5, there was greater drawdown measured in observation well 045 compared to well 046 during each test, despite the fact that well 046 is located 15.9 ft closer to the pumping well than well 046. This observation may indicate the aquifer in the vicinity of well 044 is not homogeneous. Data collected from the other two test locations did not indicate that ground water flow within the aquifer may be favorable in one direction compared to another.

Since wells 045, 046, and 126 are screened approximately within the same interval as the pumping, drawdown data from only these observation wells were analyzed. Table 6 contains the transmissivity results based on the data collected during the two tests from observation wells 045, 046, and 126. The plots used for the analyses and the drawdown data collected during the tests are contained within Appendix C.

Table 6. Well 044 Aquifer Test Transmissivity Results (ft<sup>2</sup>/day)

Test No	Data Source	Test	Analytical Method				
			Theis T(ft <sup>2</sup> /d)	C-J T(ft <sup>2</sup> /d)	Neuman T(ft <sup>2</sup> /d)	Theis Rec T(ft <sup>2</sup> /d)	Neuman Sy
044 Test 1	Obs 045	AQ	1213.9	1018.1	1606.9	NA	0.221
	Obs 046	AQ	1081.4	1213.9	1681	NA	0.425
	Obs 126	AQ	1360.8	1728	3172.5	NA	0.26
044 Test 2	Obs 045	AQ	793.4	1041.1	1277.1	NA	0.500
	Obs 046	AQ	999.4	1163.5	1319.5	NA	0.500
	Obs 126	AQ	1771.2	1598.4	2635.5	NA	0.664
	Obs 045	REC	NA	NA	NA	727.2	NA
	Obs 046	REC	NA	NA	NA	819.4	NA
	Obs 126	REC	NA	NA	NA	976.3	NA
	Pmp 044	REC	NA	NA	NA	68	NA

- OBS = Observation Well
- PMP = Pumping Well
- AQ = Aquifer Test
- REC = Recovery Test
- NA = Not applicable
- Theis = Theis Method
- C-J = Cooper Jacob Method
- Neuman = Neuman Method for Partially Penetrating Wells in Unconfined Aquifers
- Theis Rec = Theis Recovery Method
- T = Transmissivity (ft<sup>2</sup>/day)
- Sy = Specific yield

### 3.2.3 Well 047 Aquifer Test

Two aquifer tests were conducted using well 047 as the pumping well. During these tests drawdown data were collected from the pumping well and observation wells 048, 049, 135, and 136. Figure 9 is a cross-section of the well cluster at this location.

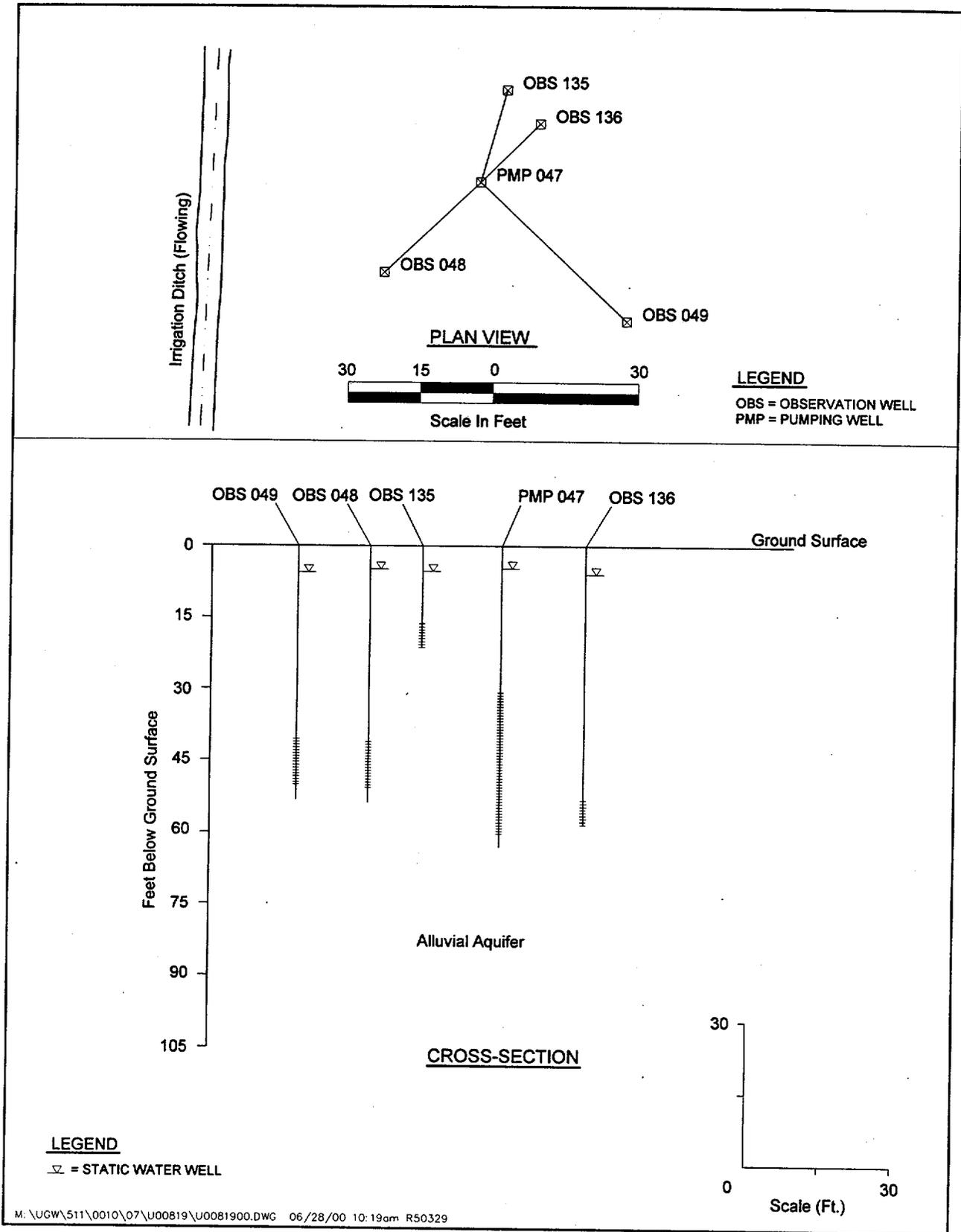


Figure 9. Well 047 Cluster Map and Cross Section

**Calculation No. U0082900**

The initial test was started on November 11, 1999, with a flow rate of 60 gpm. The goal was to run the test for 72 hours, stop pumping, and collect recovery data. However, after 62 hours the generator supplying power for the pump shut off unexpectedly, and no recovery data were collected. A second attempt was made to run at least a 24 hour test at the same flow rate starting December 8, 1999, unfortunately the generator shut off again, and no recovery data were collected at this location.

Table 7 presents the results of the 047 Test 1 discharge water chemical analyses. These results indicate the constituents remained reasonably constant during the pumping phase time period at this location also. A more complete discussion is included in the ESL report *Expedited Site Characterization of the Ground Water Chemistry During Two Pumping Tests November 20 through December 2, 1999* (ESL-RPT-2000-2).

*Table 7. Results of the 047 Test 1 Discharge Water Chemical Analysis*

Sample	Cum Vol. (Gal.)	pH	Orp	Cond (ATC)	Temp (°C)	Alk	SO <sub>4</sub> (mg/L)	NO <sub>3</sub> (mg/L)	NO <sub>2</sub> (ug/L)	NH <sub>3</sub> (ug/L)	U (ug/L)
GUN047 @ 1 min	60	6.88	-207	607	9.4	245	220	6.65	6.0	40	16
GUN047 @ 2 min	120	6.84	-218	771	8.9	275	290	2.45	5.0	40	20
GUN047 @ 3 min	180	6.83	-231	792	8.8	270	315	3.75	5.0	40	21
GUN047 @ 4 min	240	6.85	-238	812	8.8	240	340	3.1	5.0	40	21
GUN047 @ 5 min	300	6.86	-243	824	8.7	260	355	2.9	5.0	40	22
GUN047 @ 15 min	900	6.83	-215	843	8.8	255	375	3.4	7.0	40	25
GUN047 @ 30 min	1800	6.79	-202	849	8.7	250	360	3	8.0	40	26
GUN047 @ 60 min	3600	6.84	-200	861	8.6	230	375	2.9	6.0	40	26
GUN047 @ 90 min	5400	6.86	-184	862	8.5	255	355	6	6.0	40	26
GUN047 @ 17 hrs	61200	6.96	19	875	8.4	260	375	2.5	9.0	40	25
GUN047 @ 20 hrs	72000	6.94	-18	884	8.6	275	365	3.6	5.0	40	28
GUN047 @ 24 hrs	86400	7.11	-30	890	8.5	265	380	4	5.0	40	26
GUN047 @ 41 hrs	147600	6.92	85	891	8.4	225	385	4.2	5.0	40	25
GUN047 @ 44 hrs	158400	6.57	48	766	8.5	230	375	3.2	8.0	40	25
GUN047 @ 48 hrs	172800	6.62	1	902	8.2	170	370	8.6	20.0	40	20
NOTES: Water parameters (pH, ORP, Cond., Temp.) were measured (unfiltered) at the well with a calibrated YSI 3500 using a flow cell.											
All other analyses were performed on water filtered through a 0.45um flow-through filter.											
Constituent measurements are at least duplicates. If the results did not agree within 10% they were repeated.											
The pump test was halted 11/23/99 ~0700. The last sample taken was the 48 hour sample. The generator supplying power to the pump quit working sometime overnight and the rate meter froze.											
Spreadsheet has been checked for accuracy in transcription.											
Bold = Less than detection limit											

Table 8 lists the drawdown measured in the pumping well and each observation well for the two tests completed at this location.

Table 8. Total Drawdown for the Well 047 Aquifer Tests

		Test No.	047 Test 1	047 Test 2
		Q (gpm)	60	60
Well	r (ft)	Scrn Inv (ft bgs)	s (ft)	s (ft)
PMP 047	NA	30.8 - 60.2	39	27.52
OBS 048	27.2	41.2 - 50.7	4.13	3.64
OBS 049	42.1	40.6 - 50.1	3.1	2.81
OBS 135	16.4	16.3 - 21.3	0.84	0.77
OBS 136	17.3	53.2 - 58.2	3.74	3.63

Q = Pumping Rate  
 r = Distance to Pumping Well  
 Scrn Inv = Screened Interval (ft below ground surface)  
 s = Drawdown  
 Pmp = Pumping Well  
 Obs = Observation Well

Observation wells 048, 049, and 136 are screened approximately within the same interval as the pumping well. Observation well 136 did not respond quickly to an added slug of water during the response test; therefore, data collected from this well were not analyzed. Table 9 contains the transmissivity results based on the data collected during the two tests from observation wells 048 and 049. The plots used for the analyses and the drawdown data collected during the tests are contained within Appendix D.

Table 9. Well 047 Aquifer Test Transmissivity Results (ft<sup>2</sup>/day)

Test No	Data Source	Test	Analytical Method				
			Theis	C-J T(ft <sup>2</sup> /d)	Neuman T(ft <sup>2</sup> /d)	Theis Rec T(ft <sup>2</sup> /d)	Neuman Sy
047 Test 1	Obs 048	AQ	1031	1137.6	1674.1	NA	.152
	Obs 049	AQ	1156.3	1258.6	1813.8	NA	.184
047 Test 2	Obs 048	AQ	1297.4	1088.6	1883.1	NA	.079
	Obs 049	AQ	1454.4	1356.4	2036.9	NA	.065

OBS = Observation Well  
 PMP = Pumping Well  
 AQ = Aquifer Test  
 REC = Recovery Test  
 NA = Not applicable  
 Theis = Theis Unconfined Method  
 C-J = Cooper Jacob Method  
 Neuman = Neuman Method for Partially Penetrating Wells in Unconfined Aquifers  
 Theis Rec = Theis Recovery Method  
 T = Transmissivity (ft<sup>2</sup>/day)  
 Sy = Specific yield

The potential for the irrigation ditch recharging the aquifer and influencing the drawdown at each of the three testing locations (041, 044, and 047) was ruled out after the tests at well 044 were conducted. This location did not include an irrigation ditch nearby, yet the wells responded in the same manner as that demonstrated by the well 041 and 047 tests (which did contain irrigation ditches filled with water). As a result, it was determined that the tests may be reaching steady-state a relatively short time after each test was started.

The semi-log plots of the residual drawdown data collected from the pumping well during the recovery test exhibit an S-shaped curve (Appendices B through D). This shaped recovery curve is also indicative of the aquifer not being adequately stressed, and reaching steady-state conditions.

### 3.2.4 City of Gunnison Production Well Aquifer Test

These tests were conducted by a consultant to the City of Gunnison. After the installation of Production Well #10, a series of short-term aquifer tests were completed to determine the optimal pumping rate for the well on October 28 and 29, 1999. The initial test was run at a pumping rate of 421 gpm. During this test, which lasted only 1 hour, drawdown data from the pumping well and an observation well (located 42 ft from the pumping well) were collected. According to the available information, recovery data were not recorded after this short-term test. Data for these tests were not analyzed using the Neuman Method for Partially Penetrating Wells since the production well nearly fully penetrates the entire saturated thickness of the alluvial aquifer. As a result, the drawdown data collected from the observation well were analyzed using the Theis and Cooper-Jacob Methods for Unconfined Aquifers.

The following day, a step test was completed at pumping rates of 135, 265, and 400 gpm. Prior to increasing the pumping rate after each step, the pumping well was allowed to fully recover to the static water level. Pumping phases of the first two steps lasted 1 hour, while the pumping phase of the 400 gpm step lasted 17 hours. Drawdown data were collected only from the pumping well during this step test, observation well data were not recorded. As a result, only the residual drawdown data were analyzed using the Theis Recovery Method. Table 10 contains the transmissivity results obtained from the analyses of the data from the tests associated with Production Well #10. Appendix E contains the computer-generated plots used for the analyses of the data.

Another aquifer test was completed on another City of Gunnison Production Well in 1975. Residual drawdown data were collected after Production Well #7 was pumped at a rate of 274 gpm for an unknown length of time. A copy of the data collected during this test was obtained from the City of Gunnison, and is included in Appendix E.

Table 10. City Of Gunnison Production Well Aquifer Test Transmissivity Results (ft<sup>2</sup>/day)

Q (gpm)	Data Source	Test	Analytical Method		
			Theis T(ft <sup>2</sup> /d)	C-J T(ft <sup>2</sup> /d)	Theis Rec T(ft <sup>2</sup> /d)
421	Obs Well	AQ	5600	5055	NA
135	Well 10	REC	NA	NA	6164
265	Well 10	REC	NA	NA	7300
400	Well 10	REC	NA	NA	10262
274	Well 7	REC	NA	NA	8440

OBS = Observation Well  
 PMP = Pumping Well  
 AQ = Aquifer Test  
 REC = Recovery Test  
 NA = Not applicable

Theis = Theis Method  
 C-J = Cooper Jacob Method  
 Theis Rec = Theis Recovery Method  
 T = Transmissivity (ft<sup>2</sup>/day)

All the City of Gunnison Production Wells are located northeast of the site. Despite the difference in location between the City of Gunnison wells and wells 041, 044, and 047, results of these analyses may provide the most representative parameters for the alluvial aquifer underlying the site. The depositional environment is believed to be similar between the two areas, and the capability to generate a higher flow rate during the aquifer tests for the Production Wells sufficiently stresses the aquifer.

### 3.3 Hydraulic Conductivity Results

Determination of the hydraulic conductivity depends upon the thickness of the saturated zone. As previously mentioned, the thickness of the alluvial aquifer underlying the site is approximately 120 ft. The depths to water in the vicinity of the site average 5 ft, resulting in 115 ft of saturated thickness. However, pumping wells 041, 044, and 047 are screened over only 30 ft of the saturated thickness. As a result, all transmissivity results obtained from the 041, 044, and 047 tests were divided by 30 ft to obtain the hydraulic conductivity. Likewise, the City of Gunnison Production Wells are typically screened over a 60 ft length. Transmissivity results obtained from the data collected from these tests were divided by 60.

The hydraulic conductivity estimates based on the analyses of the data using the Neuman Method for Partially Penetrating Wells in Unconfined Aquifers (the most applicable method for these conditions) ranged from 13.5 to 105.7 ft/day. Using the Theis Recovery Method on the data collected from the recovery phase of the aquifer tests conducted on the City of Gunnison Production Wells, the hydraulic conductivity ranges from 103 to 171 ft/day.

### 3.4 Background Monitoring

A data logger was installed in well 186 (Figure 1) to monitor the alluvial aquifer water table surface fluctuations over the time period when the aquifer tests were conducted. This location was chosen because of the proximity to the test locations (close enough to provide representative background data without being influenced by the aquifer test activities) and because this well is screened over approximately the same interval as the pumping wells.

As shown in Figure 10, during the time period when the tests were conducted there was minimal fluctuation in the alluvial aquifer water table surface (0.4 ft) compared to the drawdown observed in the observation wells. As a result, it was not necessary to adjust drawdown or residual drawdown data collected from any of the tests completed at the 041, 044, or 047 locations.

## 4.0 Conclusions

The following conclusions can be made based on the data collected from the 1999 field investigation near the Gunnison site:

- Following the general rule, the specific capacity decreased with increased drawdown for each of the newly installed pumping wells. Data collected from the step tests indicated the specific capacity ranges from 0.17 to 0.36 ft<sup>2</sup>/min for flow rates below 30 gpm, and from 0.09 to 0.12 ft<sup>2</sup>/min for flow rates above 30 gpm.
- The aquifer tests conducted downgradient of the site at 041, 044, and 047 well cluster locations may not have stressed the aquifer adequately to provide representative hydraulic parameters. Tests completed at each of the three locations resulted in observation well drawdown data falling below the Theis curve after less than 20 minutes into the test. This response to pumping, combined with an S-shaped curve generated from data collected during the recovery phase of the test, suggest a steady-state condition was obtained early in the testing period.
- Analyses of the drawdown data (using the Neuman Method for Partial Penetration) collected from wells 041, 044, and 047 during the pumping phase suggest the alluvial aquifer transmissivity ranges from 406 to 3,172 ft<sup>2</sup>/day. Analyses of residual drawdown data collected during the recovery phase of these tests suggest the transmissivity ranges from 68 to 976 ft<sup>2</sup>/day.
- Specific yield estimates, calculated using the Neuman Method for Unconfined Aquifer with Partial Penetrating Wells, ranges from 0.016 to 0.664.
- Drawdown data collected during the recovery phase of the aquifer tests conducted using Production Wells #7 and #10 suggest the alluvial aquifer transmissivity ranges from 6,164 to 10,262 ft/day.
- Using the screened interval as the saturated thickness (30 ft for wells 041, 044, and 047 and 60 ft for the City of Gunnison Production Well tests) the conductivity for the onsite tests (pumping phase only) range from 13.5 to 105.7 ft/day, and from 103 to 171 ft/day for the Production Well tests.
- Aquifer tests conducted on the Production Wells for the City of Gunnison may provide more representative hydraulic parameter estimates due to the fact they were conducted at pumping rates of up to 421 gpm (and stressed the entire thickness of the alluvial aquifer), compared to the onsite tests that were conducted at much lower pumping rates and stressed only a small portion of the aquifer.
- Table 11 is a summary table which provides the transmissivity and hydraulic conductivity results for all tests included in this calculation set.



Table 11. Summary of Transmissivity and Hydraulic Conductivity Test Results.

041 LOCATION			WELL PMP 041		WELL OBS 042, r = 26.8'				WELL OBS 123, r = 30.8'				WELL OBS 043, r = 36.6'									
Q (gpm)	Time (hrs)		Thels Rec		Thels		Cooper-Jacob		Neuman		Thels		Cooper-Jacob		Neuman		Thels		Cooper-Jacob		Neuman	
			T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)
AQ TEST 1	35	app 19	NA	NA	301	10.03	361.4	12.05	516.9	17.23	267.8	8.93	315.4	10.51	472.5	15.75	424.8	14.16	423.4	14.11	608.9	20.30
(NO REC TEST)			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AQ TEST 2	38.1	72.25	NA	NA	292.3	9.74	352.8	11.76	551.5	18.38	231.8	7.73	325.4	10.85	488	16.27	260.6	8.69	414.7	13.82	608.7	20.29
REC TEST			302.4	10.08	325.4	10.85	NA	NA	NA	NA	319.7	10.66	NA	NA	NA	NA	394.6	13.15	NA	NA	NA	NA
AQ TEST 3	44.7	8	NA	NA	305.3	10.18	338.4	11.28	495.5	16.52	216	7.20	301	10.03	405.9	13.53	305.3	10.18	375.8	12.53	508.4	16.95
REC TEST			74.7	2.49	178.6	5.95	NA	NA	NA	NA	216	7.20	NA	NA	NA	NA	302.4	10.08	NA	NA	NA	NA

044 LOCATION			WELL PMP 044		WELL OBS 046, r = 40.9'				WELL OBS 045, r = 56.8'				WELL OBS 126, r = 16.4'									
Q (gpm)	Time (hrs)		Thels Rec		Thels		Cooper-Jacob		Neuman		Thels		Cooper-Jacob		Neuman		Thels		Cooper-Jacob		Neuman	
			T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)
AQ TEST 1	50	app 41	NA	NA	1081.4	36.05	1213.9	40.46	1681	56.03	1213.9	40.46	1018.1	33.94	1606.9	53.36	1360.8	45.36	1728	57.60	3172.5	105.75
(NO REC TEST)			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AQ TEST 2	60 / 58	15.5	NA	NA	999.4	33.31	1163.5	38.78	1319.5	43.98	793.4	26.45	1041.1	34.70	1277.1	42.57	1771.2	59.04	1598.4	53.28	2635.5	87.85
REC TEST			68	2.27	819.4	27.31	NA	NA	NA	NA	727.2	24.24	NA	NA	NA	NA	976.3	32.54	NA	NA	NA	NA

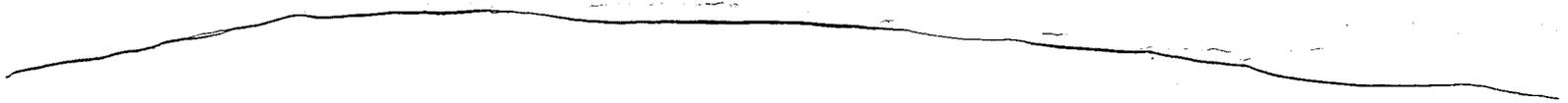
047 LOCATION			WELL PMP 047		WELL OBS 048, r = 27.2'				WELL OBS 049, r = 42.1'							
Q (gpm)	Time (hrs)		Thels Rec		Thels		Cooper-Jacob		Neuman		Thels		Cooper-Jacob		Neuman	
			T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)		
AQ TEST 1	60	app 62	NA	NA	1031	34.37	1137.6	37.92	1674.1	55.80	1156.3	38.54	1258.6	41.95	1813.8	60.46
(NO REC TEST)			-	-	-	-	-	-	-	-	-	-	-	-	-	-
AQ TEST 2	60	app 12	NA	NA	1297.4	43.25	1088.6	36.29	1883.1	62.77	1454.4	48.48	1356.4	45.21	2036.9	67.90
(NO REC TEST)			-	-	-	-	-	-	-	-	-	-	-	-	-	-

CITY OF GUNNISON			WELL #10		OBS WELL, r = 42.5'			
Q (gpm)	Time (hrs)		Thels Rec		Thels		Cooper-Jacob	
			T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)	T (ft <sup>2</sup> /d)	K (ft/d)
TEST 1 (NO REC TEST)	420	1	NA	NA	5600	93.3	5055	84.3
TEST 2 (REC ONLY)	135	1	6164	102.7	NA	NA	NA	NA
TEST 3 (REC ONLY)	265	1	7300	121.7	NA	NA	NA	NA
TEST 4 (REC ONLY)	400	17	10262	171.0	NA	NA	NA	NA
1975 TEST (WELL #7)	?	?	8440	140.7	NA	NA	NA	NA

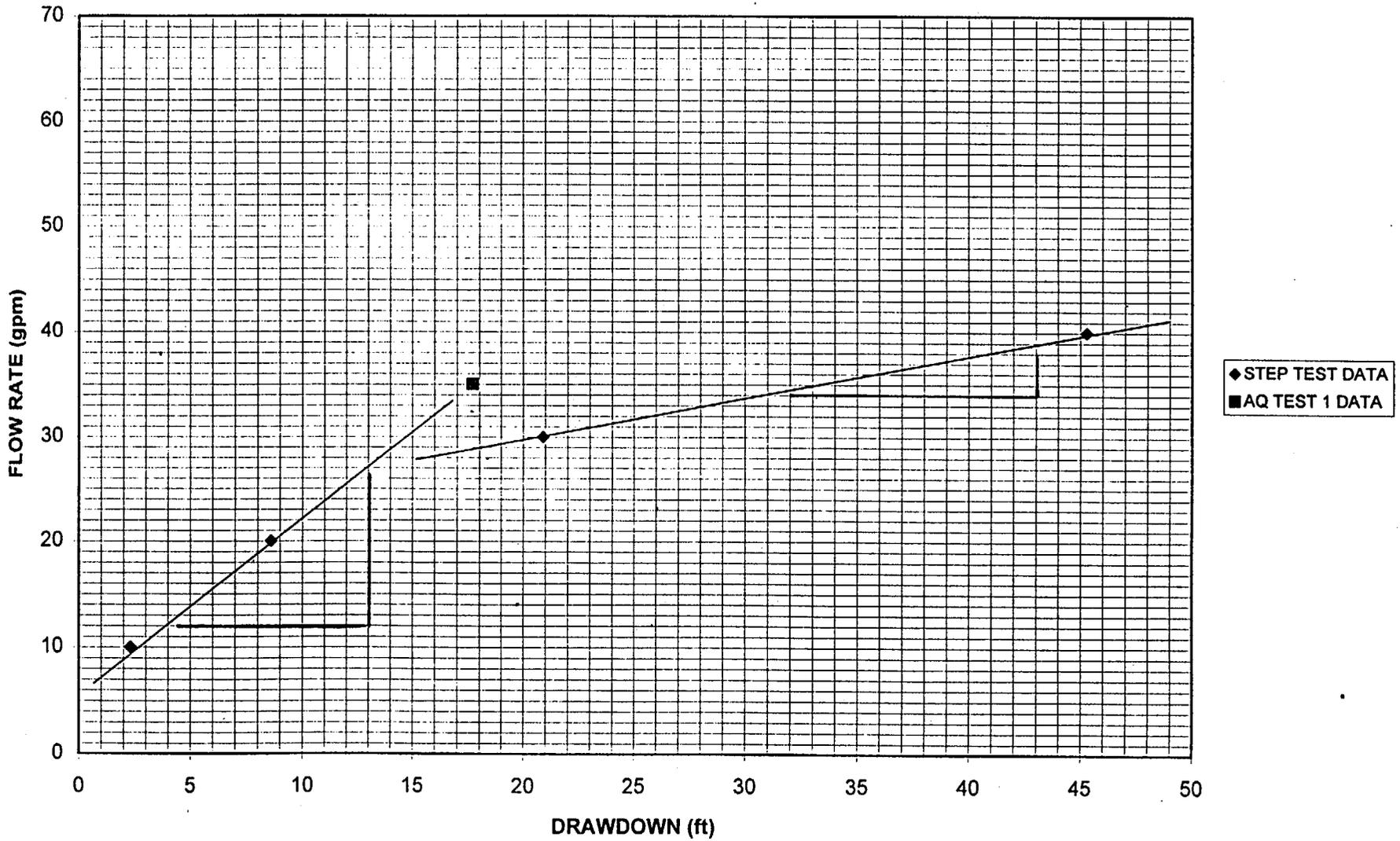
- NOTES
- T = Transmissivity (ft<sup>2</sup>/day)
  - K = Hydraulic Conductivity (ft/day)
  - Q = Pump Discharge Rate (gpm)
  - OBS = Observation Well
  - PMP = Pumping Well
  - r = Distance to Pumping Well
  - AQ = Aquifer Test
  - REC = Recovery Test
  - app = approximate
  - Thels Rec = Thels Recovery Method
  - Thels = Thels Unconfined Method
  - Cooper-Jacob = Cooper-Jacob Method
  - Neuman = Neuman Method for Partially Penetrating Wells in Unconfined Aquifers
  - NA = Not Applicable
  - = No Data

**APPENDIX A**

**STEP TEST DATA AND PLOTS FOR WELLS 041, 044, AND 047**



# WELL 041 STEP TEST 1 DATA - SPECIFIC CAPACITY DETERMINATION



LOWER Q:

$$\text{SLOPE} = \frac{15 \text{ GPM}}{9 \text{ FT}} = \underline{0.22 \text{ FT}^2/\text{MIN}}$$

HIGHER Q:

$$\text{SLOPE} = \frac{5 \text{ GPM}}{12 \text{ FT}} = \underline{0.06 \text{ FT}^2/\text{MIN}}$$

GUNNISON UMTRA SITE  
WELL 041 STEP TEST 1 DATA  
START DATE/TIME : 11/18/99, 0900

Q = 10 GPM	ELAPSED	WELL 041 DTW	WELL 042 DTW	WELL 043 DTW
	TIME (MIN)	FT BTOC	FT BTOC	FT BTOC
	0	8.226	8.039	8.393
	0.0217	11.097	8.238	8.391
	0.0434	9.523	8.277	8.389
	0.065	10.842	8.481	8.389
	0.0867	11.131	8.705	8.389
	0.1084	11.753	8.93	8.387
	0.13	12.363	9.112	8.393
	0.1517	12.928	9.273	8.396
	0.1734	11.74	9.399	8.4
	0.195	13.386	9.522	8.405
	0.2172	13.274	9.624	8.412
	0.2407	13.045	9.691	8.42
	0.2655	13.2	9.743	8.431
	0.2919	13.105	9.785	8.442
	0.3199	13.049	9.819	8.458
	0.3495	12.859	9.839	8.474
	0.3809	12.691	9.85	8.493
	0.414	12.527	9.85	8.515
	0.4492	12.35	9.843	8.538
	0.4865	12.155	9.826	8.554
	0.526	12.06	9.809	8.569
	0.5679	11.792	9.77	8.601
	0.6122	11.628	9.737	8.624
	0.6592	11.442	9.702	8.649
	0.709	11.261	9.663	8.667
	0.7617	11.097	9.626	8.686
	0.8175	10.989	9.585	8.707
	0.8767	10.811	9.546	8.724
	0.9394	10.677	9.503	8.74
	1.0057	10.569	9.462	8.753
	1.076	10.461	9.418	8.766
	1.1505	10.327	9.379	8.775
	1.2295	10.284	9.34	8.784
	1.3132	10.115	9.303	8.789
	1.4017	10.046	9.269	8.797
	1.4955	9.994	9.238	8.802
	1.5949	9.895	9.204	8.807
	1.7002	9.839	9.182	8.808
	1.8117	9.822	9.164	8.811
	1.9299	9.873	9.16	8.813
	2.055	9.947	9.186	8.816
	2.1875	10.077	9.223	8.818
	2.328	10.055	9.245	8.826
	2.4769	9.973	9.227	8.833
	2.6344	9.891	9.214	8.845
	2.8012	9.882	9.204	8.85
	2.978	9.994	9.23	8.855
	3.1654	10.111	9.266	8.862
	3.3637	10.038	9.271	8.874
	3.5739	9.999	9.266	8.882
	3.7965	9.96	9.258	8.89
	4.0324	9.943	9.256	8.895
	4.2822	9.943	9.258	8.901
	4.5469	10.029	9.282	8.907
	4.8272	10.172	9.329	8.917
	5.124	10.215	9.366	8.93
	5.4385	10.211	9.381	8.945
	5.7717	10.193	9.392	8.958
	6.1245	10.193	9.392	8.961
	6.4984	10.176	9.405	8.977
	6.8944	10.224	9.423	8.993
	7.3137	10.237	9.433	9.004
	7.758	10.254	9.444	9.014
	8.2287	10.267	9.451	9.028

8.7272	10.245	9.464	9.035
9.2552	10.271	9.472	9.048
9.8145	10.267	9.483	9.057
10.407	10.275	9.49	9.062
11.0345	10.28	9.503	9.075
11.6994	10.297	9.511	9.081
12.4035	10.288	9.52	9.091
13.1494	10.301	9.529	9.099
13.9394	10.319	9.531	9.104
14.7762	10.336	9.55	9.116
15.6627	10.332	9.561	9.126
16.6017	10.388	9.568	9.134
17.5964	10.349	9.572	9.141
18.65	10.345	9.581	9.151
19.766	10.332	9.583	9.154
20.9482	10.392	9.594	9.163
22.2004	10.388	9.609	9.173
23.5269	10.375	9.611	9.179
24.9319	10.414	9.622	9.189
26.4202	10.409	9.624	9.196
27.9967	10.396	9.631	9.203
29.6665	10.401	9.644	9.209
31.4354	10.401	9.646	9.212
33.309	10.435	9.655	9.222
35.2937	10.431	9.655	9.221
37.396	10.435	9.659	9.226
39.6229	10.427	9.659	9.232
41.9817	10.396	9.67	9.238
44.4804	10.396	9.665	9.238
47.127	10.427	9.681	9.248
49.9305	10.448	9.674	9.245
52.9002	10.47	9.689	9.256
56.0459	10.435	9.683	9.253

Q = 20 GPM

60	10.496	9.7	9.251
60.0218	10.894	9.711	9.251
60.0436	10.608	9.711	9.253
60.0655	10.703	9.722	9.253
60.0873	10.781	9.735	9.251
60.1091	10.876	9.754	9.253
60.131	10.984	9.774	9.253
60.1528	10.993	9.795	9.253
60.1746	11.166	9.819	9.254
60.1965	11.287	9.845	9.253
60.2186	11.408	9.873	9.254
60.2421	11.468	9.899	9.257
60.267	11.62	9.932	9.257
60.2933	11.702	9.96	9.256
60.3213	11.771	9.997	9.259
60.351	11.896	10.03	9.26
60.3823	11.969	10.069	9.265
60.4155	12.142	10.105	9.269
60.4506	12.207	10.147	9.27
60.488	12.341	10.188	9.275
60.5275	12.436	10.218	9.28
60.5693	12.635	10.29	9.289
60.6136	12.82	10.344	9.298
60.6606	13.049	10.407	9.305
60.7105	13.257	10.476	9.314
60.7631	13.416	10.554	9.326
60.819	13.667	10.632	9.337
60.8781	13.883	10.712	9.352
60.9408	14.068	10.797	9.366
61.0071	14.172	10.879	9.385
61.0775	14.284	10.957	9.405
61.152	14.34	11.022	9.429
61.231	14.358	11.074	9.449
61.3146	14.405	11.124	9.475
61.4031	14.427	11.165	9.5
61.497	14.487	11.209	9.523
61.5963	14.569	11.254	9.552

61.7016	14.617	11.296	9.572
61.8131	14.686	11.341	9.598
61.9313	14.746	11.387	9.625
62.0565	14.841	11.436	9.651
62.189	14.945	11.493	9.678
62.3295	15.057	11.543	9.704
62.4783	15.156	11.588	9.732
62.6358	15.269	11.647	9.76
62.8026	15.372	11.705	9.79
62.9795	15.446	11.761	9.823
63.1668	15.493	11.816	9.853
63.3651	15.575	11.868	9.884
63.5753	15.635	11.915	9.915
63.798	15.696	11.959	9.948
64.0338	15.739	12.011	9.976
64.2836	15.83	12.054	10.009
64.5483	15.817	12.097	10.041
64.8286	15.899	12.141	10.073
65.1255	15.907	12.171	10.107
65.44	15.955	12.21	10.134
65.7731	15.989	12.247	10.163
66.126	16.028	12.284	10.194
66.4998	16.045	12.318	10.224
66.8958	16.114	12.351	10.253
67.3151	16.127	12.381	10.278
67.7595	16.158	12.409	10.305
68.2301	16.196	12.444	10.334
68.7286	16.231	12.47	10.358
69.2566	16.235	12.498	10.384
69.816	16.253	12.524	10.409
70.4085	16.3	12.552	10.433
71.036	16.309	12.576	10.454
71.7008	16.36	12.589	10.472
72.405	16.365	12.626	10.5
73.1508	16.408	12.639	10.519
73.9408	16.412	12.671	10.543
74.7776	16.421	12.691	10.565
75.6641	16.429	12.732	10.583
76.6031	16.442	12.745	10.607
77.5978	16.477	12.762	10.628
78.6515	16.52	12.778	10.639
79.7675	16.524	12.797	10.66
80.9496	16.52	12.812	10.677
82.2018	16.572	12.819	10.696
83.5283	16.589	12.832	10.709
84.9333	16.567	12.869	10.725
86.4216	16.585	12.886	10.739
87.9981	16.589	12.886	10.754
89.668	16.615	12.89	10.773
91.4368	16.641	12.912	10.784
93.3105	16.658	12.927	10.797
95.2951	16.675	12.923	10.809
97.3975	16.701	12.944	10.834
99.6243	16.701	12.955	10.832
101.9831	16.701	12.957	10.835
104.4818	16.736	12.975	10.856
107.1285	16.744	12.988	10.866
109.932	16.744	12.994	10.877
112.9016	16.77	13.012	10.889
116.0473	16.796	13.022	10.899
Q = 30 GPM			
120	16.845	13.069	10.91
120.0217	17.073	13.073	10.911
120.0434	17.306	13.084	10.91
120.065	17.517	13.11	10.911
120.0867	17.707	13.131	10.911
120.1084	17.949	13.168	10.91
120.13	18.126	13.203	10.91
120.1517	18.307	13.242	10.913
120.1734	18.427	13.283	10.911
120.195	18.531	13.326	10.911

120.2167	18.643	13.363	10.911
120.2384	18.703	13.404	10.914
120.26	18.811	13.439	10.916
120.2822	18.889	13.478	10.917
120.3057	18.997	13.515	10.922
120.3305	19.096	13.552	10.922
120.3569	19.203	13.595	10.926
120.3849	19.316	13.643	10.927
120.4145	19.436	13.69	10.93
120.4459	19.57	13.738	10.939
120.479	19.695	13.794	10.949
120.5142	19.824	13.827	10.954
120.5515	19.962	13.879	10.956
120.591	20.044	13.913	10.961
120.6329	20.294	13.993	10.971
120.6772	20.402	14.045	10.978
120.7242	20.591	14.11	10.99
120.774	20.755	14.156	11.006
120.8267	20.949	14.195	11.017
120.8825	21.169	14.251	11.038
120.9417	21.401	14.318	11.049
121.0044	21.686	14.372	11.061
121.0707	21.936	14.448	11.074
121.141	22.104	14.524	11.094
121.2155	22.34	14.602	11.118
121.2945	22.547	14.671	11.138
121.3782	22.775	14.732	11.163
121.4667	22.999	14.797	11.193
121.5605	23.223	14.864	11.222
121.6599	23.421	14.942	11.244
121.7652	23.654	14.996	11.273
121.8767	23.83	15.054	11.302
121.9949	24.024	15.113	11.334
122.12	24.252	15.16	11.367
122.2525	24.429	15.238	11.401
122.393	24.614	15.279	11.434
122.5419	24.795	15.325	11.47
122.6994	24.975	15.37	11.509
122.8662	25.16	15.424	11.543
123.043	25.328	15.483	11.579
123.2304	25.492	15.522	11.617
123.4287	25.647	15.565	11.656
123.6389	25.771	15.626	11.694
123.8615	25.944	15.684	11.73
124.0974	26.055	15.734	11.768
124.3472	26.193	15.766	11.81
124.6119	26.271	15.799	11.843
124.8922	26.391	15.81	11.882
125.189	26.486	15.823	11.92
125.5035	26.585	15.827	11.958
125.8367	26.658	15.827	11.995
126.1895	26.757	15.829	12.032
126.5634	26.813	15.829	12.067
126.9594	26.924	15.831	12.116
127.3787	26.985	15.833	12.142
127.823	27.066	15.836	12.188
128.2937	27.131	15.836	12.216
128.7922	27.191	15.838	12.245
129.3202	27.264	15.838	12.28
129.8795	27.419	15.84	12.313
130.472	27.57	15.842	12.341
131.0995	27.66	15.985	12.381
131.7644	27.754	16.024	12.415
132.4685	27.815	16.061	12.457
133.2144	28.012	16.11	12.487
134.0044	28.167	16.16	12.523
134.8412	28.236	16.195	12.555
135.7277	28.331	16.219	12.596
136.6667	28.386	16.249	12.625
137.6614	28.46	16.253	12.653
138.715	28.451	16.355	12.69

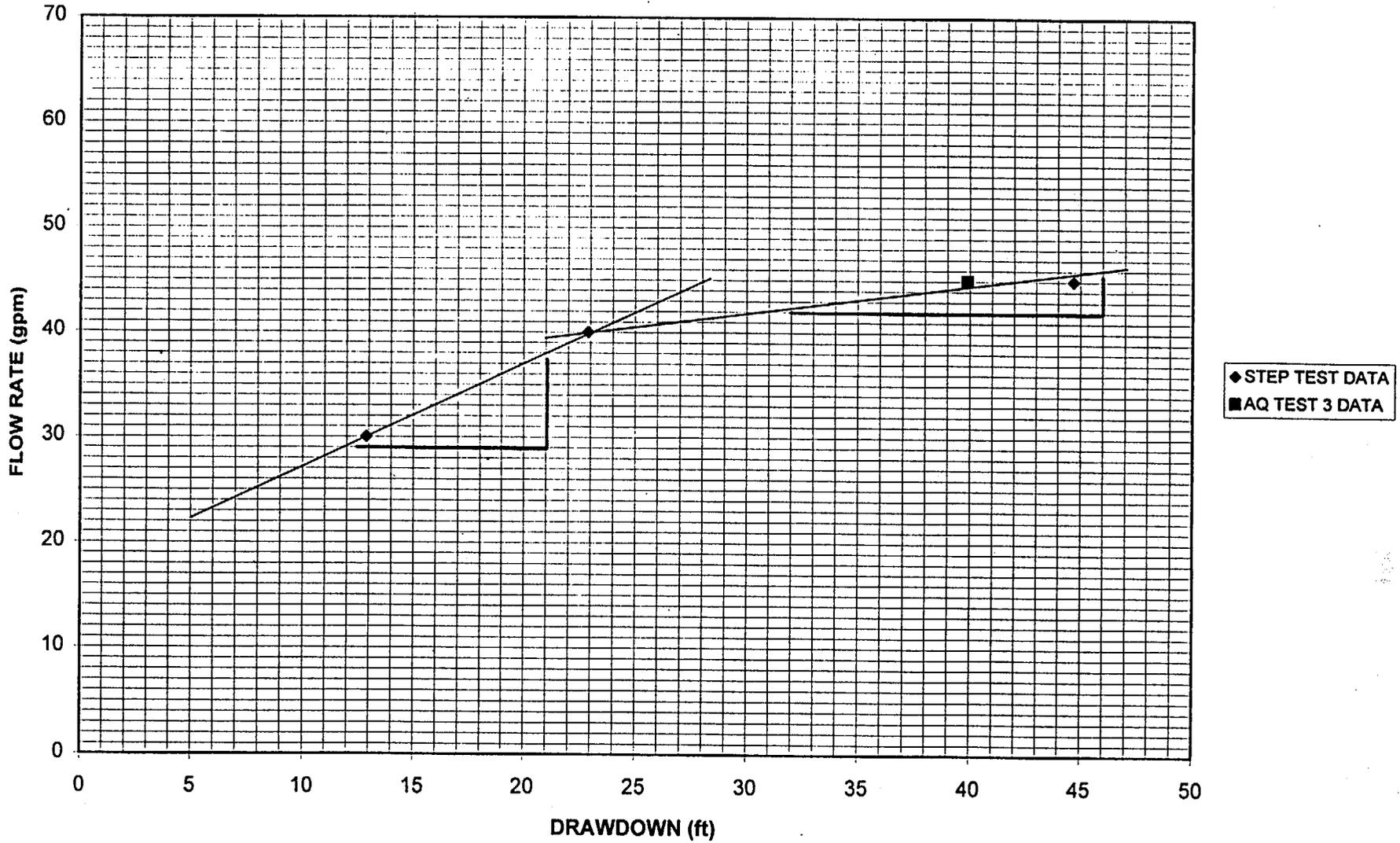
139.831	28.528	16.355	12.712
141.0132	28.589	16.355	12.738
142.2654	28.687	16.353	12.763
143.5919	28.713	16.359	12.789
144.9969	28.782	16.357	12.809
146.4852	28.816	16.357	12.828
148.0617	28.838	16.385	12.848
149.7315	28.868	16.403	12.867
151.5004	28.872	16.411	12.886
153.374	28.885	16.429	12.912
155.3587	28.937	16.444	12.924
157.461	28.963	16.463	12.946
159.6879	28.98	16.474	12.959
162.0467	28.997	16.504	12.972
164.5454	29.036	16.524	12.993
167.192	29.049	16.548	13.031
169.9955	29.083	16.55	13.027
172.9652	29.104	16.563	13.033

Q = 40 GPM

180	29.137	17.074	13.063
180.0218	29.167	17.074	13.071
180.0437	29.283	17.074	13.069
180.0655	29.434	17.072	13.064
180.0873	29.558	17.074	13.066
180.1092	29.7	17.092	13.073
180.131	29.872	17.092	13.064
180.1528	30.022	17.109	13.076
180.1747	30.16	17.124	13.066
180.1968	30.328	17.133	13.085
180.2203	30.478	17.148	13.067
180.2452	30.611	17.167	13.06
180.2715	30.774	17.189	13.067
180.2995	30.925	17.224	13.069
180.3292	31.101	17.245	13.067
180.3605	31.281	17.28	13.067
180.3937	31.44	17.321	13.071
180.4288	31.616	17.369	13.073
180.4662	31.797	17.41	13.07
180.5057	31.926	17.438	13.079
180.5475	32.162	17.516	13.087
180.5918	32.372	17.581	13.092
180.6388	32.531	17.65	13.096
180.6887	32.72	17.715	13.106
180.7413	32.918	17.777	13.119
180.7972	33.137	17.842	13.138
180.8563	33.373	17.909	13.137
180.919	33.562	17.972	13.157
180.9853	33.78	18.039	13.169
181.0557	34.025	18.102	13.189
181.1302	34.235	18.18	13.205
181.2092	34.437	18.232	13.228
181.2928	34.635	18.264	13.241
181.3813	34.785	18.292	13.259
181.4752	34.918	18.299	13.275
181.5745	35.154	18.312	13.304
181.6798	35.381	18.346	13.337
181.7913	35.6	18.394	13.34
181.9095	35.87	18.441	13.375
182.0347	36.196	18.489	13.401
182.1672	36.565	18.56	13.412
182.3077	36.934	18.645	13.443
182.4565	37.298	18.735	13.464
182.614	37.607	18.813	13.502
182.7808	37.924	18.85	13.527
182.9577	38.272	18.887	13.557
183.145	38.67	18.958	13.589
183.3433	39.03	19.023	13.625
183.5535	39.42	19.101	13.662
183.7762	39.84	19.177	13.702
184.012	40.307	19.261	13.743
184.2618	40.624	19.36	13.784

184.5265	41.001	19.425	13.821
184.8068	41.378	19.505	13.865
185.1037	41.716	19.609	13.911
185.4182	42.067	19.674	13.959
185.7513	42.444	19.767	14
186.1042	42.864	19.896	14.049
186.478	43.232	19.979	14.101
186.874	43.583	20.028	14.152
187.2933	43.891	20.097	14.2
187.7377	44.191	20.139	14.248
188.2083	44.477	20.193	14.297
188.7068	44.772	20.236	14.342
189.2348	45.068	20.301	14.391
189.7942	45.307	20.348	14.433
190.3867	45.555	20.35	14.48
191.0142	45.872	20.359	14.523
191.679	46.145	20.361	14.561
192.3832	46.364	20.361	14.609
193.129	46.74	20.363	14.649
193.919	47.227	20.363	14.696
194.7558	47.582	20.363	14.745
195.6423	47.864	20.368	14.79
196.5813	48.176	20.365	14.83
197.576	48.42	20.368	14.872
198.6297	48.809	20.368	14.914
199.7457	49.176	20.368	14.949
200.9278	49.514	20.37	14.99
202.18	49.757	20.368	15.025
203.5065	49.924	20.37	15.054
204.9115	50.172	20.372	15.083
206.3998	50.5	20.372	15.112
207.9763	50.808	20.374	15.133
209.6462	50.987	20.376	15.164
211.415	51.226	20.372	15.183
213.2887	51.517	20.376	15.203
215.2733	51.739	20.378	15.228
217.3757	52.311	20.381	15.252
219.6025	52.405	20.378	15.283
221.9613	52.627	20.381	15.3
224.46	52.789	20.391	15.322
227.1067	52.938	20.394	15.339
229.9102	53.122	20.394	15.354
232.8798	53.263	20.391	15.364
236.0255	53.327	20.396	15.375
239.3575	53.476	20.394	15.391
242.887	53.604	20.396	15.406
246.6255	53.775	20.4	15.419
250.5857	53.698	20.402	15.435
254.7805	53.813	20.402	15.441
259.2238	53.945	20.396	15.448
263.9305	54.146	20.402	15.465
268.916	54.355	20.4	15.462
274.1968	54.427	20.402	15.473

# WELL 041 STEP TEST 2 DATA - SPECIFIC CAPACITY DETERMINATION



LOWER Q:

$$\text{SLOPE} = \frac{9 \text{ GPM}}{9 \text{ FT}} = \underline{0.13 \text{ FT}^2/\text{MIN}}$$

HIGHER Q:

$$\text{SLOPE} = \frac{4 \text{ GPM}}{15 \text{ FT}} = \underline{0.04 \text{ FT}^2/\text{MIN}}$$

GUNNISON UMTRA SITE  
WELL 041 STEP TEST 2 DATA  
START DATE/TIME : 12/1/99, 1105

ELAPSED TIME (MIN)	WELL 041 DWT FT BTOC	WELL 042 DTW FT BTOC	WELL 043 DTW FT BTOC	WELL 123 DTW FT BTOC
Q = 30 GPM				
0	8.479	8.403	8.61	9.76
0.0084	9.632	8.55	8.61	9.763
0.0167	10.256	8.669	8.61	9.763
0.025	10.728	8.788	8.61	9.763
0.0334	11.229	8.906	8.61	9.763
0.0417	11.664	9.02	8.606	9.766
0.05	12.032	9.139	8.61	9.766
0.0584	12.448	9.263	8.606	9.769
0.0667	12.873	9.377	8.606	9.772
0.075	13.26	9.496	8.606	9.775
0.0834	13.628	9.61	8.606	9.775
0.0917	13.996	9.719	8.61	9.779
0.1	14.317	9.828	8.61	9.779
0.1084	14.704	9.933	8.61	9.785
0.1167	15.015	10.037	8.613	9.788
0.125	14.846	10.128	8.613	9.794
0.1334	15.544	10.232	8.616	9.798
0.1417	16.299	10.332	8.619	9.801
0.15	16.204	10.427	8.622	9.804
0.1584	16.402	10.512	8.625	9.81
0.1667	16.383	10.598	8.629	9.813
0.1834	17.694	10.769	8.638	9.826
0.2	16.648	10.878	8.648	9.839
0.2167	16.383	10.983	8.657	9.851
0.2334	16.119	11.063	8.67	9.867
0.25	15.799	11.12	8.686	9.88
0.2667	15.591	11.154	8.698	9.893
0.2834	15.355	11.173	8.714	9.909
0.3	15.025	11.173	8.73	9.921
0.3167	14.817	11.168	8.749	9.937
0.3334	14.638	11.158	8.765	9.953
0.35	14.374	11.139	8.784	9.966
0.3667	14.166	11.116	8.8	9.981
0.3834	14.015	11.092	8.819	9.997
0.4	13.76	11.059	8.835	10.013
0.4167	13.685	11.03	8.854	10.026
0.4334	13.581	11.002	8.87	10.042
0.45	13.43	10.973	8.886	10.058
0.4667	13.345	10.94	8.902	10.07
0.4834	13.25	10.916	8.917	10.086
0.5	13.194	10.888	8.933	10.099
0.5167	13.09	10.864	8.946	10.115
0.5334	12.986	10.835	8.962	10.127
0.55	12.929	10.816	8.975	10.14
0.5667	12.74	10.793	8.987	10.153
0.5834	12.854	10.778	9	10.165
0.6	12.882	10.759	9.01	10.181
0.6167	12.797	10.74	9.022	10.191
0.6334	13.543	10.75	9.032	10.203
0.65	12.939	10.731	9.044	10.216
0.6667	12.986	10.731	9.054	10.222
0.6834	13.118	10.736	9.063	10.238
0.7	13.213	10.745	9.073	10.248
0.7167	13.222	10.759	9.079	10.257
0.7334	13.345	10.774	9.089	10.27
0.75	13.467	10.797	9.098	10.283
0.7667	13.477	10.816	9.105	10.292
0.7834	13.675	10.84	9.114	10.302

0.8	13.779	10.869	9.121	10.311
0.8167	13.958	10.902	9.127	10.324
0.8334	14.072	10.935	9.137	10.333
1.0334	15.487	11.424	9.229	10.46
1.2334	16.148	11.837	9.336	10.597
1.4334	16.563	12.122	9.457	10.736
1.6334	16.949	12.364	9.571	10.879
1.8334	17.496	12.644	9.682	11.015
2.0334	17.826	12.882	9.794	11.151
2.2334	18.005	13.072	9.898	11.285
2.4334	18.222	13.238	10	11.415
2.6334	18.392	13.385	10.095	11.532
2.8334	18.552	13.518	10.181	11.649
3.0334	18.713	13.641	10.263	11.76
3.2334	18.844	13.755	10.346	11.861
3.4334	18.995	13.859	10.419	11.96
3.6334	19.052	13.964	10.489	12.055
3.8334	19.184	14.054	10.555	12.14
4.0334	19.269	14.139	10.619	12.226
4.2334	19.391	14.22	10.679	12.305
4.4334	19.401	14.291	10.736	12.378
4.6334	19.476	14.362	10.793	12.451
4.8334	19.598	14.429	10.844	12.517
5.0334	19.655	14.486	10.895	12.581
5.2334	19.674	14.543	10.942	12.641
5.4334	19.74	14.6	10.987	12.698
5.6334	19.768	14.647	11.031	12.755
5.8334	19.806	14.694	11.072	12.806
6.0334	19.9	14.737	11.11	12.857
6.2334	19.928	14.78	11.149	12.904
6.4334	19.938	14.823	11.187	12.952
6.6334	19.957	14.865	11.222	12.993
6.8334	20.07	14.898	11.253	13.034
7.0334	20.041	14.936	11.288	13.075
7.2334	20.079	14.974	11.32	13.11
7.4334	20.117	15.008	11.352	13.151
7.6334	20.154	15.041	11.38	13.183
7.8334	20.173	15.074	11.406	13.218
8.0334	20.211	15.107	11.434	13.25
8.2334	20.249	15.131	11.459	13.284
8.4334	20.258	15.159	11.485	13.316
8.6334	20.296	15.188	11.51	13.345
8.8334	20.296	15.216	11.536	13.373
9.0334	20.324	15.24	11.561	13.398
9.2334	20.333	15.264	11.58	13.43
9.4334	20.409	15.287	11.602	13.452
9.6334	20.362	15.316	11.624	13.481
9.8334	20.409	15.335	11.643	13.503
11.8334	20.588	15.529	11.824	13.712
13.8334	20.729	15.681	11.964	13.874
15.8334	20.786	15.8	12.078	14.004
17.8334	20.936	15.899	12.173	14.108
19.8334	20.955	15.984	12.252	14.194
21.8334	20.993	16.056	12.319	14.27
23.8334	21.087	16.117	12.379	14.333
25.8334	21.172	16.174	12.433	14.39
27.8334	21.219	16.217	12.481	14.444
29.8334	21.219	16.259	12.525	14.488
31.8334	21.247	16.302	12.56	14.529
33.8334	21.304	16.331	12.595	14.564
35.8334	21.285	16.359	12.627	14.596
37.8334	21.341	16.388	12.652	14.621
39.8334	21.351	16.416	12.681	14.653
Q = 40 GPM				
40	21.379	16.421	12.684	14.659
40.0083	21.52	16.421	12.684	14.659

40.0167	21.643	16.425	12.684	14.659
40.025	21.492	16.425	12.684	14.659
40.0417	21.596	16.435	12.684	14.659
40.0583	21.859	16.449	12.684	14.659
40.075	21.982	16.463	12.684	14.659
40.0917	22.076	16.487	12.684	14.659
40.1083	22.321	16.511	12.684	14.659
40.125	22.547	16.544	12.684	14.659
40.1417	22.773	16.582	12.684	14.662
40.1583	22.961	16.62	12.684	14.662
40.175	23.14	16.667	12.687	14.662
40.1917	23.338	16.71	12.684	14.662
40.2083	23.498	16.757	12.684	14.666
40.225	23.667	16.805	12.687	14.666
40.2417	23.865	16.857	12.687	14.666
40.2583	23.997	16.909	12.687	14.669
40.275	24.109	16.966	12.69	14.672
40.2917	24.288	17.023	12.69	14.672
40.3083	24.345	17.08	12.693	14.675
40.325	24.476	17.127	12.693	14.678
40.3417	24.467	17.174	12.696	14.681
40.3583	24.636	17.217	12.7	14.685
40.375	24.712	17.26	12.703	14.688
40.3917	24.693	17.298	12.709	14.691
40.4083	24.731	17.331	12.709	14.694
40.425	24.778	17.359	12.716	14.7
40.4417	24.815	17.388	12.719	14.704
40.4583	24.834	17.416	12.722	14.707
40.475	24.834	17.44	12.728	14.713
40.4917	24.843	17.464	12.731	14.716
40.5083	24.881	17.483	12.738	14.719
40.525	24.909	17.506	12.741	14.729
40.5417	24.891	17.52	12.747	14.732
40.5583	24.928	17.539	12.754	14.735
40.575	24.947	17.558	12.757	14.742
40.5917	24.956	17.573	12.763	14.748
40.6083	25.003	17.592	12.769	14.751
40.625	24.985	17.601	12.773	14.754
40.6417	25.032	17.615	12.779	14.764
40.6583	25.069	17.629	12.785	14.77
40.675	25.107	17.644	12.788	14.773
40.6917	25.098	17.653	12.795	14.777
40.8917	25.606	17.786	12.855	14.843
41.0917	26.104	17.937	12.918	14.913
41.2917	26.405	18.07	12.976	14.979
41.4917	26.659	18.184	13.036	15.052
41.6917	26.913	18.279	13.09	15.115
41.8917	27.082	18.378	13.14	15.182
42.0917	27.289	18.459	13.191	15.245
42.2917	27.562	18.544	13.239	15.305
42.4917	27.778	18.634	13.283	15.366
42.6917	27.909	18.719	13.328	15.426
42.8917	28.088	18.79	13.372	15.48
43.0917	28.295	18.861	13.413	15.533
43.2917	28.426	18.913	13.454	15.587
43.4917	28.52	18.932	13.496	15.641
43.6917	28.614	18.956	13.53	15.685
43.8917	28.737	18.994	13.565	15.73
44.0917	28.887	19.032	13.597	15.774
44.2917	28.972	19.051	13.629	15.812
44.4917	29.037	19.075	13.66	15.853
44.6917	29.122	19.108	13.689	15.888
44.8917	29.178	19.131	13.714	15.923
45.0917	29.291	19.141	13.743	15.958
45.2917	29.31	19.169	13.768	15.989
45.4917	29.338	19.198	13.79	16.021

45.6917	29.441	19.221	13.816	16.05
45.8917	29.47	19.255	13.838	16.078
46.0917	29.545	19.278	13.86	16.107
46.2917	29.611	19.302	13.882	16.129
46.4917	29.639	19.33	13.901	16.154
46.6917	29.695	19.354	13.92	16.179
46.8917	29.723	19.368	13.939	16.205
47.0917	29.742	19.382	13.958	16.227
47.2917	29.78	19.401	13.977	16.249
47.4917	29.789	19.42	13.993	16.271
47.6917	29.827	19.43	14.012	16.29
47.8917	29.892	19.453	14.028	16.309
48.0917	29.958	19.472	14.044	16.328
48.2917	29.939	19.487	14.06	16.347
48.4917	29.968	19.496	14.073	16.363
48.6917	30.024	19.51	14.088	16.382
48.8917	30.08	19.52	14.101	16.398
49.0917	30.099	19.529	14.114	16.414
49.2917	30.127	19.529	14.13	16.43
49.4917	30.071	19.529	14.139	16.445
49.6917	30.184	19.539	14.152	16.455
51.6917	30.353	19.648	14.26	16.582
53.6917	30.475	19.723	14.348	16.683
55.6917	30.616	19.771	14.415	16.762
57.6917	30.672	19.823	14.472	16.825
59.6917	30.747	19.88	14.526	16.886
61.6917	30.813	19.96	14.573	16.936
63.6917	30.851	19.984	14.615	16.981
65.6917	30.898	20.012	14.649	17.019
67.6917	30.907	20.022	14.678	17.047
69.6917	30.991	20.055	14.703	17.076
71.6917	30.963	20.069	14.732	17.104
73.6917	31.038	20.079	14.751	17.126
75.6917	31.085	20.102	14.773	17.148
77.6917	31.132	20.126	14.792	17.17

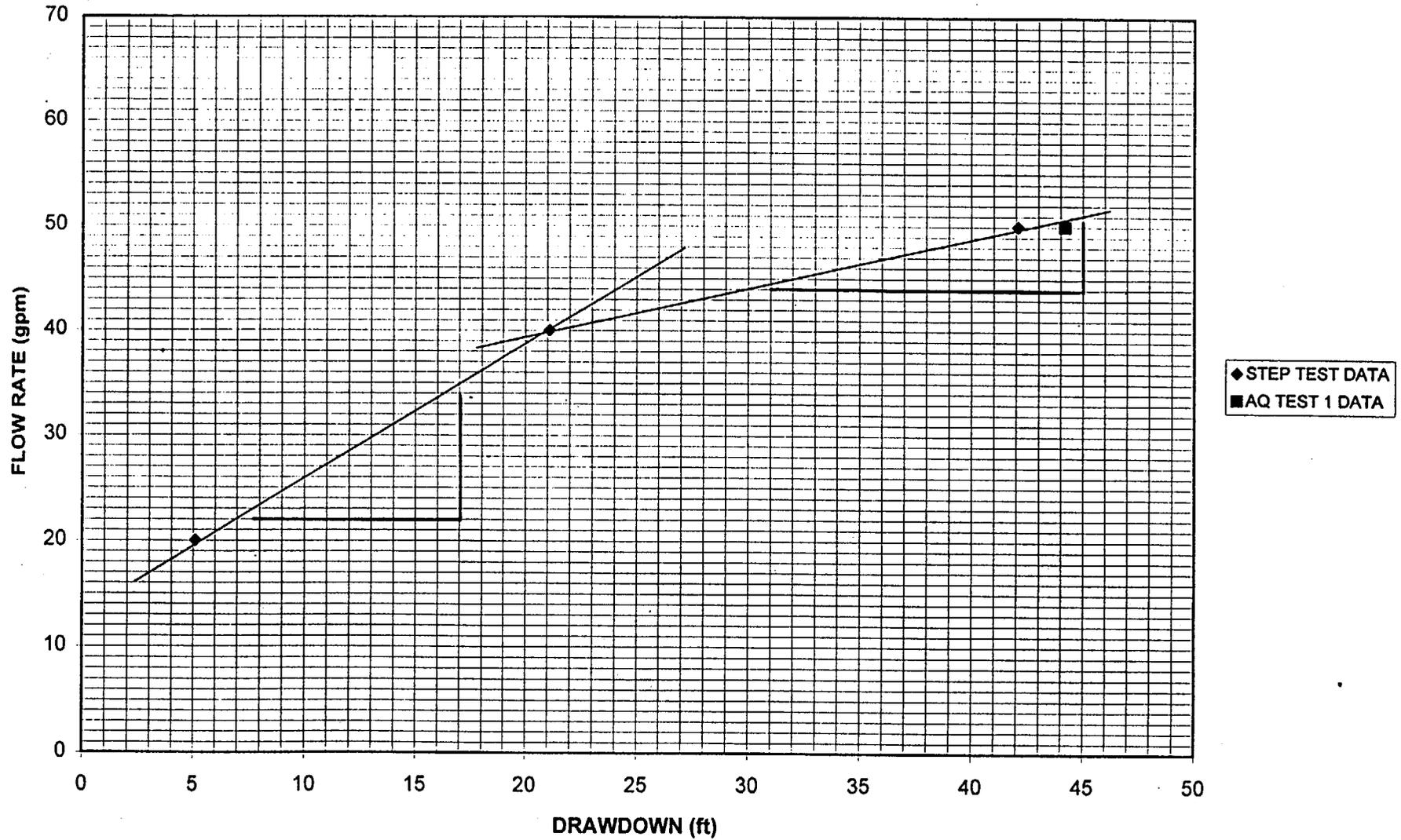
Q = 50 GPM

80	31.358	20.135	14.814	17.193
80.0083	31.386	20.135	14.814	17.193
80.0167	31.442	20.14	14.814	17.193
80.025	31.48	20.14	14.814	17.193
80.0333	31.564	20.145	14.814	17.193
80.0417	31.602	20.15	14.814	17.196
80.05	31.677	20.154	14.814	17.193
80.0583	31.724	20.159	14.814	17.193
80.0667	31.818	20.164	14.814	17.193
80.075	31.977	20.173	14.814	17.193
80.0833	31.987	20.178	14.814	17.193
80.0917	32.1	20.188	14.814	17.193
80.1	32.184	20.197	14.814	17.193
80.1167	32.391	20.216	14.814	17.193
80.1333	32.541	20.24	14.814	17.193
80.15	32.766	20.263	14.814	17.193
80.1667	32.954	20.292	14.814	17.193
80.1833	33.179	20.325	14.814	17.193
80.2	33.414	20.358	14.814	17.196
80.2167	33.592	20.391	14.814	17.196
80.2333	33.845	20.434	14.814	17.199
80.25	33.967	20.472	14.814	17.199
80.2667	34.249	20.514	14.817	17.202
80.2833	34.399	20.557	14.817	17.202
80.3	34.577	20.609	14.821	17.202
80.3167	34.727	20.652	14.821	17.205
80.3333	34.877	20.699	14.824	17.208
80.35	34.953	20.741	14.827	17.212
80.3667	35.084	20.794	14.827	17.215
80.3833	35.196	20.831	14.83	17.218

80.4	35.271	20.874	14.833	17.218
80.4167	35.328	20.912	14.836	17.224
80.4333	35.384	20.945	14.84	17.227
80.45	35.506	20.973	14.843	17.227
80.4667	35.572	21.007	14.849	17.234
80.4833	35.6	21.035	14.852	17.237
80.5	35.665	21.059	14.855	17.24
80.5167	35.787	21.082	14.862	17.243
80.5333	35.853	21.106	14.865	17.25
80.55	35.947	21.125	14.871	17.256
80.5667	36.05	21.144	14.874	17.256
80.5833	36.125	21.163	14.881	17.262
80.6	36.312	21.182	14.884	17.269
80.6167	36.369	21.205	14.89	17.272
80.6333	36.472	21.224	14.893	17.278
80.65	36.584	21.243	14.9	17.281
80.6667	36.678	21.267	14.906	17.288
80.6833	36.8	21.291	14.909	17.294
80.7	36.941	21.329	14.916	17.297
80.7167	37.034	21.366	14.919	17.3
80.7333	37.138	21.409	14.925	17.307
80.75	37.213	21.442	14.932	17.313
80.7667	37.363	21.475	14.938	17.316
80.9667	38.665	21.688	15.004	17.383
81.1667	40.071	21.863	15.077	17.427
81.3667	41.222	22.024	15.15	17.528
81.5667	42.346	22.138	15.223	17.604
81.7667	43.478	22.308	15.293	17.721
81.9667	44.451	22.45	15.363	17.778
82.1667	45.359	22.559	15.432	17.883
82.3667	46.247	22.673	15.499	18.006
82.5667	47.135	22.9	15.562	18.123
82.7667	48.21	22.999	15.626	18.164
82.9667	49.19	23.089	15.689	18.301
83.1667	50.199	23.136	15.749	18.351
83.3667	51.17	23.079	15.806	18.452
83.5667	52.122	23.042	15.863	18.566
83.7667	53.167	23.065	15.911	18.589
83.9667	54.333	23.027	15.958	18.702
84.1667	55.378	23.008	16.003	18.718
84.3667	56.385	23.004	16.044	18.759
84.5667	57.335	22.999	16.085	18.835
84.7667	58.453	22.98	16.123	18.848
84.9667	58.649	22.956	16.161	18.94
85.1667	58.518	22.952	16.193	18.956
85.3667	58.705	22.966	16.221	18.965
85.5667	58.677	22.98	16.243	19
85.7667	58.816	22.985	16.266	19.066
85.9667	58.844	22.994	16.285	19.073
86.1667	58.723	22.999	16.3	19.079
86.3667	58.891	22.999	16.319	19.111
86.5667	59.031	23.004	16.335	19.174
86.7667	58.9	23.098	16.348	19.18
86.9667	59.096	23.16	16.364	19.187
87.1667	59.077	23.24	16.383	19.193
87.3667	59.012	23.382	16.399	19.221
87.5667	59.031	23.448	16.418	19.285
87.7667	59.077	23.515	16.437	19.294
87.9667	59.124	23.515	16.456	19.301
88.1667	59.124	23.467	16.475	19.307
88.3667	59.207	23.42	16.487	19.389
88.5667	59.17	23.392	16.5	19.389
88.7667	59.189	23.354	16.513	19.392
88.9667	59.133	23.335	16.522	19.395
89.1667	59.133	23.321	16.528	19.399
89.3667	58.993	23.292	16.538	19.402

89.5667	58.611	23.273	16.541	19.402
89.7667	57.801	23.297	16.547	19.405
91.7667	55.312	23.311	16.566	19.497
93.7667	54.305	23.264	16.563	19.494
95.7667	52.869	23.217	16.551	19.49
97.7667	52.412	23.146	16.538	19.481
99.7667	51.936	23.363	16.566	19.49
101.7667	52.104	23.306	16.576	19.487
103.7667	52.234	23.25	16.589	19.49
105.7667	52.402	23.226	16.598	19.49
107.7667	52.645	23.183	16.604	19.49
109.7667	52.645	23.207	16.617	19.494
111.7667	52.645	23.306	16.636	19.566
113.7667	52.757	23.231	16.649	19.57
115.7667	52.813	23.212	16.655	19.566
117.7667	52.925	23.179	16.661	19.566
119.7667	53.149	23.15	16.668	19.566
121.7667	53.158	23.15	16.677	19.566
123.7667	53.251	23.169	16.687	19.57
125.7667	53.251	23.169	16.693	19.57
127.7667	53.289	23.212	16.703	19.57
129.7667	53.345	23.212	16.712	19.642
131.7667	53.429	23.198	16.722	19.642
133.7667	53.634	23.113	16.722	19.642
135.7667	53.736	23.103	16.725	19.642
137.7667	53.951	23.103	16.731	19.642
139.7667	53.914	23.108	16.734	19.642
141.7667	53.895	23.094	16.738	19.642
143.7667	53.979	23.094	16.744	19.642
145.7667	54.221	23.089	16.747	19.642
147.7667	54.231	23.079	16.753	19.642
149.7667	54.315	23.075	16.753	19.642
151.7667	54.427	23.098	16.763	19.642
153.7667	54.483	23.103	16.769	19.645
155.7667	54.501	23.188	16.785	19.715
157.7667	54.455	23.169	16.791	19.718
159.7667	54.52	23.179	16.795	19.718
161.7667	54.548	23.193	16.801	19.718
163.7667	54.567	23.183	16.801	19.718
165.7667	54.511	23.165	16.807	19.718
167.7667	54.585	23.155	16.807	19.718
169.7667	54.688	23.16	16.807	19.718
171.7667	54.688	23.179	16.814	19.718
173.7667	54.697	23.174	16.817	19.715
175.7667	54.65	23.15	16.817	19.715
177.7667	54.688	23.136	16.817	19.715
179.7667	54.688	23.127	16.814	19.712
199.7667	56.273	23.202	16.883	19.791
219.7667	57.028	23.046	16.88	19.778
239.7667	56.934	23.16	16.912	19.848

# WELL 044 STEP TEST 1 DATA - SPECIFIC CAPACITY DETERMINATION



LOWER Q:

$$\text{SLOPE} = \frac{13 \text{ GPM}}{10 \text{ FT}} = \underline{\underline{0.17 \text{ FT}^2/\text{MIN}}}$$

HIGHER Q:

$$\text{SLOPE} = \frac{7 \text{ GPM}}{15 \text{ FT}} = \underline{\underline{0.06 \text{ FT}^2/\text{MIN}}}$$

GUNNISON UMTRA SITE  
WELL 044 STEP TEST 1 DATA  
START DATE/TIME: 11/30/99, 1235

Q = 20 GPM	ELAPSED	WELL 044 DTW	WELL 045 DTW	WELL 046 DTW
	TIME (MIN)	FT BTOC	obs045	obs046
	0	9.446	9.392	8.828
	0.0375	10.982	9.404	8.837
	0.075	11.33	9.427	8.845
	0.1125	11.626	9.45	8.856
	0.15	11.952	9.47	8.869
	0.1875	12.187	9.488	8.883
	0.225	12.326	9.503	8.896
	0.2625	12.478	9.521	8.907
	0.3	12.53	9.534	8.92
	0.3375	12.652	9.547	8.931
	0.375	12.704	9.561	8.942
	0.4125	12.765	9.571	8.95
	0.45	12.835	9.581	8.959
	0.4875	12.878	9.592	8.963
	0.525	12.983	9.601	8.979
	0.5645	12.996	9.617	8.988
	0.6063	13.017	9.626	8.99
	0.6507	13.083	9.62	9.001
	0.6977	13.135	9.63	9.012
	0.7475	13.213	9.64	9.02
	0.8002	13.261	9.65	9.029
	0.856	13.313	9.659	9.038
	0.9152	13.387	9.673	9.047
	0.9778	13.448	9.683	9.055
	1.0442	13.509	9.694	9.068
	1.1145	13.543	9.704	9.077
	1.189	13.617	9.716	9.082
	1.268	13.613	9.727	9.097
	1.3517	13.626	9.745	9.103
	1.4402	13.626	9.745	9.114
	1.534	13.683	9.755	9.123
	1.6333	13.735	9.765	9.132
	1.7387	13.739	9.776	9.141
	1.8502	13.852	9.788	9.149
	1.9683	13.878	9.799	9.163
	2.0935	13.848	9.808	9.171
	2.226	13.917	9.819	9.182
	2.3665	13.904	9.829	9.187
	2.5153	13.97	9.841	9.202
	2.6728	13.983	9.854	9.211
	2.8397	13.978	9.864	9.222
	3.0165	13.991	9.874	9.228
	3.2038	13.97	9.884	9.237
	3.4022	13.952	9.892	9.246
	3.6123	14.065	9.905	9.259
	3.835	14.061	9.918	9.27
	4.0708	14.048	9.928	9.278
	4.3207	14.035	9.937	9.281
	4.5853	14.061	9.946	9.294
	4.8657	14.096	9.959	9.303
	5.1625	14.113	9.966	9.309
	5.477	14.1	9.971	9.313
	5.8102	14.148	9.981	9.329
	6.163	14.226	9.989	9.333
	6.5368	14.213	9.996	9.342
	6.9328	14.265	10.007	9.353
	7.3522	14.317	10.02	9.364
	7.7965	14.261	10.027	9.37
	8.2672	14.274	10.033	9.375
	8.7657	14.296	10.04	9.381
	9.2937	14.291	10.046	9.386
	9.853	14.291	10.053	9.392
	10.4455	14.282	10.059	9.399
	11.073	14.33	10.072	9.408
	11.7378	14.291	10.072	9.41

12.442	14.339	10.079	9.41
13.1878	14.391	10.088	9.421
13.9778	14.435	10.093	9.427
14.8147	14.391	10.099	9.432
15.7012	14.4	10.105	9.438
16.6402	14.43	10.114	9.445
17.6348	14.439	10.119	9.451
18.6885	14.435	10.125	9.456
19.8045	14.461	10.126	9.458
20.9867	14.439	10.132	9.458
22.2388	14.469	10.135	9.462
23.5653	14.474	10.139	9.469
24.9703	14.439	10.145	9.471
26.4587	14.482	10.144	9.473
28.0352	14.491	10.152	9.48
29.705	14.491	10.155	9.48
31.4738	14.508	10.157	9.484
33.3475	14.539	10.159	9.484
35.3322	14.513	10.161	9.486
<b>Q = 40 GPM</b>			
40	14.51	10.2	9.52
40.0379	14.524	10.2	9.522
40.0757	14.606	10.2	9.52
40.1135	14.706	10.201	9.524
40.1514	14.793	10.204	9.52
40.1892	15.032	10.207	9.522
40.227	15.219	10.212	9.527
40.2649	15.436	10.218	9.531
40.3027	15.658	10.224	9.531
40.3405	15.901	10.233	9.537
40.3784	16.083	10.24	9.54
40.4162	16.327	10.247	9.542
40.454	16.548	10.256	9.548
40.4919	16.796	10.266	9.559
40.5314	17.069	10.274	9.564
40.5732	17.304	10.284	9.568
40.6175	17.634	10.296	9.577
40.6645	17.986	10.309	9.586
40.7144	18.311	10.323	9.594
40.767	18.689	10.339	9.605
40.8229	18.967	10.353	9.618
40.882	19.353	10.378	9.636
40.9447	19.809	10.396	9.653
41.011	20.169	10.416	9.671
41.0814	20.542	10.439	9.691
41.1559	20.941	10.459	9.706
41.2349	21.366	10.485	9.726
41.3185	21.765	10.508	9.747
41.407	22.108	10.535	9.767
41.5009	22.515	10.56	9.789
41.6002	22.849	10.587	9.815
41.7055	23.166	10.613	9.837
41.817	23.478	10.64	9.863
41.9352	23.811	10.666	9.885
42.0604	24.123	10.693	9.907
42.1929	24.431	10.718	9.931
42.3334	24.713	10.745	9.957
42.4822	25.042	10.768	9.984
42.6397	25.328	10.795	10.006
42.8065	25.605	10.824	10.032
42.9834	25.87	10.848	10.054
43.1707	26.086	10.874	10.078
43.369	26.285	10.9	10.102
43.5792	26.511	10.926	10.128
43.8019	26.679	10.947	10.148
44.0377	26.874	10.973	10.167
44.2875	27.065	10.996	10.196
44.5522	27.203	11.016	10.211
44.8325	27.338	11.038	10.231
45.1294	27.437	11.059	10.251
45.4439	27.61	11.078	10.27
45.777	27.719	11.098	10.292
46.1299	27.857	11.115	10.31

46.5037	27.978	11.135	10.323
46.8997	28.156	11.154	10.345
47.319	28.32	11.171	10.36
47.7634	28.411	11.188	10.375
48.234	28.472	11.204	10.388
48.7325	28.589	11.22	10.401
49.2605	28.684	11.233	10.412
49.8199	28.77	11.246	10.428
50.4124	28.762	11.26	10.441
51.0399	28.961	11.272	10.452
51.7047	29.091	11.286	10.463
52.4089	29.177	11.3	10.476
53.1547	29.238	11.312	10.482
53.9447	29.329	11.323	10.489
54.7815	29.359	11.333	10.5
55.668	29.432	11.348	10.513
56.607	29.493	11.358	10.522
57.6017	29.567	11.368	10.531
58.6554	29.666	11.378	10.539
59.7714	29.709	11.382	10.548
60.9535	29.804	11.391	10.552
62.2057	29.8	11.396	10.559
63.5322	29.843	11.401	10.561
64.9372	29.882	11.405	10.568
66.4255	30.129	11.416	10.576
68.002	30.155	11.428	10.585
69.6719	30.272	11.439	10.596
71.4407	30.324	11.447	10.603
73.3144	30.38	11.454	10.614
75.299	30.384	11.46	10.616
77.4014	30.44	11.465	10.625
79.6282	30.436	11.468	10.627
81.987	30.479	11.471	10.627
84.4857	30.501	11.475	10.629

Q = 55 GPM

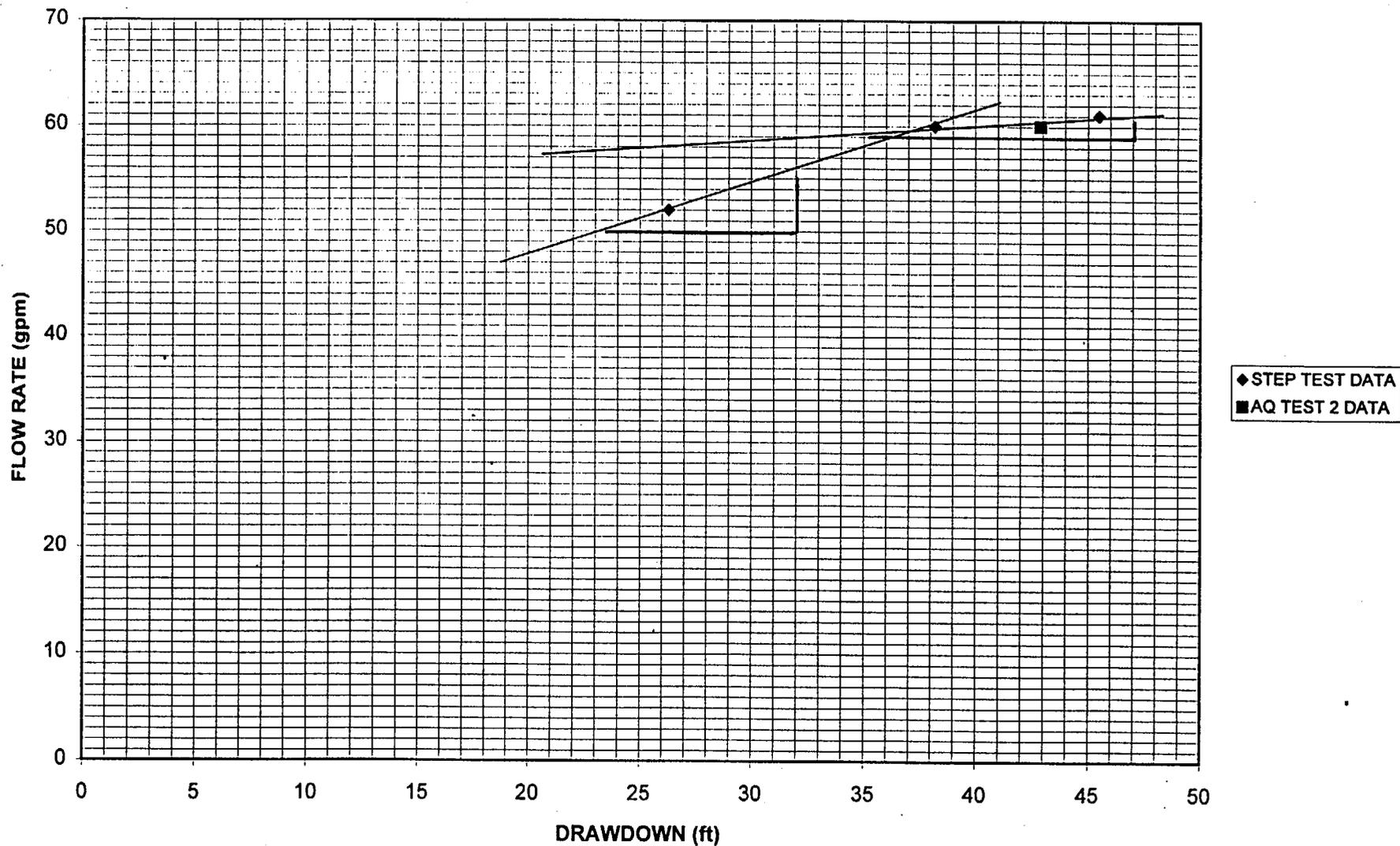
95	30.65	11.491	10.644
95.0378	30.875	11.491	10.642
95.0756	31.117	11.493	10.642
95.1135	31.377	11.494	10.644
95.1513	31.735	11.499	10.644
95.1891	32.025	11.503	10.647
95.227	32.341	11.507	10.649
95.2648	32.678	11.516	10.651
95.3026	33.037	11.523	10.657
95.3405	33.339	11.532	10.66
95.3783	33.577	11.54	10.671
95.4161	33.776	11.55	10.673
95.454	33.949	11.56	10.679
95.4918	34.229	11.57	10.686
95.5296	34.471	11.579	10.695
95.5675	34.713	11.589	10.701
95.607	35.007	11.599	10.71
95.6488	35.219	11.609	10.717
95.6931	35.4	11.622	10.725
95.7401	35.612	11.633	10.734
95.79	35.828	11.645	10.743
95.8426	36.013	11.658	10.754
95.8985	36.221	11.671	10.762
95.9576	36.519	11.687	10.778
96.0203	36.747	11.701	10.793
96.0866	36.998	11.717	10.802
96.157	37.158	11.731	10.813
96.2315	37.309	11.745	10.826
96.3105	37.563	11.76	10.841
96.3941	37.749	11.774	10.857
96.4826	38.021	11.787	10.865
96.5765	38.228	11.803	10.878
96.6758	38.513	11.819	10.889
96.7811	38.616	11.834	10.907
96.8926	38.802	11.85	10.924
97.0108	39.026	11.866	10.937
97.136	39.259	11.88	10.948
97.2685	39.609	11.896	10.961

97.409	39.919	11.915	10.977
97.5578	40.23	11.932	10.992
97.7153	40.575	11.951	11.01
97.8821	41.019	11.974	11.027
98.059	41.459	11.994	11.045
98.2463	42.015	12.017	11.062
98.4446	42.571	12.041	11.084
98.6548	43.122	12.062	11.106
98.8775	43.613	12.083	11.125
99.1133	44.096	12.101	11.147
99.3631	44.639	12.121	11.167
99.6278	45.074	12.137	11.185
99.9081	45.56	12.151	11.202
100.205	46.146	12.167	11.222
100.5195	46.628	12.182	11.239
100.8526	47.041	12.197	11.255
101.2055	47.51	12.212	11.27
101.5793	47.975	12.225	11.283
101.9753	48.315	12.239	11.3
102.3946	48.668	12.249	11.311
102.839	49.253	12.259	11.324
103.3096	49.842	12.268	11.333
103.8081	50.293	12.276	11.342
104.3361	50.865	12.285	11.357
104.8955	51.45	12.293	11.364
105.488	52.116	12.303	11.375
106.1155	53.061	12.311	11.381
106.7803	54.152	12.319	11.39
107.4845	54.981	12.339	11.399
108.2303	56.088	12.348	11.403
109.0203	56.93	12.352	11.408
109.8571	57.796	12.357	11.416

Q = 50 GPM

110.7436	55.573	12.359	11.414
111.6826	53.843	12.358	11.405
112.6773	52.782	12.352	11.401
113.731	52.228	12.348	11.399
114.847	51.755	12.349	11.397
116.0291	51.347	12.344	11.39
117.2813	51.076	12.336	11.386
118.6078	51.024	12.332	11.381
120.0128	50.968	12.331	11.384
121.5011	51.007	12.326	11.375
123.0776	51.016	12.326	11.377
124.7475	51.033	12.326	11.377
126.5163	51.123	12.324	11.373
128.39	51.14	12.325	11.377
130.3746	51.402	12.305	11.37
132.477	51.493	12.306	11.368
134.7038	51.51	12.305	11.368
137.0626	51.48	12.308	11.37
139.5613	51.312	12.309	11.37
142.208	51.385	12.308	11.368
145.0115	51.415	12.311	11.373
147.9811	51.402	12.311	11.37
151.1268	51.381	12.314	11.375
154.4588	51.42	12.312	11.375
157.9883	51.467	12.311	11.375
161.7268	51.458	12.315	11.377
165.687	51.519	12.314	11.377
169.8818	51.463	12.314	11.375
174.3251	51.467	12.312	11.373
179.0318	51.587	12.316	11.37

## WELL 044 STEP TEST 2 DATA - SPECIFIC CAPACITY DETERMINATION



LOWER Q:

$$\text{SLOPE} = \frac{6 \text{ GPM}}{9 \text{ FT}} = \underline{0.09 \text{ FT}^2/\text{MIN}}$$

HIGHER Q:

$$\text{SLOPE} = \frac{24 \text{ GPM}}{14 \text{ FT}} = 0.02 \text{ FT}^2/\text{MIN}$$

GUNNISON UMTRA SITE  
WELL 044 STEP TEST 2 DATA  
START DATE/TIME : 12/7/99, 1115

Q = 52 GPM	<u>ELPASED TIME (MIN)</u>	<u>WELL 044 DRAWDOWN</u>
	0	0
	0.0375	1.184
	0.075	2.593
	0.1125	3.797
	0.15	4.662
	0.1875	4.819
	0.225	4.814
	0.2625	4.945
	0.3	4.993
	0.3375	5.175
	0.375	5.358
	0.4125	5.875
	0.45	6.644
	0.4875	7.582
	0.525	8.428
	0.5645	9.114
	0.6063	9.526
	0.6507	9.874
	0.6977	10.047
	0.7475	10.386
	0.8002	10.776
	0.856	10.936
	0.9152	11.427
	0.9778	11.93
	1.0442	12.411
	1.1145	12.918
	1.189	13.443
	1.268	13.907
	1.3517	14.344
	1.4402	14.752
	1.534	15.155
	1.6333	15.467
	1.7387	15.887
	1.8502	16.298
	1.9683	16.653
	2.0935	17.039
	2.226	17.433
	2.3665	17.788
	2.5153	18.112
	2.6728	18.441
	2.8397	18.731
	3.0165	19.043
	3.2038	19.333
	3.4022	19.601
	3.6123	19.848
	3.835	20.181
	4.0708	20.505
	4.3207	20.799
	4.5853	21.085
	4.8657	21.288
	5.1625	21.591
	5.477	21.729
	5.8102	21.906
	6.163	22.14
	6.5368	22.33
	6.9328	22.512
	7.3522	22.667
	7.7965	22.827
	8.2672	23.017
	8.7657	23.212
	9.2937	23.372
	9.853	23.454

10.4455	23.588
11.073	23.683
11.7378	23.795
12.442	23.96
13.1878	24.042
13.9778	24.119
14.8147	24.236
15.7012	24.327
16.6402	24.435
17.6348	24.582
18.6885	24.798
19.8045	24.975
20.9867	25.122
22.2388	25.096
23.5653	25.135
24.9703	25.281
26.4587	25.368
28.0352	25.437
29.705	25.394
31.4738	25.536
33.3475	25.644
35.3322	25.675
37.4345	25.683
39.6613	25.774
42.0202	25.873
44.5188	25.903
47.1655	25.813
49.969	25.934
52.9387	25.985
56.0843	26.02
59.4163	25.985
62.9458	26.145
66.6843	26.257

Q = 60 GPM

75	26.184
75.0376	26.313
75.0753	26.529
75.113	26.749
75.1506	26.987
75.1883	27.168
75.226	27.298
75.2636	27.384
75.3013	27.526
75.339	27.613
75.3766	27.703
75.4143	27.79
75.452	27.893
75.4896	27.923
75.5291	28.001
75.571	28.062
75.6153	28.113
75.6623	28.148
75.7121	28.251
75.7648	28.359
75.8206	28.428
75.8798	28.571
75.9425	28.631
76.0088	28.756
76.0791	28.83
76.1536	28.929
76.2326	28.933
76.3163	28.985
76.4048	29.097
76.4986	29.196
76.598	29.334
76.7033	29.438
76.8148	29.602
76.933	29.761
77.0581	29.912
77.1906	30.089

77.3311	30.18
77.48	30.43
77.6375	30.538
77.8043	30.736
77.9811	30.878
78.1685	31.051
78.3668	31.262
78.577	31.417
78.7996	31.637
79.0355	31.814
79.2853	32.038
79.55	32.262
79.8303	32.508
80.1271	32.685
80.4416	32.896
80.7748	33.064
81.1276	33.206
81.5015	33.374
81.8975	33.538
82.3168	33.688
82.7611	33.805
83.2318	33.93
83.7303	34.089
84.2583	34.201
84.8176	34.3
85.4101	34.369
86.0376	34.503
86.7025	34.593
87.4066	34.744
88.1525	34.795
88.9425	34.899
89.7793	34.752
90.6658	34.472
91.6048	34.826
92.5995	35.368
93.6531	35.769
94.7691	36.027
95.9513	36.427
97.2035	36.552
98.53	36.948
99.935	37.107
101.4233	37.387
102.9998	37.482
104.6696	37.602
106.4385	37.718
108.3121	37.882
110.2968	38.007
112.3991	38.153
114.626	38.127
116.9848	38.11
119.4835	38.024
122.1301	38.144
124.9336	38.243

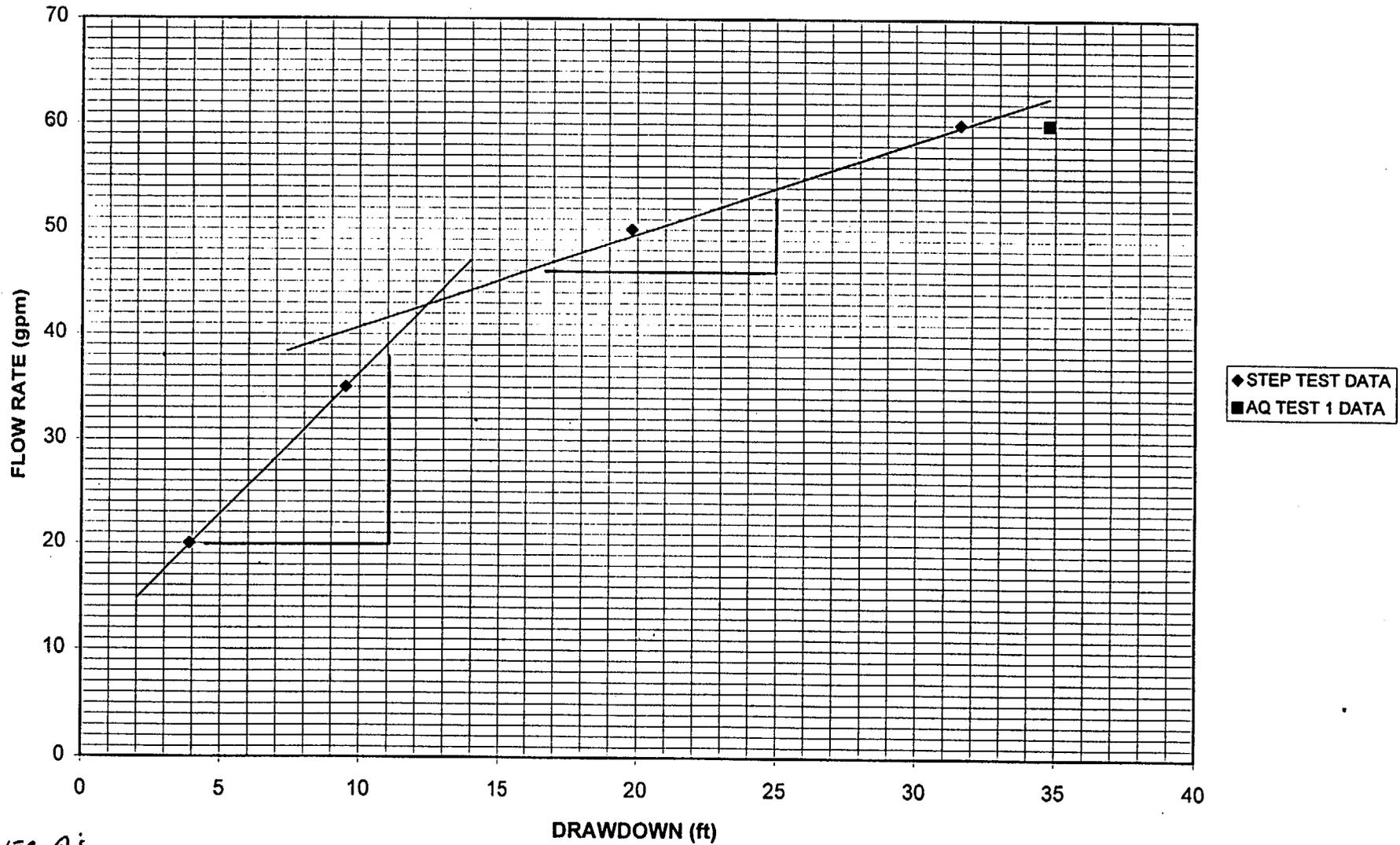
Q = 65 GPM

135	38.551
135.0217	38.65
135.0434	38.659
135.065	38.728
135.0867	38.81
135.1084	38.874
135.13	38.913
135.1522	38.96
135.1757	39.072
135.2005	39.214
135.2269	39.287
135.2549	39.3
135.2845	39.468
135.3159	39.498
135.349	39.597
135.3842	39.734

135.4215	39.889
135.461	39.945
135.5029	40.246
135.5472	40.435
135.5942	40.603
135.644	40.809
135.6967	40.891
135.7525	41.119
135.8117	41.183
135.8744	41.381
135.9407	41.553
136.011	41.815
136.0855	41.97
136.1645	42.348
136.2482	42.558
136.3367	42.756
136.4305	42.984
136.5299	43.267
136.6352	43.521
136.7467	43.774
136.8649	44.083
136.99	44.457
137.1225	44.659
137.263	44.873
137.4119	45.105
137.5694	45.191
137.7362	45.676
137.913	45.981
138.1004	46.311
138.2987	46.672
138.5089	47.028
138.7315	47.139
138.9674	47.2
139.2172	47.423
139.4819	47.363
139.7622	47.277
140.059	47.2
140.3735	46.234
140.7067	46.38
141.0595	46.74
141.4334	46.822
141.8294	46.715
142.2487	47.045
142.693	47.122
143.1637	41.798
143.6622	42.734
144.1902	43.748
144.7495	44.706
145.342	44.852
145.9695	45.225
146.6344	45.556
147.3385	45.685
148.0844	45.62
148.8744	45.676
149.7112	45.582
150.5977	45.655
151.5367	45.659
152.5314	45.646
153.585	45.637
154.701	45.629
155.8832	45.616
157.1354	45.599
158.4619	45.607
159.8669	45.62
161.3552	45.616
162.9317	45.56
164.6015	45.534
166.3704	45.612
168.244	45.517

Q = 61 GPM

# WELL 047 STEP TEST DATA - SPECIFIC CAPACITY DETERMINATION



LOWER Q's →

$$\text{SLOPE} = \frac{19 \text{ GPM}}{7 \text{ FT}} = \underline{0.36 \text{ FT}^2/\text{MIN}}$$

HIGHER Q's

$$\text{SLOPE} = \frac{8 \text{ GPM}}{9 \text{ FT}} = \underline{0.12 \text{ FT}^2/\text{MIN}}$$

GUNNISON UMTRA SITE  
WELL 047 STEP TEST DATA  
START DATE/ TIME: 11/20/99, 1020

Q = 20 GPM	ELAPSED	WELL 047 DTW	WELL 048 DTW	WELL 049 DTW
	TIME (MIN)	FT BTOC	FT BTOC	FT BTOC
	0	0	0	0
	0.0084	0.266	0.012	0.004
	0.0167	0.19	0.025	0.009
	0.025	0.228	0.018	0.004
	0.0334	0.389	0.037	0.009
	0.0417	0.589	0.05	0.009
	0.05	0.712	0.069	0.019
	0.0584	0.769	0.081	0.023
	0.0667	0.912	0.1	0.028
	0.075	1.054	0.113	0.033
	0.0834	1.121	0.132	0.043
	0.0917	1.292	0.157	0.052
	0.1	1.244	0.17	0.057
	0.1084	1.444	0.195	0.062
	0.1167	1.482	0.214	0.071
	0.125	1.605	0.233	0.081
	0.1334	1.71	0.251	0.09
	0.1417	1.767	0.27	0.095
	0.15	1.776	0.283	0.105
	0.1584	1.909	0.296	0.114
	0.1667	1.871	0.314	0.119
	0.175	1.909	0.327	0.129
	0.1834	2.004	0.346	0.134
	0.1917	2.013	0.359	0.143
	0.2	2.099	0.371	0.148
	0.2084	2.184	0.384	0.157
	0.2167	2.241	0.396	0.167
	0.225	2.336	0.409	0.172
	0.2334	2.384	0.422	0.177
	0.2417	2.336	0.434	0.181
	0.25	2.384	0.447	0.191
	0.2584	2.526	0.453	0.196
	0.2667	2.517	0.466	0.201
	0.275	2.536	0.478	0.21
	0.2834	2.631	0.484	0.215
	0.2917	2.688	0.491	0.224
	0.3084	2.602	0.51	0.234
	0.325	2.688	0.529	0.248
	0.3417	2.697	0.547	0.263
	0.3584	2.792	0.56	0.272
	0.375	2.877	0.573	0.287
	0.3917	2.972	0.585	0.291
	0.4084	2.925	0.598	0.301
	0.425	3.058	0.617	0.315
	0.4417	3.058	0.629	0.325
	0.4584	3.191	0.636	0.335
	0.475	3.153	0.655	0.344
	0.4917	3.191	0.661	0.354
	0.5084	3.162	0.673	0.363
	0.525	3.21	0.68	0.373
	0.5417	3.181	0.692	0.378
	0.5584	3.286	0.699	0.387
	0.575	3.504	0.705	0.392
	0.5917	3.352	0.718	0.402
	0.6084	3.276	0.718	0.411
	0.625	3.314	0.73	0.416

0.6417	3.314	0.736	0.425
0.6584	3.38	0.736	0.43
0.675	3.38	0.743	0.435
0.6917	3.333	0.749	0.44
0.7084	3.342	0.749	0.445
0.725	3.371	0.755	0.454
0.7417	3.342	0.762	0.459
0.7584	3.418	0.768	0.459
0.775	3.342	0.768	0.469
0.7917	3.466	0.774	0.473
0.8084	3.39	0.774	0.478
0.825	3.418	0.78	0.478
0.8417	3.513	0.787	0.483
0.8584	3.504	0.787	0.492
0.875	3.665	0.799	0.497
0.8917	3.57	0.799	0.502
0.9084	3.589	0.806	0.507
0.925	3.618	0.812	0.512
0.9417	3.646	0.818	0.516
0.9584	3.675	0.825	0.516
1.1584	3.428	0.856	0.564
1.3584	3.513	0.856	0.583
1.5584	3.551	0.869	0.603
1.7584	3.656	0.9	0.626
1.9584	3.817	0.932	0.655
2.1584	3.789	0.957	0.679
2.3584	3.931	0.969	0.698
2.5584	3.845	0.982	0.717
2.7584	3.741	0.988	0.727
2.9584	3.741	0.988	0.732
3.1584	3.713	0.988	0.741
3.3584	3.713	0.995	0.746
3.5584	3.684	0.995	0.751
3.7584	3.713	1.001	0.756
3.9584	3.703	1.007	0.765
4.1584	3.722	1.007	0.77
4.3584	3.656	1.007	0.77
4.5584	3.703	1.014	0.775
4.7584	3.751	1.014	0.78
4.9584	3.855	1.02	0.784
5.1584	3.779	1.026	0.784
5.3584	3.798	1.026	0.789
5.5584	3.732	1.032	0.799
5.7584	3.713	1.039	0.804
5.9584	3.703	1.039	0.804
6.1584	3.76	1.045	0.813
6.3584	3.76	1.007	0.813
6.5584	3.789	1.058	0.818
6.7584	3.789	1.051	0.823
6.9584	3.741	1.058	0.827
7.1584	3.76	1.064	0.827
7.3584	3.751	1.064	0.837
7.5584	3.826	1.07	0.837
7.7584	3.779	1.07	0.842
7.9584	3.77	1.07	0.842
8.1584	3.77	1.076	0.842
8.3584	3.836	1.076	0.847
8.5584	3.845	1.083	0.847
8.7584	3.836	1.083	0.851
8.9584	3.931	1.089	0.851
9.1584	3.845	1.089	0.856
9.3584	3.789	1.089	0.856
9.5584	3.883	1.095	0.861
9.7584	3.893	1.095	0.866

9.9584	3.779	1.095	0.866
11.9584	3.874	1.108	0.88
13.9584	3.826	1.121	0.89
15.9584	3.912	1.127	0.904
17.9584	3.902	1.139	0.909
19.9584	3.845	1.152	0.918
21.9584	3.864	1.146	0.914
23.9584	3.893	1.146	0.918
25.9584	3.836	1.152	0.923
27.9584	3.883	1.152	0.923
29.9584	3.95	1.158	0.928
31.9584	3.931	1.158	0.933
33.9584	3.912	1.165	0.938
35.9584	3.931	1.165	0.942
37.9584	3.883	1.171	0.942
Q = 35 GPM			
40	0	0.008	-0.001
40.0083	0.152	0.065	0.009
40.0167	0.304	-0.048	0.009
40.025	0.608	0.052	0.004
40.0333	0.674	0.065	0.013
40.0417	0.788	0.071	0.018
40.05	0.665	0.078	0.023
40.0583	0.845	0.084	0.028
40.0667	0.703	0.103	0.033
40.075	0.969	0.115	0.037
40.0833	1.102	0.134	0.042
40.0917	1.149	0.147	0.052
40.1	1.168	0.166	0.061
40.1167	1.073	0.191	0.071
40.1333	1.358	0.216	0.085
40.15	1.387	0.235	0.095
40.1667	1.501	0.26	0.104
40.1833	1.596	0.279	0.119
40.2	1.71	0.298	0.128
40.2167	1.795	0.317	0.143
40.2333	1.9	0.342	0.152
40.25	2.004	0.361	0.162
40.2667	2.032	0.38	0.176
40.2833	2.175	0.399	0.186
40.3	2.308	0.418	0.195
40.3167	2.384	0.437	0.21
40.3333	2.479	0.462	0.219
40.35	2.735	0.481	0.229
40.3667	2.697	0.5	0.248
40.3833	2.953	0.525	0.258
40.4	2.982	0.544	0.272
40.4167	3.181	0.563	0.281
40.4333	3.361	0.582	0.296
40.45	3.466	0.607	0.305
40.4667	3.475	0.626	0.32
40.4833	3.703	0.651	0.329
40.5	3.94	0.67	0.344
40.5167	3.883	0.689	0.358
40.5333	4.016	0.714	0.372
40.55	4.13	0.733	0.382
40.5667	4.263	0.752	0.396
40.5833	4.377	0.77	0.406
40.6	4.51	0.789	0.425
40.6167	4.652	0.808	0.435
40.6333	4.538	0.821	0.449
40.65	4.785	0.84	0.459
40.6667	4.813	0.852	0.473
40.6833	4.87	0.871	0.482

40.7	4.861	0.884	0.492
40.7167	4.993	0.896	0.506
40.7333	5.012	0.909	0.516
40.75	5.174	0.922	0.526
40.7667	5.174	0.934	0.535
40.9667	5.819	1.06	0.65
41.1667	6.113	1.161	0.741
41.3667	6.52	1.243	0.817
41.5667	6.833	1.306	0.884
41.7667	7.08	1.362	0.937
41.9667	7.184	1.407	0.985
42.1667	7.629	1.438	1.028
42.3667	7.601	1.476	1.066
42.5667	7.715	1.507	1.1
42.7667	7.772	1.526	1.129
42.9667	7.819	1.545	1.152
43.1667	8.113	1.57	1.176
43.3667	8.009	1.589	1.205
43.5667	8.151	1.608	1.219
43.7667	8.217	1.621	1.234
43.9667	8.198	1.64	1.258
44.1667	8.17	1.652	1.272
44.3667	8.35	1.665	1.291
44.5667	8.388	1.677	1.306
44.7667	8.331	1.69	1.315
44.9667	8.445	1.702	1.325
45.1667	8.558	1.709	1.339
45.3667	8.539	1.709	1.344
45.5667	8.482	1.728	1.353
45.7667	8.501	1.734	1.363
45.9667	8.596	1.74	1.373
46.1667	8.397	1.753	1.387
46.3667	8.606	1.759	1.382
46.5667	8.577	1.765	1.396
46.7667	8.681	1.772	1.406
46.9667	8.596	1.778	1.411
47.1667	8.719	1.784	1.42
47.3667	8.691	1.791	1.425
47.5667	8.909	1.797	1.435
47.7667	8.691	1.797	1.435
47.9667	8.719	1.81	1.444
48.1667	8.7	1.81	1.449
48.3667	8.786	1.816	1.454
48.5667	8.899	1.822	1.459
48.7667	8.748	1.828	1.463
48.9667	8.719	1.835	1.478
49.1667	8.805	1.841	1.478
49.3667	8.861	1.841	1.483
49.5667	8.824	1.847	1.492
49.7667	8.909	1.854	1.492
51.7667	8.871	1.866	1.507
53.7667	9.013	1.891	1.526
55.7667	8.994	1.917	1.554
57.7667	9.108	1.929	1.564
59.7667	9.202	1.942	1.578
61.7667	9.269	1.954	1.588
63.7667	9.174	1.967	1.602
65.7667	9.24	1.973	1.612
67.7667	9.392	1.98	1.617
69.7667	9.411	1.986	1.626
71.7667	9.477	1.992	1.626
73.7667	9.345	1.998	1.636
75.7667	9.345	1.998	1.641
77.7667	9.411	2.005	1.641

Q = 50 GPM	79.7667	9.392	2.011	1.645
80	9.505	2.027	1.66	
80.0083	9.676	2.027	1.66	
80.025	9.552	2.027	1.66	
80.0416	9.761	2.034	1.66	
80.0583	9.837	2.04	1.66	
80.075	9.884	2.04	1.665	
80.0916	9.979	2.052	1.665	
80.1083	10.083	2.052	1.665	
80.125	10.206	2.059	1.67	
80.1416	10.31	2.065	1.67	
80.1583	10.433	2.078	1.67	
80.175	10.452	2.084	1.679	
80.1916	10.67	2.09	1.679	
80.2083	10.736	2.103	1.684	
80.225	10.85	2.115	1.689	
80.2416	10.888	2.122	1.694	
80.2583	11.03	2.134	1.694	
80.275	11.162	2.141	1.698	
80.2916	11.162	2.153	1.703	
80.3083	11.304	2.166	1.708	
80.325	11.465	2.172	1.713	
80.3416	11.57	2.185	1.718	
80.3583	11.683	2.204	1.722	
80.375	11.778	2.21	1.732	
80.3916	11.835	2.222	1.737	
80.4083	11.901	2.229	1.741	
80.425	11.948	2.241	1.746	
80.4416	12.005	2.254	1.751	
80.4583	12.071	2.26	1.756	
80.475	12.185	2.273	1.761	
80.4916	12.213	2.285	1.765	
80.5083	12.355	2.292	1.775	
80.525	12.384	2.304	1.78	
80.5416	12.45	2.311	1.784	
80.5583	12.488	2.317	1.789	
80.575	12.573	2.323	1.794	
80.5916	12.601	2.336	1.799	
80.6083	12.667	2.342	1.808	
80.625	12.686	2.348	1.808	
80.6416	12.743	2.355	1.818	
80.6583	12.79	2.367	1.823	
80.675	12.847	2.374	1.823	
80.875	13.424	2.443	1.88	
81.075	13.869	2.493	1.928	
81.275	14.266	2.531	1.962	
81.475	14.597	2.569	1.995	
81.675	14.891	2.594	2.019	
81.875	15.193	2.619	2.043	
82.075	15.534	2.644	2.057	
82.275	15.751	2.663	2.081	
82.475	15.997	2.688	2.096	
82.675	16.224	2.707	2.11	
82.875	16.356	2.726	2.124	
83.075	16.545	2.739	2.139	
83.275	16.696	2.758	2.148	
83.475	16.867	2.77	2.162	
83.675	16.961	2.783	2.167	
83.875	17.131	2.795	2.177	
84.075	17.301	2.808	2.186	
84.275	17.415	2.814	2.191	
84.475	17.5	2.833	2.206	
84.675	17.604	2.839	2.21	

84.875	17.755	2.846	2.22
85.075	17.793	2.852	2.225
85.275	17.897	2.858	2.229
85.475	17.953	2.871	2.234
85.675	18.086	2.877	2.229
85.875	18.133	2.883	2.239
86.075	18.218	2.89	2.249
86.275	18.246	2.896	2.253
86.475	18.293	2.896	2.258
86.675	18.35	2.902	2.263
86.875	18.416	2.909	2.263
87.075	18.511	2.909	2.273
87.275	18.567	2.915	2.273
87.475	18.615	2.921	2.273
87.675	18.633	2.921	2.282
87.875	18.681	2.928	2.282
88.075	18.766	2.934	2.287
88.275	18.813	2.934	2.287
88.475	18.851	2.94	2.292
88.675	18.879	2.946	2.292
88.875	18.945	2.946	2.296
89.075	18.983	2.953	2.301
89.275	19.021	2.953	2.301
89.475	19.049	2.959	2.301
89.675	19.087	2.959	2.306
91.675	19.332	2.978	2.311
93.675	19.531	2.997	2.335
95.675	19.691	2.997	2.335
97.675	19.757	2.997	2.344
99.675	19.738	2.99	2.34
101.675	19.757	2.99	2.335
103.675	19.786	2.997	2.344
105.675	19.795	2.997	2.344
107.675	19.795	2.99	2.34
109.675	19.805	2.997	2.344
111.675	19.805	2.997	2.344
113.675	19.805	2.997	2.344
115.675	19.805	2.997	2.344
117.675	19.805	2.997	2.344
119.675	19.805	2.997	2.344

Q = 60 GPM

120	1.206	0.493	0.373
120.0083	1.415	0.499	0.373
120.0166	1.719	0.524	0.378
120.025	2.108	0.556	0.382
120.0333	2.307	0.581	0.397
120.0416	3.162	0.625	0.406
120.05	3.37	0.656	0.416
120.0583	3.589	0.675	0.43
120.0666	3.779	0.694	0.44
120.075	3.959	0.719	0.454
120.0833	4.206	0.745	0.464
120.0916	4.538	0.77	0.478
120.1	4.67	0.789	0.488
120.1083	4.87	0.82	0.502
120.1166	5.116	0.839	0.512
120.125	5.344	0.864	0.521
120.1333	5.505	0.883	0.536
120.1416	5.685	0.908	0.545
120.15	5.799	0.927	0.559
120.1583	5.97	0.946	0.569
120.1666	6.15	0.965	0.579
120.175	6.34	0.99	0.588
120.1833	6.567	1.009	0.603

120.1916	6.766	1.022	0.612
120.2	6.814	1.041	0.626
120.2083	7.051	1.059	0.636
120.225	7.42	1.097	0.655
120.2416	7.601	1.129	0.679
120.2583	8.018	1.166	0.698
120.275	8.254	1.198	0.722
120.2916	8.539	1.229	0.741
120.3083	8.889	1.261	0.756
120.325	9.098	1.299	0.78
120.3416	9.41	1.33	0.799
120.3583	9.714	1.362	0.818
120.375	9.969	1.387	0.837
120.3916	10.244	1.418	0.856
120.4083	10.376	1.444	0.875
120.425	10.642	1.475	0.89
120.4416	10.897	1.507	0.914
120.4583	11.162	1.532	0.933
120.475	11.399	1.557	0.952
120.4916	11.607	1.588	0.966
120.5083	11.835	1.614	0.985
120.525	11.995	1.639	1.005
120.5416	12.251	1.664	1.024
120.5583	12.469	1.689	1.038
120.575	12.724	1.714	1.057
120.5916	12.828	1.74	1.072
120.6083	13.046	1.758	1.086
120.625	13.273	1.784	1.105
120.6416	13.434	1.802	1.119
120.6583	13.585	1.828	1.139
120.675	13.831	1.847	1.153
120.6916	13.945	1.872	1.172
120.7083	14.172	1.891	1.186
120.725	14.295	1.91	1.201
120.7416	14.475	1.928	1.215
120.7583	14.626	1.947	1.229
120.775	14.806	1.966	1.244
120.7916	14.938	1.991	1.258
120.8083	15.118	2.01	1.273
120.825	15.259	2.023	1.287
120.8416	15.43	2.048	1.301
120.8583	15.543	2.067	1.311
120.875	15.694	2.08	1.325
121.075	17.178	2.275	1.469
121.275	18.416	2.426	1.598
121.475	19.446	2.558	1.708
121.675	20.305	2.671	1.799
121.875	21.051	2.772	1.885
122.075	21.589	2.854	1.962
122.275	22.164	2.929	2.024
122.475	22.589	2.992	2.081
122.675	23.042	3.049	2.134
122.875	23.419	3.099	2.177
123.075	23.768	3.143	2.22
123.275	24.051	3.187	2.258
123.475	24.353	3.219	2.287
123.675	24.598	3.257	2.32
123.875	24.834	3.282	2.349
124.075	25.06	3.313	2.378
124.275	25.267	3.332	2.402
124.475	25.437	3.357	2.426
124.675	25.616	3.376	2.45
124.875	25.795	3.395	2.469
125.075	25.908	3.414	2.483

125.275	26.021	3.433	2.502
125.475	26.182	3.446	2.517
125.675	26.332	3.464	2.531
125.875	26.427	3.477	2.545
126.075	26.54	3.49	2.555
126.275	26.672	3.502	2.569
126.475	26.794	3.521	2.584
126.675	26.869	3.534	2.588
126.875	26.954	3.534	2.598
127.075	27.067	3.546	2.603
127.275	27.18	3.553	2.603
127.475	27.256	3.559	2.612
127.675	27.359	3.571	2.617
127.875	27.435	3.584	2.631
128.075	27.548	3.59	2.646
128.275	27.623	3.603	2.65
128.475	27.717	3.609	2.66
128.675	27.783	3.622	2.665
128.875	27.887	3.628	2.67
129.075	27.981	3.634	2.67
129.275	28.037	3.641	2.679
129.475	28.085	3.647	2.684
129.675	28.132	3.653	2.689
129.875	28.207	3.653	2.689
131.875	28.706	3.71	2.741
133.875	29.139	3.741	2.77
135.875	29.497	3.773	2.794
137.875	30.052	3.767	2.775
139.875	30.372	3.798	2.789
141.875	30.532	3.817	2.804
143.875	30.683	3.836	2.818
145.875	30.852	3.848	2.827
147.875	30.956	3.855	2.842
149.875	31.106	3.861	2.842
151.875	31.219	3.861	2.847
153.875	31.417	3.867	2.842
155.875	31.473	3.88	2.847
157.875	31.558	3.88	2.851
159.875	31.662	3.88	2.856
161.875	31.709	3.886	2.856
163.875	31.699	3.892	2.871
165.875	31.765	3.892	2.875
167.875	31.793	3.899	2.875
169.875	31.859	3.892	2.871
171.875	31.981	3.899	2.871
173.875	32.038	3.911	2.88
175.875	32.066	3.911	2.88
177.875	32.433	3.936	2.894
179.875	32.499	3.943	2.899
181.875	32.565	3.949	2.904
183.875	32.565	3.949	2.909
185.875	32.612	3.955	2.914
187.875	32.612	3.955	2.918

**APPENDIX B**

**WELL 041 AQUIFER TEST DATA AND PLOTS**

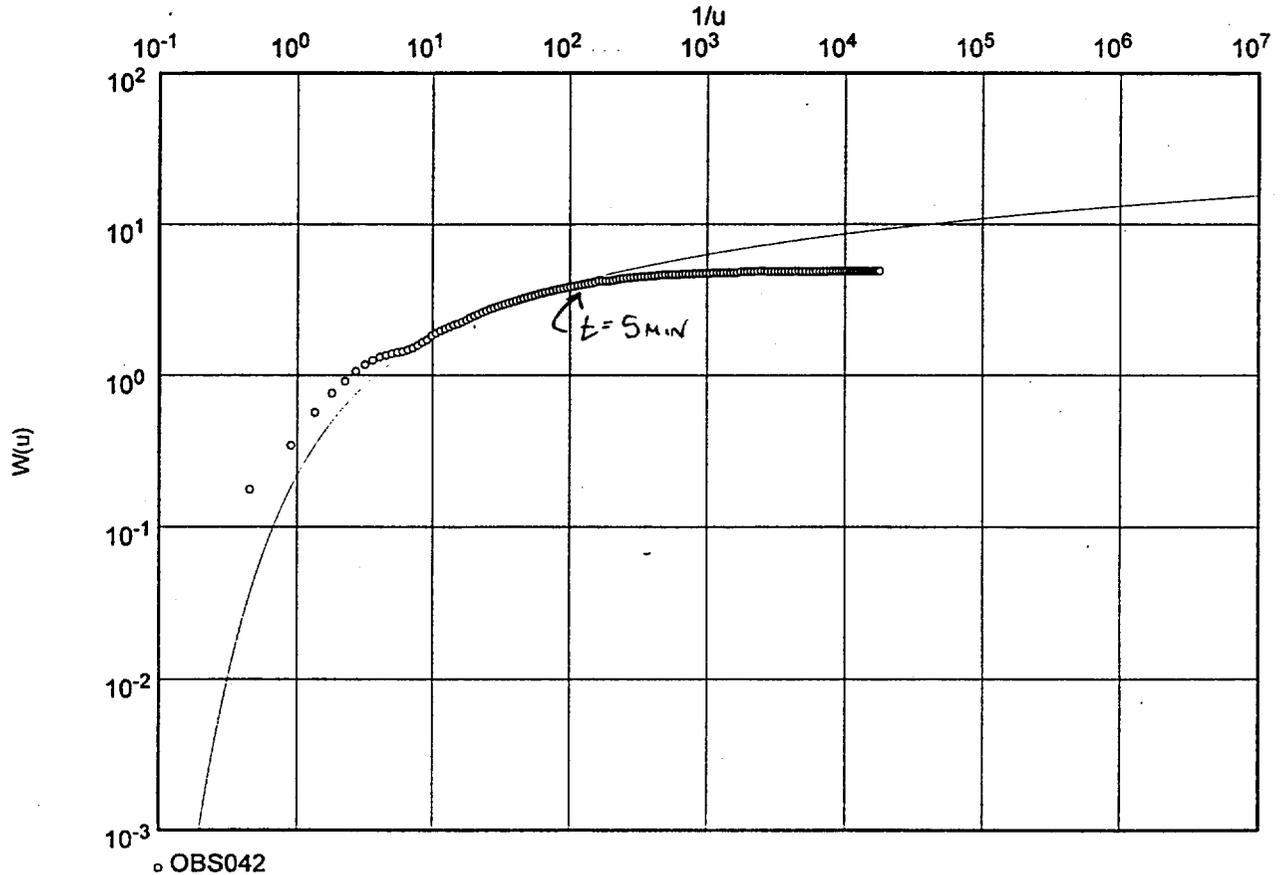
**WELL 041 AQUIFER TEST 1**  
**PLOTS FOR OBSERVATION WELLS 042, 123, AND 043**

Pumping Test No. 041 AQ TEST1, t = 19 hrs

Test conducted on: 11/19/99

OBS042, r = 26.8'

Discharge 35.00 U.S.gal/min



Transmissivity [ft<sup>2</sup>/min]:  $2.09 \times 10^{-1} = 301 \text{ ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $6.97 \times 10^{-3}$

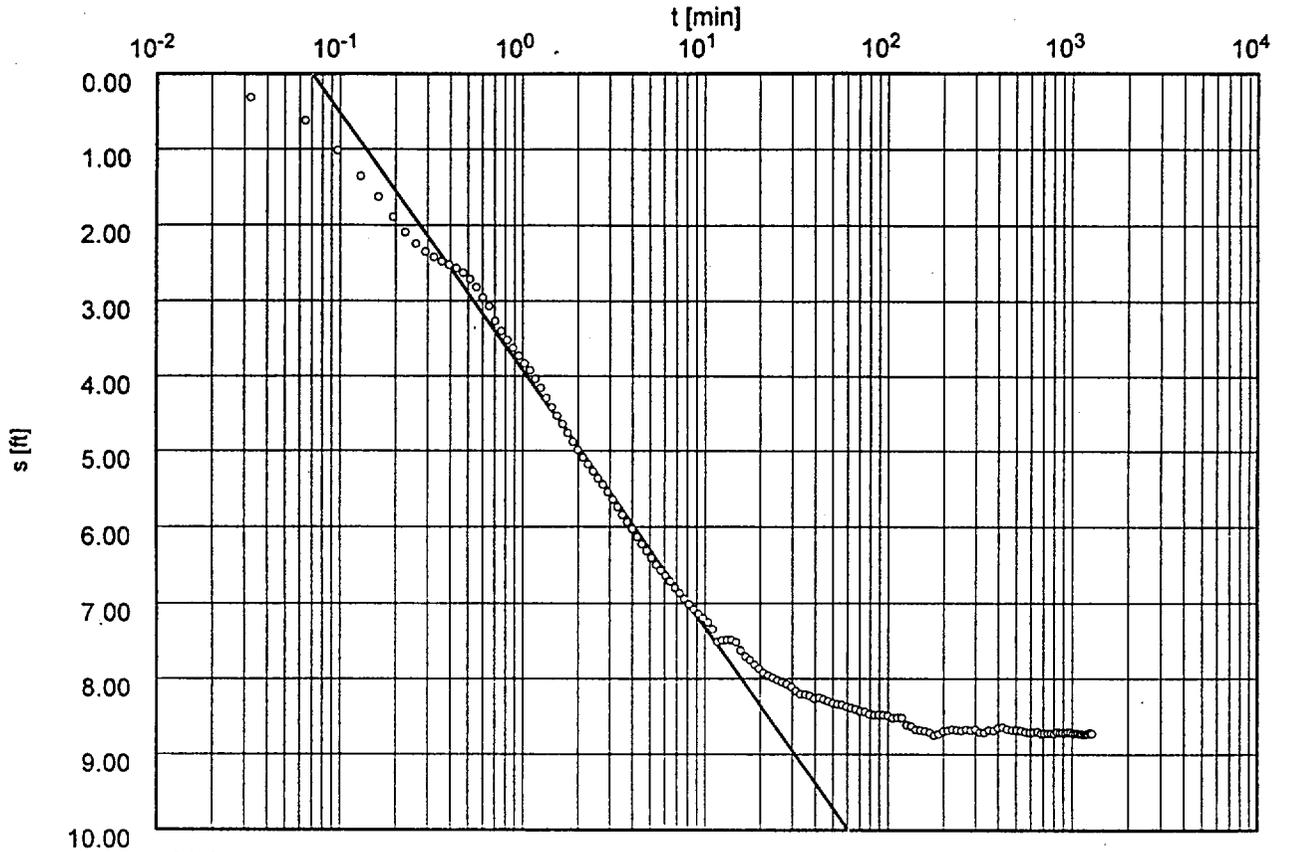
Aquifer thickness [ft]: 30.00

Pumping Test No. 041 AQ TEST1, t = 19 hrs

Test conducted on: 11/19/99

OBS042, r = 26.8'

Discharge 35.00 U.S.gal/min



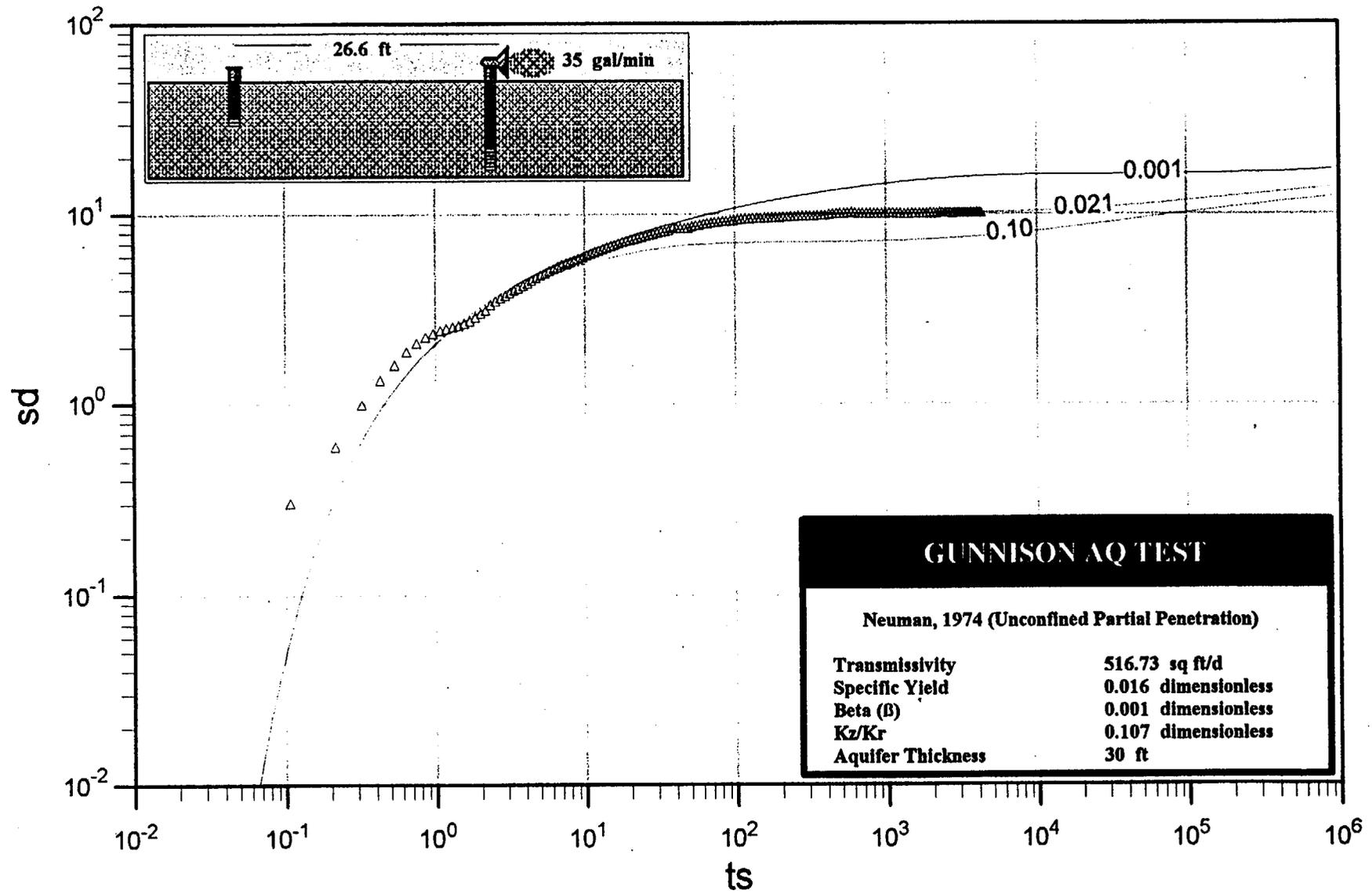
○ OBS042

Transmissivity [ft<sup>2</sup>/min]:  $2.51 \times 10^{-1} = 361.4 \text{ Ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $8.38 \times 10^{-3}$

Aquifer thickness [ft]: 30.00

# WELL OBS 042 / 041 AQ TEST 1

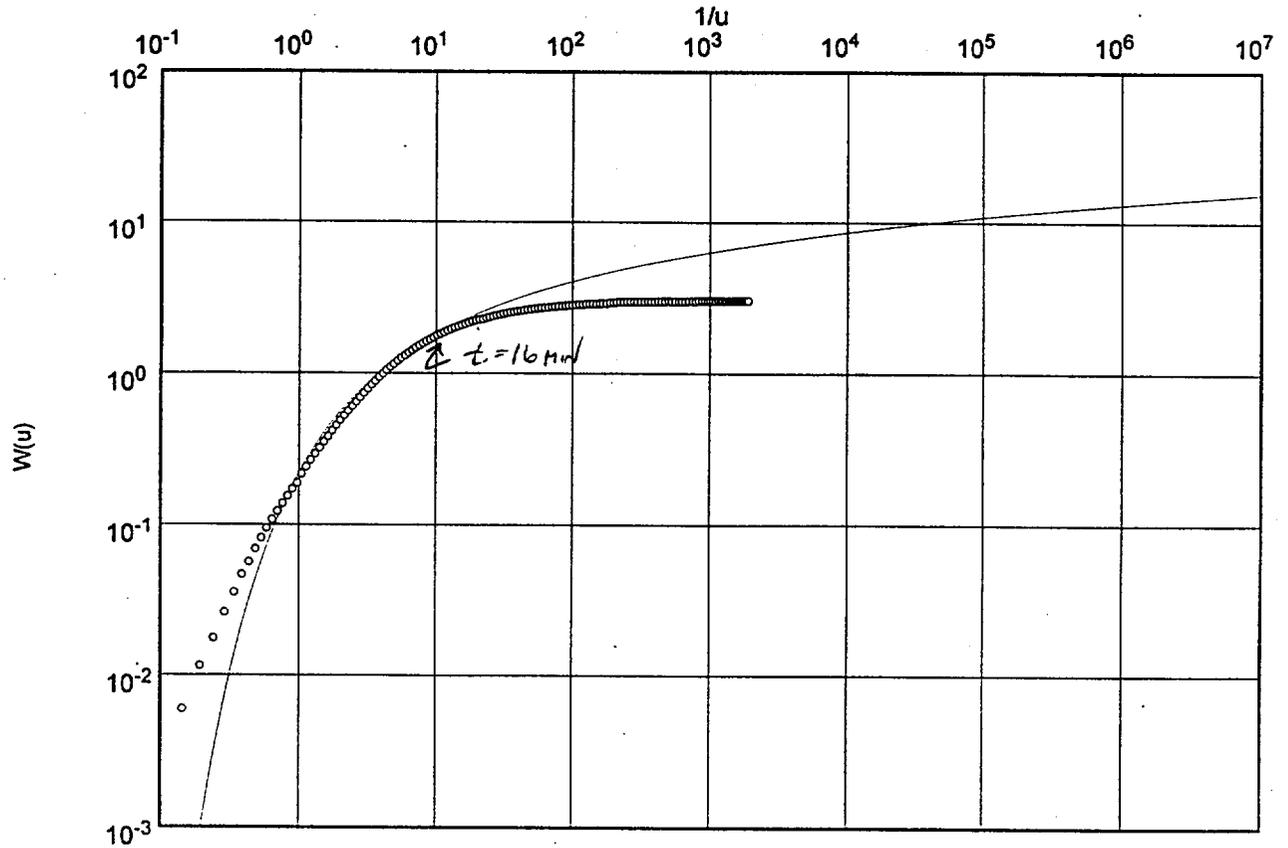


Pumping Test No. 041 AQ TEST 1, t = 19 hrs

Test conducted on: 11/19/99

OBS 123, r = 30.8', SI = 53.2' - 58.2'

Discharge 35.00 U.S.gal/min



○ OBS 123

Transmissivity [ft<sup>2</sup>/min]:  $1.86 \times 10^{-1} = 207.0 \text{ ft}^2/\text{d}$

Hydraulic conductivity [ft/min]:  $6.22 \times 10^{-3}$

Aquifer thickness [ft]: 30.00

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Pumping test analysis  
Time-Drawdown-method after  
COOPER & JACOB  
Unconfined aquifer

Page 1

Project: GUNNISON

Evaluated by:

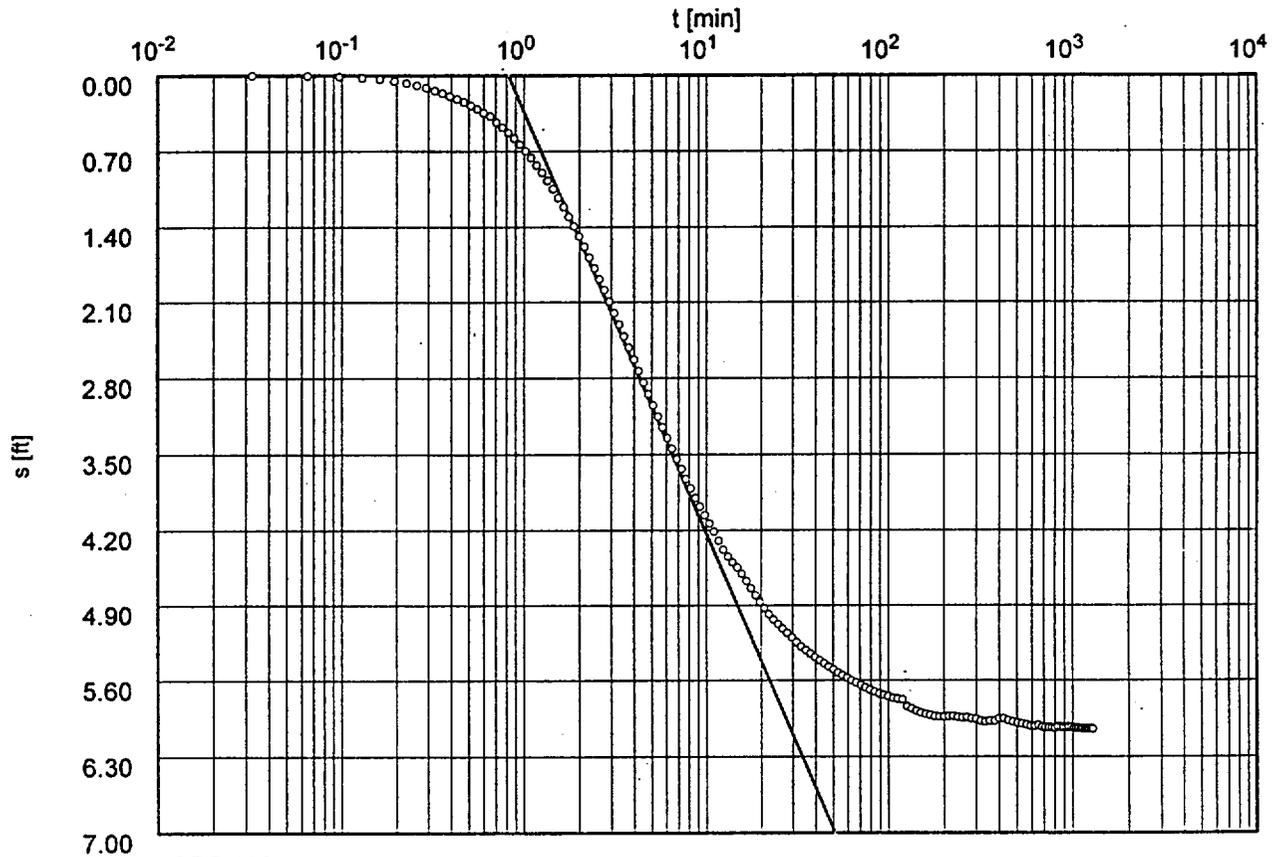
Date: 29.12.1999

Pumping Test No. 041 AQ TEST 1, t = 19 hrs

Test conducted on: 11/19/99

OBS 123, r = 30.8', SI = 53.2' - 58.2'

Discharge 35.00 U.S.gal/min



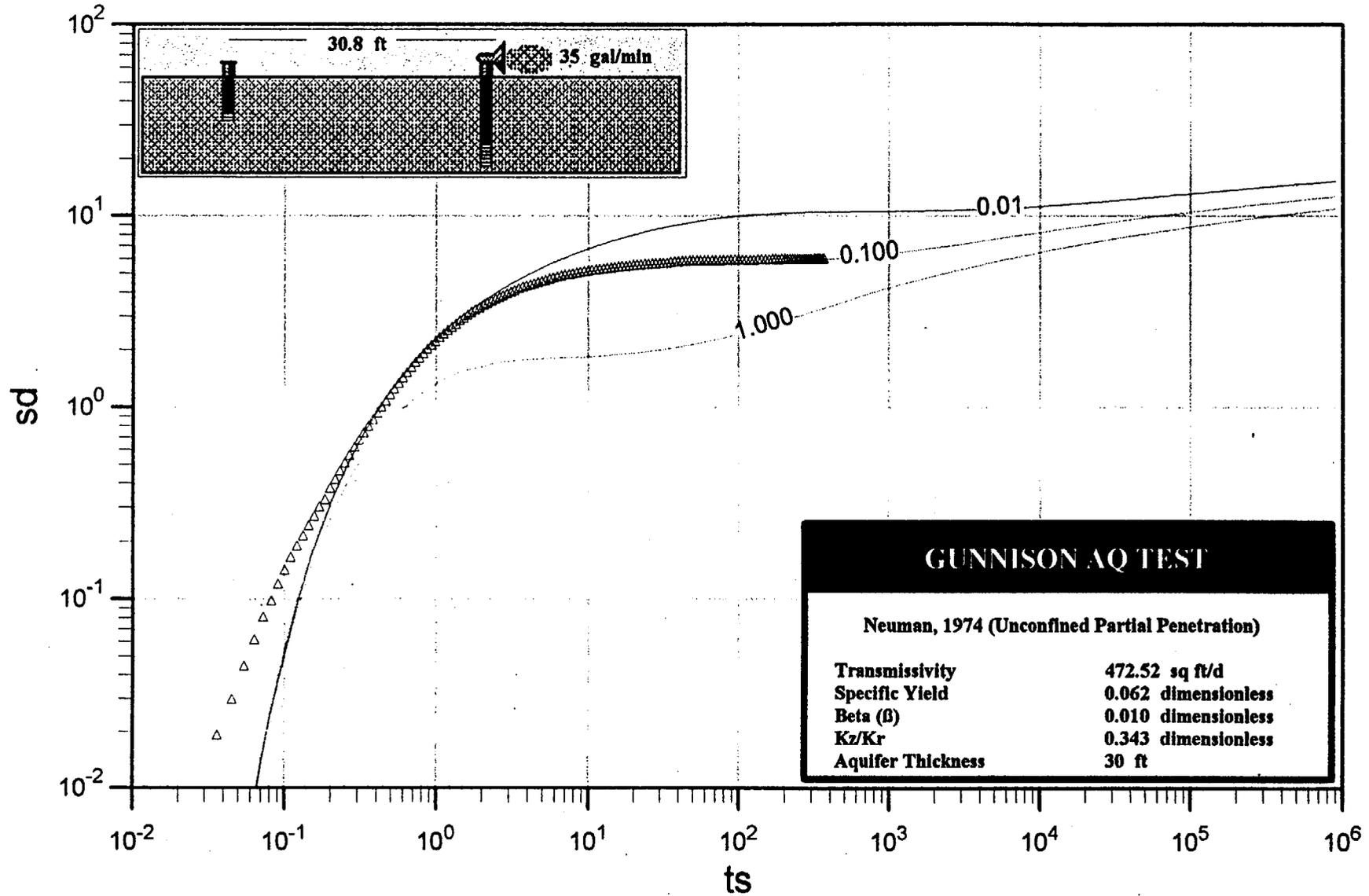
○ OBS 123

Transmissivity [ft<sup>2</sup>/min]:  $2.19 \times 10^{-1} = 315.4 \text{ ft}^2/\text{d}$

Hydraulic conductivity [ft/min]:  $7.30 \times 10^{-3}$

Aquifer thickness [ft]: 30.00

# WELL OBS 123 / 041 AQ TEST 1

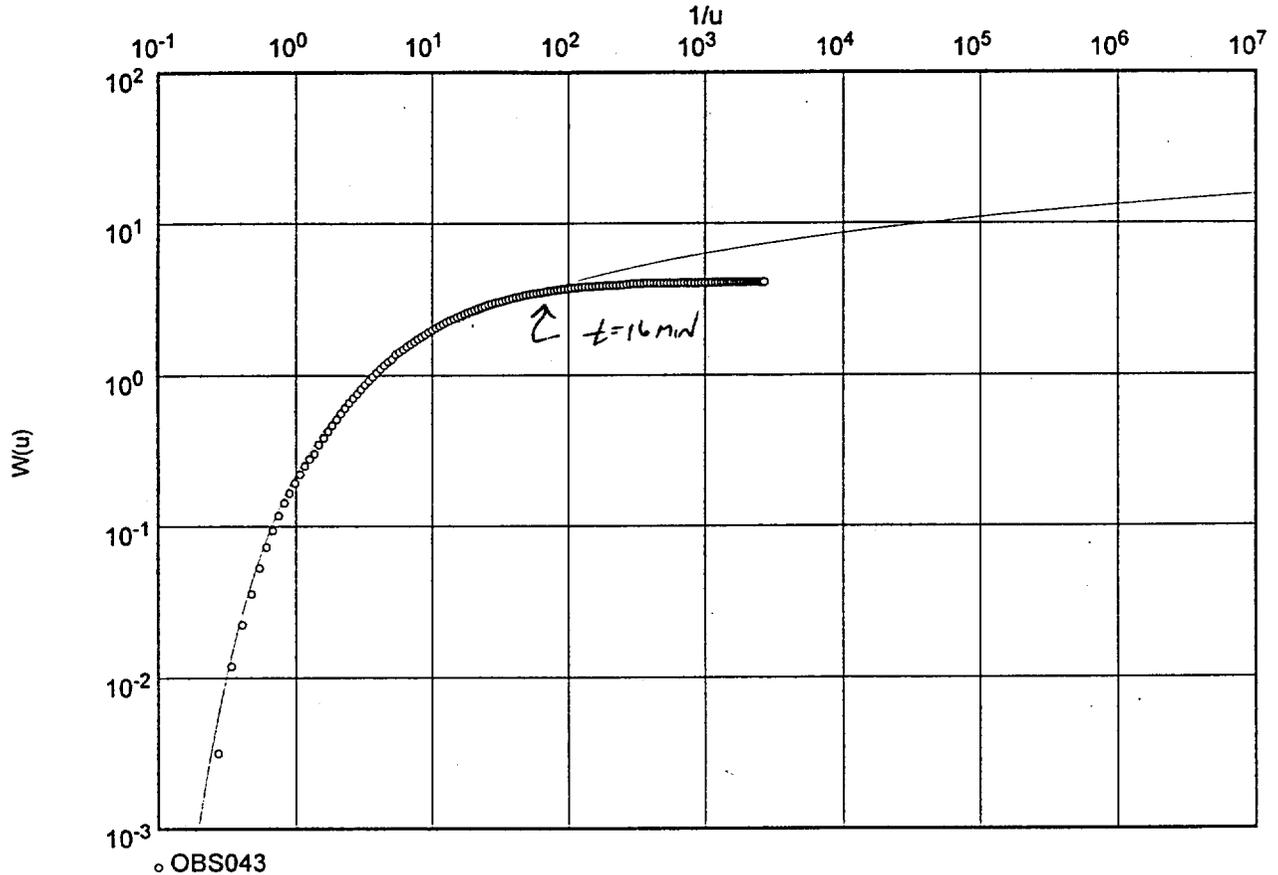


Pumping Test No. 041 AQ TEST 1, t = 19 hrs

Test conducted on: 11/19/99

OBS043, r = 36.6'

Discharge 35.00 U.S.gal/min



Transmissivity [ft<sup>2</sup>/min]:  $2.95 \times 10^{-1} = 124.8 \text{ ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $9.85 \times 10^{-3}$

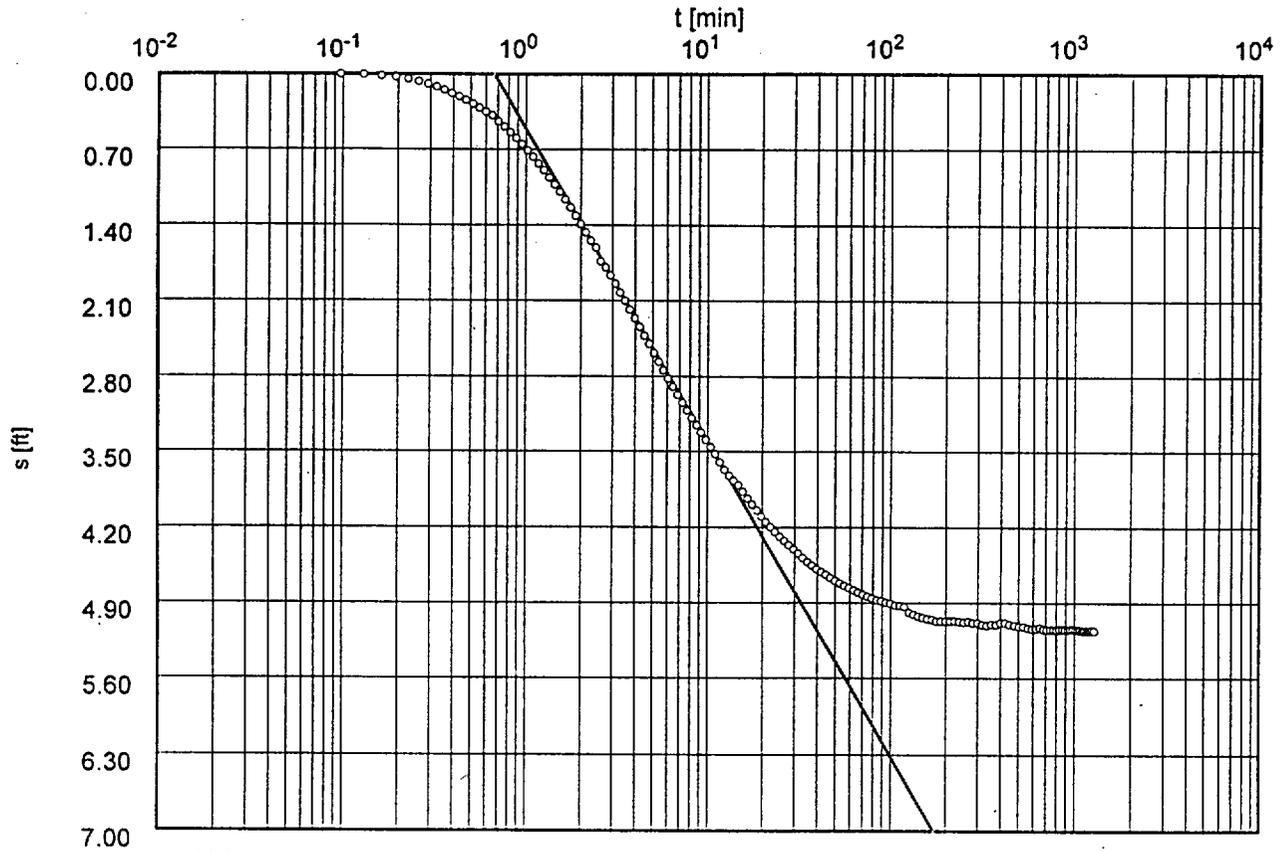
Aquifer thickness [ft]: 30.00

Pumping Test No. 041 AQ TEST 1, t = 19 hrs

Test conducted on: 11/19/99

OBS043, r = 36.6'

Discharge 35.00 U.S.gal/min



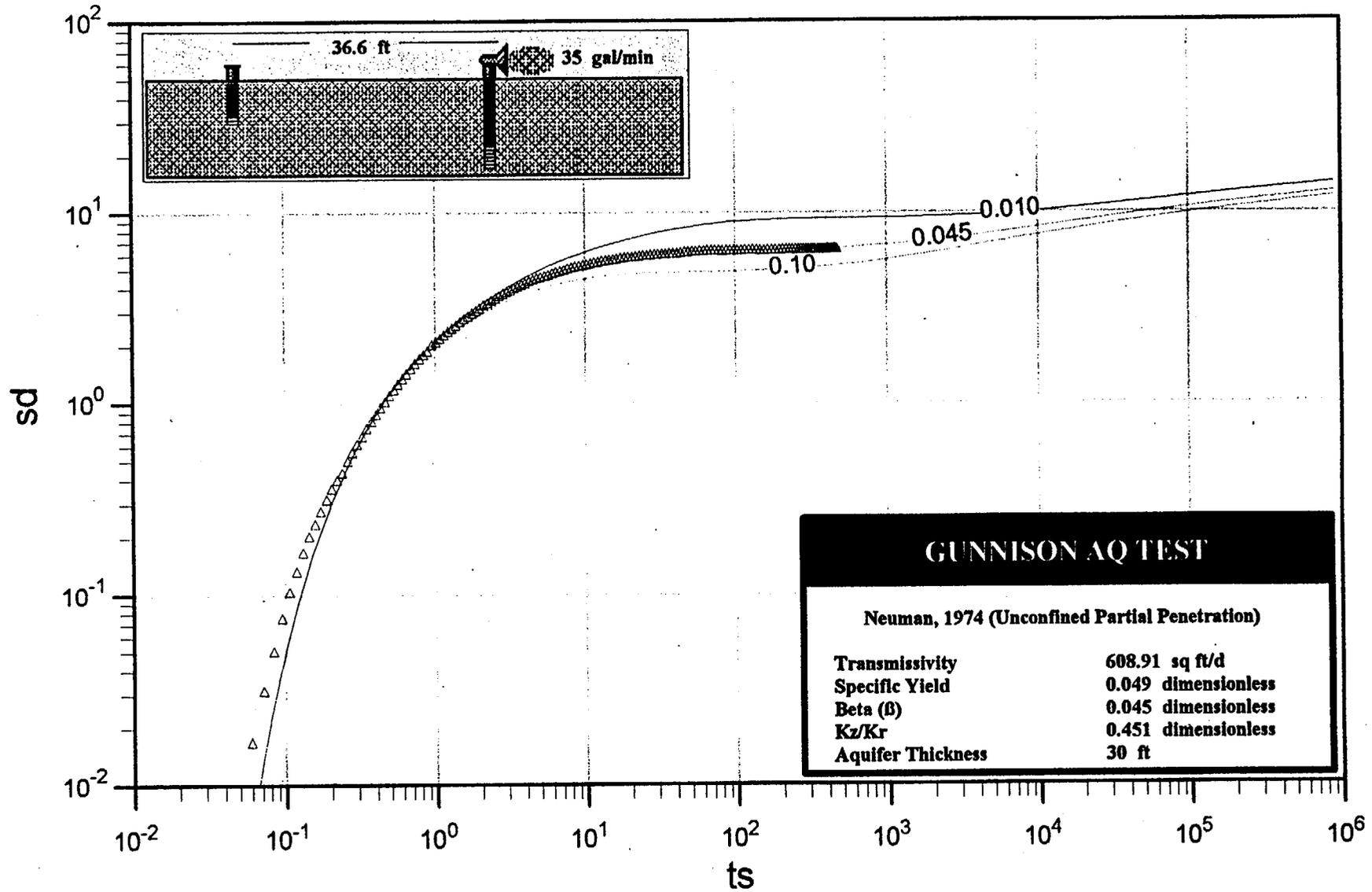
o OBS043

Transmissivity [ft<sup>2</sup>/min]:  $2.94 \times 10^{-1} = 423. A \text{ ft}^2/10$

Hydraulic conductivity [ft/min]:  $9.82 \times 10^{-3}$

Aquifer thickness [ft]: 30.00

# WELL OBS 043 / 041 AQ TEST 1



**WELL 041 AQUIFER TEST 1**

**DRAWDOWN DATA**

GUNNISON UMTRA SITE  
WELL 041 AQUIFER TEST 1 DATA  
START DATE/TIME: 11/19/99, 0900  
PUMPING RATE : 35 GPM

<u>ELAPSED TIME (MIN)</u>	<u>WELL 041 DTW (ft btoc)</u>	<u>WELL 042 DTW (ft btoc)</u>	<u>WELL 043 DTW (ft btoc)</u>	<u>WELL 120 DTW (ft btoc)</u>	<u>WELL 123 DTW (ft btoc)</u>	<u>INCHES Hg</u>
0.00	8.07	8.018	8.39	5.79	9.531	22.889
0.03	9.735	8.335	8.389	5.791	9.533	22.891
0.06	9.947	8.642	8.389	5.79	9.536	22.889
0.10	10.665	9.053	8.39	5.79	9.542	22.891
0.13	11.296	9.407	8.394	5.79	9.553	22.891
0.16	11.862	9.692	8.405	5.79	9.565	22.889
0.19	12.233	9.972	8.418	5.79	9.582	22.891
0.23	12.458	10.19	8.435	5.79	9.601	22.891
0.26	12.518	10.353	8.457	5.79	9.623	22.891
0.29	12.497	10.468	8.482	5.789	9.643	22.891
0.32	12.454	10.548	8.508	5.789	9.668	22.891
0.36	12.436	10.611	8.538	5.789	9.693	22.891
0.39	12.501	10.659	8.57	5.79	9.719	22.891
0.43	12.51	10.711	8.599	5.79	9.746	22.893
0.47	12.769	10.774	8.634	5.79	9.774	22.891
0.51	13.054	10.865	8.67	5.79	9.806	22.891
0.55	13.244	10.985	8.708	5.791	9.839	22.891
0.60	13.581	11.135	8.744	5.79	9.874	22.893
0.65	13.836	11.259	8.775	5.791	9.905	22.893
0.70	14.129	11.485	8.834	5.791	9.961	22.887
0.76	14.311	11.637	8.882	5.791	10.008	22.887
0.82	14.449	11.771	8.935	5.793	10.06	22.887
0.88	14.626	11.893	8.988	5.793	10.114	22.885
0.95	14.798	12.015	9.046	5.794	10.172	22.885
1.02	14.984	12.132	9.107	5.796	10.234	22.883
1.09	15.165	12.238	9.168	5.796	10.298	22.883
1.17	15.368	12.373	9.231	5.797	10.368	22.883
1.26	15.666	12.512	9.296	5.799	10.439	22.883
1.34	15.938	12.668	9.364	5.8	10.515	22.883
1.44	16.201	12.818	9.433	5.803	10.595	22.881
1.54	16.469	12.964	9.504	5.806	10.679	22.881
1.64	16.71	13.105	9.578	5.807	10.767	22.881
1.75	17.021	13.244	9.653	5.809	10.86	22.881
1.87	17.263	13.381	9.733	5.812	10.955	22.881
2.00	17.539	13.511	9.813	5.815	11.053	22.879
2.13	17.771	13.637	9.894	5.819	11.155	22.879
2.27	18.048	13.745	9.977	5.822	11.263	22.876
2.42	18.233	13.862	10.04	5.825	11.369	22.876
2.58	18.483	13.975	10.176	5.828	11.479	22.876
2.74	18.733	14.084	10.236	5.832	11.589	22.874
2.92	18.97	14.201	10.315	5.835	11.703	22.874
3.11	19.225	14.331	10.397	5.839	11.817	22.874
3.31	19.492	14.453	10.485	5.842	11.933	22.872
3.52	19.746	14.583	10.568	5.847	12.05	22.874
3.74	19.992	14.702	10.656	5.851	12.164	22.872
3.97	20.225	14.817	10.744	5.854	12.283	22.872
4.22	20.445	14.954	10.832	5.858	12.401	22.872
4.49	20.673	15.078	10.921	5.862	12.518	22.872

CALC SET U0082900  
WELL 041 AQ TEST 1

4.77	20.876	15.193	11.006	5.867	12.636	22.87
5.07	21.065	15.306	11.095	5.871	12.754	22.868
5.38	21.281	15.425	11.182	5.876	12.868	22.87
5.71	21.462	15.525	11.272	5.878	12.981	22.87
6.07	21.655	15.616	11.356	5.883	13.093	22.868
6.44	21.823	15.72	11.442	5.887	13.204	22.868
6.84	22	15.831	11.524	5.89	13.311	22.868
7.26	22.151	15.928	11.607	5.896	13.417	22.868
7.70	22.327	16.032	11.69	5.899	13.52	22.866
8.17	22.482	16.13	11.771	5.903	13.62	22.866
8.67	22.62	16.221	11.849	5.907	13.722	22.866
9.20	22.745	16.303	11.925	5.91	13.817	22.866
9.76	22.87	16.388	12.003	5.915	13.91	22.864
10.35	22.978	16.46	12.077	5.919	14	22.864
10.98	23.383	16.592	12.151	5.92	14.089	22.864
11.64	23.632	16.828	12.24	5.923	14.189	22.862
12.35	23.693	16.802	12.321	5.928	14.288	22.862
13.09	23.52	16.794	12.386	5.933	14.367	22.864
13.88	23.55	16.796	12.436	5.936	14.43	22.862
14.72	23.697	16.837	12.485	5.938	14.486	22.862
15.61	23.985	16.991	12.552	5.941	14.557	22.862
16.54	24.145	17.106	12.623	5.942	14.639	22.86
17.54	24.334	17.171	12.691	5.947	14.72	22.86
18.59	24.523	17.264	12.753	5.949	14.798	22.858
19.71	24.618	17.338	12.816	5.952	14.875	22.856
20.89	24.713	17.414	12.877	5.954	14.946	22.856
22.14	24.773	17.468	12.933	5.957	15.014	22.856
23.47	24.82	17.511	12.985	5.96	15.075	22.856
24.87	24.872	17.559	13.035	5.964	15.132	22.856
26.36	24.945	17.594	13.081	5.967	15.183	22.854
27.94	25.023	17.635	13.126	5.967	15.231	22.852
29.61	25.096	17.691	13.172	5.971	15.284	22.85
31.38	25.204	17.769	13.22	5.974	15.337	22.85
33.25	25.272	17.83	13.27	5.974	15.389	22.852
35.24	25.238	17.837	13.315	5.978	15.431	22.85
37.34	25.337	17.863	13.354	5.981	15.471	22.848
39.57	25.376	17.923	13.391	5.983	15.512	22.848
41.92	25.483	17.904	13.423	5.986	15.548	22.85
44.42	25.574	17.93	13.455	5.987	15.585	22.848
47.07	25.638	17.969	13.49	5.991	15.622	22.846
49.87	25.711	18.008	13.522	5.991	15.657	22.846
52.84	25.724	18.025	13.552	5.994	15.692	22.846
55.99	25.754	18.042	13.58	5.997	15.721	22.846
59.32	25.815	18.077	13.606	5.999	15.751	22.844
62.85	25.832	18.105	13.632	6	15.782	22.844
66.59	25.888	18.129	13.655	6.002	15.809	22.84
70.55	25.948	18.168	13.679	6.003	15.836	22.84
74.74	25.995	18.181	13.702	6.004	15.865	22.84
79.19	26.056	18.225	13.719	6.004	15.889	22.838
83.89	26.086	18.246	13.741	6.006	15.914	22.836
88.88	26.129	18.238	13.754	6.007	15.934	22.838
94.16	26.124	18.246	13.77	6.009	15.949	22.834
99.75	26.189	18.257	13.783	6.009	15.965	22.83
105.68	26.215	18.3	13.802	6.01	15.988	22.83
111.96	26.111	18.296	13.806	6.01	15.994	22.836
118.60	26.189	18.296	13.818	6.01	16.002	22.83

CALC SET U00&2900  
WELL 041 AQ TEST 1

125.65	26.563	18.446	13.885	6.013	16.085	22.828
133.11	26.619	18.472	13.906	6.015	16.111	22.826
141.01	26.658	18.543	13.931	6.016	16.14	22.817
149.38	26.679	18.556	13.945	6.016	16.16	22.819
158.24	26.727	18.567	13.957	6.018	16.178	22.828
167.63	26.735	18.597	13.966	6.016	16.189	22.834
177.58	26.654	18.656	13.983	6.019	16.205	22.842
188.12	26.752	18.632	13.985	6.019	16.207	22.848
199.28	26.843	18.571	13.985	6.02	16.208	22.852
211.10	26.821	18.563	13.982	6.023	16.204	22.852
223.62	26.83	18.537	13.979	6.02	16.201	22.852
236.89	26.882	18.545	13.986	6.023	16.211	22.852
250.94	26.882	18.558	13.995	6.02	16.217	22.848
265.82	26.903	18.535	13.988	6.022	16.214	22.844
281.59	26.989	18.556	14.002	6.022	16.229	22.842
298.29	27.054	18.535	14.003	6.025	16.234	22.83
315.98	27.071	18.593	14.022	6.023	16.258	22.824
334.72	27.088	18.597	14.03	6.026	16.268	22.817
354.57	27.135	18.548	14.019	6.026	16.255	22.813
375.59	27.075	18.558	14.022	6.028	16.256	22.811
397.86	27.036	18.5	14.001	6.029	16.23	22.805
421.45	27.041	18.491	14.002	6.032	16.232	22.805
446.44	27.118	18.526	14.019	6.033	16.253	22.799
472.90	27.191	18.545	14.031	6.035	16.268	22.789
500.94	27.204	18.55	14.041	6.038	16.281	22.779
530.64	27.269	18.561	14.047	6.041	16.291	22.769
560.64	27.368	18.584	14.059	6.041	16.303	22.75
590.64	27.398	18.602	14.07	6.042	16.317	22.734
620.64	27.389	18.595	14.069	6.044	16.317	22.705
650.64	27.398	18.582	14.056	6.042	16.305	22.703
680.64	27.445	18.617	14.075	6.045	16.329	22.693
710.64	27.441	18.617	14.077	6.047	16.332	22.677
740.64	27.479	18.613	14.077	6.047	16.333	22.687
770.64	27.514	18.615	14.079	6.048	16.336	22.691
800.64	27.492	18.619	14.082	6.049	16.339	22.689
830.64	27.458	18.587	14.076	6.051	16.324	22.701
860.64	27.505	18.6	14.076	6.051	16.33	22.726
890.64	27.535	18.6	14.079	6.054	16.333	22.73
920.64	27.557	18.606	14.079	6.055	16.334	22.746
950.64	27.527	18.589	14.076	6.055	16.329	22.75
980.64	27.518	18.593	14.076	6.057	16.329	22.756
1010.64	27.565	18.617	14.079	6.057	16.339	22.769
1040.64	27.57	18.619	14.08	6.058	16.34	22.789
1070.64	27.561	18.619	14.082	6.06	16.342	22.773
1100.64	27.552	18.634	14.088	6.062	16.346	22.767
1130.64	27.57	18.63	14.088	6.064	16.348	22.783
1160.64	27.578	18.63	14.09	6.065	16.348	22.787
1190.64	27.621	18.634	14.092	6.068	16.35	22.781
1220.64	27.617	18.626	14.09	6.07	16.349	22.783
1250.64	27.604	18.597	14.085	6.07	16.343	22.783
1280.64	27.63	18.621	14.092	6.073	16.353	22.797

**WELL 041 AQUIFER TEST 2**

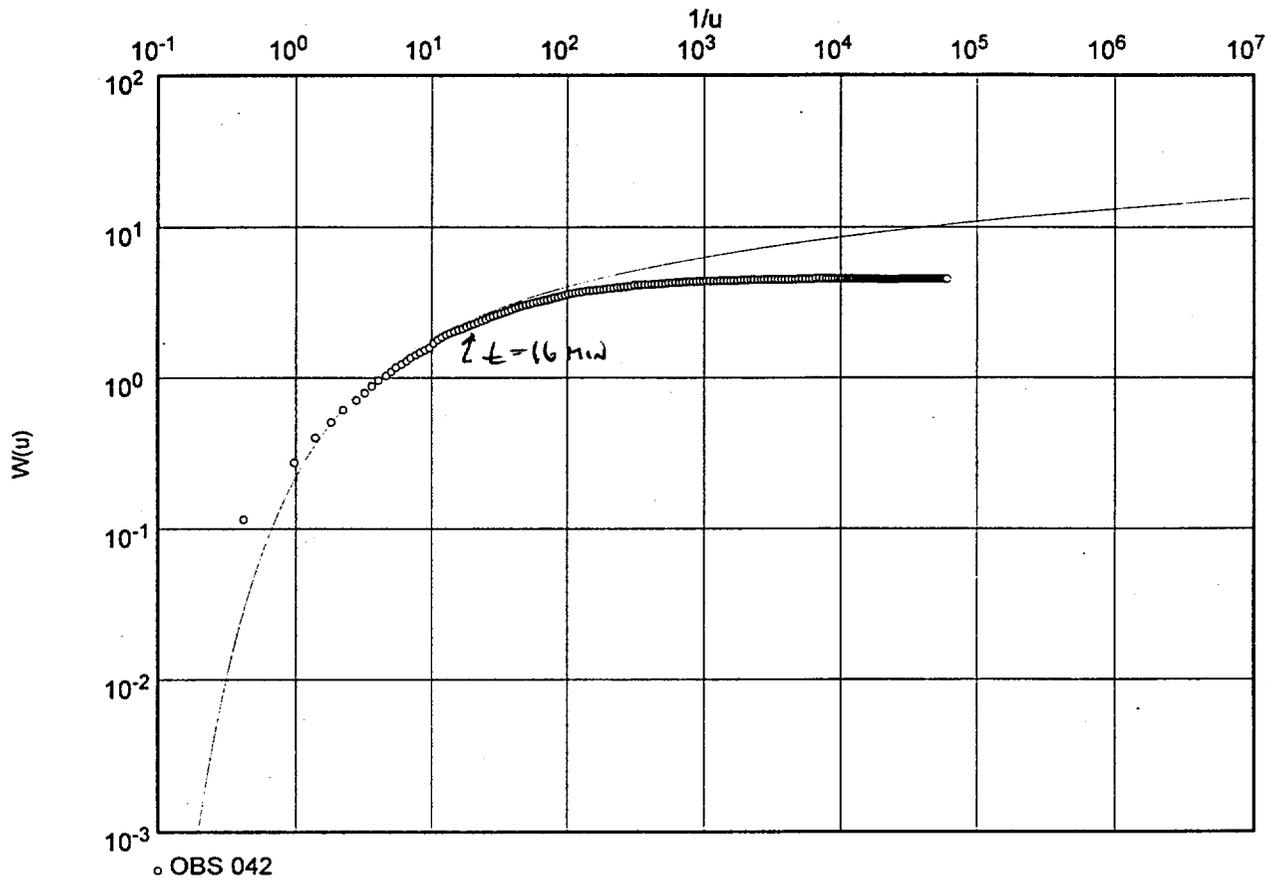
**PLOTS FOR PUMPING WELL 041 AND OBSERVATION WELLS 042, 043, AND 123**

Pumping Test No. 041 AQ TEST 2, t = 72.25 hrs

Test conducted on: 11/20/99

OBS042, r = 26.8'

Discharge 38.10 U.S.gal/min



Transmissivity [ft<sup>2</sup>/min]:  $2.03 \times 10^{-1} = 292.3 \text{ Ft}^2/\text{D}$

Hydraulic conductivity [ft/min]:  $6.77 \times 10^{-3}$

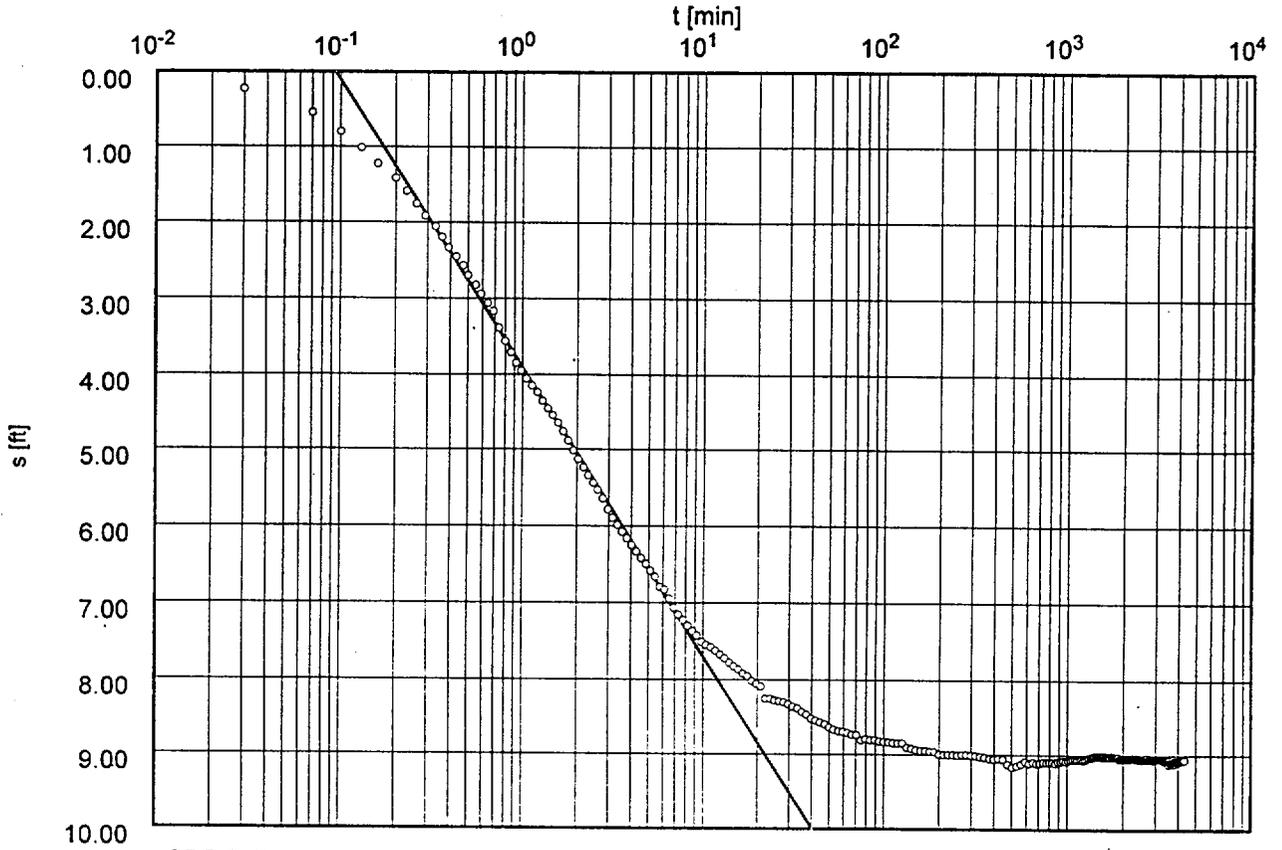
Aquifer thickness [ft]: 30.00

Pumping Test No. 041 AQ TEST 2, t = 72.25 hrs

Test conducted on: 11/20/99

OBS042, r = 26.8'

Discharge 38.10 U.S.gal/min



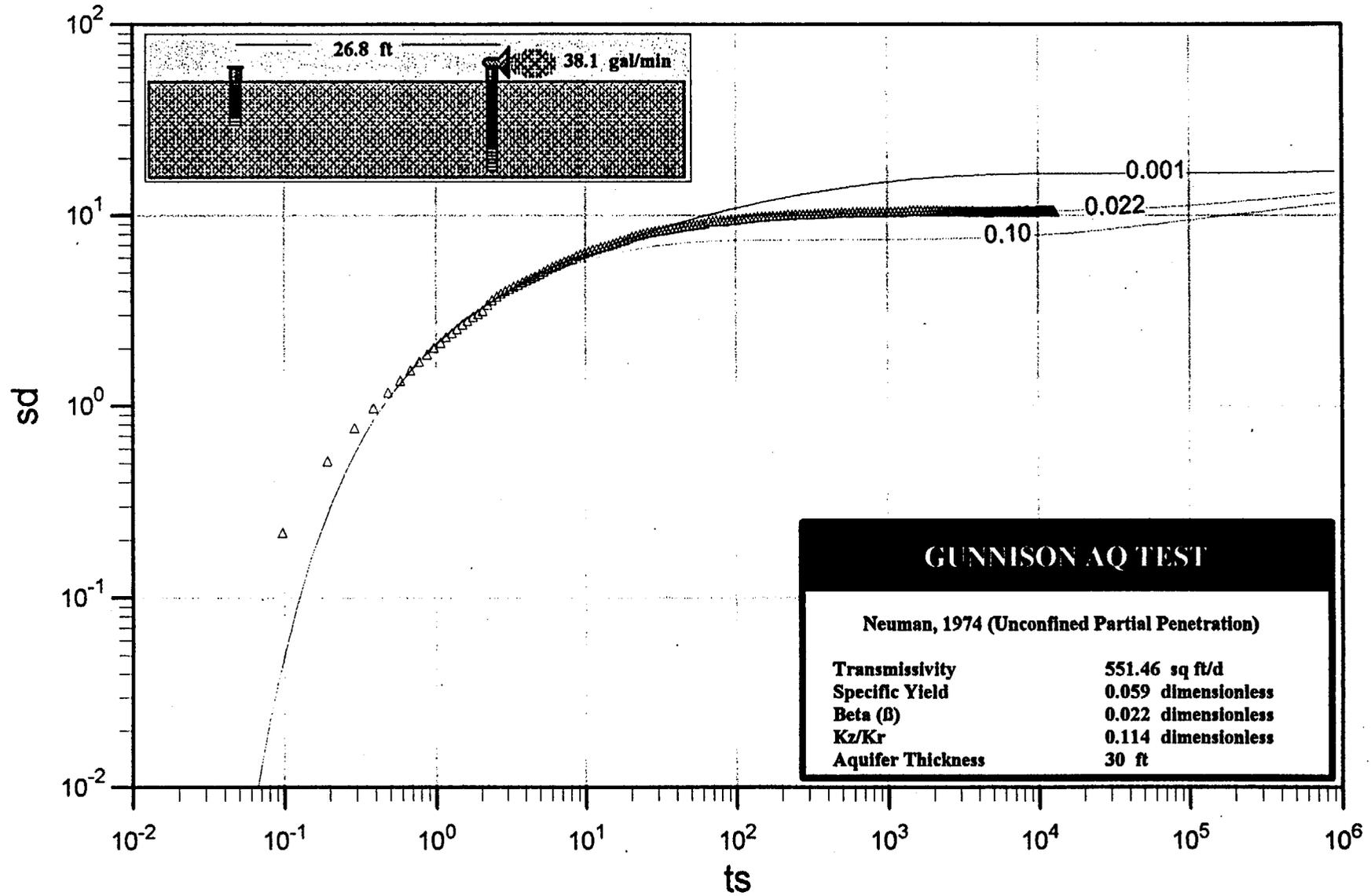
o OBS 042

Transmissivity [ft<sup>2</sup>/min]:  $2.45 \times 10^{-1} = 352.3 \text{ Ft}^2/\text{D}$

Hydraulic conductivity [ft/min]:  $8.18 \times 10^{-3}$

Aquifer thickness [ft]: 30.00

# WELL OBS 042 / 041 AQ TEST 2

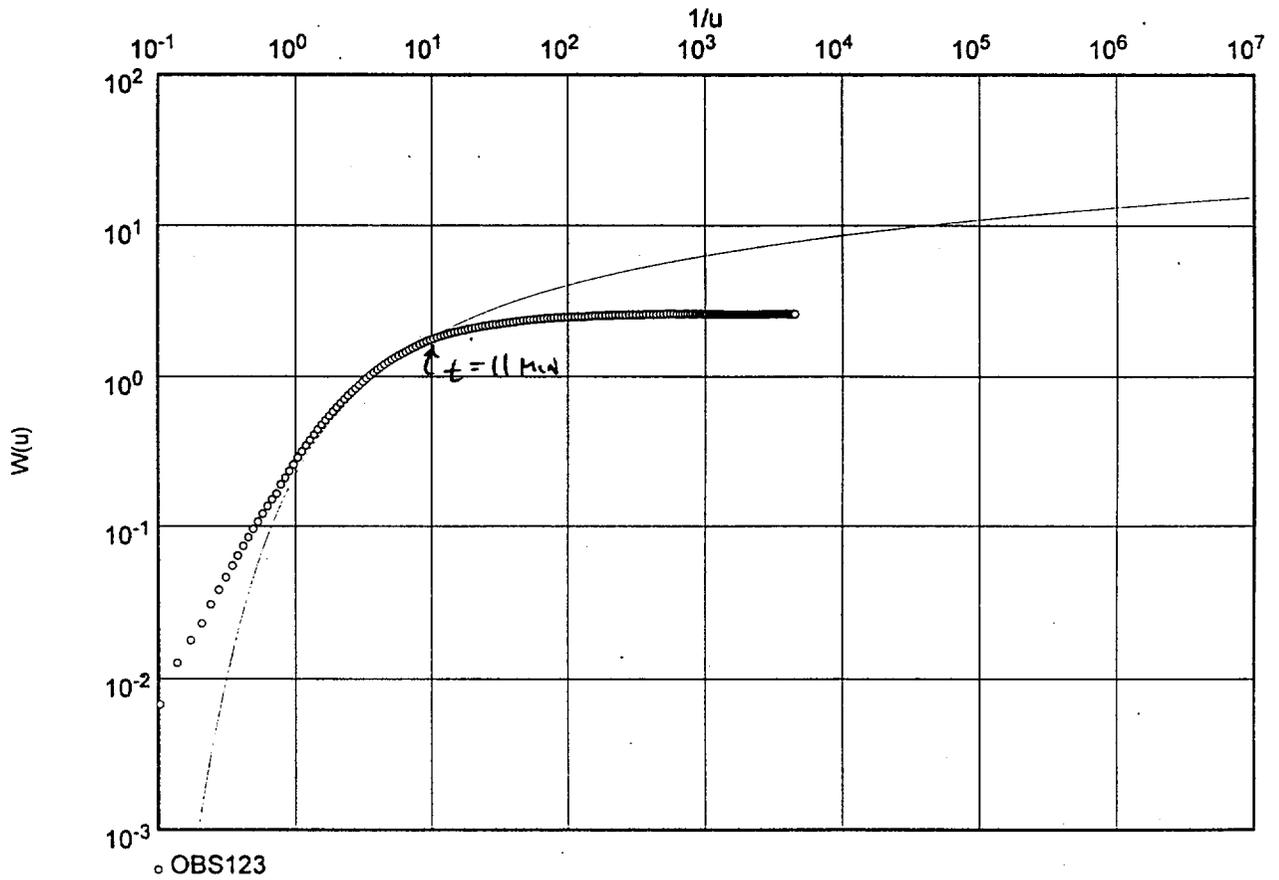


Pumping Test No. O41 AQ TEST 2, t = 72.25 HRS

Test conducted on: 11/20/99

OBS123, r = 30.8'

Discharge 38.10 U.S.gal/min



Transmissivity [ft<sup>2</sup>/min]:  $1.61 \times 10^{-1} = 231.8 \text{ ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $5.37 \times 10^{-3}$

Aquifer thickness [ft]: 30.00

**MACTEC-ERS**  
2597 B 3/4 RD  
GRAND JUNCTION, COLO  
ph.(970)248-6000

Pumping test analysis  
Time-Drawdown-method after  
COOPER & JACOB  
Unconfined aquifer

Page 1

Project: GUNNISON

Evaluated by:

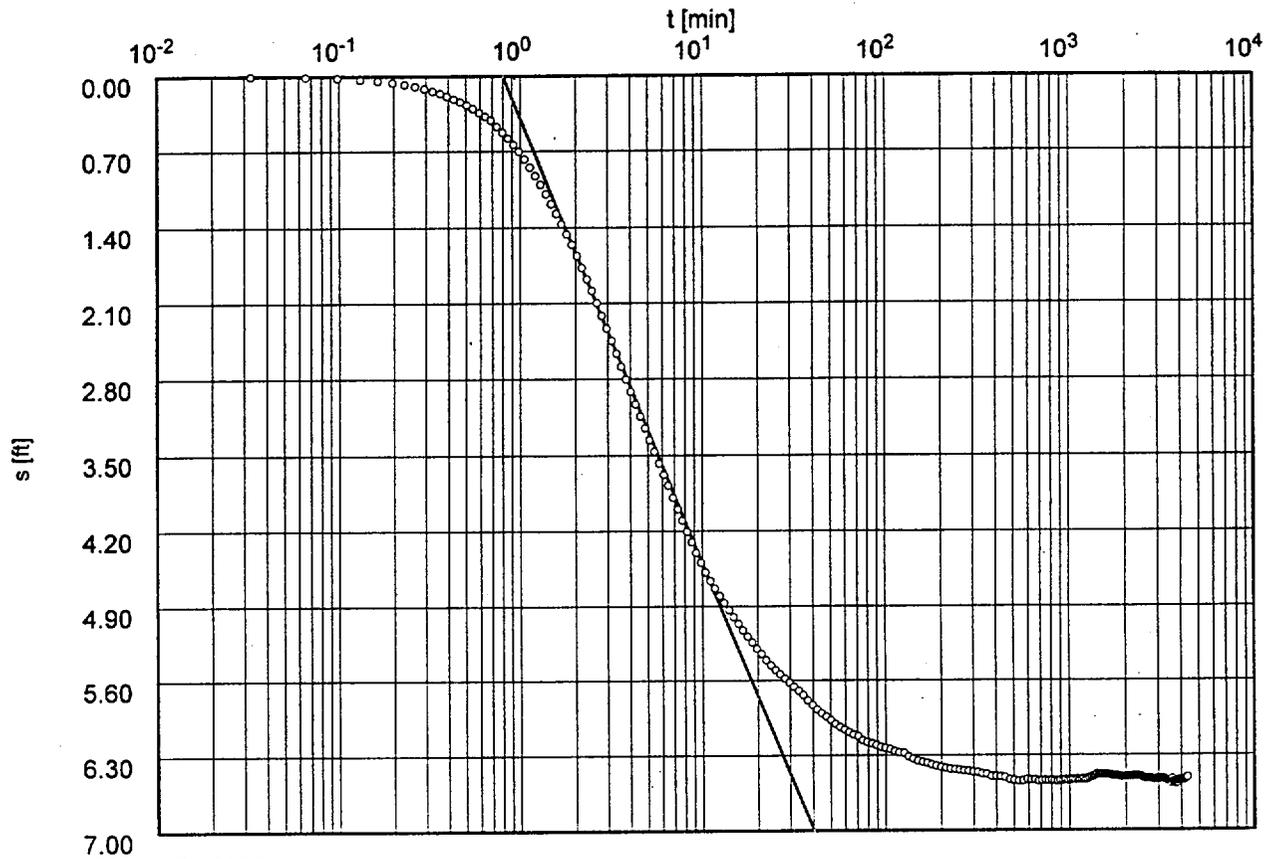
Date: 28.11.1999

Pumping Test No. O41 AQ TEST 2, t = 72.25 HRS

Test conducted on: 11/20/99

OBS123, r = 30.8'

Discharge 38.10 U.S.gal/min



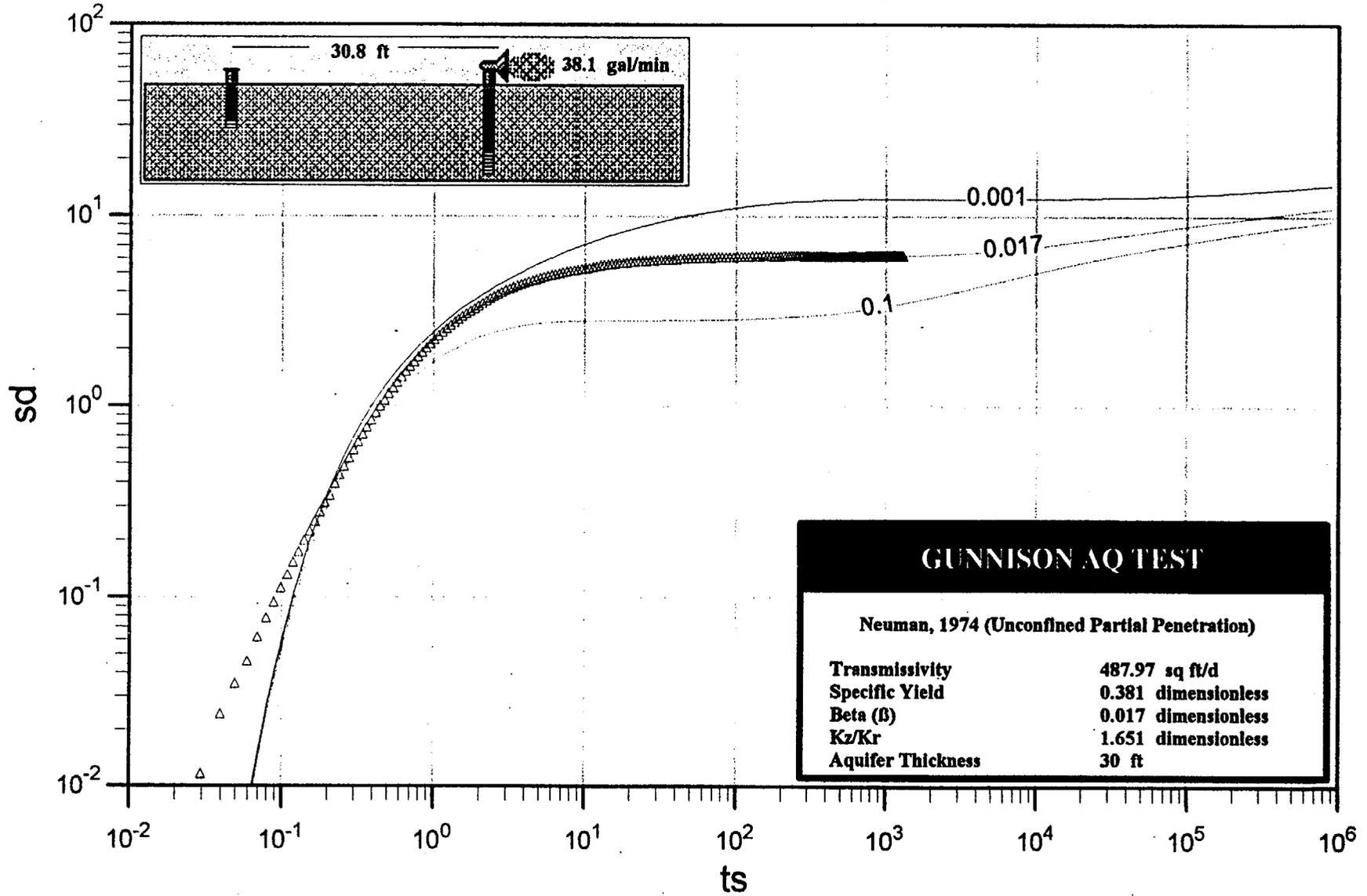
o OBS123

Transmissivity [ft<sup>2</sup>/min]:  $2.26 \times 10^{-1} = 325.4 \text{ Ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $7.55 \times 10^{-3}$

Aquifer thickness [ft]: 30.00

# WELL OBS 123 / 041 AQ TEST 2



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Pumping test analysis  
 Theis analysis method  
 Unconfined aquifer

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Project: GUNNISON

Evaluated by:

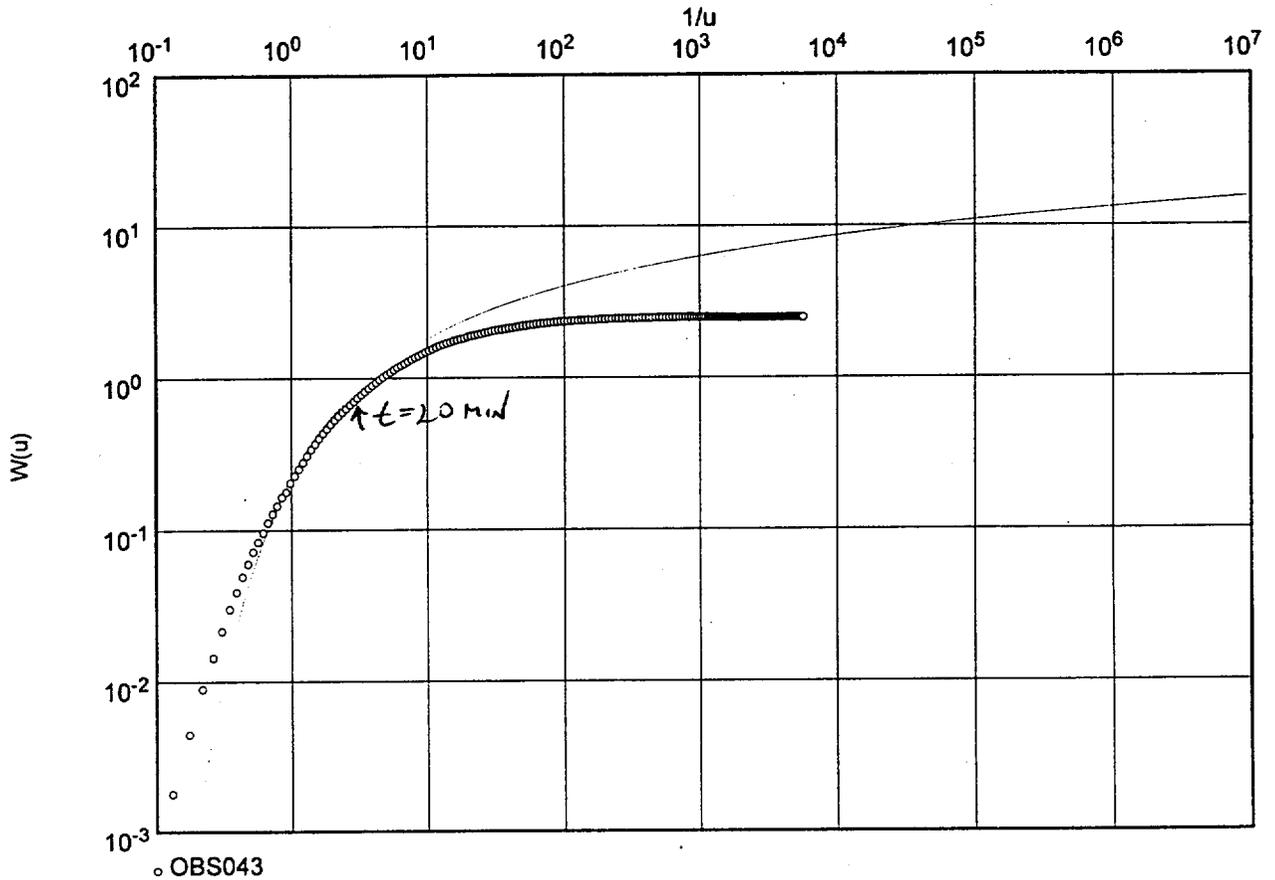
Date: 28.11.1999

Pumping Test No. 041 AQ TEST 2 , t = 72.25 hrs

Test conducted on: 11/20/99

OBS043, r = 36.6'

Discharge 38.10 U.S.gal/min



Transmissivity [ft<sup>2</sup>/min]:  $1.81 \times 10^{-1} = 260.6 \text{ ft}^2/\text{d}$

Hydraulic conductivity [ft/min]:  $6.03 \times 10^{-3}$

Aquifer thickness [ft]: 30.00

**MACTEC-ERS**  
 2597 B 3/4 RD  
 GRAND JUNCTION, COLO  
 ph.(970)248-6000

Pumping test analysis  
 Time-Drawdown-method after  
**COOPER & JACOB**  
 Unconfined aquifer

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Project: GUNNISON

Evaluated by:

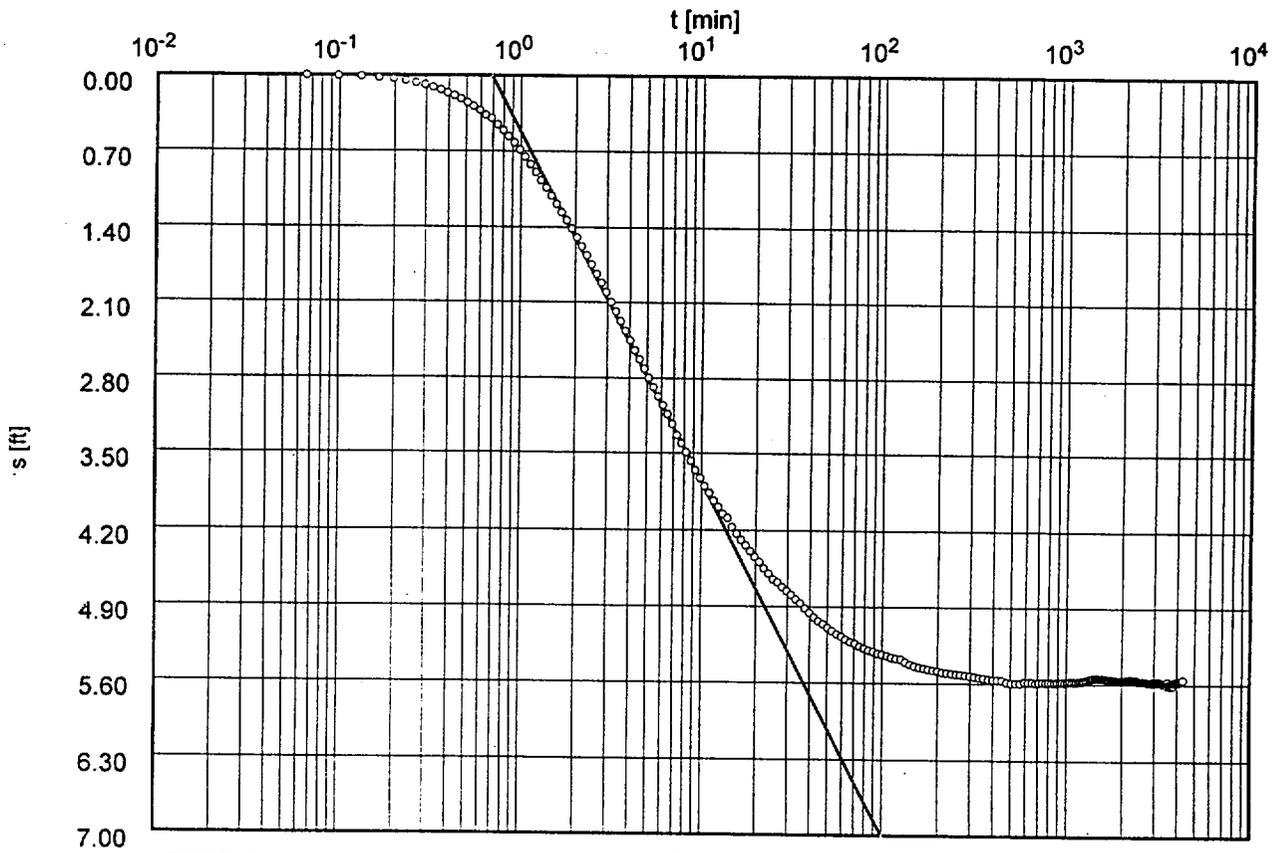
Date: 28.11.1999

Pumping Test No. 041 AQ TEST 2, t = 72.25 hrs

Test conducted on: 11/20/99

OBS043, r = 36.6'

Discharge 38.10 U.S.gal/min



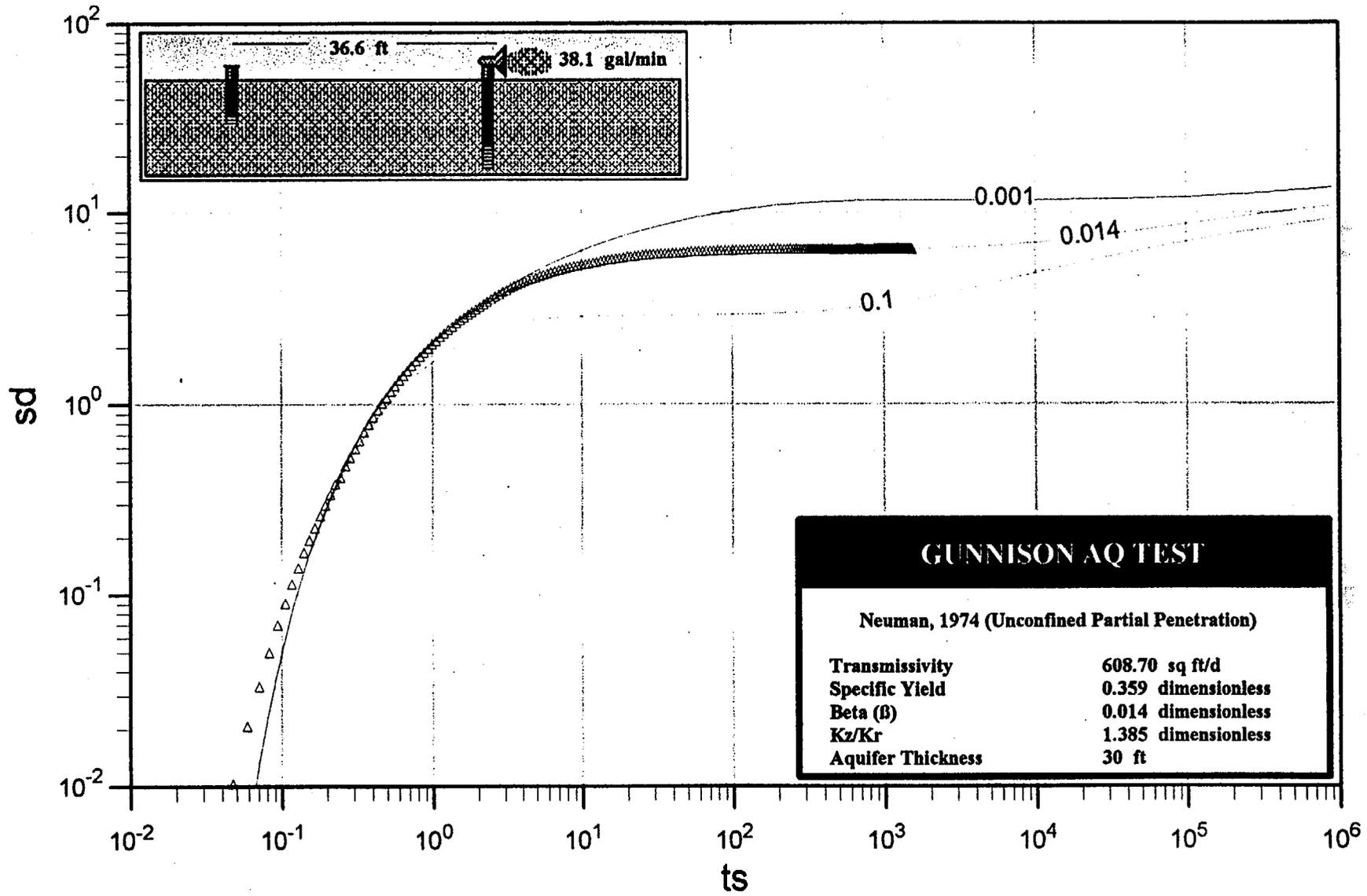
○ OBS043

Transmissivity [ft<sup>2</sup>/min]:  $2.88 \times 10^{-1} = 414.7 \text{ ft}^2/\text{D}$

Hydraulic conductivity [ft/min]:  $9.60 \times 10^{-3}$

Aquifer thickness [ft]: 30.00

# WELL OBS 043 / 041 AQ TEST 2



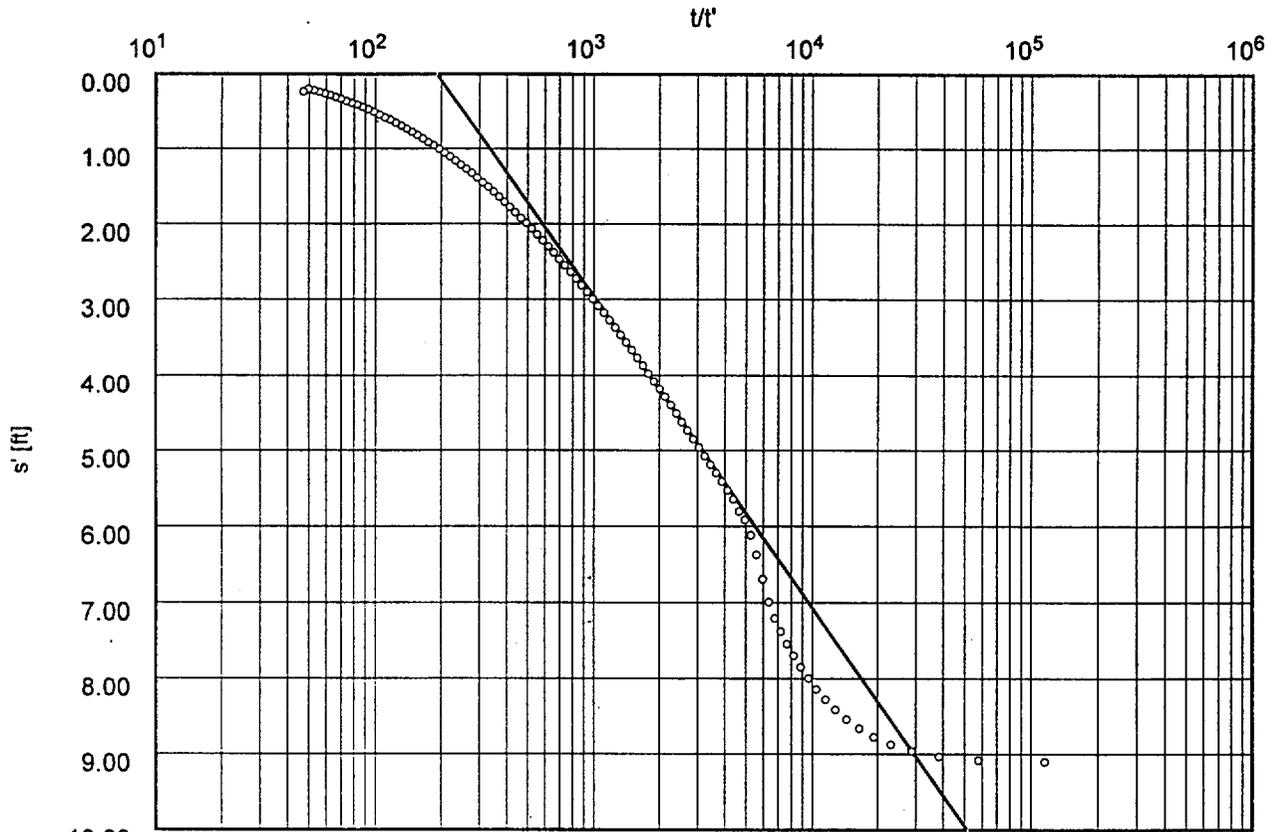
Pumping Test No. 041 AQ TEST 2 REC

Test conducted on: 11/23/99

OBS 042, r = 26.8'

Discharge 38.10 U.S.gal/min

Pumping test duration: 4335.00 min



○ OBS 042

Transmissivity [ft<sup>2</sup>/min]:  $2.26 \times 10^{-1} = 325.4 \text{ ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $7.56 \times 10^{-3}$

Aquifer thickness [ft]: 30.00

**MACTEC-ERS**  
 2597 B 3/4 RD  
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Pumping test analysis  
 Recovery method after  
 THEIS & JACOB  
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Project: GUNNISON

Evaluated by:

Date: 02.12.1999

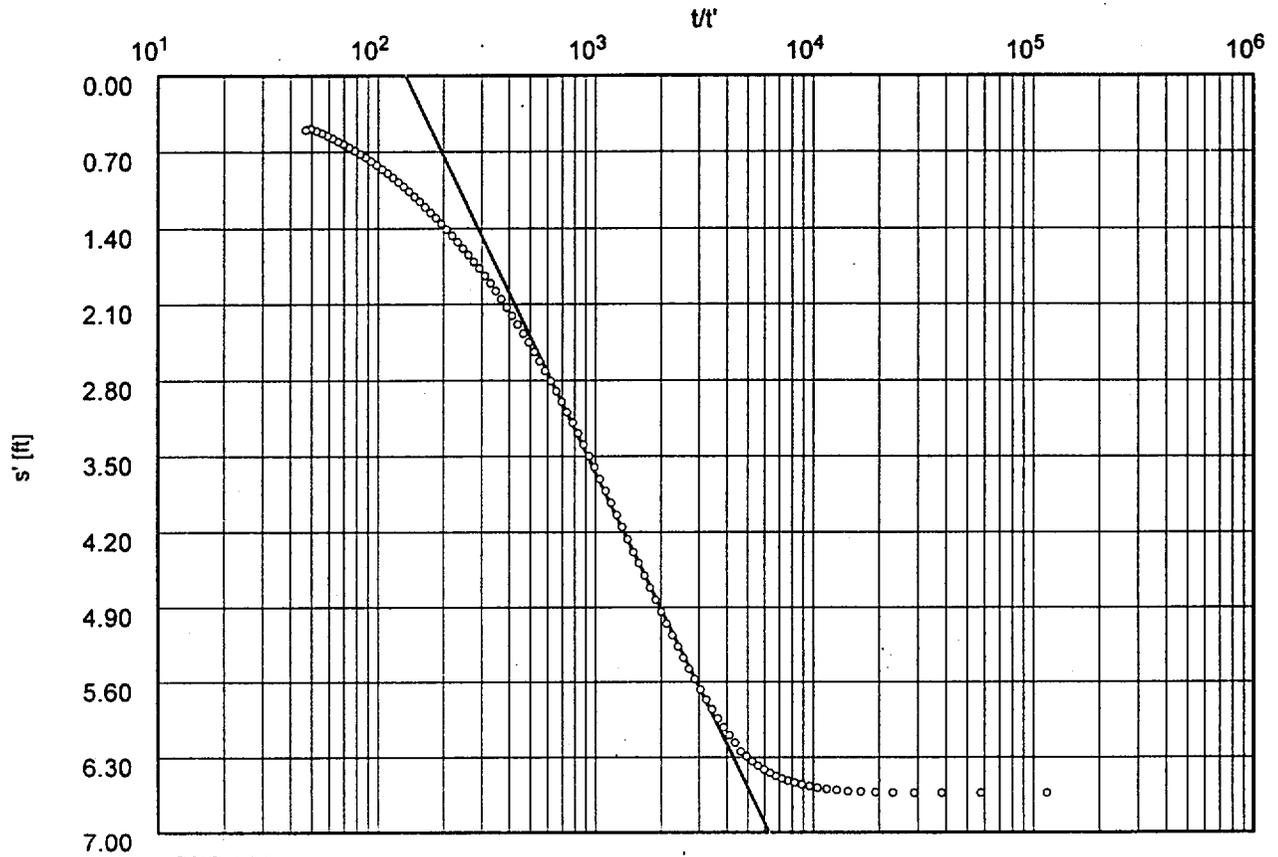
Pumping Test No. 041 AQ REC TEST 2

Test conducted on: 11/23/99

OBS 123, r = 30.8'

Discharge 38.10 U.S.gal/min

Pumping test duration: 4335.00 min



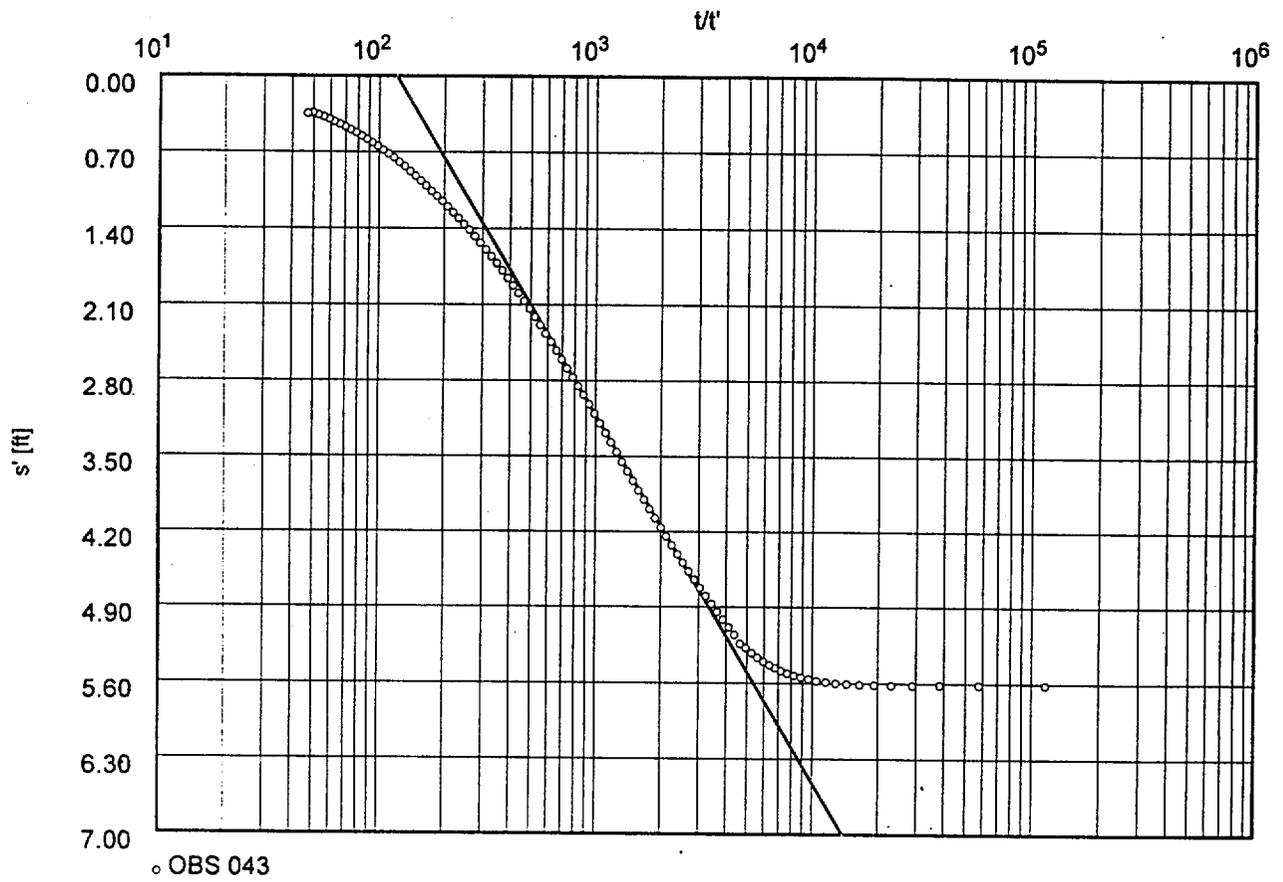
○ OBS 123

Transmissivity [ft<sup>2</sup>/min]:  $2.22 \times 10^{-1} = 319.7 \text{ Ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $7.42 \times 10^{-3}$

Aquifer thickness [ft]: 30.00

<b>MACTEC-ERS</b> 2597 B 3/4 RD GRAND JUNCTION, COLO ph.(970)248-6000	Pumping test analysis Recovery method after <b>THEIS &amp; JACOB</b> Unconfined aquifer	Page 1	
		Project: GUNNISON	
		Evaluated by:	Date: 02.12.1999
Pumping Test No. 041 AQ REC TEST 2		Test conducted on: 11/23/99	
OBS 043, r = 36.6'			
Discharge 38.10 U.S.gal/min			
Pumping test duration: 4335.00 min			



Transmissivity [ft<sup>2</sup>/min]:  $2.74 \times 10^{-1} = 394.6 \text{ FT}^2/\text{D}$

Hydraulic conductivity [ft/min]:  $9.16 \times 10^{-3}$

Aquifer thickness [ft]: 30.00

MACTEC-ERS  
2597 B 3/4 RD  
GRAND JUNCTION, COLO  
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Pumping test analysis  
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Unconfined aquifer

Page 1

Project: GUNNISON

Evaluated by:

Date: 02.12.1999

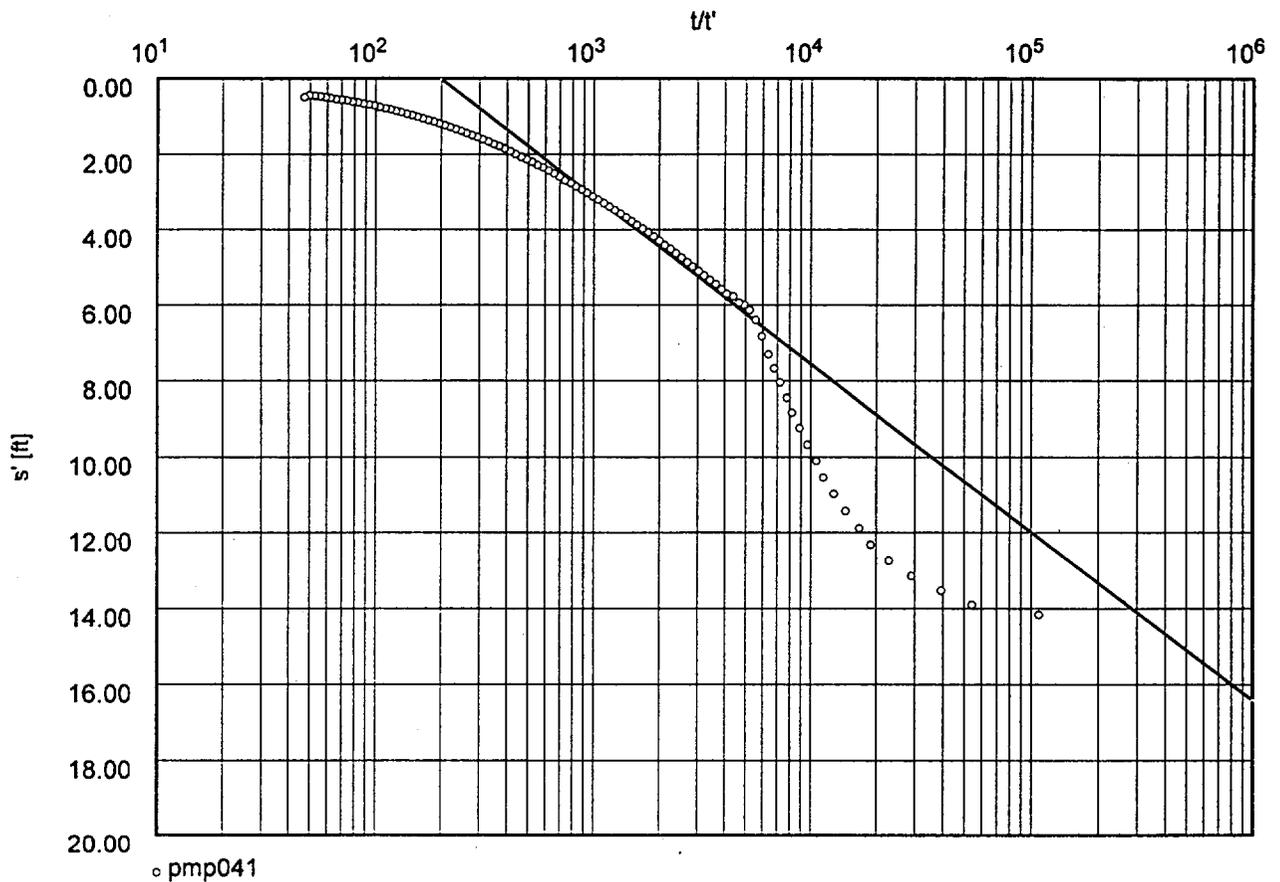
Pumping Test No. 041 AQ TEST 2 REC

Test conducted on: 11/23/99

PMP 041

Discharge 38.10 U.S.gal/min

Pumping test duration: 4335.00 min



Transmissivity [ $\text{ft}^2/\text{min}$ ]:  $2.10 \times 10^{-1} = 302.4 \text{ FT}^2/\text{min}$

Hydraulic conductivity [ $\text{ft}/\text{min}$ ]:  $7.00 \times 10^{-3}$

Aquifer thickness [ $\text{ft}$ ]: 30.00

**WELL 041 AQUIFER TEST 2**

**DRAWDOWN DATA**

GUNNISON UMTRA SITE  
WELL 041 AQUIFER TEST 2 DATA  
START DATE/TIME : 11/20/99, 1350  
PUMPING RATE : 38 GPM

<u>ELAPSED</u> <u>TIME (min)</u>	<u>WELL 041</u> <u>DTW (ft btoc)</u>	<u>WELL 042</u> <u>DTW (ft btoc)</u>	<u>WELL 043</u> <u>DTW (ft btoc)</u>	<u>WELL 123</u> <u>DTW (ft btoc)</u>	<u>INCHES Hg</u>
0.00	8.071	8.15	8.34	9.433	22.606
0.03	9.459	8.382	8.34	9.434	22.604
0.07	9.983	8.698	8.341	9.44	22.604
0.10	10.471	8.963	8.344	9.447	22.604
0.13	10.907	9.184	8.35	9.462	22.602
0.16	11.283	9.4	8.36	9.475	22.602
0.20	11.646	9.597	8.372	9.488	22.604
0.23	12.001	9.784	8.388	9.507	22.604
0.26	12.325	9.96	8.407	9.526	22.604
0.29	12.631	10.126	8.427	9.546	22.604
0.33	12.903	10.282	8.45	9.568	22.604
0.36	13.219	10.43	8.474	9.591	22.604
0.39	13.469	10.578	8.501	9.616	22.602
0.43	13.724	10.708	8.527	9.642	22.604
0.47	13.953	10.84	8.556	9.671	22.602
0.50	14.199	10.979	8.591	9.7	22.604
0.55	14.471	11.116	8.626	9.734	22.602
0.59	14.708	11.253	8.664	9.77	22.604
0.64	15.174	11.381	8.709	9.808	22.6
0.69	15.369	11.499	8.739	9.843	22.602
0.74	16.012	11.753	8.799	9.904	22.598
0.80	16.465	11.948	8.851	9.956	22.598
0.86	16.784	12.124	8.908	10.014	22.598
0.92	17.021	12.276	8.967	10.075	22.596
0.98	17.259	12.4	9.034	10.142	22.596
1.05	17.474	12.519	9.104	10.213	22.596
1.13	17.716	12.632	9.172	10.29	22.596
1.21	17.957	12.732	9.246	10.368	22.596
1.29	18.181	12.869	9.322	10.451	22.596
1.38	18.423	12.991	9.391	10.54	22.596
1.47	18.66	13.099	9.468	10.634	22.593
1.57	18.902	13.231	9.547	10.728	22.596
1.68	19.156	13.373	9.628	10.829	22.596
1.79	19.6	13.52	9.706	10.929	22.593
1.91	19.958	13.681	9.785	11.033	22.593
2.03	20.195	13.82	9.873	11.142	22.596
2.17	20.471	13.948	9.96	11.258	22.596
2.31	20.669	14.076	10.049	11.369	22.596
2.46	20.932	14.204	10.139	11.485	22.596
2.61	21.16	14.323	10.232	11.605	22.596
2.78	21.647	14.462	10.323	11.729	22.596
2.96	21.948	14.642	10.415	11.857	22.593
3.14	22.177	14.777	10.516	11.984	22.596
3.34	22.383	14.9	10.611	12.113	22.596
3.55	22.616	15.011	10.708	12.246	22.593
3.78	22.857	15.122	10.805	12.375	22.593
4.01	23.047	15.241	10.903	12.502	22.593
4.26	23.275	15.35	11.003	12.63	22.591
4.53	23.481	15.456	11.094	12.757	22.593
4.81	23.688	15.562	11.187	12.88	22.593
5.10	23.869	15.671	11.281	13.003	22.593
5.42	24.222	15.783	11.376	13.124	22.591
5.75	24.489	15.961	11.473	13.247	22.589
6.10	24.489	16.007	11.57	13.368	22.591

6.48	24.979	16.167	11.663	13.484	22.591
6.87	25.337	16.33	11.766	13.613	22.591
7.29	25.534	16.451	11.881	13.738	22.593
7.74	25.698	16.547	11.969	13.862	22.591
8.21	25.909	16.649	12.065	13.983	22.589
8.71	26.094	16.753	12.155	14.097	22.591
9.23	26.287	16.835	12.253	14.214	22.589
9.79	26.416	16.952	12.335	14.322	22.587
10.39	26.442	17	12.42	14.427	22.589
11.01	26.524	17.041	12.491	14.523	22.589
11.68	26.64	17.115	12.575	14.608	22.585
12.38	26.722	17.184	12.641	14.695	22.589
13.13	26.821	17.247	12.713	14.775	22.587
13.92	26.967	17.33	12.755	14.856	22.585
14.75	27.062	17.401	12.851	14.936	22.585
15.64	27.156	17.457	12.922	15.013	22.587
16.58	27.242	17.54	12.985	15.088	22.585
17.57	27.333	17.592	13.047	15.161	22.585
18.63	27.419	17.676	13.109	15.232	22.585
19.74	27.509	17.737	13.173	15.303	22.585
20.93	27.591	17.791	13.23	15.367	22.585
22.18	27.539	18.032	13.298	15.441	22.583
23.51	27.565	18.034	13.356	15.505	22.583
24.91	27.668	18.058	13.42	15.56	22.583
26.40	27.758	18.084	13.453	15.606	22.581
27.98	27.767	18.099	13.505	15.661	22.581
29.65	27.879	18.136	13.549	15.708	22.579
31.41	27.991	18.192	13.592	15.756	22.577
33.29	28.072	18.22	13.64	15.805	22.575
35.27	28.24	18.303	13.686	15.856	22.577
37.37	28.378	18.35	13.742	15.918	22.581
39.60	28.463	18.429	13.792	15.973	22.581
41.96	28.519	18.472	13.842	16.027	22.579
44.46	28.592	18.511	13.887	16.072	22.581
47.11	28.644	18.552	13.92	16.115	22.579
49.91	28.721	18.608	13.958	16.156	22.577
52.88	28.777	18.656	13.995	16.202	22.577
56.02	28.82	18.686	14.03	16.24	22.577
59.36	28.85	18.704	14.059	16.273	22.577
62.89	28.919	18.723	14.09	16.301	22.577
66.62	28.936	18.762	14.12	16.331	22.577
70.58	28.971	18.773	14.137	16.353	22.575
74.78	28.971	18.875	14.172	16.402	22.579
79.22	29.031	18.849	14.191	16.42	22.577
83.93	29.07	18.868	14.214	16.442	22.579
88.91	29.095	18.871	14.23	16.458	22.577
94.20	29.13	18.905	14.251	16.482	22.577
99.79	29.13	18.91	14.264	16.495	22.575
105.71	29.177	18.925	14.278	16.511	22.575
111.99	29.224	18.933	14.294	16.532	22.571
118.64	29.242	18.944	14.307	16.548	22.571
125.68	29.293	18.936	14.314	16.556	22.571
133.14	29.469	19.031	14.348	16.597	22.571
141.04	29.525	19.053	14.374	16.626	22.571
149.41	29.581	19.083	14.391	16.649	22.571
158.28	29.611	19.1	14.406	16.665	22.573
167.67	29.658	19.098	14.416	16.678	22.573
177.62	29.719	19.111	14.427	16.694	22.569
188.15	29.835	19.12	14.439	16.713	22.569
199.31	29.817	19.165	14.446	16.726	22.569
211.14	29.865	19.178	14.462	16.739	22.569
223.66	29.856	19.178	14.471	16.749	22.573

236.93	29.882	19.178	14.477	16.755	22.573
250.98	29.921	19.189	14.485	16.764	22.579
265.86	29.933	19.183	14.488	16.769	22.577
281.63	29.955	19.185	14.494	16.774	22.571
298.33	30.037	19.193	14.503	16.785	22.567
316.02	30.058	19.196	14.51	16.791	22.557
334.75	30.123	19.219	14.523	16.809	22.547
354.60	30.17	19.226	14.529	16.814	22.536
375.63	30.316	19.258	14.541	16.84	22.516
397.89	30.243	19.271	14.546	16.84	22.5
421.48	30.273	19.261	14.548	16.845	22.484
446.47	30.294	19.271	14.551	16.852	22.482
472.94	30.277	19.384	14.574	16.878	22.473
500.97	30.32	19.443	14.583	16.893	22.461
530.67	30.406	19.41	14.585	16.901	22.451
560.67	30.441	19.371	14.583	16.896	22.441
590.67	30.462	19.319	14.571	16.88	22.433
620.67	30.453	19.356	14.574	16.884	22.429
650.67	30.531	19.33	14.568	16.884	22.42
680.67	30.561	19.365	14.58	16.898	22.416
710.67	30.578	19.354	14.578	16.897	22.41
740.67	30.612	19.334	14.575	16.891	22.414
770.67	30.625	19.339	14.574	16.894	22.416
800.67	30.647	19.332	14.574	16.891	22.41
830.67	30.694	19.33	14.574	16.896	22.4
860.67	30.69	19.352	14.577	16.9	22.396
890.67	30.69	19.323	14.575	16.893	22.4
920.67	30.707	19.308	14.572	16.89	22.382
950.67	30.677	19.297	14.568	16.884	22.378
980.67	30.698	19.31	14.572	16.891	22.374
1010.67	30.69	19.291	14.57	16.882	22.376
1040.67	30.681	19.276	14.564	16.88	22.374
1070.67	30.703	19.274	14.565	16.882	22.39
1100.67	30.724	19.274	14.564	16.877	22.384
1130.67	30.746	19.28	14.565	16.884	22.394
1160.67	30.711	19.267	14.562	16.878	22.429
1190.67	30.685	19.267	14.559	16.871	22.453
1220.67	30.776	19.291	14.561	16.884	22.465
1250.67	30.737	19.269	14.556	16.874	22.455
1280.67	30.69	19.254	14.546	16.861	22.439
1310.67	30.69	19.241	14.539	16.849	22.427
1340.67	30.681	19.232	14.535	16.845	22.408
1370.67	30.66	19.215	14.526	16.833	22.398
1400.67	30.612	19.202	14.522	16.817	22.388
1430.67	30.638	19.204	14.522	16.822	22.38
1460.67	30.668	19.204	14.519	16.817	22.367
1490.67	30.668	19.202	14.52	16.817	22.353
1520.67	30.599	19.215	14.525	16.822	22.351
1550.67	30.642	19.222	14.526	16.823	22.343
1580.67	30.587	19.189	14.522	16.811	22.337
1610.67	30.621	19.206	14.526	16.817	22.331
1640.67	30.621	19.211	14.529	16.823	22.329
1670.67	30.664	19.213	14.532	16.829	22.327
1700.67	30.698	19.217	14.536	16.835	22.333
1730.67	30.72	19.202	14.532	16.832	22.333
1760.67	30.733	19.206	14.532	16.832	22.327
1790.67	30.737	19.209	14.535	16.833	22.329
1820.67	30.754	19.215	14.539	16.842	22.329
1850.67	30.746	19.217	14.542	16.843	22.331
1880.67	30.75	19.217	14.542	16.843	22.331
1910.67	30.707	19.258	14.549	16.851	22.329
1940.67	30.746	19.254	14.548	16.851	22.329

1970.67	30.728	19.252	14.548	16.849	22.329
2000.67	30.728	19.254	14.546	16.849	22.329
2030.67	30.758	19.254	14.543	16.849	22.323
2060.67	30.741	19.25	14.542	16.846	22.319
2090.67	30.737	19.243	14.539	16.843	22.313
2120.67	30.784	19.241	14.538	16.842	22.315
2150.67	30.728	19.261	14.539	16.845	22.317
2180.67	30.754	19.25	14.536	16.84	22.317
2210.67	30.703	19.241	14.533	16.836	22.313
2240.67	30.771	19.239	14.532	16.835	22.313
2270.67	30.758	19.245	14.532	16.836	22.315
2300.67	30.758	19.248	14.535	16.838	22.315
2330.67	30.746	19.241	14.535	16.838	22.313
2360.67	30.767	19.243	14.535	16.839	22.317
2390.67	30.793	19.252	14.536	16.842	22.315
2420.67	30.857	19.269	14.545	16.852	22.317
2450.67	30.874	19.265	14.551	16.856	22.321
2480.67	30.9	19.274	14.555	16.865	22.317
2510.67	30.87	19.276	14.559	16.869	22.321
2540.67	30.913	19.271	14.558	16.871	22.333
2570.67	30.866	19.261	14.554	16.865	22.351
2600.67	30.905	19.267	14.556	16.869	22.372
2630.67	30.892	19.263	14.556	16.869	22.402
2660.67	30.896	19.261	14.556	16.869	22.429
2690.67	30.857	19.245	14.555	16.864	22.451
2720.67	30.926	19.265	14.562	16.872	22.461
2750.67	30.9	19.271	14.564	16.877	22.457
2780.67	30.926	19.269	14.567	16.878	22.457
2810.67	30.935	19.271	14.571	16.881	22.471
2840.67	30.913	19.276	14.575	16.884	22.463
2870.67	30.943	19.274	14.575	16.885	22.457
2900.67	30.939	19.28	14.572	16.882	22.445
2930.67	30.982	19.276	14.565	16.877	22.443
2960.67	30.939	19.265	14.558	16.869	22.449
2990.67	30.917	19.248	14.555	16.867	22.453
3020.67	30.952	19.256	14.565	16.875	22.463
3050.67	30.947	19.263	14.57	16.88	22.465
3080.67	30.965	19.252	14.568	16.877	22.471
3110.67	30.947	19.25	14.562	16.875	22.477
3140.67	30.96	19.25	14.559	16.871	22.49
3170.67	30.947	19.252	14.556	16.869	22.49
3200.67	30.99	19.258	14.559	16.872	22.494
3230.67	30.986	19.267	14.564	16.878	22.492
3260.67	31.033	19.276	14.571	16.885	22.49
3290.67	31.051	19.278	14.571	16.887	22.498
3320.67	31.072	19.284	14.574	16.891	22.51
3350.67	31.119	19.297	14.58	16.898	22.532
3380.67	31.085	19.289	14.581	16.896	22.585
3410.67	31.132	19.306	14.583	16.904	22.689
3440.67	31.124	19.31	14.583	16.903	22.854
3470.67	31.141	19.334	14.59	16.909	23.08
3500.67	31.201	19.341	14.596	16.919	23.422
3530.67	31.214	19.367	14.604	16.929	23.793
3560.67	30.999	19.28	14.558	16.874	23.921
3590.67	31.179	19.33	14.587	16.91	23.941
3620.67	31.227	19.354	14.597	16.92	24.104
3650.67	31.252	19.345	14.597	16.919	24.395
3680.67	31.3	19.373	14.612	16.936	32.57
3710.67	31.201	19.336	14.59	16.913	34.551
3740.67	31.235	19.365	14.609	16.935	34.724
3770.67	31.261	19.356	14.603	16.93	34.681
3800.67	31.24	19.354	14.6	16.926	34.415

3830.67	31.128	19.306	14.575	16.9	24.353
3860.67	31.085	19.289	14.567	16.89	23.544
3890.67	31.089	19.287	14.562	16.887	23.102
3920.67	31.145	19.297	14.567	16.891	22.954
3950.67	31.141	19.297	14.565	16.891	22.899
3980.67	31.145	19.295	14.567	16.891	22.789
4010.67	31.167	19.3	14.564	16.891	22.716
4040.67	31.128	19.31	14.567	16.894	22.693
4070.67	31.136	19.304	14.565	16.893	22.689
4100.67	31.145	19.304	14.564	16.893	22.705
4130.67	31.115	19.291	14.555	16.882	22.738
4160.67	31.115	19.291	14.554	16.881	22.758
4190.67	31.124	19.282	14.552	16.877	22.769
4220.67	31.102	19.287	14.548	16.874	22.765
4250.67	31.055	19.28	14.545	16.867	22.765
4280.67	31.042	19.269	14.539	16.859	22.75
4310.67	31.016	19.267	14.536	16.855	22.746

RECOVERY DATA

4335.00	31.154	19.342	14.609	17.023	22.75
4335.04	30.978	19.338	14.609	17.021	22.75
4335.08	29.947	19.305	14.609	17.021	22.75
4335.11	28.679	19.23	14.61	17.021	22.75
4335.15	27.501	19.117	14.613	17.02	22.75
4335.19	26.413	18.978	14.613	17.017	22.748
4335.23	25.389	18.824	14.609	17.014	22.75
4335.26	24.412	18.653	14.606	17.007	22.752
4335.30	23.452	18.469	14.6	17	22.75
4335.34	22.547	18.276	14.591	16.987	22.75
4335.38	21.72	18.074	14.578	16.975	22.75
4335.41	20.936	17.866	14.565	16.959	22.75
4335.45	20.191	17.654	14.545	16.94	22.752
4335.49	19.484	17.437	14.526	16.92	22.752
4335.53	18.833	17.218	14.501	16.897	22.752
4335.57	18.225	16.993	14.475	16.871	22.75
4335.60	17.63	16.765	14.446	16.843	22.752
4335.64	17.09	16.52	14.413	16.811	22.75
4335.68	16.573	16.232	14.379	16.775	22.75
4335.73	15.913	15.824	14.339	16.734	22.75
4335.78	15.326	15.403	14.295	16.688	22.752
4335.83	14.993	15.064	14.243	16.634	22.752
4335.88	14.816	14.808	14.185	16.57	22.752
4335.93	14.739	14.667	14.136	16.514	22.75
4335.99	14.536	14.459	14.034	16.405	22.746
4336.06	14.449	14.314	13.952	16.315	22.746
4336.12	14.303	14.17	13.865	16.217	22.746
4336.19	14.13	14.027	13.778	16.114	22.746
4336.27	13.987	13.89	13.691	16.005	22.744
4336.35	13.845	13.749	13.602	15.89	22.744
4336.43	13.702	13.613	13.509	15.771	22.744
4336.52	13.56	13.476	13.418	15.649	22.744
4336.61	13.413	13.339	13.325	15.525	22.744
4336.71	13.271	13.205	13.23	15.397	22.744
4336.82	13.128	13.07	13.134	15.265	22.742
4336.93	12.99	12.938	13.037	15.133	22.742
4337.05	12.856	12.805	12.938	15	22.74
4337.17	12.718	12.677	12.839	14.865	22.742
4337.30	12.588	12.551	12.739	14.728	22.74
4337.44	12.459	12.427	12.639	14.592	22.74
4337.59	12.338	12.306	12.538	14.457	22.74
4337.75	12.221	12.188	12.436	14.319	22.74
4337.92	12.1	12.069	12.335	14.197	22.738
4338.09	11.988	11.956	12.233	14.051	22.74

4338.28	11.871	11.843	12.131	13.919	22.74
4338.48	11.763	11.732	12.031	13.787	22.738
4338.69	11.659	11.624	11.93	13.659	22.738
4338.91	11.551	11.515	11.831	13.53	22.738
4339.15	11.448	11.413	11.731	13.403	22.736
4339.40	11.352	11.309	11.634	13.28	22.738
4339.66	11.253	11.207	11.535	13.16	22.736
4339.94	11.154	11.107	11.439	13.039	22.736
4340.24	11.059	11.009	11.343	12.923	22.738
4340.55	10.964	10.911	11.251	12.811	22.736
4340.89	10.877	10.818	11.159	12.701	22.738
4341.24	10.773	10.727	11.068	12.594	22.734
4341.61	10.683	10.633	10.978	12.485	22.736
4342.01	10.601	10.542	10.891	12.38	22.734
4342.43	10.514	10.455	10.805	12.276	22.736
4342.87	10.436	10.37	10.719	12.177	22.734
4343.34	10.354	10.288	10.638	12.083	22.736
4343.84	10.281	10.207	10.557	11.988	22.734
4344.37	10.212	10.14	10.48	11.898	22.734
4344.93	10.125	10.057	10.403	11.81	22.734
4345.52	10.052	9.981	10.328	11.724	22.732
4346.15	9.978	9.909	10.254	11.64	22.732
4346.82	9.913	9.838	10.182	11.557	22.732
4347.52	9.848	9.768	10.111	11.477	22.732
4348.27	9.779	9.701	10.044	11.403	22.732
4349.06	9.719	9.636	9.979	11.328	22.732
4349.89	9.658	9.57	9.912	11.255	22.73
4350.78	9.598	9.507	9.851	11.187	22.732
4351.72	9.546	9.449	9.79	11.12	22.732
4352.71	9.485	9.392	9.732	11.056	22.73
4353.77	9.433	9.334	9.674	10.994	22.728
4354.88	9.381	9.277	9.618	10.931	22.726
4356.06	9.33	9.225	9.564	10.873	22.728
4357.32	9.278	9.173	9.512	10.816	22.726
4358.64	9.23	9.12	9.461	10.763	22.728
4360.05	9.191	9.079	9.416	10.712	22.728
4361.54	9.144	9.029	9.365	10.66	22.726
4363.11	9.1	8.981	9.319	10.609	22.726
4364.78	9.062	8.936	9.272	10.561	22.726
4366.55	9.018	8.894	9.229	10.512	22.728
4368.43	8.975	8.851	9.185	10.466	22.724
4370.41	8.94	8.81	9.144	10.423	22.724
4372.51	8.902	8.77	9.104	10.381	22.724
4374.74	8.867	8.736	9.067	10.339	22.726
4377.10	8.837	8.699	9.031	10.302	22.724
4379.60	8.802	8.662	8.995	10.263	22.724
4382.24	8.772	8.627	8.961	10.225	22.724
4385.05	8.737	8.597	8.928	10.191	22.72
4388.02	8.711	8.564	8.897	10.159	22.724
4391.16	8.69	8.536	8.868	10.125	22.722
4394.49	8.659	8.51	8.841	10.096	22.722
4398.02	8.638	8.481	8.813	10.067	22.722
4401.76	8.62	8.455	8.789	10.04	22.72
4405.72	8.59	8.431	8.764	10.012	22.72
4409.92	8.573	8.41	8.742	9.987	22.72
4414.36	8.551	8.388	8.72	9.964	22.718
4419.07	8.534	8.364	8.701	9.942	22.718
4424.05	8.517	8.347	8.681	9.92	22.718
4429.05	8.569	8.381	8.691	9.933	22.714

**WELL 041 AQUIFER TEST 3**

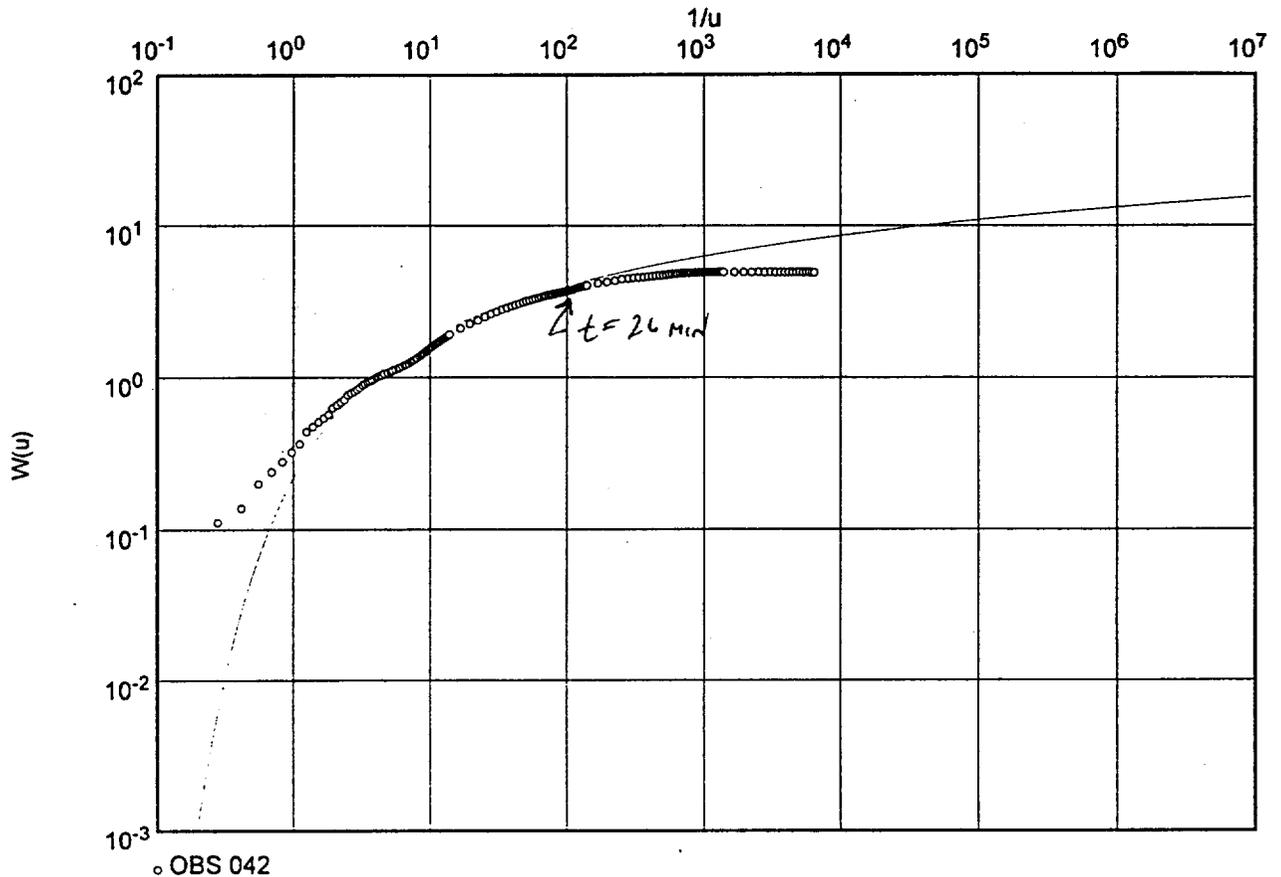
**PLOTS FOR PUMPING WELL 041 AND OBSERVATION WELLS 042, 043, AND 123**

Pumping Test No. 041 AQ TEST 3, t = 8 hrs

Test conducted on: 12/2/99

OBS 042, r = 26.8'

Discharge 44.70 U.S.gal/min



Transmissivity [ft<sup>2</sup>/min]:  $2.12 \times 10^{-1} = 305.3 \text{ ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $7.08 \times 10^{-3}$

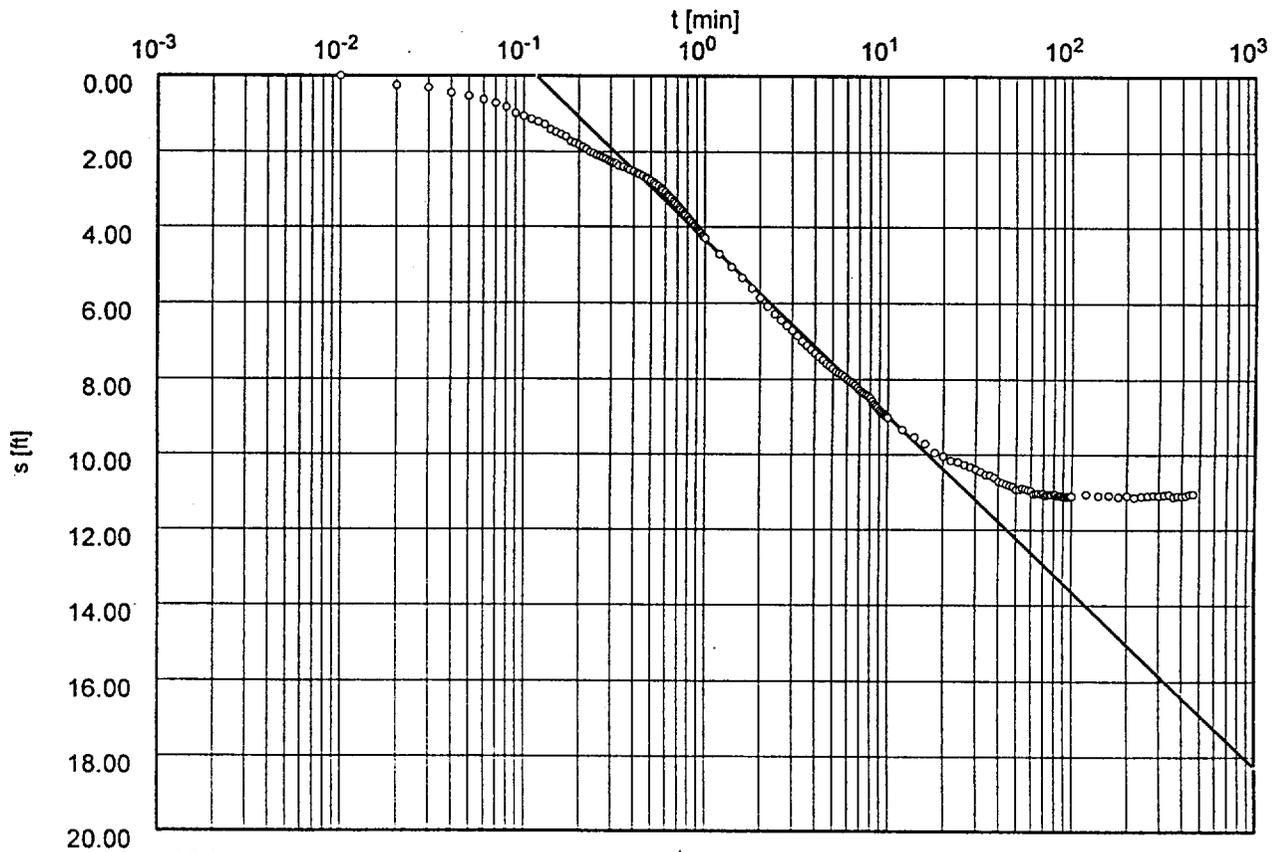
Aquifer thickness [ft]: 30.00

Pumping Test No. 041 AQ TEST 3, t = 8 hrs

Test conducted on: 12/2/99

OBS 042, r = 26.8'

Discharge 44.70 U.S.gal/min



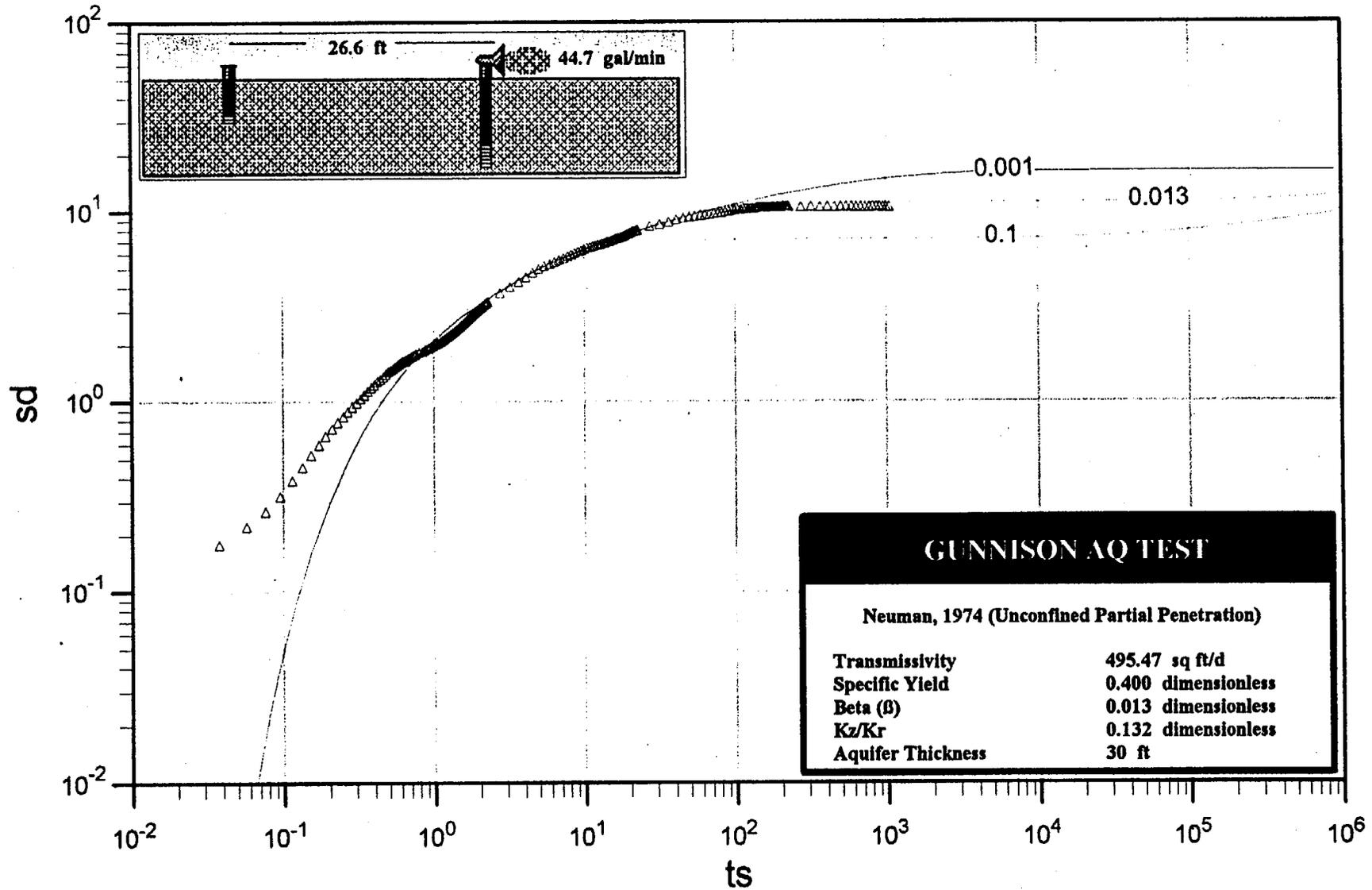
o OBS 042

Transmissivity [ft<sup>2</sup>/min]:  $2.35 \times 10^{-1} = 336.4 \text{ ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $7.83 \times 10^{-3}$

Aquifer thickness [ft]: 30.00

# WELL OBS 042 / 041 AQ TEST 3



**MACTEC-ERS**  
 2597 B 3/4 RD  
 GRAND JUNCTION, COLO  
 ph.(970)248-6000

Pumping test analysis  
 This analysis method  
 Unconfined aquifer

Page 1

Project: GUNNISON

Evaluated by:

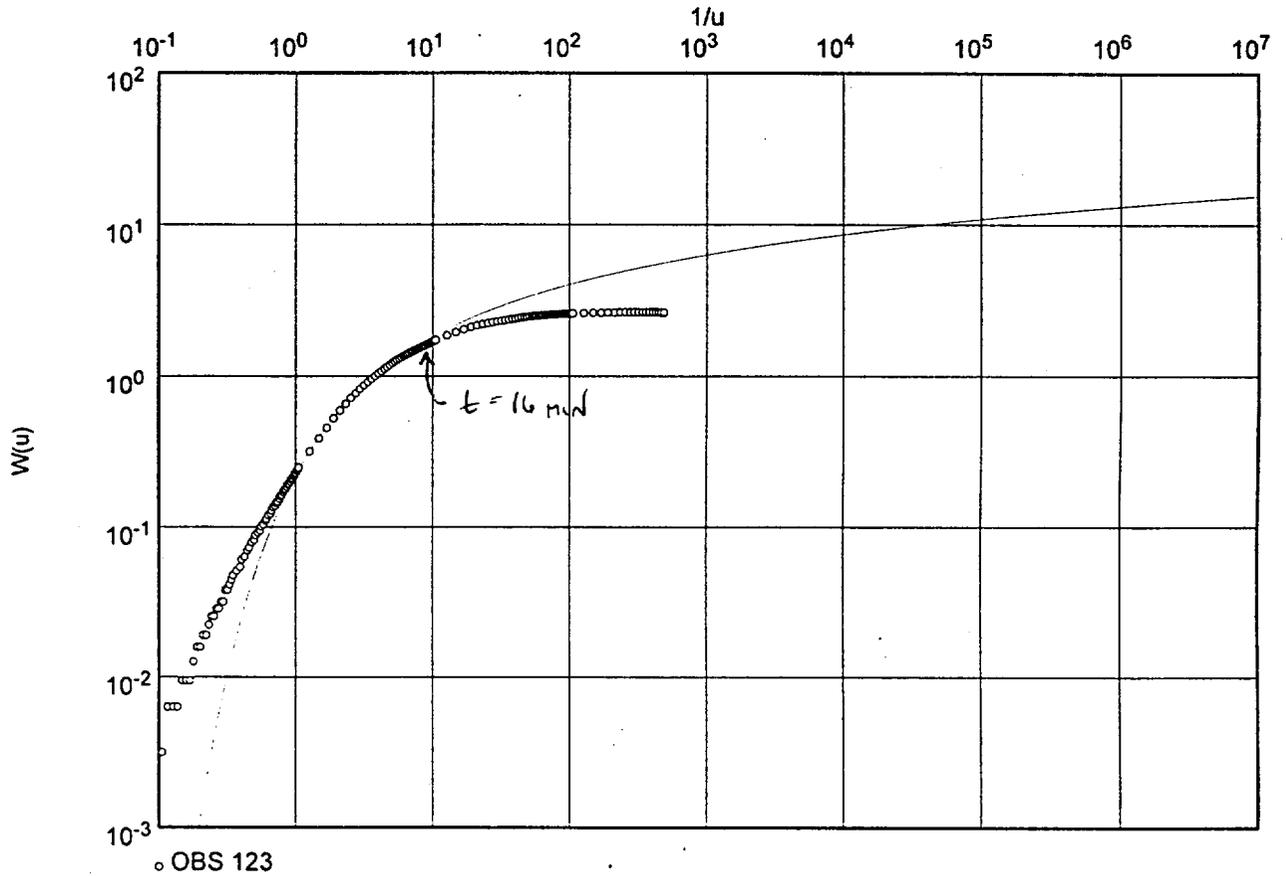
Date: 02.12.1999

Pumping Test No. 041 AQ TEST 3, t = 8 hrs

Test conducted on: 12/2/99

OBS 123, r = 30.8', SI = 53.2' - 58.2'

Discharge 44.70 U.S.gal/min



Transmissivity [ft<sup>2</sup>/min]:  $1.50 \times 10^{-1} = 216.0 \text{ Ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $5.01 \times 10^{-3}$

Aquifer thickness [ft]: 30.00

MACTEC-ERS  
2597 B 3/4 RD  
GRAND JUNCTION, COLO  
ph.(970)248-6000

Pumping test analysis  
Time-Drawdown-method after  
COOPER & JACOB  
Unconfined aquifer

Page 1

Project: GUNNISON

Evaluated by:

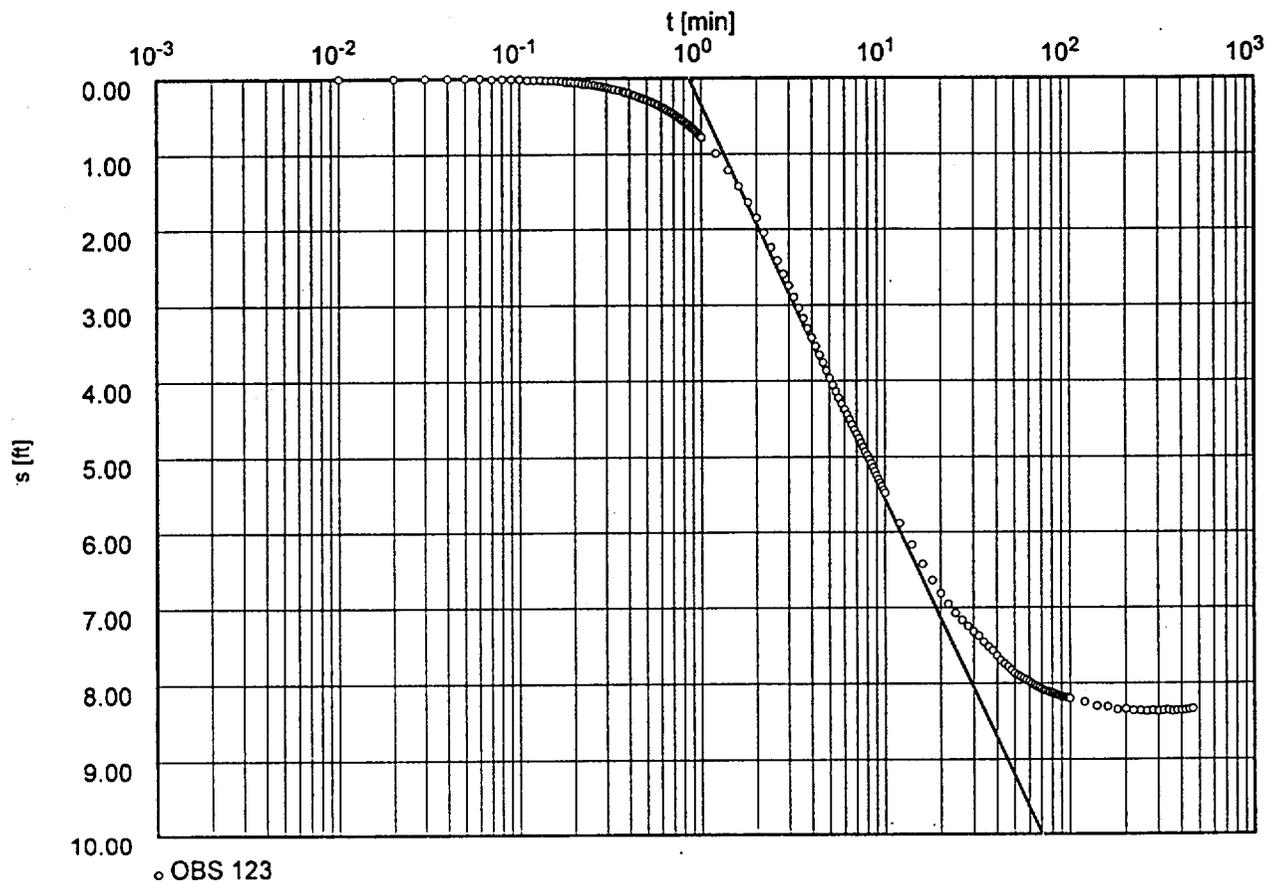
Date: 02.12.1999

Pumping Test No. 041 AQ TEST 3, t = 8 hrs

Test conducted on: 12/2/99

OBS 123, r = 30.8', SI = 53.2' - 58.2'

Discharge 44.70 U.S.gal/min

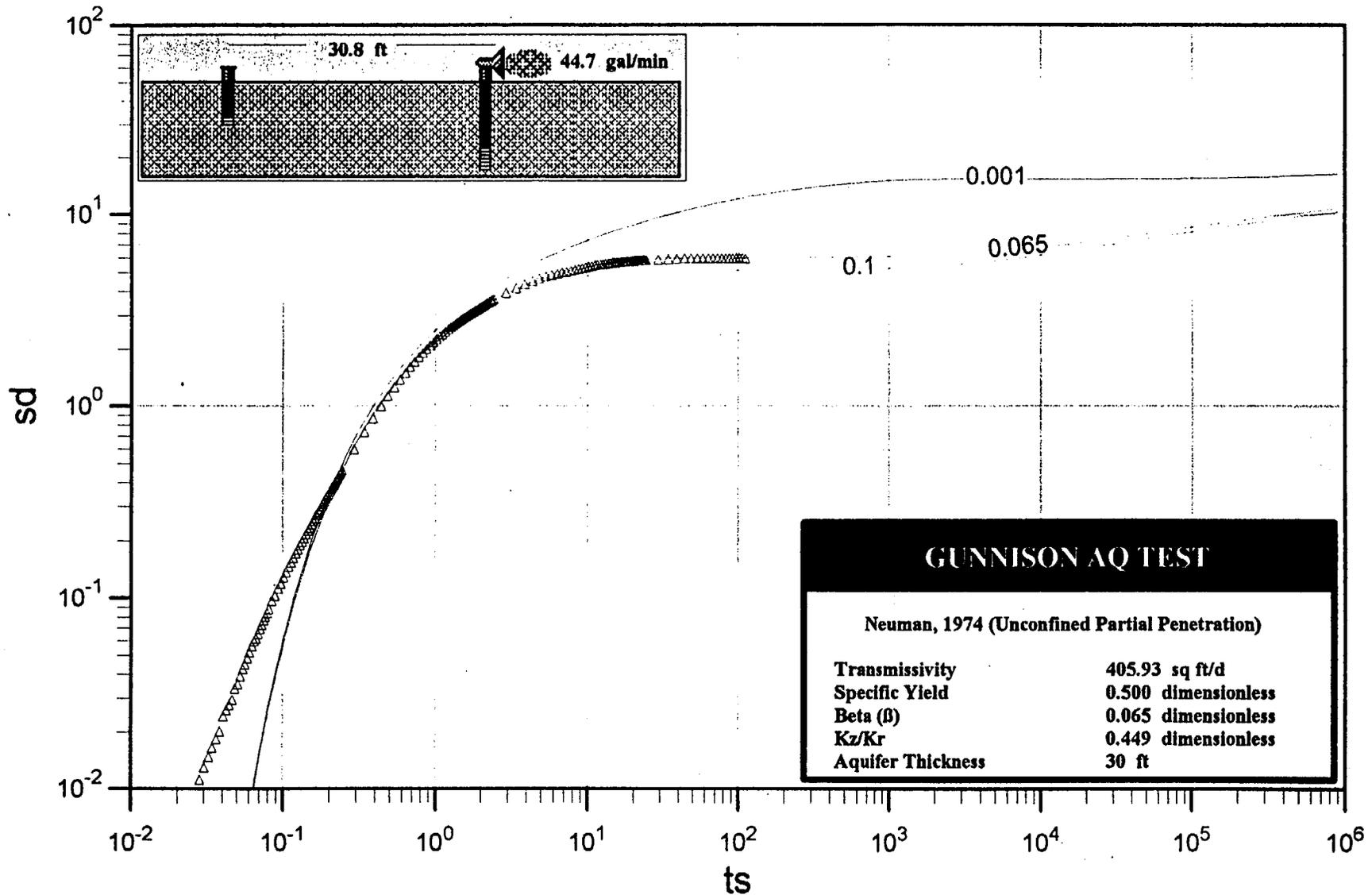


Transmissivity [ft<sup>2</sup>/min]:  $2.09 \times 10^{-1} = 321.0 \text{ ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $6.99 \times 10^{-3}$

Aquifer thickness [ft]: 30.00

# WELL OBS 123 / 041 AQ TEST 3

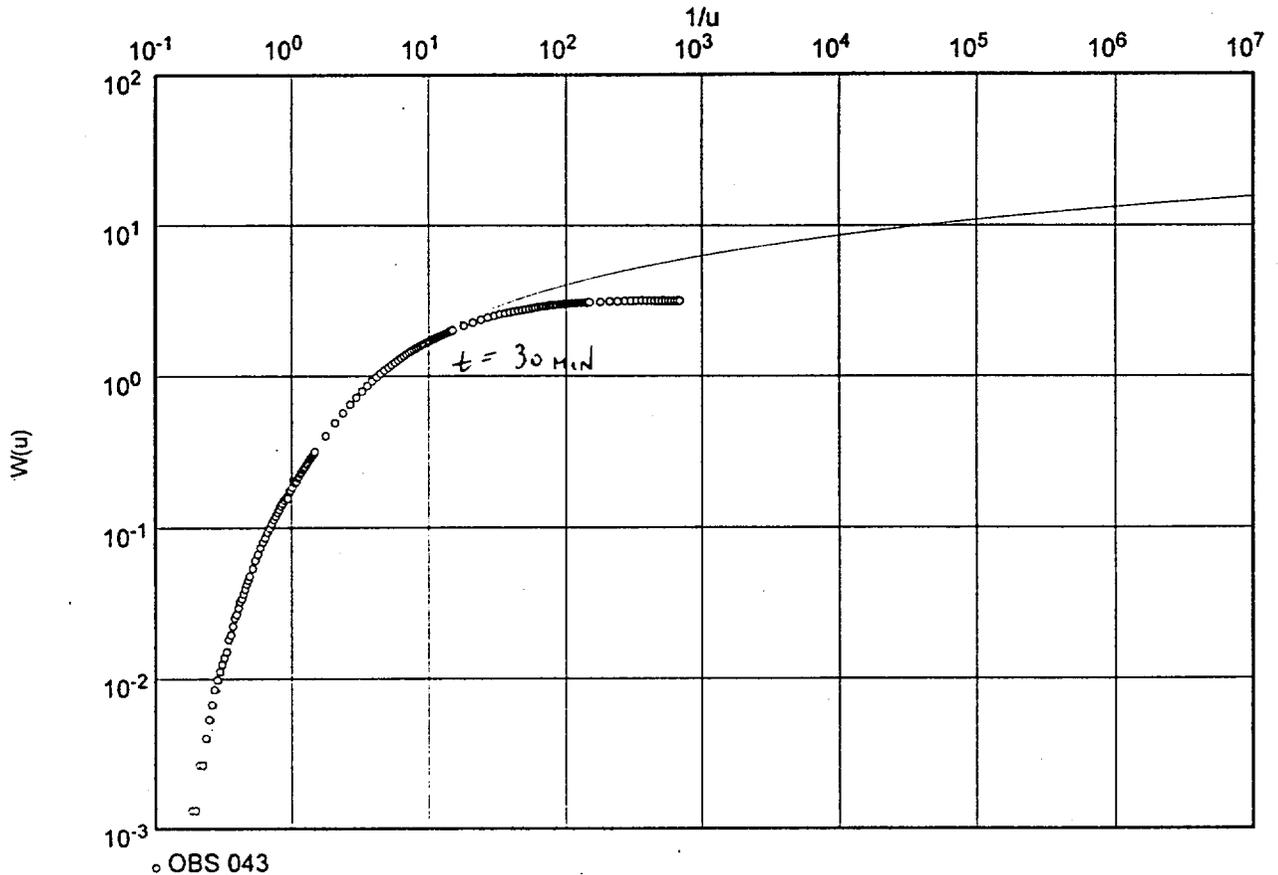


Pumping Test No. 041 AQ TEST 3, t = 8 hrs

Test conducted on: 12/2/99

OBS 043, r = 36.6'

Discharge 44.70 U.S.gal/min



Transmissivity [ft<sup>2</sup>/min]:  $2.12 \times 10^{-1} = 305.3 \text{ FT}^2/\text{D}$

Hydraulic conductivity [ft/min]:  $7.08 \times 10^{-3}$

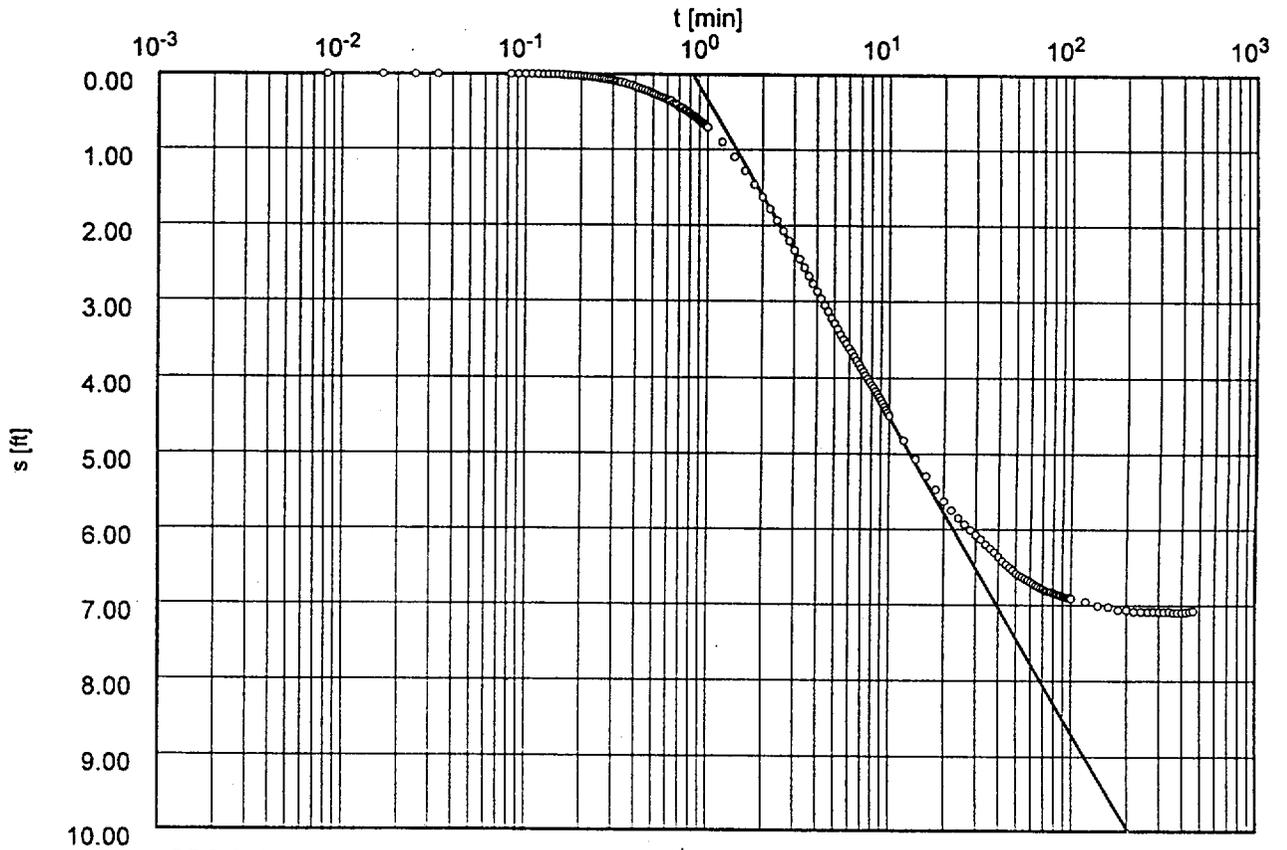
Aquifer thickness [ft]: 30.00

Pumping Test No. 041 AQ TEST 3, t = 8 hrs

Test conducted on: 12/2/99

OBS 043, r = 36.6'

Discharge 44.70 U.S.gal/min



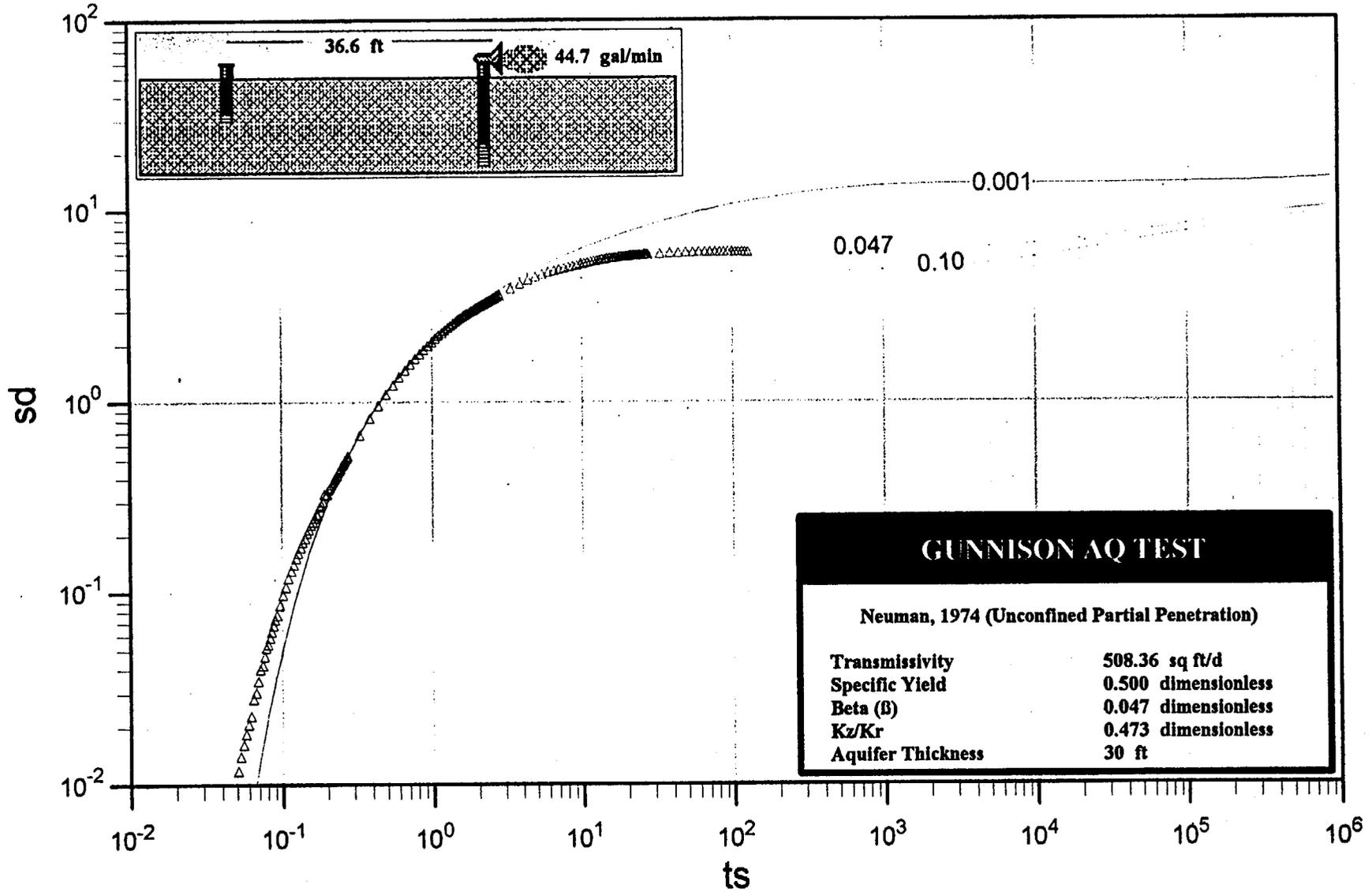
o OBS 043

Transmissivity [ft<sup>2</sup>/min]:  $2.61 \times 10^{-1} = 375.3 \text{ Ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $8.71 \times 10^{-3}$

Aquifer thickness [ft]: 30.00

# WELL OBS 043 / O41 AQ TEST 3



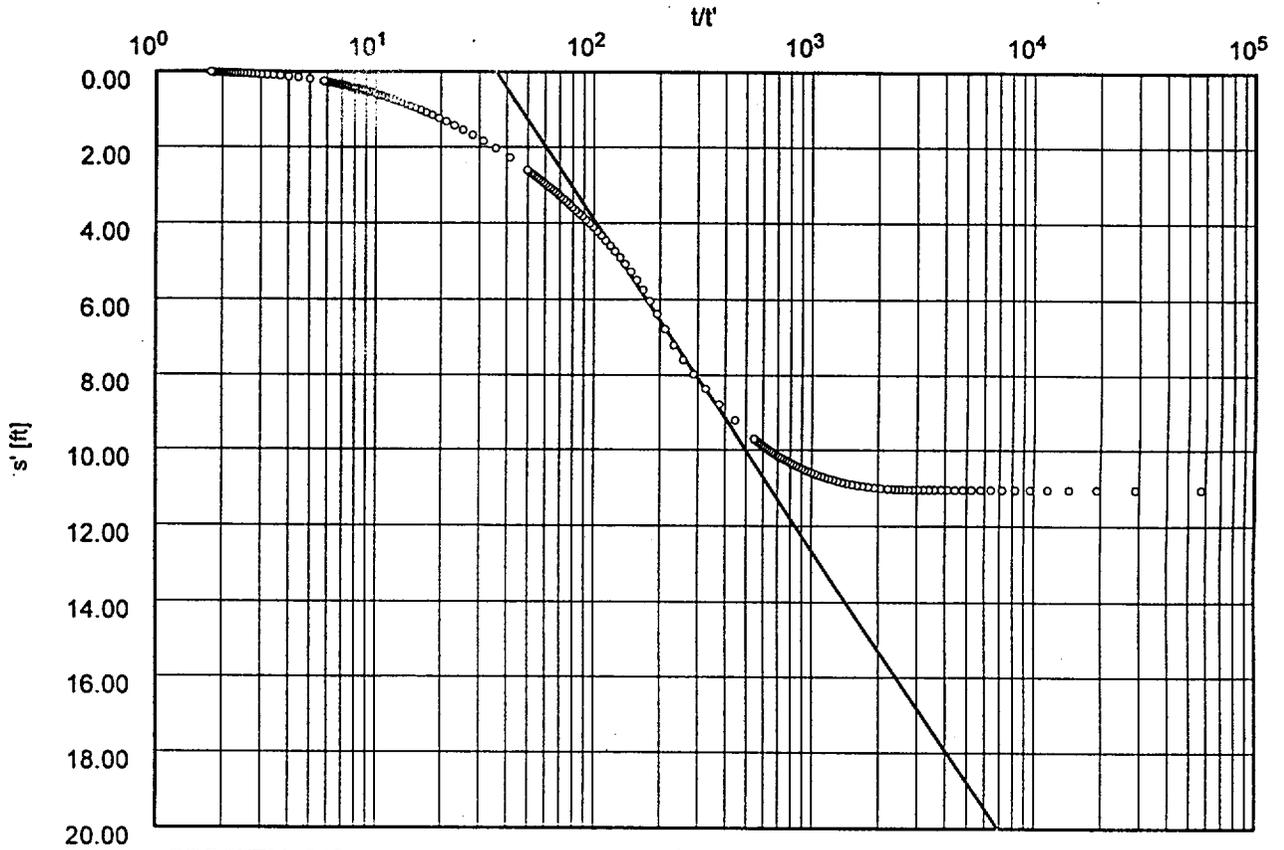
Pumping Test No. 041 AQ TEST 3 REC

Test conducted on: 12/2/99

OBS 042, r = 26.6'

Discharge 44.70 U.S.gal/min

Pumping test duration: 480.00 min



○ OBS WELL 042

Transmissivity [ft<sup>2</sup>/min]:  $1.24 \times 10^{-1} = 178.6 \text{ ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $4.16 \times 10^{-3}$

Aquifer thickness [ft]: 30.00

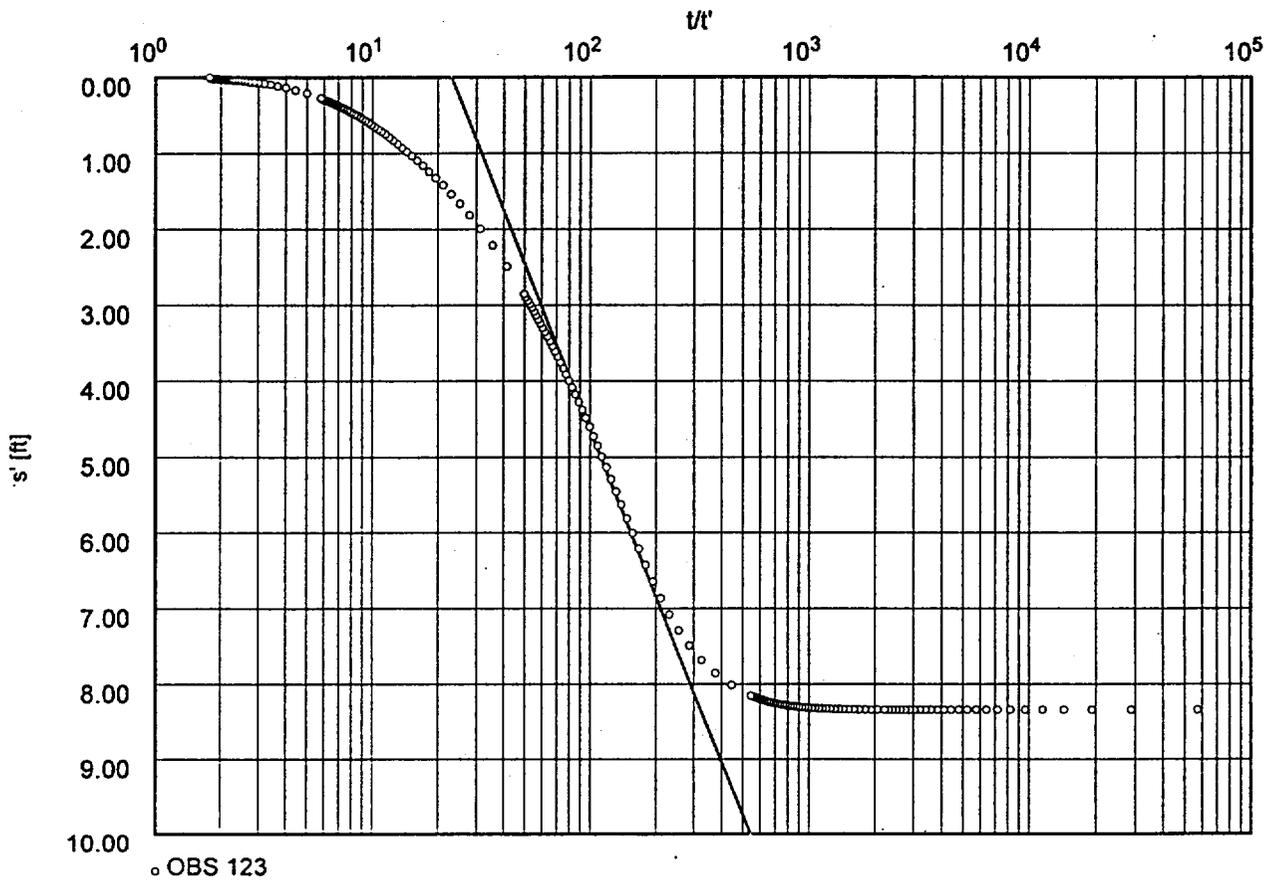
Pumping Test No. 041 AQ TEST 3 REC

Test conducted on: 12/2/99

OBS 123, r = 30.8'

Discharge 44.70 U.S.gal/min

Pumping test duration: 480.00 min



Transmissivity [ft<sup>2</sup>/min]:  $1.50 \times 10^{-1} = 216 \text{ Ft}^2/\text{D}$

Hydraulic conductivity [ft/min]:  $5.00 \times 10^{-3}$

Aquifer thickness [ft]: 30.00

MACTEC-ERS  
2597 B 3/4 RD  
GRAND JUNCTION, COLO  
ph.(970)248-6000

Pumping test analysis  
Recovery method after  
THEIS & JACOB  
Unconfined aquifer

Page 1

Project: GUNNISON

Evaluated by:

Date: 06.12.1999

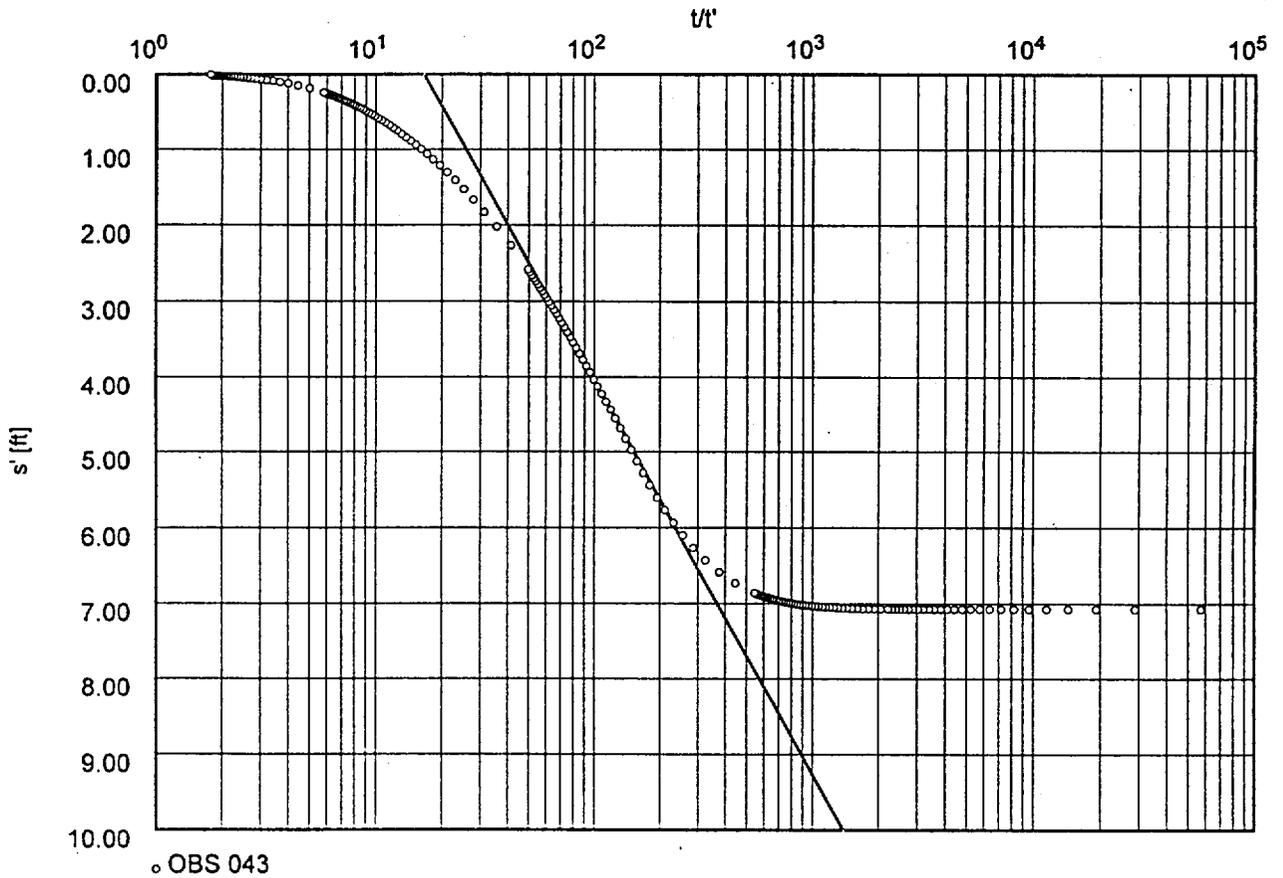
Pumping Test No. 043 AQ TEST 3 REC

Test conducted on: 12/2/99

OBS 043, r = 36.6'

Discharge 44.70 U.S.gal/min

Pumping test duration: 480.00 min



Transmissivity [ $\text{ft}^2/\text{min}$ ]:  $2.10 \times 10^{-1} = 302.4 \text{ FT}^2/\text{D}$

Hydraulic conductivity [ $\text{ft}/\text{min}$ ]:  $7.00 \times 10^{-3}$

Aquifer thickness [ $\text{ft}$ ]: 30.00

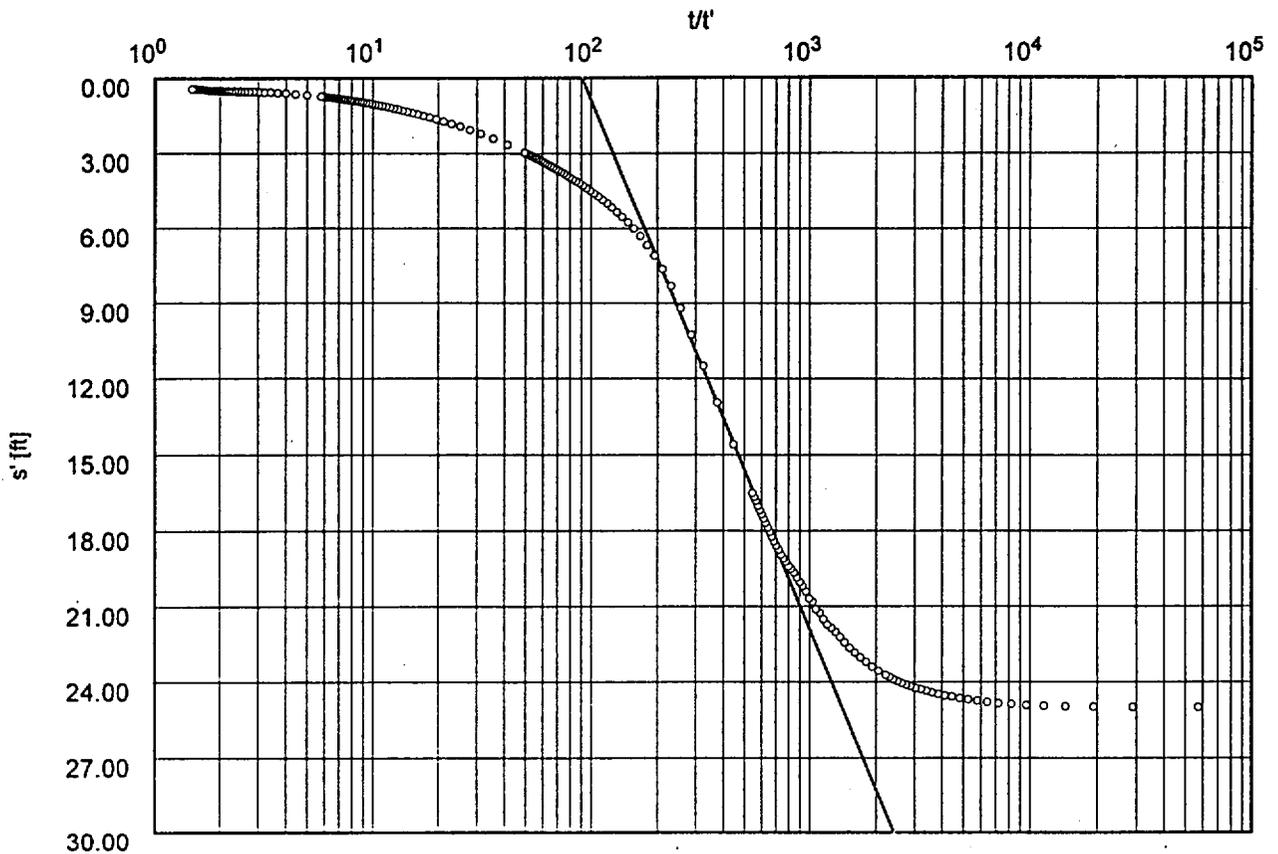
Pumping Test No. 041 AQ TEST 3 REC

Test conducted on: 12/2/99

PMP 041

Discharge 44.70 U.S.gal/min

Pumping test duration: 480.00 min



o WELL PMP 041

Transmissivity [ft<sup>2</sup>/min]:  $5.19 \times 10^{-2} = 74.7 \text{ Ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:

Aquifer thickness [ft]:

**WELL 041 AQUIFER TEST 3**

**DRAWDOWN DATA**

GUNNISON UMTRA SITE  
WELL 041 AQUIFER TEST 3 DATA  
START DATE/TIME : 12/2/99, 0830  
PUMPING RATE : 45 GPM

<u>ELAPSED TIME (min)</u>	<u>WELL 041 DTW (ft btoc)</u>	<u>WELL 042 DTW (ft btoc)</u>	<u>WELL 043 DTW (ft btoc)</u>	<u>WELL 120 DTW (ft btoc)</u>	<u>WELL 123 DTW (ft btoc)</u>	<u>WELL 122 DTW (ft btoc)</u>
0.00	7.857	8.29	8.673	6.11	9.82	10.886
0.01	9.71	8.29	8.67	6.11	9.82	10.886
0.02	9.578	8.537	8.67	6.11	9.82	10.886
0.03	9.852	8.598	8.67	6.11	9.82	10.886
0.03	10.173	8.66	8.67	6.11	9.823	10.886
0.04	10.391	8.736	8.666	6.11	9.823	10.886
0.05	10.702	8.827	8.666	6.11	9.823	10.886
0.06	10.91	8.922	8.666	6.11	9.823	10.886
0.07	11.213	9.021	8.666	6.11	9.826	10.886
0.08	11.439	9.117	8.666	6.11	9.826	10.886
0.08	11.694	9.207	8.67	6.11	9.829	10.89
0.09	11.93	9.292	8.67	6.11	9.829	10.89
0.10	12.252	9.373	8.67	6.11	9.832	10.89
0.11	12.469	9.449	8.67	6.11	9.835	10.893
0.12	12.705	9.52	8.67	6.11	9.839	10.89
0.13	12.931	9.592	8.673	6.11	9.842	10.893
0.13	13.177	9.663	8.673	6.11	9.845	10.893
0.14	13.347	9.73	8.676	6.11	9.848	10.893
0.15	13.602	9.801	8.676	6.11	9.851	10.893
0.16	13.809	9.867	8.679	6.11	9.854	10.893
0.17	13.998	9.934	8.682	6.11	9.861	10.893
0.18	14.244	9.991	8.685	6.11	9.864	10.896
0.18	14.329	10.057	8.689	6.11	9.867	10.896
0.19	14.414	10.11	8.692	6.11	9.87	10.893
0.20	14.461	10.162	8.695	6.11	9.877	10.896
0.21	14.772	10.224	8.698	6.11	9.88	10.896
0.22	14.904	10.276	8.701	6.11	9.886	10.896
0.23	14.999	10.319	8.704	6.11	9.892	10.896
0.23	14.81	10.361	8.711	6.11	9.896	10.896
0.24	15.112	10.404	8.714	6.11	9.902	10.896
0.25	15.169	10.447	8.72	6.11	9.908	10.896
0.26	15.159	10.485	8.727	6.11	9.915	10.896
0.27	15.216	10.523	8.73	6.11	9.921	10.896
0.28	15.272	10.556	8.736	6.11	9.924	10.896
0.28	15.301	10.589	8.743	6.11	9.93	10.896
0.29	15.338	10.618	8.746	6.11	9.937	10.896
0.30	15.423	10.646	8.752	6.11	9.943	10.896
0.31	15.272	10.675	8.758	6.11	9.95	10.896
0.32	15.461	10.703	8.765	6.11	9.956	10.896
0.33	15.414	10.727	8.771	6.11	9.962	10.896
0.33	15.452	10.756	8.777	6.11	9.969	10.896
0.35	15.47	10.798	8.79	6.11	9.984	10.896
0.37	15.48	10.841	8.806	6.11	9.994	10.896
0.38	15.64	10.884	8.819	6.11	10.01	10.896
0.40	15.697	10.927	8.835	6.11	10.022	10.896
0.42	15.895	10.974	8.85	6.11	10.038	10.896
0.43	15.999	11.012	8.863	6.11	10.051	10.896
0.45	16.15	11.06	8.879	6.11	10.067	10.896
0.47	16.31	11.102	8.892	6.11	10.08	10.896
0.48	16.433	11.15	8.908	6.11	10.095	10.896
0.50	16.697	11.202	8.923	6.11	10.111	10.896
0.52	16.829	11.25	8.936	6.11	10.124	10.896
0.53	17.083	11.307	8.952	6.11	10.14	10.896
0.55	17.282	11.364	8.965	6.11	10.152	10.896
0.57	17.47	11.421	8.981	6.11	10.168	10.896
0.58	17.81	11.482	8.993	6.11	10.184	10.896
0.60	17.913	11.544	9.009	6.11	10.2	10.896
0.62	18.102	11.606	9.022	6.11	10.213	10.899
0.63	18.328	11.672	9.019	6.11	10.229	10.896
0.65	18.488	11.734	9.057	6.11	10.248	10.896
0.67	18.733	11.8	9.066	6.11	10.26	10.896

0.68	18.931	11.867	9.082	6.11	10.279	10.893
0.70	19.205	11.929	9.12	6.11	10.295	10.896
0.72	19.337	11.995	9.114	6.11	10.311	10.896
0.73	19.563	12.057	9.12	6.11	10.327	10.896
0.75	19.789	12.114	9.146	6.11	10.343	10.896
0.77	19.921	12.176	9.158	6.11	10.359	10.896
0.78	20.147	12.237	9.177	6.11	10.378	10.899
0.80	20.335	12.294	9.19	6.11	10.393	10.896
0.82	20.514	12.356	9.209	6.11	10.409	10.896
0.83	20.665	12.413	9.222	6.11	10.428	10.896
0.85	20.854	12.47	9.235	6.11	10.444	10.896
0.87	21.033	12.527	9.254	6.11	10.46	10.896
0.88	21.193	12.584	9.27	6.113	10.479	10.896
0.90	21.39	12.641	9.285	6.113	10.495	10.899
0.92	21.475	12.693	9.304	6.11	10.514	10.896
0.93	21.692	12.74	9.317	6.113	10.533	10.896
0.95	21.89	12.793	9.333	6.113	10.549	10.896
0.97	21.946	12.845	9.349	6.113	10.568	10.896
0.98	22.125	12.892	9.365	6.113	10.587	10.896
1.00	22.332	12.94	9.384	6.113	10.606	10.896
1.20	23.942	13.452	9.584	6.116	10.828	10.899
1.40	25.325	13.856	9.787	6.119	11.056	10.899
1.60	26.463	14.197	9.977	6.122	11.284	10.896
1.80	27.394	14.548	10.165	6.129	11.509	10.896
2.00	28.221	14.876	10.339	6.135	11.731	10.896
2.20	28.889	15.156	10.507	6.141	11.944	10.893
2.40	29.509	15.416	10.666	6.148	12.146	10.893
2.60	30.026	15.63	10.818	6.154	12.343	10.89
2.80	30.542	15.815	10.961	6.157	12.527	10.89
3.00	31.078	15.995	11.097	6.163	12.701	10.89
3.20	31.716	16.189	11.221	6.17	12.872	10.886
3.40	32.082	16.379	11.345	6.176	13.027	10.886
3.60	32.458	16.526	11.465	6.182	13.183	10.886
3.80	32.88	16.673	11.58	6.189	13.332	10.883
4.00	33.162	16.81	11.688	6.195	13.471	10.883
4.20	33.5	16.938	11.792	6.198	13.604	10.883
4.40	33.753	17.062	11.891	6.205	13.734	10.88
4.60	33.95	17.194	11.983	6.208	13.854	10.88
4.80	34.222	17.284	12.075	6.214	13.972	10.88
5.00	34.476	17.384	12.16	6.217	14.086	10.877
5.20	34.645	17.484	12.239	6.224	14.19	10.877
5.40	34.813	17.555	12.319	6.227	14.292	10.877
5.60	34.954	17.607	12.392	6.233	14.39	10.877
5.80	35.057	17.683	12.458	6.236	14.482	10.874
6.00	35.264	17.787	12.525	6.239	14.567	10.874
6.20	35.339	17.867	12.588	6.243	14.653	10.874
6.40	35.526	17.934	12.649	6.246	14.732	10.874
6.60	35.686	18.024	12.709	6.249	14.808	10.874
6.80	35.864	18.114	12.766	6.252	14.887	10.874
7.00	36.07	18.218	12.823	6.255	14.96	10.874
7.20	36.258	18.299	12.88	6.258	15.033	10.874
7.40	36.445	18.36	12.934	6.262	15.103	10.874
7.60	36.652	18.408	12.988	6.262	15.172	10.874
7.80	36.783	18.469	13.039	6.265	15.236	10.874
8.00	37.008	18.554	13.089	6.268	15.305	10.874
8.20	37.57	18.682	13.137	6.268	15.369	10.874
8.40	37.617	18.81	13.188	6.271	15.432	10.874
8.60	37.786	18.881	13.238	6.274	15.498	10.874
8.80	38.02	18.957	13.289	6.274	15.562	10.874
9.00	38.208	19.052	13.337	6.274	15.625	10.874
9.20	38.461	19.132	13.387	6.277	15.688	10.877
9.40	38.685	19.18	13.435	6.281	15.749	10.877
9.60	38.873	19.246	13.483	6.281	15.806	10.877
9.80	39.06	19.303	13.53	6.284	15.866	10.877
10.00	39.201	19.36	13.575	6.284	15.923	10.88
12.00	40.334	19.871	13.968	6.296	16.426	10.886
14.00	41.271	20.189	14.259	6.306	16.797	10.893
16.00	42.946	20.477	14.538	6.315	17.142	10.905
18.00	43.704	20.889	14.76	6.322	17.43	10.915

20.00	44.247	21.055	14.953	6.328	17.664	10.928
22.00	44.612	21.259	15.112	6.334	17.854	10.94
24.00	44.995	21.32	15.239	6.338	18.009	10.956
26.00	45.257	21.453	15.35	6.341	18.139	10.969
28.00	45.537	21.547	15.445	6.344	18.25	10.982
30.00	45.687	21.661	15.527	6.35	18.348	11.001
32.00	45.865	21.784	15.606	6.35	18.433	11.013
34.00	46.51	21.921	15.692	6.353	18.538	11.029
36.00	46.912	21.959	15.761	6.357	18.626	11.045
38.00	47.099	22.068	15.831	6.357	18.705	11.058
40.00	47.715	22.252	15.91	6.36	18.797	11.074
42.00	48.005	22.314	15.983	6.36	18.886	11.087
44.00	48.295	22.394	16.04	6.363	18.949	11.099
46.00	48.631	22.456	16.091	6.363	19.012	11.112
48.00	48.874	22.527	16.142	6.366	19.066	11.128
50.00	48.893	22.674	16.196	6.366	19.129	11.141
52.00	49.033	22.659	16.234	6.369	19.174	11.153
54.00	49.294	22.603	16.259	6.369	19.199	11.169
56.00	49.481	22.636	16.287	6.369	19.228	11.179
58.00	49.565	22.702	16.316	6.369	19.259	11.195
60.00	49.621	22.73	16.344	6.372	19.294	11.207
62.00	49.677	22.886	16.373	6.376	19.326	11.22
64.00	49.761	22.872	16.408	6.376	19.364	11.23
66.00	50.004	22.868	16.43	6.376	19.386	11.242
68.00	50.275	22.901	16.452	6.376	19.408	11.255
70.00	50.275	22.863	16.468	6.376	19.43	11.268
72.00	50.182	22.981	16.496	6.376	19.459	11.277
74.00	50.247	22.929	16.509	6.376	19.474	11.287
76.00	50.406	22.92	16.519	6.379	19.484	11.299
78.00	50.546	22.929	16.528	6.379	19.497	11.312
80.00	50.695	22.924	16.541	6.379	19.509	11.325
82.00	50.816	22.92	16.554	6.382	19.525	11.338
84.00	50.844	23.009	16.566	6.382	19.541	11.347
86.00	50.919	22.972	16.579	6.382	19.557	11.36
88.00	50.966	22.967	16.588	6.382	19.566	11.373
90.00	50.901	23.024	16.601	6.382	19.579	11.382
92.00	50.854	23.057	16.617	6.382	19.591	11.392
94.00	50.929	23.033	16.62	6.385	19.598	11.401
96.00	50.966	23.028	16.626	6.385	19.604	11.411
98.00	51.106	23.028	16.636	6.385	19.614	11.42
100.00	51.246	23.014	16.642	6.385	19.617	11.43
120.00	52.692	22.91	16.699	6.388	19.686	11.519
140.00	53.644	22.995	16.772	6.391	19.765	11.595
160.00	53.831	22.972	16.794	6.398	19.784	11.659
180.00	54.773	23.038	16.845	6.401	19.838	11.719
200.00	55.332	22.967	16.845	6.401	19.835	11.77
220.00	55.295	23.076	16.873	6.404	19.864	11.817
240.00	55.668	23.009	16.873	6.404	19.864	11.862
260.00	56.106	22.995	16.88	6.407	19.87	11.897
280.00	56.246	22.962	16.873	6.407	19.86	11.932
300.00	56.451	22.967	16.88	6.41	19.867	11.964
320.00	56.525	22.943	16.877	6.414	19.86	11.992
340.00	56.656	22.92	16.873	6.414	19.851	12.018
360.00	56.246	23.043	16.892	6.414	19.87	12.04
380.00	56.628	23	16.889	6.417	19.86	12.059
400.00	56.702	23.005	16.889	6.42	19.86	12.078
420.00	56.833	22.967	16.886	6.42	19.854	12.097
440.00	56.665	22.924	16.87	6.42	19.841	12.113
460.00	56.693	22.905	16.861	6.42	19.829	12.129

RECOVERY TEST DATA

480.00	56.907	22.891	16.861	6.423	19.826	12.141
480.01	56.805	22.896	16.861	6.423	19.826	12.141
480.02	56.618	22.891	16.861	6.423	19.826	12.141
480.03	56.311	22.891	16.861	6.423	19.826	12.141
480.03	55.854	22.896	16.861	6.423	19.826	12.141
480.04	55.351	22.891	16.861	6.423	19.826	12.141
480.05	54.838	22.891	16.861	6.423	19.826	12.141
480.06	54.213	22.891	16.861	6.423	19.826	12.141
480.07	53.747	22.891	16.861	6.423	19.826	12.141

480.08	53.206	22.891	16.861	6.423	19.826	12.141
480.08	52.674	22.891	16.864	6.423	19.826	12.141
480.09	52.217	22.891	16.864	6.423	19.826	12.141
480.10	51.759	22.891	16.864	6.423	19.826	12.141
480.11	51.321	22.891	16.861	6.423	19.826	12.141
480.12	50.985	22.886	16.861	6.423	19.826	12.141
480.13	50.546	22.886	16.861	6.423	19.826	12.141
480.13	50.191	22.886	16.861	6.423	19.826	12.141
480.14	49.733	22.886	16.861	6.423	19.826	12.141
480.15	49.406	22.886	16.861	6.423	19.826	12.141
480.16	49.108	22.882	16.861	6.423	19.826	12.141
480.17	48.753	22.877	16.861	6.423	19.826	12.141
480.18	48.388	22.877	16.861	6.423	19.826	12.141
480.18	48.033	22.872	16.861	6.423	19.826	12.141
480.19	47.659	22.863	16.861	6.423	19.826	12.141
480.20	47.295	22.858	16.861	6.423	19.826	12.141
480.21	46.921	22.849	16.861	6.423	19.826	12.141
480.22	46.575	22.839	16.858	6.423	19.826	12.141
480.23	45.865	22.811	16.858	6.423	19.822	12.141
480.25	45.173	22.782	16.854	6.423	19.826	12.138
480.27	44.462	22.749	16.854	6.423	19.822	12.138
480.28	43.807	22.707	16.854	6.423	19.819	12.138
480.30	43.143	22.664	16.851	6.423	19.819	12.138
480.32	42.534	22.617	16.848	6.423	19.819	12.138
480.33	41.823	22.565	16.845	6.423	19.816	12.138
480.35	41.177	22.517	16.842	6.423	19.816	12.138
480.37	40.587	22.461	16.839	6.423	19.813	12.138
480.38	40.156	22.399	16.835	6.423	19.81	12.138
480.40	39.744	22.347	16.829	6.423	19.807	12.138
480.42	39.182	22.286	16.826	6.423	19.803	12.135
480.43	38.507	22.224	16.82	6.423	19.8	12.138
480.45	38.151	22.167	16.816	6.423	19.797	12.138
480.47	37.392	22.101	16.81	6.423	19.794	12.135
480.48	37.092	22.039	16.804	6.423	19.788	12.135
480.50	36.436	21.973	16.797	6.423	19.781	12.135
480.52	35.92	21.907	16.791	6.423	19.778	12.135
480.53	35.545	21.836	16.785	6.423	19.772	12.135
480.55	35.17	21.77	16.778	6.423	19.765	12.135
480.57	34.71	21.703	16.772	6.423	19.756	12.135
480.58	34.382	21.637	16.763	6.423	19.75	12.135
480.60	34.166	21.571	16.753	6.423	19.743	12.135
480.62	33.791	21.5	16.747	6.423	19.734	12.135
480.63	33.556	21.443	16.737	6.423	19.727	12.132
480.65	33.237	21.377	16.728	6.423	19.718	12.135
480.67	32.843	21.315	16.715	6.423	19.705	12.132
480.68	32.524	21.254	16.709	6.423	19.696	12.132
480.70	32.167	21.188	16.696	6.426	19.686	12.132
480.72	31.829	21.121	16.687	6.426	19.68	12.132
480.73	31.463	21.06	16.677	6.426	19.667	12.132
480.75	31.153	20.993	16.664	6.426	19.655	12.132
480.77	30.815	20.932	16.652	6.423	19.645	12.132
480.78	30.505	20.866	16.642	6.426	19.629	12.132
480.80	30.204	20.804	16.633	6.426	19.617	12.132
480.82	29.904	20.738	16.62	6.426	19.604	12.132
480.83	29.622	20.676	16.607	6.426	19.591	12.132
480.85	29.274	20.61	16.595	6.426	19.576	12.129
480.87	28.992	20.548	16.582	6.426	19.563	12.129
480.88	28.72	20.482	16.569	6.426	19.553	12.129
481.08	25.589	19.71	16.392	6.426	19.348	12.126
481.28	23.123	19.014	16.196	6.426	19.12	12.129
481.48	21.099	18.36	15.99	6.426	18.867	12.126
481.68	19.44	17.754	15.777	6.423	18.595	12.126
481.88	18.083	17.19	15.562	6.423	18.313	12.126
482.08	16.989	16.654	15.353	6.42	18.022	12.129
482.28	16.169	16.076	15.144	6.414	17.727	12.126
482.48	15.527	15.54	14.934	6.41	17.433	12.129
482.68	15.027	15.099	14.728	6.404	17.139	12.129
482.88	14.612	14.724	14.526	6.401	16.857	12.132
483.08	14.263	14.406	14.332	6.395	16.591	12.135

483.28	13.97	14.131	14.148	6.388	16.341	12.135
483.48	13.715	13.884	13.974	6.385	16.103	12.138
483.68	13.489	13.666	13.809	6.379	15.885	12.138
483.88	13.281	13.471	13.657	6.376	15.679	12.141
484.08	13.101	13.296	13.511	6.369	15.489	12.145
484.28	12.941	13.134	13.378	6.363	15.315	12.145
484.48	12.79	12.987	13.248	6.36	15.144	12.145
484.68	12.658	12.85	13.127	6.353	14.992	12.148
484.88	12.535	12.726	13.016	6.35	14.843	12.148
485.08	12.422	12.608	12.905	6.347	14.703	12.148
485.28	12.308	12.498	12.804	6.341	14.577	12.148
485.48	12.204	12.394	12.709	6.338	14.453	12.151
485.68	12.119	12.299	12.617	6.331	14.336	12.151
485.88	12.034	12.204	12.528	6.328	14.228	12.151
486.08	11.949	12.119	12.446	6.325	14.124	12.154
486.28	11.874	12.033	12.366	6.322	14.022	12.154
486.48	11.789	11.952	12.29	6.319	13.93	12.154
486.68	11.723	11.881	12.217	6.315	13.839	12.157
486.88	11.657	11.81	12.147	6.312	13.753	12.154
487.08	11.59	11.739	12.084	6.309	13.674	12.157
487.28	11.524	11.672	12.017	6.306	13.595	12.157
487.48	11.468	11.615	11.957	6.303	13.519	12.157
487.68	11.402	11.549	11.897	6.3	13.449	12.157
487.88	11.354	11.497	11.843	6.3	13.379	12.157
488.08	11.298	11.435	11.786	6.296	13.316	12.157
488.28	11.241	11.387	11.735	6.29	13.249	12.157
488.48	11.194	11.33	11.684	6.29	13.192	12.154
488.68	11.156	11.283	11.637	6.287	13.132	12.157
488.88	11.099	11.235	11.586	6.284	13.075	12.157
489.08	11.061	11.188	11.542	6.284	13.021	12.157
489.28	11.014	11.14	11.497	6.281	12.967	12.154
489.48	10.976	11.102	11.456	6.281	12.92	12.157
489.68	10.939	11.055	11.412	6.277	12.869	12.154
489.88	10.901	11.022	11.373	6.277	12.821	12.154
491.88	10.57	10.665	11.028	6.262	12.419	12.148
493.88	10.315	10.399	10.764	6.249	12.118	12.138
495.88	10.117	10.19	10.555	6.239	11.88	12.126
497.88	9.956	10.015	10.38	6.23	11.69	12.116
499.88	9.814	9.872	10.234	6.224	11.532	12.1
501.88	9.701	9.749	10.111	6.217	11.395	12.087
503.88	9.597	9.634	10	6.211	11.272	12.072
505.88	9.512	9.544	9.908	6.208	11.173	12.056
507.88	9.436	9.463	9.822	6.205	11.085	12.043
509.88	9.36	9.392	9.749	6.201	11.005	12.03
511.88	9.304	9.321	9.682	6.195	10.932	12.014
513.88	9.247	9.259	9.622	6.195	10.869	11.999
515.88	9.2	9.212	9.571	6.192	10.812	11.989
517.88	9.153	9.159	9.52	6.189	10.758	11.976
519.88	9.105	9.112	9.473	6.186	10.707	11.964
521.88	9.067	9.069	9.428	6.186	10.66	11.948
523.88	9.03	9.031	9.39	6.182	10.619	11.938
525.88	8.992	8.993	9.352	6.179	10.577	11.922
527.88	8.963	8.96	9.32	6.179	10.542	11.913
529.88	8.935	8.926	9.289	6.176	10.511	11.897
531.88	8.907	8.903	9.26	6.176	10.479	11.887
533.88	8.888	8.874	9.231	6.173	10.45	11.875
535.88	8.85	8.846	9.206	6.173	10.422	11.862
537.88	8.831	8.822	9.184	6.173	10.397	11.849
539.88	8.812	8.803	9.162	6.17	10.371	11.836
541.88	8.793	8.779	9.139	6.17	10.349	11.824
543.88	8.774	8.76	9.12	6.17	10.327	11.811
545.88	8.755	8.741	9.101	6.167	10.308	11.802
547.88	8.746	8.727	9.085	6.167	10.289	11.789
549.88	8.727	8.708	9.07	6.167	10.273	11.782
551.88	8.708	8.694	9.054	6.167	10.254	11.77
553.88	8.699	8.679	9.038	6.163	10.238	11.76
555.88	8.689	8.665	9.025	6.163	10.225	11.748
557.88	8.67	8.651	9.012	6.163	10.21	11.741
559.88	8.661	8.641	9	6.163	10.197	11.728

561.88	8.651	8.627	8.99	6.163	10.184	11.719
563.88	8.642	8.617	8.981	6.16	10.171	11.709
565.88	8.633	8.608	8.968	6.16	10.162	11.7
567.88	8.623	8.598	8.958	6.16	10.149	11.693
569.88	8.614	8.589	8.949	6.16	10.14	11.684
571.88	8.604	8.575	8.939	6.16	10.13	11.674
573.88	8.595	8.57	8.933	6.16	10.121	11.665
575.88	8.585	8.56	8.923	6.157	10.111	11.655
577.88	8.576	8.551	8.917	6.157	10.102	11.646
579.88	8.576	8.546	8.911	6.157	10.092	11.636
599.88	8.519	8.484	8.854	6.154	10.029	11.563
619.88	8.481	8.446	8.816	6.154	9.988	11.5
639.88	8.453	8.423	8.79	6.154	9.956	11.446
659.88	8.434	8.399	8.771	6.151	9.934	11.398
679.88	8.415	8.385	8.755	6.151	9.915	11.353
699.88	8.406	8.375	8.746	6.151	9.902	11.315
719.88	8.396	8.366	8.736	6.151	9.892	11.284
739.88	8.387	8.356	8.73	6.151	9.883	11.255
759.88	8.387	8.351	8.72	6.151	9.877	11.23
779.88	8.377	8.342	8.717	6.151	9.867	11.204
799.88	8.368	8.337	8.711	6.151	9.864	11.182
819.88	8.368	8.332	8.708	6.151	9.858	11.16
839.88	8.358	8.332	8.704	6.151	9.854	11.144
859.88	8.368	8.328	8.701	6.151	9.854	11.131
879.88	8.358	8.328	8.701	6.151	9.851	11.115
899.88	8.358	8.323	8.698	6.151	9.848	11.096
919.88	8.358	8.323	8.695	6.151	9.845	11.083
939.88	8.358	8.323	8.695	6.151	9.845	11.071
959.88	8.358	8.318	8.695	6.151	9.845	11.061
979.88	8.349	8.318	8.692	6.151	9.842	11.048
999.88	8.349	8.318	8.692	6.151	9.842	11.039
1019.88	8.349	8.313	8.689	6.151	9.839	11.029
1039.88	8.349	8.313	8.689	6.151	9.839	11.023
1059.88	8.349	8.313	8.689	6.154	9.835	11.013
1079.88	8.349	8.309	8.685	6.154	9.832	11.001
1099.88	8.34	8.299	8.676	6.154	9.82	10.988
1119.88	8.33	8.285	8.66	6.154	9.807	10.972
1139.88	8.311	8.275	8.65	6.154	9.794	10.956
1159.88	8.302	8.266	8.641	6.154	9.785	10.944
1179.88	8.302	8.256	8.631	6.154	9.775	10.931
1199.88	8.292	8.251	8.628	6.154	9.769	10.918
1219.88	8.292	8.251	8.625	6.154	9.766	10.909
1239.88	8.283	8.247	8.622	6.154	9.759	10.896
1259.88	8.283	8.242	8.619	6.154	9.759	10.89
1279.88	8.283	8.237	8.616	6.154	9.756	10.88
1299.88	8.283	8.237	8.616	6.154	9.753	10.874
1319.88	8.273	8.237	8.612	6.154	9.753	10.867
1339.88	8.273	8.237	8.616	6.154	9.753	10.861
1359.88	8.283	8.237	8.612	6.157	9.75	10.858
1379.88	8.273	8.237	8.612	6.154	9.753	10.851
1399.88	8.273	8.237	8.612	6.157	9.753	10.848
1419.88	8.273	8.237	8.616	6.157	9.753	10.845
1439.88	8.283	8.237	8.612	6.157	9.753	10.845
1459.88	8.273	8.237	8.616	6.157	9.753	10.842
1479.88	8.283	8.237	8.612	6.157	9.753	10.835

**APPENDIX C**

**WELL 044 AQUIFER TEST DATA AND PLOTS**

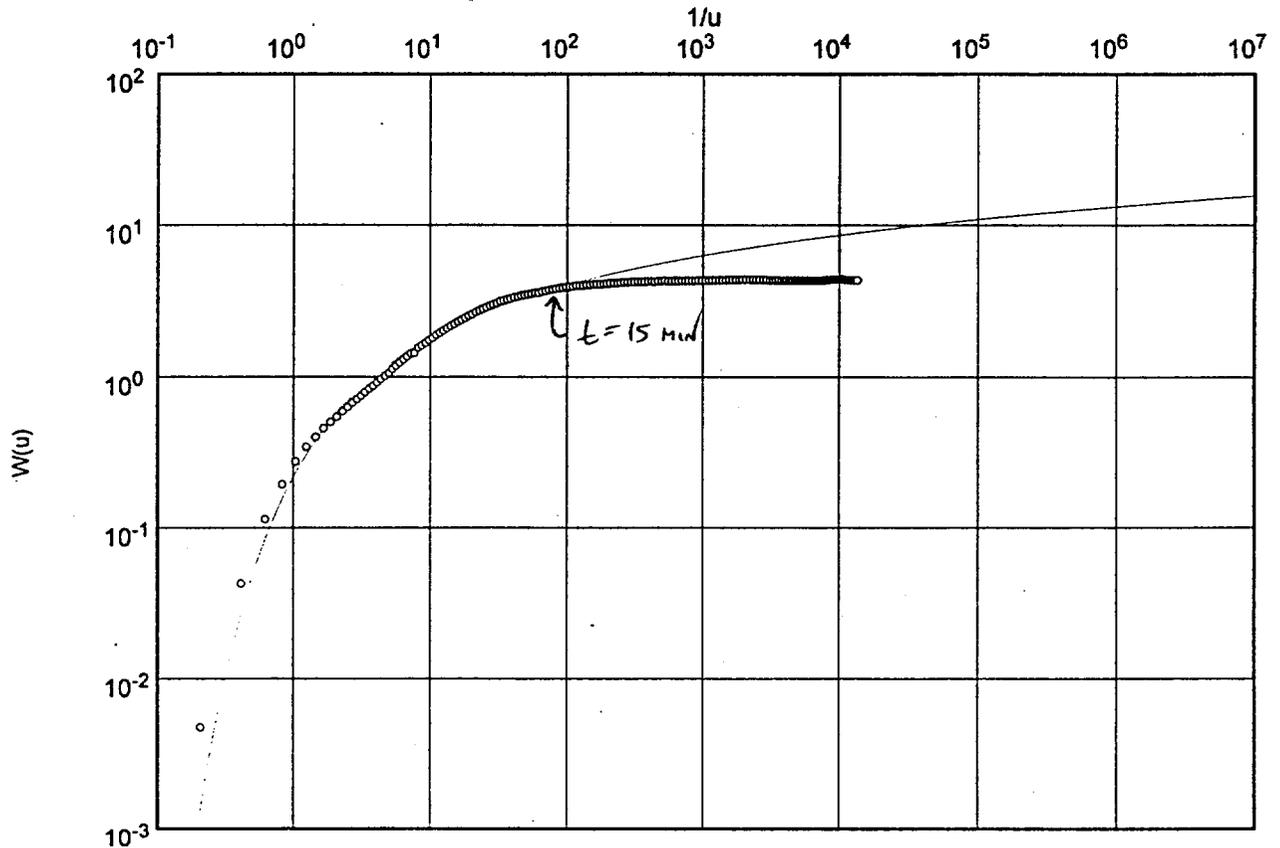
**WELL 044 AQUIFER TEST 1**  
**PLOTS FOR OBSERVATION WELLS 045, 046, AND 126**

Pumping Test No. 044 AQ TEST 1, t = 41 hrs

Test conducted on: 12/1/99

OBS 045, r = 56.8', SI = 40.9' - 50.5'

Discharge 50.00 U.S.gal/min



o OBS 045

Transmissivity [ft<sup>2</sup>/min]:  $8.43 \times 10^{-1} = 1213.9 \text{ Ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $2.81 \times 10^{-2}$

Aquifer thickness [ft]: 30.00

**MACTEC-ERS**  
 2597 B 3/4 RD  
 GRAND JUNCTION, COLO  
 ph.(970)248-6000

Pumping test analysis  
 Time-Drawdown-method after  
 COOPER & JACOB  
 Unconfined aquifer

Page 1

Project: GUNNISON

Evaluated by:

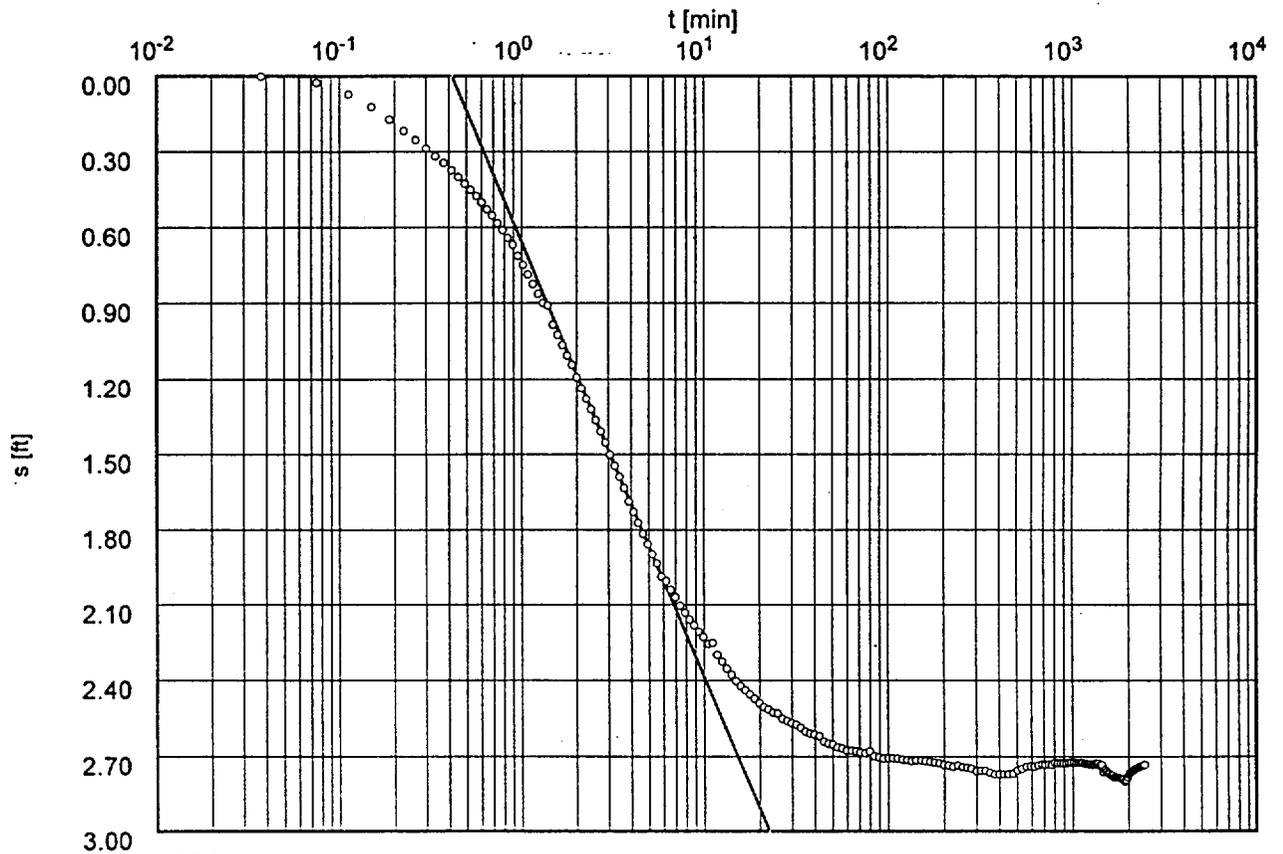
Date: 06.12.1999

Pumping Test No. 044 AQ TEST 1, t = 41 hrs

Test conducted on: 12/1/99

OBS 045, r = 56.8', SI = 40.9' - 50.5'

Discharge 50.00 U.S.gal/min



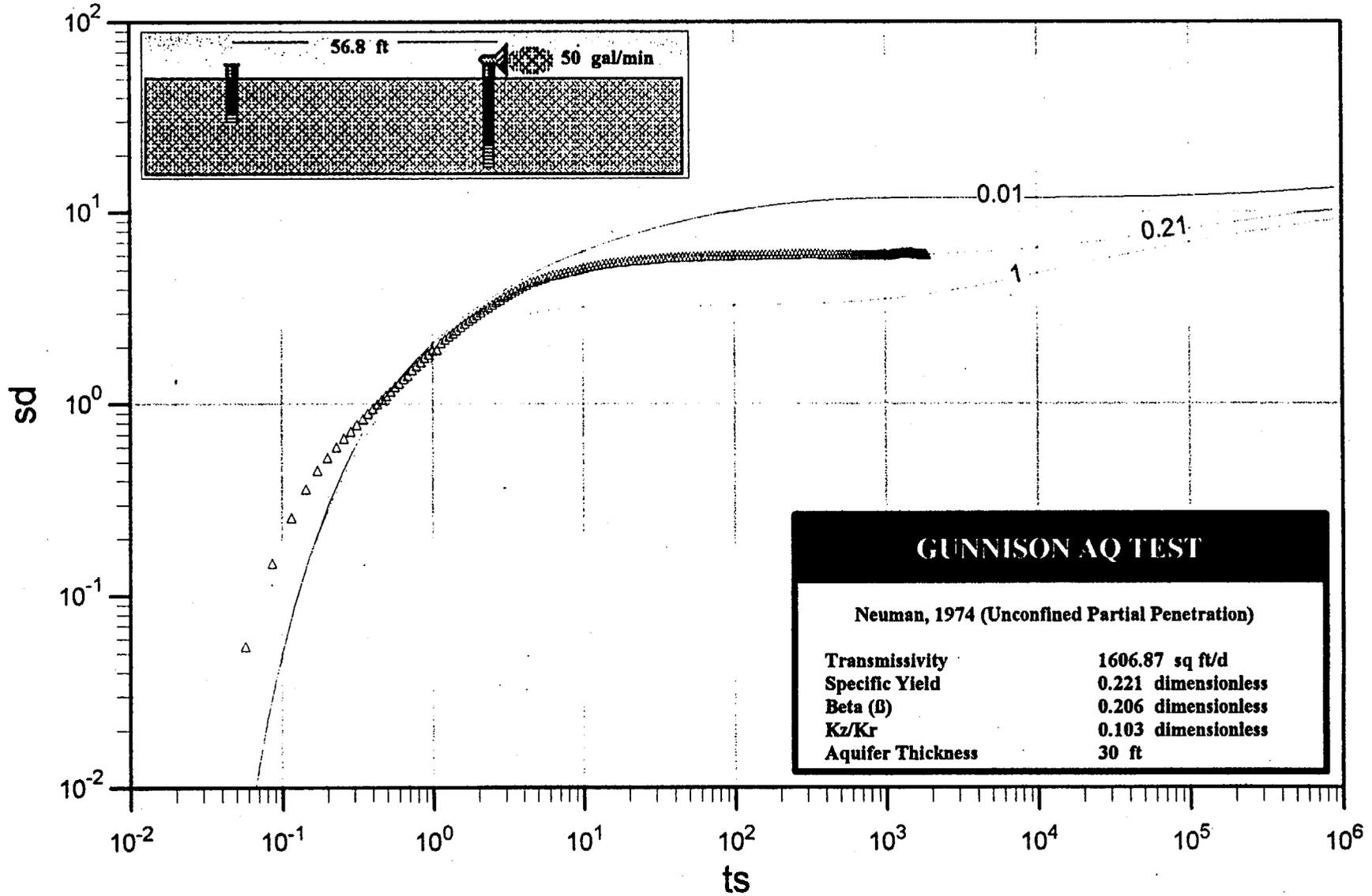
o OBS 045

Transmissivity [ft<sup>2</sup>/min]:  $7.07 \times 10^{-1} = 1018.1 \text{ ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $2.35 \times 10^{-2}$

Aquifer thickness [ft]: 30.00

# WELL OBS 045 / 044 AQ TEST 1



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Pumping test analysis  
 Theis analysis method  
 Unconfined aquifer

Page 1

Project: GUNNISON

Evaluated by:

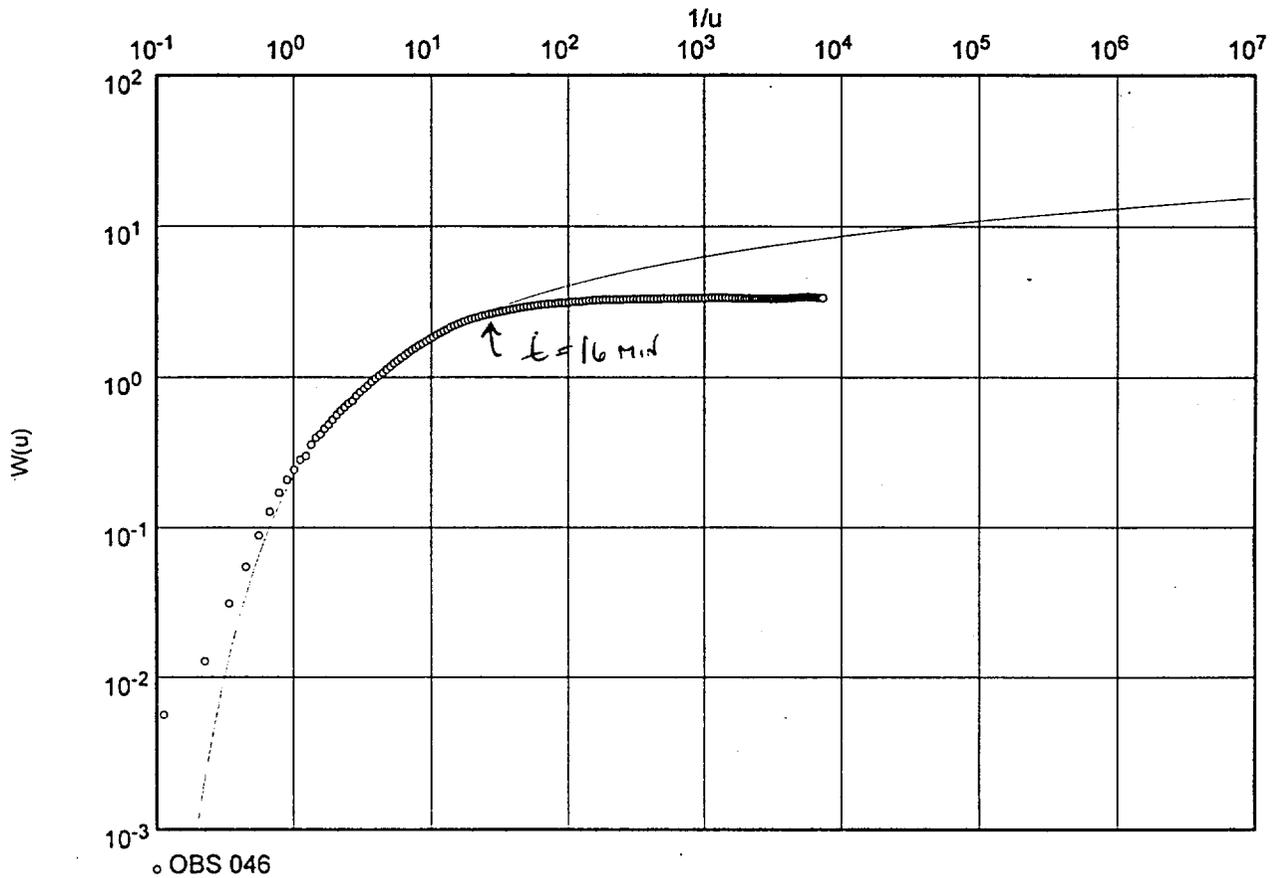
Date: 06.12.1999

Pumping Test No. 044 AQ TEST 1, t = 41 hrs

Test conducted on: 12/1/99

OBS 046, r = 40.9'

Discharge 50.00 U.S.gal/min



Transmissivity [ $\text{ft}^2/\text{min}$ ]:  $7.51 \times 10^{-1} = 1081.4 \text{ Ft}^2/\text{d}$

Hydraulic conductivity [ $\text{ft}/\text{min}$ ]:  $2.50 \times 10^{-2}$

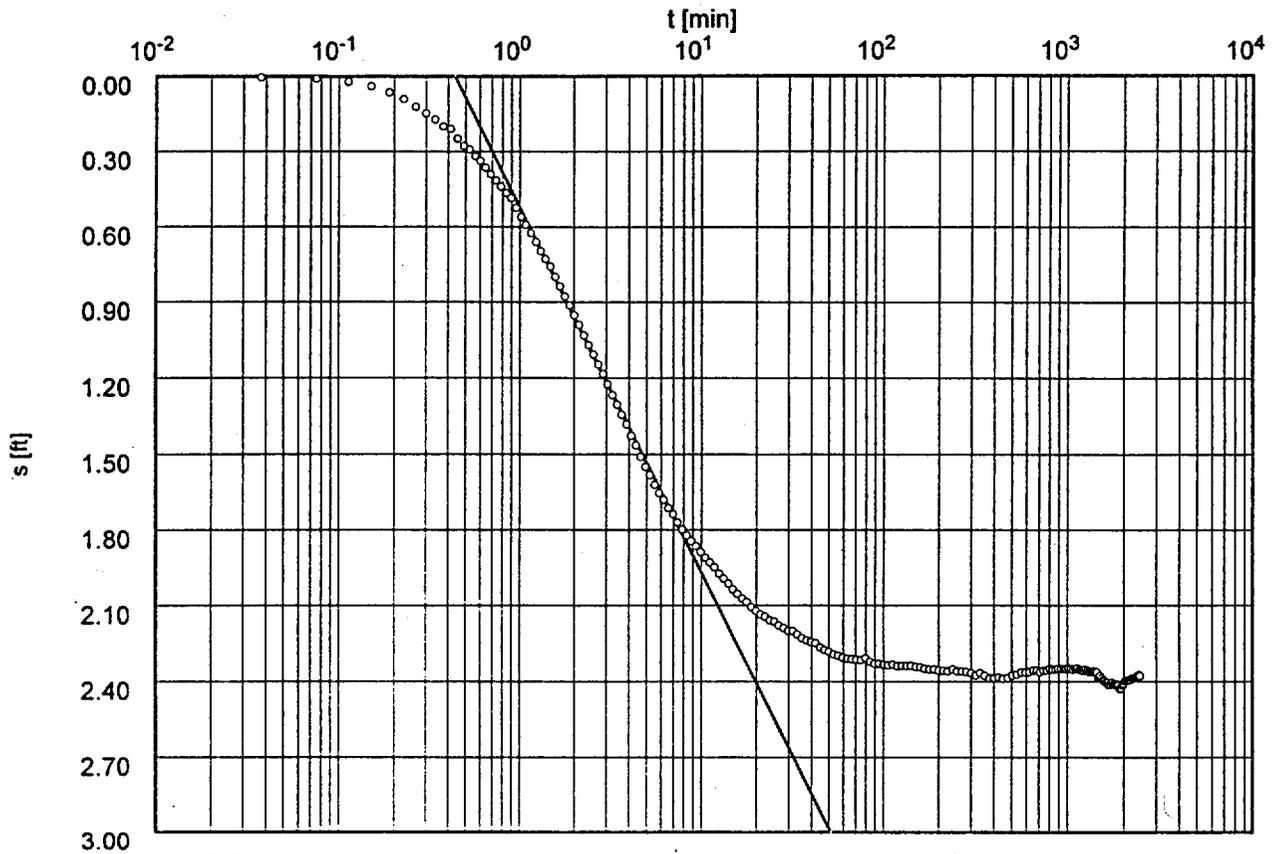
Aquifer thickness [ $\text{ft}$ ]: 30.00

Pumping Test No. 044 AQ TEST 1, t = 41 hrs

Test conducted on: 12/1/99

OBS 046, r = 40.9'

Discharge 50.00 U.S.gal/min



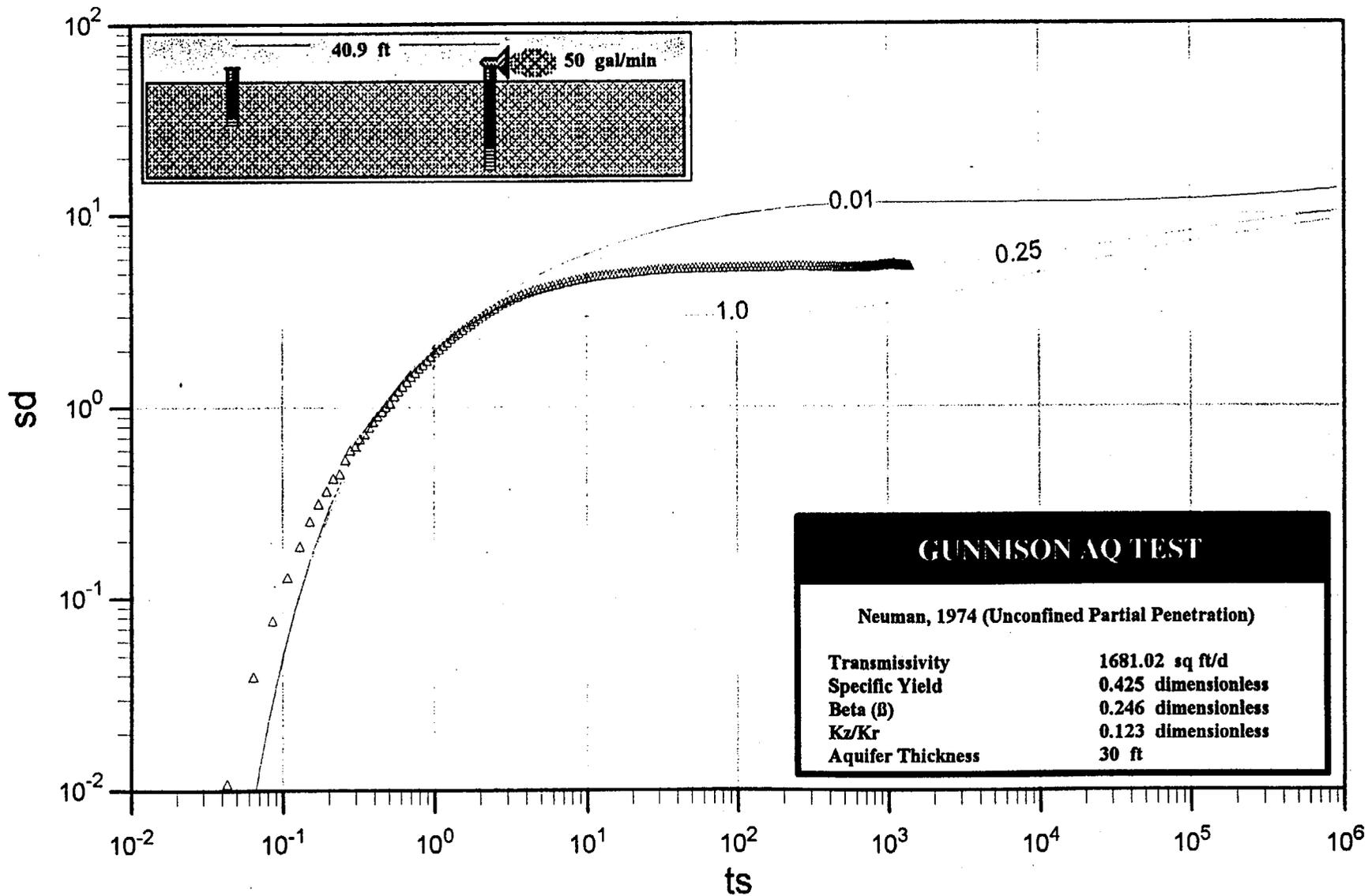
o OBS 046

Transmissivity [ft<sup>2</sup>/min]:  $8.43 \times 10^{-1} = 1213.9 \text{ Ft}^2/\text{D}$

Hydraulic conductivity [ft/min]:  $2.81 \times 10^{-2}$

Aquifer thickness [ft]: 30.00

# WELL OBS 046 / 044 AQ TEST 1

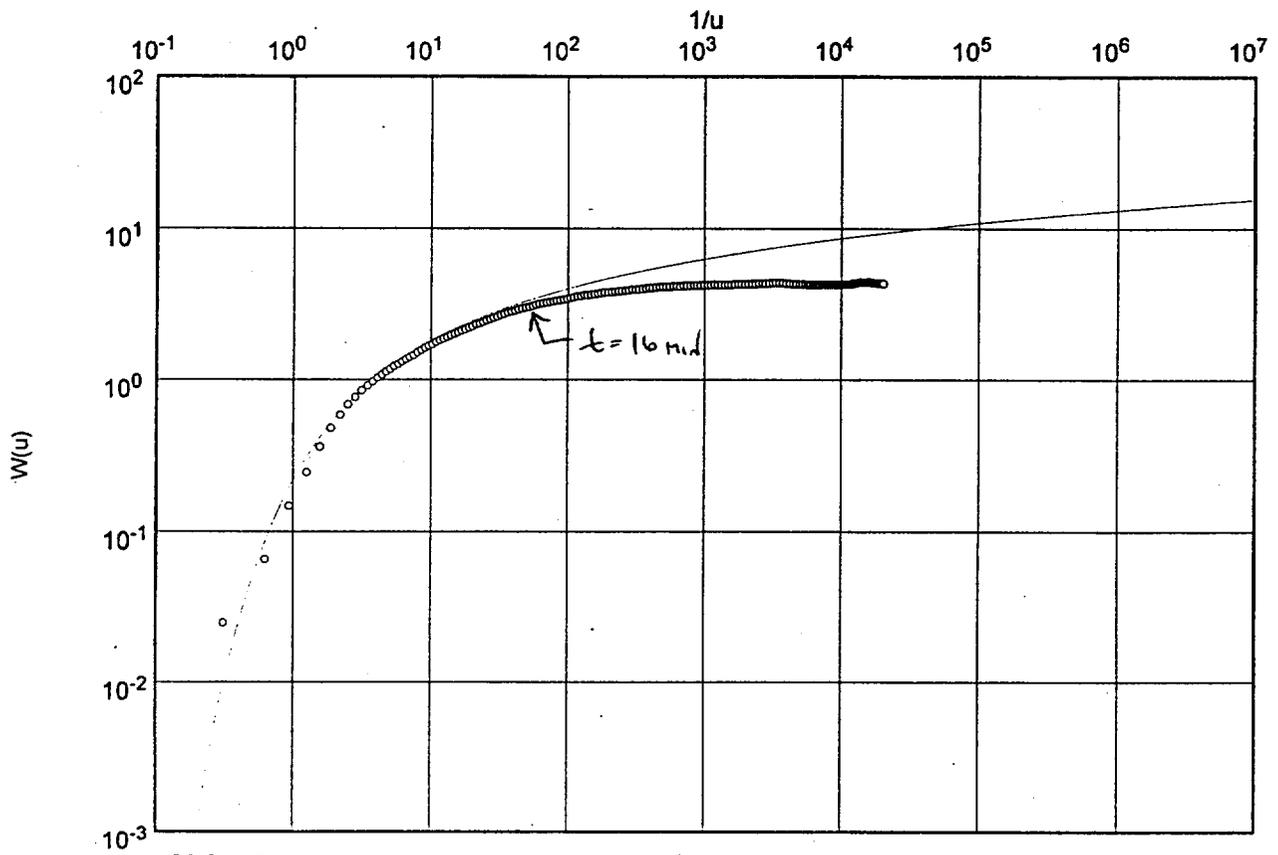


Pumping Test No. 044 AQ TEST 1, t = 41 hrs

Test conducted on: 12/1/99

OBS 126, r = 16.4, SI = 53.2' - 58.2'

Discharge 50.00 U.S.gal/min



○ OBS 126

Transmissivity [ft<sup>2</sup>/min]:  $9.45 \times 10^{-1} = 1360.8 \text{ Ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $3.15 \times 10^{-2}$

Aquifer thickness [ft]: 30.00

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Pumping test analysis  
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COOPER & JACOB  
Unconfined aquifer

Page 1

Project: GUNNISON

Evaluated by:

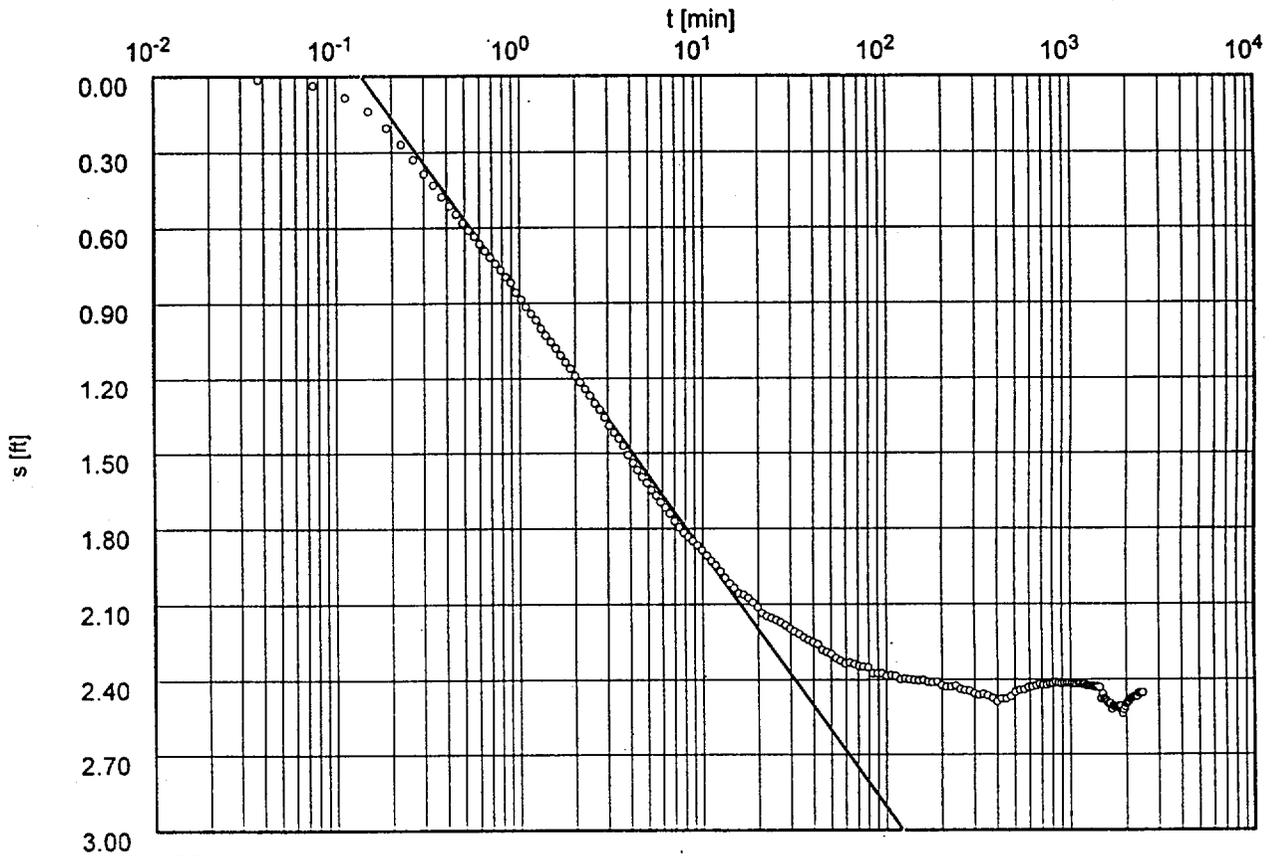
Date: 28.12.1999

Pumping Test No. 044 AQ TEST 1, t = 41 hrs

Test conducted on: 12/1/99

OBS 126, r = 16.4, SI = 53.2' - 58.2'

Discharge 50.00 U.S.gal/min



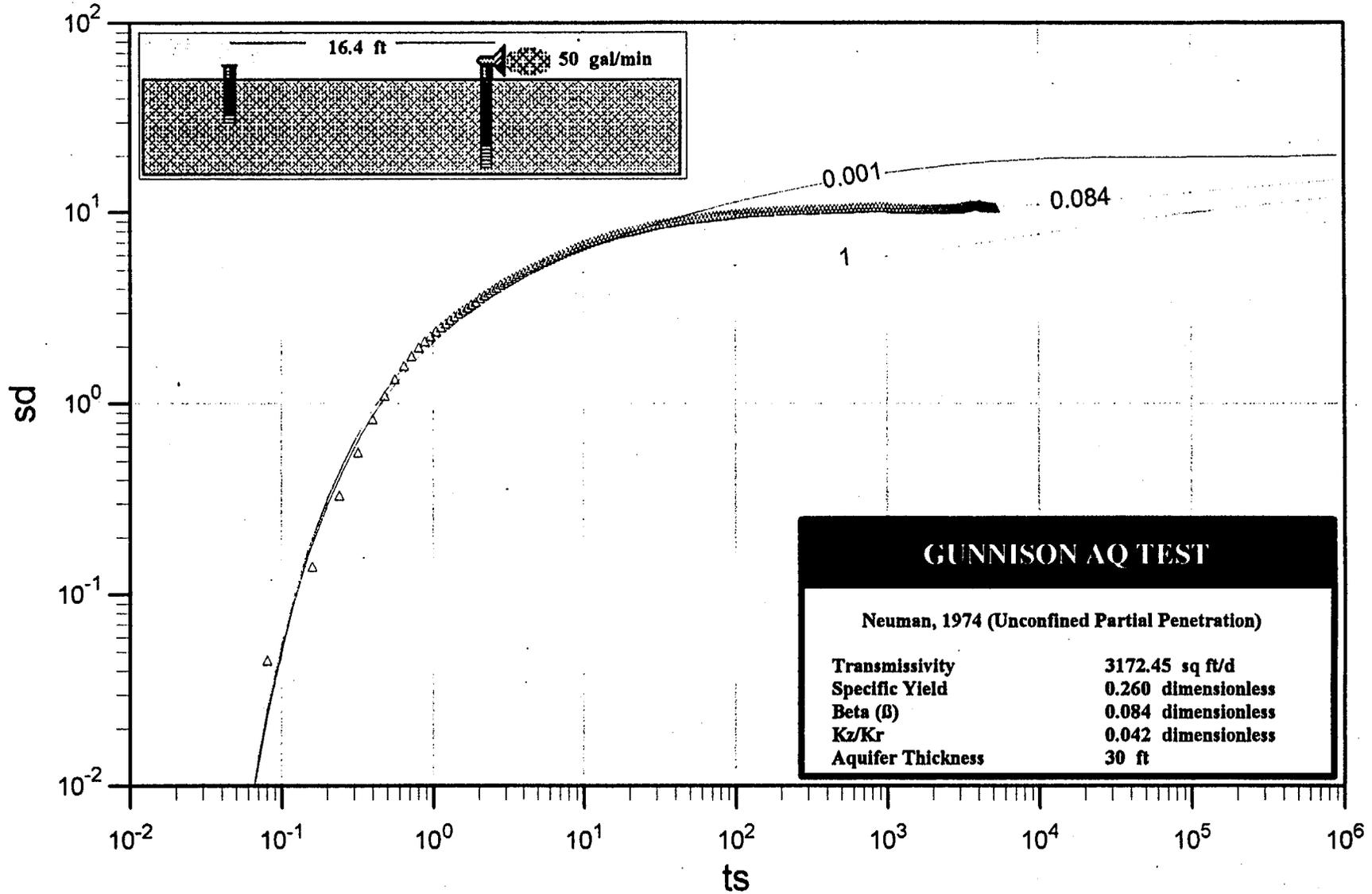
o OBS 126

Transmissivity [ $\text{ft}^2/\text{min}$ ]:  $1.20 \times 10^0 = 1.20 \text{ Ft}^2/\text{D}$

Hydraulic conductivity [ $\text{ft}/\text{min}$ ]:  $4.01 \times 10^{-2}$

Aquifer thickness [ft]: 30.00

# WELL OBS 126 / 044 AQ TEST 1



**WELL 044 AQUIFER TEST 1**

**DRAWDOWN DATA**

GUNNISON UMTRA SITE  
WELL 044 AQUIFER TEST 1 DATA  
START DATE/TIME : 12/1/99, 0900  
PUMPING RATE : 50 GPM

<u>ELAPSED TIME (min)</u>	<u>WELL 044 pmp 044</u>	<u>WELL 045 obs045</u>	<u>WELL 046 obs046</u>	<u>WELL 126 obs 126</u>	<u>WELL 125 obs 125</u>	<u>WELL 127 obs 127</u>	<u>INCHES Hg</u>
0.00	9.51	9.451	8.924	10.603	9.199	11.793	22.624
0.04	12.065	9.453	8.924	10.614	9.199	11.794	22.626
0.08	11.586	9.477	8.929	10.637	9.2	11.796	22.626
0.11	13.665	9.522	8.942	10.683	9.209	11.799	22.626
0.15	15.412	9.573	8.959	10.738	9.222	11.797	22.628
0.19	16.88	9.624	8.983	10.804	9.239	11.796	22.63
0.23	17.758	9.668	9.01	10.87	9.26	11.794	22.63
0.26	18.148	9.704	9.04	10.931	9.282	11.793	22.63
0.30	18.543	9.739	9.067	10.988	9.304	11.791	22.632
0.34	18.991	9.769	9.091	11.034	9.322	11.791	22.634
0.38	19.481	9.796	9.119	11.081	9.342	11.79	22.634
0.41	19.98	9.826	9.13	11.118	9.358	11.79	22.632
0.45	20.423	9.852	9.169	11.152	9.374	11.789	22.632
0.49	20.826	9.879	9.198	11.187	9.39	11.789	22.634
0.53	21.238	9.904	9.213	11.216	9.404	11.789	22.636
0.56	21.646	9.929	9.239	11.242	9.419	11.787	22.636
0.60	22.075	9.955	9.259	11.27	9.43	11.787	22.636
0.64	22.457	9.983	9.285	11.299	9.445	11.787	22.638
0.69	22.938	10.008	9.312	11.325	9.457	11.787	22.64
0.74	23.363	10.039	9.338	11.351	9.469	11.787	22.638
0.79	23.844	10.067	9.362	11.377	9.482	11.787	22.638
0.84	24.286	10.1	9.388	11.406	9.495	11.787	22.64
0.89	24.646	10.127	9.408	11.429	9.505	11.79	22.64
0.95	25.192	10.172	9.449	11.469	9.521	11.79	22.636
1.02	25.686	10.209	9.484	11.498	9.535	11.789	22.636
1.08	26.162	10.247	9.517	11.529	9.547	11.79	22.634
1.15	26.673	10.287	9.55	11.558	9.555	11.79	22.634
1.23	27.102	10.326	9.587	11.584	9.567	11.791	22.634
1.31	27.556	10.363	9.624	11.619	9.577	11.791	22.634
1.39	27.942	10.374	9.657	11.647	9.587	11.793	22.634
1.48	28.396	10.453	9.688	11.673	9.594	11.794	22.634
1.57	28.812	10.493	9.729	11.699	9.603	11.794	22.632
1.67	29.218	10.535	9.769	11.728	9.611	11.796	22.632
1.78	29.69	10.577	9.81	11.757	9.621	11.797	22.632
1.89	30.105	10.615	9.847	11.783	9.629	11.799	22.634
2.01	30.529	10.667	9.887	11.814	9.636	11.802	22.632
2.13	30.871	10.713	9.926	11.84	9.643	11.803	22.632
2.26	31.252	10.759	9.97	11.869	9.649	11.806	22.632
2.40	31.602	10.803	10.009	11.898	9.653	11.809	22.63
2.55	31.965	10.848	10.047	11.932	9.656	11.81	22.63
2.71	32.419	10.894	10.088	11.958	9.66	11.813	22.63
2.88	32.912	10.941	10.127	11.99	9.667	11.816	22.63
3.05	33.366	10.991	10.169	12.024	9.675	11.819	22.628
3.24	33.552	11.037	10.215	12.053	9.683	11.824	22.628
3.44	33.966	11.082	10.254	12.079	9.685	11.826	22.628
3.65	34.511	11.129	10.296	12.11	9.683	11.832	22.628
3.87	34.973	11.187	10.337	12.148	9.679	11.837	22.628
4.11	35.37	11.231	10.383	12.182	9.675	11.84	22.628
4.36	35.785	11.277	10.423	12.211	9.675	11.844	22.628
4.62	36.217	11.324	10.471	12.24	9.676	11.848	22.626
4.90	36.593	11.369	10.512	12.266	9.678	11.854	22.628
5.20	36.804	11.412	10.547	12.295	9.678	11.86	22.624
5.51	37.067	11.451	10.587	12.318	9.68	11.866	22.624
5.85	37.305	11.508	10.622	12.346	9.682	11.87	22.624
6.20	37.508	11.528	10.65	12.369	9.682	11.876	22.624
6.57	37.767	11.564	10.685	12.395	9.685	11.883	22.622
6.97	37.991	11.597	10.711	12.427	9.686	11.889	22.622
7.39	38.142	11.633	10.746	12.453	9.689	11.895	22.62
7.83	38.393	11.664	10.777	12.476	9.692	11.901	22.62
8.30	38.436	11.693	10.801	12.493	9.693	11.908	22.62
8.80	38.513	11.717	10.825	12.51	9.695	11.917	22.62

9.33	38.703	11.745	10.847	12.528	9.695	11.923	22.62
9.89	38.859	11.768	10.873	12.548	9.696	11.933	22.618
10.48	39.035	11.798	10.897	12.571	9.699	11.94	22.62
11.11	39.221	11.794	10.917	12.594	9.702	11.946	22.622
11.78	39.406	11.845	10.937	12.614	9.699	11.953	22.624
12.48	39.808	11.874	10.965	12.64	9.698	11.962	22.626
13.23	40.045	11.904	10.985	12.666	9.701	11.971	22.628
14.02	40.248	11.93	11.007	12.689	9.702	11.981	22.626
14.85	40.424	11.957	11.031	12.709	9.702	11.992	22.624
15.74	40.567	11.979	11.05	12.732	9.705	12	22.622
16.68	40.769	11.997	11.07	12.738	9.705	12.007	22.622
17.67	40.989	12.016	11.085	12.752	9.705	12.014	22.626
18.73	41.166	12.033	11.107	12.772	9.706	12.026	22.628
19.84	41.317	12.053	11.123	12.792	9.709	12.039	22.622
21.02	41.395	12.069	11.138	12.818	9.709	12.048	22.616
22.28	41.494	12.08	11.147	12.83	9.711	12.054	22.616
23.60	41.576	12.093	11.162	12.838	9.712	12.062	22.624
25.01	41.856	12.098	11.168	12.847	9.714	12.073	22.622
26.50	42.02	12.119	11.184	12.858	9.714	12.08	22.618
28.07	42.102	12.129	11.195	12.87	9.714	12.087	22.616
29.74	42.218	12.139	11.208	12.884	9.715	12.097	22.618
31.51	42.248	12.146	11.208	12.896	9.715	12.106	22.624
33.39	42.567	12.158	11.223	12.907	9.703	12.116	22.622
35.37	42.826	12.175	11.238	12.922	9.706	12.124	22.62
37.47	42.899	12.184	11.247	12.933	9.708	12.129	22.622
39.70	42.946	12.188	11.254	12.942	9.709	12.138	22.62
42.06	43.175	12.195	11.258	12.95	9.709	12.142	22.614
44.56	43.425	12.218	11.278	12.976	9.715	12.163	22.618
47.20	43.597	12.227	11.289	12.985	9.721	12.17	22.616
50.01	43.709	12.231	11.295	12.993	9.721	12.175	22.612
52.98	43.92	12.243	11.308	13.011	9.719	12.182	22.618
56.12	44.067	12.247	11.313	13.022	9.719	12.189	22.618
59.45	44.243	12.257	11.322	13.034	9.721	12.193	22.614
62.98	44.217	12.258	11.326	13.031	9.722	12.201	22.616
66.72	44.248	12.26	11.328	13.037	9.719	12.204	22.616
70.68	44.269	12.266	11.33	13.045	9.721	12.212	22.62
74.88	44.411	12.268	11.333	13.048	9.719	12.217	22.624
79.32	44.204	12.261	11.324	13.051	9.714	12.211	22.626
84.03	44.76	12.283	11.339	13.077	9.718	12.224	22.626
89.01	44.67	12.287	11.348	13.077	9.724	12.231	22.628
94.29	44.721	12.293	11.348	13.077	9.719	12.233	22.63
99.89	44.773	12.291	11.352	13.088	9.722	12.24	22.636
105.81	44.851	12.291	11.354	13.086	9.721	12.242	22.638
112.09	44.95	12.293	11.352	13.088	9.715	12.244	22.642
118.74	45.092	12.297	11.359	13.103	9.712	12.246	22.642
125.78	45.079	12.3	11.357	13.1	9.714	12.249	22.644
133.24	45.169	12.303	11.357	13.103	9.716	12.255	22.646
141.14	45.242	12.301	11.357	13.106	9.718	12.255	22.642
149.51	45.303	12.301	11.361	13.109	9.718	12.256	22.638
158.38	45.298	12.303	11.363	13.106	9.724	12.26	22.636
167.77	45.415	12.307	11.37	13.114	9.724	12.265	22.63
177.71	45.518	12.31	11.372	13.117	9.724	12.268	22.624
188.25	45.703	12.314	11.372	13.114	9.719	12.271	22.616
199.41	45.708	12.32	11.376	13.129	9.728	12.279	22.608
211.23	45.725	12.323	11.378	13.137	9.725	12.285	22.598
223.76	45.768	12.329	11.381	13.137	9.724	12.293	22.583
237.02	45.544	12.323	11.372	13.132	9.726	12.295	22.577
251.07	45.604	12.33	11.381	13.146	9.725	12.301	22.563
265.96	45.565	12.333	11.381	13.152	9.724	12.309	22.557
281.72	45.69	12.337	11.383	13.155	9.721	12.314	22.549
298.42	45.751	12.349	11.389	13.166	9.721	12.322	22.539
316.11	45.824	12.347	11.398	13.172	9.721	12.329	22.524
334.85	45.901	12.347	11.387	13.169	9.709	12.323	22.522
354.70	46.026	12.356	11.398	13.175	9.715	12.332	22.512
375.72	46.039	12.363	11.411	13.186	9.716	12.336	22.5
397.99	45.936	12.362	11.411	13.201	9.718	12.342	22.486
421.58	46.177	12.362	11.407	13.189	9.722	12.343	22.469
446.57	46.22	12.363	11.413	13.189	9.719	12.345	22.459
473.04	46.241	12.359	11.409	13.18	9.721	12.332	22.447

501.07	46.31	12.346	11.398	13.16	9.725	12.319	22.439
530.77	46.345	12.339	11.394	13.152	9.731	12.31	22.418
560.77	46.474	12.329	11.385	13.149	9.731	12.3	22.41
590.77	46.414	12.327	11.385	13.14	9.732	12.298	22.42
620.77	46.586	12.329	11.383	13.137	9.724	12.288	22.447
650.77	46.478	12.323	11.376	13.132	9.734	12.282	22.445
680.77	46.573	12.319	11.376	13.126	9.734	12.279	22.441
710.77	46.65	12.32	11.383	13.129	9.734	12.276	22.445
740.77	46.676	12.319	11.378	13.129	9.732	12.274	22.443
770.77	46.676	12.32	11.376	13.123	9.732	12.271	22.433
800.77	46.706	12.311	11.37	13.123	9.735	12.263	22.429
830.77	46.668	12.314	11.372	13.117	9.737	12.263	22.429
860.77	46.724	12.313	11.372	13.12	9.738	12.263	22.429
890.77	46.741	12.313	11.37	13.123	9.739	12.263	22.427
920.77	46.754	12.313	11.37	13.12	9.739	12.262	22.427
950.77	46.771	12.311	11.37	13.12	9.739	12.262	22.422
980.77	46.797	12.309	11.37	13.12	9.741	12.259	22.416
1010.77	46.844	12.309	11.367	13.123	9.741	12.26	22.416
1040.77	46.814	12.31	11.37	13.126	9.741	12.263	22.425
1070.77	46.853	12.31	11.374	13.126	9.742	12.263	22.425
1100.77	46.719	12.31	11.37	13.12	9.749	12.265	22.431
1130.77	46.801	12.311	11.367	13.123	9.749	12.265	22.427
1160.77	46.835	12.314	11.372	13.126	9.745	12.265	22.427
1190.77	46.861	12.316	11.376	13.126	9.748	12.265	22.418
1220.77	46.939	12.317	11.378	13.132	9.749	12.268	22.412
1250.77	46.982	12.316	11.372	13.132	9.751	12.269	22.418
1280.77	47.016	12.32	11.378	13.134	9.749	12.269	22.447
1310.77	47.038	12.319	11.383	13.134	9.749	12.269	22.457
1340.77	47.214	12.314	11.383	13.137	9.751	12.272	22.469
1370.77	47.145	12.314	11.381	13.14	9.754	12.272	22.482
1400.77	47.064	12.323	11.381	13.137	9.757	12.274	22.494
1430.77	47.145	12.321	11.385	13.14	9.758	12.275	22.52
1460.77	47.503	12.352	11.409	13.189	9.76	12.291	22.549
1490.77	47.072	12.342	11.4	13.169	9.767	12.307	22.563
1520.77	47.163	12.349	11.409	13.189	9.764	12.317	22.575
1550.77	47.292	12.356	11.418	13.195	9.757	12.323	22.579
1580.77	47.253	12.36	11.422	13.203	9.762	12.333	22.569
1610.77	47.262	12.366	11.429	13.212	9.765	12.342	22.555
1640.77	47.305	12.367	11.429	13.212	9.762	12.343	22.545
1670.77	47.791	12.376	11.44	13.235	9.765	12.348	22.526
1700.77	47.326	12.373	11.437	13.221	9.765	12.351	22.518
1730.77	47.292	12.373	11.429	13.224	9.765	12.352	22.506
1760.77	47.481	12.377	11.437	13.229	9.762	12.355	22.502
1790.77	47.451	12.379	11.437	13.229	9.764	12.352	22.494
1820.77	47.459	12.38	11.435	13.224	9.761	12.355	22.49
1850.77	47.49	12.382	11.437	13.221	9.762	12.354	22.473
1880.77	47.485	12.383	11.44	13.221	9.764	12.355	22.461
1910.77	48.281	12.395	11.457	13.255	9.764	12.357	22.429
1940.77	48.2	12.387	11.453	13.238	9.77	12.346	22.4
1970.77	48.281	12.375	11.44	13.224	9.77	12.327	22.363
2000.77	48.251	12.364	11.433	13.212	9.771	12.316	22.339
2030.77	48.268	12.357	11.424	13.206	9.771	12.306	22.337
2060.77	48.342	12.353	11.422	13.201	9.772	12.3	22.341
2090.77	48.479	12.349	11.42	13.192	9.768	12.288	22.329
2120.77	48.484	12.344	11.418	13.189	9.77	12.287	22.327
2150.77	48.432	12.343	11.416	13.183	9.772	12.284	22.304
2180.77	48.466	12.337	11.418	13.183	9.775	12.279	22.28
2210.77	48.484	12.334	11.409	13.18	9.775	12.276	22.274
2240.77	48.488	12.334	11.409	13.18	9.774	12.274	22.266
2270.77	48.552	12.332	11.411	13.18	9.774	12.272	22.266
2300.77	48.539	12.329	11.409	13.178	9.775	12.272	22.258
2330.77	48.311	12.327	11.405	13.166	9.781	12.268	22.249
2360.77	48.428	12.324	11.4	13.163	9.783	12.266	22.243
2390.77	48.423	12.323	11.4	13.163	9.781	12.266	22.243
2420.77	48.389	12.321	11.396	13.163	9.783	12.265	22.237
2450.77	48.402	12.321	11.4	13.163	9.783	12.263	22.235

**WELL 044 AQUIFER TEST 2**

**PLOTS FOR PUMPING WELL 044 AND OBSERVATION WELLS 045, 046, AND 126**

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Pumping test analysis  
 Theis analysis method  
 Unconfined aquifer

Page 1

Project: GUNNISON

Evaluated by:

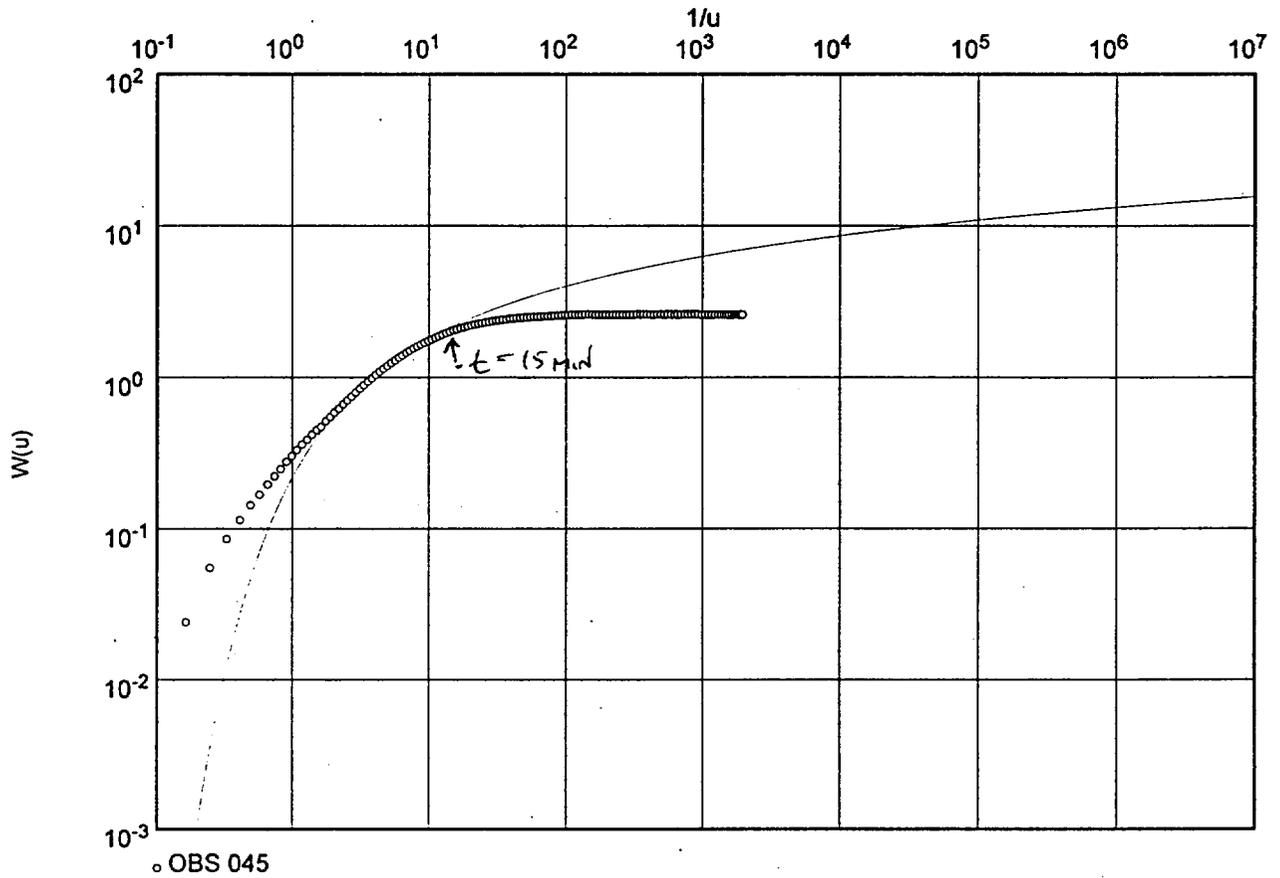
Date: 13.12.1999

Pumping Test No. 044 AQ TEST 2, t = 15.5 hrs

Test conducted on: 12/7/99

OBS 045, r = 56.8', SI = 40.9' - 50.5'

Discharge 58.16 U.S.gal/min



Transmissivity [ft<sup>2</sup>/min]:  $5.51 \times 10^{-1} = 793.4 \text{ Ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $1.83 \times 10^{-2}$

Aquifer thickness [ft]: 30.00

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Time-Drawdown-method after  
COOPER & JACOB  
Unconfined aquifer

Page 1

Project: GUNNISON

Evaluated by:

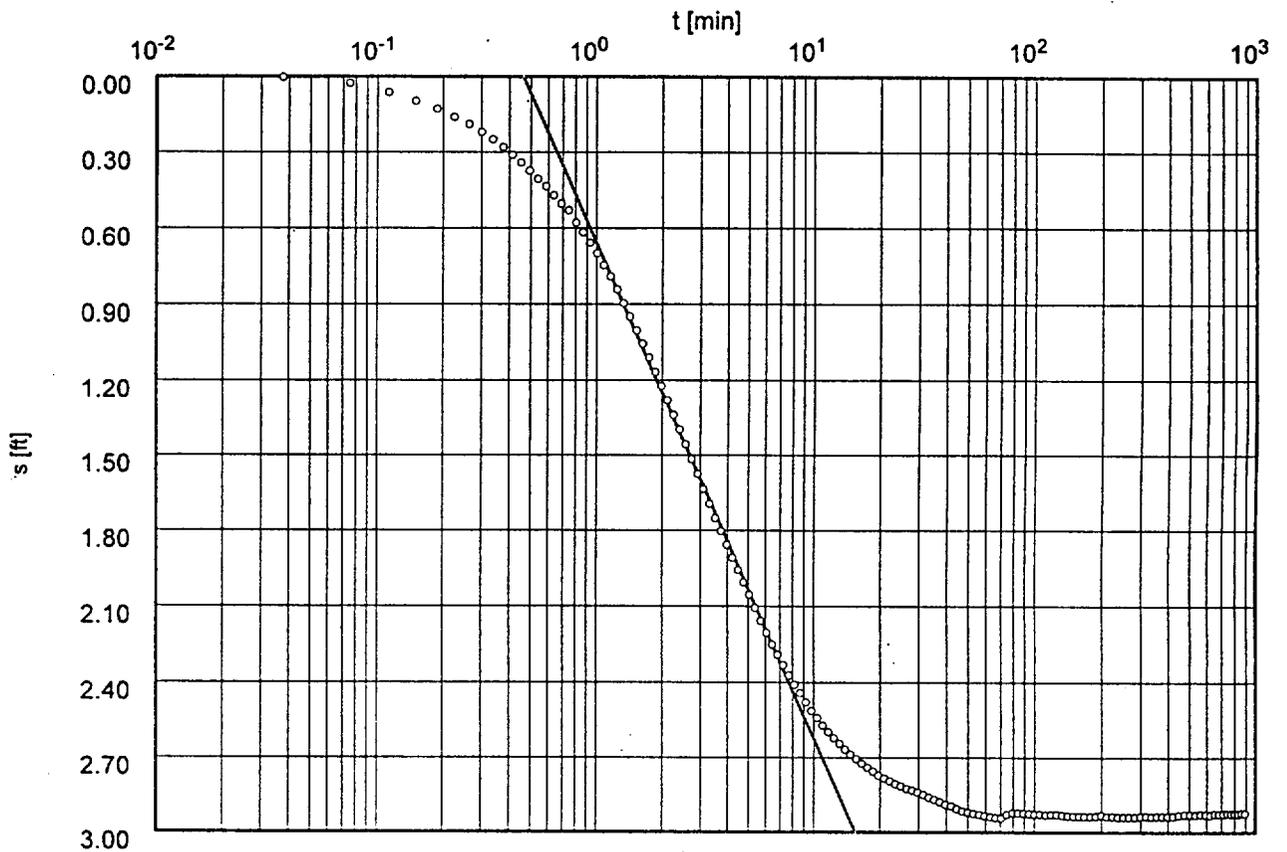
Date: 13.12.1999

Pumping Test No. 044 AQ TEST 2, t = 15.5 hrs

Test conducted on: 12/7/99

OBS 045, r = 56.8', SI = 40.9' - 50.5'

Discharge 58.16 U.S.gal/min

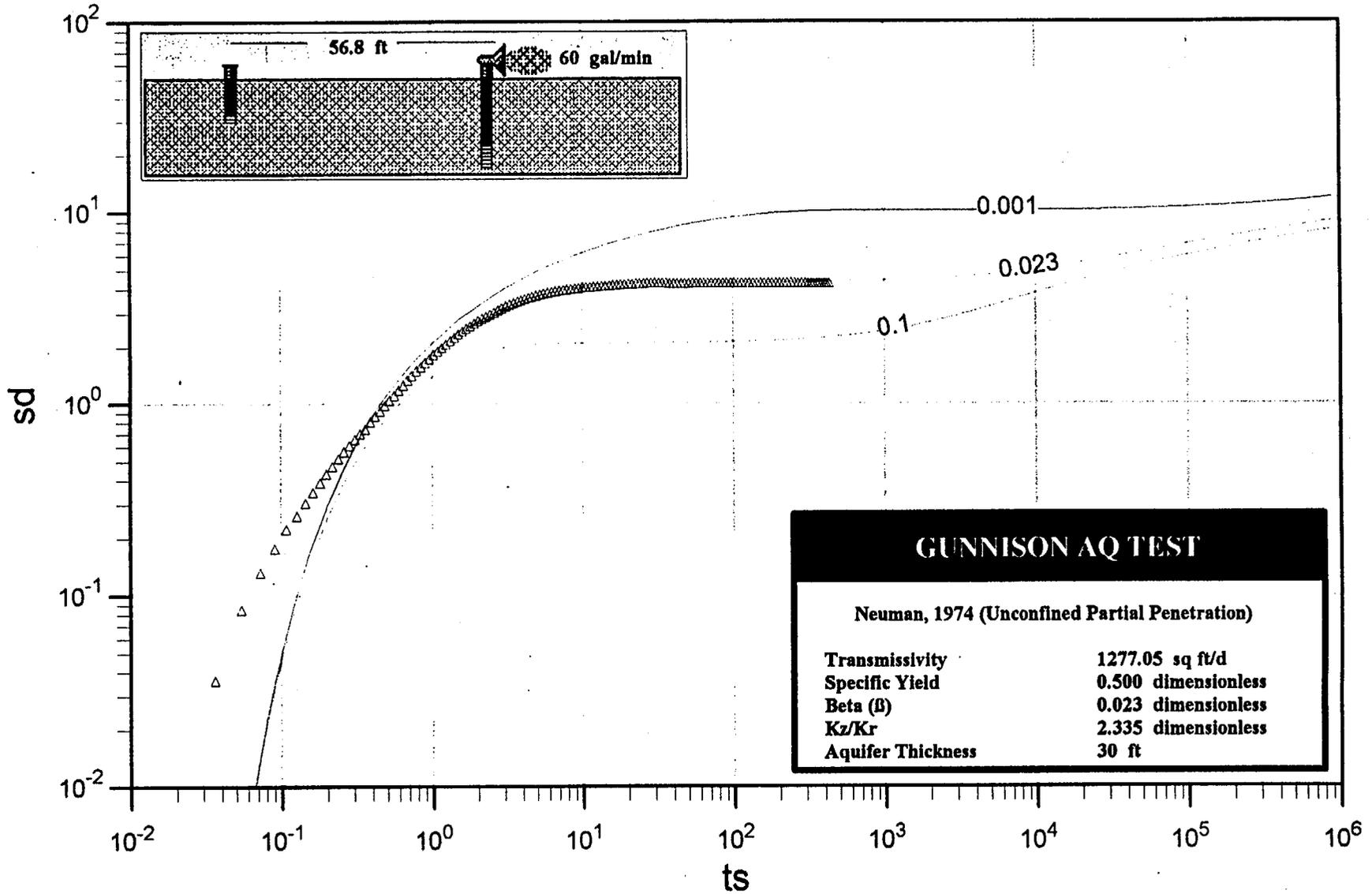


Transmissivity [ft<sup>2</sup>/min]:  $7.23 \times 10^{-1} = 1041.1 \text{ Ft}^2/\text{D}$

Hydraulic conductivity [ft/min]:  $2.41 \times 10^{-2}$

Aquifer thickness [ft]: 30.00

# WELL OBS 045 / 044 AQ TEST 2



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 Theis analysis method  
 Unconfined aquifer

Page 1

Project: GUNNISON

Evaluated by:

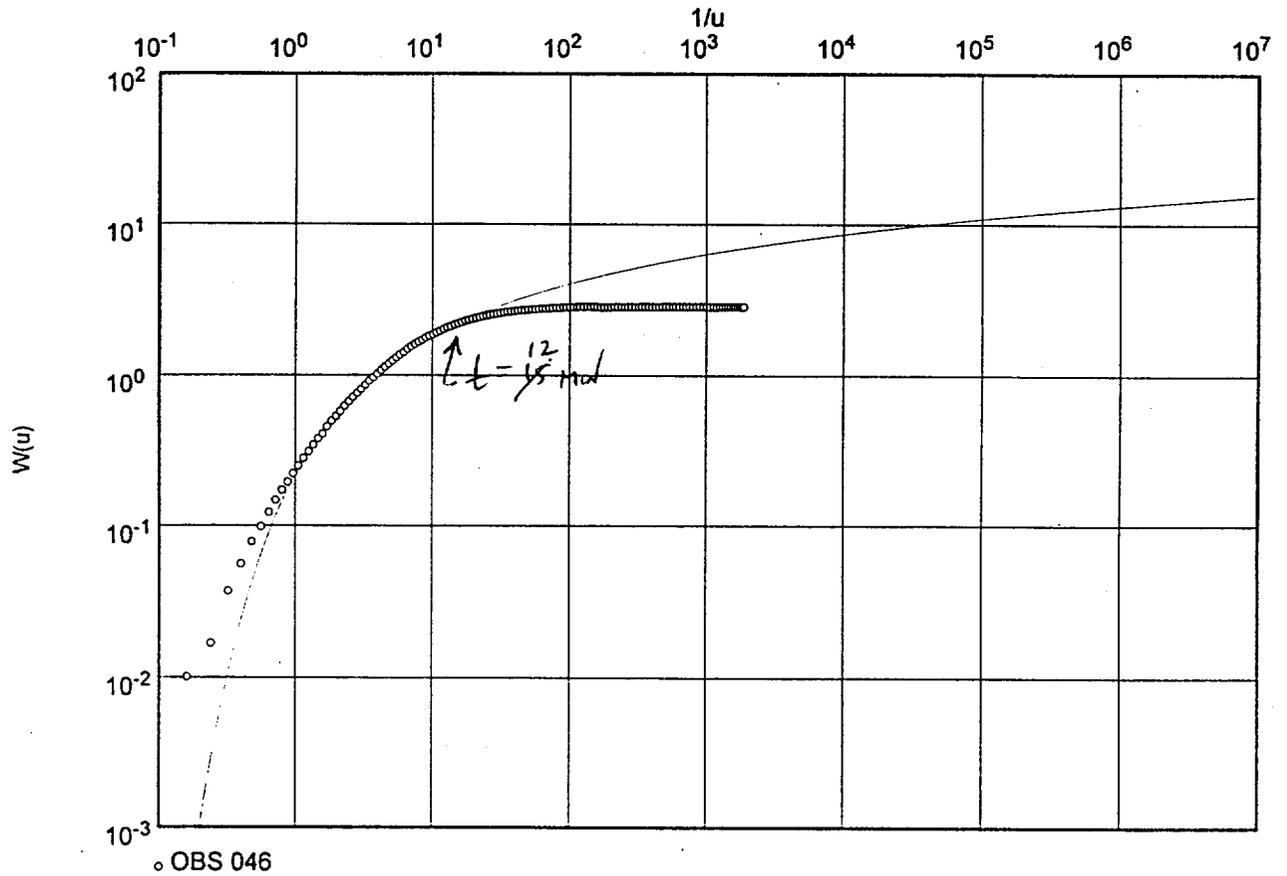
Date: 13.12.1999

Pumping Test No. 044 AQ TEST 2, t = 15.5 hrs

Test conducted on: 12/7/99

OBS 046, r = 40.9'

Discharge 58.16 U.S.gal/min



Transmissivity [ft<sup>2</sup>/min]:  $6.94 \times 10^{-1}$  - 999.4 Ft<sup>2</sup>/d

Hydraulic conductivity [ft/min]:  $2.31 \times 10^{-2}$

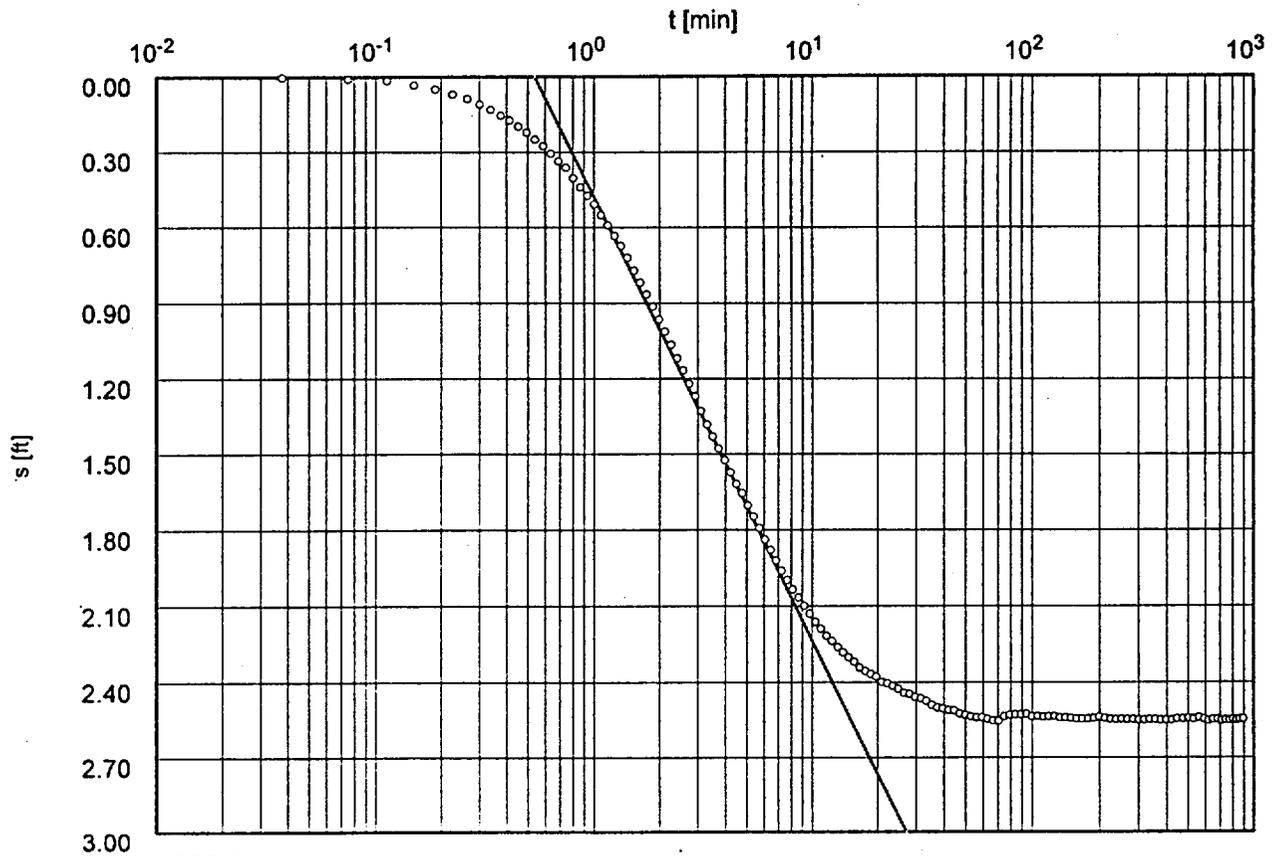
Aquifer thickness [ft]: 30.00

Pumping Test No. 044 AQ TEST 2, t = 15.5 hrs

Test conducted on: 12/7/99

OBS 046, r = 40.9'

Discharge 58.16 U.S.gal/min



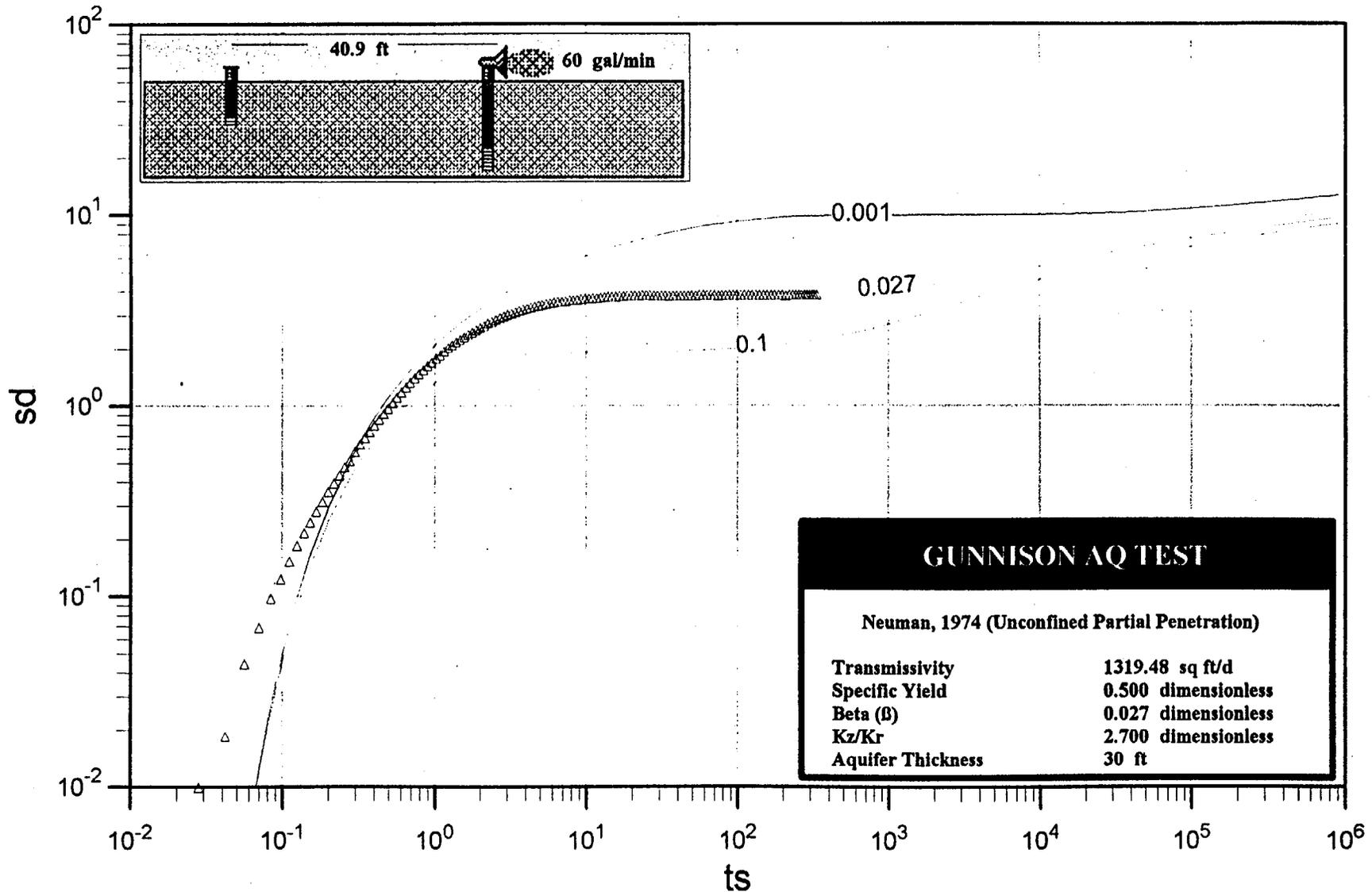
o OBS 046

Transmissivity [ft<sup>2</sup>/min]:  $8.08 \times 10^{-1} = 11635 \text{ Ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $2.69 \times 10^{-2}$

Aquifer thickness [ft]: 30.00

# WELL OBS 046 / 044 AQ TEST 2



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Pumping test analysis  
 Theis analysis method  
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Page 1

Project: GUNNISON

Evaluated by:

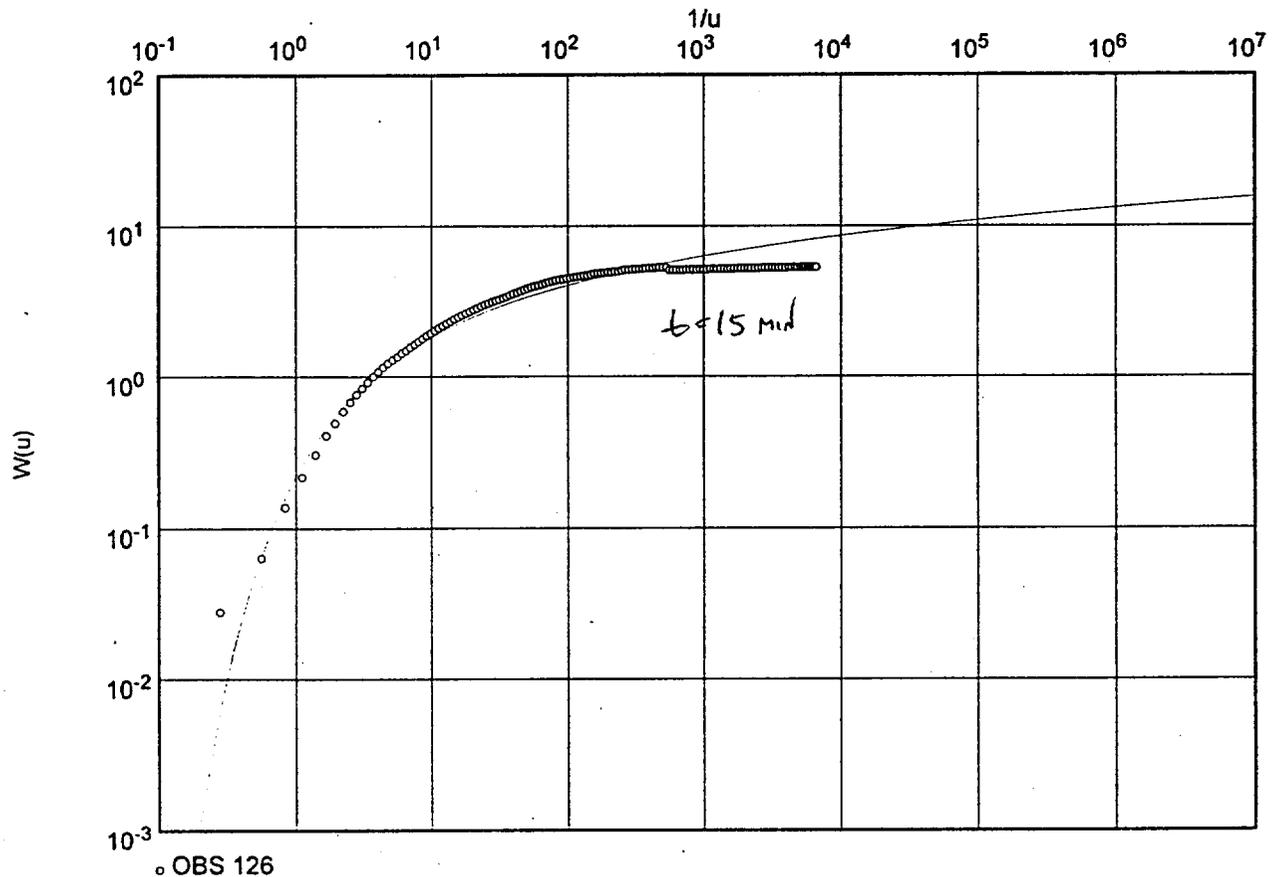
Date: 29.12.1999

Pumping Test No. 044 AQ TEST 2, t = 15.5 hrs

Test conducted on: 12/7/99

OBS 126, r = 16.4', SI = 53.2' - 58.2'

Discharge 58.15 U.S.gal/min



Transmissivity [ft<sup>2</sup>/min]:  $1.23 \times 10^0 = 1771.2 \text{ FT}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $4.11 \times 10^{-2}$

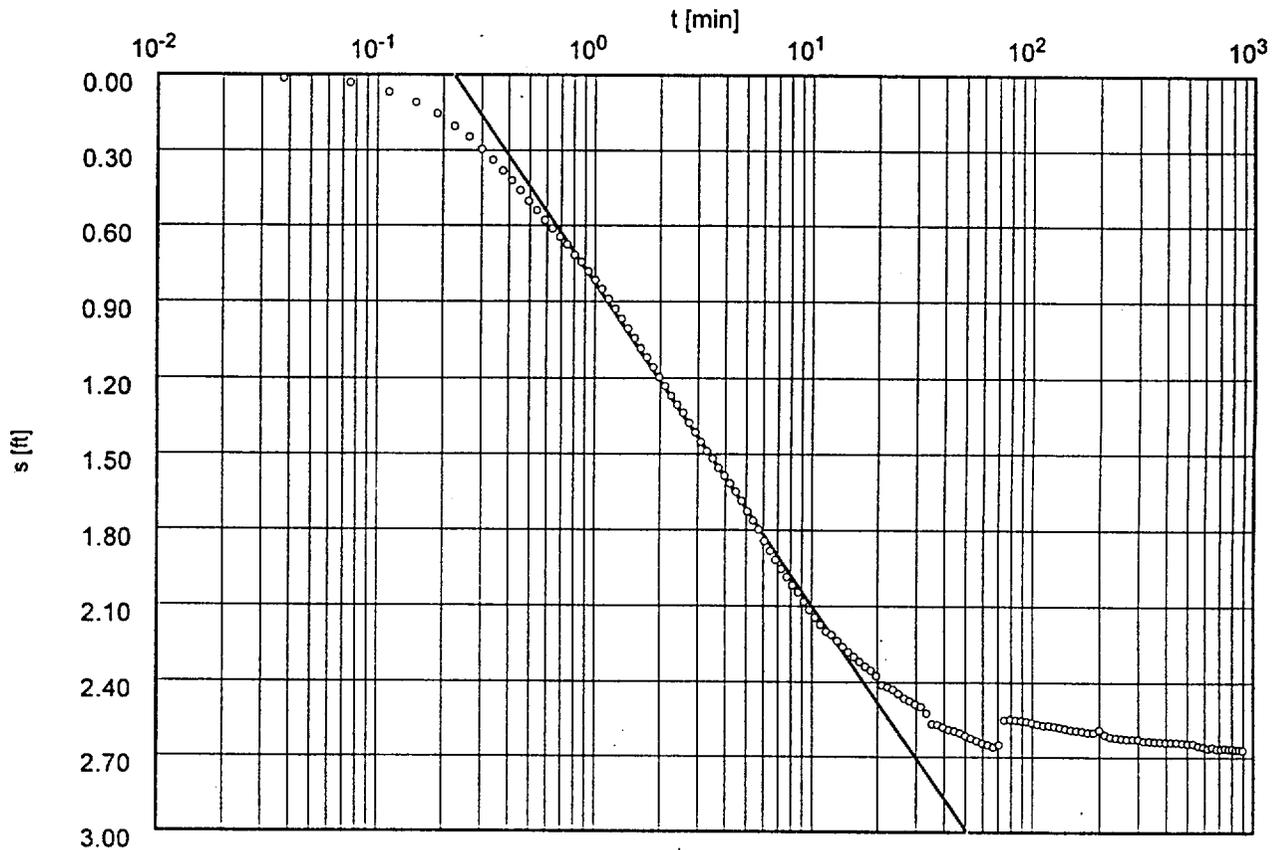
Aquifer thickness [ft]: 30.00

Pumping Test No. 044 AQ TEST 2, t = 15.5 hrs

Test conducted on: 12/7/99

OBS 126, r = 16.4', SI = 53.2' - 58.2'

Discharge 58.15 U.S.gal/min



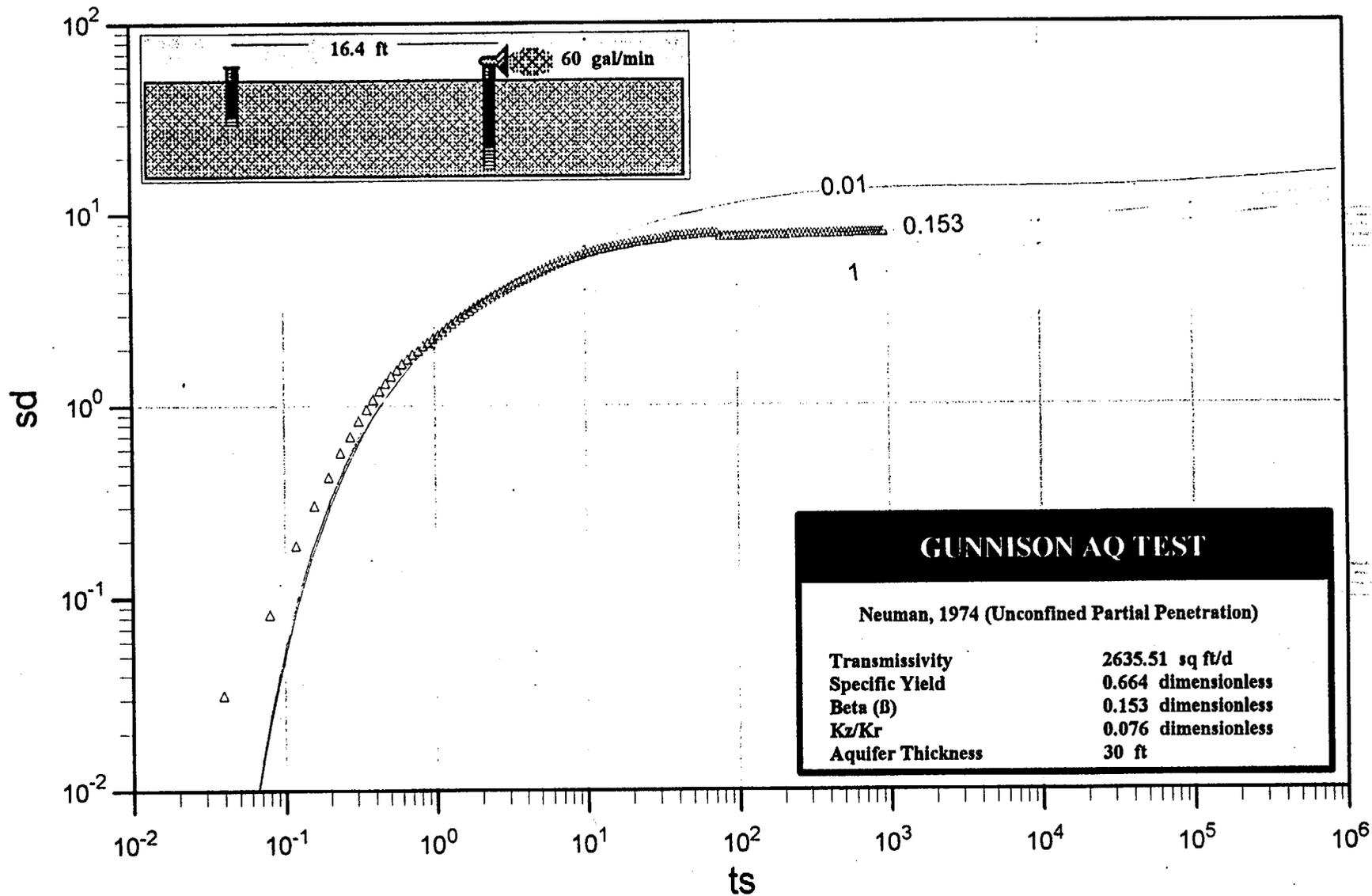
o OBS 126

Transmissivity [ft<sup>2</sup>/min]:  $1.11 \times 10^0 = 1593.4 \text{ Ft}^2/\text{D}$

Hydraulic conductivity [ft/min]:  $3.72 \times 10^{-2}$

Aquifer thickness [ft]: 30.00

# WELL OBS 126 / 044 AQ TEST 2



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Pumping test analysis  
 Recovery method after  
**THEIS & JACOB**  
 Unconfined aquifer

Page 1

Project: GUNNISON

Evaluated by:

Date: 13.12.1999

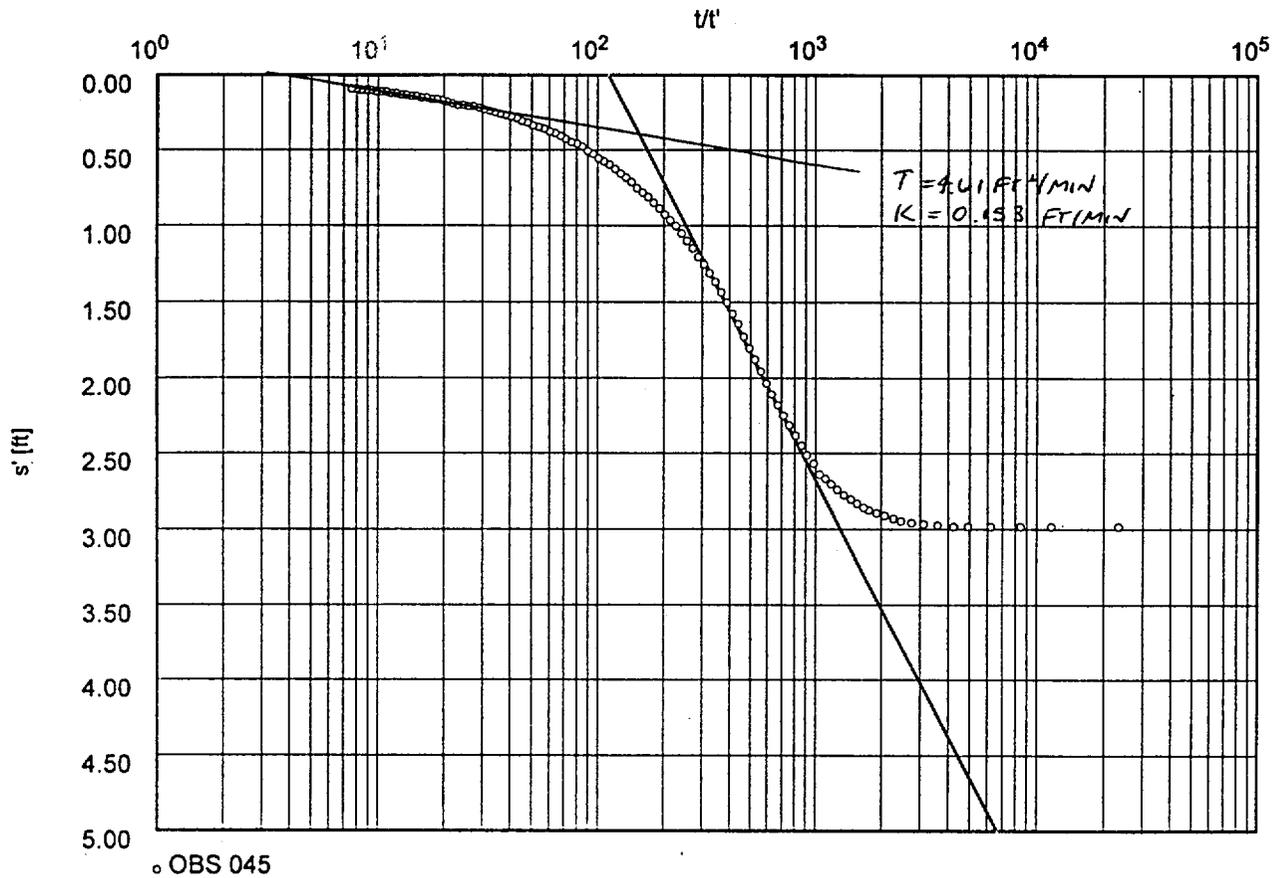
Pumping Test No. 044 AQ REC TEST 2

Test conducted on: 12/8/99

OBS 045, r = 56.8'

Discharge 58.15 U.S.gal/min

Pumping test duration: 930.00 min



Transmissivity [ $\text{ft}^2/\text{min}$ ]:  $5.05 \times 10^{-1} = 727.2 \text{ Ft}^2/\text{d}$

Hydraulic conductivity [ $\text{ft}/\text{min}$ ]:  $1.68 \times 10^{-2}$

Aquifer thickness [ $\text{ft}$ ]: 30.00

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Pumping test analysis  
 Recovery method after  
**THEIS & JACOB**  
 Unconfined aquifer

Page 1

Project: GUNNISON

Evaluated by:

Date: 13.12.1999

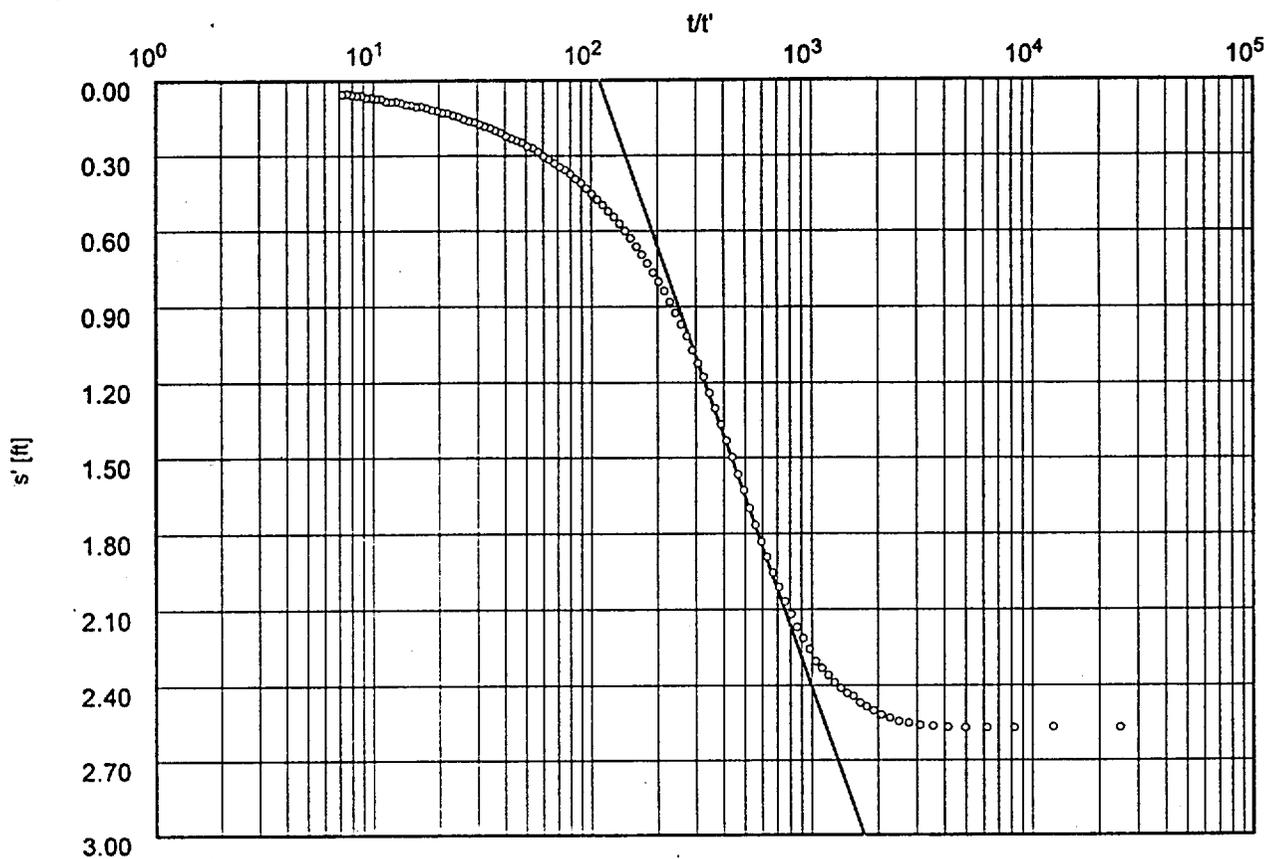
Pumping Test No. 044 AQ REC TEST 2

Test conducted on: 12/8/99

OBS 046, r = 40.9'

Discharge 58.15 U.S.gal/min

Pumping test duration: 930.00 min



o OBS 046

Transmissivity [ft<sup>2</sup>/min]:  $5.69 \times 10^{-1}$  - 319.4 Ft<sup>2</sup>/min

Hydraulic conductivity [ft/min]:  $1.89 \times 10^{-2}$

Aquifer thickness [ft]: 30.00

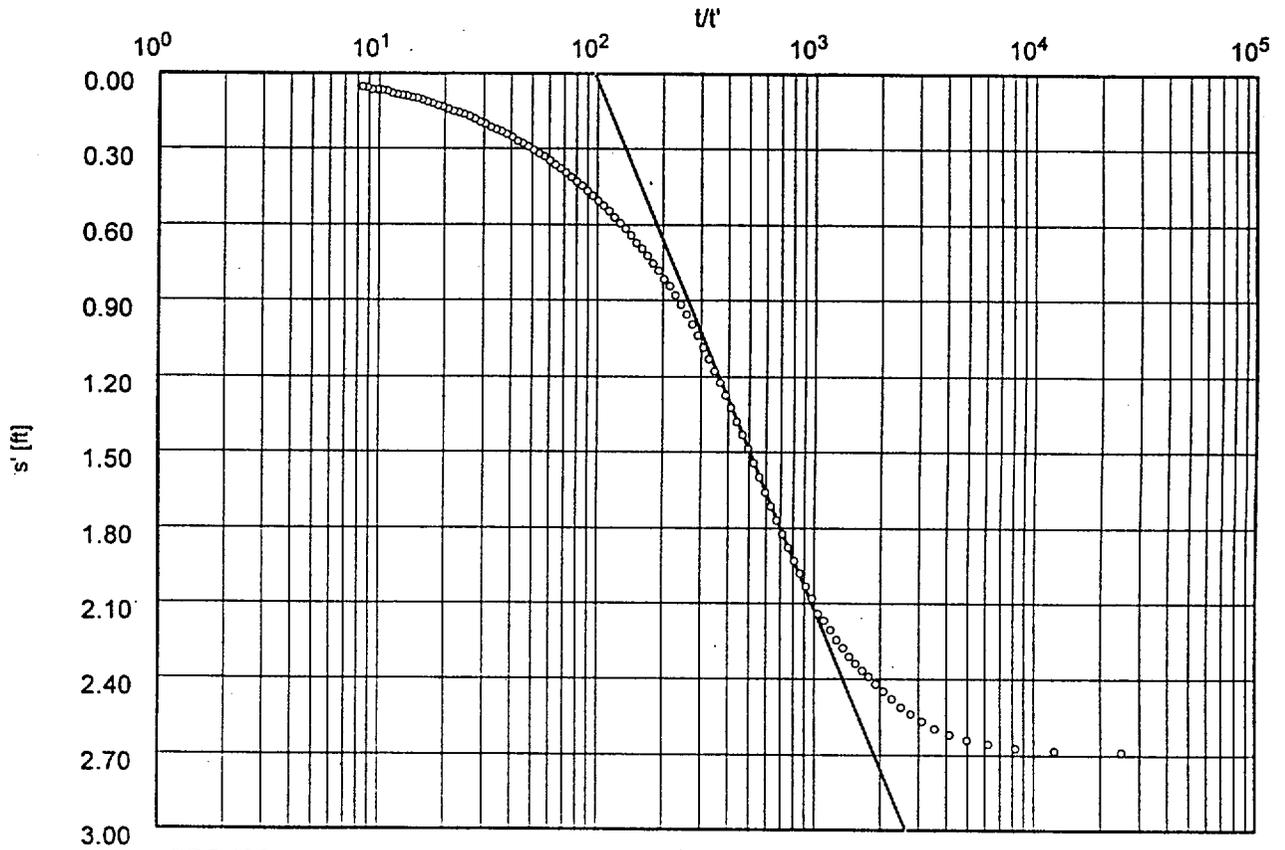
Pumping Test No. 044 AQ REC TEST 2

Test conducted on: 12/8/99

OBS 126,  $r = 14.6'$ ,  $SI = 53.2' - 58.2'$

Discharge 58.15 U.S.gal/min

Pumping test duration: 930.00 min



○ OBS 126

Transmissivity [ft<sup>2</sup>/min]:  $6.78 \times 10^{-1} = 476.3 \text{ Ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $2.26 \times 10^{-2}$

Aquifer thickness [ft]: 30.00

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 GRAND JUNCTION, COLO  
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Pumping test analysis  
 Recovery method after  
 THEIS & JACOB  
 Unconfined aquifer

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Project: GUNNISON

Evaluated by:

Date: 13.12.1999

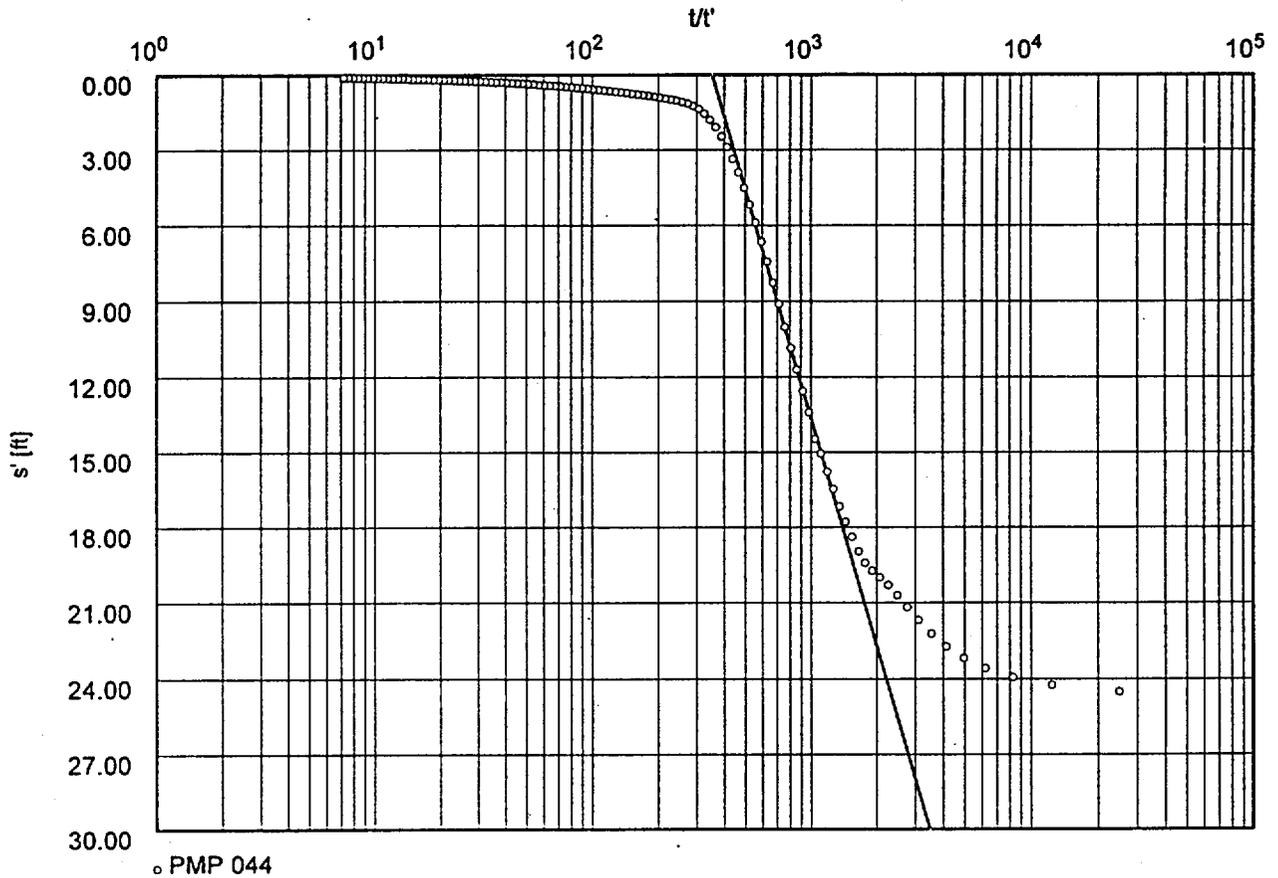
Pumping Test No. 044 AQ REC TEST 2

Test conducted on: 12/8/99

PMP 044

Discharge 58.15 U.S.gal/min

Pumping test duration: 930.00 min



Transmissivity [ft<sup>2</sup>/min]:  $4.72 \times 10^{-2} = 69 \text{ Ft}^2/\text{d}$

Hydraulic conductivity [ft/min]:

Aquifer thickness [ft]:

**WELL 044 AQUIFER TEST 2**

**DRAWDOWN DATA**

GUNNISON UMTRA SITE  
WELL 044 AQUIFER TEST 2 DATA  
START DATE/TIME : 12/7/99, 1600  
PUMPING RATE : 60/58 GPM

ELAPSED TIME (min)	WELL 044 DTW (ft btoc)	WELL 045 DTW (ft btoc)	WELL 046 DTW (ft btoc)	WELL 126 DTW (ft btoc)	WELL 125 DTW (ft btoc)	WELL 127 DTW (ft btoc)	INCHES Hg
Q = 60 GPM							
0.00	9.615	9.501	8.972	10.703	9.31	11.883	22.414
0.04	9.684	9.503	8.972	10.714	9.31	11.883	22.414
0.08	11.451	9.527	8.979	10.732	9.316	11.881	22.416
0.11	12.49	9.562	8.985	10.769	9.327	11.881	22.414
0.15	13.451	9.596	9.003	10.809	9.342	11.881	22.414
0.19	14.355	9.628	9.02	10.853	9.359	11.881	22.414
0.23	15.098	9.661	9.04	10.904	9.376	11.88	22.416
0.26	15.802	9.689	9.058	10.947	9.398	11.88	22.416
0.30	16.488	9.721	9.079	10.996	9.416	11.88	22.418
0.34	17.205	9.75	9.101	11.04	9.438	11.88	22.416
0.38	17.96	9.781	9.123	11.083	9.457	11.88	22.416
0.41	18.755	9.813	9.143	11.123	9.477	11.879	22.416
0.45	19.514	9.843	9.167	11.163	9.498	11.879	22.418
0.49	20.161	9.876	9.191	11.206	9.52	11.879	22.418
0.54	20.92	9.909	9.219	11.244	9.543	11.877	22.418
0.59	21.505	9.939	9.246	11.284	9.566	11.877	22.418
0.64	22.069	9.974	9.276	11.319	9.592	11.877	22.418
0.69	22.52	10.008	9.307	11.353	9.616	11.877	22.418
0.74	22.932	10.035	9.333	11.382	9.634	11.879	22.418
0.80	23.538	10.084	9.375	11.425	9.664	11.879	22.414
0.87	24.24	10.123	9.412	11.454	9.685	11.879	22.414
0.93	24.786	10.165	9.447	11.491	9.707	11.879	22.412
1.00	25.622	10.208	9.482	11.526	9.727	11.88	22.412
1.08	26.367	10.256	9.526	11.563	9.749	11.88	22.412
1.16	27.108	10.302	9.567	11.603	9.77	11.88	22.412
1.24	27.774	10.354	9.609	11.644	9.793	11.881	22.412
1.33	28.493	10.409	9.65	11.684	9.815	11.883	22.41
1.42	29.22	10.463	9.698	11.724	9.834	11.883	22.41
1.52	29.899	10.519	9.749	11.762	9.855	11.884	22.41
1.63	30.556	10.574	9.799	11.802	9.872	11.886	22.41
1.74	31.335	10.631	9.847	11.839	9.89	11.886	22.408
1.86	31.944	10.69	9.897	11.88	9.903	11.889	22.408
1.98	32.575	10.75	9.95	11.92	9.917	11.89	22.408
2.11	33.263	10.81	10	11.957	9.933	11.892	22.408
2.25	33.79	10.871	10.055	11.998	9.946	11.893	22.408
2.40	34.403	10.931	10.11	12.035	9.962	11.897	22.406
2.56	34.969	10.993	10.16	12.069	9.972	11.9	22.406
2.73	35.651	11.056	10.215	12.11	9.977	11.902	22.404
2.90	36.273	11.119	10.267	12.15	9.979	11.905	22.404
3.09	36.843	11.183	10.328	12.19	9.979	11.908	22.404
3.29	37.322	11.245	10.385	12.228	9.979	11.912	22.402
3.50	37.585	11.305	10.436	12.259	9.977	11.915	22.402
3.72	38.026	11.361	10.486	12.297	9.975	11.919	22.402
3.96	38.496	11.419	10.536	12.331	9.973	11.924	22.404
4.21	38.763	11.473	10.586	12.363	9.972	11.928	22.402
4.47	39.052	11.525	10.635	12.397	9.969	11.932	22.402
4.75	39.57	11.577	10.674	12.435	9.969	11.938	22.402
5.05	40.036	11.631	10.724	12.478	9.967	11.944	22.402
5.36	40.536	11.687	10.772	12.518	9.967	11.95	22.402
5.70	41.032	11.742	10.82	12.556	9.969	11.956	22.402
6.05	41.614	11.793	10.869	12.602	9.97	11.963	22.402
6.42	42.165	11.843	10.912	12.645	9.972	11.969	22.406
6.82	42.644	11.887	10.956	12.682	9.975	11.975	22.404
7.24	43.101	11.931	11	12.72	9.976	11.983	22.402
7.68	43.454	11.975	11.039	12.754	9.977	11.992	22.402
8.15	43.85	12.014	11.079	12.789	9.979	11.999	22.402
8.65	44.307	12.051	11.113	12.82	9.98	12.008	22.4

9.18	44.815	12.09	11.148	12.86	9.982	12.015	22.4
9.74	45.289	12.128	11.183	12.895	9.985	12.026	22.398
10.33	45.603	12.158	11.216	12.927	9.986	12.036	22.4
10.96	45.93	12.192	11.245	12.958	9.989	12.043	22.398
11.63	46.223	12.221	11.275	12.987	9.99	12.053	22.4
12.33	46.558	12.247	11.297	13.001	9.99	12.064	22.398
13.08	46.855	12.272	11.323	13.027	9.992	12.074	22.396
13.87	47.118	12.297	11.347	13.053	9.995	12.085	22.398
14.70	47.294	12.32	11.367	13.076	9.996	12.096	22.398
15.59	47.548	12.34	11.387	13.096	9.999	12.107	22.396
16.53	47.75	12.36	11.411	13.116	9.999	12.117	22.394
17.52	47.923	12.379	11.426	13.137	10.002	12.129	22.394
18.58	48.224	12.396	11.439	13.154	10.005	12.138	22.392
19.69	48.576	12.414	11.45	13.177	10.005	12.148	22.392
20.87	48.555	12.426	11.474	13.217	10.006	12.158	22.392
22.13	48.727	12.439	11.479	13.226	10.006	12.17	22.39
23.45	49.041	12.452	11.49	13.237	10.009	12.182	22.39
24.86	49.252	12.462	11.503	13.254	10.01	12.192	22.39
26.35	49.282	12.472	11.52	13.275	10.01	12.202	22.388
27.92	49.557	12.48	11.525	13.286	10.012	12.212	22.386
29.59	49.66	12.488	11.538	13.3	10.013	12.221	22.386
31.36	49.867	12.499	11.544	13.312	10.015	12.232	22.384
33.24	50.477	12.511	11.555	13.341	10.015	12.241	22.384
35.22	51.689	12.521	11.573	13.387	10.016	12.25	22.384
37.32	51.504	12.531	11.584	13.39	10.016	12.262	22.382
39.55	51.612	12.542	11.588	13.401	10.018	12.272	22.382
41.91	51.766	12.548	11.595	13.413	10.018	12.279	22.38
44.41	51.831	12.561	11.597	13.418	10.018	12.286	22.38
47.05	51.99	12.571	11.61	13.427	10.019	12.297	22.382
49.86	52.14	12.577	11.616	13.439	10.019	12.305	22.382
52.83	52.269	12.582	11.623	13.45	10.021	12.313	22.38
55.97	52.497	12.587	11.627	13.462	10.021	12.321	22.382
59.30	52.536	12.592	11.627	13.473	10.019	12.329	22.384
62.83	52.707	12.597	11.634	13.479	10.022	12.336	22.38
66.57	52.707	12.601	11.641	13.49	10.023	12.343	22.386
70.53	52.295	12.602	11.643	13.479	10.022	12.348	22.384
74.73	50.361	12.587	11.623	13.37	10.023	12.352	22.384
79.17	50.597	12.579	11.616	13.367	10.023	12.352	22.382
83.88	50.679	12.579	11.614	13.37	10.023	12.356	22.38
88.86	50.761	12.581	11.614	13.372	10.023	12.359	22.378
94.14	50.903	12.582	11.612	13.375	10.023	12.361	22.374
99.74	50.907	12.585	11.623	13.381	10.021	12.365	22.37
105.66	51.023	12.585	11.621	13.387	10.022	12.368	22.361
111.94	51.075	12.588	11.625	13.393	10.023	12.371	22.353
118.59	51.126	12.587	11.623	13.393	10.022	12.372	22.343
125.63	51.208	12.587	11.621	13.398	10.023	12.375	22.337
133.09	51.234	12.589	11.627	13.401	10.025	12.378	22.329
140.99	51.165	12.592	11.627	13.407	10.025	12.38	22.331
149.36	51.281	12.594	11.63	13.413	10.025	12.385	22.321
158.23	51.307	12.594	11.632	13.416	10.025	12.385	22.319
167.62	51.38	12.595	11.632	13.418	10.023	12.39	22.313
177.56	51.603	12.595	11.632	13.424	10.025	12.391	22.31
188.10	51.397	12.594	11.63	13.424	10.023	12.393	22.308
199.26	51.083	12.589	11.625	13.413	10.022	12.393	22.302
211.08	51.693	12.595	11.63	13.433	10.025	12.397	22.308
223.61	51.818	12.595	11.634	13.444	10.025	12.399	22.308
236.87	51.805	12.598	11.636	13.447	10.025	12.401	22.306
250.92	51.87	12.598	11.634	13.45	10.026	12.401	22.304
265.81	51.964	12.598	11.636	13.453	10.026	12.406	22.31
281.57	51.999	12.598	11.636	13.453	10.026	12.406	22.317
298.27	52.11	12.595	11.638	13.453	10.028	12.407	22.317
315.96	52.097	12.594	11.638	13.462	10.029	12.41	22.315
334.70	52.145	12.597	11.636	13.462	10.032	12.409	22.317
354.55	52.175	12.595	11.636	13.464	10.031	12.409	22.313
375.57	52.222	12.595	11.638	13.464	10.033	12.409	22.3

Q = 58 GPM

CALC SET U0082900  
WELL 044 AQ TEST 2

397.84	52.312	12.595	11.638	13.467	10.035	12.409	22.296
421.43	52.265	12.594	11.638	13.467	10.036	12.41	22.298
446.42	52.471	12.589	11.632	13.467	10.036	12.41	22.288
472.89	52.626	12.587	11.632	13.47	10.032	12.407	22.278
500.92	52.798	12.587	11.63	13.473	10.035	12.409	22.278
530.62	52.948	12.588	11.634	13.473	10.033	12.407	22.296
560.62	53.219	12.585	11.627	13.482	10.035	12.407	22.359
590.62	53.313	12.587	11.634	13.487	10.036	12.406	22.526
620.62	53.425	12.589	11.641	13.493	10.039	12.409	22.864
650.62	53.455	12.584	11.636	13.49	10.041	12.407	23.276
680.62	53.549	12.585	11.636	13.496	10.044	12.409	23.693
710.62	53.592	12.584	11.641	13.496	10.045	12.406	24.1
740.62	53.614	12.582	11.638	13.493	10.048	12.407	33.27
770.62	53.618	12.584	11.638	13.496	10.048	12.409	34.561
800.62	53.687	12.584	11.636	13.496	10.049	12.409	34.738
830.62	53.828	12.584	11.638	13.499	10.054	12.413	34.675
860.62	53.751	12.581	11.636	13.499	10.055	12.415	26.195
890.62	53.721	12.581	11.634	13.502	10.054	12.415	23.459

RECOVERY TEST DATA

930.00	53.896	12.651	11.66	13.52	10.06	12.421	
930.04	52.598	12.65	11.66	13.52	10.059	12.421	
930.08	50.91	12.65	11.658	13.514	10.059	12.421	
930.11	49.336	12.65	11.66	13.503	10.061	12.42	
930.15	47.723	12.65	11.66	13.485	10.061	12.42	
930.19	46.122	12.649	11.66	13.468	10.063	12.42	
930.23	44.529	12.646	11.658	13.445	10.064	12.42	
930.26	42.922	12.641	11.653	13.419	10.066	12.42	
930.30	41.396	12.633	11.649	13.388	10.066	12.42	
930.34	40.055	12.623	11.64	13.356	10.067	12.42	
930.38	38.904	12.607	11.632	13.327	10.069	12.42	
930.41	37.954	12.588	11.618	13.29	10.069	12.421	
930.45	37.251	12.57	11.603	13.258	10.069	12.42	
930.49	36.659	12.547	11.586	13.227	10.069	12.421	
930.53	35.986	12.527	11.568	13.195	10.07	12.421	
930.56	35.057	12.505	11.551	13.169	10.07	12.421	
930.60	33.895	12.479	11.522	13.138	10.072	12.421	
930.64	32.759	12.452	11.509	13.109	10.073	12.421	
930.69	31.648	12.42	11.487	13.071	10.073	12.423	
930.74	30.433	12.385	11.463	13.037	10.07	12.423	
930.79	29.256	12.344	11.43	12.994	10.066	12.423	
930.84	28.075	12.301	11.4	12.953	10.056	12.421	
930.89	27.161	12.267	11.371	12.925	10.05	12.426	
930.95	25.55	12.187	11.319	12.859	10.031	12.426	
931.02	24.329	12.126	11.273	12.807	10.014	12.426	
931.08	23.133	12.063	11.225	12.752	9.995	12.426	
931.15	21.979	11.994	11.17	12.697	9.972	12.426	
931.23	20.891	11.924	11.115	12.64	9.949	12.426	
931.31	19.741	11.849	11.054	12.582	9.922	12.427	
931.39	18.695	11.772	10.993	12.525	9.899	12.426	
931.48	17.697	11.692	10.927	12.465	9.87	12.426	
931.57	16.759	11.608	10.862	12.407	9.843	12.426	
931.67	15.89	11.525	10.792	12.344	9.814	12.424	
931.78	15.082	11.442	10.722	12.286	9.785	12.424	
931.89	14.343	11.359	10.647	12.226	9.758	12.424	
932.01	13.678	11.276	10.58	12.168	9.731	12.421	
932.13	13.091	11.194	10.508	12.114	9.705	12.423	
932.26	12.578	11.115	10.438	12.056	9.68	12.42	
932.40	12.135	11.04	10.37	12.004	9.656	12.419	
932.55	11.756	10.971	10.302	11.95	9.634	12.416	
932.71	11.448	10.904	10.238	11.901	9.617	12.413	
932.88	11.195	10.842	10.171	11.852	9.598	12.411	
933.05	11	10.782	10.116	11.806	9.583	12.408	
933.24	10.86	10.725	10.061	11.757	9.568	12.404	
933.44	10.765	10.67	10.004	11.711	9.557	12.401	
933.65	10.699	10.618	9.956	11.671	9.547	12.397	
933.87	10.639	10.571	9.91	11.63	9.538	12.391	

934.11	10.595	10.524	9.864	11.593	9.529	12.387
934.36	10.551	10.481	9.819	11.555	9.521	12.381
934.62	10.512	10.438	9.781	11.527	9.513	12.375
934.90	10.473	10.397	9.744	11.492	9.509	12.369
935.20	10.443	10.36	9.707	11.463	9.503	12.362
935.51	10.412	10.323	9.672	11.432	9.498	12.354
935.85	10.382	10.287	9.639	11.403	9.492	12.346
936.20	10.364	10.255	9.606	11.38	9.489	12.34
936.57	10.321	10.221	9.576	11.348	9.482	12.331
936.97	10.295	10.188	9.547	11.322	9.478	12.324
937.39	10.269	10.159	9.521	11.299	9.473	12.315
937.83	10.243	10.13	9.497	11.276	9.469	12.306
938.30	10.216	10.105	9.471	11.251	9.466	12.298
938.80	10.195	10.077	9.449	11.23	9.463	12.287
939.33	10.177	10.056	9.427	11.21	9.462	12.28
939.89	10.156	10.03	9.405	11.19	9.457	12.271
940.48	10.134	10.007	9.383	11.17	9.454	12.263
941.11	10.116	9.984	9.366	11.15	9.452	12.251
941.78	10.099	9.965	9.346	11.133	9.449	12.241
942.48	10.082	9.947	9.329	11.115	9.446	12.231
943.23	10.06	9.927	9.318	11.098	9.443	12.222
944.02	10.047	9.909	9.302	11.081	9.44	12.212
944.85	10.029	9.894	9.287	11.066	9.44	12.202
945.74	10.016	9.875	9.274	11.049	9.434	12.188
946.68	10.003	9.859	9.256	11.032	9.433	12.177
947.67	9.973	9.853	9.241	11.02	9.429	12.165
948.73	9.96	9.838	9.234	11.006	9.429	12.158
949.84	9.951	9.819	9.219	10.992	9.426	12.146
951.02	9.934	9.806	9.21	10.98	9.424	12.137
952.28	9.921	9.793	9.202	10.971	9.423	12.127
953.60	9.912	9.782	9.193	10.954	9.421	12.116
955.01	9.899	9.774	9.18	10.943	9.42	12.105
956.50	9.899	9.76	9.171	10.931	9.419	12.097
958.07	9.886	9.749	9.16	10.923	9.417	12.088
959.74	9.881	9.739	9.154	10.914	9.416	12.076
961.51	9.868	9.728	9.145	10.902	9.414	12.066
963.39	9.86	9.72	9.138	10.894	9.413	12.06
965.37	9.851	9.711	9.132	10.882	9.41	12.05
967.47	9.842	9.708	9.125	10.871	9.41	12.04
969.70	9.838	9.703	9.114	10.862	9.407	12.03
972.06	9.829	9.695	9.11	10.856	9.406	12.022
974.56	9.816	9.69	9.101	10.851	9.403	12.017
977.20	9.807	9.68	9.099	10.842	9.403	12.008
980.01	9.799	9.673	9.092	10.833	9.4	11.999
982.98	9.794	9.664	9.088	10.828	9.398	11.993
986.12	9.786	9.657	9.079	10.819	9.397	11.985
989.45	9.781	9.652	9.073	10.813	9.394	11.979
992.98	9.777	9.648	9.075	10.805	9.393	11.973
996.72	9.773	9.642	9.068	10.799	9.391	11.964
1000.68	9.764	9.637	9.066	10.796	9.391	11.96
1004.88	9.755	9.631	9.059	10.79	9.39	11.955
1009.32	9.751	9.628	9.053	10.787	9.39	11.952
1014.03	9.746	9.622	9.055	10.784	9.388	11.947
1019.01	9.742	9.618	9.053	10.779	9.384	11.939
1024.29	9.738	9.612	9.042	10.77	9.38	11.934
1029.89	9.738	9.611	9.042	10.767	9.381	11.932
1035.81	9.729	9.606	9.038	10.764	9.378	11.926
1042.09	9.725	9.602	9.038	10.764	9.378	11.926
1048.74	9.725	9.598	9.029	10.756	9.377	11.919

**APPENDIX D**

**WELL 047 AQUIFER TEST DATA AND PLOTS**

**WELL 047 AQUIFER TEST 1**  
**PLOTS FOR OBSERVATION WELLS 048, 049, AND 136**

**MACTEC-ERS**  
 2597 B 3/4 RD  
 GRAND JUNCTION, COLC  
 ph.(970)248-6000

Pumping test analysis  
 Theis analysis method  
 Unconfined aquifer

Page 1

Project: GUNNISON

Evaluated by:

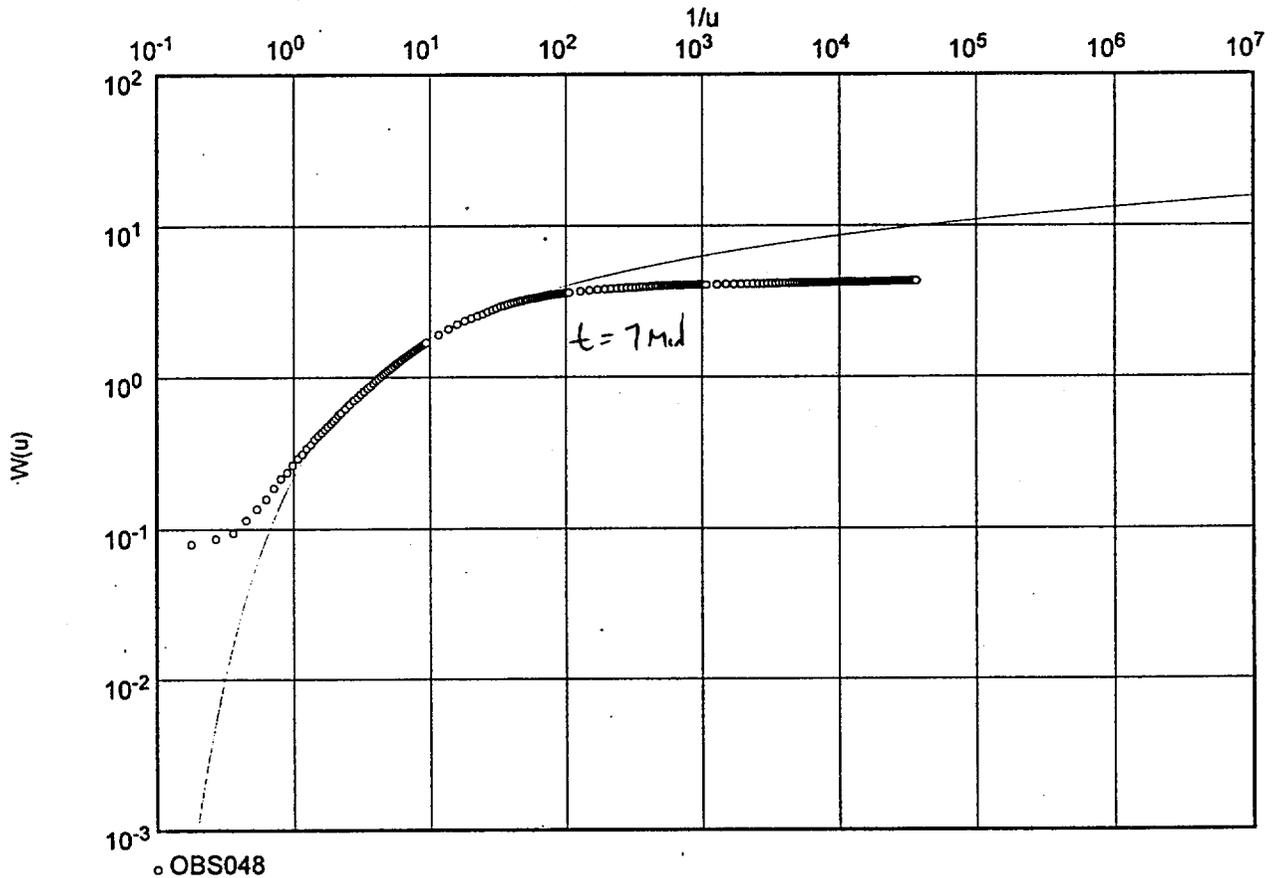
Date: 28.11.1999

Pumping Test No. 047 AQ TEST 1, t = 62 hrs

Test conducted on: 11/20/99

OBS048, r = 27.2'

Discharge 60.00 U.S.gal/min



Transmissivity [ft<sup>2</sup>/min]:  $7.16 \times 10^{-1} = 1031 \text{ Ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $2.38 \times 10^{-2}$

Aquifer thickness [ft]: 30.00

**MACTEC-ERS**  
 2597 B 3/4 RD  
 GRAND JUNCTION, COLO  
 ph.(970)248-6000

Pumping test analysis  
 Time-Drawdown-method after  
 COOPER & JACOB  
 Unconfined aquifer

Page 1

Project: GUNNISON

Evaluated by:

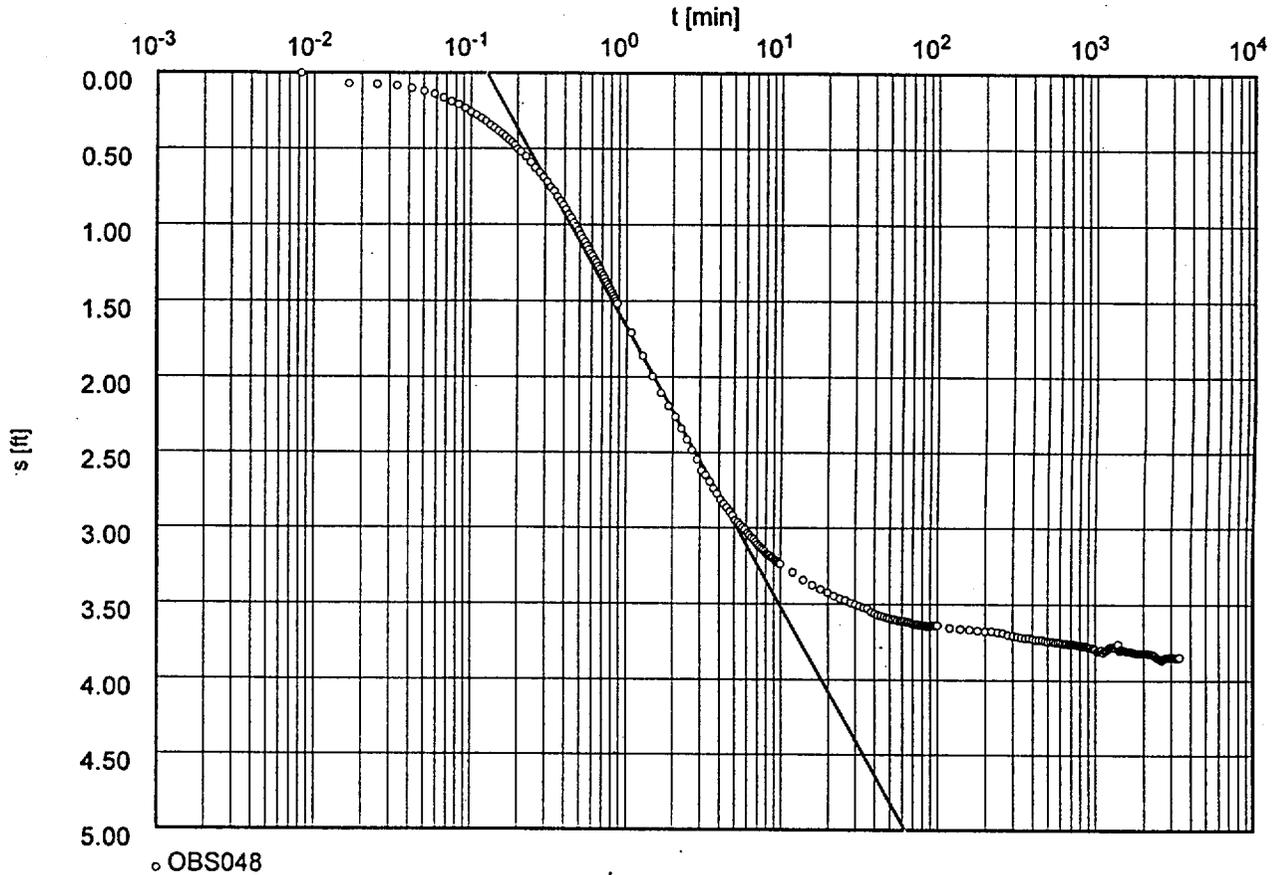
Date: 28.11.1999

Pumping Test No. 047 AQ TEST 1, t = 62 hrs

Test conducted on: 11/20/99

OBS048, r = 27.2'

Discharge 60.00 U.S.gal/min

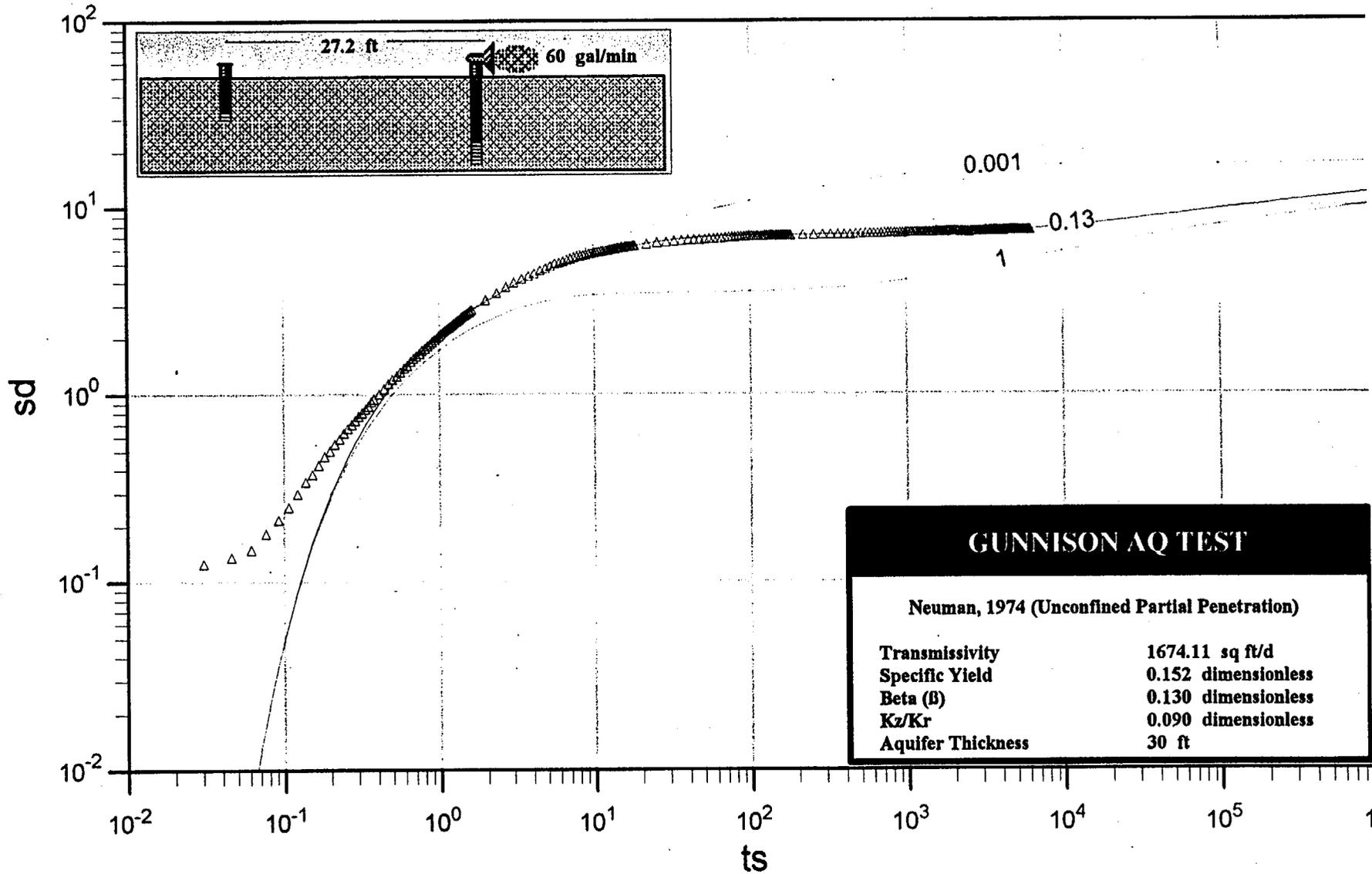


Transmissivity [ft<sup>2</sup>/min]:  $7.90 \times 10^{-1} = 1137.6 \text{ ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $2.63 \times 10^{-2}$

Aquifer thickness [ft]: 30.00

# WELL OBS 048 / 047 AQ TEST 1

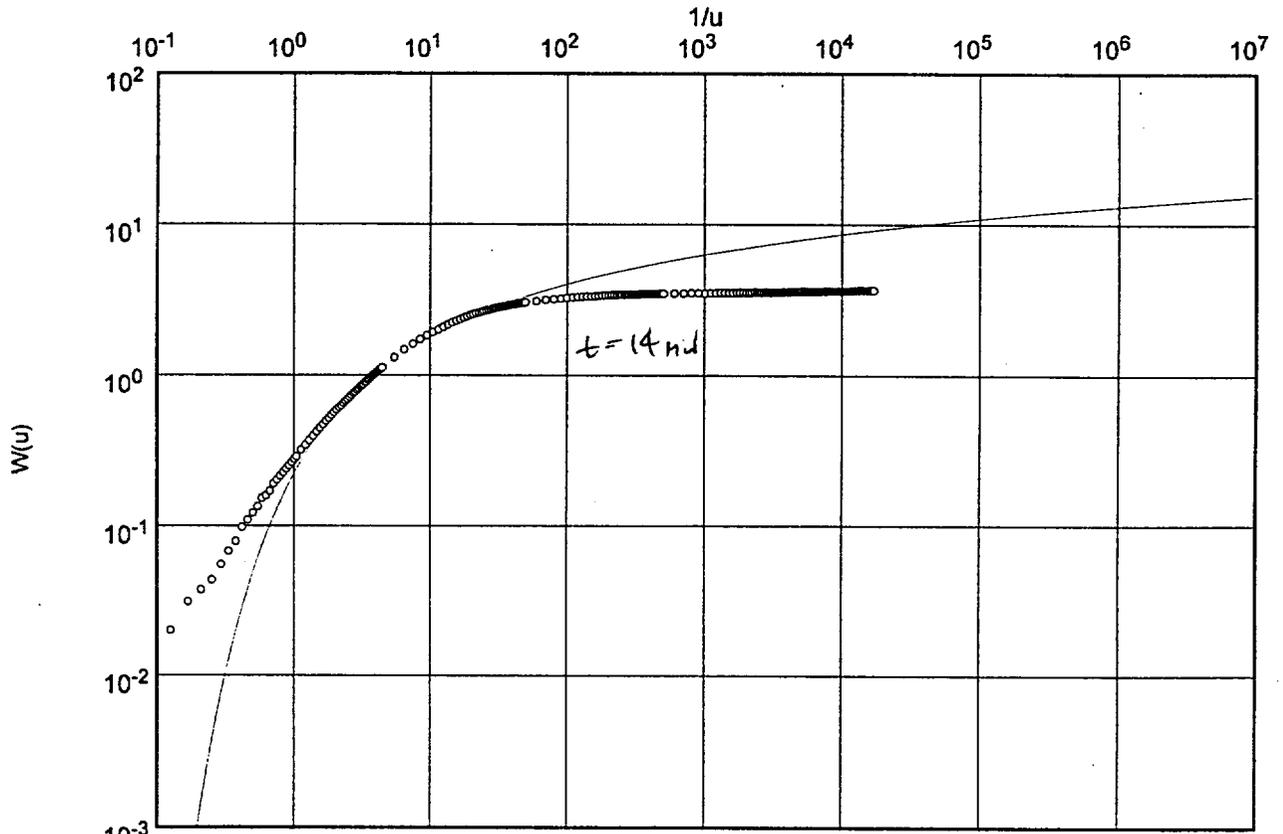


Pumping Test No. 047 AQ TEST 1, t = 62 hrs

Test conducted on: 11/20/99

OBS049, r = 42.1'

Discharge 60.00 U.S.gal/min



○ OBS049

Transmissivity [ft<sup>2</sup>/min]:  $8.03 \times 10^{-1} = 1156.3 \text{ Ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $2.67 \times 10^{-2}$

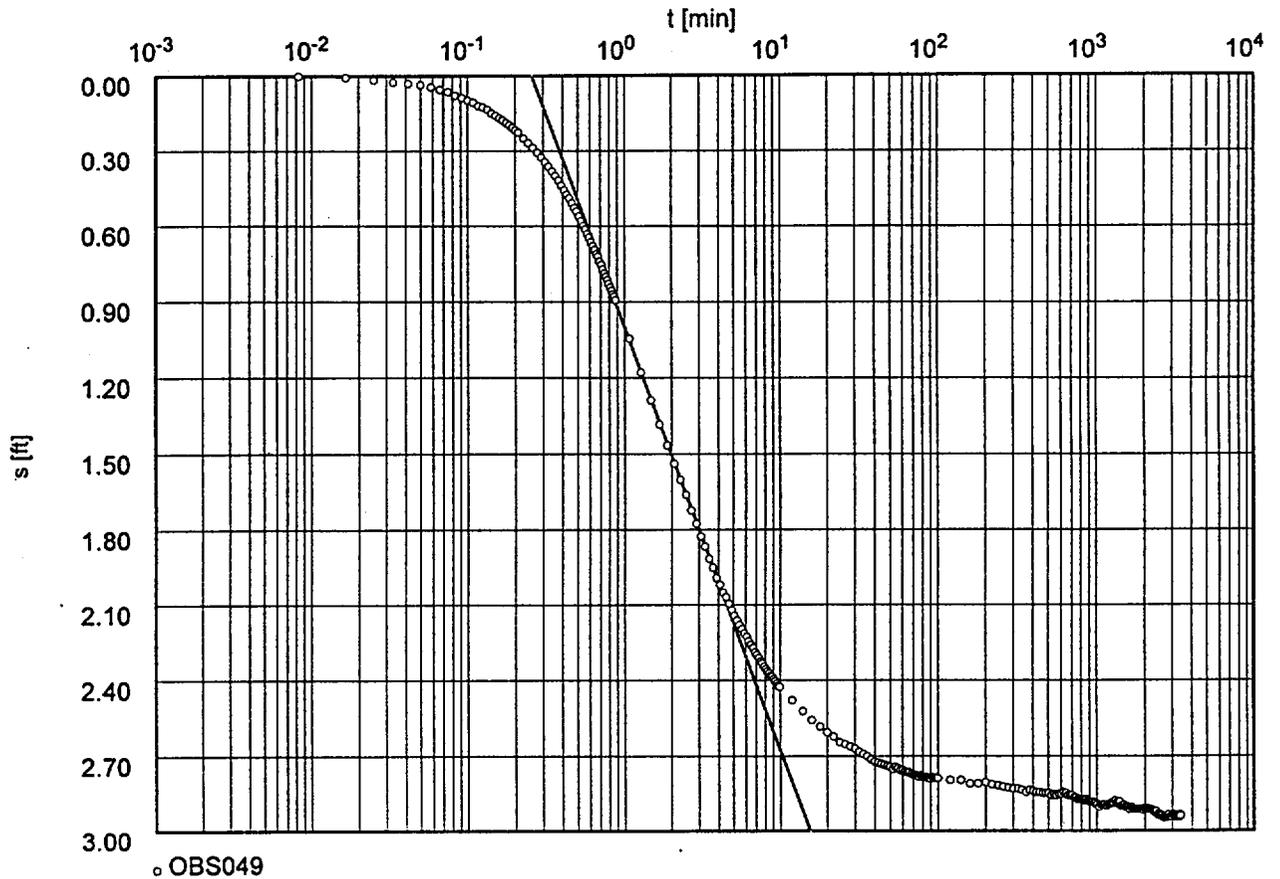
Aquifer thickness [ft]: 30.00

Pumping Test No. 047 AQ TEST 1, t = 62 hrs

Test conducted on: 11/20/99

OBS049, r = 42.1'

Discharge 60.00 U.S.gal/min

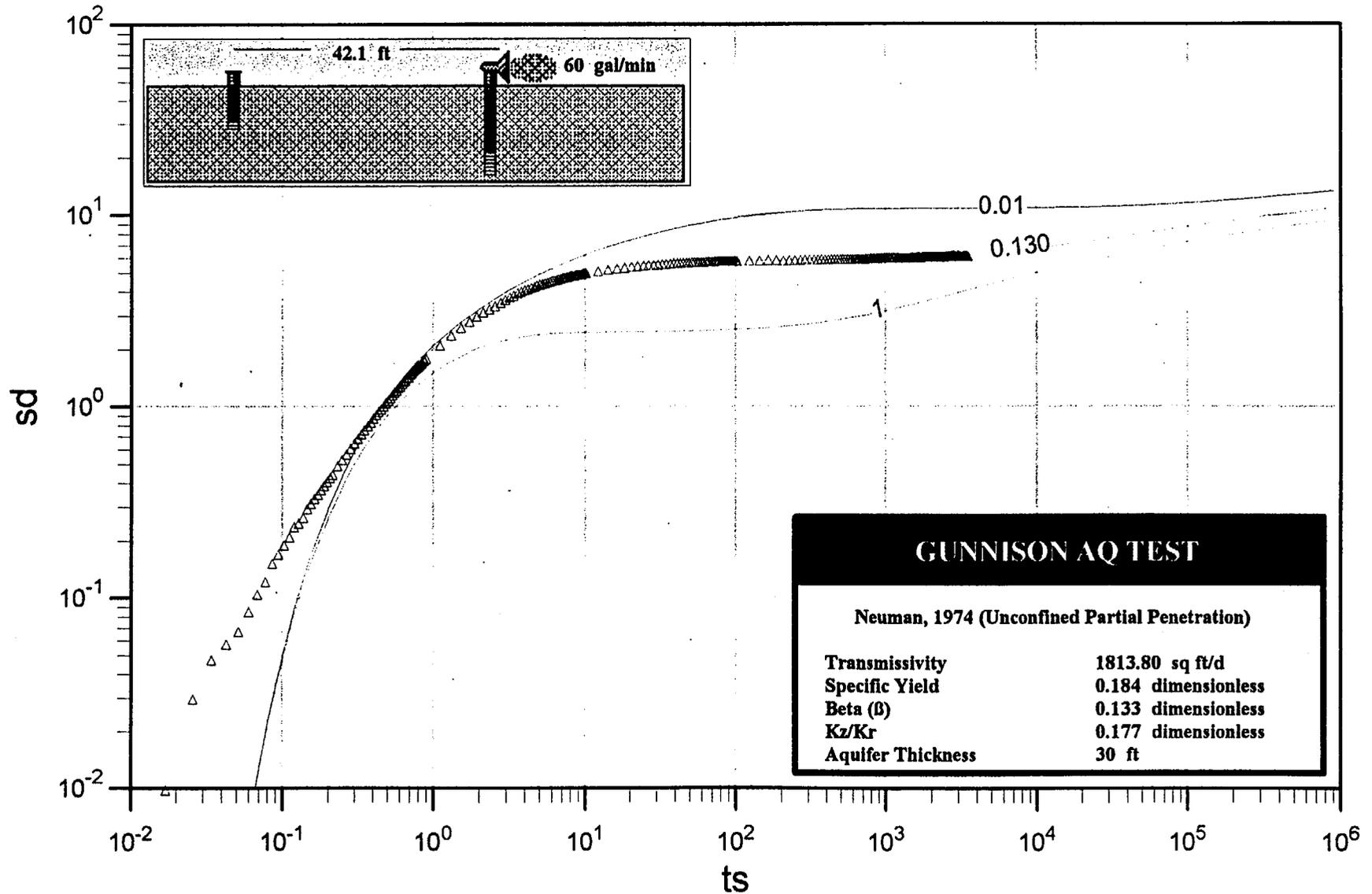


Transmissivity [ft<sup>2</sup>/min]:  $8.74 \times 10^{-1}$   $\approx 1253.6$  FT<sup>2</sup>/D

Hydraulic conductivity [ft/min]:  $2.91 \times 10^{-2}$

Aquifer thickness [ft]: 30.00

# WELL OBS 049 / 047 AQ TEST 1



**WELL 047 AQUIFER TEST 1**

**DRAWDOWN DATA**

GUNNISON UMTRA SITE  
WELL 047 AQUIFER TEST 1 DATA  
START DATE/TIME : 11/20/99, 1530  
PUMPING RATE : 60 GPM

<u>ELAPSED TIME (min)</u>	<u>WELL 047 DTW (ft btoc)</u>	<u>WELL 048 obs048</u>	<u>WELL 049 obs049</u>	<u>WELL 136 OBS 136</u>	<u>WELL 135 obs 135</u>
0.00	6.902	6.922	7.521	8.686	7.176
0.01	7.671	6.922	7.521	8.686	7.173
0.02	8.317	6.991	7.526	8.686	7.173
0.03	8.479	6.997	7.536	8.686	7.173
0.03	8.982	7.004	7.545	8.686	7.173
0.04	9.2	7.022	7.55	8.686	7.173
0.05	9.533	7.041	7.555	8.686	7.173
0.06	9.912	7.06	7.564	8.686	7.173
0.07	10.178	7.085	7.574	8.686	7.176
0.08	10.501	7.111	7.583	8.686	7.176
0.08	10.776	7.13	7.598	8.686	7.176
0.09	11.08	7.155	7.607	8.686	7.176
0.10	11.317	7.18	7.617	8.686	7.176
0.11	11.744	7.199	7.627	8.686	7.18
0.12	11.962	7.224	7.641	8.683	7.18
0.13	12.265	7.243	7.646	8.683	7.183
0.13	12.436	7.268	7.655	8.686	7.183
0.14	12.815	7.287	7.67	8.683	7.186
0.15	13.024	7.306	7.679	8.683	7.189
0.16	13.128	7.325	7.689	8.683	7.189
0.17	13.517	7.344	7.698	8.686	7.192
0.18	13.716	7.363	7.708	8.683	7.192
0.18	13.982	7.382	7.717	8.683	7.195
0.19	14.114	7.4	7.727	8.683	7.195
0.20	14.304	7.426	7.737	8.683	7.202
0.21	14.626	7.444	7.746	8.683	7.202
0.23	15.062	7.476	7.77	8.683	7.208
0.24	15.441	7.514	7.789	8.683	7.211
0.26	15.896	7.552	7.808	8.683	7.217
0.28	16.294	7.583	7.828	8.683	7.224
0.29	16.73	7.615	7.847	8.686	7.227
0.31	17.071	7.646	7.866	8.683	7.233
0.33	17.412	7.684	7.885	8.683	7.239
0.34	17.762	7.709	7.904	8.686	7.246
0.36	18.084	7.747	7.923	8.686	7.252
0.38	18.434	7.778	7.942	8.683	7.255
0.39	18.803	7.803	7.962	8.683	7.261
0.41	19.116	7.835	7.981	8.686	7.268
0.43	19.381	7.866	8	8.683	7.271
0.44	19.693	7.892	8.014	8.686	7.277
0.46	20.024	7.923	8.033	8.686	7.283
0.48	20.289	7.948	8.052	8.686	7.287
0.49	20.582	7.973	8.067	8.686	7.293
0.51	20.866	8.005	8.086	8.686	7.296
0.53	21.169	8.03	8.105	8.686	7.302
0.54	21.396	8.055	8.124	8.686	7.305
0.56	21.651	8.081	8.139	8.686	7.312
0.58	21.926	8.106	8.158	8.686	7.315
0.59	22.19	8.131	8.172	8.686	7.321
0.61	22.398	8.15	8.191	8.686	7.327
0.63	22.625	8.175	8.206	8.686	7.334

0.64	22.862	8.194	8.22	8.689	7.337
0.66	23.098	8.219	8.239	8.686	7.34
0.68	23.334	8.238	8.249	8.686	7.346
0.69	23.533	8.263	8.268	8.686	7.35
0.71	23.731	8.282	8.282	8.686	7.356
0.73	23.911	8.301	8.301	8.689	7.359
0.74	24.09	8.326	8.316	8.686	7.365
0.76	24.298	8.345	8.33	8.686	7.368
0.78	24.525	8.364	8.344	8.686	7.372
0.79	24.724	8.383	8.359	8.689	7.375
0.81	24.865	8.402	8.373	8.686	7.381
0.83	25.045	8.421	8.387	8.689	7.384
0.84	25.253	8.439	8.402	8.689	7.39
0.86	25.404	8.458	8.411	8.689	7.397
0.88	25.555	8.477	8.426	8.689	7.397
1.08	27.387	8.679	8.584	8.689	7.447
1.28	28.756	8.842	8.722	8.689	7.485
1.48	29.888	8.987	8.837	8.692	7.523
1.68	30.746	9.107	8.938	8.692	7.548
1.88	31.491	9.201	9.024	8.692	7.576
2.08	32.094	9.277	9.1	8.692	7.595
2.28	32.783	9.359	9.167	8.701	7.62
2.48	33.357	9.441	9.23	8.698	7.639
2.68	33.876	9.516	9.297	8.701	7.652
2.88	34.413	9.585	9.354	8.705	7.664
3.08	34.865	9.667	9.407	8.705	7.677
3.28	35.26	9.699	9.45	8.705	7.683
3.48	35.571	9.749	9.502	8.711	7.689
3.68	35.901	9.799	9.541	8.711	7.696
3.88	36.155	9.837	9.584	8.711	7.702
4.08	36.381	9.881	9.612	8.711	7.705
4.28	36.607	9.913	9.646	8.711	7.712
4.48	36.776	9.938	9.665	8.714	7.712
4.68	36.974	9.969	9.694	8.714	7.715
4.88	37.153	9.994	9.722	8.714	7.718
5.08	37.294	10.032	9.746	8.714	7.721
5.28	37.416	10.045	9.766	8.717	7.724
5.48	37.548	10.064	9.785	8.717	7.724
5.68	37.68	10.083	9.804	8.72	7.73
5.88	37.774	10.101	9.823	8.72	7.73
6.08	37.887	10.127	9.837	8.727	7.734
6.28	37.99	10.139	9.856	8.727	7.737
6.48	38.113	10.158	9.871	8.73	7.74
6.68	38.235	10.171	9.885	8.733	7.743
6.88	38.338	10.19	9.904	8.733	7.746
7.08	38.451	10.208	9.914	8.736	7.746
7.28	38.536	10.221	9.928	8.736	7.749
7.48	38.602	10.234	9.943	8.736	7.752
7.68	38.696	10.246	9.952	8.739	7.752
7.88	38.781	10.259	9.966	8.739	7.756
8.08	38.846	10.278	9.976	8.742	7.756
8.28	38.912	10.284	9.986	8.742	7.756
8.48	38.969	10.29	9.995	8.745	7.759
8.68	39.025	10.303	10.005	8.745	7.759
8.88	39.072	10.309	10.01	8.752	7.759
9.08	39.119	10.322	10.019	8.749	7.765
9.28	39.176	10.328	10.029	8.752	7.765
9.48	39.223	10.334	10.038	8.752	7.765
9.68	39.27	10.347	10.048	8.755	7.768

9.88	39.298	10.353	10.053	8.755	7.768
11.88	39.637	10.416	10.11	8.77	7.778
13.88	39.975	10.473	10.158	8.789	7.784
15.88	40.22	10.511	10.196	8.802	7.787
17.88	40.408	10.542	10.225	8.818	7.793
19.88	40.549	10.567	10.249	8.836	7.797
21.88	40.68	10.592	10.268	8.849	7.803
23.88	40.793	10.611	10.292	8.868	7.806
25.88	40.915	10.624	10.301	8.883	7.809
27.88	41.047	10.643	10.311	8.899	7.806
29.88	41.103	10.655	10.32	8.915	7.809
31.88	41.141	10.668	10.335	8.927	7.809
33.88	41.216	10.681	10.344	8.943	7.812
35.88	41.282	10.687	10.354	8.962	7.812
37.88	41.592	10.712	10.368	8.974	7.809
39.88	41.677	10.725	10.378	8.987	7.812
41.88	41.771	10.737	10.383	9.006	7.809
43.88	41.78	10.743	10.387	9.015	7.809
45.88	41.818	10.75	10.392	9.034	7.815
47.88	41.855	10.756	10.397	9.047	7.812
49.88	41.874	10.762	10.402	9.059	7.812
51.88	41.921	10.769	10.411	9.075	7.815
53.88	42.025	10.769	10.402	9.09	7.815
55.88	42.062	10.775	10.407	9.106	7.815
57.88	42.062	10.781	10.416	9.119	7.815
59.88	42.109	10.781	10.416	9.134	7.815
61.88	42.165	10.781	10.421	9.15	7.815
63.88	42.194	10.788	10.426	9.159	7.815
65.88	42.212	10.788	10.426	9.175	7.815
67.88	42.259	10.794	10.431	9.188	7.819
69.88	42.335	10.8	10.435	9.203	7.819
71.88	42.335	10.806	10.44	9.216	7.819
73.88	42.316	10.806	10.44	9.232	7.819
75.88	42.382	10.806	10.445	9.244	7.819
77.88	42.419	10.813	10.44	9.26	7.822
79.88	42.429	10.813	10.445	9.272	7.822
81.88	42.457	10.813	10.445	9.285	7.819
83.88	42.438	10.813	10.445	9.301	7.822
85.88	42.476	10.819	10.45	9.316	7.822
87.88	42.513	10.819	10.45	9.326	7.822
89.88	42.532	10.819	10.454	9.338	7.822
91.88	42.382	10.813	10.445	9.351	7.812
93.88	42.335	10.813	10.45	9.366	7.822
95.88	42.353	10.813	10.45	9.385	7.825
97.88	42.363	10.813	10.45	9.395	7.825
99.88	42.41	10.813	10.45	9.404	7.825
119.88	42.57	10.832	10.459	9.533	7.828
139.88	42.72	10.838	10.459	9.655	7.831
159.88	42.804	10.844	10.474	9.771	7.834
179.88	42.927	10.85	10.474	9.878	7.837
199.88	43.049	10.857	10.469	9.984	7.841
219.88	43.124	10.857	10.478	10.085	7.841
239.88	43.19	10.863	10.483	10.179	7.841
259.88	43.34	10.869	10.488	10.273	7.844
279.88	43.528	10.882	10.493	10.361	7.844
299.88	43.603	10.888	10.497	10.445	7.847
319.88	43.716	10.894	10.497	10.524	7.85
339.88	43.8	10.901	10.502	10.602	7.85
359.88	43.838	10.907	10.512	10.677	7.853

379.88	43.96	10.907	10.502	10.746	7.853
399.88	44.091	10.913	10.507	10.815	7.853
419.88	44.204	10.92	10.512	10.881	7.856
439.88	44.185	10.92	10.512	10.947	7.859
459.88	44.298	10.92	10.517	11.007	7.856
479.88	44.317	10.926	10.517	11.066	7.859
499.88	44.382	10.932	10.517	11.123	7.863
519.88	44.42	10.932	10.526	11.176	7.863
539.88	44.458	10.932	10.521	11.226	7.866
559.88	44.505	10.939	10.526	11.276	7.869
579.88	44.561	10.939	10.521	11.323	7.869
599.88	44.645	10.939	10.521	11.37	7.869
619.88	44.786	10.945	10.512	11.414	7.872
639.88	44.88	10.951	10.517	11.455	7.872
659.88	44.777	10.945	10.526	11.496	7.872
679.88	44.861	10.951	10.526	11.536	7.875
699.88	44.88	10.951	10.526	11.574	7.875
719.88	44.767	10.951	10.536	11.608	7.878
739.88	44.796	10.951	10.536	11.643	7.878
759.88	44.814	10.957	10.545	11.674	7.882
779.88	44.833	10.957	10.545	11.706	7.885
799.88	44.861	10.957	10.545	11.737	7.885
819.88	44.88	10.964	10.545	11.765	7.891
839.88	44.843	10.97	10.55	11.793	7.891
859.88	44.918	10.964	10.545	11.818	7.891
879.88	44.965	10.97	10.55	11.844	7.894
899.88	44.993	10.976	10.555	11.869	7.897
919.88	44.993	10.976	10.555	11.891	7.897
939.88	44.936	10.976	10.555	11.913	7.9
959.88	44.936	10.983	10.56	11.934	7.904
979.88	44.936	10.983	10.56	11.953	7.904
999.88	45.115	10.989	10.569	11.975	7.907
1029.88	45.237	11.008	10.579	12.003	7.916
1059.88	45.077	11.001	10.569	12.032	7.922
1089.88	45.068	10.995	10.569	12.057	7.929
1119.88	45.265	11.014	10.569	12.076	7.932
1149.88	45.124	11.001	10.574	12.094	7.935
1179.88	45.096	10.995	10.569	12.116	7.938
1209.88	44.927	10.983	10.564	12.129	7.935
1239.88	44.861	10.976	10.56	12.144	7.938
1269.88	44.936	10.976	10.56	12.16	7.941
1299.88	44.974	10.97	10.55	12.166	7.932
1329.88	44.993	10.976	10.56	12.182	7.932
1359.88	44.88	10.964	10.564	12.195	7.935
1389.88	44.476	10.951	10.555	12.204	7.941
1419.88	45.462	11.001	10.574	12.21	7.938
1449.88	45.181	10.989	10.574	12.223	7.938
1479.88	45.237	10.995	10.569	12.232	7.938
1509.88	45.218	10.995	10.579	12.239	7.941
1539.88	45.256	11.001	10.574	12.248	7.941
1569.88	45.274	11.001	10.579	12.257	7.944
1599.88	45.312	11.008	10.588	12.264	7.944
1629.88	45.378	11.008	10.579	12.273	7.948
1659.88	45.35	11.008	10.579	12.276	7.948
1689.88	45.35	11.008	10.584	12.282	7.951
1719.88	45.397	11.014	10.588	12.289	7.954
1749.88	45.415	11.014	10.588	12.295	7.954
1779.88	45.453	11.02	10.588	12.301	7.957
1809.88	45.397	11.02	10.588	12.304	7.957

1839.88	45.472	11.02	10.588	12.311	7.96
1869.88	45.434	11.02	10.588	12.317	7.963
1899.88	45.434	11.02	10.588	12.32	7.963
1929.88	45.462	11.02	10.588	12.329	7.966
1959.88	45.443	11.02	10.593	12.329	7.966
1989.88	45.443	11.02	10.584	12.333	7.97
2019.88	45.509	11.02	10.588	12.336	7.97
2049.88	45.481	11.02	10.584	12.342	7.97
2079.88	45.472	11.02	10.584	12.342	7.973
2109.88	45.519	11.02	10.588	12.348	7.976
2139.88	45.612	11.02	10.588	12.348	7.973
2169.88	45.566	11.027	10.588	12.355	7.976
2199.88	45.631	11.027	10.588	12.358	7.979
2229.88	45.65	11.027	10.593	12.358	7.979
2259.88	45.659	11.027	10.593	12.361	7.982
2289.88	45.716	11.027	10.598	12.364	7.979
2319.88	45.791	11.033	10.603	12.367	7.982
2349.88	45.847	11.039	10.598	12.367	7.982
2379.88	45.969	11.039	10.598	12.37	7.979
2409.88	46.016	11.052	10.612	12.373	7.982
2439.88	45.979	11.058	10.608	12.38	7.989
2469.88	45.988	11.058	10.617	12.383	7.995
2499.88	45.932	11.058	10.617	12.386	7.998
2529.88	45.885	11.064	10.612	12.389	8.004
2559.88	45.866	11.064	10.617	12.395	8.011
2589.88	45.819	11.064	10.617	12.395	8.011
2619.88	46.063	11.077	10.627	12.395	8.011
2649.88	45.791	11.071	10.622	12.402	8.014
2679.88	45.669	11.064	10.627	12.405	8.017
2709.88	45.631	11.058	10.622	12.405	8.011
2739.88	45.697	11.064	10.627	12.411	8.011
2769.88	45.716	11.058	10.622	12.411	8.014
2799.88	45.706	11.052	10.622	12.408	8.011
2829.88	45.688	11.052	10.612	12.414	8.014
2859.88	45.669	11.052	10.612	12.414	8.014
2889.88	45.659	11.052	10.622	12.414	8.017
2919.88	45.697	11.052	10.622	12.414	8.017
2949.88	45.622	11.058	10.622	12.417	8.017
2979.88	45.631	11.058	10.622	12.42	8.017
3009.88	45.641	11.052	10.612	12.417	8.017
3039.88	45.678	11.052	10.612	12.42	8.02
3069.88	45.669	11.046	10.617	12.423	8.02
3099.88	45.725	11.052	10.612	12.423	8.02
3129.88	45.744	11.052	10.612	12.42	8.02
3159.88	45.819	11.052	10.617	12.423	8.02
3189.88	45.885	11.058	10.622	12.423	8.02
3219.88	45.903	11.058	10.622	12.427	8.02
3249.88	45.866	11.058	10.622	12.427	8.02
3279.88	45.875	11.058	10.617	12.43	8.02
3309.88	45.903	11.058	10.617	12.427	8.02
3339.88	45.903	11.058	10.622	12.43	8.023
3369.88	45.866	11.052	10.612	12.43	8.02
3399.88	45.903	11.052	10.617	12.43	8.023

**WELL 047 AQUIFER TEST 2**  
**PLOTS FOR OBSERVATION WELLS 048, 049, AND 136**

MACTEC-ERS  
 2597 B 3/4 RD  
 GRAND JUNCTION, COLO  
 ph.(970)248-6000

Pumping test analysis  
 Theis analysis method  
 Unconfined aquifer

Page 1

Project: GUNNISON

Evaluated by:

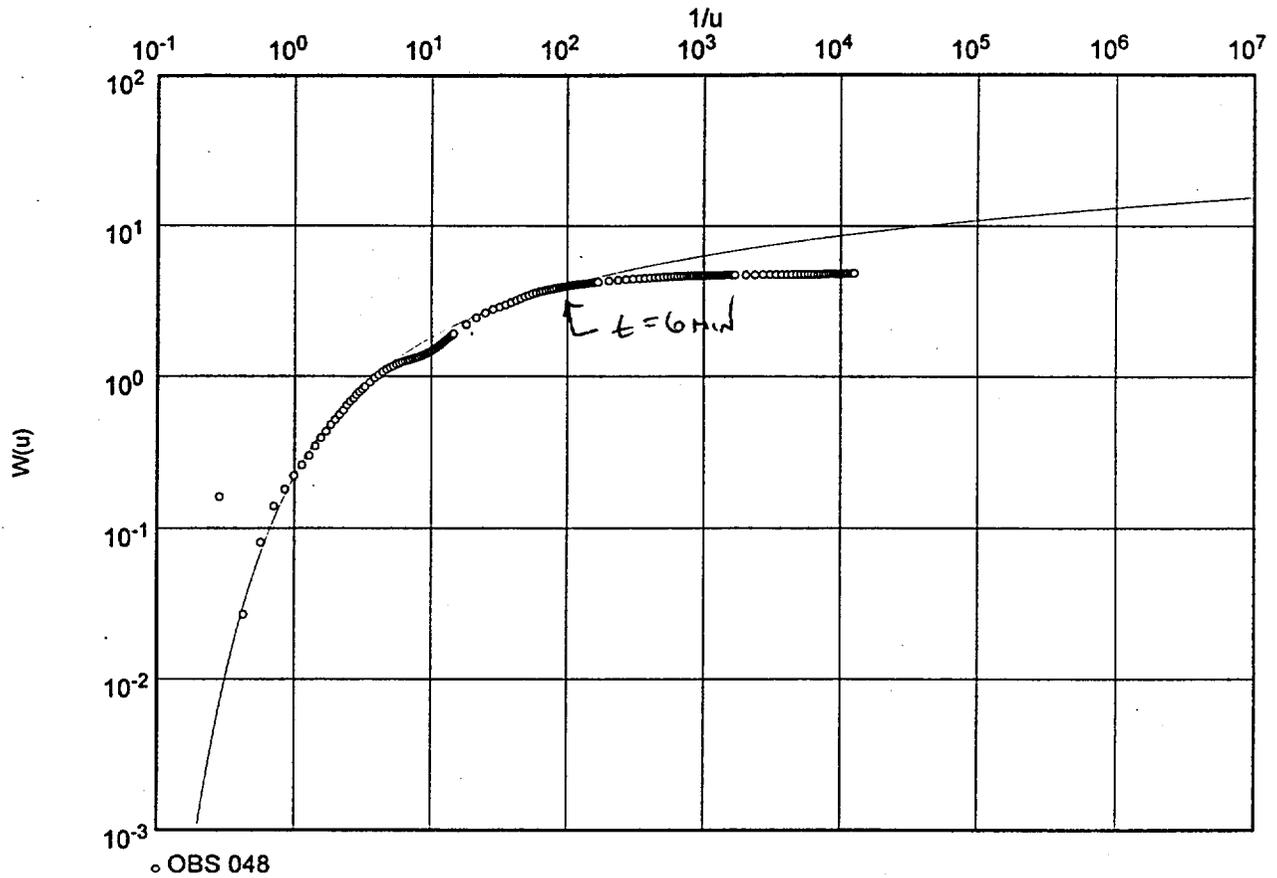
Date: 14.12.1999

Pumping Test No. 047 AQ TEST 2, t = 12 hrs

Test conducted on: 12/8/99

OBS 048, r = 27.7'

Discharge 60.00 U.S.gal/min



Transmissivity [ft<sup>2</sup>/min]:  $9.01 \times 10^{-1} = 1297.4 \text{ Ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $3.00 \times 10^{-2}$

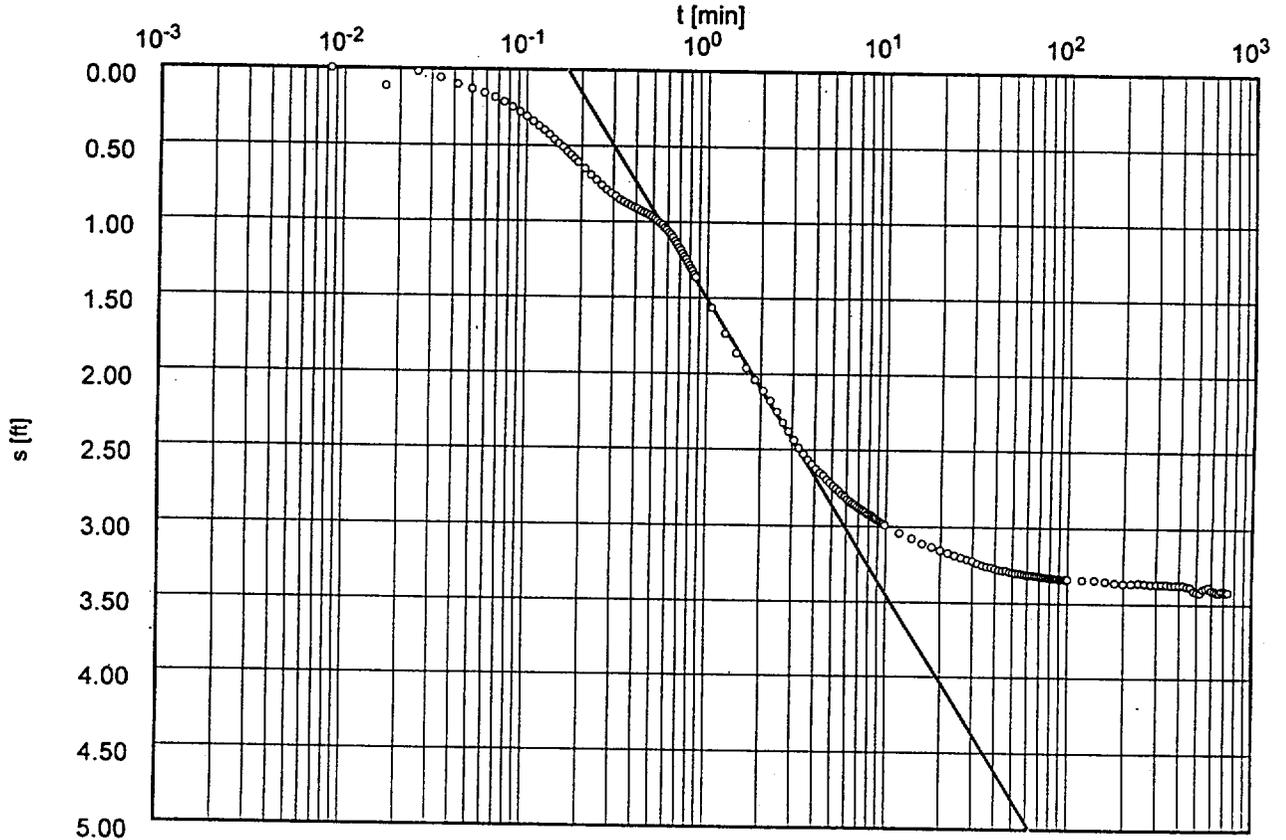
Aquifer thickness [ft]: 30.00

Pumping Test No. 047 AQ TEST 2, t = 12 hrs

Test conducted on: 12/8/99

OBS 048, r = 27.7'

Discharge 60.00 U.S.gal/min



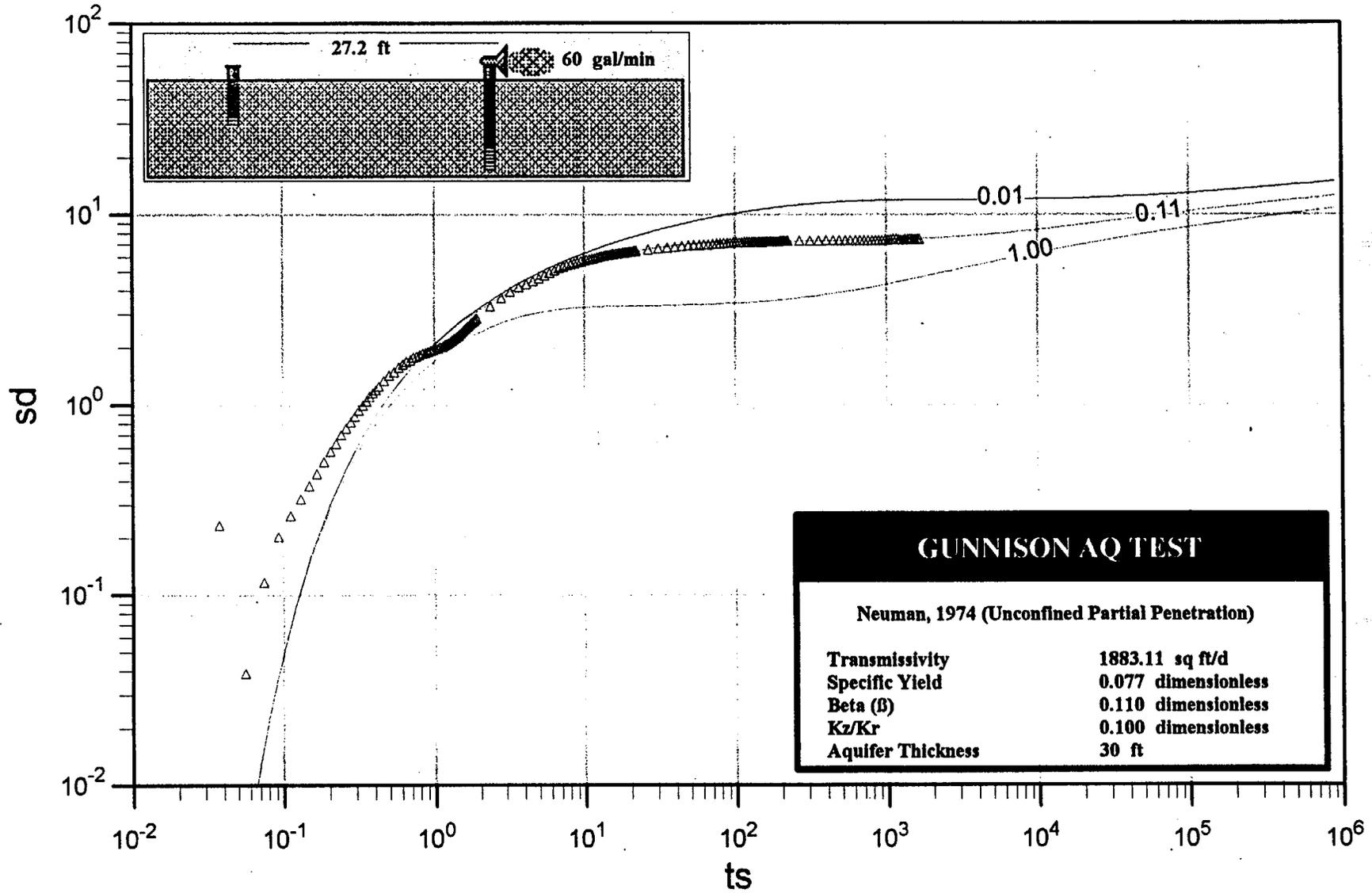
o OBS 048

Transmissivity [ft<sup>2</sup>/min]:  $7.56 \times 10^{-1} = 1038.4 \text{ Ft}^2/\text{D}$

Hydraulic conductivity [ft/min]:  $2.52 \times 10^{-2}$

Aquifer thickness [ft]: 30.00

# WELL OBS 048 / 047 AQ TEST 2

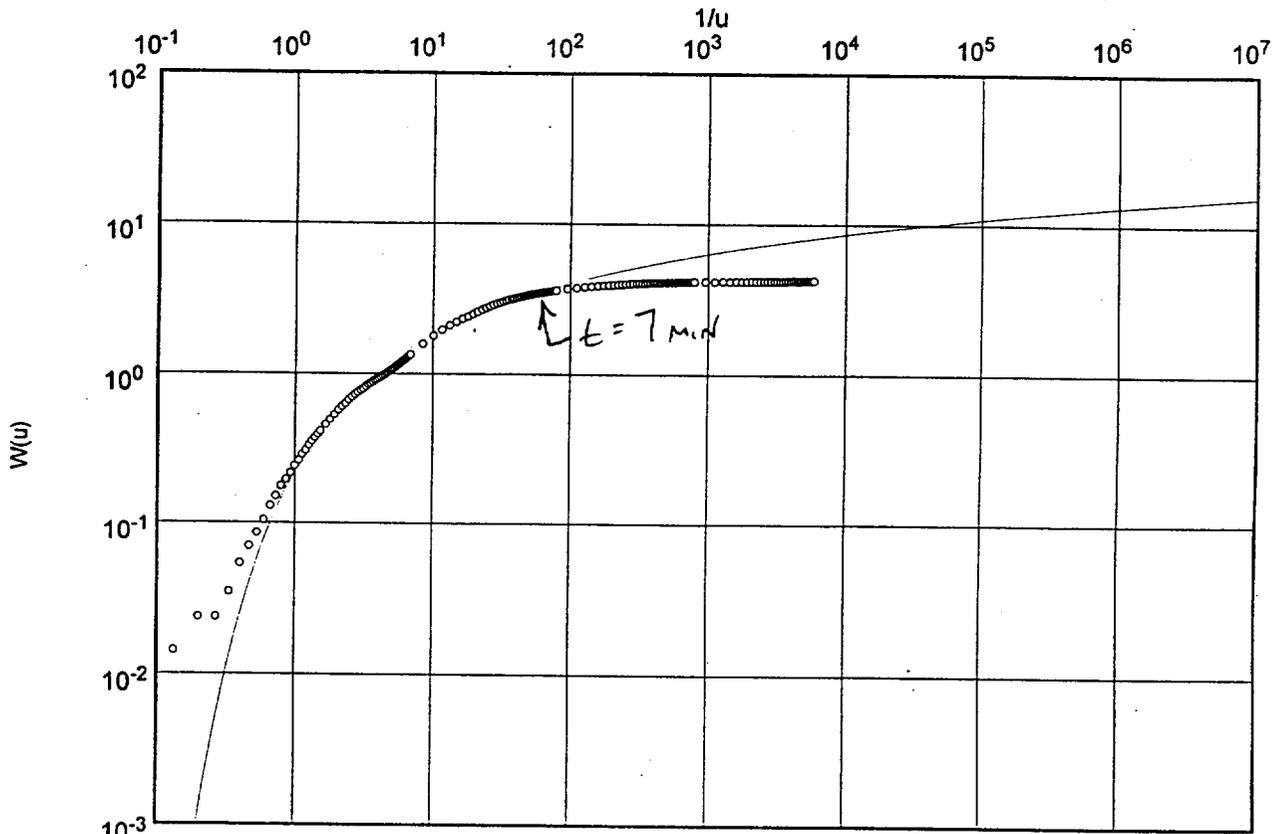


Pumping Test No. 047 AQ TEST 2, t = 12 hrs

Test conducted on: 12/8/99

OBS 049, r = 42.1'

Discharge 60.00 U.S.gal/min



o OBS 049

Transmissivity [ $\text{ft}^2/\text{min}$ ]:  $1.01 \times 10^0 = 1454.4 \text{ Ft}^2/\text{d}$

Hydraulic conductivity [ $\text{ft}/\text{min}$ ]:  $3.37 \times 10^{-2}$

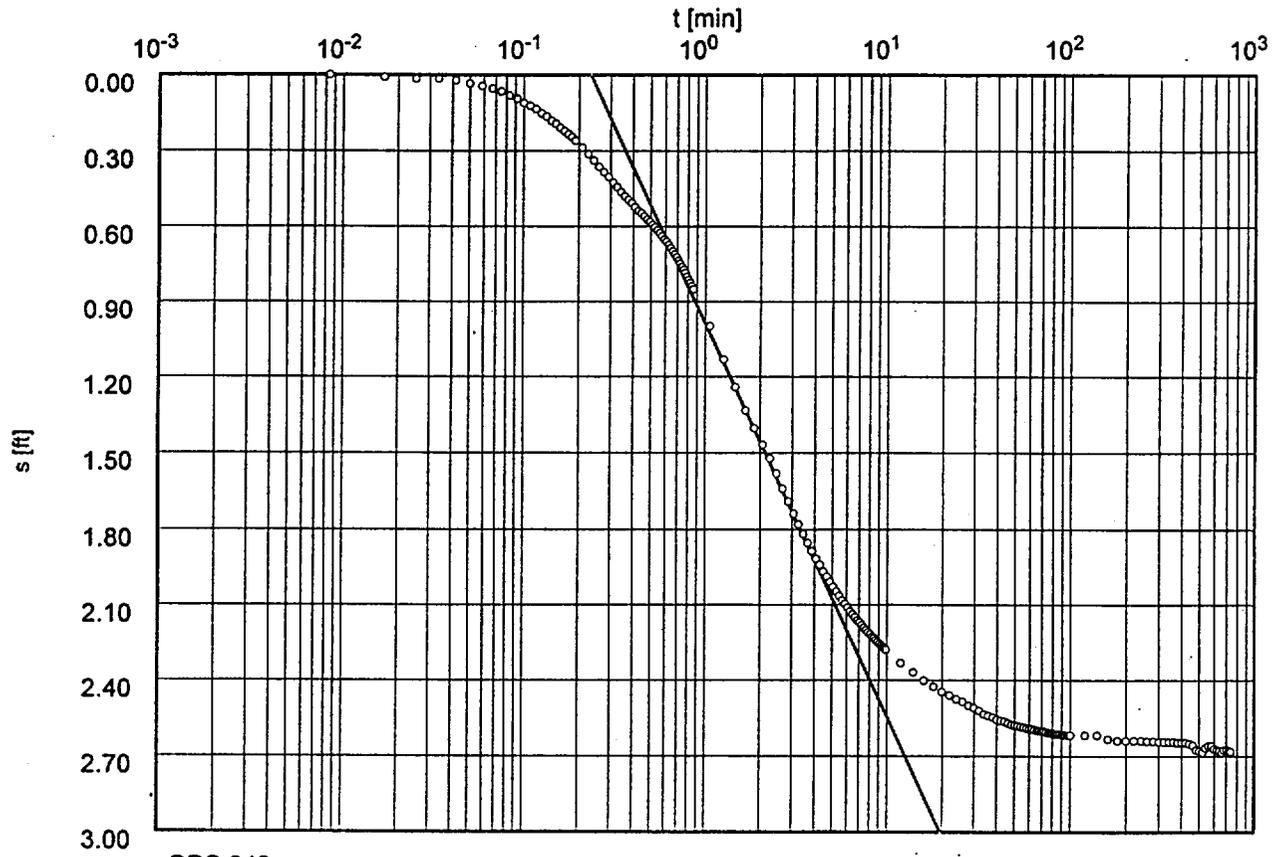
Aquifer thickness [ $\text{ft}$ ]: 30.00

Pumping Test No. 047 AQ TEST 2, t = 12 hrs

Test conducted on: 12/8/99

OBS 049, r = 42.1'

Discharge 60.00 U.S.gal/min



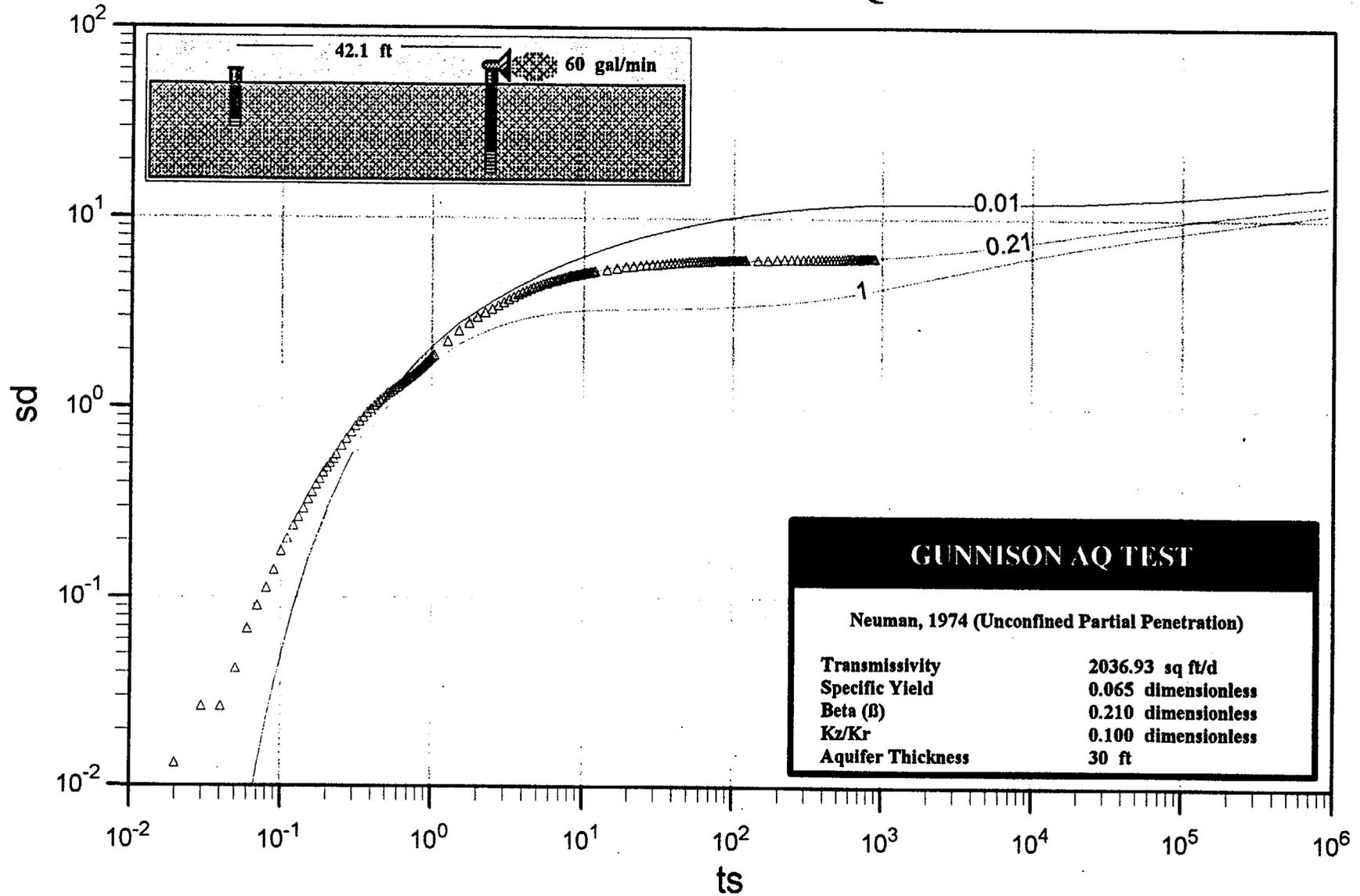
o OBS 049

Transmissivity [ft<sup>2</sup>/min]:  $9.42 \times 10^{-1} = 1356.4 \text{ Ft}^2/\text{min}$

Hydraulic conductivity [ft/min]:  $3.14 \times 10^{-2}$

Aquifer thickness [ft]: 30.00

# WELL OBS 049 / 047 AQ TEST 2



**WELL 047 AQUIFER TEST 2**

**DRAWDOWN DATA**

GUNNISON UMTRA SITE  
WELL 047 AQUIFER TEST 2 DATA  
START DATE/TIME : 12/8/99, 1120  
PUMPING RATE : 60 GPM

<u>ELAPSED TIME (min)</u>	<u>WELL 047 DTW (ft btoc)</u>	<u>WELL 048 DTW (ft btoc)</u>	<u>WELL 049 DTW (ft btoc)</u>	<u>WELL 135 DTW (ft btoc)</u>	<u>WELL 136 DTW (ft btoc)</u>
0.00	7.15	7.12	7.733	7.393	7.916
0.01	9.992	7.12	7.73	7.39	7.913
0.02	9.879	7.234	7.739	7.396	7.913
0.03	7.338	7.139	7.745	7.393	7.916
0.03	8.396	7.177	7.745	7.393	7.916
0.04	8.944	7.219	7.752	7.393	7.913
0.05	9.378	7.248	7.764	7.393	7.913
0.06	9.831	7.277	7.774	7.393	7.916
0.07	10.133	7.305	7.784	7.393	7.916
0.08	10.586	7.334	7.796	7.393	7.916
0.08	10.945	7.367	7.812	7.393	7.916
0.09	11.341	7.4	7.825	7.396	7.916
0.10	11.587	7.429	7.841	7.396	7.916
0.11	11.945	7.462	7.853	7.396	7.916
0.12	12.304	7.491	7.866	7.399	7.916
0.13	12.634	7.519	7.882	7.402	7.916
0.13	12.907	7.548	7.895	7.402	7.916
0.14	13.181	7.581	7.911	7.405	7.916
0.15	13.482	7.61	7.923	7.409	7.916
0.16	13.756	7.633	7.939	7.409	7.916
0.17	14.02	7.662	7.952	7.412	7.916
0.18	14.029	7.686	7.965	7.415	7.916
0.18	14.51	7.71	7.977	7.418	7.916
0.19	14.454	7.733	7.99	7.421	7.919
0.21	15.029	7.776	8.019	7.428	7.919
0.23	15.17	7.819	8.044	7.434	7.916
0.24	15.16	7.852	8.07	7.437	7.916
0.26	14.821	7.89	8.095	7.443	7.916
0.28	15.283	7.919	8.117	7.45	7.916
0.29	15.406	7.943	8.136	7.456	7.919
0.31	15.387	7.962	8.159	7.463	7.919
0.33	15.311	7.986	8.178	7.469	7.919
0.34	15.349	8	8.197	7.472	7.916
0.36	15.302	8.014	8.213	7.478	7.919
0.38	15.302	8.028	8.228	7.482	7.919
0.39	15.34	8.038	8.241	7.485	7.922
0.41	15.33	8.047	8.257	7.488	7.919
0.43	15.368	8.062	8.273	7.494	7.919
0.44	15.415	8.071	8.282	7.494	7.919
0.46	15.726	8.081	8.295	7.501	7.919
0.48	15.453	8.09	8.308	7.504	7.919
0.49	15.575	8.104	8.317	7.504	7.922
0.51	15.726	8.114	8.33	7.507	7.919
0.53	15.933	8.128	8.34	7.51	7.922
0.54	16.037	8.143	8.352	7.513	7.919
0.56	16.197	8.157	8.362	7.517	7.922
0.58	16.376	8.176	8.375	7.52	7.922
0.59	16.678	8.19	8.387	7.52	7.919
0.61	16.743	8.209	8.397	7.523	7.919
0.63	16.951	8.223	8.41	7.526	7.919
0.64	17.205	8.242	8.422	7.529	7.919
0.66	17.422	8.266	8.435	7.532	7.922
0.68	17.657	8.285	8.448	7.536	7.922
0.69	17.808	8.309	8.46	7.539	7.922
0.71	18.034	8.328	8.473	7.539	7.922
0.73	18.241	8.352	8.486	7.542	7.919
0.74	18.41	8.371	8.499	7.548	7.922
0.76	18.646	8.39	8.511	7.551	7.922

0.78	18.806	8.414	8.524	7.551	7.922
0.79	18.994	8.433	8.54	7.558	7.922
0.81	19.182	8.452	8.553	7.558	7.922
0.83	19.39	8.471	8.565	7.564	7.922
0.84	19.597	8.495	8.578	7.564	7.925
0.86	19.775	8.514	8.591	7.571	7.922
1.06	21.761	8.728	8.746	7.609	7.925
1.26	23.294	8.908	8.883	7.647	7.929
1.46	24.177	9.046	8.997	7.678	7.929
1.66	24.863	9.151	9.093	7.704	7.932
1.86	25.408	9.232	9.166	7.726	7.932
2.06	25.878	9.308	9.236	7.742	7.935
2.26	26.423	9.379	9.293	7.758	7.935
2.46	27.221	9.46	9.356	7.774	7.935
2.66	27.841	9.541	9.417	7.79	7.935
2.86	28.264	9.607	9.471	7.802	7.935
3.06	28.714	9.669	9.522	7.815	7.938
3.26	29.071	9.722	9.566	7.828	7.938
3.46	29.39	9.764	9.607	7.837	7.938
3.66	29.634	9.807	9.645	7.85	7.944
3.86	29.84	9.84	9.68	7.856	7.944
4.06	30.047	9.874	9.712	7.863	7.944
4.26	30.225	9.902	9.738	7.872	7.948
4.46	30.366	9.921	9.766	7.875	7.948
4.66	30.535	9.95	9.788	7.882	7.948
4.86	30.704	9.974	9.811	7.888	7.948
5.06	30.76	9.997	9.833	7.891	7.951
5.26	30.91	10.016	9.852	7.898	7.951
5.46	30.947	10.035	9.871	7.904	7.951
5.66	31.004	10.059	9.89	7.907	7.954
5.86	31.154	10.073	9.906	7.91	7.957
6.06	31.135	10.092	9.922	7.913	7.96
6.26	31.257	10.107	9.938	7.917	7.963
6.46	31.332	10.121	9.95	7.92	7.963
6.66	31.37	10.13	9.963	7.923	7.967
6.86	31.435	10.145	9.976	7.926	7.967
7.06	31.463	10.154	9.985	7.929	7.97
7.26	31.51	10.164	9.995	7.932	7.97
7.46	31.566	10.173	10.008	7.936	7.97
7.66	31.642	10.183	10.017	7.936	7.973
7.86	31.67	10.197	10.027	7.939	7.973
8.06	31.688	10.202	10.036	7.939	7.973
8.26	31.735	10.211	10.046	7.942	7.976
8.46	31.801	10.221	10.052	7.942	7.979
8.66	31.81	10.23	10.062	7.945	7.979
8.86	31.801	10.24	10.068	7.945	7.982
9.06	31.848	10.249	10.077	7.948	7.982
9.26	31.848	10.254	10.084	7.948	7.986
9.46	31.885	10.264	10.09	7.948	7.986
9.66	31.913	10.268	10.096	7.952	7.986
9.86	31.96	10.278	10.103	7.955	7.992
11.86	32.11	10.335	10.16	7.964	8.008
13.86	32.27	10.373	10.201	7.974	8.017
15.86	32.42	10.411	10.236	7.977	8.036
17.86	32.485	10.435	10.262	7.986	8.059
19.86	32.542	10.459	10.284	7.99	8.074
21.86	32.645	10.478	10.3	7.993	8.093
23.86	32.692	10.497	10.316	7.996	8.109
25.86	32.701	10.511	10.328	7.999	8.125
27.86	32.757	10.525	10.344	8.002	8.141
29.86	32.814	10.535	10.354	8.005	8.16
31.86	33.011	10.554	10.366	8.009	8.176
33.86	33.029	10.568	10.382	8.012	8.195
35.86	33.067	10.577	10.389	8.015	8.211
37.86	33.095	10.582	10.395	8.012	8.223
39.86	33.17	10.592	10.405	8.015	8.239

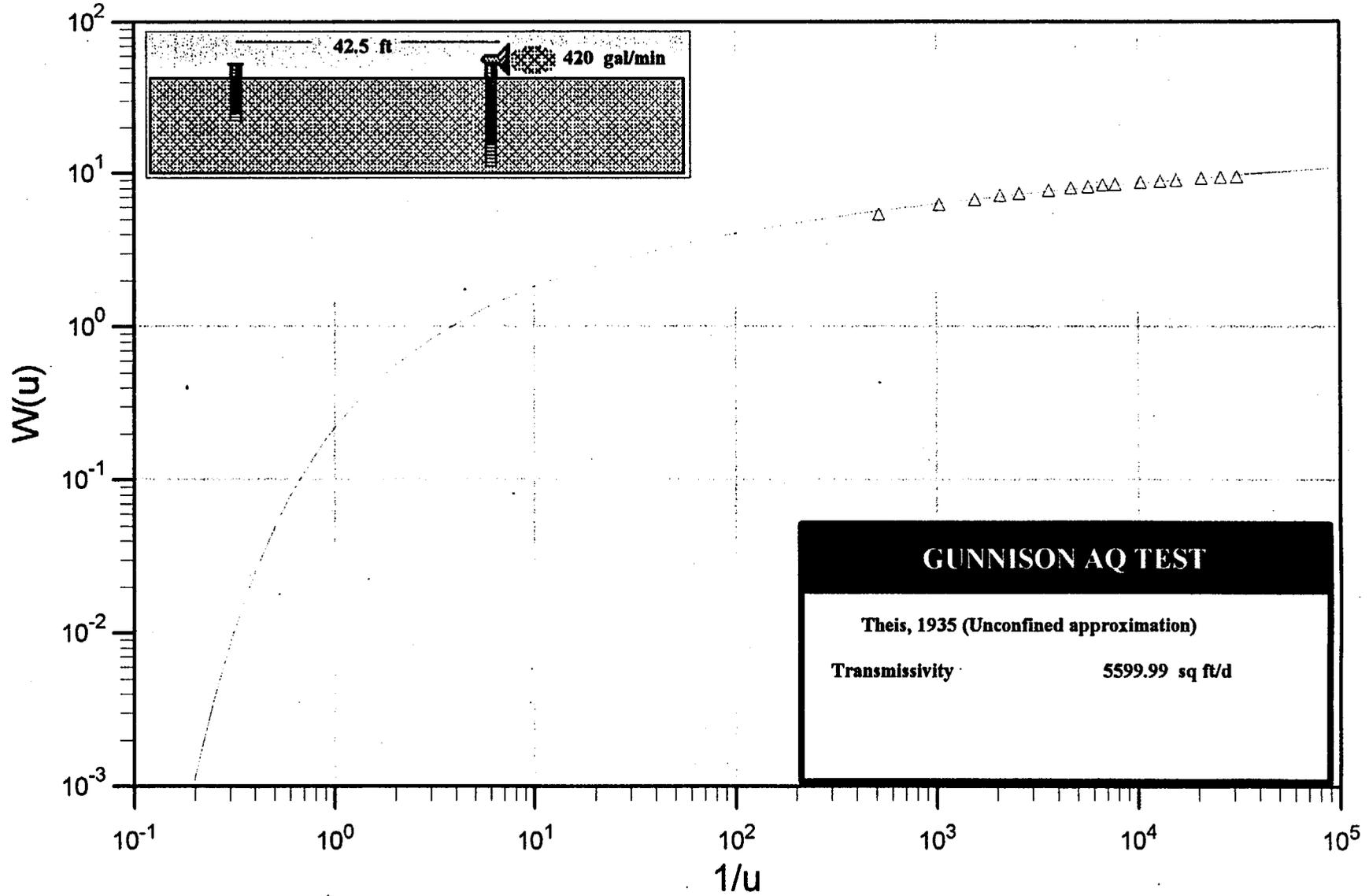
41.86	33.207	10.601	10.411	8.018	8.258
43.86	33.17	10.606	10.414	8.018	8.274
45.86	33.189	10.606	10.42	8.021	8.29
47.86	33.207	10.615	10.427	8.021	8.309
49.86	33.245	10.62	10.43	8.025	8.328
51.86	33.207	10.625	10.433	8.025	8.341
53.86	33.235	10.625	10.436	8.025	8.357
55.86	33.273	10.63	10.439	8.028	8.376
57.86	33.292	10.634	10.443	8.025	8.388
59.86	33.292	10.639	10.446	8.028	8.407
61.86	33.367	10.639	10.446	8.031	8.423
63.86	33.395	10.639	10.449	8.034	8.442
65.86	33.395	10.644	10.452	8.031	8.455
67.86	33.376	10.644	10.452	8.034	8.471
69.86	33.385	10.649	10.455	8.034	8.49
71.86	33.395	10.649	10.455	8.034	8.502
73.86	33.376	10.653	10.459	8.037	8.522
75.86	33.404	10.653	10.462	8.037	8.537
77.86	33.442	10.658	10.462	8.037	8.553
79.86	33.404	10.658	10.465	8.04	8.569
81.86	33.432	10.658	10.468	8.04	8.588
83.86	33.46	10.663	10.468	8.04	8.604
85.86	33.451	10.663	10.468	8.044	8.617
87.86	33.489	10.663	10.468	8.044	8.632
89.86	33.498	10.668	10.471	8.044	8.648
91.86	33.479	10.668	10.471	8.044	8.664
93.86	33.517	10.668	10.474	8.047	8.68
95.86	33.498	10.668	10.474	8.047	8.696
97.86	33.47	10.672	10.474	8.047	8.712
99.86	33.46	10.668	10.474	8.047	8.731
119.86	33.451	10.672	10.474	8.056	8.877
139.86	33.545	10.672	10.474	8.063	9.022
159.86	33.601	10.682	10.49	8.069	9.165
179.86	33.704	10.691	10.497	8.075	9.305
199.86	33.77	10.696	10.497	8.082	9.441
219.86	33.789	10.696	10.497	8.085	9.568
239.86	33.798	10.691	10.497	8.091	9.691
259.86	33.91	10.696	10.5	8.094	9.809
279.86	33.882	10.701	10.5	8.101	9.923
299.86	33.91	10.701	10.503	8.104	10.031
319.86	33.967	10.701	10.503	8.107	10.138
339.86	33.91	10.701	10.503	8.11	10.24
359.86	34.013	10.706	10.503	8.113	10.335
379.86	34.051	10.706	10.506	8.12	10.433
399.86	34.042	10.706	10.506	8.123	10.519
419.86	34.088	10.706	10.506	8.123	10.604
439.86	34.173	10.715	10.509	8.126	10.687
459.86	34.192	10.72	10.516	8.129	10.763
479.86	34.557	10.749	10.538	8.132	10.839
499.86	34.576	10.758	10.541	8.136	10.915
519.86	34.613	10.763	10.547	8.136	10.985
539.86	34.36	10.734	10.528	8.139	11.051
559.86	34.379	10.729	10.519	8.139	11.111
579.86	34.21	10.72	10.519	8.142	11.172
599.86	34.454	10.744	10.532	8.142	11.229
619.86	34.501	10.749	10.538	8.145	11.282
639.86	34.651	10.758	10.541	8.148	11.336
659.86	34.744	10.763	10.547	8.148	11.384
679.86	34.51	10.749	10.538	8.152	11.428
699.86	34.557	10.753	10.538	8.152	11.473
719.86	34.688	10.758	10.541	8.155	11.511
739.86	34.669	10.758	10.544	8.155	11.552

**APPENDIX E**

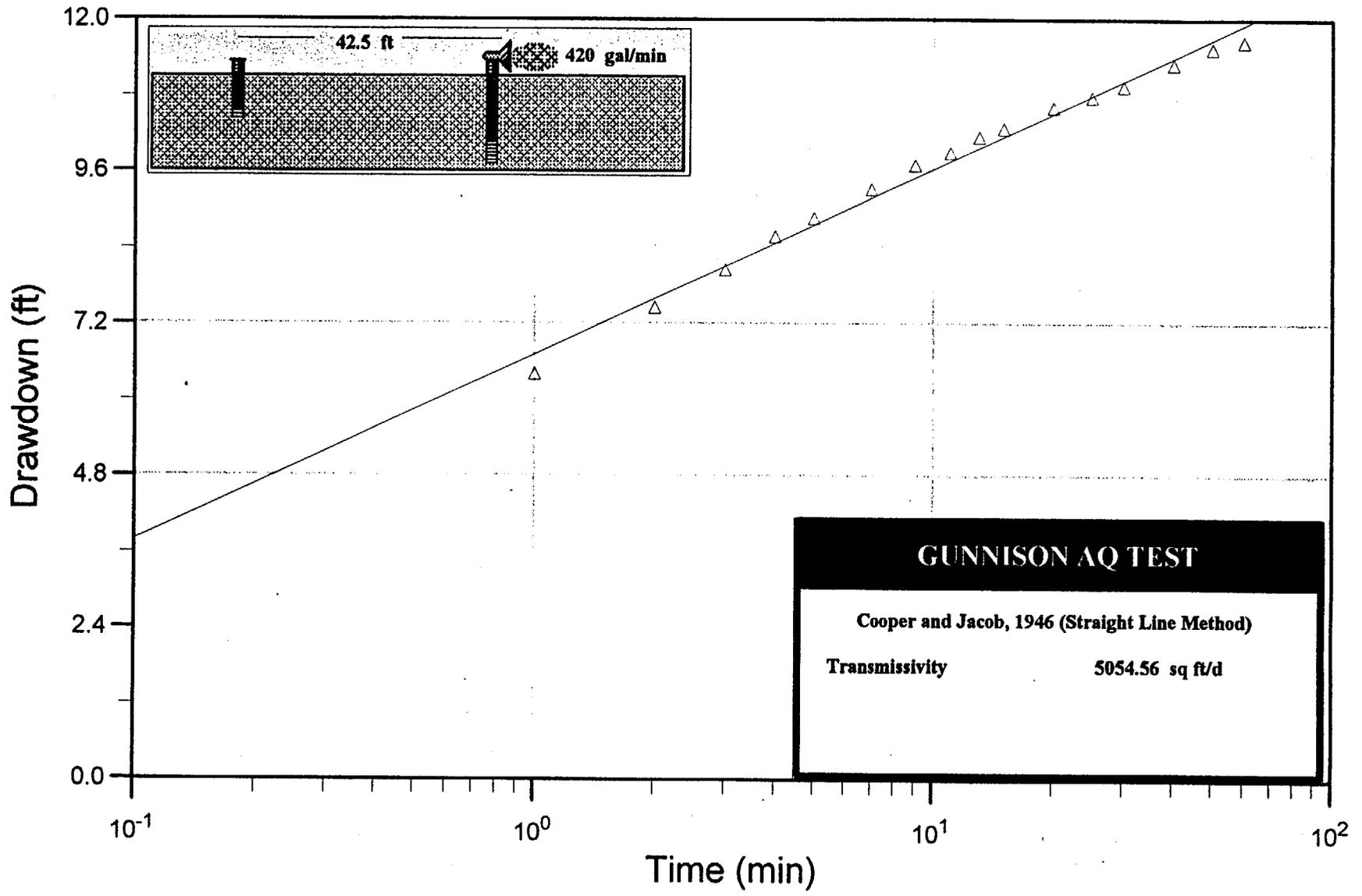
**CITY OF GUNNISON PRODUCTION WELL AQUIFER TEST DATA AND PLOTS**

**CITY OF GUNNISON AQUIFER TEST**  
**PLOTS FOR PRODUCTION WELLS #10 AND #7**

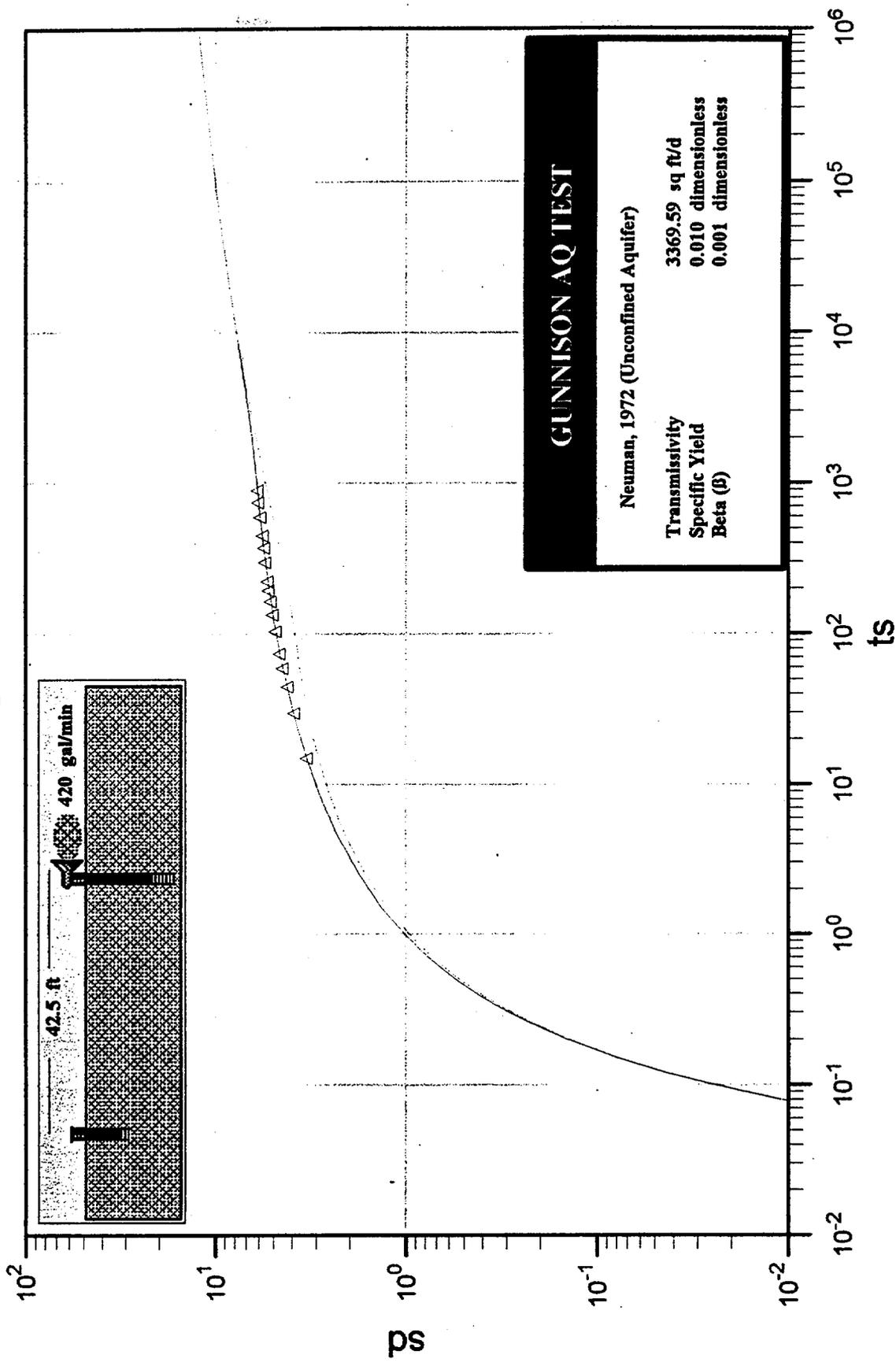
# CITY WELL 10 AQ TEST, OBS WELL DATA



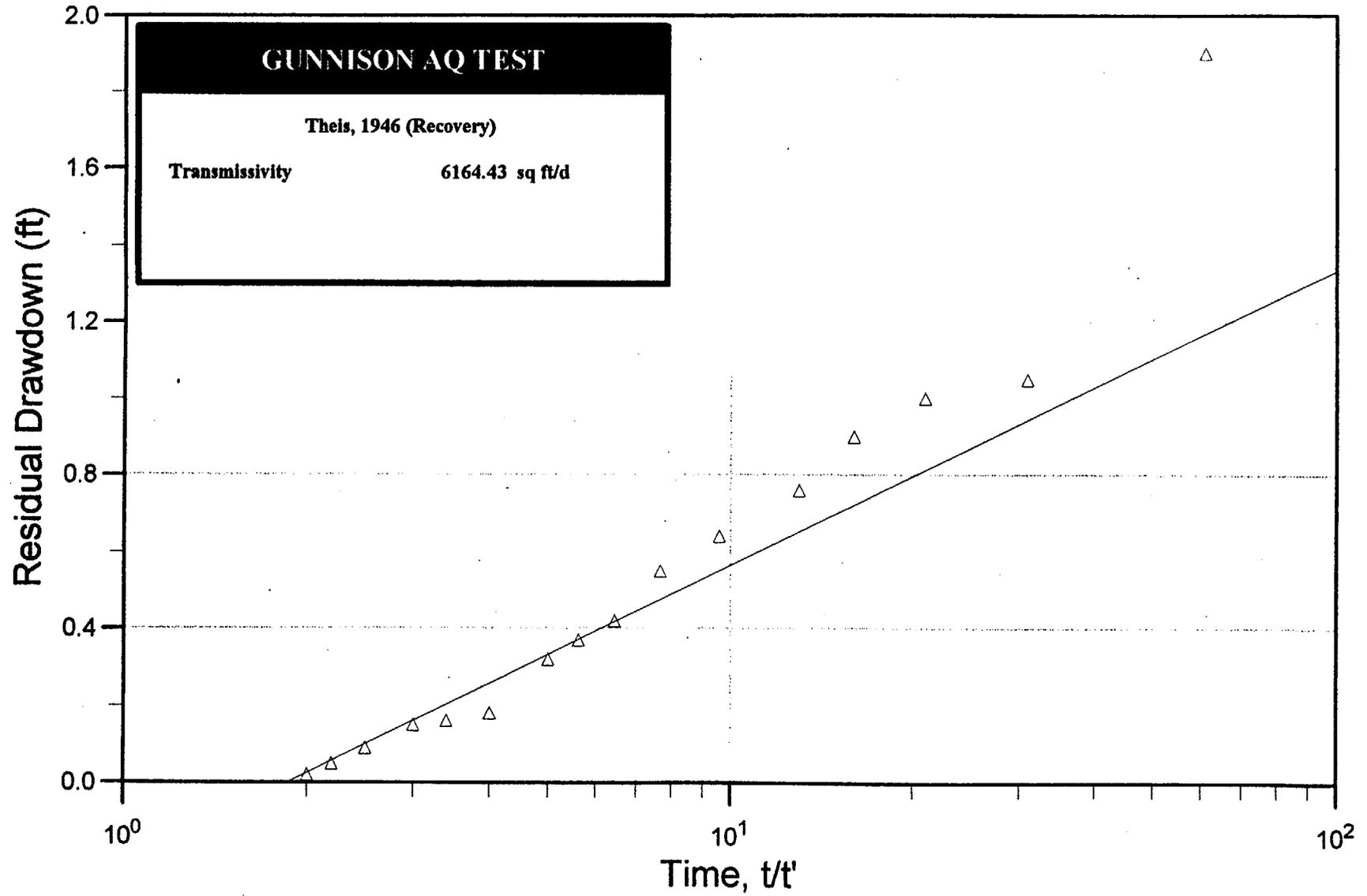
# CITY WELL 10 AQ TEST, OBS WELL DATA



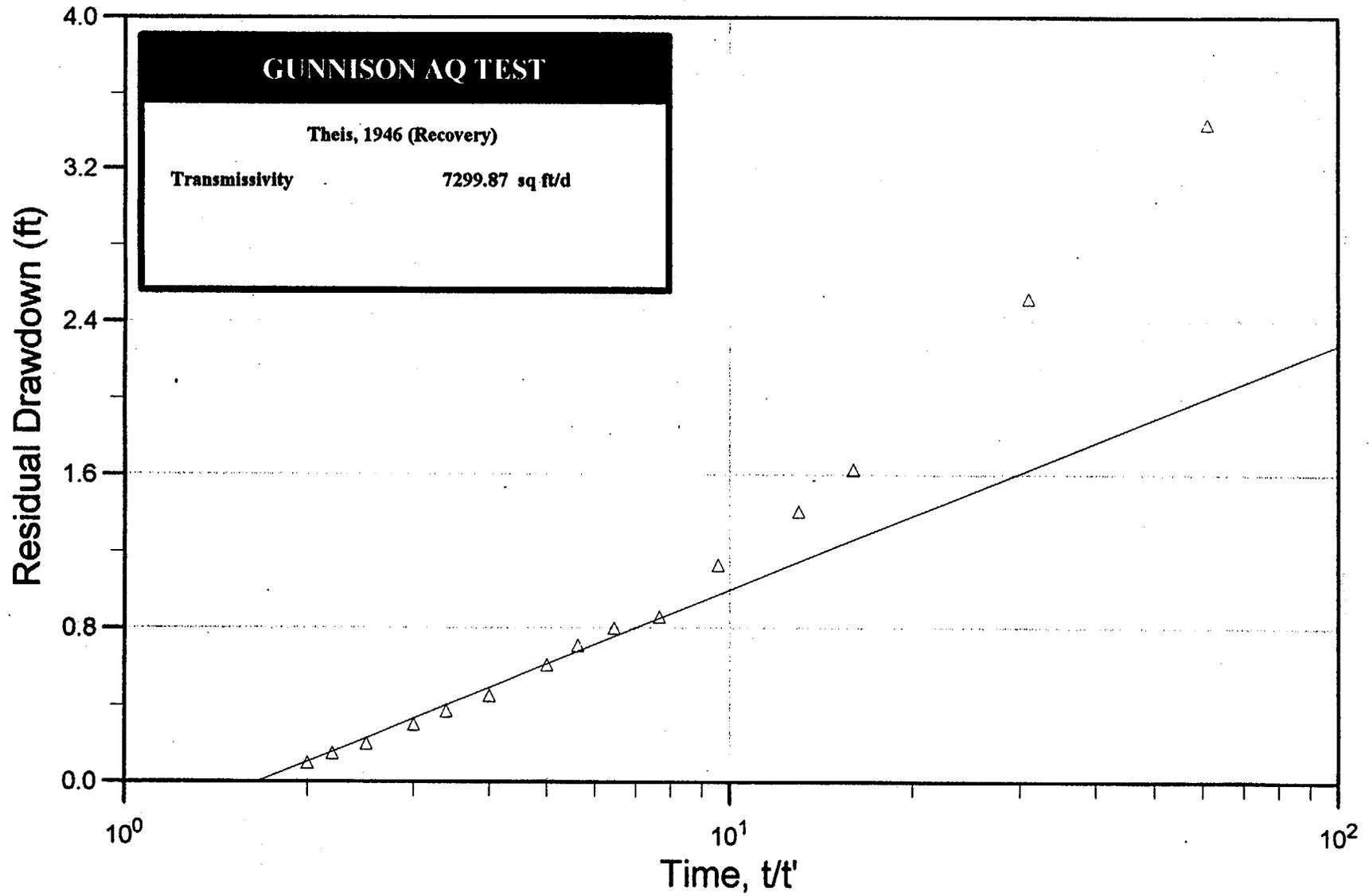
# CITY WELL 10 AQ TEST, OBS WELL DATA



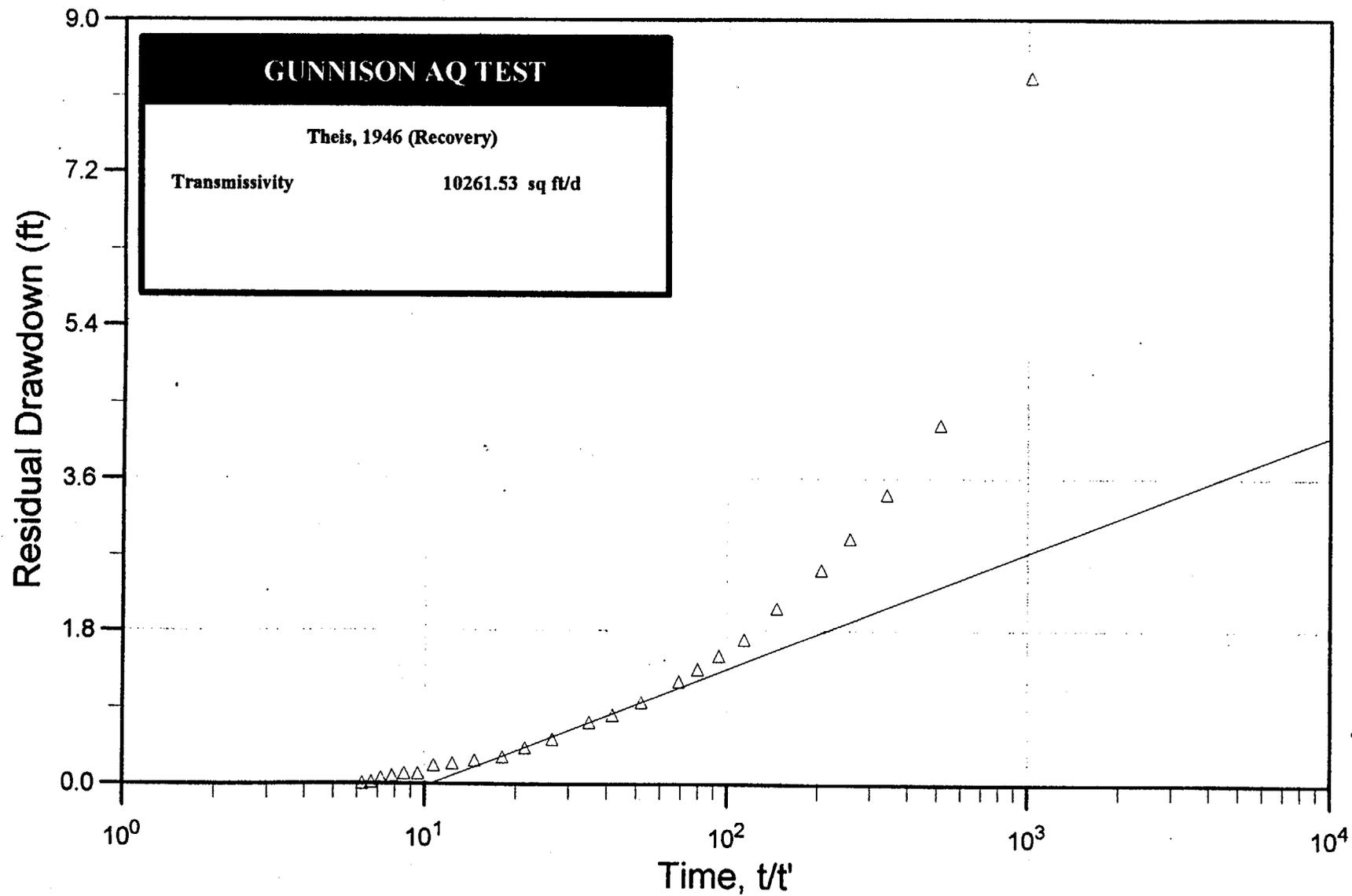
# CITY WELL 10 AQ REC TEST, Q = 135 GPM

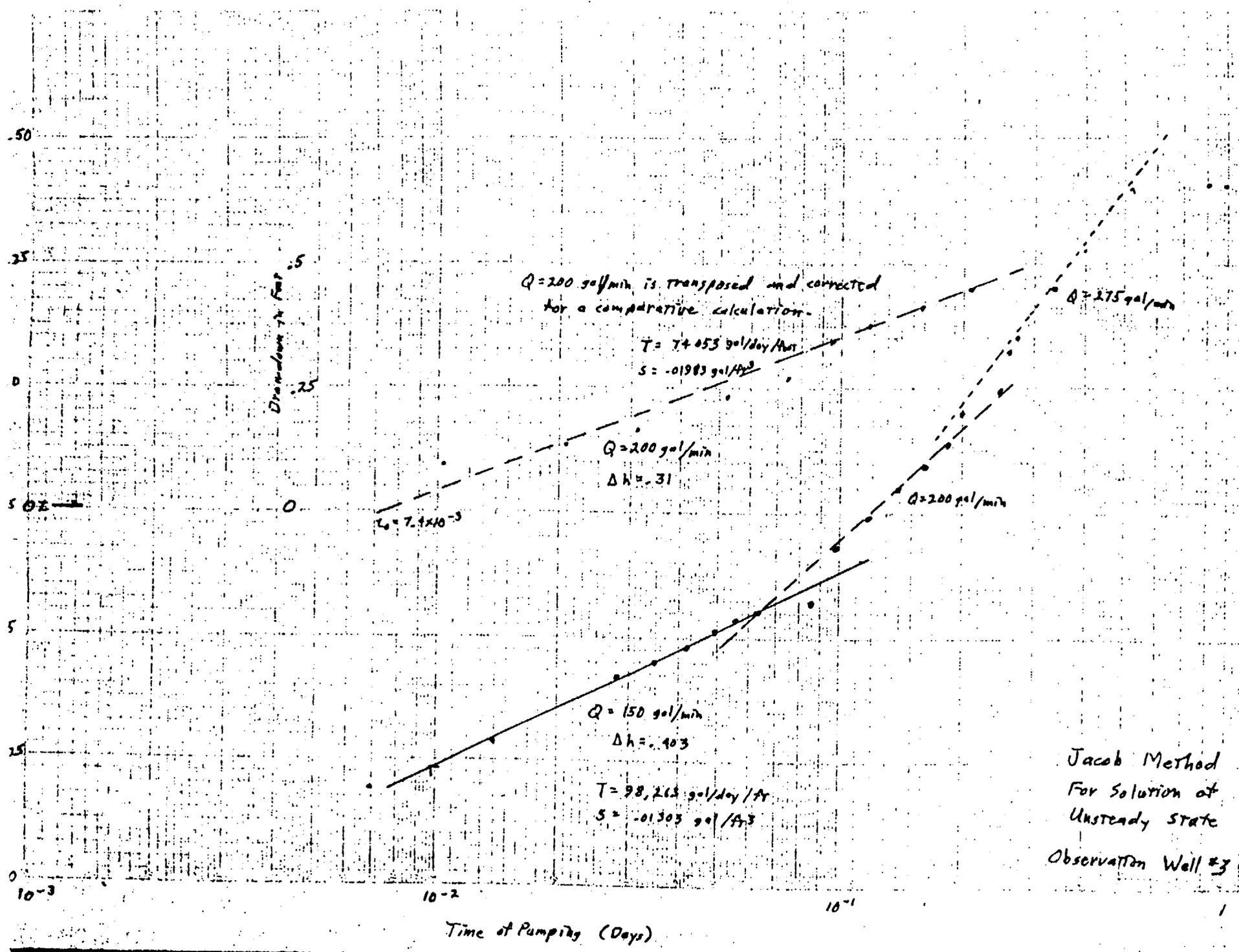


# CITY WELL 10 AQ REC TEST, Q = 265 GPM



# CITY WELL 10 AQ REC TEST, Q = 400 GPM





Jacob Method  
 For Solution of  
 Unsteady State  
 Observation Well #3

**CITY OF GUNNISON AQUIFER TEST**

**DRAWDOWN DATA**

GUNNISON AQUIFER TEST DATA  
CITY OF GUNNISON PRODUCTION WELL #10  
COLLECTED BY LAYNE-WESTERN  
10/28/99  
Q = 421 GPM

1 HR TEST, HAVE DATA FROM PUMPING WELL AND 2" OBS WELL 42.5 FT AWAY

<u>ELPASED</u> <u>TIME (min)</u>	<u>WELL #10</u> <u>DTW (ft btoc)</u>	<u>OBSERVATION WELL</u> <u>DTW (ft btoc)</u>
0	19	15.82
1	39.22	22.2
2	41.2	23.25
3	42.4	23.85
4	42.95	24.38
5	43.77	24.67
7	44.73	25.12
9	45.5	25.5
11	45.9	25.7
13	46.45	25.95
15	47.23	26.08
20	47.4	26.42
25	47.43	26.58
30	48.3	26.75
40	49	27.1
50	50.43	27.35
60	51	27.45

NO RECOVERY TEST DATA

STEP TEST DATA, 10/29/99  
STEP 1, Q = 135 GPM

<u>ELPASED</u> <u>TIME (min)</u>	<u>WELL #10</u> <u>DTW (ft btoc)</u>
0	18.2
1	19.9
2	26.1
3	26.54
4	26.62
5	26.75
7	26.75
9	26.76
11	26.76
13	26.8
15	26.88
20	27.02
25	27.16
30	27.31
40	27.25
50	27.36
60	27.5

RECOVERY DATA

61	20.1
62	19.25
63	19.2
64	19.1
65	18.96
67	18.84
69	18.75
71	18.62
73	18.57
75	18.52
80	18.38
85	18.36

90	18.35
100	18.29
110	18.25
120	18.22

STEP 2, Q = 270 GPM

<u>ELPASED</u> <u>TIME (min)</u>	<u>WELL #10</u> <u>DTW (ft btoc)</u>
0	18.2
5	32.95
7	33.64
9	34.1
11	34.52
13	34.65
15	34.66
20	34.9
25	35.04
30	35.09
40	35.14
50	35.35
60	35.39

RECOVERY DATA

61	21.64
62	20.72
64	19.83
65	19.61
67	19.33
69	19.06
71	19
73	18.91
75	18.81
80	18.65
85	18.57
90	18.5
100	18.4
110	18.35
120	18.3

STEP 3, Q = 400 GPM

<u>ELPASED</u> <u>TIME (min)</u>	<u>WELL #10</u> <u>DTW (ft btoc)</u>
0	18.3
1	38.75
2	40.4
3	41.22
4	42.29
5	43.44
7	43.95
9	44.86
11	45.15
13	45.48
15	45.53
20	46.05
25	45.7
30	46.47
40	46.28
50	49.38
60	50.87
75	51.55
90	51.35
105	51.3

120	51.82
135	51.84
150	52.09
165	51.74
180	50.96
195	50.87
210	57.08
225	50.41
240	50
270	49.91
300	49.88
330	49.93
360	49.82
390	49.82
420	49.54
450	49.84
480	49.66
510	49.25
540	48.54
570	48.48
630	47.73
690	48.24
750	47.36
810	47.66
870	47.96
930	48.22
990	48.66
1020	47.66

RECOVERY DATA

1021	26.62
1022	22.54
1023	21.72
1024	21.2
1025	20.83
1027	20.37
1029	20
1031	19.81
1033	19.65
1035	19.51
1040	19.26
1045	19.11
1050	19.03
1060	18.83
1070	18.73
1080	18.62
1095	18.58
1110	18.54
1125	18.52
1140	18.42
1155	18.42
1170	18.39
1185	18.37
1200	18.32
1215	18.31
1230	18.3
1250	18.23
1260	18.22
1275	18.21

All values taken from observation well #3  
 Wells # 1 & 2 did not produce sufficient data.

RECOVERY

Time	Drawdown
$.133 \times 10^{-2}$ days	1.98 feet
.903	1.27
1.597	1.11
2.361	1.02
3.264	.90
3.889	.84
4.444	.73
5.268	.69
5.833	.61
6.528	.57
7.222	.52
7.917	.48
8.611	.40
9.653	.32
10.69	.27
11.74	.25
$16.46 \times 10^{-2}$	0

Pumping

Time	Drawdown	
$.694 \times 10^{-2}$ days	.12 feet	
1.388	.29	143 gal/min
2.777	.42	
3.472	.46	146 gal/min
4.167	.48	
4.861	.52	145 gal/min
5.555	.56	
$8.333 \times 10^{-2}$	.58	150 gal/min
0	0	
$1.042 \times 10^{-2}$	.09	202 gal/min
2.083	.13	
3.125	.17	208 gal/min
5.208	.23	
7.292	.27	200 gal/min
9.375	.34	
11.46	.38	202 gal/min
$15.62 \times 10^{-2}$	.42	198 gal/min
0	0	
$1.042 \times 10^{-2}$	.08	246 gal/min
2.083	.1	
3.167	.21	262 gal/min
$20 \times 10^{-2}$	.21	274 gal/min
		274 gal/min

**Appendix H**  
**Ground Water Flow and Transport Modeling**

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# 1.0 Introduction

## 1.1 General Setting

The Gunnison Uranium Mill Tailings Remedial Action (UMTRA) Project site is located adjacent to the City of Gunnison in Gunnison County, Colorado, just south of the airport runway between the Gunnison River to the west and Tomichi Creek to the east (Figure 1). The site lies 0.4 mile east of the Gunnison River, 0.4 mile northwest of Tomichi Creek, and 1.5 miles northeast of the confluence. The site covers 61 acres of which approximately 35 acres were occupied by the rectangularly shaped tailings pile and approximately 20 acres were occupied by the former mill structures, the former ore storage area, and miscellaneous areas (Figure 2). The millsite was constructed in the late 1950s to process uranium and was operated from February 1958 until April 1962. During the 4 years of operation, the mill processed about 540,000 tons of ore. A sand and gravel operation (Valco, Inc.) directly south of the site operates for about 4 to 5 months of the year from late spring until early fall.

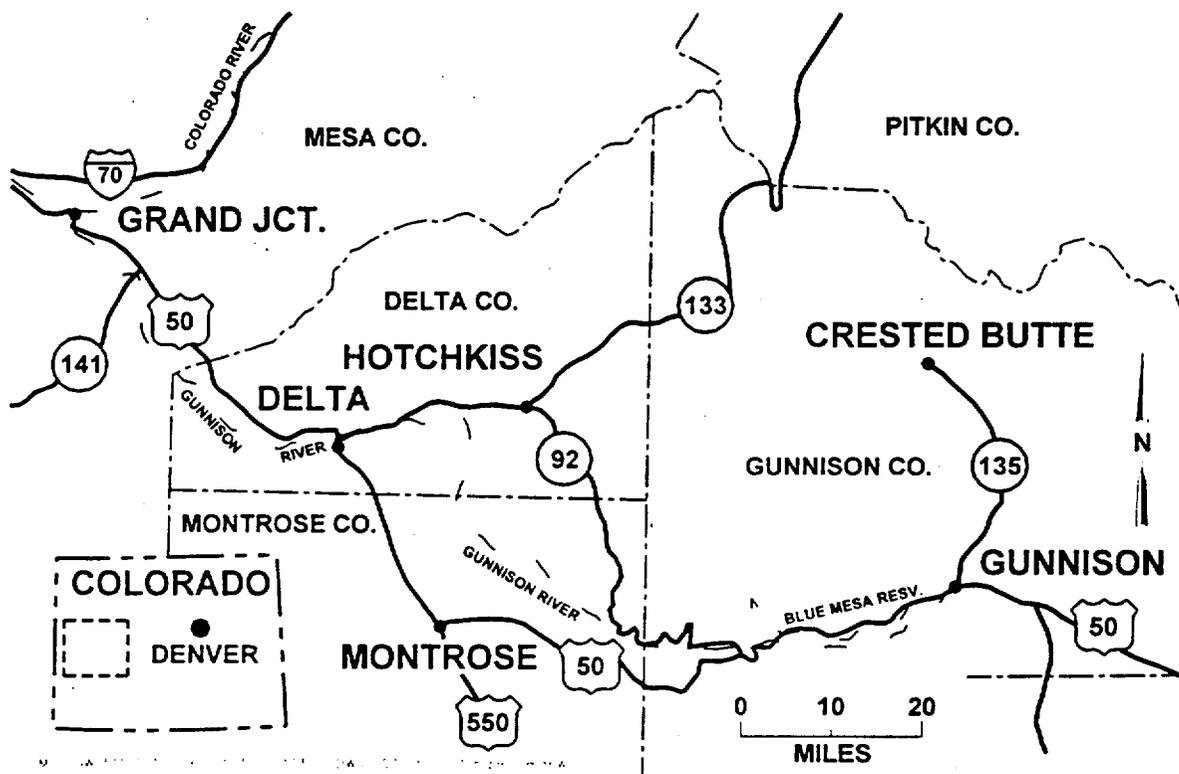


Figure 1. Location of the Gunnison Site

## 1.2 Study Objective

As part of the final compliance strategy for the cleanup of contaminated ground water at the Gunnison UMTRA Project site it is necessary to develop a computer ground water flow model and a subsequent contaminant transport model to assist in forecasting whether natural flushing of uranium is a viable remediation alternative.

This document presents the development of steady state, steady state stochastic, and transient state hydrologic flow and contaminant transport models to predict the concentration of the uranium in the future. The various flow and transport parameters that affect the hydraulic head and contamination distribution for the steady state, steady state stochastic, and transient state models are described.

The steps used for obtaining a calibrated flow and transport model for the site follow the ASTM Standard Guides D5447-93 and D5718-95. The specific steps are to: (1) evaluate the hydrogeologic setting and develop a conceptual model, (2) select the code to be used in the analysis, (3) establish the relationship between the conceptual and numerical models, and (4) perform flow model calibration and sensitivity analysis on transport parameters.

Stochastic simulations for the steady state model were performed varying both flow and transport parameters, to evaluate the uncertainty in the predicted concentrations. These stochastic simulations were used to calculate mean concentrations and the probability of contamination remaining above acceptable levels across the site at specific times.

The calibrated steady state model was used to develop a transient flow and transport model. Two factors suggest the need for a transient model. First, hydrographs indicated a difference of more than 10 feet (ft) in ground water levels in some shallow zone and intermediate zone monitoring wells on a seasonal basis. Analysis of the data presented in the hydrographs indicates that some of the monitoring wells could support a transient model of four stress period per year, but in general the monitoring well data could justify only two stress periods per year, with one stress period of 3 months duration and the second period of 9 months duration. The second factor suggesting the need for a transient model is the seasonal nature of the Valco, Inc. sand and gravel operation. Typically this business operates for about 4 to 5 months of the year. This operation alters the natural ground water flow direction during these months, where dewatering occurs from the pit being mined into an overflow pond south of the mined pit. This dewatering operation has the capability of pumping up to 4,000 gallons per minute (gpm) from the mined pit, however it is estimated that about 2,500 gpm was being pumped on a 24 hour basis during the months of operation. The operating months of the sand and gravel operation overlap the high flow period of the Gunnison River and Tomichi Creek. Since it is felt that the high and low flow in the Gunnison River and Tomichi Creek is the primary force in the transient behavior, it was decided that a high flow period of 3 months (91 days) and a low flow period of 9 months (274 days) would be used. The high flow period roughly corresponds to the summer months of June, July, and August. The rest of the year is represented by the low flow period.

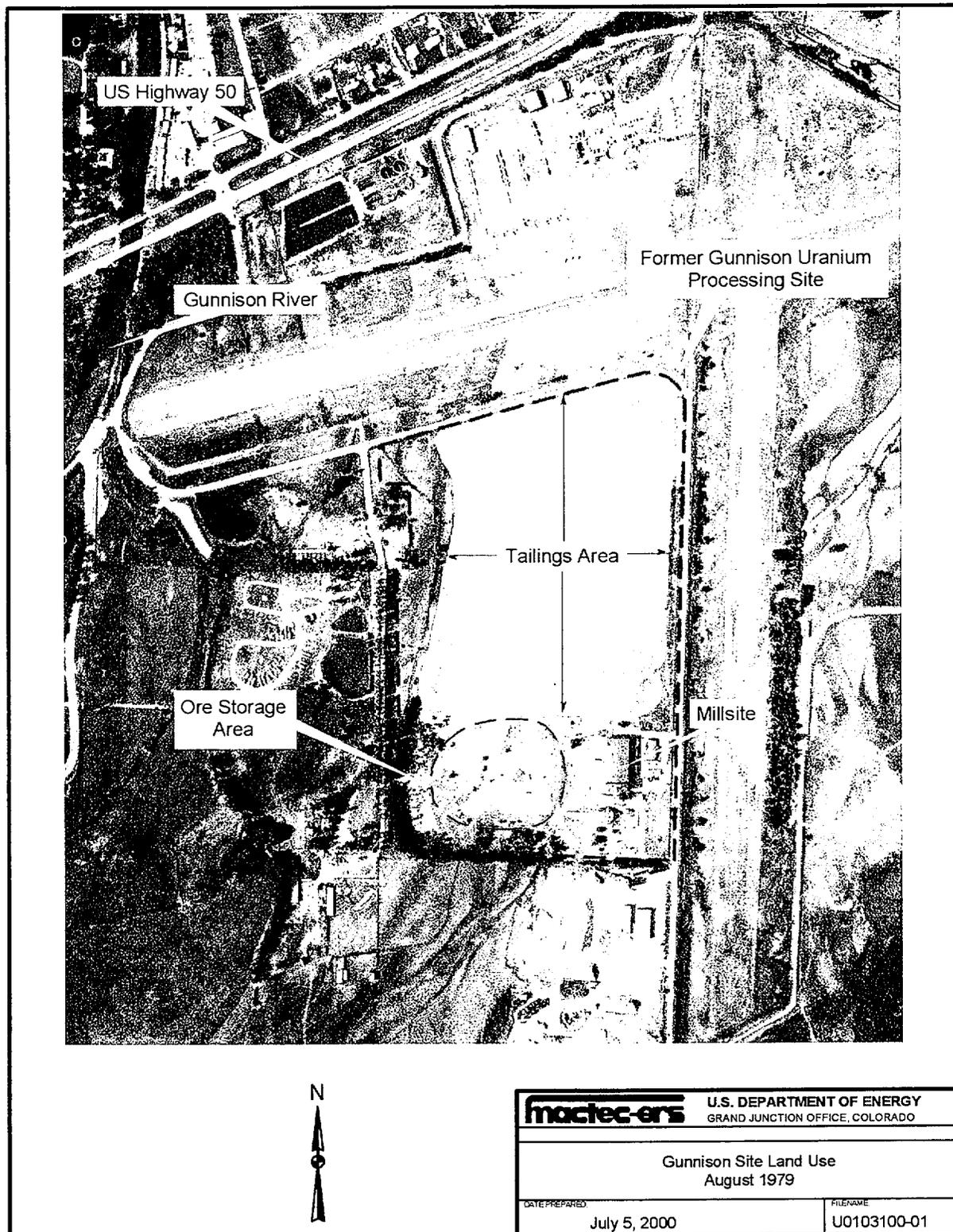


Figure 2. Gunnison Site Land Use – August 1979

## 2.0 Conceptual Model

### 2.1 Aquifer System Framework

The Gunnison site and surrounding vicinity rests on widespread recent floodplain and terrace deposits (alluvium) associated with the Gunnison River and Tomichi Creek. The alluvium is composed of poorly sorted sediments ranging from clay-sized material through gravel, with cobbles and occasional boulders and generally tends to become more clayey with depth. The alluvium ranges from 72 ft to greater than 130 ft in thickness. A discontinuous unit of unknown extent and thickness identified as the Brushy Basin Member of the Jurassic Morrison Formation underlies the alluvium. This formation is not a significant water-bearing unit and is considered the bottom of the aquifer. The alluvial aquifer is unconfined. However, discontinuous layers of lower hydraulic conductivity silt and clay may create semiconfined zones with increasing depth. The model assumes the alluvial aquifer is unconfined.

### 2.2 Ground Water Flow System

Water level elevations measured in the intermediate zone monitor wells in May 1999 are displayed in Figure 3. This map shows that the ground water flows to the south-southwest and generally mimics the surface flow between the Gunnison River and Tomichi Creek. The alluvial aquifer receives recharge from upgradient subsurface flow, precipitation and snowmelt, and from the Gunnison River and Tomichi Creek during spring runoff. In addition, seasonal recharge occurs from: (1) flood irrigation in the fields between Fairway Lane on the west and Tomichi Creek on the east and (2) extensive sprinkler watering on the golf course. In the vicinity of the Valco, Inc. sand and gravel operation the ground water flows toward the dewatering pit and away from the overflow pond. The alluvial aquifer discharges water to the Gunnison River and Tomichi Creek during low flow.

### 2.3 Hydrological Boundaries

The Gunnison River and Tomichi Creek are represented in the model by constant or prescribed heads. The northwest boundary is defined where the Tertiary West Elk breccia geological unit crops out and rises above the alluvium. The southeast boundary is defined by the contact of the valley alluvium with two geological units. The northern part of this boundary is defined by the contact with the Tertiary West Elk breccia unit. The remaining part of this boundary is at the contact of the alluvium and the Quaternary undifferentiated surficial deposits. This unit includes extensive landslide debris, mudflow deposits, rock streams, talus, and colluvial slope wash. The southwest boundary occurs where the Precambrian crystalline rock geological unit rises sharply above the valley floor.

The remaining boundaries are not as well defined by hydrological or geological boundaries, but are considered far enough from the former mill site to have minimal effect on the model results. The northeast part of the model is represented by a head-dependent flux boundary (general head boundary [GHB] source) to account for upgradient subsurface flow. The west central side of the model is also represented by a head-dependent flux boundary to account for downgradient subsurface flow. The south central side of the model is represented as a separate recharge zone to account for the small amount of flow from Gold Creek Basin.

## 2.4 Hydraulic Properties

The flow model hydraulic properties of interest that apply stresses to the aquifer system are the hydraulic conductivity of the alluvial aquifer, the areal recharge due to precipitation and snowmelt, infiltration due to field flood irrigation and golf course watering, recharge from and discharge to the Gunnison River and Tomichi Creek, and the sand and gravel operation induced flow. In addition, for transient flow the specific yield must be considered.

The contaminant transport properties of interest are the initial concentration distribution of uranium, the effective porosity, the aquifer bulk density, the distribution coefficient ( $K_d$ ), dispersivity, and the background concentration entering the site from infiltration, recharge, Gunnison River and Tomichi Creek inflow.

## 2.5 Sources and Sinks

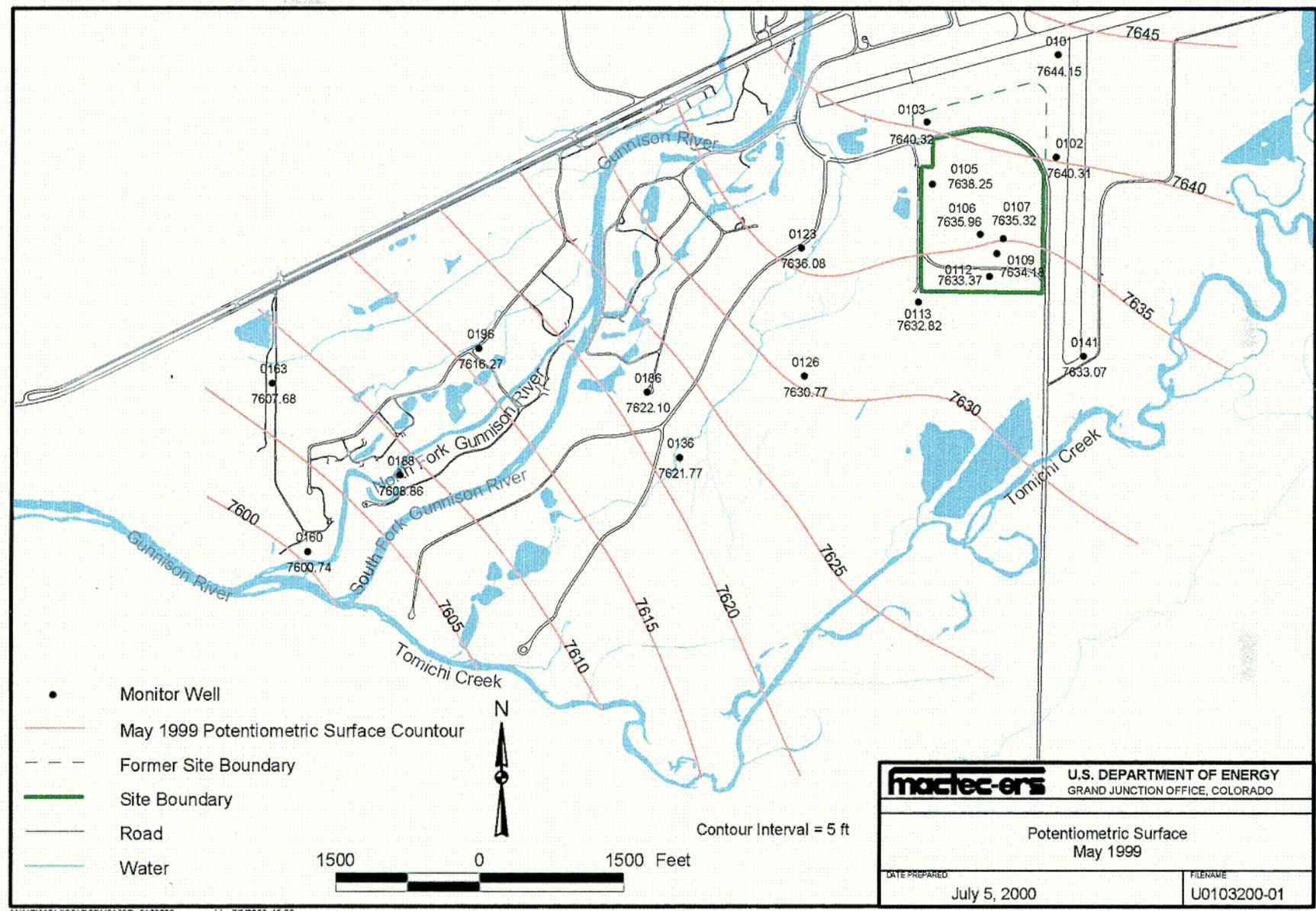
The Gunnison River and Tomichi Creek are sources of water and background contamination to the aquifer, although the contamination is considered insignificant. Areal recharge over the area is an annual source of water to the site. Field flood irrigation and golf course water are seasonal sources of water to the site. The Gunnison River and Tomichi Creek are both a sink and a source, i.e., the aquifer discharges water to the river/creek along some reaches and the river/creek recharges the alluvial aquifer along other reaches. Discharge and recharge are also seasonal in nature. The Valco, Inc. sand and gravel operation is both a sink and a source, i.e., the dewatering pit removes water from the alluvial aquifer and the overflow pond recharges water to the alluvial aquifer.

### 2.5.1 Inflow Sources

Multiple sources of recharge to the alluvial aquifer have been identified. These include recharge from precipitation and snowmelt, recharge from Gold Basin Creek, field flood irrigation, golf course sprinkler watering, recharge from the Gunnison River and Tomichi Creek, and recharge due to the Valco, Inc. sand and gravel operation as a result of pumping from the dewatering pit into the overflow pond. The discharge/recharge due to the Valco, Inc. operation is accounted for in the model by placing an extraction well in the dewatering pit and an injection well in the vicinity of the overflow pond with equal flow rates.

#### 2.5.1.1 Site Precipitation

Based on site-specific meteorological data there is approximately 11 inches of annual precipitation (0.0025 feet per day [ft/day]) in the Gunnison area, with July and August being the wettest months. Multiplying the estimated 0.0025 ft/day of precipitation by the 100,220,000 square feet (ft<sup>2</sup>) area for the site, results in a total 250,550 cubic feet per day (ft<sup>3</sup>/day) of precipitation that is available for recharge. However, it is assumed that because of evapotranspiration and runoff, only one-fourth of this amount, or 2.75 inches per year (in/yr), infiltrates. This results in a net recharge flux of 0.00063 ft/day for the steady state model. For the transient model it was assumed that one-half of the net recharge flux occurs during each of the stress periods. This results in a net recharge flux during the high flow period (91 days) of 0.00127 ft/day and a net recharge flux during the low flow period (274 days) of 0.00042 ft/day.



M:\UGA\511\0010109\U0103200\0103200.apr reynoldm 7/5/2000, 13:23

Figure 3. Potentiometric Surface - May 1999

C30

### 2.5.1.2 Surface Water

Surface flow in Gold Basin Creek was estimated at 100 gpm. There are 31 model cells along this south central recharge boundary for a total of 310,000 ft<sup>2</sup>. This results in a net inflow from Gold Basin Creek of 19,251 ft<sup>3</sup>/day, which is equivalent to a recharge flux of 0.0621 ft/day. Adding the site precipitation net recharge flux of 0.00063 ft/day results in a total of 0.06273 ft/day for the steady state model. For the transient model the values are 0.06337 ft/day and 0.06252 ft/day for the high flow period and low flow period, respectively.

### 2.5.1.3 Golf Course Watering

For this component of recharge it is first necessary to estimate the transient model values and then use a weighted average for the steady state model. Information from the maintenance staff at the golf course indicates that approximately 200,000 gallons per day (gal/day) are used to water the course on a seasonal basis from late spring until early fall. There are 351 model cells that cover the golf course for a total of 3,510,000 ft<sup>2</sup>. Assuming this water is applied during the high flow (91 days), this results in a recharge flux from watering of 0.00762 ft/day. Adding the site precipitation of 0.00127 ft/day results in a total of 0.00889 ft/day. The low flow period (274 days) recharge flux is equal to the site precipitation of 0.00042 ft/day. The weighted average flux for the steady state model is 0.00253 ft/day.

### 2.5.1.4 Infiltration from Field Flood Irrigation

It is also necessary to first estimate the transient model values for this component. There are 930 model cells that cover the field flood area for a total of 9,300,000 ft<sup>2</sup>. It is assumed that the flood irrigation is applied during the high flow period (91 days) and estimated to be 4 times the annual net recharge flux rate from site precipitation during this period (0.00254 ft/day or 11 in/yr). This results in a total recharge flux, adding site precipitation, of 0.00381 ft/day for the high flow period. The low flow period (274 days) recharge flux is equal to the site precipitation of 0.00042 ft/day. The weighted average flux for the steady state model is 0.00127 ft/day.

## 2.5.2 Outflow Sources

Several source of discharge from the alluvial aquifer have been identified. These include evapotranspiration, discharge due to the Valco, Inc. sand and gravel operation as a result of pumping from the dewatering pit into the overflow pond, and ground water discharge from the alluvial aquifer due to ground water subsurface flow from the alluvial aquifer into the Gunnison River and Tomichi Creek. Evapotranspiration is accounted for by considering net recharge, i.e., recharge from site precipitation, field flow irrigation, and golf course watering minus evapotranspiration. The discharge/recharge due to the Valco, Inc. operation is accounted for in the model by placing an extraction well in the dewatering pit and an injection well in the vicinity of the overflow pond with equal flow rates.

## 3.0 Computer Code

### 3.1 Code Selection

MODFLOW (McDonald and Harbaugh 1988), a modular three-dimensional finite-difference ground water flow model published by the U.S. Geological Survey (USGS) was selected as the flow code for this project. MT3D (Zheng 1990), a modular three-dimensional transport model for simulation of advection, dispersion, and chemical reaction of contaminants in ground water systems was selected as the transport code for this project. Each of these codes is divided into a main program and a group of independent subroutines called *modules*. Each module is made up of *packages* that deal with a single aspect of the simulation. The user of either MODFLOW or MT3D need only use those modules that simulate the stresses placed upon the flow and transport systems. The original public domain version of MT3D contained numerous errors and is not up-to-date. Therefore, a new public domain version called MT3DMS, which fixes all the known errors, was used for this project. This version of MT3D contains a new transport solver that is very efficient and makes multiple long simulations runs feasible.

GWVistas (Environmental Simulations, Inc. 1997), a Windows-driven, graphical, pre- and post-processor for MODFLOW and MT3D is used in conjunction with the site model to facilitate data entry, data-file modification, program execution, and analysis of modeling results.

### 3.2 Code Description

These codes are fully described in the references cited. They have been verified, benchmarked, and approved for use by most government and regulatory agencies.

## 4.0 Steady State Flow Model

### 4.1 Model Grid and Model Boundary Conditions

Since the Gunnison River and Tomichi Creek flow directions and the ground water flow direction change considerable over the area covered by the model, the model grid was not rotated. The x-axis of the model is oriented in the east/west direction. A 100 ft by 100 ft orthogonal grid, consisting of 118 rows and 139 columns was designed to encompass the site and an extensive area surrounding the site. The western boundary of the model is west of the confluence of the Gunnison River and Tomichi Creek. The northern boundary is approximately along the main east-west street of the town of Gunnison (Tomichi Avenue). The eastern boundary of the model extends to where the Tomichi Creek drainage narrows sufficiently so that the upgradient subsurface flow is confined to a small number of cells. The southern boundary is slightly south of where Tomichi Creek is turned westerly by the Precambrian crystalline rock outcrop that rises abruptly above the valley floor. Figure 4 shows the model extent with some site features.

The northwest side of the model is represented by as a noflow boundary where the Tertiary West Elk breccia geological unit crops out and rises above the alluvium. The southeast side of the model is also represented by a noflow boundary. This boundary is defined by the contact of the alluvium and two geological units. The northern section, of this boundary, is defined by the contact with the

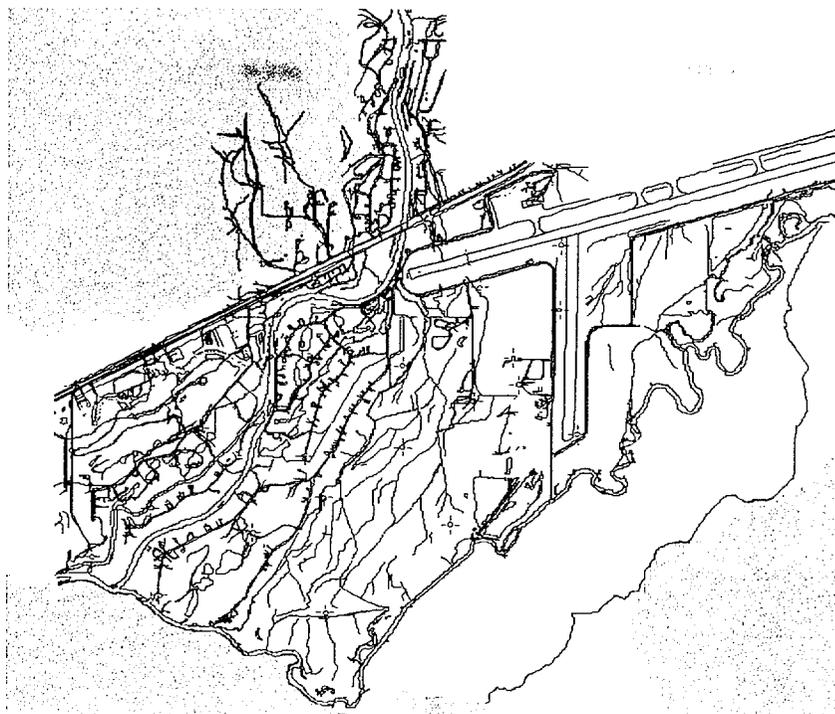


Figure 4. Model Extent and Site Features

Tertiary West Elk breccia unit. The remaining, or southern, section of this boundary is at the contact of the alluvium and the Quaternary undifferentiated surficial deposits. The southwest side of the model is represented by a noflow boundary where the Precambrian crystalline rock geological unit rises sharply above the valley floor. The northeast part of the model is represented by a head-dependent flux boundary (GHB source) to account for upgradient subsurface flow. The west central side of the model is also represented by a head-dependent flux boundary to account for downgradient subsurface flow. The south central side of the model is represented as a separate recharge zone to account for the small amount of flow from Gold Creek Basin.

## 4.2 Hydraulic Parameters

Aquifer tests were completed at three locations downgradient of the site to determine the hydraulic parameters of the alluvial aquifer. These tests were performed during November and December 1999 using newly installed wells 041, 044, and 047 as pumping wells. Pumping rates for the tests ranged from 35 to 60 gpm at the three locations.

A review of the drawdown data collected during these tests indicated that the flow rates might have been too low to properly stress the aquifer, resulting in a steady state condition for the tests. Using the Neuman Method for Unconfined Aquifer with Partial Penetrating Wells (these pumping wells were screened for 30 ft of the over 100 ft thick aquifer) to analyze the data, the hydraulic conductivity (K) is estimated to range from 13.5 to 105.7 ft/day (Table 1).

Table 1. Measured Hydraulic Conductivity

	Location			
	Well 041	Well 044	Well 047	City Well #10
K range (ft/day)	13.5 – 20.3	42.6 – 105.7	55.8 – 67.9	103 – 171
K geomean (ft/day)	17.1	61.2	61.6	131.7

During October 1999 the City of Gunnison installed Production Well #10 north of town. Subsequent to the well installation, a city consultant conducted aquifer tests. These tests were completed using pumping rates that ranged from 135 to 421 gpm. Analyses of the data collected during these tests indicate the hydraulic conductivity ranges from 103 to 171 ft/day (Table 1). Because of these higher pumping rates, the data collected from these tests provided hydraulic conductivity estimates that are believed to be more representative of the alluvial aquifer. A hydraulic conductivity value of 135 ft/day was used for the steady state calibrated model with transverse equal to longitudinal.

Recharge components to the ground water system are specified in Section 2.5.1. The steady state recharge values assigned to the zones representing the stress to the alluvial aquifer system are presented in Table 2. Recharge zones are shown on Figure 5. The steady state stochastic parameters are described in Section 6.1. The transient state recharge values assigned to the zones for the high flow period and the low flow period are described in Section 7.2.

Table 2. Steady State Recharge Parameters

Zone No.	Description	Net Recharge Flux		
		Cells	Area (ft <sup>2</sup> )	(ft/day)
1	Area	10022	100,220,000	0.00063
2	Gold Basin Creek	31	310,000	0.06273
3	Golf Course	351	3,510,000	0.00253
4	Field Flood	930	9,300,000	0.00127

Discharge from the ground water system consists of subsurface flow from some sections of the Gunnison River and Tomichi Creek on a seasonal basis.

### 4.3 Constant Head Boundary Conditions

The Gunnison River west of the site and Tomichi Creek east and south of the site are represented in the model as constant head boundaries. River elevations for the steady state and steady state stochastic models are based on 10 year average annual measurements at gauging stations and the confluence. The transient model stress period-variant constant head boundary conditions are described in Section 7.3. Constant head values were interpolated at the grid cells for both the steady state model and the transient model.

#### 4.4 Selection of Calibration Targets

Prior to beginning model calibration it is important to decide upon the acceptance criteria for the calibration process. The acceptance criteria chosen for this project are:

- 1) The model must be able to simulate the general flow directions observed at the site. Measured ground water elevations in May 1999 are presented in Figure 3. Simulated steady state ground water elevations are presented in Figure 6.
- 2) The numerical model should not have any inherent bias. In other words, since the model will either over or under predict the measured hydraulic heads, the arithmetic mean of the residuals should be as close to 0.0 as possible and fairly evenly distributed above and below 0.0. Figure 7 displays the observed versus residuals for the steady state model. The plot shows a slight bias of overestimating water levels at the lower elevations and underestimating water levels at the higher elevations.
- 3) Twenty calibration targets were selected for the steady state model based on the average of 1998 and 1999 water level measurements. Several flow model calibration objectives were set prior to calibrating the model. The objectives and the calibrated model results for the steady state are shown in Table 3. Although some of the criteria are not met, none of the criteria is exceeded by a significant amount.
- 4) The mass balance error must be less than 1 percent. The mass balance error for the steady state model is -0.0012 percent.

Table 3. Calibration Objectives and Results

	Residual Mean (ft)	Absolute Residual Mean (ft)	Sum of Squares (ft <sup>2</sup> )	Minimum Residual (ft)	Maximum Residual (ft)	Standard Deviation/Range (%)
Objective	0	< 1.	< 20.	> -2.0	< 2.0	< 5.0
Actual	-0.003	0.717	16.469	-2.052	1.762	1.987

#### 4.5 Flow Model Calibration and Residual Analysis

The steady state calibrated model results and the residual at each target are shown in Table 4. The results satisfy the specified criteria. A plot of predicted (simulated) head versus observed head demonstrates that the model accurately predicts field measurements (Figure 8).

Recharge

Zone	Value
1	6.300e-004
2	6.273e-002
3	2.530e-003
4	1.270e-003

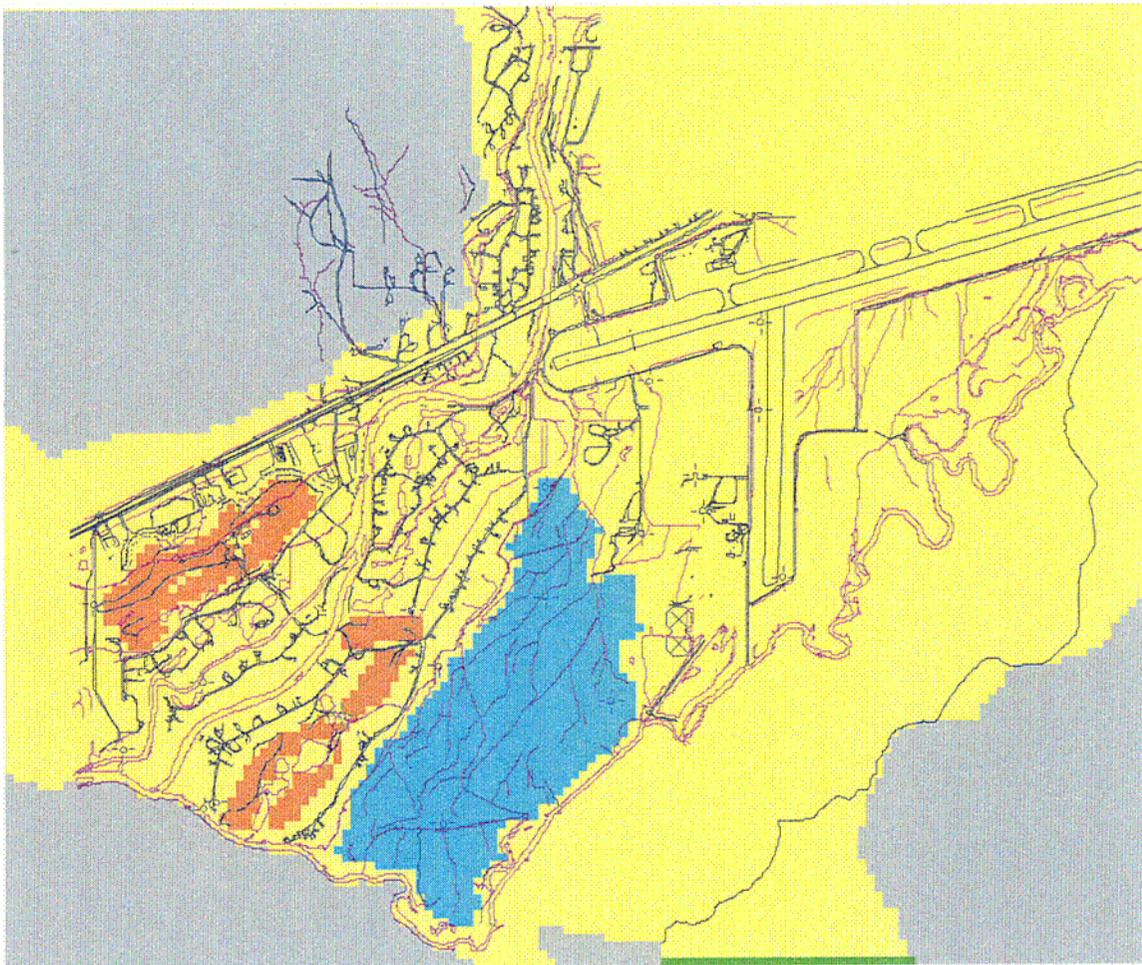


Figure 5. Recharge Zones

C31

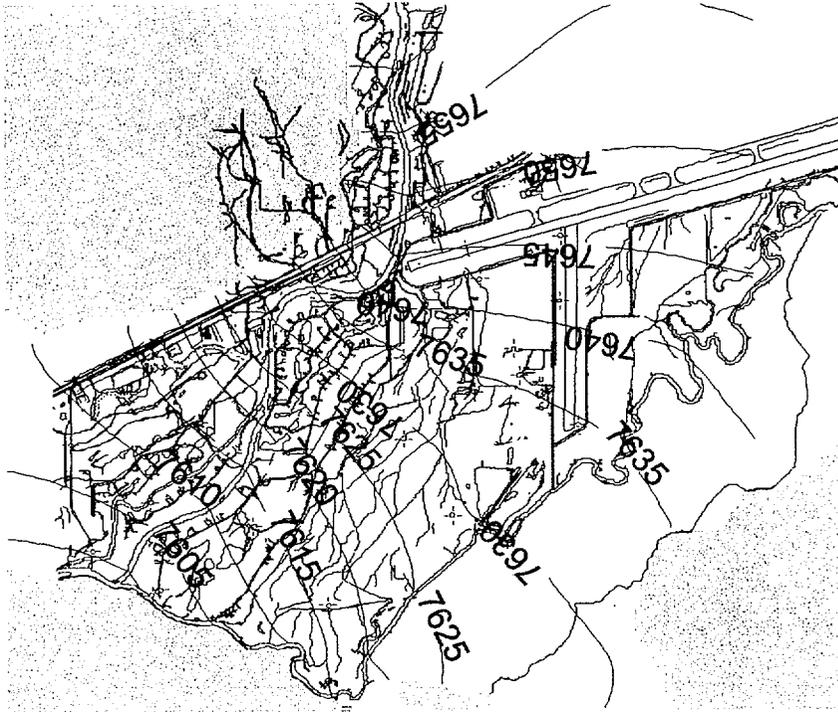


Figure 6. Simulated Steady State Ground Water Elevations

**Observed vs. Residuals**

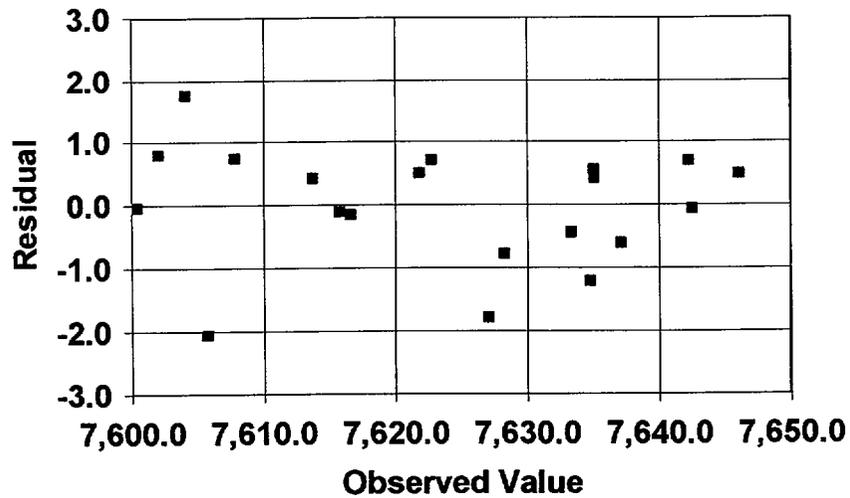


Figure 7. Comparison of Residual versus Observed Head

Table 4. Calibration Target Residuals

Well ID	Observed Head (ft)	Predicted Head (ft)	Residual (observed - predicted)
1	7646.05	7645.56	0.49
2	7642.22	7641.52	0.70
3	7642.49	7642.56	-0.07
6	7637.08	7637.68	-0.60
12	7634.72	7635.92	-1.20
13	7633.30	7633.73	-0.43
58	7602.03	7601.23	0.80
59	7604.06	7602.30	1.76
61	7600.37	7600.41	-0.04
188	7607.80	7607.05	0.75
196	7615.69	7615.80	-0.11
120	7635.02	7634.46	0.56
126	7628.25	7629.02	-0.77
135	7621.78	7621.27	0.51
140	7635.03	7634.61	0.42
145	7627.04	7628.82	-1.78
155	7616.55	7616.70	-0.15
163	7605.71	7607.76	-2.05
181	7613.67	7613.25	0.42
187	7622.70	7621.98	0.72
n	20		
mean	-0.003		
Absolute mean	0.717		
sum of squares	16.469		
Standard deviation	0.907		
minimum	-2.05		
maximum	1.76		

Observed vs. Computed Target Values

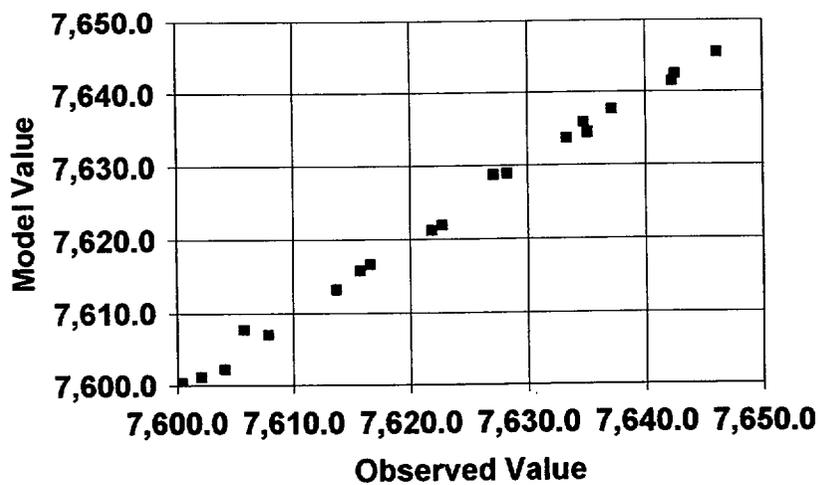


Figure 8. Comparison of Predicted versus Observed Heads

## 5.0 Steady State Contaminant Transport Model

### 5.1 Transport Parameters

The contaminant transport parameters of interest are longitudinal and transverse dispersivity, effective porosity, bulk density, initial uranium concentration distribution, and  $Kd$ .

The  $Kd$  will have the greatest effect on the amount of time required for natural flushing to reduce the contamination level below the required standard. The estimated range of values for this site is from 1.7 to 5.24 milliliters per gram (mL/g). An average value of 3.47 mL/g was used as the  $Kd$  value for contaminant transport modeling (see Section 4.4).

The literature on dispersivity as it relates to large-scale models is vague and often contradictory, with longitudinal values ranging from 2 percent to 30 percent of the length of the plume or maximum flow path length. In addition, dispersivity is almost impossible to measure in the field for large sites. Commonly a value of 10 percent of the length of the plume is used for longitudinal dispersivity and 10 percent of longitudinal dispersivity is used for transverse dispersivity. For this transport model a value of 250 ft was used for longitudinal dispersivity with transverse dispersivity 10 percent of longitudinal dispersivity (25 ft). With a maximum flow path length of approximately 7,000 ft, this dispersivity value is less than 4 percent of the length and considered a conservative estimate.

Bulk density was set at 95 pounds per cubic foot (lbs/ft<sup>3</sup>) (1.5218 g/mL). The effective porosity was set to 30 percent.

A uranium concentration plume was developed in **Surfer**® using a weighted average of measured concentration values at selected pairs of monitoring wells. The weighted average was calculated by estimating that the shallow well of each pair represents the upper 25 percent of the alluvial thickness while the intermediate well represents the lower 75 percent of the alluvial thickness. This surface was then interpolated to all active model grid cell centers and imported as the initial concentration plume. The map presented in Figure 9 shows the weighted average measured uranium concentrations obtained as described above.

### 5.2 Predictive Results for Uranium

A contaminant transport model using MT3DMS, based on the calibrated steady state flow model, was used for predictive simulations. Simulation results were extracted for selected times up to 100 years into the future. Predicted uranium concentrations above the UMTRA Project maximum concentration level (MCL) of 0.044 milligrams per liter (mg/L) at 50 and 100 years into the future are presented in Figure 10 and Figure 11 for the flow model. For this scenario the maximum predicted concentration at 100 years is 0.036627 mg/L.

## 6.0 Stochastic Simulations

### 6.1 Stochastic Parameters

The flow and transport parameters that are treated as uncertain parameters are shown in Table 5. The distribution type and distribution parameters assigned to each of the stochastic parameters are specified.

Table 5. Stochastic Flow and Transport Parameters

Parameter	Distribution			
	Type	Standard Deviation	Minimum	Maximum
Hydraulic Conductivity (ft/day)				
Longitudinal	Uniform	N/A	100	170
Transverse	Uniform	N/A	100% Longitudinal	
Dispersivity (ft)				
Longitudinal	Uniform	N/A	200	300
Transverse	Uniform	N/A	10% Longitudinal	
<i>Kd</i>				
Uranium (ft <sup>3</sup> /lb)	Uniform	N/A	0.0272	.0839
(mL/g)	Uniform	N/A	1.7	5.24
Recharge (zone 1) (ft/day)	Uniform	N/A	0.00031	.00126
Recharge (zone 2) (ft/day)	Uniform	N/A	0.03168	.12483
Recharge (zone 4) (ft/day)	Uniform	N/A	0.00063	.00254
GHB Conductance (ft <sup>2</sup> /day)	Uniform	N/A	100	170
Porosity	Uniform	N/A	0.25	.4

Non-stochastic flow and transport parameters are shown in Table 6.

Table 6. Non-Stochastic Flow and Transport Parameters

Parameter	Uranium
Recharge (zone 3) (ft/day)	0.0253
Recharge Concentration (zone 1) (mg/L)	0.0
(zone 2) (mg/L)	0.0
(zone 3) (mg/L)	0.0
(zone 4) (mg/L)	0.0
Constant Head Concentration (mg/L)	0.0
GHB Concentration (mg/L)	0.0
Bulk Density (lb/ft <sup>3</sup> )	95
(g/mL)	1.5218

Initial Concentrations

Zone	Value
3411	0.327
2983	7.822e-002
2557	3.764e-002
2131	2.924e-002
1705	2.258e-002
1279	1.675e-002
853	1.200e-002
427	5.727e-003
1	1.681e-005

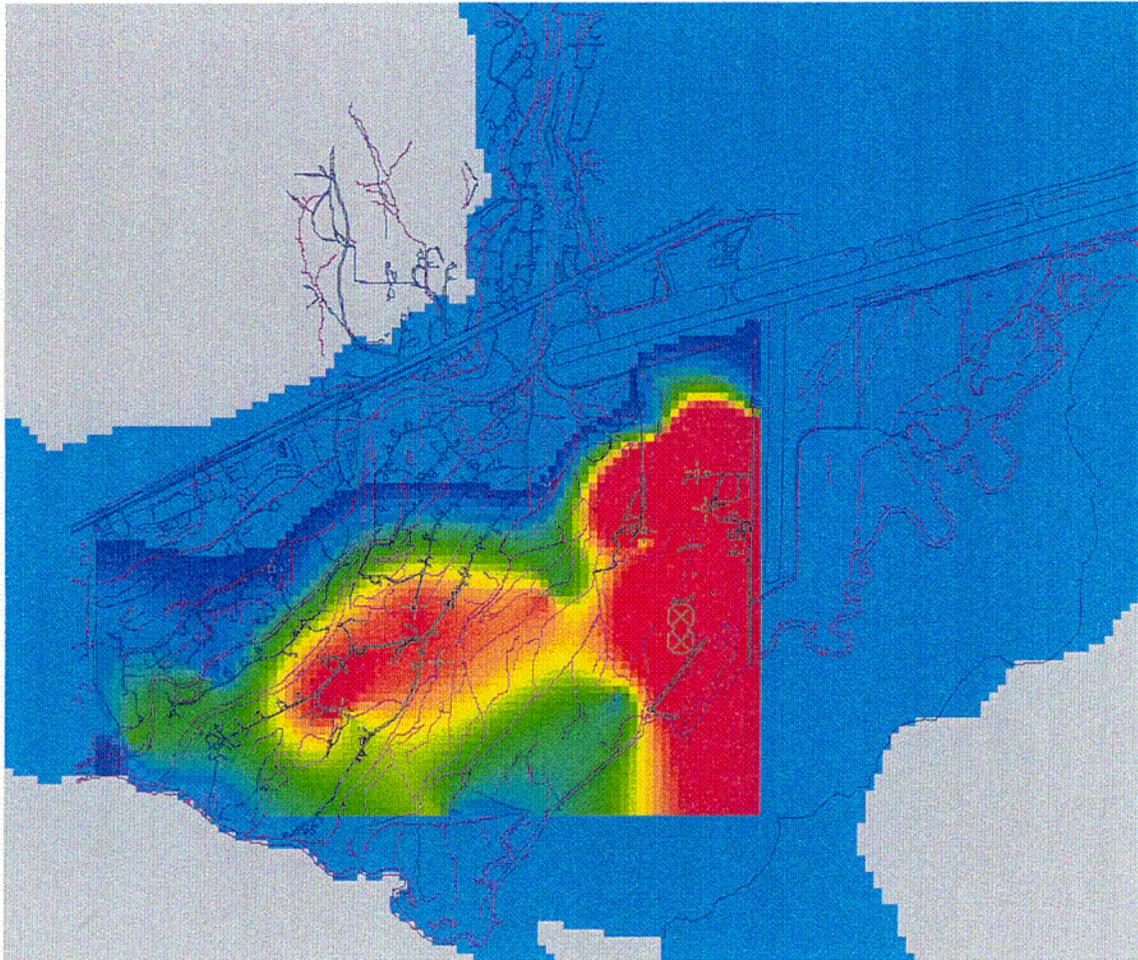


Figure 9. Initial Uranium Concentration at Gunnison Site

C32

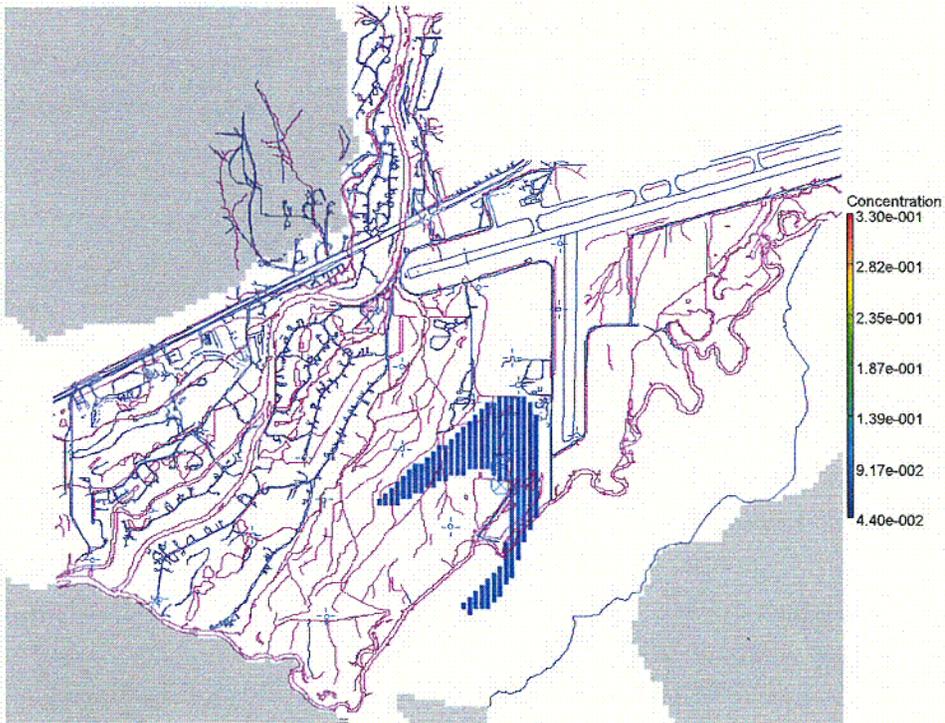


Figure 10. Predicted Steady State Uranium Concentration at 50 Years

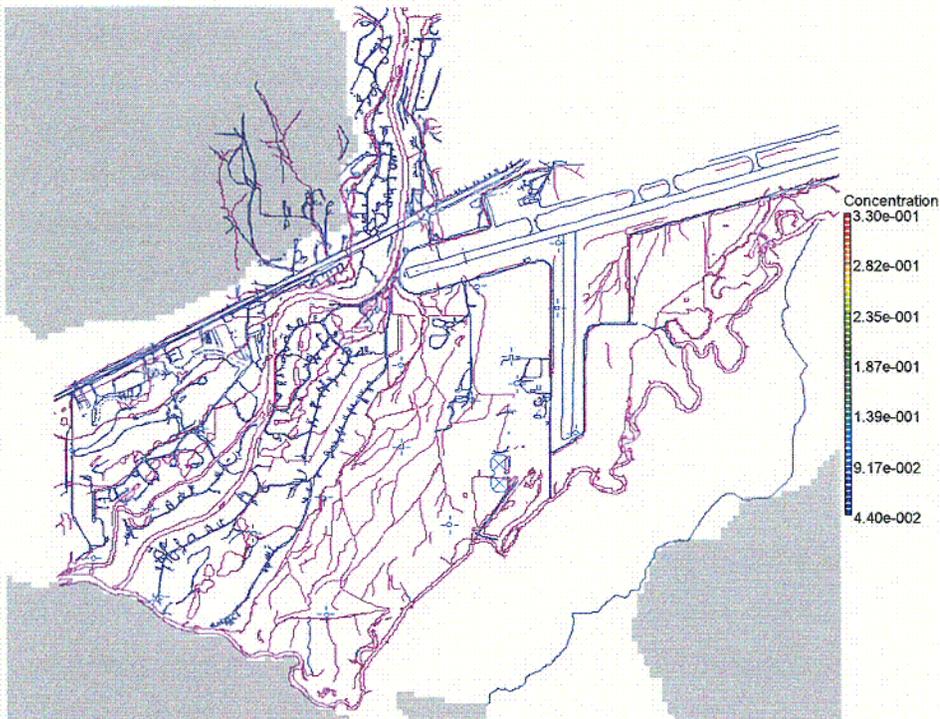


Figure 11. Predicted Steady State Uranium Concentration at 100 Years

C133

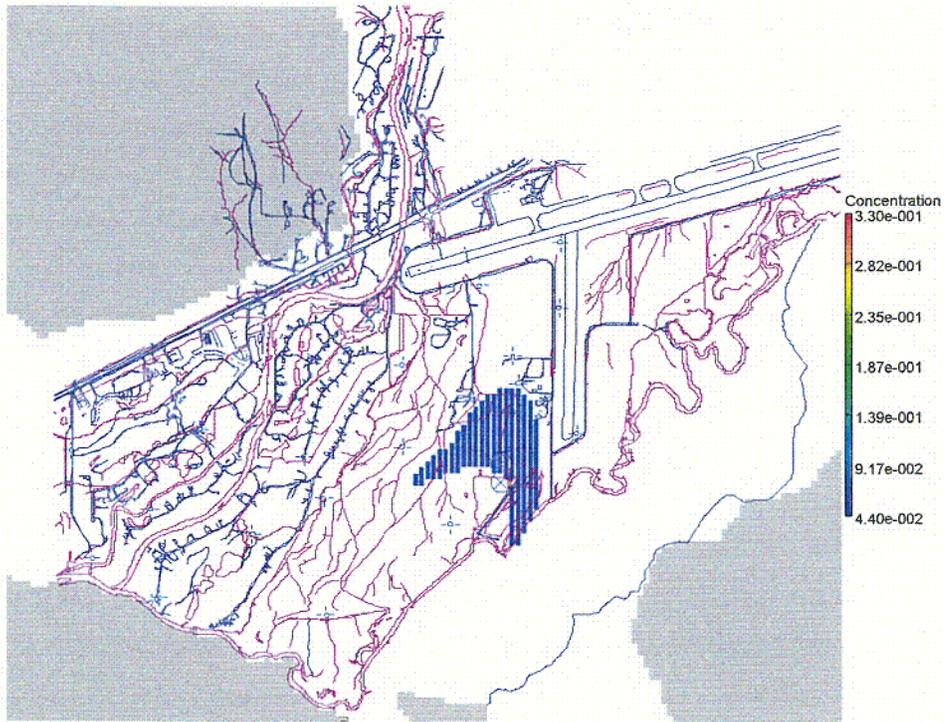


Figure 12. Predicted Stochastic Uranium Concentration at 50 Years (100 simulations)

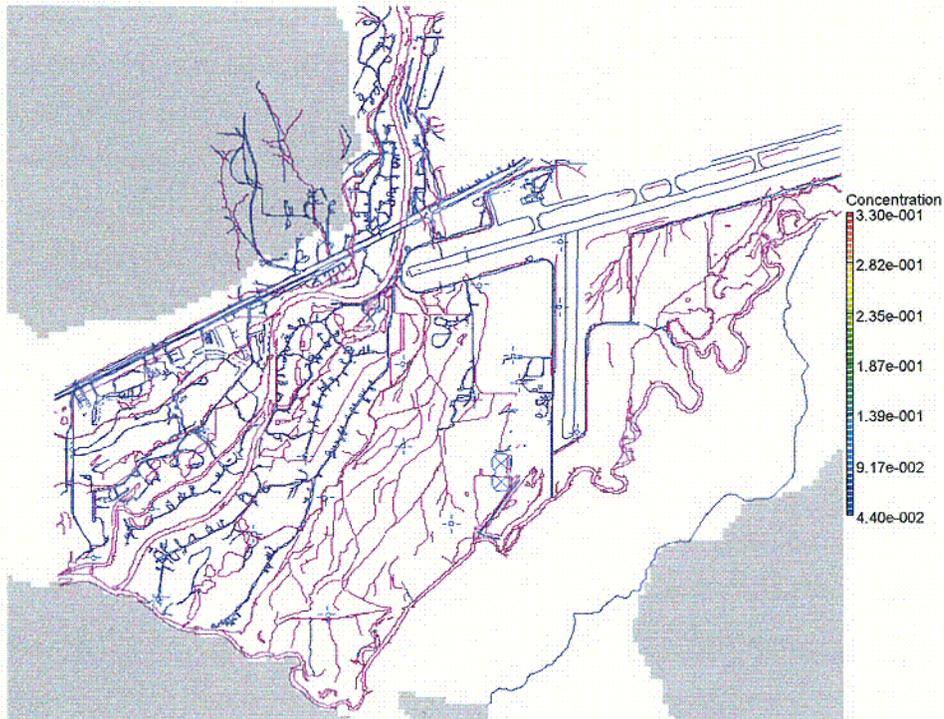


Figure 13. Predicted Stochastic Uranium Concentration at 100 Years (100 simulations)

C34

## 6.2 Predictive Results for Uranium

Contaminant transport simulation results for uranium were extracted for selected times up to 100 years into the future. Average concentrations and the associated uncertainty at each time period of interest are based on 100 computer simulations. Concentrations in Figure 9 represent the initial uranium values used as input at each grid cell for the stochastic MT3D simulations. Predicted uranium concentrations above the UMTRA 0.044 mg/L ground water standard at 50 and 100 years into the future are presented in Figure 12 and Figure 13. The maximum average remaining concentration at 100 years is 0.031574mg/L.

By varying the value of the uncertain or stochastic parameters during each of the 100 simulations, the variance associated with the mean predicted concentration was used to calculate the probability that the mean uranium concentration will exceed the standard for uranium. Probability contour maps showing areas within the alluvial aquifer that exceed the uranium ground water standard at 50 and 100 years into the future are illustrated in Figure 14 and Figure 15. At 100 years there is a 28 percent probability that the standard will be exceeded over a small area of the alluvial aquifer.

## 7.0 Transient Flow and Transport Model

### 7.1 Model Grid and Model Boundary Conditions

The grid and boundary conditions for the transient model are the same as for the steady state model described in Section 4.1.

### 7.2 Hydraulic Parameters

Hydraulic conductivity for the transient model is 135 ft/day, the same as for the steady state model. The details of the hydraulic conductivity testing and analysis are in Section 4.2.

For an unconfined transient flow model specific yield is required. Specific yield for this transient flow model is set at 0.2 (Fetter 1980).

Recharge components to the ground water system are specified in Section 2.5.1. Recharge zones are shown on Figure 5. The transient state recharge values assigned to the zones for the high flow period and the low flow period are shown in Table 7 and Table 8, respectively.

Table 7. Transient State High Flow Recharge Parameters

Zone No.	Description	Net Recharge Flux		
		Cells	Area (ft <sup>2</sup> )	(ft/day)
1	Area	10022	100220000	0.00127
2	Gold Basin Creek	31	310000	0.06337
3	Golf Course	351	3510000	0.00889
4	Field Flood	930	9300000	0.00381

Table 8. Transient State Low Flow Recharge Parameters

Zone No.	Description	Net Recharge Flux		
		Cells	Area (ft <sup>2</sup> )	(ft/day)
1	Area	10022	100220000	0.00042
2	Gold Basin Creek	31	310000	0.06252
3	Golf Course	351	3510000	0.00042
4	Field Flood	930	9300000	0.00042

For the high flow period, dewatering of the sand and gravel mining operation is represented in the model by an extraction well in the dewatering or mined pit and an injection well into the overflow pond. The pump rate for the extraction wells is 2,500 gpm or 481,280 ft<sup>3</sup>/day. The injection well rate is equal to the extraction well rate. For the low flow period the rates are zero, to indicate that there is no sand and gravel operation, i.e., dewatering during this period.

Discharge from the ground water system consists of subsurface flow from some sections of the Gunnison River and Tomichi Creek on a seasonal basis.

### 7.3 Constant Head Boundary Conditions

Constant head boundary conditions for the steady state model are described in Section 4.3. For the transient model the Gunnison River to the west of the site and Tomichi Creek to the east and south of the site are represented in the model as a stress period-variant constant head boundary. For the transient model the high flow period river elevations are the average of the 3 highest months (May, June, and, July) at the measurement locations. The low flow period river elevations are the average of the 9 lowest months (Aug – Dec, Jan – Apr). Constant head values were interpolated at the grid cells for both the steady state model and the transient model.

### 7.4 Selection of Calibration Targets

Eighteen calibration targets were selected for the transient model. The high flow period target values are an average of measurement taken during May and June of 1998 and 1999. The low flow period target values are an average of measurements taken during September and October of 1998 and 1999. No specific criteria were set for the transient state modeling because of significant gaps in the data used to calculate the target values. However, the residuals for each stress period seem reasonable when compared to the steady state residuals.

### 7.5 Transport Parameters

The transient transport parameters are the same as for the steady state model described in Section 5.1.

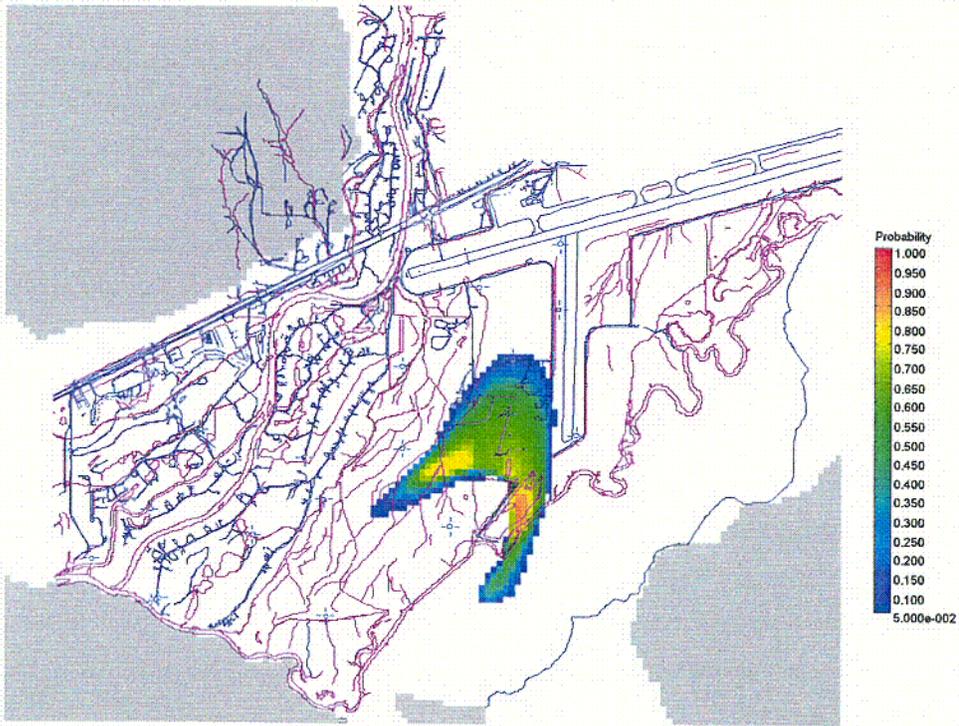


Figure 14. Probability of Uranium Concentration Exceeding the Standard at 50 Years (100 simulations)

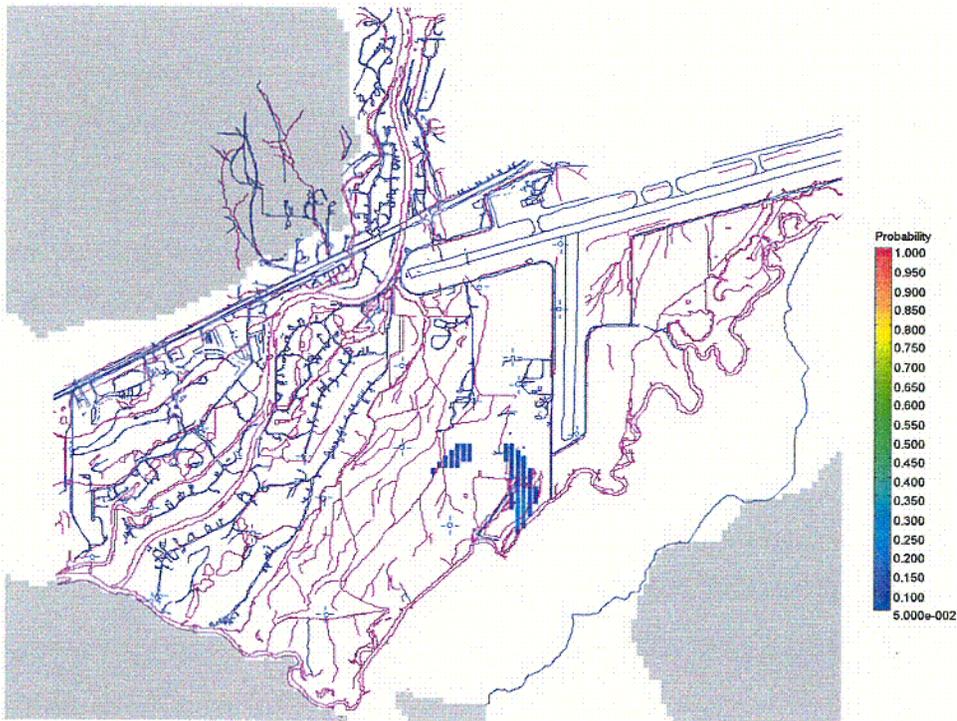


Figure 15. Probability of Uranium Concentration Exceeding the Standard at 100 Years (100 simulations)

C35

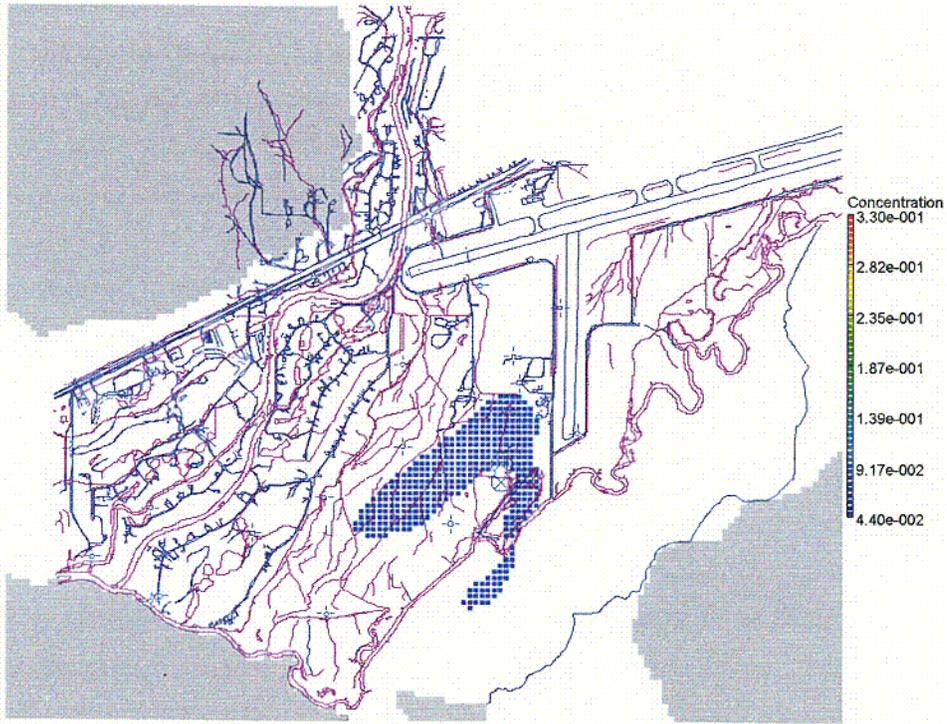


Figure 16. Predicted Transient Uranium Concentration at 50 Years

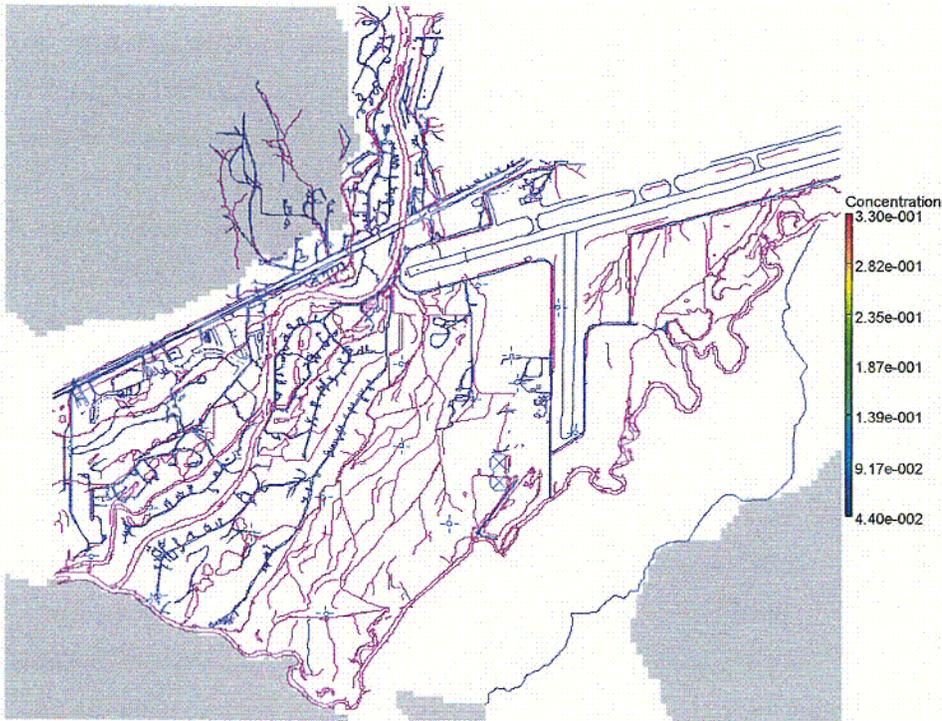


Figure 17. Predicted Transient Uranium Concentration at 100 Years

C36

## 8.0 Summary and Conclusions

### 8.1 Qualitative Analysis

Ground water flow patterns predicted by the steady state flow model (Figure 6) closely resemble the ground water gradient measured in May 1999 (Figure 3). This visual analysis suggests that the calibrated flow model adequately and accurately predicts the observed water level elevations.

### 8.2 Quantitative Analysis

Data presented in Table 3 and Figures 7 and 8 indicate that the calibrated steady state flow model satisfies the acceptance criteria and calibration objectives established before modeling. Calibration results presented in Figure 7 demonstrate that the flow model has a slight bias of overestimating water levels at the lower elevations and underestimating water levels at the higher elevations. However, the residuals are evenly distributed above and below 0.0 ft. This is evidenced by a mean residual of  $-0.003$  ft and an absolute mean residual of  $0.717$  ft. Results presented in Figure 8 demonstrate that the predicted hydraulic heads versus the observed heads fall on a straight line as expected.

### 8.3 Model Predictions

Results of the steady state MT3DMS predictive simulations indicate that on average the maximum uranium concentration in the ground water at the Gunnison site will decrease to below the UMTRA Project standard for uranium of  $0.044$  mg/L in 100 years (Figure 11). The maximum predicted concentration at 100 years is  $0.036627$  mg/L, which is below the standard.

The steady state stochastic MT3D simulations show similar results. Average concentrations and the associated uncertainty at each time period of interest are based on 100 computer simulations. Figure 13 indicates that on average the maximum remaining concentration in the ground water will decline below the UMTRA ground water standard in 100 years. The maximum average predicted concentration at 100 years is  $0.031574$  mg/L. Furthermore, the stochastic simulations predict that at 100 years there is a low probability that the maximum concentration will be greater than the standard over a small area of the alluvial aquifer (Figure 15). All these data suggests that there is a high probability that the remaining concentration will not exceed the standard.

Result of the transient MT3DMS simulations indicate that the maximum uranium concentration in the ground water will decrease to just below the standard in 100 years using a  $K_d = 3.47$  (Figure 17). The maximum average predicted concentration at 10 years is  $0.043996$  mg/L.

## 9.0 References

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Zheng, C. and P. Wang, 1999. *MT3DMS: A Modular Three-Dimensional Multispecies Transport Model for Simulation of Advection, Dispersion, and Chemical Reactions of Contaminants in Groundwater Systems*, Documentation and User's Guide, Department of Geological Sciences, University of Alabama, Tuscaloosa, Alabama.

**Appendix I**  
**Institutional Controls**

# STATE OF COLORADO

Bill Owens, Governor  
Jane E. Norton, Executive Director

*Dedicated to protecting and improving the health and environment of the people of Colorado*

## HAZARDOUS MATERIALS AND WASTE MANAGEMENT DIVISION

<http://www.cdphe.state.co.us/hm/>

4300 Cherry Creek Dr. S.  
Denver, Colorado 80246-1530  
Phone (303) 692-3300  
Fax (303) 759-5355

222 S. 6th Street, Room 232  
Grand Junction, Colorado 81501-2768  
Phone (970) 248-7164  
Fax (970) 248-7198



Colorado Department  
of Public Health  
and Environment

January 21, 2000

Mr. Jeff Brauer  
Real Estate Programs  
State Buildings Department\GSS  
225 E. 16th Avenue, Room 900  
Denver, CO 80203

Re: State Inventory - Property Transfers

Dear Mr. Brauer:

Enclosed please find one quitclaim deed for property transferred from the Colorado Department of Public Health and Environment, Hazardous Materials and Waste Management Division to Gunnison County.

This property is located in Gunnison County, Colorado, and was transferred to the City pursuant to the Uranium Mill Tailings Remediation Control Act (UMTRCA). Please add these property transfers to the State inventory as required by C.R.S. Section 24-30-1303.5

If you have any questions, please do not hesitate to contact me directly at (303) 692-3387.

Sincerely,

Jeffrey Deckler  
Remedial Programs Manager

Enclosures

cc (w/enclosures): David Kreutzer, AGO  
Kent Long, CDPHE  
Pete Loeb, CDPHE  
File UM.GUN. 5.F

## ATTACHMENT A

### LAND ANNOTATION

#### GUNNISON, COLORADO PROCESSING SITE

The Uranium Mill Tailings Radiation Control Act (Public Law 95-604), Section 104, requires that the State notify any person who acquires a designated processing site of the nature and extent of residual radioactive materials removed from the site, including notice of the date when such action took place, and the condition of the site after such action. The following information is provided to fulfill this requirement.

The Gunnison, Colorado processing site consists of two separate land parcels. The northern parcel contained the tailings pile, while the southern parcel contained the mill building and associated structures. However, since the two sites are contiguous and physically similar, the remainder of this annotation will address the mill site as a whole.

Approximately 734,000 cubic yards of contaminated materials which included 1) tailings; 2) subpile soils; 3) surficial materials in the mill yard; 4) windblown materials; and 5) mill demolition debris were removed from the mill site from 1993 to 1995. The remediation was conducted in accordance with regulations promulgated by the U.S. Environmental Protection Agency, in 40 CFR 192. These regulations require that the concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than: 5 pCi/g (picocuries per gram), averaged over the first 15 cm (centimeters) of soil below the surface, and 15 pCi/g averaged over 15 cm thick layers of soil more than 15 cm below the surface. Verification measurements were conducted at the site by dividing the site into approximately 2,900 30-foot by 30-foot grids. A soil sample was collected and analyzed for contaminants from each grid to verify that the standards had been met.

After remediation was complete the site was backfilled with approximately 450,000 cubic yards of clean fill material, graded for drainage and revegetated. Backfill materials were routinely analyzed for radium-226 and were determined to have concentrations near background. Material with radium-226 concentrations less than 5 pCi/g were used for surface backfill.

Excavation of residual radioactive material was also conducted for thorium-230 beneath the tailings pile in the subpile soils which consisted mainly of large cobbles, sands and gravels. For thorium-230, the cleanup standard was determined as a projected 1,000 year radium-226 concentration based on the eventual decay of the thorium to radium. Because the material contained large cobbles, a mass correction factor was applied which allowed for the averaging of the thorium concentration throughout the soil mass. This resulted in a bulk thorium-230 concentration of approximately 35 pCi/g as the clean-up standard.

Due to the shallow depth of the water table beneath the tailings pile, complete excavation of all thorium-contaminated material was not feasible without extensive dewatering. Thus, in accordance with the EPA regulations a procedure was developed whereby thorium contamination

was left in place at depth, once the water table was reached in the excavation. Any concentration of thorium above 175 pCi/g that was to remain in place was to receive a cap layer of one foot of fine-grained backfill, called "select fill" as low in the excavation as possible, to reduce the eventual emissions of radon gas from the thorium deposits. (The value of 175 pCi/g was based on a radon emanation model that determined that after backfill, the radon escaping from a deposit of less than 175 pCi/g would be below the EPA standard for radon emanation. Any concentration greater than 175 pCi/g would need to have a cap layer that would minimize the radon emissions.) At the Gunnison site, 596 grids received the select backfill material (approximately 22,000 cubic yards of select fill were used at the site). An additional 41 grids contain thorium deposits in concentrations greater than 175 pCi/g, but are not covered by the select fill material. The locations of the thorium-containing grids are shown on the attached map. Additional information regarding the depth to the thorium deposits and the depth to the select fill is available upon request from Colorado Department of Public Health and Environment and has been provided to Gunnison County. The select fill can be visually distinguished from the general fill by its darker color and fine-grained texture (the general fill was a coarse-grained sand/gravel material).

The groundwater beneath the Gunnison Mill site remains contaminated and will be addressed during Phase II of the uranium mill tailings remedial action project. Several groundwater monitor wells are present on and downgradient of the site and will remain in place until the U.S. Department of Energy determines that they can be removed.

Any person who acquires a designated processing site shall apply for any permits, including U.S. Army Corps of Engineers Section 404 permits regarding construction in or near wetlands, as required by law.

Additional information concerning the remedial action, groundwater conditions, and thorium deposits is available from the Colorado Department of Public Health and Environment, Hazardous Materials and Waste Management Division.

Recorded at \_\_\_\_\_ o'clock \_\_\_\_\_ M., \_\_\_\_\_  
Reception No. \_\_\_\_\_

Recorder \_\_\_\_\_

QUIT CLAIM DEED

The Colorado Department of Public Health and the Environment ("Grantor"), whose address is 4300 Cherry Creek Drive South, Denver, Colorado, 80222-1530, City and County of Denver, State of Colorado, pursuant to 42 U.S.C § 7914 (c) (1) (B) and C.R.S. § 25-11-303, hereby donates and quit claims to the County of Gunnison ("Grantee"), whose address is 200 E. Virginia, Gunnison, Colorado, 81230, City and County of Gunnison, State of Colorado, the following real property in the County of Gunnison, State of Colorado, to wit: A parcel of land in Gunnison County, State of Colorado, containing Sixty and ninety two hundredths (60.92) acres, more or less, described as follows:

Township 49 North, Range 1 West, N.M.P.M.

A tract of land situated in the S $\frac{1}{4}$ NW $\frac{1}{4}$  of Section 2 and the NE $\frac{1}{4}$ NW $\frac{1}{4}$  of Section 11 more particularly described as follows:

Commencing at the North quarter corner of said Section 11; thence South 89°34'00" West along the North line of said Section 11, a distance of 30.91 feet to the Westerly right-of-way line of the existing county road; thence North 01°07'00" West along said right-of-way line 742.17 feet; thence North 53°22'00" West, 231.90 feet, to the POINT OF BEGINNING; thence Southeasterly along said right-of-way along a curve to the right, having a radius of 144.71 feet, 268.98 feet, chord bearing South 53°22'00" East, 231.90 feet; thence South 01°07'00" East along said right-of-way line, 742.17 feet, to the North line of said Section 11; thence South 00°48'00" East along said right-of-way line, to the South line of said NE $\frac{1}{4}$ NW $\frac{1}{4}$ ; thence South 89°41'00" West along said South line, 1,271.72 feet; thence North 01°06'00" West, 1,320.03 feet to said North line of Section 11; thence North 89°34'00" East along said North line, 112.00 feet; thence North 01°31'00" East, 219.42 feet; thence North 89°09'00" West, 166.32 feet; thence North 13°56'00" West 99.16 feet; thence North 06°14'00" West, 211.88 feet to the Southerly right-of-way line of said existing county road; thence Northeasterly along said right-of-way line, to the POINT OF BEGINNING

Subject to: (i) any coal, oil, gas, or other mineral rights in any person; (ii) existing rights-of-way for roads, railroads, telephone lines, transmission lines, outlines, ditches, conduits, or pipelines on, over, or across said lands; (iii) court liens, judgments, or financial encumbrances such as deeds of trust for which a formal consent or order has been obtained from a court for the lien holder; (iv) other rights, interests, reservation or exceptions of record, and the following terms, conditions, rights, reservations and covenants:

Grantor reserves to, (i) itself, the U. S. Department of Energy, their employees, agents and contractors the right of access to the property as may be necessary to complete activities under the Uranium Mill Tailings Radiation Control Act of 1978, 42 U.S.C. § 7901 et seq. ("UMTRCA") and for other lawful purposes, until such time as Grantor and the U.S. Department of Energy determine that all remedial activities are complete; and (ii) to itself any non tributary groundwater underlying this parcel, the right to develop tributary groundwater, and the right to surface access for groundwater development

Grantee covenants to hold harmless the Grantor and the Department of Energy for any liability associated with disruption of any public purpose ventures on the property conveyed by this deed, the disruption of any improvement on said property made by the Grantee, its successors and assigns, and any temporary or permanent limitations to the use of the property, should the Grantor and the Department of Energy be required to perform additional surface remedial activities on the property conveyed by this deed.

Grantee covenants (i) to comply with the applicable provisions of UMTRCA, 42 U.S.C. § 7901 et. seq., as amended, (ii) not to use ground water from the site for any purpose, and not to construct wells or any means of expressing ground water to the surface unless prior written approval for such use is given by the Grantor and the U.S. Department of Energy; (iii) not to sell or transfer the land to anyone other than a governmental entity within the state, (iv) that any sale or transfer of the property described in this deed shall have prior written approval from the Grantor and the U.S. Department of Energy; and that any deed or other document created for such sale or transfer and any subsequent sale or transfer will include information stating that the property was once used as a uranium milling site and all other information regarding the extent of residual radioactive materials removed from the property as required by Section 104(d) of the Uranium Mill Tailings, 42 U.S.C. sec. 701(d), and as set forth in the Annotation attached hereto, (v) not to perform construction and/or excavation or soil removal of any kind on the property without permission from the Grantor and the U.S. Department of Energy unless prior written approval of construction plans (e.g., facilities type and location), is given by the Grantor and the U.S. Department of Energy; (vi) that any habitable structures constructed on the property shall employ a radon ventilation system or other radon mitigation measures; and (vii) that its use of the property shall not adversely impact groundwater quality, nor interfere in any way, with groundwater remediation under UMTRCA activities; and (viii) to use the

property and any profits or benefits derived therefrom only for public purposes as required by UMTRCA sec. 104(e)(1)(C), 42 U.S.C. 7914(e)(1)(C).

These covenants are made in favor and to the benefit of Grantor, shall run with the land and be binding upon Grantee and its successors and assigns, and shall be enforceable by Grantor, and its successors and assigns;

Grantee acknowledges that the property was once used as a uranium milling site, and that the Grantor makes no representations or warranties that the property is suitable for Grantee's purposes;

IN WITNESS WHEREOF:

GRANTOR:

APPROVED AS TO FORM:

  
David Kreutzer - Assistant Attorney General

STATE OF COLORADO  
Bill Owens, Governor  
Acting by and through  
The Department of Public Health and Environment

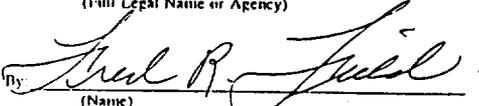
By:   
Executive Director

By:   
Program Approval

ACCEPTANCE OF DEED  
AND COVENANTS

GRANTEE:

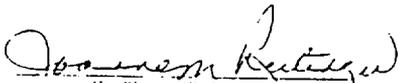
(Full Legal Name or Agency)

By:   
(Name)

Title: Chairperson, Gunnison County Commissioners

(Affix Seal)

ATTESTATION

  
City/County Clerk

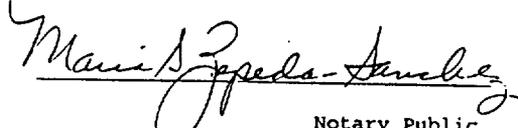
Signed this 6th day of December, 19 99

STATE OF COLORADO, }  
County of Denver } SS.

The foregoing instrument was acknowledged before me this 19th day of January, 2000, by Maria S. Zepeda-Sanchez

My commission expires April 14, 2003

Witness my hand and official seal

  
Notary Public.



**Final Site Observational Work Plan  
for the UMTRA Project Site at  
Gunnison, Colorado  
Appendices B, C, E, and F**