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SEP 27 2000

Thomas H. Essig, Chief
Uranium Recovery and Low-Level Waste Branch
U.S. Nuclear Regulatory Commission
Mail Stop T7J8
Washington, DC 20555-0001

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,

Donald R. Metzler, P.Hg.
Technical/Project Manager

Enclosures

cc w/o enclosure:
R. Heydenburg, MACTEC-ERS
S. Marutzky, MACTEC-ERS
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UMTRA
Ground Water Project

# 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

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

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Prepared by
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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 |
| $ft^2$/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 |
| *Kd* | 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 |
| $UCL_{95}$ | 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.

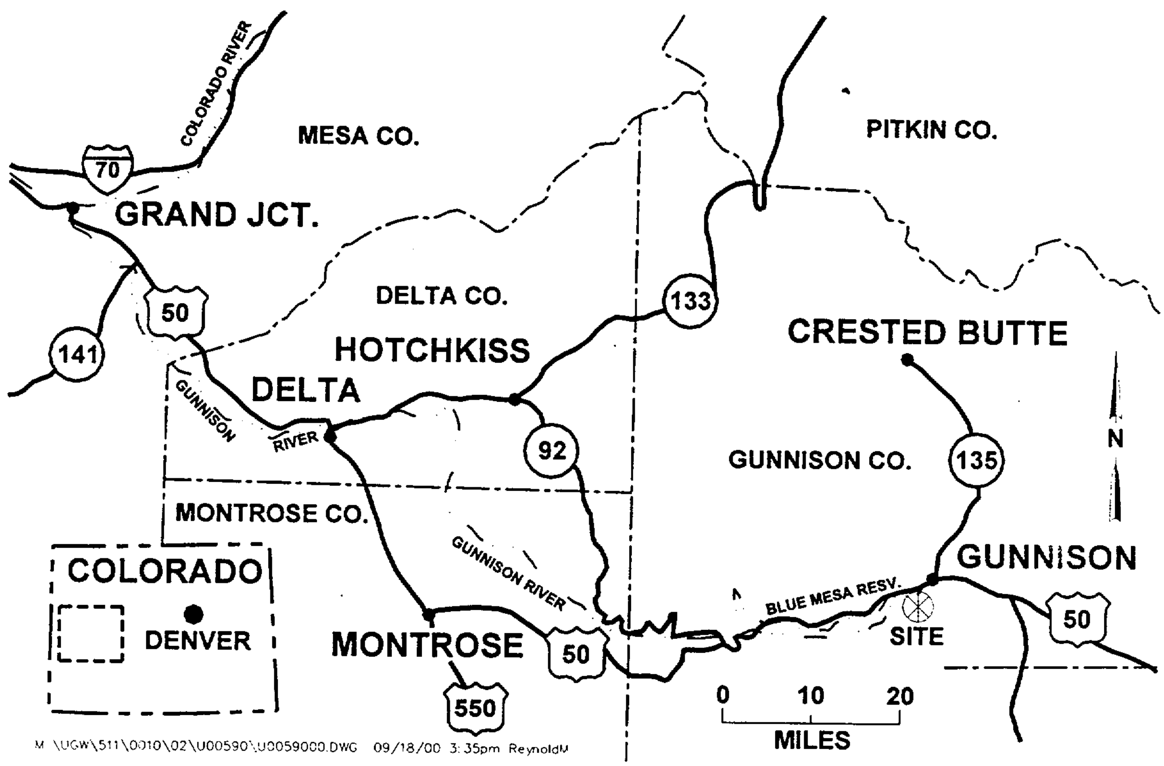


*Figure 1–1. Gunnison Site Location Map*

## 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

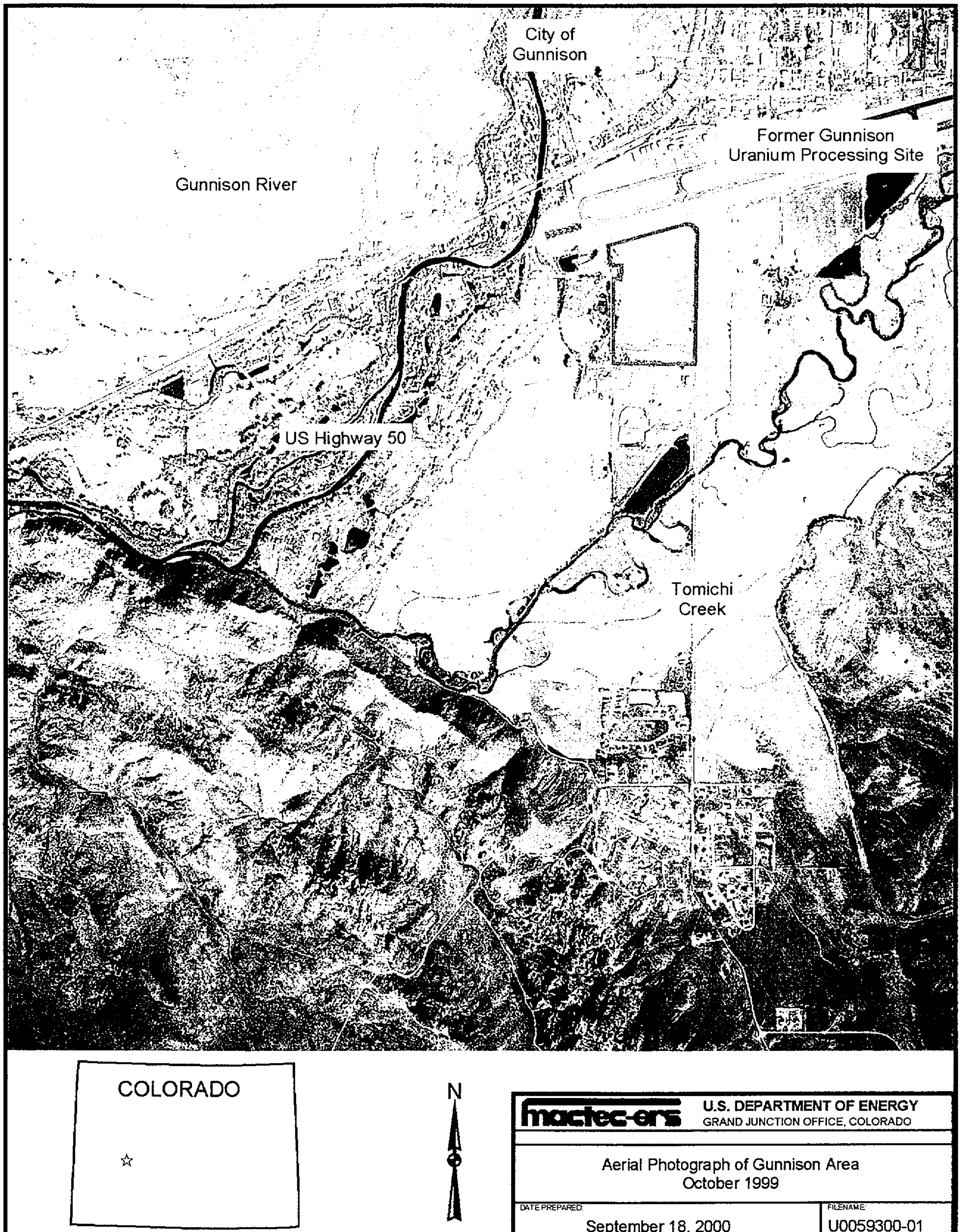


*Figure 3–1. Aerial Photograph of Gunnison Area, October 1999*

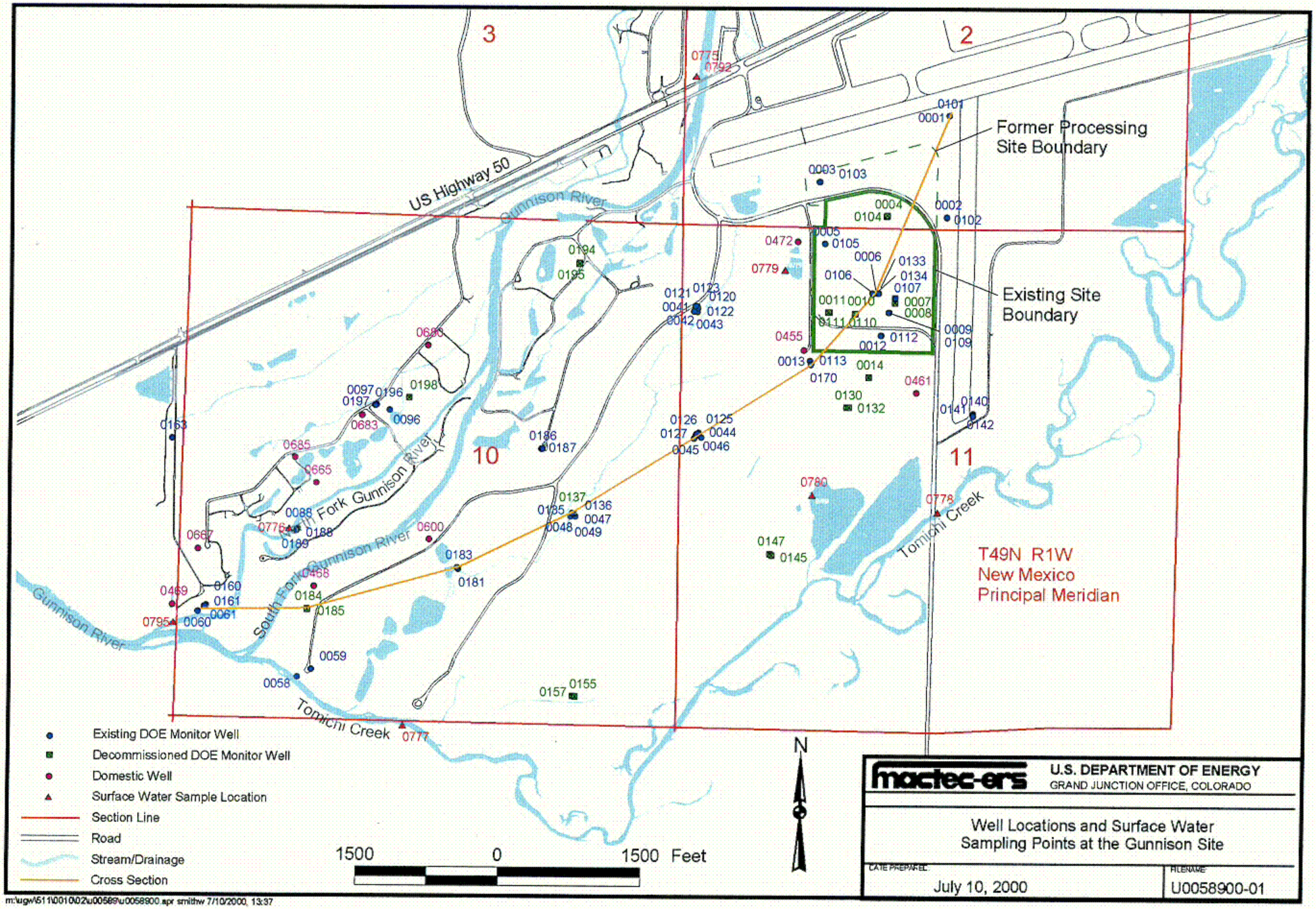


Figure 3–2. Well Locations and Surface Water Sampling Points at the Gunnison Site

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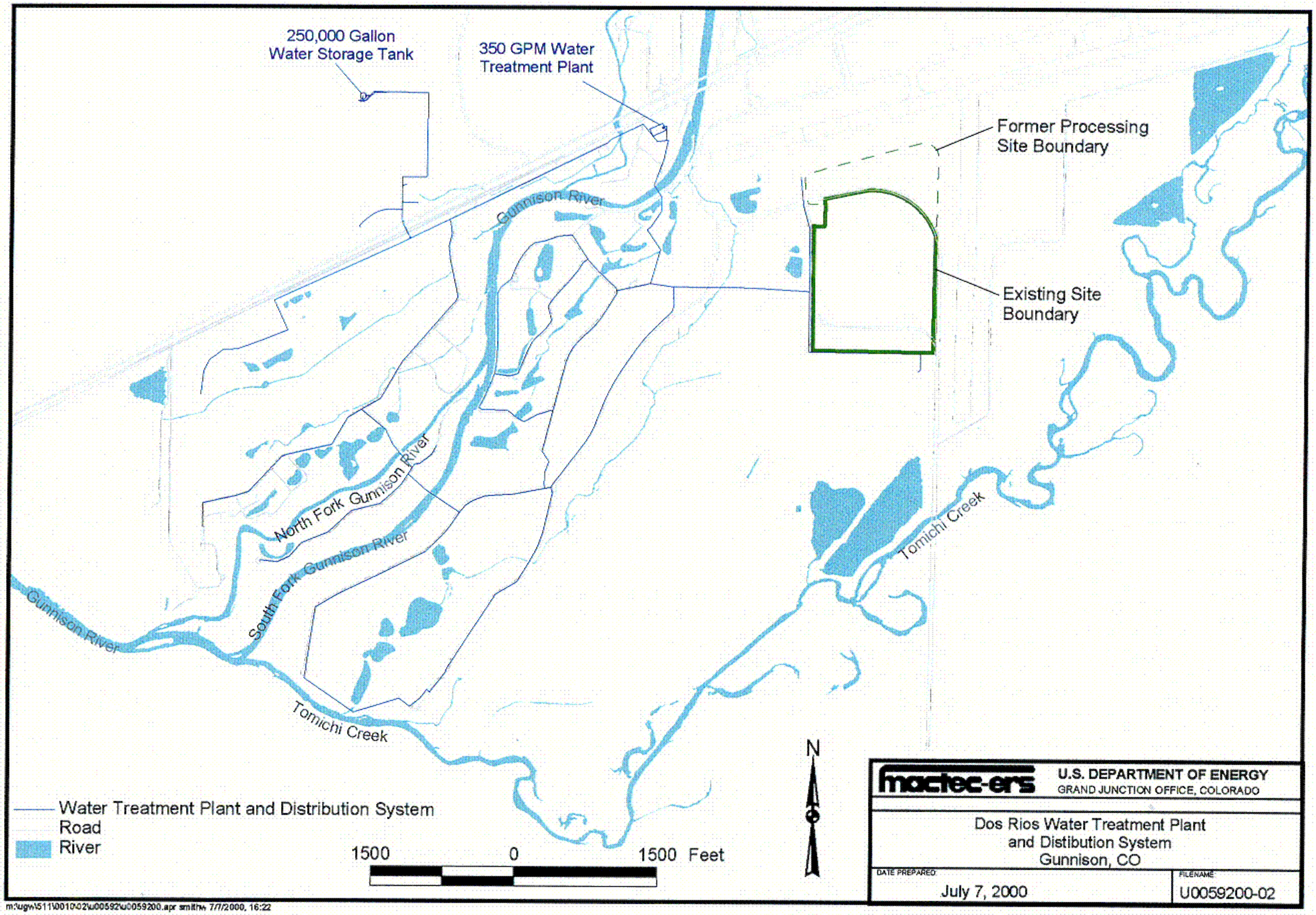



*Figure 3–3. Dos Rios Water Treatment Plant and Distribution System, Gunnison, Colorado*

C02

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.

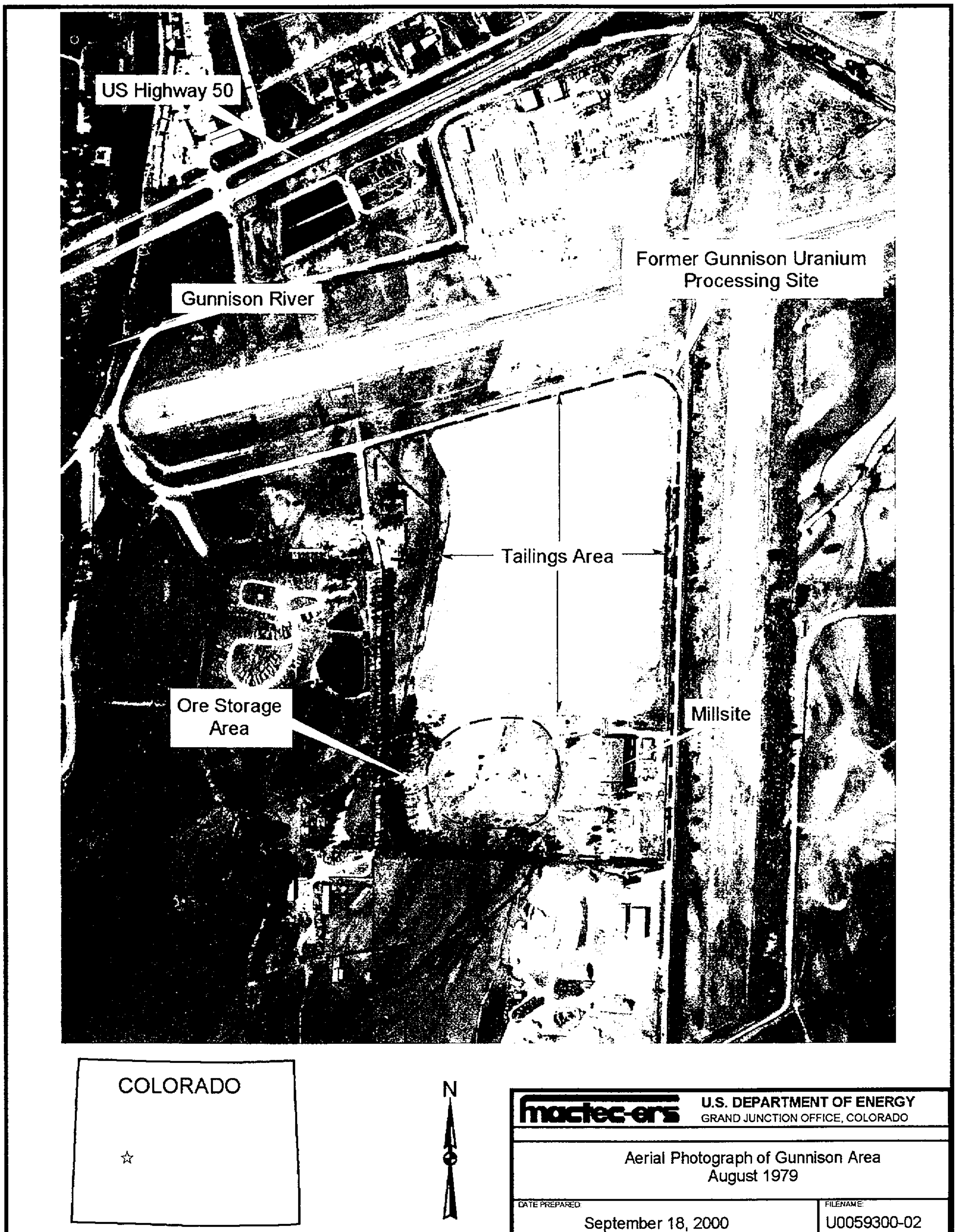
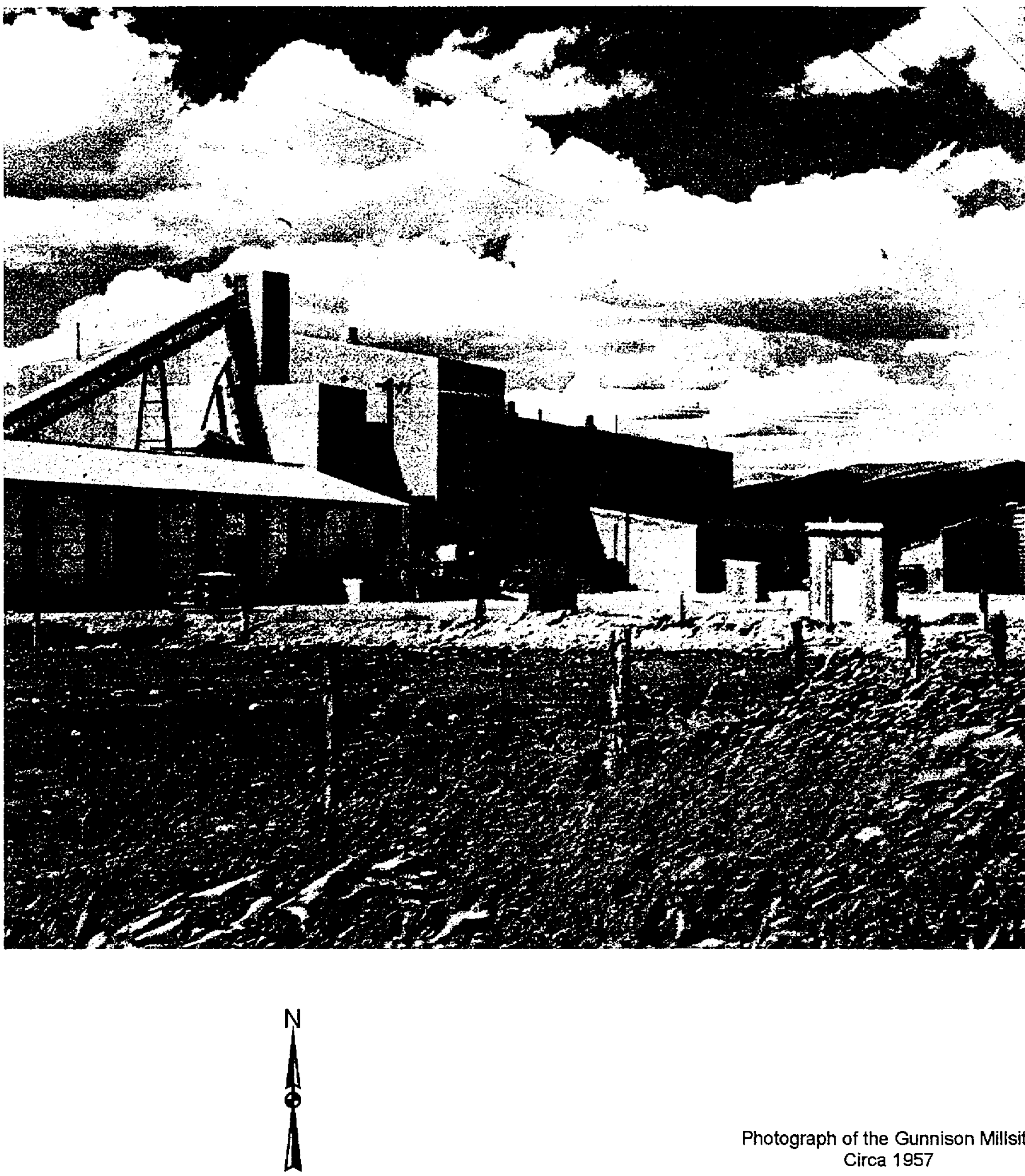



*Figure 3–4. Aerial Photograph of the Gunnison Area, August 1979*




Photograph of the Gunnison Millsite
Circa 1957

M:\UGW\511\0010\02\U00593\u0059300.apr reynoldm 3/30/2000, 8:01 U0059300-03

*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.

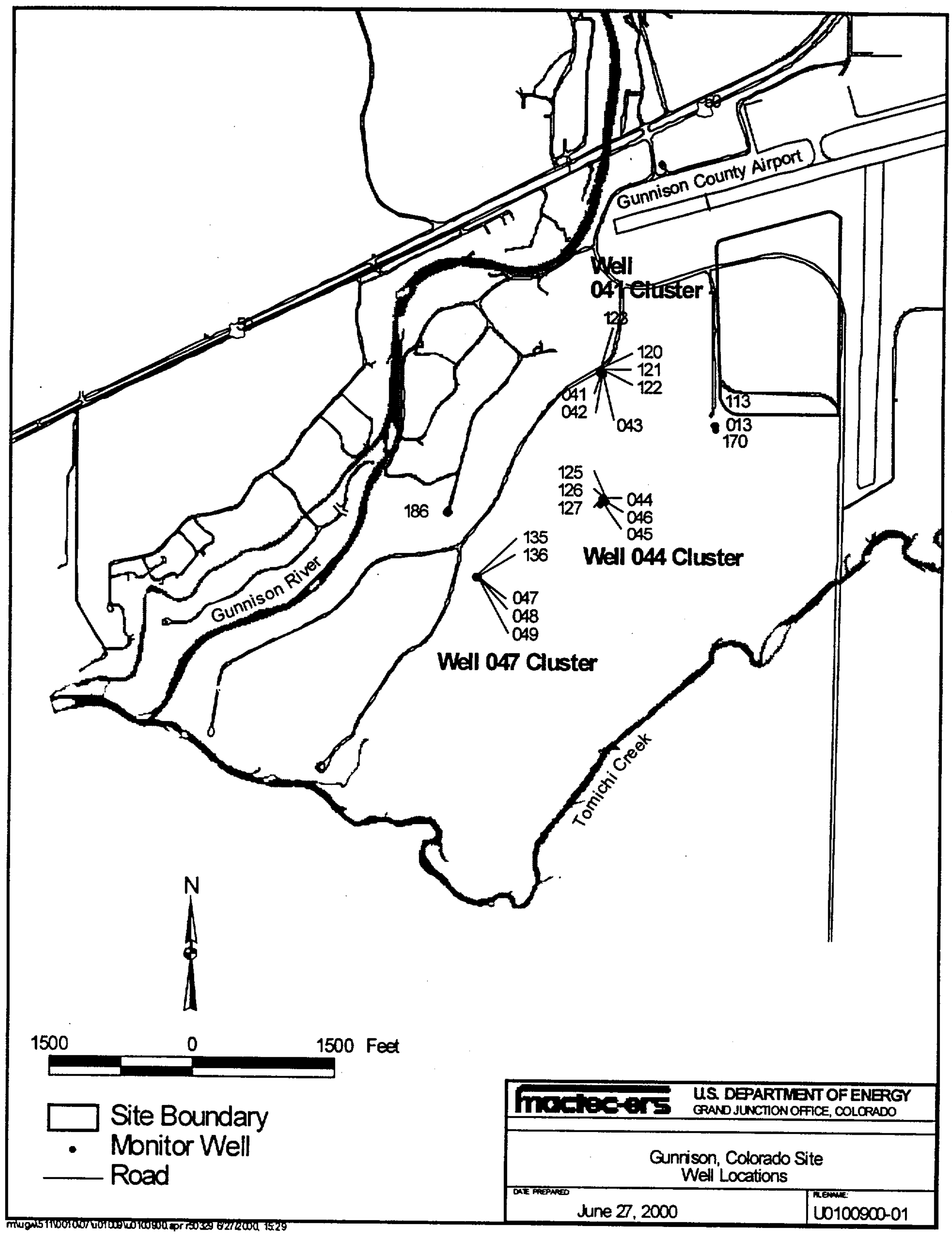



*Figure 4–1. Well Location Map at the Gunnison Site*

*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)[a] | 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 |

[a]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 ($ft^2$/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 $ft^2$/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)*

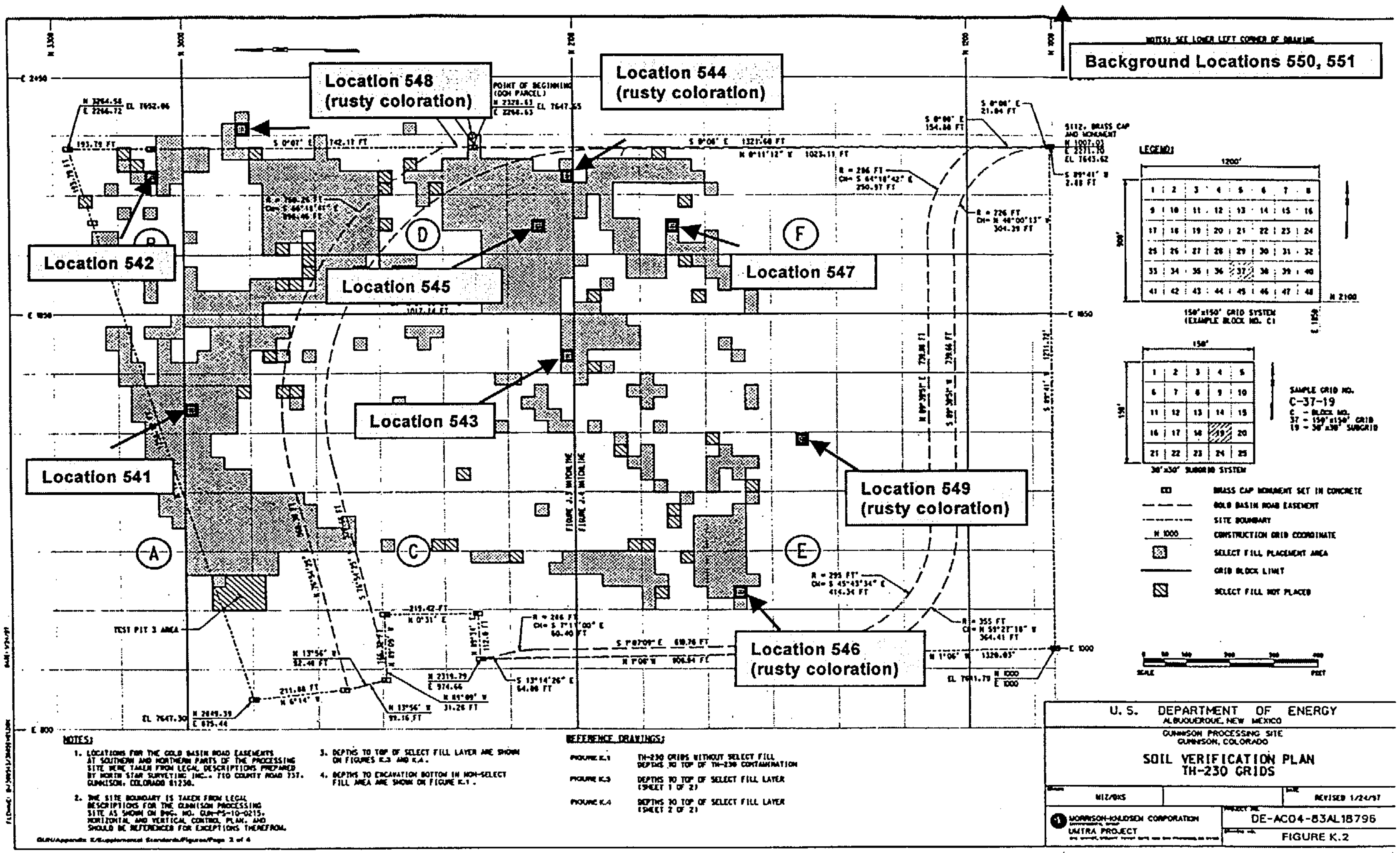



*Figure 4–4. Sampling Locations and Coloration of Samples Posted on Soil Verification Plan*

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

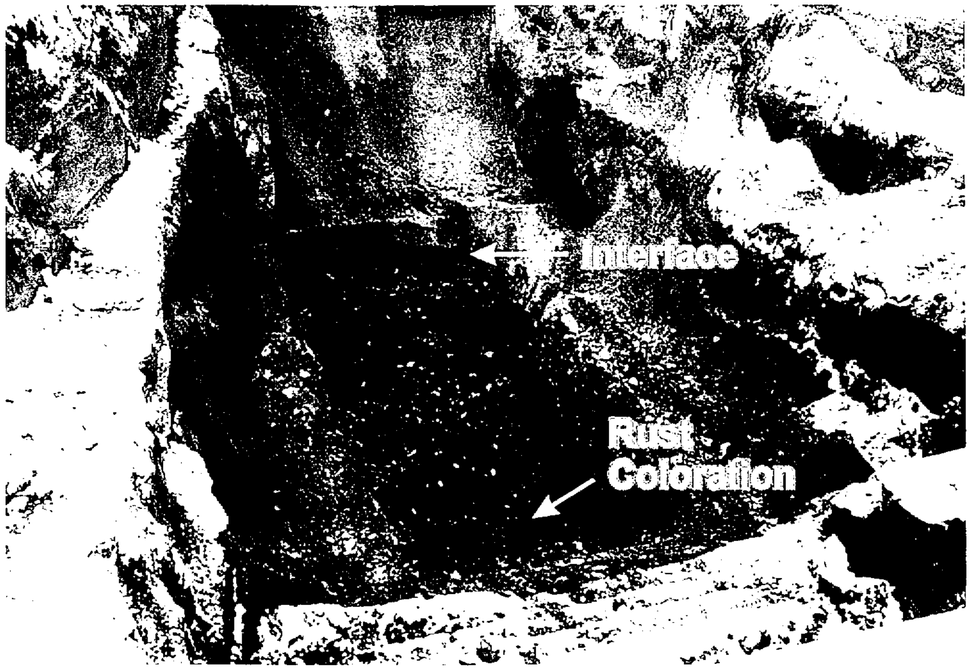



*Figure 4–5. Excavation Shortly After Surface Remediation (1995) (View 1)*

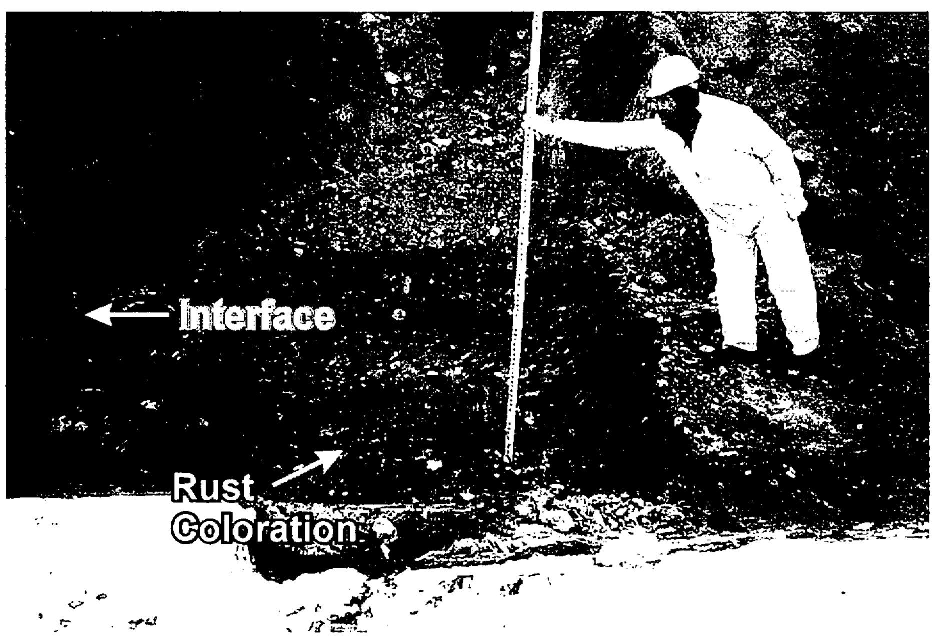



*Figure 4–6. Excavation Shortly After Surface Remediation (1995) (View 2)*
*- Note: rusty coloration of sediment below the select fill*

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

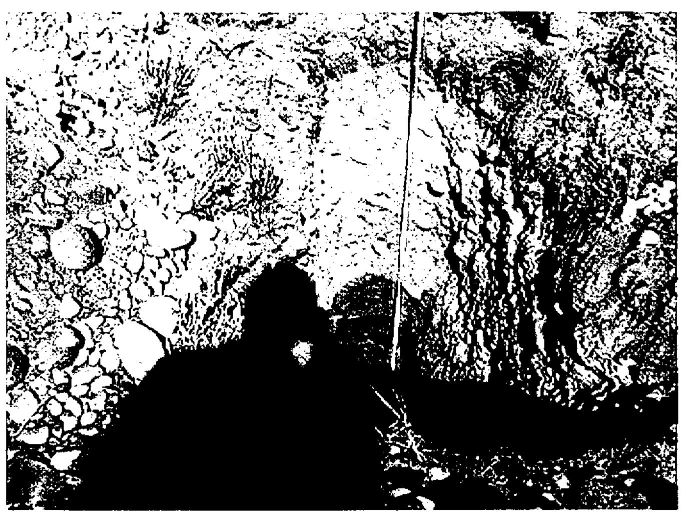


*Figure 4–8. Excavation on the Millsite in November 1999 (View 2) - Note: the select fill appears as a distinct layer in the test pits*

### 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 |
| **Locations that did not receive select fill** | | | | |
| 548 | D–04–21 | 1,068 | n./a. | 4.5 |
| **Ore storage area** | | | | |
| 549 | E–31–23 | n./a. | n./a. | n./a. |
| **Background area** | | | | |
| 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 (µm) 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*

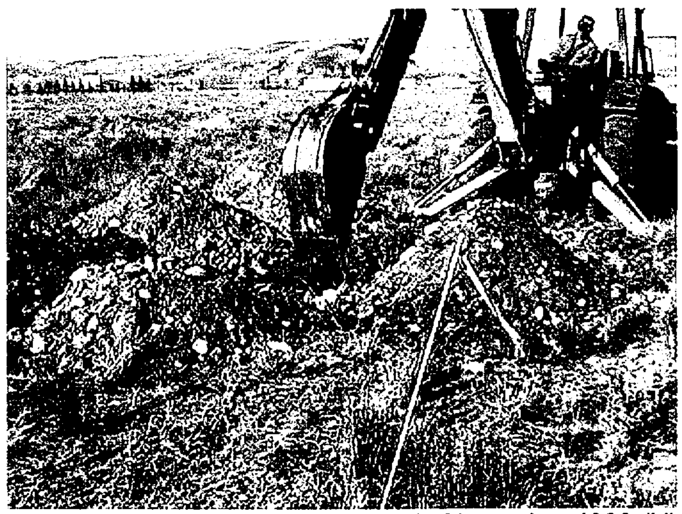


*Figure 4–10. Excavation on the Millsite in November 1999 (View 4)*
*Note: Excavated material was separated in different piles and backfillled in the same order*

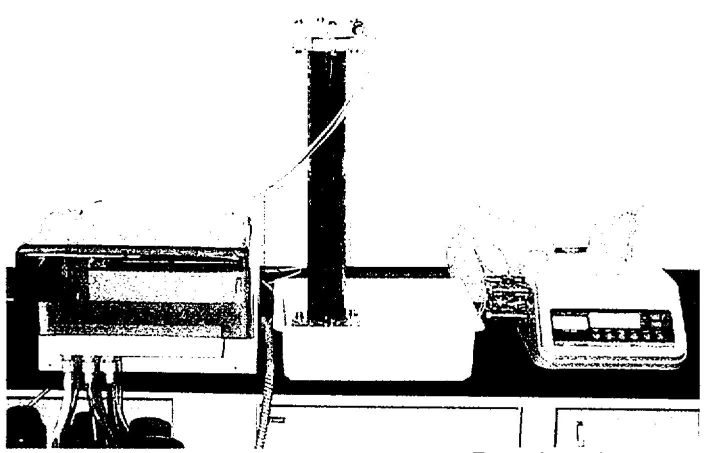


*Figure 4–11. Setup of Column Experiment*
*Note: source tank and peristaltic pump (right), column filled with subpile soil (middle) fraction collector (left)*

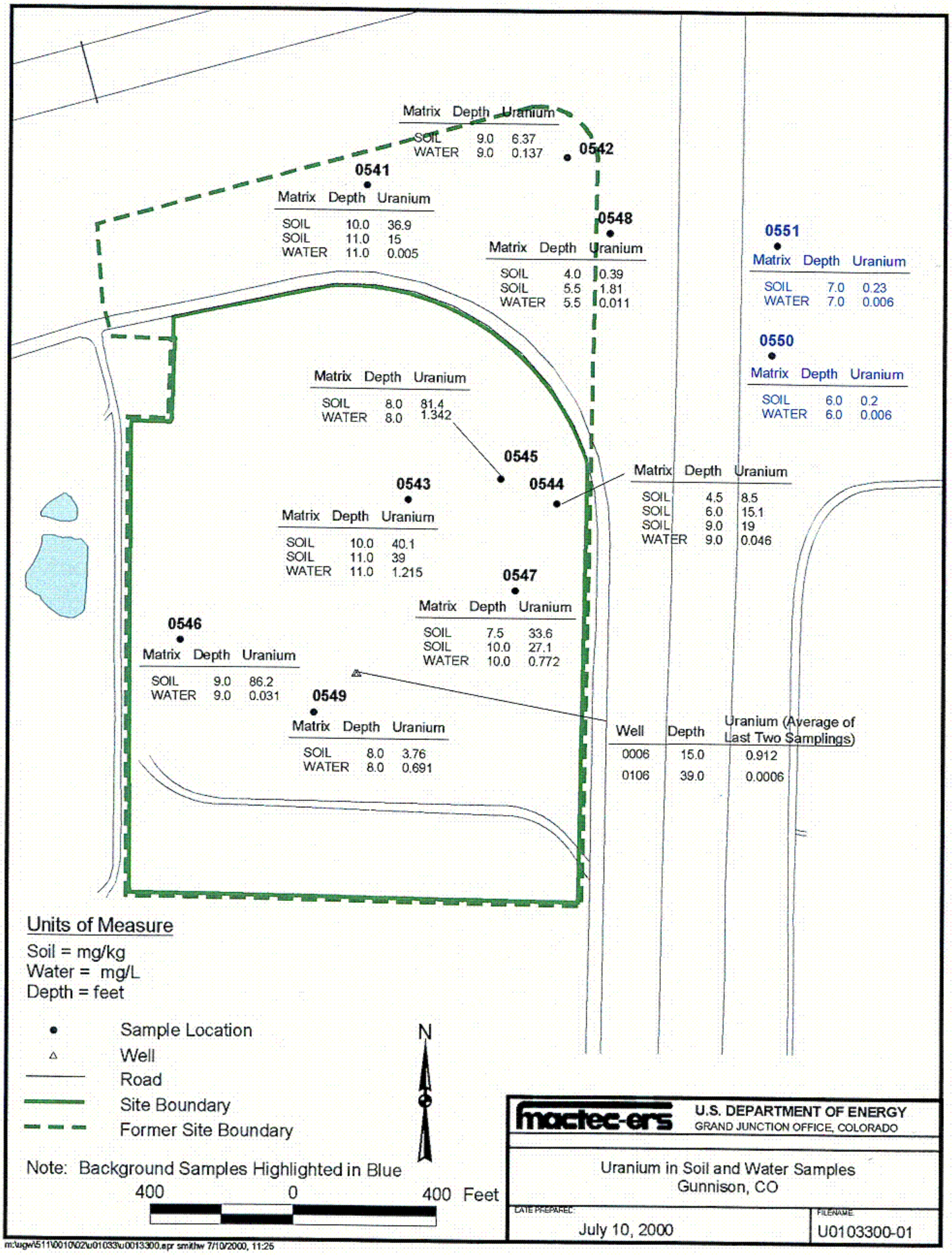



*Figure 4–12. Uranium in Soil and Water Samples Gunnison, Colorado*



C03

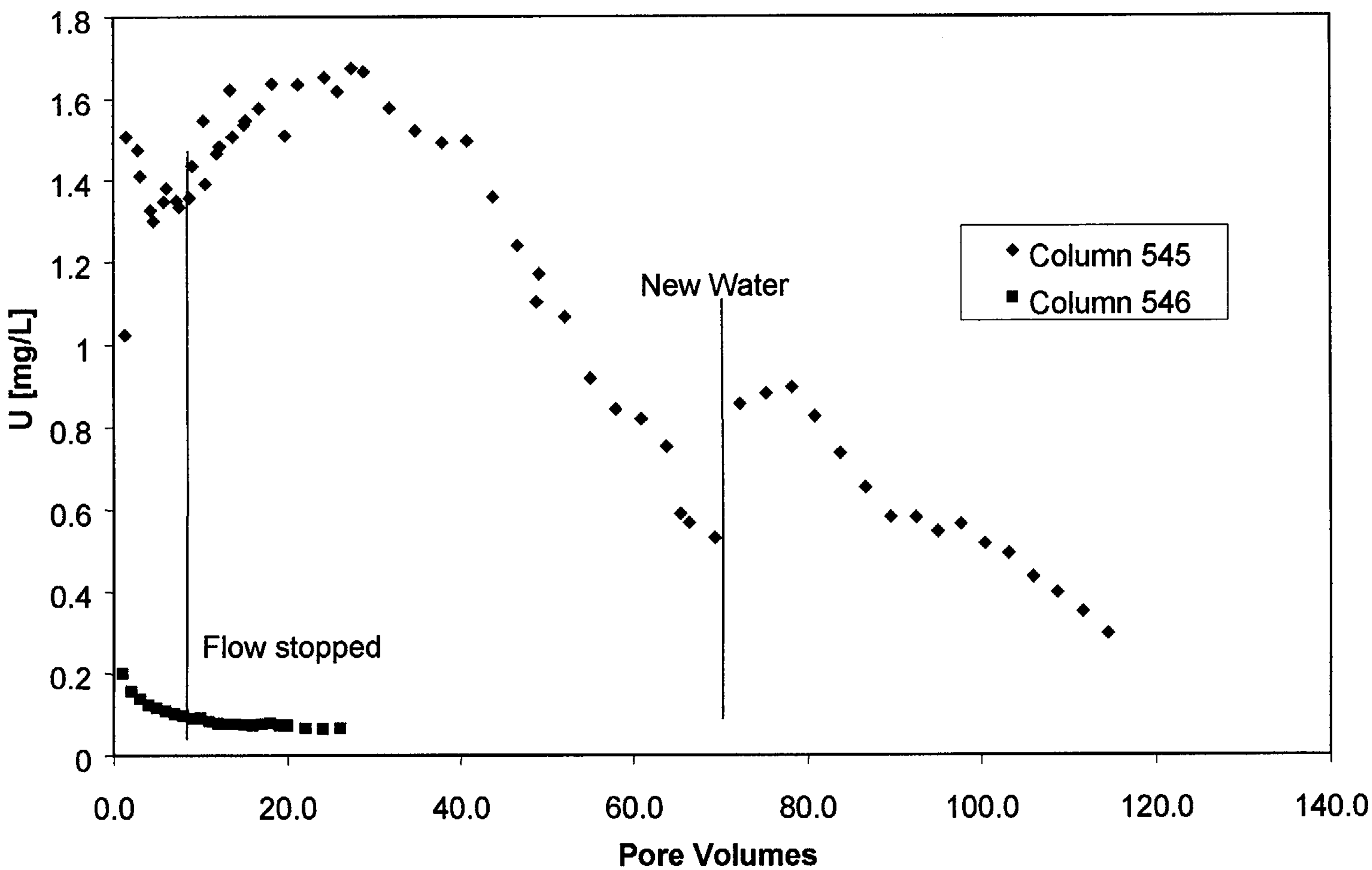



*Figure 4–13. Uranium Concentration in Effluents from Column Experiments*

*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 |
| **Background Locations** | | | | | | |
| 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. Managanese 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 where 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:

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

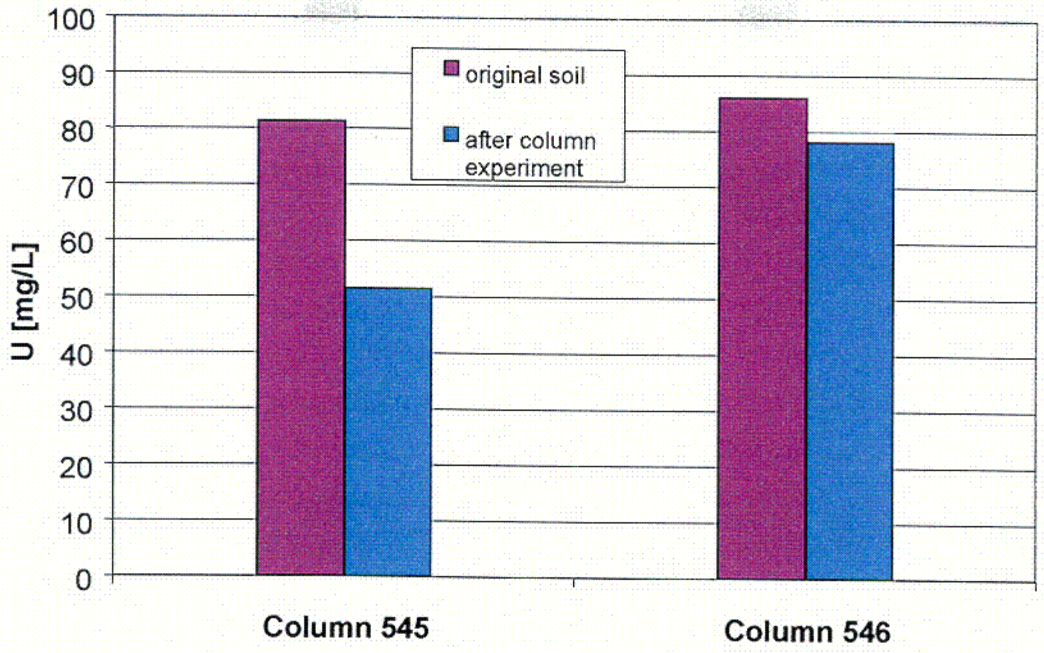



*Figure 4–14. Uranium Concentration in Soils Before and After Column Leaching*

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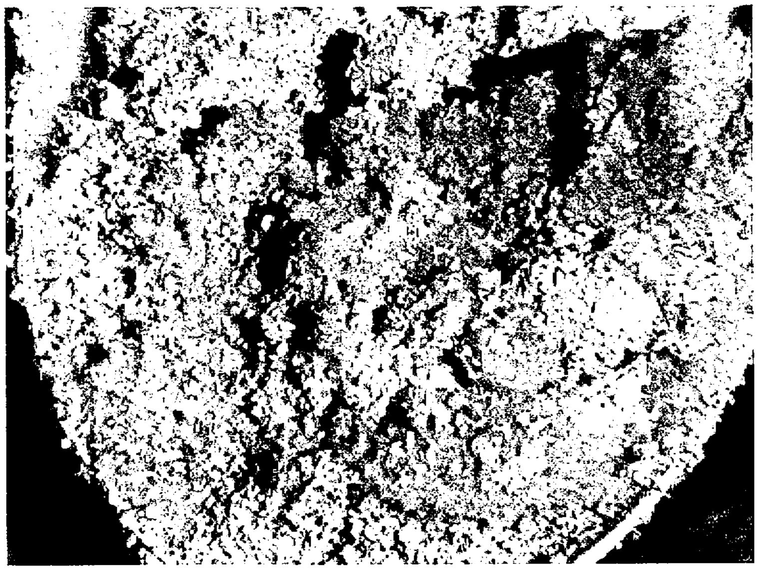

*Figure 4–15. Rusty Coloration of Subpile Soils Caused by Ferric Oxyhydroxides (Location 544)*

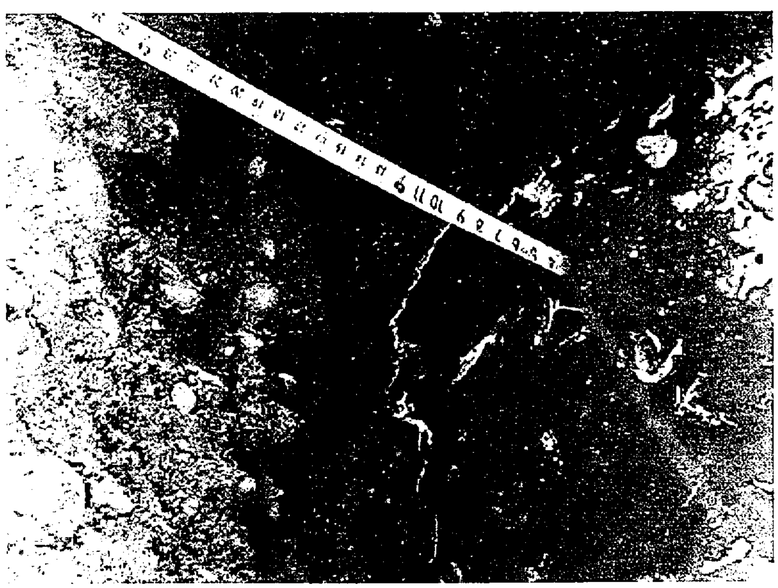

*Figure 4–16. Rusty Colored Sediment at Location 544*

*Rd* values are calculated from experimental data as

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

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:

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

where

$Rd_{adj}$ = adjusted *Rd* values,
$Rd_{(<2\ mm)}$ = 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-µm 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

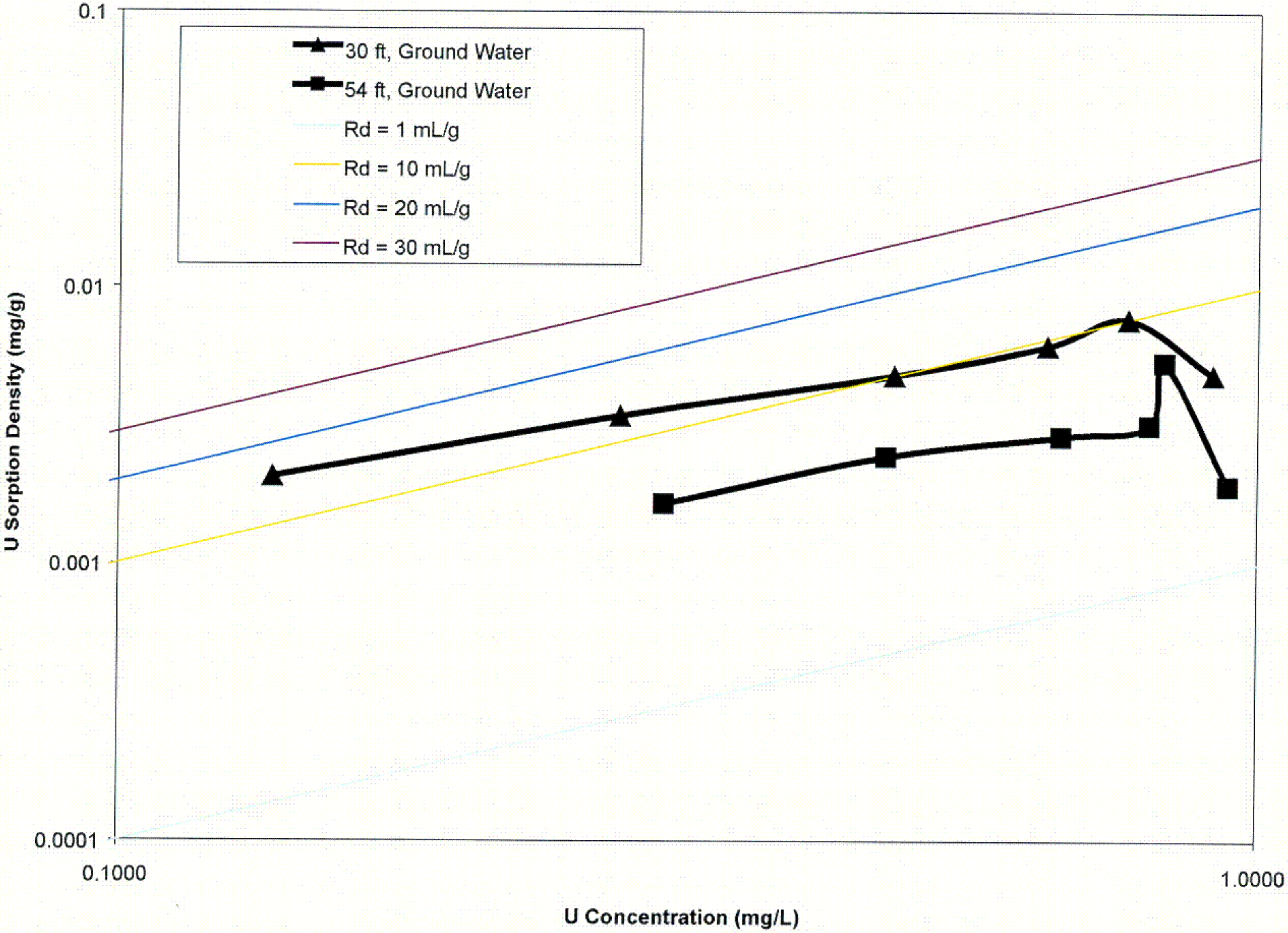


*Figure 4–17. Results of Rd Determinations at the Gunnison Site*

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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 $CaCO_3$) | *Rd* (mL/g) |
|---|---|---|---|
| Gunnison | Qal (30 ft) | 208 | 11.40 |
| Gunnison | Qal (54 ft) | 208 | 4.73 |
| Shiprock | Weathered Km | 231 | 1.59[a] |
| Shiprock | Unweathered Km | 231 | 2.13[a] |
| Shiprock | Qal (floodplain) | 1,036 | 0.54[a] |
| New Rifle | Qal | 500 | 0.7[b] |
| Old Rifle | Qal | 377 | 0.5[c] |
| Old Rifle | Wasatch claystone | 377 | 1.3[c] |
| Grand Junction | Qal | 260 | 2.15[d] |

Note: All samples were sieved to less than 2 mm.
Qal = Quaternary alluvium; Km = Cretaceous Mancos Shale
[a]DOE (1999a)
[b]DOE (1999d)
[c]DOE (1999e)
[d]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)<br>1989–1993 |
| 776 | Surface water | Gunnison River | COPC concentrations (downstream)<br>1989–1993 |
| 777 | Surface water | Tomichi Creek | COPC concentrations (downstream)<br>1989–1993 |
| 778 | Surface water | Tomichi Creek | Background concentrations (upstream)<br>1989–1993 |
| 779 | Surface water | Campground pond | COPC concentrations (pond)<br>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.<br>1990–1995 |
| 792 | Surface water | Gunnison River | Background concentrations (upstream from location 775)<br>1997–Present |
| 795 | Surface water | Gunnison / Tomichi Creek confluence | COPC concentrations (downstream from location 776)<br>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[a] | 777[b] | 779[c] | 780[d] | 795[e] |
|---|---|---|---|---|---|
| Ammonium | | | | | |
| Calcium | | X | | X | |
| Cadmium | | | | | |
| Cobalt | | | | X | |
| Iron | | | X | | |
| Lead-210 | | | | | |
| Magnesium | | X | | X | |
| Manganese | | | | X | |
| Nickel | | | | | |
| Polonium-210 | | | | | |
| Potassium | | | | X | |
| Silica | X | | | | Note[f] |
| Sodium | | | | X | |
| Strontium | | | | | |
| Sulfate | | X | | X | |
| Thorium-230 | | | | | |
| Uranium | | | | X | |
| Zinc | | | X | | |

[a]Results compared to background at location 775
[b]Results compared to background at location 778
[c]Results compared to background at location 775 and 778
[d]Results compared to background at location 792
[e]Results compared to background at location 792
[f]Silca 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.

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# 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.

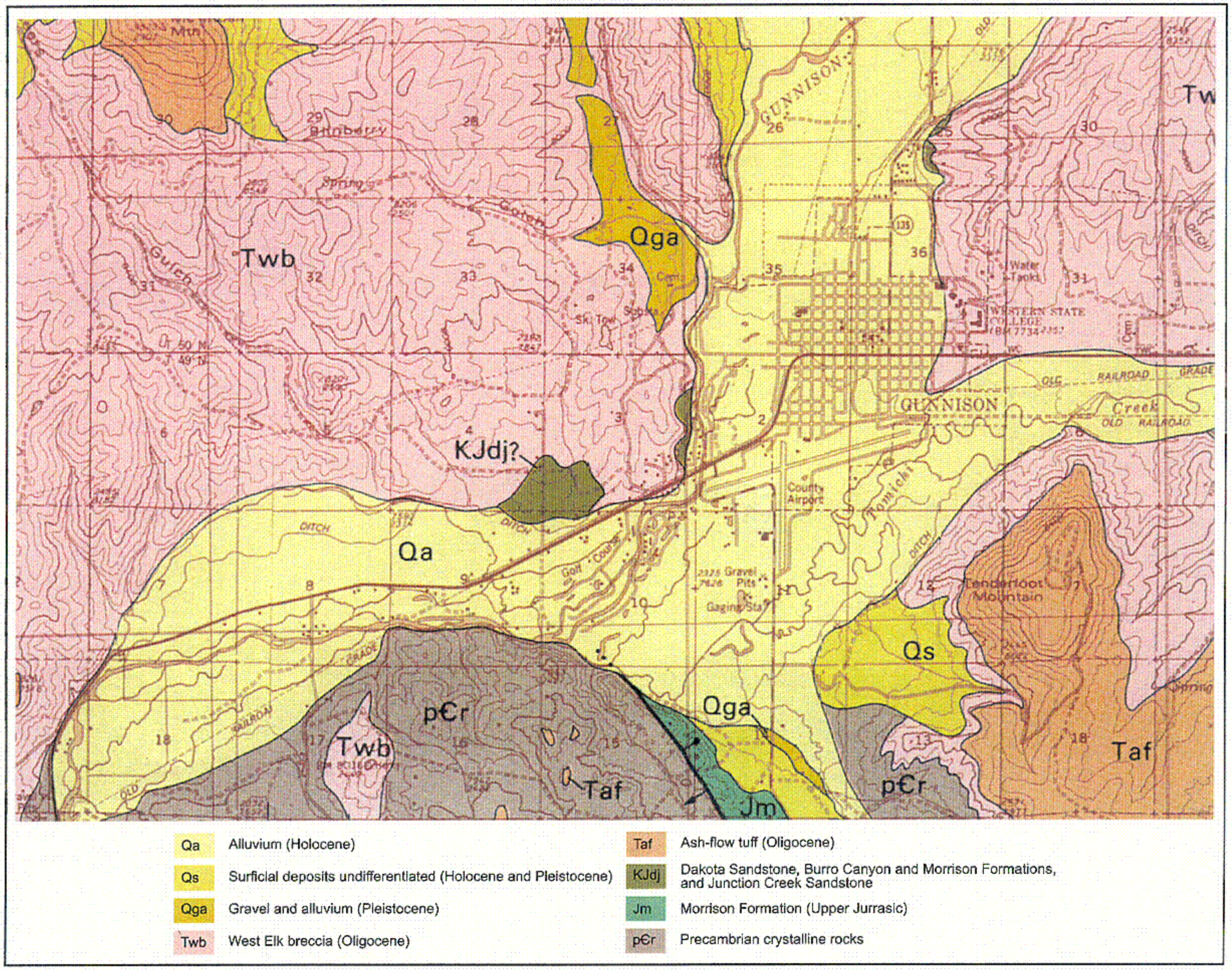


*Figure 5–1. Geologic Map of the Gunnison, Colorado, Area*

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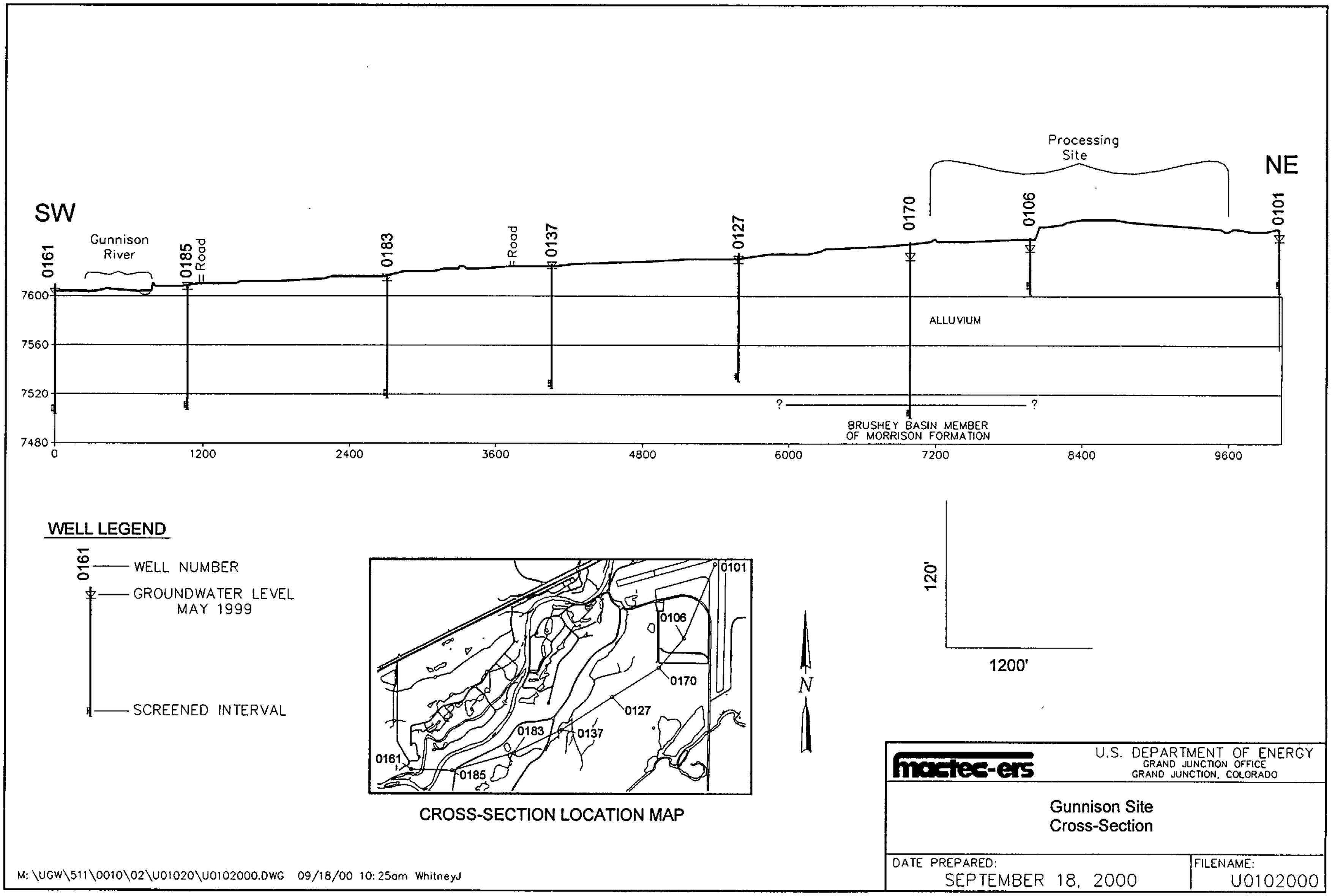


*Figure 5–2. Cross Section of the Gunnison Site, Colorado*

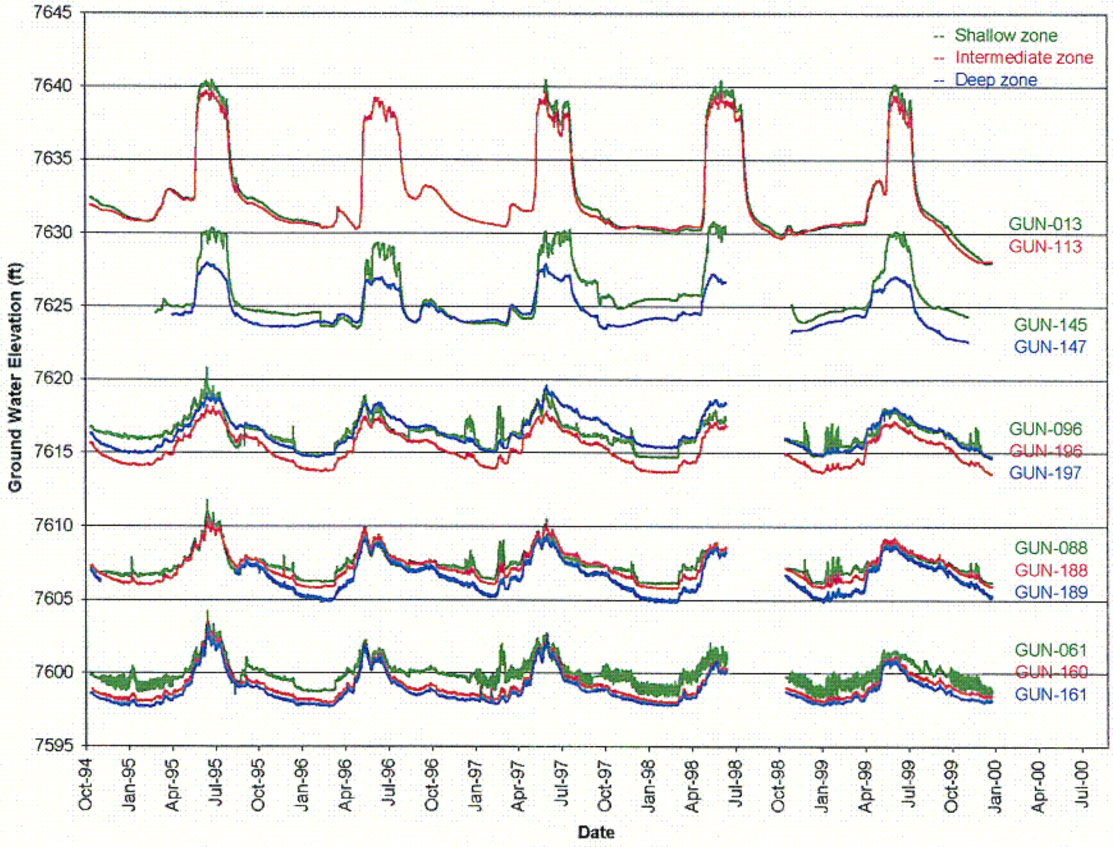


*Figure 5–3. Ground Water Elevations in Different Zones of the Alluvial Aquifer*

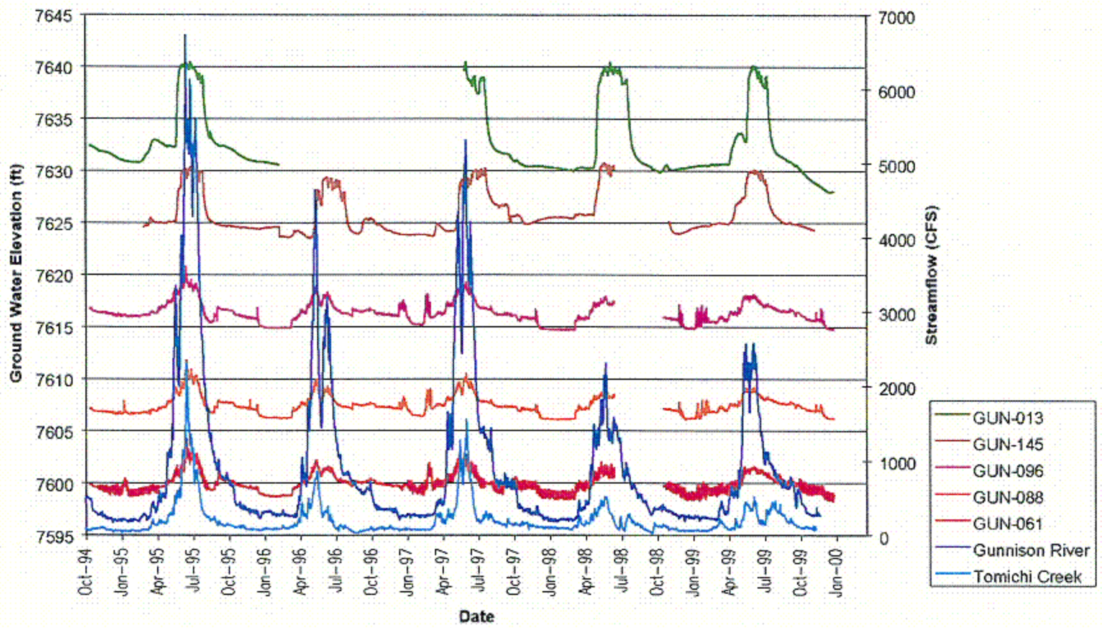


*Figure 5–5. Ground Water Elevations in the Shallow Zone of the Alluvial Aquifer and Streamflow in the Gunnison River and Tomichi Creek*



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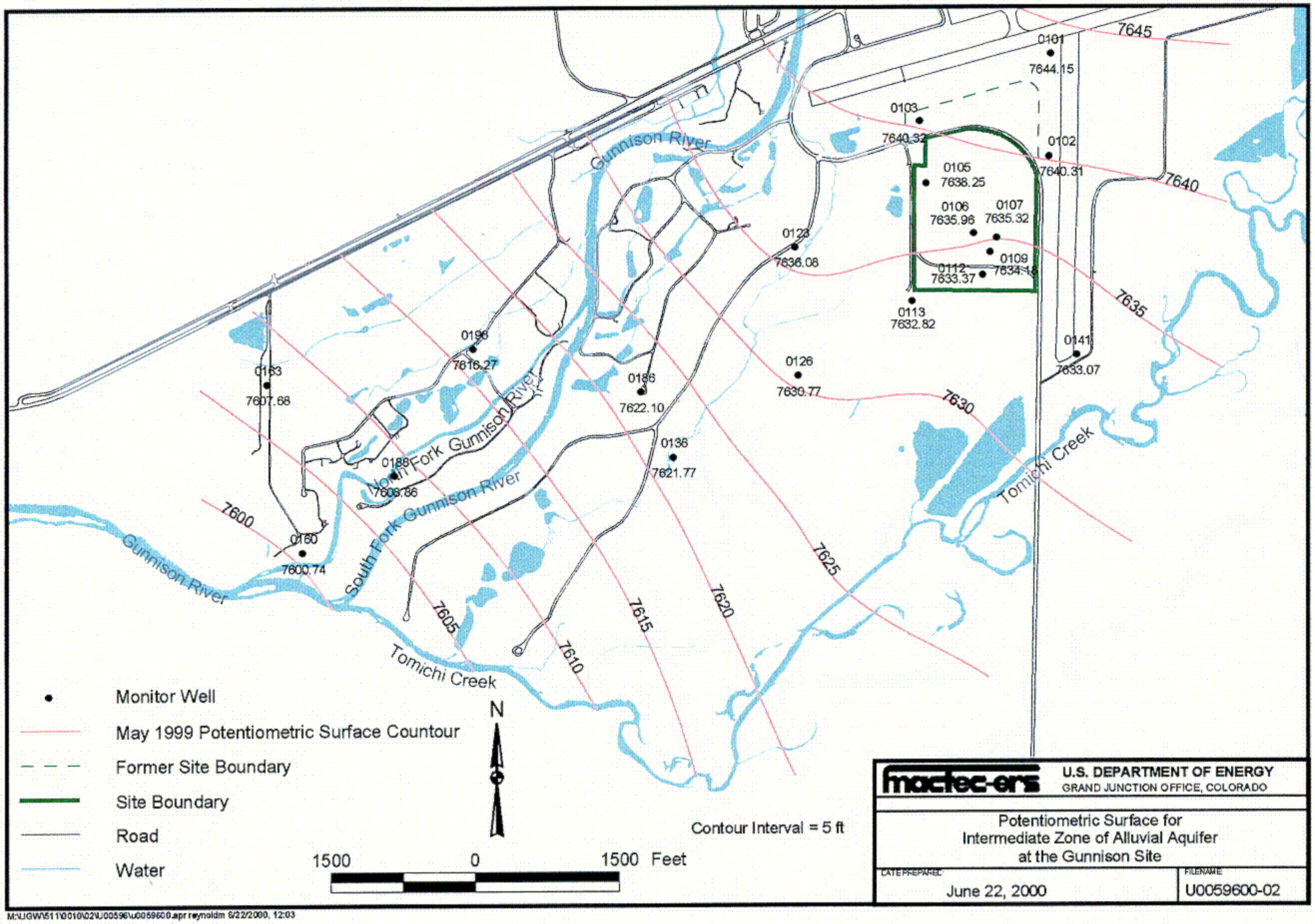


*Figure 5–4. Potentiometric Surface for Intermediate Zone of Alluvial Aquifer at the Gunnison Site*

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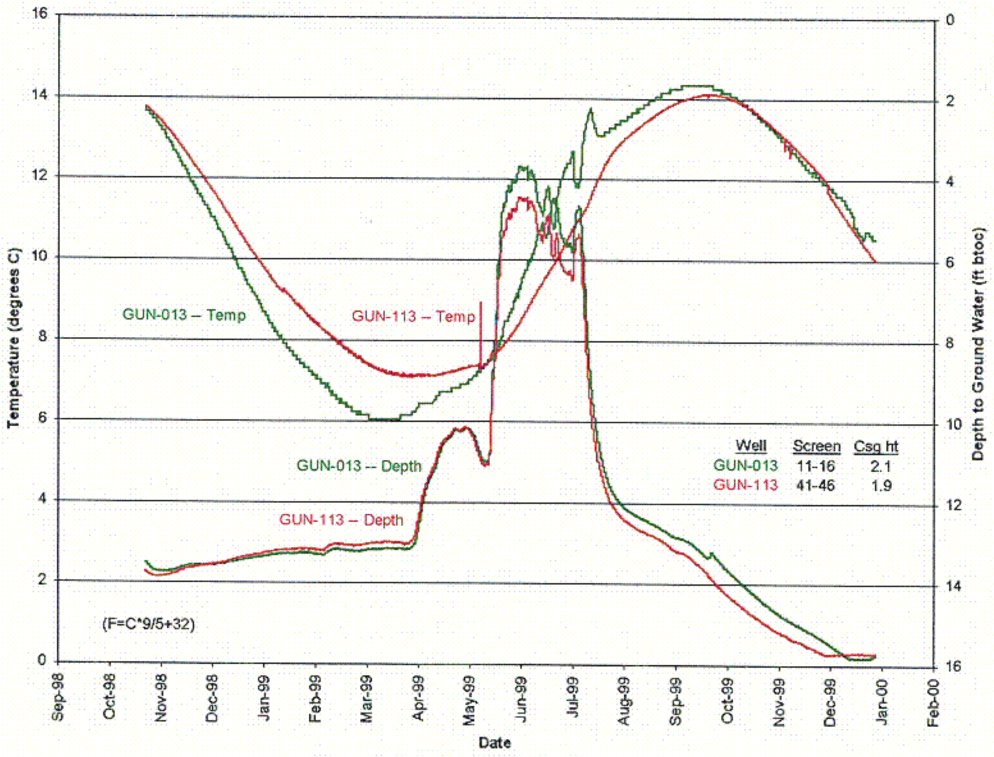


*Figure 5–6. Ground Water Temperature and Depth at the Gunnison Site*

## 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[a] | Sampling Point | | | | | |
|---|---|---|---|---|---|---|
| | 792[b] | 795[b] | 778[c] | 777[c] | 779[f] | 780[e] |
| | 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[f]** | 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. |

[a]Concentrations in mg/L except radium in pCi/L
[b]currently sampled May/Oct 99
[c]last sampled 8/30/89
[d]last sampled 10/9/95
[e]last sampled 5/10/95
[f]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 $CaCO_3$ 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 $CaCO_3$ but can be as high as 1,075 mg/L $CaCO_3$ 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 $CaCO_3$, 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[a] | UMTRA MCL | Background[b] | 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[c] | | 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
[a]Concentrations in mg/L except radium in pCi/L
[b]average from well 001, 101, 002, 102
[c]combined $^{226}Ra$ + $^{228}Ra$

### 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 $Mn^{2+}$ 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 ($SO_4^{2-}$). The precipitation of gypsum ($CaSO_4$) or sodium sulfate ($Na_2SO_4$) 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 $[UO_2(CO_3)_2^{2-}]$ is a dominant mobile species. Uranium adsorbs to ferric oxyhydroxide and clay minerals in soils and rocks. Under reducing conditions, uranium precipitates as uraninite ($UO_2$), 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 maganese concentrations for the last 15 years. This suggests that there might be another

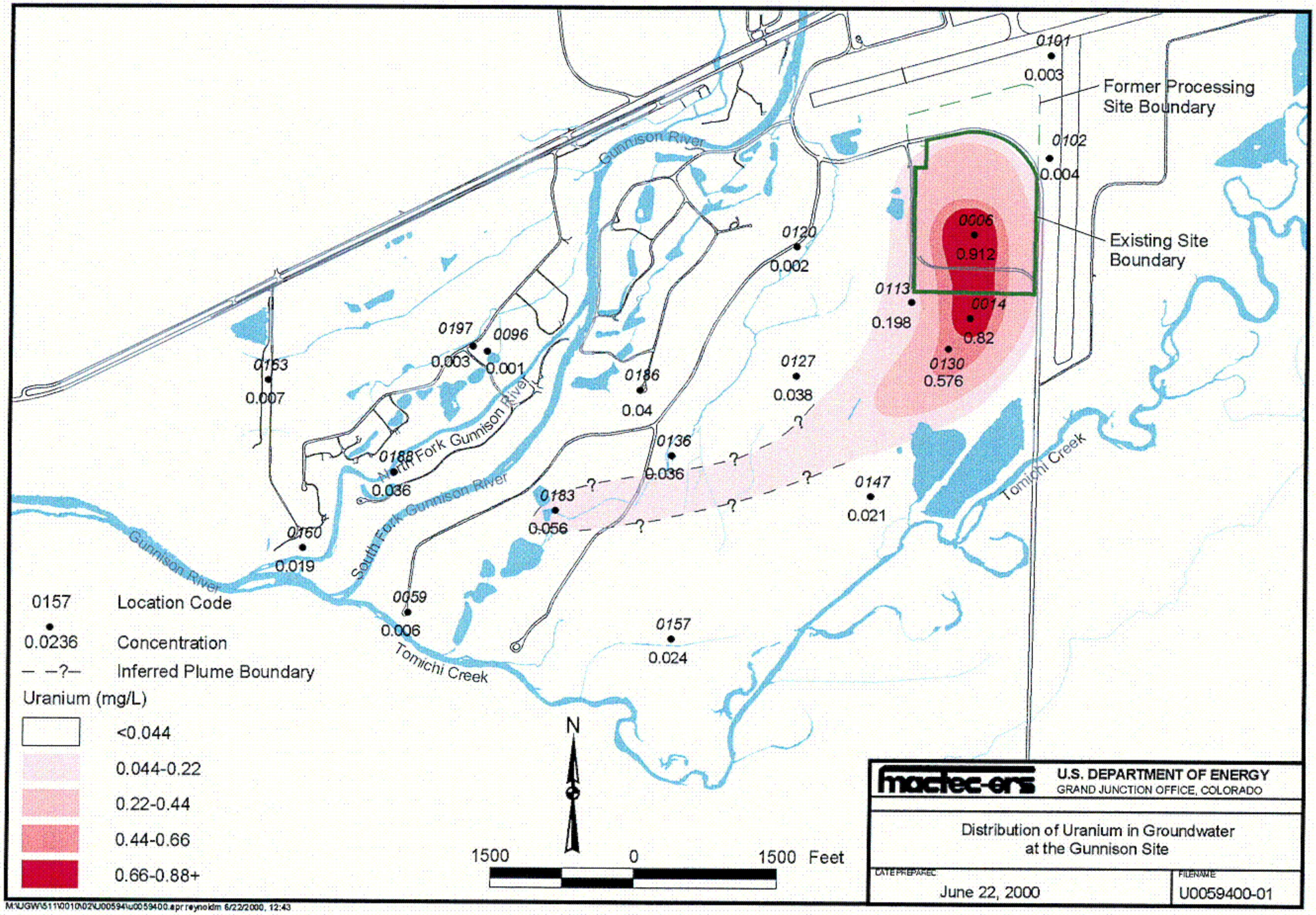


*Figure 5–7. Distribution of Uranium in Ground Water at the Gunnison Site*

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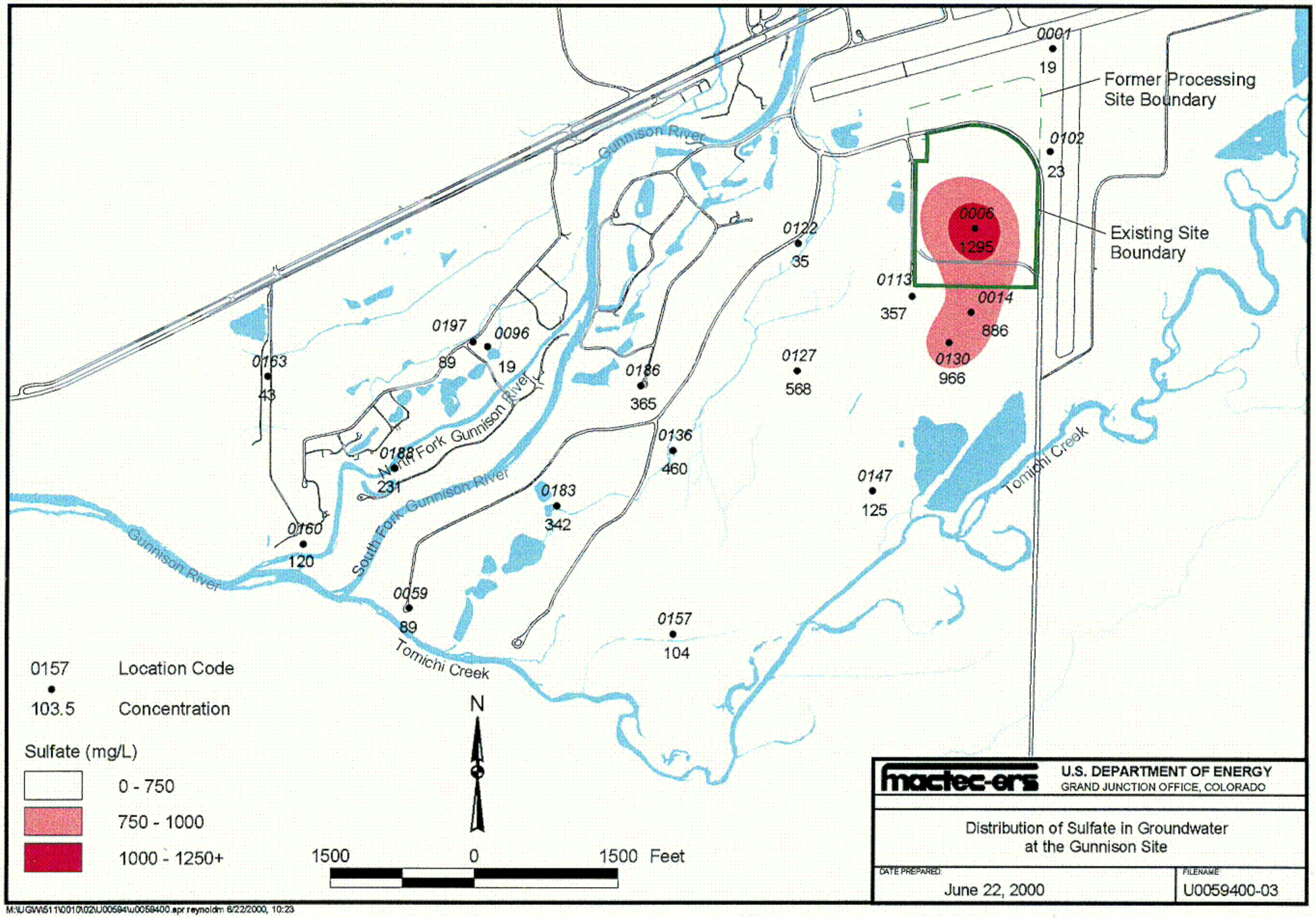


*Figure 5–8. Distribution of Sulfate in Ground Water at the Gunnison Site*

C11

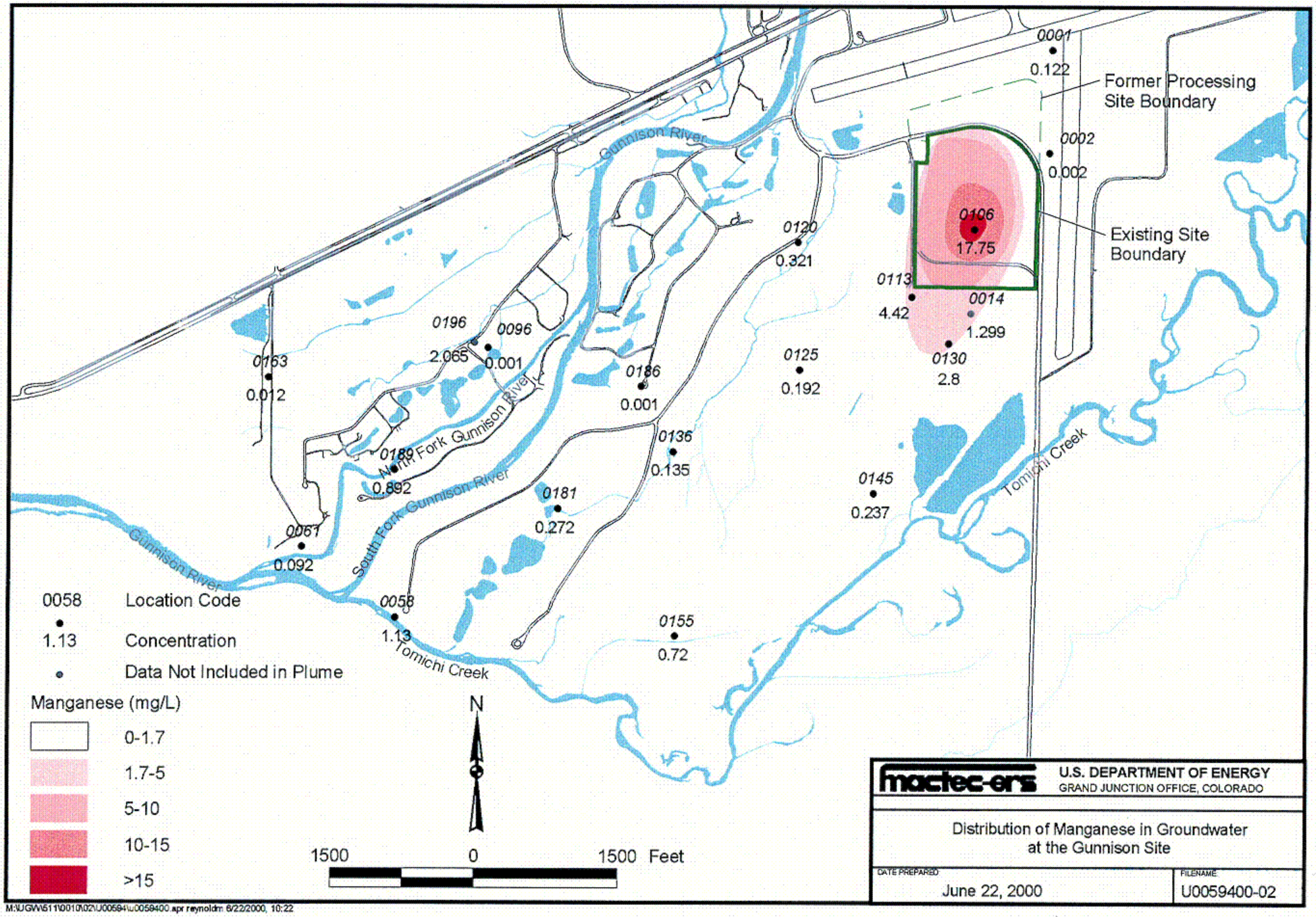


*Figure 5–9. Distribution of Manganese in Ground Water at the Gunnison Site*

C12

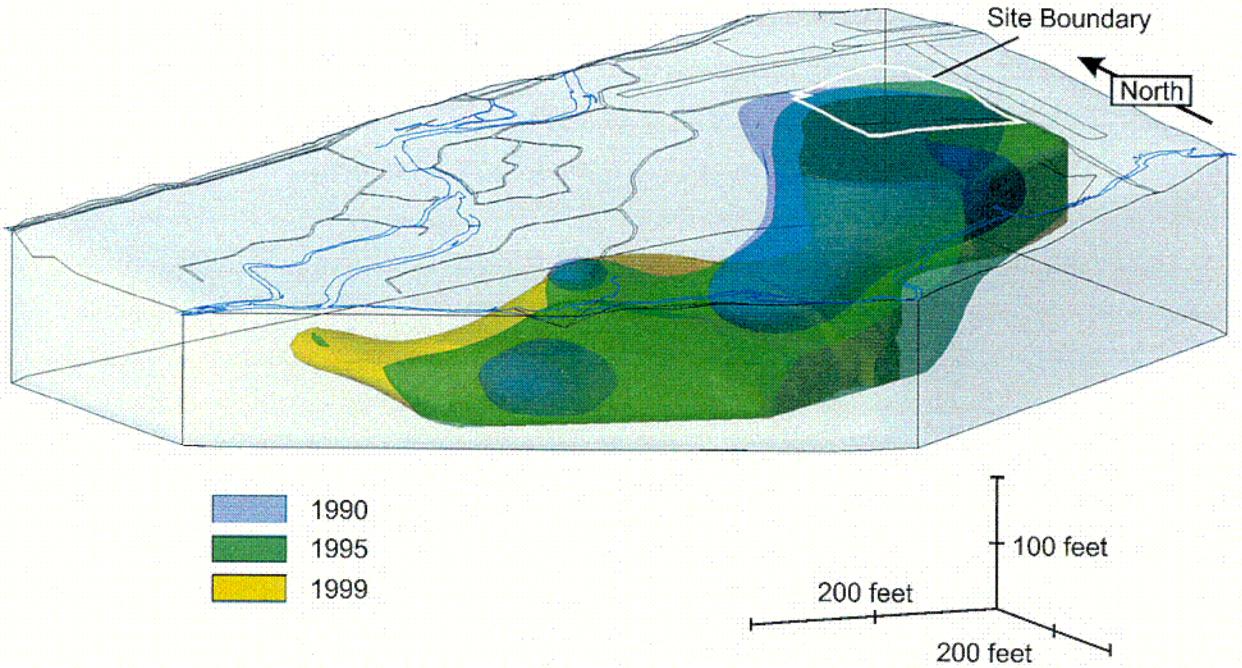


*Figure 5–10. Migration of Uranium Plume in the Subsurface Over Time*

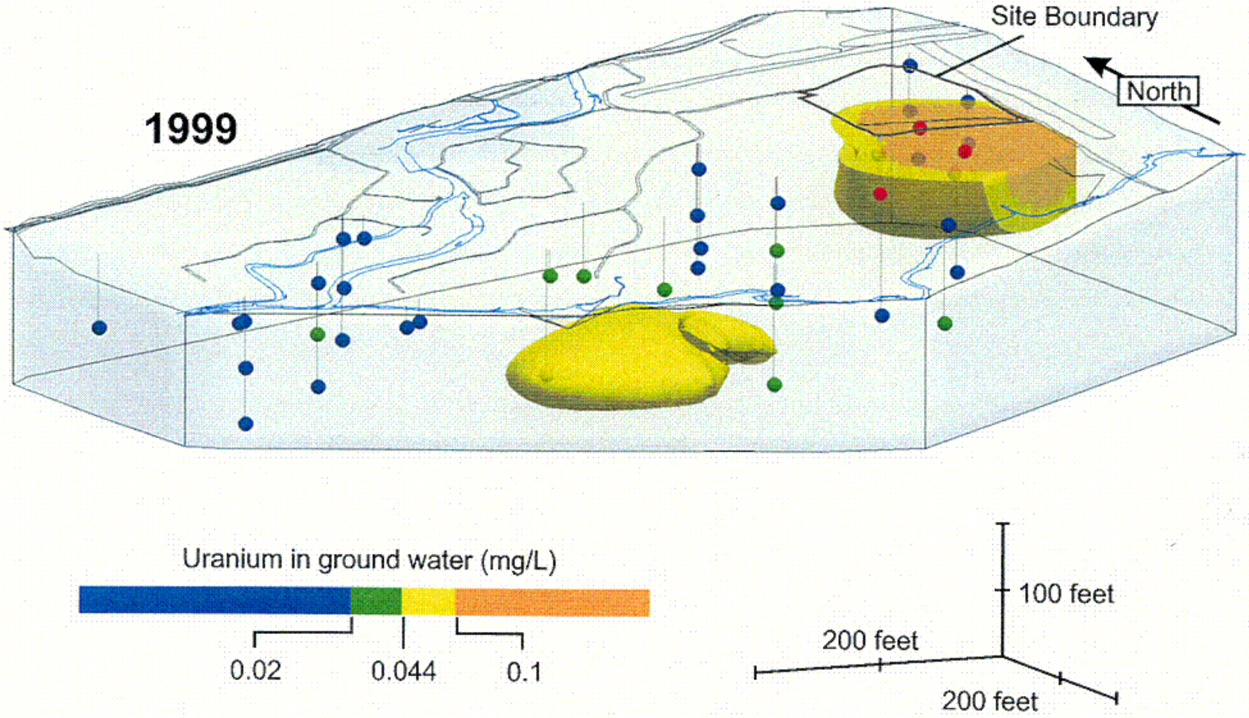


*Figure 5–11. Uranium Concentrations >0.044 mg/L in Ground Water in 1999*

C13

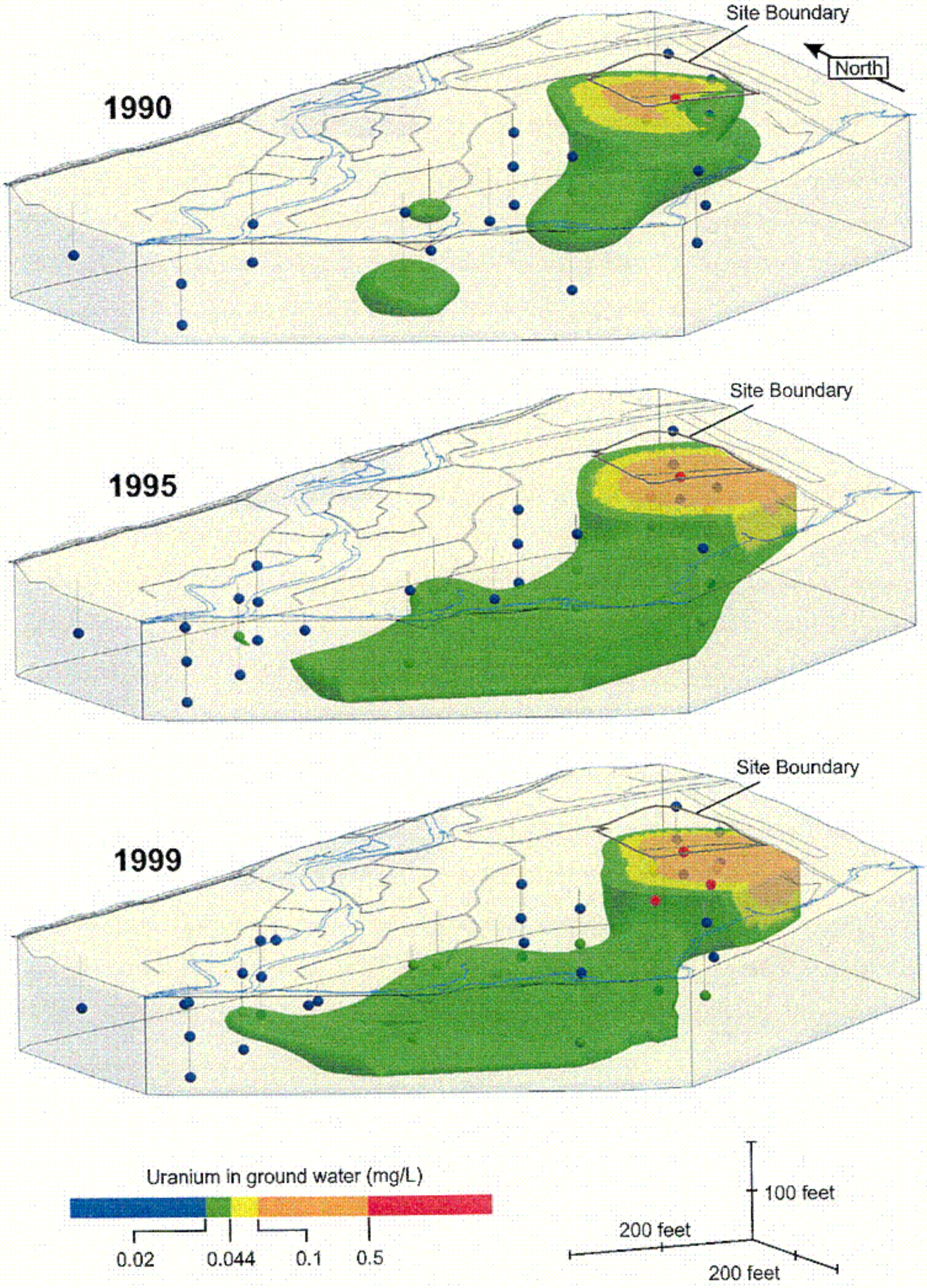


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*Figure 5–12. Extent of Uranium Concentrations >0.02 mg/L in Ground Water in 1990, 1995, and 1999*

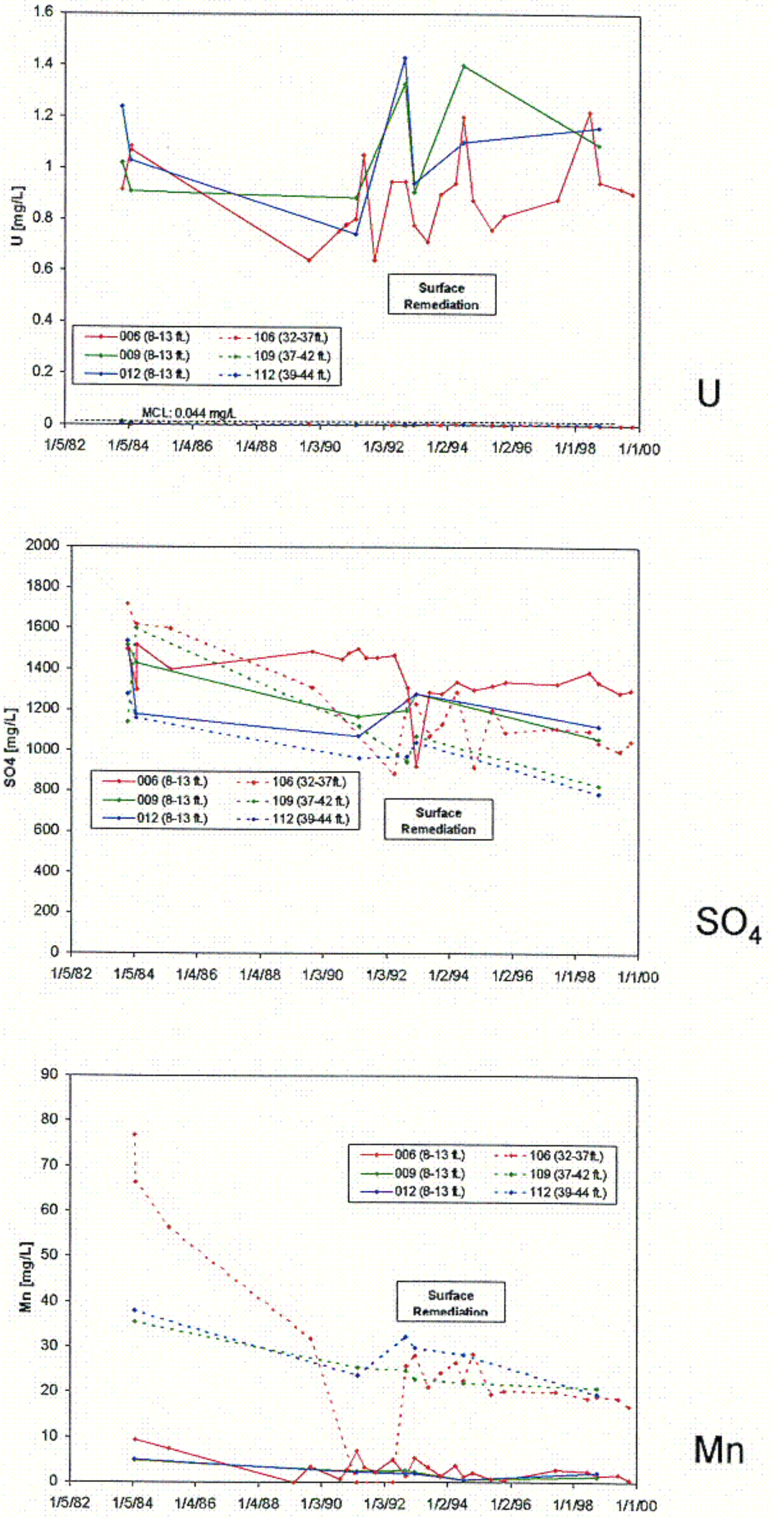


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*Figure 5–13. Ground Water Concentrations Over Time at the Millsite*

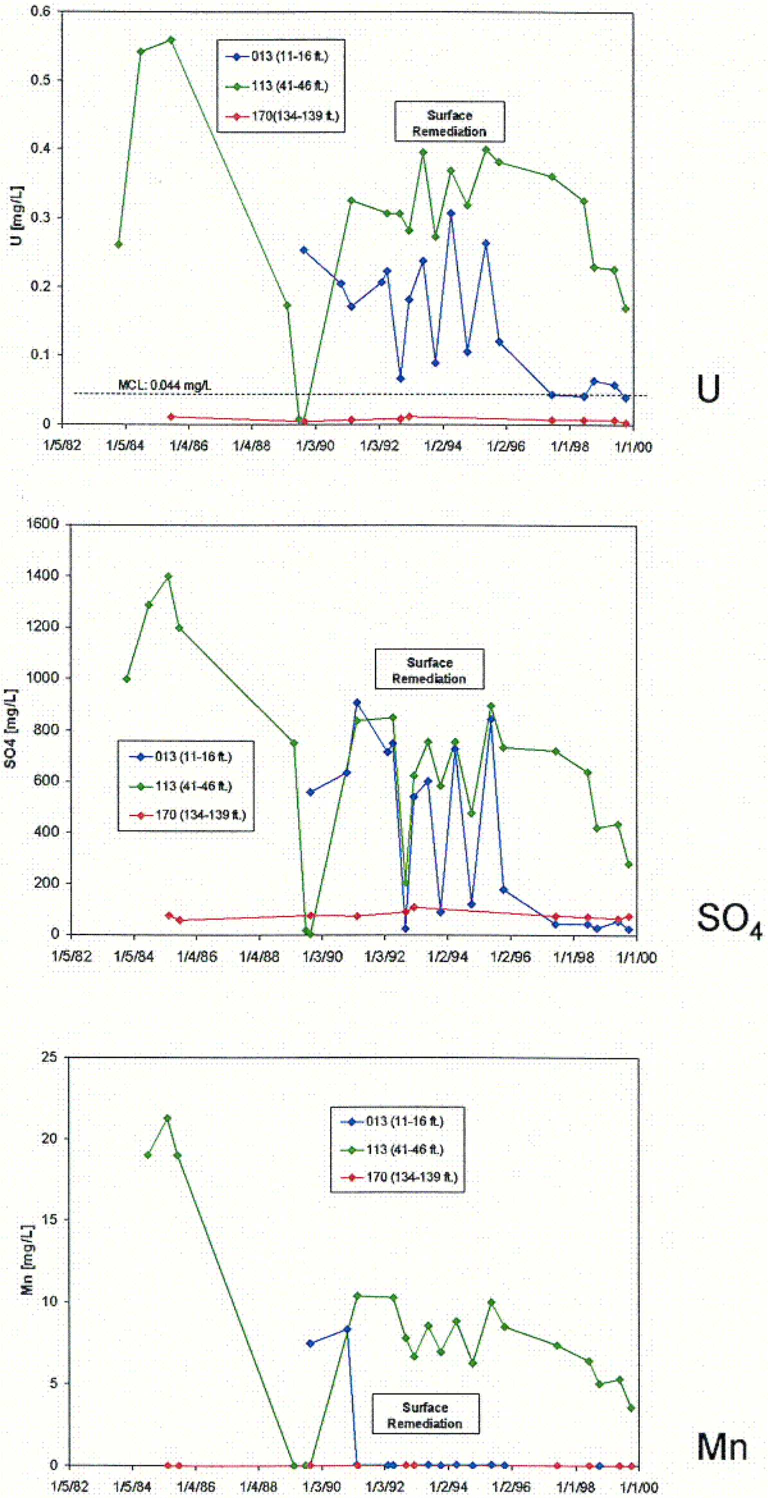


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*Figure 5–14. Ground Water Concentrations Over Time at Well Cluster 013, 113, and 170*

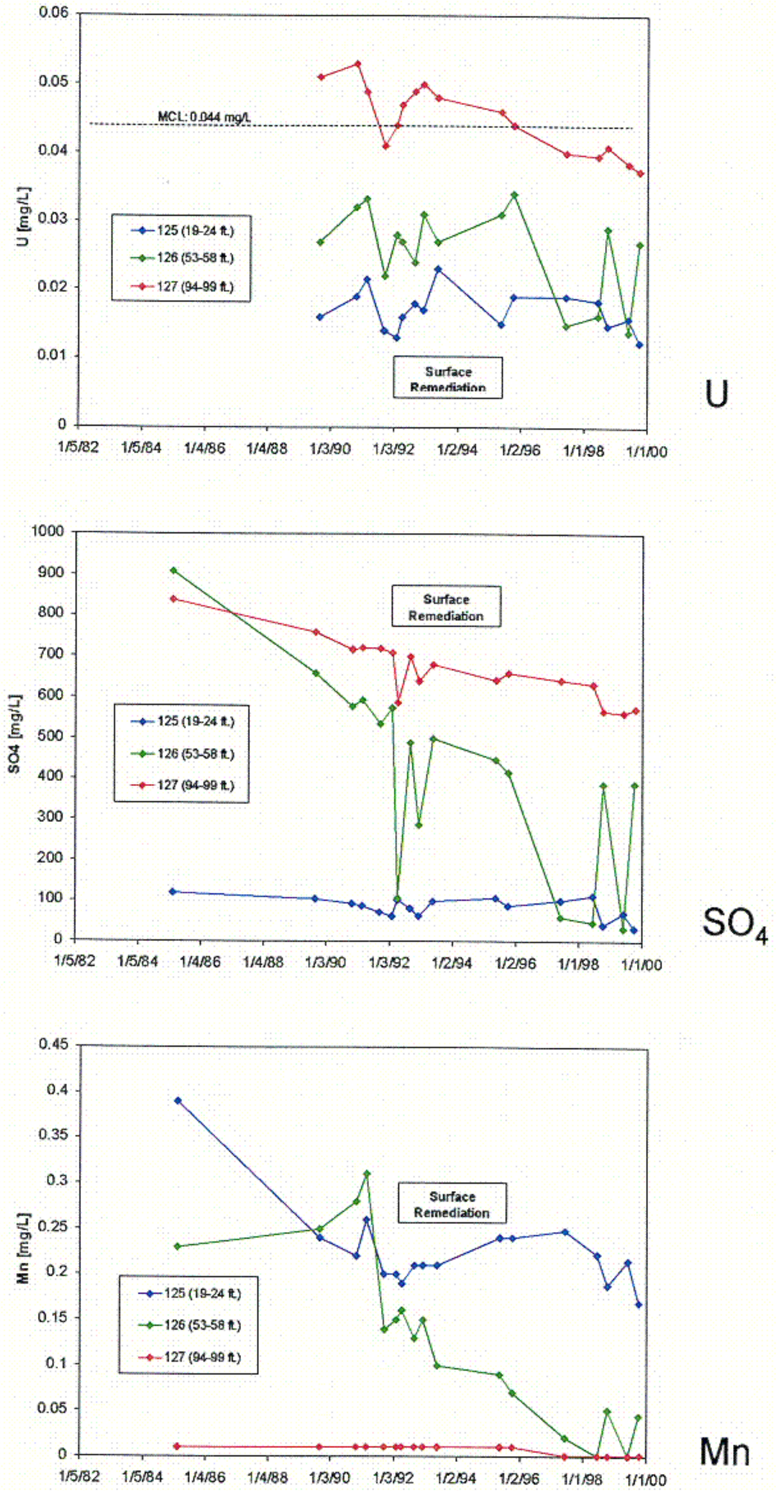


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*Figure 5–15. Ground Water Concentrations Over Time at Well Cluster 125, 126, and 127*

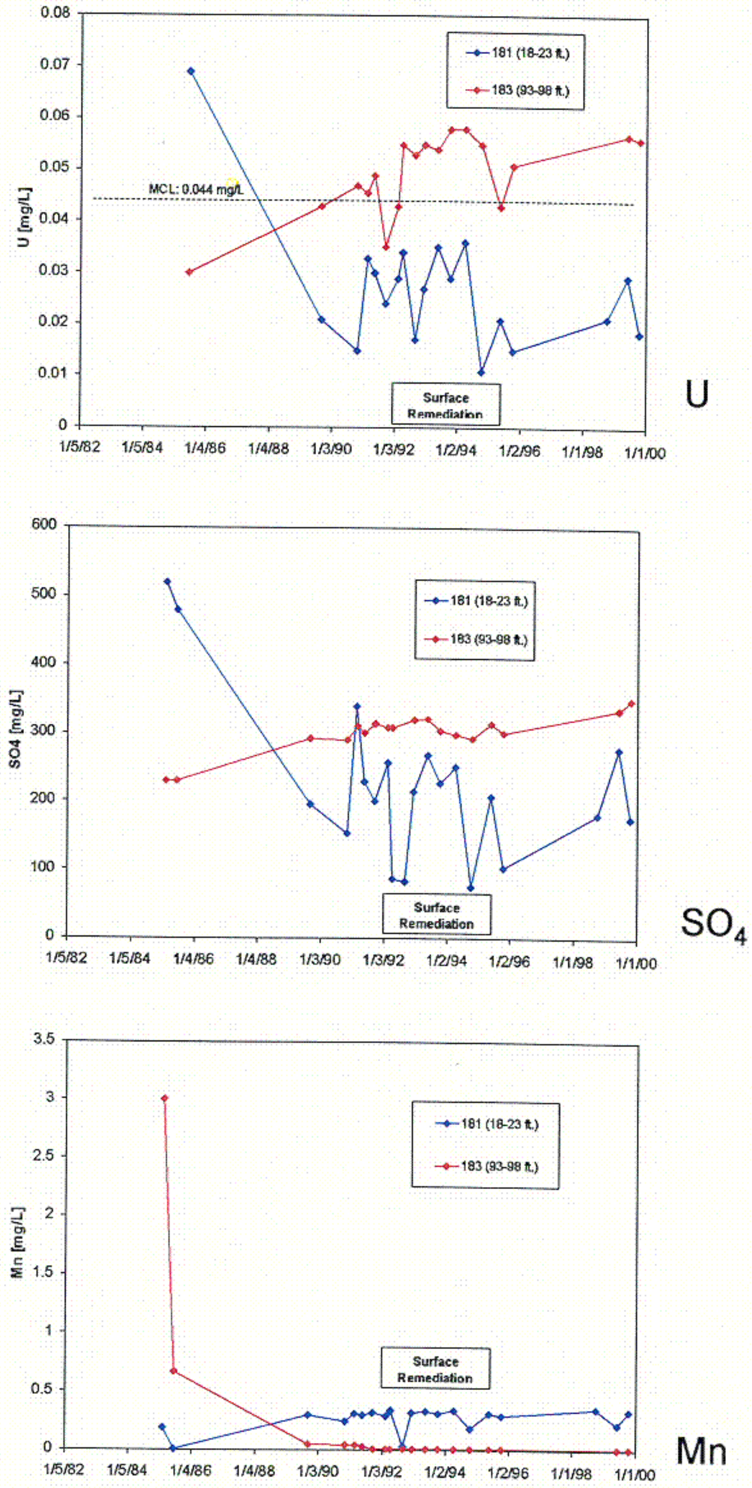


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*Figure 5–16. Ground Water Concentrations Over Time at Well Cluster 181, 183*

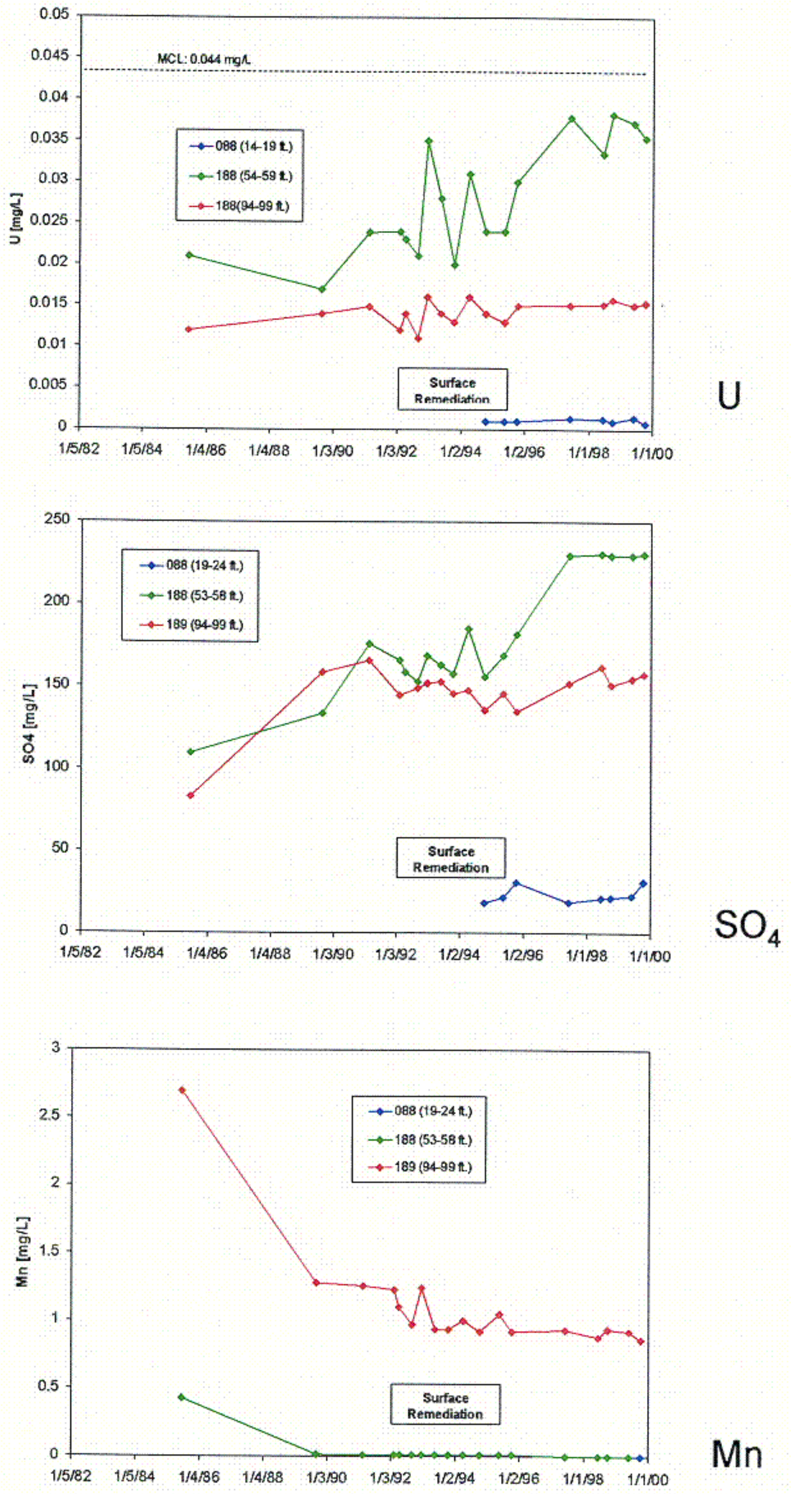


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*Figure 5–17. Ground Water Concentrations Over Time at Well Cluster 088, 188, and 189*

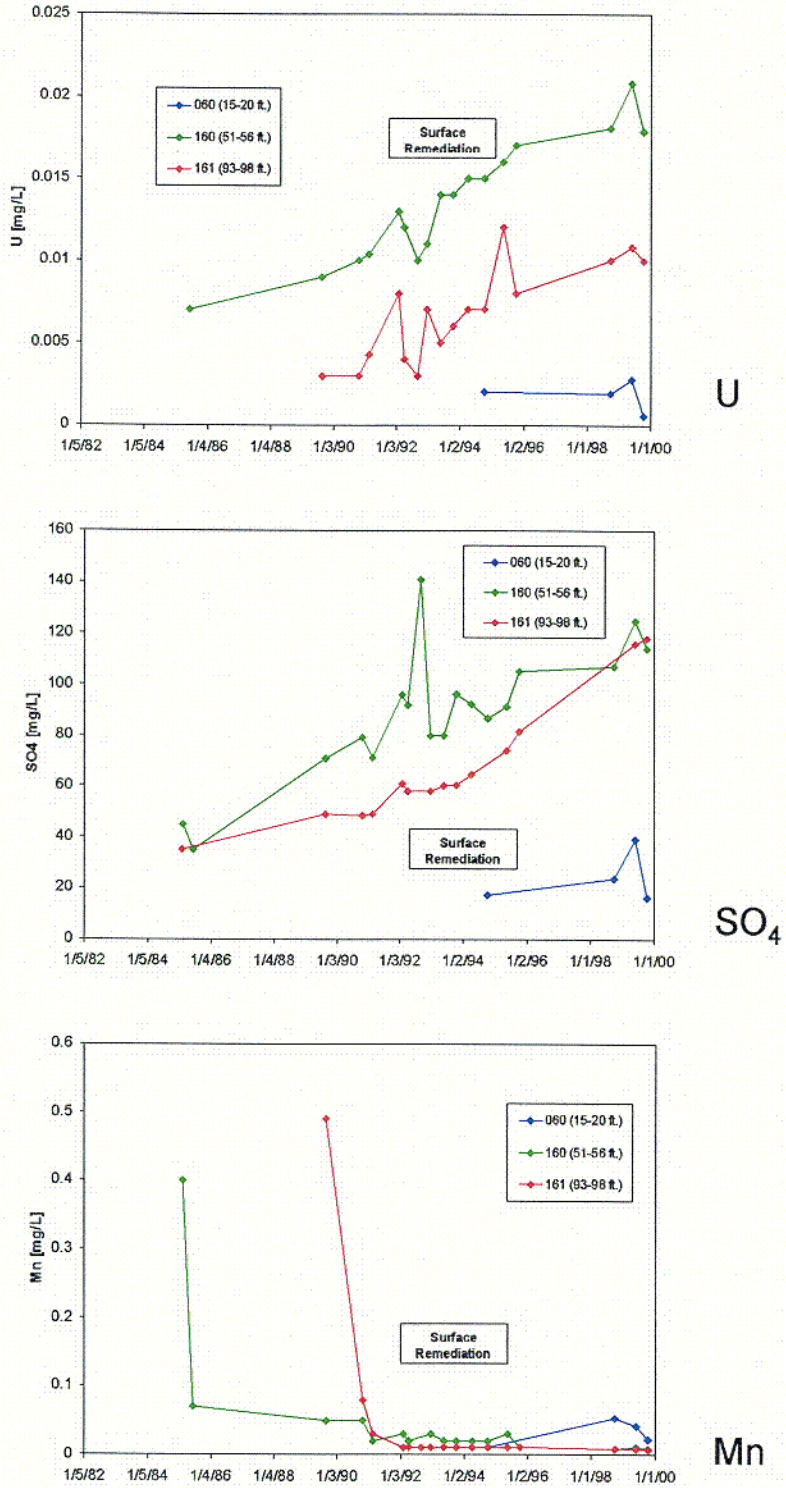


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*Figure 5–18. Ground Water Concentrations Over Time at Well Cluster 060, 160, and 161*

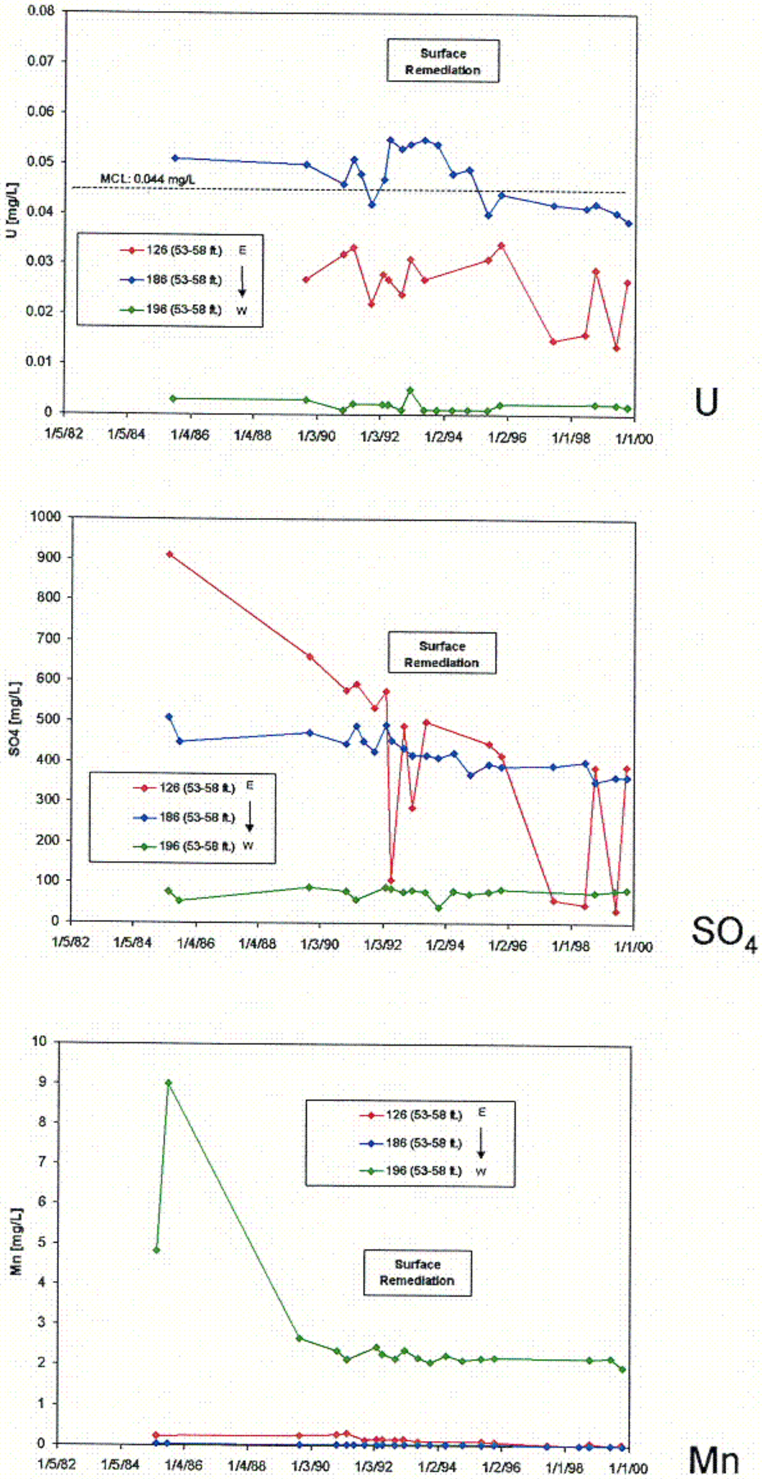


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*Figure 5–19. Ground Water Concentrations Over Time at Well Cluster 126, 186, and 196*

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 *Kd* 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 *Kd* 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 *(Kd)* was identified as the most sensitive input parameter. Dewatering activites 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.

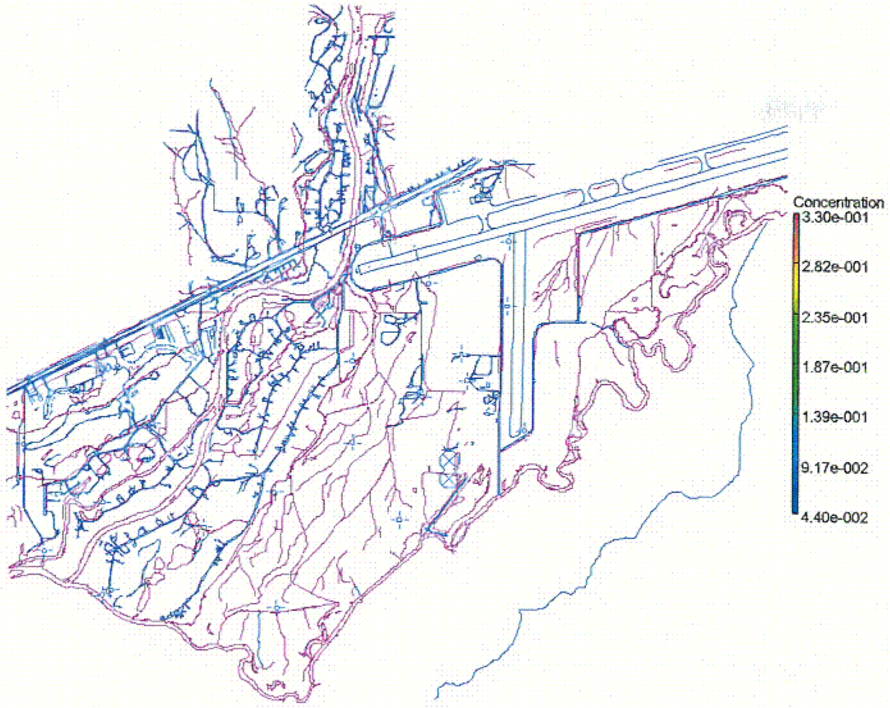


*Figure 5–20. Predicted Steady State Uranium Concentration at 100 Years*

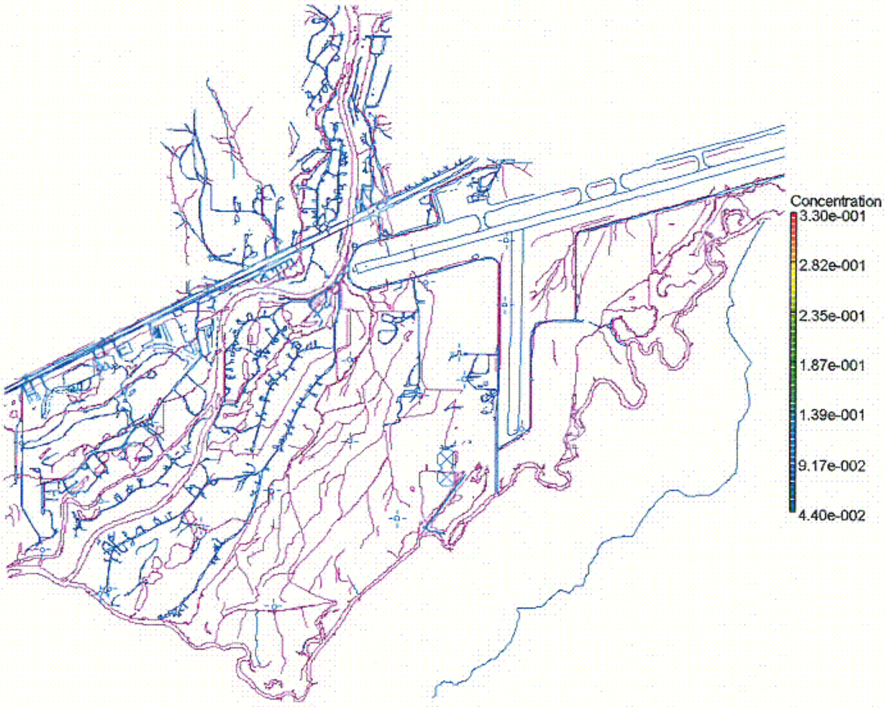


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*Figure 5–21. Predicted Stochastic Uranium Concentration at 100 Years (100 simulations)*

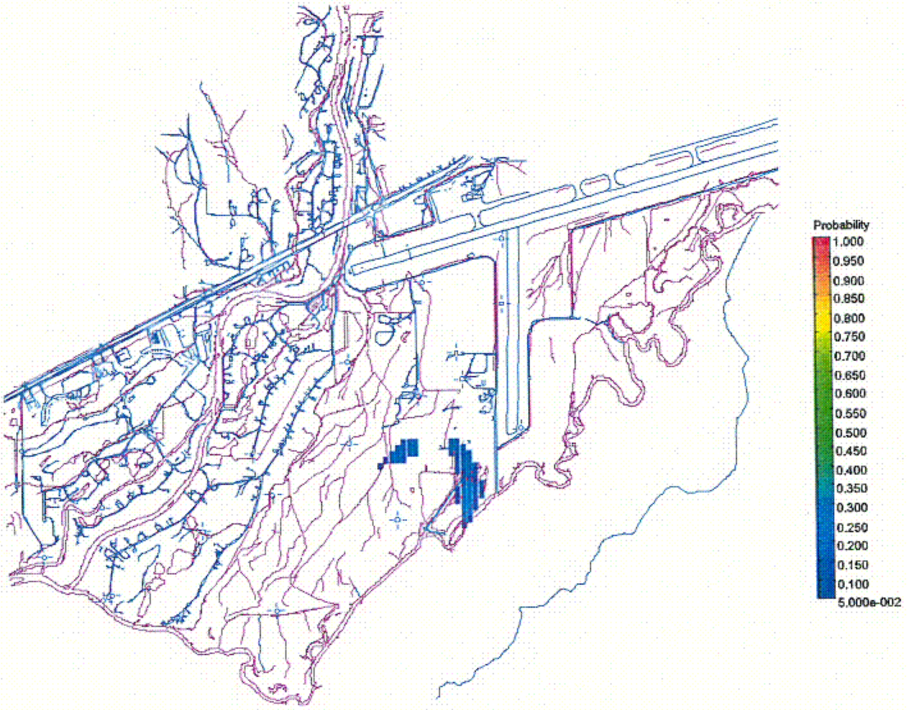


*Figure 5–22. Probability of Uranium Concntration Exceeding the UMTRA 0.044 Standard at 100 Years (100 simulations)*

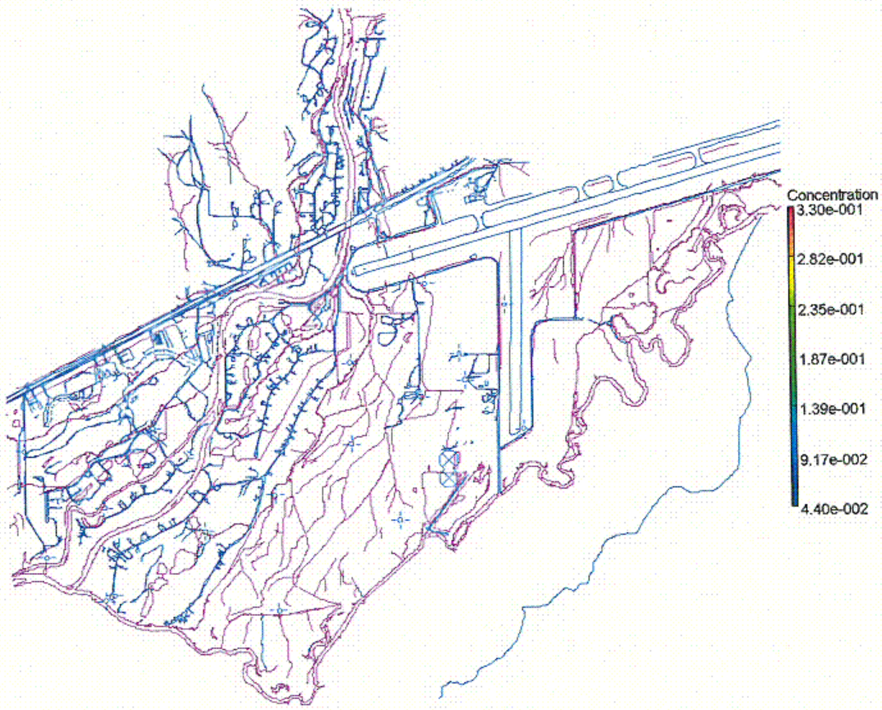


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*Figure 5–23. Predicted Transient Uranium Concentration at 100 Years*

# 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[a] |
|---|---|---|---|---|---|---|---|
| Iron | | | | | | 11N | |
| Background | 2/16 | 0.004 | 0.869 | n/a | | | 0% |
| Current Plume | 18/30 | 0.003 | 4.73 | 0.581 | | | 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, SO4, U (1989-93 data); 106, 109, 110-112 for Mn (1989-93 data)

[a]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 $UCL_{95}$ (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 $UCL_{95}$ 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)*

| **Noncarcinogens – Ground Water Ingestion Only (adults)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Contaminant** | | **CW** | **IR** | **EF** | **ED** | **BW** | **AT** | **Intake** | **RfD[b]** | **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 |
| **Carcinogens – Ground Water Ingestion Only (Adults)** | | | | | | | | | | |
| **Contaminant** | | **CW** | **IR** | **EF** | **ED** | **BW** | **AT** | **Intake** | **SF[b]** | **Risk** |
| U234+238[c] | 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 |

[a]All exposure factors are from EPA 1989b
[b]Data are mainly from EPA's Integrated Risk Information System (IRIS); other values are from EPA Region III Risk-Based Concentration Table
[c]assumes 1 mg U = 686 pCi of U234 + U238; SF used is average of U234 and U238

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

where[a]:

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**[b] | **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**[b] | **Risk** |
| | | | | | | | | | | | |
| U234+238[c] | 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 |

[a]All exposure factors are from EPA 1989b
[b]Data are from EPA's Integrated Risk Information System (IRIS); other values are from EPA Region III Risk-Based Concentration Table
[c]assumes 1 mg U = 686 pCi of U234 + U238; SF used is average of U234 and U238

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

where[a]:

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[a] mg/L | Sa $cm^2$ | Pc cm/h | Cf $L/cm^3$ | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Noncarcingenic** | | | | | | | | | | | | |
| 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 |
| **Carcinogenic** | | | | | | | | | | | **Slope Factor** | **Risk** |
| Uranium (pCi/L) | 836.92 | 312 | 0.001 | 0.001 | 8 | 250 | 30 | na | na | 15667.14 | 4.36E-11 | 6.83E-07 |

[a]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**

| Source → | Release → | Contaminated Media → | Pathway → | Receptor → | Effect |
|---|---|---|---|---|---|
| Mill tailings and RRM | Into soil and ground water | Ground water, surface water and sediments | Ingestion or absorption | Plants and wildlife | No effect, mortality, or non-lethal effects |

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 (*Kd*) (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 Backgound 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.

## GUNNISON ECOLOGICAL RISK ASSESSMENT MODEL

### PROBLEM FORMULATION

**BLRA**

Evaluate historical data
Conduct contaminant of potential concern (COPC) screening
Preliminary identification of potential exposure pathways and food webs
Preliminary selection of receptors
Develop initial site conceptual model
Conduct screening-level risk assessment

**CHARACTERIZATION ACTIVITIES WORK PLAN**

Develop work plan scope and objectives
—Develop management goals, assessment endpoints, and measures
—Develop data quality objectives (DQOs) for the field sampling
—Develop field sampling and analysis strategy
- Evaluate selected reference areas
- Evaluate selected sampling locations

Refine food web, site conceptual model, and ecological receptors
Evaluate historical aquatic and terrestrial field sampling and analysis

↑↓

### ANALYSIS

Characterization of Exposure & Ecological Effects

Statistically evaluate sample data among locations and reference areas for significant differences.
Compare maximum site COPC concentrations against ecological screening criteria.

If deemed necessary following evaluation of ecological data :
Prepare exposure profiles
Prepare toxicity assessment
Prepare ecological response analysis
Develop exposure and ecological effects analysis

↓ See note below

### RISK CHARACTERIZATION

Risk Estimation
—Calculate hazard quotients (HQs) and hazard indices (HIs)
—Evaluate lines of evidence
Risk Description
—Ecological risk summary
—Interpretation of ecological significance
Uncertainty Analysis

Note: If data evaluation indicates no significant differences between Gunnison sampling locations and reference areas, or unacceptable ecological risk appears unlikely based on screening criteria, quantitative risk assessment calculations will not be performed.

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*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[a] | NA |
| Uranium | | | | | | X | Tomichi Creek |

[a]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)

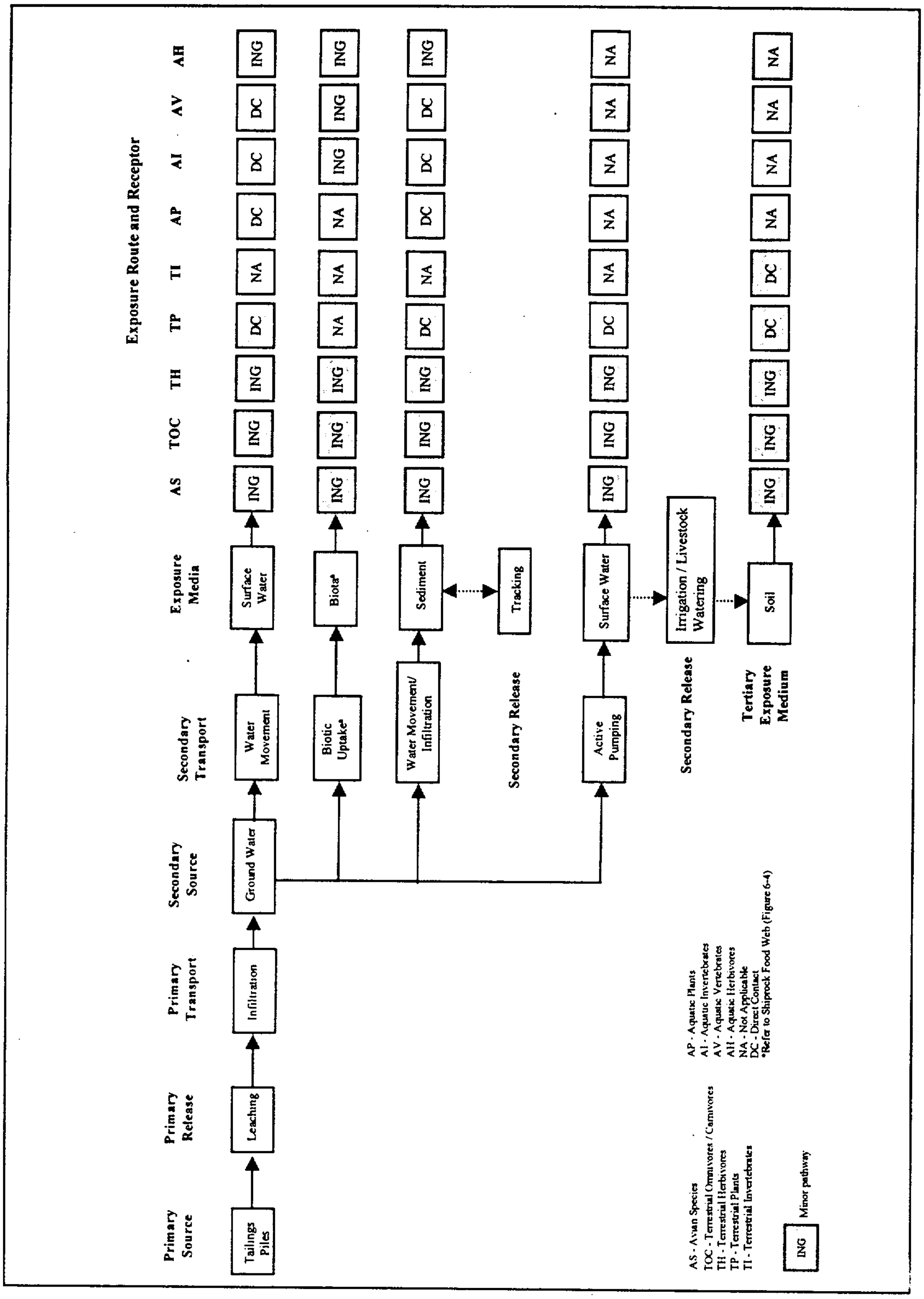


Figure 6–2. Gunnison Site Conceptual Model

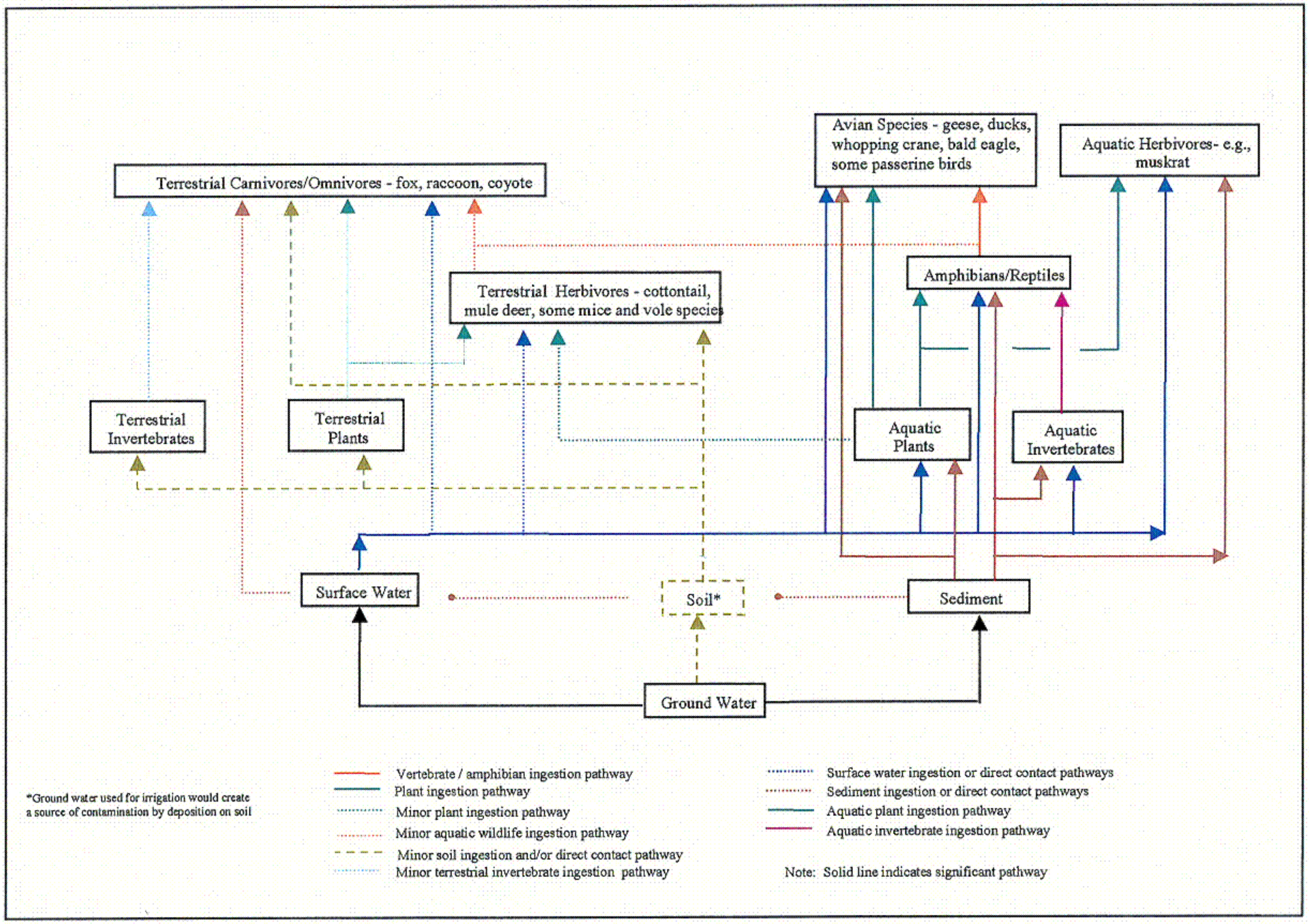


*Figure 6–3. Generalized Food Web for Gunnison Ecological Receptors*

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Because the contaminants associated with the Gunnsion site are inorganics, dermal absorption pathways have not been included in this screening assessment. Dust inhalation is also excluded from this 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

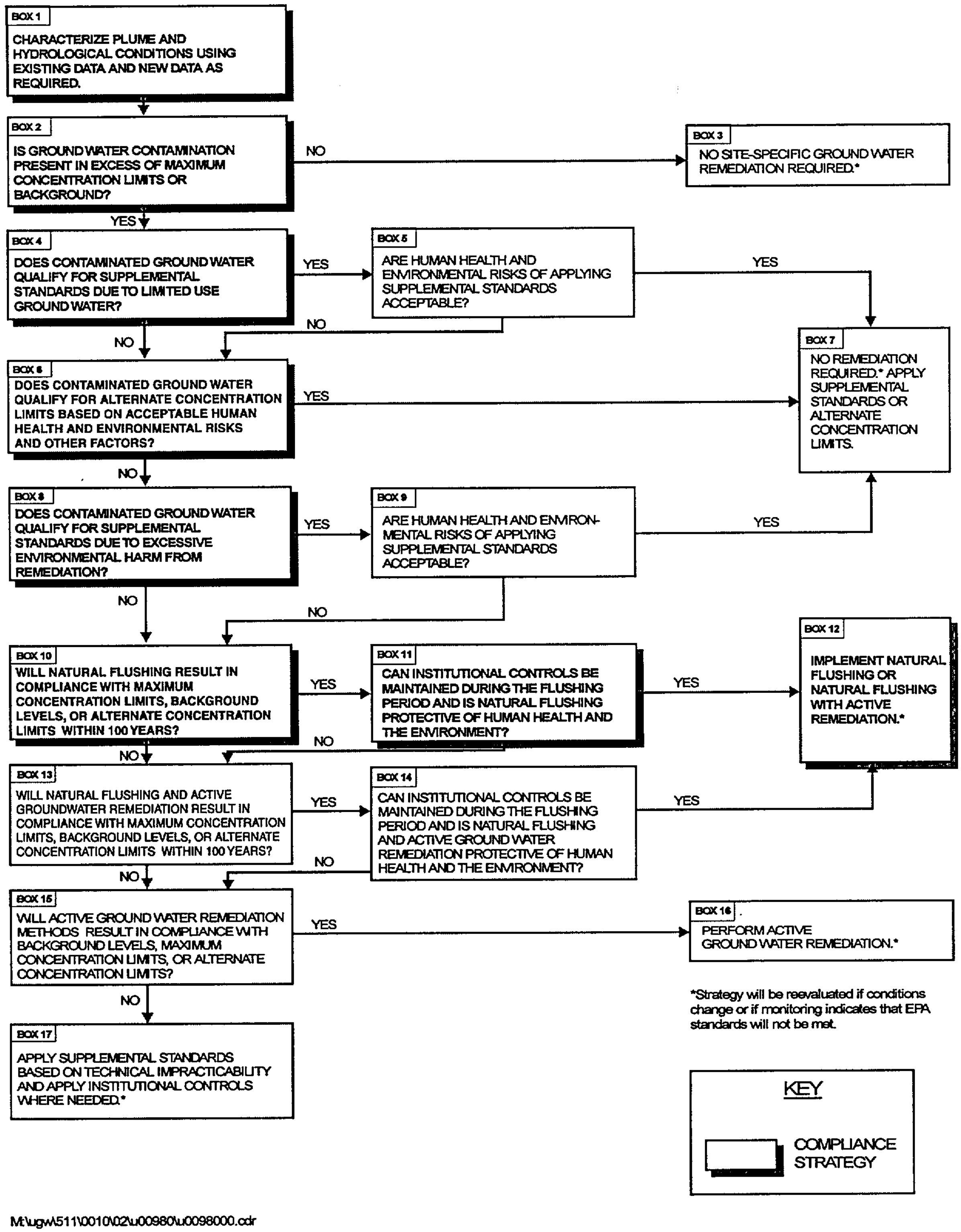


*Figure 7–1. Compliance Strategy*

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.

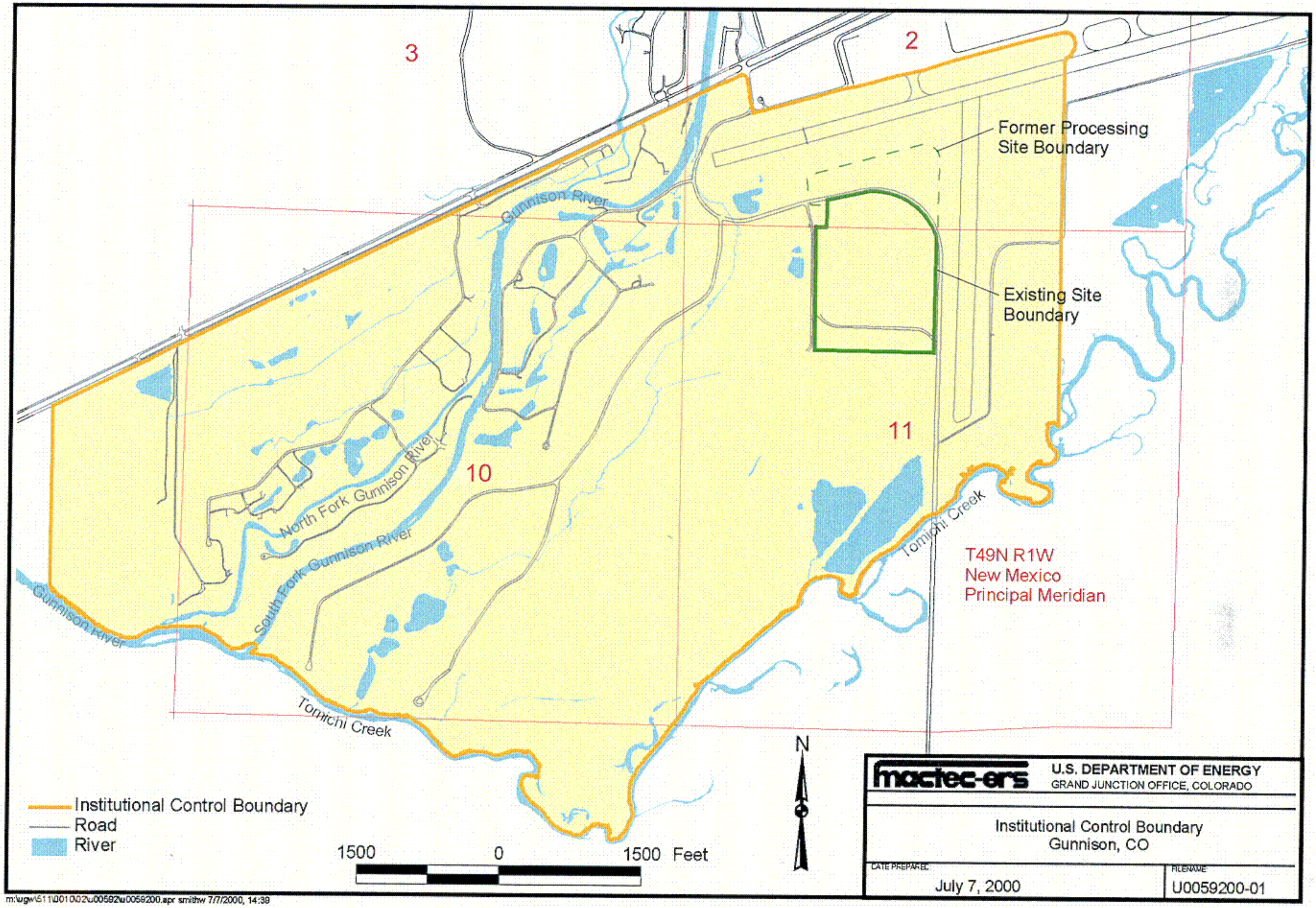


*Figure 7–2. Institutional Control Boundary, Gunnison, Colorado*

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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) |
|---|---|---|---|---|
| **Ground Water** | | | | |
| 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 |
| **Surface Water** | | | | |
| GUN–777 | | | Tomichi Creek | Background |
| GUN–780 | | | Valco, Inc. gravel pit | Above MCL |
| GUN–792 | | | Gunnison River | Background |
| GUN–795 | | | Gunnison River | Background |

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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 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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)

| 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 | $NO_3$ mg/L | Na mg/L | Po-210 pCi/L | Ra-226 pCi/L | Ra-228 pCi/L | $SO_4$ 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 |

| 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 |

| Site Code | Location Code | Date Sampled | Mn mg/L | $NO_3$ mg/L | Na mg/L | Po-210 pCi/L | Ra-226 pCi/L | Ra-228 pCi/L | $SO_4$ 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 |

| 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 |

| Site Code | Location Code | Date Sampled | Mn mg/L | $NO_3$ mg/L | Na mg/L | Po-210 pCi/L | Ra-226 pCi/L | Ra-228 pCi/L | $SO_4$ 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 |

| 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 | $NO_3$ mg/L | Na mg/L | Po-210 pCi/L | Ra-226 pCi/L | Ra-228 pCi/L | $SO_4$ 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 |

| 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 |

| Site Code | Location Code | Date Sampled | Mn mg/L | $NO_3$ mg/L | Na mg/L | Po-210 pCi/L | Ra-226 pCi/L | Ra-228 pCi/L | $SO_4$ 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 |

| 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 |

| Site Code | Location Code | Date Sampled | Mn mg/L | $NO_3$ mg/L | Na mg/L | Po-210 pCi/L | Ra-226 pCi/L | Ra-228 pCi/L | $SO_4$ 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 |

| 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 |

| Site Code | Location Code | Date Sampled | Mn mg/L | $NO_3$ mg/L | Na mg/L | Po-210 pCi/L | Ra-226 pCi/L | Ra-228 pCi/L | $SO_4$ 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 |

| 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 |
| **GUN01** | **0188** | 06/03/1997 | 220 | 903 | 23 | 607 | 7.00 | 133 | <0.001 | 11.3 | 0.0072 | 2.75 | 29 |
| | | 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 |
| **GUN01** | **0189** | 06/05/1997 | 881 | 224 | -5 | 1400 | 6.19 | 240 | <0.001 | 93.3 | 6.16 | 35.9 | 29.4 |
| | | 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 |
| **GUN01** | **0196** | 10/01/1998 | 1079 | 1997 | 58 | 1280 | 6.01 | 339 | <0.001 | 7.35 | 8.82 | 34 | 29.5 |
| | | 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 |
| **GUN01** | **0197** | 10/01/1998 | 1020 | 1926 | 41 | 1210 | 6.06 | 300 | <0.001 | 13 | 8.12 | 30.9 | 25.8 |
| | | 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 | $NO_3$ mg/L | Na mg/L | Po-210 pCi/L | Ra-226 pCi/L | Ra-228 pCi/L | $SO_4$ 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 |

| 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 | --- | --- | --- | --- | --- | --- |

| Site Code | Location Code | Date Sampled | Mn mg/L | $NO_3$ mg/L | Na mg/L | Po-210 pCi/L | Ra-226 pCi/L | Ra-228 pCi/L | $SO_4$ 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 |

| 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 | $NO_3$ mg/L | Na mg/L | Po-210 pCi/L | Ra-226 pCi/L | Ra-228 pCi/L | $SO_4$ 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.

Driscol, F.G., 1986. Ground Water and Wells, 2nd Edition, Johnson Division, St. Paul, Minnesota.

Environmental Simulations, Inc., 1999. Guide To Using Aquifer Win32, Version 2.17.

Kruseman, G.P., and DeRidder, N.A., 1991. Analysis and Evaluation of Pumping Test Data, International Institute for Land Reclamation and Improvement, 2nd Edition, Wageningen, The Netherlands.

Neuman, S.P., 1972. Theory of flow in unconfined aquifers considering delayed response of the watertable, Water Resources Research, vol. 8, pp. 1031-1045.

Neuman, S.P., 1974. Effect of partial penetration on flow in unconfined aquifers considering delayed gravity response, Water Resources Research, Vol. 10, pp. 303-312.

Theis, C.V., 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using ground water storage, Am. Geophys. Union Trans., Vol. 16, pp. 519-524.

USDOE, 2000. Expedited Site Characterization of Ground Water Chemistry During Two Pumping Tests November 20 through December 2, 1999, ESL-RPT-2000-2.

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 |
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| [signature] | 7/13/00 | [signature] | 7/13/00 | [signature] | 13 July 2000 | | |

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# 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 $ft^2$/min after converting the pumping rate from gpm to cubic feet per min ($ft^3$/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.

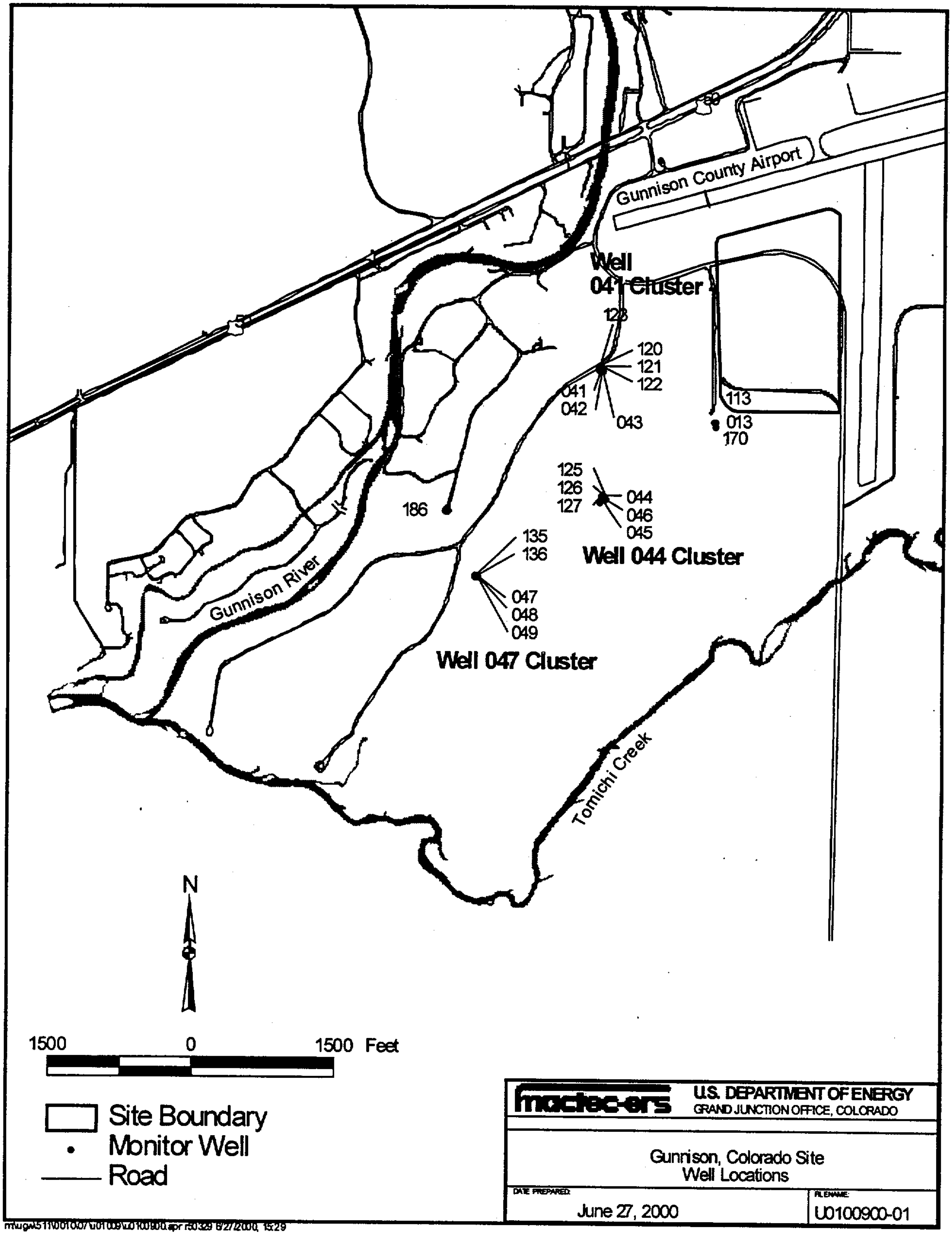


*Figure 1. Well Location Map*

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)[a] | 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 |

[a]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.

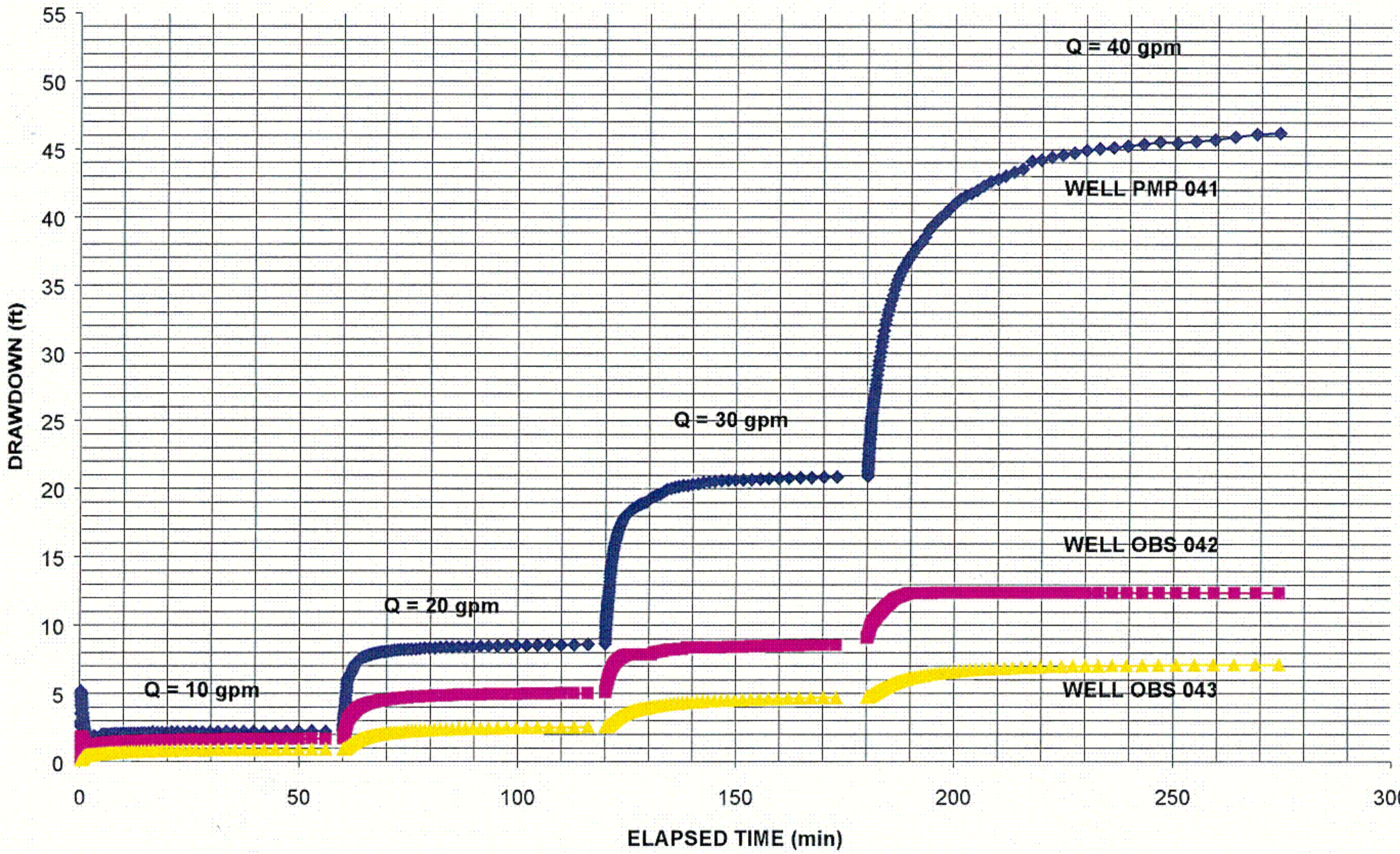


*Figure 2. Well 041 Step Test 1 Data*

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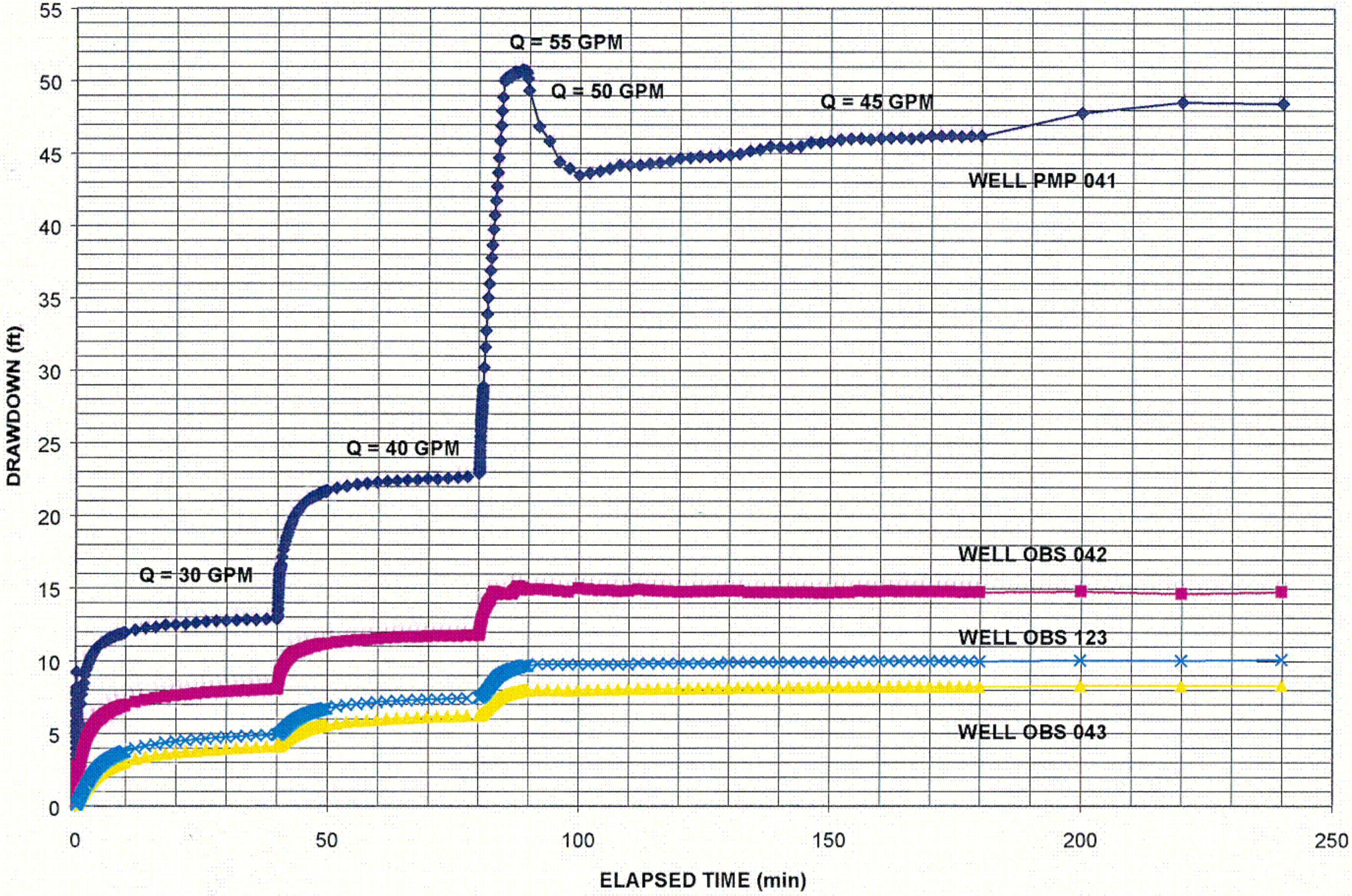


*Figure 3. Well 041 Step Test 2 Data*



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Analysis of the data collected during the first step test resulted in a specific capacity of 0.22 square feet per minute ($ft^2$/min) for flow rates between 10 and 30 gpm, and a reduced specific capacity of 0.06 $ft^2$/min for flow rates between 30 and 40 gpm. The specific capacity decreases with increased drawdown (Driscol 1986). Based on the data from the second test, the specific capacity for flow rates between 30 and 40 gpm increased to 0.13 $ft^2$/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 $ft^2$/min, and decreased to 0.06 $ft^2$/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 $ft^2$/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 $ft^2$/min, while flow rates above 40 gpm result in a specific capacity of 0.12 $ft^2$/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

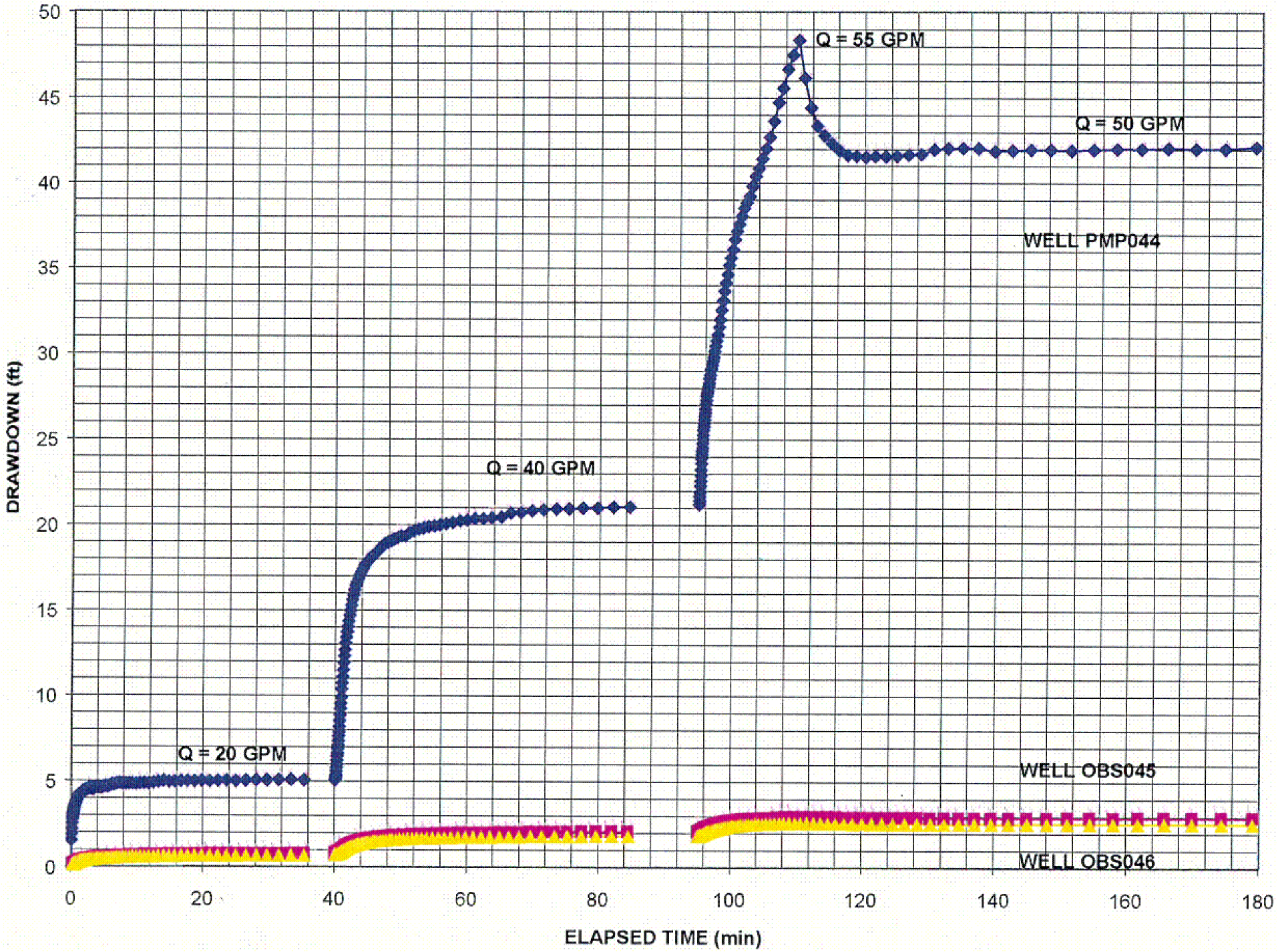


Figure 4. Well 044 Step Test 1 Data

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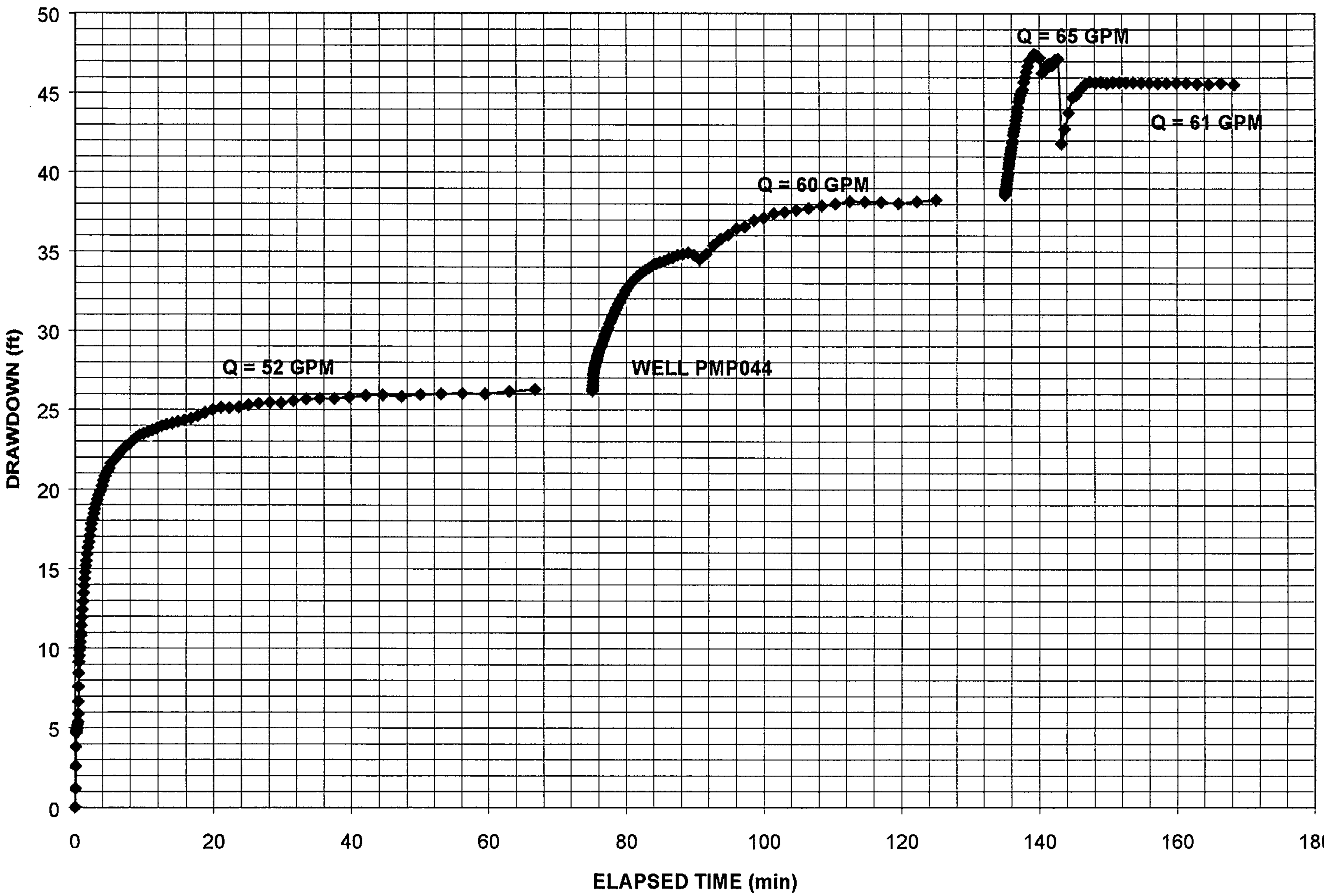


Figure 5. Well 044 Step Test 2 Data

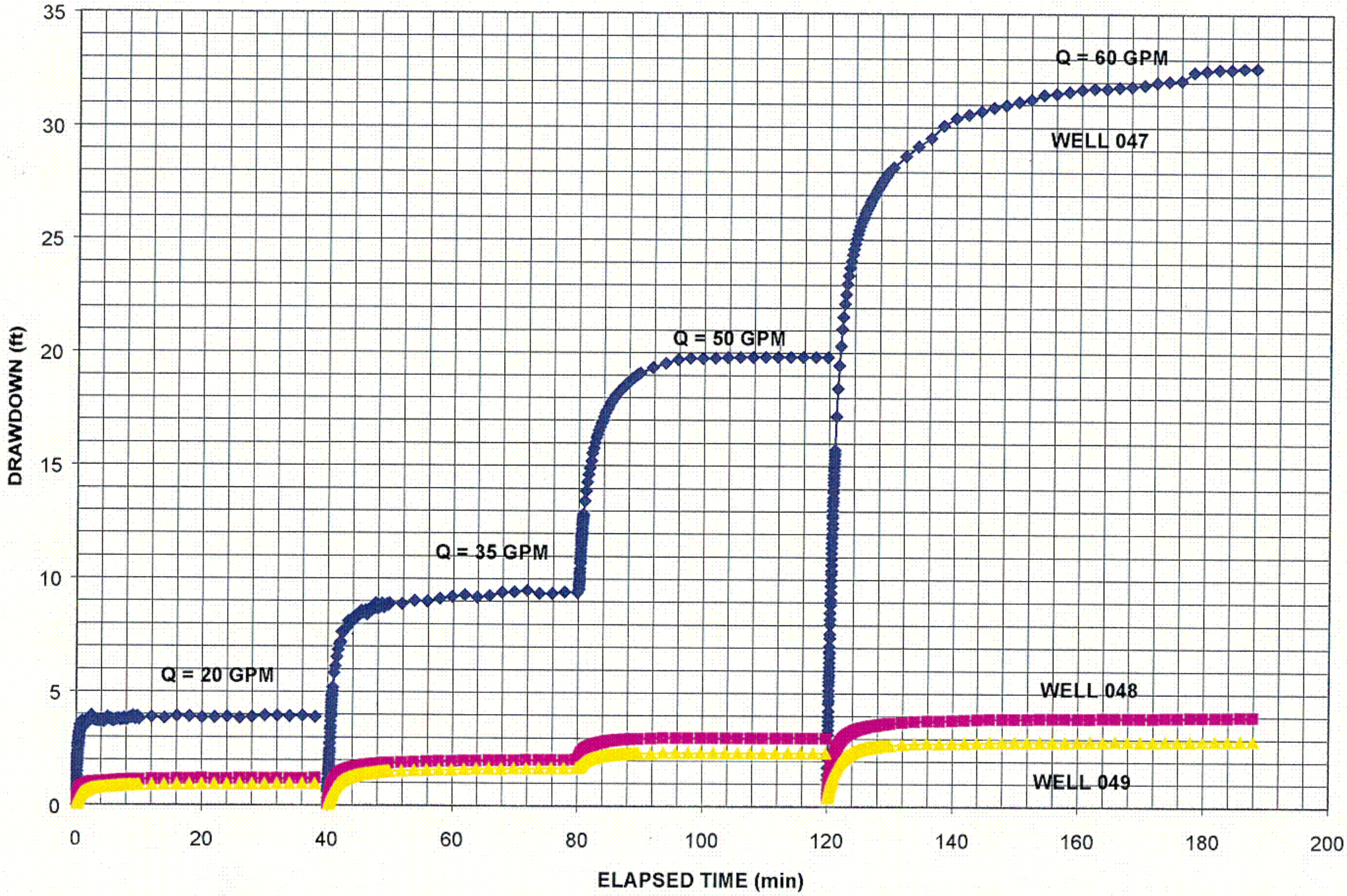


Figure 6. Well 047 Step Test Data





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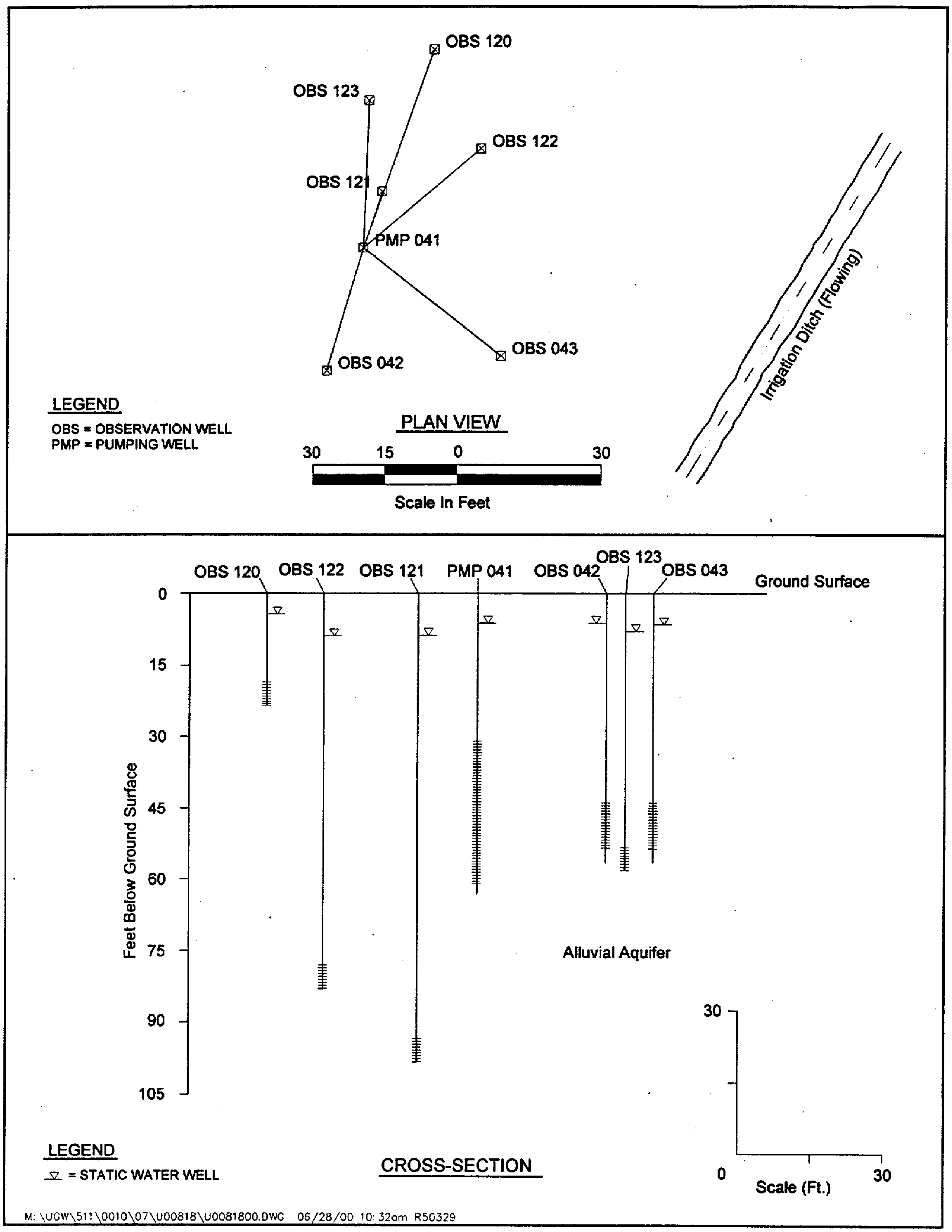



*Figure 7. Well 041 Cluster Map and Cross Section*

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 Transmissivitiy Results (ft²/day)*

| Test No | Data Source | Test | Analytical Method | | | | |
|---|---|---|---|---|---|---|---|
| | | | Theis T(ft²/d) | C-J T(ft²/d) | Neuman T(ft²/d) | Theis Rec T(ft²/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 (ft²/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).

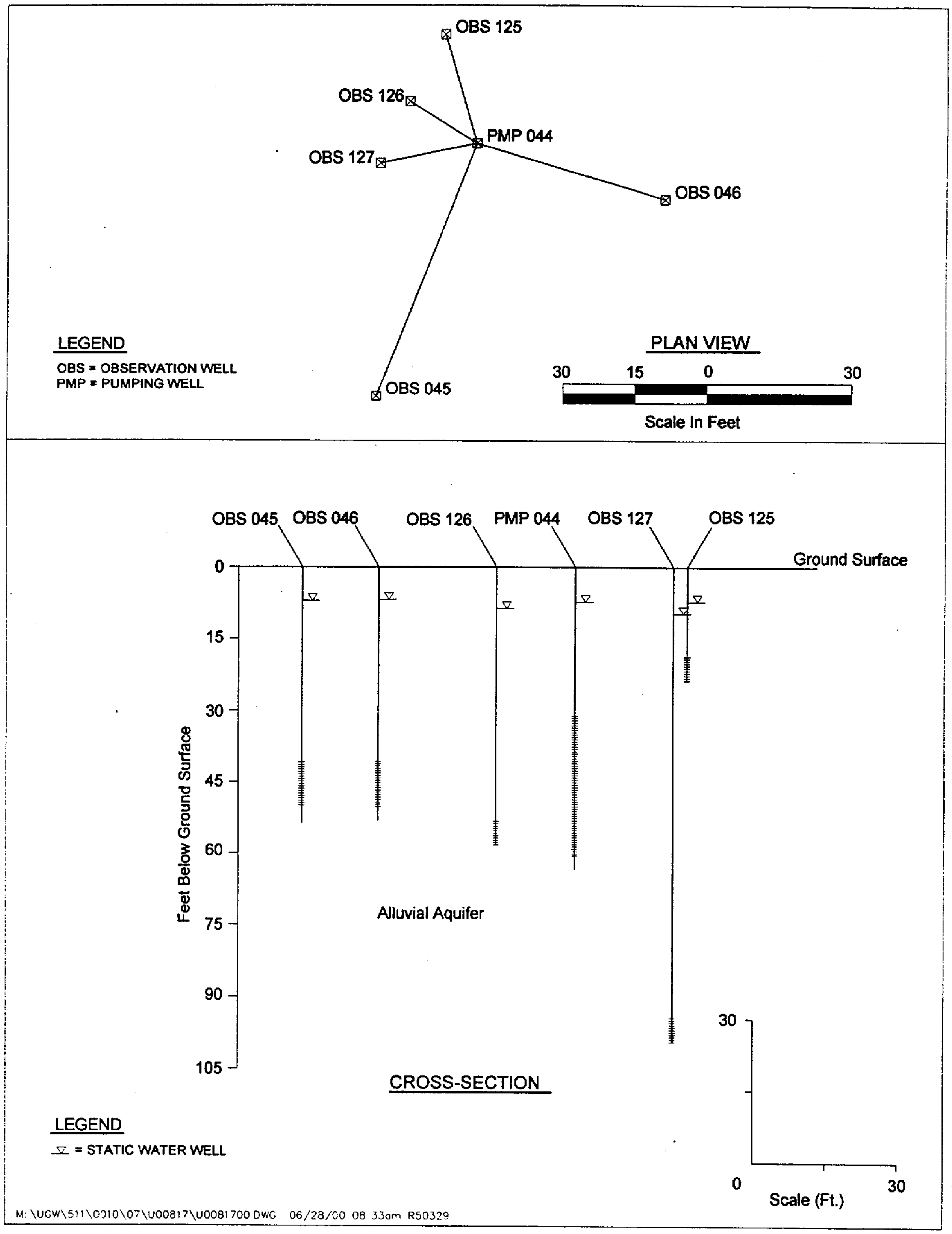



*Figure 8. Well 044 Cluster Map and Cross Section*

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

| Sample | Cum Vol. | pH | ORP | Cond | Temp | ALK | $SO_4$ | $NO_3$ | $NO_2$ | $NH_3$ | U |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | (Gal.) | | | (ATC) | (°C) | | (mg/L) | (mg/L) | (µg/L) | (µg/L) | (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 0.45um 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 Transmissivitiy Results (ft²/day)*

| Test No | Data Source | Test | Analytical Method | | | | |
|---|---|---|---|---|---|---|---|
| | | | Theis T(ft²/d) | C-J T(ft²/d) | Neuman T(ft²/d) | Theis Rec T(ft²/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 (ft²/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.

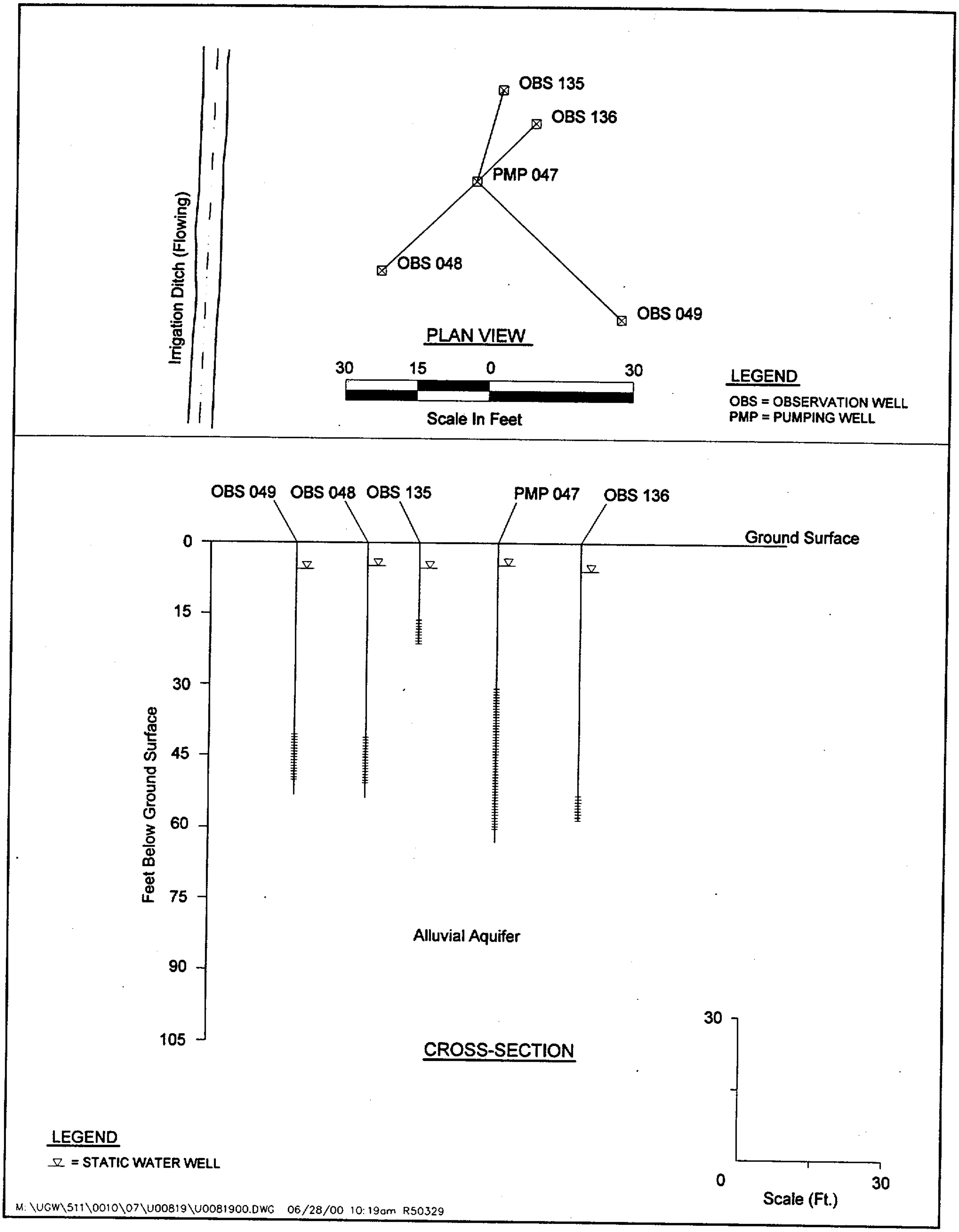



*Figure 9. Well 047 Cluster Map and Cross Section*

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 | $SO_4$ (mg/L) | $NO_3$ (mg/L) | $NO_2$ (ug/L) | $NH_3$ (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 Transmissivitiy Results (ft²/day)*

| Test No | Data Source | Test | Analytical Method | | | | |
|---|---|---|---|---|---|---|---|
| | | | Theis | C-J T(ft²/d) | Neuman T(ft²/d) | Theis Rec T(ft²/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 (ft²/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 Transmissivitiy Results ($ft^2$/day)*

| Q (gpm) | Data Source | Test | Analytical Method | | |
|---|---|---|---|---|---|
| | | | Theis T($ft^2$/d) | C-J T($ft^2$/d) | Theis Rec T($ft^2$/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 ($ft^2$/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 $ft^2$/min for flow rates below 30 gpm, and from 0.09 to 0.12 $ft^2$/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 $ft^2$/day. Analyses of residual drawdown data collected during the recovery phase of these tests suggest the transmissivity ranges from 68 to 976 $ft^2$/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.

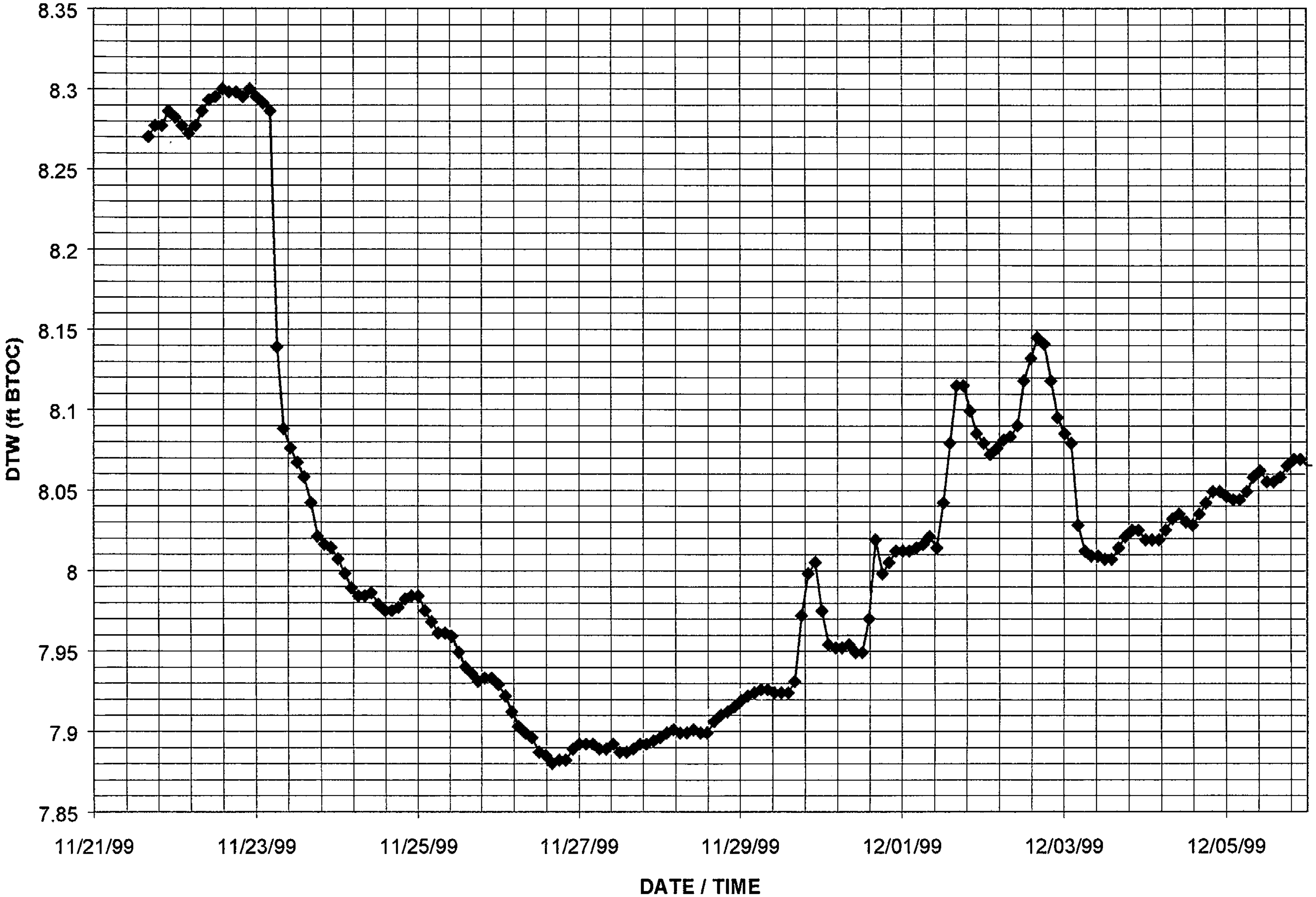



*Figure 10. Water Table Fluctuations between November 21 and December 5, 1999, in Background Well 186.*

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

| 041 LOCATION | Q (gpm) | Time (hrs) | WELL PMP 041 | | WELL OBS 042, r = 26.8' | | | | | | WELL OBS 123, r = 30.8' | | | | | | WELL OBS 043, r = 36.6' | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Theis Rec | | Theis | | Cooper-Jacob | | Neuman | | Theis | | Cooper-Jacob | | Neuman | | Theis | | Cooper-Jacob | | Neuman | |
| | | | T (ft2/d) | K (ft/d) | T (ft2/d) | K (ft/d) | T (ft2/d) | K (ft/d) | T (ft2/d) | K (ft/d) | T (ft2/d) | K (ft/d) | T (ft2/d) | K (ft/d) | T (ft2/d) | K (ft/d) | T (ft2/d) | K (ft/d) | T (ft2/d) | K (ft/d) | T (ft2/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 | Q (gpm) | Time (hrs) | WELL PMP 044 | | WELL OBS 046, r = 40.9' | | | | | | WELL OBS 045, r = 56.8' | | | | | | WELL OBS 126, r = 16.4' | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Theis Rec | | Theis | | Cooper-Jacob | | Neuman | | Theis | | Cooper-Jacob | | Neuman | | Theis | | Cooper-Jacob | | Neuman | |
| | | | T (ft2/d) | K (ft/d) | T (ft2/d) | K (ft/d) | T (ft2/d) | K (ft/d) | T (ft2/d) | K (ft/d) | T (ft2/d) | K (ft/d) | T (ft2/d) | K (ft/d) | T (ft2/d) | K (ft/d) | T (ft2/d) | K (ft/d) | T (ft2/d) | K (ft/d) | T (ft2/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 | 53.56 | 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 | Q (gpm) | Time (hrs) | WELL PMP 047 | | WELL OBS 048, r = 27.2' | | | | | | WELL OBS 049, r = 42.1' | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Theis Rec | | Theis | | Cooper-Jacob | | Neuman | | Theis | | Cooper-Jacob | | Neuman | |
| | | | T (ft2/d) | K (ft/d) | T (ft2/d) | K (ft/d) | T (ft2/d) | K (ft/d) | T (ft2/d) | K (ft/d) | T (ft2/d) | K (ft/d) | T (ft2/d) | K (ft/d) | T (ft2/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 | Q (gpm) | Time (hrs) | WELL #10 | | OBS WELL , r = 42.5' | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Theis Rec | | Theis | | Cooper-Jacob | |
| | | | T (ft2/d) | K (ft/d) | T (ft2/d) | K (ft/d) | T (ft2/d) | K (ft/d) |
| TEST 1 | 420 | 1 | NA | NA | 5600 | 93.3 | 5055 | 84.3 |
| (NO REC TEST) | | | - | - | - | - | - | - |
| 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 |

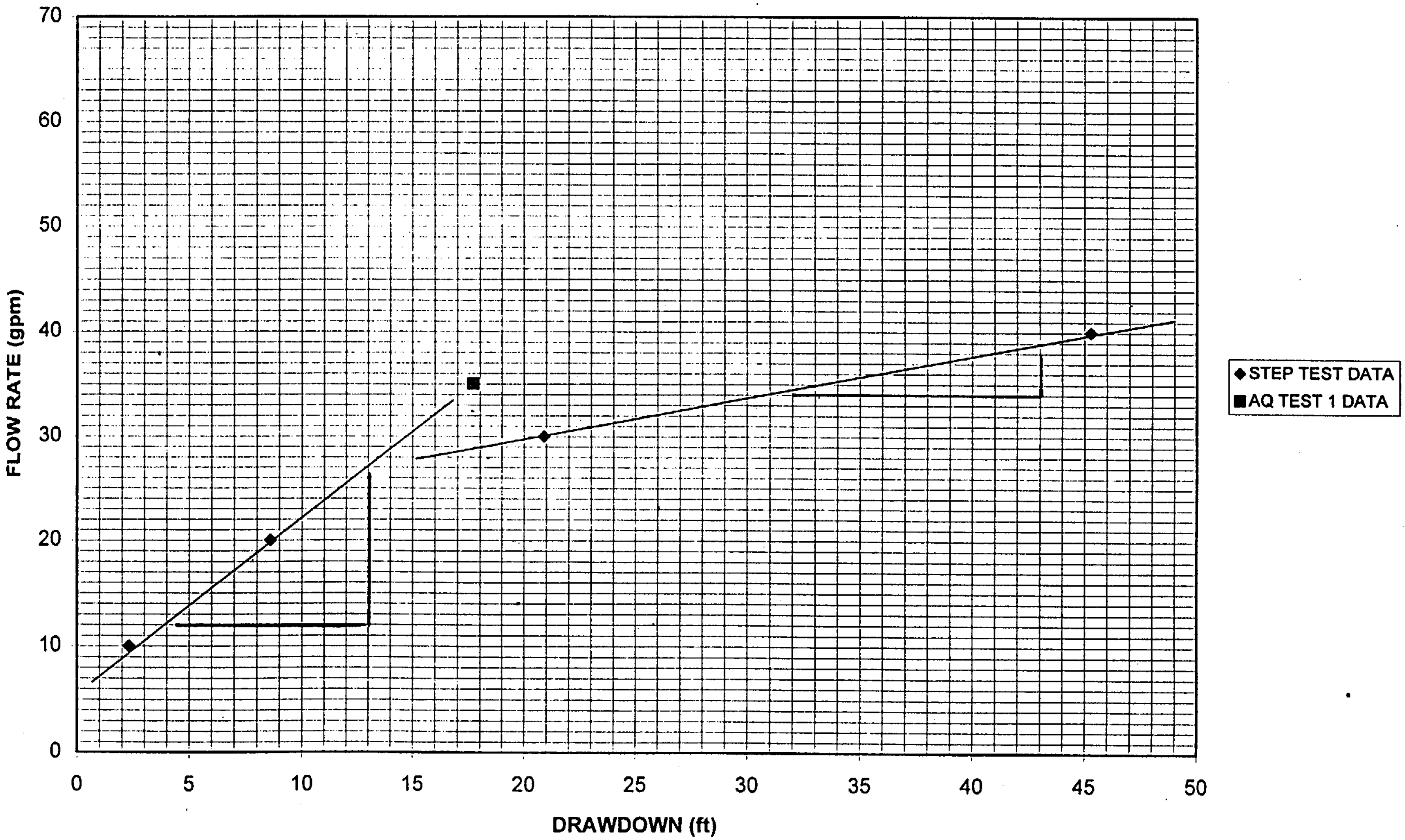
NOTES

| | | |
|---|---|---|
| T | = | Transmissivity (ft2/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 |
| Theis Rec | = | Theis Recovery Method |
| Theis | = | Theis 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**

| | ELAPSED TIME (MIN) | WELL 041 DTW FT BTOC | WELL 042 DTW FT BTOC | WELL 043 DTW FT BTOC |
|---|---|---|---|---|
| Q = 10 GPM | | | | |
| | 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

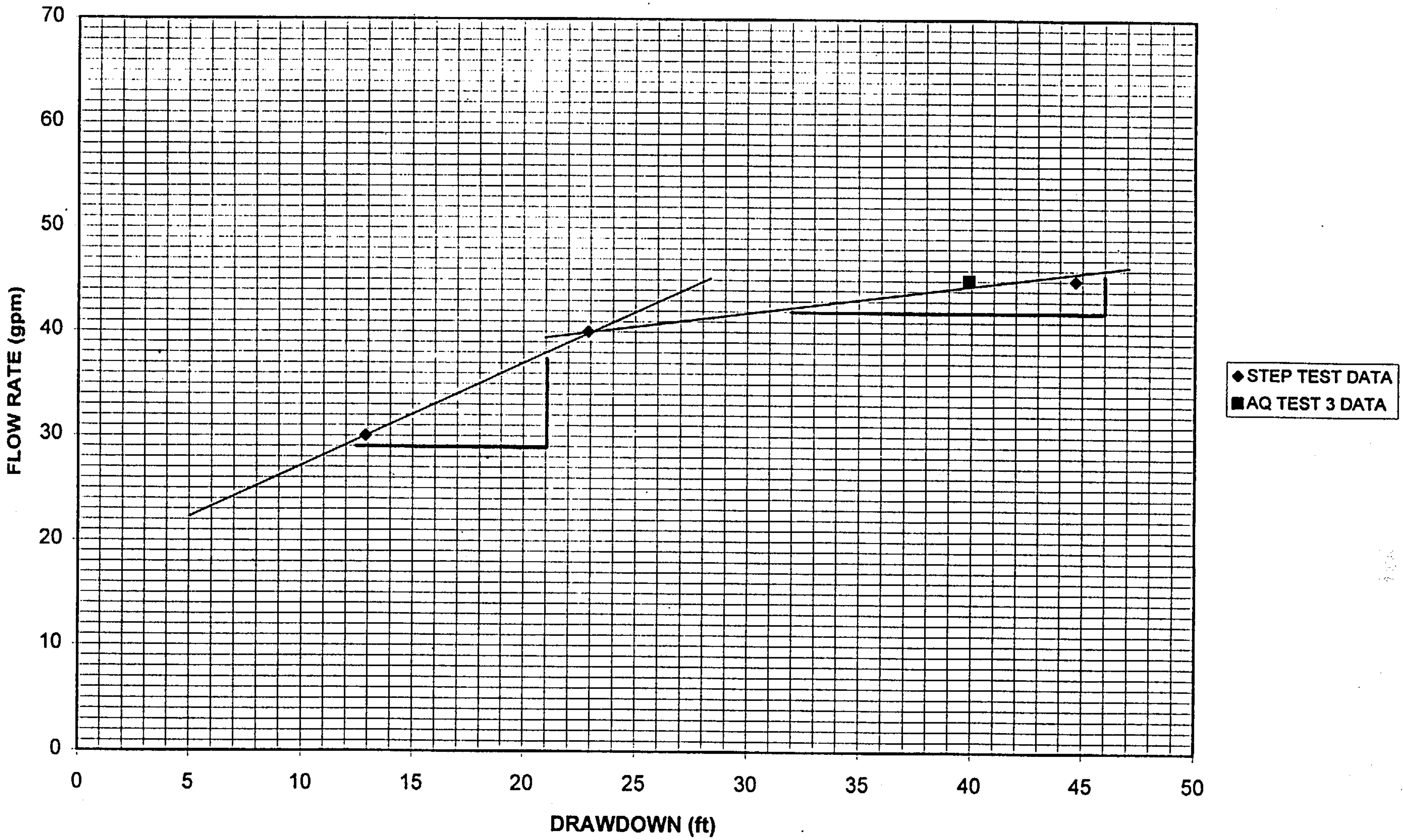
| | | | |
|---|---|---|---|
| 120 | 16.845 | 13.069 | 10.91 |
| 120.0217 | 17.073 | 13.073 | 10.911 |
| 120.0434 | 17.306 | 13.084 | 10.91 |
| 120.065 | 17.517 | 13.11 | 10.911 |
| 120.0867 | 17.707 | 13.131 | 10.911 |
| 120.1084 | 17.949 | 13.168 | 10.91 |
| 120.13 | 18.126 | 13.203 | 10.91 |
| 120.1517 | 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:

SLOPE = $\frac{9 \text{ GPM}}{9 \text{ FT}}$ = 0.13 FT²/MIN

HIGHER Q:

SLOPE = $\frac{4 \text{ GPM}}{15 \text{ FT}}$ = 0.04 FT²/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 |

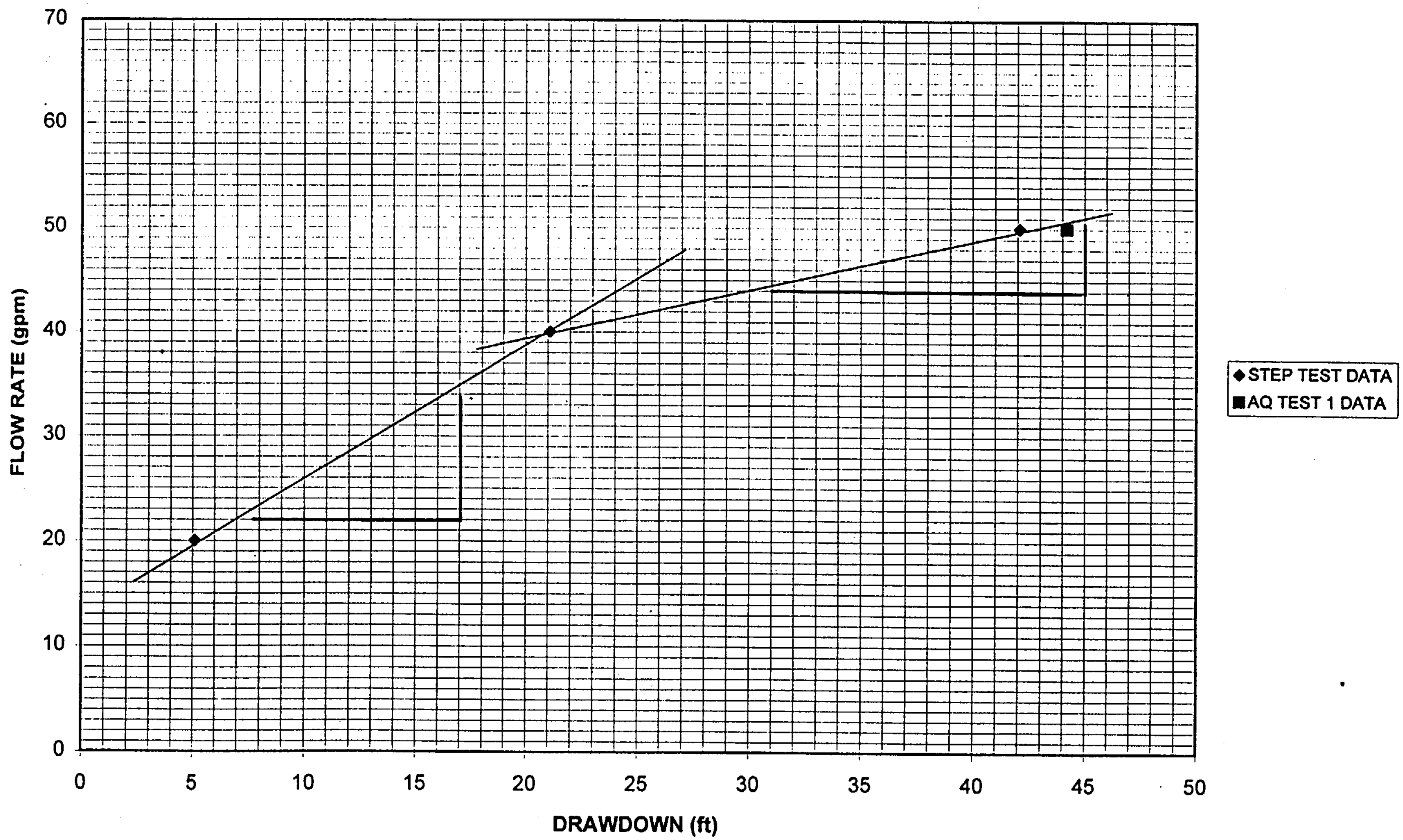
| | | | | |
|---|---|---|---|---|
| 40.0167 | 21.643 | 16.425 | 12.684 | 14.659 |
| 40.025 | 21.492 | 16.425 | 12.684 | 14.659 |
| 40.0417 | 21.596 | 16.435 | 12.684 | 14.659 |
| 40.0583 | 21.859 | 16.449 | 12.684 | 14.659 |
| 40.075 | 21.982 | 16.463 | 12.684 | 14.659 |
| 40.0917 | 22.076 | 16.487 | 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:

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

HIGHER Q:

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

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

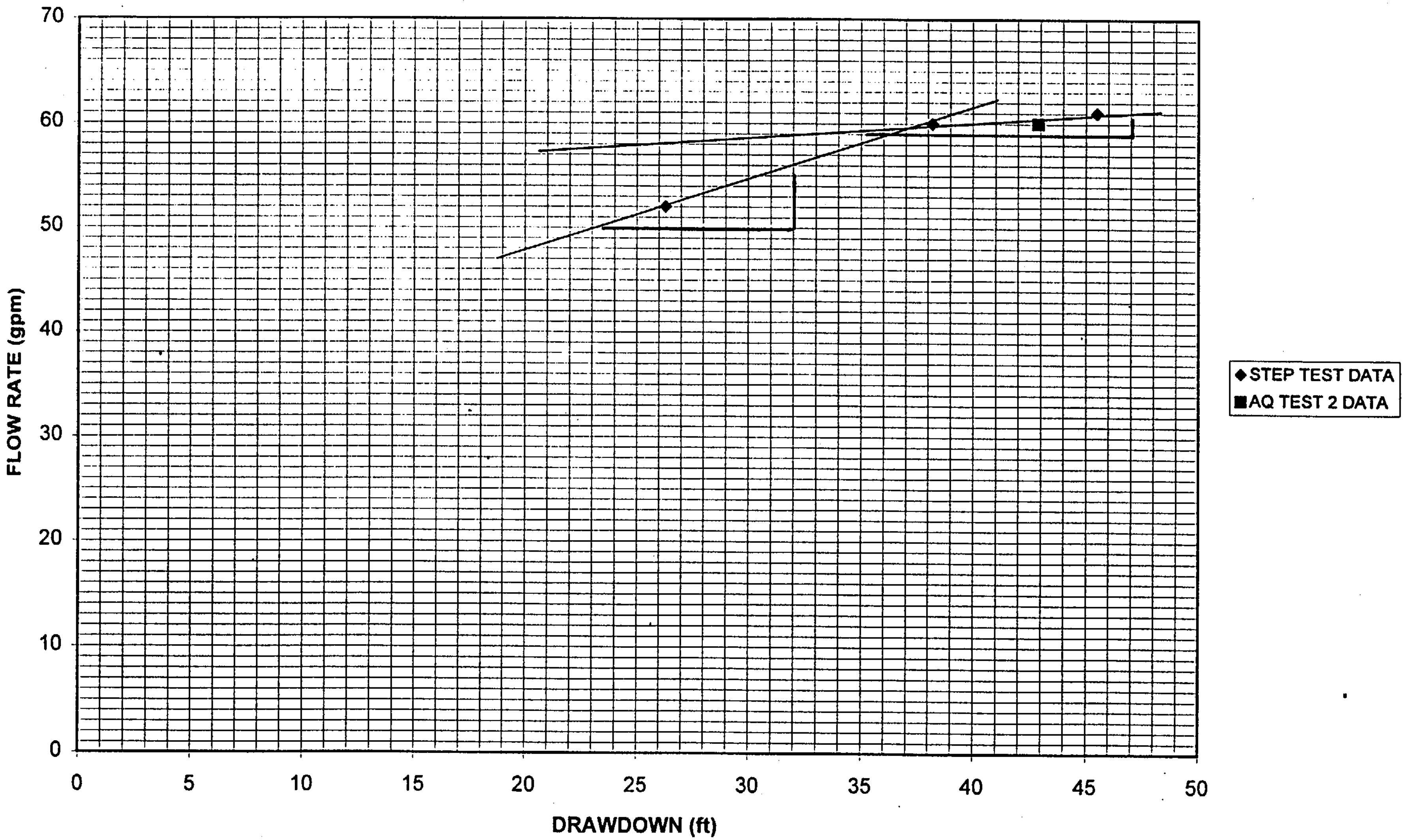
| | ELAPSED TIME (MIN) | WELL 044 DTW FT BTOC | WELL 045 DTW obs045 | WELL 046 DTW obs046 |
|---|---|---|---|---|
| Q = 20 GPM | | | | |
| | 0 | 9.446 | 9.392 | 8.828 |
| | 0.0375 | 10.982 | 9.404 | 8.837 |
| | 0.075 | 11.33 | 9.427 | 8.845 |
| | 0.1125 | 11.626 | 9.45 | 8.856 |
| | 0.15 | 11.952 | 9.47 | 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 |
| Q = 40 GPM | | | | |
| | 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:

SLOPE = 6GPM / 9FT = 0.09 FT²/MIN

HIGHER Q:

SLOPE = 2GPM / 14FT = 0.02 FT²/MIN

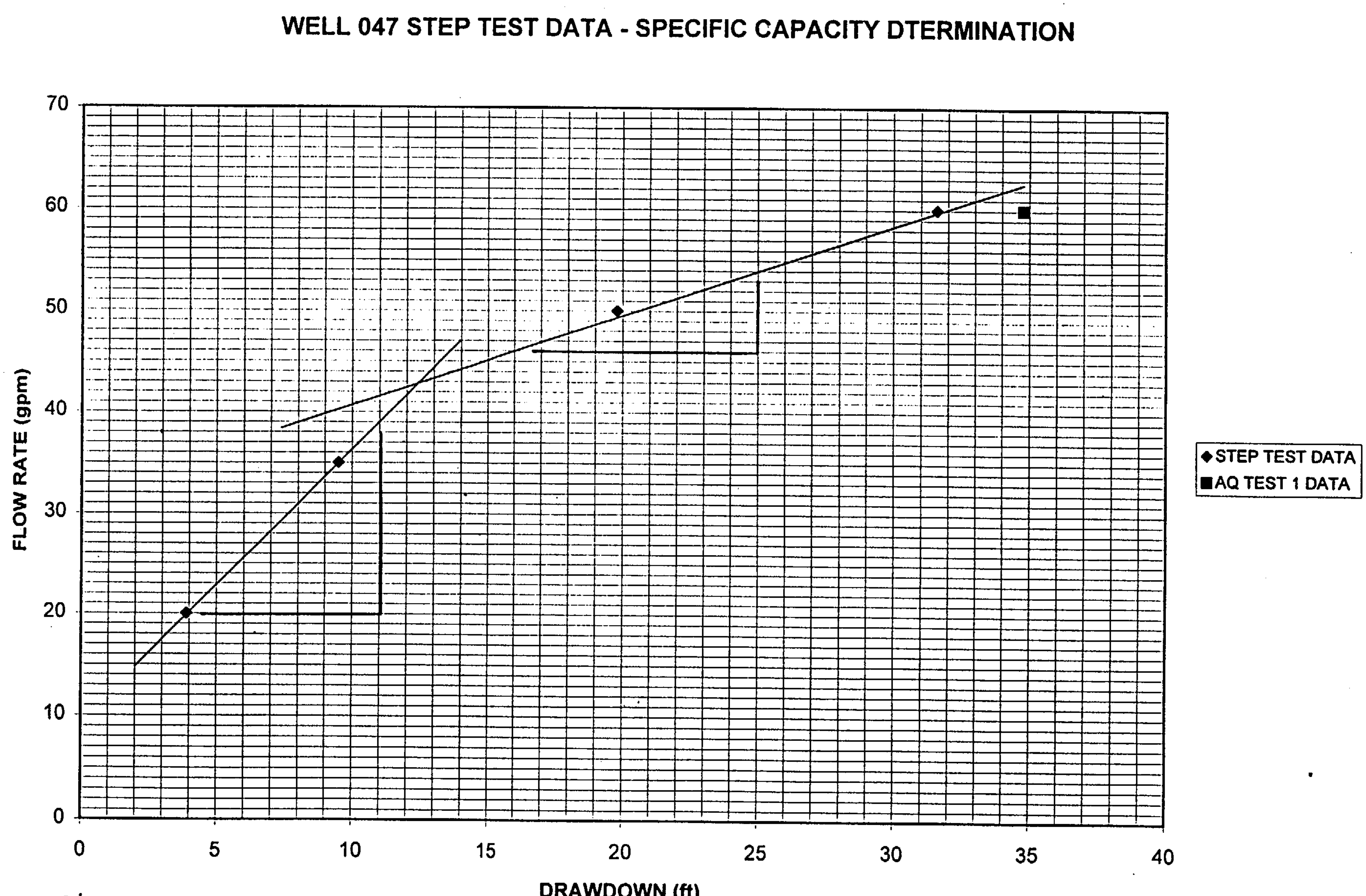
**GUNNISON UMTRA SITE**
**WELL 044 STEP TEST 2 DATA**
**START DATE/TIME : 12/7/99, 1115**

| | ELPASED TIME (MIN) | WELL 044 DRAWDOWN |
|---|---|---|
| Q = 52 GPM | | |
| | 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 |
| Q = 61 GPM | | |
| | 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 |




LOWER Q's

SLOPE = $\frac{19 \text{ GPM}}{7 \text{ FT}}$ = 0.36 FT²/MIN

HIGHER Q's

SLOPE = $\frac{8 \text{ GPM}}{9 \text{ FT}}$ = 0.12 FT²/MIN

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

| | ELAPSED TIME (MIN) | WELL 047 DTW FT BTOC | WELL 048 DTW FT BTOC | WELL 049 DTW FT BTOC |
|---|---|---|---|---|
| Q = 20 GPM | | | | |
| | 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 |

| | | | | |
|---|---|---|---|---|
| | 79.7667 | 9.392 | 2.011 | 1.645 |
| **Q = 50 GPM** | | | | |
| | 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

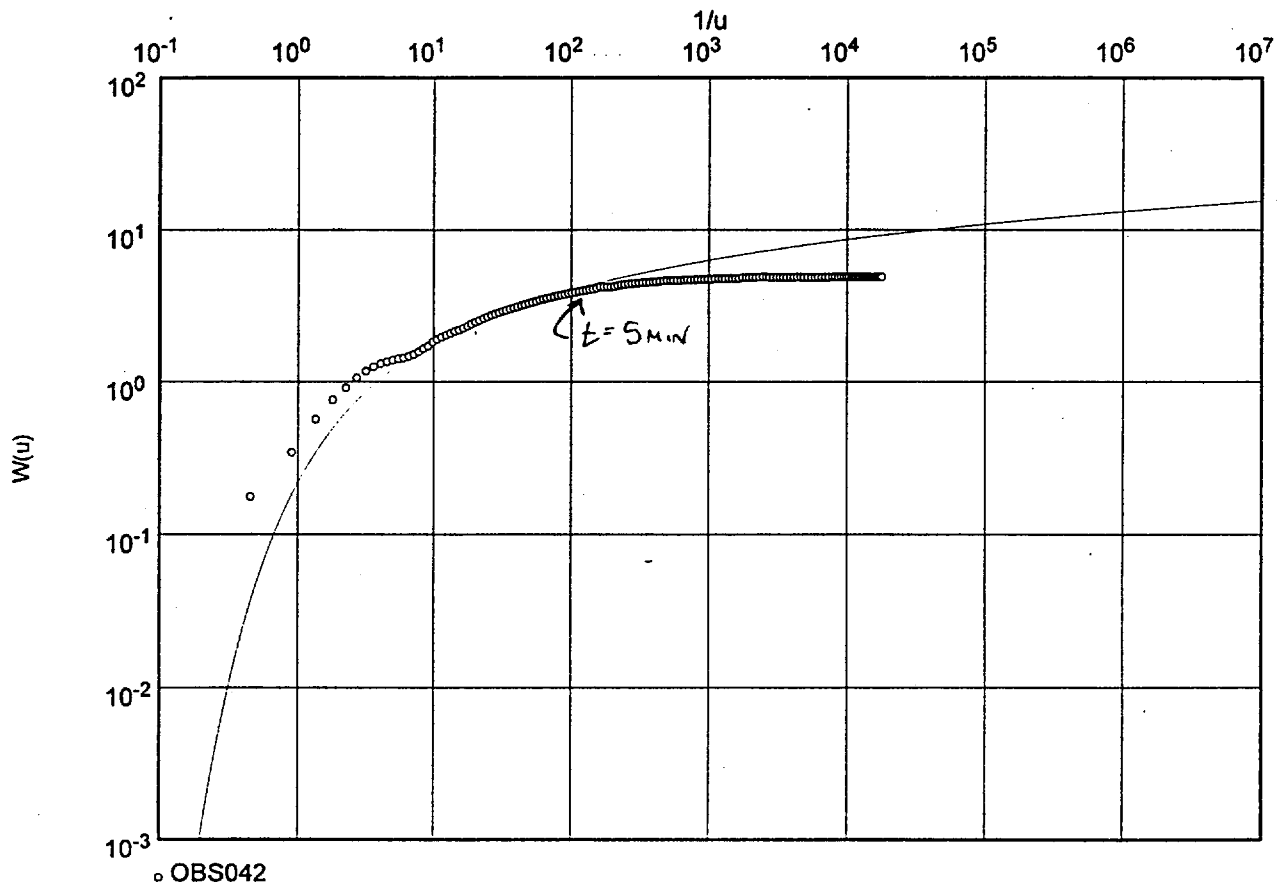
## WELL 041 AQUIFER TEST DATA AND PLOTS

## WELL 041 AQUIFER TEST 1

## PLOTS FOR OBSERVATION WELLS 042, 123, AND 043

| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Theis analysis method<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>Evaluated by: / Date: 30.11.1999 |
|---|---|---|

| | |
|---|---|
| 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 | |



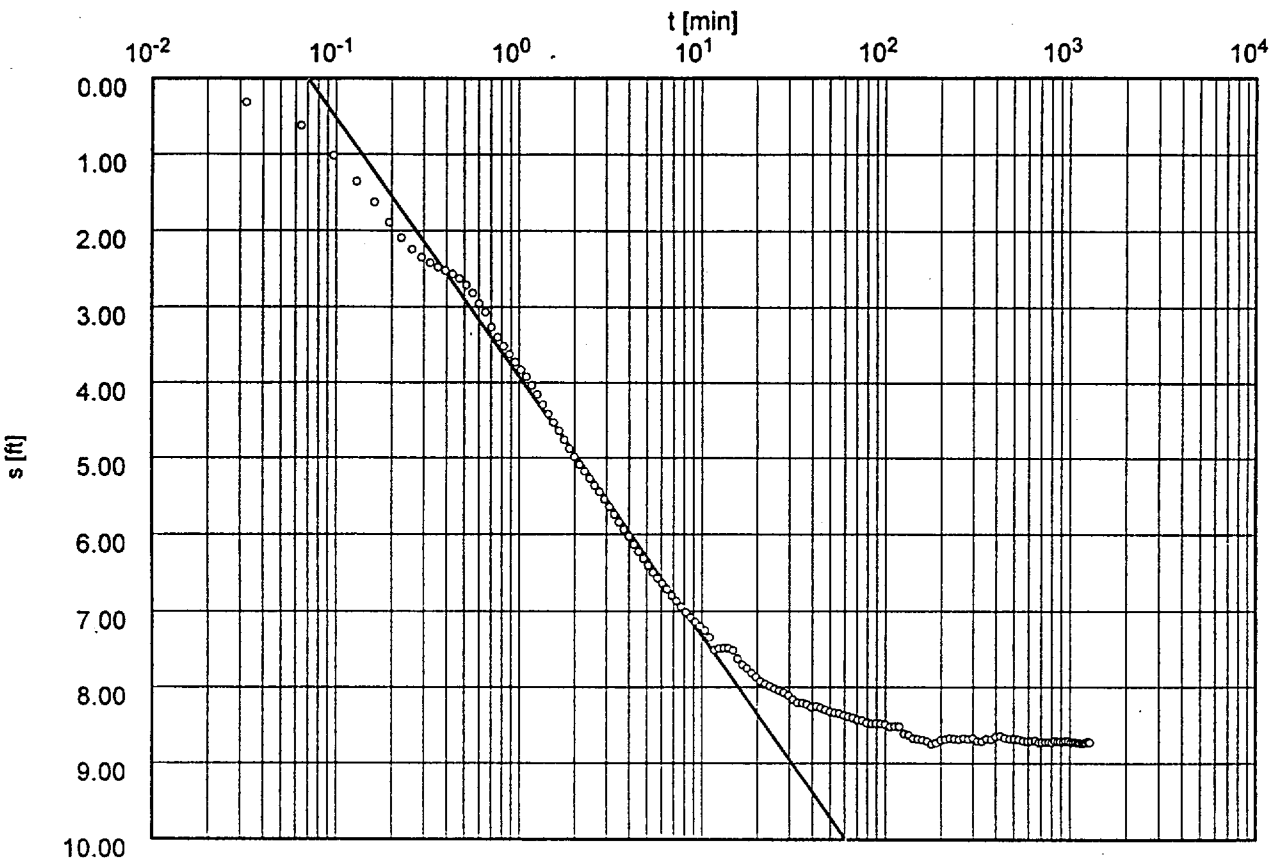

Transmissivity [ft²/min]: $2.09 \times 10^{-1}$ = 301 ft²/D

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

Aquifer thickness [ft]: 30.00

| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Time-Drawdown-method after<br>COOPER & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>Evaluated by: Date: 30.11.1999 |
|---|---|---|

| | |
|---|---|
| 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 | |



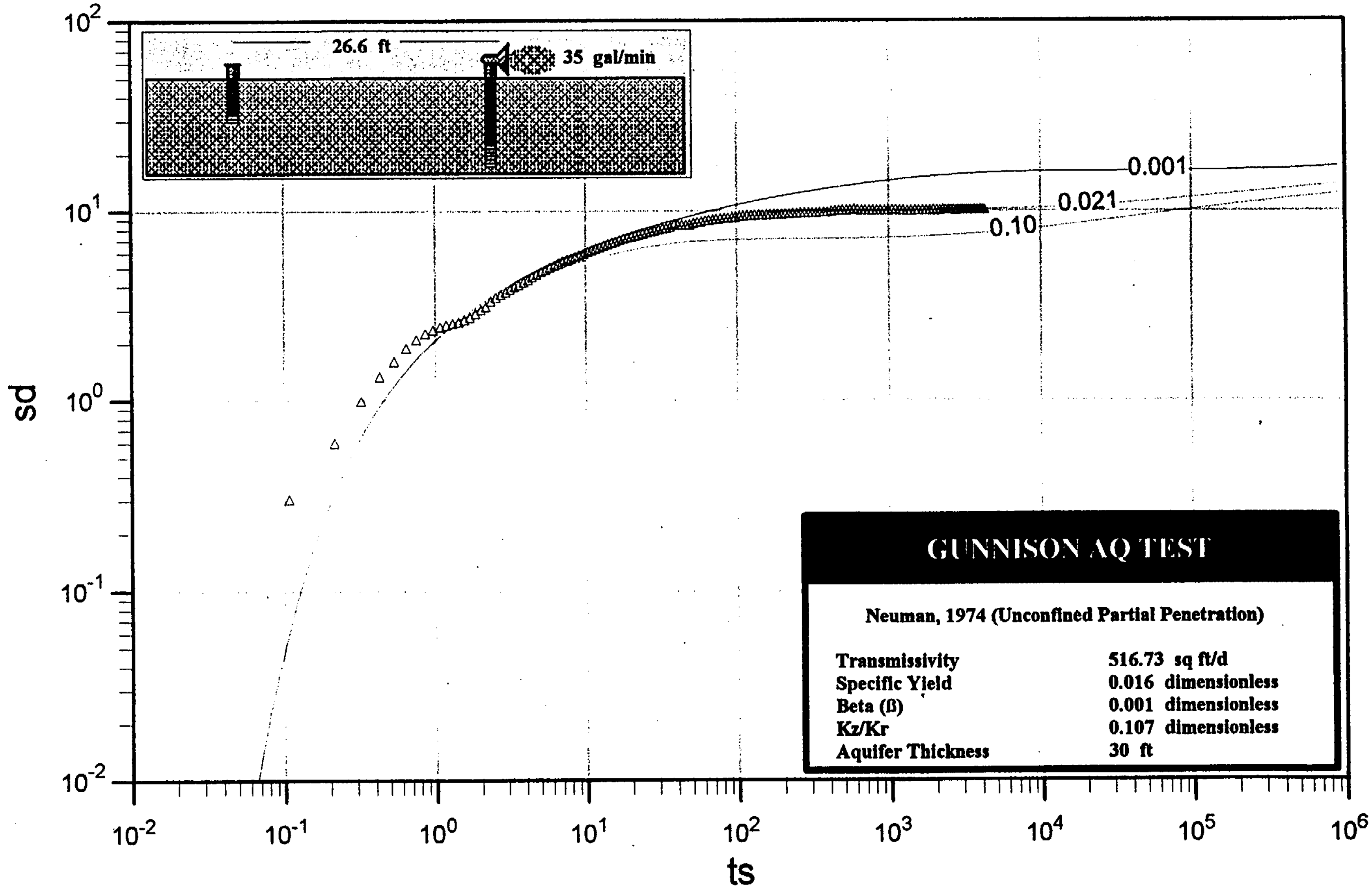

∘ OBS042

Transmissivity [ft²/min]: $2.51 \times 10^{-1}$ = 361.4 ft²/d

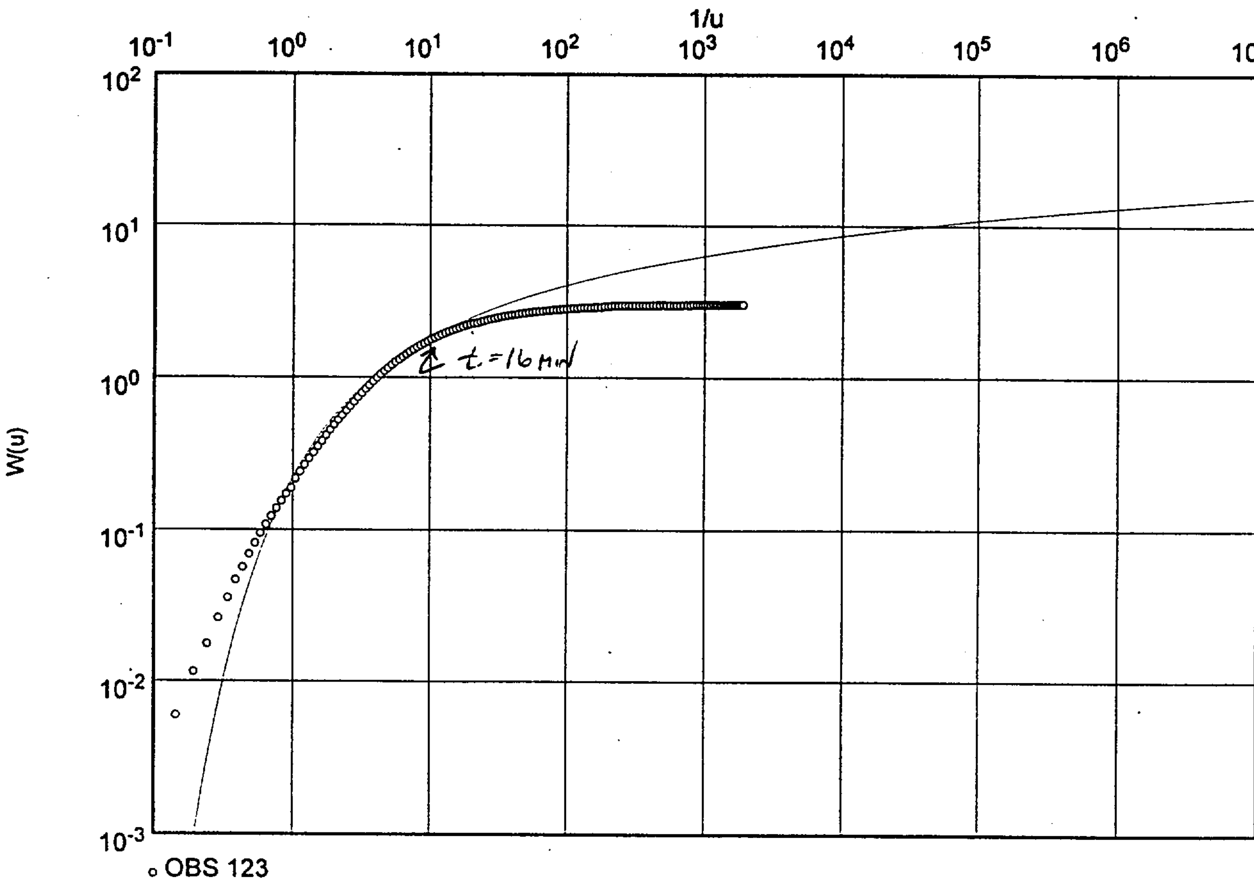
Hydraulic conductivity [ft/min]: $8.38 \times 10^{-3}$

Aquifer thickness [ft]: 30.00

# WELL OBS 042 / 041 AQ TEST 1



| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Theis analysis method<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 | | |



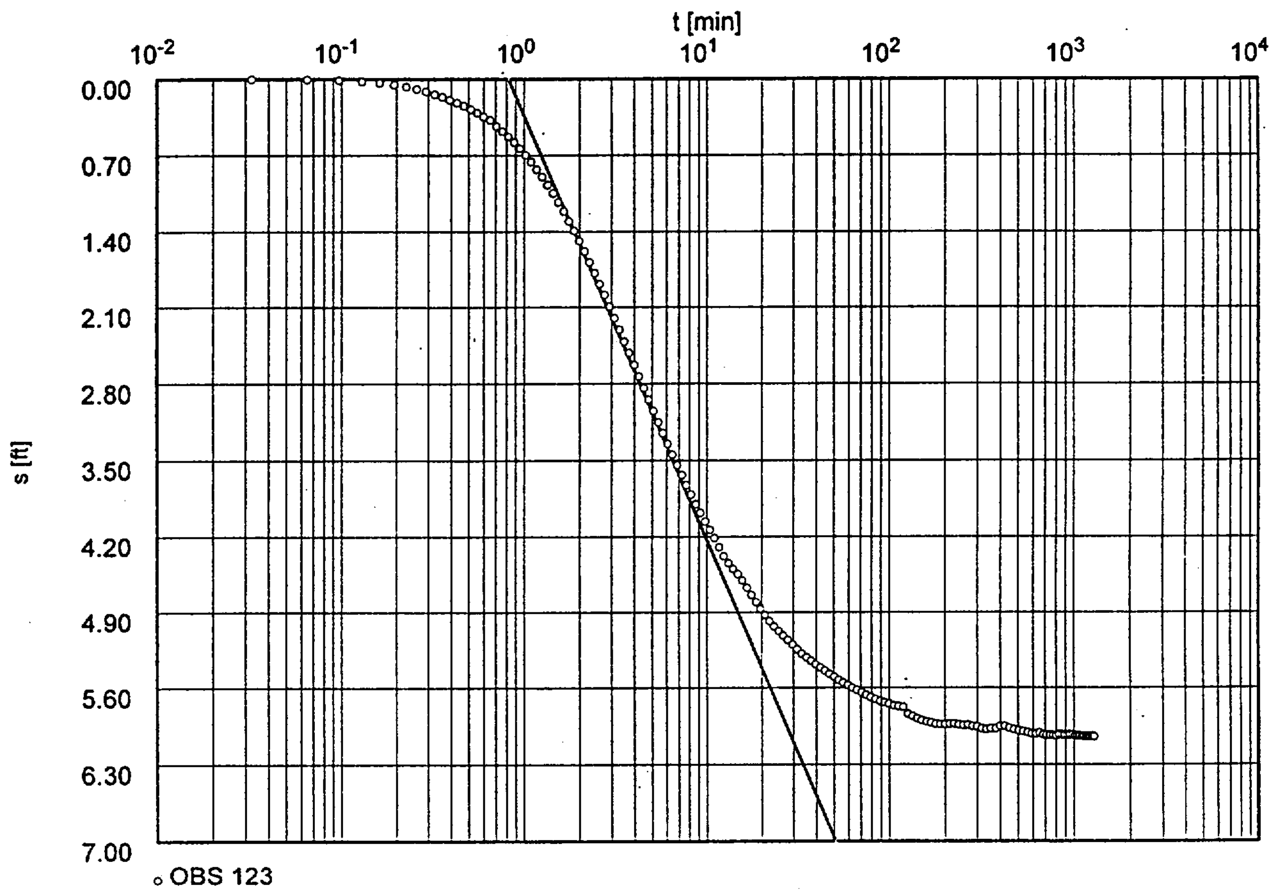

Transmissivity [ft²/min]: $1.86 \times 10^{-1}$ = 267.8 ft²/d

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

Aquifer thickness [ft]: 30.00

| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Time-Drawdown-method after<br>COOPER & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>Evaluated by: | <br><br>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 | |

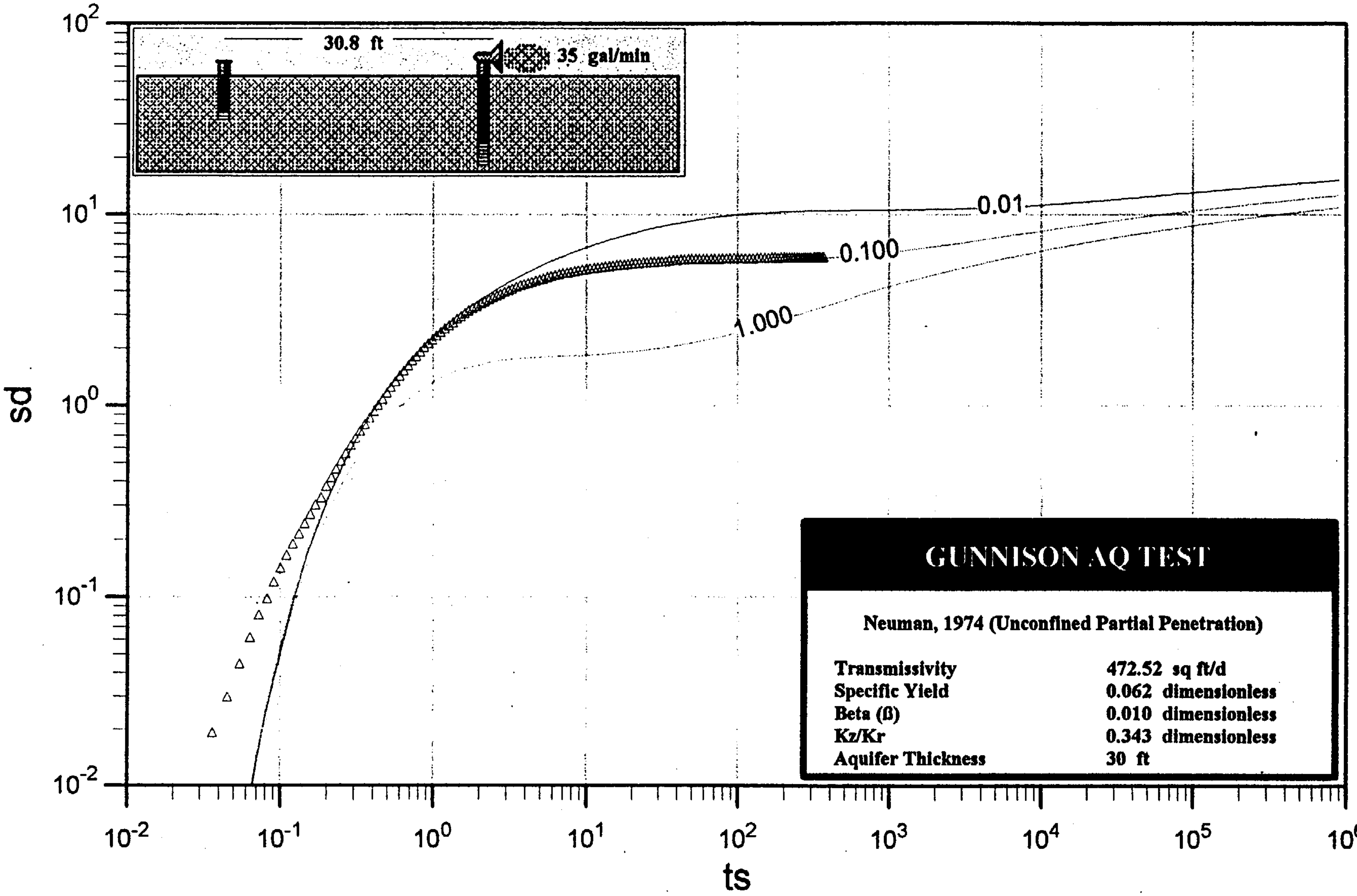



Transmissivity [ft²/min]: $2.19 \times 10^{-1}$ = 315.4 ft²/D

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

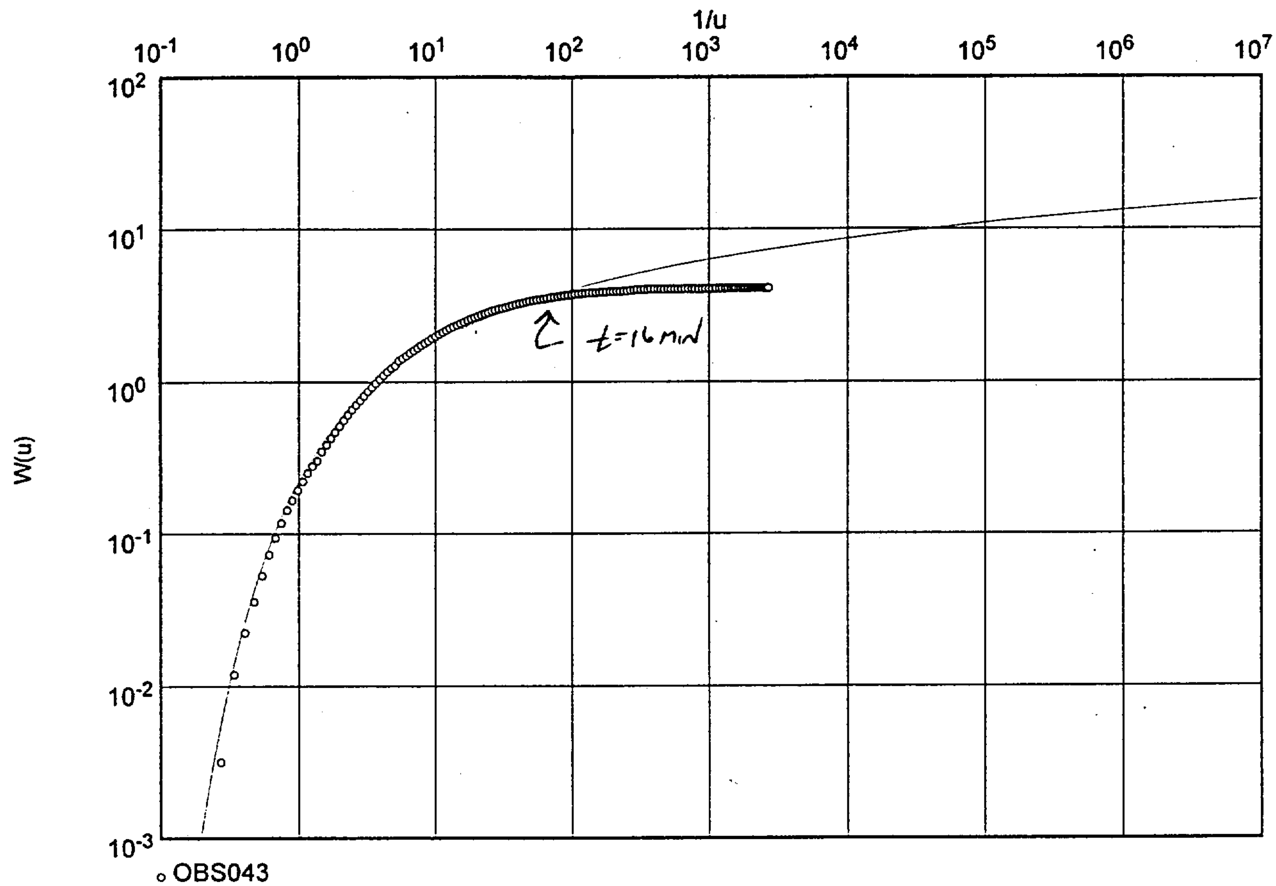
Aquifer thickness [ft]: 30.00

# WELL OBS 123 / 041 AQ TEST 1



| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Theis analysis method<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>Evaluated by: / Date: 30.11.1999 |
|---|---|---|

| | |
|---|---|
| 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 | |



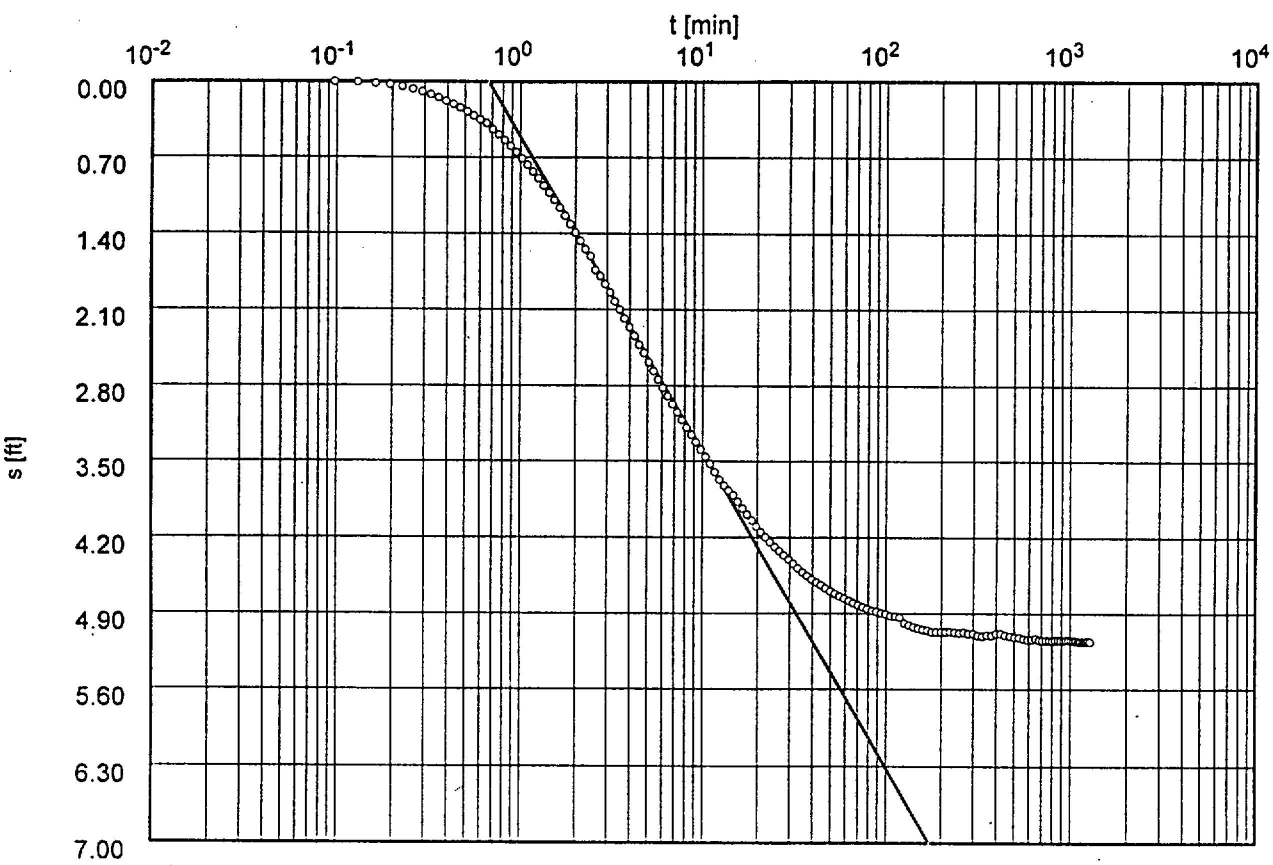

Transmissivity [ft²/min]: $2.95 \times 10^{-1}$ = 424.8 ft²/d

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

Aquifer thickness [ft]: 30.00

| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Time-Drawdown-method after<br>COOPER & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>Evaluated by: / Date: 30.11.1999 |
|---|---|---|

| | |
|---|---|
| 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 | |



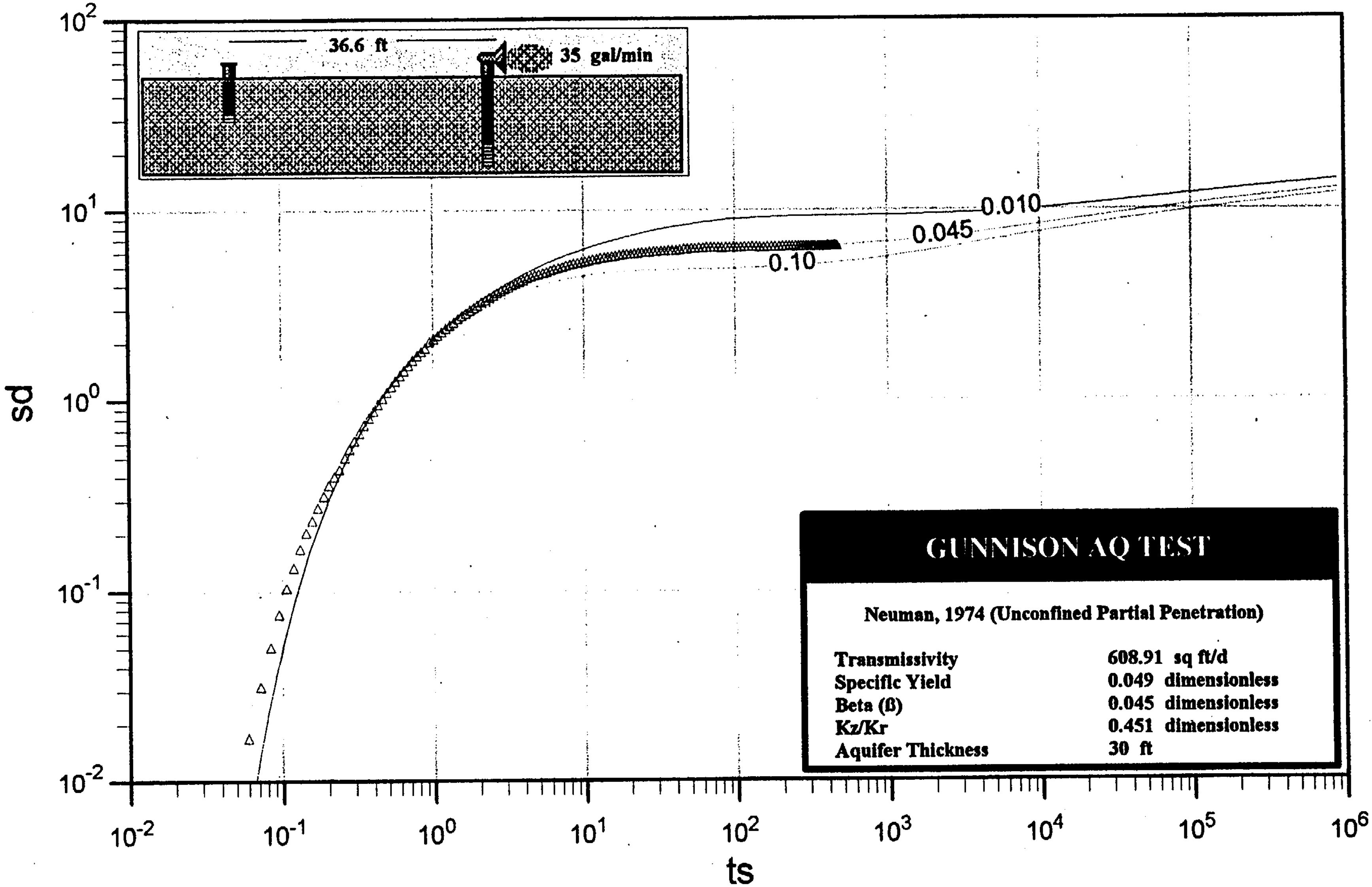

◦ OBS043

Transmissivity [ft²/min]: $2.94 \times 10^{-1}$ = 423.A ft²/D

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**

| ELAPSED TIME (MIN) | WELL 041 DTW (ft btoc) | WELL 042 DTW (ft btoc) | WELL 043 DTW (ft btoc) | WELL 120 DTW (ft btoc) | WELL 123 DTW (ft btoc) | INCHES Hg |
|---|---|---|---|---|---|---|
| 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 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 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 |

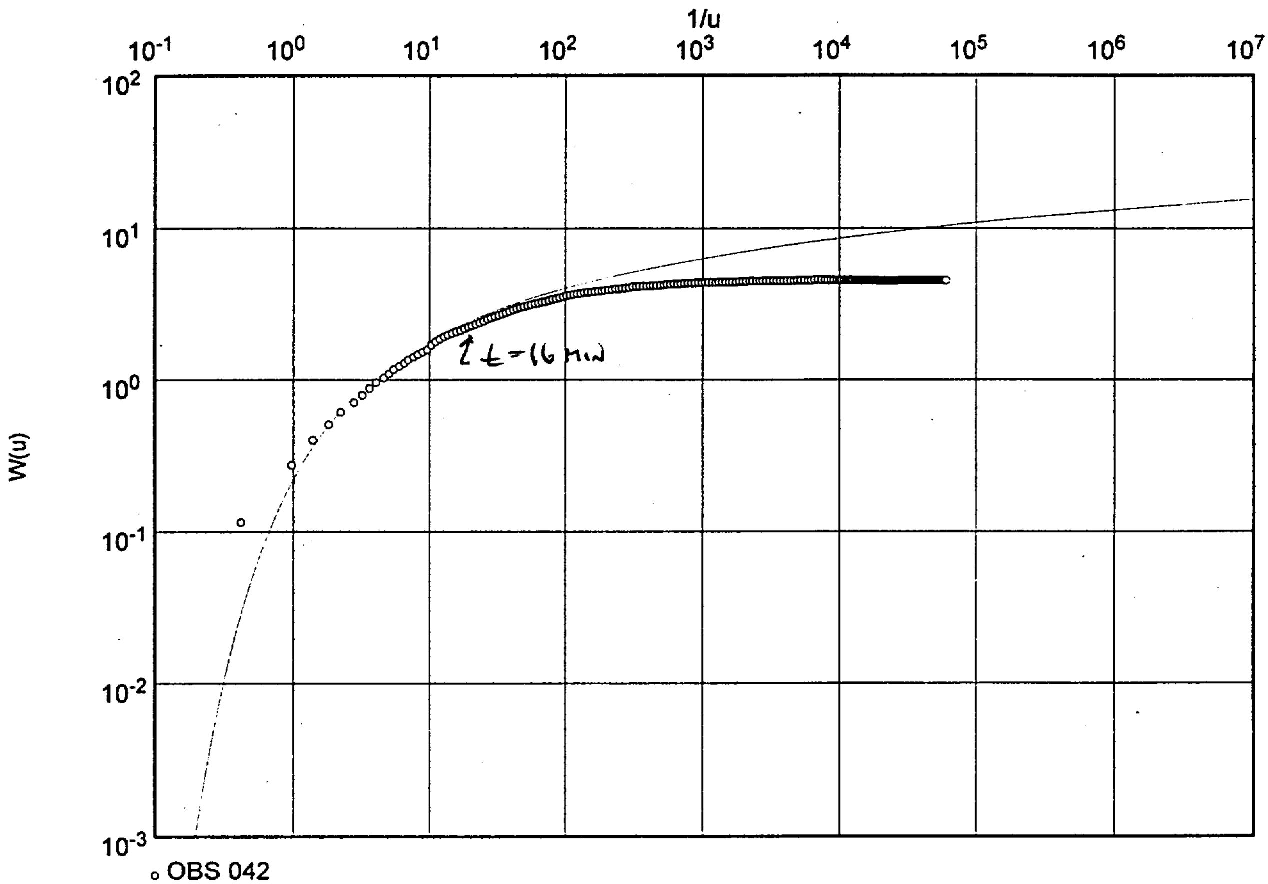
| | | | | | | |
|---|---|---|---|---|---|---|
| 125.65 | 26.563 | 18.446 | 13.885 | 6.013 | 16.085 | 22.828 |
| 133.11 | 26.619 | 18.472 | 13.906 | 6.015 | 16.111 | 22.826 |
| 141.01 | 26.658 | 18.543 | 13.931 | 6.016 | 16.14 | 22.817 |
| 149.38 | 26.679 | 18.556 | 13.945 | 6.016 | 16.16 | 22.819 |
| 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

| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Theis analysis method<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>Evaluated by: | Date: 28.11.1999 |
|---|---|---|---|

| | |
|---|---|
| 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 | |



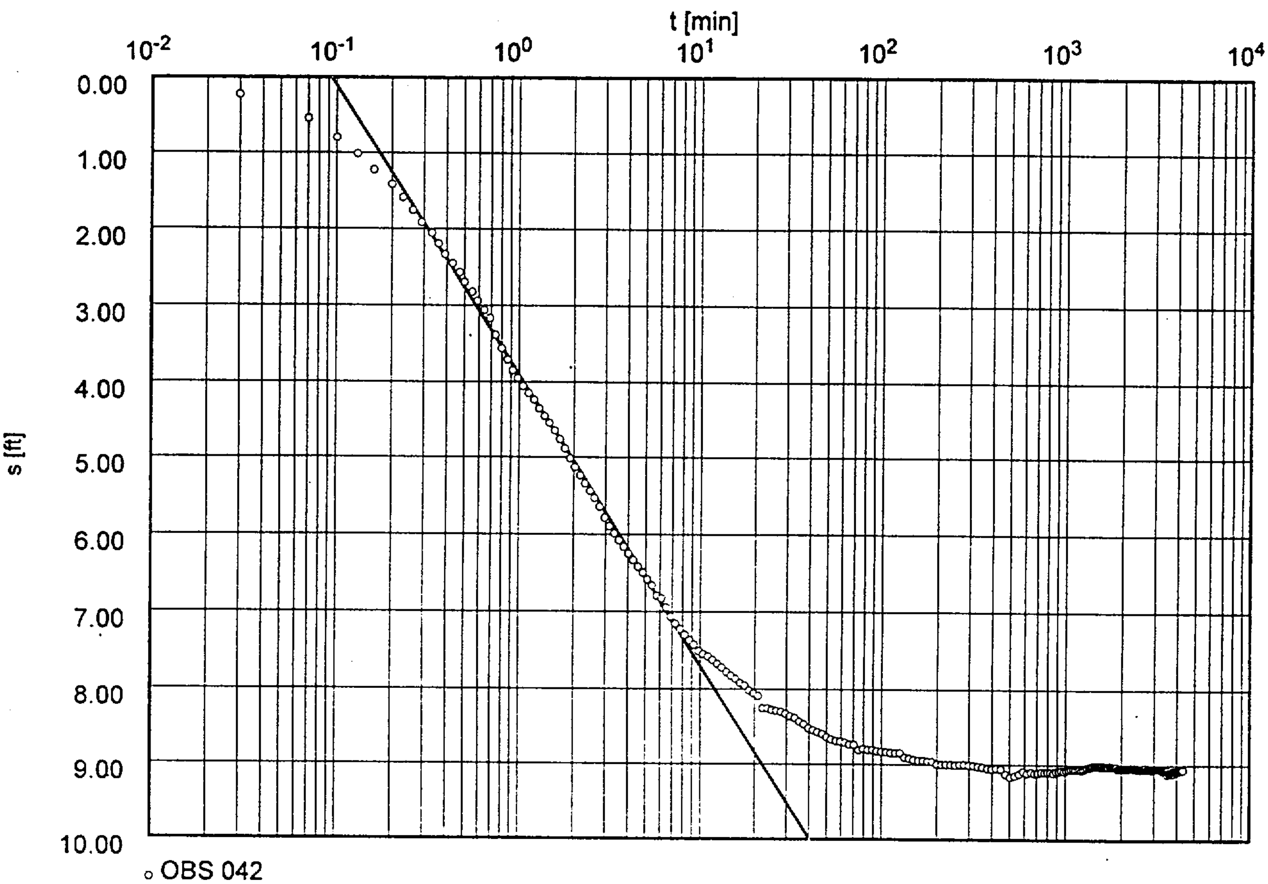

Transmissivity [ft²/min]: $2.03 \times 10^{-1}$ = 292.3 ft²/D

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

Aquifer thickness [ft]: 30.00

| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Time-Drawdown-method after<br>COOPER & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>Evaluated by: / Date: 28.11.1999 |
|---|---|---|

| | |
|---|---|
| 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 | |

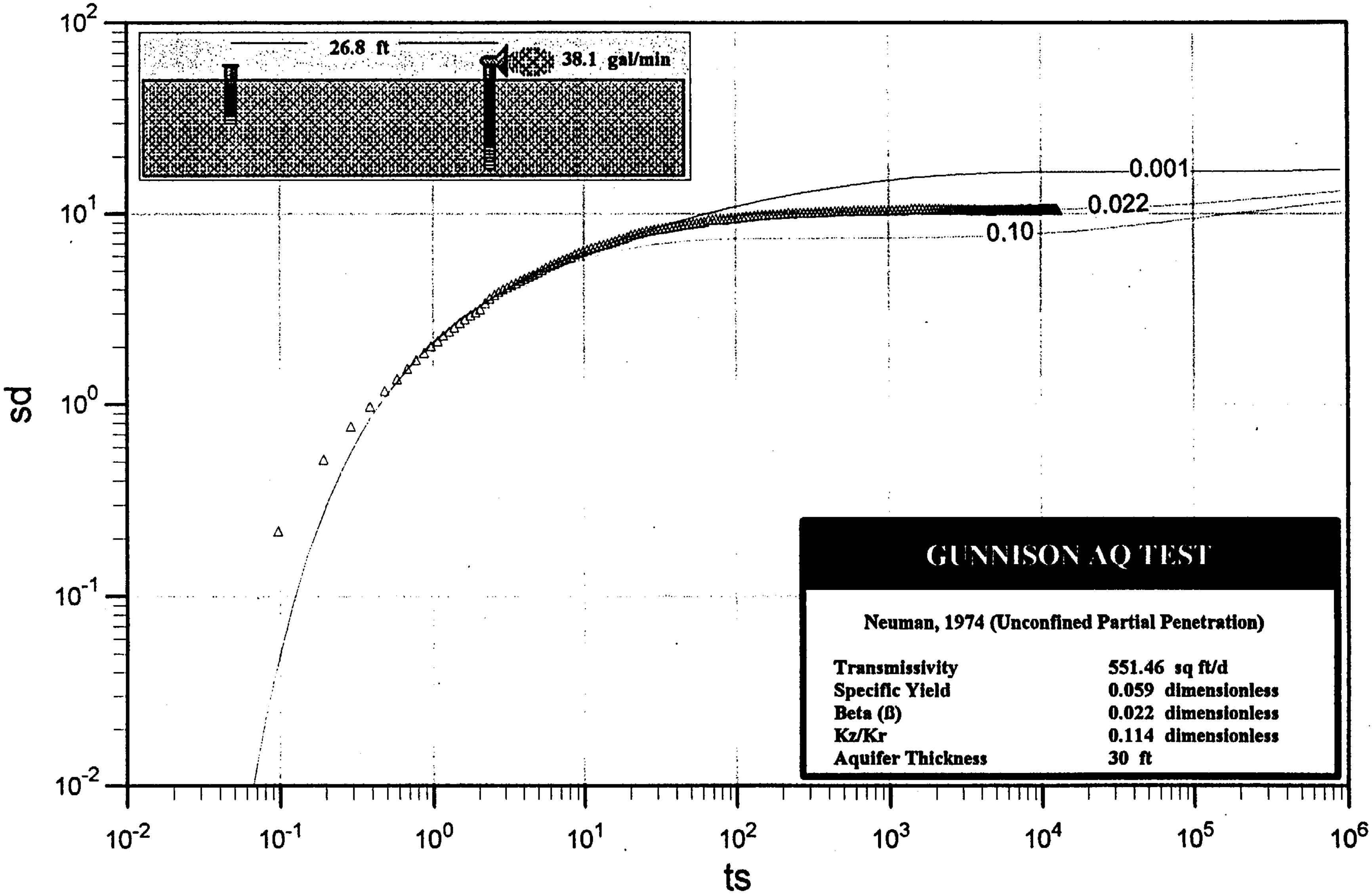



Transmissivity [ft²/min]: $2.45 \times 10^{-1}$ = 352.8 Ft²/D

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

Aquifer thickness [ft]: 30.00

# WELL OBS 042 / 041 AQ TEST 2



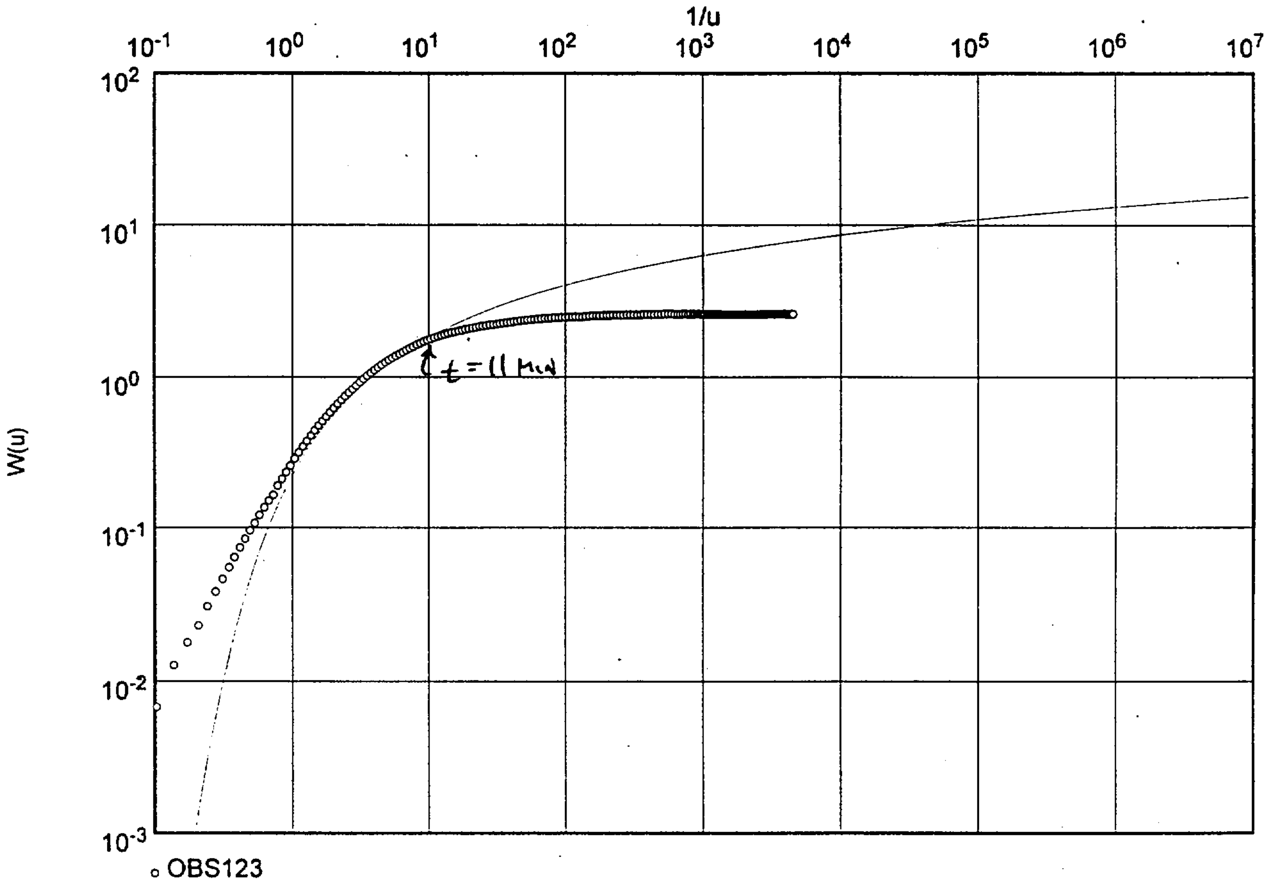

## GUNNISON AQ TEST

**Neuman, 1974 (Unconfined Partial Penetration)**

| | |
|---|---|
| Transmissivity | 551.46 sq ft/d |
| Specific Yield | 0.059 dimensionless |
| Beta (ß) | 0.022 dimensionless |
| Kz/Kr | 0.114 dimensionless |
| Aquifer Thickness | 30 ft |

| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Theis analysis method<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 | |



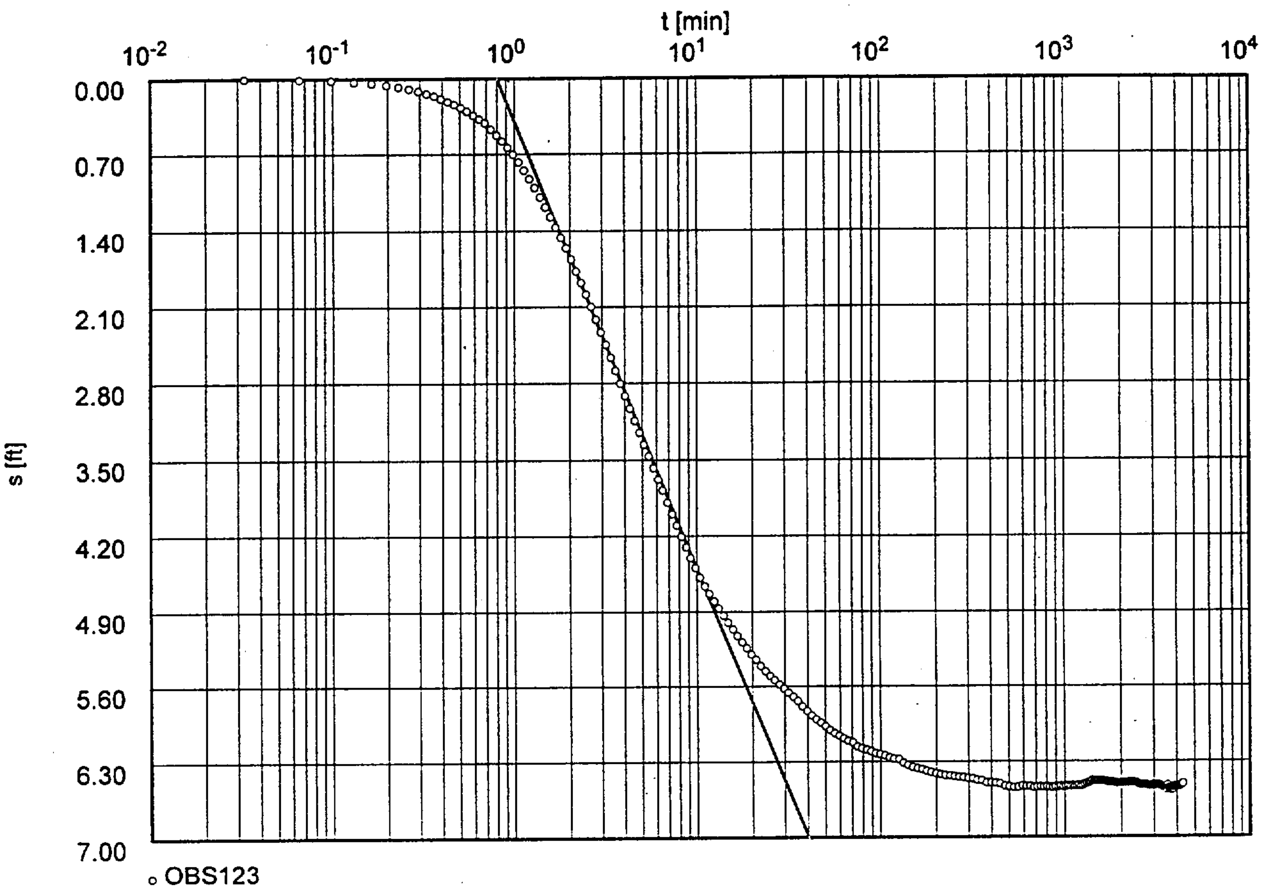

Transmissivity [ft²/min]: $1.61 \times 10^{-1}$ = 231.8 ft²/d

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

Aquifer thickness [ft]: 30.00

| | | |
|---|---|---|
| **MACTEC-ERS**<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Time-Drawdown-method after<br>COOPER & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 | |

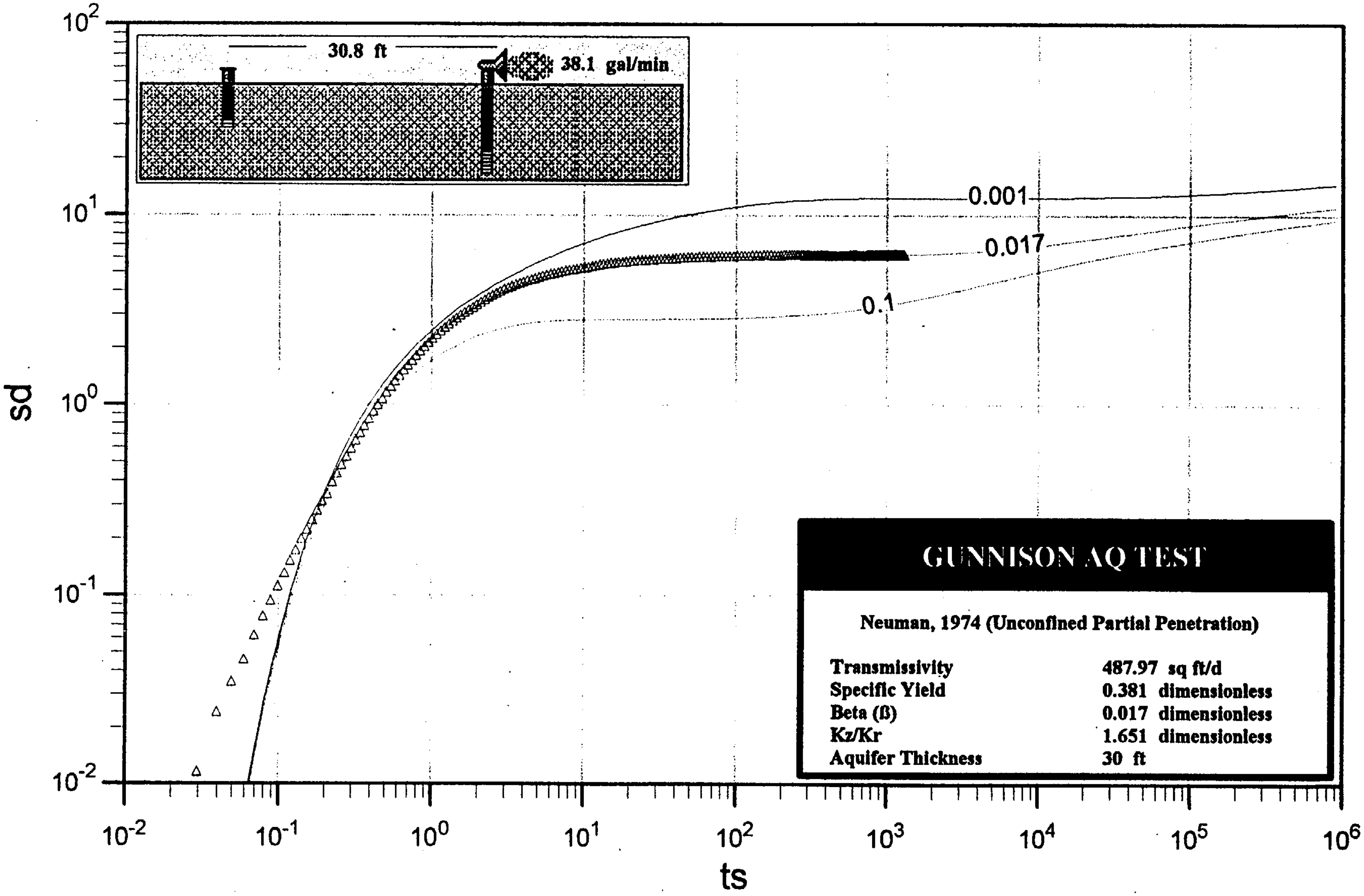



Transmissivity [ft²/min]: $2.26 \times 10^{-1}$ = 325.4 Ft²/D

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

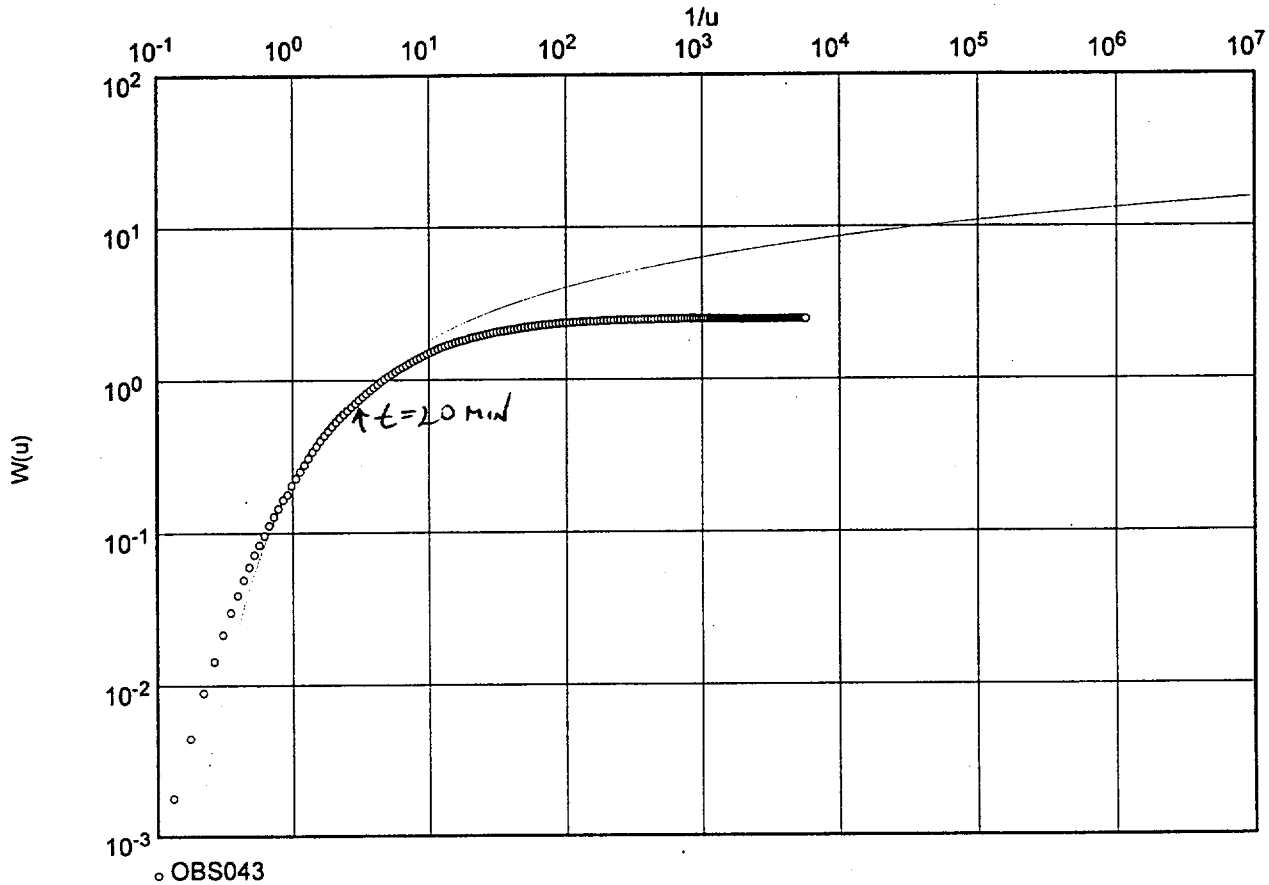
Aquifer thickness [ft]: 30.00

# WELL OBS 123 / 041 AQ TEST 2



| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Theis analysis method<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 | |



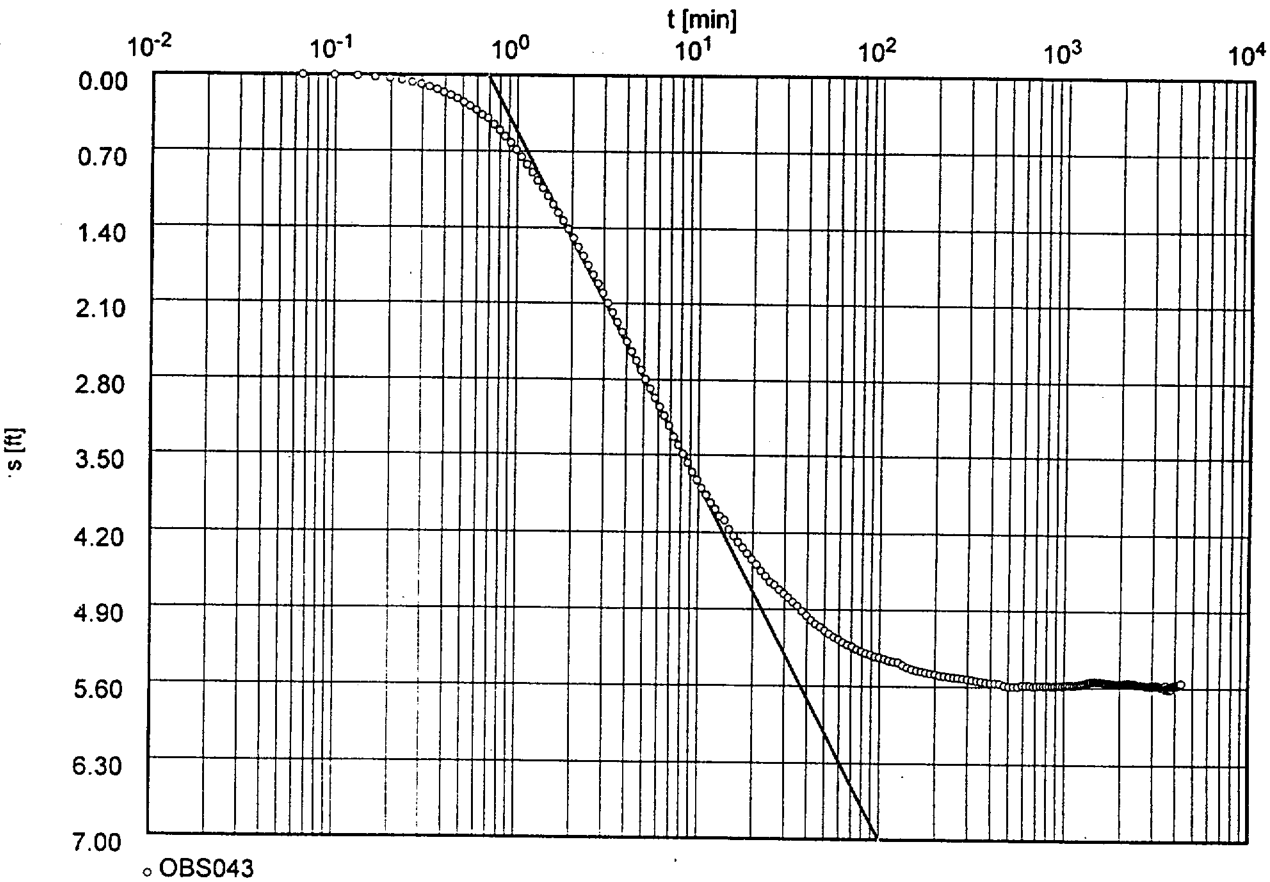

Transmissivity [ft²/min]: $1.81 \times 10^{-1}$ = 260.6 FT²/D

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

Aquifer thickness [ft]: 30.00

| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Time-Drawdown-method after<br>COOPER & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 | |

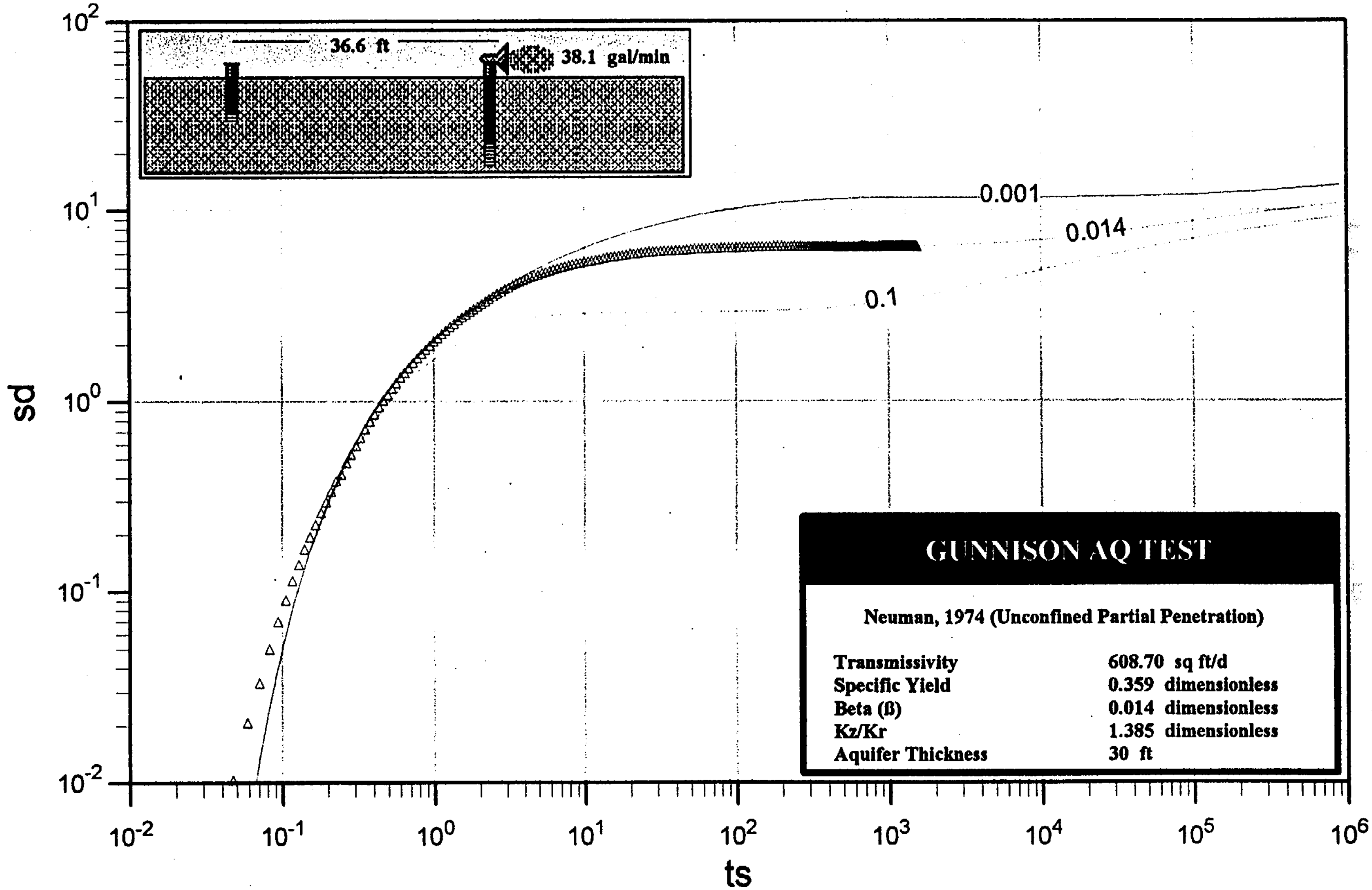



Transmissivity [ft²/min]: $2.88 \times 10^{-1}$ = 414.7 ft²/d

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

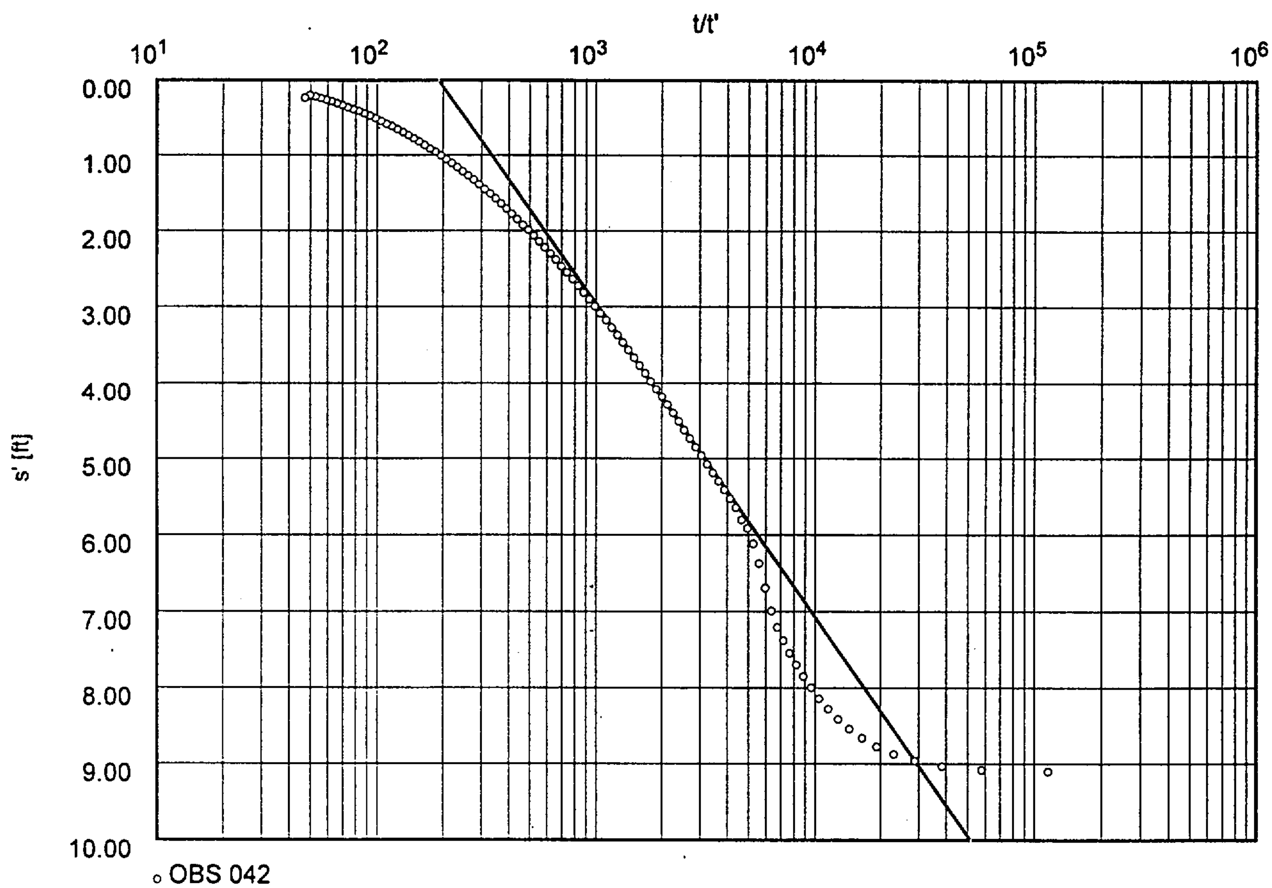
Aquifer thickness [ft]: 30.00

# WELL OBS 043 / 041 AQ TEST 2



| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Recovery method after<br>THEIS & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>Evaluated by: Date: 02.12.1999 |
|---|---|---|

| | |
|---|---|
| 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 |



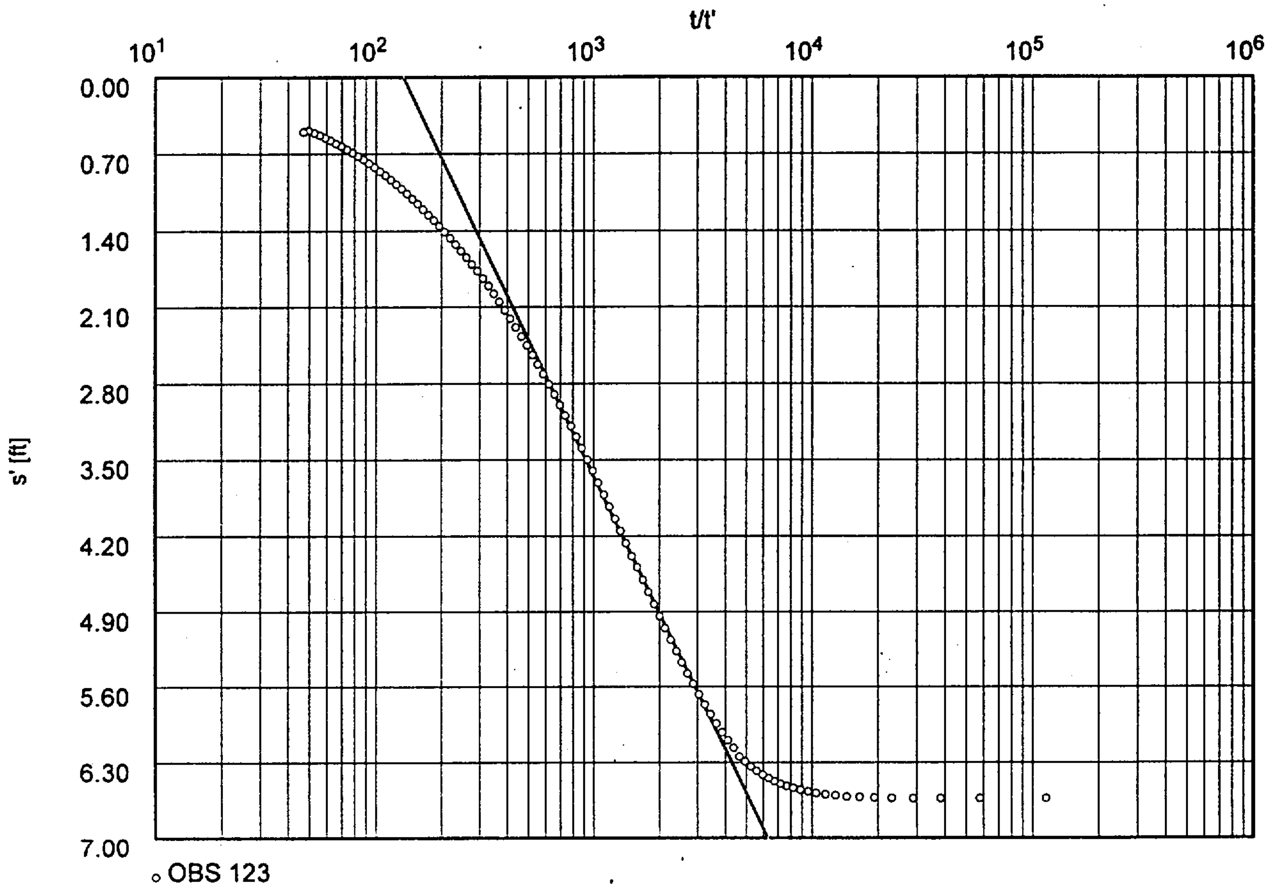

Transmissivity [ft²/min]: $2.26 \times 10^{-1}$ = 325.4 ft²/d

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

Aquifer thickness [ft]: 30.00

| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Recovery method after<br>THEIS & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 |



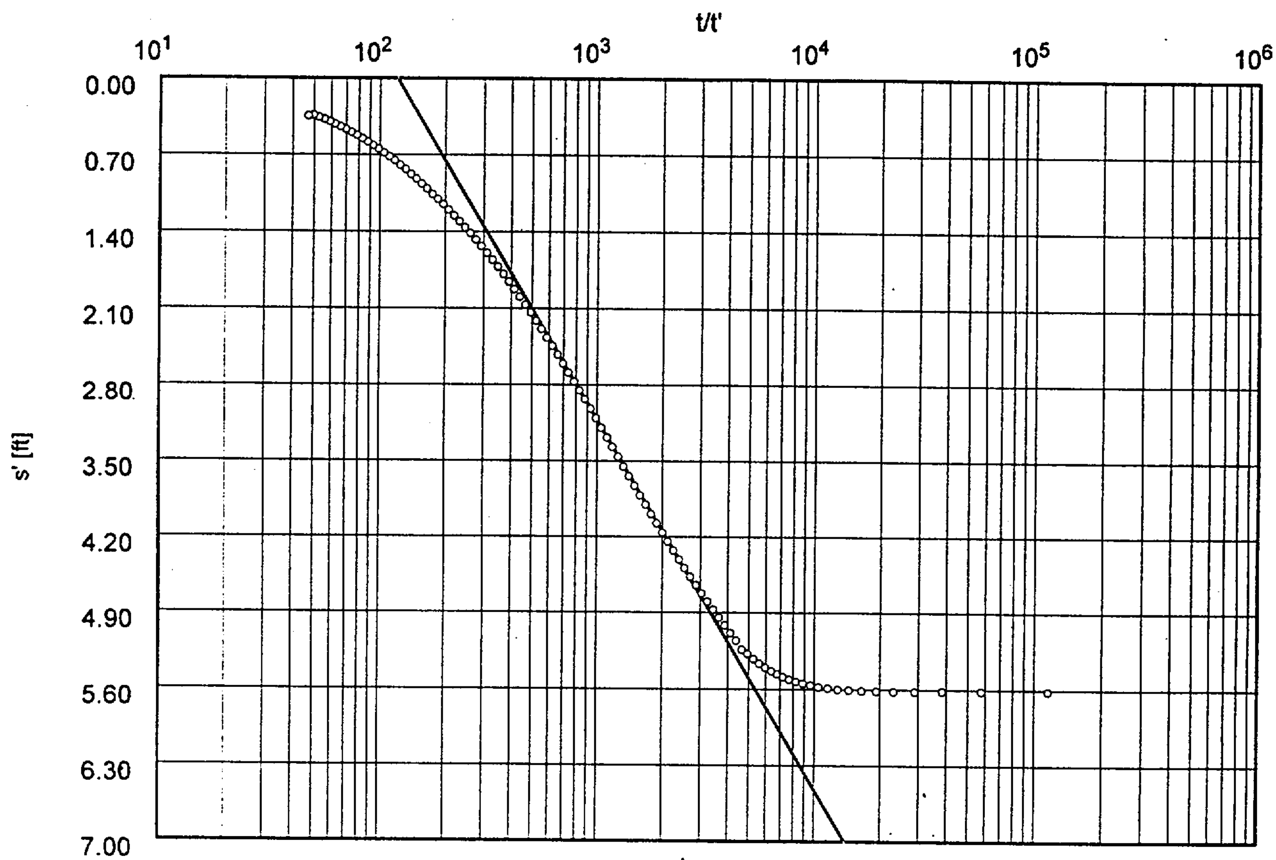

Transmissivity [ft²/min]: $2.22 \times 10^{-1}$ = 319.7 FT²/D

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

Aquifer thickness [ft]: 30.00

| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Recovery method after<br>THEIS & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 |




∘ OBS 043

Transmissivity [ft²/min]: $2.74 \times 10^{-1}$ = 394.6 ft²/D

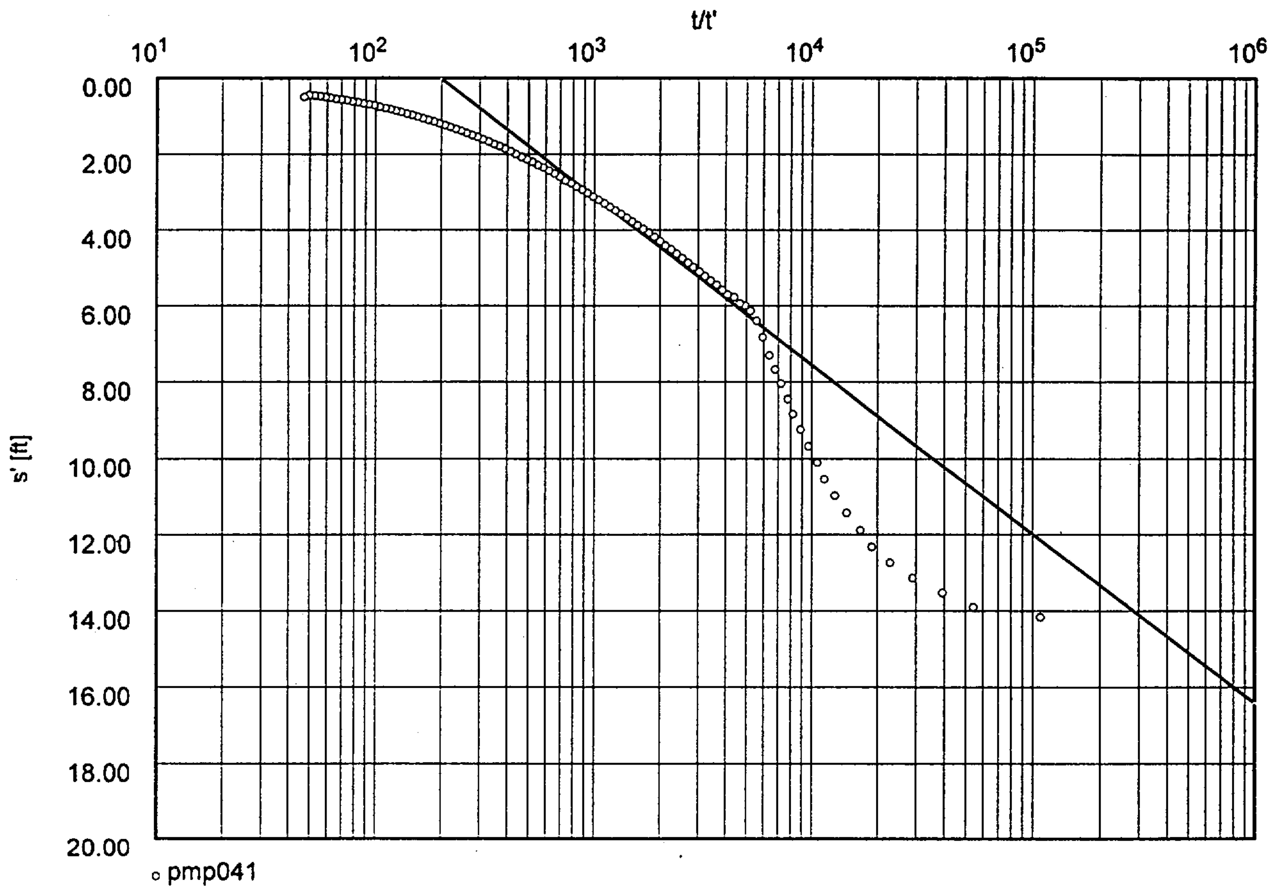
Hydraulic conductivity [ft/min]: $9.16 \times 10^{-3}$

Aquifer thickness [ft]: 30.00

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

| | | |
|---|---|---|
| Pumping test analysis Recovery method after THEIS & JACOB 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 [ft²/min]: $2.10 \times 10^{-1}$ = 302.4 FT²/D

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

Aquifer thickness [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**

| ELAPSED TIME (min) | WELL 041 DTW (ft btoc) | WELL 042 DTW (ft btoc) | WELL 043 DTW (ft btoc) | WELL 123 DTW (ft btoc) | INCHES Hg |
|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|
| 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 |

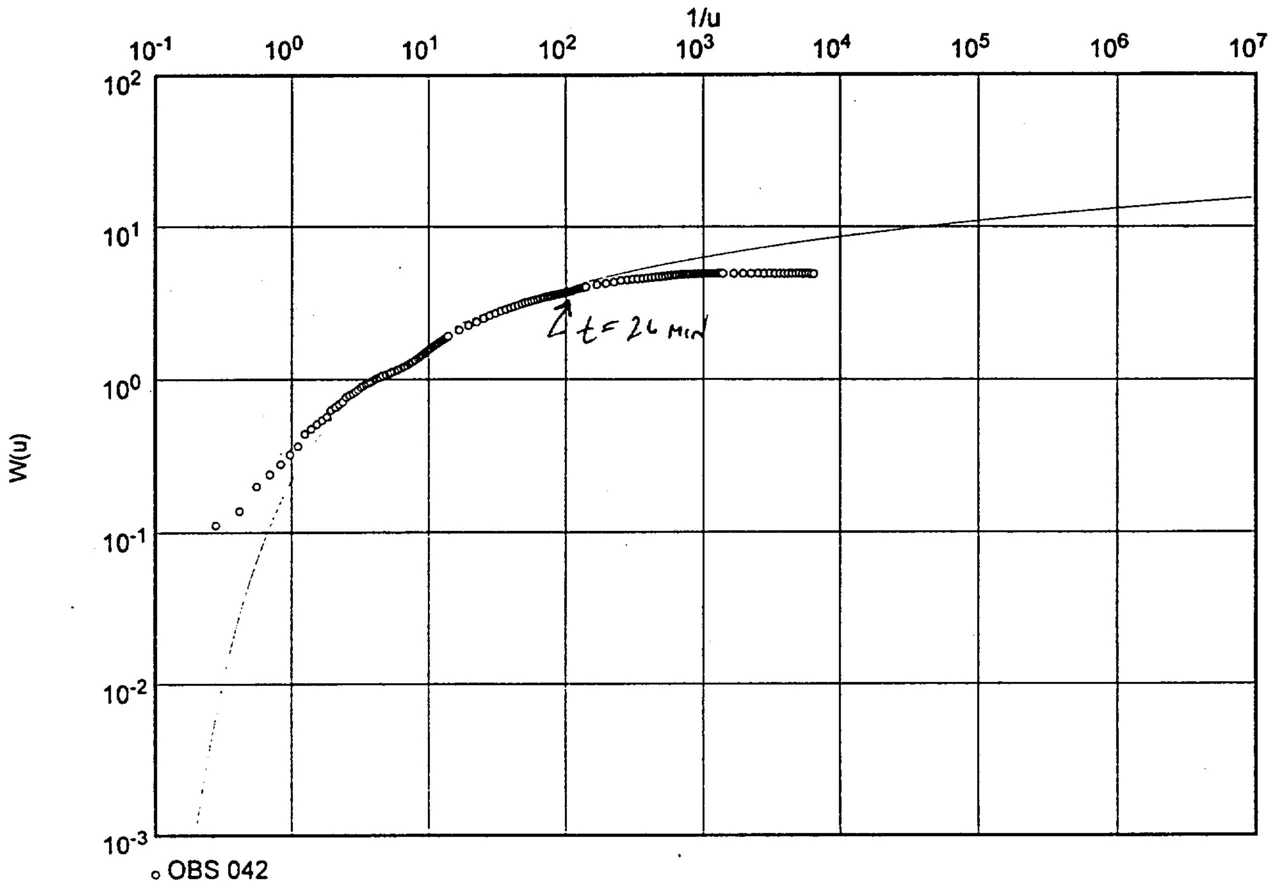
| | | | | | |
|---|---|---|---|---|---|
| 4338.28 | 11.871 | 11.843 | 12.131 | 13.919 | 22.74 |
| 4338.48 | 11.763 | 11.732 | 12.031 | 13.787 | 22.738 |
| 4338.69 | 11.659 | 11.624 | 11.93 | 13.659 | 22.738 |
| 4338.91 | 11.551 | 11.515 | 11.831 | 13.53 | 22.738 |
| 4339.15 | 11.448 | 11.413 | 11.731 | 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**

| | | |
|---|---|---|
| **MACTEC-ERS**<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Theis analysis method<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>Evaluated by: / Date: 02.12.1999 |

| | |
|---|---|
| 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 | |



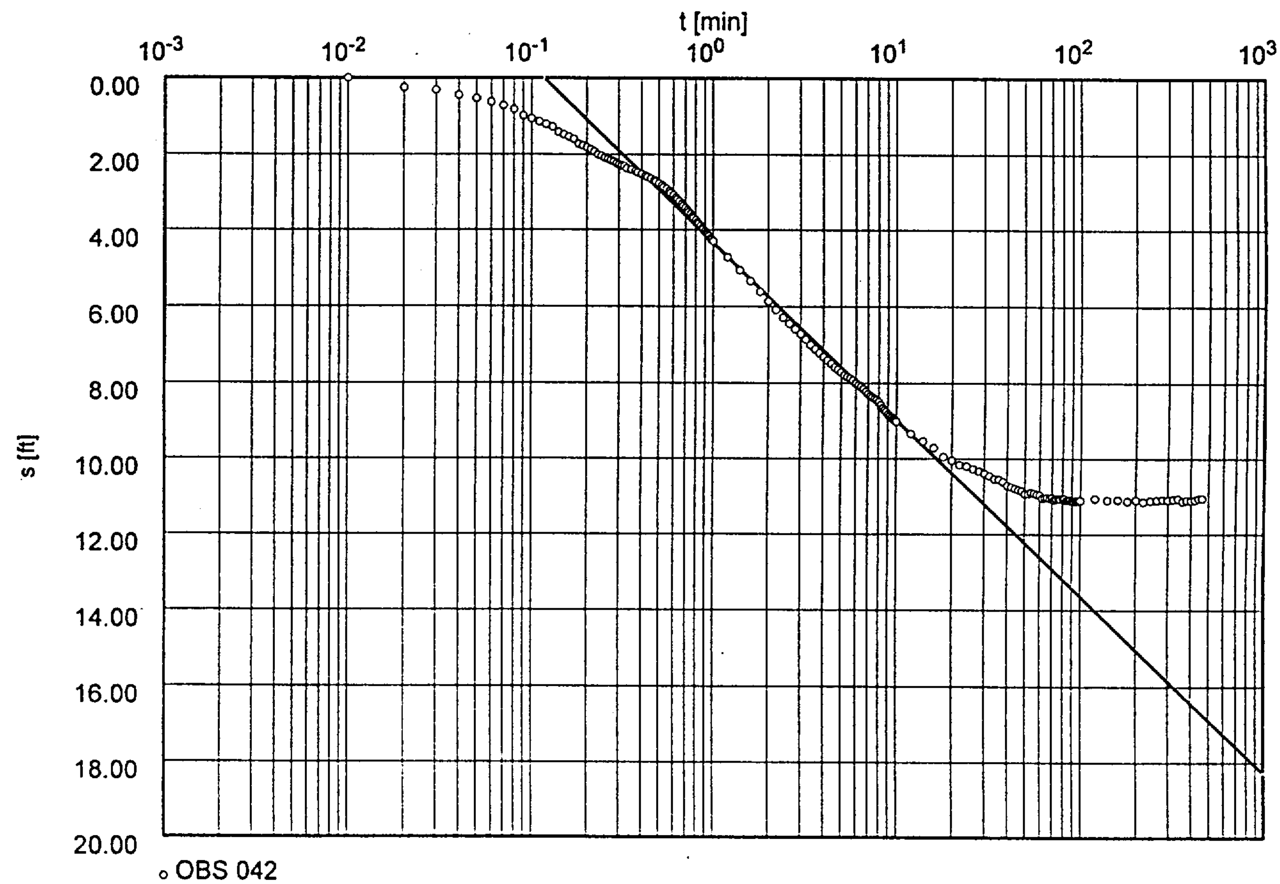

Transmissivity [ft²/min]: $2.12 \times 10^{-1}$ = 305.3 ft²/d

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

Aquifer thickness [ft]: 30.00

| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Time-Drawdown-method after<br>COOPER & JACOB<br>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 042, r = 26.8' | |
| Discharge 44.70 U.S.gal/min | |

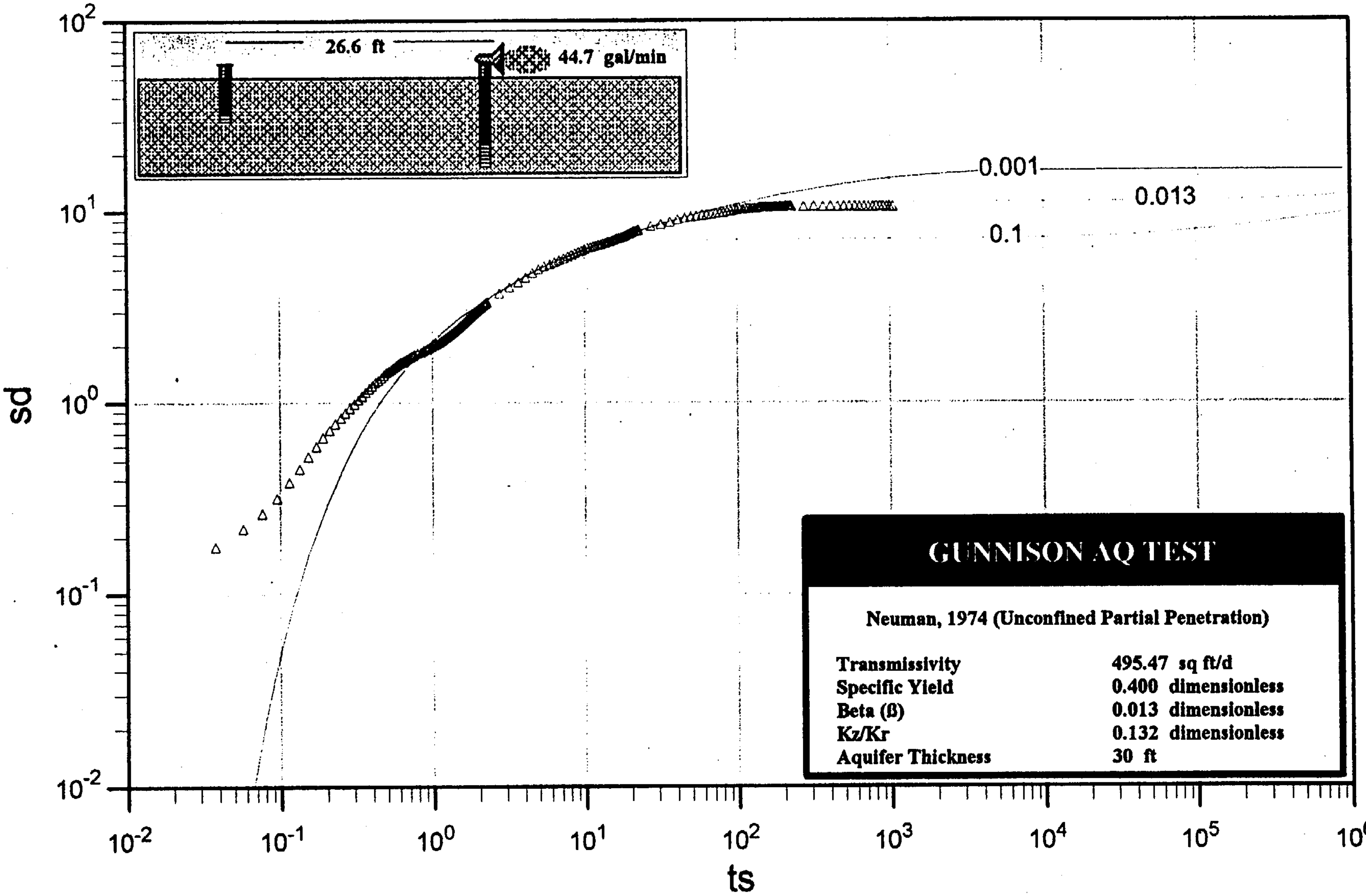



Transmissivity [ft²/min]: $2.35 \times 10^{-1}$ = 338.4 ft²/d

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

Aquifer thickness [ft]: 30.00

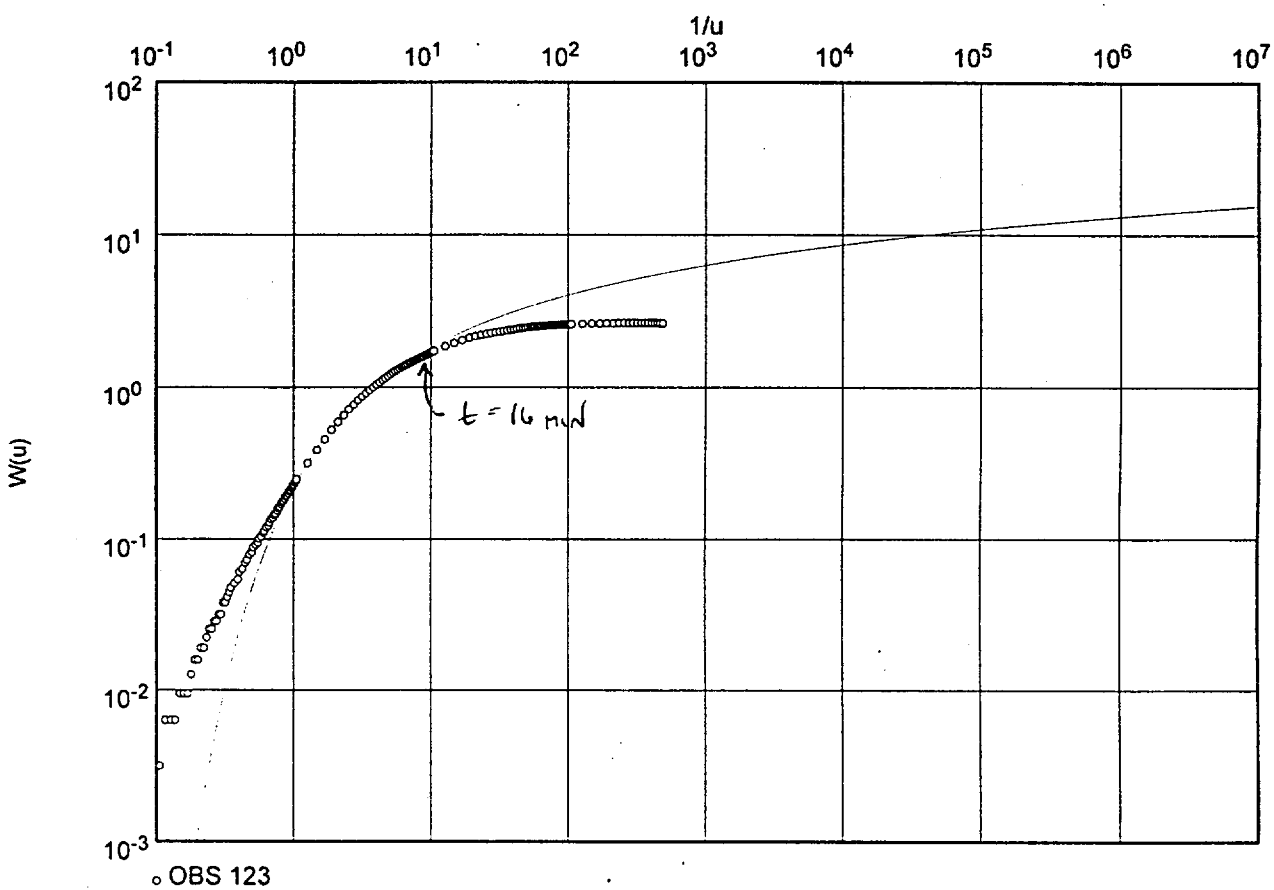
# WELL OBS 042 / 041 AQ TEST 3



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

| | | |
|---|---|---|
| Pumping test analysis<br>Theis analysis method<br>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 | |



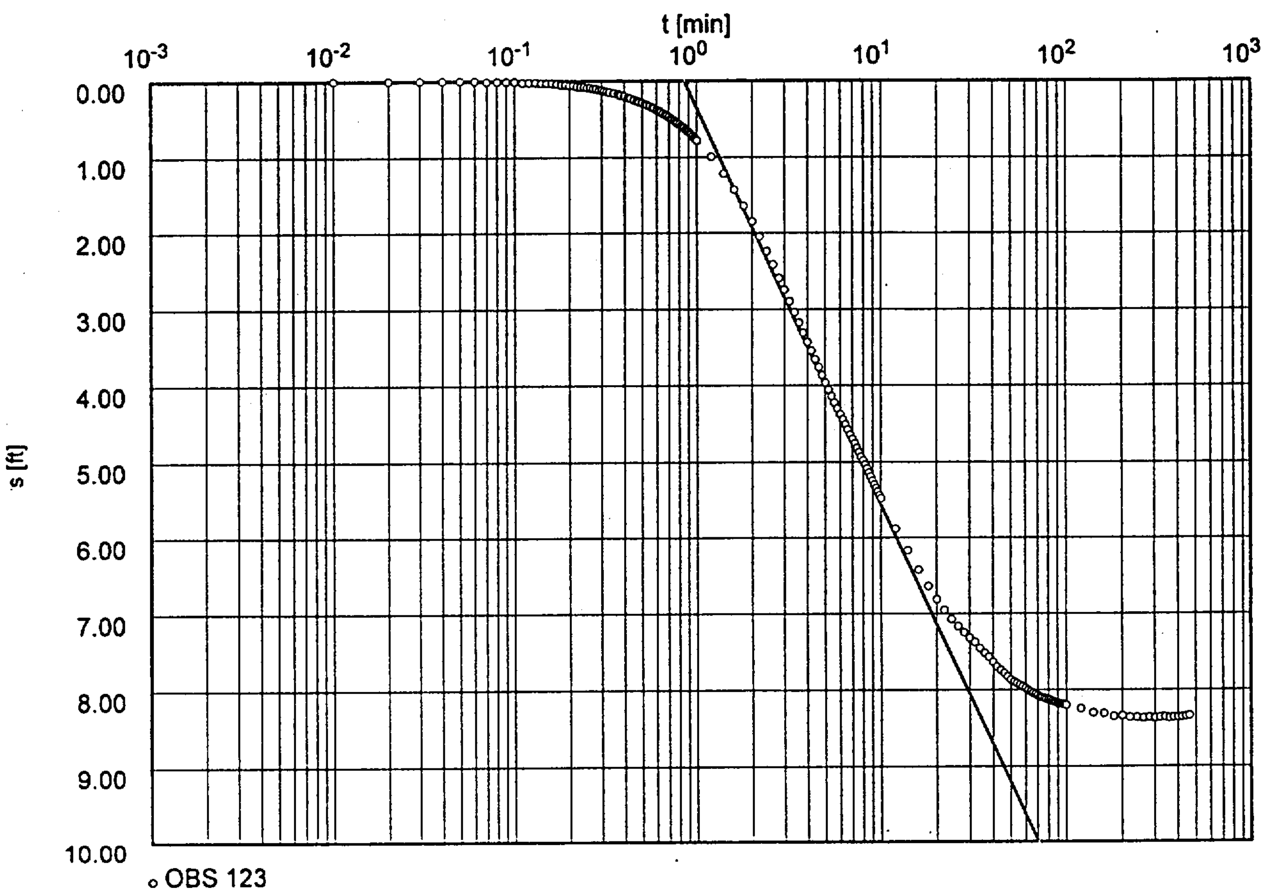

Transmissivity [ft²/min]: $1.50 \times 10^{-1}$ = 216.0 ft²/d

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

Aquifer thickness [ft]: 30.00

| | | |
|---|---|---|
| **MACTEC-ERS**<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Time-Drawdown-method after<br>COOPER & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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', Sl = 53.2' - 58.2' | |
| Discharge 44.70 U.S.gal/min | |

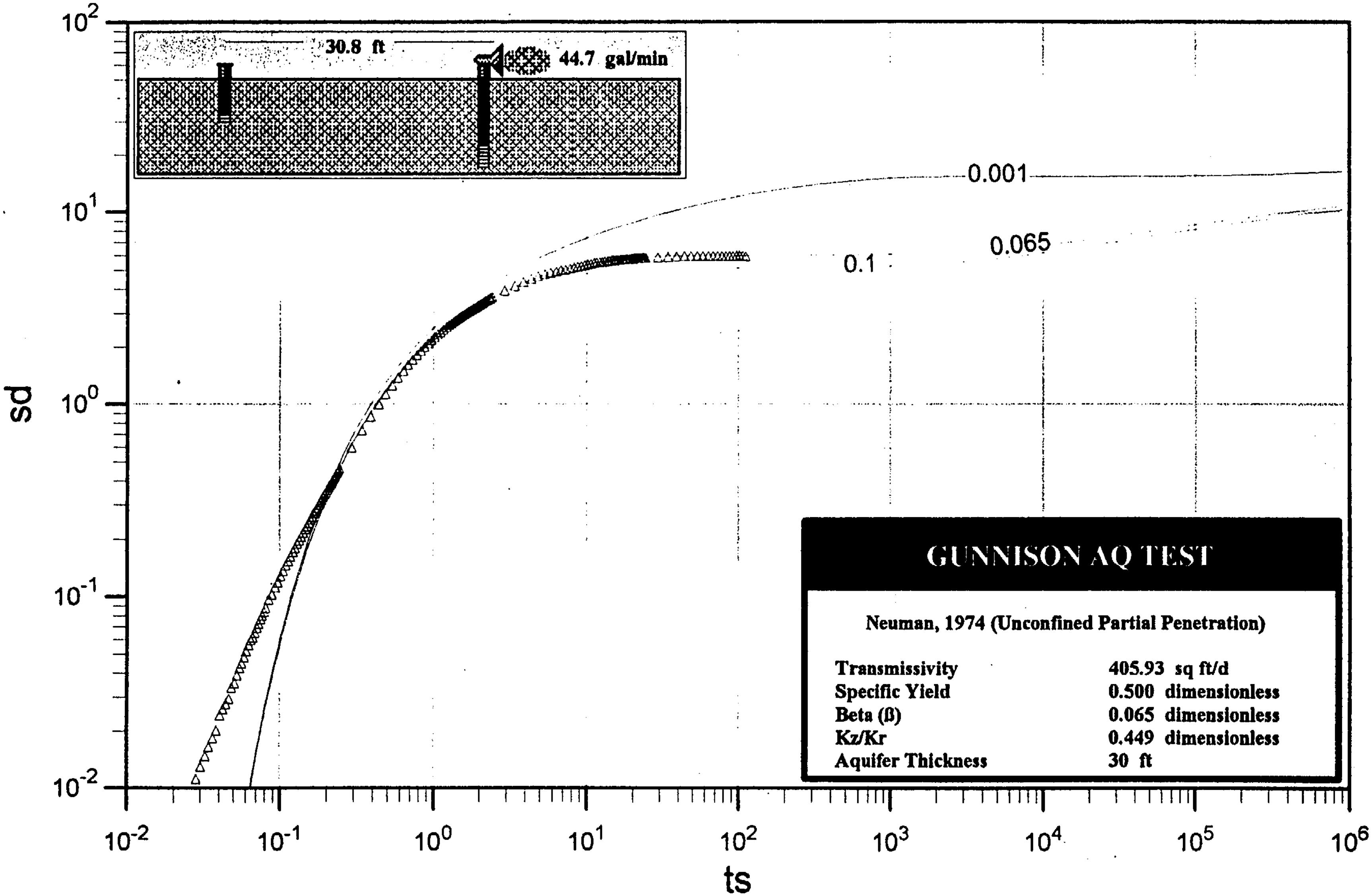



Transmissivity [ft²/min]: $2.09 \times 10^{-1}$ = 301.0 ft²/d

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

Aquifer thickness [ft]: 30.00

# WELL OBS 123 / 041 AQ TEST 3



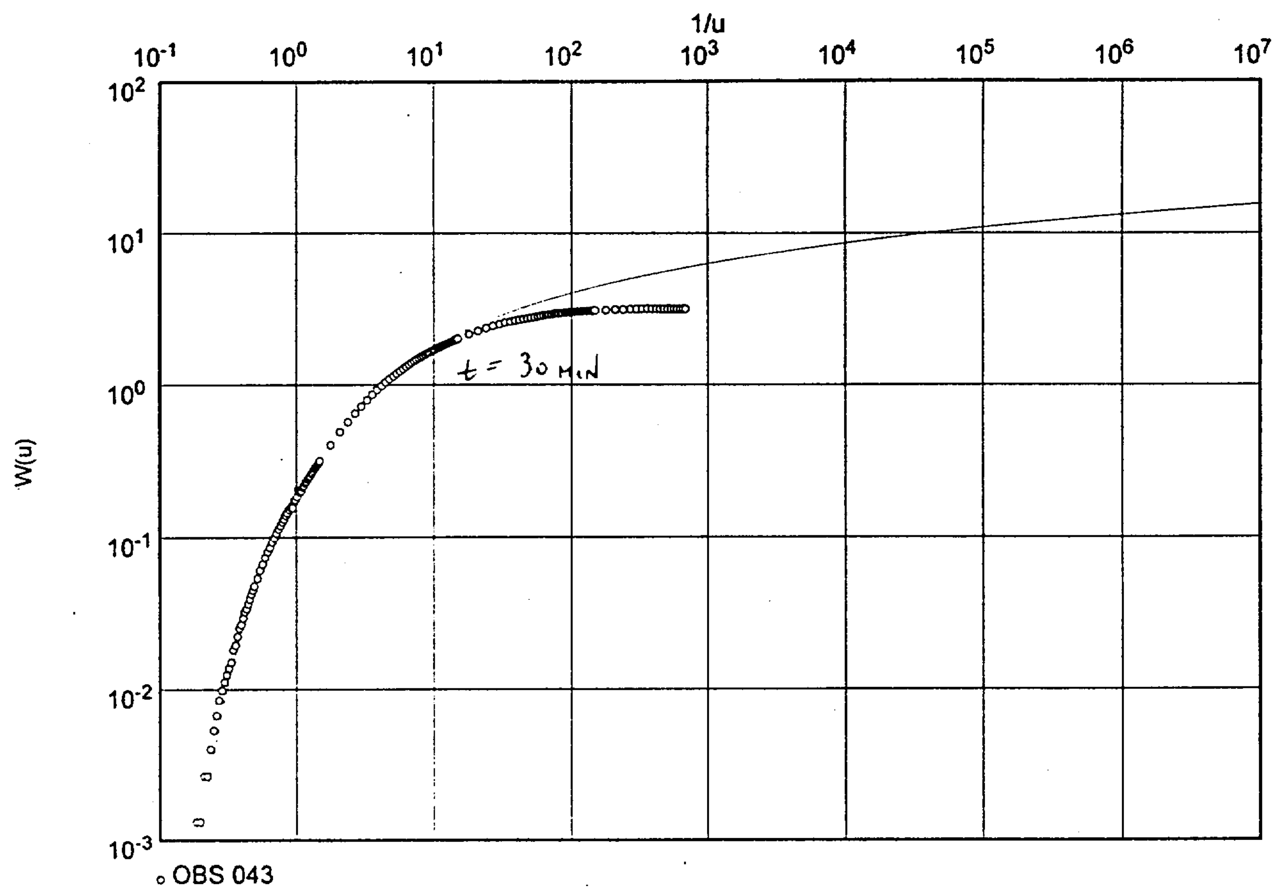

**GUNNISON AQ TEST**

**Neuman, 1974 (Unconfined Partial Penetration)**

| | |
|---|---|
| **Transmissivity** | **405.93 sq ft/d** |
| **Specific Yield** | **0.500 dimensionless** |
| **Beta (ß)** | **0.065 dimensionless** |
| **Kz/Kr** | **0.449 dimensionless** |
| **Aquifer Thickness** | **30 ft** |

| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Theis analysis method<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>Evaluated by: / Date: 02.12.1999 |
|---|---|---|

| | |
|---|---|
| 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 | |



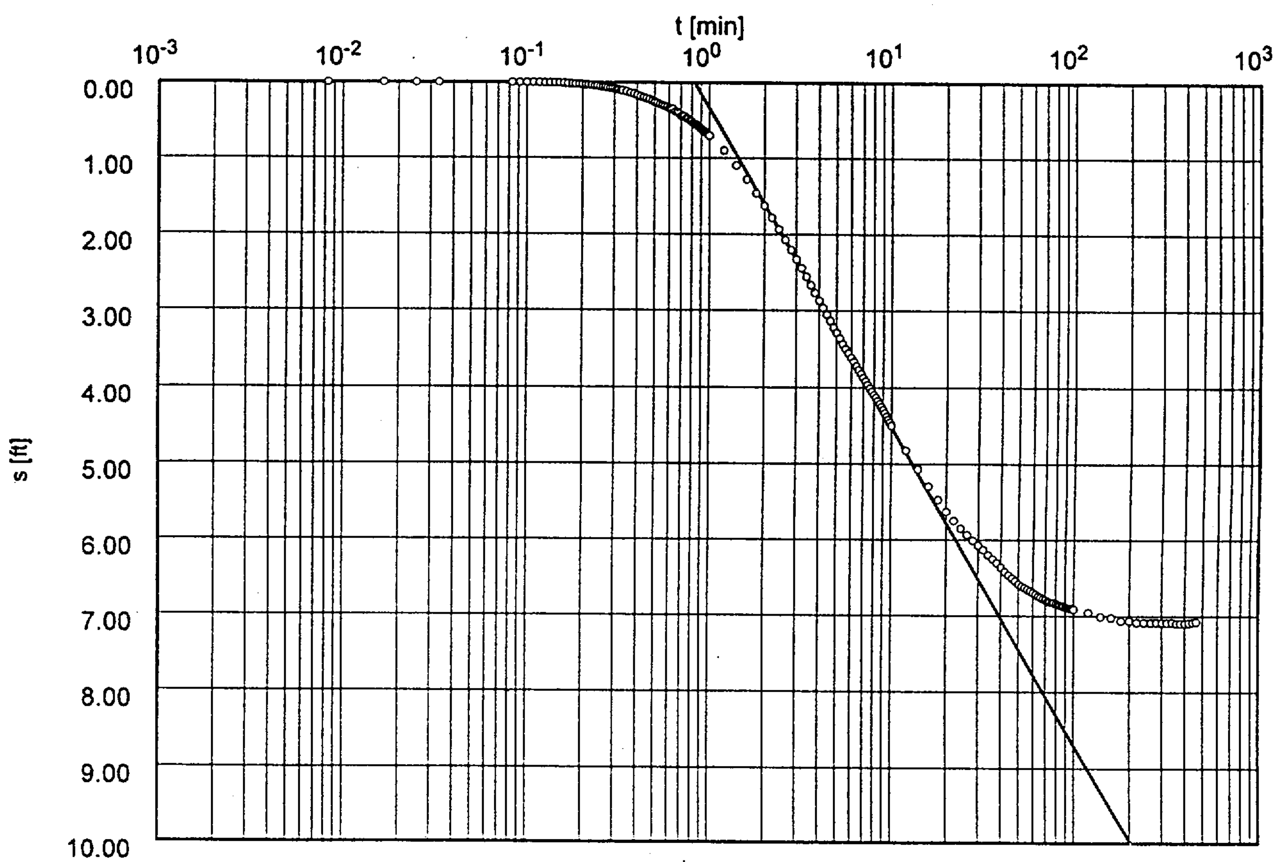

Transmissivity [ft²/min]: $2.12 \times 10^{-1}$ = 305.3 ft²/d

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

Aquifer thickness [ft]: 30.00

| | | |
|---|---|---|
| **MACTEC-ERS**<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Time-Drawdown-method after<br>COOPER & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>Evaluated by: / Date: 02.12.1999 |

| | |
|---|---|
| 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 | |



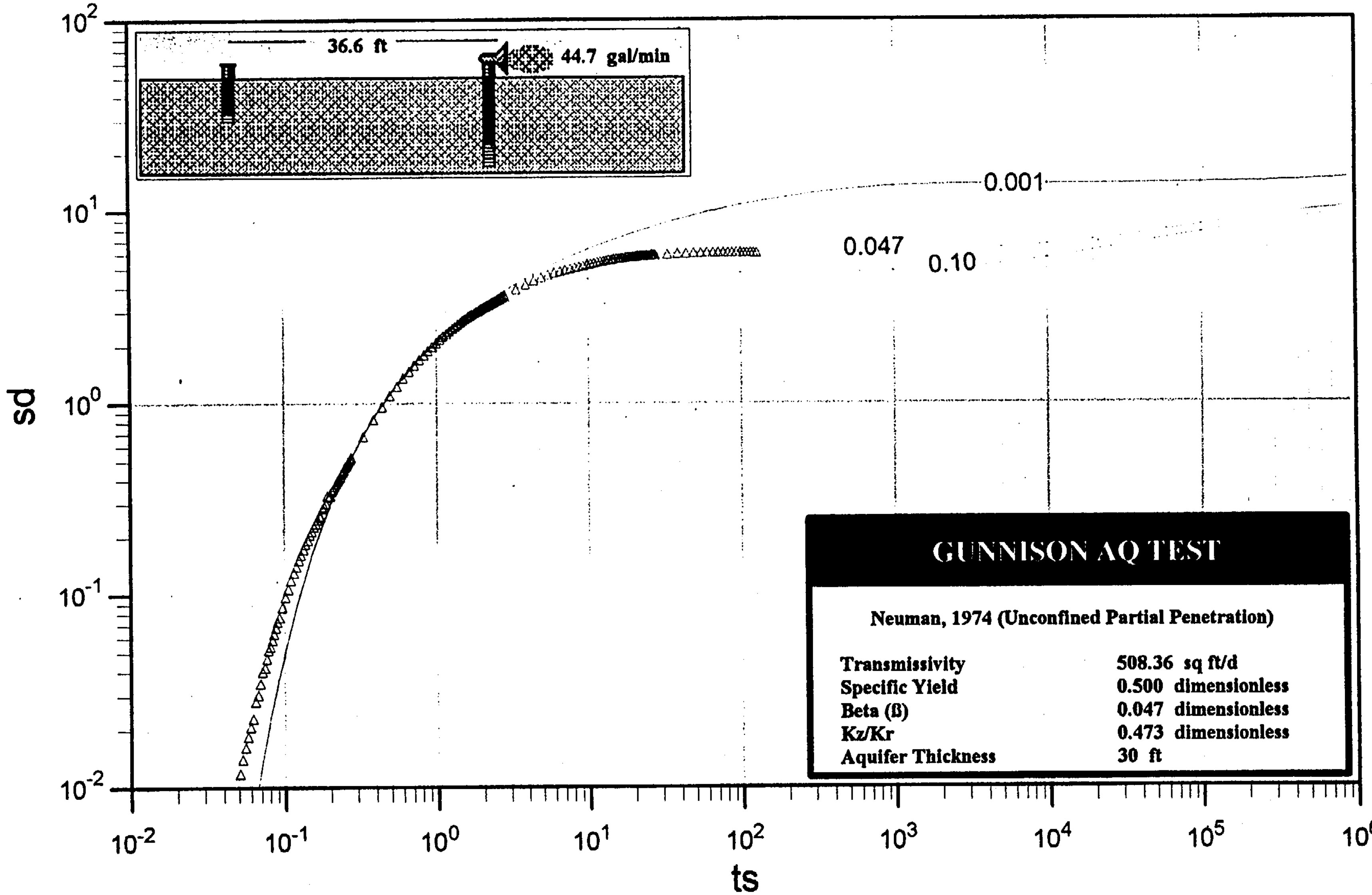

∘ OBS 043

Transmissivity [ft²/min]: $2.61 \times 10^{-1}$ = 375.8 FT$^2$/D

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

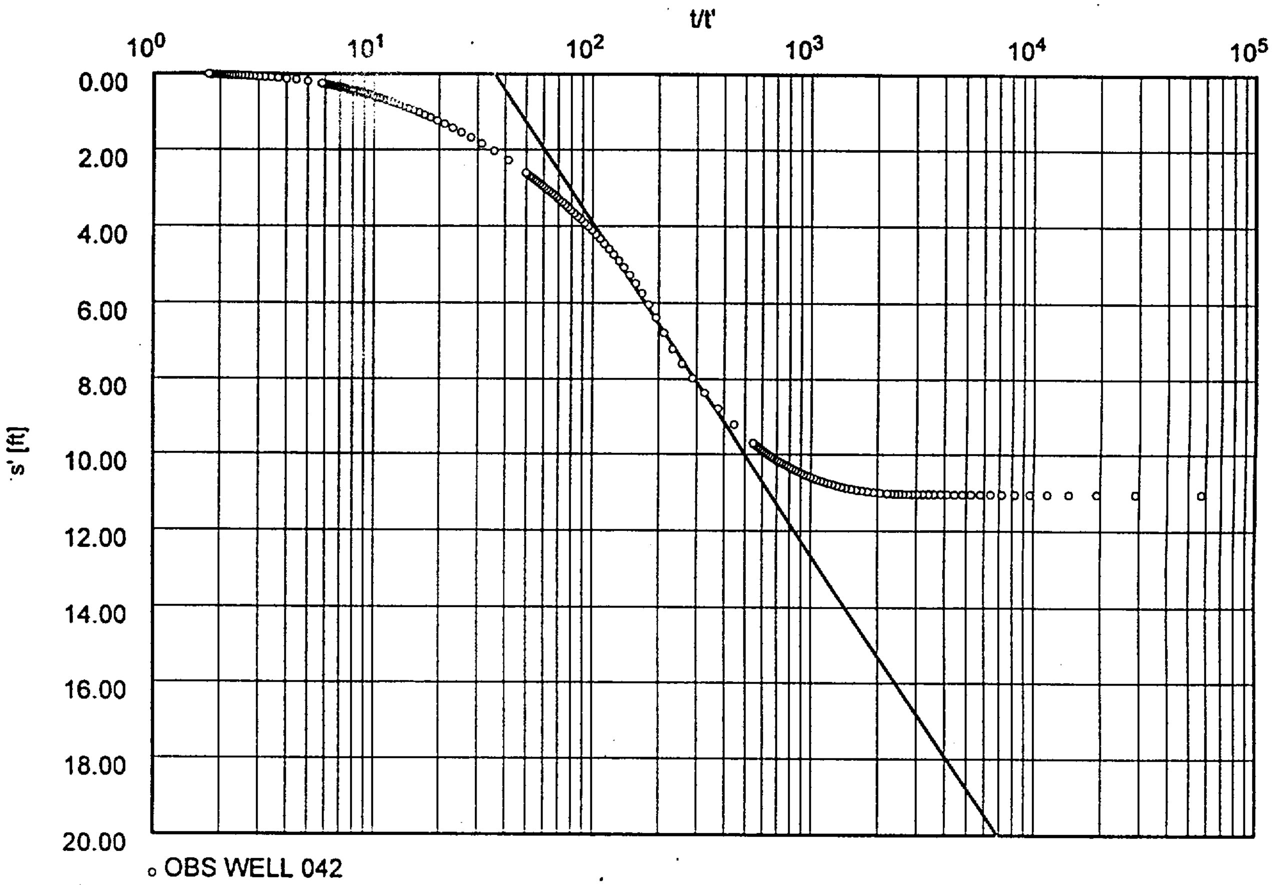
Aquifer thickness [ft]: 30.00

# WELL OBS 043 / O41 AQ TEST 3



| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Recovery method after<br>THEIS & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>Evaluated by: / Date: 06.12.1999 |
|---|---|---|

| | |
|---|---|
| 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 |



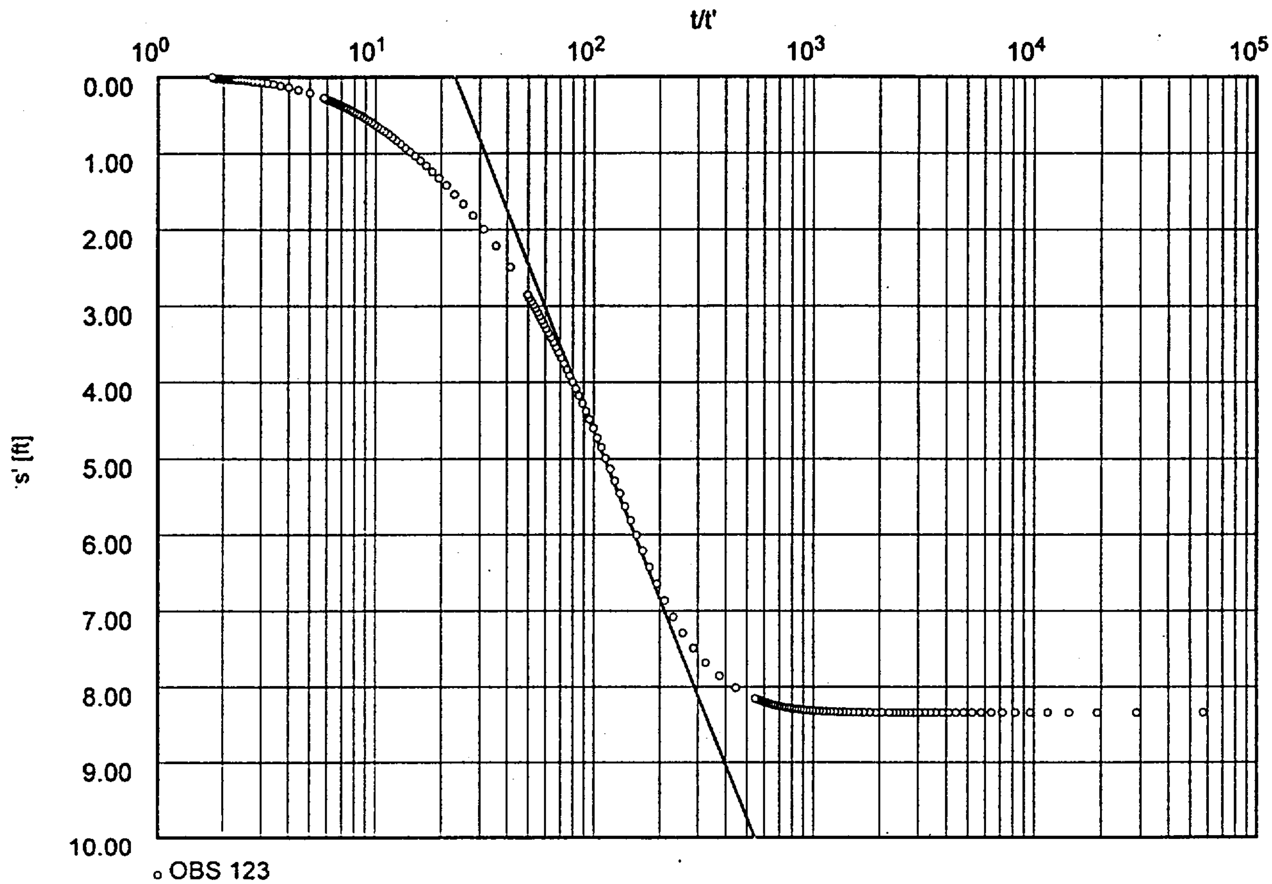

Transmissivity [ft²/min]: $1.24 \times 10^{-1}$ = 178.6 ft²/d

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

Aquifer thickness [ft]: 30.00

| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Recovery method after<br>THEIS & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>Evaluated by: Date: 06.12.1999 |
|---|---|---|

| | |
|---|---|
| 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 |



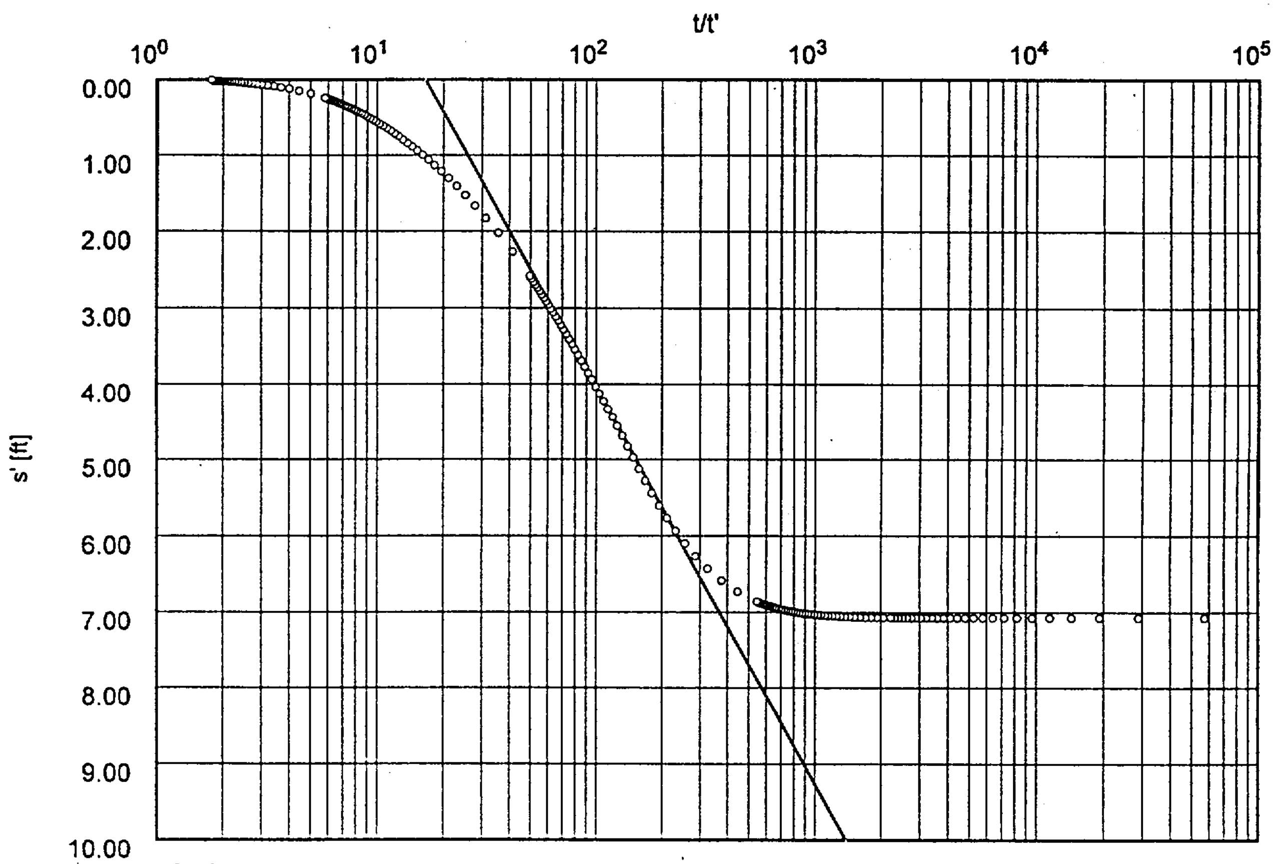

Transmissivity [ft²/min]: $1.50 \times 10^{-1}$ = 216 ft²/D

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

Aquifer thickness [ft]: 30.00

| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Recovery method after<br>THEIS & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 |




∘ OBS 043

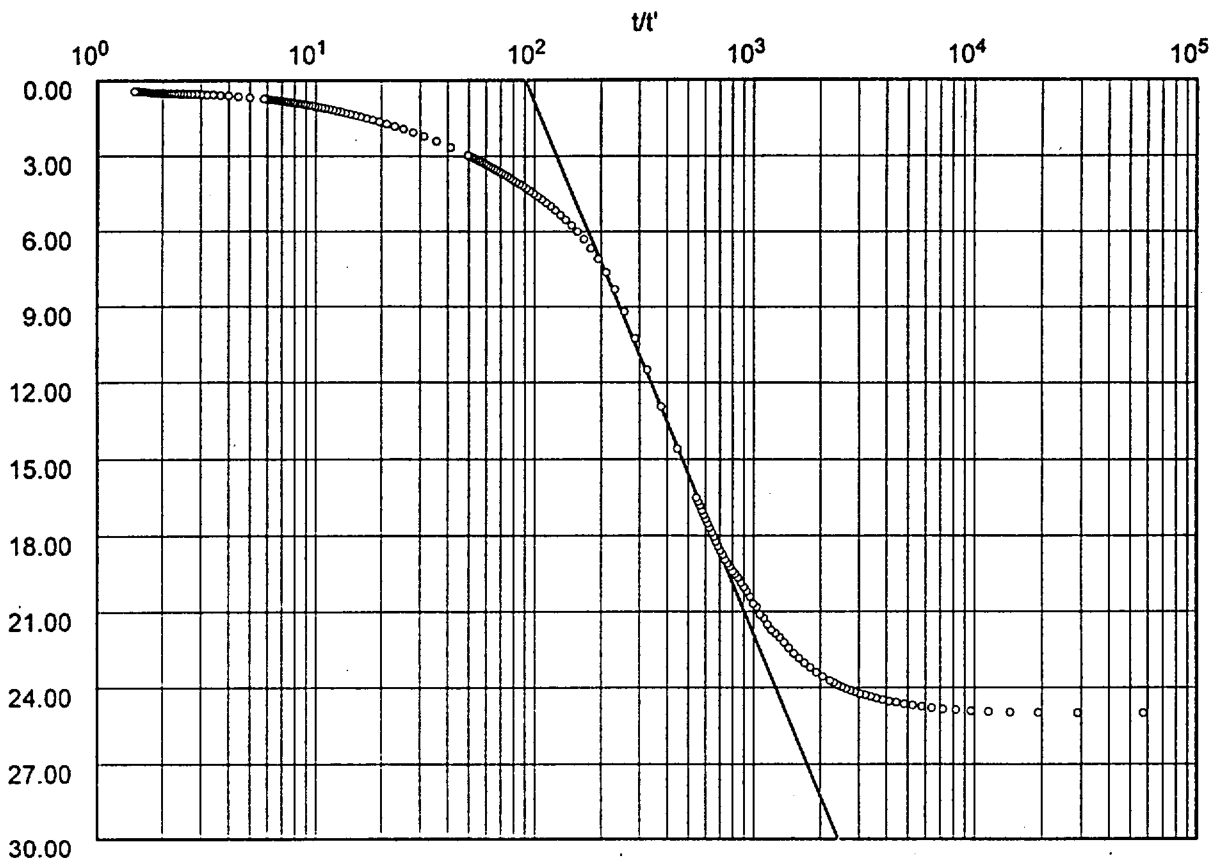
Transmissivity [ft²/min]: $2.10 \times 10^{-1}$ - 302.4 FT²/D

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

Aquifer thickness [ft]: 30.00

| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION; COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Recovery method after<br>THEIS & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>Evaluated by: / Date: 06.12.1999 |
|---|---|---|

| | |
|---|---|
| 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 |




∘ WELL PMP 041

Transmissivity [ft²/min]: $5.19 \times 10^{-2}$ = 74.7 ft²/d

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**

| ELAPSED TIME (min) | WELL 041 DTW (ft btoc) | WELL 042 DTW (ft btoc) | WELL 043 DTW (ft btoc) | WELL 120 DTW (ft btoc) | WELL 123 DTW (ft btoc) | WELL 122 DTW (ft btoc) |
|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|---|
| 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

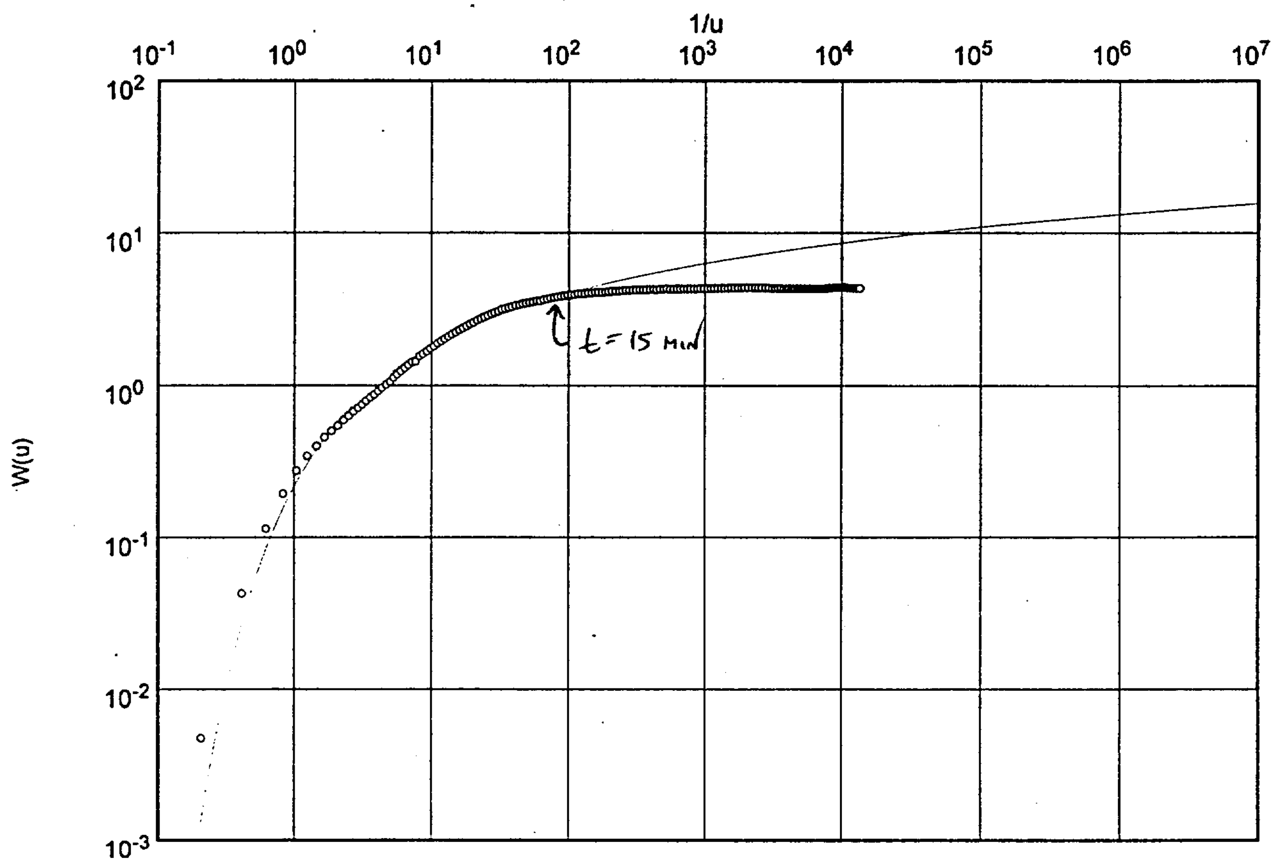
## WELL 044 AQUIFER TEST DATA AND PLOTS

**WELL 044 AQUIFER TEST 1**

**PLOTS FOR OBSERVATION WELLS 045, 046, AND 126**

| | | |
|---|---|---|
| **MACTEC-ERS**<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Theis analysis method<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 | |




∘ OBS 045

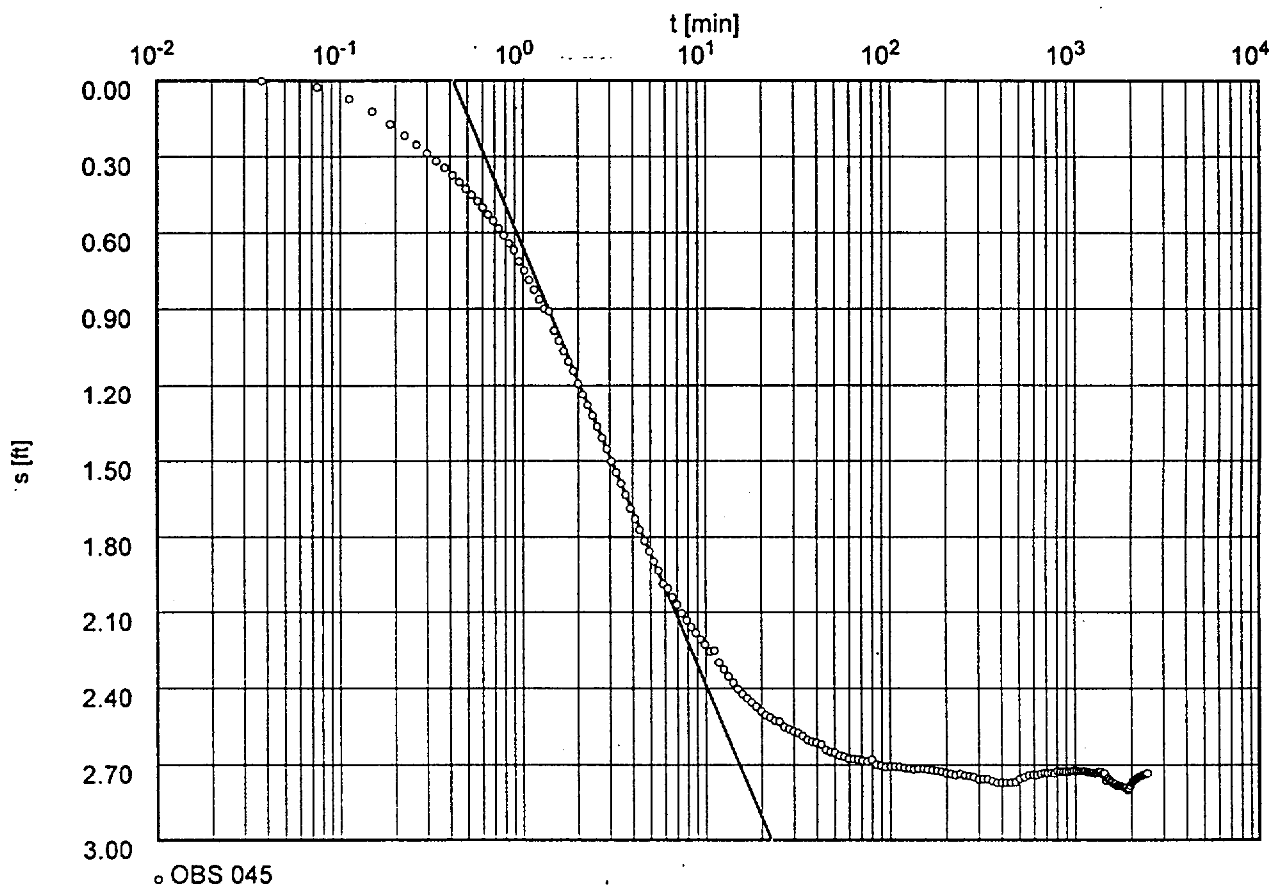
Transmissivity [ft²/min]: $8.43 \times 10^{-1}$ = 1213.9 ft²/D

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

Aquifer thickness [ft]: 30.00

| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Time-Drawdown-method after<br>COOPER & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 | |

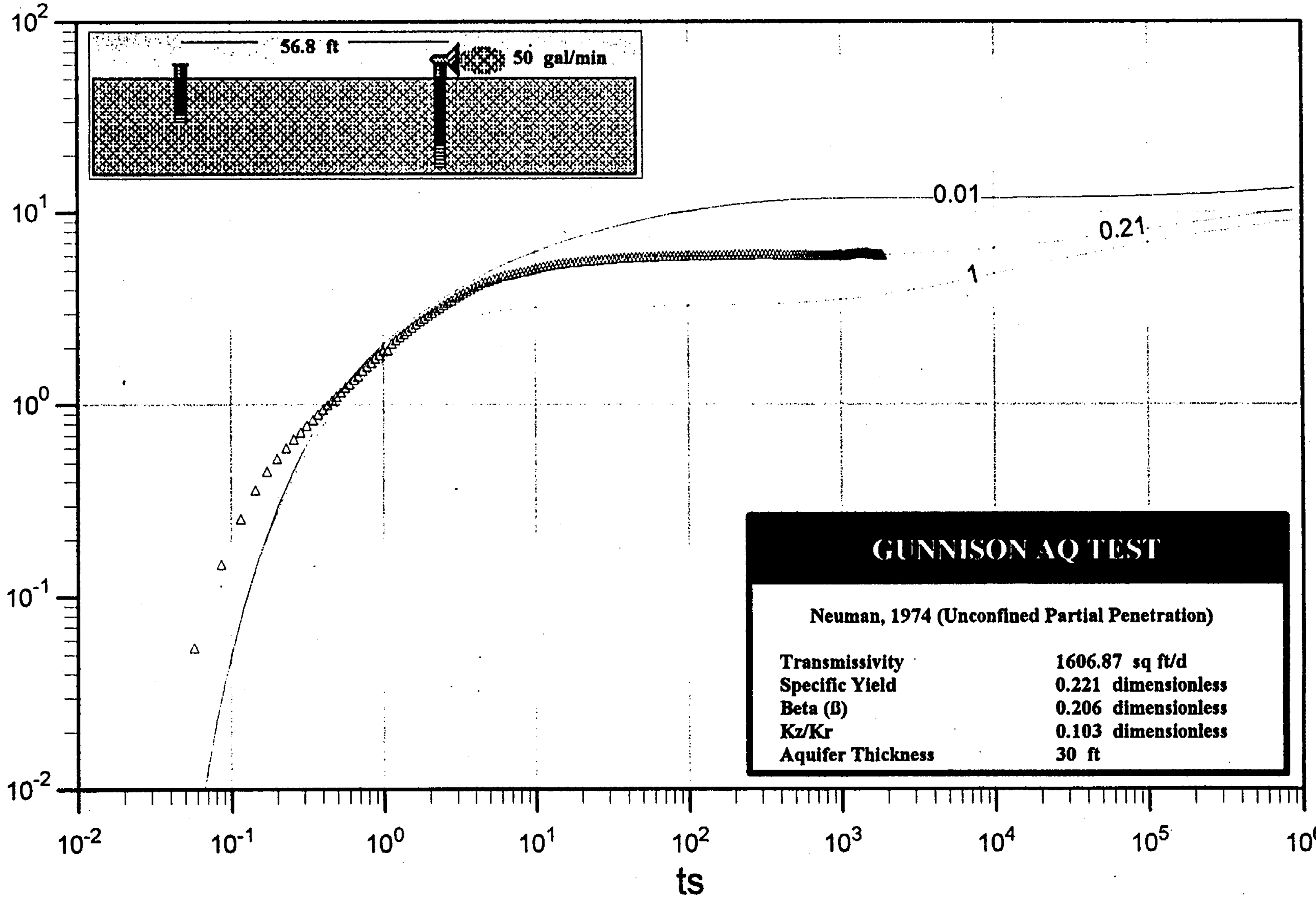



Transmissivity [ft²/min]: $7.07 \times 10^{-1}$ = 1018.1 ft²/d

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

Aquifer thickness [ft]: 30.00

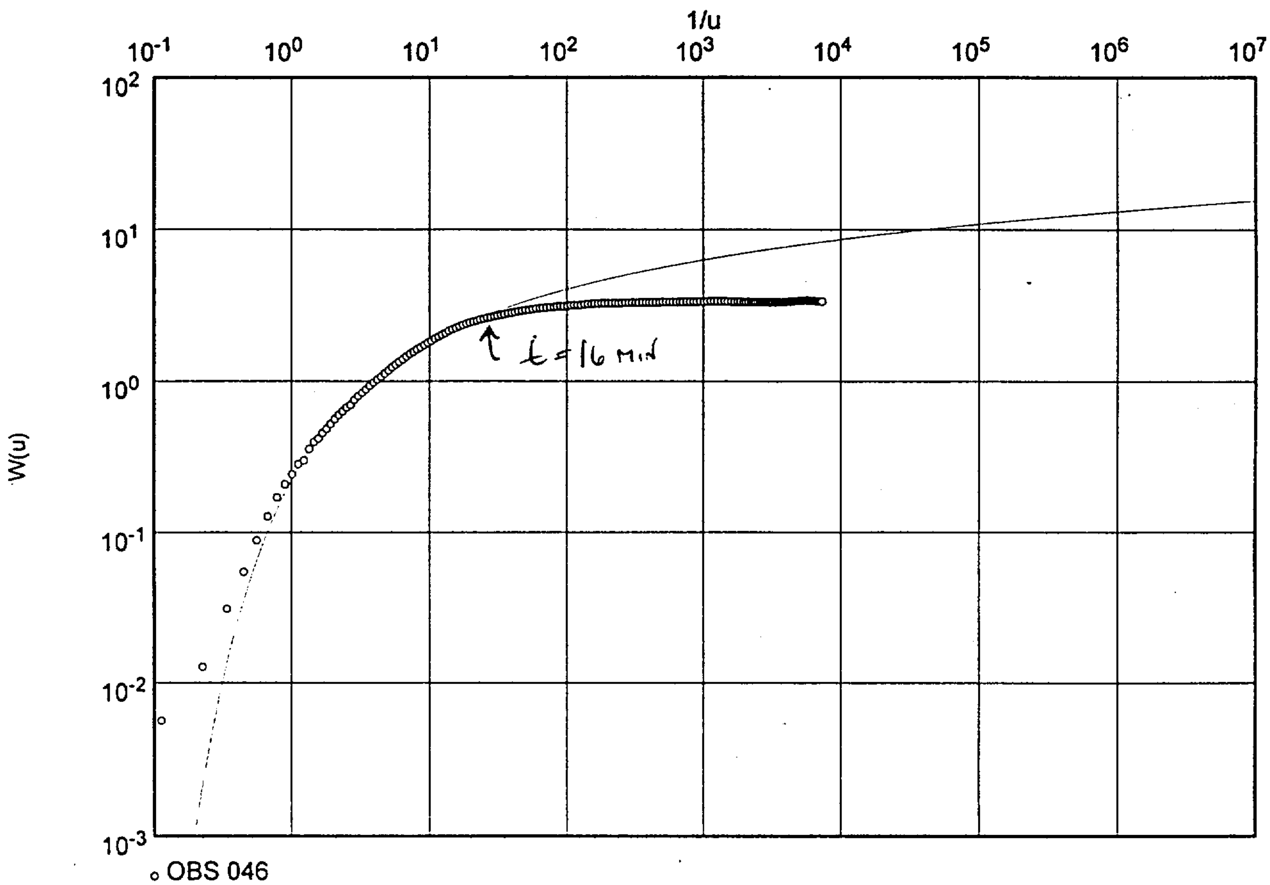
# WELL OBS 045 / 044 AQ TEST 1




| GUNNISON AQ TEST | |
|---|---|
| Neuman, 1974 (Unconfined Partial Penetration) | |
| Transmissivity | 1606.87 sq ft/d |
| Specific Yield | 0.221 dimensionless |
| Beta (ß) | 0.206 dimensionless |
| Kz/Kr | 0.103 dimensionless |
| Aquifer Thickness | 30 ft |

| | | |
|---|---|---|
| **MACTEC-ERS**<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Theis analysis method<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 | |



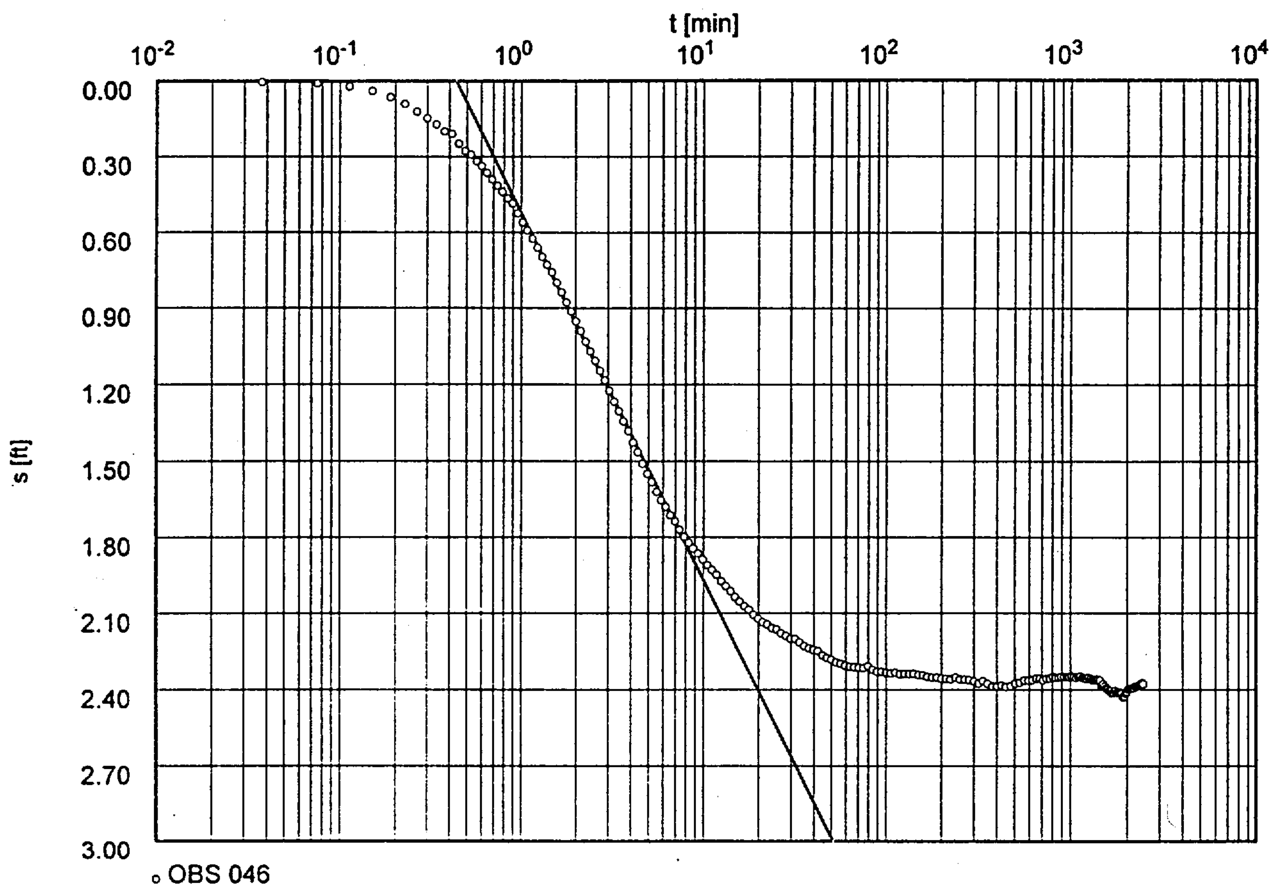

Transmissivity [ft²/min]: $7.51 \times 10^{-1}$ = 1081.4 ft²/d

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

Aquifer thickness [ft]: 30.00

| | | |
|---|---|---|
| **MACTEC-ERS**<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Time-Drawdown-method after<br>COOPER & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 | |

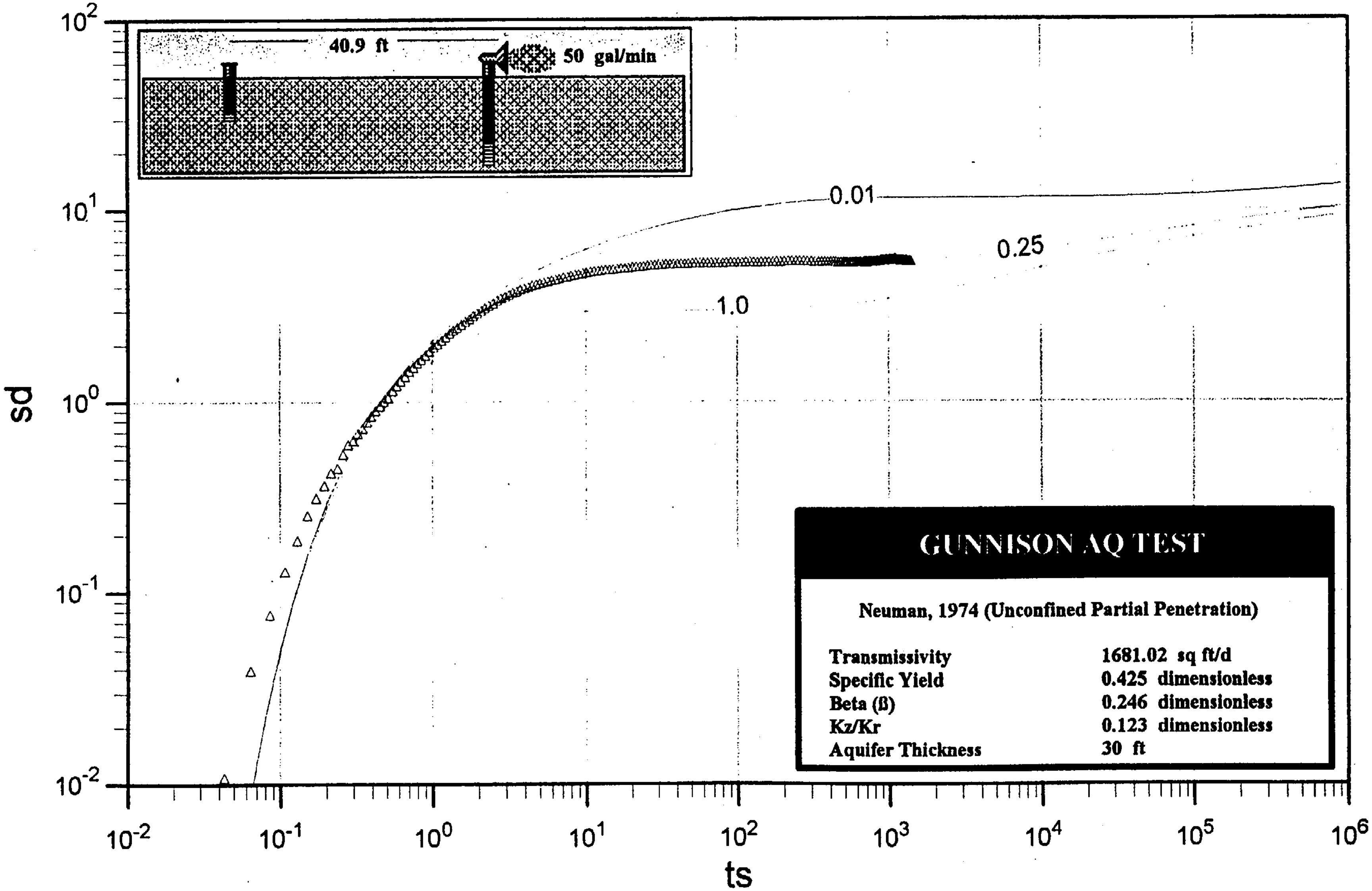



Transmissivity [ft²/min]: $8.43 \times 10^{-1}$ = 1213.9 ft²/d

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

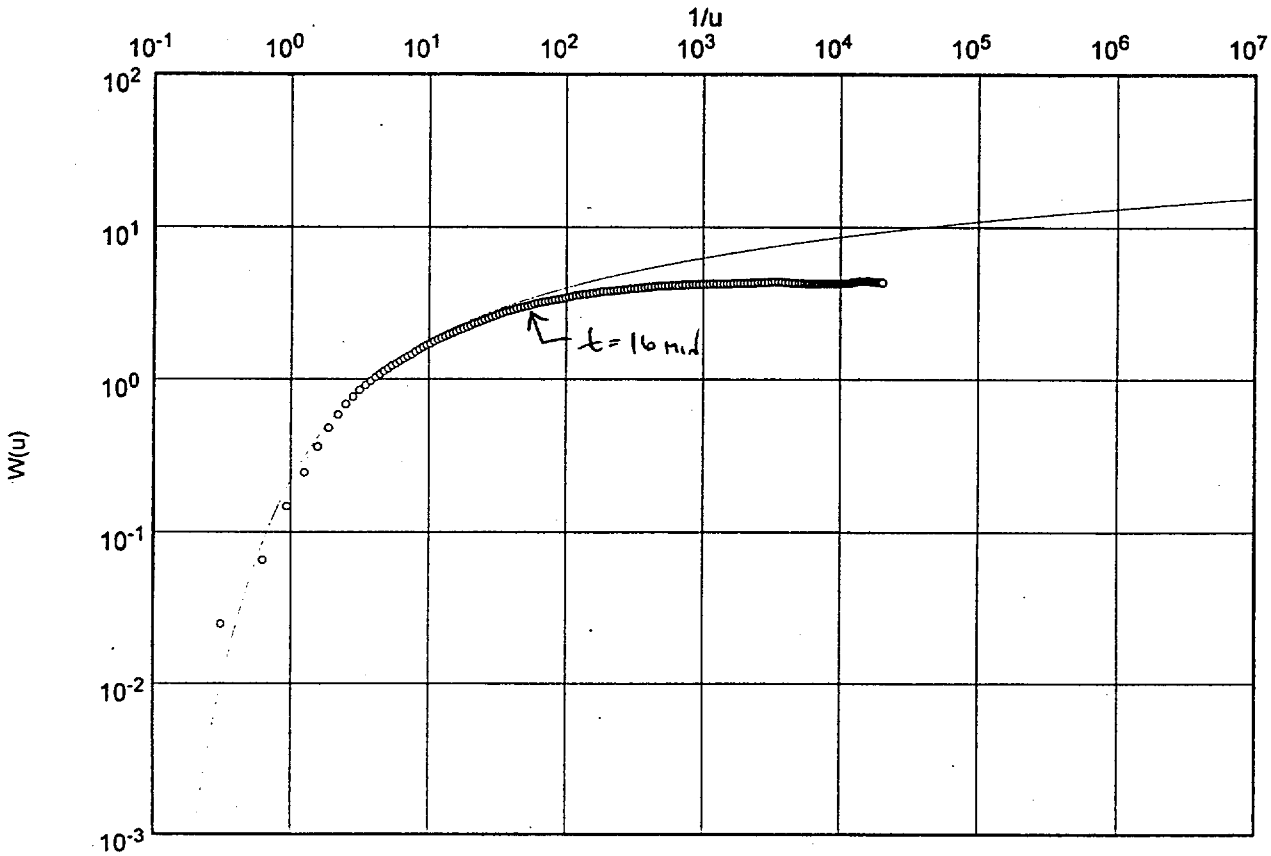
Aquifer thickness [ft]: 30.00

# WELL OBS 046 / 044 AQ TEST 1



| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Theis analysis method<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 | |




∘ OBS 126

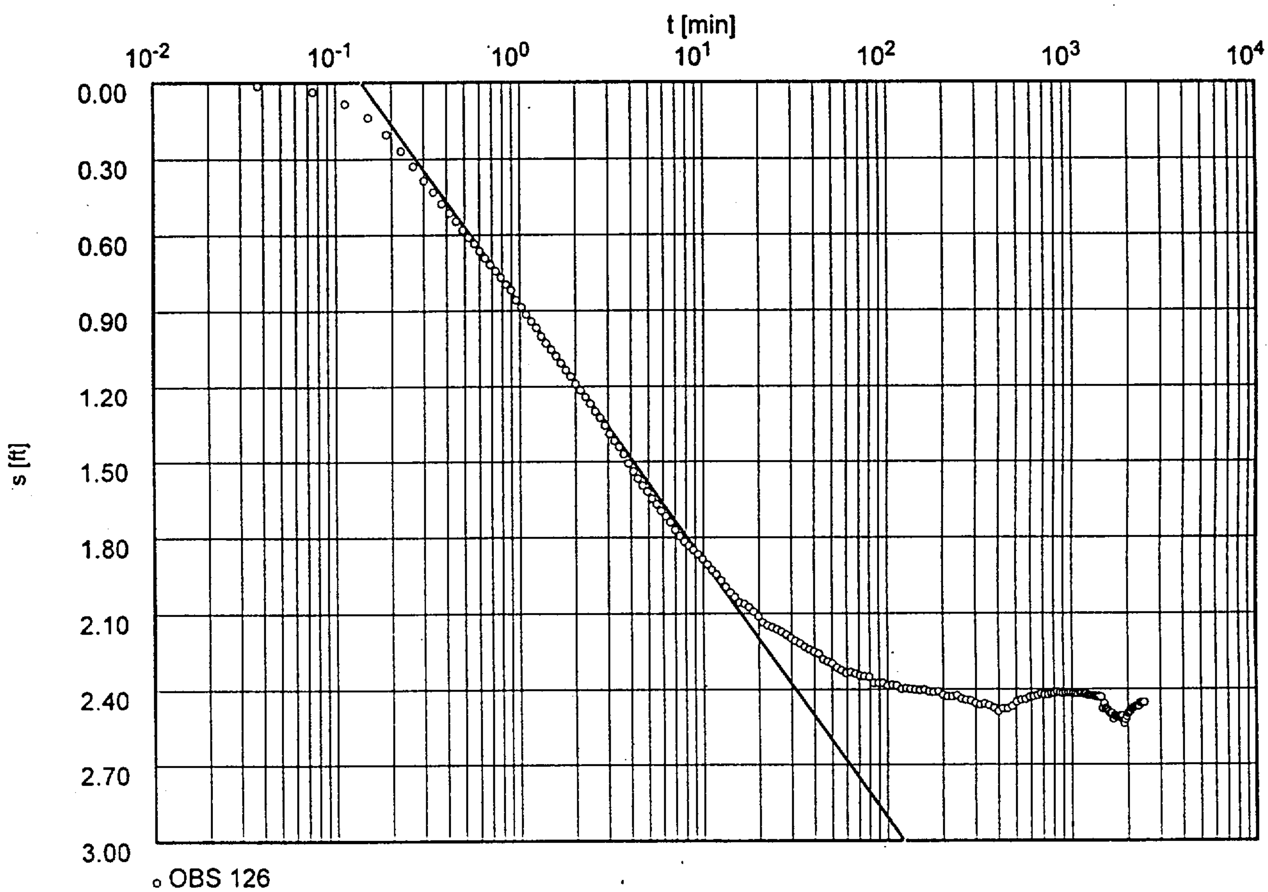
Transmissivity [ft²/min]: $9.45 \times 10^{-1}$ = 1360.8 ft²/d

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

Aquifer thickness [ft]: 30.00

| | | | |
|---|---|---|---|
| **MACTEC-ERS**<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Time-Drawdown-method after<br>COOPER & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>Evaluated by: | Date: 28.12.1999 |

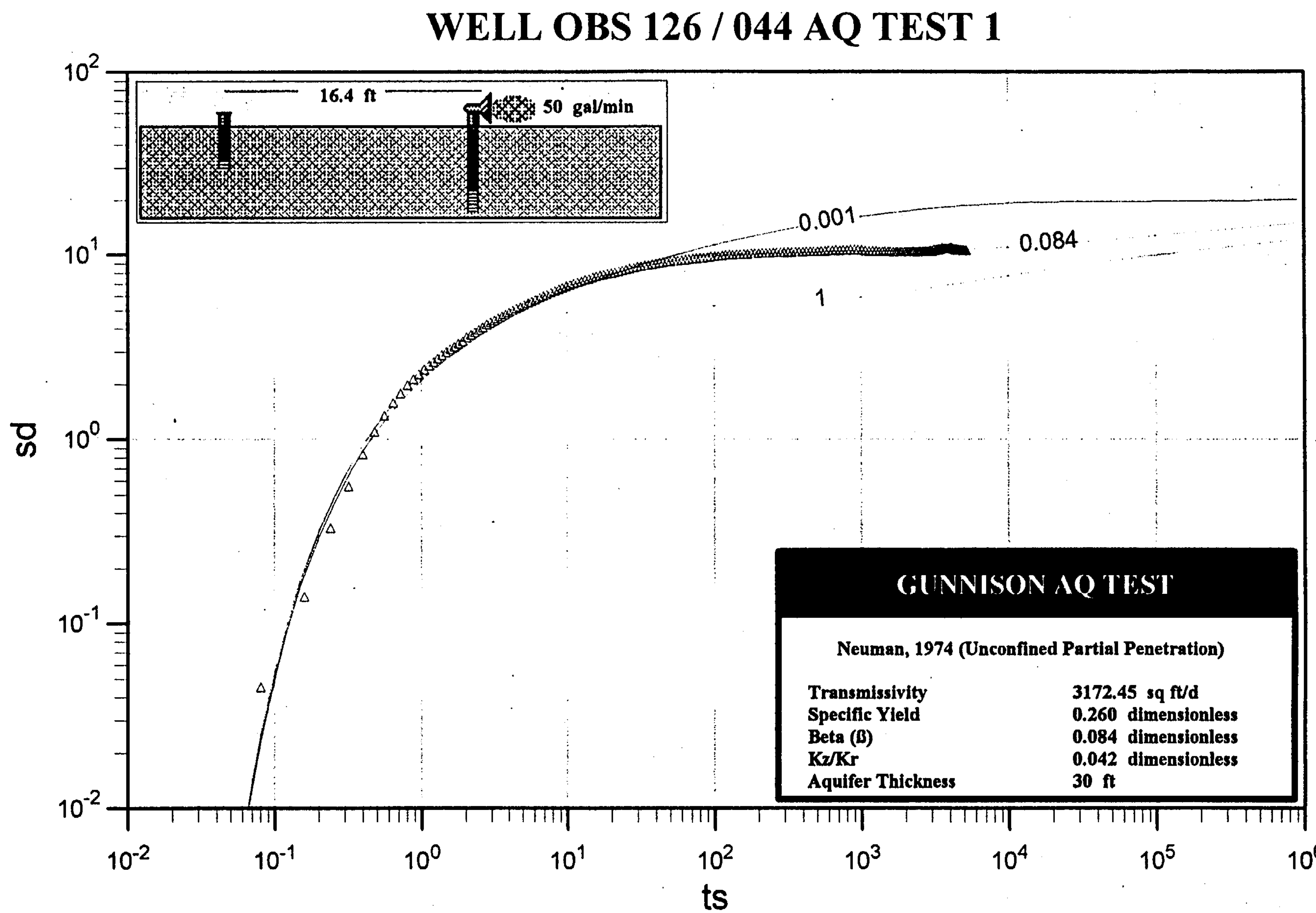
| | |
|---|---|
| Pumping Test No. 044 AQ TEST 1, t =41 hrs | Test conducted on: 12/1/99 |
| OBS 126, r = 16.4, Sl = 53.2' - 58.2' | |
| Discharge 50.00 U.S.gal/min | |




Transmissivity [ft²/min]: $1.20 \times 10^{0}$ = 1728 ft²/d

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

Aquifer thickness [ft]: 30.00



WELL OBS 126 / 044 AQ TEST 1
16.4 ft
50 gal/min
0.001
0.084
1
sd
ts
GUNNISON AQ TEST
Neuman, 1974 (Unconfined Partial Penetration)
Transmissivity 3172.45 sq ft/d
Specific Yield 0.260 dimensionless
Beta (ß) 0.084 dimensionless
Kz/Kr 0.042 dimensionless
Aquifer Thickness 30 ft

# 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**

| ELAPSED TIME (min) | WELL 044 pmp 044 | WELL 045 obs045 | WELL 046 obs046 | WELL 126 obs 126 | WELL 125 obs 125 | WELL 127 obs 127 | INCHES Hg |
|---|---|---|---|---|---|---|---|
| 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 |

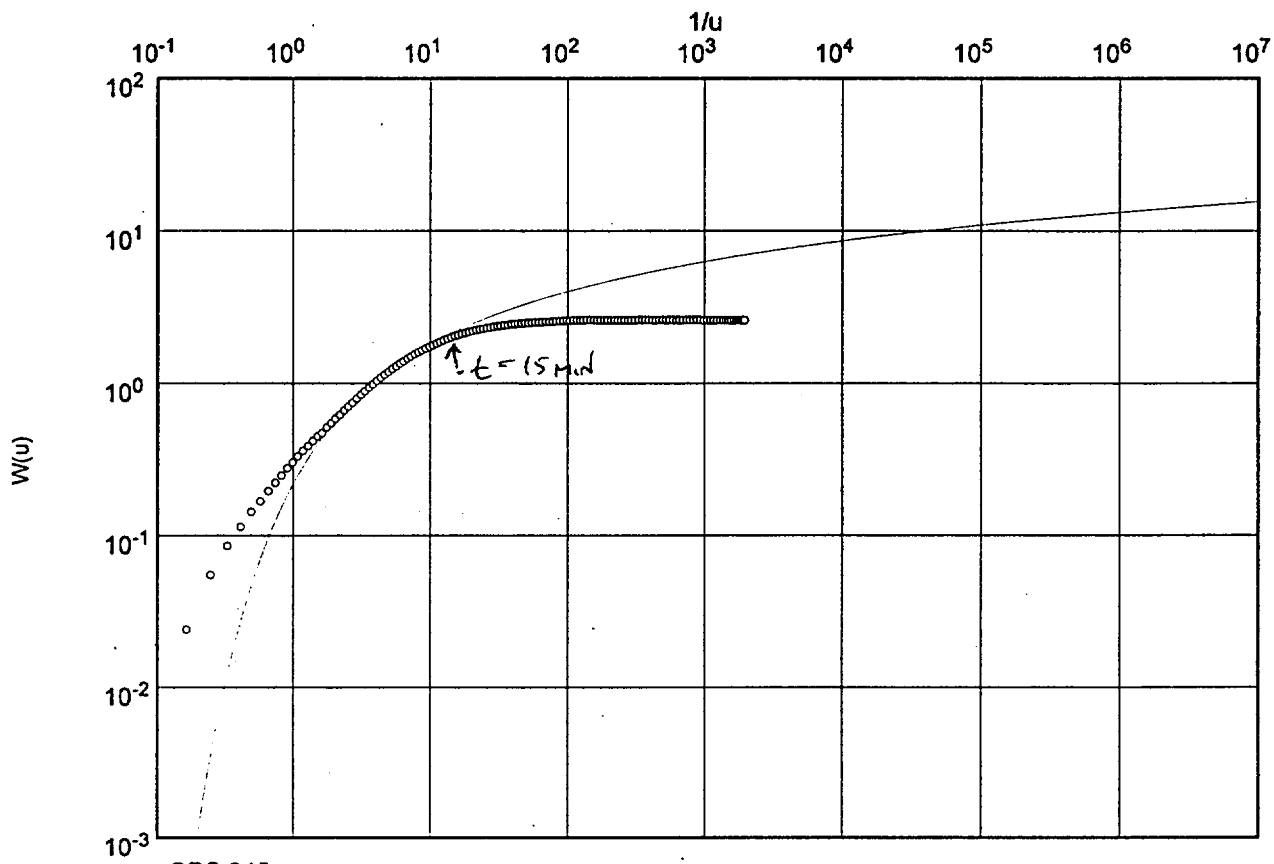
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 501.07 | 46.31 | 12.346 | 11.398 | 13.16 | 9.725 | 12.319 | 22.439 |
| 530.77 | 46.345 | 12.339 | 11.394 | 13.152 | 9.731 | 12.31 | 22.418 |
| 560.77 | 46.474 | 12.329 | 11.385 | 13.149 | 9.731 | 12.3 | 22.41 |
| 590.77 | 46.414 | 12.327 | 11.385 | 13.14 | 9.732 | 12.293 | 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

| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Theis analysis method<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 | |




∘ OBS 045

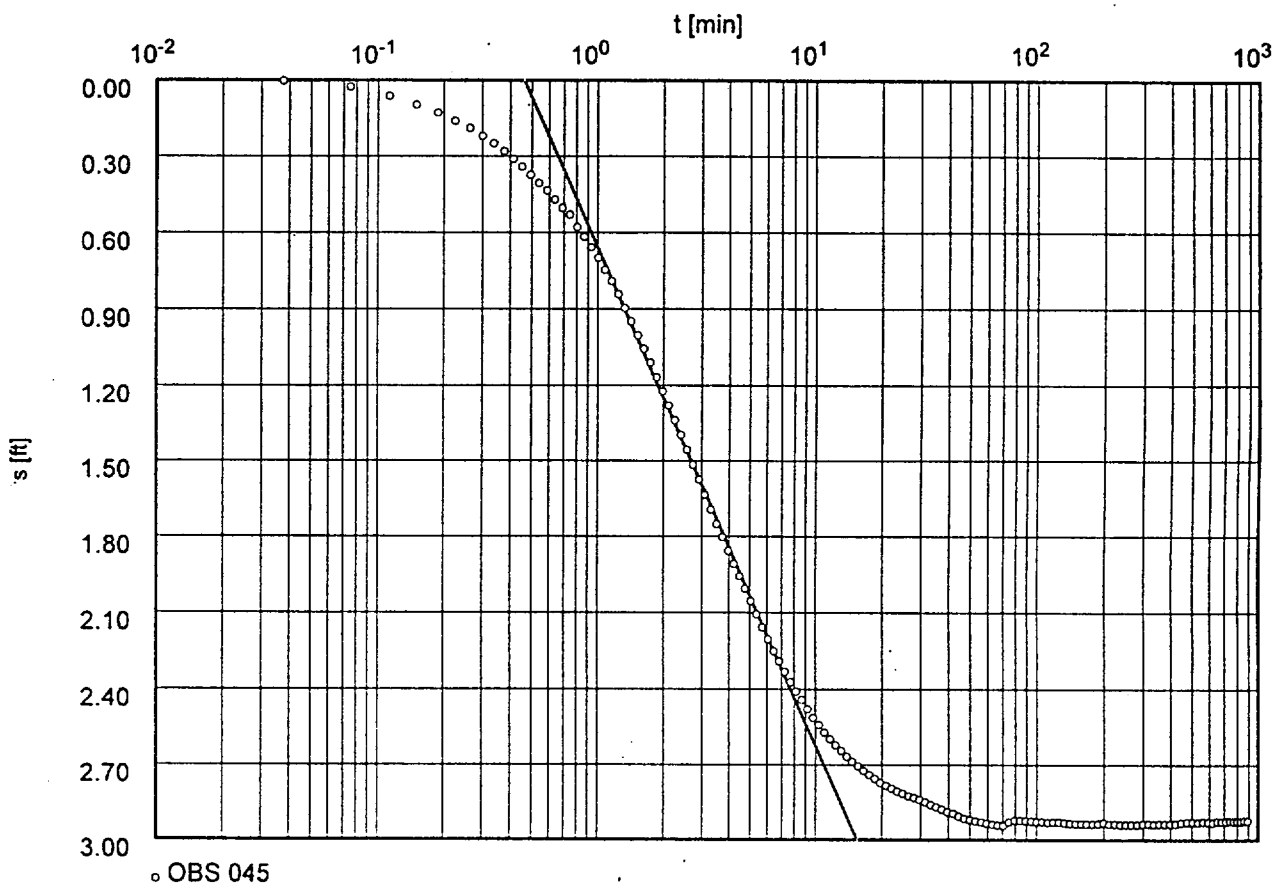
Transmissivity [ft²/min]: $5.51 \times 10^{-1}$ = 793.4 ft²/d

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

Aquifer thickness [ft]: 30.00

| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Time-Drawdown-method after<br>COOPER & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 | |

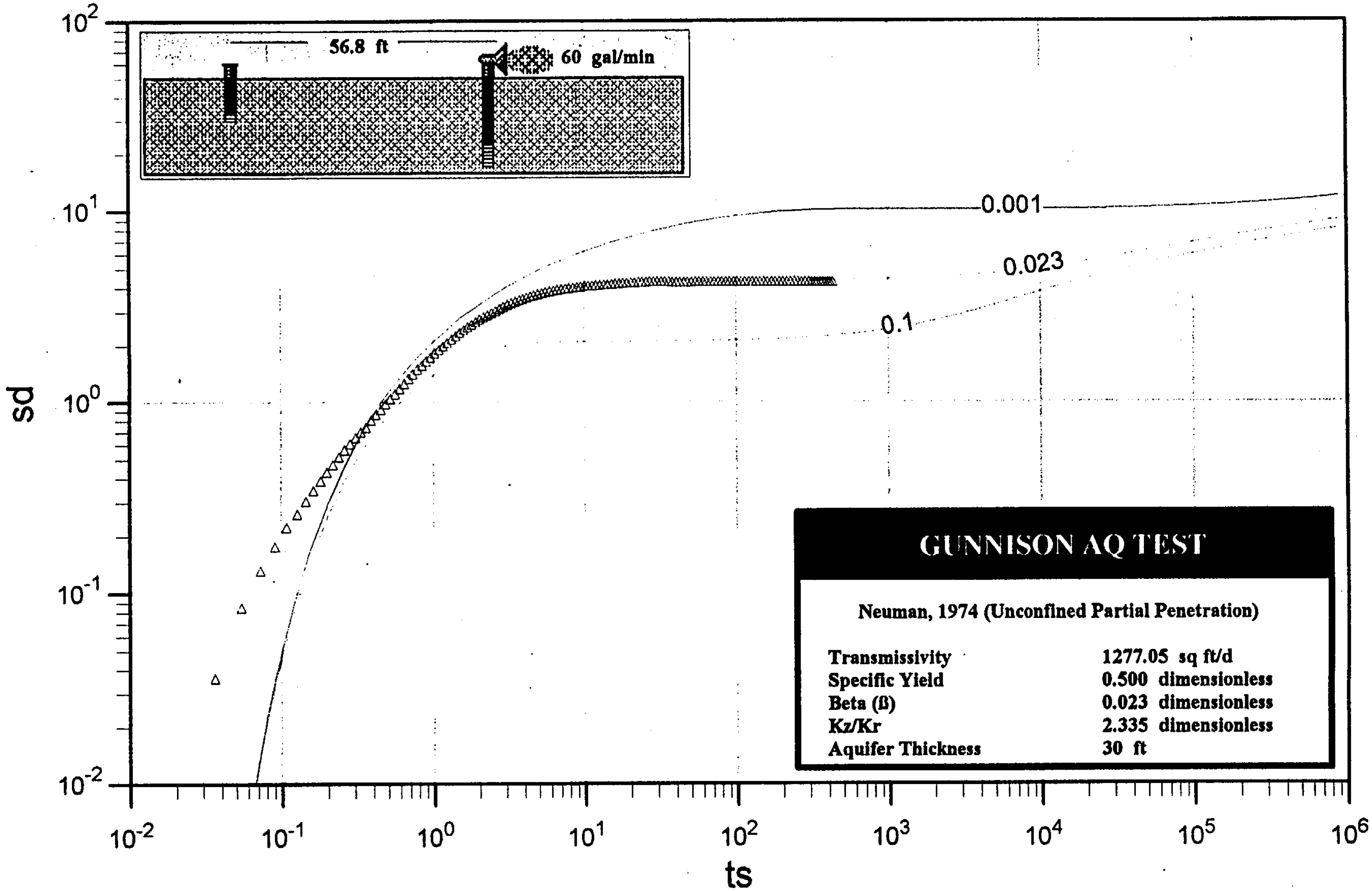



Transmissivity [ft²/min]: $7.23 \times 10^{-1}$ = 1041.1 ft²/d

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

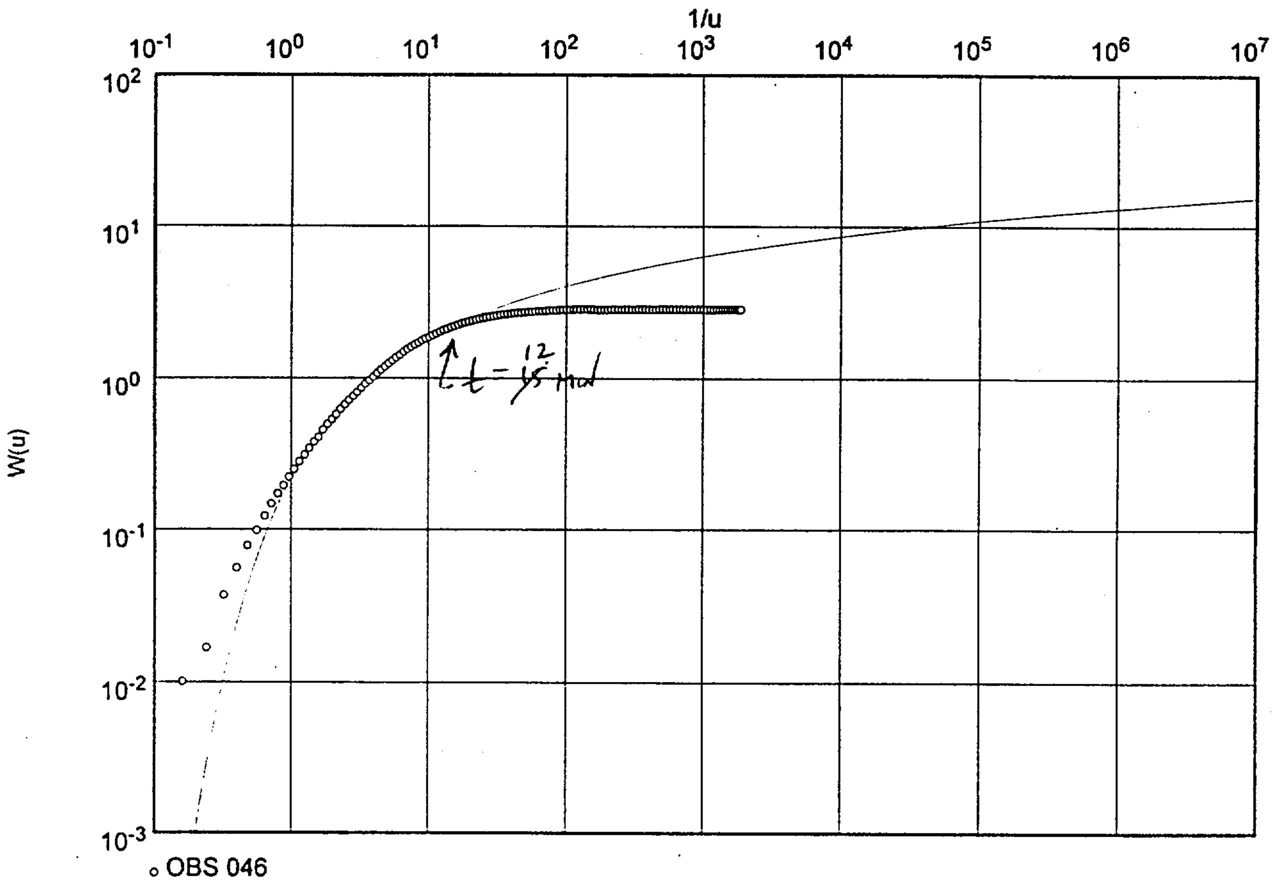
Aquifer thickness [ft]: 30.00

# WELL OBS 045 / 044 AQ TEST 2



| | | |
|---|---|---|
| **MACTEC-ERS**<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Theis analysis method<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 | |



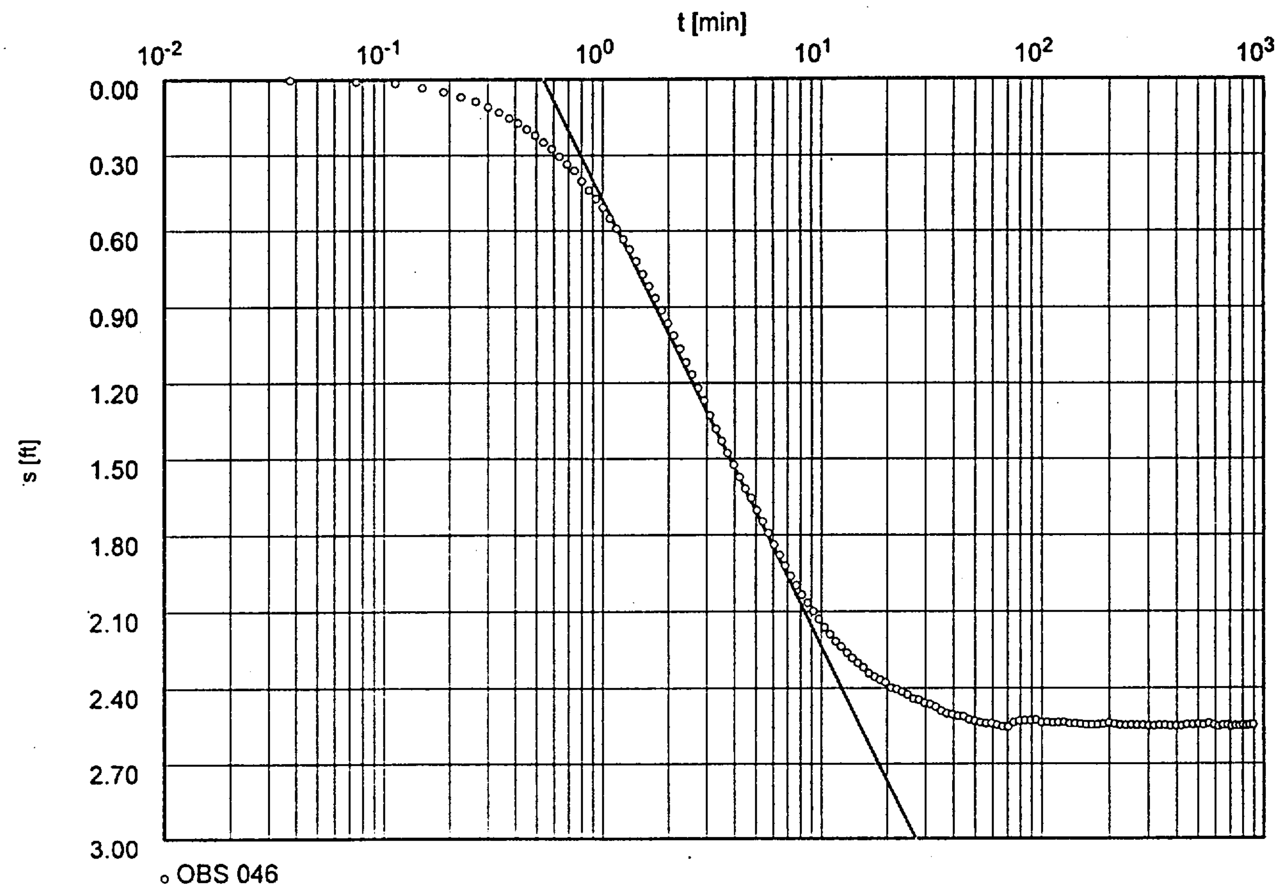

Transmissivity [ft²/min]: $6.94 \times 10^{-1}$ - 999.4 ft²/d

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

Aquifer thickness [ft]: 30.00

| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Time-Drawdown-method after<br>COOPER & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 | |

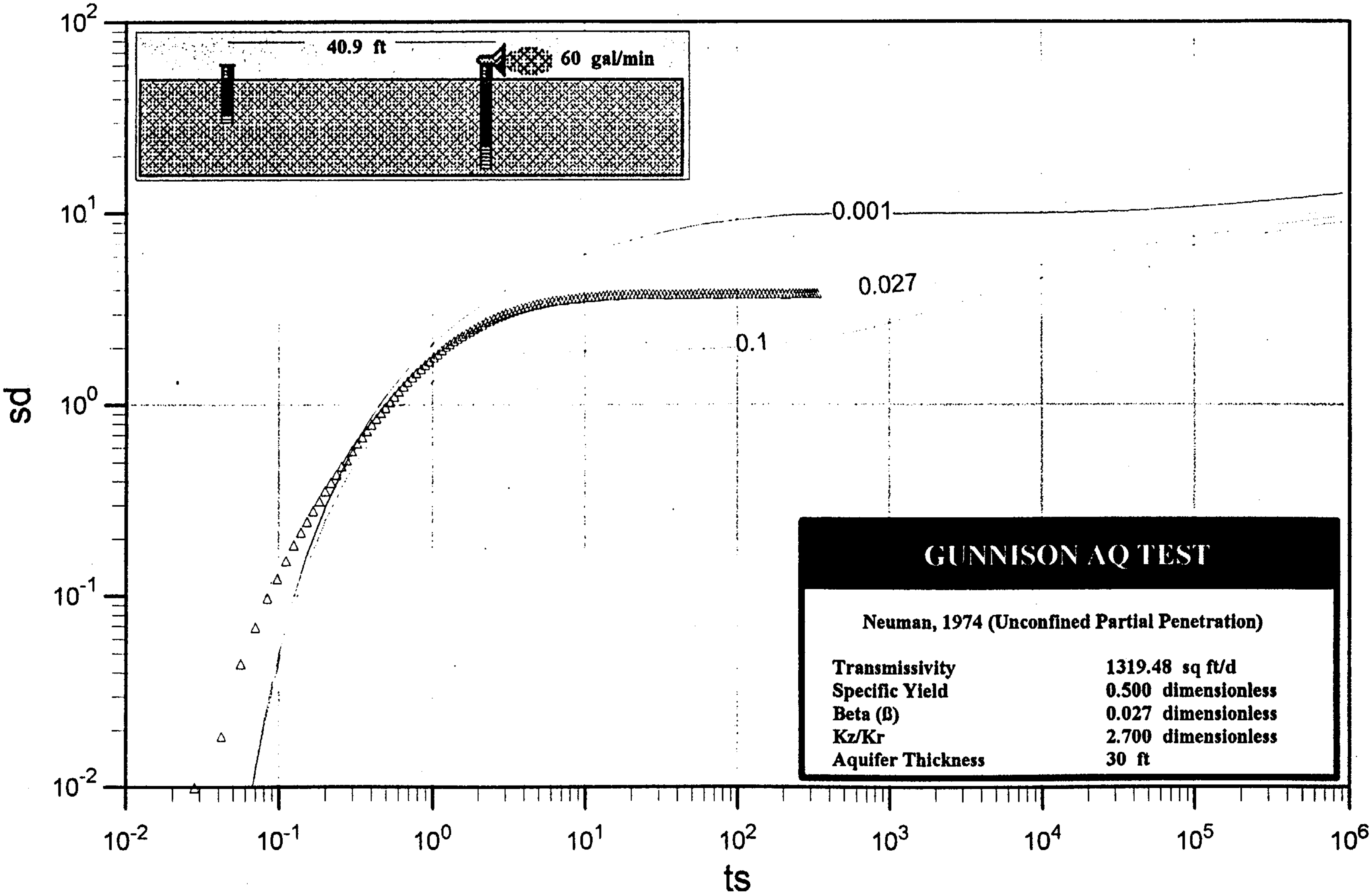



Transmissivity [ft²/min]: $8.08 \times 10^{-1}$ = 1163.5 FT²/D

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

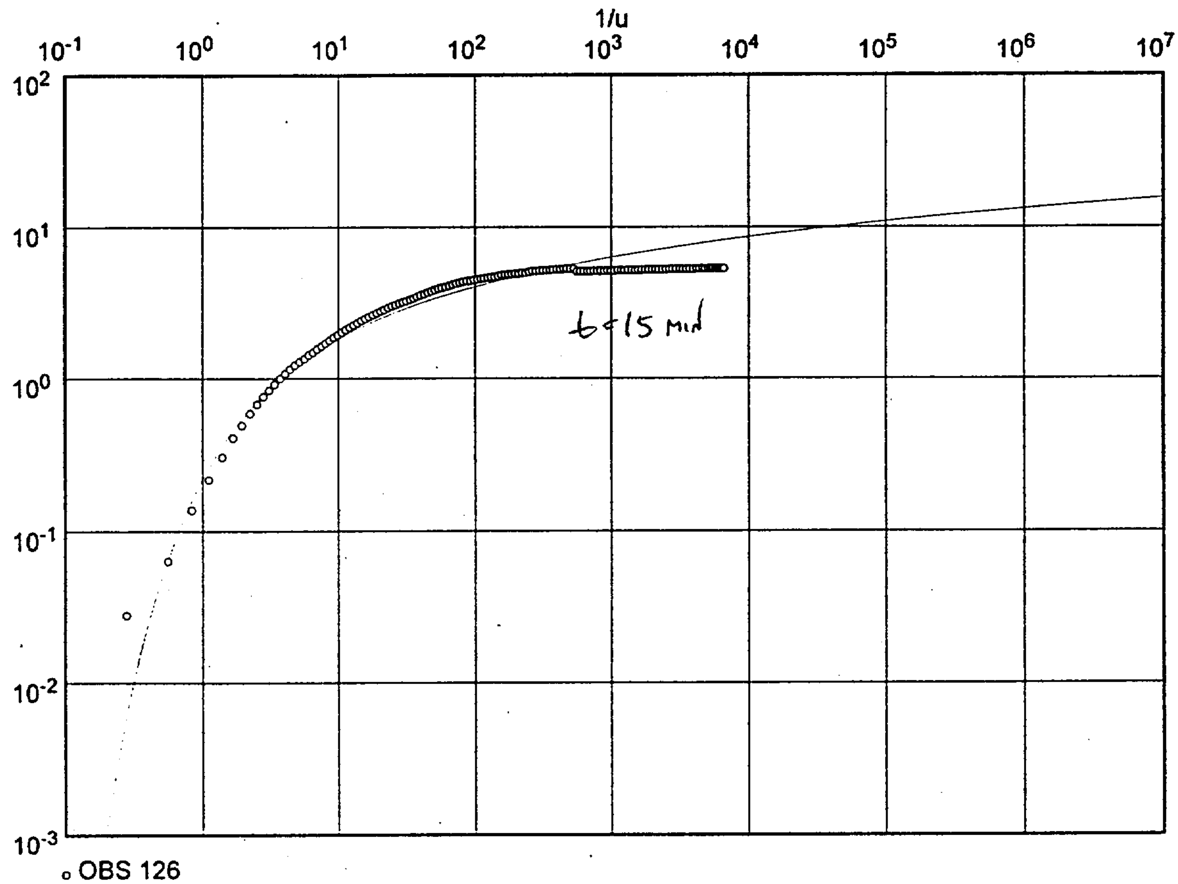
Aquifer thickness [ft]: 30.00

# WELL OBS 046 / 044 AQ TEST 2



| **MACTEC-ERS**<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Theis analysis method<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 | |



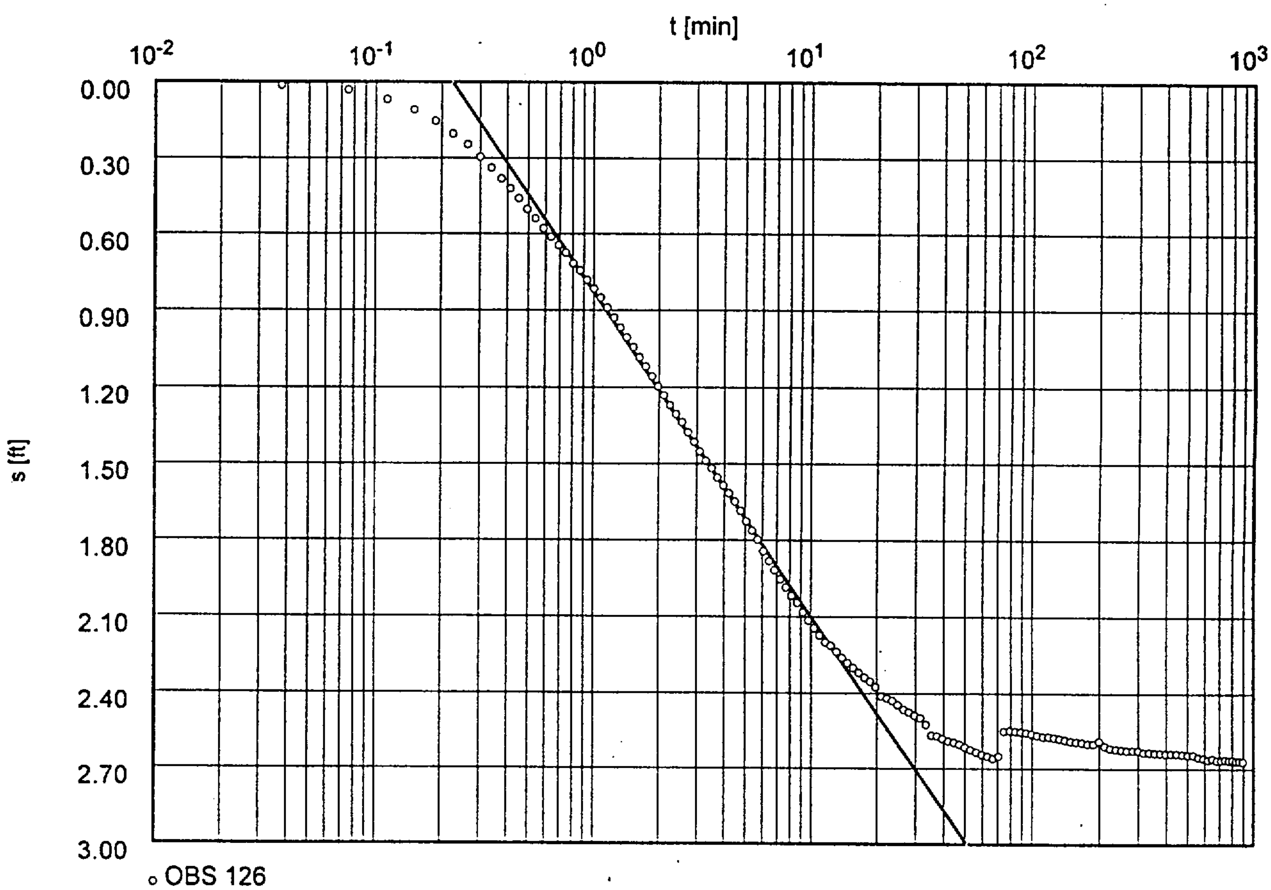

Transmissivity [ft²/min]: $1.23 \times 10^{0}$ = 1771.2 ft²/d

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

Aquifer thickness [ft]: 30.00

| **MACTEC-ERS**<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Time-Drawdown-method after<br>COOPER & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 | |

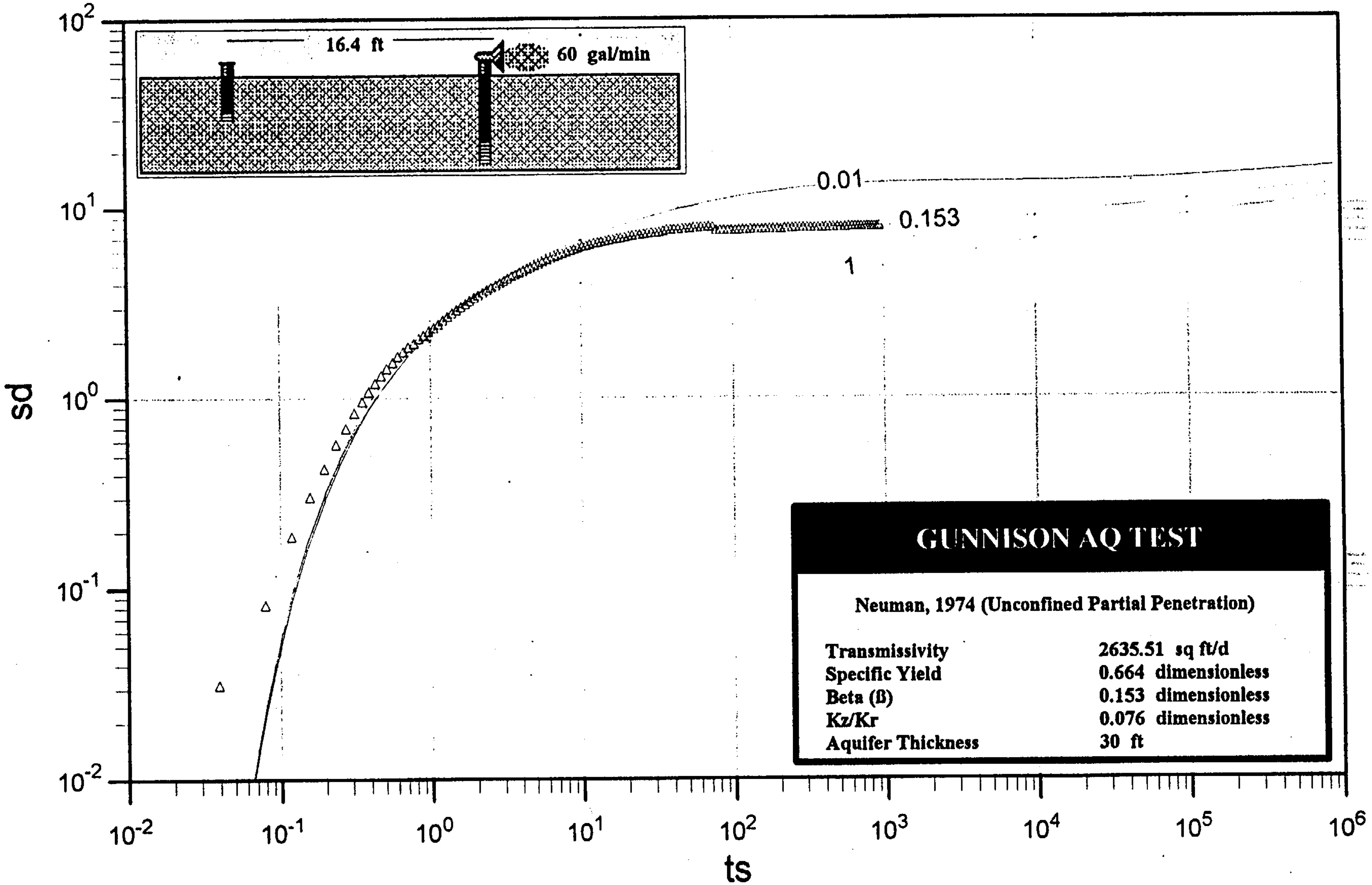



Transmissivity [ft²/min]: $1.11 \times 10^{0}$ = 1593.4 ft²/d

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

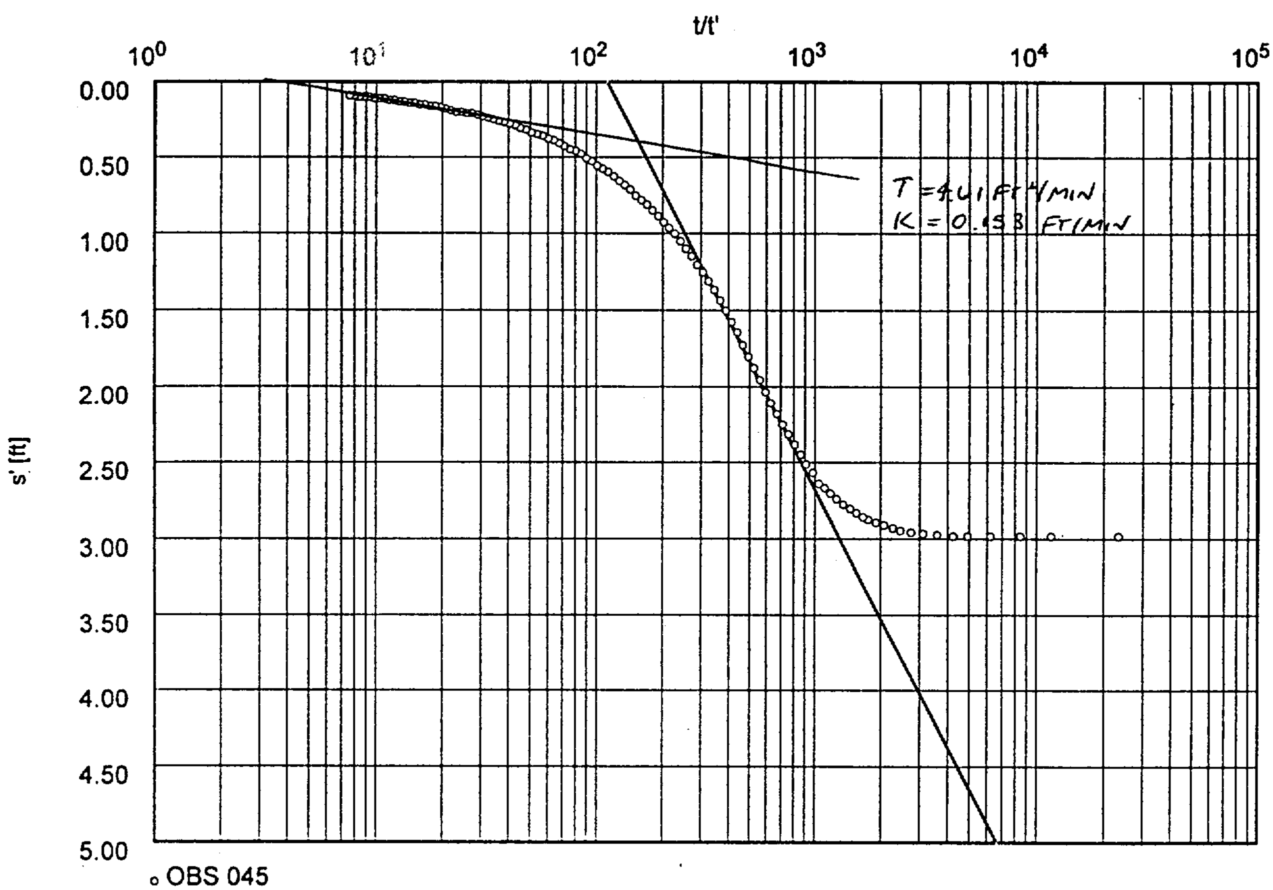
Aquifer thickness [ft]: 30.00

# WELL OBS 126 / 044 AQ TEST 2



| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Recovery method after<br>THEIS & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 |



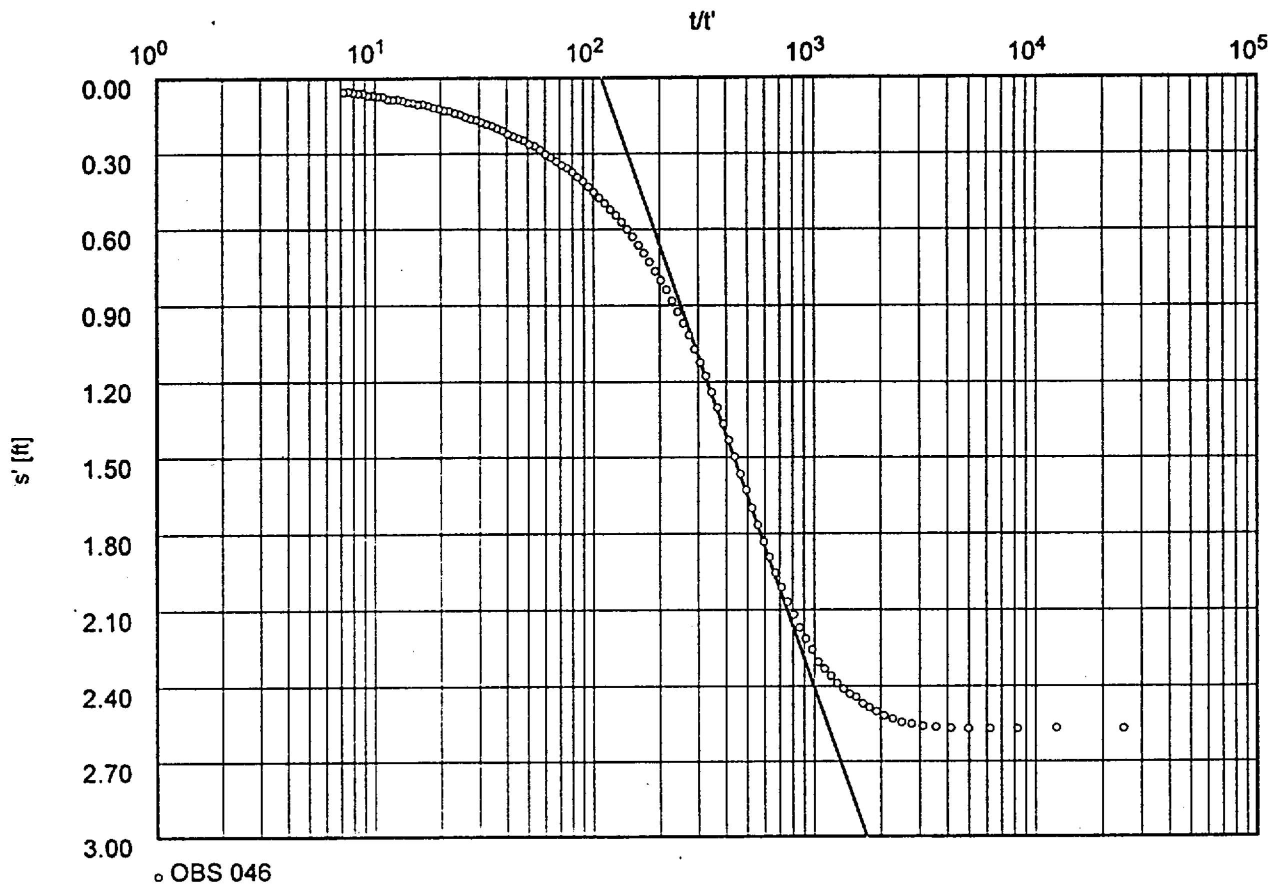

Transmissibility [ft²/min]: $5.05 \times 10^{-1}$ = 727.2 ft²/d

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

Aquifer thickness [ft]: 30.00

| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Recovery method after<br>THEIS & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 |



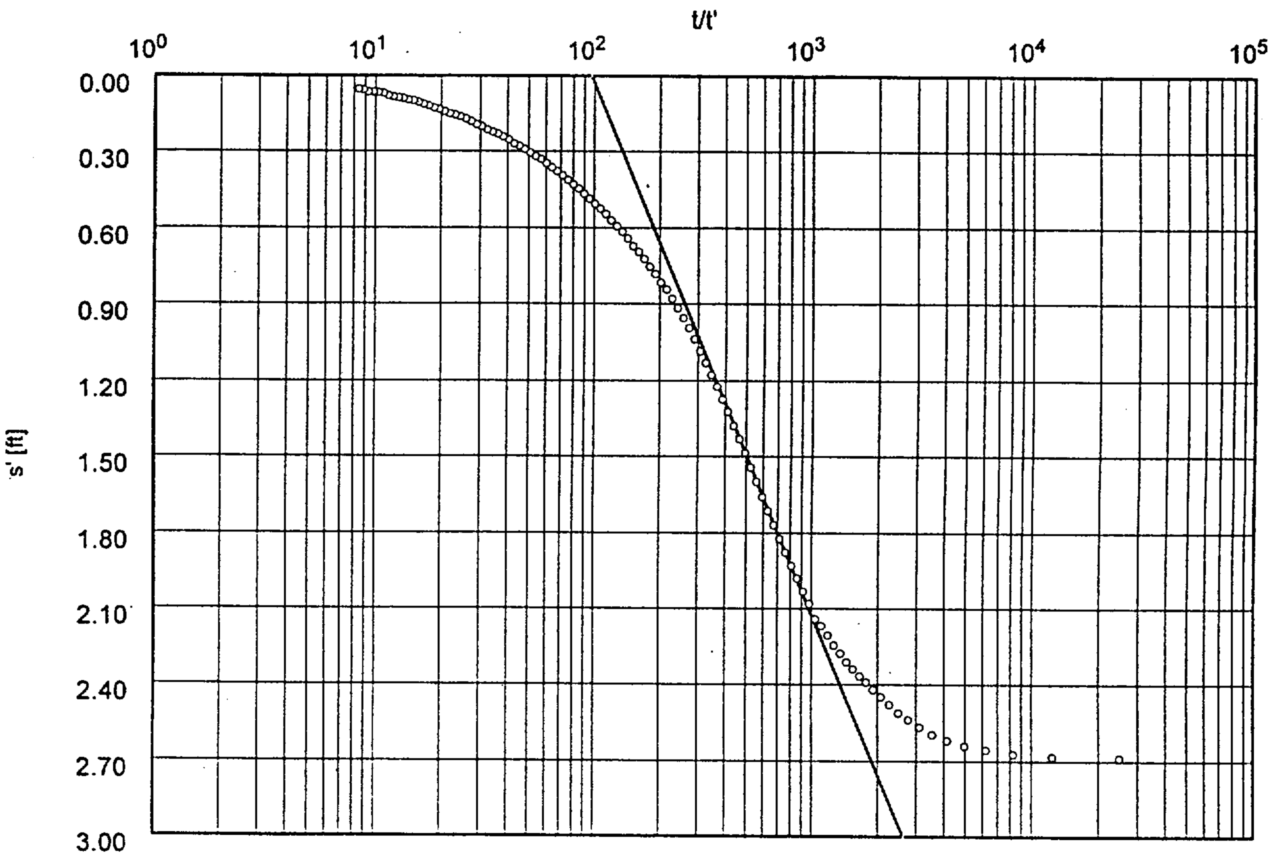

Transmissivity [ft²/min]: $5.69 \times 10^{-1}$ - 819.4 ft²/D

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

Aquifer thickness [ft]: 30.00

| | | |
|---|---|---|
| **MACTEC-ERS**<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Recovery method after<br>THEIS & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>Evaluated by: / Date: 13.12.1999 |

| | |
|---|---|
| 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

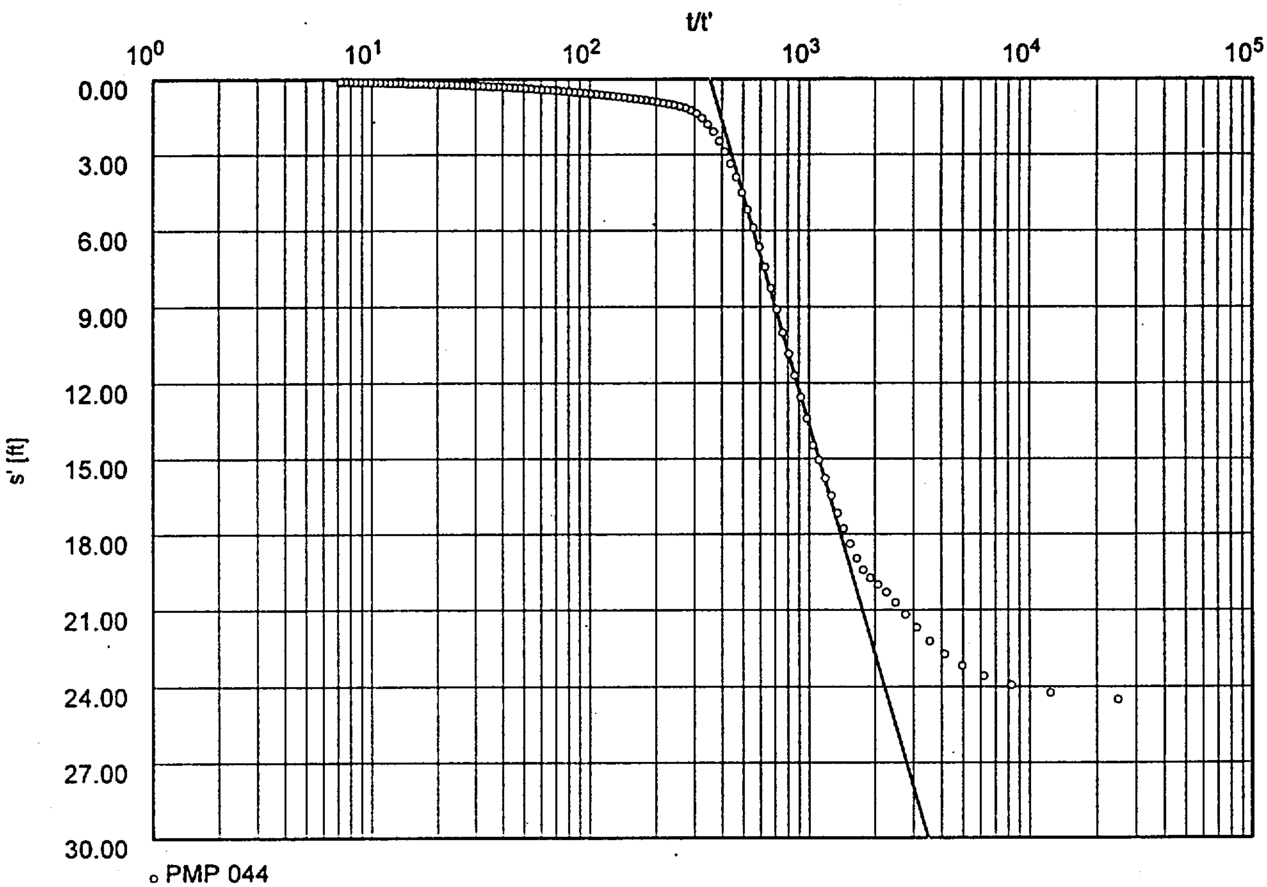
Transmissivity [ft²/min]: $6.78 \times 10^{-1}$ = 976.3 ft²/d

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

Aquifer thickness [ft]: 30.00

| | | |
|---|---|---|
| **MACTEC-ERS**<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Recovery method after<br>THEIS & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 [ft²/min]: 4.72 x $10^{-2}$ = 68 ft²/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 |
| Q = 58 GPM | | | | | | | |
| 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 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 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

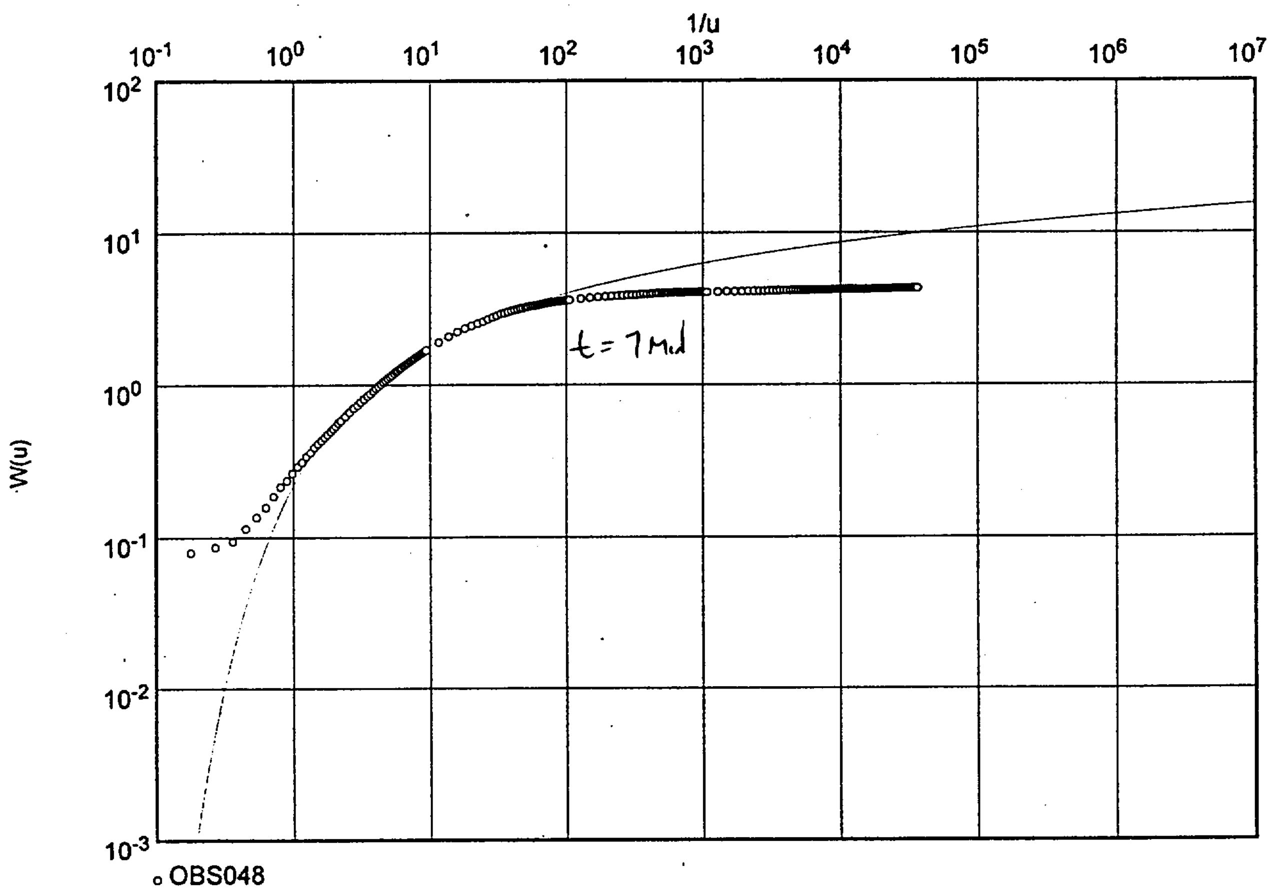
## WELL 047 AQUIFER TEST DATA AND PLOTS

## WELL 047 AQUIFER TEST 1

## PLOTS FOR OBSERVATION WELLS 048, 049, AND 136

| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLC<br>ph.(970)248-6000 | Pumping test analysis<br>Theis analysis method<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 | |



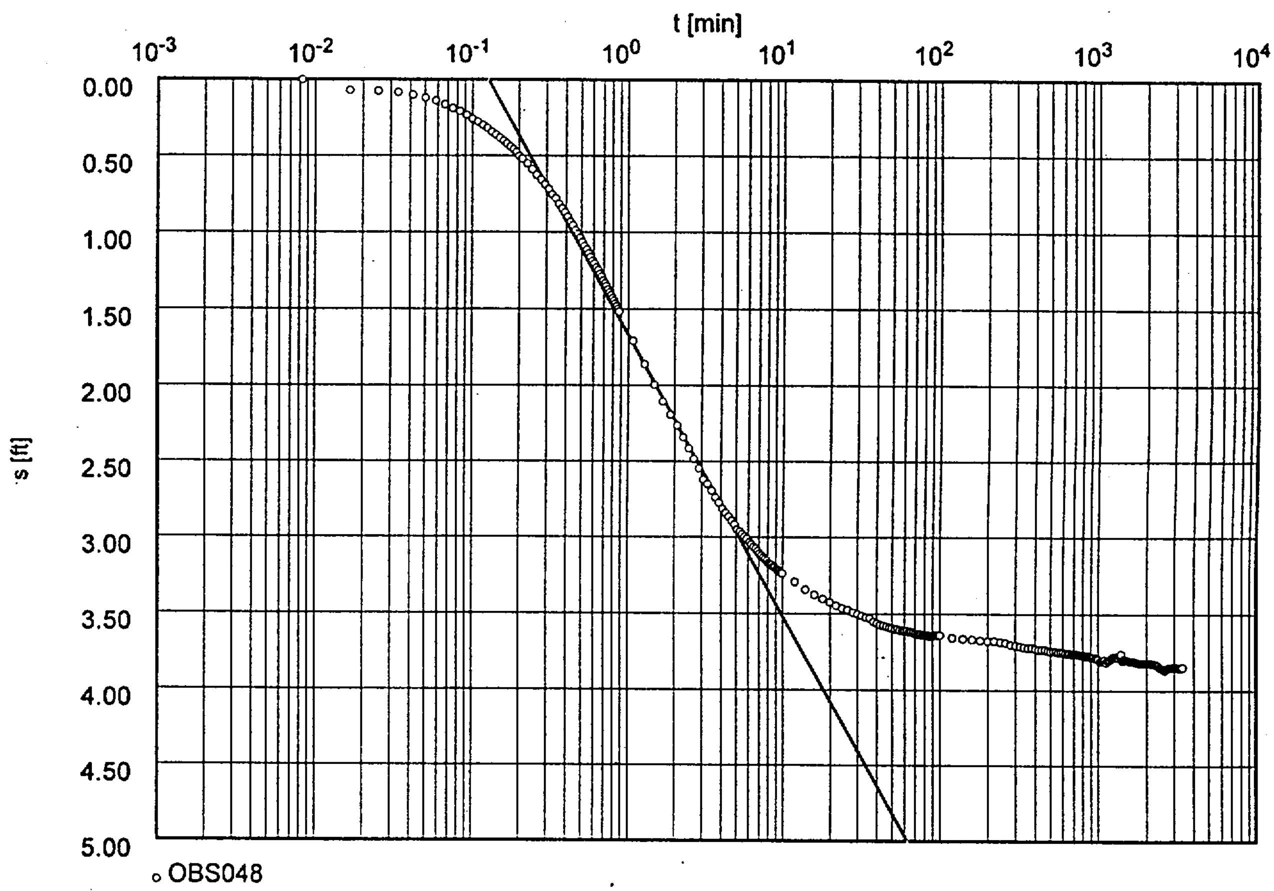

Transmissivity [ft²/min]: $7.16 \times 10^{-1}$ = 1031 FT$^2$/D

Hydraulic conductivity [ft/min]: $2.38 \times 10^{-2}$

Aquifer thickness [ft]: 30.00

| | | |
|---|---|---|
| **MACTEC-ERS**<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Time-Drawdown-method after<br>COOPER & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 | |

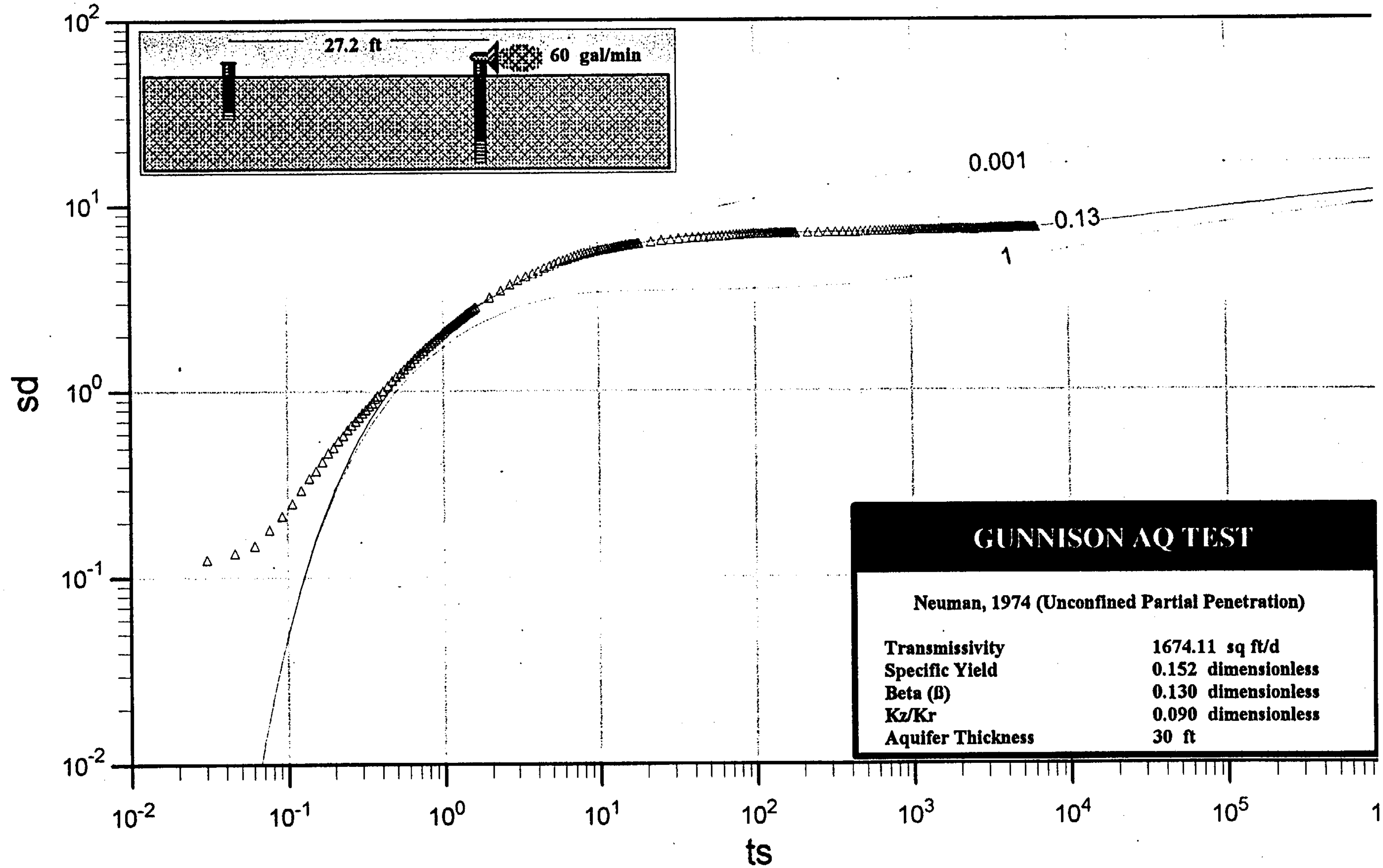



Transmissivity [ft²/min]: $7.90 \times 10^{-1}$ = 1137.6 ft²/d

Hydraulic conductivity [ft/min]: $2.63 \times 10^{-2}$

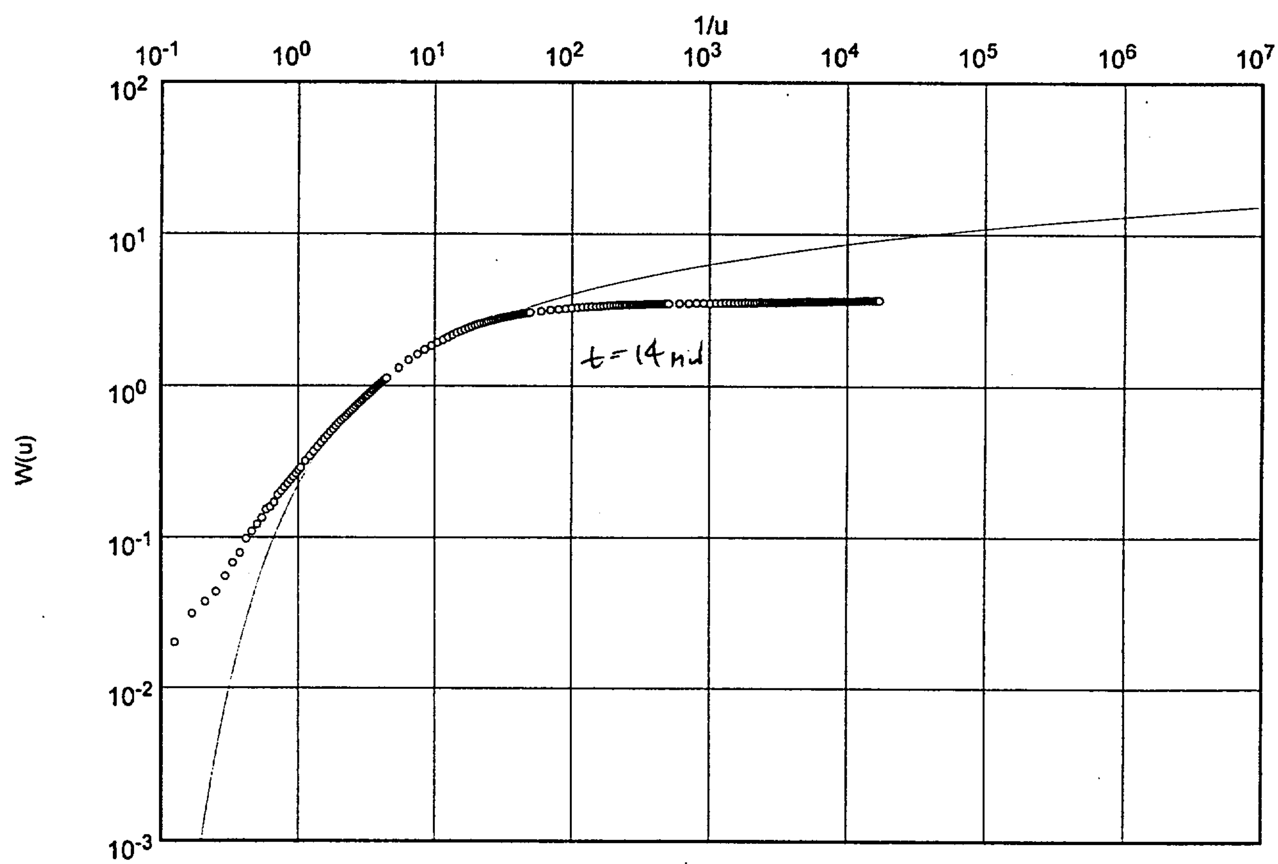
Aquifer thickness [ft]: 30.00

# WELL OBS 048 / 047 AQ TEST 1



| **MACTEC-ERS**<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Theis analysis method<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>Evaluated by: Date: 28.11.1999 |
|---|---|---|

| | |
|---|---|
| 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 | |




o OBS049

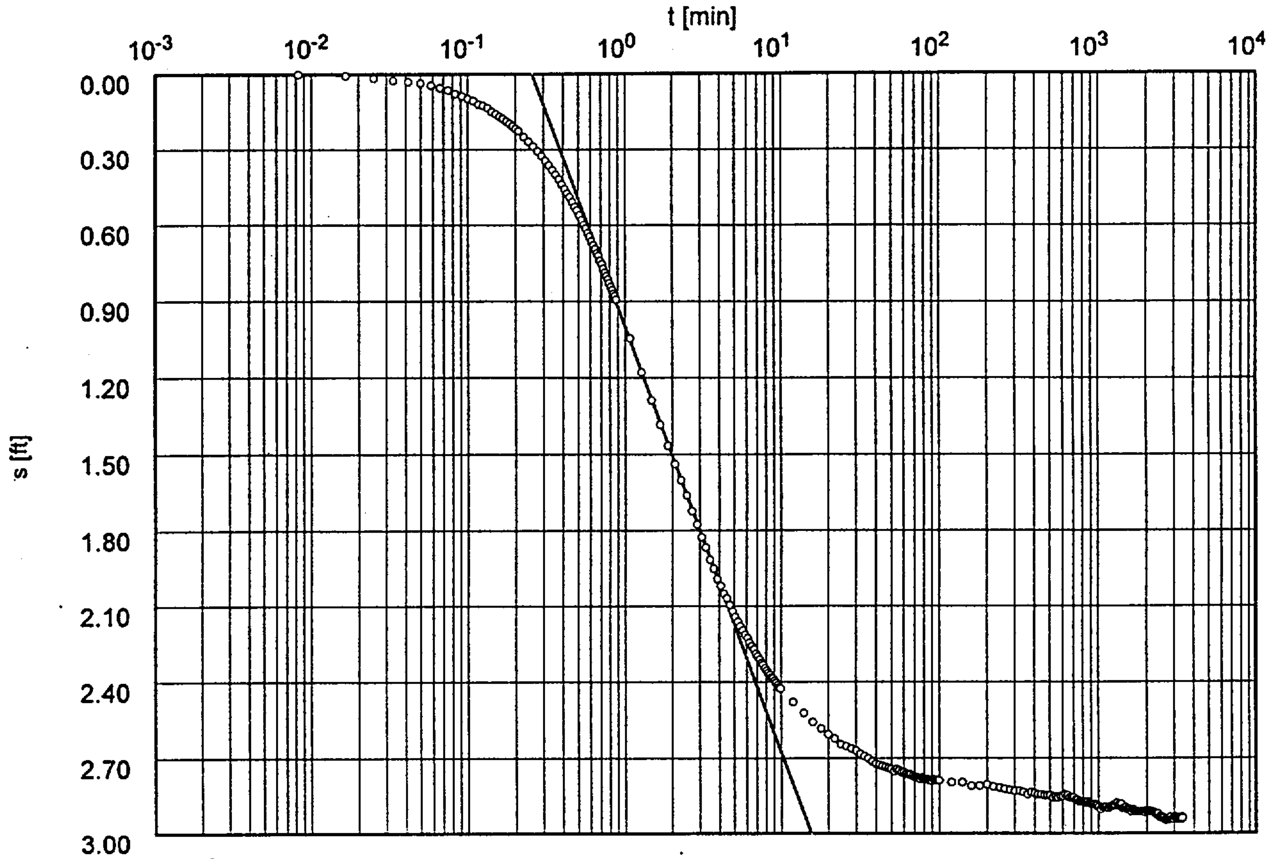
Transmissivity [$ft^2$/min]: $8.03 \times 10^{-1}$ = 1156.3 $ft^2/d$

Hydraulic conductivity [ft/min]: $2.67 \times 10^{-2}$

Aquifer thickness [ft]: 30.00

| MACTEC-ERS<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Time-Drawdown-method after<br>COOPER & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>Evaluated by: / Date: 28.11.1999 |
|---|---|---|

| | |
|---|---|
| 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 | |



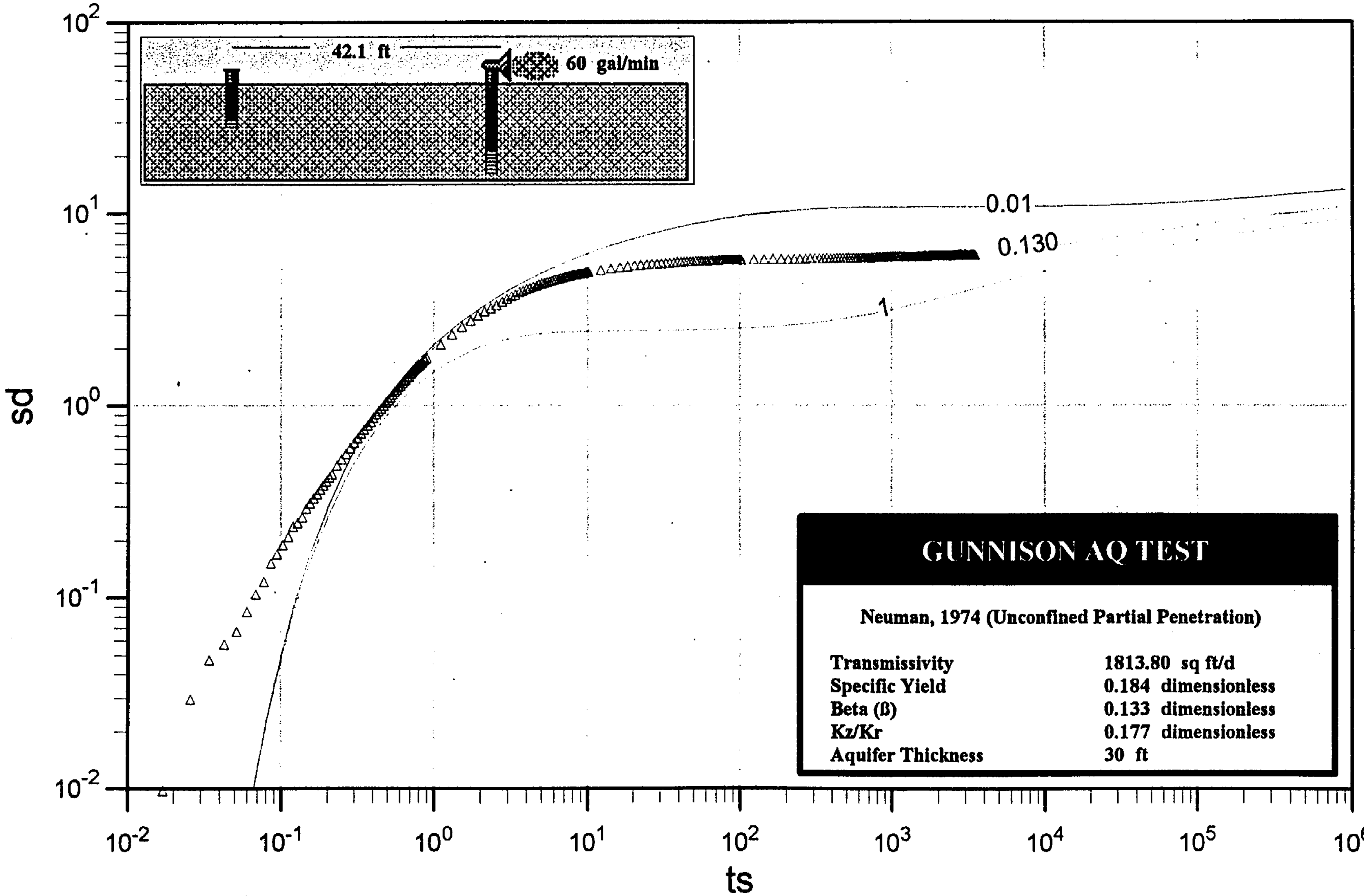

o OBS049

Transmissivity [ft²/min]: $8.74 \times 10^{-1}$ = 1258.6 ft²/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**

| ELAPSED TIME (min) | WELL 047 DTW (ft btoc) | WELL 048 obs048 | WELL 049 obs049 | WELL 136 OBS 136 | WELL 135 obs 135 |
|---|---|---|---|---|---|
| 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 |

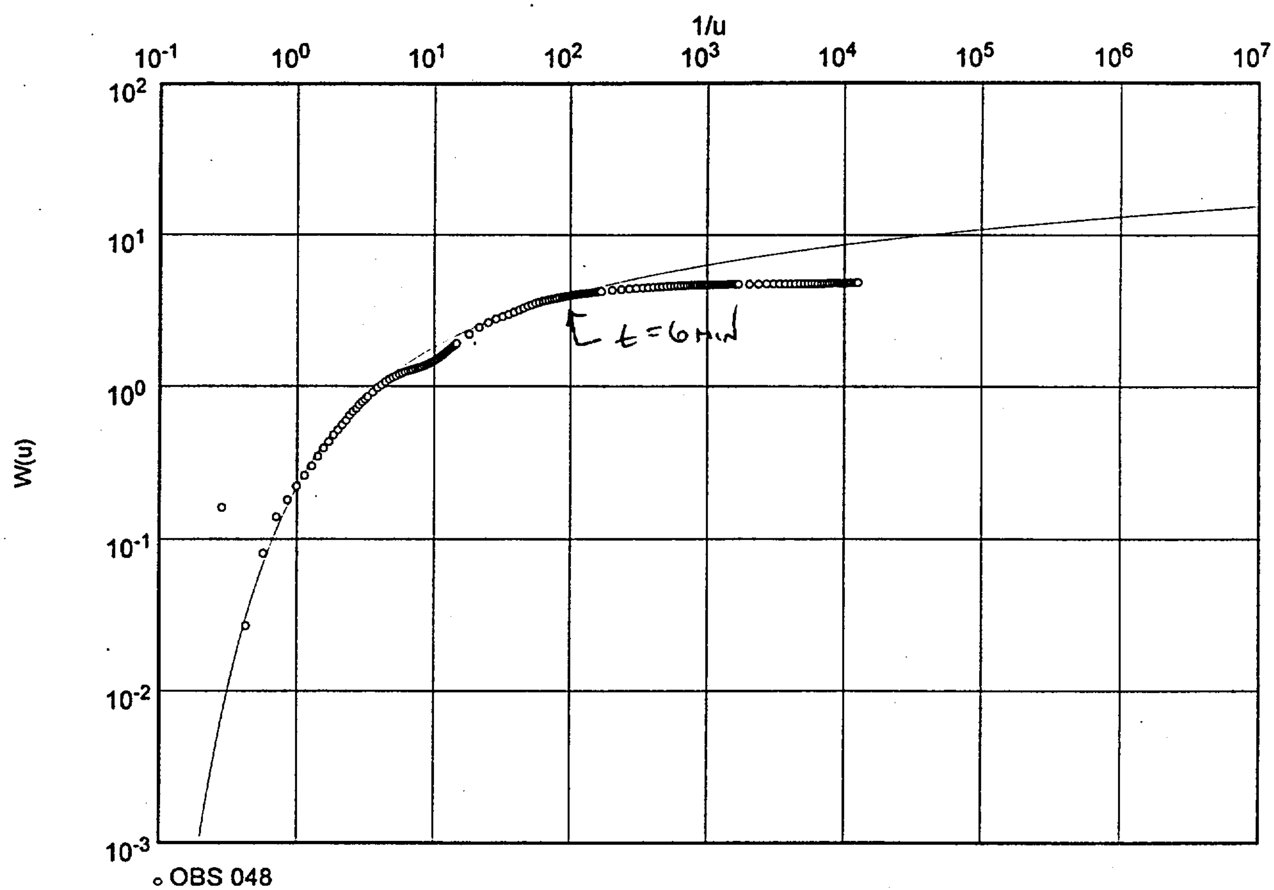
| | | | | | |
|---|---|---|---|---|---|
| 1839.88 | 45.472 | 11.02 | 10.588 | 12.311 | 7.96 |
| 1869.88 | 45.434 | 11.02 | 10.588 | 12.317 | 7.963 |
| 1899.88 | 45.434 | 11.02 | 10.588 | 12.32 | 7.963 |
| 1929.88 | 45.462 | 11.02 | 10.588 | 12.329 | 7.966 |
| 1959.88 | 45.443 | 11.02 | 10.593 | 12.329 | 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<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Theis analysis method<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 | |



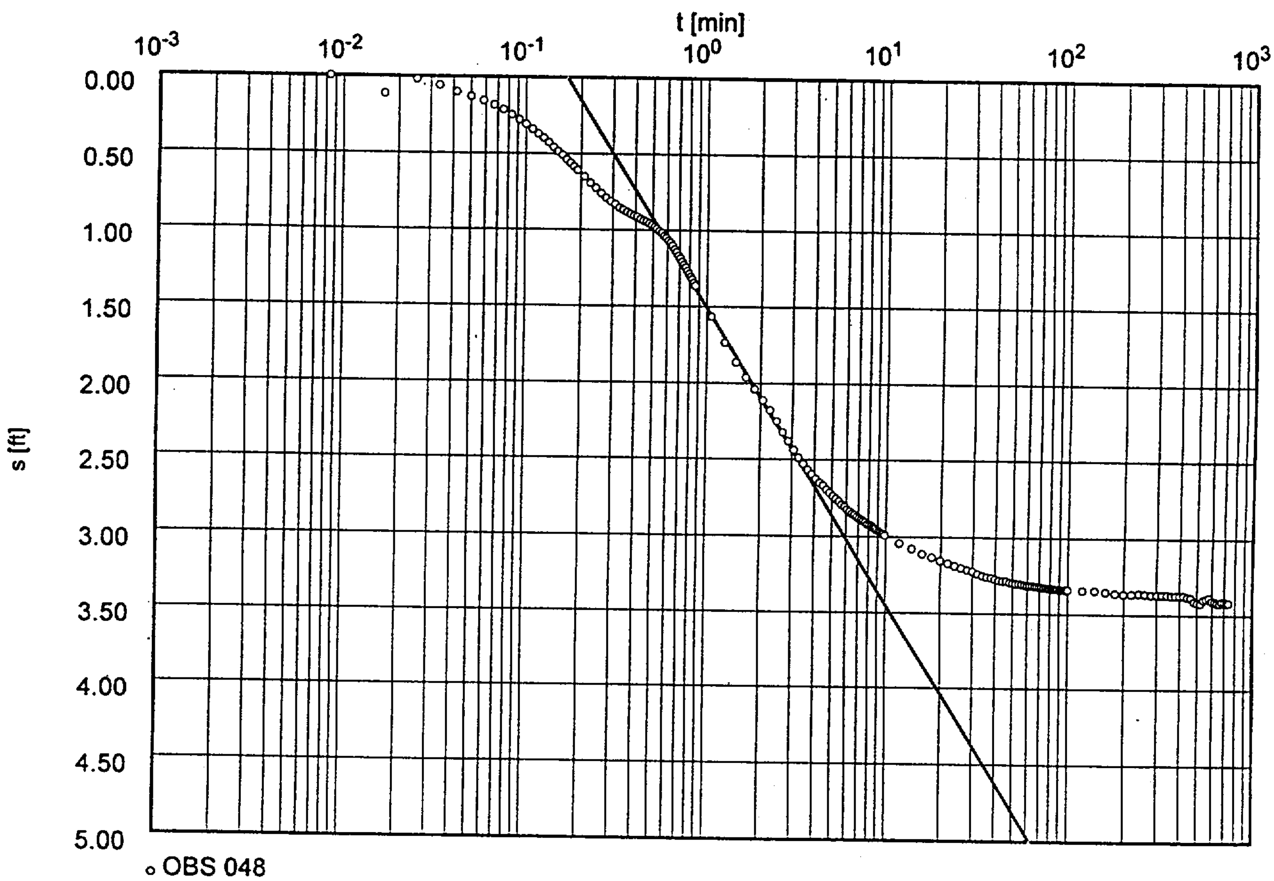

Transmissivity [ft²/min]: $9.01 \times 10^{-1}$ = 1297.4 ft²/d

Hydraulic conductivity [ft/min]: $3.00 \times 10^{-2}$

Aquifer thickness [ft]: 30.00

| | | |
|---|---|---|
| **MACTEC-ERS**<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Time-Drawdown-method after<br>COOPER & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>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 | |

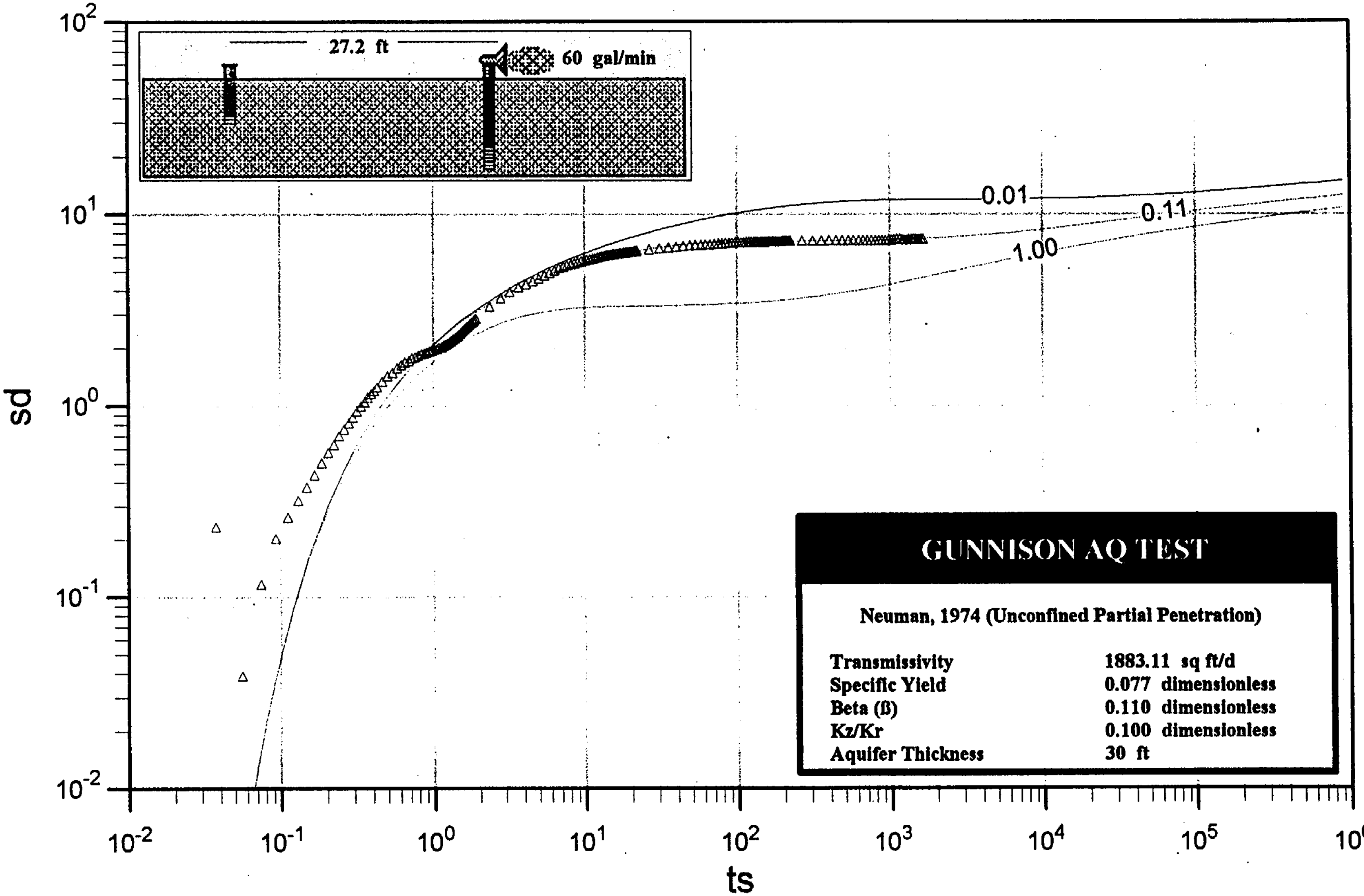



Transmissivity [$ft^2$/min]: $7.56 \times 10^{-1}$ = 1088.6 $ft^2$/d

Hydraulic conductivity [ft/min]: $2.52 \times 10^{-2}$

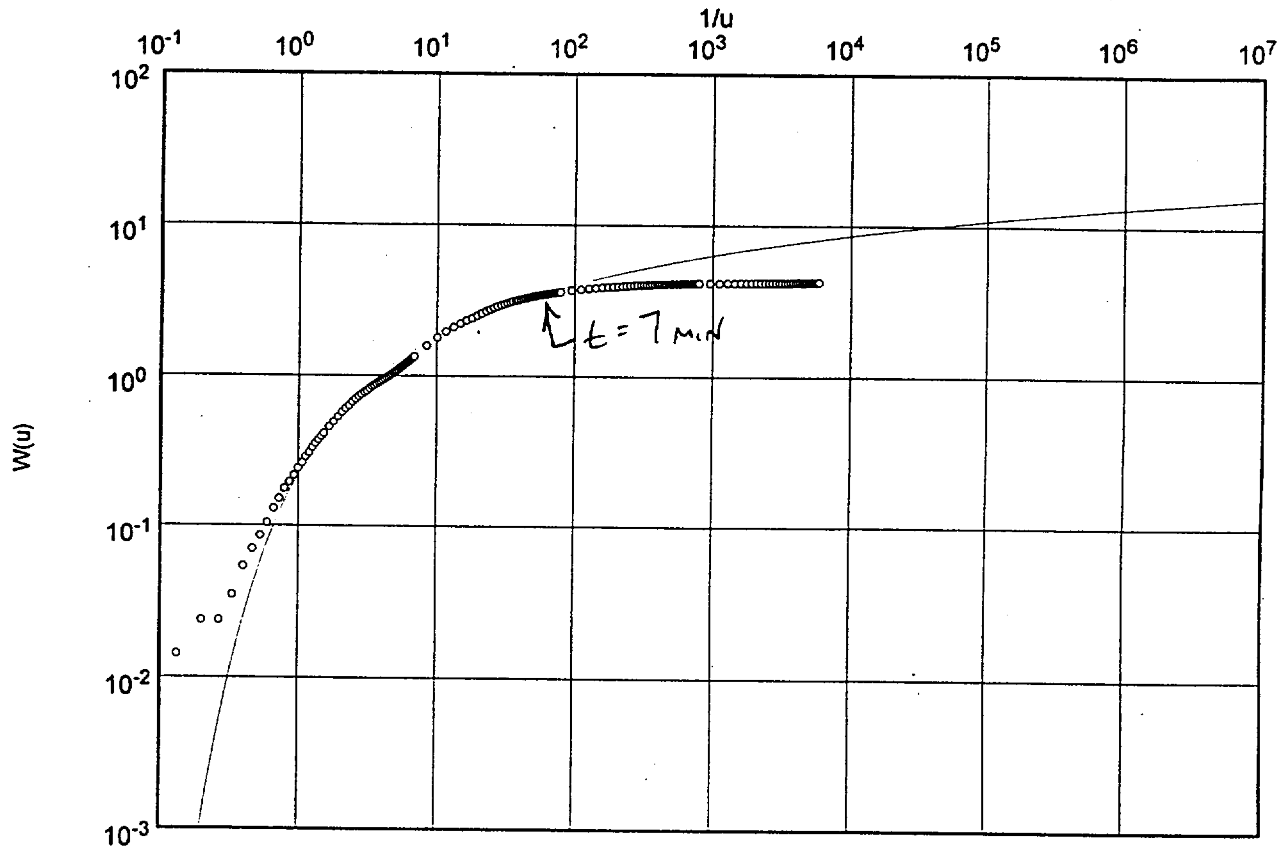
Aquifer thickness [ft]: 30.00

# WELL OBS 048 / 047 AQ TEST 2



| | | |
|---|---|---|
| **MACTEC-ERS**<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Theis analysis method<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>Evaluated by: Date: 14.12.1999 |

| | |
|---|---|
| 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

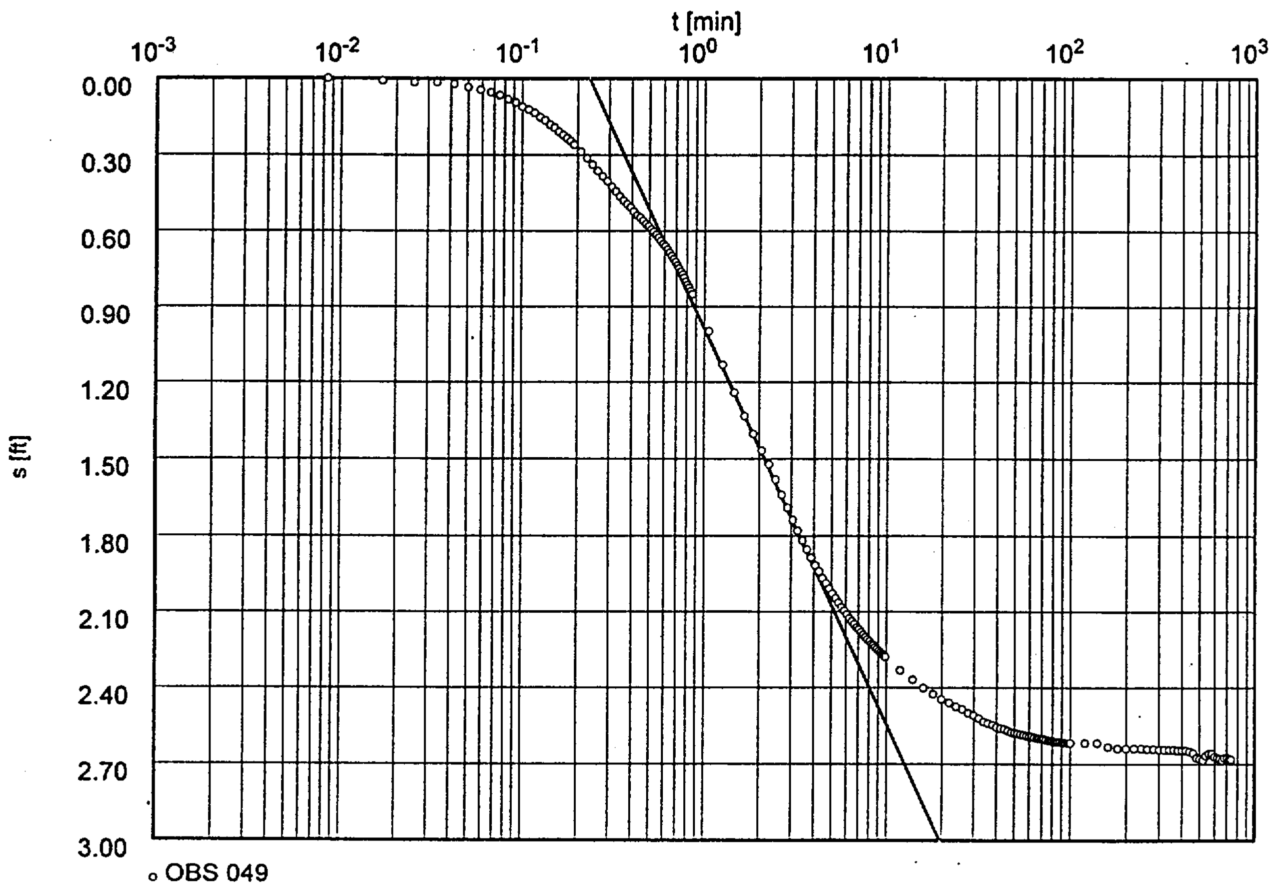
Transmissivity [ft²/min]: $1.01 \times 10^{0}$ = 1454.4 $FT^2/D$

Hydraulic conductivity [ft/min]: $3.37 \times 10^{-2}$

Aquifer thickness [ft]: 30.00

| | | | |
|---|---|---|---|
| **MACTEC-ERS**<br>2597 B 3/4 RD<br>GRAND JUNCTION, COLO<br>ph.(970)248-6000 | Pumping test analysis<br>Time-Drawdown-method after<br>COOPER & JACOB<br>Unconfined aquifer | Page 1<br>Project: GUNNISON<br>Evaluated by: | Date: 14.12.1999 |

| | |
|---|---|
| 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 | |

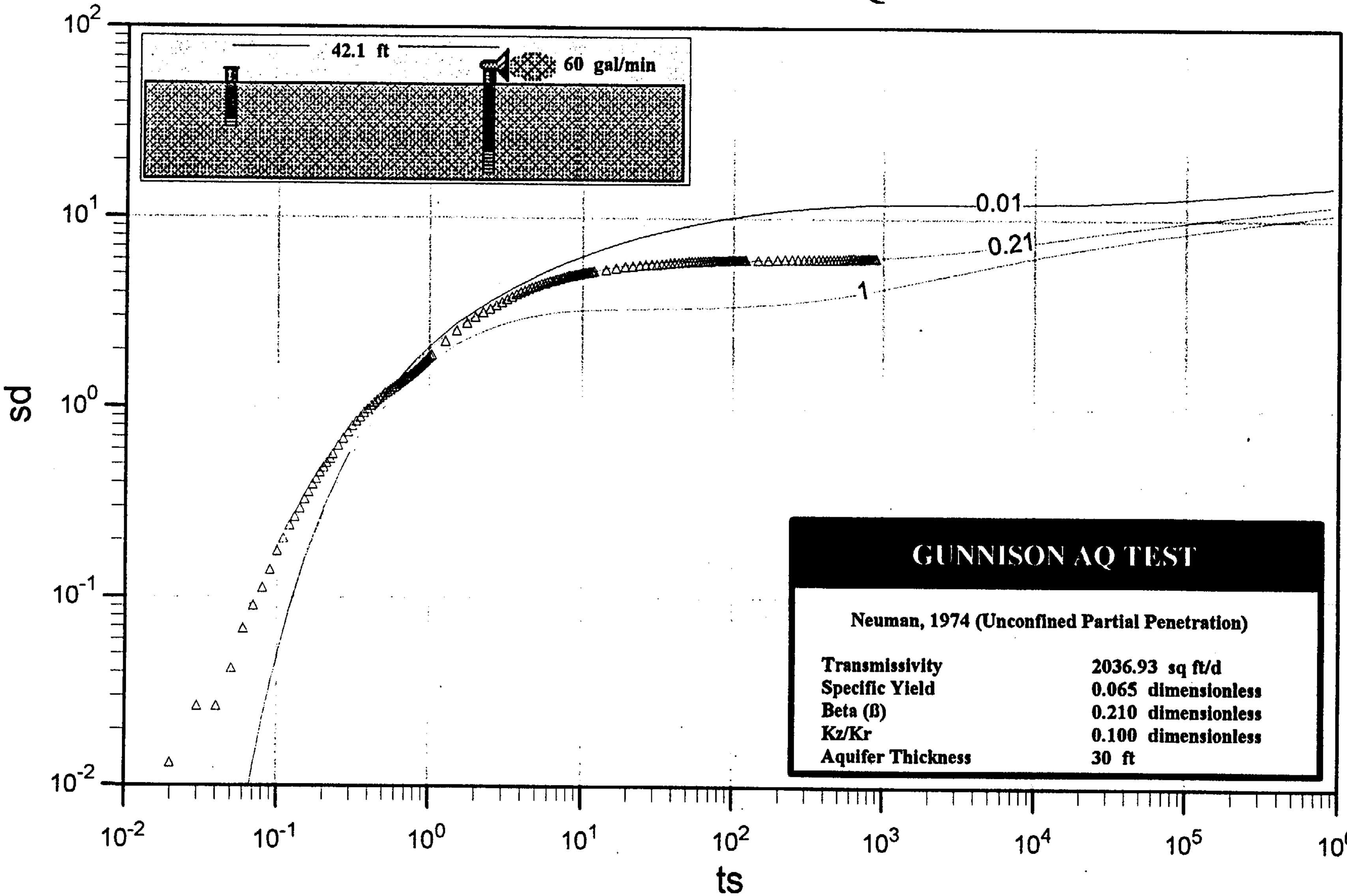



Transmissivity [ft²/min]: $9.42 \times 10^{-1}$ = 1356.4 ft²/d

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**

| ELAPSED TIME (min) | WELL 047 DTW (ft btoc) | WELL 048 DTW (ft btoc) | WELL 049 DTW (ft btoc) | WELL 135 DTW (ft btoc) | WELL 136 DTW (ft btoc) |
|---|---|---|---|---|---|
| 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 |

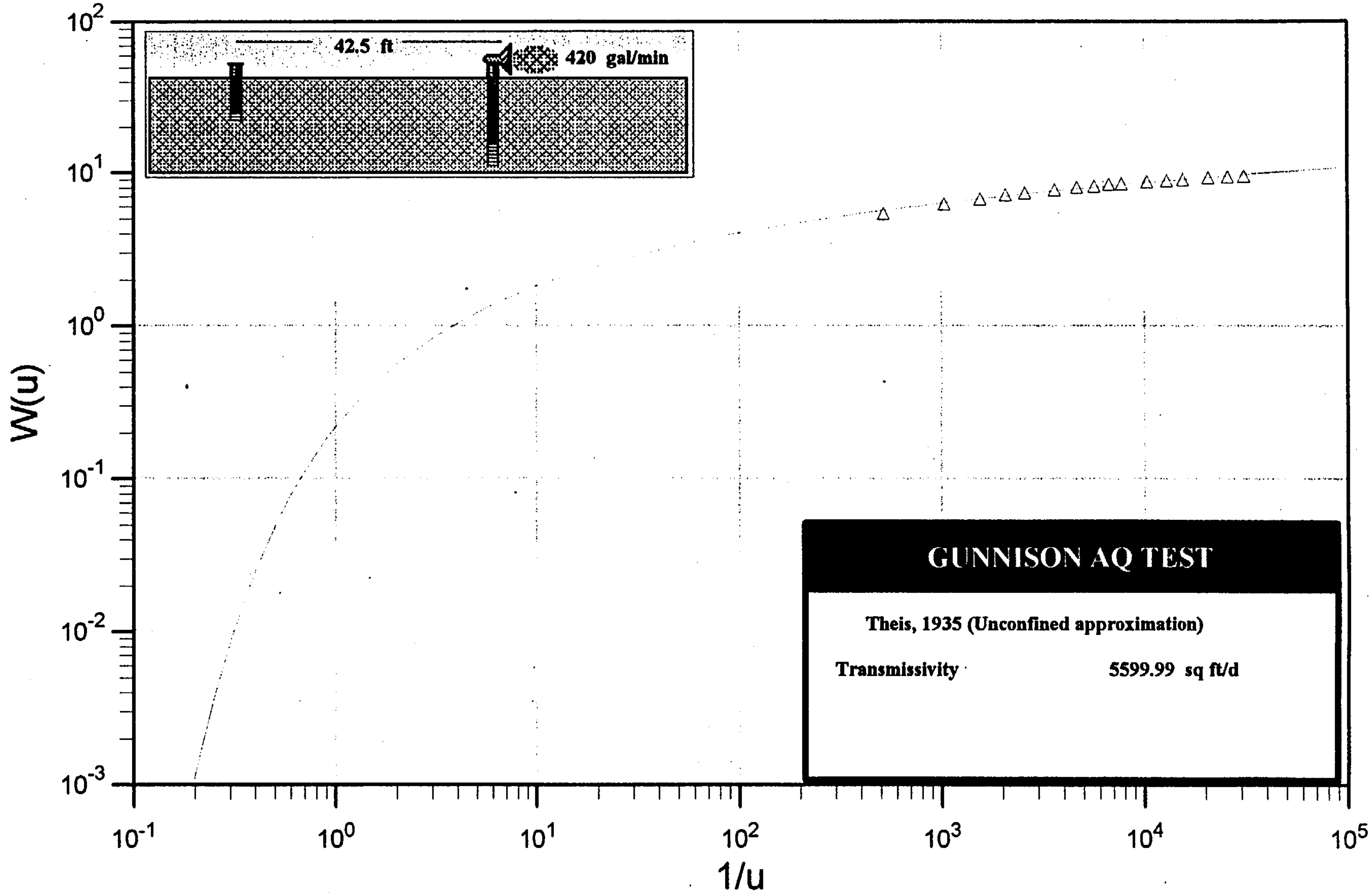
# APPENDIX E

## CITY OF GUNNISON PRODUCTION WELL AQUIFER TEST DATA AND PLOTS

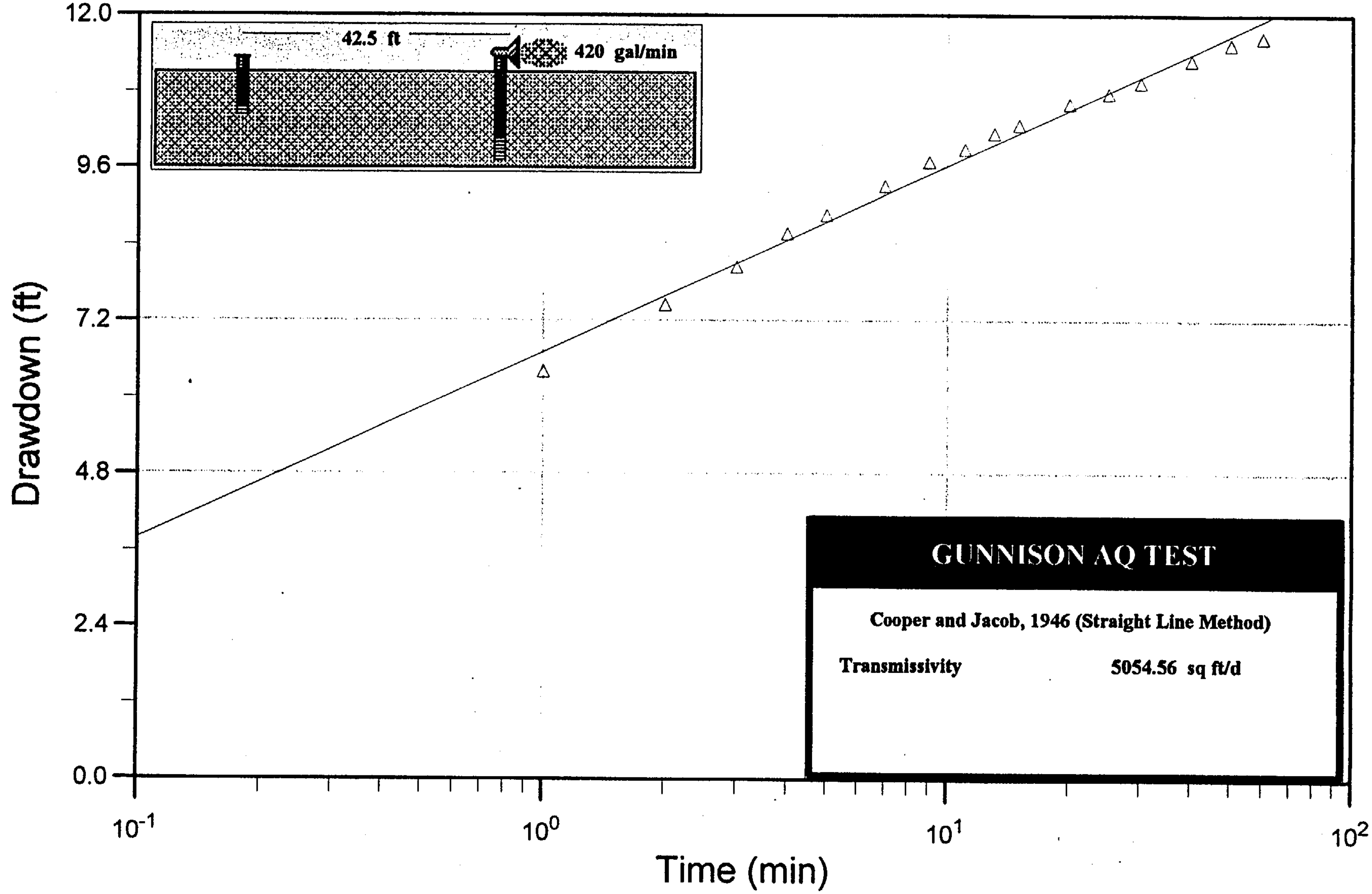
CITY OF GUNNISON AQUIFER TEST

PLOTS FOR PRODUCTION WELLS #10 AND #7

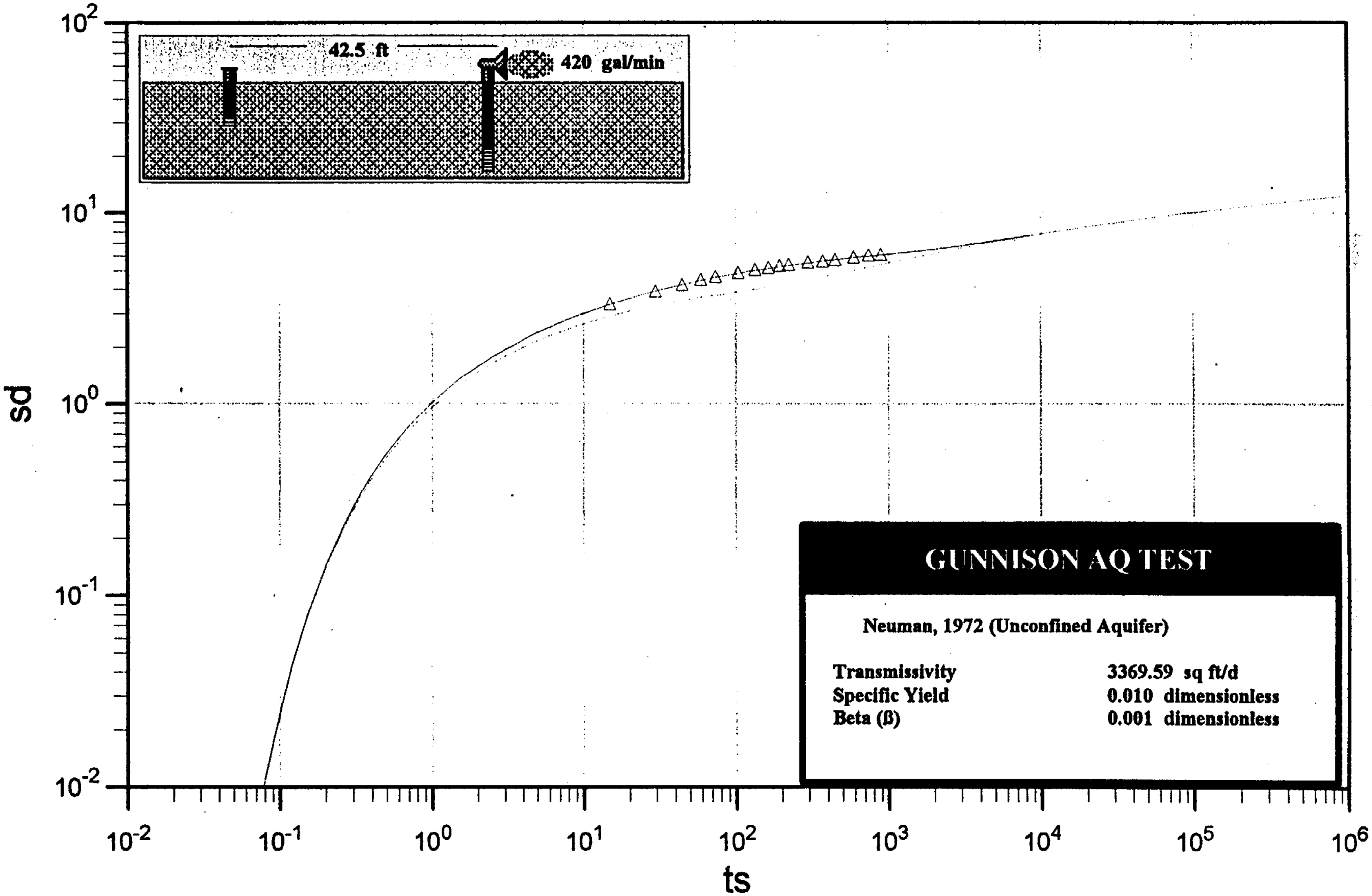
# CITY WELL 10 AQ TEST, OBS WELL DATA

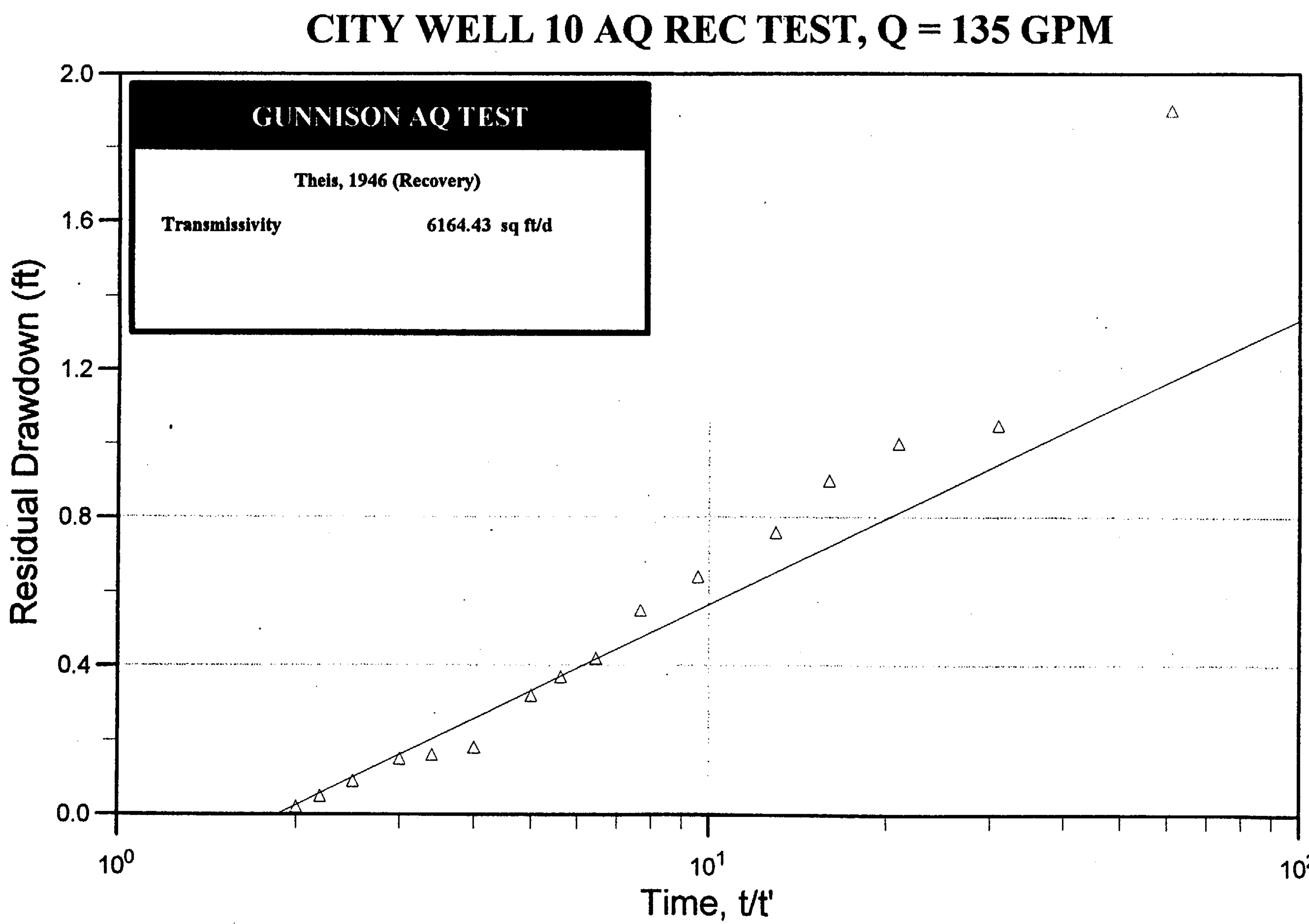


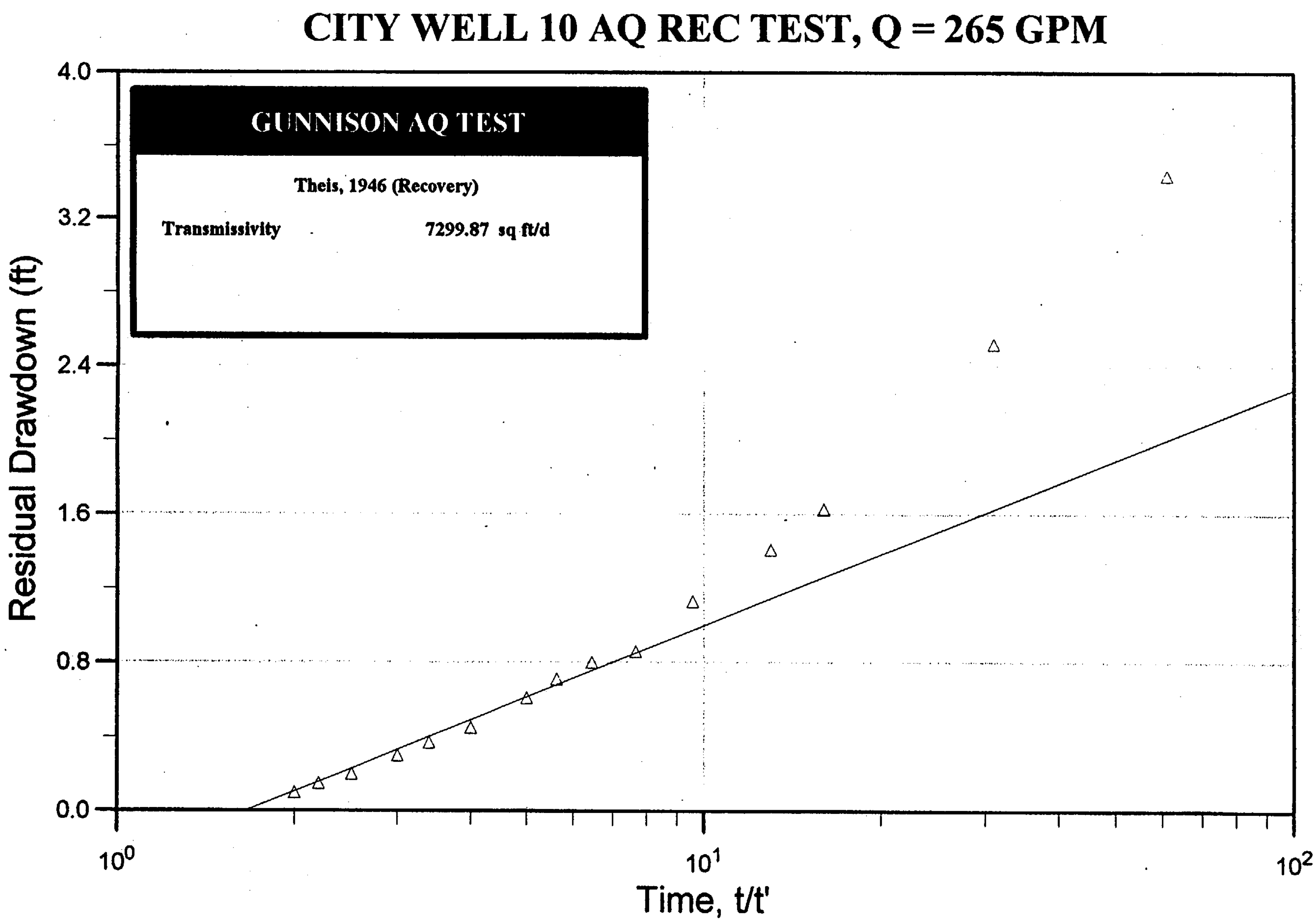
# CITY WELL 10 AQ TEST, OBS WELL DATA



# CITY WELL 10 AQ TEST, OBS WELL DATA

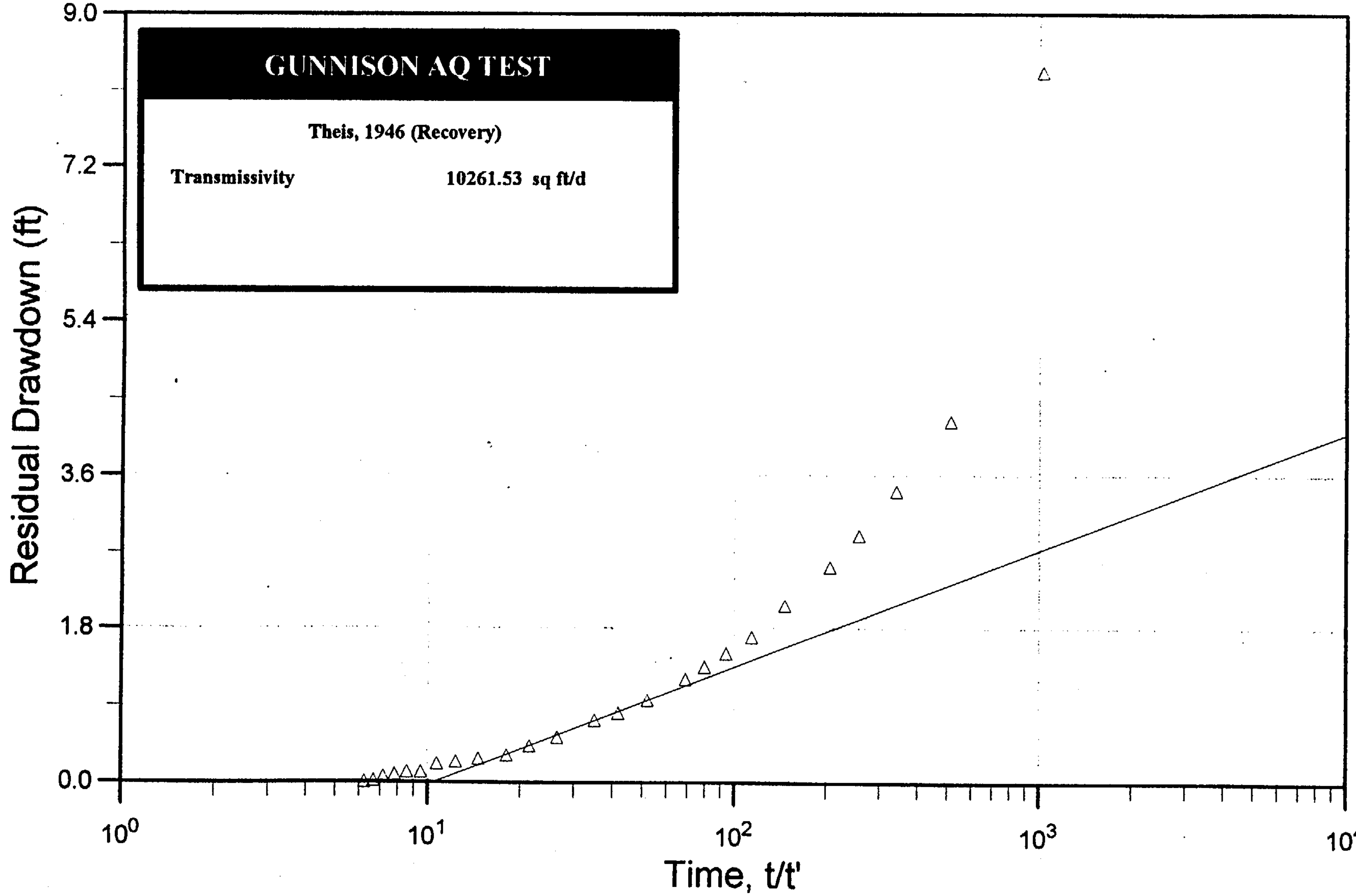


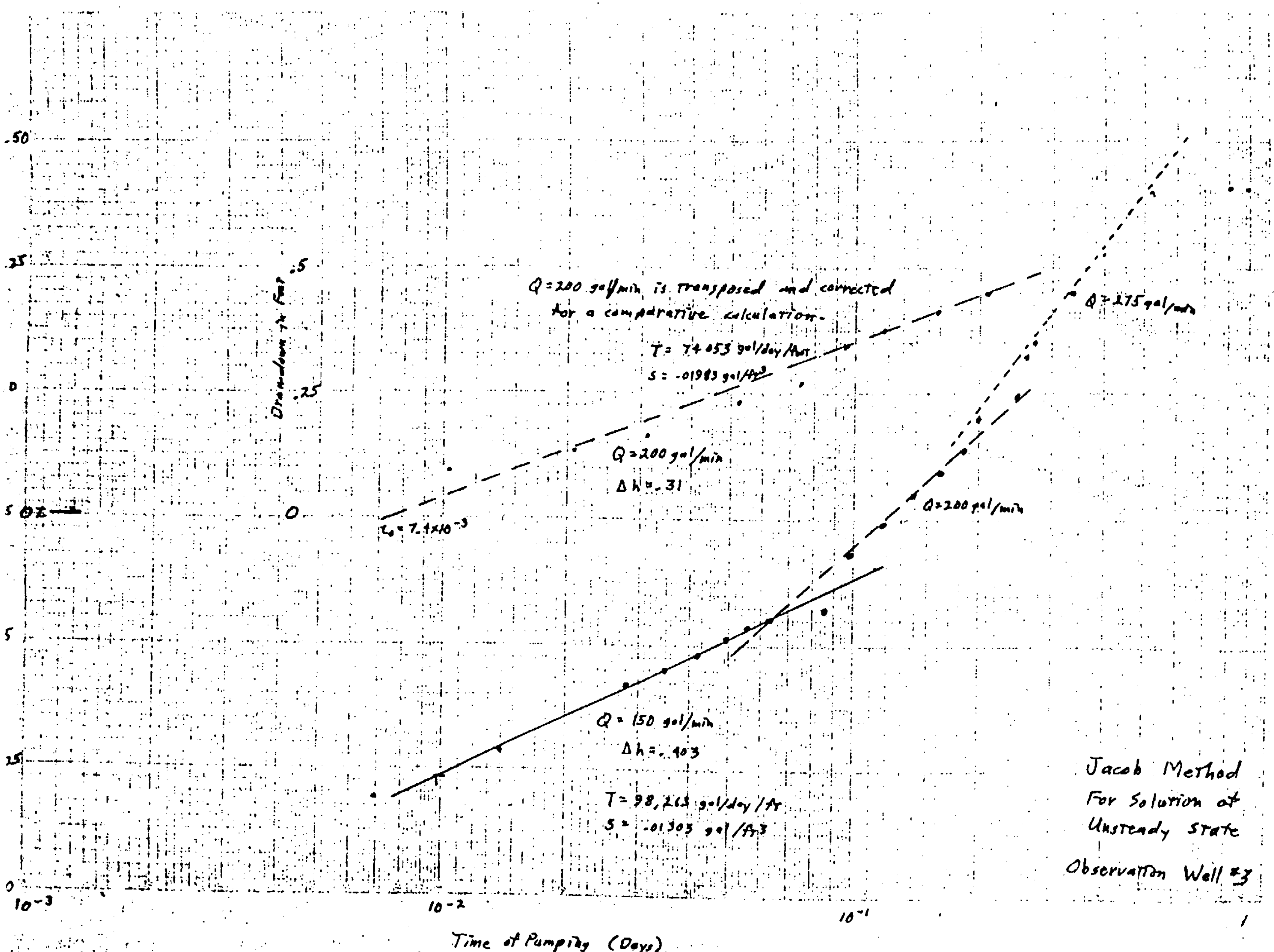

CITY WELL 10 AQ REC TEST, Q = 135 GPM
GUNNISON AQ TEST
Theis, 1946 (Recovery)
Transmissivity 6164.43 sq ft/d
Residual Drawdown (ft)
2.0
1.6
1.2
0.8
0.4
0.0
$10^0$
$10^1$
$10^2$
Time, t/t'



CITY WELL 10 AQ REC TEST, Q = 265 GPM
GUNNISON AQ TEST
Theis, 1946 (Recovery)
Transmissivity 7299.87 sq ft/d
Residual Drawdown (ft)
4.0
3.2
2.4
1.6
0.8
0.0
10^0
10^1
10^2
Time, t/t'

# CITY WELL 10 AQ REC TEST, Q = 400 GPM





Q = 200 gal/min is transposed and corrected for a comparative calculation.
T = 74,053 gal/day/ft
S = .01983 gal/ft3
Q = 200 gal/min
Δh = .31
$t_0 = 7.4 \times 10^{-3}$
Q = 275 gal/min
Q = 200 gal/min
Q = 150 gal/min
Δh = .403
T = 98,263 gal/day/ft
S = .01303 gal/ft3
Drawdown in Feet
Time of Pumping (Days)
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

| ELPASED TIME (min) | WELL #10 DTW (ft btoc) | OBSERVATION WELL DTW (ft btoc) |
|---|---|---|
| 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

| ELPASED TIME (min) | WELL #10 DTW (ft btoc) |
|---|---|
| 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

| ELPASED TIME (min) | WELL #10 DTW (ft btoc) |
|---|---|
| 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

| ELPASED TIME (min) | WELL #10 DTW (ft btoc) |
|---|---|
| 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 | 51.62 |
| 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 |
|---|---|
| .139x10⁻² days | 1.48 feet |
| .903 | 1.27 |
| 1.597 | 1.11 |
| 2.361 | 1.02 |
| 3.264 | .90 |
| 3.889 | .84 |
| 4.444 | .73 |
| 5.208 | .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 |
| 16.46x10⁻² | 0 |

Pumping

| Time | Drawdown | |
|---|---|---|
| .694x10⁻² days | .19 feet | |
| 1.388 | .29 | |
| 2.777 | .42 | 143 gal/min |
| 3.472 | .46 | |
| 4.167 | .48 | 148 gal/min |
| 4.861 | .52 | 145 gal/min |
| 5.555 | .56 | |
| 8.333x10⁻² | .58 | 150 gal/min |
| | | |
| 0 | 0 | |
| 1.042x10⁻² | .09 | 202 gal/min |
| 2.083 | .13 | 208 gal/min |
| 3.125 | .17 | |
| 5.208 | .23 | |
| 7.292 | .27 | 200 gal/min |
| 9.375 | .34 | 202 gal/min |
| 11.46 | .38 | |
| 15.62x10⁻² | .42 | 198 gal/min |
| | | |
| 0 | 0 | |
| 1.042x10⁻² | .08 | 246 gal/min |
| 2.083 | .1 | 262 gal/min |
| 4.167 | .21 | 274 gal/min |
| 20x10⁻² | .21 | 274 gal/min |

Field Data - Pump Test Well #7

LINCOLN-DeVORE TESTING LABORATORY
COLORADO SPRINGS, PUEBLO, COLORADO—ROCK SPRINGS, WYOMING

# Appendix H

# Ground Water Flow and Transport Modeling

# Contents



# Figures

# Tables

# 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.

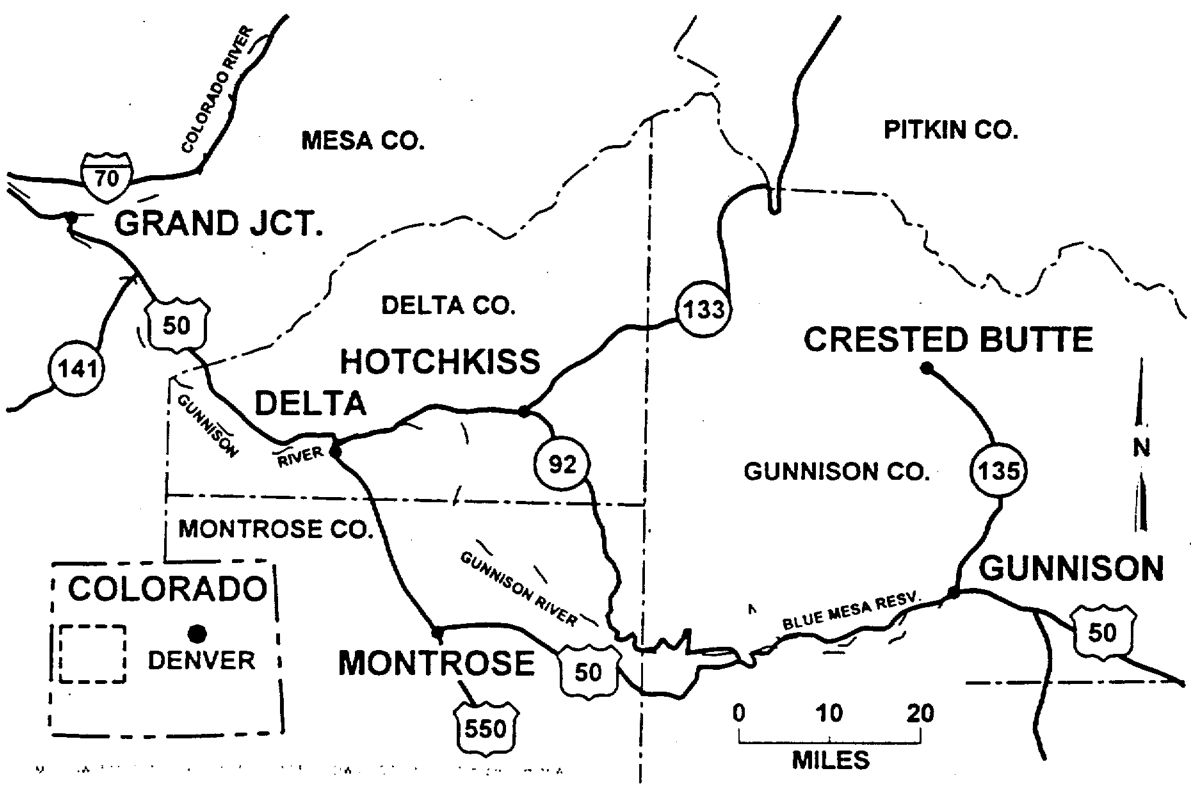



*Figure 1. Location of the Gunnison Site*

## 1.2 Study Objective

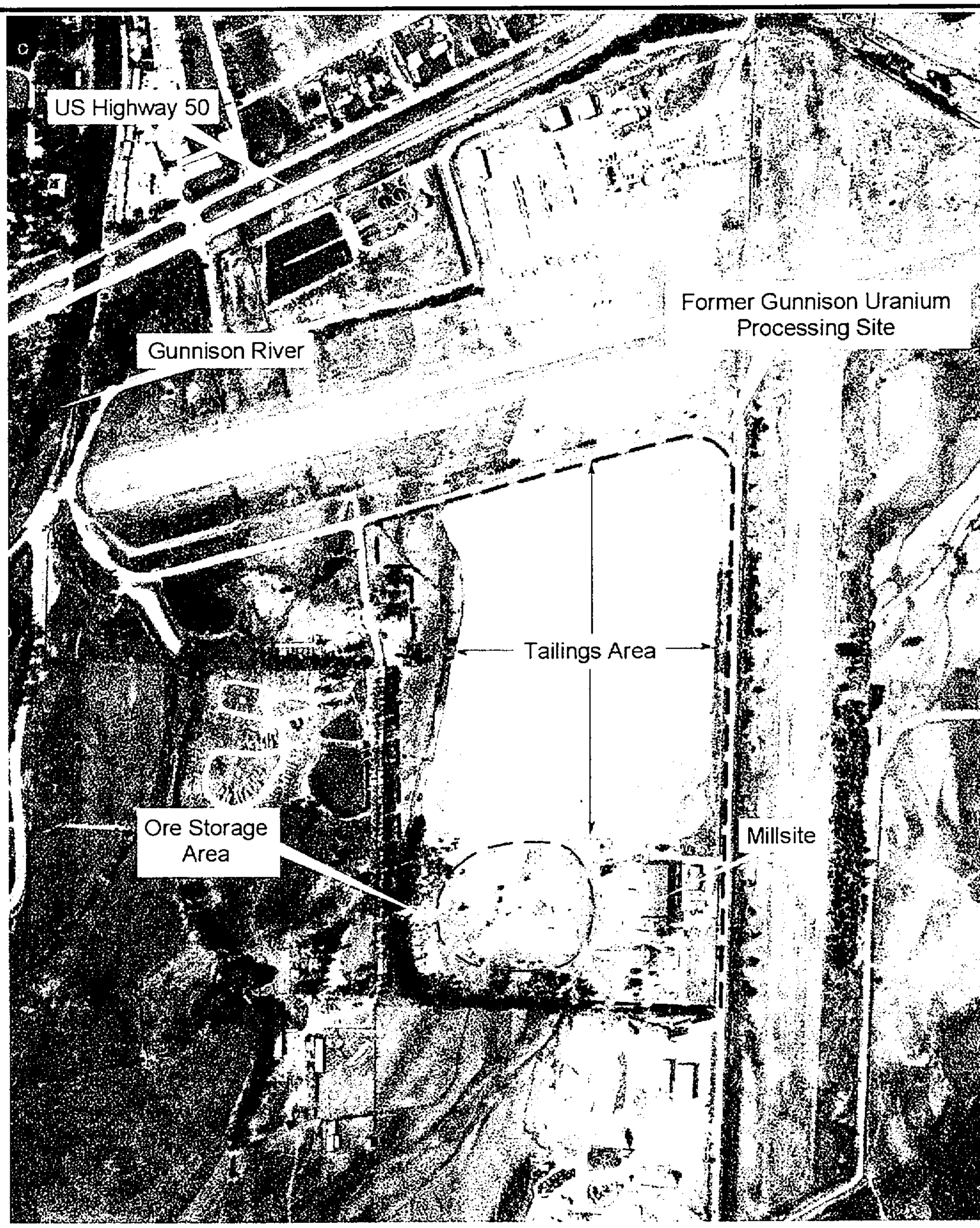
As part of the final compliance strategy for the cleanup of contaminated ground water at the Gunnison UMTRA Project site it is necessary to develop a computer ground water flow model and a subsequent contaminant transport model to assist in forecasting whether natural flushing of uranium is a viable 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 (91days) 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.




| | |
|---|---|
| mactec-ers | U.S. DEPARTMENT OF ENERGY<br>GRAND JUNCTION OFFICE, COLORADO |
| Gunnison Site Land Use<br>August 1979 | |
| DATE PREPARED:<br>July 5, 2000 | FILENAME:<br>U0103100-01 |

M:\UGW\511\0010\09\U01031\u0103100.apr reynoldm 7/5/2000, 11:50

*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 (*Kd*), 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 ($ft^2$) area for the site, results in a total 250,550 cubic feet per day ($ft^3$/day) of precipitation that is available for recharge. However, it is assumed that because of evapotransporation 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.

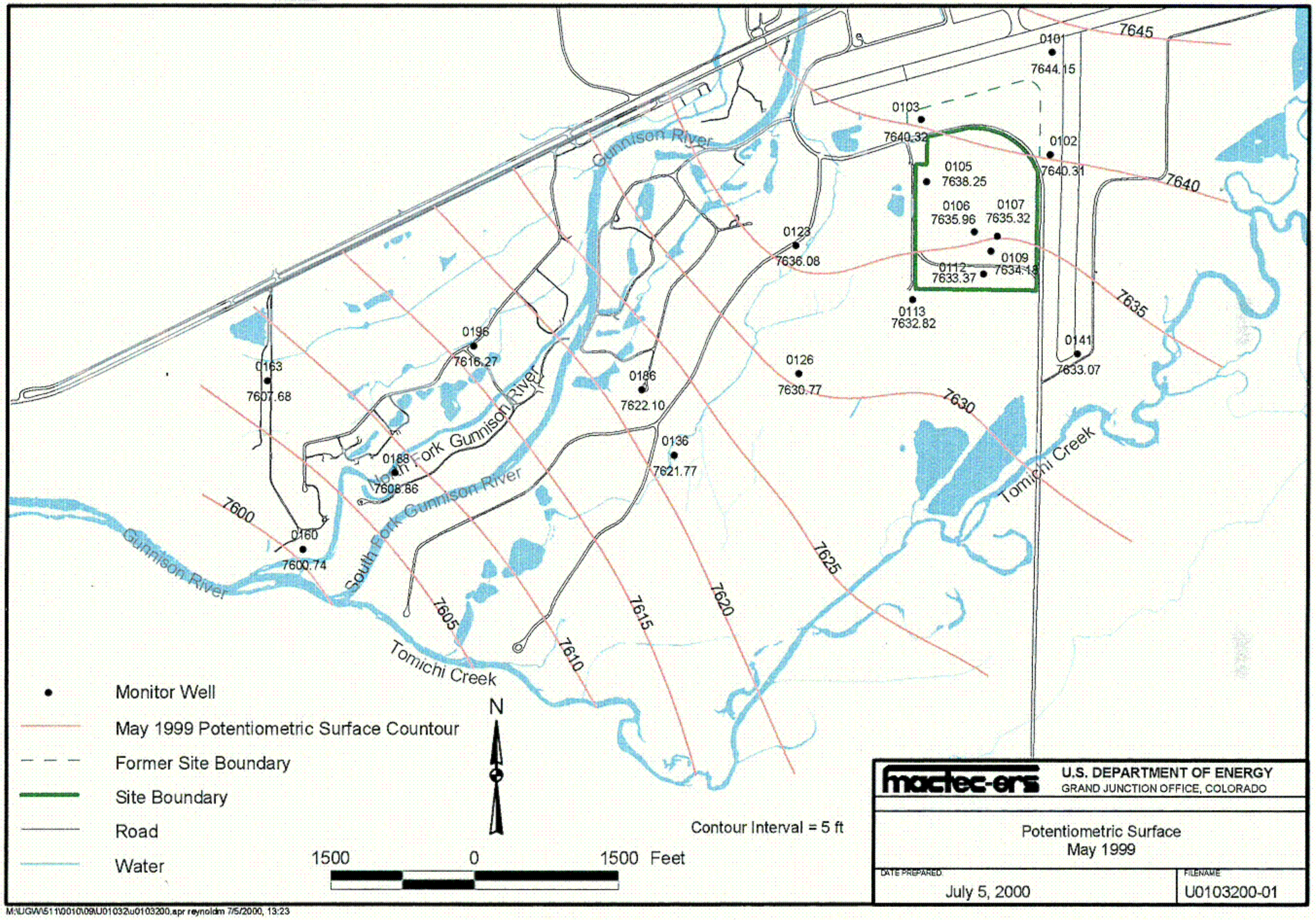



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*Figure 3. Potentiometric Surface – May 1999*

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### 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 $ft^2$. This results in a net inflow from Gold Basin Creek of 19,251 $ft^3$/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 $ft^2$. 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 $ft^2$. 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 evapotransipration. 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 sited. 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

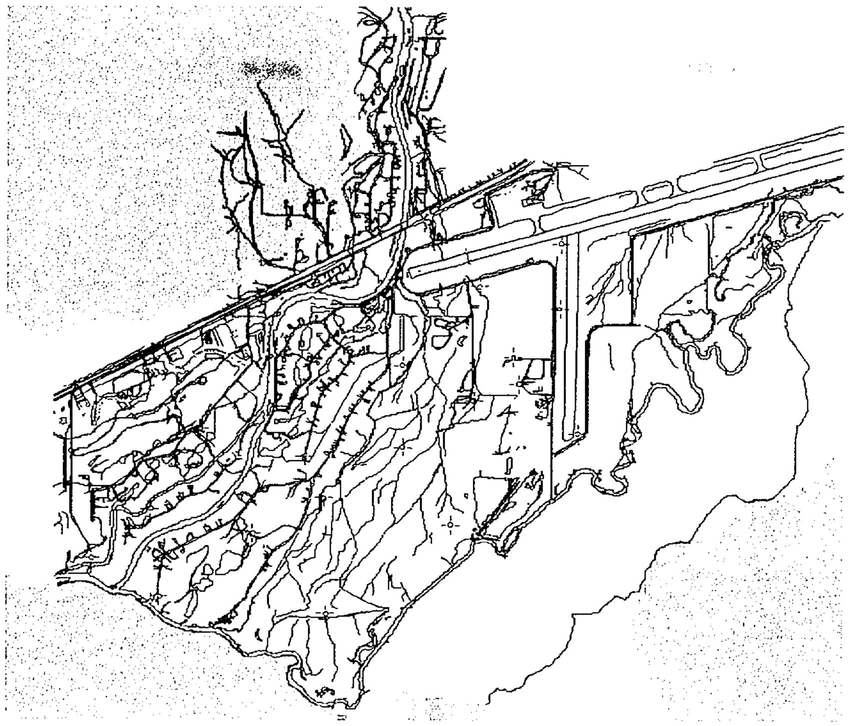

*Figure 4. Model Extent and Site Features*

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 ($ft^2$)** | **(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 ($ft^2$) | 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).

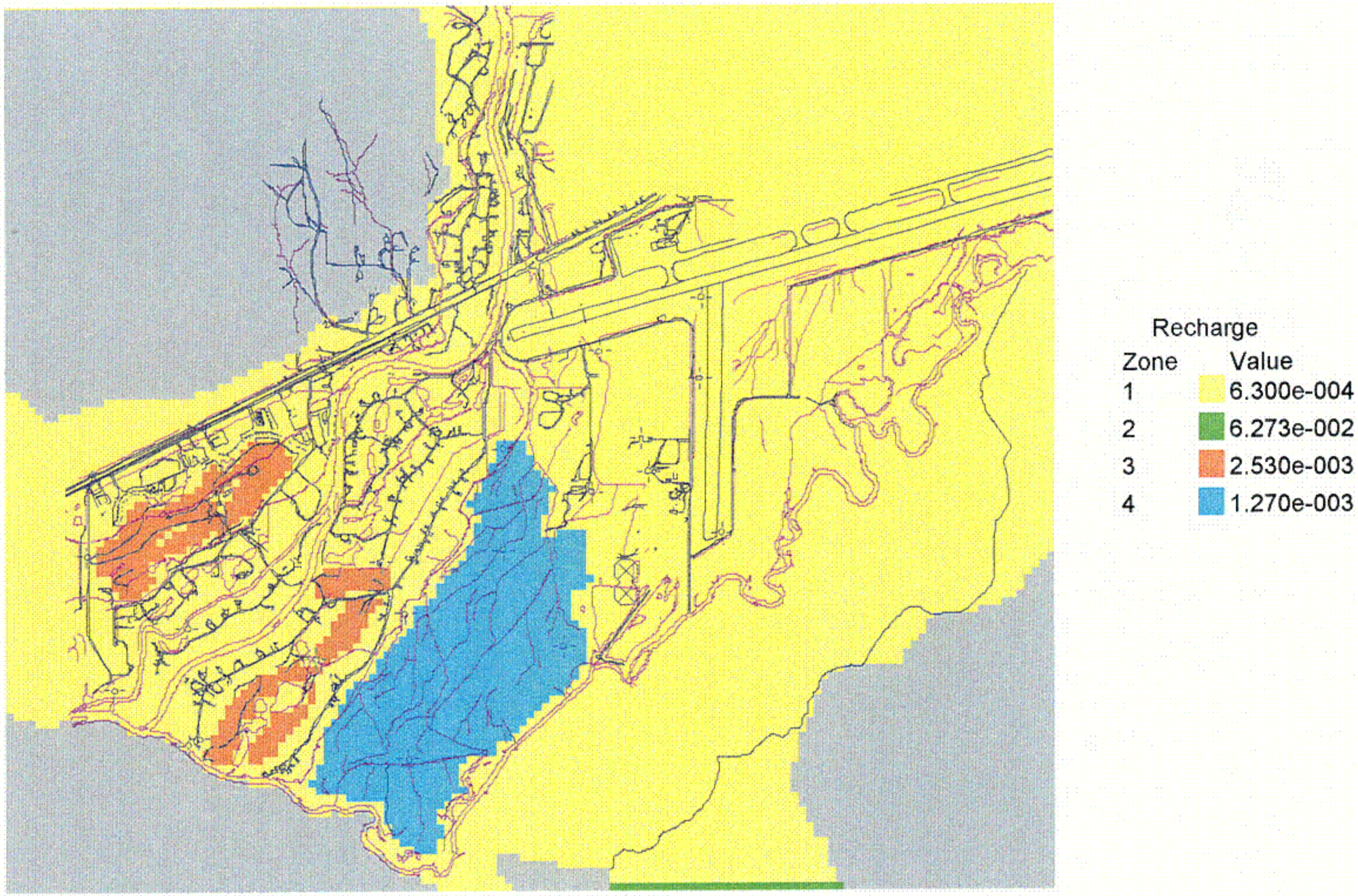


*Figure 5. Recharge Zones*

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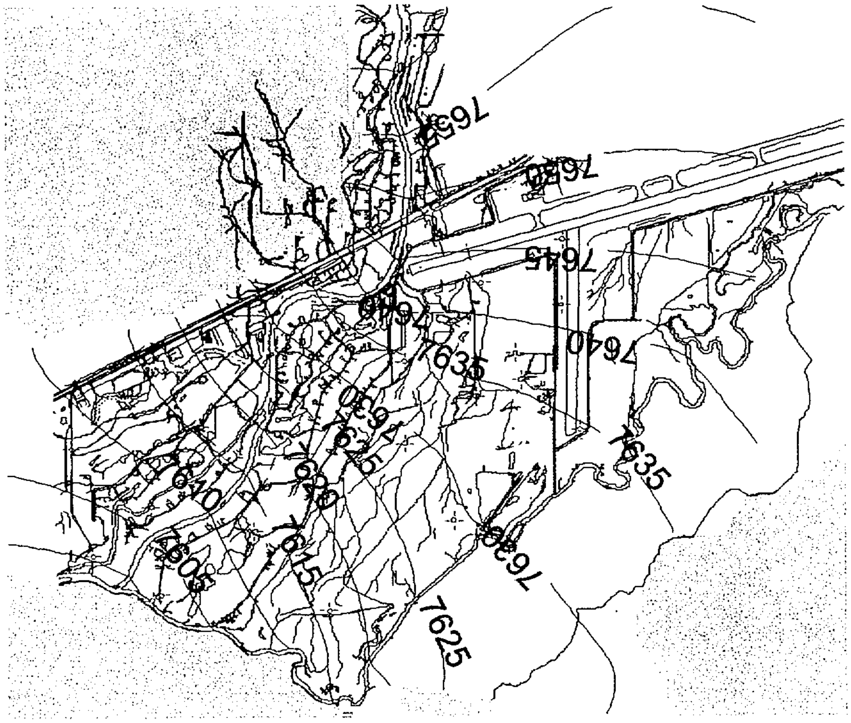


*Figure 6. Simulated Steady State Ground Water Elevations*

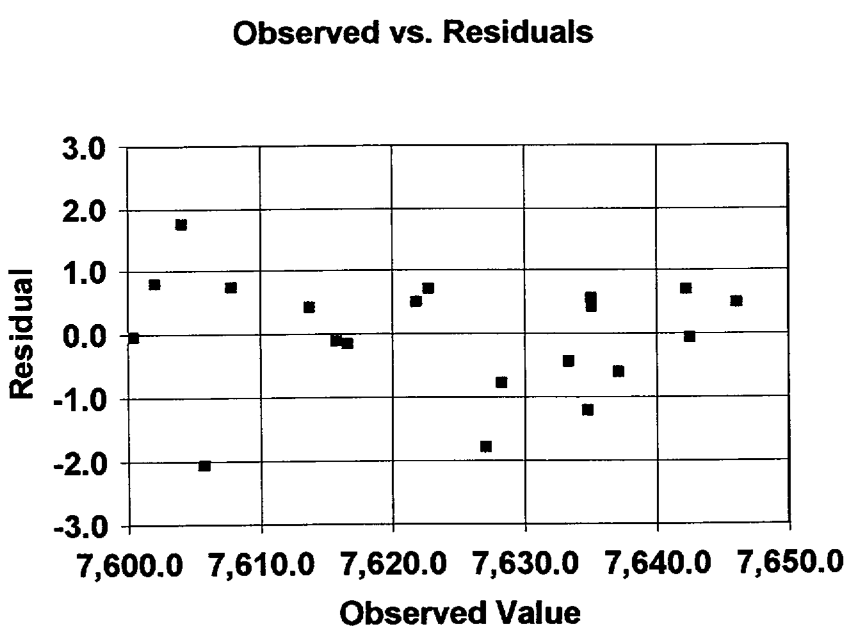


*Figure 7. Comparison of Residual versus Observed Head*

*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 | | |

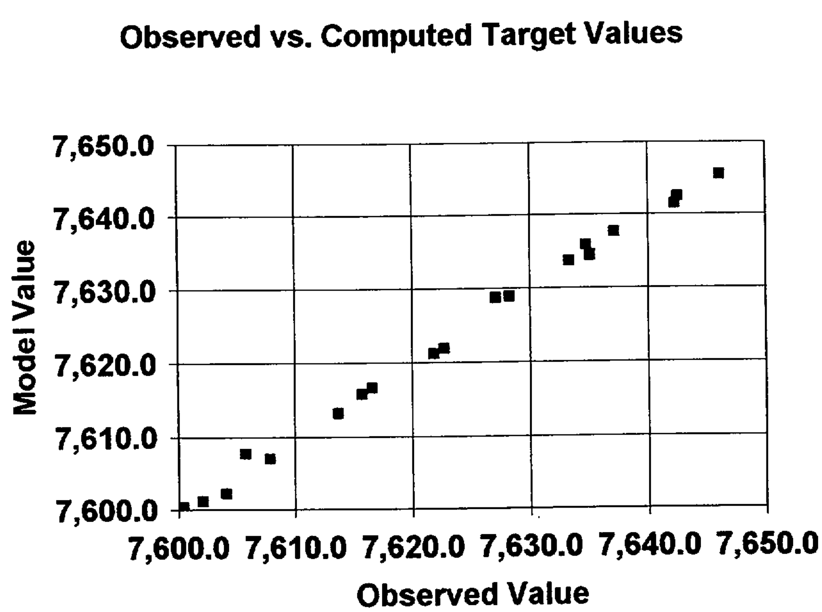


*Figure 8. Comparison of Predicted versus Observed Heads*

# 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 ($lbs/ft^3$) (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 | |
| *Kd* | | | | |
| Uranium ($ft^3$/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 ($ft^2$/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 ($lb/ft^3$) | 95 |
| (g/mL) | 1.5218 |

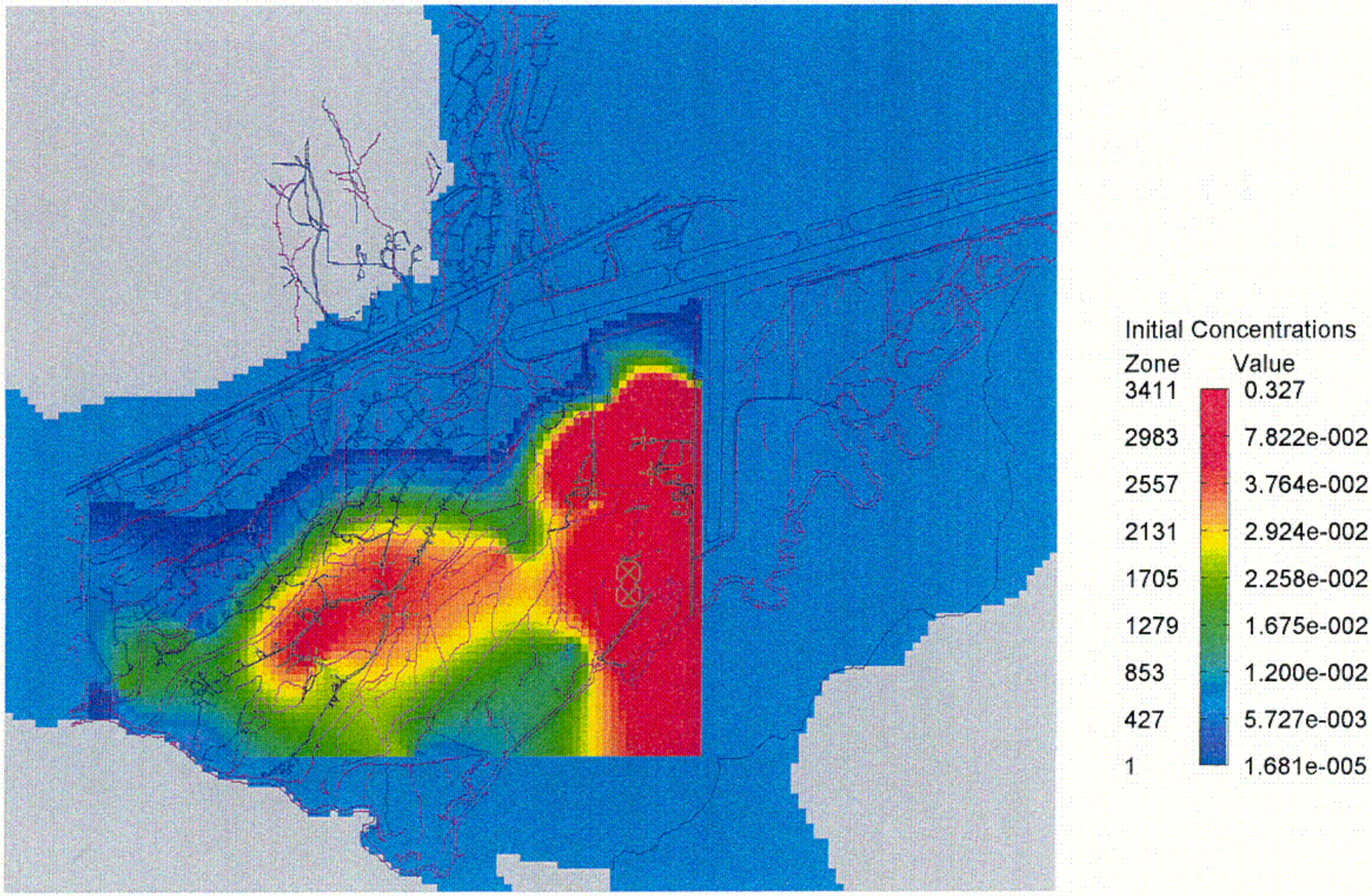


*Figure 9. Initial Uranium Concentration at Gunnison Site*

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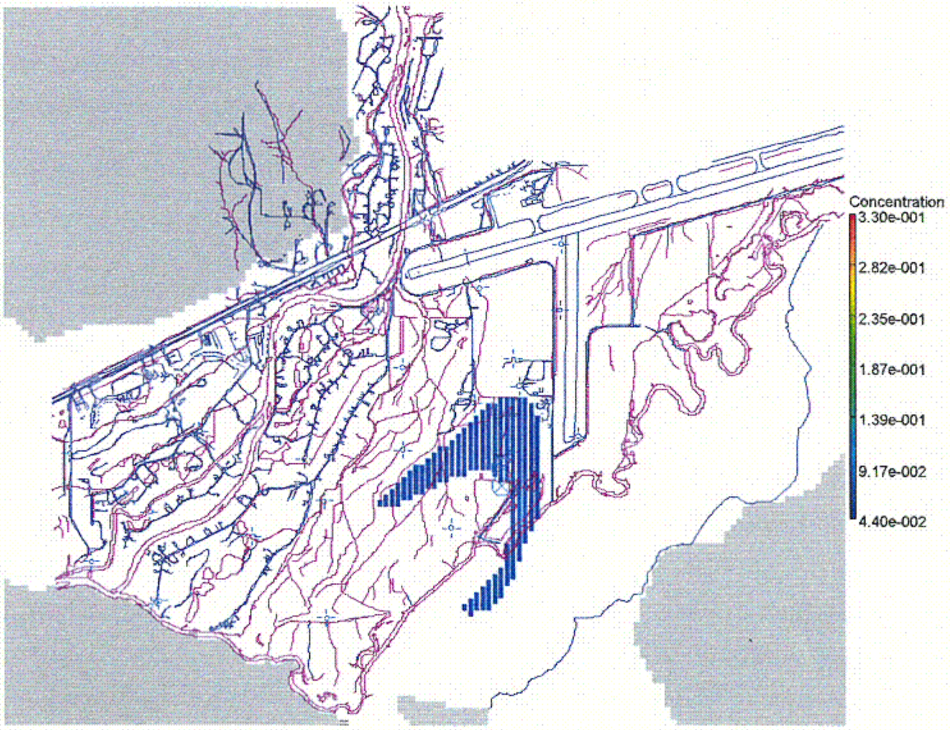


*Figure 10. Predicted Steady State Uranium Concentration at 50 Years*

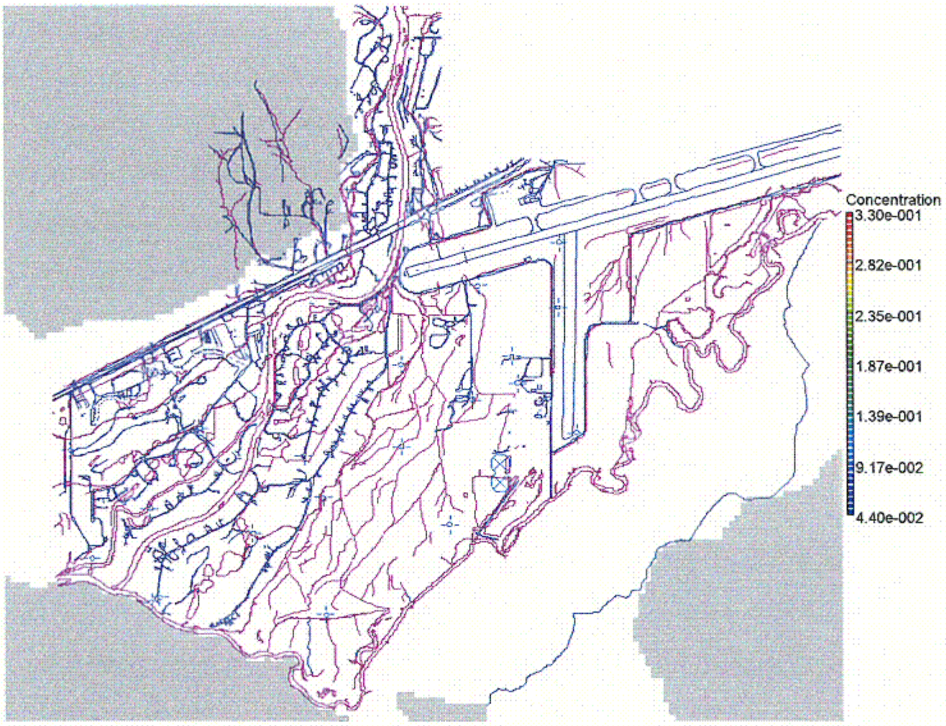


*Figure 11. Predicted Steady State Uranium Concentration at 100 Years*

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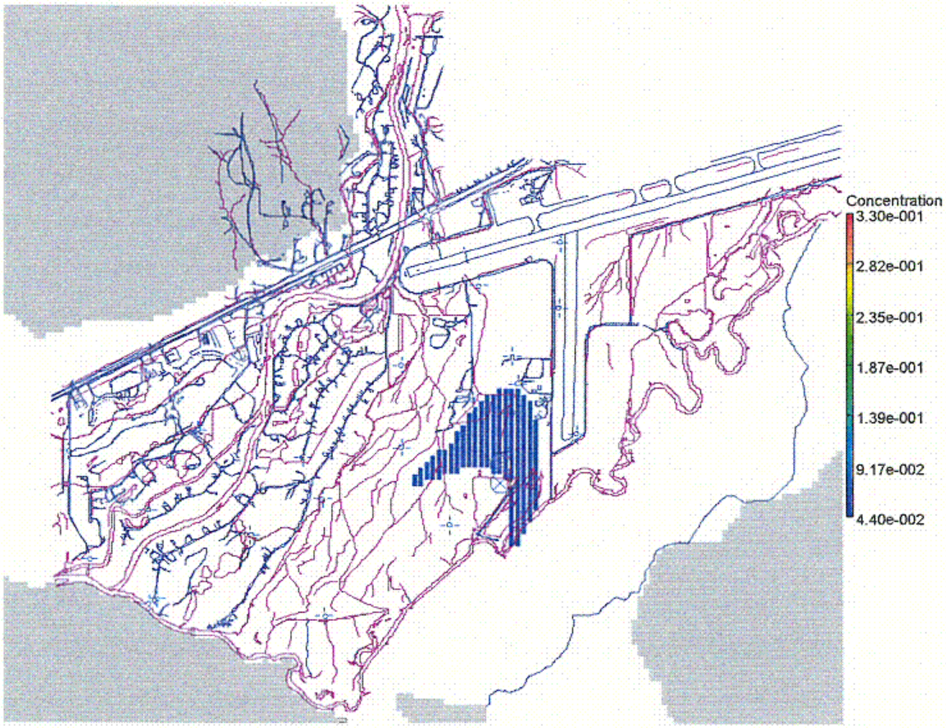


*Figure 12. Predicted Stochastic Uranium Concentration at 50 Years (100 simulations)*

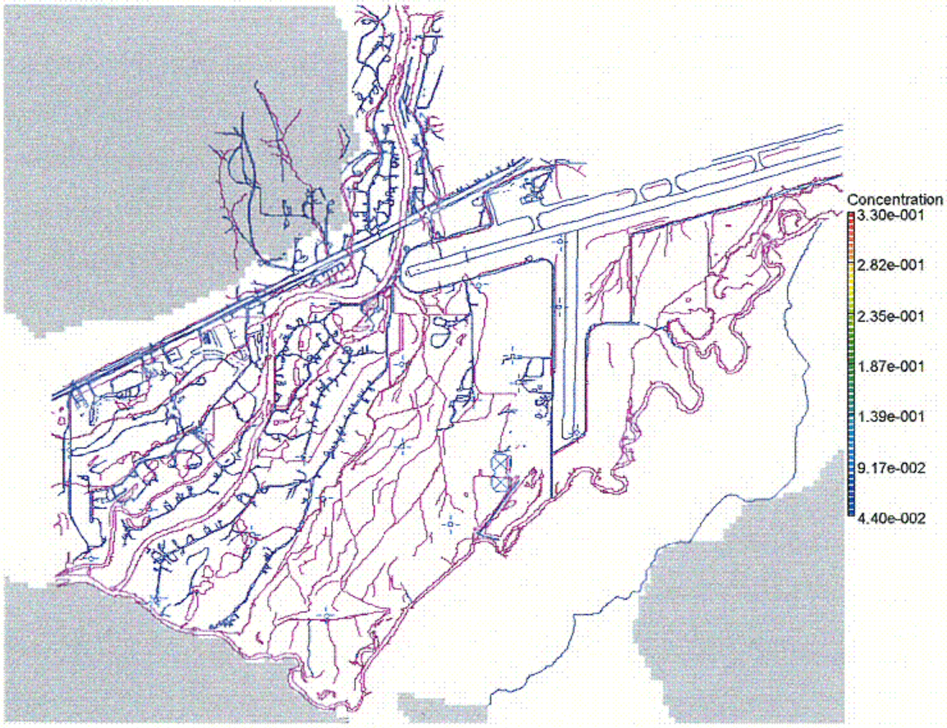


*Figure 13. Predicted Stochastic Uranium Concentration at 100 Years (100 simulations)*



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## 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 ($ft^2$) | (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 ($ft^2$) | (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 $ft^3$/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.

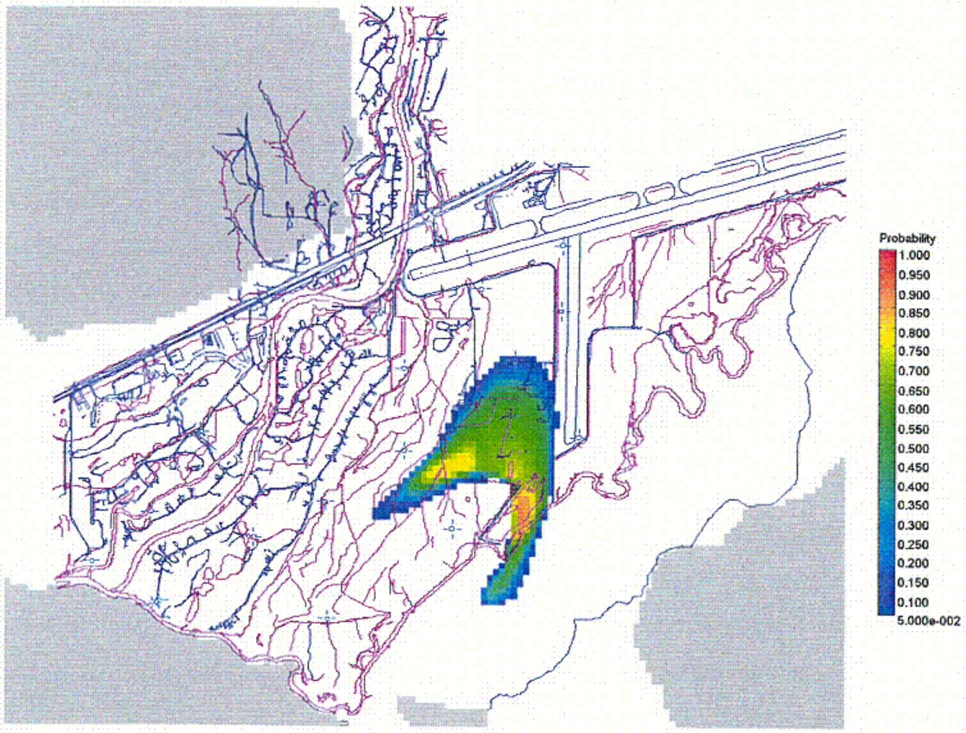


*Figure 14. Probability of Uranium Concentration Exceeding the Standard at 50 Years (100 simulations)*

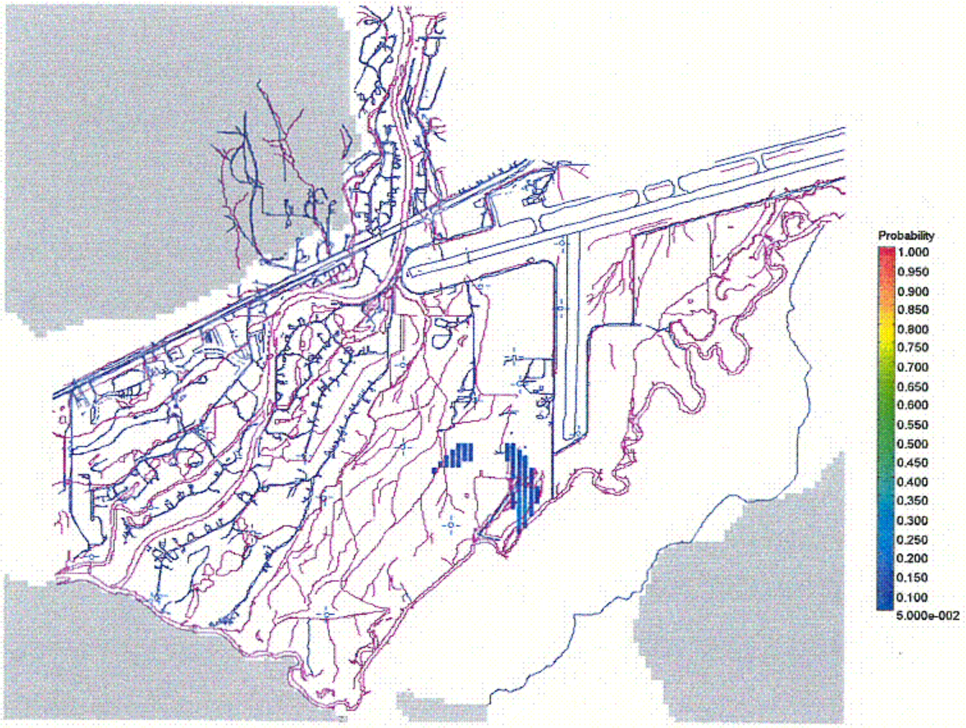


*Figure 15. Probability of Uranium Concentration Exceeding the Standard at 100 Years (100 simulations)*

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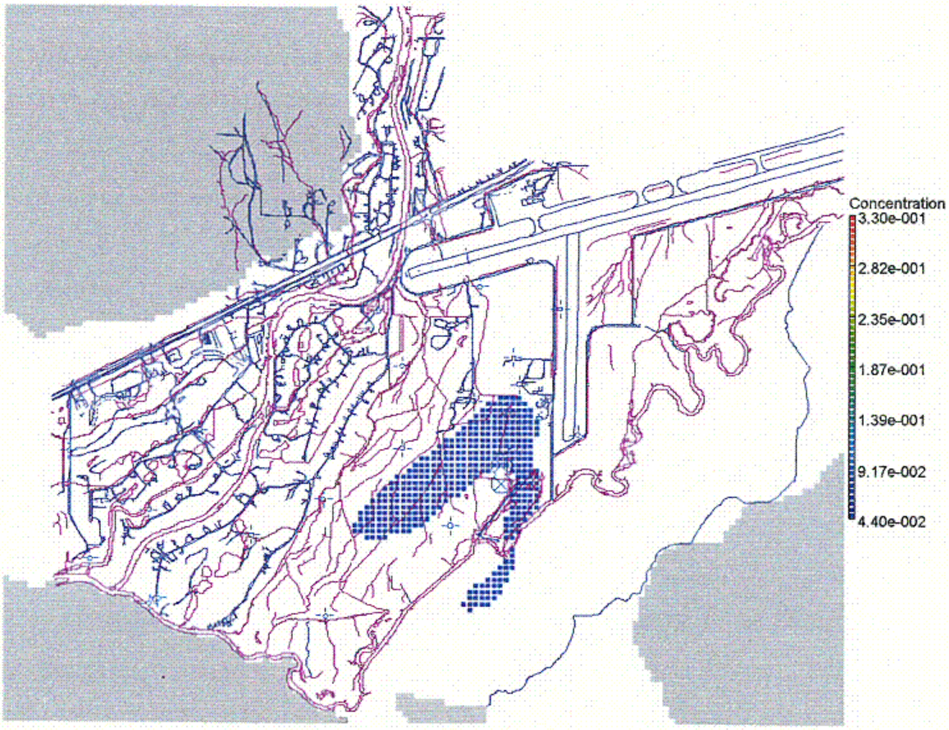


*Figure 16. Predicted Transient Uranium Concentration at 50 Years*

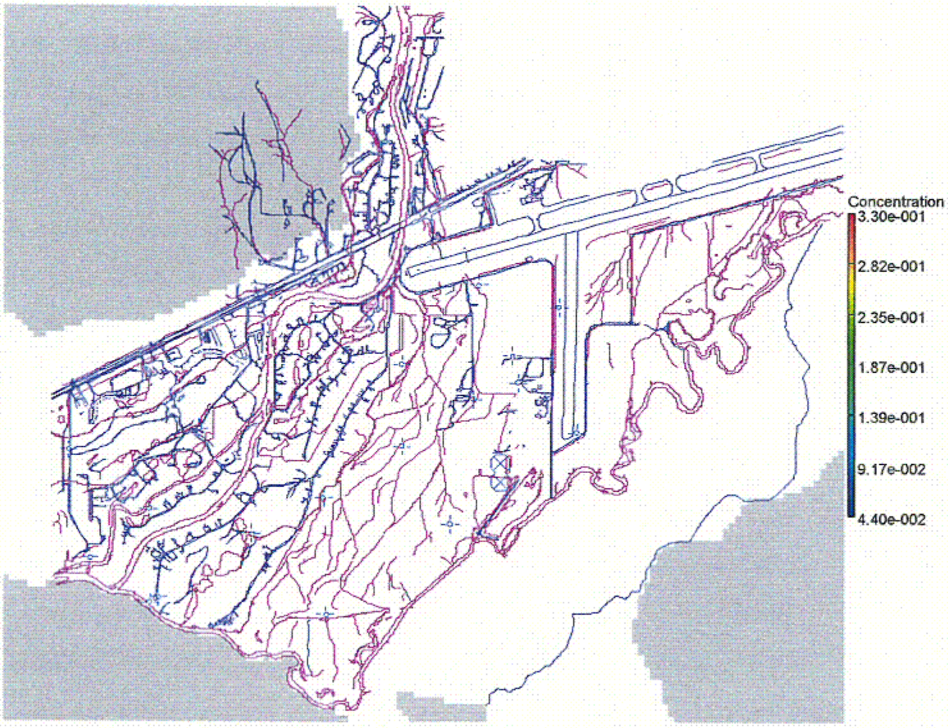


*Figure 17. Predicted Transient Uranium Concentration at 100 Years*

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 headsversus. 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 $Kd = 3.47$ (Figure 17). The maximum average predicted concentration at 10 years is 0.043996 mg/L.

# 9.0 References

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Zheng, C., 1990. *MT3D, A Modular Three-Dimensional Transport Model*, Documentation and User's Guide, First Edition, S.S. Papadopulos and Associates, Inc., Bethesda, Maryland.

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# 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 (e) (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:

<u>Township 49 North, Range 1 West, N.M.P.M.</u>

A tract of land situated in the S½SW¼ of Section 2 and the NE¼NW¼ 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 00°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 00°07'00" East along said right-of-way line, 742.17 feet, to the North line of said Section 11; thence South 00°08'00" East along said right-of-way line, to the South line of said NE¼NW¼; thence South 89°41'00" West along said South line, 1,271.72 feet ; thence North 01°06'00" West, 1320.03 feet to said North line of Section 11; thence North 89°34'00" East along said North line, 112.00 feet ; thence North 00°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, utilities, 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 exposing 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 7914(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

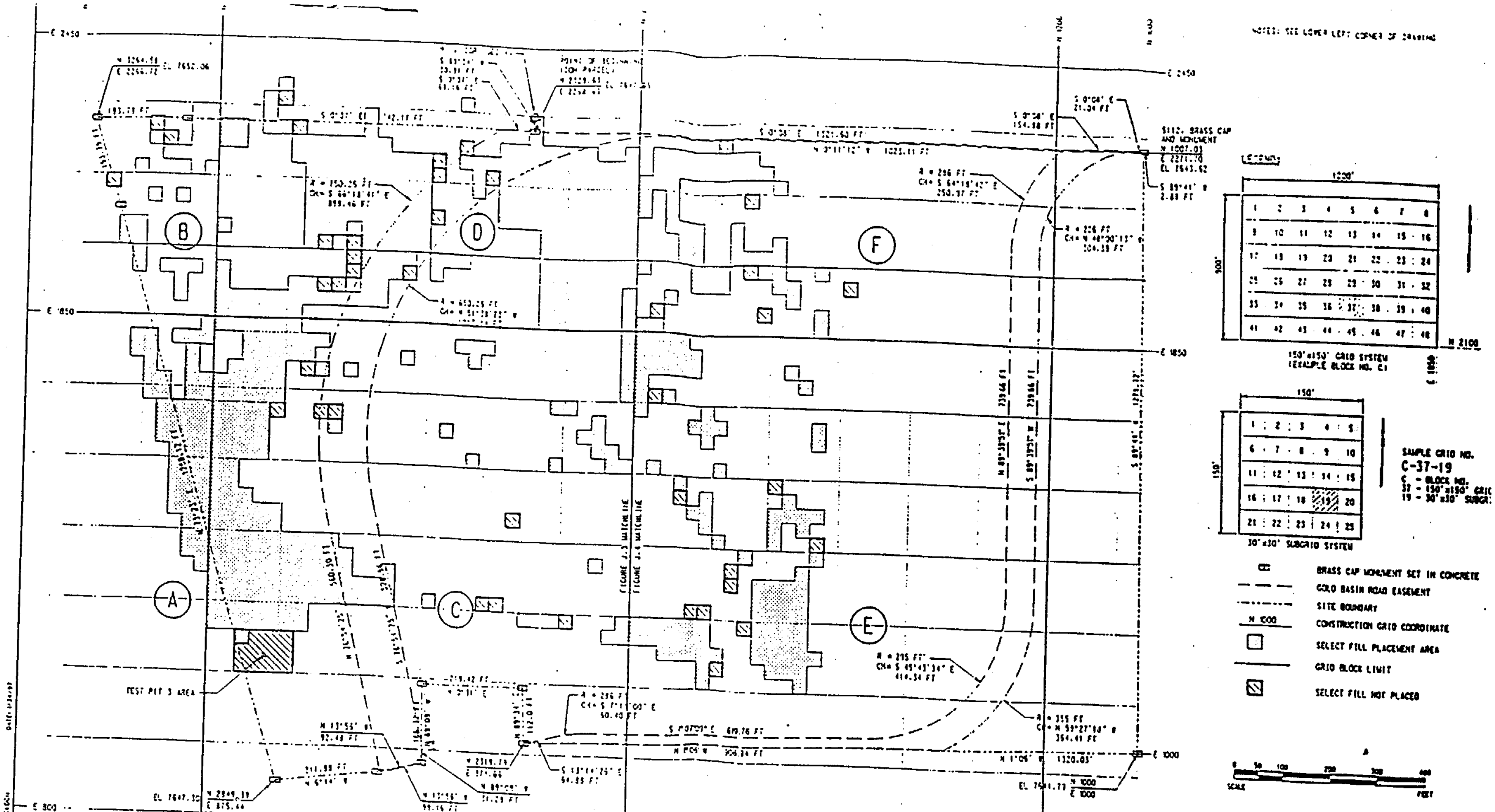
STATE OF COLORADO, } SS.
County of Denver

The foregoing instrument was acknowledged before me this 19th day of January, 2000, ~~19__~~, by Maria S. Zepeda-Sanchez

My commission expires April 14, 2003

Witness my hand and official seal

______________________
Notary Public.




NOTES:

1. LOCATIONS FOR THE COLD BASIN ROAD EASEMENTS AT SOUTHERN AND NORTHERN PARTS OF THE PROCESSING SITE WERE TAKEN FROM LEGAL DESCRIPTIONS PREPARED BY NORTH STAR SURVEYING INC., 710 COUNTY ROAD 27, GUNNISON, COLORADO 81230.
2. THE SITE BOUNDARY IS TAKEN FROM LEGAL DESCRIPTIONS FOR THE GUNNISON PROCESSING SITE AS SHOWN ON DWG. NO. GUN-PS-10-0215, HORIZONTAL AND VERTICAL CONTROL PLAN, AND SHOULD BE REFERENCED FOR EXCEPTIONS THEREFROM.
3. DEPTHS TO TOP OF SELECT FILL LAYER ARE SHOWN ON FIGURES K.3 AND K.4.
4. DEPTHS TO EXCAVATION BOTTOM IN NON-SELECT FILL AREA ARE SHOWN ON FIGURE K.1.

REFERENCE DRAWINGS:

| | |
|---|---|
| FIGURE K.1 | TH-230 GRIDS WITHOUT SELECT FILL DEPTHS TO TOP OF TH-230 CONTAMINATION |
| FIGURE K.3 | DEPTHS TO TOP OF SELECT FILL LAYER (SHEET 1 OF 2) |
| FIGURE K.4 | DEPTHS TO TOP OF SELECT FILL LAYER (SHEET 2 OF 2) |

Gun/Appendix K/Supplemental Standards/Figures/Page 2 of 4

U.S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

GUNNISON PROCESSING SITE
GUNNISON, COLORADO

# SOIL VERIFICATION PLAN
## TH-230 GRIDS

MIZ/DTS | REVISED 1/24/1

MORRISON-KNUDSEN CORPORATION
UMTRA PROJECT

DE-AC04-83AL18795

FIGURE K.2

**Final Site Observational Work Plan**
**for the UMTRA Project Site at**
**Gunnison, Colorado**
**Appendices B, C, E, and F**