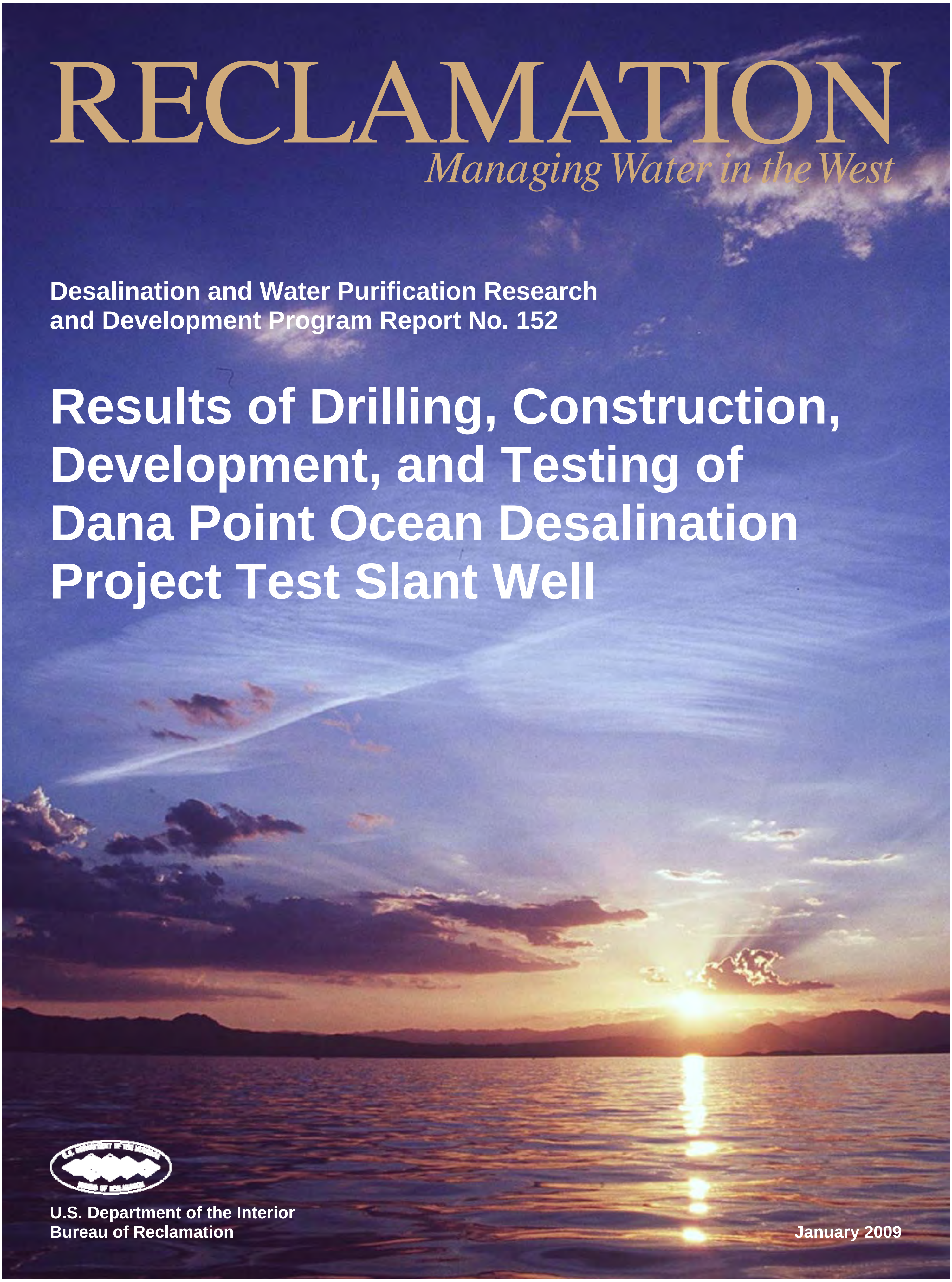

RECLAMATION

Managing Water in the West

Desalination and Water Purification Research
and Development Program Report No. 152

Results of Drilling, Construction, Development, and Testing of Dana Point Ocean Desalination Project Test Slant Well

U.S. Department of the Interior
Bureau of Reclamation

January 2009

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14. ABSTRACT ***(Maximum 200 words)***
A Test Slant Well was constructed at Doheny State Beach for the Municipal Water District of Orange County as part of a phased investigation into the feasibility of using subsurface intakes at the mouth of San Juan Creek for potential desalination plant feedwater supply. The purpose of the Test Slant Well investigation was to obtain measurements of aquifer parameters such as transmissivity, storativity, and leakance through several well pumping tests. In addition, monitoring of ground water quality during the constant rate pumping tests was conducted to estimate potential feed water quality variations from a slant well intake system. The investigation showed that with proper design, construction, and development, near-horizontal wells (i.e., slant wells) can provide high quantities of water with low turbidity and silt densities.

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by

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San Francisco Public Utilities

U.S. Environmental Protection Agency

California Department of Water Resources

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Water and Environmental Services Division
Water Treatment Engineering Research Team
Denver, Colorado

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MISSION STATEMENTS

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The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Disclaimer

Acknowledgement

This investigation was made possible by the cost sharing provided by the United States Department of the Interior, Bureau of Reclamation, Desalination and Water Purification Research and Development Program with funding provided the California Department of Water Resources Proposition 50 and the Municipal Water District of Orange County.

GEOSCIENCE Support Services, Inc., under the overall project management of the firm's principal, Dr. Dennis E. Williams, was responsible for developing the field investigation methodology, design of the test well, inspection of drilling and well construction activities, and all elements in the field testing, including calibration and verification of instruments, data collection and analysis, data management, data interpretation, quality assurance/quality control, and the preparation of this report. Drilling, well construction, and development pumping and testing were supervised in the field by Ms. Diane Smith. Her long hours and constant vigil helped ensure the success of the project. Assistance in the areas of engineering and water quality was provided by Dr. Mark Williams of Williams-McCaron, Inc., and water quality analyses were performed by Weck Laboratories, Del Mar Analytical Laboratories, CRG Marine Laboratories, and MWH Laboratories. Special thanks and acknowledgement goes to Ms. Sarah Bartlett, project geohydrologist, for her professionalism, dedication, and persistence in all aspects of the project.

Boart-Longyear Geo-Tech Division, under the overall project management of Robert Stadeli, was the contractor responsible for the drilling, construction, and test-pumping of the Dana Point Test Slant Well. Mr. Stadeli and the entire Boart team provided the innovation and professionalism needed to overcome many challenges during construction to complete the well on time and within budget.

Special appreciation goes to Project Manager Mr. Richard Bell, Mr. Kevin Hunt, Mr. Karl Seckel, and Ms. Michelle Tuchman from the Municipal Water District of Orange County for their tireless efforts in developing and managing this pioneering investigation.

Ms. Mary Jane Foley provided invaluable assistance in obtaining the permits and authorizations required in order to undertake the project, and Chambers Group Inc. developed the environmental documentation required by the California Environmental Quality Act and National Environmental Policy Act. Chambers Group personnel also provided biological monitoring during field work activities on the beach.

State Parks personnel Mr. Richard Rozzelle and Mr. David Pryor provided essential guidance and cooperation. We thank the rangers, lifeguards, staff, and beach-goers at Doheny State Beach for their cooperation and patience during drilling activities on the beach.

Acronyms

316L	Grade 316L stainless steel
ASTM	American Society for Testing Materials
bgs	below ground surface
cfm	cubic feet per minute
CEQA	California Environmental Quality Act
DO	dissolved oxygen
DR-24HD	dual rotary (24-inch diameter lower drive) heavy duty drilling rig
DR-40	dual rotary drilling rig with 40-inch diameter lower drive
DWR	California Department of Water Resources
EPA	United States Environmental Protection Agency
ft	feet, foot
ft bgs	feet below ground surface
gpd/ft	gallons per day per foot, a unit of aquifer transmissivity
gpd/ft2	gallons per day per square foot, a unit of aquifer hydraulic conductivity
gpm	gallons per minute
ID	inside diameter
in	inch
lbs	pounds
MCL	maximum contaminant level
mg/L	milligrams per liter
min	minute
MLLW	mean lower low water
mm	millimeter
MSL	mean sea level
MWDOC	Municipal Water District of Orange County
NAVD88	North American Vertical Datum of 1988
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
NTU	nephelometric turbidity unit
OD	outside diameter
ORP	oxidation reduction potential
PDT	Pacific Daylight Time

ppm	parts per million
psi	pounds per square inch
PST	Pacific Standard Time (UTC – 8 hours)
Reclamation	Bureau of Reclamation
RO	reverse osmosis
SDI	silt density index
SERRA	South East Regional Reclamation Authority
SJBA	San Juan Basin Authority
SLC	California State Lands Commission
SOCWA	South Orange County Wastewater Authority
TDS	total dissolved solids
μg/L	micrograms per liter
μS/cm	microsiemens per centimeter
USACE	United States Army Corps of Engineers
UTC	Coordinated Universal Time (PST + 8 hours)

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1. Executive Summary

Water purveyors in California planning future seawater desalination projects are being asked by regulators and environmental interests to evaluate the feasibility of using subsurface intakes for feedwater supply in lieu of using open ocean intakes. Open ocean water intakes pull water directly from the seawater column. These are not in favor as they can cause impingement, whereby marine organisms are drawn into the intake and trapped against a screen, and entrainment, whereby organisms too small to be screened are drawn into the facility and killed within the system.

The Municipal Water District of Orange County (MWDOC) identified a favorable site for evaluating the feasibility of using a subsurface intake system for an ocean desalination supply at Doheny State Beach near the mouth of San Juan Creek, in Dana Point, California. The subsurface deposits of sand and gravel associated with the San Juan Creek channel are estimated to extend off shore beneath the ocean, with favorable aquifer properties for transmitting water to wells. To test the potential of these subsurface deposits for a desalination plant intake supply, it was decided to construct a "test" well. Potential types of wells considered included horizontal collector wells (e.g., Ranney® type), horizontal directionally drilled wells (i.e., horizontal directional drilling [HDD] wells) and near-horizontal wells (i.e., slant wells). Because of the unproven nature at this time of methods for the construction of high capacity, artificially filter-packed near-horizontal test wells, consultation with individuals, organizations, and companies worldwide in the ground water and well construction industry led to the selection of the dual rotary method of construction for the Test Slant Well. A 350-foot-long 12-inch-diameter (casing and screen) test slant well was constructed on the beach in order to obtain actual measurements of subsurface intake discharge rates and aquifer properties through performance of several pumping tests. This report presents the results of drilling, construction, development, and testing of the Dana Point Test Slant Well. The Test Slant Well represents the first successful high capacity slant well completed with an artificial filter pack beneath the ocean floor.

The Test Slant Well project demonstrated the feasibility of using the dual rotary drilling method for construction of shallow angle wells for potential desalination intake supply in a beach environment. At a cost of approximately $1.1 million, the Test Slant Well was drilled, constructed, developed and tested by the contractor over a period of 84 12-hour working days. Drilling and well construction took 53 days; development pumping and aquifer testing lasted 17 days. Subsequent to a spring/Easter holiday, a second (deep zone) aquifer pumping test and wellhead completion took place over an additional 14 days.

Aquifer parameters derived from the Test Slant Well pumping tests indicate favorable geohydrologic conditions for establishing a subsurface intake system at the mouth of San Juan Creek. The yield of the well was 1,660 gallons per minute, and specific capacity was approximately 77 feet per gallon per minute during a 5-day constant rate pumping test. Silt density index measurements made in the field during aquifer testing averaged 0.58, indicating low reverse osmosis membrane fouling potential. Salinity remained brackish throughout the aquifer pumping tests, increasing only very slightly with time. Total dissolved solids concentration measured approximately 2,600 milligrams per liter (mg/L) compared to the typical value of 35,000 mg/L for seawater.

Water quality results during the pumping tests indicated that 5 days of pumping was not a long enough time to estimate long-term hydraulic communication trends with the seawater. As a followup, long-term pumping of the Test Slant Well is recommended to determine the potential variability of water quality from the brackish condition measured during the first tests to a quality more closely resembling pure seawater. In the next phase of the Dana Point Ocean Desalination Project, aquifer parameters (e.g., transmissivity, storativity, and leakance) will be used to model the operations of a full-scale desalination intake system.

2. Introduction

The Test Slant Well, SL-1, was constructed at Doheny State Beach for Phase 2 of the Municipal Water District of Orange County (MWDOC) Dana Point Ocean Desalination Project, a phased investigation into the feasibility of using subsurface intakes at the mouth of San Juan Creek for potential desalination plant feedwater supply (figure 1). A prior phase (Phase 1) was performed in 2005 and consisted of four vertical borings along Doheny Beach and completion of two of these borings as nested monitoring wells. The feasibility of a subsurface intake system is being investigated as the system presents significant advantages over traditional open seawater intakes. These advantages include:

- Avoidance of entrainment and impingement impacts to marine life
- Reduction or elimination of costly reverse osmosis (RO) pretreatment
- Protection from shock loads
- No ocean construction impacts
- No permanent visual impacts

The Test Slant Well was drilled and constructed at an angle of 23 degrees below horizontal using a dual rotary drilling rig, and represents the first time a shallow angled well has been constructed with a filter pack beneath the ocean floor.[1] The well is 350 feet (ft) long and consists of 12¾-outside-diameter (OD) 316L stainless steel casing and louver screen (figure 2). The well is screened from 351 to 130 lineal ft, which corresponds to approximately 51 to 137 vertical feet below ground surface (bgs).

Construction and testing of a slant well was recommended based on results from the Dana Point Ocean Desalination Project Phase 1 Hydrogeology Investigation (GEOSCIENCE, 2005a). The Phase 1 investigation found favorable geohydrologic conditions for production of ground water for potential ocean desalination plant feedwater supply based on aquifer materials and water quality encountered during a vertical borehole drilling program.

2.1 Purpose and Scope

The Test Slant Well project was undertaken as Phase 2 of the Dana Point Ocean Desalination Project. This second phase was necessary in order to obtain measurements of aquifer parameters such as transmissivity, storativity, and leakance through several well pumping tests. The aquifer parameters enabled

[1] The application of dual rotary drilling at an angle for water well construction has been performed adjacent to rivers in South Dakota and North Dakota (i.e., Missouri River) as well as in New York along the Hudson River. Knowledge of the success of these projects led to the selection of the dual rotary method of construction for the Dana Point Test Slant Well.

estimation of potential yield from a near-shore subsurface intake system. In addition, monitoring of ground water quality during the constant rate pumping tests was conducted in order to estimate potential feed water quality variations from a slant well intake system. The full scope of work included:

- Borehole drilling
- Lithologic logging of borehole samples
- Mechanical grading analysis of borehole samples
- Installation of well screen and casing
- Installation of gravel pack in borehole annulus
- Well development by airlifting and swabbing
- Installation of cement seal in well annulus and extraction of outer casing
- Installation of submersible test pump in well
- Well development by pumping
- Step drawdown and 5-day constant rate aquifer pumping tests
- Deep zone constant rate aquifer pumping test with inflatable packers
- Water quality analyses during aquifer pumping tests
- Monitoring nearby observation wells MW-1 and MW-2
- Fluid resistivity logging
- Video survey of test slant well
- Wellhead completion including nitrogen blanket and measurement of inclination and azimuth of completed well

3. Background

3.1 Initial Site Selection

MWDOC initially identified the Dana Point site at the mouth of San Juan Creek as an ideal location to investigate using beach wells for desalination plant intake supply as part of the South Orange County Water Reliability Study. The site was considered ideal because of the availability of land nearby for a potential desalination plant, the presence of an ocean outfall owned by the South Orange County Wastewater Authority (SOCWA), and its location in South Orange County, where new sources of water supply are needed. The site at the mouth of San Juan Creek was also considered an ideal candidate for investigating the feasibility of a subsurface intake system because of the presence of permeable sand and gravel alluvium associated with the creek. The Phase 1 Hydrogeology Investigation confirmed the presence of permeable aquifer materials related to the creek channel to a depth of at least 188 ft bgs, as the deepest borehole, at borehole B-4/MW-2 did not encounter bedrock.

3.2 Previous Investigations

3.2.1 Previous Investigations by MWDOC

In 2001, Geopentech preliminarily evaluated the feasibility of beach wells to supply seawater for a desalination plant at San Juan Creek, under subcontract to Boyle Engineering for MWDOC's South Orange County Water Reliability Study. Based upon a review of readily available reports and well data, the study estimated that the alluvial aquifer at the mouth of San Juan Creek was approximately 3,000 ft wide and 200 ft deep. Ultimately, the study recommended a site-specific feasibility investigation, including a geophysical survey, geotechnical borings, a test well and monitoring wells, and an aquifer pumping test (Geopentech, 2002).

In 2005, GEOSCIENCE conducted the Phase 1 Hydrogeology Investigation for MWDOC in order to obtain the site-specific information needed to assess the feasibility of subsurface intakes at the mouth of San Juan Creek (GEOSCIENCE Support Services, 2005a). The objective was to determine the vertical and lateral extent of subsurface aquifer materials at the mouth of San Juan Creek, the capacity of aquifer materials to transmit water to wells, as well as depth-specific ground water quality data. The investigation included drilling four exploratory boreholes, completing two nested monitoring wells, and performing laboratory analyses of water quality and permeability.

The Phase 1 investigation found favorable aquifer materials, consisting largely of sands and gravels with some cobble and clay layers, to a maximum depth of 188 ft on the western side of the present San Juan Creek channel. Estimated hydraulic conductivity of the aquifer materials averaged approximately 1,200 gallons per day per square foot (gpd/ft^2), based on grain size analyses and permeameter testing. Laboratory results indicated brackish water quality within the alluvial aquifer (2,200 to 2,700 milligrams per liter [mg/L] total dissolved solids [TDS]) and elevated iron and manganese concentrations (1,600 to 3,100 micrograms per liter (µg/L) and 1,300 to 1,900 µg/L, respectively). Based on the favorable geohydrologic results, GEOSCIENCE recommended that MWDOC pursue the second phase of the feasibility investigation: construction of a shallow angle test well and performance of an aquifer pumping test—the subject of the present report.

3.2.2 Previous Investigations by Others

In the 1970s, Converse Davis Dixon Associates performed onshore and offshore geologic investigations under subcontract to NBS Lowry for the South East Regional Reclamation Authority (SERRA, now SOCWA) ocean outfall project (Converse Davis Dixon Associates, 1973, 1976, 1977; Lowry and Associates, 1977). Submarine geology of the continental shelf area off Dana Point was interpreted based on seismic profiling, projection of onshore mapping, geologic mapping by SCUBA diving geologists, vibracore sampling, and jet probing. The investigation found bedrock (Capistrano Formation) to outcrop on the seafloor approximately 1,000 to 1,500 ft offshore, 400 ft west of the outfall alignment (figure 3). The jet probes and vibracores along the alignment did not encounter bedrock, and did not penetrate deeper than 32 ft below the sea floor.

In 1992, Capistrano Beach County Water District (now South Coast Water District) drilled a test well approximately 4,200 ft (0.8 mile [mi]) inland from the shore, 250 ft east of the centerline of San Juan Creek (Boyle, 1993). The test well encountered alluvium consisting of interbedded cobbles, sand, silt, and clay to a depth of 108 ft bgs. The underlying bedrock was identified as Monterey Formation claystone based on a stratigraphic analysis. The well was screened at depths of 48 to 92 ft bgs and 98 to 108 ft bgs. Aquifer pumping tests indicated an aquifer transmissivity in the range of 130,000 to 150,000 gallons per day per foot (gpd/ft) and a storage coefficient of 0.0004, reflecting confined aquifer conditions. Water from the test well exceeded secondary maximum contaminant levels (MCLs) for manganese (50 µg/L) and iron (300 µg/L) with 930 µg/L manganese and 5,130 µg/L iron. TDS concentration in the test well also exceeded the secondary MCL for TDS (500 mg/L) and measured 2,198 mg/L.

In 2004, Geotechnical Consultants, Inc. drilled two boreholes within the San Juan Basin approximately 2 miles and 2.4 miles inland for the city of San Juan Capistrano to evaluate new production well sites (GCI, 2004). The southernmost borehole (“North Kinoshita”) was located approximately 1,750 ft west of the confluence of Trabuco Creek and San Juan Creek and contained alluvium to a depth of 67 ft. The “City Hall East” borehole was drilled approximately 1,000 ft northeast of the confluence of the two creeks and encountered alluvium to a depth of 108 ft bgs. Both boreholes were underlain by olive-gray siltstone of the Capistrano Formation.

Currently, ground water modeling of the San Juan Basin is performed by Psomas for the San Juan Basin Authority. During the next phase (Phase 3) of the Dana Point Ocean Desalination Project, MWDOC's consultant, GEOSCIENCE, will incorporate available data from San Juan Basin Authority and Psomas into a three-dimensional variable density ground water flow and solute transport model of the full-scale subsurface intake system at Doheny Beach.

3.3 Permitting Process

Prior to construction of the Test Slant Well, MWDOC consulted with several permitting agencies that had an interest or conditions for the project. Several permits and authorizations were obtained in order to complete the work, described in the following sections.

3.3.1 California Environmental Quality Act (CEQA)

MWDOC was the lead agency for the project. An Initial Study/Negative Declaration for the Subsurface Intake System Feasibility Investigation Test Slant Well Project was completed by Chambers Group on October 12, 2005. The Notice of Completion was posted with the County Clerk-Recorder on October 12, 2005, and the documents were filed with the State Clearinghouse on October 13, 2005. A notice from the State Clearinghouse dated November 15, 2005, indicated no State agencies submitted comments. MWDOC's Board of Directors approved the Negative Declaration and project on November 21, 2005. A Notice of Determination was posted on November 29, 2005, with the County Clerk-Recorder.

3.3.2 National Environmental Policy Act (NEPA)

The Bureau of Reclamation (Reclamation) was the lead agency for the project pursuant to NEPA. A Draft Environmental Assessment was prepared by Chambers Group in October 2005. The Southern California Area Office of Reclamation prepared the NEPA materials, circulated the document to Federal agencies, made findings, and issued categorical exclusion No. 06-SCAO-001-CX on December 16, 2005, for the project.

3.3.3 California Coastal Commission Coastal Development Permit

Because the project is located within the coastal zone in Orange County at Doheny State Beach, city of Dana Point (outside of their Local Coastal Program), a coastal development permit was required from the California Coastal Commission. MWDOC prepared, filed, and obtained the coastal development permit. Special conditions applied to the project through this permit included allowing for undisrupted public access to the beach, prohibiting work during "peak use" summer beach season, prohibiting interference with the spawning of California grunion, requiring a biologist to monitor for sensitive species during construction activities, and restoring the site to preconstruction conditions with the well head buried 3 ft bgs. The application for the coastal development permit included a detailed project plan, including a spill prevention and contingency control plan (GEOSCIENCE, 2005b).

3.3.4 California State Lands Commission Lease

The California State Lands Commission (SLC) has jurisdiction over submerged lands extending seaward of the "Ordinary High Water Mark" of the Pacific Ocean. Because the Test Slant Well extended offshore underneath these submerged lands, MWDOC obtained a lease from the SLC to undertake the Test Slant Well Project.

3.3.5 California State Parks Right of Entry Permit

MWDOC held several meetings with key State Parks environmental and top management staff in developing the detailed project plan for the Test Slant Well Project (GEOSCIENCE, 2005b). The project plan included several conditions and measures to minimize public use and safety impacts based on input from State Parks staff. During the Test Slant Well project, MWDOC and its contractors were guests of California State Parks and allowed permission to access Doheny State Beach for the project through a Right of Entry Permit. The Right of Entry Permit contained 24 special conditions pertaining to the protection of public access and safety. One condition required a site safety officer for answering public questions and directing pedestrian and bicycle traffic during times when equipment was moving between the parking lot staging area and well site. Other requirements included that the beach work site have a minimum footprint and be surrounded by a 6-foot temporary chain link fence with informational signage, that engine and generator noise be dampened to the maximum extent practicable, and that biological monitoring of wintering western snowy plovers occur throughout the project as long as plovers were present on Doheny State Beach.

3.3.6 San Diego Regional Water Quality Control Board National Pollutant Discharge Elimination System (NPDES) Permit No. CAG919002

Because the Test Slant Well project was going to generate water during the well development and test pumping stages, MWDOC enrolled under Order No. 2001-96, NPDES No CAG9190002, *General Waste Discharge Requirements for Groundwater Extraction Waste Discharges from Construction, Remediation, and Permanent Groundwater Extraction Projects to Surface Waters within the San Diego Region Except for San Diego Bay*. Discharges from the Test Slant Well went into an onsite Baker tank that gravity fed into a pipeline leading to a diffuser placed on top of the bed of the San Juan Creek. The diffuser consisted of a 10-foot length of mild steel wire-wrapped screen that was attached to the top of two 20-foot lengths of 18-inch OD steel casing. At this point, discharge to San Juan Creek was considered discharge to the surf zone when the sand berm across the creek at its mouth was "breached," or open to the Pacific Ocean.

The NPDES permit requires that discharge meet effluent limitations specified in Order No. 2001-96, and specifies parameters requiring monitoring as well as the frequency of analysis. Because water quality testing at MW-1 indicated very low dissolved oxygen (DO) concentration in the ground water, an air injection system was devised for the Baker tank to maintain DO levels at the minimum 5 mg/L required by the permit. If the concentration of DO in the discharge, measured in the tank at its exit point, dropped to below 5 mg/L, an air compressor would be used to allow air to enter the tank via perforated polyvinyl chloride (PVC) tubes and raise the DO levels to above 5 mg/L.

3.3.7 United States Army Corps of Engineers Nationwide Permit Number 7

Discharge of water to the diffuser in San Juan Creek was the preferred discharge alternative because the location would not create impacts to public access on the beach. A second discharge alternative, which was not used, consisted of burying a pipeline and dispersion screen within the beach sand next to the well site and allowing discharge water to seep to the subsurface. Both discharge alternatives required compliance with the United States Army Corps of Engineers (USACE) Nationwide Permit Number 7 for Outfall Structures and Maintenance. In addition to the terms of the nationwide permit, the USACE required compliance with special conditions, including that Best Management Practices be employed to prevent materials from entering waters of the United States, that the discharge structures be removed upon project completion and that an onsite biological monitor ensure that the western snowy plover or other winter transient wildlife were not harassed during project activities.

3.3.8 San Diego Regional Water Quality Control Board Clean Water Act Section 401 Water Quality Certification

Section 401 of the Clean Water Act requires that any person applying for a Federal permit or license which may result in a discharge of pollutants into waters of the United States must obtain a State water quality certification that the activity complies with all applicable water quality standards, limitations, and restrictions. Section 401 certification was required for the Test Slant Well project because the USACE Nationwide Permit Number 7 applied. The Water Quality Certification issued by the Regional Board required that a plan be developed and kept onsite for managing and preventing discharges of pollutants in storm water discharges associated with the construction activity. Other conditions included minimization of disturbance to grunion runs and avoidance of harassment to western snowy plovers as determined by a biological monitor.

3.3.9 Orange County Health Care Agency Well Construction Permit

The Orange County Well Ordinance (County Ordinance No. 2607) requires that a permit be obtained prior to the construction or destruction of any well. The Environmental Health Division of the Orange County Health Care Agency issued a well construction permit for the Test Slant Well upon review of well construction details.

3.3.10 California Department of Fish and Game Streambed Alteration Agreement

MWDOC conferred with the California Department of Fish and Game, who determined that a Streambed Alteration Agreement was not required as no alteration was to take place and the location of the discharge was at the ocean.

4. Geohydrology

4.1 Ground Water Basin

The Dana Point Test Slant Well is located at the mouth of San Juan Creek, where the San Juan Valley Groundwater Basin (San Juan Basin) discharges to the Pacific Ocean (see figure 4). The San Juan Basin is bounded on the southwest by the Pacific Ocean, and elsewhere by Tertiary semi-permeable marine deposits (California Department of Water Resources [DWR], 2004). The San Juan Basin has a tributary area of approximately 26 square miles (16,700 acres) (DWR, 2004). Ground water in the San Juan Basin flows southwest towards the Pacific Ocean. The State Water Resources Control Board (SWRCB) classifies the San Juan Basin as a subterranean stream flowing through known and definite channels, and not as a ground water basin (SJBA, 2006).

The total storage capacity of San Juan Basin has been calculated to be 90,000 acre-ft (DWR, 1972) and 63,220 acre-ft (NBS Lowry, 1992). Maximum perennial yield of the basin has been estimated to be approximately 4,000 acre-feet per year (acre-ft/yr) (NBS Lowry, 1992). Recharge of the basin is from percolation of streamflow in San Juan Creek, Oso Creek, and Arroyo Trabuco, as well as precipitation on the valley floor and spring water from Hot Spring Canyon flowing into San Juan Creek (DWR, 1972). Average annual subsurface outflow to the ocean has been estimated to be 450 acre-ft/yr (DWR, 1972). In current modeling work, Psomas estimates annual subsurface outflow to be 800 to 1,300 acre-ft/yr (Bell, 2005).

4.2 Aquifer Systems

The alluvial portions of San Juan Creek contain the primary ground water aquifers in the area, which for the most part, are composed of interbedded cobbles, gravel, sand, silt, and clay overlying sedimentary basement rocks. The San Juan Creek alluvium ranges in thickness from 65 ft to 200 ft (DWR, 1972; Edgington, 1974). The basement rock, or bedrock, in the area consists primarily of nonwater-bearing marine siltstone and shale of the Capistrano Formation. The sands within the sedimentary formations (e.g., Capistrano Formation) in the San Juan Basin may have the potential to yield small amounts of water to wells (DWR, 1972).

In the vicinity of Doheny Beach, the Phase 1 Hydrogeology Investigation (GEOSCIENCE, 2005a) identified a shallow, middle, and deep aquifer zone based on the lithology encountered in the three boreholes drilled west of San Juan Creek (B-2/MW-1, B-3, B-4/MW-2). Borehole B-1 was drilled approximately 1,400 ft east of the present day San Juan Creek channel and is presumed to be outside of the extent of the alluvial aquifers associated with the creek. Beach sands were encountered to a depth of 20 ft bgs in borehole B-1, below which was 40 ft of clay which may represent Capistrano Formation bedrock. Bedrock was also encountered in borehole B-3, located approximately 850 ft west of the creek, at approximately 155 ft bgs. Borehole B-3 contained moderately-cemented clayey sand, clay, and sand with clay, from 155 ft bgs to total borehole depth of 181 ft bgs. The dark greenish-gray color, moderate cementation, and presence of mica suggest that these materials may represent the Capistrano Formation. In the two boreholes drilled immediately west of San Juan Creek (B-2/MW-1 and B-4/MW-2), lithology becomes finer-grained and moderately cemented at borehole depths greater than 158 and 166 ft bgs, respectively. However, these boreholes ended in dark gray fine to coarse-grained sand at maximum depths of 175 and 188 ft, respectively, and are not considered to have penetrated bedrock.

It is unknown how far offshore the San Juan Creek alluvium extends, although it most probably extends a considerable distance beneath the ocean floor and is in hydraulic continuity with seawater. Preliminary estimates from extrapolation of ground water level elevations (see figure 5) show the width of the gap through which freshwater is discharging to the ocean is at least 1,000 ft from the shoreline. The offshore jet probe and vibracore investigation conducted in the 1970s which followed the alignment of the SOCWA sewer outfall for a distance of approximately 1.5 miles encountered cobbles, gravel, silty sand, and clay layers and did not penetrate bedrock to maximum depths of 32 ft. The Test Slant Well also did not encounter bedrock to a maximum vertical depth of 137 ft, approximately 170 ft offshore from the beach at Thor's Hammer.[2] For comparison, the continental shelf near Doheny State Beach extends approximately 5 miles offshore.

4.2.1 Shallow Zone

The shallow aquifer system is located above a fine-grained zone (clay and clayey sand) that was encountered at depths of approximately 25 ft to 40 ft bgs in the three boreholes drilled west of San Juan Creek (B-2/MW-1, B-3, B-4/MW-2). The clay layers in this zone are approximately 4 to 5 ft thick and associated with layers of clayey sand approximately 3.5 to 5 ft thick. Monitoring wells MW-1S and MW-2S are screened in this aquifer zone, approximately 10 to 25 ft bgs. It is uncertain at this time how laterally extensive this upper fine-grained layer is. Based on ground water level fluctuations and response to the test well pumping (see figure 6), the layer does not appear to be an aquiclude (i.e., confining layer) but may be a localized aquitard (i.e., leaky layer). Further long -erm pumping tests will verify this.

Ground water elevations in the shallow zone, measured by automatically recording pressure transducers, indicated that the water levels in this zone are weakly affected by the tide. Water levels in MW-1S and MW-2S fluctuate by less than one ft approximately in synch with the tide, which fluctuates by as much as 8 ft in a tidal cycle. The pressure transducer data from MW-1S and MW-2S

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[2] Thor's Hammer is the colloquial name for the concrete structure at the terminus of the groin along the western bank of San Juan Creek.

also indicate that ground water levels gradually build in the shallow zone when the berm across the mouth of San Juan Creek closes, forming a lagoon. A rapid fall in shallow ground water levels results when the berm breaks open and the creek drains to the Pacific Ocean (see figure 6). In addition to the water level data, water quality measured by the Troll 9000 multi-parameter instrument in MW-1S indicates that the shallow zone is in hydraulic connection with the creek. This is evidenced by elevated specific conductivity measurements during periods in which the berm across San Juan Creek retains ocean water within the creek (see figure 7).

4.2.2 Middle Zone

The middle aquifer zone is located at approximately 40 to 130 ft bgs and is characterized by mostly medium to coarse grained sand and cobbles. Monitoring wells MW-1M and MW-2M are screened in this interval. Finer-grained materials (clayey gravel and sand with clay and gravel) were encountered during drilling of boreholes B-2/MW-1 and B-4/MW-2 at a depth of approximately 140 ft. It should be noted that fine grained materials below the "middle zone" were not encountered in borehole B-3 until 150 ft bgs, and finer-grained materials, including 3- to 4-ft interbedded clay layers, dominated the borehole lithology to total depth of 181 ft bgs. These moderately cemented, dark greenish gray clayey sands, clays, and sand with clay probably represent the Capistrano Formation in borehole B-3.

Water levels in MW-1M and MW-2M are affected by tidal pressure, and fluctuate by as much as 3 ft in a tidal cycle, in synch with the tides (see figure 6). The location of the well screen in the Test Slant Well (approximately 51 to 137 ft bgs) generally corresponds to the location of the middle aquifer zone.

4.2.3 Deep Zone

The deep zone refers to the sand and gravel materials underlying the fine-grained materials (clay and clayey gravel) located at approximately 140 ft bgs in Boreholes B-2/MW-1 and B-4/MW-2. Monitoring Wells MW-1D and MW-2D are screened in this zone at approximately 140 to 165 ft bgs. There is a greater amount of fine-grained materials in the deep zone, including clay. Additionally, several lithologic samples from these depths in Boreholes B-2/MW-1 and B-3 were characterized by a hydrogen sulfide odor.

Ground water levels were not continuously monitored within the deep zone of nested monitoring wells MW-1 and MW-2.

4.3 Ground Water and Tide Elevations

Ground water elevations have been recorded continuously in the shallow and middle zones of monitoring wells MW-1 and MW-2 since October 26, 2005. Level Troll 500 pressure transducers made by In-Situ, Inc. have been recording pressure and temperature at 5-minute intervals in MW-2S and MW-2M since October 26, 2005. Troll 9000 multiparameter instruments made by In-Situ, Inc. recorded pressure, temperature, conductivity, pH, and oxidation reduction potential (ORP) at 15-minute intervals in MW-1S and MW-1M between October 26, 2005, and May 15, 2006.[3] As discussed in section 4.2, ground water levels in the middle zones of MW-1 and MW-2 fluctuate by as much as 1.5 ft around mean ground water elevation. This fluctuation in the middle zone is coincident with tide elevation fluctuations. Ground water fluctuation in the shallow zones of MW-1 and MW-2 was more muted and did not precisely match the pattern of tide elevation fluctuation as in MW-1M and MW-2M (see figure 6). The difference in response to tides in the shallow and middle zones is probably the result of the shallow zone being unconfined and the middle zone being a semiconfined (i.e., leaky) aquifer system.

Tide elevation data was downloaded from the National Oceanic and Atmospheric Administration (NOAA) Tides and Currents Web site for the nearby La Jolla tide station (Station ID No. 9410230).[4] According to the station information published at the Web site, the “diurnal range,” or difference in height between mean higher high water and mean lower low water, at the La Jolla station is 5.33 ft. The “mean range,” or difference in height between mean high water and mean low water, is 3.69 ft. Tidal elevation data can be downloaded from the NOAA Web site referenced to a variety of tidal datums. The North American Vertical Datum of 1988 (NAVD datum) was used because the monitoring well reference point elevations were surveyed to the NAVD datum. The NOAA Web site also provides tidal station datum elevations so that elevation data can be transformed between different datums, such as from NAVD to mean sea level (MSL). As seen in table 1, MSL is 2.54 ft greater than NAVD. Tide elevation data referenced to NAVD is depicted in figure 6 along with ground water elevation data from monitoring wells MW-1S, MW-1M, MW-2S, and MW-2M.

4.4 Water Quality

Both the Phase 1 Hydrogeology Investigation and the Phase 2 Test Slant Well encountered brackish ground water at the mouth of San Juan Creek. This section will discuss water quality information obtained during the Phase 1 investigation, which included laboratory water quality analyses and continuous monitoring of

[3] The Troll 9000 instruments in MW-1S and MW-1M were removed for sensor repairs and data cable troubleshooting on May 15, 2006.

[4] http://tidesandcurrents.noaa.gov, accessed May 2006. Dana Point is located approximately half way between NOAA tide station Nos. 9410230 (La Jolla) and 9410660 (Los Angeles). The data from one station was used for simplicity of analysis, and the La Jolla Station was selected because it is located in the same littoral cell (Oceanside Littoral Cell) as Dana Point. Tidal data from the two stations are similar. Tidal datums are only slightly different: MSL is 2.62 ft higher than NAVD at the Los Angeles station, whereas is it 2.54 ft higher than NAVD at the La Jolla . The difference, 0.08 ft is less than inch.

monitoring well ground water quality using Troll 9000 multiparameter instruments made by In-Situ. The results of water quality analyses conducted during the Test Slant Well aquifer pumping tests will be discussed in section 9.

4.4.1 Phase 1 Laboratory Water Quality Analyses

During the Phase 1 Hydrogeology Investigation, water samples were collected from nested monitoring wells MW-1 and MW-2 using a 2-gallon-per-minute (gpm) Grundfos pump. Samples from monitoring wells MW-1M, MW-1D, MW-2M, and MW-2D were collected in March and October 2005 and analyzed for a list of constituents important for desalination feedwater supply considerations (see table 2). Samples from MW-1S and MW-2S (shallow zone) were only analyzed for bacteriological parameters—because the shallow zone was not considered a potential source aquifer—and for comparison with surface water quality data collected by Orange County.

Both the middle and deep zones in both monitoring wells had brackish water quality, with TDS ranging from 2,000 to 2,700 mg/L. The deep zone in each well had a slightly higher TDS than the middle zone, and the water from each zone became slightly fresher between March 2005 and October 2005 (the two sampling events). Plotting the data from the monitoring wells on a trilinear diagram shows that the water type is the same from each zone, and distinct from that of seawater, reflecting recharge from the nearby San Juan Creek channel (see figure 8). The trilinear diagram also shows that the ground water does not have any dominant cation or anion type—and can be characterized as calcium-magnesium sulfate-chloride type.

Ground water collected from the monitoring wells contained a high concentration of dissolved iron and dissolved manganese. Dissolved iron in the middle and deep zones of both monitoring wells ranged from 2,600 to 3,800 micrograms per liter (µg/L). Dissolved manganese concentrations in the monitoring wells ranged from 1,200 to 2,100 µg/L. Much of the dissolved iron in the ground water oxidized out of solution after sample collection—shown when the laboratory obtained much higher color and turbidity results than the field. At the time of sampling, the water samples were generally clear with turbidity less than 1nephelometric turbidity unit (NTU). However, the laboratory reported high color units (as high as 100) and turbidity (as high as 31 NTU). Accurate measurement of dissolved iron concentration in the water only occurred when the monitoring well samples were filtered in the field at the wellhead, and either preserved (acidified) in the field, or, if not preserved in the field, accurate measurement of dissolved iron required that the lab did not filter the sample again prior to analysis (a typical laboratory procedure when analyzing for dissolved metals).

4.4.2 Continuous Water Quality Measurements in MW-1S and MW-1M

Troll 9000 multiparameter instruments made by In-Situ, Inc. were placed within monitoring wells MW-1S and MW-1M on October 26, 2005, to obtain water quality trends over time. The Troll 9000s were equipped to monitor conductivity, ORP, and pH at 15-minute intervals. However, within a few months, the pH sensors began malfunctioning and are not considered to have provided accurate reportable data. At the start of the test, the pH, measured in both the shallow and middle zones, was approximately 7 pH units, which is in line with laboratory water quality results and field measurements taken during the aquifer pumping tests.

The trends in conductivity data show stable concentrations in the middle zone, and variable concentration in the shallow zone. The variability in the shallow zone is probably due to hydraulic continuity with the shallow zone and recharge from San Juan Creek. When the sand berm at the mouth of the creek completely builds across, ocean water that entered the creek during high tide events is prevented from flowing out to the ocean. After a known berm breakthrough event, such as on February 17, 2006, specific conductivity in MW-1S dropped from approximately 14,000 to approximately 5,500 microsiemens per centimeter (µS/cm), in concert with dropping water levels in the shallow zone (see figure 7). Specific conductivity in MW-1M remained relatively constant and measured approximately 3,300 µS/cm for most of the period of observation (see figure 7).

The trends in ORP data show stable concentrations in the middle zone of approximately -400 millivolts (mV) and concentrations in the shallow zone which fluctuate from approximately -400 to approximately +300 mV. The spikes in ORP data from MW-1M reflect when the sensor was removed from the borehole for calibration and that it takes a couple of weeks for the sensor to stabilize. The relatively constant negative ORP values show that the ground water in MW-1M is reducing. The fluctuating ORP values in MW-1S are further evidence that the shallow zone is in hydraulic communication with surface water in the creek (see figure 9).

5. Selection of Slant Well Drilling Technology

The dual rotary drilling technology was selected for construction of the Test Slant Well as it enabled the construction of a large-diameter, high-capacity, artificially filter-packed well within a cased borehole. In selecting this method, “risk avoidance” was a major consideration as up until now, no successful artificially filter-packed well with the lengths and capacity of the Dana Point Test Slant Well had been successfully completed beneath the ocean floor. The dual rotary method was a proven method for constructing wells. The method and has been successfully used to construct a shallow-angle well along the Missouri River for the Lewis and Clark Water District in South Dakota (however, without an artificial filter pack) and to construct a filter-packed shallow-angle well parallel the Hudson River in New York. The geohydrologists for these two projects, Ms. Martha Silks of Quad State Services, Inc. in Perry, Kansas (for the South Dakota project), and Mr. Gary Smith of Wright-Pierce Inc. in Portsmouth, New Hampshire (for the New York project), provided valuable input in the initial stages of design and technical specifications for the MWDOC Test Slant Well.

The dual rotary drilling method allowed the slant well to extend as far as possible beneath the ocean, with the least amount of risk. Traditional Ranney-type collector wells are limited in length to approximately 150 ft, and they require construction of a large diameter caisson, which would be too expensive, would take too long to construct, and would be aesthetically infeasible for the beach environment. HDD could potentially be used to construct a shallow angle well, extending up to 1,500 ft. However, this method has yet to be proven for the construction of water wells (and especially artificially filter-packed—not “prepacked”—water wells). The HDD method typically uses specialized “drilling mud” to keep boreholes open and optimally proceeds as a “pull-through” operation, in that the borehole has a separate entry and exit point. The drilling mud used in HDD could pose a potential environmental risk in the event of “frac-out,” where drilling mud under pressure in the borehole escapes to the surface. Additionally, HDD contractors in California and Texas contacted during the planning phases of the Test Slant Well project could not guarantee borehole stability in very coarse (i.e., large gravel and cobbles) unconsolidated sediments or removal of the drilling mud from the borehole, which would be essential for well performance. A further unresolved technical challenge with the HDD method is how to provide for an artificial filter pack and development of the well.

The slant well had several advantages over constructing a vertical well for the purposes of conducting aquifer pumping tests for a desalination intake feasibility study. Construction of a slant well allowed for a screen section closer to the seawater interface, increasing the likelihood of producing seawater. Construction of a slant well also allowed for a greater length of screen within the aquifer and, therefore, a larger production capacity from the well. Additionally, by constructing the Test Slant Well at a shallow angle, it was possible to obtain lithologic information about the extension of the aquifer associated with the San Juan Creek alluvium for a horizontal distance of approximately 320 ft from the borehole entry point towards the ocean.

6. Well Construction

The Test Slant Well was constructed at an angle of 23 degrees (°) below horizontal using a DR-24HD (Dual Rotary 24-inch diameter lower rotary drive, Heavy Duty) drilling rig manufactured by Foremost Industries, LP of Calgary, Canada. The drilling contractor was Boart Longyear Geo-Tech Division of Tualatin, Oregon. The following sections discuss details regarding the well drilling, construction, and development processes. Appendix A summarizes the chronology of construction.

An onsite project kick-off meeting was held January 30, 2006. Representatives from MWDOC, California Department of Parks and Recreation (State Parks), GEOSCIENCE Support Services, Inc., Boart Longyear Geo-Tech Division, MJF Consulting, Chambers Group, Williams-McCaron, Inc., and South Coast Water District attended the meeting. The primary issues discussed were details of the drilling project including permits, contact numbers, spill prevention, public safety and notification, water disposal, and work schedule.

6.1 Test Slant Well Location

The Test Slant Well is located on Doheny State Beach, approximately 160 ft southwest of the existing (May 2006) main lifeguard station, and approximately 73 ft west of the rock and cement groin which comprises the western bank of San Juan Creek where it outlets to the Pacific Ocean (see figure 1). The SL-1 wellhead is also located approximately 55 ft southwest of buried monitoring well MW-1, constructed in March 2005.

The SL-1 wellhead is buried 3 ft vertically below ground surface so as not to create any nuisance on the beach. The well casing and screen extend perpendicular from the beach face offshore for 350 lineal ft at a 23-degree angle from horizontal. The well was located in a stable beach area above the mean high tide line to protect the well and the drilling operation from beach erosion. The width of Doheny State Beach west of San Juan Creek is kept relatively stable by the rock and cement groin which terminates in the cement structure known as “Thor’s Hammer” (Coastal Environments, 2004). The SL-1 wellhead is located on the beach approximately 150 ft north of Thor’s Hammer.

Well construction took place on the beach within a 60-ft-wide by 130-ft-long fenced work site (see figure 1), the minimum size deemed feasible by the contractor. A small footprint was required to minimize impacts to the beach-going public. A larger staging area (approximately 80 ft wide by 140 ft long) was located within the beach parking lot, approximately 600 ft from the work site. Trips to and from the staging area were kept to a minimum, and the contractor planned so that essential equipment for the day’s drilling activity was at the worksite at the start of the day.

Photograph 1. Drilling rig set up on the beach (February 18, 2006).

6.2 Dual Rotary Drilling Method

The dual rotary (i.e., formerly called Barber) drilling method uses a lower rotary drive that is used to advance up to 40-inch- diameter[5]steel casing through unconsolidated overburden such as sand, gravel, and boulders. Hydraulically powered jaws located in the lower drive unit lock onto the steel casing and are capable of exerting a number of rotational forces (i.e., pulldown or pullback with both clockwise and counterclockwise movements) during casing advancement or extraction. Dual rotary drilling units are very powerful, having very high pullback to weight ratios, which are very useful when extracting the casing and drilling string from the borehole under difficult downhole conditions.

A casing guide, or guide shoe, that has carbide buttons imbedded in the outer edges is welded to the leading end of the casing to keep the end of the casing from collapsing or from becoming dented and to cut through the overburden materials. An upper, or tophead, rotary drive unit is used to simultaneously pull down and rotate a "dual wall" drill string that is placed in the borehole through the center of the casing. As formation materials are being removed through the rotating dual wall drill string, the borehole is advanced while rotating the casing using the lower drive.

The dual-wall reverse-circulation rotary method uses flush-jointed double-walled drill pipe. Compressed air or water, or a combination of both, is injected through

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[5] The drilling rig designations of DR-24 and DR-40 refer to the dual rotary drilling system with the ability to handle maximum diameter casings, respectively.

an inlet on the side of the rotary head and is forced downward under high pressure between the outer barrel (or wall) of the drill string and the inner barrel. At a point above the drill bit, the air or water is diverted to the inside of the inner barrel through a series of vents or jets. There, drill cuttings are picked up from the face of the bit and are carried to the surface through the inner barrel of the drill string. The mixture of cuttings and air or water is discharged through a goose-neck swivel at the tophead drive and a large-diameter reinforced hose to a cyclone separator, where the materials are deposited into a roll-off bin. Rubber seals that are located between the casing, swivel, and drilling rods prevent leakage at these points and contain all cuttings and fluids within the closed-circulation system of the drill string. This system of drilling, while providing a very accurate method for collecting formation samples, also provides a safe method for discharging materials under high pressure.

The dual-wall drill string used for this work measured 7 inches for the OD and 4 inches for the inside diameter (ID). The two sizes of drill pipe are concentrically connected by way of centralizers at the top and bottom of each 20-ft section. At the leading end of the dual-wall drill string, a roller cone bit was attached to break up large diameter formation materials (i.e., large gravel and cobbles to remove during advancement of the borehole.

Photograph 2. Preparation to begin drilling of a 24-inch borehole (February 4, 2005).

During drilling, the bit can be either run just inside the leading edge of the casing, well inside the leading edge of the casing or ahead of the casing as the borehole is being advanced, depending upon downhole conditions.

The dual rotary drilling method uses two driving units (upper and lower) that are able to operate independently of one another in raising and lowering the drill string. In addition, they can operate at differing rotational speeds (from one another) as downhole conditions require. When downhole frictional forces build to beyond the effective operating range of the equipment, a smaller diameter string of casing is installed within the original casing string, and advancement of the borehole continues with reduced losses to side-wall friction. Several such telescoping casing strings may be used as is necessary to reach the total depth of the borehole. The sections of casing are joined by welding to ensure a very strong connection to withstand the rotational forces of the large-diameter casing.

Once the total depth of the borehole has been reached, the dual wall drill string is removed; and the screen and casing assembly can be installed. The outer casing is subsequently rotated or rocked back and forth as it is retracted from the borehole using the lower rotary drive. The tophead rotary drive, in addition to rotating and forcing the drill string through the formation during drilling, is used to break apart and spin out the 20-ft sections of the drill pipe.

6.3 Configuration of the DR-24HD Dual Rotary Drilling Rig and Mobilization

The dimensions of the DR-24HD with the position of the mast folded down are 38.75 ft long by 13.5 ft tall by 8 ft wide. For this project, in order to drill the borehole at a 23° angle of from horizontal and prior to mobilization to the work site, the drilling contractor constructed an adjustable angled drilling platform to support the mast of the drilling rig at the desired 23°angle.

The DR-24HD has a top drive capable of 84,000 pounds (lbs) of pullback and 25,900 lbs of pulldown. The lower drive is capable of 117,000 lbs of pullback and 42,000 lbs of pulldown. To accommodate the forces exerted by the drilling rig when pulling down on the casing during drilling and when pulling back the casing during extraction, anchors were installed January 31, 2006, at both the front and the back of the mast. The anchors consisted of 8⅝-inch OD casings set into boreholes that were drilled to 18 ft bgs using a hollow stem auger rig and using 10¼-inch ID hollow stem auger flights. Two anchors were installed at the back of the rig, and four were located at the front. The boreholes were backfilled and compacted using native beach sand. While the anchors were being installed, the temporary chain-link fence—6 ft high and covered with screening material to reduce visibility—was erected around the drilling site. A 20-ft-wide gate provided access into the site at the northern end as well as security when drilling operations were halted. The drilling site measured 60 ft wide by 130 ft long and was oriented in an approximately north-south direction along the San Juan Creek channel (see figure 1).

Mobilization continued from February 1 to February 3, 2006, with delivery of the drilling rig mast,[6] drilling platform, power unit, and 950-cubic-feet-per-minute (cfm) per 350-pounds-per-square-inch (psi) air compressor, as well as a 21,000-gallon Baker tank to manage water generated by the drilling process for circulation back to the borehole.

Plastic sheeting with 6 mil[7] thickness was placed under all stationary equipment. Berms were built around the perimeter of each plastic sheet. Throughout the drilling process, the plastic sheets periodically were replaced as needed when they became torn. K-rails were placed around the perimeter of the site, 1-inch-thick steel plates were laid down to serve as landing mats for the 20-cubic-yard rolloff bin, and a sound barrier was constructed around the air compressor and power unit to mitigate noise generated by the drilling equipment.

During this time, a temporary water line was constructed from a nearby fire hydrant (located north of the main lifeguard tower) to the beach drilling site to convey water to use during the drilling process. The fire hydrant and supply line were installed by SCWD for this project.

6.4 Advancement of 24- and 20-inch Casings to Total Borehole Depth

Drilling of the slant borehole began February 4, 2006, and was advanced to a final depth of 362 lineal ft bgs on February 24, 2006.

On February 4, 2006, the first section of 24-inch OD mild steel casing with ½-inch wall thickness and 30 ft in length was laid in the mast of the drilling rig. A 24-inch diameter casing shoe, consisting of a ring of hardened steel measuring approximately 1 inch in thickness and imbedded with tungsten carbide "buttons," was welded to the leading end of the 24-inch OD steel casing. This casing shoe served to keep the end of the casing from being dented or collapsed during casing advancement and to cut through formation materials. Additionally, with the outer edge of the casing shoe being somewhat larger in diameter than the casing, a slightly oversized hole was cut. This delayed loss of rotational energy due to friction between the casing and the borehole walls. An inner drill string and tricone drilling bit was installed within the 24-inch casing. A stabilizer consisting of four "blades" was threaded onto the first section of drill pipe to keep the drill pipe and bit centered within the casing/borehole. As the casing was advanced, the drill string was also advanced, removing formation materials from the bottom of the borehole by breaking up large-diameter materials as the casing is being rotated and advanced. Large volumes of compressed air were forced down the inside of the 7-inch OD drill string, through a crossover

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[6] The drilling rig mast was transported to the beach and was using a truck-mounted crane.

[7] 1 mil equals 1/1,000 inch.

sub, blowing material back up to the surface inside the 4-inch inner barrel of the drill string by the reverse air rotary drilling method.

Photograph 3. Welding Caing shoe to the end of the 24-inch OD casing (February 4, 2006).

A sampling cyclone was set up over a 20-cubic-yard roll-off bin to slow the velocity of formation material and water being discharged from the drill string and to assist in collecting formation samples at 5-ft intervals.

Drilling was advanced to a depth of 5 lineal ft bgs before a mechanical problem forced a temporary halt to the drilling. Drilling of the 24-inch borehole resumed February 6, 2006; and by February 10, 2006, the 24-inch casing had been advanced to its final depth of 97.44 lineal ft bgs. Drilling rates increased as Boart Longyear personnel became more familiar with aligning and welding the casing and drill string on the 23° angle. Some minor ground vibration was detected above the leading end of the casing until a vertical depth of approximately 50 ft was reached.

On February 12, 2006, 20-inch-OD mild steel casing with ⅜-inch-thick wall was installed within the 24-inch-OD casing. Because 20 ft of "heaving sand"[8] was found within the 24-inch casing upon removing the drill string, the decision was made to not cut off the 24-inch casing shoe but to leave it intact, as it was felt that withdrawal of the casing would not be hindered by the casing shoe. It was

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[8] Heaving sand conditions are created when the hydrostatic head in the formation is allowing loose, unconsolidated materials to flow into the drill string. At times, the amount of "heave" is significant enough to impair drilling progress. If, in the process of combating the heaving sand, too much material is removed, the borehole can become enlarged due to "mining" of the formation and create further instability problems.

determined that the risk of getting the cutting head stuck inside the casing was significantly increased with the presence of heaving sand. A large amount of water was pumped into the casing overnight in an attempt to push down on the heaving sand before pulling up on the 24-inch casing several feet and pushing it back down. This technique seemed to eliminate the heaving sand problem.

At this time, the drilling rig was changed over from reverse air rotary to true dual-wall flooded reverse circulation before advancing the 20-inch casing to total depth. During flooded reverse circulation drilling, the inside of the 20-inch-OD casing (between the outside of the 7-inch drill string and the inside of the 20-inch casing) was kept flooded with water to place an artificial head against the formation in order to manage heaving sand conditions during drilling. As water was being circulated from the borehole by reverse flow through the tricone drilling bit and into the inner barrel of the dual wall drill pipe, additional water from the Baker tank was also pumped into the borehole as necessary. Centralizers were added to the dual-tube drill string approximately every 60 ft to keep it centered within the 20-inch-OD casing.

Noise levels were noticeably decreased with the flooded dual-tube reverse rotary drilling method (versus when drilling with the reverse air drilling method), as the air compressor was now operating at a lower pressure, resulting in a reduced speed of rotation.

The drilling contractor initially proposed drilling a borehole that telescoped from 24 inches in diameter at the surface (the maximum diameter feasible with the DR-24HD) to 18 inches in diameter at the target borehole depth of 350 ft, with a 20-inch-diameter middle section from 100 to 225 lineal ft bgs. However, favorable drilling conditions at a depth of 225 lineal ft bgs led to the decision to proceed to final borehole depth with the 20-inch-diameter casing, eliminating the need to reduce the diameter to 18 inches. Again, heaving sand conditions encountered at the bottom of the borehole led to the need to over-drill the borehole from 350 to 362 lineal ft bgs to ensure that the entire length of casing and screen could be placed to the targeted well depth of 350 ft.

Formation materials encountered during borehole drilling consisted of fine- to coarse-grained sand to 55 lineal ft bgs, sandy clay and clay from 55 to 100 lineal ft bgs, and predominantly sand and gravel from 100 lineal ft to total borehole depth of 362.37 lineal ft bgs (see appendix B). Cobbles in the formation below 250 lineal ft bgs caused some delays to the drilling process as up to nearly 4-in-diameter fragments were able get by the bit without being broken into smaller pieces, becoming lodged in the 4-inch inner barrel of the drill string. When this occurred, the drill rig operator would pressurize the drill string with both air and water while simultaneously using the rig hydraulics to shake the drill string and move the oversized materials out of the borehole.

Once total depth of the borehole was reached with the 20-inch-OD casing on February 24, 2006, the bottom of the hole was tagged; and it was found that approximately 11 ft of heaving sand was inside the casing. The same methods were utilized as with the 24-inch casing—adding water and moving the casing to get the sand pushed out to an acceptable depth on February 25, 2006. As a result, Boart personnel were able to push the heaving sand down to a depth of 358 lineal ft bgs before preparing to install the well construction materials.

During drilling of both the 24-inch and 20-inch boreholes, grab samples were caught, using a 5-gallon bucket placed under the cyclone, and were logged at 5-ft intervals according to the Procedure for Determining Unified Soil Classification (Reclamation, 1986). A detailed lithologic log of the borehole is found in appendix B of this report, and a photographic log of the formation materials is found in appendix C.

Again, because of the heaving sand conditions, the decision was made to forego cutting off the casing shoe to avoid the risk of getting the cutting tools wedged within the 20-inch casing. Typically, the casing shoe is cut off each time the casing diameter is reduced to avoid excessive friction losses around the shoe (resulting in loss of pullback power) during casing extraction.

6.5 Casing and Screen Design

The initial casing and screen design for the Test Slant Well was based on the lithology encountered during the drilling of nearby vertical monitoring well MW-1 in March 2005. Formation materials encountered during Test Slant Well drilling correlated very closely with MW-1 lithology, so it was decided to proceed with the initial casing and screen design.

Well screen materials consist of Roscoe Moss Manufacturing Company 12 ¾-inch-OD[9] by $^{5}/_{16}$-inch wall Type 316L stainless steel Ful-Flo horizontal louvered well screen with 0.094-inch ($^{3}/_{32}$-inch) openings (figure 2). The screened interval was placed from 350 to 130 lineal ft bgs. Blank well casing consisting of a 12¾-inch-OD by $^{5}/_{16}$-inch-thick wall Type 316L stainless steel, was installed from 130 lineal ft bgs to ground surface. A circular plate consisting of Type 316L stainless steel with a $^{5}/_{16}$-inch-thick wall was circumferentially welded to the lowermost section of screen.

Type 316L stainless steel was selected over the more corrosion resistant compound AL-6XN due to a combination of factors but mainly cost and availability (AL-6XN was backordered for up to 6 months and cost approximately 3.3 times higher than 316L). Furthermore, recent research indicates that the rate

[9] 12⅛-inch ID.

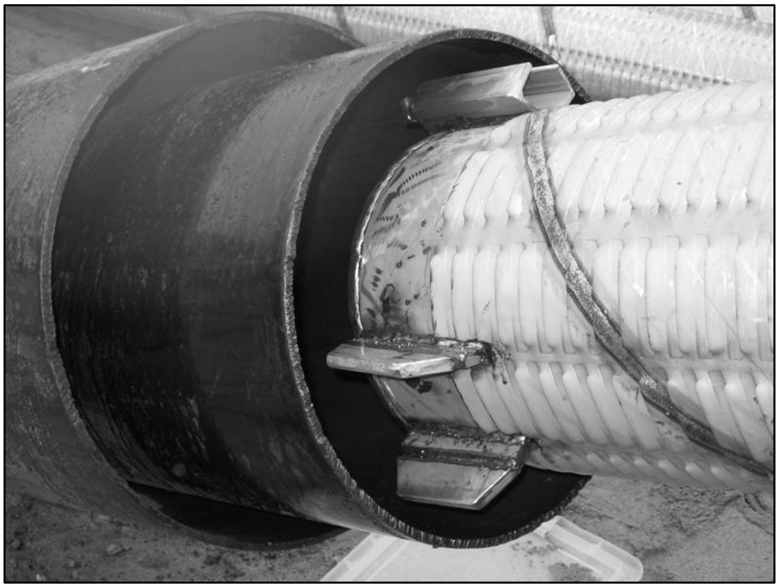
of pitting corrosion in an anoxic seawater environment (as was encountered in the Phase 1 drilling investigation) is only 5 percent (%) of that in aerated seawater (Todd, 1986).

Photograph 4. Type 316L stainless steel 12¾-in-OD louvered screen and casing delivered to the site (February 22, 2006).

To maximize production within the aquifer, a total of 220 ft of well screen and 130 ft of blank casing was installed from February 27 to March 3, 2006, for a total well completion depth of 350 lineal ft bgs. The maximum diameter of the screen, measured at the louvers, was 13.56 inches.

Centralizers and tremie pipe guides were welded to the screen and casing at 20-ft intervals. The centralizers consisted of ½-inch-thick Type 316L stainless steel flat bar stock that had been cut into a trapezoidal shape measuring 4 inches long on the short side and 6 inches long on the long side. Centralizer height measured 2¾ inches with all nonwelded edges on each centralizer rounded to avoid catching on the inside of the 20-inch-OD casing during installation of the 12¾-inch-OD well materials or during extraction of the 20-inch-OD casing materials. The centralizers were welded to the screen and casing at 90 degrees to the vertical axis and at 60-degree intervals below the horizontal plane. The tremie guides consisted of two ¼-inch-thick by 6-inch-long pieces of 1½-inch Type 316L stainless steel angle iron that were welded to the upper portion (vertical axis) of the screen and casing (see figure 10).

Well casing and screen installation took place from February 27, 2006, to March 3, 2006. Prior to delivery to Dana Point, Roscoe Moss passified all welds on the screen and casing at their manufacturing facility using an acid bath consisting of a mixture of hydrochloric acid and phosphoric acid.[10] Additionally, all welds made in the field during screen and casing placement, including the centralizers and tremie guides, were passified at the time of installation using the same acid solution.



Photograph 5. Installing 12¾-in-OD 316 L stainless steel louvered well screen.

Photograph 6. Passifying field welds (March 1, 2006). Note tremie pipe at 12:00 position.

[10] Envirowash Hard Surface Cleaner by Envirotek Corporation, Santa Ana, California.

The 1½-inch schedule 40 mild steel tremie pipe[11] was installed within the tremie guides as the screen and casing was placed within the 20-inch-OD casing. To ensure that the tremie pipe would not come apart during well construction, the tremie pipe sections were connected by welding.

6.6 Filter Pack Installation

Formation samples from nine intervals between 135 and 335 ft bgs (all of which are within the recommended screened interval) were selected for mechanical grading analysis (see figure 10). The filter pack was designed to stabilize aquifer materials using Terzhagi migration criteria. This resulted in a pack/aquifer ratio of 4 to 10 times the finest aquifer (see table 3). The mean grain diameter (i.e., the 50-percent passing size) of the aquifer materials ranged from 0.35 to 3.00 millimeters (mm), with one sample of mostly cobbles having a mean grain size diameter of 25 mm. Uniformity coefficients[12] of aquifer materials ranged from approximately 2.16 to 17.5.

Filter pack materials consisting of a 4 by 16 custom blend by Tacna Sand & Gravel of Yuma, Arizona, were installed from approximately 358 to 45 lineal ft bgs. With a 0.094-inch well screen slot, this material allowed a 17% passing.

Approximately half of the filter pack for the custom blend used in the Test Slant Well consisted of well-rounded 6 x 9 Colorado Silica Sand supplied by Oglebay Norton of Colorado Springs, Colorado; and the other half consisted of Tacna material supplied by Tacna Sand & Gravel of Yuma, Arizona. A well-rounded filter pack material such as Colorado Silica Sand was desired to facilitate the placement. However, because the Colorado Silica Sand deposit is currently limited to grain diameters less than or equal to U.S. Standard Sieve Size No. 6 (3.36 mm), the coarsest fraction of the custom blend filter pack was supplied by Tacna Sand & Gravel. Additionally, Tacna Sand & Gravel sieved and blended the final product before placing it in 1-cubic-yard supersacks for delivery to the site. The filter pack gradation as designed for the Test Slant Well is found in table 3 and in figure 11.

On February 28, 2006, the filter pack was sampled and tested after it was delivered to the site. Sieve analysis of these samples showed the filter pack as delivered was very close to the design gradation (see figure 11).

Gravel was installed within the annular space between the borehole wall and the 12¾-inch OD screen and casing via a 1½-inch (1.9-inch OD) schedule 40 steel tremie pipe. The tremie was inserted in the borehole simultaneously with

[11] 1½-inch schedule 40 steel pipe measures 1.90 inches OD and 1.61 inches ID.

[12] The uniformity coefficient is defined as the 60% passing grain size (d_{60}) divided by the 10% passing grain size (d_{10}). The lower the value of the uniformity coefficient, the more uniform the grading. Similarly, the larger the value, the less uniform the grading of the material.

casing and screen materials and was held in place at the top of the well casing by angle iron guides. The guides consisted of ¼-inch thick 316L stainless steel angle iron welded to the well casing and screen at 20-ft intervals. The outer 20-inch and 24-inch drill casings were extracted simultaneously with gravel installation. Installation of filter pack took place between March 4 and March 12, 2006.

On March 4, 2006, the mast of the drilling rig was chained to the anchors set at the front and rear of the rig in preparation for filter packing and casing extraction. Additionally, the top head drive unit was attached with a short section of drill pipe to the 12 ¾-inch OD casing to keep it from floating upward during the filter pack installation and casing extraction. Initially, the contractor began rocking the 20-inch-OD casing back and forth to break any frictional hold that the formation may have on the casing before pumping any filter pack material. This was done by holding onto the outer 20-inch-OD casing with the jaws of the lower drive and gently rotating the drive back and forth (using approximately 10 to 15 degrees of rotation) while pulling back slightly on the casing. Once it was assured that the casing was no longer tight in the borehole and the borehole was taking water, filter packing was started.

The filter packing process consisted of circulating the borehole by pumping water through the 1½-inch-diameter tremie pipe using a small centrifugal pump that drew water from a small tank that was continually filled using the nearby fire hydrant. The bottom of the tremie was kept very close to the bottom of the 20- or 24-inch casing at all times during filter packing. Once satisfactory circulation was established through the tremie pipe, filter pack material was slowly introduced to the flow of water going down the tremie pipe. Supersacks, containing approximately 30 cubic feet each of 4 x 16 filter pack material, were lifted above a funnel-shaped hopper using the forklift. A slide plate was located at the base of the hopper to stop the flow of filter pack material into the tank as needed. In addition to pumping water and filter pack through the tremie, a fire hose was placed in the top of the 20-inch casing so that an additional 200 gpm of water could be added to the well during filter packing to assist in pushing the filter pack to the bottom of the borehole. Occasionally during filter packing, the well would overflow with the excess water, which was contained and not allowed to leave the site by using plastic sheeting and trenches that led to a sump where it was pumped back into the onsite Baker tank. The level of the filter pack was always kept at least 5 to 10 ft above the bottom of the 20- or 24-inch casing during placement to prevent “bridging” (i.e., entraining voids) within the filter pack as it is placed in the annular space.

Photograph 7. Installing filter pack (March 5, 2006).

The bottom of the 12¾-inch casing was landed at 350.96 lineal ft bgs with the 4 x 16 filter pack installed from 358 to 45 lineal ft bgs from March 4 to March 12, 2006. Removal of the 20-inch-OD casing began March 6, 2006. As filter pack was added to the borehole the 20-inch-OD casing was slowly extracted. The casing was removed in approximately 20-ft sections, with casing removal facilitated by pulling while rocking the casing back and forth. The level of the filter pack was kept 5 to 10 ft above the bottom of the 20- or 24-inch casing at all times during gravel packing to ensure no voids would occur within the filter packed annulus.

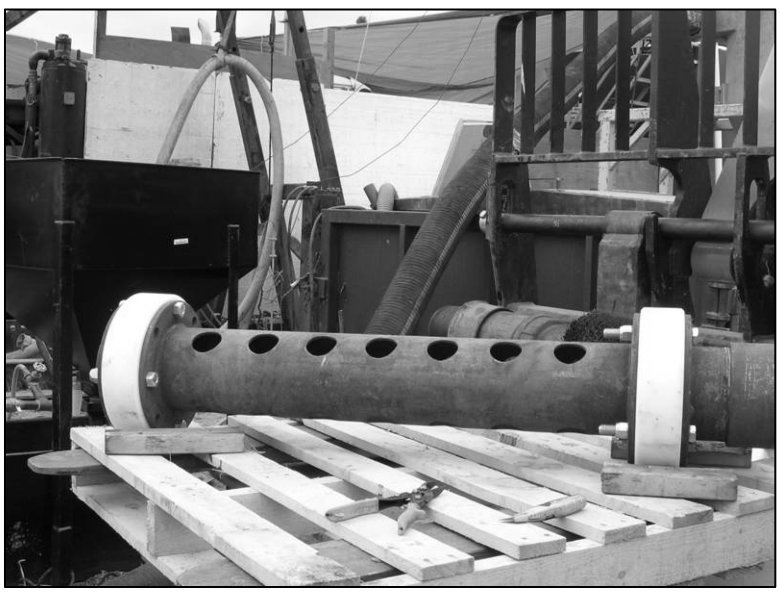
When the level of the filter pack reached 90 lineal ft bgs, the rest of the 20-inch casing was removed, leaving the 24-inch-OD casing to a depth of 97 lineal ft bgs. The top of the filter pack was continually tagged during placement using 1-inch-diameter flush threaded PVC. As the level of the filter pack increased in the borehole, the 1-inch PVC was removed in 10-ft lengths. In addition, as filter packing progressed, the 1½-inch steel tremie pipe was removed in sections to keep the lower end at the level of the filter pack in the annular space.

To assure maximum compaction of filter pack, a swabbing tool (with packers spaced 3 ft apart) was installed inside the 12¾-inch-OD well screen; and each 20-ft interval was mechanically swabbed and airlifted immediately following placement of each lift of filter pack. Additionally, on a continual basis, a large quantity of freshwater was added to the inside of the casing to keep the filter pack moving downward and to add hydrostatic pressure to the formation to keep heaving sand from disrupting the filter pack.

A total of eight supersacks (approximately 240 cubic ft) of filter pack material were placed in the annulus of the Test Slant Well. The calculated volume of the annulus between the borehole and the casing was 432 cubic ft. The difference between calculated annulus volume and the volume of the filter pack placed most likely is due to reduction in annular volume during withdrawal of the temporary casing (see section 10.3).

6.7 Initial Well Development by Airlifting

The Test Slant Well was initially developed using a combination airlifting and swabbing tool to consolidate the filter pack during placement and to remove colloidal and fine-grained sediments from within the well, filter pack, and near-well zone. The packers on the tool were placed 3 ft apart and consisted of high-density plastic cylinders that measured slightly less than the inside diameter of the well. Between the packers, large holes were cut into the center pipe that allowed water to be pulled in through the tool during airlifting. The airline was kept well above the tool to ensure that air would not be allowed to leak into the screened interval. Each 20-ft interval of the well screen (from 130 to 350 lineal ft bgs) was swabbed and airlifted simultaneously until relatively clean water was discharged to the cyclone separator and Baker tank.



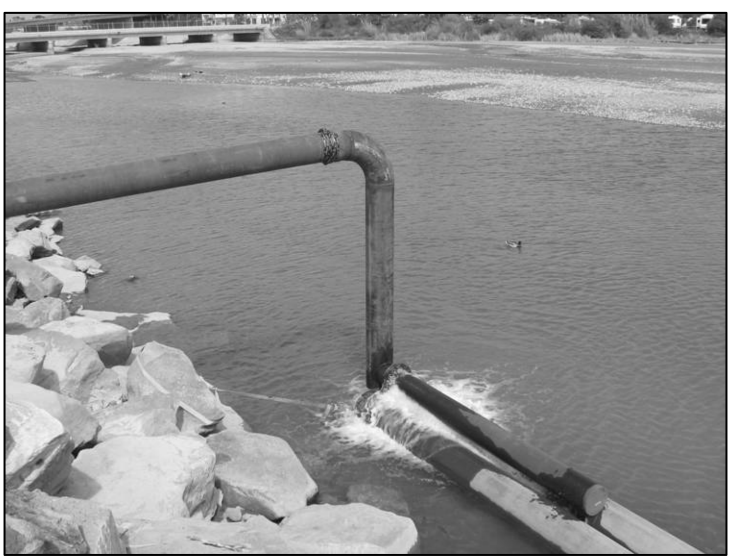
Photograph 8. Swabbing tool for initial airlift development (March 9, 2006).

From March 13 to March 20, 2006, a total of approximately 70 hours ultimately were spent airlifting and swabbing the screened sections of the well before installing the cement annular seal and extracting the remaining 24-inch-OD casing on March 20, 2006.

Photograph 9. Discharging during initial development by airlifting and swabbing (March 15, 2006).

6.7.1 Discharge to the Surf Zone During Development

On March 13, 2006, a diffuser device was installed in San Juan Creek for discharging water to the surf zone. The diffuser consisted of a 10-ft length of mild steel wire-wrapped screen that was attached to the top of two 20-ft lengths of 18-inch-OD steel casing. Water discharged from the well was piped to an onsite Baker tank and then flowed by gravity to the diffuser. A 12-inch-diameter discharge line connected the diffuser to the small Baker tank located adjacent to the well, and the diffuser was secured to the groin using heavy straps.



Photograph 10. Discharging to diffuser (March 25, 2006).

The dissolved oxygen level in the water being discharged to the creek during airlifting and swabbing was monitored closely. Because the level did not fall below the required threshold of 5 mg/L, it was not necessary to add air using the available air compressor. During discharge activities throughout the Test Slant Well project, NPDES water quality samples were collected biweekly for analysis for submittal to Del Mar Analytical in Irvine, California. The first set of biweekly discharge samples were collected during airlift development on March 19, 2006. Analytical results are included in appendix D.

6.8 Installation of the Cement Annular Seal

On March 20, 2006, following completion of airlifting and swabbing, a fine sand layer consisting of #1/20 Monterey Sand was installed from a depth of 45 to 42 lineal ft bgs within annular space between the 24-inch-OD drive casing and the 12¾-inch-OD well casing by pumping the material through a tremie pipe, in the same way the filter pack was installed. Once the fine sand layer had been placed, 4 cubic yards of neat cement was delivered to the site via a ready-mix truck. The cement was mixed with 2,000 pounds of fine sand at the site before being pumped through the tremie pipe into the remaining annular space from 42 lineal ft bgs to ground surface. The remaining 24-inch-OD casing and the tremie pipe were then completely removed from the borehole. The top of the cement seal was measured at 6 lineal ft bgs. The top of the 12¾-inch casing was cut off just above ground surface. Prior to leaving the site, a steel plate was attached to the top of the casing to cover the opening, and the ground around the well casing was compacted.

Work with the drilling rig was completed on March 21, 2005, and demobilization activities began. A 100-ton crane arrived to pick the drilling rig off the beach site on March 23, 2006.

6.9 Final Well Development by Pumping

Installation of the submersible test pump began March 23, 2006 and was completed by March 24, 2006. The test pump consisted of a 125-horsepower motor and a Berkeley 10T75-1600 pump bowl assembly. The pump was set with 8-inch (8 5/8-inch OD) threaded and coupled galvanized pump column. Two 1-inch diameter PVC lines were installed with the pump in order to install a pressure transducer and to take manual water level measurements using an electric water level indicator. High-density plastic centralizers were attached to the motor and the pump bowl assembly as well as at approximately 20-ft intervals along the 8-inch pump column to keep the pump centered in the well and prevent dragging of the pump components on the stainless steel screen and casing. The intake of the pump was set at 124 lineal ft bgs, above the top of the screen.

Because of the diameter of pump that was selected (10 inches), it was not possible to run a flowmeter survey tool past the pump. The inside diameter of the well is 12⅛ inches which left a 1-inch annulus around the pump. The flowmeter tool diameter measures just under 2 inches, so there was no room for its placement beneath the pump. It was necessary to maximize the pump diameter to maximize the production rate from the Test Slant Well.

Final development, which consisted of pumping the well at gradually increasing discharge rates until the sand concentration reached a minimum threshold, was conducted using a submersible test pump from March 24 to March 28, 2006. When a high rate of flow was reached, the well was "surged" repeatedly, resuming pumping at a low rate and increasing to higher and higher rates of discharge as long as the sand content remained less than 10 parts per million (ppm). The contractor's notes taken during the well development process are contained in appendix E.

Photograph 11. Discharging from SL-1 during pumping (March 26, 2006).

During development, the discharge rate was measured using an in-line propeller meter, and water level measurements were collected using an electric wireline water level indicator, while the sand concentration was measured using a centrifugal Rossum Sand Tester. When the specific capacity (discharge rate divided by drawdown) approached a maximum and the turbidity and sand concentration approached a minimum and remained stable, well development was considered complete.

Photograph 12. Measuring water levels in SL-1 following test pump installation (March 23, 2006).

During development pumping, the static water level changed with the tides; it also varied from 19.1 to 24.0 lineal ft bgs (7.44 to 9.36 vertical ft bgs) during development and testing. A maximum short-term discharge rate of approximately 1,857 gpm was achieved with approximately 59 lineal ft (23 vertical ft) of drawdown in the well. Most of the development time was conducted at slightly lower discharge rates. A total of 40 hours was spent on final development by pumping.

6.9.1 Discharge to the Surf Zone During Development and Testing

During development by pumping, the step-drawdown test, the 5-day pumping test, and the 48-hour pumping test with the packer installed, the dissolved oxygen in the discharge to the creek was monitored closely. When the dissolved oxygen level declined to less than 5 mg/L, an air compressor was used to add air to the water in the tank. NPDES water quality samples were collected biweekly and were submitted to Del Mar Analytical in Irvine, California, for analysis. Biweekly samples of discharge to the creek were collected on April 3, 2006, during the 5-day constant rate pumping test and on May 13, 2006, during the 48-hour deep zone constant rate pumping test. Analytical results are included in appendix D.

6.10 Well and Aquifer Testing

After development pumping was completed, step drawdown and constant rate pumping tests were initially conducted, with a 48-hour deep zone constant rate pumping test added at a later date. During both tests, the pumping water level, discharge rate, and sand content were closely monitored. The field procedure for these tests followed the American Society for Testing and Materials (ASTM) (ASTM, 1994, standard test method D 4050). Nearby monitoring wells MW-1 and MW-2 were monitored during both the 5-day constant rate and 48-hour deep zone pumping tests.

Complete analyses of the pumping tests are found in section 7 of this report.

6.11 Geophysical Borehole Logging

Upon removal of the test pump at the conclusion of the constant rate pumping test on April 6, 2006, Pacific Surveys of Claremont, California, ran temperature and fluid resistivity logs in the Test Slant Well and in the middle and deep zones of the monitoring well MW-1. The results of the fluid resistivity logs showed the specific conductivity of ground water in the Slant Test Well to be 2,886 to 4,871 µS/cm (see appendix F).

On May 3, 2006, after 4 weeks of idle time, a second fluid resistivity survey was conducted by Pacific Surveys within the Test Slant Well. The fluid resistivity survey tool was calibrated in the field using 1,000-µS/cm calibration solution prior to beginning the survey. Weighted bars were attached to the top of the fluid resisitivity tool to assist in getting it to the bottom of the slant well. A fine-mesh screen covered the opening to the sensors on the tool to keep sand and sediment out. The specific conductivity of the fluid within the screened interval measured 3,046 to 3,304 µS/cm (see appendix F).

6.12 Downhole Video Survey

After the conclusion of the 5-day constant rate test and removal of the test pump, Pacific Surveys of Claremont, California, conducted a video survey in the Test Slant Well on April 6, 2006 (appendix G). The video survey showed that sand had accumulated on the lower side of the well screen at a depth of 332.4 lineal ft, prohibiting the camera tool from proceeding any deeper. The water column was observed to be clear below approximately 160 lineal ft, and was cloudy above this approximate depth. Red-brown precipitates were observed in the water column and along the sides of the casing above 160 lineal ft. The stainless steel casing and screen were observed to be in very good condition and were placed properly in the well according to their design.

6.13 Additional Testing of Deep Zone

Following the April 6, 2006, and May 3, 2006, fluid resistivity surveys, it was determined that the deeper portion of the screened interval from 300 to 350 lineal ft bgs should be isolated from the rest of the screened interval and be tested by pumping in an attempt to draw in high-salinity water through that zone. The submersible test pump[13] was reinstalled in the well from May 3 to May 12, 2006, with isolation of the deep zone accomplished through using an inflatable packer[14] installed on the 8-inch-diameter pump column pipe. The start of the deep zone pumping test was delayed because the submersible test pump as initially installed would not run, necessitating removal to check the components before reinstallation. Upon removal of the submersible test pump, it was found that the lower 60 ft of the electrical cable had been damaged during installation. While the test pump was out of the well, a 2-inch-diameter steel eductor pipe and airline were installed to 350 lineal ft bgs; and accumulated sand and sediment were removed from the lower portion of the well to facilitate reinstallation of the pump. Modifications were made to the pump installation procedure before being reinstalled.

Photograph 13. Inflatable rubber packer used for isolating and testing the deep zone (May 3, 2006).

The inflatable packer located above the intake portion of the pump, was installed at a depth of 307 lineal ft bgs with the intake of the pump set at 311 lineal ft bgs. The pump intake was set within a short section of blank casing that is located at a casing joint and between two sections of louvered screen to prevent excessive

[13] 125-horsepower Carlington Electric motor with Berkeley 10T 75-1600 single-stage pump bowl assembly.

[14] The packer used was a Newby rubber inflatable packer. See photo insert 13.

stress on the filter pack during pumping as would occur if the intake were located within the screen itself. Water levels before, during, and following pumping were measured above the packer using an electric (i.e., wireline) water level indicator, while water levels were measured below the packer using an airline, compressed nitrogen gas, and a pressure gauge.

On May 12, 2006, the submersible pump was started; and the deep zone was developed for several hours prior to testing. Initially, the packer remained deflated; and development pumping began at 500 gpm. The discharge rate was increased to 1,600 gpm as the sand content declined. At 1,600 gpm, the discharge was visually clear; however the sand content did not decline readily as had occurred at lower flow rates. The packer was inflated to 75 psi (to overcome background pressure by 25 psi), and pumping was resumed. Again, pumping started at 500 gpm and was incrementally increased to 1,000 gpm as the sand content declined. The maximum discharge rate from the deep zone was approximately 800 gpm, as the pump broke suction[15] at 1,000 gpm.

A 48-hour constant rate pumping test was conducted on the deep zone from May 13 to May 15, 2006, at an average discharge rate of 739 gpm,[16] and was followed by 4 hours of recovery measurements on May 15, 2006. During the pumping test, field silt density index (SDI) measurements were periodically collected in addition to the field parameters[17] monitored using a YSI 556 Multi-Probe System (MPS).

During development and testing of the deep zone, discharges to San Juan Creek were closely monitored using a YSI 58 DO meter, in compliance with the NPDES requirement for keeping DO levels higher than 5 mg/L when discharging to the surf zone. The sand berm across the mouth of San Juan Creek remained breached during the deep zone testing. Additionally, biweekly NPDES water quality samples were collected May 13, 2006, and were delivered to Del Mar Analytical in Irvine, California, for analysis. Analytical results are included in appendix D.

6.14 Plumbness and Alignment Survey

Boart personnel measured deviation at four depths in the completed Test Slant Well on May 17, 2006, using a Reflex EZ-Shot electronic single-shot drillhole

[15] Suction is broken when the water level within the well is lowered to a depth that is very near the pump intake, resulting from more water being removed from the well (via pumping) than is entering the well through the available screen interval.

[16] The pumping test was started at 800 gpm; however after 1 ½ hours of pumping, the pump began to break suction causing the discharge rate to be reduced.

[17] The YSI 556 MPS (Multi-Probe System) simultaneously measured field temperature, conductivity, pH, ORP, and . From this data, specific conductivity, total dissolved solids, and salinity were calculated.

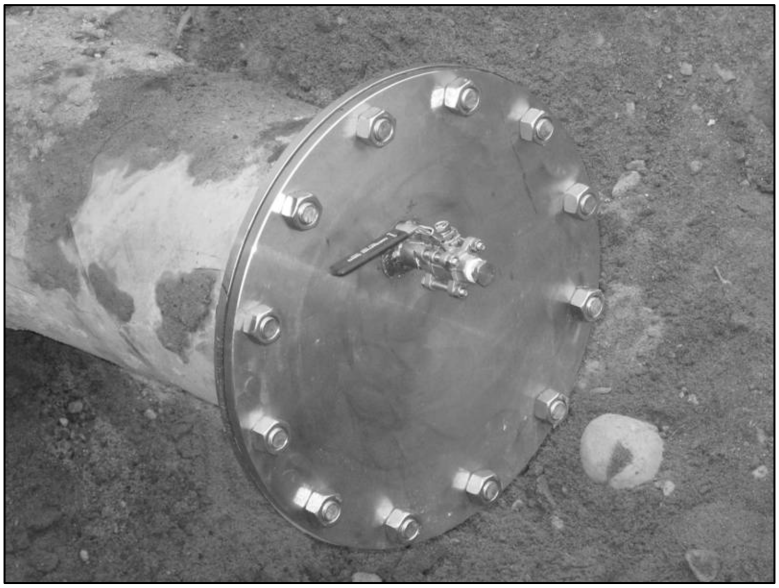
survey tool. The EZ-Shot tool was set in the well at selected depths, setting a timer to allow time to get the tool in place and stop moving before collecting a reading. The tool measured borehole and directional parameters, including inclination, temperature, magnetic field strength, and azimuth. The results of the readings are shown below:

Reflex EZ-Shot Well Survey Data

Parameter Measured by EZ-Shot Tool	Reading 1	Reading 2	Reading 3	Reading 4
Depth (lineal ft bgs)	0.0	129.7	265.3	339.8
Inclination (° of dip)	-22.1	-22.6	-22.5	-21.3
Temperature (degrees Celsius [°C])	24.6 (air)	20.8 (water)	20.7 (water)	20.7 (water)
Magnetic Field Strength (nT)	4,728	4,753	5,067	4,704
Azimuth (direction °)	186.2	188.9	188.8	179.0

6.15 Wellhead Completion

A final video survey of the well was conducted by Pacific Surveys on May 16, 2006 (appendix G). On May 17, 2006, the ground around the 12¾-inch-OD 316L stainless steel casing was excavated to a depth of approximately 4 ft. A total of 7.7 lineal ft of casing was cut off so that the top of the well was 3 vertical feet below ground surface before a Type 316L stainless steel flange was welded to it. A 150-lb neoprene gasket was placed between the flange and a ½-inch-thick 316L stainless steel blind flange. The assembly was held together using 1¼-inch stainless steel bolts. A ½-inch hole had previously been drilled through the blind flange, and a small ball valve was threaded through the flange. The nitrogen blanket was installed using ¼-inch poly tubing attached to the ball valve through which compressed nitrogen gas was used to fill the interior of the casing to a pressure of 10 psi. The gate valve was then closed securely, and the tubing was removed before attaching an additional stainless steel cap to seal the valve assembly. The excavation was back filled and compacted using native material.



Photograph 14. Slant well cut off 3 ft bgs, capped and filled with nitrogen gas (anoxic block; May 17, 2005).

Photograph 15. Beach drilling site following demobilization.

6.16 Well Completion Report

Appendix H contains a copy of the Well Completion Report filed with the State of California Department of Water Resources.

6.17 Contractor's Supporting Data

Appendix I contains copies of miscellaneous data, such as Driller's Daily Logs.

7. Pumping Test Analysis Procedures and Results

7.1 General

Analytical equations to evaluate the drawdown distribution in the vicinity of near-horizontal wells (i.e., slanted or slant wells) are limited and not well tested at this time. Zhan and Zlotnik (2002) present semianalytical methods for the evaluation of drawdown in the vicinity of near-horizontal wells. However, the method is somewhat cumbersome and does not lend itself to straight-forward analysis of near-horizontal well pumping test data. Barlow and Moench (1999) have developed a computer program (WTAQ) to calculate drawdown and estimate hydraulic properties for such wells. Other investigators (Langseth, et al., 2004) have suggested using the inverse approach to solve directly for aquifer parameters from pumping test data. They also suggest using another approach called "forward simulation," which includes developing a ground water model of the aquifer system of interest and calibrating the model until observed data (i.e., pumping test data) match model-generated data within an acceptable accuracy.

For purposes of analysis of the Dana Point Test Slant Well pumping test, forward simulation was used along with conventional vertical well analytical methods to estimate aquifer parameters. Close agreement was found between the model-derived aquifer parameters and the parameters derived from conventional methods. However, the ground water model enables much more flexibility in varying aquifer parameters with area and aquifer depth.

7.2 Analysis of Pumping Test Data Using Conventional Analytical Methods

After development pumping was completed, two separate pumping tests were initially[18] conducted. A step drawdown test was performed to determine specific capacity and well efficiency relationships. Following the step drawdown test, a 5-day constant rate pumping test was conducted. The constant rate pumping test was followed by 4 hours of recovery measurements.

During the pumping tests, the pumping water level, discharge rate, and sand content were closely monitored (see appendix J).

The field procedure for these tests followed the American Society for Testing and Materials (ASTM, 1994, standard test method D 4050).

[18] At a later date, a deep zone constant rate pumping test was conducted.

In nearby monitoring wells MW-1 and MW-2, water levels were monitored during both the 5-day constant rate and 48-hour deep zone pumping tests. Water levels in the middle and shallow zones were continuously monitored with pressure transducers; manual water level measurements were made with an electric sounder at approximately 1-hr intervals in the deep zone.

Photograph 16. Measuring water levels in MW-2.

7.3 Basic Assumptions Used in Analysis of Pumping Test Data

The purpose of a pumping test is to obtain field data, which, when substituted into an equation or set of equations, will yield estimates of well and aquifer properties. As certain assumptions have been used to derive these equations, it is important to observe or control these factors during the test. These assumptions and conditions are:

- The aquifer material is assumed to consist of porous media, with flow velocities being laminar and obeying Darcy's law.

- The aquifer is considered to be homogeneous, isotropic, of infinite aerial extent, and of constant thickness throughout.

- Water is released from (or added to) internal aquifer storage instantaneously upon change in water level.

- No storage occurs in the semiconfining layers of leaky aquifers.

- The storage in the well is negligible.
- The pumping well penetrates the entire aquifer and receives water from the entire thickness by horizontal flow.
- The slope of the water table or piezometric surface is assumed to be flat during the test with no natural (or other) recharge occurring, which would affect test results.

The pumping rate is assumed to be constant during the entire pumping time period during a constant-rate test and constant during each discharge step in a variable-rate test.

7.4 Pumping Test Data Analysis Methods

7.4.1 Step Drawdown Test Method

The purpose of the step drawdown test is to determine formation losses, well losses, and well efficiency—all of which are necessary in determining the design of the permanent pump and associated equipment. In an actively pumping well, the total drawdown in the well is composed of both laminar and turbulent head loss components. Laminar losses generally occur away from the borehole (where approach velocities are low), while turbulent losses are confined to the area in and around the immediate vicinity of the well screen and within the well borehole.

The total drawdown in a pumping well may be expressed as:

(1) Drawdown in a Pumping Well

$$s_w = BQ + CQ^2$$

where:

s_w = Total drawdown measured in the well, [ft]

B = Formation or aquifer loss coefficient, [ft/gpm]

Q = Discharge rate of the well, [gpm]

C = Well loss coefficient, [ft/gpm^2]

The first and second terms in equation (1) are referred to as formation, or aquifer loss[19] (BQ) and well loss[20] (CQ^2), respectively. Formation (i.e., aquifer) loss and well loss coefficients are determined from the step drawdown test. The test

[19] Aquifer loss is the head loss measured at the interface between the aquifer and the filter pack. The magnitude of the aquifer loss can be found from consideration of radial flow into the well and can be calculated, for example, using Jacob's equation.

[20] Well losses are turbulent flow losses which are head losses associated with the entrance of water into and through the well screen as well as those losses incurred as the flow moves axially towards the pump intake. These losses vary as the square of the velocity.

procedure involves pumping the well at multiple (at least three) discharge rates with each "step" being a fraction of the maximum discharge. Analysis of the step drawdown data requires plotting the "specific drawdown" (s_w/Q) for each step against discharge rate. The formation loss coefficient (B) is the y-intercept of the best-fit straight line through the specific drawdown data points. The slope of the line is equal to the well loss coefficient (C).

Well efficiency (E) is defined as the ratio of the formation (i.e., aquifer) loss component (BQ) to the total drawdown measured in the well (s_w) and is expressed as a percent (Roscoe Moss, 1990):

(2) Well Efficiency

$$E = 100\frac{BQ}{s_w} = \frac{100}{1 + CQ/B}$$

where:

E = Well efficiency, [percent]
B = Formation or aquifer loss coefficient, [ft/gpm]
Q = Discharge rate of the well, [gpm]
s_w = Total drawdown measured in the well, [ft]
C = Well loss coefficient, [ft/gpm^2]

7.4.2 Constant Rate Test Method

Calculation of aquifer parameters from pumping test data is based on analytical solutions of the basic differential equation of ground water flow that can be derived from fundamental laws of physics. One of the most widely used solutions of this equation for non-steady radial flow to wells is the "Theis Equation":

(3) Theis Equation

$$s(r,t) = \frac{114.6Q}{T}W(u)$$

where:

s(r,t) = Drawdown in the vicinity of an artesian well, [ft]
r = Distance from pumping well, [ft]
Q = Discharge rate of pumping well, [gpm]
T = Transmissivity of aquifer, [gpd/ft]
W(u) = "Well function of Theis"
u = $1.87 \times r^2 \times S / (T \times t)$
where:
S = Storativity, [fraction]
t = Time after pumping started, [days]

7.4.2.1 Jacob's Straight-Line (Modified Theis Non-Equilibrium) Method

According to Jacob (1950), for small values of "u" ($u < 0.05$), the Theis equation may be approximated by Jacob's equation:

(4) Jacob's Equation

$$s(r,t) = \frac{264Q}{T}\log\left(\frac{0.3\,Tt}{r^2 S}\right)$$

Jacob's equation is valid for use for most hydrogeologic problems of practical interest, is easier to use than the Theis equation, and involves a simple graphical procedure to calculate transmissivity and storativity. This method (D 4105) is summarized by ASTM (1994).

Transmissivity (T, in gpd/ft) is defined as the rate of flow (gallons per day) moving through the entire saturated thickness of an aquifer having a width of 1 mile under a hydraulic gradient of 1 ft per mile. T can be calculated as:

(5)

$$T = \frac{264Q}{\Delta s}$$

where:

Q	= Pumping rate, [gpm]
Δs	= Change in drawdown over one log cycle of time, [ft]

Storativity (S) is defined as the amount of water released or added to storage through a vertical column of the aquifer having a unit cross-sectional area, due to a unit amount of decline or increase in average hydraulic Head. S can be calculated as:

(6)

$$S = \frac{0.3Tt_0}{r^2}$$

where:

T	= Transmissivity, [gpd/ft]
t_0	= Time at the zero-drawdown intercept, [days]
r	= Radial distance from the pumping well, [ft]

7.5 Pumping Test Data Analysis and Results

7.5.1 Step Drawdown Pumping Test

A step drawdown test was performed on March 29, 2006, at average discharge rates of 511 gpm; 1,010 gpm; 1,514 gpm; and 1,652 gpm. The static water level at the beginning of the test was approximately 8.17 vertical ft bgs. Figure 12 is a plot of the step drawdown test data and shows the time-drawdown curve for each step. The specific drawdown for each step is shown below:

Specific Drawdown Measured During Step-Drawdown Pumping Test

Step (m)	Discharge Rate Q_m (gpm)	Incremental Drawdown Δs_m (vertical ft)	Drawdown[1] s_m (vertical ft)	Specific Drawdown $(s/Q)_m$ (vertical ft/gpm)
1	511	6.0	6.0	0.0117
2	1,010	7.5	13.5	0.0134
3	1,514	7.0	20.5	0.0135
4	1,652	2.0	22.5	0.0136

[1] Drawdown at 1,440 minutes after the start of each step.

The specific drawdown chart (see figure 13) shows the relationship between specific drawdown (s/Q) and the discharge rate (Q). The testing showed a formation loss coefficient (B) of 0.011253 ft/gpm and a well loss coefficient (C) of 1.5481×10^{-6} ft/gpm^2.

The specific capacity diagram is shown in figure 14. As can be seen, at a discharge rate of 1,660 gpm, the well efficiency was 81%. Also, the diagram shows that at a discharge rate of 2,000 gpm, the expected pumping well drawdown would be approximately 29 ft with a specific capacity of 69 gpm/ft and a well efficiency of 78%.

7.5.2 Constant Rate Pumping Test

7.5.2.1 5-Day Constant Rate Pumping Test

Following recovery from the step drawdown test, a 5-day constant rate pumping test was conducted from March 31 to April 5, 2006. Ground water levels were measured in the pumping well (SL-1) and observation wells (MW-1M and MW-2M) using pressure transducers manufactured by In-Situ (see figure 15). The static water level at the start of the test, measured with a wireline sounder, was approximately 8.09 vertical ft bgs. The average discharge rate during the test was 1,660 gpm.

As seen in figure 15, ocean tides affected ground water levels in SL-1, MW-1M, and MW-2M during pumping. Measured drawdown in the pumping well and observation wells was corrected for tidal fluctuations by subtracting measured ground water elevations from predicted static water elevations. Static water elevations at SL-1, MW-1M, and MW-2M were predicted by correlating tidal data and ground water level data for each well during nonpumping periods. This was possible because the ground water level data closely followed the shape and periodicity (without lag) of the tidal data. Figure 16 shows the linear regression relationships that were used to predict static water levels in MW-1M, MW-2M, and the Test Slant Well SL-1. Figure 17 shows ground water elevations during the constant rate pumping test corrected for tidal fluctuations in SL-1, MW-1M, and MW-2M on a semilog plot. Figure 18 is a plot of tidally-corrected ground water elevations during the end of the constant rate pumping test, showing the recovery period in detail.

Figure 19 is a time drawdown plot of SL-1. The Jacob's straight-line method was used to analyze the drawdown data with results showing an aquifer transmissivity of approximately 122,000 gpd/ft. Figure 20 is an analysis of calculated recovery in the Test Slant Well SL-1. This analysis shows a transmissivity of 169,000 gpd/ft.

Monitoring wells MW-1M and MW-2M were also analyzed for transmissivity, storativity, and leakance[21] using both Jacob's straight-line method as well as Hantush's Inflection Point method.[22] Figures 21 and 22 show results for monitoring wells MW-1M and MW-2M, respectively. Figure 23 is a distance drawdown plot of the monitoring wells and the pumping well at the end of the 5-day constant rate pumping test.

A summary of the aquifer parameters from the 5-day constant rate pumping test is summarized below:

Test Type	Transmissivity, (gpd/ft)	Storativity (fraction)	Leakance (1/days)
SL-1 Time Drawdown	122,000	NA	NA
SL-1 Calculated Recovery	169,000	NA	NA
MW-1M Time Drawdown (Jacob's Method)	91,300	0.0014	NA
MW-1M Time Drawdown (Hantush Inflection Point Method)	76,400	0.0017	0.005
MW-2M Time Drawdown (Jacob's Method)	115,000	0.0010	NA
MW-2M Time Drawdown (Hantush Inflection Point Method)	93,000	0.0012	0.003
SL-1, MW-1M and MW-2M Distance Drawdown	146,000	0.0040	NA
Average	116,000	0.0019	0.004

7.5.2.2 48-Hour Constant Rate Pumping Test

Following installation of the submersible test pump and packer in order to isolate the deep portion of the screened interval (see section 6.13), a 48-hour constant rate pumping test was conducted from May 13 to May 15, 2006. Time-drawdown data for the Test

[21] Leakance is defined as the rate of flow crossing a unit cross-sectional area of the aquifer/aquitard interface under a unit head differential measured between the top and bottom of the semipervious layer, Leakance is the quotient of the semipervious layer hydraulic conductivity and the layer thickness (K'/b').

[22] The typical "S"-shaped time drawdown curves reflect leakage.

Slant Well are shown in figure 24, and time-drawdown data for monitoring wells MW-1M and MW-2M are shown in figure 25. The purpose of the pumping test was to test the salinity of the deepest zone of the well (approximately 300 to 350 lineal ft bgs). The static water level at the start of the test was approximately 7.48 vertical ft bgs within the isolated zone, and the average discharge rate was 739 gpm. Water quality results obtained during the 48-hour constant rate pumping test are discussed in section 9.

7.6 Analysis of Aquifer Parameters Using Forward Simulation – Three-dimensional Ground Water Model

As mentioned in section 7.1, pumping test data were analyzed using conventional analytical methods for vertical wells as well as using a ground water model. The initial data for the model consisted of average values of results obtained using vertical well methods (section 7.5.2.1). The average transmissivity as summarized above (116,000 gpd/ft) was divided by the total aquifer thickness penetrated by the Test Slant Well (approximately 86 ft), resulting in an average hydraulic conductivity of approximately 1,349 gpd/ft^2. This value was used initially in the 10-layer ground water model along with an average storativity value of 0.0019 and a leakance value of 0.004 per day.

To verify values obtained from conventional vertical well analytical methods, a ground water model was developed for the unconsolidated sediments of the lower San Juan Basin. The conceptual ground water model (see figures 26 and 27) consists of 10 distinct model layers based on the aquifer systems, discussed in section4.2, and models the completion interval of the Test Slant Well (i.e., from a vertical depth of approximately 50 ft to a depth of approximately 140 ft).

- Layer 1 – Thickness = 50 ft upper alluvial aquifer system
- Layers 2 - 10 – Thickness = 10 ft/layer middle alluvial aquifer system

Flow is assumed to occur horizontally within the each of the model layers, and the layers maintain hydraulic continuity with each other through vertical leakance.

The model used to verify the aquifer parameters is MODFLOW, a block-centered, finite-difference ground water flow model. MODFLOW is widely used and versatile, being developed by the United States Geological Survey (McDonald and Harbaugh, 1988 and 1996) to model ground water flow.

7.6.1 Model Size and Grid Geometry

The ground water flow model grid covers approximately 4.4 square miles (2,817 acres) with a finite-difference grid consisting of 173 cells in the I-direction (north to south along rows), 134 cells in the J-direction (west to east along columns), and 102 cells in the K-direction (layers) for a total of 231,820 cells.

The smallest model cells that are in the area of interest and in the map view are squares 10 ft by 10 ft; the largest model cells that are in the corners and in the map view are squares 255 ft by 255 ft. See figures 26 and 27 for the location and layout of the model grid.

7.6.2 PEST Inverse Modeling Software

In addition to MODFLOW, the software package Visual Parameter ESTimation (PEST) (Doherty, 2000) was used to aid in the calibration of both the steady-state and transient Dana Point ground water flow model. The calibration procedure (using PEST) is accomplished using the Gauss-Marquardt-Levenberg algorithm to estimate different sets of adjustable parameters that satisfy the nonlinear (unconfined) flow equation. Observed ground water level elevations at 17 different time periods (i.e., stress periods) in the Test Slant Well and MW-1M and MW-2M were used as "target" elevations for calibration by the program to judge the fit of the model-generated ground water surface to the actual ground water table that was observed.

When the "residual" (model-generated minus measured water levels) were minimized, the model was considered calibrated.[23] Figures 28 and 29 show the results of model calibration for the 5-day pumping test.

7.7 Model Simulation Results

Based on average aquifer parameters as summarized above, the model was run for the 5-day constant rate pumping test period and 180 minutes of recovery. Results from the model showed good agreement with the average aquifer parameters determined from conventional analytical methods. The relative error (a measure of calibration) was 7.1% which showed that the model was calibrated and well within the industry standard of 10%.

The Dana Point Pumping Test Ground Water Model was first run under steady-state conditions using the average aquifer parameters obtained from the analysis of the data using conventional vertical well methods. Following this, PEST was used to determine the optimum aquifer parameters hydraulic conductivity (K), storativity (S), and leakance (K'/b') during the 5-day pumping period (7,140 minutes) plus 180 minutes of recovery. Model results showed the following:

- Hydraulic Conductivity 1,618 gpd/ft^2

[23] A measure of ground water model calibration is the relative error (RE). The relative error is the standard deviation of the residuals divided by the range of hydraulic heads of SL-1, MW-1M, and MW-2M during the 5-day pumping test and subsequent 180-minute recovery period. When the relative error is less than 10%, the industry standard accepts the model as well calibrated. The Dana Point Pumping Test Ground Water Model had a relative error of 7.1%.

- Transmissivity 139,000 gpd/ft
- Storativity 0.00033
- Leakance 0.0275 day^{-1}

Figure 29 summarizes the ground water flow model results along with graphical plots of SL-1, MW-1M, and MW-2M. As can be seen, there is good agreement between model-generated data and measured data. Also, there is generally good agreement between model-generated aquifer parameters and parameters estimated using conventional vertical well analyses. Figures 30 and 31 show drawdowns and ground water level elevations respectively at the end of the 5-day pumping test.

8. Design Discharge Rate, Total Lift and Pump Setting

Based on analysis of the pumping test data, a discharge rate of 2,000 gpm is recommended for the Test Slant Well. Under current conditions, at this rate of discharge, a short-term drawdown of approximately 29 vertical ft (74.2 lineal ft) is expected, with a total vertical lift to ground surface of 37.1 ft (95.0 lineal ft) based on a static water level of 8.1 vertical ft bgs (20.7 lineal ft bgs). The effect of ocean tides on water levels has been considered in deriving anticipated water levels for static and pumping conditions. Long-term pumping level may vary depending on tidal, seasonal, and boundary effects (e.g., recharge from San Juan Creek channel and ocean recharge).

The specific capacity and well efficiency chart (see figure 14) shows the estimated drawdown and well efficiency. Estimated drawdown and well efficiency may also be calculated from equations (1) and (2) described above in section 7.4.1, "Step Drawdown Test Method." After 1 day of pumping at the design discharge rate of 2,000 gpm, the specific capacity of the Test Slant Well is approximately 69 gpm/ft, with a well efficiency of approximately 78 percent.

It is recommended that the pump intake is set at a depth of 128 lineal ft bgs (50.0 vertical ft bgs), slightly above the top of the louvered well screen located at 130 lineal ft bgs (50.8 vertical ft).[24]

The recommended pump design based on current depth to ground water conditions is summarized below:

Recommended Pump Design – Test Slant Well

Design pumping rate	2,000 gpm
Design drawdown	29 vertical ft (74 lineal ft)
Design well efficiency	78 %
Pump setting	50 vertical ft bgs (128 lineal ft bgs)
Static water level depth	8 vertical ft bgs (21 lineal ft bgs)
Total lift to surface (Does not include regional decline in static water level)	37 vertical ft (95 lineal ft)

Note: Long-term pumping level may vary depending on tidal, seasonal, and boundary effects (e.g., recharge from San Juan Creek channel and ocean).

[24] The top of the 12¾-inch-OD 316L stainless steel casing is currently found at 3 vertical ft bgs (7.7 lineal ft bgs).

9. Water Quality

Water quality measurements taken during the Phase 2 Test Slant Well investigation included:

- Laboratory analysis of final feed water quality parameters from water samples collected at the conclusion of the 5-day pumping test and deep zone pumping test

- Laboratory analysis of dissolved trace metals in Test Slant Well water samples using U.S. Environmental Policy Agency Method 1640

- Laboratory analysis of a shorter list of parameters from water samples collected during each day of the 5-day pumping test

- Field measurement of water quality parameters (specific conductivity, salinity, TDS, oxidation reduction potential, dissolved oxygen, turbidity, temperature, and pH) in well discharge during the 5-day pumping test and deep zone pumping test

- Field measurement of silt density index of well discharge during the deep zone pumping test

- Laboratory analysis of parameters required by the NPDES discharge permit for discharge to San Juan Creek during well development and test pumping

9.1 Laboratory Analysis of Final Feed Water Quality

As part of the Phase 1 Hydrogeology Investigation, water quality samples were collected from monitoring wells MW-1M, MW-2M, MW-1D, and MW-2D for an extensive list of water quality parameters critical for analysis of desalination plant feedwater supply (see section 4.4.1). These same parameters were analyzed in the Test Slant Well at the conclusion of the aquifer pumping tests. Samples were collected on April 5, 2006, at the end of the 5-day pumping test and on May 15, 2006, at the end of the 48-hour deep zone pumping test (see table 2 for results). The water from the Test Slant Well was brackish, with TDS measuring 2,600 mg/L at the end of the 5-day test and 2,500 mg/L at the end of the 48-hour deep zone pumping test. The trilinear diagram depicted in figure 7 shows that the final feedwater quality of the Test Slant Well is similar to the water quality of ground water collected from the middle and deep zones of monitoring wells MW-1 and MW-2.

9.2 Laboratory Analysis of Trace Metals in Seawater by EPA Method 1640

The San Diego Regional Water Quality Control Board required detection of metals to very low levels for compliance with the NPDES permit for Test Slant Well discharges to the surf zone. High dissolved solids content in seawater cause interferences that make it necessary to dilute samples when using traditional methods of metals analysis (e.g., EPA Method 200.8). Because sample dilution would increase water quality reporting limits to levels exceeding minimum levels required by the permit, metals in the Test Slant Well samples were analyzed using EPA Method 1640, by CRG Marine Laboratories of Torrance, California. The more costly EPA Method 1640 allows for very low reporting limits, on the order of hundredths of a microgram.

Samples were collected from the Test Slant Well for trace metals analysis throughout the 5-day pumping test (March 31, April 1, April 2, April 3, and April 5, 2006) and at the end of the 48-hour deep zone pumping test on May 15, 2006. A seawater sample immediately offshore from the Test Slant Well was also collected for trace metals analysis on March 31, 2006. Results of metals analyses are reported in table 4.

9.3 Laboratory Analyses During 5-Day Pumping Test

Water samples were collected from the Test Slant Well each day of the 5-day pumping test for analysis of a shorter suite of parameters suggested by Dr. Matt Charette of the Woods Hole Oceanographic Institute (Charette, 2006). This suite included dissolved iron, manganese, and nutrients (nitrate, ammonium, phosphate, and silicate) as well as field parameters from the YSI 556 probe (salinity, conductivity, dissolved oxygen, pH, ORP, and temperature). In addition to the Test Slant Well samples collected during the constant rate pumping test, one seawater sample was collected for a short list of laboratory water quality analyses. The purpose of the daily water quality testing was to identify the pattern of water quality change over time with pumping. The results reported in table 5 indicate that water quality parameters remained relatively stable throughout the 5-day pumping test period.

9.4 Field Measurement of Water Quality During Pumping Tests

YSI 556 and YSI 650 multiprobe instruments were used during the aquifer pumping tests to monitor water quality parameters of conductivity, specific conductance, pH, temperature, ORP, DO, TDS, and salinity. Turbidity of Test Slant Well discharge was measured in the field using a Hach 2100P field instrument.

9.4.1 5-Day Constant Rate Pumping Test

Water quality parameters measured in the field remained relatively stable throughout the 5-day constant rate pumping test. The water quality was consistently brackish (approximately 2,500 mg/L TDS), dissolved oxygen was generally less than 0.5 mg/L, pH was approximately 7, turbidity was generally less than 1 NTU, and ORP was negative (see table 6). A plot of the TDS data obtained by field measurements shows that, throughout the pumping test, salinity increased very slightly with time, by a rate of 57 to 97 mg/L per day (see figure 27).

Immediately prior to the pumping test, conductivity as measured by the Troll 9000 sensor in MW-1M had been relatively constant at approximately 3,250 µS/cm. During the low tide cycles towards the end of the pumping test, there are spikes in conductivity in MW-1M, almost to the conductivity levels measured in the shallow zone (approximately 6,000 µS/cm). It is believed that these spikes in conductivity indicate that the well seal between the middle and shallow zones of MW-1 are leaky. It is likely that higher conductivity shallow zone water is reaching the level of the Troll 9000 sensor during the period of lowest drawdown, only to rise above the level of the sensor during rising water levels.

9.4.2 48-Hour Constant Rate Pumping Test

Water quality parameters measured in the field remained relatively stable throughout the 48-hour deep zone constant rate pumping test and did not differ substantially from measurements obtained during the 5-day constant rate pumping test. The water quality was consistently brackish (approximately 2,500 mg/L TDS), dissolved oxygen was generally less than 0.5 mg/L, pH was approximately 7, turbidity was generally less than 1 NTU, and ORP was negative (see table 7). A plot of the TDS data obtained by field measurements shows that, throughout the 48-hour pumping test, salinity increased very slightly with time, by a rate of 106 mg/L per day, slightly more rapidly than during the 5-day pumping test (see figure 30).

9.5 Field Measurements of Silt Density Index

Silt density index is a measure of submicron particles and is an indicator of feedwater plugging potential for RO membranes. To measure SDI, flowing water at specific pressure is filtered through a membrane and collected for a fixed period of time. The speed of water flow and total volume collected determines the index value. SDI was measured during the 48-hour deep zone pumping test using the SDI-2000 field kit made by Applied Membranes, Inc. of Vista, California, in accordance with ASTM Standard Method D4189-95. SDI values obtained by field measurement on May 14, 2006, averaged 0.58 (see table 8). Silt density index values obtained by laboratory analysis of Test Slant Well water samples were 0.05 for water collected at the end of the 5-day pumping test and 0.21 for water collected at the end of the 48-hour deep zone pumping test (see table 2).

9.6 Analyses Required by NPDES Permit

The NPDES permit obtained from the San Diego Regional Water Quality Control Board required that certain water quality parameters were monitored on a biweekly basis during discharge activities, and a longer list of constituents was analyzed once as part of a semiannual analysis requirement. Additionally, the permit required that the flow rate of discharge to the San Juan Creek diffuser be calculated on a daily basis. The monitoring reports, including water quality results, are included in appendix D.

10. Conclusions and Recommendations

The Dana Point Test Slant Well is the result of successful merging of water well design and construction technology with near-horizontal well construction methods. Results from the Phase 2 work clearly demonstrated that it is now feasible to obtain a high-capacity desalination feed water supply beneath the ocean. Furthermore, the Phase 2 work showed that with proper design, construction, and development near-horizontal wells (i.e., slant wells) can provide high quantities of water with low turbidity (and silt densities). The Dana Point Phase 2 work showed the following main conclusions:

- An experienced "team" was necessary for successful completion of the project. The project team included experts in ground water hydrology, well design, well construction, water quality, and project management.

- Tried and true vertical water well technology for well design, artificial filter packing, construction, and testing can be modified for near-horizontal wells with equal success.

- The Dual-Rotary method of drilling is a proven technique for construction of artificially filter-packed slant wells beneath the ocean.

- Artificial filter packing a near-horizontal well is more challenging than vertical wells, and creative methods must be adapted to ensure proper filter pack placement and development of the near well zone.

- Well logging of slant wells requires special tools and methods for successful logging.

- Slant wells can be pumped at high capacities using submersible pumps placed on an angle and centered within the pump house chamber.

- The maximum length and diameter of an artificially filter-packed subsurface slant well for desalination supply is not presently known at this time, but it is expected that a total lineal length of 500 ft is entirely possible with present technology (DR-24HD rig). Longer depths may be possible with the larger DR-40 drilling rig.

- A feasible design for a high-capacity slant well would include a blank 16-inch pump house casing with a 12-inch ID well screen extending to a lineal length of at least 500 ft.

- The angles for shallow angled slant wells can be also be varied as required for the application.

- Analysis of pumping test data for slant wells is best accomplished by using a three-dimensional ground water flow model. The most accurate results employ “forward simulation” which consists of varying aquifer parameters until measured pumping test and model water levels are in close agreement. However, fairly good agreement was seen between the more accurate ground water model results and conventional vertical well analytical methods.

During the next phase of the Dana Point Ocean Desalination Project, GEOSCIENCE will model the full-scale subsurface intake system, using the aquifer parameters estimated from Test Slant Well pumping tests. However, extended pumping of the Test Slant Well is recommended to obtain better understanding of the variability of feedwater quality with time. The 5-day period was not enough to observe major changes in water quality, such as a seawater contribution to the Test Slant Well. This extended duration pumping should be done subsequent to ground water modeling of the well intake system to corroborate model findings.

Additionally, slight modifications can be made to the drilling and construction process for future slant wells constructed using the dual rotary drilling method. These recommendations are outlined in the following sections.

10.1 Modifications to Drilling Bit

Some delays were experienced in the drilling progress as up to 4-inch-diameter cobble fragments were able to bypass the roller cones of the drilling bit without being further broken up. As a result, they became lodged within the 4-inch inner barrel of the drill string, requiring the drill rig operator to halt drilling, alternately pressurize the drill string with air and/or water, and shake both the drill string and mast using the rig’s hydraulics. This technique was continually used below approximately 200 lineal ft to loosen the oversized materials within the inner barrel so that they could be forced up through the drill string and out of the borehole.

To avoid oversized material from entering the inner barrel of the drill string, a skirt (consisting of a bar or plate) should be welded between the shoulders of the drill bit (inside the stabilizing collar) to reduce the size of the opening between the roller cones at the perimeter of the bit.

Photograph 17. 20-in. drill bit with integral stabilizer (February 9, 2006).

10.2 Modifications to the Sound Barriers

Noise levels were within acceptable limits throughout the Test Slant Well Project; however, they were occasionally higher than desired in spite of the sound barriers that were placed next to the power unit. For example, on February 15, 2006, noise levels were measured as high as 97 decibels within 5 ft of the sound barrier and 88 decibels approximately 150 ft away from the drilling site. These maximum noise levels occurred while experiencing temporary plugging of the inner barrel with oversized materials.

Noise dampening effects could be increased by surrounding the engine compartment with a shroud or enclosure containing baffles and acoustical insulation. Additional cooling or ventilation fans may be necessary to keep the engine temperature within the desired operational range. Additionally, the power unit may be quieted by installing intake and exhaust mufflers such as critical- or hospital-grade mufflers that have welded and double-walled construction as well as multiple internal chambers.

10.3 Pressure Pack the Filter Pack During Placement to Ensure a Higher-Placed Volume to Calculated Borehole Volume Ratio

Although the Test Slant Well was developed to a sand-free condition and silt density indices were low during testing, there are benefits to being able to place a volume of filter pack that more closely compares with calculated borehole volumes. Future slant wells may not be located in areas where the unconsolidated formations are as coarse as that which occur offshore at Doheny State Beach, so additional research should be performed to refine the filter packing process.

In using the dual-rotary drilling method, the temporary casing is rotated and advanced in combination with the inner drill string as formation materials are removed. Rather than the process resulting in an open borehole in which to construct the well as with the other rotary drilling methods (e.g. reverse or direct mud), the temporary casing holds loose formation material back as it is advanced. Placement of the screen and casing occurs within the temporary casing; the filter pack is then pumped down the annulus through the tremie pipe as the temporary casing is extracted.

It is believed that while placing the filter pack and simultaneously extracting the temporary casing, loose, unconsolidated formation material was able to move into the "open" borehole faster than the filter pack was able to move out of the temporary casing to fill the annular space. This is in spite of pumping 200 gpm into the annulus at all times during filter packing to try and force the filter pack downward. In the end, a total of 240 cubic feet of filter pack was placed in the annulus, while the calculated volume was 432 cubic feet.

By increasing the diameter of the borehole, it is felt that more filter pack could be placed which would provide a thicker filter for additional assurance for sand-free production. Discussions with the drilling contractor have resulted in a number of ideas including installation of a straddle packer inside the well screen during filter packing which would direct fluid and filter pack material downward and out of the face of the borehole. An increased borehole diameter would also allow a larger diameter tremie pipe (2-inch minimum diameter) to be used to avoid potential plugging or bridging of the filter pack within the tremie pipe during pumping. Although plugging did not occur using the 1½-inch tremie pipe, using a larger diameter pipe would allow for greater flexibility and the ability to use greater pressure and a coarser filter pack gradation, if required.

In addition, in order to add pressure to the filter pack during placement, a custom-built packer should be installed at the surface to seal between the 12¾-inch-OD casing and the 20-inch temporary casing with an opening for the tremie pipe to pass through. By placing pressure on the annulus during installation of the filter pack and while pumping additional fluid down the hole, one can be more assured of pushing the newly placed filter pack quickly out of the bottom of the casing. A packer should also be placed inside the 12¾-inch casing above the top of the screen to prevent water from flowing upward and out of the casing during filter packing.

The gravel pumping system should be capable of generating significant pressure during placement of the filter pack. Typically, a large-diameter centrifugal pump, such as a 5- by 6-inch or a 4- by 6-inch size, with a dual hopper design is used in constructing large-diameter reverse rotary wells. The engine used must be large enough to drive the pump and typically has at least four cylinders. The volume of filter pack being pumped at any time can be measured to very small amounts using a 5-gallon bucket if necessary.

10.4 Casing Collars and Centralizers

During installation of the louvered screen and casing, collared casing was used rather than material with beveled ends for welding as was specified. This change was opened to consideration when the decision was made to continue advancing 20-inch casing to total depth, providing a larger diameter borehole in which to construct the well. In addition to the extra strength that collars add to each connection (over welding plain ends together), alignment of each section was facilitated, making alignment and welding of each section easier. The collars were manufactured from the same material as the casing and screen[25] and measured 5 inches in height. Three ⅜-inch-diameter sight holes were drilled at the midpoint of each collar and were equally spaced around the circumference to be used for casing alignment purposes. Collars are fabricated by slightly expanding a short section of casing so that it fits over the standard-sized casing. It is then welded to one end of the casing, with the casing extending midway through the length of the collar.

In the field during installation of the screen and casing, it was found that many of the collars were slightly over-sized; and because of the 23-degree angle, when slipped together, the casing would rest on the bottom of the collar rather than remain centered. This created some difficulty during installation as it was not easy to fully align the sections of casing on an angle with the collars being loose; and once aligned, a small offset was created. A larger gap needed to be filled at the upper part of the casing during welding. Additionally, this may have created some of the problems experienced when installing the submersible test pump as these small ledges or offsets likely were catching on the ultra high molecular weight (UHMW) plastic pump centralizers and electrical cable, causing them to become excessively worn. A lot of plastic shavings and pieces of tape were observed in the well during the final video survey on May 16, 2006.

[25] ASTM Specification A778 Type 316L stainless steel, 12¾-inch-OD by $^{5}/_{16}$-inch wall thickness.

It should be noted that, although UHMW plastic is very abrasion resistant (more so than Dupont Teflon® PTFE); polyurethane is rated as being tougher. Whatever the type of plastic used, the centralizers must be tightly attached, fully gripping the smooth stainless steel motor cover so that it will not slip off during pump installation or removal. One of the UHMW plastic centralizers that was placed on the submersible motor during the deep zone testing came off during removal, requiring several hours to be spent fishing it out of the well. The Pacific Survey's downhole video camera, which was onsite at the time, was of great assistance during the fishing operation.

10.5 Final Cleaning of Well at the Completion of Work

The May 16, 2006, video survey showed that a fair amount of debris remained in the well following removal of the submersible test pump. The debris consisted of pieces of black waterproof tape (from taping the electrical cable to the pump column); plastic shavings from the pump centralizers; as well as sand and gravel that were not removed due to the low velocity experienced in the deeper portion of the well during final development and pump testing.

The Test Slant Well should be airlifted following removal of the test pump at the completion of testing to remove all remaining sediment, plastic shavings, tape debris, and filter pack materials. Due to time restraints and the deadline for getting all equipment off the beach by May 18, 2006, there was not enough time to perform the final cleaning.

10.6 Modifications to Diffuser and Discharge System

Throughout development and testing of the well, the diffuser that was installed in San Juan Creek required constant monitoring and maintenance due to the buildup of sediment within the interior screen section. Because a solid plate had been welded on the end of the screen section, there was no way to flush oversized materials from the inside of the diffuser. To avoid the potential for clogging, Boart personnel had to periodically beat on the screen with a hammer (creating additional noise) and use a wire brush to dislodge clogging sand, plastic shavings, and fine gravel from between the V-shaped horizontally wrapped wires of the screen section. At one point early in the pump development process, the screen became thoroughly clogged, which increased the pressure within the diffuser and caused the water to spray broadly rather than maintain the mild bubbling appearance that was typical when the screen section was not clogged.

By adding a removable end cap to the design of the diffuser, the interior of the screen could be periodically flushed to clean out clogging materials and so avoid the continual maintenance efforts. Early successful modifications to the diffuser design (suggested by the contractor) included changing from a solid concrete platform as a base for the diffuser screen to two 18-inch-diameter by 20-foot-long sections of casing. The casings were oriented parallel to the stream and tidal flow of San Juan Creek and the groin and allowed high water resulting from spring storms to flow unhindered through the base of the diffuser.

Additionally, tightly fitting baffles should be installed in the temporary holding tank to lower the velocity of the water flowing through the tank, and so reduce the sediment-carrying capacity of the discharged fluids. It was observed that the velocity of the discharge through the Baker tank was fast enough to carry medium- and coarse-grained sand particles through the tank and out into the diffuser.

The addition of several baffles would allow fluids to have more slow-water zones within to tank to allow the suspended load to be dropped out. Additionally, baffles would allow more control over discharged fluids and would allow additional opportunity for dilution when sediment levels and turbidity exceeded the requirements of the NPDES permit.

10.7 Increased Borehole and Casing Diameters

The Test Slant Well was constructed using 12¾-inch-OD casing and screen that was installed within 19¼-inch-ID casing. Near the completion of the field work, discussions were held with Boart Longyear personnel where it was indicated that drilling a larger diameter borehole may be possible at Doheny using the DR 24-HD drilling rig. In past projects, Boart has been successful in drilling 30-inch diameter boreholes to depths of 100 vertical ft bgs without problems, before reducing to 24-inch-diameter casing to continue the borehole. It should be noted that at least 24-inch-diameter casing is needed if 16-inch-ID casing is to be placed, (even as a pump house) as the 24-inch borehole (23-inch-ID casing) will allow a 3.188-inch annular space with 16⅝-inch-OD casing during construction. The portion of the borehole adjacent to the 12¾-inch-OD casing (within a 24-inch borehole) would allow a very acceptable annular thickness for placement of the filter pack.

The advantage of placing a pump house casing is that higher production rates can be maintained using the 10-inch-diameter pump bowl assembly, while still allowing room for an access tube to run a spinner survey. The access tube would need to be installed past the pump and would be used to guide the flowmeter tool past the pump intake so that a flow profile within the screened interval may be obtained.

The 1½-inch (1.9 inches OD) tremie pipe that was used in the construction and filter packing of the test slant well is the minimum diameter that would be recommended for filter pack placement. Tremie pipe having a larger diameter, such as 2⅞ inches would be even more acceptable.

10.8 Flexibility in Design

The test slant well was predesigned based on the nearby monitoring well MW-1 which showed that very coarse alluvial materials occurred at 40 to 130 vertical ft bgs (103 to 333 lineal ft bgs). The filter pack design was based on mechanical grading analyses of eight intervals selected from the cores obtained while drilling MW-1 as well as nine formation samples collected while drilling the test slant well. If it is found that formation samples in the actual borehole differ from that of what is anticipated by the monitoring well lithology, the final well design can be modified to include embedded blank sections to remove fine-grained intervals from the screened section or a different slot size. Additionally, a blank section could be installed at depth to serve as a pump house casing or for setting a packer if it becomes necessary.

10.9 Gyroscopic Survey

Due to the constraints of pushing downhole surveying tools to the total depth of the well at a 23 degrees from horizontal angle, a gyroscopic survey was not planned. In lieu of this and to save costs, a Reflex EZ-Shot electronic single-shot drillhole survey tool was provided by Boart at no additional cost to the project to check the inclination, or dip, of the well at four points along its length. Because of time constraints and the EZ-Shot tool is not a wireline surveying tool, but takes a single set of measurements at predetermined depths, a full directional profile of the well was not generated; however, the EZ-Shot tool verified that a nearly 23-degree angle was maintained in the completed well. A true gyroscopic survey would provide further definition of the inclination and azimuth of the well. In hindsight, it was found that downhole survey tools could be easily worked to the bottom of the well, and 1-inch diameter PVC could be used if additional assistance was needed. The accumulation of fine-grained sand and filter pack on the bottom side of the casing provided the major portion of the resistance met in placing the tools to total depth.

10.10 Construct Well at a Shallower Angle

In discussing the Test Slant Well project with the contractor at the completion of the work, the contractor stated that after learning the lessons of the project at this particular site, an even shallower angle would be possible. An angle of 20 degrees from horizontal would have resulted in a total well depth of 410 lineal feet, and an angle of 15 degrees from horizontal would have yielded a total well depth of 540 lineal ft, for the same vertical depth (140 vertical ft).

10.11 Additional Working Time

We would not have been as pressed for time if Boart Longyear had been able to return to Doheny Beach directly after spring break and without the additional mobilization to return the pump rig to the site. Time was also lost in not being prepared with enough 8-inch column pipe after returning to install the packer and pump to test the deep zone, and the pipe that was delivered was bent. More time was lost due to pump malfunction—causing it to be removed—and then the screened interval was airlifted before reinstalling the pump.

10.12 Contractor Flexibility

The most important factor when introducing new technology is to hire a contractor who is willing to be flexible, keep communication lines open, and work to solve problems and/or challenges as they may arise. In working with Boart Longyear Geotech Division, these objectives were accomplished.

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Tables

Table 1 - Tidal Datums for La Jolla Tide Station No. 9410230

Datum	Value [ft]	Description
MHHW	9.70	Mean Higher-High Water
MHW	8.97	Mean High Water
DTL	7.03	Mean Diurnal Tide Level
MTL	7.12	Mean Tide Level
MSL	7.10	Mean Sea Level
MLW	5.27	Mean Low Water
MLLW	4.37	Mean Lower-Low Water
GT	5.33	Great Diurnal Range
MN	3.69	Mean Range of Tide
DHQ	0.73	Mean Diurnal High Water Inequality
DLQ	0.90	Mean Diurnal Low Water Inequality
HWI	5.01	Greenwich High Water Interval (in Hours)
LWI	11.07	Greenwich Low Water Interval (in Hours)
NAVD	4.56	North American Vertical Datum
Maximum	12.02	Highest Water Level on Station Datum
Max Date	13-Nov-97	Date Of Highest Water Level
Max Time	15:36	Time Of Highest Water Level
Minimum	1.50	Lowest Water Level on Station Datum
Min Date	17-Dec-33	Date Of Lowest Water Level
Min Time	15:36	Time Of Lowest Water Level

Tidal datums based on 1983-2001 National Tidal Datum Epoch.
Source:
http://tidesandcurrents.noaa.gov/data_menu.shtml?stn=9410230%20La%20Jolla,%20CA&type=Datums
Accessed June, 2006.

Table 2 - Final Feedwater Quality Analyses[1] for MW-1, MW-2, and SL-1

Constituent	MW-1 Shallow[2]	MW-1 Shallow[2]	MW-1 Middle[3]	MW-1 Middle[3]	MW-1 Deep[4]	MW-1 Deep[4]	MW-2 Shallow[5]	MW-2 Shallow[5]	MW-2 Middle[3]	MW-2 Middle[3]	MW-2 Deep[6]	MW-2 Deep[6]	SL-1[7]	SL-1 Deep[8]	Units	Method
Sample Date and Time	3/17/2005 1:35 PM	10/03/2005 14:15 PM	3/17/2005 4:30 PM	10/03/2005 12:25 PM	3/17/2005 5:40 PM	10/03/2005 10:10 AM	3/21/2005 1:50 PM	10/5/2005 12:35 PM	3/21/2005 12:50 PM	10/5/2005 10:20 AM	3/21/2005 11:25 AM	10/5/2005 8:20 AM	4/5/2006 8:15 AM	5/15/2006 7:00 AM		
Color			50	40	25	20			75	15	100	7.5	38	15	Units	EPA 110.2
pH			7.27	6.73	7.03	6.68			7.07	6.92	7.03	6.89	6.98	6.91	pH Units	SM 4500 H+
Turbidity (Laboratory)			15	8.1	7.2	3.3			22	5.2	31	2.3	19	16	NTU	EPA 180.1
Turbidity (Field)	4.68	2.08	2.54	0.08	0.49	0.99	62.4[7]	0.85	0.83	0.18	4.92	1.16	0.15	0.33	NTU	Field Meter - Hach 2100P
Temperature (Field)	21.35	24.13	20.78	21.55	20.63	21.21	20.95	23.05	20.55	20.89	20.69	20.54	20.73	20.36	°C	Field Meter - YSI 556
Dissolved Oxygen (Field)	0.37	0.26	1.43	0.05	0.02	0.01	0.00	0.11	0.00	0.01	0.01	0.02	5.98[10]	0.02	mg/L	Field Meter - YSI 556
Threshold Odor Number (TON)			2.0	NA	1.0	NA			1.0	NA	2.0	NA	NA	NA	TON	EPA 140.1
Total Dissolved Solids (TDS)			2,200	2,000	2,700	2,400			2,300	2,200	2,700	2,300	2,600	2,500	mg/L	SM 2540 C
Specific Conductance (EC)			3,700	3,600	4,700	4,900			3,800	3,700	4,400	4,300	4,400	5,000	µmhos/cm	SM 2510 B
Total Cations			34	36	42	46			35	36	41	42	45	47	mEq/L	Calculation
Total Anions			37	36	45	46			35	39	41	44	49	44	mEq/L	Calculation
Calcium			290	330	290	310			310	330	300	340	350	360	mg/L	EPA 200.7
Magnesium			84	91	110	120			81	87	100	110	110	120	mg/L	EPA 200.7
Sodium			280	270	410	470			280	280	390	360	420	430	mg/L	EPA 200.7
Potassium			13	4.9	16	16			8.2	7.3	13	10	11	14	mg/L	EPA 200.7
Total Fluoride			0.37	0.40	0.36	0.34			0.34	0.37	0.34	0.34	0.31	0.23	mg/L	EPA 300.0
Chloride			450	460	540	620			350	440	510	550	730	650	mg/L	EPA 300.0
Sulfate as SO_4			900	800	1,100	1,000			830	890	910	1,000	950	890	mg/L	EPA 300.0
Nitrate as NO_3			<0.50	<0.50	<0.50	<0.50			<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	mg/L	EPA 300.0
Alkalinity as $CaCO_3$			280	340	360	400			370	380	370	370	440	380	mg/L	SM 2320 B
Carbonate Alkalinity as $CaCO_3$			<2.0	<2.0	<2.0	<2.0			<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	mg/L	SM 2320 B
Bicarbonate Alkalinity as HCO_3			340	410	440	480			450	460	460	450	540	470	mg/L	SM 2320 B
Hydroxide Alkalinity as $CaCO_3$			<2.0	<2.0	<2.0	<2.0			<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	mg/L	SM 2320 B
Total Hardness as $CaCO_3$			1,100	1,200	1,200	1,300			1,100	1,200	1,200	1,300	1,300	1,400	mg/L	EPA 200.7
Nitrite as N			<150	<1,500	<150	<1,500			<150	<1,500	<150	<1,500	<150	<100	µg/L	EPA 300.0
Phosphate			<0.30	<0.30	<0.30	<0.30			<0.30	<0.30	<0.30	<0.30	0.63	0.17	mg/L	EPA 300.0
Silt Density Index (SDI)[11]			0.43	0.34	0.24	0.32			0.22	0.49	0.23	0.33	0.05	0.21		ASTM D4189
Total Dissolved Organic Carbon			2.2	2.1	2.2	2.4			2.1	2.2	2.1	2.1	6.0	2.2	mg/L	SM 5310 C
Metals																
Total Aluminum			19	<5.0	<5.0	<5.0			12	<5.0	35	25	<5.0	<5.0	µg/L	EPA 200.8
Total Antimony			1.2	<0.50	<0.50	<0.50			<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	µg/L	EPA 200.8
Total Arsenic			7.8	18	9.2	22			19	15	14	15	23	22	µg/L	EPA 200.8
Total Barium			76	59	27	27			48	40	28	24	56	48	µg/L	EPA 200.8
Total Beryllium			<0.10	<0.10	<0.10	<0.10			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	µg/L	EPA 200.8
Total Boron			350	340	520	450			400	340	520	420	330	340	µg/L	EPA 200.7/EPA 200.8
Total Cadmium			<0.10	<0.10	<0.10	<0.10			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	µg/L	EPA 200.8
Total Chromium			<0.20	<0.20	<0.20	<0.20			<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	µg/L	EPA 200.8
Total Copper			<10	<0.50	<10	<0.50			<10	<0.50	<10	<0.50	<0.50	<0.50	µg/L	EPA 200.7/EPA 200.8
Total Iron			1,600	3,500	2,100	2,400			2,000	2,100	3,100	2,700	2,500	1,700	µg/L	EPA 200.7
Iron, Dissolved[12]			NA	3,800	NA	2,600			NA	2,300	NA	2,700	2,210[13]	1,180[13]	µg/L	EPA 200.7
Total Lead			<0.20	<0.20	<0.20	<0.20			<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	µg/L	EPA 200.8
Total Manganese			1,300	2,100	1,800	1,800			1,900	1,900	1,900	2,000	2,300	2,200	µg/L	EPA 200.7/EPA 200.8
Manganese, Dissolved[12]			1,200	2,100	1,700	1,800			1,900	1,900	1,900	2,100	2,100	2,100	µg/L	EPA 200.7
Total Mercury			<0.10	<0.10	<0.10	<0.10			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	µg/L	EPA 245.1
Total Nickel			13	8.9	11	10			17	12	15	12	15	16	µg/L	EPA 200.8
Total Selenium			0.94	<0.40	<0.40	<0.40			<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	µg/L	EPA 200.8
Total Silica			30	28	32	32			32	30	34	32	31	33	mg/L	EPA 200.7
Total Silver			<0.20	<0.20	<0.20	<0.20			<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	µg/L	EPA 200.8
Total Thallium			<0.20	<0.20	<0.20	<0.20			<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	µg/L	EPA 200.8
Total Zinc			<50	<2.0	<50	<2.0			<50	<2.0	<50	<2.0	50	150	µg/L	EPA 200.7/EPA 200.8

Table 2 - Final Feedwater Quality Analyses[1] for MW-1, MW-2, and SL-1

Constituent	MW-1 Shallow[2]	MW-1 Shallow[2]	MW-1 Middle[3]	MW-1 Middle[3]	MW-1 Deep[4]	MW-1 Deep[4]	MW-2 Shallow[5]	MW-2 Shallow[5]	MW-2 Middle[3]	MW-2 Middle[3]	MW-2 Deep[6]	MW-2 Deep[6]	SL-1[7]	SL-1 Deep[8]	Units	Method
Disinfection Precursors:																
Iodide[11]			160	81.6	370	234			180	100	320	200	120	180	µg/L	EPA 200.8
Bromide			1.5	1.6	2.4	2.7			1.4	1.7	2.3	2.4	2.6	2.6	mg/L	EPA 300.0
Radiological:																
Gross Alpha			10.8	2.22	1.62	0.720			2.39	0.000	2.11	0.000	1.42	2.16	pCi/L	EPA 900-s
Gross Alpha counting error (+/-)			1.44	3.44	1.14	3.82			0.958	1.59	0.900	1.85	0.565	0.614	pCi/L	EPA 900-s
Gross Beta			8.86	1.36	11.6	4.22			4.41	0.970	6.44	2.82	2.5	7.3	pCi/L	EPA 900.0
Gross Beta counting error (+/-)			3.52	2.35	3.28	2.65			2.65	1.18	2.84	1.38	0.98	2.3	pCi/L	EPA 900.0
Total Uranium			10.9	0.94	1.27	1.4			1.78	1.2	1.26	1.4	1.2	1.5	pCi/L	EPA 200.8
Tritium			121	0.000	132	103			63.3	533	74.7	412	0.00	0.00	pCi/L	EPA 906.0
Tritium counting error (+/-)			189	187	189	193			187	201	188	198	209	200	pCi/L	EPA 906.0
Strontium 90			0.000	0.0382	0.307	0.153			0.000	0.185	0.000	0.185	0.330	0.00	pCi/L	EPA 905.0
Strontium 90 counting error (+/-)			0.331	0.289	0.413	0.310			0.296	0.279	0.328	0.279	0.389	0.489	pCi/L	EPA 905.0
Microbial Quality:																
Total Coliform	3.6	<1.1	<2.0	<1.1	<2.0	<1.1	<2.0	<1.1	<2.0	<1.1	<2.0	>=23	<2.0	<2.0[14]	MPN/100 ml	SM 9221 B
Fecal Coliform	<2.0	<1.1	<2.0	<1.1	<2.0	<1.1	<2.0	<1.1	<2.0	<1.1	<2.0	<1.1	<2.0	<2.0[14]	MPN/100 ml	SM 9221 E
Enterococcus	<1.00	<1.0	<1.00	<1.0	<1.00	<1.0	<1.00	<1.0	<1.00	<1.0	<1.00	<1.0	<1.0	<1.0[14]	CFU/100 ml	Enterolert with Quantiray 2000
Heterotrophic Plate Count	>/= 5,700	53	>= 5,700	<1.0	>= 5,700	<1.0	<1.0	6.0	990	110	600	110	160	550[14]	CFU/ml	SM 9215 B

Notes:
1. Analyses by Weck Laboratories of City of Industry, California, unless otherwise noted.
2. MW-1 Shallow screen interval: 10-22 feet below ground surface (ft bgs).
3. MW-1 Middle and MW-2 Middle screen interval: 40-130 ft bgs
4. MW-1 Deep screen interval: 141-166 ft bgs
5. MW-2 Shallow screen interval: 10-25 ft bgs
6. MW-2 Deep screen interval: 140-165 ft bgs
7. SL-1 screen interval is 130-350 lineal ft bgs, or approximately 51-137 vertical ft bgs
8. SL-1 deep zone is 300-350 lineal ft bgs, or approximately 117-137 vertical ft bgs.
9. White flakes of suspended material noted in the water sample.
10. Suspected false reading from YSI650 instrument. DO throughout constant rate pumping test had been <0.5 mg/L.
11. Analysis by MWH Labs of Monrovia, California.
12. Oct-05 dissolved iron and manganese results were obtained after filtering sample at the wellhead with 0.45 micron filter (no filtering at lab).
Because of rapid precipitation of dissolved iron, results for dissolved iron are only meaningful when the sample is filtered at the wellhead and not at the lab.
13. Analysis by CRG Marine Laboratories, Inc. using Method EPA 1640. Sample filtered at wellhead with 0.45 micron filter and preserved with nitric acid.
14. Sampled 05/13/06 9:30 AM.

Abbreviations:
NTU - Nephelometric Turbidity Units
mg - Milligram
µg - Microgram
µmho - Micromho
mEq - Milliequivalent
pCi - Pico Curie
MPN - Most Probable Number
CFU - Colony Forming Units

Table 3 – Well Design Parameters and Recommended Filter Pack - MWDOC Test Slant Well SL-1

Design Criteria	Depth [ft]	Formula (D = Filter Pack) (d = Aquifer)	Value	Recommended Value
Pack/Aquifer Ratio (Finest Zone)	SL-1 (275-280 lineal ft, 107-109 ft bgs)	D_{50}/d_{50}	8.1	4 to 10
Terzaghi Migration Factor (Finest Zone)	SL-1 (275-280 lineal ft, 107-109 ft bgs)	D_{15}/d_{85}	3.2	less than 4
Terzaghi Permeability Factor (Coarsest Zone)	SL-1 (330-335 lineal ft, 129-131 ft bgs)	D_{15}/d_{15}	0.4	greater than 4
Screen Slot [in.]	-	-	0.094	-
Percent Filter Pack Passing Screen Slot	-	-	17.1	10% to 20%
Uniformity Coefficient of Filter Pack	-	$C_u = D_{60}/D_{10}$	1.8	-

Mechanical Grading Analysis – As Designed 4x16 Filter Pack

U.S. Standard Sieve No.	Sieve Opening [in.]	Sieve Opening [mm]	Cumulative Percent Passing
1/4"	0.250	6.35	100
4	0.187	4.75	88
6	0.132	3.36	55
8	0.094	2.38	17
10	0.079	2.00	10
12	0.066	1.68	6
16	0.047	1.19	2
20	0.033	0.84	0.1

Table 4 - Analysis Results for Trace Metals by EPA Method 1640

Constituent	Seawater	SL-1 Day 1 of 5-Day Constant Rate Pumping Test, R1	SL-1 Day 1 of 5-Day Constant Rate Pumping Test, R2	SL-1 Day 2 of 5-Day Constant Rate Pumping Test	SL-1 Day 3 of 5-Day Constant Rate Pumping Test	SL-1 Day 4 of 5-Day Constant Rate Pumping Test	SL-1 End of 5-Day Constant Rate Pumping Test	SL-1 End of 48-Hour Deep Zone Pumping Test, R1	SL-1 End of 48-Hour Deep Zone Pumping Test, R2	Units	Reporting Limit	Method
Sample Date and Time	3/31/2006 12:00 PM	3/31/2006 11:40 AM	3/31/2006 11:40 AM	4/1/2006 3:50 PM	4/2/2006 3:35 PM	4/3/2006 12:40 PM	4/5/2006 8:45 AM	5/15/2006 6:20 AM	5/15/2006 6:20 AM			
Aluminum (Al)	<6	<6	<6	<6	<6	<6	<6	<6	<6	µg/L	6	EPA 1640
Antimony (Sb)	0.156	0.035	0.042	0.033	0.023	0.024	0.019	0.023	0.047	µg/L	0.015	EPA 1640
Arsenic (As)	1.56	12.3	11.9	12.4	13.2	12.6	12.7	11.213	10.983	µg/L	0.015	EPA 1640
Beryllium (Be)	0.02	0.021	0.02	0.021	0.02	0.021	0.021	<0.01	<0.01	µg/L	0.01	EPA 1640
Cadmium (Cd)	0.121	0.061	0.056	0.056	0.053	0.047	0.04	<0.01	<0.01	µg/L	0.01	EPA 1640
Chromium (Cr)	0.19	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	µg/L	0.05	EPA 1640
Cobalt (Co)	0.249	0.165	0.223	0.25	0.268	0.307	0.323	0.07	0.071	µg/L	0.01	EPA 1640
Copper (Cu)	0.396	0.132	0.167	0.096	0.177	0.091	0.047	0.16	0.19	µg/L	0.02	EPA 1640
Iron (Fe)	27.2	2,030	2,030	2,140	2,150	2,220	2,210	1,179.922	1,051.922	µg/L	1	EPA 1640
Lead (Pb)	0.025	<0.01	J 0.006	<0.01	J 0.006	<0.01	<0.01	J 0.006	0.017	µg/L	0.01	EPA 1640
Manganese (Mn)	48	2,290	2,260	2,440	2,520	2,480	2,521	2,132.93	2,146.93	µg/L	0.02	EPA 1640
Mercury (Hg)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	µg/L	0.02	EPA 1640
Molybdenum (Mo)	8.53	4.7	5.19	5.11	4.81	5.36	4.85	4.679	4.786	µg/L	0.01	EPA 245.7
Nickel (Ni)	0.787	0.343	0.363	0.309	0.28	0.272	0.265	0.213	0.228	µg/L	0.01	EPA 1640
Selenium (Se)	0.052	0.029	0.031	0.018	J 0.012	0.022	J 0.015	<0.015	0.038	µg/L	0.015	EPA 1640
Silver (Ag)	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	µg/L	0.04	EPA 1640
Thallium (Tl)	0.026	0.02	0.02	0.02	0.019	0.02	0.02	<0.01	<0.01	µg/L	0.01	EPA 1640
Tin (Sn)	J 0.007	0.014	0.018	J 0.006	0.038	0.016	0.011	J 0.009	0.019	µg/L	0.01	EPA 1640
Titanium (Ti)	0.197	0.162	0.15	0.195	0.221	0.177	0.157	0.1	0.087	µg/L	0.07	EPA 1640
Vanadium (V)	1.54	0.283	0.257	0.153	0.128	0.096	0.07	0.19	0.183	µg/L	0.04	EPA 1640
Zinc (Zn)	9.53	30	30.7	29.2	33.2	28.8	28.7	128.479	127.179	µg/L	0.01	EPA 1640

Notes:
Analysis by CRG Marine Laboratories of Torrance, CA.
J - Estimated value below the Reporting Limit and above the Method Detection Limit
R1 - Replicate 1
R2 - Replicate 2

Table 5 - Water Quality During 5-Day Constant Rate Test - "Short List" Suite of Analyses

Constituent	Seawater[1] 31-Mar-06 10:45	SL-1, Day 1 31-Mar-06 10:45	SL-1, Day 2 1-Apr-06 15:50	SL-1, Day 3 2-Apr-06 15:35	SL-1, Day 4 3-Apr-06 12:40	SL-1, Day 5 5-Apr-06 8:15	Units	Reporting Limit	Method
					Field Constituents				
Specific Conductance	53,629	3,777	3,536	3,668	3,755	3,713	µS/cm		Field Meter YSI 650
Oxidation Reduction Potential	-90.6	-47	-67	-87.8	-18	-28.2	mV		Field Meter YSI 650
Dissolved Oxygen	9.68	1.17	1.39	0.71	0.82	5.98[2]	mg/L		Field Meter YSI 650
Salinity	39.1	2.00	1.87	1.94	1.99	2.14	ppt		Field Meter YSI 650
Temperature	14.92	20.18	20.26	20.23	20.29	20.13	°C		Field Meter YSI 650
pH	8.19	6.92	6.86	6.52	6.78	6.77	pH units		Field Meter YSI 650
TDS	39,360	2,455	2,291	2,384	2,438	2,628	mg/L		Field Meter YSI 650
Turbidity	NA	0.21	0.28	0.27	0.23	0.15	NTU		Field Meter Hach 2100P
					Laboratory Constituents				
Iron, Dissolved	27.2	2,030	2,140	2,150	2,220	2,210	µg/L	0.5	EPA 1640[3]
Manganese, Dissolved	48	2,290	2,440	2,520	2,480	2,521	µg/L	0.01	EPA 1640[3]
Nitrate, as NO_3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	mg/L	0.1	EPA 300.0[4]
Ammonium (NH_{4+})	<0.1	0.7	0.82	0.82	0.86	1.1	mg/L	0.1	EPA 350.1[4]
Phosphate	0.16	0.62	0.65	0.58	0.58	0.63	mg/L	0.1	EPA 300.0[4]
Silica	2.9	30	30	30	30	31	mg/L	0.1	EPA 200.7[4]

Notes:

1- Seawater field parameters were collected 21-Mar-06 at 10:30.

2- Suspected false reading from YSI 650 instrument. Dissolved oxygen throughout April 4, 2006 constant rate pumping had been generally <0.5 mg/L. The YSI flow-through cell requires periodic shaking to maintain flow and accurate dissolved oxygen readings, and had been unattended for several hours.

3- Analysis by CRG Marine Laboratories of Torrance, CA. In addition to Fe and Mn, EPA 1640 also analyzes for Al, Sb, As, Be, Cd, Cr, Co, Cu, Pb, Mo, Ni, Se, Ag, Tl, Sn, Ti, V, and Zn. Samples were filtered with a 0.45 micron filter and acidified in the field.

4- Analyses by Weck Laboratories, Inc. of City of Industry, CA.

Table 6 - Field Water Quality Parameters During Development Pumping and During the Step-Drawdown and Five-Day Constant Rate Pumping Tests[1]

Date / Time	Temperature [°C]	Specific Conductance [µS/cm]	Conductivity [µS/cm]	TDS [mg/L]	Salinity [ppt]	Dissolved Oxygen [%]	Dissolved Oxygen [mg/L]	pH [pH units]	ORP [mV]	Turbidity [NTU]
3/25/2006 11:05	20.28	3,674	3,343	2,388	1.94	2.9	0.26	7.52	-210	4.17
3/25/2006 12:03	20.64	3,683	3,376	2,394	1.95	1.5	0.13	7.22	-329	6.97
3/25/2006 12:36	20.83	3,697	3,402	2,403	1.95	1.4	0.13	7.00	-326	5.38
3/25/2006 13:50	20.52	3,720	3,401	2,419	1.97	0.7	0.06	6.65	-316	6.22
3/25/2006 14:50	20.19	3,731	3,384	2,425	1.97	0.6	0.05	6.37	-312	5.32
3/25/2006 15:40	20.11	3,741	3,392	2,435	1.98	0.5	0.05	6.47	-318	6.49
3/25/2006 16:58	20.11	3,751	3,400	2,438	1.99	1.0	0.09	6.21	-145	4.45
3/26/2006 11:03	20.33	3,736	3,402	2,427	1.98	3.6	0.32	7.02	-91	0.83
3/26/2006 12:18	20.89	3,741	3,447	2,432	1.98	0.9	0.08	7.37	-328	3.38
3/26/2006 12:48	20.44	3,744	3,424	2,438	1.99	4.5	0.40	7.33	-207	47.2
3/26/2006 15:30	20.41	3,748	3,419	2,436	1.98	2.6	0.24	7.56	-228	2.83
3/26/2006 16:32	20.22	3,745	3,403	2,434	1.98	0.9	0.08	7.28	-271	2.83
3/26/2006 17:40	20.01	3,770	3,410	2,450	2.00	2.9	0.26	6.67	-156	10.6
3/26/2006 17:58	20.21	3,768	3,423	2,452	2.00	1.9	0.17	5.47	-170	4.92
3/27/2006 11:00	20.38	3,657	3,336	2,377	1.93	2.3	0.20	6.77	-174	4.45
3/27/2006 13:15	20.27	3,337	3,036	2,169	1.75	1.4	0.13	6.88	64	1.21
3/27/2006 13:50	20.43	3,553	3,243	2,310	1.87	0.9	0.08	6.92	-201	1.64
3/27/2006 15:25	20.48	3,571	3,263	2,321	1.88	2.5	0.22	6.84	-169	0.76
3/27/2006 15:50	20.39	3,573	3,259	2,322	1.89	1.4	0.12	6.91	-237	0.99
3/27/2006 16:30	19.40	3,563	3,181	2,316	1.88	1.6	0.14	6.80	-171	2.29
3/27/2006 17:55	20.29	3,585	3,264	2,331	1.89	2.7	0.23	6.66	-114	4.51
3/29/2006 11:27	20.47	3,479	3,178	2,262	1.83	16.9	1.51	6.95	-63	-
3/29/2006 11:41	20.47	3,468	3,168	2,254	1.83	17.8	1.59	6.97	-62	-
3/29/2006 12:15	20.47	3,487	3,183	2,266	1.84	15.3	1.38	6.99	-67	0.67
3/29/2006 12:45	20.27	3,485	3,170	2,265	1.84	13.5	1.21	7.00	-74	0.72
3/29/2006 13:06	20.23	3,468	3,147	2,251	1.82	13.6	1.26	7.00	-77	0.67
3/29/2006 13:50	20.23	3,483	3,171	2,263	1.83	12.8	1.15	7.01	-70	1.29
3/29/2006 14:27	20.23	3,484	3,173	2,265	1.84	12.0	1.08	7.01	-75	0.70
3/29/2006 15:37	20.28	3,478	3,164	2,260	1.83	12.5	1.11	7.05	-33	0.57
3/29/2006 16:28	20.26	3,473	3,158	2,257	1.83	12.6	1.12	7.02	-54	0.64
3/29/2006 17:02	20.04	3,464	3,135	2,251	1.82	12.2	1.10	7.02	-64	0.82
3/29/2006 17:28	20.19	3,463	3,144	2,251	1.82	14.2	1.26	7.02	-66	0.76
3/29/2006 18:04	20.14	3,484	3,161	2,265	1.84	14.5	1.29	7.04	-48	0.73
3/29/2006 18:44	20.14	3,479	3,156	2,262	1.83	13.4	1.20	7.02	-63	0.70
3/29/2006 19:00	20.14	3,479	3,156	2,261	1.83	13.4	1.20	7.02	-63	0.71
3/31/2006 9:38	20.09	3,790	3,435	2,464	2.01	13.5	1.21	6.91	-44	0.27
3/31/2006 9:43	20.11	3,788	3,434	2,462	2.01	13.3	1.19	6.92	-47	-
3/31/2006 9:48	20.10	3,783	3,429	2,459	2.00	13.1	1.18	6.92	-48	-
3/31/2006 9:53	20.12	3,780	3,428	2,457	2.00	13.0	1.17	6.92	-50	-
3/31/2006 9:58	20.14	3,800	3,447	2,470	2.01	13.4	1.20	6.92	-50	-
3/31/2006 10:03	20.18	3,797	3,447	2,468	2.01	13.2	1.18	6.92	-50	0.21
3/31/2006 10:08	20.18	3,793	3,444	2,465	2.01	13.2	1.18	6.92	-49	-
3/31/2006 10:13	20.19	3,790	3,442	2,464	2.01	13.2	1.18	6.92	-49	-
3/31/2006 10:18	20.21	3,786	3,439	2,461	2.00	13.3	1.19	6.92	-50	-
3/31/2006 10:23	20.19	3,787	3,439	2,462	2.01	13.3	1.19	6.92	-49	-
3/31/2006 10:28	20.18	3,784	3,435	2,460	2.00	13.4	1.20	6.92	-48	-
3/31/2006 10:33	20.19	3,781	3,434	2,458	2.00	13.3	1.19	6.92	-49	0.21
3/31/2006 10:38	20.18	3,777	3,429	2,455	2.00	13.2	1.18	6.92	-48	-
3/31/2006 10:43	20.18	3,777	3,429	2,455	2.00	13.1	1.17	6.92	-47	-
3/31/2006 10:48	20.19	3,777	3,430	2,455	2.00	13.0	1.16	6.92	-47	-
3/31/2006 10:53	20.19	3,775	3,428	2,454	2.00	13.0	1.16	6.92	-48	-
3/31/2006 10:58	20.20	3,774	3,428	2,453	2.00	12.9	1.16	6.92	-48	-
3/31/2006 11:03	20.19	3,787	3,439	2,462	2.01	12.9	1.15	6.93	-48	0.19
3/31/2006 11:08	20.18	3,784	3,435	2,460	2.00	12.9	1.15	6.92	-48	-
3/31/2006 11:13	20.20	3,784	3,437	2,460	2.00	12.9	1.15	6.93	-48	-
3/31/2006 11:18	20.21	3,783	3,437	2,459	2.00	15.2	1.36	6.93	-50	-
3/31/2006 11:23	20.22	3,799	3,452	2,469	2.01	13.1	1.17	6.93	-51	-
3/31/2006 11:28	20.22	3,796	3,450	2,467	2.01	13.1	1.17	6.93	-52	-
3/31/2006 11:33	20.22	3,797	3,451	2,468	2.01	12.0	1.07	6.93	-53	0.17
3/31/2006 11:38	20.22	3,794	3,448	2,466	2.01	11.9	1.07	6.93	-53	-
3/31/2006 11:43	20.22	3,794	3,447	2,466	2.01	12.1	1.08	6.93	-53	-
3/31/2006 11:48	20.24	3,792	3,447	2,465	2.01	12.0	1.07	6.93	-53	-
3/31/2006 11:53	20.24	3,789	3,445	2,463	2.01	11.8	1.06	6.93	-52	-
3/31/2006 11:58	20.26	3,787	3,444	2,462	2.01	11.7	1.05	6.93	-52	-
3/31/2006 12:03	20.24	3,791	3,447	2,464	2.01	11.5	1.03	6.93	-52	-

Table 6 - Field Water Quality Parameters During Development Pumping and During the Step-Drawdown and Five-Day Constant Rate Pumping Tests[1]

Date / Time	Temperature [°C]	Specific Conductance [µS/cm]	Conductivity [µS/cm]	TDS [mg/L]	Salinity [ppt]	Dissolved Oxygen [%]	Dissolved Oxygen [mg/L]	pH [pH units]	ORP [mV]	Turbidity [NTU]
3/31/2006 12:08	20.25	3,797	3,453	2,468	2.01	11.4	1.02	6.93	-52	-
3/31/2006 12:13	20.28	3,794	3,452	2,466	2.01	11.3	1.01	6.93	-51	-
3/31/2006 12:18	20.30	3,793	3,452	2,465	2.01	11.1	0.99	6.93	-51	0.34
3/31/2006 12:23	20.29	3,791	3,450	2,464	2.01	10.9	0.98	6.93	-51	-
3/31/2006 12:28	20.29	3,790	3,449	2,464	2.01	11.0	0.98	6.93	-51	-
3/31/2006 12:33	20.27	3,790	3,447	2,464	2.01	10.8	0.96	6.93	-52	-
3/31/2006 12:38	20.26	3,783	3,440	2,459	2.00	10.7	0.96	6.93	-52	-
3/31/2006 12:43	20.25	3,792	3,448	2,465	2.01	10.1	0.90	6.93	-52	-
3/31/2006 12:48	20.25	3,792	3,448	2,465	2.01	10.0	0.90	6.93	-53	-
3/31/2006 12:53	20.28	3,793	3,451	2,465	2.01	9.8	0.88	6.93	-53	-
3/31/2006 12:58	20.28	3,791	3,449	2,464	2.01	9.7	0.87	6.93	-53	-
3/31/2006 13:03	20.27	3,792	3,450	2,465	2.01	9.5	0.85	6.93	-54	0.18
3/31/2006 13:08	20.28	3,797	3,455	2,468	2.01	9.3	0.83	6.93	-53	-
3/31/2006 13:13	20.27	3,795	3,452	2,467	2.01	9.2	0.82	6.93	-53	-
3/31/2006 13:18	20.28	3,800	3,457	2,470	2.01	9.0	0.81	6.93	-53	-
3/31/2006 13:23	20.30	3,799	3,458	2,469	2.01	9.0	0.80	6.93	-52	-
3/31/2006 13:28	20.27	3,800	3,457	2,470	2.01	8.9	0.80	6.93	-51	-
3/31/2006 13:33	20.28	3,798	3,456	2,469	2.01	8.8	0.79	6.93	-52	0.25
3/31/2006 13:38	20.26	3,796	3,452	2,467	2.01	8.8	0.79	6.93	-53	-
3/31/2006 13:43	20.25	3,798	3,453	2,469	2.01	8.8	0.78	6.93	-53	-
3/31/2006 13:48	20.25	3,794	3,450	2,466	2.01	8.5	0.76	6.93	-53	-
3/31/2006 13:53	20.26	3,795	3,451	2,467	2.01	8.5	0.76	6.93	-53	-
3/31/2006 13:58	20.26	3,794	3,450	2,466	2.01	8.3	0.74	6.93	-53	-
3/31/2006 14:03	20.26	3,798	3,455	2,469	2.01	8.8	0.79	6.93	-54	0.18
3/31/2006 14:08	20.24	3,799	3,453	2,469	2.01	8.7	0.78	6.93	-54	-
3/31/2006 14:13	20.26	3,797	3,453	2,468	2.01	8.6	0.77	6.93	-55	-
3/31/2006 14:18	20.29	3,804	3,461	2,473	2.01	8.4	0.75	6.93	-55	-
3/31/2006 14:23	20.26	3,813	3,467	2,478	2.02	8.5	0.76	6.93	-55	-
3/31/2006 14:28	20.24	3,811	3,464	2,477	2.02	8.3	0.74	6.93	-54	-
3/31/2006 14:33	20.24	3,809	3,462	2,476	2.02	8.2	0.73	6.93	-54	0.15
3/31/2006 14:38	20.25	3,811	3,466	2,477	2.02	8.2	0.73	6.93	-54	-
3/31/2006 14:43	20.24	3,809	3,463	2,476	2.02	8.4	0.75	6.93	-54	-
3/31/2006 14:48	20.25	3,809	3,463	2,476	2.02	8.2	0.73	6.93	-55	-
3/31/2006 14:53	20.25	3,810	3,464	2,477	2.02	8.1	0.73	6.93	-54	-
3/31/2006 14:58	20.25	3,810	3,464	2,477	2.02	7.9	0.71	6.93	-54	-
3/31/2006 15:03	20.24	3,809	3,463	2,476	2.02	7.8	0.70	6.93	-54	0.14
3/31/2006 15:08	20.24	3,807	3,460	2,475	2.02	7.7	0.69	6.93	-54	-
3/31/2006 15:13	20.25	3,806	3,461	2,474	2.02	7.7	0.69	6.93	-54	-
3/31/2006 15:18	20.24	3,806	3,460	2,474	2.02	8.1	0.72	6.93	-54	-
3/31/2006 15:23	20.24	3,803	3,457	2,472	2.01	7.9	0.71	6.93	-54	-
3/31/2006 15:28	20.24	3,803	3,457	2,472	2.01	7.8	0.70	6.93	-54	-
3/31/2006 15:33	20.25	3,803	3,458	2,472	2.01	7.5	0.67	6.93	-54	-
3/31/2006 15:38	20.23	3,805	3,459	2,473	2.02	7.5	0.67	6.93	-54	-
3/31/2006 15:43	20.24	3,804	3,458	2,473	2.01	7.3	0.66	6.93	-54	-
3/31/2006 15:48	20.24	3,803	3,457	2,472	2.01	7.5	0.67	6.94	-55	0.16
3/31/2006 15:53	20.25	3,800	3,455	2,470	2.01	7.6	0.68	6.93	-55	-
3/31/2006 15:58	20.25	3,799	3,454	2,469	2.01	5.3	0.47	6.94	-55	-
3/31/2006 16:03	20.26	3,799	3,454	2,469	2.01	5.4	0.48	6.94	-55	0.22
3/31/2006 16:08	20.25	3,798	3,454	2,469	2.01	5.6	0.50	6.94	-55	-
3/31/2006 16:13	20.25	3,797	3,452	2,468	2.01	5.6	0.50	6.93	-55	-
3/31/2006 16:18	20.24	3,799	3,454	2,469	2.01	5.8	0.51	6.93	-55	-
3/31/2006 16:23	20.22	3,816	3,468	2,480	2.02	5.8	0.52	6.93	-55	-
3/31/2006 16:28	20.22	3,823	3,474	2,485	2.03	5.7	0.51	6.93	-55	-
3/31/2006 16:33	20.22	3,831	3,481	2,490	2.03	5.8	0.52	6.93	-55	-
3/31/2006 16:38	20.21	3,829	3,478	2,489	2.03	5.5	0.49	6.93	-55	0.18
3/31/2006 16:43	20.21	3,827	3,476	2,488	2.03	5.5	0.49	6.93	-55	-
3/31/2006 16:48	20.20	3,825	3,475	2,486	2.03	5.5	0.49	6.93	-55	-
3/31/2006 16:53	20.20	3,822	3,471	2,484	2.03	5.5	0.50	6.93	-56	-
3/31/2006 16:58	20.20	3,821	3,471	2,484	2.02	5.6	0.50	6.93	-56	-
3/31/2006 17:03	20.20	3,824	3,473	2,486	2.03	5.7	0.51	6.93	-56	0.20
3/31/2006 17:08	20.21	3,822	3,472	2,484	2.03	5.7	0.51	6.93	-56	-
3/31/2006 17:13	20.21	3,827	3,477	2,488	2.03	5.6	0.50	6.93	-55	-
3/31/2006 17:30	20.17	3,826	3,473	2,487	2.03	5.8	0.52	6.93	-55	0.25
3/31/2006 18:00	20.16	3,830	3,476	2,490	2.03	5.8	0.52	6.93	-56	0.31
3/31/2006 18:30	20.15	3,843	3,488	2,498	2.04	5.5	0.50	6.93	-56	0.25

Table 6 - Field Water Quality Parameters During Development Pumping and During the Step-Drawdown and Five-Day Constant Rate Pumping Tests[1]

Date / Time	Temperature [°C]	Specific Conductance [µS/cm]	Conductivity [µS/cm]	TDS [mg/L]	Salinity [ppt]	Dissolved Oxygen [%]	Dissolved Oxygen [mg/L]	pH [pH units]	ORP [mV]	Turbidity [NTU]
3/31/2006 19:00	20.16	3,836	3,481	2,493	2.03	5.3	0.48	6.93	-56	0.23
3/31/2006 19:30	20.13	3,836	3,479	2,493	2.03	5.3	0.47	6.93	-56	0.26
3/31/2006 20:00	20.13	3,841	3,484	2,497	2.04	5.0	0.45	6.93	-56	0.18
3/31/2006 20:30	20.14	3,837	3,480	2,494	2.03	4.9	0.44	6.94	-55	0.24
3/31/2006 21:00	20.13	3,851	3,493	2,504	2.04	5.0	0.45	6.93	-56	0.18
3/31/2006 21:30	20.12	3,845	3,487	2,499	2.04	5.1	0.45	6.93	-55	0.19
3/31/2006 22:00	20.12	3,848	3,490	2,501	2.04	5.1	0.46	6.93	-55	0.20
3/31/2006 22:30	20.13	3,841	3,484	2,497	2.04	5.2	0.46	6.93	-55	0.35
3/31/2006 23:00	20.10	3,854	3,494	2,505	2.04	3.6	0.32	6.93	-55	0.29
3/31/2006 23:30	20.08	3,851	3,489	2,506	2.04	3.7	0.32	6.93	-55	0.21
4/1/2006 0:00	20.11	3,855	3,495	2,506	2.04	3.7	0.33	6.93	-55	0.27
4/1/2006 0:30	20.11	3,856	3,495	2,506	2.04	3.6	0.32	6.93	-56	0.22
4/1/2006 1:00	20.06	3,863	3,499	2,511	2.05	3.7	0.34	6.93	-55	0.18
4/1/2006 1:30	20.08	3,886	3,521	2,526	2.06	3.7	0.32	6.93	-56	0.36
4/1/2006 2:00	20.07	3,882	3,516	2,523	2.06	3.4	0.30	6.93	-56	0.26
4/1/2006 2:30	20.07	3,885	3,519	2,525	2.06	3.2	0.29	6.93	-56	0.26
4/1/2006 3:00	20.07	3,883	3,518	2,524	2.06	3.2	0.28	6.93	-56	0.29
4/1/2006 3:30	20.07	3,882	3,517	2,523	2.06	3.3	0.30	6.93	-56	0.27
4/1/2006 4:00	20.08	3,895	3,529	2,531	2.07	3.5	0.33	6.93	-55	0.17
4/1/2006 4:30	20.06	3,885	3,518	2,526	2.06	3.5	0.32	6.92	-56	0.27
4/1/2006 5:00	20.06	3,880	3,514	2,522	2.06	3.5	0.31	6.92	-55	0.24
4/1/2006 5:30	20.08	3,879	3,514	2,518	2.05	3.7	0.33	6.91	-55	0.17
4/1/2006 6:00	19.95	3,919	3,542	2,548	2.08	2.4	0.21	6.90	-55	0.17
4/1/2006 6:30	19.99	3,909	3,535	2,542	2.08	2.4	0.21	6.90	-55	0.17
4/1/2006 7:00	20.07	3,922	3,552	2,549	2.08	2.2	0.20	6.90	-55	0.14
4/1/2006 7:30	19.94	3,927	3,548	2,553	2.09	2.0	0.18	6.90	-55	0.14
4/1/2006 8:00	19.97	3,928	3,551	2,553	2.08	1.9	0.17	6.90	-56	0.24
4/1/2006 8:30	19.98	3,930	3,554	2,554	2.09	1.7	0.16	6.90	-56	0.17
4/1/2006 9:00	20.01	3,934	3,557	2,557	2.09	1.6	0.15	6.90	-56	0.29
4/1/2006 9:30	20.00	3,935	3,559	2,558	2.09	1.6	0.14	6.90	-56	0.15
4/1/2006 10:03	20.04	3,920	3,549	2,548	2.08	1.5	0.13	6.89	-56	0.15
4/1/2006 10:30	20.02	3,941	3,541	2,561	2.09	1.4	0.12	6.89	-56	0.16
4/1/2006 11:00	20.11	3,942	3,574	2,562	2.09	1.4	0.12	6.89	-57	0.25
4/1/2006 12:00	20.15	3,934	3,570	2,558	2.09	1.4	0.12	6.89	-57	0.13
4/1/2006 13:13	20.19	3,939	3,577	2,560	2.09	2.0	0.18	6.89	-57	-
4/1/2006 13:16	20.20	3,948	3,586	2,566	2.10	1.7	0.15	6.89	-57	-
4/1/2006 13:25	20.23	3,944	3,585	2,564	2.09	1.7	0.15	6.89	-57	-
4/1/2006 15:14	20.07	3,552	3,218	2,309	1.87	39.1	3.51	6.97	49	-
4/1/2006 15:29	20.26	3,541	3,220	2,302	1.87	12.9	1.15	6.84	-56	-
4/1/2006 15:44	20.26	3,536	3,216	2,298	1.87	15.6	1.39	6.86	-67	-
4/1/2006 15:59	20.25	3,533	3,212	2,296	1.86	14.3	1.28	6.86	-72	-
4/1/2006 16:14	20.25	3,526	3,206	2,292	1.86	10.5	0.94	6.87	-74	-
4/1/2006 16:29	20.24	3,523	3,203	2,290	1.86	10.8	0.97	6.87	-76	0.19
4/1/2006 16:44	20.24	3,524	3,203	2,291	1.86	12.0	1.07	6.88	-77	-
4/1/2006 16:59	20.25	3,537	3,216	2,299	1.87	14.0	1.25	6.88	-77	-
4/1/2006 17:14	20.22	3,528	3,206	2,293	1.86	12.3	1.10	6.87	-78	0.18
4/1/2006 17:29	20.21	3,530	3,207	2,295	1.86	11.1	0.99	6.87	-78	-
4/1/2006 17:44	20.22	3,531	3,208	2,295	1.86	7.4	0.66	6.88	-79	-
4/1/2006 17:59	20.20	3,526	3,203	2,292	1.86	7.8	0.70	6.88	-79	-
4/1/2006 18:14	20.20	3,521	3,198	2,289	1.86	9.7	0.87	6.88	-79	0.21
4/1/2006 18:29	20.20	3,532	3,208	2,296	1.86	7.8	0.70	6.88	-79	-
4/1/2006 18:44	20.20	3,537	3,213	2,299	1.87	8.8	0.79	6.88	-80	-
4/1/2006 18:59	20.21	3,532	3,209	2,296	1.86	8.4	0.75	6.88	-79	-
4/1/2006 19:14	20.19	3,531	3,206	2,295	1.86	7.4	0.67	6.88	-80	0.29
4/1/2006 19:29	20.19	3,529	3,204	2,294	1.86	7.6	0.68	6.88	-80	-
4/1/2006 19:44	20.18	3,532	3,207	2,296	1.86	8.9	0.80	6.88	-80	-
4/1/2006 19:59	20.19	3,529	3,204	2,294	1.86	8.1	0.73	6.88	-80	-
4/1/2006 20:14	20.19	3,548	3,222	2,306	1.87	8.1	0.73	6.88	-80	0.28
4/1/2006 20:29	20.19	3,545	3,219	2,304	1.87	7.8	0.69	6.88	-80	-
4/1/2006 20:44	20.18	3,546	3,220	2,305	1.87	5.5	0.49	6.88	-80	-
4/1/2006 20:59	20.18	3,549	3,223	2,307	1.87	5.9	0.53	6.88	-80	0.35
4/1/2006 22:00	20.18	3,546	3,220	2,305	1.87	6.0	0.54	6.88	-80	0.38
4/1/2006 23:00	20.18	3,546	3,220	2,305	1.87	6.0	0.54	6.88	-80	0.22
4/2/2006 0:00	20.18	3,546	3,220	2,305	1.87	6.0	0.54	6.88	-80	0.22
4/2/2006 1:00	-	-	-	-	-	-	-	-	-	0.37

Table 6 - Field Water Quality Parameters During Development Pumping and During the Step-Drawdown and Five-Day Constant Rate Pumping Tests[1]

Date / Time	Temperature [°C]	Specific Conductance [µS/cm]	Conductivity [µS/cm]	TDS [mg/L]	Salinity [ppt]	Dissolved Oxygen [%]	Dissolved Oxygen [mg/L]	pH [pH units]	ORP [mV]	Turbidity [NTU]
4/2/2006 2:00	-	-	-	-	-	-	-	-	-	0.24
4/2/2006 3:00	-	-	-	-	-	-	-	-	-	0.23
4/2/2006 4:00	-	-	-	-	-	-	-	-	-	0.28
4/2/2006 5:00	-	-	-	-	-	-	-	-	-	0.26
4/2/2006 6:00	-	-	-	-	-	-	-	-	-	0.19
4/2/2006 7:00	-	-	-	-	-	-	-	-	-	0.15
4/2/2006 8:00	-	-	-	-	-	-	-	-	-	0.12
4/2/2006 9:00	-	-	-	-	-	-	-	-	-	0.12
4/2/2006 10:00	-	-	-	-	-	-	-	-	-	0.11
4/2/2006 11:00	-	-	-	-	-	-	-	-	-	0.28
4/2/2006 12:00	-	-	-	-	-	-	-	-	-	0.13
4/2/2006 13:00	-	-	-	-	-	-	-	-	-	0.34
4/2/2006 16:20	20.23	3,668	3,334	2,384	1.94	8.0	0.71	6.52	-88	0.19
4/2/2006 16:32	20.23	3,659	3,326	2,378	1.93	11.2	1.00	6.71	-18	-
4/2/2006 16:47	20.26	3,663	3,332	2,381	1.94	11.1	0.99	6.77	-48	-
4/2/2006 17:02	20.25	3,666	3,334	2,383	1.94	7.3	0.65	6.80	-57	0.09
4/2/2006 17:08	20.25	3,661	3,329	2,380	1.94	7.6	0.68	6.81	-60	-
4/2/2006 17:23	20.26	3,669	3,337	2,385	1.94	7.1	0.63	6.82	-63	-
4/2/2006 17:38	20.25	3,660	3,328	2,379	1.93	6.8	0.61	6.82	-65	-
4/2/2006 17:53	20.28	3,655	3,326	2,376	1.93	6.7	0.60	6.83	-65	-
4/2/2006 18:08	20.25	3,660	3,328	2,379	1.93	6.3	0.57	6.83	-66	0.14
4/2/2006 18:23	20.25	3,654	3,323	2,375	1.93	6.3	0.57	6.83	-66	-
4/2/2006 18:38	20.25	3,657	3,325	2,377	1.93	5.7	0.51	6.83	-66	-
4/2/2006 18:53	20.22	3,657	3,323	2,377	1.93	5.6	0.50	6.84	-67	-
4/2/2006 19:08	20.22	3,649	3,316	2,372	1.93	5.8	0.52	6.84	-68	0.32
4/2/2006 19:23	20.22	3,648	3,315	2,371	1.93	5.7	0.51	6.84	-68	-
4/2/2006 19:38	20.23	3,653	3,320	2,374	1.93	5.6	0.50	6.84	-69	-
4/2/2006 19:53	20.23	3,653	3,320	2,374	1.93	5.3	0.48	6.84	-69	-
4/2/2006 20:08	20.21	3,658	3,323	2,378	1.93	5.2	0.46	6.84	-70	0.18
4/2/2006 20:23	20.21	3,658	3,324	2,378	1.93	5.1	0.46	6.84	-70	-
4/2/2006 20:38	20.21	3,662	3,327	2,380	1.94	5.1	0.46	6.84	-70	-
4/2/2006 20:53	20.21	3,665	3,330	2,382	1.94	5.4	0.48	6.84	-70	-
4/2/2006 21:08	20.21	3,660	3,325	2,379	1.93	6.6	0.59	6.84	-70	0.18
4/2/2006 21:23	20.21	3,665	3,329	2,382	1.94	6.3	0.56	6.84	-70	-
4/2/2006 21:38	20.21	3,658	3,324	2,378	1.93	6.2	0.56	6.84	-71	-
4/2/2006 21:53	20.23	3,680	3,344	2,392	1.95	4.4	0.40	6.84	-71	-
4/2/2006 22:08	20.22	3,674	3,339	2,388	1.94	4.7	0.42	6.84	-71	0.22
4/2/2006 22:23	20.22	3,672	3,336	2,387	1.94	4.8	0.43	6.84	-71	-
4/2/2006 22:38	20.21	3,665	3,329	2,382	1.94	4.8	0.43	6.84	-71	-
4/2/2006 22:53	20.22	3,676	3,340	2,389	1.94	4.9	0.44	6.84	-71	-
4/2/2006 23:08	20.21	3,670	3,334	2,386	1.94	5.5	0.49	6.84	-71	0.26
4/2/2006 23:23	20.21	3,668	3,332	2,384	1.94	5.3	0.47	6.84	-71	-
4/2/2006 23:38	20.20	3,670	3,333	2,386	1.94	5.1	0.46	6.84	-71	-
4/2/2006 23:53	20.19	3,663	3,326	2,381	1.94	4.3	0.39	6.84	-71	-
4/3/2006 0:08	20.19	3,663	3,327	2,381	1.94	4.4	0.39	6.84	-71	0.28
4/3/2006 0:23	20.18	3,682	3,343	2,393	1.95	4.5	0.40	6.84	-72	-
4/3/2006 0:38	20.19	3,678	3,340	2,391	1.94	4.9	0.44	6.84	-72	-
4/3/2006 0:53	20.18	3,676	3,337	2,389	1.94	5.0	0.45	6.84	-72	-
4/3/2006 1:08	20.17	3,680	3,341	2,392	1.95	4.7	0.43	6.84	-72	0.22
4/3/2006 1:23	20.16	3,682	3,341	2,393	1.95	4.6	0.42	6.84	-72	-
4/3/2006 1:38	20.16	3,682	3,341	2,393	1.95	4.6	0.41	6.84	-72	-
4/3/2006 1:53	20.15	3,682	3,341	2,393	1.95	4.3	0.38	6.84	-72	-
4/3/2006 2:08	20.15	3,683	3,342	2,394	1.95	4.3	0.39	6.84	-72	0.20
4/3/2006 2:23	20.16	3,696	3,354	2,402	1.95	4.3	0.39	6.84	-72	-
4/3/2006 2:38	20.15	3,691	3,349	2,399	1.95	4.3	0.38	6.84	-72	-
4/3/2006 2:53	20.16	3,688	3,347	2,397	1.95	4.2	0.38	6.84	-72	-
4/3/2006 3:08	20.17	3,697	3,356	2,403	1.96	4.2	0.38	6.84	-73	0.22
4/3/2006 3:23	20.16	3,691	3,349	2,399	1.95	4.3	0.38	6.84	-73	-
4/3/2006 3:38	20.15	3,699	3,357	2,404	1.96	4.2	0.37	6.84	-73	-
4/3/2006 3:53	20.13	3,704	3,360	2,408	1.96	4.0	0.36	6.84	-73	-
4/3/2006 4:08	20.13	3,696	3,352	2,402	1.95	4.1	0.37	6.84	-73	0.27
4/3/2006 4:23	20.11	3,695	3,351	2,402	1.95	4.0	0.36	6.84	-73	-
4/3/2006 4:38	20.10	3,693	3,347	2,400	1.95	3.9	0.35	6.84	-73	-
4/3/2006 4:53	20.11	3,694	3,349	2,401	1.95	4.1	0.37	6.84	-73	-
4/3/2006 5:08	20.11	3,696	3,351	2,402	1.95	4.1	0.37	6.84	-73	0.24

Table 6 - Field Water Quality Parameters During Development Pumping and During the Step-Drawdown and Five-Day Constant Rate Pumping Tests[1]

Date / Time	Temperature [°C]	Specific Conductance [µS/cm]	Conductivity [µS/cm]	TDS [mg/L]	Salinity [ppt]	Dissolved Oxygen [%]	Dissolved Oxygen [mg/L]	pH [pH units]	ORP [mV]	Turbidity [NTU]
4/3/2006 5:23	20.13	3,698	3,354	2,404	1.96	4.0	0.36	6.84	-73	-
4/3/2006 5:38	20.12	3,702	3,357	2,406	1.96	4.0	0.36	6.84	-73	-
4/3/2006 5:53	20.12	3,702	3,357	2,406	1.96	4.0	0.36	6.84	-73	-
4/3/2006 6:08	20.11	3,708	3,362	2,410	1.96	3.7	0.34	6.84	-73	0.19
4/3/2006 6:23	20.11	3,698	3,352	2,404	1.96	3.8	0.34	6.84	-73	-
4/3/2006 6:38	20.14	3,695	3,352	2,402	1.95	5.0	0.45	6.84	-73	-
4/3/2006 6:53	20.14	3,691	3,348	2,399	1.95	4.0	0.36	6.84	-73	-
4/3/2006 7:08	20.16	3,712	3,369	2,413	1.96	3.7	0.33	6.84	-73	0.19
4/3/2006 7:23	20.17	3,706	3,364	2,409	1.96	3.8	0.34	6.84	-73	-
4/3/2006 9:50	20.33	3,716	3,384	2,415	1.97	4.3	0.38	6.83	-70	-
4/3/2006 10:05	20.27	3,721	3,384	2,419	1.97	3.7	0.33	6.83	-70	0.14
4/3/2006 10:20	20.32	3,719	3,387	2,417	1.97	3.7	0.33	6.83	-70	-
4/3/2006 10:35	20.34	3,716	3,385	2,415	1.97	3.8	0.34	6.83	-71	-
4/3/2006 10:51	20.33	3,713	3,382	2,413	1.96	5.2	0.46	6.84	-70	-
4/3/2006 11:06	20.34	3,723	3,392	2,420	1.97	4.0	0.36	6.83	-71	0.16
4/3/2006 11:21	20.32	3,718	3,386	2,417	1.97	3.9	0.35	6.83	-71	-
4/3/2006 12:20	20.26	3,773	3,431	2,452	2.00	11.3	1.01	6.57	142	0.13
4/3/2006 12:35	20.29	3,755	3,417	2,441	1.99	9.2	0.82	6.78	-18	-
4/3/2006 12:50	20.32	3,750	3,415	2,438	1.98	10.9	0.98	6.82	-37	-
4/3/2006 13:05	20.31	3,767	3,429	2,449	1.99	9.8	0.88	6.84	-43	0.24
4/3/2006 13:20	20.31	3,752	3,415	2,439	1.99	9.0	0.81	6.84	-47	-
4/3/2006 13:35	20.30	3,751	3,414	2,438	1.99	8.3	0.74	6.85	-48	-
4/3/2006 13:50	20.31	3,748	3,412	2,436	1.98	7.3	0.65	6.85	-50	-
4/3/2006 14:05	20.27	3,762	3,422	2,445	1.99	7.1	0.64	6.85	-51	0.21
4/3/2006 14:20	20.28	3,752	3,414	2,439	1.99	6.8	0.61	6.86	-51	-
4/3/2006 14:35	20.28	3,747	3,409	2,436	1.98	6.5	0.58	6.86	-52	-
4/3/2006 14:50	20.28	3,742	3,404	2,432	1.98	6.4	0.57	6.86	-52	-
4/3/2006 15:05	20.28	3,741	3,404	2,432	1.98	5.9	0.53	6.86	-53	0.22
4/3/2006 15:20	20.26	3,738	3,400	2,430	1.98	5.9	0.53	6.86	-53	-
4/3/2006 15:23	20.26	3,729	3,392	2,424	1.97	6.9	0.62	6.86	-53	-
4/3/2006 15:38	20.25	3,741	3,402	2,432	1.98	5.8	0.52	6.86	-53	-
4/3/2006 15:53	20.26	3,725	3,388	2,421	1.97	5.7	0.51	6.86	-54	-
4/3/2006 16:08	20.27	3,765	3,425	2,447	1.99	5.8	0.52	6.86	-54	0.21
4/3/2006 16:23	20.27	3,757	3,418	2,442	1.99	5.8	0.52	6.86	-54	-
4/3/2006 16:38	20.27	3,757	3,418	2,442	1.99	6.0	0.53	6.86	-55	-
4/3/2006 16:53	20.28	3,749	3,411	2,437	1.98	5.9	0.53	6.86	-55	-
4/3/2006 17:08	20.27	3,749	3,410	2,437	1.98	5.7	0.51	6.86	-55	0.22
4/3/2006 17:23	20.27	3,757	3,417	2,442	1.99	5.7	0.51	6.86	-55	-
4/3/2006 17:38	20.24	3,756	3,414	2,441	1.99	5.6	0.50	6.86	-55	-
4/3/2006 17:53	20.26	3,749	3,410	2,437	1.98	6.0	0.53	6.86	-55	-
4/3/2006 18:08	20.25	3,754	3,414	2,440	1.99	5.6	0.50	6.86	-56	0.24
4/3/2006 18:23	20.25	3,774	3,431	2,453	2.00	5.4	0.49	6.86	-56	-
4/3/2006 18:38	20.25	3,767	3,425	2,449	1.99	5.2	0.46	6.86	-56	-
4/3/2006 18:53	20.25	3,761	3,420	2,445	1.99	5.0	0.45	6.86	-56	-
4/3/2006 19:08	20.24	3,763	3,420	2,446	1.99	4.9	0.43	6.86	-56	0.25
4/3/2006 19:23	20.23	3,760	3,418	2,444	1.99	4.9	0.44	6.86	-56	-
4/3/2006 19:38	20.24	3,757	3,415	2,442	1.99	4.6	0.41	6.86	-56	-
4/3/2006 19:53	20.22	3,753	3,411	2,439	1.99	4.7	0.42	6.86	-56	-
4/3/2006 20:08	20.22	3,745	3,403	2,434	1.98	4.7	0.42	6.86	-56	0.41
4/3/2006 20:23	20.22	3,752	3,409	2,439	1.99	4.5	0.40	6.86	-56	-
4/3/2006 20:38	20.23	3,763	3,420	2,446	1.99	4.9	0.44	6.86	-56	-
4/3/2006 20:53	20.21	3,761	3,417	2,445	1.99	4.7	0.42	6.86	-56	-
4/3/2006 21:08	20.22	3,768	3,423	2,449	1.99	4.6	0.41	6.86	-56	0.16
4/3/2006 21:23	20.22	3,767	3,423	2,449	1.99	4.5	0.41	6.86	-57	-
4/3/2006 21:38	20.23	3,762	3,419	2,445	1.99	4.6	0.41	6.86	-57	-
4/3/2006 21:53	20.21	3,765	3,420	2,447	1.99	4.5	0.41	6.86	-57	-
4/3/2006 22:08	20.22	3,764	3,420	2,447	1.99	4.3	0.39	6.86	-57	0.23
4/3/2006 22:23	20.22	3,753	3,410	2,439	1.99	4.3	0.38	6.86	-57	-
4/3/2006 22:38	20.21	3,754	3,411	2,440	1.99	4.2	0.38	6.86	-57	-
4/3/2006 22:53	20.21	3,746	3,404	2,435	1.98	4.1	0.37	6.86	-57	-
4/3/2006 23:08	20.22	3,761	3,417	2,445	1.99	4.2	0.37	6.86	-57	0.23
4/3/2006 23:23	20.21	3,751	3,408	2,438	1.99	4.2	0.38	6.86	-57	-
4/3/2006 23:38	20.21	3,767	3,423	2,449	1.99	4.1	0.37	6.86	-57	-
4/3/2006 23:53	20.21	3,769	3,424	2,450	2.00	4.1	0.37	6.86	-57	-
4/4/2006 0:08	20.21	3,762	3,418	2,445	1.99	4.2	0.37	6.86	-57	0.21

Table 6 - Field Water Quality Parameters During Development Pumping and During the Step-Drawdown and Five-Day Constant Rate Pumping Tests[1]

Date / Time	Temperature [°C]	Specific Conductance [µS/cm]	Conductivity [µS/cm]	TDS [mg/L]	Salinity [ppt]	Dissolved Oxygen [%]	Dissolved Oxygen [mg/L]	pH [pH units]	ORP [mV]	Turbidity [NTU]
4/4/2006 0:23	20.19	3,781	3,434	2,458	2.00	4.1	0.37	6.86	-57	-
4/4/2006 0:38	20.20	3,782	3,435	2,458	2.00	4.1	0.37	6.86	-57	-
4/4/2006 0:53	20.21	3,784	3,438	2,460	2.00	4.1	0.37	6.86	-57	-
4/4/2006 1:08	20.20	3,781	3,434	2,458	2.00	4.1	0.36	6.86	-57	0.23
4/4/2006 1:23	20.20	3,787	3,440	2,462	2.01	3.9	0.35	6.86	-57	-
4/4/2006 1:38	20.19	3,780	3,432	2,457	2.00	4.1	0.37	6.86	-57	-
4/4/2006 1:53	20.19	3,777	3,430	2,455	2.00	3.7	0.33	6.86	-57	-
4/4/2006 2:08	20.19	3,776	3,429	2,454	2.00	3.7	0.33	6.86	-57	0.20
4/4/2006 2:23	20.19	3,776	3,429	2,454	2.00	3.8	0.34	6.86	-57	-
4/4/2006 2:38	20.19	3,770	3,424	2,451	2.00	3.7	0.33	6.86	-57	-
4/4/2006 2:53	20.20	3,774	3,428	2,453	2.00	3.8	0.34	6.86	-57	-
4/4/2006 3:08	20.19	3,781	3,434	2,458	2.00	3.9	0.35	6.86	-57	0.32
4/4/2006 3:23	20.20	3,777	3,431	2,455	2.00	4.0	0.36	6.86	-57	-
4/4/2006 3:38	20.19	3,789	3,441	2,463	2.01	3.9	0.35	6.86	-57	-
4/4/2006 3:53	20.20	3,784	3,438	2,460	2.00	4.0	0.36	6.86	-58	-
4/4/2006 4:08	20.20	3,786	3,438	2,461	2.00	3.8	0.34	6.86	-58	0.28
4/4/2006 4:23	20.20	3,798	3,449	2,469	2.01	4.0	0.35	6.86	-58	-
4/4/2006 4:38	20.20	3,794	3,446	2,466	2.01	3.9	0.35	6.86	-58	-
4/4/2006 4:53	20.20	3,787	3,440	2,462	2.01	4.0	0.36	6.86	-58	-
4/4/2006 5:08	20.19	3,788	3,439	2,462	2.01	4.1	0.37	6.86	-58	0.25
4/4/2006 5:23	20.18	3,783	3,435	2,459	2.00	4.2	0.37	6.86	-58	-
4/4/2006 5:38	20.19	3,792	3,444	2,465	2.01	3.9	0.35	6.86	-58	-
4/4/2006 5:53	20.19	3,802	3,453	2,471	2.01	3.8	0.34	6.86	-58	-
4/4/2006 6:08	20.19	3,807	3,457	2,475	2.02	3.6	0.32	6.86	-58	0.21
4/4/2006 6:23	20.20	3,810	3,460	2,477	2.02	3.7	0.33	6.86	-58	-
4/4/2006 6:38	20.18	3,809	3,459	2,476	2.02	3.7	0.33	6.86	-58	-
4/4/2006 6:53	20.19	3,804	3,455	2,473	2.02	3.7	0.33	6.86	-58	-
4/4/2006 7:08	20.18	3,806	3,456	2,474	2.02	3.7	0.33	6.86	-58	0.29
4/4/2006 7:23	20.20	3,807	3,459	2,475	2.02	3.7	0.33	6.86	-58	-
4/4/2006 7:38	20.18	3,812	3,462	2,478	2.02	3.7	0.34	6.86	-58	-
4/4/2006 7:53	20.22	3,806	3,459	2,474	2.02	3.9	0.35	6.86	-58	-
4/4/2006 8:08	20.25	3,806	3,461	2,474	2.02	3.8	0.34	6.86	-58	0.18
4/4/2006 8:23	20.36	3,820	3,481	2,483	2.02	3.9	0.35	6.86	-58	-
4/4/2006 8:38	20.52	3,816	3,489	2,480	2.02	4.3	0.38	6.86	-59	-
4/4/2006 8:53	20.28	3,807	3,463	2,475	2.02	4.2	0.38	6.86	-58	-
4/4/2006 9:08	20.28	3,808	3,465	2,475	2.02	4.4	0.39	6.86	-58	0.17
4/4/2006 9:23	20.23	3,816	3,468	2,480	2.02	4.5	0.40	6.86	-58	-
4/4/2006 9:38	20.28	3,816	3,472	2,480	2.02	4.6	0.41	6.86	-58	-
4/4/2006 9:53	20.27	3,811	3,466	2,477	2.02	4.5	0.40	6.86	-58	-
4/4/2006 10:08	20.24	3,814	3,467	2,479	2.02	4.5	0.40	6.86	-58	0.29
4/4/2006 10:23	20.23	3,820	3,472	2,483	2.02	4.3	0.38	6.86	-58	-
4/4/2006 10:38	20.23	3,825	3,476	2,486	2.03	4.2	0.38	6.86	-58	-
4/4/2006 11:48	19.99	3,965	3,586	2,577	2.11	21.1	1.90	6.28	159	0.16
4/4/2006 12:03	20.17	3,960	3,595	2,574	2.10	11.5	1.03	6.68	18	-
4/4/2006 12:18	20.15	3,961	3,594	2,575	2.10	9.6	0.86	6.74	-4	0.04
4/4/2006 12:33	20.16	3,965	3,598	2,577	2.11	8.0	0.72	6.76	-11	-
4/4/2006 12:48	20.15	3,972	3,604	2,582	2.11	7.5	0.67	6.77	-15	-
4/4/2006 12:49	20.15	3,968	3,600	2,579	2.11	8.7	0.78	6.78	-15	-
4/4/2006 13:04	20.16	3,960	3,593	2,574	2.10	6.3	0.56	6.78	-18	-
4/4/2006 13:19	20.13	3,961	3,593	2,575	2.10	5.5	0.49	6.78	-18	0.16
4/4/2006 13:34	20.13	3,962	3,594	2,575	2.10	4.8	0.43	6.78	-18	-
4/4/2006 13:49	20.13	3,960	3,591	2,574	2.10	4.3	0.38	6.78	-19	-
4/4/2006 14:04	20.12	3,965	3,595	2,577	2.11	3.9	0.35	6.78	-20	-
4/4/2006 14:19	20.12	3,962	3,593	2,575	2.10	3.7	0.33	6.78	-20	0.12
4/4/2006 14:34	20.16	3,967	3,600	2,579	2.11	3.4	0.31	6.78	-20	-
4/4/2006 14:49	20.15	3,968	3,600	2,579	2.11	3.3	0.29	6.78	-21	-
4/4/2006 15:04	20.17	3,978	3,610	2,586	2.11	3.2	0.29	6.78	-22	0.12
4/4/2006 15:19	20.17	3,970	3,604	2,581	2.11	3.0	0.27	6.78	-22	-
4/4/2006 15:34	20.19	3,971	3,606	2,581	2.11	2.6	0.24	6.78	-23	-
4/4/2006 15:49	20.16	3,975	3,608	2,584	2.11	2.0	0.18	6.78	-23	-
4/4/2006 16:04	20.14	3,971	3,602	2,581	2.11	1.9	0.17	6.79	-23	0.21
4/4/2006 16:19	20.15	3,976	3,608	2,584	2.11	1.9	0.17	6.79	-23	-
4/4/2006 16:34	20.18	3,972	3,606	2,582	2.11	1.8	0.16	6.78	-23	-
4/4/2006 16:49	20.14	3,974	3,606	2,583	2.11	1.8	0.16	6.78	-23	-
4/4/2006 17:04	20.16	3,979	3,611	2,586	2.11	1.8	0.16	6.79	-23	-

Table 6 - Field Water Quality Parameters During Development Pumping and During the Step-Drawdown and Five-Day Constant Rate Pumping Tests[1]

Date / Time	Temperature [°C]	Specific Conductance [µS/cm]	Conductivity [µS/cm]	TDS [mg/L]	Salinity [ppt]	Dissolved Oxygen [%]	Dissolved Oxygen [mg/L]	pH [pH units]	ORP [mV]	Turbidity [NTU]
4/4/2006 17:19	20.16	3,978	3,610	2,586	2.11	2.3	0.21	6.78	-23	0.14
4/4/2006 17:34	20.16	3,975	3,607	2,584	2.11	2.5	0.23	6.79	-23	-
4/4/2006 17:49	20.15	3,973	3,605	2,582	2.11	2.5	0.22	6.78	-24	-
4/4/2006 18:04	20.13	3,980	3,610	2,587	2.11	2.5	0.22	6.78	-24	0.15
4/4/2006 18:19	20.16	3,982	3,614	2,588	2.12	72.8	6.52	6.78	-24	-
4/4/2006 18:45	20.15	3,987	3,618	2,592	2.12	87.2	7.81	6.79	-25	-
4/4/2006 19:00	20.15	3,983	3,614	2,589	2.12	64.1	5.74	6.78	-24	0.20
4/4/2006 19:15	20.14	3,980	3,611	2,587	2.11	63.2	5.66	6.78	-24	-
4/4/2006 19:30	20.13	3,991	3,619	2,594	2.12	63.7	5.71	6.78	-24	-
4/4/2006 19:45	20.13	3,985	3,614	2,590	2.12	65.8	5.89	6.78	-24	-
4/4/2006 20:00	20.13	3,980	3,609	2,587	2.11	75.2	6.74	6.78	-25	0.13
4/4/2006 20:15	20.14	3,983	3,613	2,589	2.12	71.9	6.44	6.78	-25	-
4/4/2006 20:30	20.15	3,990	3,620	2,594	2.12	73.5	6.58	6.78	-25	-
4/4/2006 20:45	20.14	3,986	3,617	2,591	2.12	73.8	6.61	6.78	-25	-
4/4/2006 21:00	20.08	3,987	3,612	2,592	2.12	57.4	5.15	6.78	-25	0.21
4/4/2006 21:15	20.10	3,988	3,614	2,592	2.12	57.7	5.17	6.78	-25	-
4/4/2006 21:30	20.01	3,993	3,612	2,595	2.12	52.4	4.71	6.78	-25	-
4/4/2006 21:45	20.06	3,986	3,610	2,591	2.12	40.4	3.62	6.78	-25	-
4/4/2006 22:00	20.08	3,995	3,620	2,597	2.12	41.5	3.72	6.78	-25	0.23
4/4/2006 22:15	20.10	3,991	3,618	2,594	2.12	43.0	3.85	6.78	-25	-
4/4/2006 22:30	20.12	3,994	3,622	2,596	2.12	72.2	6.47	6.78	-25	-
4/4/2006 22:45	20.14	3,996	3,625	2,597	2.12	70.8	6.34	6.77	-25	-
4/4/2006 23:00	20.14	4,000	3,629	2,600	2.13	75.0	6.71	6.77	-26	0.25
4/4/2006 23:15	20.14	3,998	3,627	2,599	2.12	75.3	6.74	6.77	-26	-
4/4/2006 23:30	20.13	4,001	3,629	2,601	2.13	75.5	6.76	6.77	-26	-
4/4/2006 23:45	20.15	3,997	3,627	2,598	2.12	73.6	6.59	6.77	-26	-
4/5/2006 0:00	20.15	4,001	3,630	2,601	2.13	73.2	6.56	6.77	-26	0.20
4/5/2006 0:15	20.11	4,008	3,634	2,605	2.13	73.7	6.60	6.77	-26	-
4/5/2006 0:30	20.13	4,008	3,635	2,605	2.13	72.9	6.53	6.77	-26	-
4/5/2006 0:45	20.12	4,006	3,633	2,604	2.13	73.7	6.60	6.77	-26	-
4/5/2006 1:00	20.11	4,006	3,631	2,604	2.13	72.1	6.46	6.77	-26	0.18
4/5/2006 1:15	20.08	4,009	3,632	2,606	2.13	71.6	6.42	6.77	-26	-
4/5/2006 1:30	20.08	4,010	3,633	2,607	2.13	65.1	5.84	6.77	-26	-
4/5/2006 1:45	20.08	4,011	3,634	2,607	2.13	63.1	5.66	6.77	-26	-
4/5/2006 2:00	20.08	4,008	3,631	2,605	2.13	64.3	5.76	6.77	-26	0.19
4/5/2006 2:15	20.09	4,014	3,638	2,609	2.13	66.7	5.98	6.77	-26	-
4/5/2006 2:30	20.08	4,013	3,635	2,608	2.13	67.2	6.03	6.77	-26	-
4/5/2006 2:45	20.06	4,015	3,636	2,610	2.13	71.0	6.36	6.77	-26	-
4/5/2006 3:00	20.07	4,011	3,634	2,607	2.13	68.6	6.15	6.77	-26	0.21
4/5/2006 3:15	20.09	4,012	3,635	2,608	2.13	71.2	6.38	6.77	-26	-
4/5/2006 3:30	20.06	4,017	3,638	2,611	2.14	69.7	6.25	6.77	-26	-
4/5/2006 3:45	20.07	4,024	3,645	2,616	2.14	61.2	5.48	6.77	-26	-
4/5/2006 4:00	20.07	4,020	3,642	2,613	2.14	60.7	5.44	6.77	-26	0.23
4/5/2006 4:15	20.08	4,015	3,638	2,610	2.13	60.9	5.46	6.77	-26	-
4/5/2006 4:30	20.08	4,018	3,641	2,612	2.14	60.9	5.46	6.77	-26	-
4/5/2006 4:45	20.10	4,020	3,644	2,613	2.14	60.8	5.45	6.77	-26	-
4/5/2006 5:00	20.09	4,018	3,642	2,612	2.14	61.4	5.51	6.77	-26	0.25
4/5/2006 5:15	20.07	4,020	3,642	2,613	2.14	64.5	5.78	6.77	-26	-
4/5/2006 5:30	20.06	4,018	3,639	2,612	2.14	63.8	5.72	6.77	-26	-
4/5/2006 5:45	20.07	4,024	3,645	2,616	2.14	65.0	5.83	6.77	-27	-
4/5/2006 6:00	20.08	4,021	3,643	2,614	2.14	66.0	5.92	6.77	-27	0.28
4/5/2006 6:15	20.03	4,024	3,642	2,616	2.14	66.7	5.99	6.77	-27	-
4/5/2006 6:30	20.06	4,024	3,644	2,616	2.14	66.9	6.00	6.77	-27	-
4/5/2006 6:45	20.07	4,023	3,644	2,615	2.14	64.3	5.76	6.77	-27	-
4/5/2006 7:00	20.07	4,029	3,649	2,619	2.14	64.3	5.76	6.77	-27	0.19
4/5/2006 7:15	20.09	4,030	3,652	2,620	2.14	74.6	6.68	6.77	-27	-
4/5/2006 8:00	20.73	4,043	3,713	2,628	2.15	67.6	5.98	6.77	-28	0.15

Notes:

1. Development pumping occurred from March 24 to 28, 2006. The step-drawdown test occurred on March 29, 2006. The five-day constant rate pumping test occurred from March 31 to April 5, 2006. All field parameters were measured with a YSI 650 probe, except during the period prior to March 29, 2006, when a YSI 556 probe was used, and except for the parameter of Turbidity, which was measured with a Hach 2100P field instrument.

Table 7 - Field Water Quality Parameters During 48-Hour Constant Rate Pumping Test[1]

Date / Time	Temperature [°C]	Specific Conductance [µS/cm]	Conductivity [µS/cm]	TDS [mg/L]	Salinity [ppt]	Dissolved Oxygen [%]	Dissolved Oxygen [mg/L]	pH [pH units]	ORP [mV]	Turbidity [NTU]
5/13/2006 8:11	20.17	3,591	3,260	2,334	1.90	44.8	4.01	6.93	6	17.4
5/13/2006 8:26	20.31	3,664	3,335	2,382	1.94	1.8	0.16	7.00	22	-
5/13/2006 8:41	20.30	3,670	3,341	2,386	1.94	0.7	0.06	7.06	12	-
5/13/2006 8:56	20.30	3,670	3,341	2,386	1.94	0.6	0.05	6.98	-5	3.07
5/13/2006 9:11	20.30	3,674	3,344	2,388	1.94	0.9	0.08	7.00	3	-
5/13/2006 9:26	20.30	3,673	3,343	2,387	1.94	0.3	0.03	6.96	-38	1.06
5/13/2006 9:41	20.31	3,668	3,339	2,384	1.94	0.8	0.07	6.86	-27	-
5/13/2006 9:56	20.31	3,668	3,339	2,384	1.94	0.5	0.05	6.86	-46	-
5/13/2006 10:11	20.38	3,684	3,359	2,395	1.95	0.8	0.07	6.80	-40	1.47
5/13/2006 10:26	20.49	3,685	3,368	2,395	1.95	0.9	0.08	6.87	-29	-
5/13/2006 10:41	20.53	3,690	3,375	2,398	1.95	1.2	0.11	6.76	0	1.41
5/13/2006 10:56	20.51	3,698	3,381	2,403	1.95	1.2	0.11	6.90	-36	-
5/13/2006 11:11	20.54	3,699	3,384	2,404	1.96	1.3	0.12	6.62	-45	-
5/13/2006 11:26	20.56	3,713	3,398	2,413	1.96	1.8	0.16	6.86	-25	1.65
5/13/2006 11:41	20.60	3,713	3,400	2,413	1.96	0.3	0.02	6.45	-32	-
5/13/2006 11:56	20.64	3,712	3,403	2,413	1.96	0.3	0.03	6.56	-33	0.74
5/13/2006 12:11	20.61	3,718	3,406	2,417	1.97	0.4	0.04	6.80	-33	-
5/13/2006 12:26	20.73	3,725	3,422	2,421	1.97	0.9	0.08	6.72	-11	0.53
5/13/2006 12:41	20.56	3,726	3,411	2,422	1.97	0.5	0.04	6.50	-23	-
5/13/2006 12:56	20.62	3,723	3,412	2,420	1.97	0.6	0.05	6.57	-15	1.29
5/13/2006 13:11	20.66	3,736	3,426	2,428	1.98	1.0	0.09	5.97	24	-
5/13/2006 13:26	20.50	3,733	3,412	2,427	1.97	0.4	0.04	6.19	-10	-
5/13/2006 13:41	20.67	3,733	3,424	2,426	1.97	0.3	0.03	6.57	-25	0.77
5/13/2006 13:56	20.62	3,729	3,417	2,424	1.97	0.2	0.02	6.72	-37	-
5/13/2006 14:11	20.69	3,730	3,423	2,424	1.97	0.3	0.03	6.83	-18	0.28
5/13/2006 14:26	20.68	3,732	3,424	2,426	1.97	0.4	0.04	6.71	-28	-
5/13/2006 14:41	20.73	3,738	3,433	2,430	1.98	0.4	0.03	6.77	-33	0.64
5/13/2006 14:56	20.84	3,730	3,433	2,425	1.97	0.5	0.04	6.74	-34	-
5/13/2006 15:11	20.67	3,733	3,424	2,426	1.97	0.7	0.06	6.75	-23	0.64
5/13/2006 15:26	20.67	3,735	3,426	2,428	1.98	0.6	0.05	6.94	-55	-
5/13/2006 15:41	20.68	3,753	3,444	2,440	1.99	0.4	0.03	6.88	-64	0.23
5/13/2006 15:56	20.68	3,755	3,445	2,441	1.99	0.4	0.04	6.94	-70	-
5/13/2006 16:11	20.79	3,762	3,459	2,445	1.99	0.4	0.03	6.00	-51	0.22
5/13/2006 16:26	20.81	3,762	3,461	2,445	1.99	0.3	0.03	6.26	-52	-
5/13/2006 16:41	20.78	3,762	3,459	2,445	1.99	0.3	0.03	6.30	-58	0.25
5/13/2006 16:56	20.78	3,765	3,461	2,447	1.99	0.5	0.04	6.39	-57	-
5/13/2006 17:11	20.76	3,762	3,458	2,446	1.99	0.7	0.06	6.70	-31	0.33
5/13/2006 17:26	20.74	3,766	3,459	2,448	1.99	0.5	0.04	6.40	-53	-
5/13/2006 17:41	20.58	3,768	3,450	2,449	1.99	0.4	0.03	6.77	-65	0.27
5/13/2006 17:56	20.65	3,767	3,454	2,449	1.99	0.5	0.05	6.75	-63	-
5/13/2006 18:11	20.54	3,775	3,454	2,454	2.00	0.5	0.04	6.99	-40	0.73
5/13/2006 18:26	20.34	3,773	3,438	2,453	2.00	0.4	0.03	6.92	-60	-
5/13/2006 18:41	20.28	3,772	3,432	2,452	2.00	0.4	0.03	6.73	-61	-
5/13/2006 18:56	20.11	3,770	3,418	2,450	2.00	0.6	0.05	6.79	-49	-
5/13/2006 19:11	20.01	3,770	3,411	2,450	2.00	1.2	0.11	6.81	4	-
5/13/2006 19:31	19.93	3,779	3,413	2,456	2.00	2.9	0.26	7.89	44	1.41
5/13/2006 19:46	19.88	3,781	3,411	2,457	2.00	1.0	0.09	7.30	-36	-
5/13/2006 20:01	19.85	3,777	3,406	2,455	2.00	0.4	0.03	7.36	-47	0.24
5/13/2006 20:16	19.86	3,775	3,405	2,454	2.00	0.4	0.04	7.33	-60	-
5/13/2006 20:31	19.87	3,775	3,406	2,454	2.00	0.4	0.04	7.34	-61	-
5/13/2006 20:46	19.86	3,776	3,405	2,454	2.00	0.6	0.06	7.28	-60	-
5/13/2006 21:01	19.93	3,776	3,410	2,454	2.00	1.2	0.11	7.27	-17	0.49
5/13/2006 21:16	19.89	3,776	3,408	2,455	2.00	0.8	0.08	7.29	-10	-
5/13/2006 21:31	19.90	3,781	3,413	2,458	2.00	0.6	0.05	7.28	-47	-
5/13/2006 21:46	19.89	3,778	3,410	2,456	2.00	0.6	0.06	7.27	-47	-
5/13/2006 22:01	19.84	3,779	3,406	2,456	2.00	0.9	0.09	7.25	-26	0.42
5/13/2006 22:16	19.84	3,788	3,414	2,462	2.01	1.9	0.17	7.27	20	-
5/13/2006 22:31	19.90	3,787	3,418	2,461	2.01	2.3	0.21	7.30	31	-
5/13/2006 22:46	19.87	3,786	3,415	2,461	2.01	2.5	0.23	7.30	34	-
5/13/2006 23:01	19.85	3,809	3,434	2,476	2.02	4.9	0.44	7.35	44	0.23
5/13/2006 23:16	19.83	3,808	3,432	2,475	2.02	0.1	0.01	7.47	-14	-
5/13/2006 23:31	19.78	3,804	3,425	2,472	2.02	0.2	0.02	7.51	-39	-
5/13/2006 23:46	19.74	3,807	3,424	2,474	2.02	0.2	0.02	7.50	-49	-
5/14/2006 0:01	19.67	3,805	3,418	2,473	2.02	0.3	0.02	7.43	-51	0.42
5/14/2006 0:16	19.65	3,815	3,425	2,479	2.02	0.4	0.03	7.44	-50	-
5/14/2006 0:31	19.63	3,812	3,421	2,478	2.02	0.3	0.03	7.42	-62	-
5/14/2006 0:46	19.64	3,809	3,419	2,476	2.02	0.3	0.02	7.43	-67	-

Table 7 - Field Water Quality Parameters During 48-Hour Constant Rate Pumping Test[1]

Date / Time	Temperature [°C]	Specific Conductance [µS/cm]	Conductivity [µS/cm]	TDS [mg/L]	Salinity [ppt]	Dissolved Oxygen [%]	Dissolved Oxygen [mg/L]	pH [pH units]	ORP [mV]	Turbidity [NTU]
5/14/2006 1:01	19.63	3,819	3,427	2,482	2.02	0.3	0.03	7.30	-64	0.62
5/14/2006 1:16	19.59	3,815	3,421	2,480	2.02	0.3	0.03	7.43	-72	-
5/14/2006 1:31	19.54	3,817	3,419	2,481	2.02	0.4	0.03	7.44	-64	-
5/14/2006 1:46	19.58	3,814	3,420	2,479	2.02	0.5	0.04	7.43	-39	-
5/14/2006 2:01	19.57	3,826	3,430	2,487	2.03	0.6	0.06	7.39	-29	0.38
5/14/2006 2:16	19.60	3,822	3,428	2,484	2.03	1.0	0.09	7.45	-8	-
5/14/2006 2:31	19.61	3,820	3,426	2,483	2.02	1.4	0.13	7.44	8	-
5/14/2006 2:46	19.61	3,822	3,429	2,484	2.03	2.0	0.18	7.42	21	-
5/14/2006 3:01	19.61	3,822	3,429	2,484	2.03	2.2	0.20	7.21	28	0.48
5/14/2006 3:16	19.64	3,831	3,439	2,490	2.03	2.2	0.20	7.44	27	-
5/14/2006 3:31	19.66	3,827	3,437	2,488	2.03	2.3	0.21	7.43	28	-
5/14/2006 3:46	19.63	3,827	3,435	2,488	2.03	2.9	0.26	7.43	40	-
5/14/2006 4:01	19.65	3,825	3,434	2,486	2.03	4.3	0.39	7.39	58	0.35
5/14/2006 4:16	19.66	3,836	3,445	2,493	2.03	5.3	0.48	7.44	64	-
5/14/2006 4:31	19.63	3,833	3,440	2,491	2.03	7.6	0.69	7.47	81	-
5/14/2006 4:46	19.75	3,834	3,449	2,492	2.03	10.5	0.95	7.48	85	-
5/14/2006 5:01	19.69	3,836	3,447	2,493	2.03	9.5	0.86	7.38	87	0.34
5/14/2006 5:16	19.70	3,836	3,448	2,494	2.03	9.4	0.85	7.47	85	-
5/14/2006 5:31	19.73	3,835	3,449	2,493	2.03	12.1	1.10	7.47	85	-
5/14/2006 5:46	19.69	3,835	3,446	2,493	2.03	10.8	0.97	7.48	85	-
5/14/2006 6:01	19.79	3,851	3,468	2,503	2.04	8.5	0.77	7.46	82	0.27
5/14/2006 6:16	19.76	3,847	3,462	2,501	2.04	15.0	1.35	7.50	83	-
5/14/2006 6:31	19.78	3,849	3,465	2,502	2.04	11.3	1.02	7.50	83	-
5/14/2006 6:46	19.84	3,848	3,469	2,501	2.04	9.8	0.88	7.49	83	-
5/14/2006 7:01	19.84	3,847	3,468	2,500	2.04	10.5	0.95	7.47	83	0.27
5/14/2006 7:16	19.88	3,848	3,472	2,501	2.04	10.2	0.91	7.44	82	-
5/14/2006 7:31	19.94	3,850	3,478	2,502	2.04	9.6	0.87	6.31	81	-
5/14/2006 7:46	20.00	3,860	3,492	2,509	2.05	1.1	0.10	7.37	59	-
5/14/2006 8:01	20.05	3,859	3,494	2,508	2.05	0.4	0.04	7.17	22	0.31
5/14/2006 8:16	20.06	3,859	3,495	2,508	2.05	0.2	0.01	7.47	-8	-
5/14/2006 8:31	20.12	3,859	3,499	2,508	2.05	0.1	0.01	7.51	-27	-
5/14/2006 8:46	20.16	3,857	3,501	2,507	2.04	0.2	0.01	7.55	-41	-
5/14/2006 9:01	20.20	3,865	3,511	2,513	2.05	0.9	0.08	7.56	-34	0.66
5/14/2006 9:16	20.26	3,861	3,511	2,509	2.05	0.3	0.03	7.63	-60	-
5/14/2006 9:31	20.27	3,862	3,512	2,510	2.05	0.3	0.02	7.63	-68	0.60
5/14/2006 9:46	20.28	3,863	3,514	2,511	2.05	0.7	0.06	7.65	-41	-
5/14/2006 10:01	20.35	3,867	3,524	2,514	2.05	1.5	0.13	7.68	-16	0.71
5/14/2006 10:16	20.36	3,872	3,529	2,517	2.05	0.6	0.05	7.73	-57	-
5/14/2006 10:31	20.44	3,875	3,537	2,519	2.05	0.3	0.03	7.77	-74	-
5/14/2006 10:46	20.69	3,879	3,560	2,522	2.06	0.5	0.04	7.91	-52	-
5/14/2006 11:01	21.09	3,880	3,590	2,522	2.06	0.5	0.04	7.59	-25	0.55
5/14/2006 11:16	21.35	3,883	3,612	2,524	2.06	0.3	0.03	7.70	-52	-
5/14/2006 11:31	21.32	3,882	3,610	2,523	2.06	0.3	0.02	7.68	-59	-
5/14/2006 11:46	21.30	3,883	3,609	2,524	2.06	0.4	0.04	7.71	-49	-
5/14/2006 12:05	20.46	3,895	3,558	2,532	2.07	0.3	0.02	7.90	18	1.89
5/14/2006 12:28	20.48	3,895	3,559	2,532	2.07	1.3	0.12	7.57	14	-
5/14/2006 12:43	20.47	3,898	3,561	2,534	2.07	0.1	0.01	7.82	-64	-
5/14/2006 12:58	20.46	3,900	3,562	2,535	2.07	0.1	0.01	8.13	-105	-
5/14/2006 13:13	20.48	3,900	3,564	2,535	2.07	0.1	0.01	8.04	-104	6.17
5/14/2006 13:28	20.49	3,899	3,564	2,535	2.07	0.1	0.01	8.02	-94	-
5/14/2006 13:43	20.49	3,900	3,564	2,535	2.07	0.1	0.01	7.99	-92	-
5/14/2006 13:58	20.50	3,902	3,567	2,537	2.07	3.1	0.28	8.02	-42	-
5/14/2006 14:13	20.49	3,904	3,568	2,538	2.07	0.1	0.01	8.05	-83	0.27
5/14/2006 14:28	20.48	3,907	3,569	2,539	2.07	0.2	0.02	8.07	-99	-
5/14/2006 14:43	20.49	3,906	3,570	2,539	2.07	0.2	0.02	7.92	-103	-
5/14/2006 14:58	20.50	3,906	3,571	2,539	2.07	0.2	0.02	7.84	-104	-
5/14/2006 15:13	20.46	3,911	3,572	2,542	2.07	0.2	0.02	7.89	-108	3.07
5/14/2006 15:28	20.45	3,912	3,572	2,542	2.08	0.2	0.02	7.89	-112	-
5/14/2006 15:43	20.44	3,912	3,572	2,543	2.08	0.2	0.02	7.87	-116	-
5/14/2006 15:58	20.43	3,915	3,573	2,545	2.08	0.2	0.02	7.84	-117	-
5/14/2006 16:13	20.42	3,917	3,574	2,546	2.08	0.2	0.02	7.79	-118	0.82
5/14/2006 16:28	20.40	3,919	3,575	2,547	2.08	0.2	0.02	7.55	-119	-
5/14/2006 16:43	20.40	3,920	3,575	2,548	2.08	0.2	0.02	7.52	-120	-
5/14/2006 16:58	20.39	3,922	3,577	2,549	2.08	0.7	0.06	7.75	-45	0.96
5/14/2006 17:01	20.39	3,923	3,578	2,550	2.08	0.2	0.02	7.83	-61	-
5/14/2006 17:16	20.39	3,923	3,577	2,550	2.08	0.2	0.02	7.71	-108	-
5/14/2006 17:31	20.39	3,924	3,579	2,551	2.08	0.2	0.02	7.77	-118	-

Table 7 - Field Water Quality Parameters During 48-Hour Constant Rate Pumping Test[1]

Date / Time	Temperature [°C]	Specific Conductance [µS/cm]	Conductivity [µS/cm]	TDS [mg/L]	Salinity [ppt]	Dissolved Oxygen [%]	Dissolved Oxygen [mg/L]	pH [pH units]	ORP [mV]	Turbidity [NTU]
5/14/2006 17:46	20.38	3,925	3,579	2,552	2.08	0.2	0.02	7.68	-122	-
5/14/2006 18:01	20.38	3,928	3,581	2,553	2.08	0.2	0.02	7.62	-125	-
5/14/2006 18:16	20.37	3,930	3,582	2,554	2.09	0.2	0.02	7.60	-127	-
5/14/2006 18:31	20.37	3,932	3,584	2,556	2.09	0.2	0.02	7.61	-129	-
5/14/2006 18:46	20.38	3,933	3,586	2,556	2.09	0.2	0.02	7.59	-129	-
5/14/2006 19:01	20.37	3,934	3,586	2,557	2.09	0.2	0.02	7.62	-131	1.75
5/14/2006 19:16	20.37	3,936	3,588	2,558	2.09	0.2	0.02	7.58	-132	-
5/14/2006 19:31	20.37	3,937	3,589	2,559	2.09	0.2	0.02	7.59	-133	-
5/14/2006 19:46	20.37	3,939	3,591	2,561	2.09	0.2	0.02	7.59	-133	-
5/14/2006 20:01	20.35	3,939	3,590	2,561	2.09	0.2	0.02	7.57	-133	1.09
5/14/2006 20:16	20.37	3,943	3,594	2,563	2.09	0.2	0.02	7.57	-134	-
5/14/2006 20:31	20.36	3,946	3,596	2,565	2.09	0.2	0.02	7.57	-135	-
5/14/2006 20:46	20.36	3,944	3,594	2,564	2.09	0.2	0.02	7.57	-136	-
5/14/2006 21:01	20.37	3,946	3,597	2,565	2.09	0.2	0.02	7.50	-137	0.52
5/14/2006 21:16	20.37	3,949	3,600	2,567	2.10	0.2	0.02	7.54	-137	-
5/14/2006 21:31	20.37	3,950	3,601	2,568	2.10	0.2	0.02	7.56	-138	-
5/14/2006 21:46	20.37	3,951	3,601	2,568	2.10	0.2	0.02	7.53	-138	-
5/14/2006 22:01	20.37	3,953	3,604	2,570	2.10	0.2	0.02	7.50	-138	0.39
5/14/2006 22:16	20.37	3,954	3,604	2,570	2.10	0.2	0.02	7.53	-139	-
5/14/2006 22:31	20.37	3,958	3,607	2,572	2.10	0.2	0.02	7.54	-140	-
5/14/2006 22:46	20.36	3,959	3,608	2,573	2.10	0.2	0.02	7.53	-141	-
5/14/2006 23:01	20.37	3,960	3,610	2,574	2.10	0.2	0.02	7.51	-141	0.48
5/14/2006 23:16	20.37	3,962	3,611	2,575	2.10	0.2	0.02	7.55	-142	-
5/14/2006 23:31	20.36	3,962	3,611	2,575	2.10	0.2	0.02	7.53	-142	-
5/14/2006 23:46	20.37	3,964	3,613	2,576	2.10	0.2	0.02	7.54	-143	-
5/15/2006 0:01	20.37	3,966	3,615	2,578	2.11	0.2	0.02	7.44	-142	0.45
5/15/2006 0:16	20.36	3,966	3,615	2,578	2.11	0.2	0.02	7.55	-144	-
5/15/2006 0:31	20.37	3,968	3,617	2,579	2.11	0.2	0.02	7.55	-144	-
5/15/2006 0:46	20.36	3,968	3,616	2,579	2.11	0.2	0.02	7.54	-144	-
5/15/2006 1:01	20.36	3,970	3,618	2,580	2.11	0.2	0.02	7.46	-144	0.53
5/15/2006 1:16	20.35	3,970	3,618	2,581	2.11	0.2	0.02	7.50	-144	-
5/15/2006 1:31	20.36	3,973	3,621	2,583	2.11	0.2	0.02	7.49	-144	-
5/15/2006 1:46	20.35	3,974	3,621	2,583	2.11	0.2	0.02	7.47	-145	-
5/15/2006 2:01	20.35	3,973	3,620	2,582	2.11	0.2	0.02	7.48	-144	0.54
5/15/2006 2:16	20.35	3,974	3,621	2,583	2.11	0.2	0.02	7.47	-145	-
5/15/2006 2:31	20.35	3,975	3,622	2,584	2.11	0.2	0.02	7.46	-145	-
5/15/2006 2:46	20.35	3,977	3,623	2,585	2.11	0.2	0.02	7.45	-145	-
5/15/2006 3:01	20.36	3,976	3,624	2,585	2.11	0.2	0.02	7.46	-145	0.55
5/15/2006 3:16	20.36	3,979	3,626	2,586	2.11	0.2	0.02	7.51	-146	-
5/15/2006 3:31	20.35	3,978	3,624	2,586	2.11	0.2	0.02	7.47	-146	-
5/15/2006 3:46	20.36	3,978	3,626	2,586	2.11	0.2	0.02	7.47	-146	-
5/15/2006 4:01	20.35	3,979	3,626	2,586	2.11	0.2	0.02	7.48	-145	1.65
5/15/2006 4:16	20.37	3,979	3,627	2,586	2.11	0.2	0.02	7.49	-146	-
5/15/2006 4:31	20.36	3,978	3,626	2,586	2.11	0.2	0.02	7.50	-146	-
5/15/2006 4:46	20.37	3,981	3,629	2,588	2.11	0.2	0.02	7.48	-147	-
5/15/2006 5:01	20.36	3,982	3,629	2,588	2.11	0.2	0.02	7.49	-146	0.64
5/15/2006 5:16	20.36	3,980	3,627	2,587	2.11	0.2	0.02	7.44	-146	-
5/15/2006 5:31	20.37	3,982	3,629	2,588	2.11	0.2	0.02	7.45	-146	-
5/15/2006 5:46	20.35	3,982	3,628	2,588	2.11	0.2	0.02	7.45	-146	-
5/15/2006 6:01	20.36	3,982	3,629	2,588	2.11	0.2	0.02	7.47	-146	0.43
5/15/2006 6:16	20.35	3,983	3,629	2,589	2.12	0.2	0.02	7.43	-145	-
5/15/2006 6:31	20.36	3,984	3,631	2,589	2.12	0.2	0.02	7.46	-144	-
5/15/2006 6:46	20.36	3,984	3,631	2,590	2.12	0.2	0.02	7.51	-143	-
5/15/2006 7:01	20.36	3,986	3,633	2,591	2.12	0.2	0.02	7.48	-140	0.33
5/15/2006 7:16	20.36	3,984	3,631	2,589	2.12	0.2	0.02	7.39	-141	-
5/15/2006 7:31	20.36	3,986	3,632	2,591	2.12	0.2	0.02	7.52	-141	-
5/15/2006 7:46	20.37	3,987	3,634	2,591	2.12	0.2	0.01	7.55	-44	-
5/15/2006 8:01	20.37	3,984	3,631	2,589	2.12	0.2	0.02	7.52	-106	-

Notes:

1. The 48-hour deep zone constant rate pumping test occurred from May 13 to 15, 2006. All field parameters were measured with a YSI 556 probe, except for the parameter of Turbidity, which was measured with a Hach 2100P field instrument.

Table 8 - Summary of Silt Density Index (SDI) Field Measurements, Taken 14-May-2006 at MWDOC Test Slant Well SL-1

Start Time for t_i	t_i [sec]	Init. Temp. °C	Start Time for t_f *(t_i start +15 min)*	t_f [sec]	Final Temp. °C	% P_{30}	SDI_{15}
13:07:15	17.50	20.62	13:22:15	19.13	20.66	8.52	0.57
13:53:00	17.69	20.67	14:08:00	19.32	20.69	8.44	0.56
14:20:30	18.65	20.69	14:35:30	19.25	20.73	3.12	0.21
15:16:15	16.91	20.67	15:31:15	18.79	20.68	10.01	0.67
15:47:00	17.22	20.68	16:02:00	19.87	20.79	13.34	0.89
						Average SDI:	**0.58**

Note: SDI Test Kit, Model No. SDI-2000, and 0.45 Micron Filters, Model No. SDI-045, from Applied Membranes, Inc. of Vista, CA, provided by Malcolm Pirnie, Inc, Irvine, CA. The calculation of SDI per the ASTM Standard Test Method D 4189-95 is as follows:

$$\mathrm{SDI}_T = \frac{\% P_{30}}{T} = \frac{[1 - \frac{t_i}{t_f}] \times 100}{T}$$

where:

$\%P_{30}$ = percent at 207 kPa (30 psi) feed pressure,

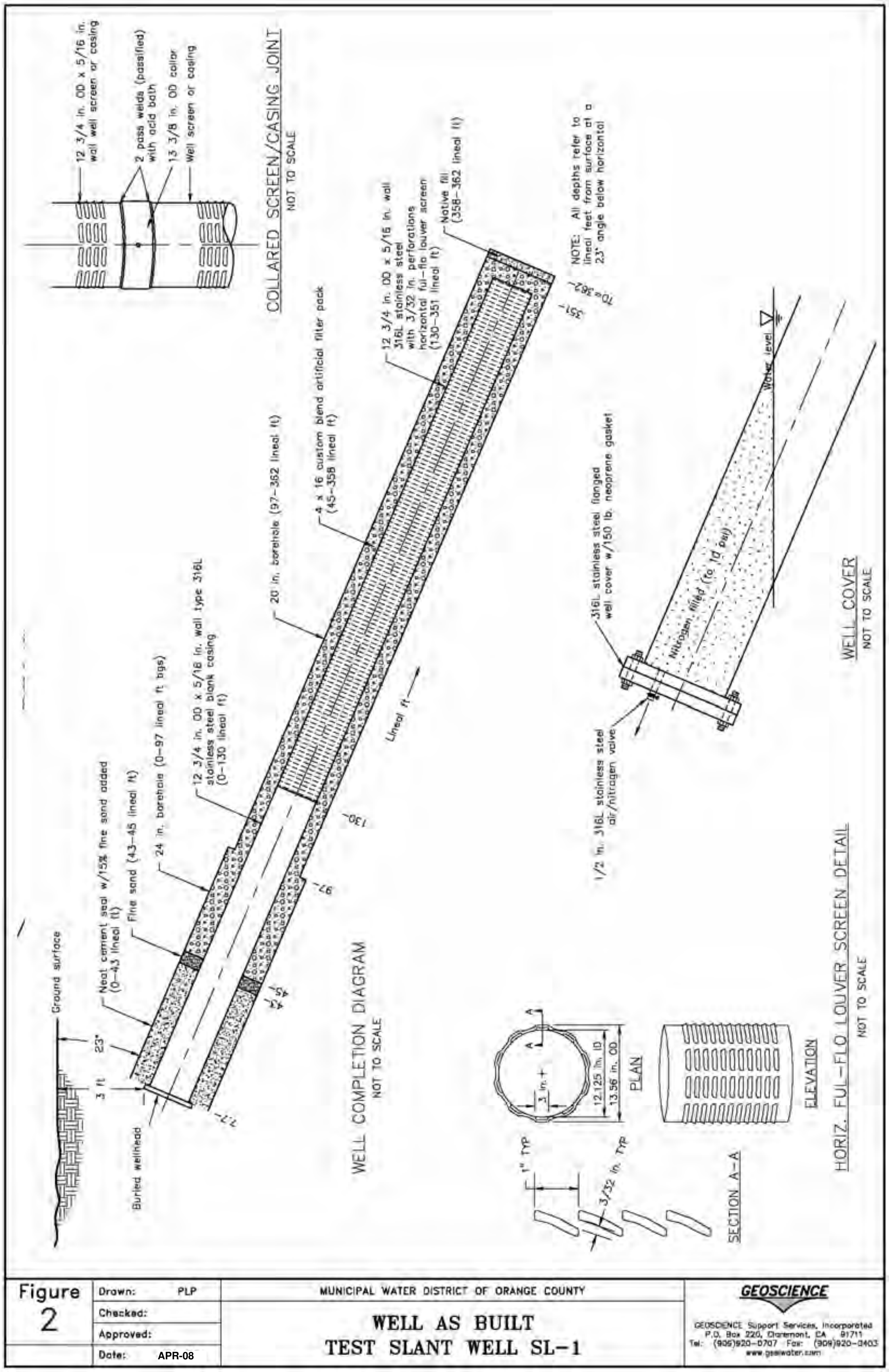
T = total elapsed flow time, min (usually 15 min),

t_i = initial time required to collect 500 mL of sample, s, and

t_f = time required to collect 500 mL of sample after test time T, s.

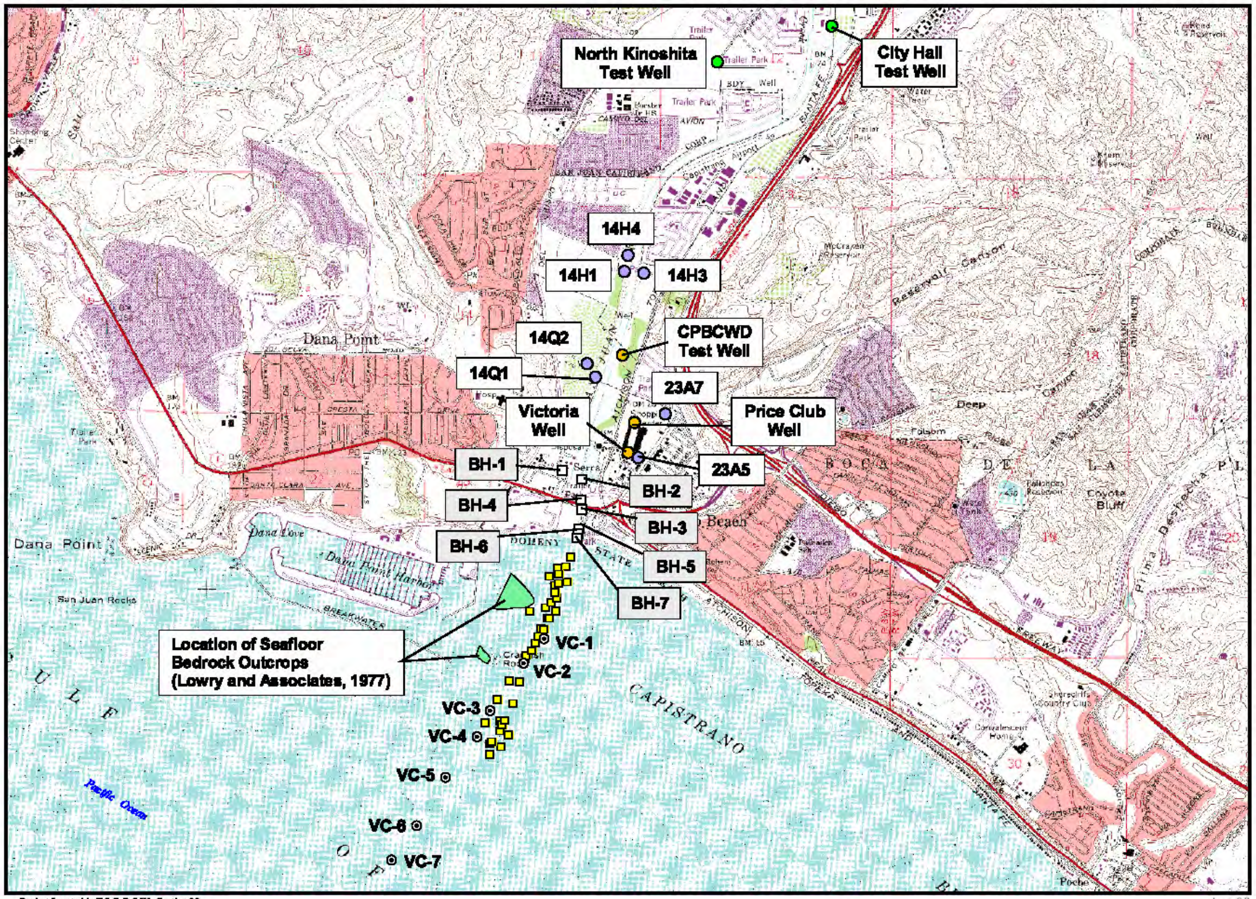
Figures

MUNICIPAL WATER DISTRICT OF ORANGE COUNTY
RESULTS OF DRILLING, CONSTRUCTION, DEVELOPMENT AND TESTING OF DANA POINT OCEAN DESALINATION PROJECT TEST SLANT WELL
TEST SLANT WELL LOCATION
EXPLANATION
350 ft Test Well Drilled Using Dual Rotary Rig (23 degrees from horizontal)
MW-1
Phase I Nested Monitoring Well (Constructed 2005)
B-3
Phase I Exploratory Borehole (destroyed 2005)
Diffuser Screen Assembly for Discharge to San Juan Creek / Surf Zone
Drilling Area Footprint
Parking Lot Staging Area
White Arrow
Driller's Access Route
California County Inset
Los Angeles
Orange
Riverside
San Diego
Pacific Ocean
Project Area
40 Miles
GEOSCIENCE
Figure 1
Doheny Park Rd
Coast Highway
Metrolink
Pacific Coast Highway
Del Obispo St
Dana Point Harbor Dr
San Juan Creek
Parking Lot Staging Area
Well Site Access Route
Temporary 10 ft Diffuser Screen for Discharge to San Juan Creek
B-4/MW-2
B-2/MW-1
TEST WELL LOCATION
350 ft Test Slant Well (at 23 degree angle from horizontal)
B-3
B-1
Pacific Ocean
Apr-08
NORTH
0 200 400 Feet
Aerial Basemap from: Eagle Aerial Imaging, 6-Jun-05.
Project Located in T.8 S. and R.8 W.
Prepared by: DWB
Map Projection: State Plane Zone VI, NAD83. U.S. Feet


Ground surface
3 ft
23°
Buried wellhead
Neat cement seal w/15% fine sand added
(0–43 lineal ft)
Fine sand (43–45 lineal ft)
24 in. borehole (0–97 lineal ft bgs)
12 3/4 in. OD x 5/16 in. wall type 316L
stainless steel blank casing
(0–130 lineal ft)
20 in. borehole (97–362 lineal ft)
4 x 16 custom blend artificial filter pack
(45–358 lineal ft)
12 3/4 in. OD x 5/16 in. wall
316L stainless steel
with 3/32 in. perforations
horizontal ful–flo louver screen
(130–351 lineal ft)
Native fill
(358–362 lineal ft)
7.7–
43–
45–
97–
130–
351–
TD= 362–
Lineal ft
WELL COMPLETION DIAGRAM
NOT TO SCALE
12 3/4 in. OD x 5/16 in.
wall well screen or casing
2 pass welds (passified)
with acid bath
13 3/8 in. OD collar
Well screen or casing
COLLARED SCREEN/CASING JOINT
NOT TO SCALE
NOTE: All depths refer to
lineal feet from surface at a
23° angle below horizontal
1" TYP
3/32 in. TYP
SECTION A–A
3 in.
A
A
12.125 in. ID
13.56 in. OD
PLAN
ELEVATION
HORIZ. FUL–FLO LOUVER SCREEN DETAIL
NOT TO SCALE
1/2 in. 316L stainless steel
air/nitrogen valve
316L stainless steel flanged
well cover w/150 lb. neoprene gasket
Nitrogen filled (to 10 psi)
Water level
WELL COVER
NOT TO SCALE
Figure
2
Drawn: PLP
Checked:
Approved:
Date: APR-08
MUNICIPAL WATER DISTRICT OF ORANGE COUNTY
WELL AS BUILT
TEST SLANT WELL SL–1
GEOSCIENCE
GEOSCIENCE Support Services, Incorporated
P.O. Box 220, Claremont, CA 91711
Tel: (909)920–0707 Fax: (909)920–0403
www.gssiwater.com

MUNICIPAL WATER DISTRICT OF ORANGE COUNTY

RESULTS OF DRILLING, CONSTRUCTION, DEVELOPMENT AND TESTING OF
DANA POINT OCEAN DESALINATION PROJECT TEST SLANT WELL



EXISTING WELLS AND OTHER SUBSURFACE DATA FROM PREVIOUS INVESTIGATIONS

EXPLANATION

Boreholes, Vibracores, and Jet Probes from Previous Investigation (Lowry and Associates, 1977.)

- BH-1 — Onshore Boreholes
- VC-1 — Offshore Vibracores
- Offshore Jet Probes

Local Wells Referenced in Previous Reports

- Victoria Well — Boyle, 1993
- 14Q1 — Geopentech, 2002.
- City Hall Test Well — Geotechnical Consultants, 2004.
- Seafloor Bedrock Outcrop (Lowry and Associates, 1977.)

Project Located in T.8 S, R.8 W., Section 23.

Prepared by: DWB

Map Projection:
UTM Zone 11, NAD27
Central Meridian: -117 degrees

Base map from USGS 7 1/2 minute Dana Point (1975) Quadrangle.

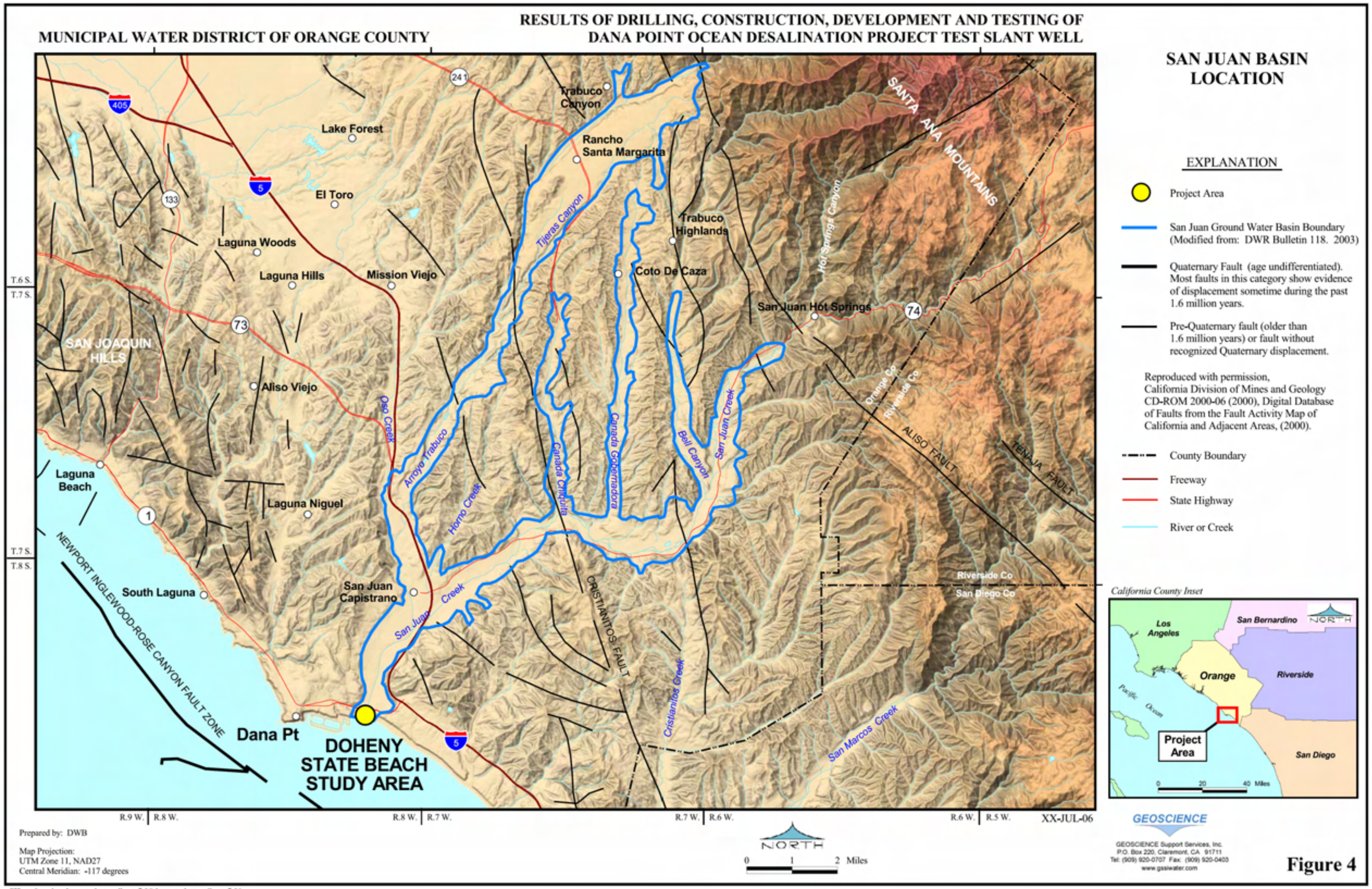
NORTH

0 2000 4000 Feet

GEOSCIENCE
GEOSCIENCE Support Services, Inc.
P.O. Box 220, Claremont, CA 91711
Tel: (909) 920-0707 Fax: (909) 920-0403
www.gssiwater.com

Figure 3

D:\GIS_proj\mwdoc_dana_pt_slant_well_rpt_7-06\dana_pt_phase_2_fig_5_7-06.apr



GIS_proj\mwdoc_dana_pt_slant_well_rpt_7-06\dana_pt_slant_well_rpt_7-06.apr

Figure 5 - Static Ground Water Table Profile Prior to the Five-Day Constant Rate Test

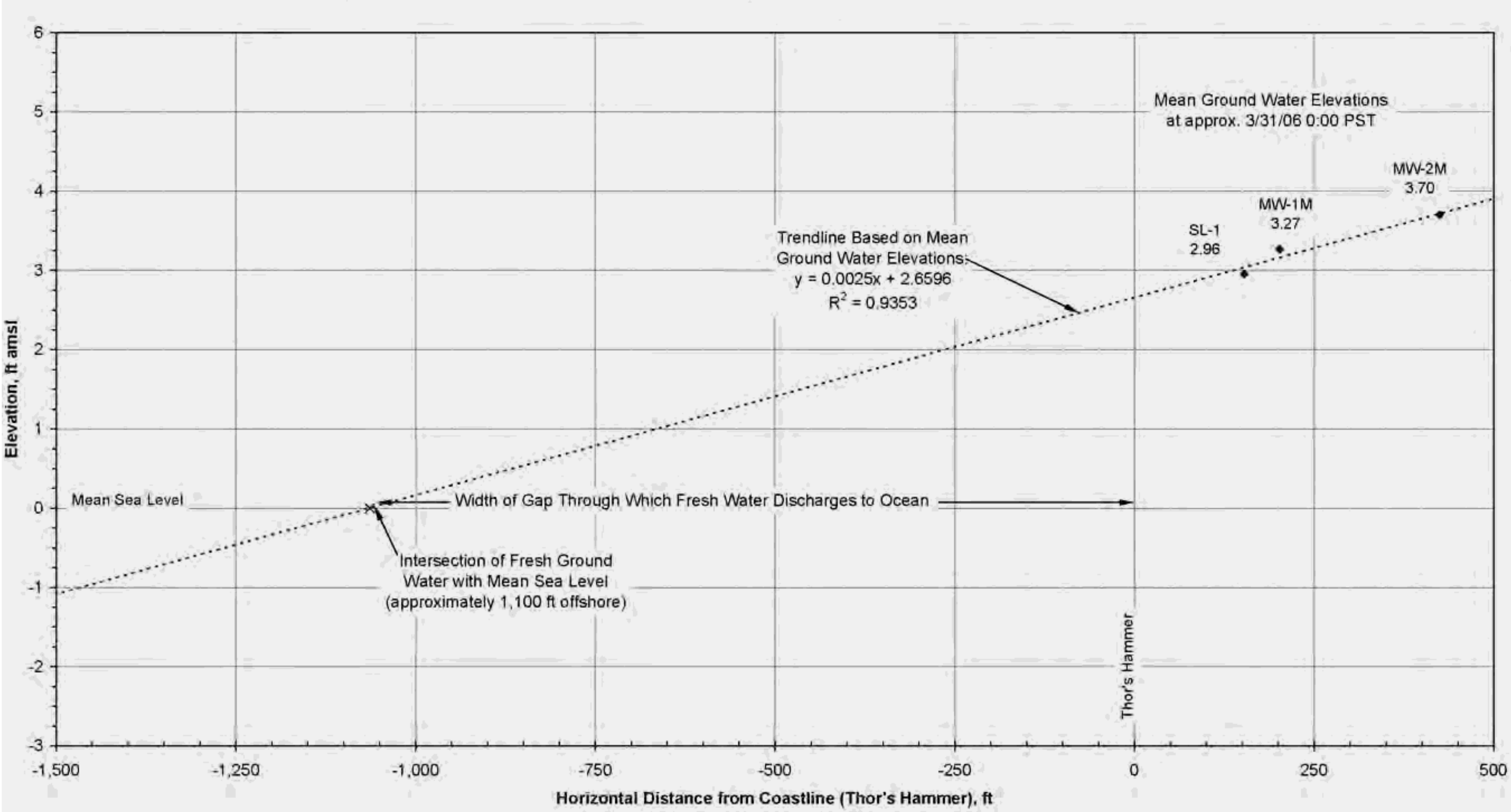


Figure 6 - Monitoring Well Transducer Data, 10/26/2005 to 5/15/2006
Ground Water Elevations and Tide Elevations

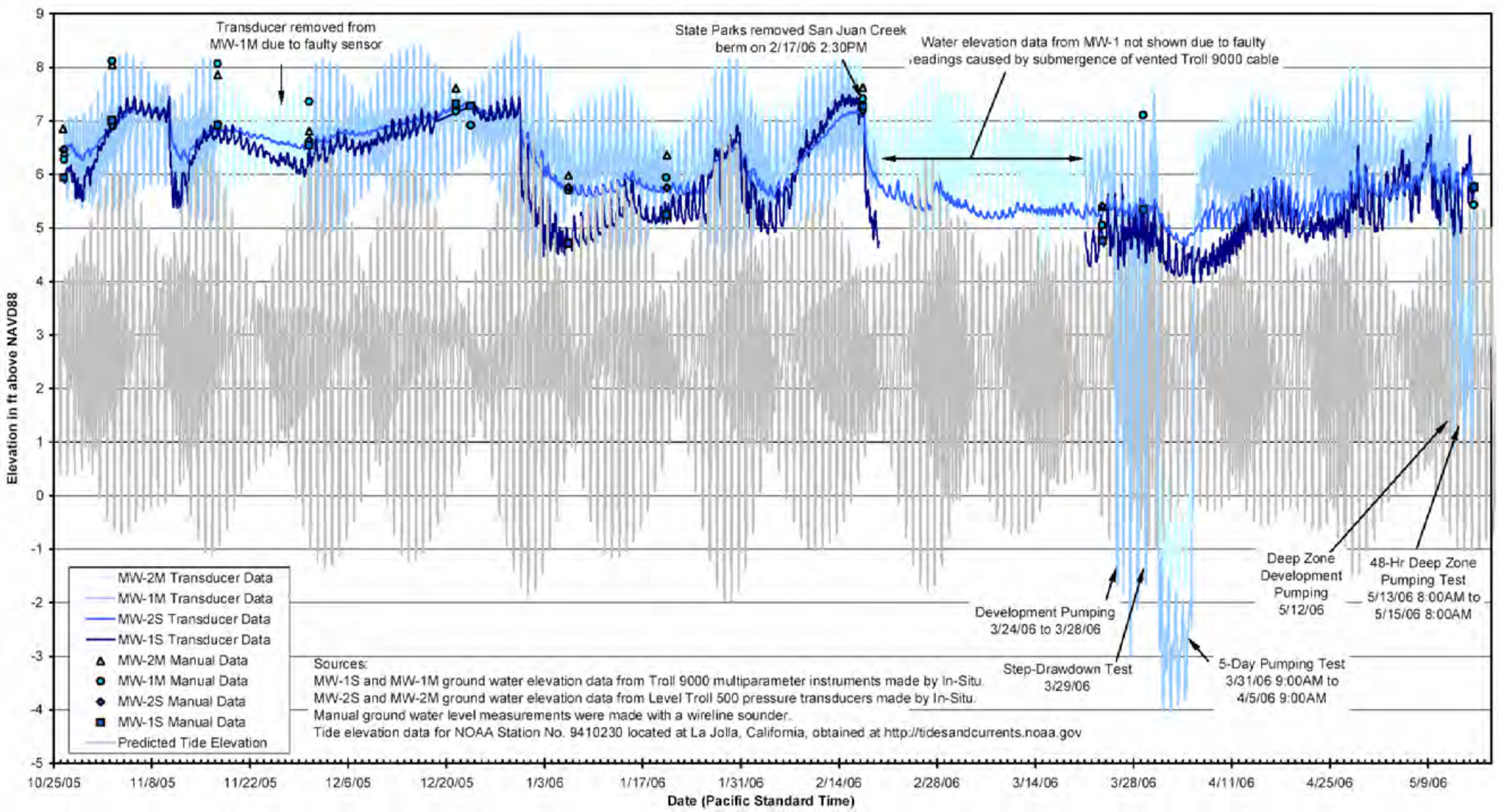


Figure 7 - Monitoring Well MW-1M and MW-1S Troll 9000 Data, 10/26/2005 to 5/15/2006
Ground Water Elevations and Specific Conductivity

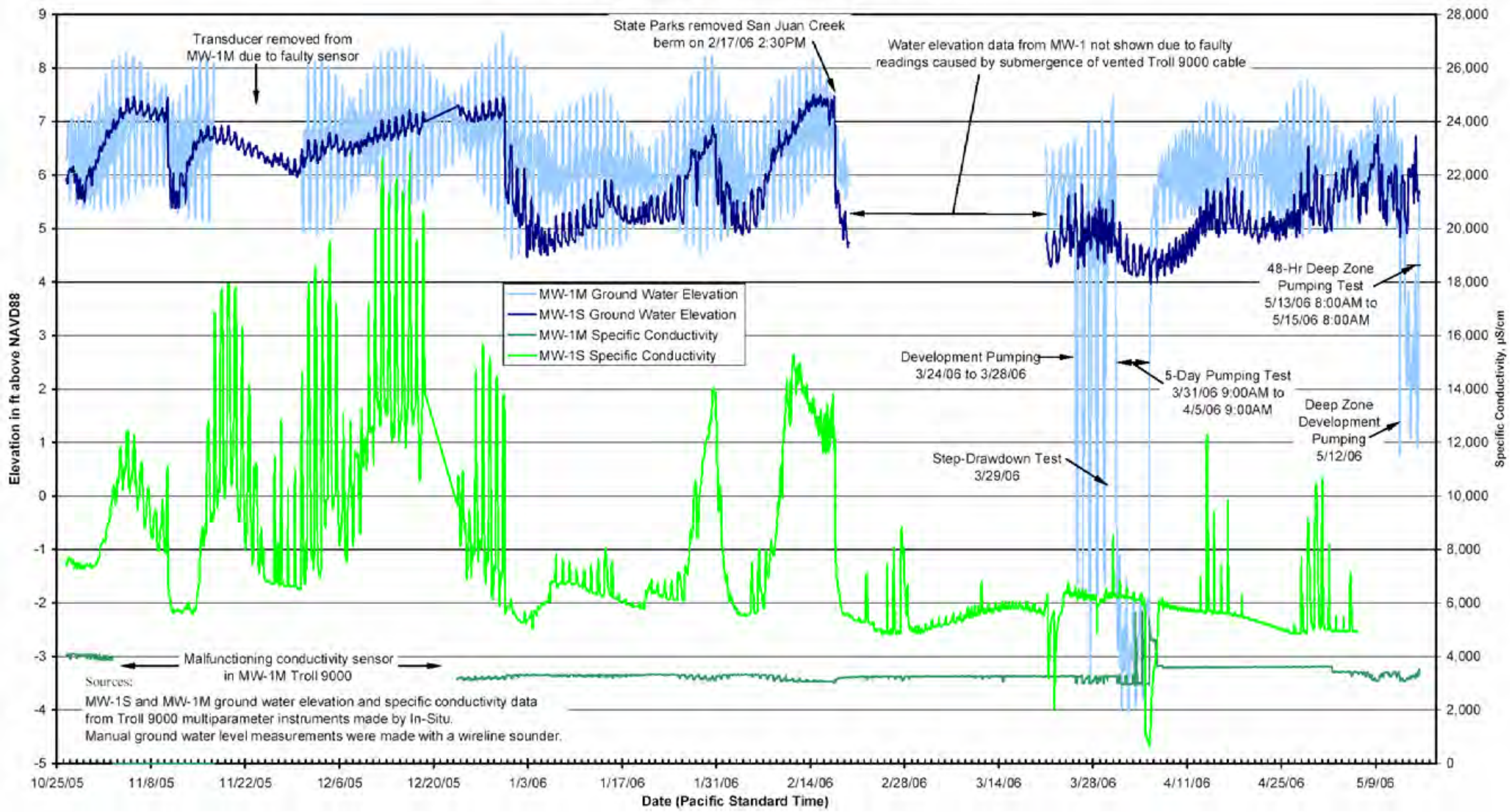


Figure 8 - Trilinear Diagram
Monitoring Wells MW-1M, MW-1D, MW-2M, and MW-2D, and Test Slant Well SL-1

Notes:

SL-1 is screened approximately 51-137 vertical feet below ground surface (ft bgs), and a deep zone was isolated and pumped correlating to a depth of approximately 117-137 ft bgs.

MW-1M and MW-2M are both screened 40-130 ft bgs.

MW-1D is screened from 141-166 ft bgs and MW-2D is screened from 140-165 ft bgs.

The typical composition of seawater (from Hem, 1985) has been added for comparison.

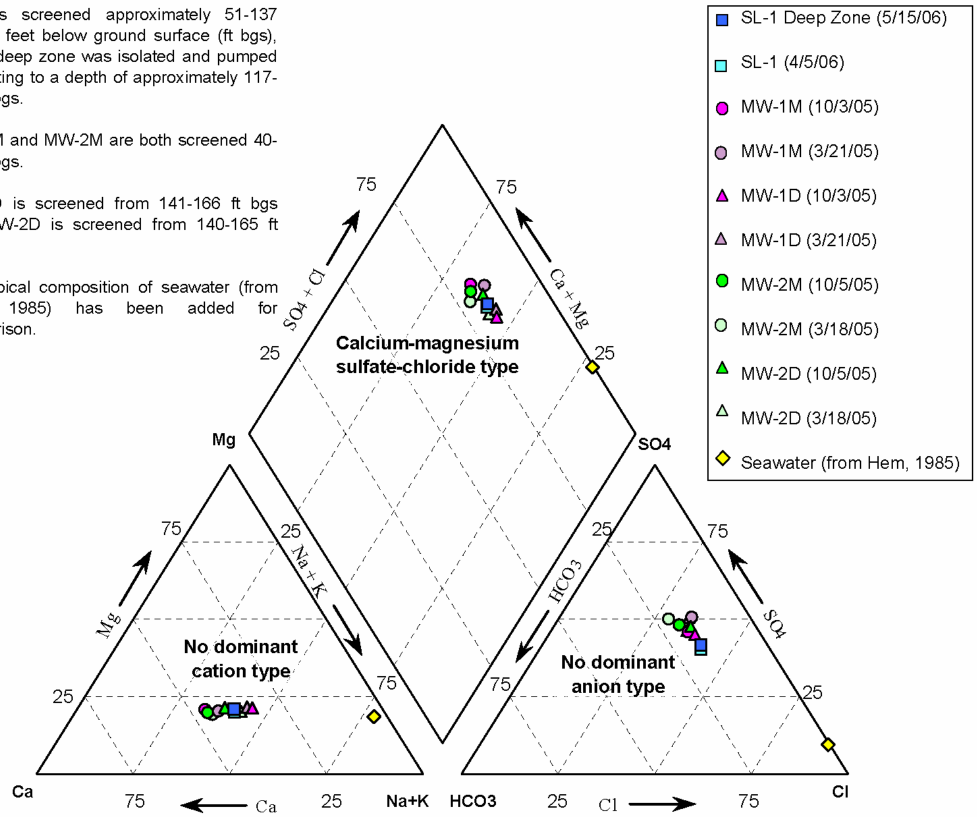
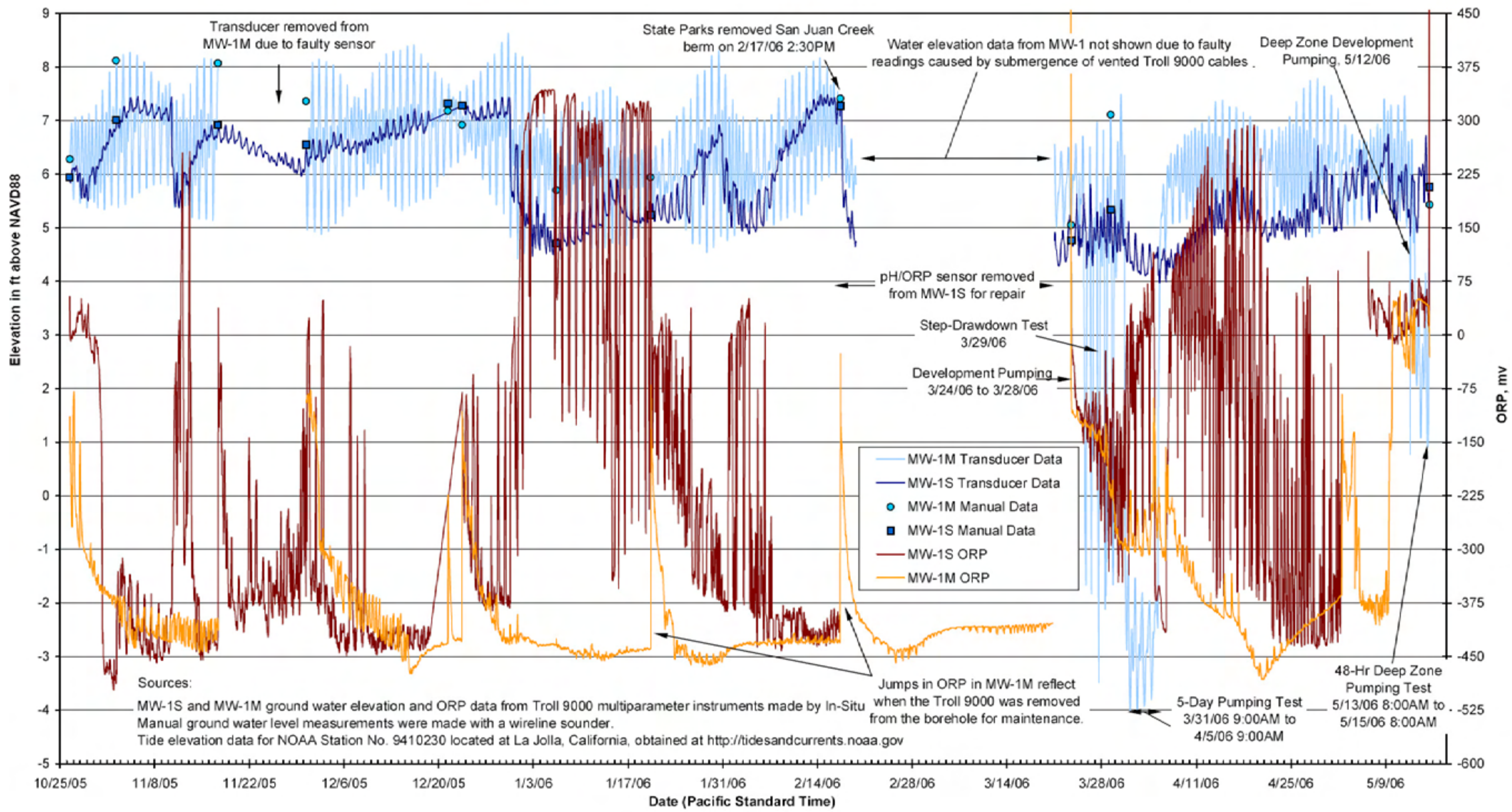


Figure 9 - Monitoring Well MW-1M and MW-1S Troll 9000 Data, 10/26/2005 to 5/15/2006
Ground Water Elevations and Oxidation Reduction Potential (ORP)



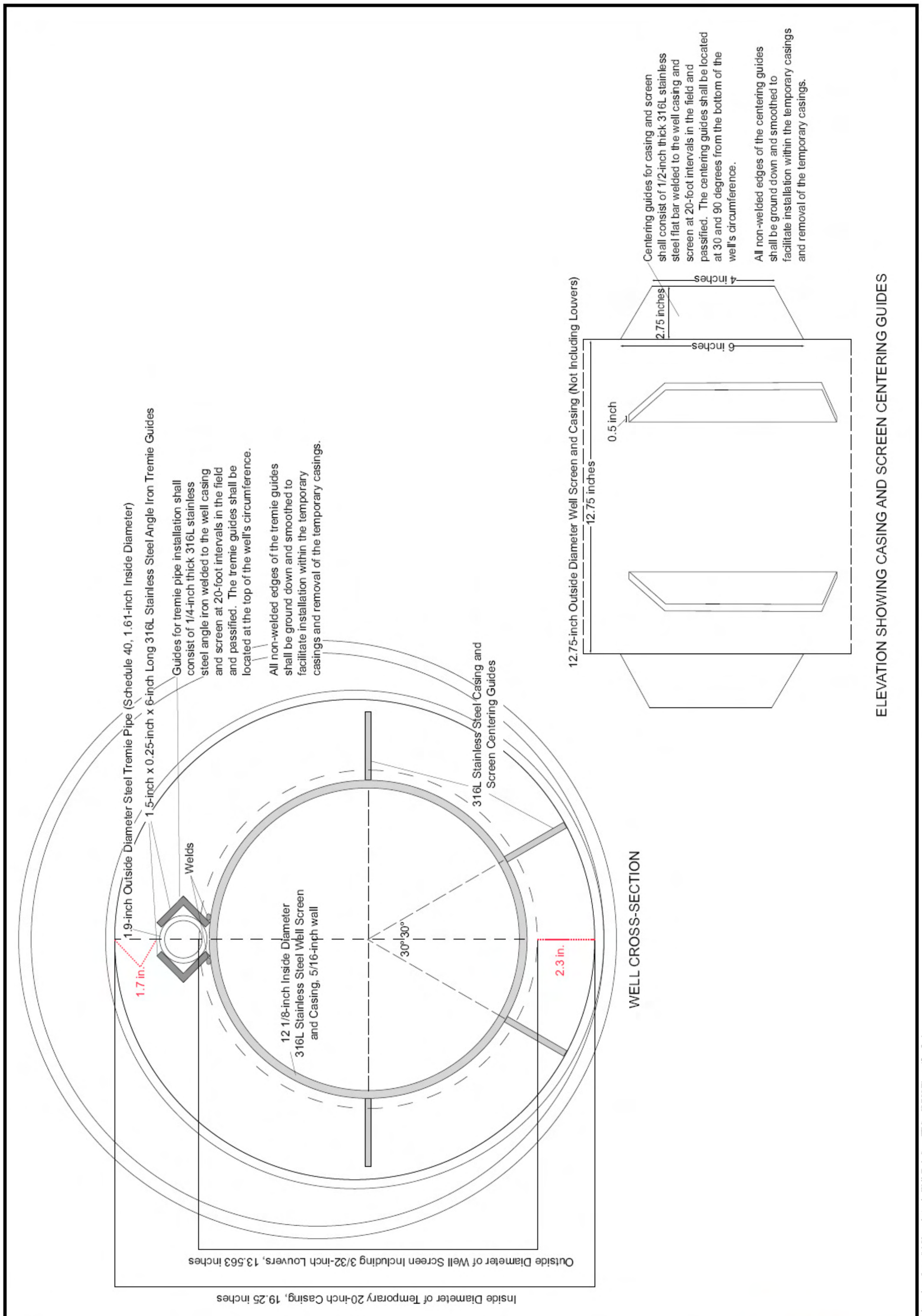


Figure 10	Drawn: SJB Checked: Approved: Date: Apr-08	MUNICIPAL WATER DISTRICT OF ORANGE COUNTY CENTERING GUIDE DETAILS FOR CASING, SCREEN AND TREMIE PIPE	GEOSCIENCE GEOSCIENCE Support Services, Incorporated P.O. Box 220, Claremont, CA 91711 Tel: (909)920-0707 Fax: (909)920-0403 www.gssiwater.com

Figure 11 - Mechanical Grading Analysis
MWDOC Test Slant Well SL-1

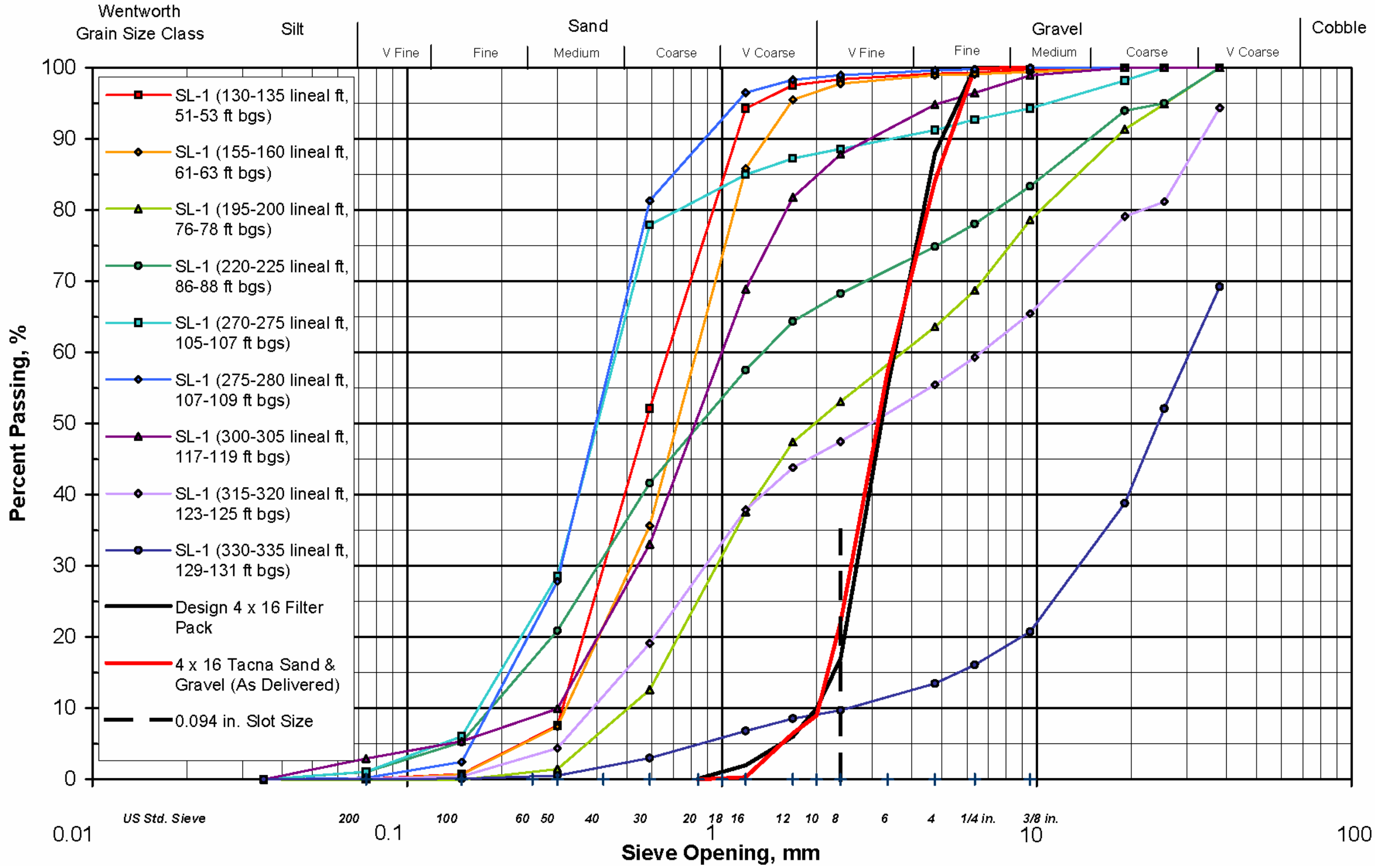


Figure 12 - Step Drawdown Test - SL-1
Time-Drawdown Curve - 29-Mar-06

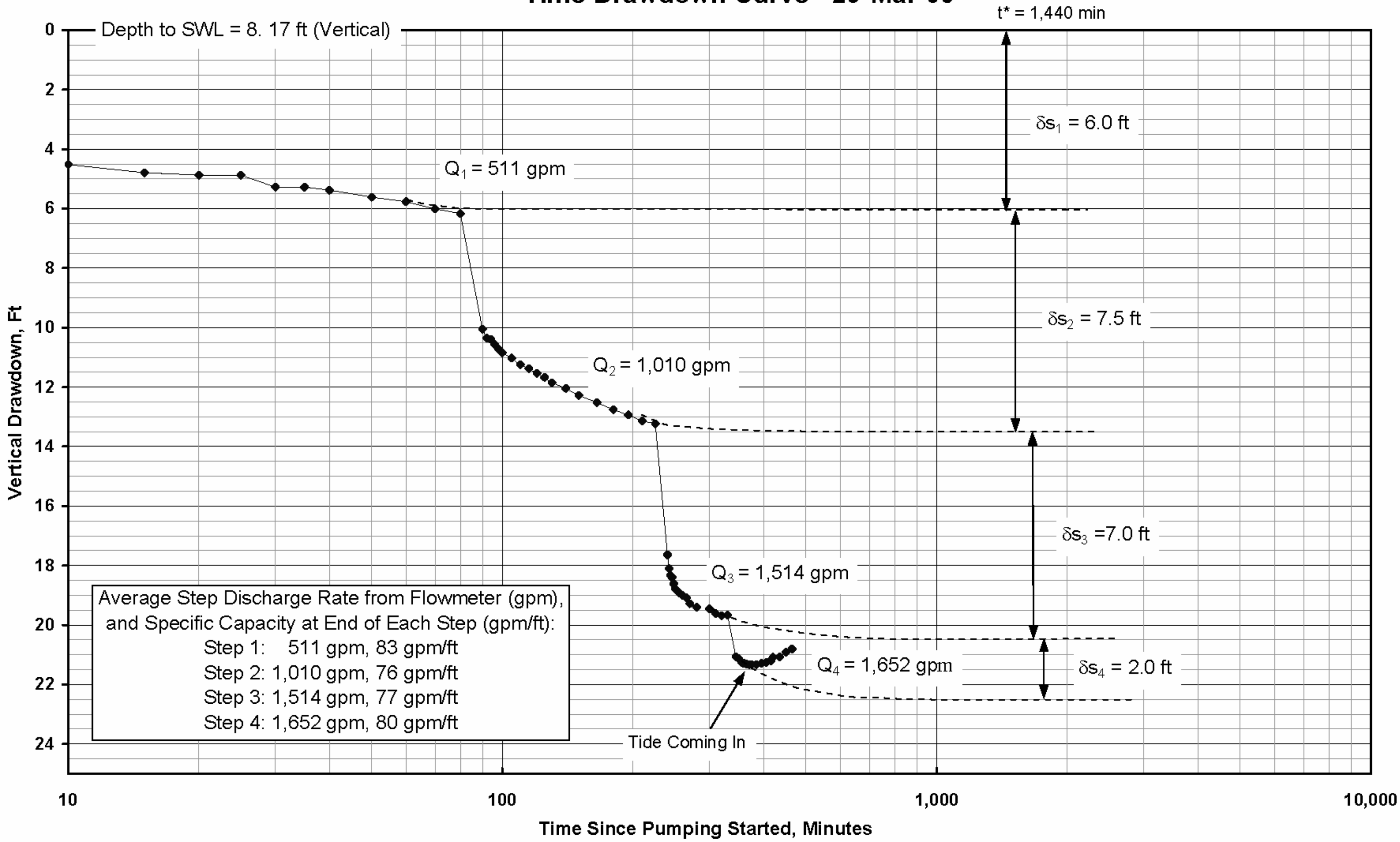
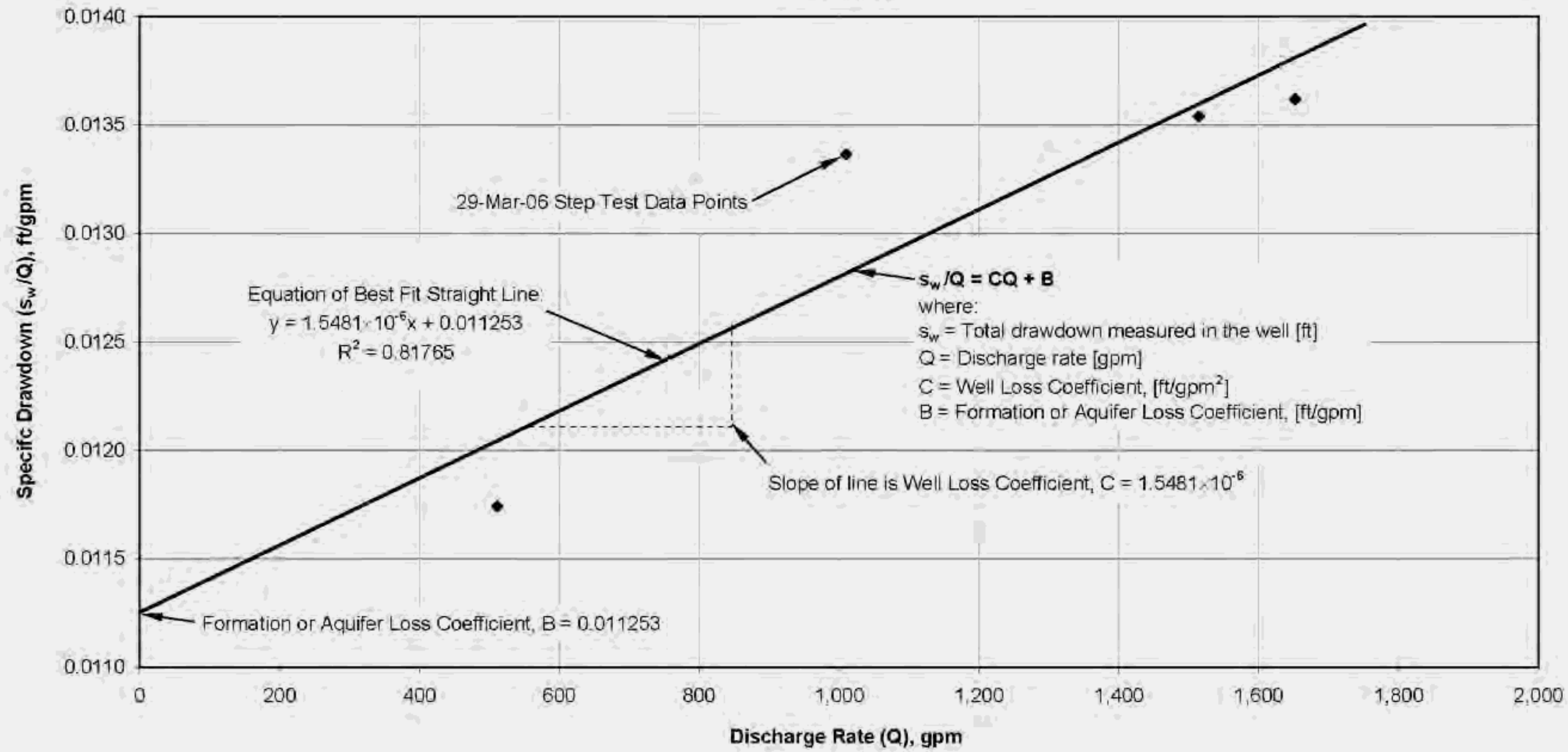


Figure 13 - Specific Drawdown - SL-1
29-Mar-06



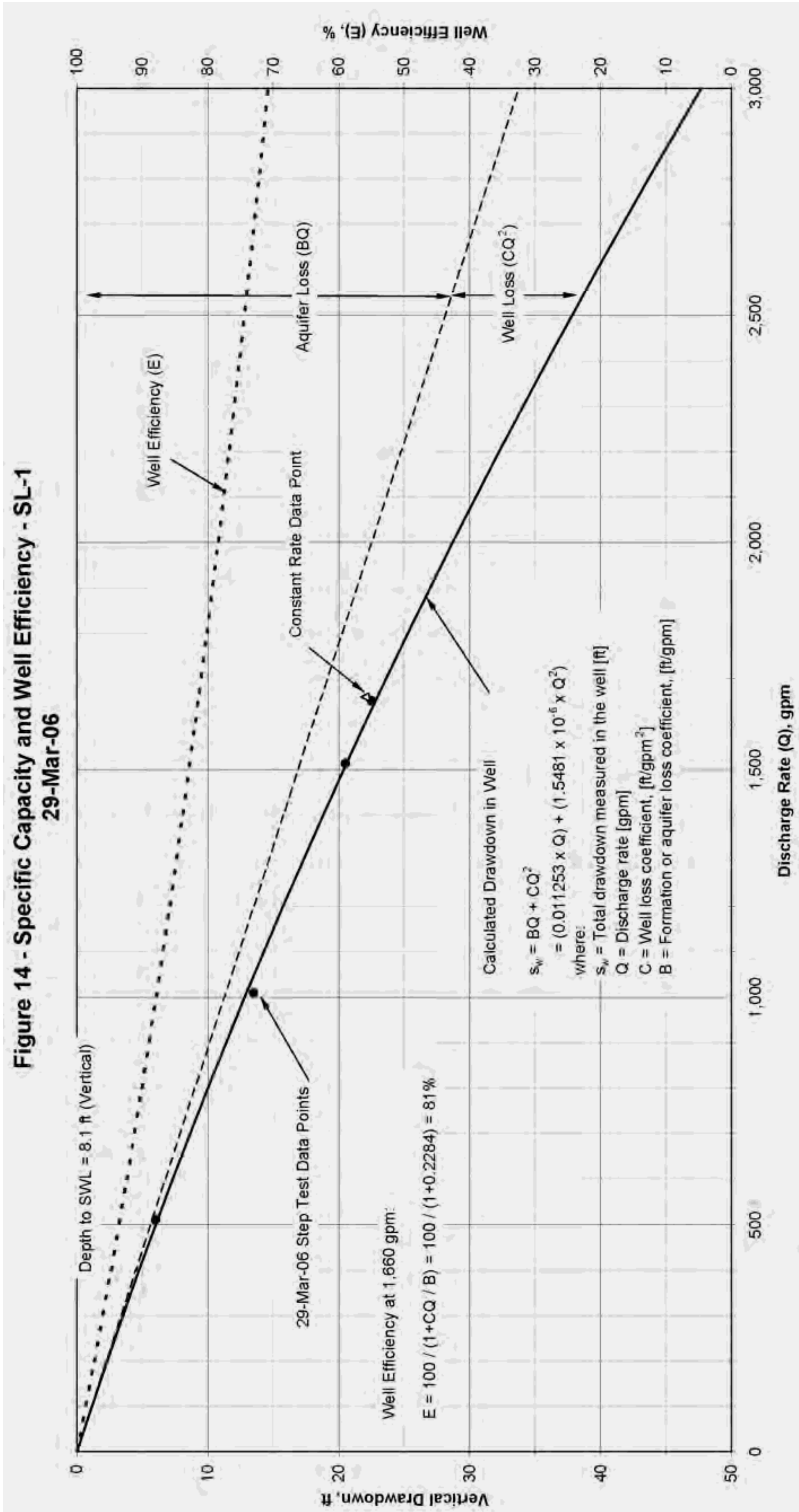


Figure 14 - Specific Capacity and Well Efficiency - SL-1
29-Mar-06
Depth to SWL = 8.1 ft (Vertical)
Well Efficiency (E)
Aquifer Loss (BQ)
Well Loss (CQ²)
Constant Rate Data Point
29-Mar-06 Step Test Data Points
Calculated Drawdown in Well
Well Efficiency at 1,660 gpm:
E = 100 / (1+CQ / B) = 100 / (1+0.2284) = 81%
s_w = BQ + CQ²
= (0.011253 x Q) + (1.5481 x 10⁻⁶ x Q²)
where:
s_w = Total drawdown measured in the well [ft]
Q = Discharge rate [gpm]
C = Well loss coefficient, [ft/gpm²]
B = Formation or aquifer loss coefficient, [ft/gpm]
Vertical Drawdown, ft
Well Efficiency (E), %
Discharge Rate (Q), gpm
0
500
1,000
1,500
2,000
2,500
3,000
10
20
30
40
50
60
70
80
90
100

Figure 15 - Ground Water Elevations at SL-1, MW-1M, and MW-2M during Five-Day Constant Rate Pumping Test

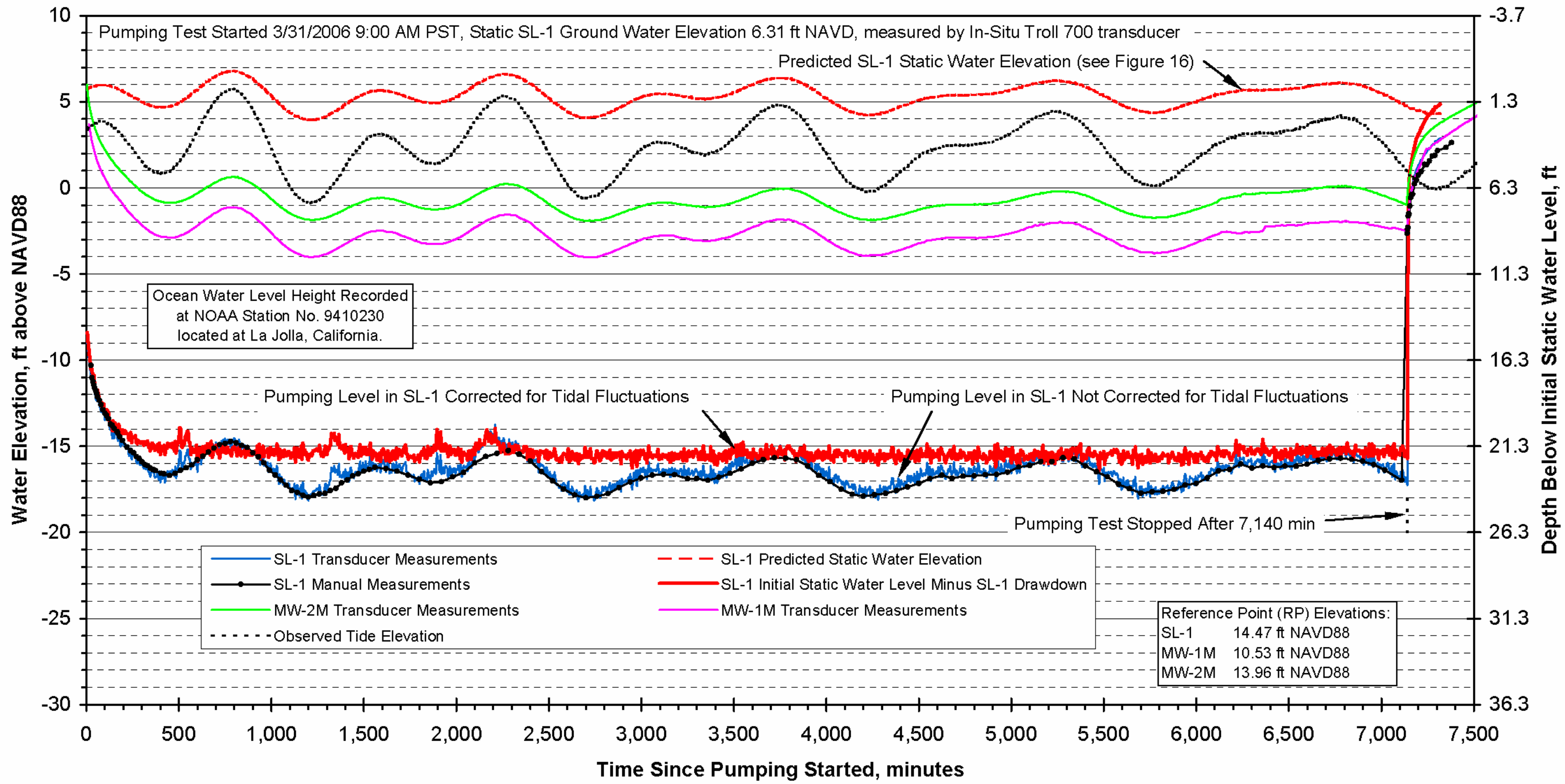


Figure 16 - Linear Regression of Static Ground Water Elevation with Observed Tide Elevation

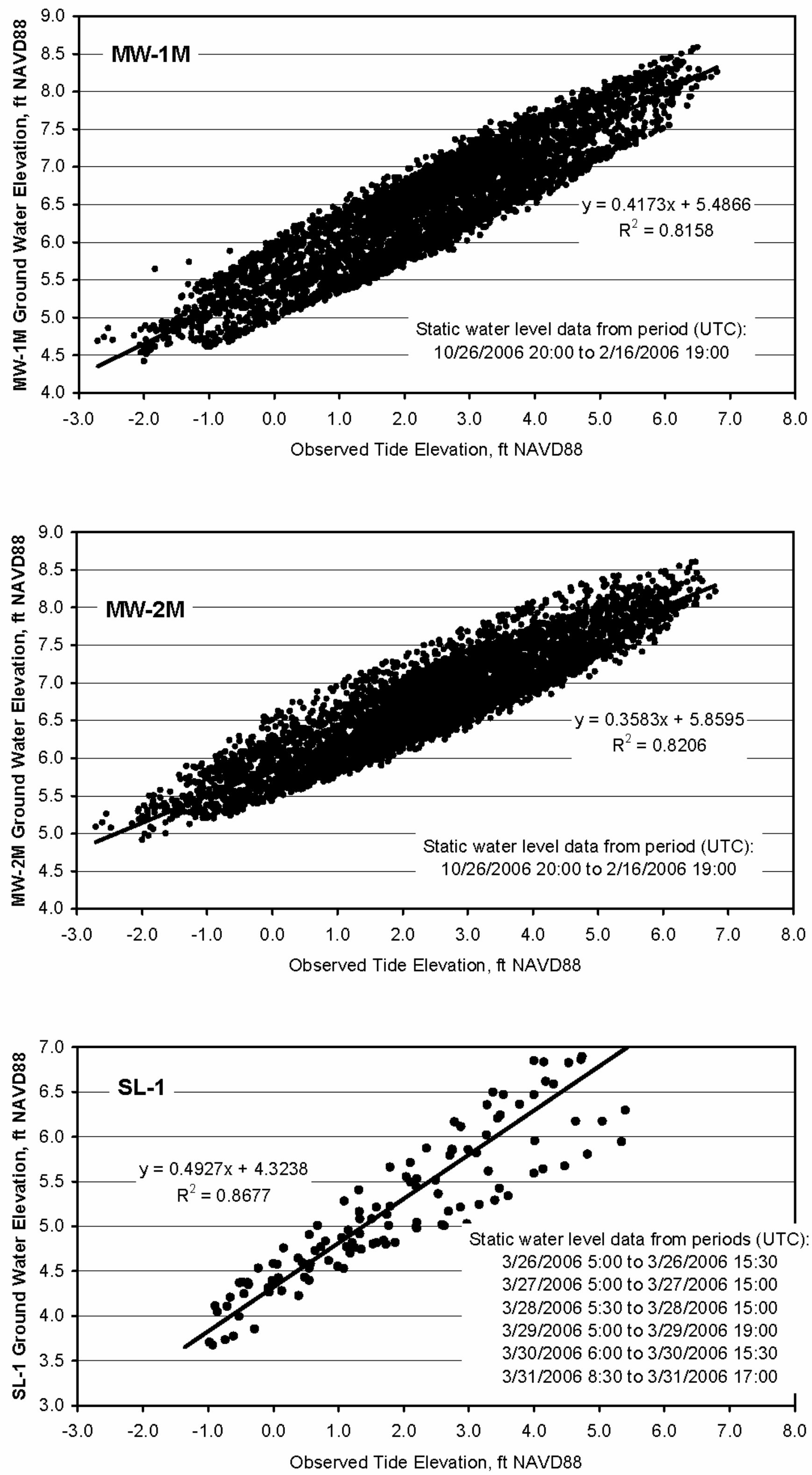


Figure 17 - Ground Water Elevations in Test Slant Well SL-1 and Monitoring Wells MW-1M, and MW-2M during the Five-Day Constant Rate Pumping Test (31-Mar-06 to 5-Apr-06)

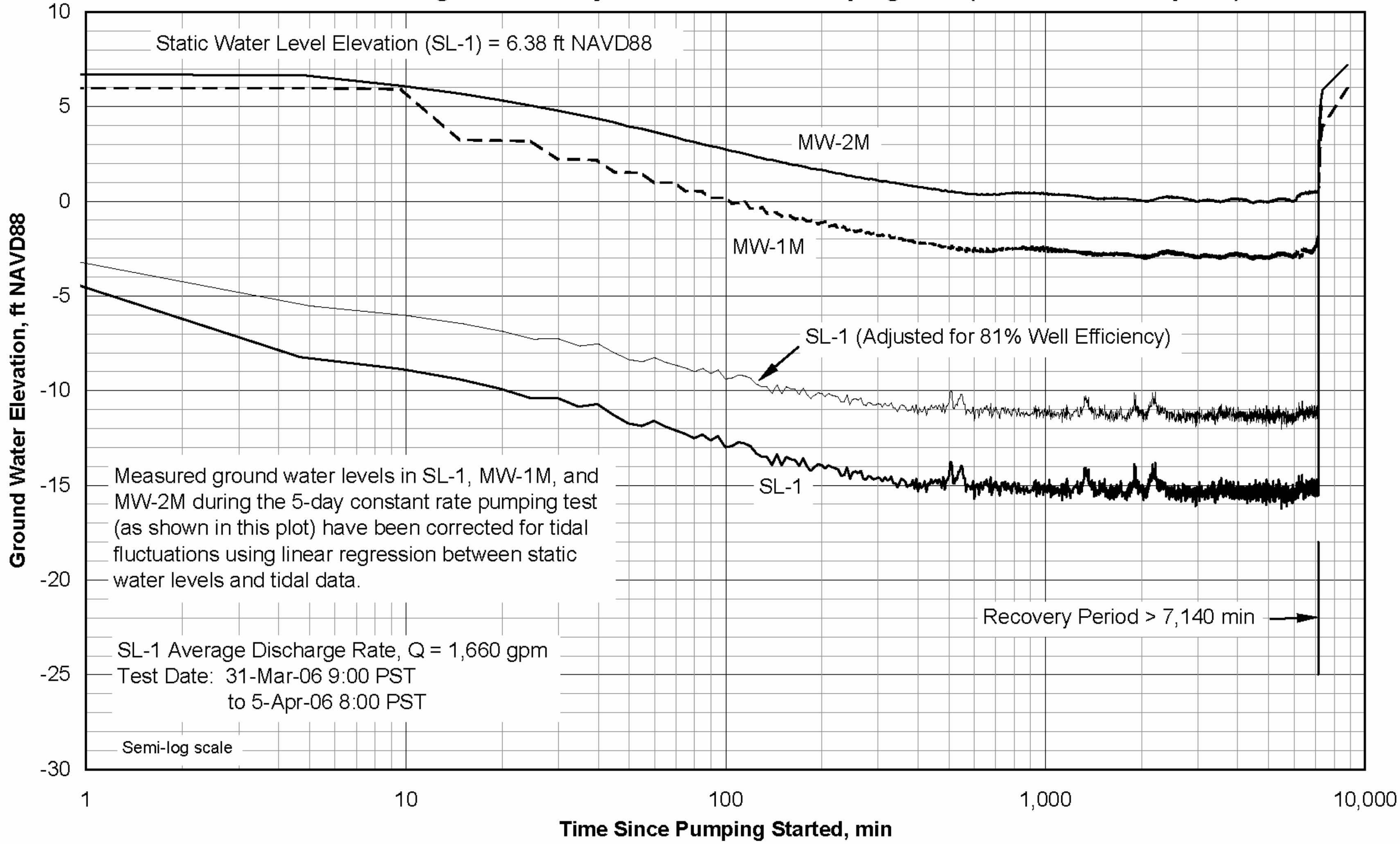


Figure 18 - Recovery Ground Water Elevations in Test Slant Well SL-1 and Monitoring Wells MW-1M,and MW-2M during the Five-Day Constant Rate Pumping Test (31-Mar-06 to 5-Apr-06)

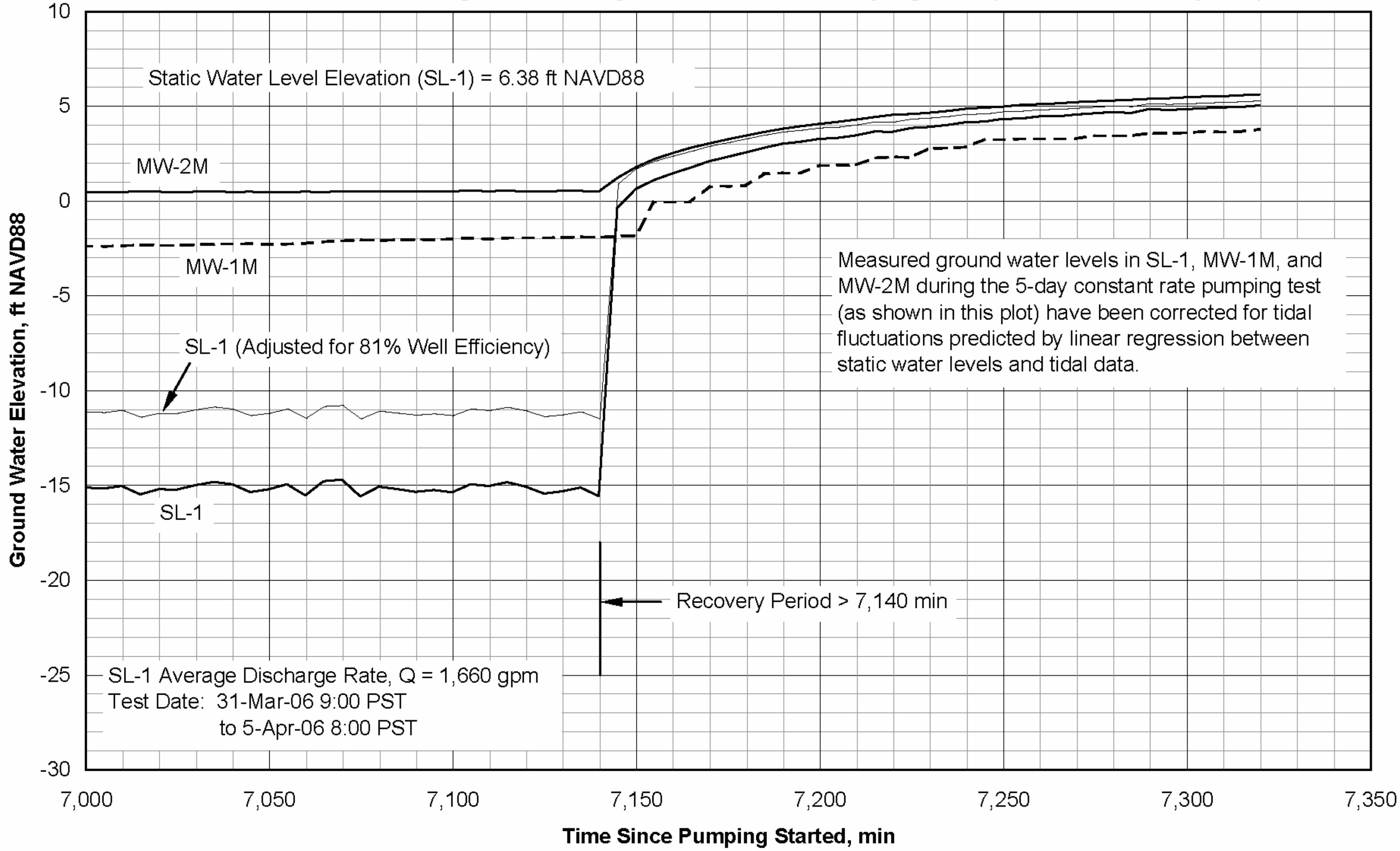


Figure 19 - Five-Day Constant Rate Pumping Test
SL-1 Time-Drawdown Curve

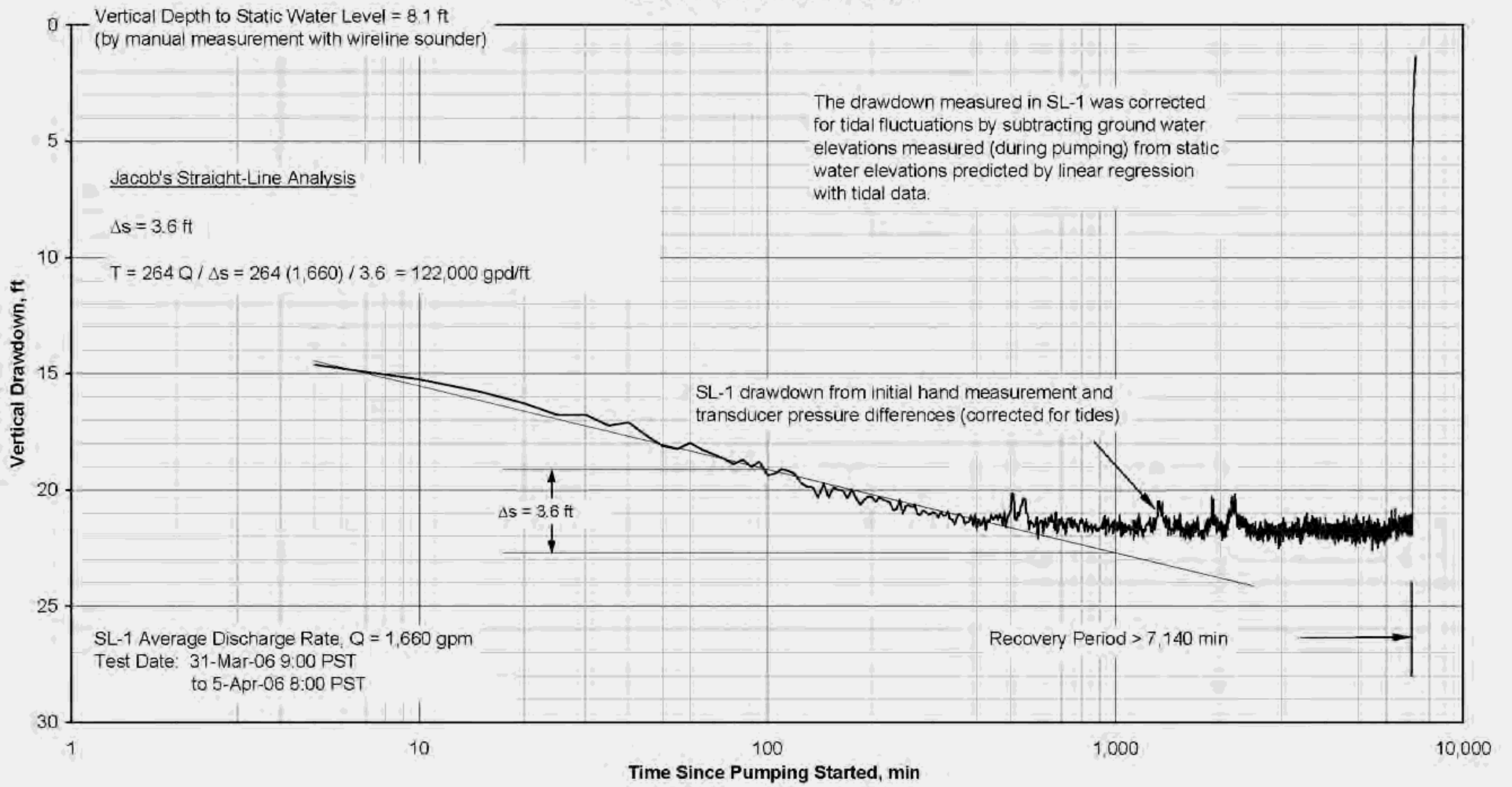


Figure 20 - Calculated Recovery, SL-1

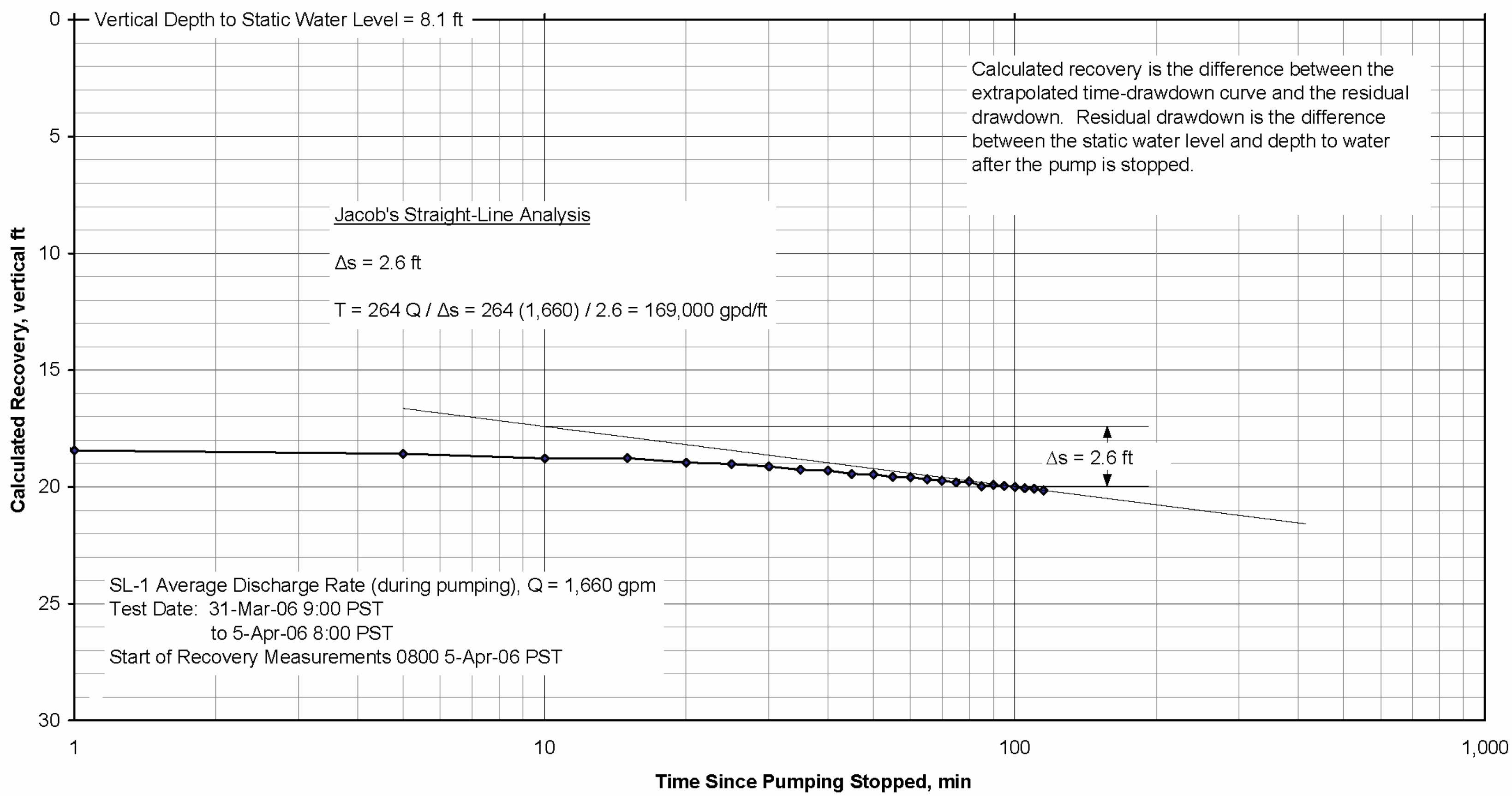


Figure 21 - Monitoring Well MW-1M
Time-Drawdown Data During Five-Day Constant Rate Pumping Test

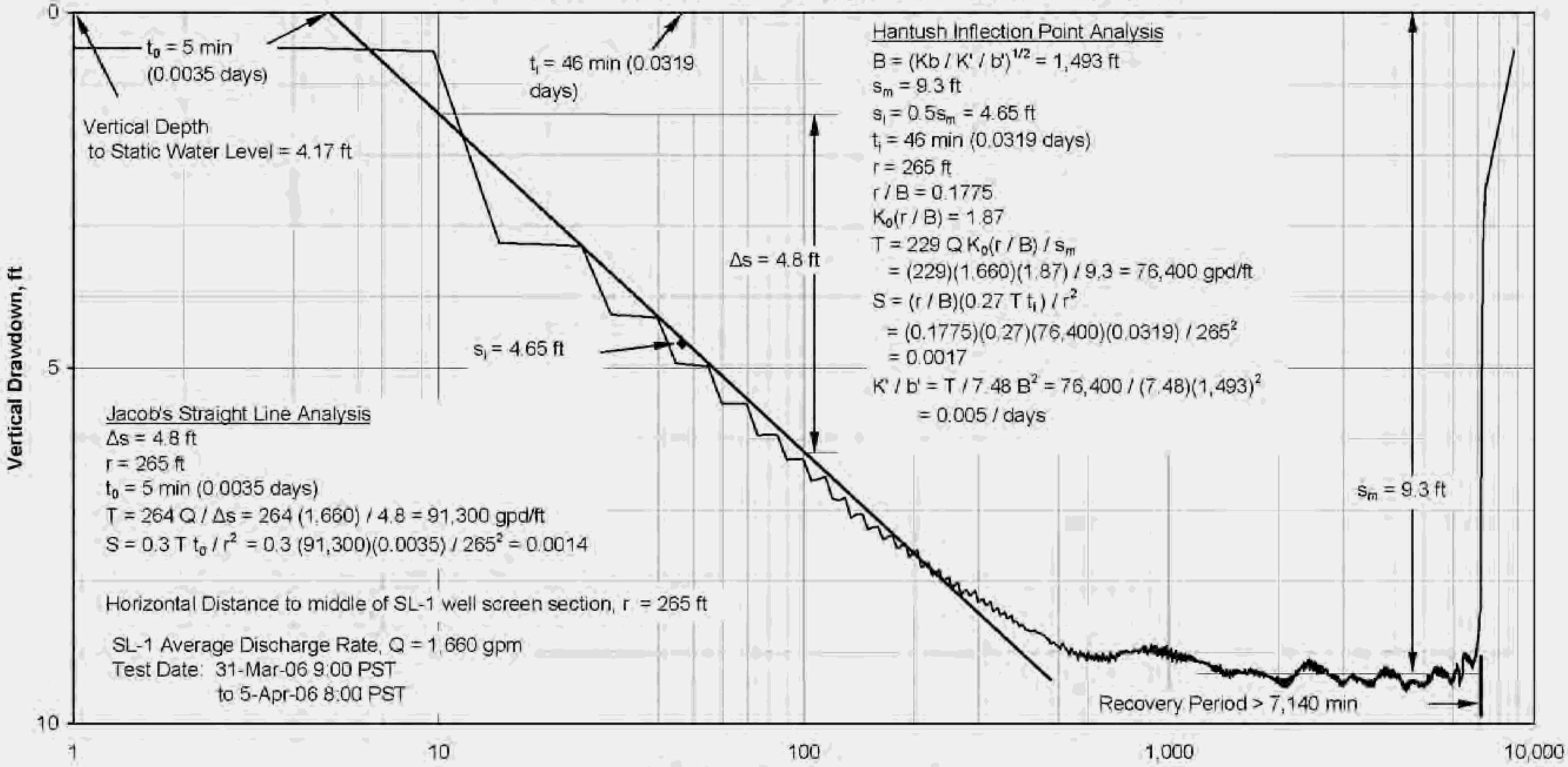


Figure 22 - Monitoring Well MW-2M
Time-Drawdown Data during the Five-Day Constant Rate Pumping Test

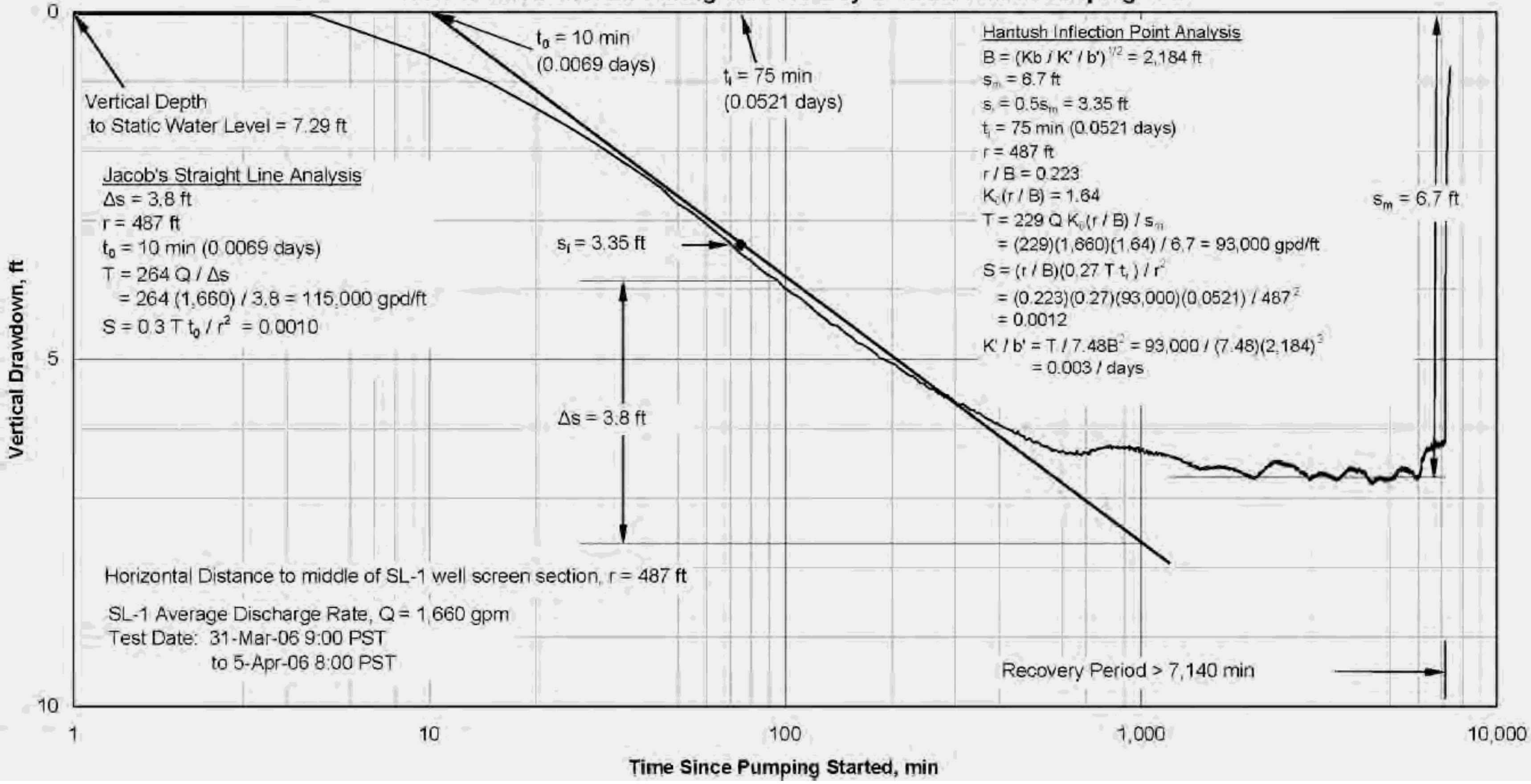


Figure 23 - Distance Drawdown during the Five-Day Constant Rate Pumping Test

(at the end of the 5-day test, or 7,140 min)

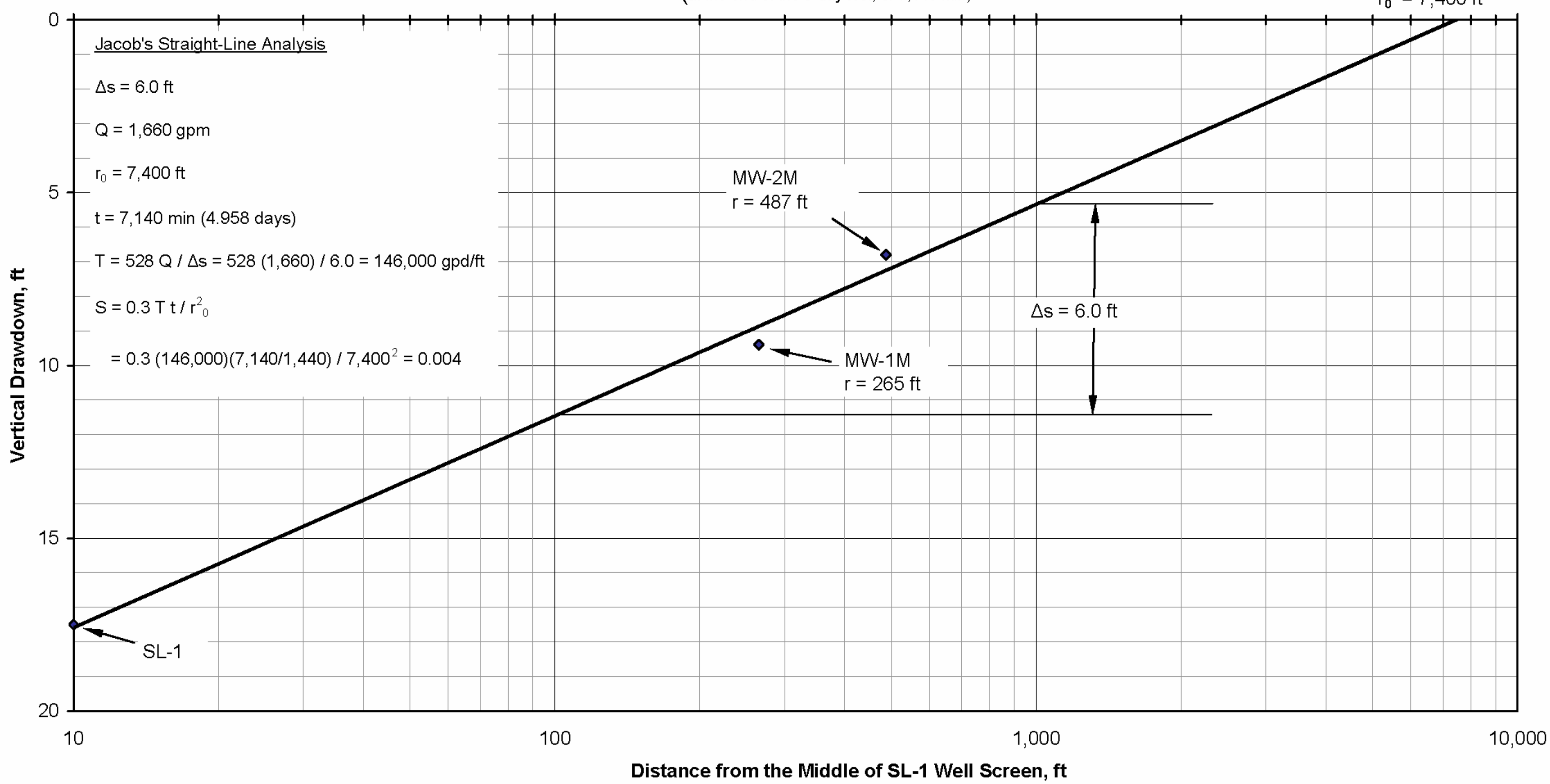


Figure 24 - SL-1 Time-Drawdown and Recovery Data during 48-Hour Constant Rate Pumping Test

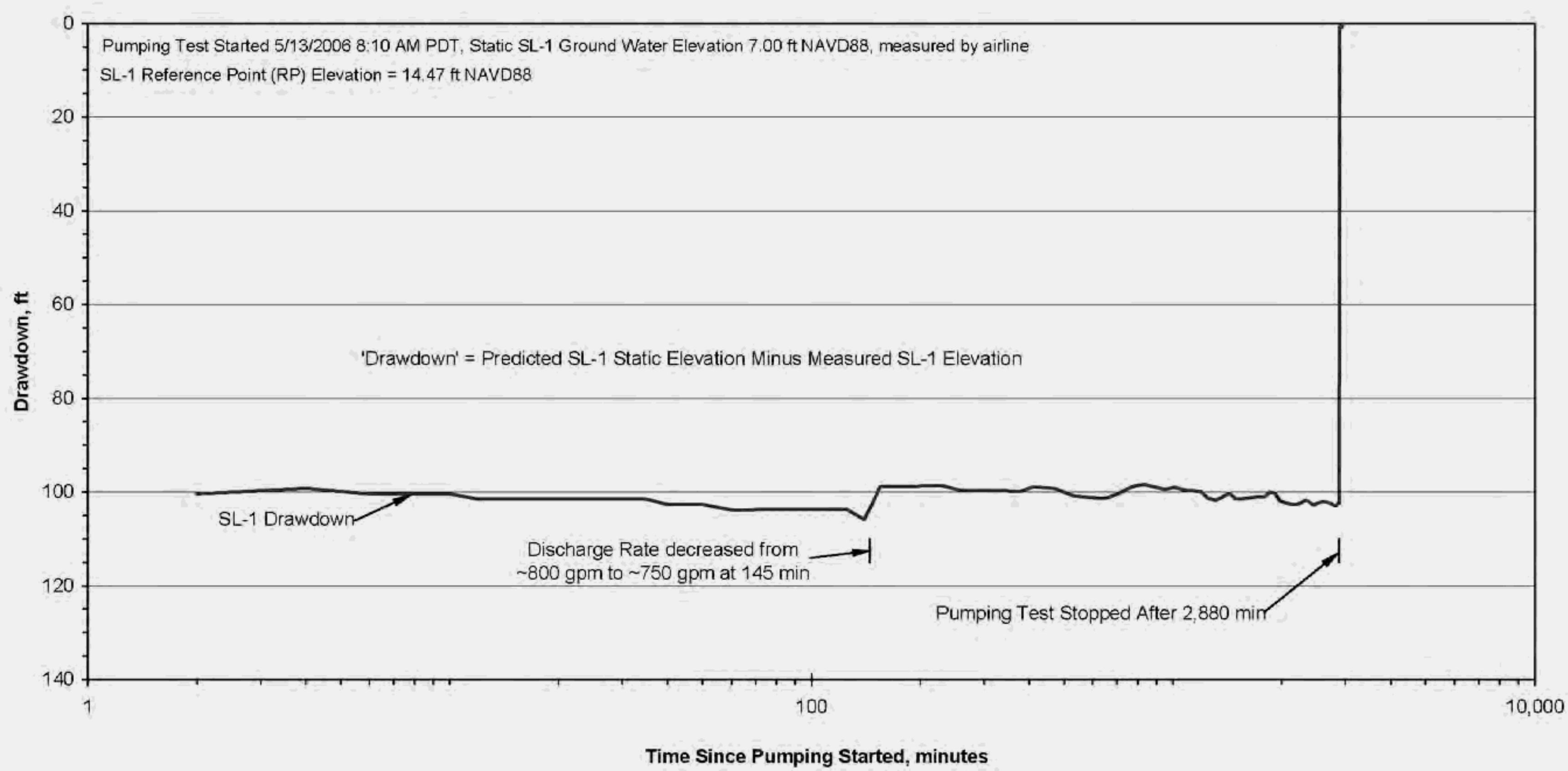
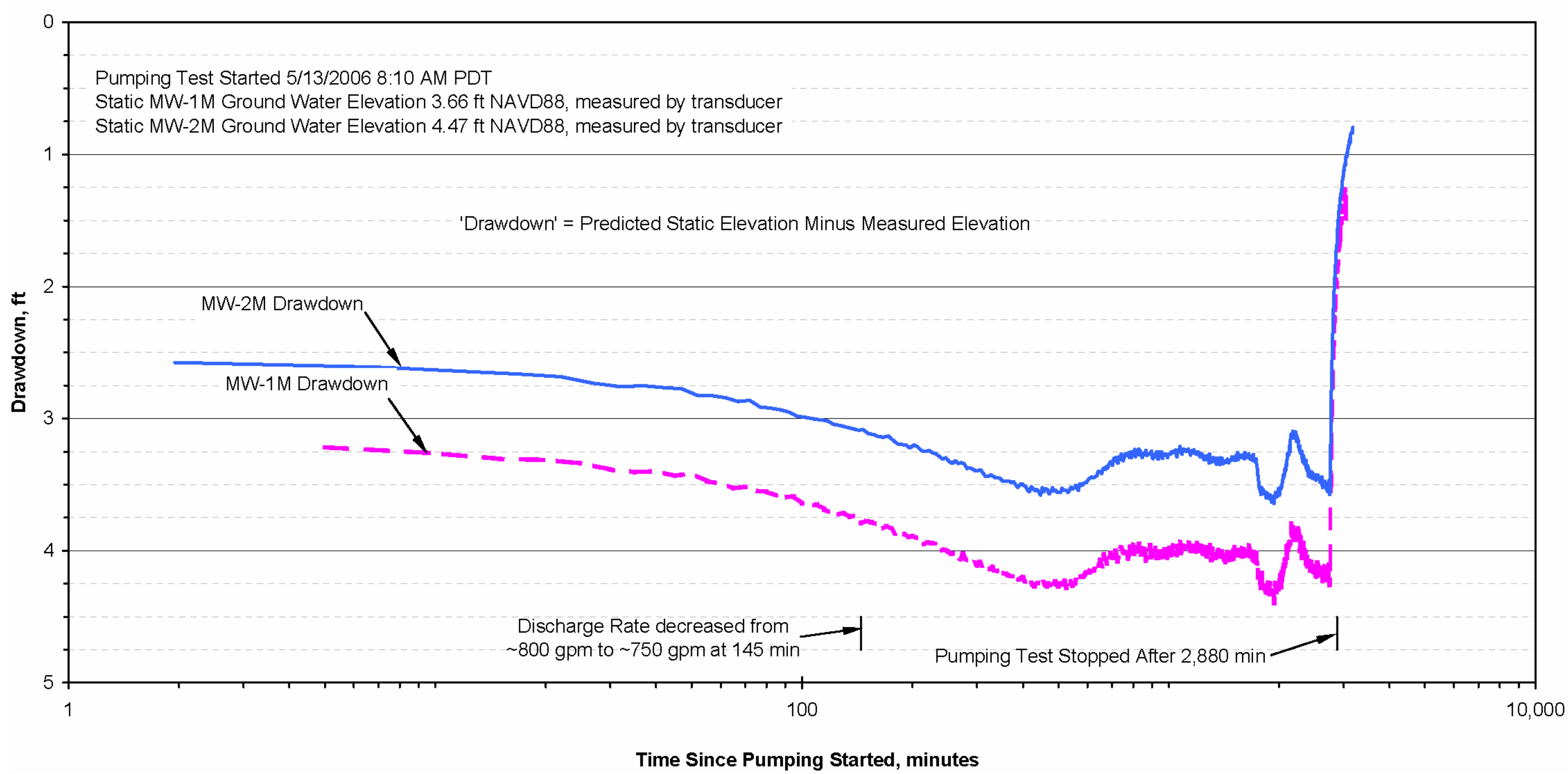


Figure 25 - Monitoring Wells MW-1M and MW-2M Time-Drawdown and Recovery Data during 48-Hour Constant Rate Pumping Test



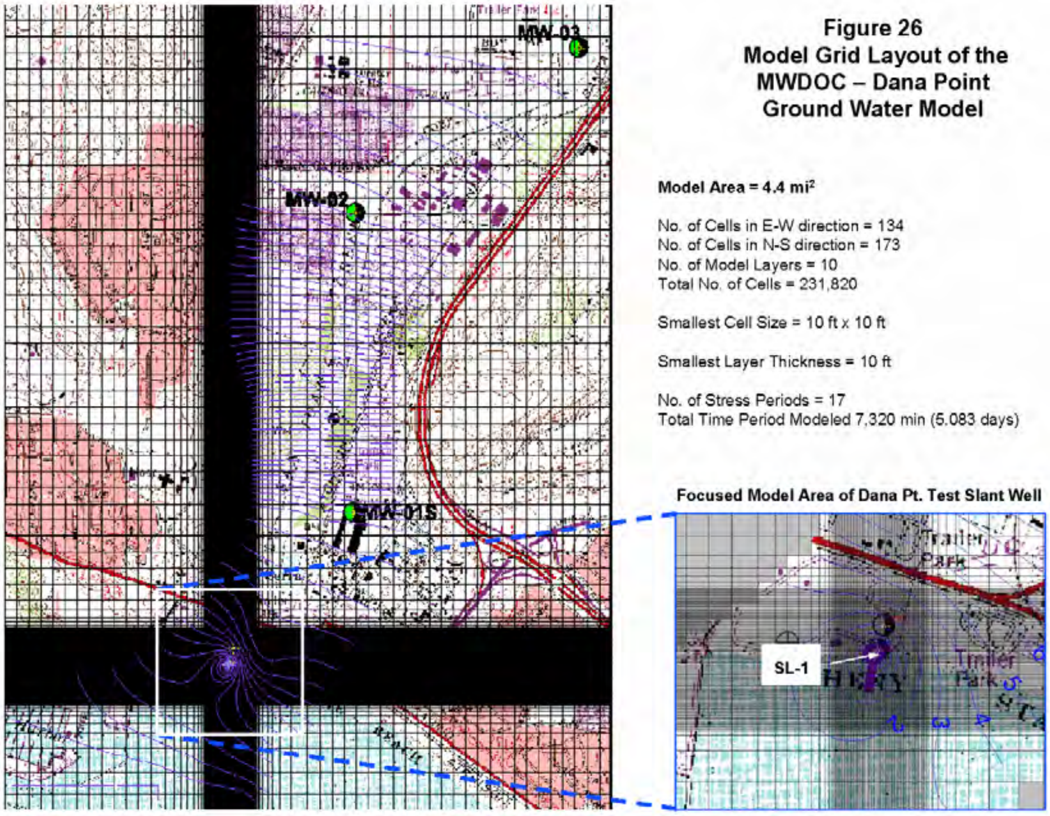


Figure 26
Model Grid Layout of the MWDOC – Dana Point Ground Water Model

Model Area = 4.4 mi²

No. of Cells in E-W direction = 134
No. of Cells in N-S direction = 173
No. of Model Layers = 10
Total No. of Cells = 231,820

Smallest Cell Size = 10 ft x 10 ft

Smallest Layer Thickness = 10 ft

No. of Stress Periods = 17
Total Time Period Modeled 7,320 min (5.083 days)

Figure 27 – Elevation and Plan View of the MWDOC – Dana Point Ground Water Model Layers

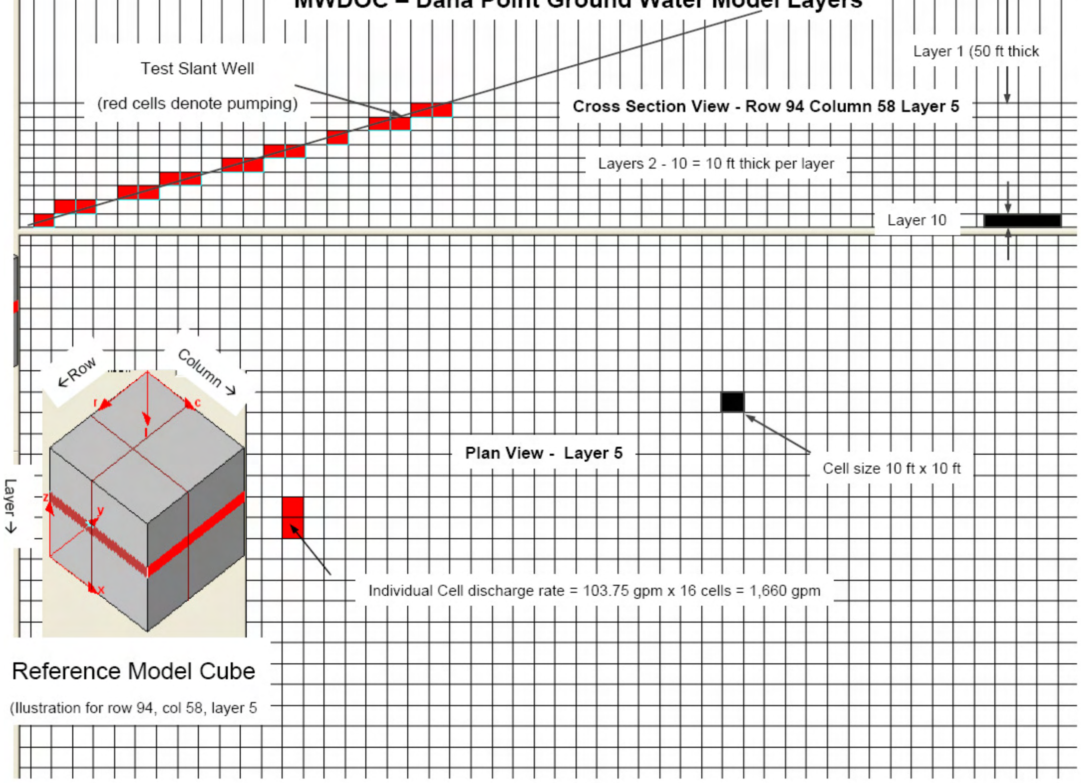
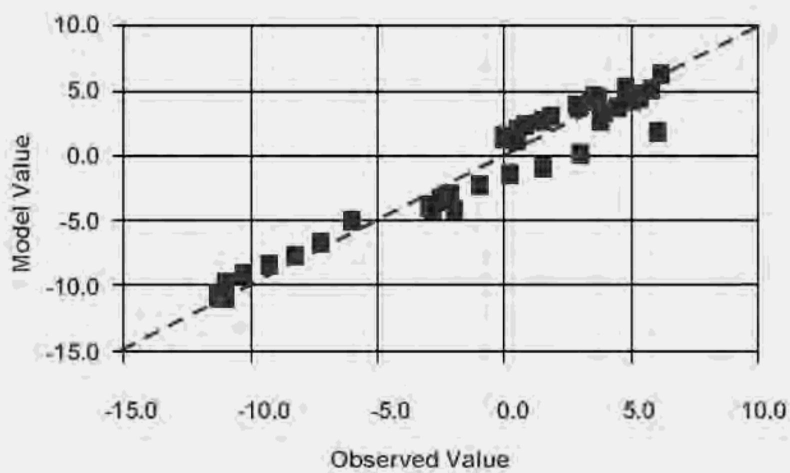
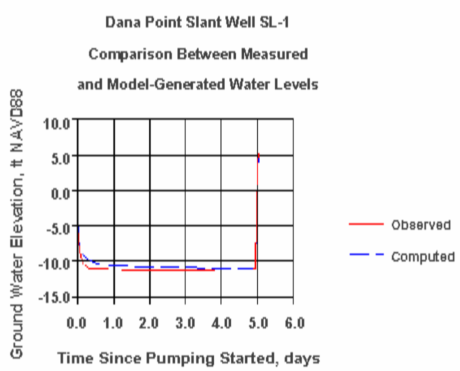


Figure 28 - Observed vs. Computed Ground Water Levels during the Five-Day Pumping Test



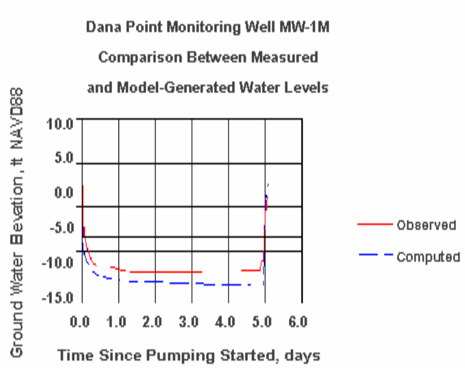
Transient Calibration (Five-Day Test) – Relative Error = 7.1%

Figure 29 - Ground Water Model Simulation Results



Model Generated Aquifer Parameter	Units	Model Generated Value
Hydraulic Conductivity	gpd/ft^2	1,618
Transmissivity[1]	gpd/ft	139,000
Storativity	fraction	0.00033
Vertical Leakance	1/days	0.0275

1 – Calculated from the product of the model hydraulic conductivity x vertical saturated thickness of slant well screen section (86 ft)



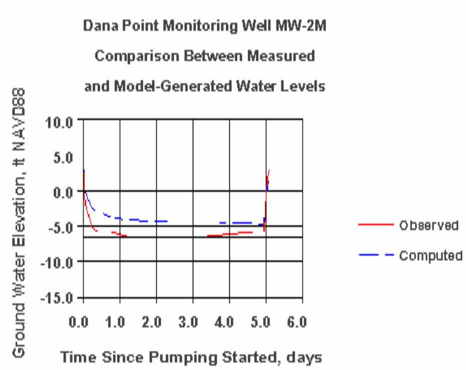


Figure 30 – Drawdowns at the End of the Five-day Pumping Test

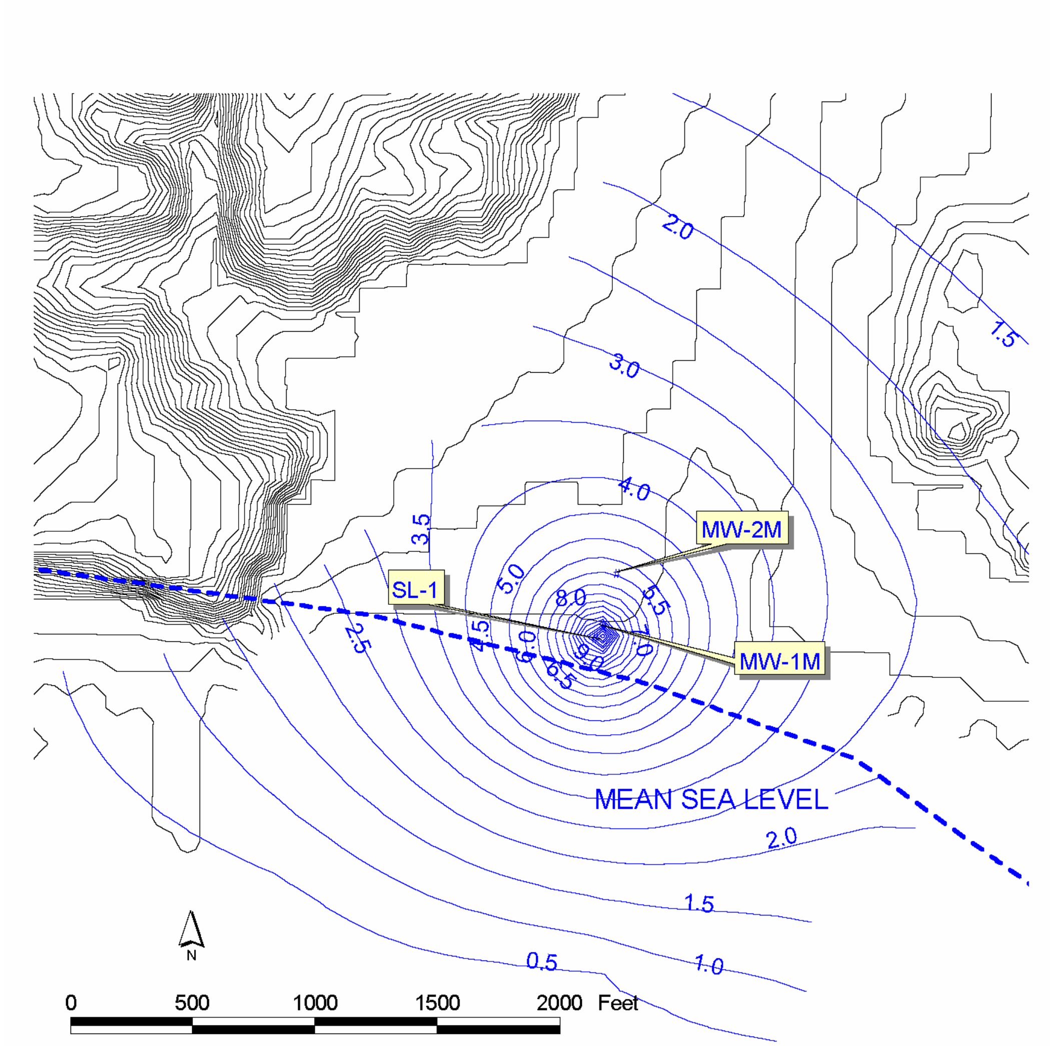


Figure 31 - Ground Model Water Level Elevations at the End of the Five-Day Pumping Test

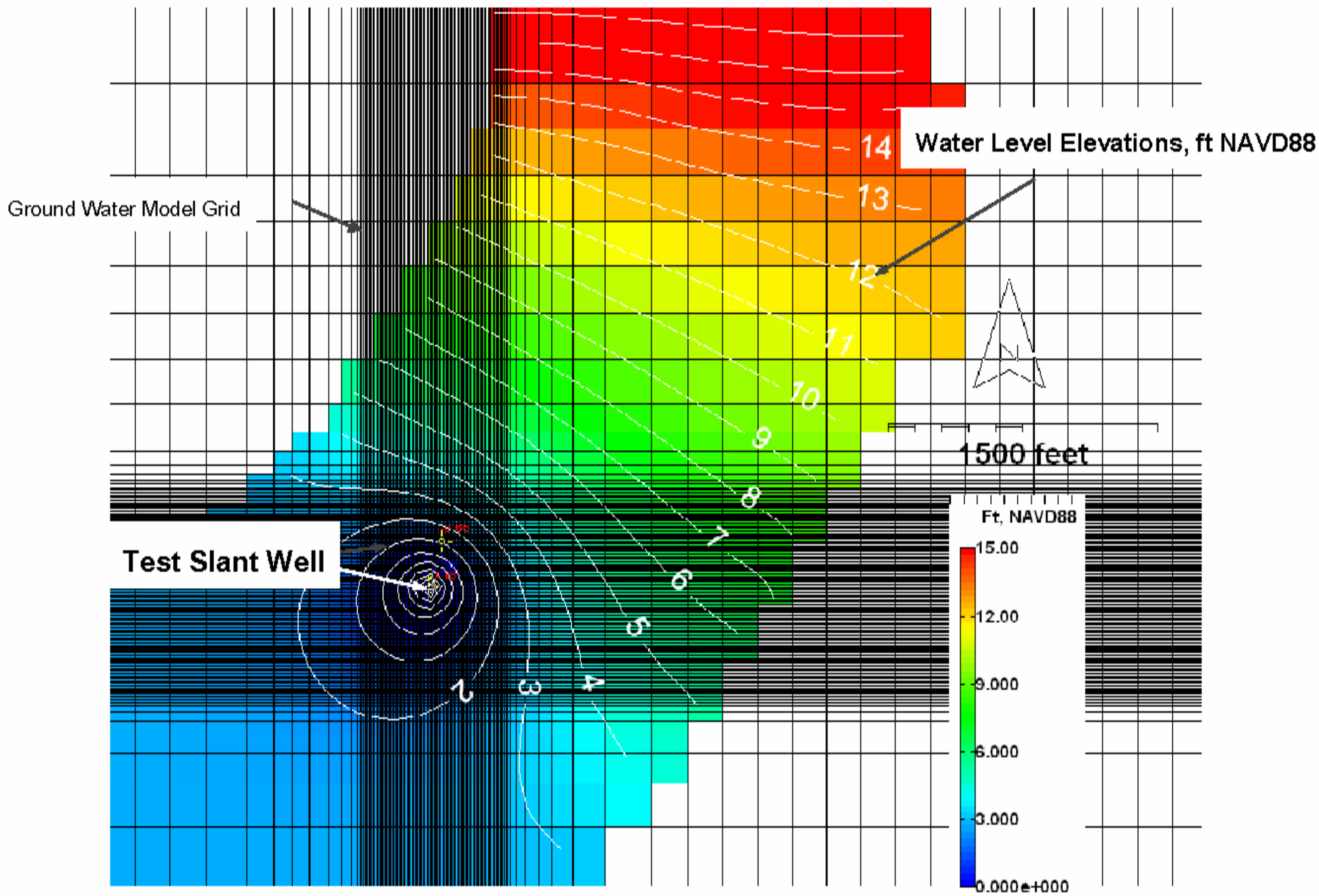
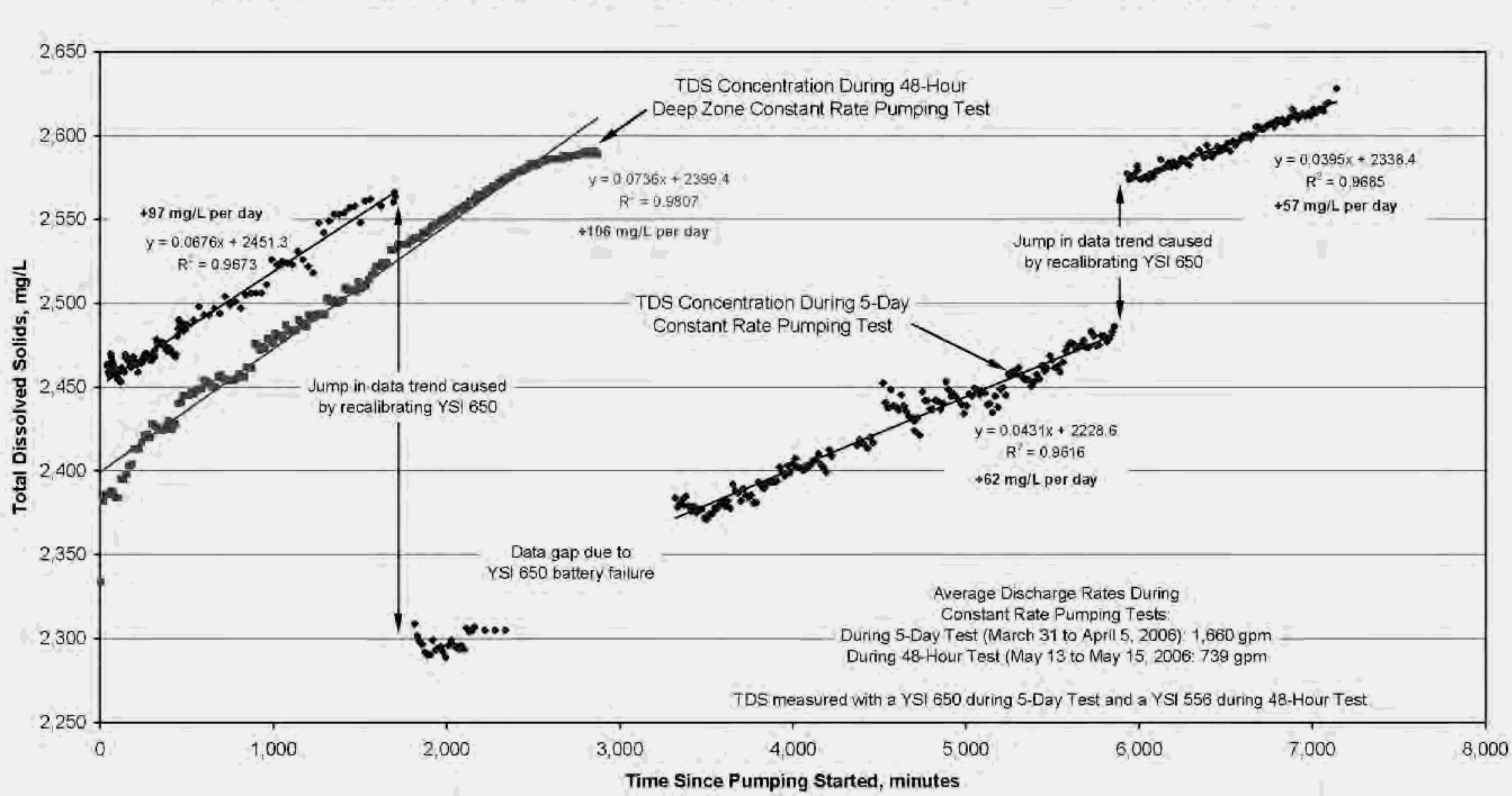


Figure 32 - Trend in Total Dissolved Solids (TDS) Concentration During Constant Rate Pumping Tests



Appendix A
Chronology of Construction

30-Jan-06 A pre-construction meeting was held at Doheny State Beach, in Dana Point, California that included all key personnel involved with the slant well drilling project. In attendance were representatives from MWDOC, California State Parks Department, GEOSCIENCE Support Services, Inc., Boart Longyear Geo-Tech Division, MJF Consulting, Chambers Group, Williams-McCaron, Inc., and South Coast Water District. The primary issues discussed were details of the drilling project including permits, contact numbers, spill prevention, public safety and notification, water disposal and work schedule.

31-Jan-06 Boart Longyear Geo-Tech Division of Tualatin, Oregon began mobilizing to the beach site. A fencing contractor installed temporary fences around the beach worksite and parking lot staging area. Six 8-5/8 inch OD by 18 ft long anchors were set into the beach using a CME 95 hollow stem auger drilling rig from Boart Long year's Peoria, AZ office.

1-Feb-06 The mast section of the Foremost DR-24HD dual rotary drilling rig, containing the top head drive and lower rotary drive units, was delivered to the beach. A 100-ton crane was used to lift the mast section off the trailer and position it within the array of anchors. K-rails were placed around the perimeter of the site and plastic sheeting was placed under all stationary equipment.

2-Feb-06 Mobilization and setting up of the drilling equipment continued. The 21,000 gallon Baker tank and 20 cubic yard roll off bin were delivered to the site. The mast of the drilling rig was set up at an angle of 23° from horizontal. Monitoring well MW-1 was excavated for ease of access during the drilling process.

3-Feb-06 Mobilization and setting up of the drilling equipment continued. Sound barriers were installed adjacent to the power unit and 950 cfm/350 psi air compressor. Thick steel plates were placed at the site as landing mats to off-load roll off bins onto the beach sand.

4-Feb-06	Boart completed the mobilization process and began drilling the 24-inch diameter borehole. A carbide-button casing shoe welded to the leading end of the 24-inch OD by ½-inch wall mild steel casing. The 24 inch OD casing was advanced to a depth of 5 lineal feet (LF) below ground surface (bgs) at a 23° angle from horizontal using the direct air rotary drilling method. Cuttings were removed from the borehole by way of the 7 inch OD by 4 inch ID dual-wall drill pipe that was installed within the 24 inch casing. A 4-blade stabilizer and a 23-inch diameter tricone drilling bit were attached to the end of the drill pipe. Boart personnel halted drilling at 5 LF bgs because of problems in the power unit's gear box.
5-Feb-06	Boart removed the gear box from the power unit. A replacement gear box was shipped from Foremost Industries, LP Calgary, Alberta, Canada.
6-Feb-06	A weekly progress meeting was held with MWDOC and State Parks Dept. personnel. Additional insulation was added to the sound barriers.
7-Feb-06	Boart personnel resumed drilling the 24-inch diameter borehole at 5 LF bgs. The temporary casing was advanced to a depth of 15 LF bgs by 4:00 PM.
8-Feb-06	Boart continued advancing the 24-inch diameter borehole in approximately 20 ft sections. The temporary casing was advanced to a depth of 39 LF bgs by 7:00 PM.
9-Feb-06	Continued advancing the 24-inch diameter borehole and installing additional sections of casing. The 24-inch diameter temporary casing was advanced to a depth of 74 LF bgs by 3:00 PM.
10-Feb-06	Completed advancing the 24-inch diameter borehole to a depth of 97.44 LF bgs by 8:45 AM. The 24-inch OD temporary casing was landed at this depth before removing the 7-inch OD by 4-inch ID dual-wall drill string, stabilizer and bit in preparation for cutting off the 24 inch casing shoe.
11-Feb-06	Because 20 ft of fine-grained formation material had pushed up into the 24-inch casing, Boart made the decision to forego cutting off the casing shoe. Boart made modifications to the drilling rig and discharge hose support system to facilitate drilling at the 23° angle.

12-Feb-06 Boart began installing 20-inch OD by 3/8-inch wall mild steel temporary casing within the 24-inch OD casing. A carbide-button casing shoe was welded to the leading end of the 20-inch OD temporary casing. A 19-inch tricone mill-tooth bit with an integral stabilizer was attached to the end of the drill string before being installed within the 20-inch OD temporary casing.

13-Feb-06 After cleaning out the heaving sand material, Boart began advancing the 20-inch borehole with 20-inch OD temporary casing. The 20-inch temporary casing was installed to a depth of 103 LF bgs by 4:15 PM. Centralizers were placed on the drill string at approximately 60 ft intervals to keep it centered within the casing.

14-Feb-06 Boart continued advancing the borehole and installing 20-inch OD casing. The 20-inch OD temporary casing was advanced to a depth of 143 LF bgs by 4:45 PM. A progress meeting was held with State Parks personnel.

15-Feb-06 Boart continued advancing the borehole and installing temporary casing. The 20-inch borehole and casing was advanced to a depth of 203 LF bgs by 5:40 PM. Large gravels (to 3 1/2-inches) and heaving sand temporarily plugged the inner barrel of the drill string, slowing drilling progress.

16-Feb-06 Boart continued advancing the borehole and installing temporary casing. The 20-inch borehole was advanced to a depth of 235 LF bgs by 6:00 PM. Because drilling was progressing well, the decision was made to continue advancing the 20-inch casing to total depth, rather than reduce the borehole and casing diameter to 18-inches.

17-Feb-06 Boart continued advancing the borehole and installing 20-inch casing. The 20-inch temporary casing was advanced to a depth of 263 LF bgs by 6:00 PM. Large gravels lodging in the inner barrel of the drill string and heaving sand slowed the drilling progress.

18-Feb-06 Boart continued advancing the borehole and installing casing. The 20-inch diameter temporary casing was advanced to a depth of 280 LF bgs by 6:45 PM. Large gravels and heaving sand continued to temporarily plug the inner barrel of the drill string.

19-Feb-06 Boart continued advancing the borehole and installing the temporary casing. The 20-inch diameter borehole and casing was advanced to a depth of 303 LF bgs by 4:45 PM. Large gravels and heaving sand continued to impede drilling progress.

20-Feb-06 Boart continued advancing the 20-inch diameter borehole and installing temporary casing. The 20-inch diameter borehole and casing was advanced to a depth of 315 LF bgs by 3:15 PM. The alternator on the power unit was not recharging the batteries, causing the engine to die frequently.

21-Feb-06 The alternator on the power unit was replaced. Boart resumed drilling the 20-inch borehole and installing the temporary casing. The 20-inch diameter borehole and casing was advanced to a depth of 323 LF bgs by 4:30 PM.

22-Feb-06 Boart continued advancing the 20-inch borehole and installing temporary casing. The 20-inch casing was advanced to a depth of 337 bgs LF by 6:00 PM.

23-Feb-06 Boart continued advancing the 20-inch borehole and installing temporary casing. The 20-inch casing was advanced to a depth of 341 LF bgs by 5:30 PM.

24-Feb-06 Boart completed advancing the 20-inch borehole by installing 20-inch OD temporary casing to 362.37 LF bgs by 12:30 PM. Fine-grained sediments were encountered below 352 LF bgs, facilitating completion of drilling. The dual-wall drill string was removed and the bottom of the borehole was measured at 350 LF bgs, indicating 12 ft of sand had pushed into the casing. The casing was filled with water overnight.

25-Feb-06 Boart personnel pumped additional water into the casing and began moving the 20-inch casing up and down to dislodge the plug of heaving sand. The bottom of the borehole was measured at 358 ft bgs. The decision was made to forego cutting off the casing shoe because of the risk of bringing in additional heaving sand. Boart prepared for installation of screen and casing.

26-Feb-06 Boart personnel secured the site for the day.

27-Feb-06 Boart personnel began installing one section of 12 ¾-inch OD by 5/16 inch wall Type 316L stainless steel louvered screen, centralizers and tremie guides, including acid-bath passivation of all field welds. Roscoe Moss personnel were onsite to assist in the process and handling of the acid. A progress meeting was held with State Parks personnel.

28-Feb-06 Boart continued installing five sections of 12 ¾-inch OD Type 316L stainless steel louvered screen. Centralizers and tremie guides were placed on each section of screen and included passivation of all welds made in the field. Tacna Sand & Gravel delivered 16 supersacks of 4 x 16 custom blended filter pack material to the site. The filter pack was sampled and sieved by GEOSCIENCE.

1-Mar-06 Boart continued installing five sections of 12 ¾-inch OD Type 316L stainless steel louvered screen and two sections of 12 ¾-inch OD by 5/16 inch wall thickness Type 316L stainless steel blank casing. Centralizers and tremie guides were welded onto each section, including passifying all welds made in the field.

2-Mar-06 Boart continued installing four sections of 12 ¾-inch OD Type 316L stainless steel blank casing. Centralizers and tremie guides were placed on each section of screen and included passivation of all welds made in the field.

3-Mar-06 Boart completed installing the final (10 ft length) section of 12 ¾-inch OD Type 316L stainless steel blank casing. The bottom of the casing was placed 350.96 LF bgs. Centralizers and tremie guides were welded to the top of the section and field welds were passified. The bottom of the borehole was measured at 359 LF bgs using 1 inch diameter PVC.

4-Mar-06 A 12 ¾ inch OD mild steel handling piece was welded to the top of the Type 316L stainless steel casing. A short section of 20-inch OD casing was reattached in order to be able to reach the temporary casing with the lower rotary drive during casing extraction. Boart personnel circulated the borehole and began extraction of the 20-inch OD temporary casing by gently rocking it back and forth. The borehole was initially tight. Boart personnel began setting up the gravel packing equipment and using very heavy chains, secured the drilling rig to the 8 5/8-inch by 18 ft anchors that had been set around the rig during initial mobilization.

5-Mar-06 Boart experienced electrical problems with the rig, but quickly got it repaired by a Cummins mechanic. The 20-inch OD temporary casing was extracted while pumping filter pack into the annular space between the 12 ¾ inch OD screen and the 20 inch OD casing. Filter packing progressed from 359 LF to 342 LF bgs and the top of the filter pack was kept at least 5 ft up inside the 20 inch casing (when measured at the bottom

6-Mar-06	Boart continued extraction of 20-inch temporary casing and filter pack installation from 342 LF bgs to 311 LF bgs.
7-Mar-06	Boart continued extraction of 20-inch temporary casing and filter pack installation from 311 LF bgs to 266 LF bgs. State Parks personnel were onsite to discuss placement of the diffuser in San Juan Creek.
8-Mar-06	Boart personnel installed the dual-wall drill pipe within the 12 ¾-inch OD casing and began airlifting from 270 LF bgs to the bottom of the screened interval to ensure a tight filter pack.
9-Mar-06	Boart continued extraction of 20-inch temporary casing and filter pack installation from 266 LF bgs to 245 LF bgs. The dual-tube drill string was installed in the well with the swabbing tool and began airlifting each 20 ft interval immediately after the filter pack was installed
10-Mar-06	Boart continued extraction of 20-inch temporary casing and filter pack installation from 245 LF to 185 LF bgs and continued development by airlifting in 20 ft intervals immediately after the filter pack was placed.
11-Mar-06	Boart completed extraction of 20-inch temporary casing after the filter pack was placed from 185 LF bgs to 97 LF bgs and continued development by airlifting in 20 ft intervals immediately after the filter pack was placed.
12-Mar-06	Boart began extraction of 24-inch temporary casing and continued installing filter pack from 97 LF to 57 LF bgs. The top of the filter pack within the 24-inch OD casing was measured at 48 LF bgs. A total of 8 supersacks (240 cubic feet) were placed in the annular space.
13-Mar-06	The diffuser was installed adjacent to the drilling site in the San Juan Creek channel. The berm to the ocean remained breached. Boart personnel began airlifting the screened interval from 344 LF to 350 LF bgs to test the diffuser and set up the dissolved oxygen monitoring equipment.
14-Mar-06	Boart continued to airlift the screened interval from 344 LF to 210 LF bgs. The dissolved oxygen level in the discharge to the diffuser was monitored.

15-Mar-06 Boart continued to airlift the screened interval from 210 LF to 130 LF bgs, then began airlifting and swabbing from 130 LF to 171 LF bgs. The dissolved oxygen level in the discharge to the diffuser was monitored.

16-Mar-06 Boart continued to airlift and swab the screened interval from 171 LF to 351 LF bgs. The dissolved oxygen level in the discharge to the diffuser was monitored.

17-Mar-06 Michelle Tuchman and a reporter from the Orange County Register were onsite taking photographs. Boart continued to airlift and swab the screened interval from 351 LF to 291 LF bgs. The dissolved oxygen level in the discharge to the diffuser was monitored.

18-Mar-06 Boart continued swabbing and airlifting the screened intervals from 291 to 131 LF bgs. The dissolved oxygen level in the discharge to the diffuser was monitored.

19-Mar-06 Boart continued swabbing and airlifting the screened intervals from 131 LF to 351 LF bgs. The dissolved oxygen level in the discharge to the diffuser was monitored. GEOSCIENCE personnel collected discharge samples for weekly NPDES water quality analysis.

20-Mar-06 GEOSCIENCE personnel delivered NPDES discharge samples to Del Mar Analytical in Irvine, California. Boart completed airlifting and swabbing the screened interval from 351 LF to 131 LF bgs before installing 6 ft^3 of fine sand (#1/20 Monterey Sand) from 45 LF bgs to 42 LF bgs. A total of 4 yd^3 of neat cement mixed with 2,000 lbs of #1/20 sand was installed for the deep annular seal that was placed from a depth of 42 LF bgs to ground surface within the 24-inch OD casing. The remaining 24-inch temporary casing was removed from the borehole. Cement was visible in the annular space at 6 LF bgs. The 12 ¾-inch casing was cut off just above ground level.

21-Mar-06 Boart began demobilizing the drilling rig and power unit from the beach.

22-Mar-06 Boart continued to demobilize the drilling equipment.

23-Mar-06 Boart completed demobilizing the drilling rig by picking up the mast unit using a 90 ton crane. The anchors were pulled. Installation of the 125 HP 10 inch diameter submersible test pump was begun. Two 1 inch diameter PVC tubes were installed adjacent to the submersible pump cable through which water levels could be measured manually and with a transducer.

24-Mar-06 Boart personnel completed installation of the vertical turbine test pump with the intake set at 124 LF bgs and began final development by pumping at a discharge rate of 500 gpm. The sand content ranged from10 parts per million (ppm) to a trace with the static water level measuring 20.6 LF bgs. All discharge to the diffuser was monitored for dissolved oxygen concentration.

25-Mar-06 Boart continued development pumping at 500 gpm increasing to a maximum discharge rate of 1,857 gpm (without surging) with an average short-term specific capacity of 74 gpm/ft. The sand content ranged from trace to 63 ppm. The discharge to the diffuser was monitored for dissolved oxygen concentration.

26-Mar-06 Boart continued development pumping with surging to maximum discharge rate of 1,100 gpm with an average short-term specific capacity of 71 gpm/ft. The sand content ranged from trace to 10 ppm. The discharge to the diffuser was monitored for dissolved oxygen concentration.

27-Mar-06 Boart continued development pumping with surging to a maximum discharge rate of 1,700 gpm with an average short-term specific capacity of 71 gpm/ft was achieved. The sand content ranged from trace to 10 ppm. The discharge to the diffuser was monitored for dissolved oxygen concentration.

28-Mar-06 Boart completed 40 hours of final development by pumping. A maximum pumping rate of 1,700 gpm was achieved with an average short-term specific capacity of 80 gpm/ft. The sand content ranged from trace to 5 ppm. The discharge to the diffuser was monitored for dissolved oxygen concentration.

29-Mar-06 The step drawdown test was performed at discharge rates of 511 gpm, 1,010 gpm, and 1,514 gpm. The discharge to the diffuser was monitored for dissolved oxygen concentration.

31-Mar-06	The 5-day constant rate pump test began. GEOSCIENCE personnel collected sea water samples and well discharge samples for water quality analysis by Weck Laboratories, Inc., City of Industry, California and CRG Marine Laboratories in Torrance, California. Discharges to the diffuser were monitored for dissolved oxygen concentration and the discharge from the well was monitored for temperature, conductivity, dissolved oxygen, turbidity, pH, and ORP.
1-Apr-06	The constant rate pumping test continued. GEOSCIENCE personnel collected well discharge samples for water quality analyses by Weck Laboratories, Inc. and CRG Marine Laboratories. Discharges to the diffuser were monitored for dissolved oxygen concentration and the discharge from the well was monitored for temperature, conductivity, dissolved oxygen, turbidity, pH, and ORP.
2-Apr-06	The constant rate pumping test continued. GEOSCIENCE personnel collected well discharge samples for water quality analyses by Weck Laboratories, Inc. and CRG Marine Laboratories. Discharges to the diffuser were monitored for dissolved oxygen concentration and the discharge from the well was monitored for temperature, conductivity, dissolved oxygen, turbidity, pH, and ORP.
3-Apr-06	The constant rate pumping test continued. GEOSCIENCE personnel collected well discharge samples for water quality analyses by Weck Laboratories, Inc. and CRG Marine Laboratories. Discharges to the diffuser were monitored for dissolved oxygen concentration and the discharge from the well was monitored for temperature, conductivity, dissolved oxygen, turbidity, pH, and ORP. GEOSCIENCE personnel collected samples of the discharge to the diffuser in San Juan Creek for semi-annual NPDES water quality analysis by Del Mar Analytical.
4-Apr-06	The constant rate pumping test continued. GEOSCIENCE personnel collected well discharge samples for water quality analysis by Weck Laboratories, Inc. and CRG Marine Laboratories. Pacific Surveys, Inc. conducted fluid resistivity and temperature logs in nearby monitoring wells MW-1Middle and MW-1Deep.

5-Apr-06 Completed the constant rate pumping test that was followed by 4 hours of recovery measurements. The average discharge rate was 1,660 gpm over five days (120 hrs). GEOSCIENCE personnel collected samples from the test slant well for water quality analysis by Weck Laboratories, Inc., CRG Marine Laboratories, and MWH Laboratories of Monrovia, California. Boart personnel began dismantling the discharge line in preparation for removing the test pump.

6-Apr-06 Boart completed removal of the submersible test pump. American Asphalt removed the damaged section of pavement in the main driveway and replaced it with fresh asphalt. After calibrating tools onsite, Pacific Surveys completed a fluid resistivity logs in MW-1Middle, MW-1Deep and the Test Slant Well. Additionally, Pacific Surveys completed a video survey of the Test Slant Well. The video survey showed evidence of precipitation of dissolved minerals (feathery debris and orange staining) at 98 LF bgs, 127 LF bgs and 150 LF bgs. Sediment build-up (i.e., sand and filter pack material) on the bottom of the slant well was found at 323 LF bgs and 316 LF bgs. Approximately 3.5 ft in depth (347.5 to 351 ft bgs).

7-Apr-06 The site was secured for Spring Break (April 7th to April 16th, 2006.

3-May-06 Pacific Surveys calibrated tools in the field and ran a second fluid resistivity and temperature log in the Test Slant Well. Boart personnel began installing the submersible test pump with a packer in the well.

4-May-06 Boart continued to install the submersible test pump.

5-May-06 Boart continued to install the submersible test pump.

6-May-06 Boart continued to install the submersible test pump. The Baker tank onsite has been cleaned.

7-May-06 Boart completed installation of the submersible test pump to 300 LF bgs, however, the pump would not start. Boart disconnected the discharge head, ran 1-inch PVC airline to 300 ft and airlifted from the interior of the column pipe to remove possible sediment from the pump bowls. After reconnecting the discharge head, the pump still would not start.

8-May-06 Boart began removing the submersible test pump.

9-May-06	The submersible test pump was removed from the well. All components checked out well. The submersible pump cable was badly scraped in places (260-300 LF). 2-inch diameter steel T&C pipe with a 1 inch airline was installed to 350 LF bgs to airlift sand and filter pack debris from the well.
10-May-06	Boart removed the 2-inch steel pipe and began reinstalling the submersible test pump with the packer placed approximately 10 ft above the pump intake.
11-May-06	Boart continued to install the submersible test pump.
12-May-06	Boart completed installation of the submersible test pump with the intake at 310.77 LF bgs and the packer placed at 306.77 LF bgs and began development pumping with the packer deflated. The discharge rate was increased from 500 gpm to 1,600 gpm as the sand content declined, before inflating the packer. The packer was inflated to 75 psi (to overcome background pressure by approximately 25 psi). Pumping was resumed, starting at 500 gpm and increasing to 800 gpm as the sand content declined. Discharges to San Juan Creek were monitored for dissolved oxygen content. The pump was turned off to allow the well to recover overnight.
13-May-06	The 48 hour deep zone pumping test was started. Discharges to the diffuser were monitored for dissolved oxygen while the discharge from the well was monitored for field SDI, temperature, conductivity, dissolved oxygen, turbidity, pH, and ORP.
14-May-06	The 48 hour deep zone pumping test continued. Discharges to the diffuser were monitored for dissolved oxygen while the discharge from the well was monitored for field SDI, temperature, conductivity, dissolved oxygen, turbidity, pH, and ORP.
15-May-06	The 48 hour deep zone pumping test was concluded followed by 4 hours of recovery measurements. Discharges to the diffuser were monitored for dissolved oxygen while the discharge from the well was monitored for field SDI, temperature, conductivity, dissolved oxygen, turbidity, pH, and ORP. Boart began dismantling the discharge piping and began removing the submersible pump.
16-May-06	Boart completed removal of the submersible test pump. Pacific Surveys conducted a second video survey of the Test Slant Well. A plastic centralizer was removed from the well.

17-May-06 Deviation surveys were conducted in the Test Slant Well using an EZ-Shot tool. Inclination measured at four points was -21.3° to -22.6° from horizontal. The casing was excavated to a depth of 4 feet below ground surface. The stainless steel casing was cut off at 3 ft below ground surface before a Type 316L stainless steel flange was welded to it. A blind flange with a ¼ inch fitting was attached and the interior of the casing was filled with nitrogen gas to 10 psi (at low tide). The diffuser was removed from the creek. The excavations around the slant well and the monitoring well were filled in and compacted.

18-May-06 Boart removed the pipe for the water line and the fencing at both the beach and the parking area were removed. The beach site was leveled and the sand was placed back over the site. All equipment was loaded onto the pump rig and the trailer. The parking area was swept and the large piles of sand, soil and filter pack material were picked up.

19-May-06 Boart equipment left the site. United Rentals picked up the forklift and the generator. State Parks personnel drove a street sweeper over the parking area to remove any remaining debris.

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Claremont, CA 91711
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www.gssiwater.com

WELL LOCATION MAP

N

MAP SCALE: 100 ft:1 in.

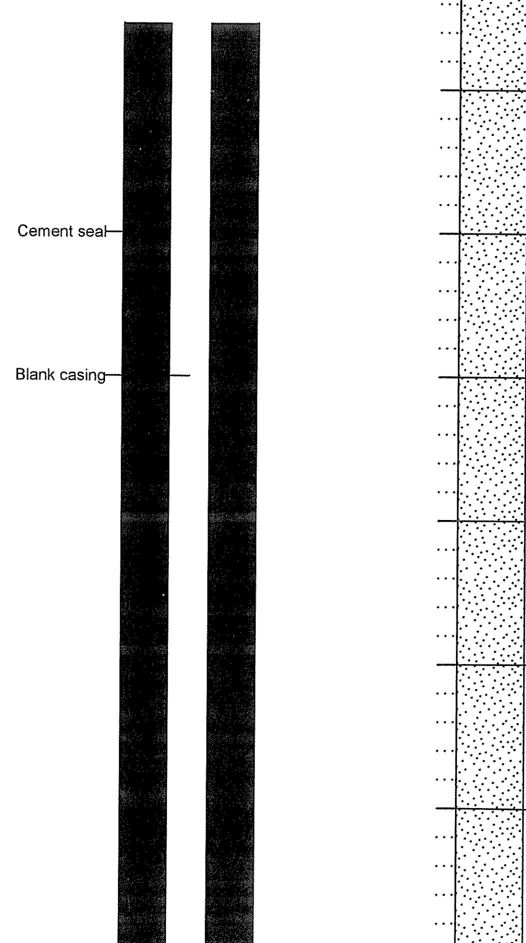
BOREHOLE LITHOLOGIC LOG

WELL NUMBER	SL-1
CLIENT	Municipal Water District of Orange County
PROJECT NUMBER	
LOCATION	Dana Point, California
REPORT DATE	July, 2006
DRILLING CONTRACTOR	Boart Longyear Geotech Division
DRILLER	
LOGGED BY	D. Smith

		SCREEN / BLANK	TOP DEPTH (ft bgs)	BOTTOM DEPTH (ft bgs)	LENGTH (ft)	MATERIAL	WALL THICKNESS (in.)	DIAMETER (in.)	SCREEN TYPE	PERF. SIZE (in.)
DRILLING RIG TYPE	Foremost DR-24HD									
DRILLING METHOD	Dual Rotary	Blank	7.7	130	122.3	316L SS	0.3125	12.125 / ID		
SAMPLING METHOD	Grab	Screen	130	350	220	316L SS	0.3125	12.125 / ID	Ful-Flo	0.09375
BOREHOLE DIAMETER	20 in									
SURFACE ELEVATION										
TOC ELEVATION										
START DATE										
FINISH DATE										

Lithologic Log

NOTE: Grain size distribution percentages are approximate. Material code (e.g. SP) reference Unified Soil Classification visual method. Color code (e.g. 10YR 5/2) reference Munsell Soil Color Charts.



Depth bgs (feet)	Lithologic Log	Sieve Sample Number	Drill Rate (ft/hr)
0–5	NO SAMPLE.		
5–10	SAND (SP): light olive brown (2.5Y 5/3), 95% medium to coarse grained sand, angular to subrounded; 5% fine gravel up to 12mm, angular to subrounded, mostly granitic (some metasediments); trace cobbles; well sorted; contains quartz, feldspar and mica, some weathered feldspars; 3.9 ft bgs.		
10–15	SAND (SP): dark grayish brown (2.5Y 4/2), 98% fine to coarse grained sand, subangular to subrounded; 2% fine gravel up to 12mm, subangular to subrounded, increase of dark minerals; well sorted; contains quartz, feldspar and mica, slightly weathered feldspars; 5.9 ft bgs.		
15–20	SAND (SP): light olive brown (2.5Y 5/3), 100% fine to coarse grained sand, subangular to subrounded; trace coarse gravel subangular to subrounded, increase of dark minerals; well sorted; contains quartz, feldspar and mica, slightly weathered feldspars; 7.8 ft bgs.		
20–25	SAND (SP): dark grayish brown (2.5Y 4/2), 100% medium to coarse grained sand, subangular to subrounded, less fine-grained; trace coarse gravel subangular to subrounded; well sorted; contains quartz, feldspar and mica, 9.8 ft bgs.		
25–30	SAND (SP): dark grayish brown (2.5Y 4/2), 100% medium to coarse grained sand, subangular to subrounded; trace cobbles; trace coarse gravel subangular to subrounded, granitic and mafic; well sorted; contains quartz, feldspar and mica, slightly weathered feldspars; 11.7 ft bgs.		
30–35	SAND (SP): gray (2.5Y 5/1) and grayish brown (2.5Y 5/2), 100% medium to coarse grained sand, subangular to subrounded; trace cobbles; trace fine gravel up to 10mm, subangular to subrounded; well sorted; contains quartz, feldspar and mica, granitic with increase of dark minerals, minor staining; 13.7 ft bgs.		
35–40	SAND (SP): dark gray (2.5Y 4/1), 100% fine grained sand, subangular to subrounded; trace fine gravel up to 8mm, subangular to subrounded; well sorted; contains quartz, feldspar and mica, increase of mafic minerals; 15.6 ft bgs.		

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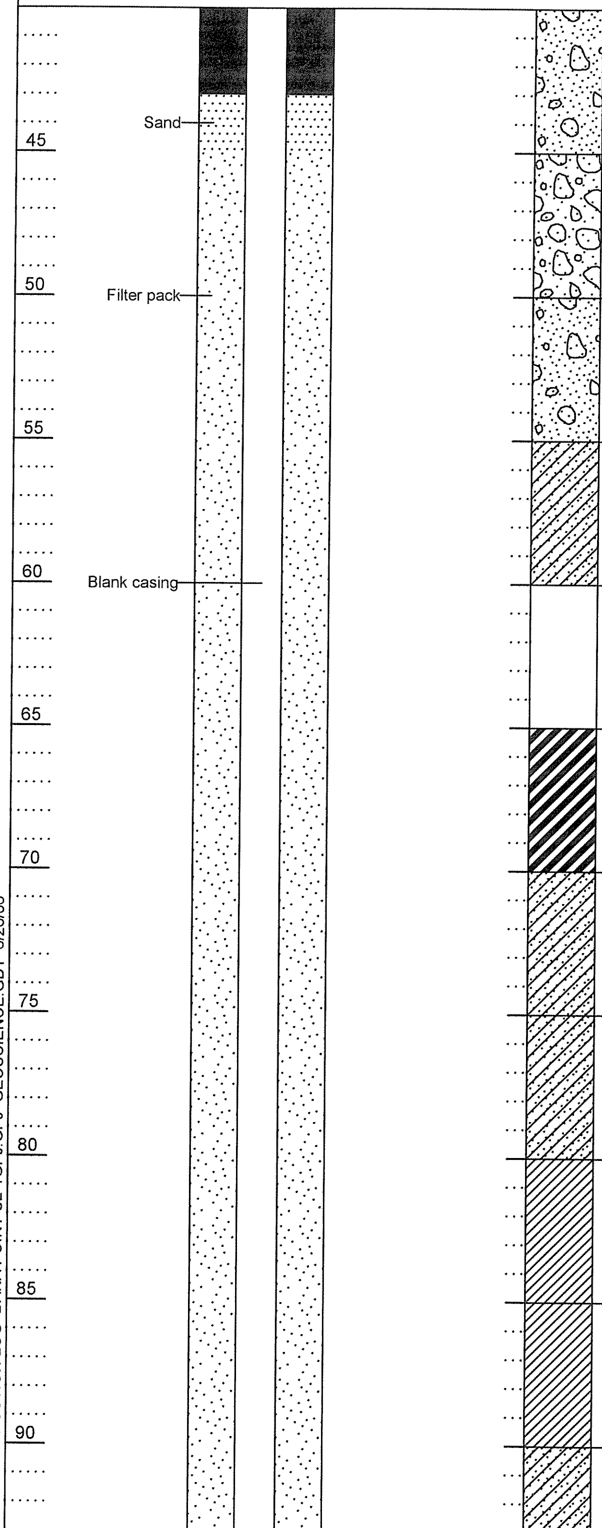
WELL NUMBER
SL-1

BOREHOLE LITHOLOGIC LOG (continued)

CLIENT Municipal Water District of Orange County
PROJECT NUMBER
LOCATION
Dana Point, California

Depth bgs (feet) | (continued) | Zone Test | Graphic Log



Lithologic Log

NOTE: Grain size distribution percentages are approximate. Material code (e.g. SP) reference Unified Soil Classification visual method. Color code (e.g. 10YR 5/2) reference Munsell Soil Color Charts.

Lithologic Log	Depth bgs (feet)	Sieve Sample Number	Drill Rate (ft/hr)
SAND WITH GRAVEL (SP): dark gray (2.5Y 4/1), 70% medium to coarse grained sand, subangular to rounded; 30% fine to coarse gravel up to 20mm, subangular to rounded; well sorted; contains quartz, feldspar and mica, increase of mafic minerals; 17.6 ft bgs.	45		
GRAVEL WITH SAND (GP): very dark gray (2.5Y 3/1), 60% fine to coarse gravel up to 25mm, subangular to rounded; 40% medium to coarse grained sand, subangular to rounded; trace cobbles; trace clay; well sorted; contains quartz, feldspar and mica, 19.5 ft bgs.	50		
SAND WITH GRAVEL (SP): (3N), 80% fine to coarse grained sand, angular to rounded; 15% fine to coarse gravel up to 20mm, angular to rounded, some very well rounded; 5% clay, medium plasticity; poorly sorted; contains quartz, feldspar and mica, 21.5 ft bgs.	55		
CLAYEY SAND (SC): (4N), 60% fine to coarse grained sand, angular to subrounded, interbedded; 30% clay, low plasticity; 10% fine to coarse gravel up to 20mm, angular to subrounded; poorly sorted; contains quartz, feldspar and mica, poor recovery; 23.4.	60		
NO SAMPLE.	65		
FAT CLAY WITH SAND (CH): dark greenish gray (10Y 4/1), 85% clay, low to medium plasticity, interbedded with sandy clay; 10% fine to coarse grained sand, angular to subrounded, poorly sorted; 5% fine gravel up to 5mm, angular to subrounded; contains quartz, feldspar and mica, trace fine mica flakes; poor recovery; 27.4 ft bgs.	70		
CLAYEY SAND (SC): (5GY 3/1), 80% fine grained sand, subrounded; 20% clay, low plasticity; trace fine gravel up to 5mm, subrounded; poorly sorted; contains quartz, feldspar and mica, sample is soupy (no chunks of clay); 29.3 ft bgs.	75		
CLAYEY SAND (SC): (5GY 3/1), 75% fine grained sand, subangular to subrounded; 25% clay, trace hard, dry clay, low plasticity; poorly sorted; contains quartz, feldspar and mica, sample is soupy; 31.3 ft bgs.	80		
CLAY (CL): (5GY 3/1), 95% clay, low plasticity; 5% fine grained sand, subangular to subrounded, well sorted; contains quartz, feldspar and mica, sample is soupy; 33.2 ft bgs.	85		
CLAY WITH SAND (CL): (5GY 3/1), 85% clay, low plasticity; 15% fine grained sand, subangular to subrounded, poorly sorted; trace fine gravel up to 5mm, subangular to subrounded; contains quartz, feldspar and mica, sample is soupy; 35.2 ft bgs.	90		
CLAYEY SAND (SC): (5GY 3/1), 60% fine to medium grained sand, subangular to subrounded; 40% clay, low plasticity; poorly sorted; contains quartz, feldspar and mica, sample is very watery; 37.1 ft bgs.			

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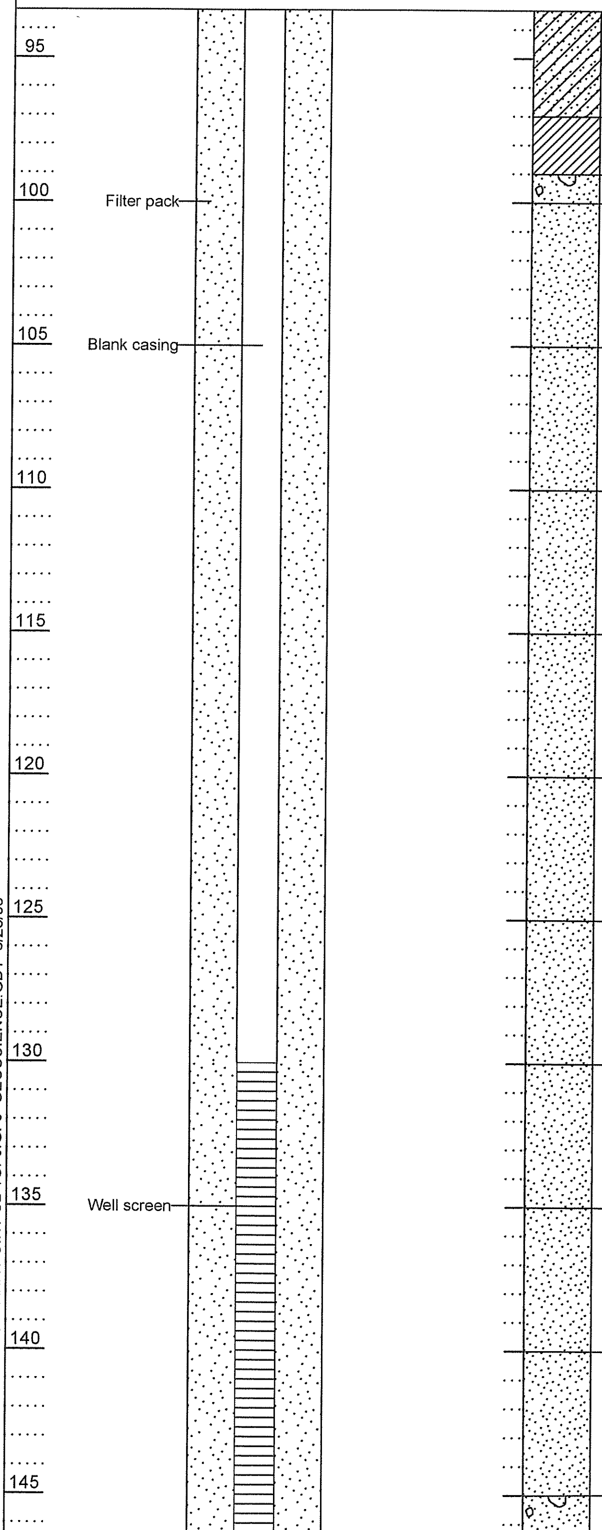
WELL NUMBER **SL-1**

BOREHOLE LITHOLOGIC LOG (continued)

CLIENT Municipal Water District of Orange County
PROJECT NUMBER
LOCATION **Dana Point, California**

Depth bgs (feet) | (continued) | Zone Test | Graphic Log



Lithologic Log

NOTE: Grain size distribution percentages are approximate. Material code (e.g. SP) reference Unified Soil Classification visual method. Color code (e.g. 10YR 5/2) reference Munsell Soil Color Charts.

Depth bgs (feet)	Lithologic Log	Sieve Sample Number	Drill Rate (ft/hr)
95			
~98–100	CLAY WITH SAND (CL): (5GY 3/1), 80% clay, low plasticity; 20% fine grained sand, subangular to subrounded, well sorted; contains quartz, feldspar and mica.		
100	SAND WITH GRAVEL (SP): (5GY 3/1), 80% medium to coarse grained sand, subangular to rounded; 20% fine to coarse gravel up to 75mm, subangular to rounded, and cobbles up to 100 mm; well sorted; contains quartz, feldspar and mica, 39.1 ft bgs.		
100–105	SAND (SP): dark gray (5Y 4/1), 100% medium to coarse grained sand, subangular to rounded; trace cobbles; trace fine to coarse gravel up to 30mm, subangular to rounded; well sorted; contains quartz, feldspar and mica, abundant medium to coarse dark fragments; 41.0 ft bgs.		
105–110	SAND (SP): gray (10YR 6/1), 100% medium to coarse grained sand, subangular to rounded, mostly medium-grained, granitic with some small mafic particles; trace coarse gravel up to 20mm, subangular to rounded, mafic, well rounded; well sorted; contains quartz, feldspar and mica, 43.0 ft bgs.		
110–115	SAND (SP): dark gray (10YR 4/1), 100% medium to coarse grained sand, subangular to rounded, mostly medium-grained, granitic with trace small shell fragments; trace gravel up to 30mm, subangular to rounded; well sorted; contains quartz, feldspar and mica, some well rounded, mafic and metasedimentary particles; 44.9 ft bgs.		
115–120	SAND (SP): dark gray (10YR 4/1), 100% medium to coarse grained sand, subangular to rounded, mostly medium-grained, granitic with trace small shell fragments; trace gravel up to 30mm, subangular to rounded; well sorted; contains quartz, feldspar and mica, some well rounded, mafic and metasedimentary particles; 46.9 ft bgs.		
120–125	SAND (SP): gray (2.5Y 5/1), 95% medium to coarse grained sand, subangular to rounded; 5% fine to coarse gravel up to 40mm, subangular to rounded, metamorphosed, well rounded, some highly micaceous; well sorted; contains quartz, feldspar and mica, 48.8 ft bgs.		
125–130	SAND (SP): dark gray (2.5Y 4/1), 100% medium to coarse grained sand, subangular to rounded; trace gravel up to 10mm, subangular to rounded, metamorphosed, well rounded, some highly micaceous; well sorted; contains quartz, feldspar and mica, 50.8 ft bgs.		
130–135	SAND (SP): gray (2.5Y 6/1), 100% fine to medium grained sand, subrounded, lighter in color, granitic; well sorted; contains quartz, feldspar and mica, 52.7 ft bgs.		
135–140	SAND (SP): dark gray (2.5Y 4/1), 100% fine to coarse grained sand, subangular to rounded; trace gravel subangular to rounded, granitic and metasediments; trace clay, micaceous; well sorted; contains quartz, feldspar and mica, 54.7 ft bgs.		
140–145	SAND (SP): dark gray (2.5Y 4/1), 90% fine to coarse grained sand, subangular to rounded; 5% fine to coarse gravel up to 50mm, subangular to rounded, granitic and metasediments; 5% clay, micaceous, low plasticity; medium sorted; contains quartz, feldspar and mica, 56.7 ft bgs.		
145–	SAND WITH GRAVEL (SP): very dark gray (2.5Y 3/1), 80% fine to coarse grained sand, subangular to rounded; 20% fine gravel up to		

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WELL NUMBER SL-1

BOREHOLE LITHOLOGIC LOG (continued)

CLIENT Municipal Water District of Orange County
PROJECT NUMBER
LOCATION **Dana Point, California**

(continued)

Filter pack

Well screen

Lithologic Log

NOTE: Grain size distribution percentages are approximate. Material code (e.g. SP) reference Unified Soil Classification visual method. Color code (e.g. 10YR 5/2) reference Munsell Soil Color Charts.

Depth bgs (feet)	Description	Sieve Sample Number	Drill Rate (ft/hr)
–150	10mm, subangular to rounded, granitic, metasediments, and intrusives; trace cobbles; well sorted; contains quartz, feldspar and mica, with visible alteration; cobbles are stained; 58.6 ft bgs.		
150–155	SAND (SP): dark gray (2.5Y 4/1), 100% fine to coarse grained sand, subangular to rounded, mostly fine-grained, granitic and micaceous; trace fine gravel up to 10mm, subangular to rounded; well sorted; contains quartz, feldspar and mica, 60.6 ft bgs.		
155–160	SAND (SP): gray (2.5Y 5/1), 100% fine to medium grained sand, subangular to subrounded, granitic; well sorted; contains quartz, feldspar and mica, 62.5 ft bgs.		
160–165	SAND (SP): very dark gray (2.5Y 3/1), 100% fine to coarse grained sand, subangular to rounded, granitic; trace gravel up to 10mm, subangular to rounded; trace clay, low plasticity; medium sorted; contains quartz, feldspar and mica, 64.5 ft bgs.		
165–170	SAND (SP): very dark gray (2.5Y 3/1), 90% fine to coarse grained sand, subangular to rounded; 10% fine to coarse gravel up to 25mm, subangular to rounded, metasediments, weathered and stained; trace clay, medium plasticity; medium sorted; contains quartz, feldspar and mica, with visible alteration; 66.4 ft bgs.		
170–175	SAND (SP): dark gray (2.5Y 4/1), 90% fine to coarse grained sand, subangular to rounded; 10% fine to coarse gravel up to 30mm, subangular to rounded, granitic and metasediments; trace clay, high plasticity; well sorted; contains quartz, feldspar and mica, with visible alteration; some rock fragments, weathered and stained; 68.4 ft bgs.		
175–180	SAND WITH GRAVEL (SP): dark gray (2.5Y 4/1), 80% fine to coarse grained sand, subangular to rounded; 20% fine to coarse gravel up to 50mm, subangular to rounded, granitic and metasediments; trace clay, high plasticity; well sorted; contains quartz, feldspar and mica, with visible alteration; some rock fragments, weathered and stained; 70.3 ft bgs.		
180–185	CLAYEY SAND WITH GRAVEL (SC): dark gray (5Y 4/1), 70% fine to coarse grained sand, subangular to rounded; 15% fine to coarse gravel up to 40mm, subangular to rounded, granitic, metasediments, and volcanics, slight staining; 15% clay, medium plasticity; trace cobbles; poorly sorted; contains quartz, feldspar and mica, with visible alteration; 72.3 ft bgs.		
185–190	SAND (SP): dark gray (2.5Y 4/1), 90% fine to coarse grained sand, subangular to rounded; 10% fine to coarse gravel up to 50mm, subangular to rounded, granitic, metasediments, and volcanics, slight staining; trace cobbles; well sorted; contains quartz, feldspar and mica, with visible alteration; 74.2 ft bgs.		
190–195	SAND WITH GRAVEL (SP): dark gray (2.5Y 4/1), 80% medium to coarse grained sand, subangular to rounded; 20% fine to coarse gravel up to 75mm, subangular to rounded, granitic, metasediments, and volcanics, slight staining; trace cobbles; well sorted; contains quartz, feldspar and mica, with visible alteration; 76.2 ft bgs.		
195–200	SAND WITH GRAVEL (SP): dark gray (2.5Y 4/1), 80% medium to coarse grained sand, subangular to rounded; 20% fine to coarse gravel up to 75mm, subangular to rounded, granitic, metasediments, and volcanics, slight staining; well sorted; contains quartz, feldspar and mica, with visible alteration; 78.1 ft bgs.		

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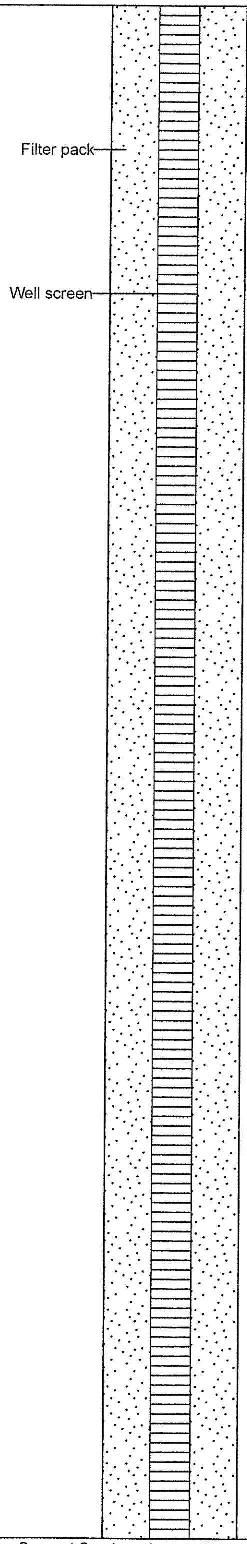
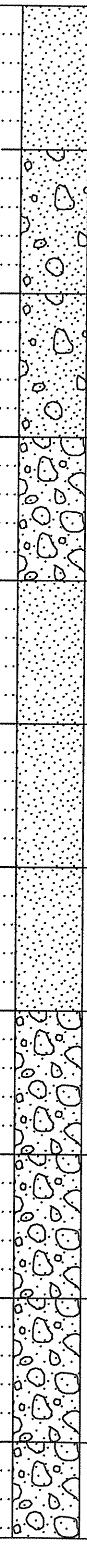
BOREHOLE LITHOLOGIC LOG (continued)

WELL NUMBER: SL-1
CLIENT: Municipal Water District of Orange County
PROJECT NUMBER:
LOCATION: Dana Point, California

(continued)





Lithologic Log

NOTE: Grain size distribution percentages are approximate. Material code (e.g. SP) reference Unified Soil Classification visual method. Color code (e.g. 10YR 5/2) reference Munsell Soil Color Charts.

Depth bgs (feet)	Zone Test	Lithologic Log	Depth bgs (feet)	Sieve Sample Number	Drill Rate (ft/hr)
205		SAND (SP): dark gray (2.5Y 4/1), 90% fine to coarse grained sand, subangular to rounded; 10% fine to coarse gravel up to 60mm, subangular to rounded, granitic, metasediments, and volcanics, slight staining; trace cobbles; well sorted; contains quartz, feldspar and mica, with visible alteration; 80.1 ft bgs.	205		
210		SAND WITH GRAVEL (SP): dark gray (2.5Y 4/1), 70% medium to coarse grained sand, subangular to rounded; 30% fine to coarse gravel up to 75mm, subangular to rounded, granitic, metasediments, and volcanics, slight staining; well sorted; contains quartz, feldspar and mica, with visible alteration; 82.1 ft bgs.	210		
215		SAND WITH GRAVEL (SP): gray (2.5Y 5/1), 70% medium to coarse grained sand, subangular to rounded; 30% fine to coarse gravel up to 75mm, subangular to rounded, granitic, metasediments, and volcanics, slight staining; well sorted; contains quartz, feldspar and mica, with visible alteration; 84.0 ft bgs.	215		
220		GRAVEL WITH SAND (GP): dark gray (2.5Y 4/1), 60% fine to coarse gravel up to 20mm, subangular to rounded, granitic and metasediments, slight staining; 40% medium to coarse grained sand, subangular to rounded; well sorted; contains quartz, feldspar and mica, with visible alteration; 86.0 ft bgs.	220		
225		SAND (SP): dark gray (2.5Y 4/1), 95% fine to coarse grained sand, subangular to rounded; 5% fine to coarse gravel up to 75mm, subangular to rounded, granitic, metasediments, and volcanics, slight staining; well sorted; contains quartz, feldspar and mica, with visible alteration; 87.9 ft bgs.	225		
230		SAND (SP): dark gray (2.5Y 4/1), 100% fine to coarse grained sand, subangular to rounded; trace fine to coarse gravel up to 25mm, subangular to rounded, granitic, metasediments, and volcanics, slight staining; well sorted; contains quartz, feldspar and mica, with visible alteration; 89.9 ft bgs.	230		
235		SAND (SP): dark gray (2.5Y 4/1), 90% medium to coarse grained sand, subangular to rounded; 10% fine to coarse gravel up to 50mm, subangular to rounded, granitic, metasediments, and volcanics, slight staining; well sorted; contains quartz, feldspar and mica, with visible alteration; 91.8 ft bgs.	235		
240		GRAVEL WITH SAND (GP): dark gray (2.5Y 4/1), 55% fine to coarse gravel up to 75mm, subangular to rounded, granitic, metasediments, and volcanics, slight staining; 45% fine to coarse grained sand, subangular to rounded; trace cobbles; medium sorted; contains quartz, feldspar and mica, with visible alteration; large mix of sizes; 93.8 ft bgs.	240		
245		GRAVEL WITH SAND (GP): dark gray (2.5Y 4/1), 55% fine to coarse gravel up to 75mm, subangular to rounded, granitic, metasediments, and volcanics, slight staining; 45% fine to coarse grained sand, subangular to rounded; trace cobbles; medium sorted; contains quartz, feldspar and mica, with visible alteration; large mix of sizes; 95.7 ft bgs.	245		
250		GRAVEL WITH SAND (GP): dark gray (2.5Y 4/1), 70% fine to coarse gravel up to 75mm, subangular to rounded, granitic, metasediments, and volcanics, slight staining; 30% fine to coarse grained sand, subangular to rounded; trace cobbles; medium sorted; contains quartz, feldspar and mica, with visible alteration; large mix of sizes; 97.7 ft bgs.	250		
		GRAVEL WITH SAND (GP): very dark gray (2.5Y 3/1), 70% fine to coarse gravel up to 75mm, subangular to rounded, granitic, metasediments, and volcanics, slight staining; 30% fine to coarse grained sand, subangular to rounded; trace cobbles; medium sorted;			

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WELL NUMBER SL-1	**BOREHOLE LITHOLOGIC LOG (continued)**
CLIENT Municipal Water District of Orange County PROJECT NUMBER	LOCATION **Dana Point, California**

(continued) — Filter pack; Well screen

Depth bgs (feet)	Lithologic Log (NOTE: Grain size distribution percentages are approximate. Material code (e.g. SP) reference Unified Soil Classification visual method. Color code (e.g. 10YR 5/2) reference Munsell Soil Color Charts.)	Depth bgs (feet)	Sieve Sample Number	Drill Rate (ft/hr)
–255	contains quartz, feldspar and mica, with visible alteration; large mix of sizes; 99.6 ft bgs.	255		
255–260	SAND (SP): dark gray (5Y 4/1), 95% fine to coarse grained sand, subangular to rounded; 5% fine to coarse gravel up to 30mm, subangular to rounded, granitic, metasediments, and volcanics, slight staining; poorly sorted; contains quartz, feldspar and mica, with visible alteration; 101.6 ft bgs.	260		
260–265	GRAVEL WITH SAND (GP): black (5Y 2.5/1), 60% fine to coarse gravel up to 75mm, subangular to rounded, metasediments, slight to moderate weathering; 40% fine to coarse grained sand, subangular to rounded, mostly fine-grained; medium sorted; contains quartz, feldspar and mica, with visible alteration; 103.5 ft bgs.	265		
265–270	SAND (SP): dark gray (2.5Y 4/1), 95% fine to medium grained sand, subangular to rounded; 5% fine to coarse gravel up to 50mm, subangular to rounded, metasediments, slight to moderate weathering; medium sorted; contains quartz, feldspar and mica, interval drilled quickly; 105.5 ft bgs.	270		
270–275	SAND (SP): dark gray (2.5Y 4/1), 100% fine to medium grained sand, subangular to rounded, some weathered feldspars; trace fine to coarse gravel up to 30mm, subangular to rounded, metasediments, less staining; medium sorted; contains quartz, feldspar and mica, 107.5 ft bgs.	275		
275–280	SAND (SP): very dark gray (2.5Y 3/1), 100% fine to medium grained sand, subangular to subrounded; well sorted; contains quartz, feldspar and mica, 109.4 ft bgs.	280		
280–285	GRAVEL WITH SAND (GP): very dark gray (2.5Y 3/1), 70% fine to coarse gravel up to 50mm, subangular to rounded, metasediments, slight to moderate weathering; 30% medium to coarse grained sand, subangular to rounded; trace cobbles; medium sorted; contains quartz, feldspar and mica, with visible alteration; 111.4 ft bgs.	285		
285–290	GRAVEL WITH SAND (GP): black (2.5Y 2.5/1), 60% fine to coarse gravel up to 75mm, subangular to rounded, metasediments, slight to moderate weathering; 40% fine to coarse grained sand, subangular to rounded; medium sorted; contains quartz, feldspar and mica, with visible alteration; 113.3 ft bgs.	290		
290–295	GRAVEL WITH SAND (GP): very dark gray (2.5Y 3/1), 60% fine to coarse gravel up to 50mm, subangular to rounded, metasediments, slight to moderate weathering; 40% fine to coarse grained sand, subangular to rounded; medium sorted; contains quartz, feldspar and mica, with visible alteration; 115.3 ft bgs.	295		
295–300	SAND (SP): dark gray (2.5Y 4/1), 100% medium to coarse grained sand, subangular to rounded; trace fine to coarse gravel up to 20mm, subangular to rounded; well sorted; contains quartz, feldspar and mica, with visible alteration; 117.2 ft bgs.	300		
300–305	SAND (SP): dark gray (2.5Y 4/1), 100% fine to coarse grained sand, subangular to rounded; trace fine to coarse gravel up to 20mm, subangular to rounded; well sorted; contains quartz, feldspar and mica, with visible alteration; 119.2 ft bgs.	305		
305–	GRAVEL WITH SAND (GP): dark gray (2.5Y 4/1), 80% fine to coarse gravel up to 50mm, subangular to rounded, granitic, metasediments,			

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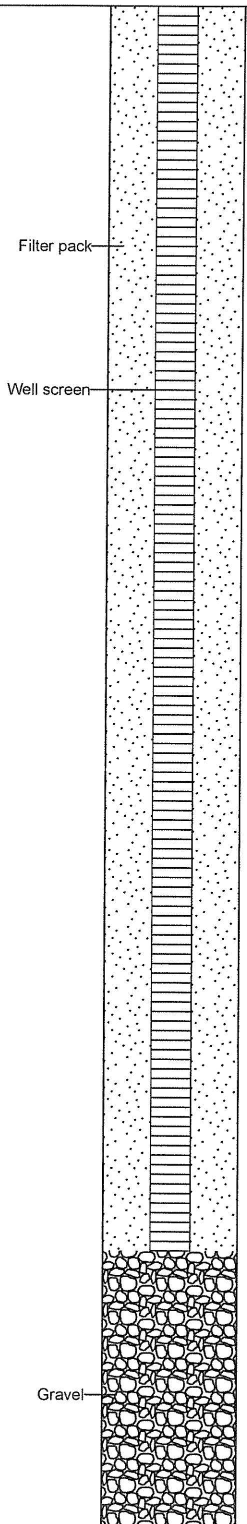
WELL NUMBER: **SL-1**

BOREHOLE LITHOLOGIC LOG (continued)

CLIENT: Municipal Water District of Orange County
PROJECT NUMBER:
LOCATION: **Dana Point, California**

(continued)



Lithologic Log

NOTE: Grain size distribution percentages are approximate. Material code (e.g. SP) reference Unified Soil Classification visual method. Color code (e.g. 10YR 5/2) reference Munsell Soil Color Charts.

Depth bgs (feet)	Zone Test	Lithologic Log	Depth bgs (feet)	Sieve Sample Number	Drill Rate (ft/hr)
310		and volcanics, slight to moderate weathering; 20% medium to coarse grained sand, subangular to rounded; trace cobbles; well sorted; contains quartz, feldspar and mica, with visible alteration; 121.1 ft bgs.	310		
315		GRAVEL WITH SAND (GP): dark gray (2.5Y 4/1), 70% fine to coarse gravel up to 60mm, subangular to rounded, granitic, metasediments, and volcanics, slight to moderate weathering; 30% medium to coarse grained sand, subangular to rounded; trace cobbles; well sorted; contains quartz, feldspar and mica, with visible alteration; 123.1 ft bgs.	315		
320		SAND WITH GRAVEL (SP): dark gray (2.5Y 4/1), 85% medium to coarse grained sand, subangular to rounded; 15% fine to coarse gravel up to 75mm, subangular to rounded, granitic, metasediments, and volcanics, slight to moderate weathering; trace cobbles; medium sorted; contains quartz, feldspar and mica, with visible alteration; 125.0 ft bgs.	320		
325		GRAVEL WITH SAND (GP): dark gray (2.5Y 4/1), 80% fine to coarse gravel up to 50mm, angular to rounded, granitic and metasediments; 20% medium to coarse grained sand, angular to rounded; trace cobbles; well sorted; contains quartz, feldspar and mica, with visible alteration; some rock fragments with moderate staining; 127.0 ft bgs.	325		
330		GRAVEL WITH COBBLES (GP): dark gray (2.5Y 4/1), 80% fine to coarse gravel up to 75mm, subangular to rounded; 10% medium to coarse grained sand, subangular to rounded; 10% cobbles up to 80mm; well sorted; contains quartz, feldspar and mica, with visible alteration; granitic, metasediments, and volcanic material; cobbles are very well rounded; 128.9 ft bgs.	330		
335		GRAVEL WITH COBBLES (GP): dark gray (2.5Y 4/1), 80% fine to coarse gravel up to 75mm, subangular to rounded; 10% medium to coarse grained sand, subangular to rounded; 10% cobbles up to 80mm; well sorted; contains quartz, feldspar and mica, with visible alteration; granitic, metasediments, and volcanic material; cobbles are very well rounded; 130.9 ft bgs.	335		
340		GRAVEL WITH COBBLES (GP): dark gray (2.5Y 4/1), 70% fine to coarse gravel up to 75mm, subangular to rounded; 25% fine to coarse grained sand, subangular to rounded; 5% cobbles up to 80mm; medium sorted; contains quartz, feldspar and mica, with visible alteration; granitic, metasediments, and volcanic material; cobbles are very well rounded; 132.8 ft bgs.	340		
345		GRAVEL WITH SAND (GP): dark gray (2.5Y 4/1), 80% fine to coarse gravel up to 70mm, subangular to rounded, granitic, metasediments, and volcanics, slightly to moderately stained; 20% medium to coarse grained sand, subangular to rounded, mostly medium- to coarse-grained; medium sorted; contains quartz, feldspar and mica, with visible alteration; 134.8 ft bgs.	345		
350		GRAVEL WITH SAND (GP): dark gray (2.5Y 4/1), 70% fine to coarse gravel up to 75mm, subangular to rounded, granitic, metasediments, and volcanics; 30% fine to coarse grained sand, subangular to rounded; trace cobbles up to 90mm; trace silt; poorly sorted; contains quartz, feldspar and mica, with visible alteration; 136.8 ft bgs.	350		
355		SAND (SP): dark gray (2.5Y 4/1), 100% fine grained sand, subangular to subrounded; trace silt; trace clay, with very fine-grained sand, medium plasticity; medium sorted; contains quartz, feldspar and mica, sample is watery; 138.7 ft bgs.	355		
360		SAND (SP): dark grayish brown (10YR 4/2), 100% fine to medium grained sand, subrounded, highly micaceous; well sorted; contains quartz, feldspar and mica, 140.7 ft bgs.	360		

WELL CONSTRUCTION LOG DANA POINT SL-1GPJ.GPJ GEOSCIENCE.GDT 6/28/06

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WELL NUMBER SL-1	BOREHOLE LITHOLOGIC LOG (continued)
CLIENT Municipal Water District of Orange County PROJECT NUMBER	LOCATION Dana Point, California

Depth bgs (feet)	(continued)	Zone Test	Graphic Log	Lithologic Log NOTE: Grain size distribution percentages are approximate. Material code (e.g. SP) reference Unified Soil Classification visual method. Color code (e.g. 10YR 5/2) reference Munsell Soil Color Charts.	Depth bgs (feet)	Sieve Sample Number	Drill Rate (ft/hr)
				SAND (SP): dark grayish brown (10YR 4/2), 100% fine to medium grained sand, subrounded, highly micaceous; well sorted; contains quartz, feldspar and mica, 141.4 ft bgs.			
				Bottom of borehole at 362 feet.			

WELL CONSTRUCTION LOG DANA POINT SL-1GPJ.GPJ GEOSCIENCE.GDT 6/28/06

Appendix C
Photographic Log of Borehole Samples from Test Slant Well SL-1

Lineal footage is equal to the distance from ground surface along the 23 degree angle of the Test Slant Well. Vertical footage is equal to lineal footage multiplied by the sine of 23°.

Lineal Feet Below Ground Surface	Vertical Feet Below Ground Surface	
5 to 10	2.0 to 3.9	
10 to 15	3.9 to 5.9	
15 to 20	5.9 to 7.8	

Lineal Feet Below Ground Surface	Vertical Feet Below Ground Surface	
20 to 25	7.8 to 9.8	
25 to 30	9.8 to 11.7	
30 to 35	11.7 to 13.7	

Lineal Feet	Vertical Feet	
35 to 40	13.7 to 15.6	
40 to 45	15.6 to 17.6	
45 to 50	17.6 to 19.5	
50 to 55	19.5 to 21.5	

Lineal Feet	Vertical Feet	
55 to 60	21.5 to 23.4	
60 to 65	23.4 to 25.4	No Sample Collected
65 to 70	25.4 to 27.4	
70 to 75	27.4 to 29.3	

Lineal Feet	Vertical Feet	
75 to 80	29.3 to 31.3	
80 to 85	31.3 to 33.2	
85 to 90	33.2 to 35.2	
90 to 95	35.2 to 37.1	

Lineal Feet	Vertical Feet	
95 to 100	37.1 to 39.1	
100 to 105	39.1 to 41.0	
105 to 110	41.0 to 43.0	
110 to 115	43.0 to 44.9	

Lineal Feet	Vertical Feet	
115 to 120	44.9 to 46.9	
120 to 125	46.9 to 48.8	
125 to 130	48.8 to 50.8	
130 to 135	50.8 to 52.7	

Lineal Feet	Vertical Feet	
135 to 140	52.7 to 54.7	
140 to 145	54.7 to 56.7	
145 to 150	56.7 to 58.6	
150 to 155	58.6 to 60.6	

Lineal Feet	Vertical Feet	
155 to 160	60.6 to 62.5	
160 to 165	62.5 to 64.5	
165 to 170	64.5 to 66.4	
170 to 175	66.4 to 68.4	

Lineal Feet	Vertical Feet	
175 to 180	68.4 to 70.3	
180 to 185	70.3 to 72.3	
185 to 190	72.3 to 74.2	
190 to 195	74.2 to 76.2	

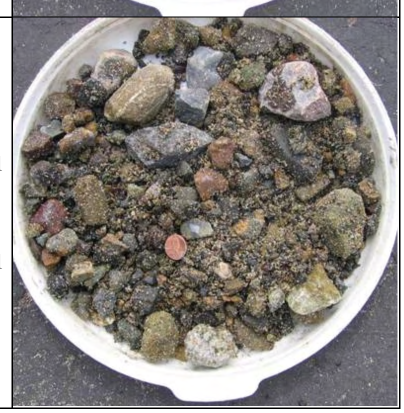
Lineal Feet	Vertical Feet	
195 to 200	76.2 to 78.1	
200 to 205	78.1 to 80.1	
205 to 210	80.1 to 82.1	
210 to 215	82.1 to 84.0	

Lineal Feet	Vertical Feet	
215 to 220	84.0 to 86.0	
220 to 225	86.0 to 87.9	
225 to 230	87.9 to 89.9	
230 to 235	89.9 to 91.8	

Lineal Feet	Vertical Feet	
235 to 240	91.8 to 93.8	
240 to 245	93.8 to 95.7	
245 to 250	95.7 to 97.7	
250 to 255	97.7 to 99.6	

Lineal Feet	Vertical Feet	
255 to 260	99.6 to 101.6	
260 to 265	101.6 to 103.5	
265 to 270	103.5 to 105.5	
270 to 275	105.5 to 107.5	

Lineal Feet	Vertical Feet	
275 to 280	107.5 to 109.4	
280 to 285	109.4 to 111.4	
285 to 290	111.4 to 113.3	
290 to 295	113.3 to 115.3	

Lineal Feet	Vertical Feet	
295 to 300	115.3 to 117.2	
300 to 305	117.2 to 119.2	
305 to 310	119.2 to 121.1	
310 to 315	121.1 to 123.1	

Lineal Feet	Vertical Feet	
315 to 320	123.1 to 125.0	
320 to 325	125.0 to 127.0	
325 to 330	127.0 to 128.9	
330 to 335	128.9 to 130.9	

Lineal Feet	Vertical Feet	
335 to 340	130.9 to 132.8	
340 to 345	132.8 to 134.8	
345 to 350	134.8 to 136.8	
350 to 355	136.8 to 138.7	

Lineal Feet	Vertical Feet	
355 to 360	138.7 to 140.7	
360 to 362	140.7 to 141.7	

MUNICIPAL WATER DISTRICT OF ORANGE COUNTY

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April 28, 2006

Whitney J. Ghoram
Industrial Compliance Unit
California Regional Water Quality Control Board, San Diego Region
9174 Sky Park Circle, Suite 100
San Diego, CA 92124

Dear Ms. ~~Ghoram~~ Whitney:

Subject: Monthly Monitoring Report
General NPDES Permit Order 2001-96
Test Slant Well at Doheny State Beach

In accordance with the subject NPDES Permit Monitoring and Reporting requirements, attached are: Table 1 laboratory water quality analyses and Table 2 daily flow rates. The results reported are for constituents requiring biweekly analysis and monthly reporting for the test well discharge for March 2006.

The project work was suspended over the Easter/Spring Break and a short term deep zone pump test will be conducted over May 6-7, 2006. This will complete the testing work and discharges will cease at that time.

If you should need any additional information or have any questions, please do not hesitate to call me at (714) 593-5003 or contact me via email at rbell@mwdoc.com.

Sincerely,

Richard B. Bell, P.E.
Principal Engineer and Project Manager

Attachments:

1. Table 1 Laboratory Water Quality Analysis Results for Constitutents Requiring Biweekly Analysis and Monthly Reporting

2. Table 2 Ground Water Discharge Daily Flowrate

Table 1

Ground Water Discharge Monitoring for Short-Term Discharges from MWDOC Test Slant Well (SL-1) at Doheny Beach, Dana Point, CA
Laboratory Water Quality Analysis Results for Constituents Requiring Biweekly Analysis and Monthly Reporting
Monitoring and Reporting Program No. 2001-96, Section D.5.

Constituent	Sample Date		Units	Method	Section B.3 (Discharge to Surf Zone) Effluent Limitations				
	3/19/2006	*4/3/2006*			6-Month Median	30-Day Average	Daily Maximum	Instant-aneous Maximum	Section B.3 Eff. Units
Flowrate	See Table 2 for daily flow rate (gpd)								
Total Nitrogen[1]	**2.0**	**1.7**	mg/l	Calculation	none	none	none	none	
Total Phosphorus[1]	**0.11**	**0.18**	mg/l	EPA 365.3	none	none	none	none	
Settleable Solids	<0.10	<0.10	ml/l/hr	EPA 160.5	-	1	-	2	ml/L
Total Suspended Solids	<10	<10	mg/l	EPA 160.2	-	60	-	100	mg/L
Hydrogen Sulfide	<0.10	<0.10	mg/l	SM4500-S,F	none	none	none	none	
Total Residual Chlorine (TRC)[2]	<0.10	<0.10	mg/l	EPA 330.5	8	-	32	240	µg/L
pH	**7.94**	**7.17**	pH Units	EPA 150.1	Within the limits of 6.0 to 9.0 at all times.				units
Total Petroleum Hydrocarbons[3]	<50	<50	µg/l	EPA 8015B/8021B	-	-	-	0.5	mg/L
MTBE	<5.0	<5.0	µg/l	EPA 8015B/8021B	none	none	none	none	

NOTES:
Laboratory analyses performed by Del Mar Analytical, of Irvine, CA, unless otherwise noted.

1. Analysis of nitrogen and phosphorus are not required for direct discharges to the surf zone.
2. Total Chlorine Residual must be monitored if any portion of the extraction waste stream is chlorinated.
3. Groundwater remediation projects involving only diesel fuels and groundwater dewatering operations may use the California Department of Health Services' recommended analytical procedure contained in the Leaking Underground Fuel Tank Field Manual: Guidelines for Site Assessment, Cleanup, and Underground Storage Tank Closure, October 1989 (LUFT Manual) for determining diesel total petroleum hydrocarbon concentrations (TPH - diesel) in the discharge unless other analytical methods are specified by the Regional Board. Groundwater remediation projects involving only gasoline may use standard analytical techniques contained in the LUFT Manual for the determination of TPH concentrations in the discharge unless other methods are specified by the Regional Board.

Table 2

Ground Water Discharge Monitoring for Short-Term Discharges from MWDOC Test Slant Well (SL-1) at Doheny Beach, Dana Point, CA
Daily Flowrate

Date	Volume Discharged (gallons per day)	Task Related to Discharge
14-Mar-06	158,220	Airlift and Swab Development
15-Mar-06	121,320	Airlift and Swab Development
16-Mar-06	89,325	Airlift and Swab Development
17-Mar-06	111,405	Airlift and Swab Development
18-Mar-06	155,880	Airlift and Swab Development
19-Mar-06	195,800	Airlift and Swab Development
20-Mar-06	30,000	Empty Discharge Tanks
24-Mar-06	36,000	Pump Installation
25-Mar-06	595,000	Development Pumping
26-Mar-06	520,000	Development Pumping
27-Mar-06	711,500	Development Pumping
28-Mar-06	617,000	Development Pumping
29-Mar-06	529,500	Step Test
31-Mar-06	1,504,000	Constant Rate Test
1-Apr-06	2,390,000	Constant Rate Test
2-Apr-06	2,287,000	Constant Rate Test
3-Apr-06	2,386,000	Constant Rate Test
4-Apr-06	2,385,000	Constant Rate Test
5-Apr-06	898,000	Constant Rate Test
Total Volume Discharged	**15,720,950**	

MUNICIPAL WATER DISTRICT OF ORANGE COUNTY

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June 15, 2006

Industrial Compliance Unit
ATTN: Ms. Whitney J. Ghoram
California Regional Water Quality Control Board, San Diego Region
9174 Sky Park Circle, Suite 100
San Diego, CA 92124

Subject: Notice of Discharge Termination
General NPDES Permit Order 2001-96
Subsurface Intake System Feasibility Investigation
Test Slant Well at Doheny State Beach

Dear Ms. Ghoram:

Pursuant to the subject NPDES permit, this letter is sent to notify you that the temporary discharge from the subject Test Slant Well construction phase was terminated on May 15, 2006. Monitoring reports for water quality and flow monitoring are attached with this email. The original letter will be mailed.

If you should have any questions or need additional information, please do not hesitate to call me at (714) 593-5003 or (714) 271-6641 (cell) or contact me via email at rbell@mwdoc.com.

Sincerely,

Richard B. Bell, P.E.
Principal Engineer/Project Manager

Attachments:

Table 1 Ground Water Discharge Monitoring – Laboratory Analyses
Table 2 Ground Water Discharge Monitoring – Daily Flowrate

cc: Dr. Dennis Williams/Sarah Bartlett - Geoscience

Table 1

Ground Water Discharge Monitoring for Short-Term Discharges from MWDOC Test Slant Well (SL-1) at Doheny Beach, Dana Point, CA
Laboratory Water Quality Analysis Results for Monitoring and Reporting Program No. 2001-96, Section D.5.

Constituent	Sample Date			Units	Method	Section B.3 (Discharge to Surf Zone) Effluent Limitations				
	3/19/2006	*4/3/2006*	*5/13/2006*			6-Month Median	30-Day Average	Daily Maximum	Instant-aneous Maximum	Section B.3 Eff. Units
Flowrate	See Table 2 for daily flow rate (gpd)									
Total Nitrogen[1]	**2.0**	**1.7**	**3.1**	mg/l	Calculation	none	none	none	none	
Total Phosphorus[1]	**0.11**	**0.18**	**0.24**	mg/l	EPA 365.3	none	none	none	none	
Settleable Solids	<0.10	<0.10	<0.10	ml/l/hr	EPA 160.5	-	1	-	2	ml/L
Total Suspended Solids	<10	<10	<10	mg/l	EPA 160.2	-	60	-	100	mg/L
Hydrogen Sulfide	<0.10	<0.10	<0.10	mg/l	SM4500-S,F	none	none	none	none	
Total Residual Chlorine (TRC)[2]	<0.10	<0.10	<0.10	mg/l	EPA 330.5	8	-	32	240	μg/L
pH	**7.94**	**7.17**	**7.19**	pH Units	EPA 150.1	Within the limits of 6.0 to 9.0 at all times.				units
Total Petroleum Hydrocarbons[3]	<50	<50	<50	μg/l	EPA 8015B/8021B	-	-	-	0.5	mg/L
MTBE	<5.0	<5.0	<5.0	μg/l	EPA 8015B/8021B	none	none	none	none	
Tributyltin	-	<0.005	-	μg/l	GC - FPD	-	5.6	-	-	ng/L
Arsenic CTR	-	**14**	-	μg/l	EPA 200.8	23	-	119	311	μg/L
Cadmium CTR	-	<3.0	-	μg/l	EPA 200.8	4	-	16	40	μg/L
Hexavalent Chromium [4] CTR	-	<0.025	-	mg/l	EPA 7196A	8	-	32	80	μg/L
Copper CTR	-	**7.9** [a]	-	μg/l	EPA 200.8	**6**	-	42	114	μg/L
Copper CTR	-	**0.091**[a]	-	μg/l	EPA 1640	6	-	42	114	μg/L
Lead CTR	-	<3.0	-	μg/l	EPA 200.8	8	-	32	80	μg/L
Mercury CTR	-	<0.00020	-	mg/l	EPA 245.1	0.16	-	0.64	1.6	μg/L
Nickel CTR	-	<3.0	-	μg/l	EPA 200.8	20	-	80	200	μg/L
Silver CTR	-	<3.0	-	μg/l	EPA 200.8	2.32	-	10.7	28	μg/L
Zinc CTR	-	**42**	-	μg/l	EPA 200.8	56	-	296	776	μg/L
Cyanide CTR	-	<0.0050	-	mg/l	EPA 335.2	4	-	16	40	μg/L
Phenolic Compounds (non-chlorinated)	-	ND	-	μg/l	EPA 8270C	120	-	480	1,200	μg/L
Chlorinated Phenolics	-	ND	-	μg/l	EPA 8270C	4	-	16	40	μg/L
Acute Toxicity (in lieu of Chronic Toxicity[5])	-	0.0	-	TUa	EPA 2006.0	-	1.5	-	2.5	TUa
Base/Neutrals[7]	-	ND	-	μg/l	EPA 8270C	-	-	-	10	μg/L
126 Priority Pollutants (Excluding Constituents Above Marked CTR)										
Antimony	-	<6.0	-	μg/l	EPA 200.8	-	4.8	-	-	mg/L
Beryllium	-	<1.5	-	μg/l	EPA 200.8	-	132	-	-	ng/L
Chromium (III)	-	<0.0050	-	mg/l	Calculation	none	none	none	none	
Selenium	-	**10**	-	μg/l	EPA 200.8	60	-	240	600	μg/L

Table 1

Ground Water Discharge Monitoring for Short-Term Discharges from MWDOC Test Slant Well (SL-1) at Doheny Beach, Dana Point, CA
Laboratory Water Quality Analysis Results for Monitoring and Reporting Program No. 2001-96, Section D.5.

Constituent	Sample Date			Units	Method	Section B.3 (Discharge to Surf Zone) Effluent Limitations				
	3/19/2006	4/3/2006	5/13/2006			6-Month Median	30-Day Average	Daily Maximum	Instant-aneous Maximum	Section B.3 Eff. Units
Thallium	-	<3.0	-	µg/l	EPA 200.8	-	56	-	-	µg/L
Asbestos	-	<5.4	-	MF/L	TEM (100.1-WW)	none	none	none	none	
2,3,7,8-TCDD (Dioxin)	-	<1.8	-	pg/L	EPA 8280	none	none	none	none	
Acrolein	-	<5.0	-	µg/l	EPA 8260B	-	-	-	10	µg/L
Acrylonitrile	-	<2.0	-	µg/l	EPA 8260B	-	0.40	-	-	µg/L
Benzene	<0.30	<0.30	<0.30	µg/l	EPA 8015B/8021B	-	-	-	5	µg/L
Bromoform	-	<1.0	-	µg/l	EPA 8260B	-	-	-	5	µg/L
Carbon tetrachloride	-	<0.50	-	µg/l	EPA 8260B	-	3.6	-	-	µg/L
Chlorobenzene	-	<1.0	-	µg/l	EPA 8260B	-	-	-	5	µg/L
Chlorodibromomethane	-	<1.0	-	µg/l	EPA 8260B	-	-	-	5	µg/L
Chloroethane	-	<1.0	-	µg/l	EPA 8260B	none	none	none	none	
2-Chloroethyl vinyl ether	-	<5.0	-	µg/l	EPA 8260B	none	none	none	none	
Chloroform	-	<1.0	-	µg/l	EPA 8260B	-	0.52	-	-	mg/L
Dichlorobromomethane	-	<1.0	-	µg/l	EPA 8260B	-	-	-	5	µg/L
1,1-Dichloroethane	-	<1.0	-	µg/l	EPA 8260B	none	none	none	none	
1,2-dichloroethane	-	<0.50	-	µg/l	EPA 8260B	-	-	-	5	µg/L
1,1-dichloroethylene	-	<1.0	-	µg/l	EPA 8260B	-	-	-	5	µg/L
1,2-dichloropropane	-	<1.0	-	µg/l	EPA 8260B	none	none	none	none	
1,3-Dichloropropene	-	<0.50	-	µg/l	EPA 8260B	-	-	-	5	µg/L
Ethylbenzene	<0.30	<0.30	<0.30	µg/l	EPA 8015B/8021B	-	-	-	5	µg/L
Bromomethane	-	<1.0	-	µg/l	EPA 8260B	-	-	-	5	µg/L
Chloromethane	-	<1.0	-	µg/l	EPA 8260B	-	-	-	5	µg/L
Dichloromethane (Methylene chloride)	-	<5.0	-	µg/l	EPA 8260B	-	-	-	10	µg/L
1,1,2,2-tetrachloroethane	-	<1.0	-	µg/l	EPA 8260B	-	-	-	5	µg/L
Tetrachloroethylene	-	<1.0	-	µg/l	EPA 8260B	-	-	-	5	µg/L
Toluene	<0.30	<0.30	**5.1**[b]	µg/l	EPA 8015B/8021B	-	-	-	5	µg/L
trans-1,2-Dichloroethylene	-	<1.0	-	µg/l	EPA 8260B	none	none	none	none	
1,1,1-trichloroethane	-	<1.0	-	µg/l	EPA 8260B	-	-	-	5.0	µg/L
1,1,2-trichloroethane	-	<1.0	-	µg/l	EPA 8260B	-	-	-	5.0	µg/L
Trichloroethylene	-	<1.0	-	µg/l	EPA 8260B	-	-	-	5	µg/L
Vinyl chloride	-	<0.50	-	µg/l	EPA 8260B	-	-	-	5	µg/L
2-Chlorophenol	-	<0.94	-	µg/l	EPA 8270C	none	none	none	none	
2,4-Dichlorophenol	-	<1.9	-	µg/l	EPA 8270C	none	none	none	none	
2,4-Dimethylphenol	-	<1.9	-	µg/l	EPA 8270C	none	none	none	none	

Table 1

Ground Water Discharge Monitoring for Short-Term Discharges from MWDOC Test Slant Well (SL-1) at Doheny Beach, Dana Point, CA
Laboratory Water Quality Analysis Results for Monitoring and Reporting Program No. 2001-96, Section D.5.

Constituent	Sample Date			Units	Method	Section B.3 (Discharge to Surf Zone) Effluent Limitations				
	3/19/2006	*4/3/2006*	*5/13/2006*			6-Month Median	30-Day Average	Daily Maximum	Instant-aneous Maximum	Section B.3 Eff. Units
2-Methyl-4,6-Dinitrophenol (4,6-dinitro-2-methylphenol)	-	<4.7	-	µg/l	EPA 8270C	-	-	-	10	µg/L
2,4-dinitrophenol	-	<4.7	-	µg/l	EPA 8270C	-	-	-	10	µg/L
2-Nitrophenol	-	<1.9	-	µg/l	EPA 8270C	none	none	none	none	
4-Nitrophenol	-	<4.7	-	µg/l	EPA 8270C	none	none	none	none	
3-Methyl-4-Chlorophenol (4-Chloro-3-methylphenol)	-	<1.9	-	µg/l	EPA 8270C	none	none	none	none	
Pentachlorophenol	-	<1.9	-	µg/l	EPA 8270C	none	none	none	none	
Phenol	-	<0.94	-	µg/l	EPA 8270C	none	none	none	none	
2,4,6-trichlorophenol	-	<0.94	-	µg/l	EPA 8270C	-	1.16	-	-	µg/L
Acenaphthene	-	<0.47	-	µg/l	EPA 8270C	none	none	none	none	
Acenapthylene	-	<0.47	-	µg/l	EPA 8270C	-	35.2	-	-	ng/L
Anthracene	-	<0.47	-	µg/l	EPA 8270C	-	35.2	-	-	ng/L
Benzidine	-	<4.7	-	µg/l	EPA 8270C	-	0.28	-	-	ng/L
Benzo(a)anthracene (1,2-Benzanthracene)	-	<4.7	-	µg/l	EPA 8270C	-	35.2	-	-	ng/L
Benzo(a)pyrene (3,4-Benzopyrene)	-	<1.9	-	µg/l	EPA 8270C	none	none	none	none	
Benzo(b)fluoranthene (3,4-Benzofluoranthene)	-	<1.9	-	µg/l	EPA 8270C	-	35.2	-	-	ng/L
Benzo(g,h,i)perylene	-	<4.7	-	µg/l	EPA 8270C	none	none	none	none	
Benzo(k)fluoranthene	-	<0.47	-	µg/l	EPA 8270C	-	35.2	-	-	ng/L
bis(2-chloroethoxy) methane	-	<0.47	-	µg/l	EPA 8270C	-	-	-	10	µg/L
bis(2-chloroethyl) ether	-	<0.47	-	µg/l	EPA 8270C	-	0.18	-	-	µg/L
bis(2-chloroisopropyl) ether	-	<0.47	-	µg/l	EPA 8270C	-	-	-	10	µg/L
bis(2-ethylhexyl) phthalate	-	<4.7	-	µg/l	EPA 8270C	-	-	-	10	µg/L
4-Bromophenyl phenyl ether	-	<0.94	-	µg/l	EPA 8270C	none	none	none	none	
Butyl benzyl phthalate	-	<4.7	-	µg/l	EPA 8270C	none	none	none	none	
2-Chloronaphthalene	-	<0.47	-	µg/l	EPA 8270C	none	none	none	none	
4-Chlorophenyl phenyl ether	-	<0.47	-	µg/l	EPA 8270C	none	none	none	none	
Chrysene	-	<0.47	-	µg/l	EPA 8270C	none	none	none	none	
Dibenzo(a,h)-anthracene	-	<0.47	-	µg/l	EPA 8270C	none	none	none	none	
1,2-Dichlorobenzene	-	<0.47	-	µg/l	EPA 8270C	-	-	-	10.0	µg/L
1,3-Dichlorobenzene	-	<0.47	-	µg/l	EPA 8270C	-	-	-	10.0	µg/L
1,4-Dichlorobenzene	-	<0.47	-	µg/l	EPA 8270C	none	none	none	none	
3,3-dichlorobenzidine	-	<4.7	-	µg/l	EPA 8270C	-	32.4	-	-	ng/L
Diethyl phthalate	-	<0.94	-	µg/l	EPA 8270C	-	-	-	10	µg/L
Dimethyl phthalate	-	<0.47	-	µg/l	EPA 8270C	-	-	-	10	µg/L
Di-n-butyl phthalate	-	<1.9	-	µg/l	EPA 8270C	-	-	-	10	µg/L

Table 1

Ground Water Discharge Monitoring for Short-Term Discharges from MWDOC Test Slant Well (SL-1) at Doheny Beach, Dana Point, CA
Laboratory Water Quality Analysis Results for Monitoring and Reporting Program No. 2001-96, Section D.5.

Constituent	Sample Date			Units	Method	Section B.3 (Discharge to Surf Zone) Effluent Limitations				
	3/19/2006	4/3/2006	5/13/2006			6-Month Median	30-Day Average	Daily Maximum	Instant-aneous Maximum	Section B.3 Eff. Units
2,4-dinitrotoluene	-	<4.7	-	µg/l	EPA 8270C	-	10.4	-	-	µg/L
2,6-Dinitrotoluene	-	<4.7	-	µg/l	EPA 8270C	none	none	none	none	
Di-n-octylphthalate	-	<4.7	-	µg/l	EPA 8270C	none	none	none	none	
1,2-diphenylhydrazine	-	<0.94	-	µg/l	EPA 8270C	-	0.64	-	-	µg/L
Fluoranthene	-	<0.47	-	µg/l	EPA 8270C	-	-	-	10	µg/L
Fluorene	-	<0.47	-	µg/l	EPA 8270C	none	none	none	none	
Hexachlorobenzene	-	<0.94	-	µg/l	EPA 8270C	-	0.84	-	-	ng/L
Hexachlorobutadiene	-	<1.9	-	µg/l	EPA 8270C	-	-	-	5	µg/L
Hexachlorocyclopentadiene	-	<4.7	-	µg/l	EPA 8270C	-	-	-	10	µg/L
Hexachloroethane	-	<2.8	-	µg/l	EPA 8270C	-	10.0	-	-	µg/L
Indeno(1,2,3-c,d)pyrene	-	<1.9	-	µg/l	EPA 8270C	-	35.2	-	-	ng/L
Isophorone	-	<0.94	-	µg/l	EPA 8270C	-	-	-	10	µg/L
Naphthalene	-	<0.94	-	µg/l	EPA 8270C	none	none	none	none	
Nitrobenzene	-	<0.94	-	µg/l	EPA 8270C	-	-	-	10	µg/L
N-nitrosodimethylamine	-	<1.9	-	µg/l	EPA 8270C	-	29.2	-	-	µg/L
N-Nitrosodi-n-propylamine	-	<1.9	-	µg/l	EPA 8270C	none	none	none	none	
N-nitrosodiphenylamine	-	<0.94	-	µg/l	EPA 8270C	-	10.0	-	-	µg/L
Phenanthrene	-	<0.47	-	µg/l	EPA 8270C	-	35.2	-	-	ng/L
Pyrene	-	<0.47	-	µg/l	EPA 8270C		35.2	-	-	ng/L
1,2,4-Trichlorobenzene	-	<0.94	-	µg/l	EPA 8270C	none	none	none	none	
Aldrin	-	<0.0047	-	µg/l	EPA 8081A	-	0.09	-	-	ng/L
alpha-Hexachlorocyclohexane (BHC)	-	<0.0047	-	µg/l	EPA 8081A	16	-	32	48	ng/L
beta-Hexachlorocyclohexane	-	<0.0094	-	µg/l	EPA 8081A	16	-	32	48	ng/L
gamma-Hexachlorocyclohexane	-	<0.0094	-	µg/l	EPA 8081A	16	-	32	48	ng/L
delta-Hexachlorocyclohexane	-	<0.0047	-	µg/l	EPA 8081A	16	-	32	48	ng/L
Chlordane	-	<0.094	-	µg/l	EPA 8081A	-	0.09	-	-	ng/L
4,4'-DDT	-	<0.0094	-	µg/l	EPA 8081A	-	-	-	10	µg/L
4,4'-DDE	-	<0.0047	-	µg/l	EPA 8081A	-	-	-	10	µg/L
4,4'-DDD	-	<0.0047	-	µg/l	EPA 8081A	-	-	-	10	µg/L
Dieldrin	-	<0.0047	-	µg/l	EPA 8081A	-	0.16	-	-	ng/L
alpha-Endosulfan	-	<0.0047	-	µg/l	EPA 8081A	36	-	72	108	ng/L
beta-Endosulfan	-	<0.0047	-	µg/l	EPA 8081A	36	-	72	108	ng/L
Endosulfan sulfate	-	<0.0094	-	µg/l	EPA 8081A	36	-	72	108	ng/L
Endrin	-	<0.0047	-	µg/l	EPA 8081A	8	-	16	24	ng/L
Endrin Aldehyde	-	<0.0094	-	µg/l	EPA 8081A	none	none	none	none	

Ground Water Discharge Monitoring for Short-Term Discharges from MWDOC Test Slant Well (SL-1) at Doheny Beach, Dana Point, CA
Laboratory Water Quality Analysis Results for Monitoring and Reporting Program No. 2001-96, Section D.5.

Constituent	Sample Date			Units	Method	Section B.3 (Discharge to Surf Zone) Effluent Limitations				
	3/19/2006	4/3/2006	5/13/2006			6-Month Median	30-Day Average	Daily Maximum	Instant-aneous Maximum	Section B.3 Eff. Units
Heptachlor	-	<0.0094	-	µg/l	EPA 8081A	-	2.88	-	-	ng/L
Heptachlor Epoxide	-	<0.0047	-	µg/l	EPA 8081A	-	2.88	-	-	ng/L
Arochlor-1016	-	<0.47	-	µg/l	EPA 3510/8082	-	0.076	-	-	ng/L
Arochlor-1221	-	<0.47	-	µg/l	EPA 3510/8082	-	0.076	-	-	ng/L
Arochlor-1232	-	<0.47	-	µg/l	EPA 3510/8082	-	0.076	-	-	ng/L
Arochlor-1242	-	<0.47	-	µg/l	EPA 3510/8082	-	0.076	-	-	ng/L
Arochlor-1248	-	<0.47	-	µg/l	EPA 3510/8082	-	0.076	-	-	ng/L
Arochlor-1254	-	<0.47	-	µg/l	EPA 3510/8082	-	0.076	-	-	ng/L
Arochlor-1260	-	<0.47	-	µg/l	EPA 3510/8082	-	0.076	-	-	ng/L

NOTES:
Laboratory analyses performed by Del Mar Analytical, of Irvine, CA, unless otherwise noted.

a. Copper result by EPA 200.8 exceeds 6-mo median of 6 ug/L (potentially due to interference). Result by EPA 1640 (Trace Metals in Seawater by CRG Labs) is less than 6-mo median.
b. Detection of Toluene may be from the glue on the tape used to attached the submersible pump cable to the pump column pipe.

1. Analysis of nitrogen and phosphorus are not required for direct discharges to the surf zone.
2. Total Chlorine Residual must be monitored if any portion of the extraction waste stream is chlorinated.
3. Groundwater remediation projects involving only diesel fuels and groundwater dewatering operations may use the California Department of Health Services' recommended analytical procedure contained in the Leaking Underground Fuel Tank Field Manual: Guidelines for Site Assessment, Cleanup, and Underground Storage Tank Closure, October 1989 (LUFT Manual) for determining diesel total petroleum hydrocarbon concentrations (TPH - diesel) in the discharge unless other analytical methods are specified by the Regional Board. Groundwater remediation projects involving only gasoline may use standard analytical techniques contained in the LUFT Manual for the determination of TPH concentrations in the discharge unless other methods are specified by the Regional Board.
4. The hexavalent and trivalent chromium limits may be met as a total chromium limit. If analytical results for total chromium reveal a total chromium concentration greater than the effluent limitations for hexavalent chromium, and the sample has not been analyzed for hexavalent chromium, it will be assumed that hexavalent chromium concentrations are in violation of the effluent limitation.
5. Discharges with a duration of 30 days or less at a particular groundwater extraction site shall conduct one acute toxicity test in lieu of chronic toxicity testing.
6. Use USEPA Method Number 624(GCMS) for these constituents. The Regional Board may waive monitoring requirements for these constituents in cases where the discharger identifies and requests use of an appropriate "indicator constituent" in lieu of these constituents.
7. "Base/Neutrals" are listed in 40 CFR 136.
8. For any discharge where gasoline, diesel, other petroleum product(s) or solvent based constituent(s) are encountered, knowingly or incidental to a construction or other project as a result of drawdown, the discharger shall conduct monitoring for those constituents in Monitoring Provision D.1 in addition to any other applicable monitoring Provision herein.

Table 2

Ground Water Discharge Monitoring for Short-Term Discharges from MWDOC Test Slant Well (SL-1) at Doheny Beach, Dana Point, CA
Daily Flowrate

Date	Volume Discharged (gallons per day)	Task Related to Discharge
14-Mar-06	158,220	Airlift and Swab Development
15-Mar-06	121,320	Airlift and Swab Development
16-Mar-06	89,325	Airlift and Swab Development
17-Mar-06	111,405	Airlift and Swab Development
18-Mar-06	155,880	Airlift and Swab Development
19-Mar-06	195,800	Airlift and Swab Development
20-Mar-06	30,000	Empty Discharge Tanks
24-Mar-06	36,000	Pump Installation
25-Mar-06	595,000	Development Pumping
26-Mar-06	520,000	Development Pumping
27-Mar-06	711,500	Development Pumping
28-Mar-06	617,000	Development Pumping
29-Mar-06	529,500	Step Test
31-Mar-06	1,504,000	Constant Rate Test
1-Apr-06	2,390,000	Constant Rate Test
2-Apr-06	2,287,000	Constant Rate Test
3-Apr-06	2,386,000	Constant Rate Test
4-Apr-06	2,385,000	Constant Rate Test
5-Apr-06	898,000	Constant Rate Test
12-May-06	238,000	Development Pumping
13-May-06	710,000	Constant Rate Test
14-May-06	1,060,000	Constant Rate Test
15-May-06	358,000	Constant Rate Test
Total Volume Discharged	**18,086,950**	

Appendix E
Development Notes

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WELL DEVELOPMENT DATA SHEET

Date 3-25-06 Day of Week Sat Job # ____ Job Name ____ Rig # 201

Type of Development performed ____ Pump/~~Airlift Setting~~ 126'

Operator Butch Sand Content Measurement type ____

Pre Pumping Static Level 20.6 Measuring Point Top of PVC Instrument Type Probe

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc. (Sand)	Surging/Jetting From	Surging/Jetting To	Depth
7:30	20.6		67024 x000 ~~clear~~			
8:00		500	clear			
8:03	30.4		67025			
8:07	31.6	500	67027			
8:11	32.1	500	67029 .2			
8:15	32.5	500	67031			
8:22	32.3	500	67035 .01			PSI 85
8:30	34.2	500	67038 .05			
8:40	34.3	500	67043			
8:41	38.5	700	6' Clear			
8:45	39.8	700	67047			PSI 78
8:50	39.8	700	67050			
8:55	40.2	700	67054			
9:00	40.6	700	67058 .2			
9:15	41.8	700	67068			PSI 78

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Type of Development performed ____ Pump/~~Airlift Setting~~ 126'

Operator Butch Sand Content Measurement type ____

Pre Pumping Static Level 20.6 Measuring Point ____ Instrument Type ____

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.			Surging/Jetting From	To	Depth
9:20	42.	700	67072	clear	.2			PSI 78
35	42.85	700	67083		.4			
9:45	43.3	700	67090		.3			
9:55	43.8	700	67097					
10:00	44.1	700	67101					
10:10	44.2	700	67108					
10:15	44.4	700	67111		.05			
10:16	48.6	900	67112	clear				PSI 70
10:20	49.2	900	67115					
10:35	50.1	900	67128		.4			
10:40	50.4	900	67133		.2			
10:45	50.7	900	67137[5]		.3			
11:00	51.2	900	67151		.3			
05	51.4	900	67156		.2			
11:18	51.8	900	67167[5]		.1[5]			

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Date 3-25-06 Day of Week Sat Job # ______ Job Name ______ Rig # 201

Type of Development performed ______ Pump/~~Airlift Setting~~ 126

Operator Butch Sand Content Measurement type ______

Pre Pumping Static Level 20.6 Measuring Point ______ Instrument Type ______

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.			Surging/Jetting From	To	Depth
11:25	52.1	900	67174	Clear	.1			PSI 70
11:30	50.2	900	67178					
11:35	57.2	1100	67183.5		.4			PSI 64
11:40	57.8	1100	67189		.3			
11:50	57.6	1100	67201		.1			
12:00	59.	1100	67211	Clear	.2			PSI 64
12:10	59.1	1100	67222		.2			
12:30	59.9	1100	67244		.1			
12:40	60.1	1100	67254.5					
12:41			67256					
1:30	60.5	1100	67309					
1:35	60.5		67314					
1:36	66.	1300	67317	Clear				PSI 58
1:46	66.6	1300	6732		.6			
2:00	66.85	1300	67347		.5			

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Date 3·25-06 Day of Week Sat Job # ____ Job Name ____ Rig # 201

Type of Development performed ____ Pump/~~Airlift Setting~~ 126

Operator Butch Sand Content Measurement type ____

Pre Pumping Static Level 20.6 Measuring Point ____ Instrument Type ____

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.		Sand	Surging/Jetting From	To	Depth
2:20	67.3	1300	67372.5	clear	.5			PSI 58
2:35	66.4	1200	67392		,3			
2:40	66.4	1300	67400		.2			
2:50	66.3	1300	67413		,2			
3:00	66.3	1300	67425					
3:05	66.3		67432		,05			
3:09	72.4	1500	67435	clear				PSI 48
3:15	73.	1500	67446		.6			
3:33	73.6	1500	67474					
3:38	73.6	1500	67481		,05			
3:45	73.6	1600	67491		,05			
3:47	78.2	1650	67495	clear				PSI 8
3:57	78.7	1650	67511					
4:06	79.5	1650	67527.5		,05			
4:15	79.4	1650	67541		,05			

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Date________ Day of Week ______ Job #__________ Job Name______________ Rig #________

Type of Development performed __________________________ Pump/Airlift Setting__________

Operator___________________ Sand Content Measurement type_________________________

Pre Pumping Static Level ____________ Measuring Point ___________ Instrument Type________

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.	Surging/Jetting From	To	Depth
4:30	79.7	1650	67568[5] clear .05			PSI 8
4:40	79.8	1650	67583 .05			
4:46	79.6		67593			
5:00	79.6		67619			

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Date 3-26-06 Day of Week Sun Job # _____ Job Name _____ Rig # 201

Type of Development performed _____ Pump/~~Airlift Setting~~ 126

Operator Butch Sand Content Measurement type _____

Pre Pumping Static Level 19.8 Measuring Point Top PVC Sand Instrument Type _____

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.		Surging/Jetting From	To	Depth
7:16	19.8		67618	Clear			
7:45	32.3	500					
7:58	33.1	500	67626	.2			PSI 82
8:05	34.	500	67630	.05			
8:20	34.6		67638	.05			
8:25	39.1	700	67641	Trace			76
9:04	42'		76670				
9:15	42.6		67678	Trace			
9:20	42.4		67681 5				
9:21	48.	900	67682 5				
9:30	48.8		~~67669~~ 67692	.05			
9:50	49.9	900	67710	Trace			
9:51	55	1100	67711				PSI 62
10:01	55.9	1100	67722	Trace			
10:10	57.1	1100	67732	Trace			

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Date 3-26-06 Day of Week Sun Job #______ Job Name______ Rig # 201

Type of Development performed ______ Pump/~~Airlift Setting~~ 126

Operator Butch Sand Content Measurement type______

Pre Pumping Static Level ______ Measuring Point Top PVC Instrument Type______

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.			Surging/Jetting From	To	Depth
10:52	59.3	1100	67779	clear	Trace			
:55	64.5	1300	67783					PSI 57
11:00	65.1	1300	67789		Trace			
11:10	65.9	1300	67802		Trace			
11:33	67.1	1300	67833					
11:35	72.4	1500	67835					47
11:55	74.	1500	67865		Trace			
12:00	78.5	~~1700~~ 1650	67873					8-10
12:10	79.8		67888		Trace			
12:20	81.6		67905			12:21	12:22	
12:26	50.9	500	67908		.05			PSI 80
12:28		|			Clear	12:28	12:30	
12:31	48.8	|	67910	Milky color	.1			
12:41		|	67915	clear	Trace	12:40	12:43	
12:45	47.2	|	67916.5					

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Date________ Day of Week ______ Job #__________ Job Name______________ Rig #________

Type of Development performed __________________________ Pump/Airlift Setting__________

Operator____________________ Sand Content Measurement type__________________________

Pre Pumping Static Level ____________ Measuring Point ____________ Instrument Type________

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.	Surging/Jetting From	To	Depth
12:50	47.9	500	67919 Clear Trace	12:51	12:53	PSI 80
12:55	4'	500	Gray			
12:57	46.8		67922 .1			
1:00	46.8		clear			
1:05	46.8		67926 .05	1:05	1:10	
1:11	45.3		67927 Gray color			PSI 80
1:15	45.5		67928.5 clear .1	1:17	1:20	80
1:25	44.9		67932 Gray color .05			
1:30	4		67935.5 Clear .1	1:35	1:37	
1:40	43.6		67939 color			
1:56			67947 Clear	1:56	1:58	
2:04	43.2		67949.5 clear .05			
2:12	43.2	500	67954 clear Trace			80
2:13	48.2	700	67954	2:15	2:18	76
2:19	48.6		67957 Gray Color			

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WELL DEVELOPMENT DATA SHEET

Date 3-26-06 Day of Week Sun Job # ________ Job Name ________ Rig # 201

Type of Development performed ________ Pump/~~Airlift Setting~~ 126

Operator Butch Sand Content Measurement type ________

Pre Pumping Static Level ________ Measuring Point ________ Instrument Type ________

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.			Surging/Jetting From	To	Depth
2:22	48.6	700	67959	clear	.1	2:24	2:26	PSI 76
2:27	48.2	700	67961	Color				
2:30	47.4	700	67963	Clear	.1	2:33	2:35	
2:37	46.7	700		Light Gray Color				
2:40		700	67968	Clear				
2:48	47	700	67974	clear	.1	2:50	2:52	
2:53				Little Color				
2:56	46.1	700	67977	Clear				
3:00		700	67980		.05	3:02	3:04	
3:05	45.6	700		Little Color				
3:07		700		clear	.1	3:10	3:12	PSI 76
3:14	45.2	700		Little Color				
3:18	45.6	700	67989	Clear	.05			PSI ~~66~~
3:20	50.6	900	67990					PSI 66
3:22		900	67992			3:23	3:25	

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WELL DEVELOPMENT DATA SHEET

Date 3-26-06 Day of Week Sun Job # ______ Job Name ______ Rig # 201

Type of Development performed ______ Pump/~~Airlift Setting~~ 126'

Operator Butch Sand Content Measurement type ______

Pre Pumping Static Level ______ Measuring Point ______ Instrument Type ______

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.			Surging/Jetting From	To	Depth
3:28	50.7	900	67995[5]	Little Color				PSI 66
3:33	51.2	900	68000	Clear	.1			
3:38	51.4	900	68005	Clear	.1	3:40	3:42	
3:44	50.9			Little Color				
3:45	51.2	900	68009					
3:51	52.4	900	68015		.05	3:55	3:57	
3:58		900		Little Color				
4:00	51.1	900	68021	Clear		4:06	4:08	
4:10	50.1			Little Color				
4:15	50.5		68032[5]	clear	.05	4:17	4:19	
4:20	50.2	900	68035	Little Color				
4:25	50.4	900	68040	clear	.05			
4:26		1100	68040[5]					PSI 62
4:28	54.7	1100	68043	Clear				
4:30	55.1	1100	68045					

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WELL DEVELOPMENT DATA SHEET

Date 3-26-06 Day of Week Sun Job # ______ Job Name ______ Rig # 201

Type of Development performed ______ Pump/~~Airlift~~ Setting 126'

Operator Butch Sand Content Measurement type ______

Pre Pumping Static Level ______ Measuring Point ______ Instrument Type ______

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.			Surging/Jetting From	To	Depth
4:35	55.4	1100	68050.5	Clean	.1			PSI 62
4:38	55.6	1100	68065		Trace	4:48	4:50	
4:51		1100	68067	Some Color				
4:54	57.7	1100	68070	Clear	.05			
5:00			68077		Trace			
5:10	56.3	1100	68088	Clear	Trace	5:12	5:15	
5:16	54.3	1100	68091	Little Color	.05			
5:19	55.1		68094	Clear		5:34	5:36	
5:38	55.	1100	68114	Clear				
5:42	55.3	1100	68118		Trace			
5:45	.	1100	68122			5:46	5:48	
5:50	54.6		68124.5	Clear				
5:58	55.2		68133		Trace			
6:00	55.3	1100	68136.5		Trace			
6:02			68138	pump OFF				

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WELL DEVELOPMENT DATA SHEET

Date 3-27-06 Day of Week mon Job # ____ Job Name ____ Rig # 201

Type of Development performed ____ Pump/~~Airlift Setting~~ 126

Operator Butch Sand Content Measurement type ____

Pre Pumping Static Level 19.1 Measuring Point Top PVC Instrument Type ____

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.	Surging/Jetting From	Surging/Jetting To	Depth
7:03	19.1		68138			
7:15		1300				
7:16	46.6		68140 clear .05			PSI 57
7:19	46		68143 5			
7:32	50.1	1300	68160 Pit well 7.5	7:33	7:35	
7:36	50.	1300	68163 Clear .05			
7:45	52.	1300	68174	~~7:47~~		
8:03	54.1	1300	68198	8:04	8:06	
8:09		1300	68204 clear .05			
8:17	54.8	1300	68215	8:21	8:23	
8:25	54.4	1300	68222 clear .05			
8:57	58.1	1300	68265	8:58	9:00	
9:01	57.6	1300	68268 Clear .05			
9:05	58.0	1300	68273			
9:12	58.1	1300	68282 clear Trace			

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Date 3-27-06 Day of Week mon Job #_____ Job Name_____ Rig #_____

Type of Development performed _____ Pump/Airlift Setting_____

Operator_____ Sand Content Measurement type_____

Pre Pumping Static Level 19.' Measuring Point Top PVC Instrument Type_____

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.	Surging/Jetting From	Surging/Jetting To	Depth
9:15	63.7	1500	68286 clear .05			47
9:20	64.5	1500	68295			
9:27	65.4	1500	68304 .05			
9:42	66.6	1500	68327 Clear	9:43	9:45	
9:46		1500	68331 Little tint Color			
9:48	66.2	1500	68332 5 Clear	9:54	9:57	
9:58	65.1	1500	68342 5 .05			
10:00	66.1		68345 5			
10:23	69.2		68380	10:25	10:28	
10:29	6	1500	68385 Clear .05			
10:33	68.4		68391 5 Little tint Color	10:40	10:43	
10:44	68.5	1500	68404 5 Clear			
10:47	69.3		68410 Clear			
10:55	70.3		68421	10:57	10:59	
11:00	68.7	1500	68425 Little Tint .0			

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WELL DEVELOPMENT DATA SHEET

Date 3-27-06 Day of Week mon Job #____ Job Name____ Rig # 201

Type of Development performed ____ Pump/~~Airlift Setting~~ 126

Operator Butch Sand Content Measurement type____

Pre Pumping Static Level 19.1 Measuring Point Top PVC Instrument Type____

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.	Surging/Jetting From	To	Depth
11.04	69.9	1500	68431 Clear			PSI 47
11:10	75.	1650 1700	68441			PSI 8
11:15	75.9	1700	68448 Clear Trace	11:16	11:18	
11:19	74.5	1700	68452 Little tint color			
11:21	75.6	1700	68454.5 Trace			
11:32	77.1	1700	68473.5 clear .05	11:33	11:35	
11:36	75.4	1700	68476			
11:40	77.2	1700	68482.5 Clear .1	11:51	11:54	
11:55	75.8	1700	68502.5 Little tint color Pit well 14.3			
12:05		1700	68519 clear .05	12:08	12:20	PSI 8
12:21	78.25	1700	68542 Little tint			
12:25	79.1	1700	68549 clear .1			
12:30			Top off Air comp			
12:48	80.4	1700	68587 .05	12:50	12:53	
12:54		1700	68591 Clear			

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WELL DEVELOPMENT DATA SHEET

Date 3-27-06 Day of Week mon Job # ________ Job Name ____________ Rig # 201

Type of Development performed ____________________ Pump/~~Airlift Setting~~ 126

Operator Butch ____________ Sand Content Measurement type ____________________

Pre Pumping Static Level 19.1 Measuring Point Top PVC Instrument Type ________

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.			Surging/Jetting From	To	Depth
12:55	78.75	1700	68593	clear				
1:19	81.2	1625						
1:22	81.2	1625	686375	clear	.05	1:24	1:26	
1:27	79.4		68642	Little tint	.05	1:40	1:42	
1:43	79.3		68665	Little tint				
1:45			68618					
1:48	80.8		68674	clear	Trace			
2:24	81.9		68733	Clear	Trace			
2:30		500						
2:32	55.9	500	68744	clear		2:34	2:36	PSI 80
2:37		500		Little Color	.05			
2:39	51.7	500	68746	Clear				
2:40		500	68747			242	2:44	
2:45	51.9	500	68748	Little Gray Color	.05			
2:48	50.7	500	68750	clear	.05			

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WELL DEVELOPMENT DATA SHEET

Date 3-27-06 Day of Week mon Job # ______ Job Name ______ Rig # 201

Type of Development performed ______ Pump/~~Airlift Setting~~ 126'

Operator Butch Sand Content Measurement type Rossum

Pre Pumping Static Level 19.1' Measuring Point Top PVC Instrument Type ______

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.	Surging/Jetting From	To	Depth
2:50	50.2	500	68751 Clear .05	2:52	2:55	PSI 80
2:56	48.1	500	68752 Little color Pit well 14'			
3:00	48.5	500	68754 Clear	3:05		
3:25	47.3	500	68767 Clear	3:25	3:28	
3:29	47.3	500	68768 Trace color .05			
3:32	47.3	500	68770 Clear			
4:12	6		68793			
4:14	47.5		68794 Clear Trace	4:16	4:18	
4:22			68798 Trace color Trace			
4:30	45.3	500	68802 Clear	4:30	4:33	
4:34			Little tint			PSI
4:35	44.3	500	68804 Trace			80
4:36			68804.5 Clear			
4:39	44.4	500	68806.5	4:40	4:42	
4:44	43.7	500	68808			

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WELL DEVELOPMENT DATA SHEET

Date 3-27-06 Day of Week mon Job # ________ Job Name ________ Rig # 201

Type of Development performed ________ Pump/~~Airlift Setting~~ 126'

Operator Butch Sand Content Measurement type ________

Pre Pumping Static Level 19.' Measuring Point Top PVC Instrument Type ________

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.				Surging/Jetting From	To	Depth
4:47	46.6	700	68800	clear					
4:50	46.6	700	68812	clear					PSI 74
457	64.7	700	68817.5			Trace	4:58	5:00	
5:01		700		Little tint					
5:02	44.8	700	68819	Clear		Trace	5:05	5:09	
5:10		700	68822	Trace Color					
5:15	44.1	700	68825	Clear		Trace	5:17	5:19	
5:26	43.4		68826.5	Trace Color		Trace			
5:22	43.5	700	68828	clear	Pit well 11.2	Trace	5:25	5:27	
5:28				Trace Color					
5:29	43.7	700	68831	clear					
5:36			68835.5			Trace	5:37	5:39	PSI 74
5:40				Trace color					
5:42	44.5		68838	clear		trace	5:47	5:49	
5:50			68842	Trace Color					

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WELL DEVELOPMENT DATA SHEET

Date 3-27-06 Day of Week mon Job # ___ Job Name ___ Rig # 207

Type of Development performed ___ Pump/~~Airlift Setting~~ 126

Operator Butch Sand Content Measurement type ___

Pre Pumping Static Level ___ Measuring Point Top PVC Instrument Type ___

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.	Surging/Jetting From	To	Depth
						PSI
5:51	43.9	700	68843 clear			74
5:54			68845 clear			
6:00			68849 5			

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Date 3-28-06 Day of Week Tue Job # ______ Job Name ______ Rig # 201

Type of Development performed ______ Pump/~~Airlift Setting~~ 126

Operator Betel Sand Content Measurement type ______

Pre Pumping Static Level 19.' Measuring Point ______ Instrument Type ______

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.	Surging/Jetting From	Surging/Jetting To	Depth
			Pit well 7.4			
7:12						Dst 78
7:15	19.5	700	68850 clear			
7:20	33.5	700	68852	7:22	7:25	
7:26	34.6	700	68854 Trace color			
7:30	34.8	700	68857 Clear .05	7:33	7:35	
7:36	34.8	700	68859.5 Trace color			
7:40		700	68862.5 clear .05	7:42	7:44	
7:46	35.4					
7:48	35.7	700	68866 clear .05	7:51	7:55	
7:56			Little color			
7:57	35.4	700	68869.5 clear .05	7:59	8:02	
8:03			Little Color			
8:04	35.5	700	68872 clear .05			
8:06		700	68873.5 clear .05	8:08	8:11	
8:13	35.8	700	68876.5 Clear			

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Date 3-28-06 Day of Week Tues Job # ______ Job Name ______ Rig # 201

Type of Development performed ______ Pump/~~Airlift Setting~~ 126

Operator Butch Sand Content Measurement type ______

Pre Pumping Static Level 19.1 Measuring Point Top PVC Instrument Type ______

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.			Surging/Jetting From	To	Depth
								PSI
8:16	35.	700	68879	clear		8:17	8:23	76
8:24		700	68880	Little Color				
8:25	36.1	700	68881	clear				
8:28	36.3	700	68883		.05	8:30	8:32	
8:33	36.1	700	68885	Little Color				
8:35		700	68886.5	Clear				
8:42	37.2	700	68892	Clear	.05	8:44	8:47	
8:49	36.9	700	68896	Little Color				
8:50		700	68896.5	Clear				
8:55	37.7	700	68900	Clear	.05	8:56	8:58	
8:59	37.2	700	68901	Little tint				
9:02	37.6	700	68903	Clear		9:03	9:05	
9:06	37.3	700	68905	Little tint				
9:08		700	68906	Clear	.05			
9:11	38.2	700	68909	Clear		9:12	9:14	

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WELL DEVELOPMENT DATA SHEET

Date 3-28-06 Day of Week Tues Job #_____ Job Name_____ Rig # 201

Type of Development performed _____ Pump/~~Airlift Setting~~ 126'

Operator Butch Sand Content Measurement type Rossum

Pre Pumping Static Level 19.' Measuring Point Top PVC Instrument Type_____

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.	Surging/Jetting From	Surging/Jetting To	Depth
9:15	37.9	700	68910 Little Tint			
9:20	38.4	700	68913 5 Clear			
9:48	39.9		68934 Clear .05			PSI 3
9:49		1700	68936			
9:52		1700	68941			
1000		1700	Clear			
10:10		1700	68970			
10:24	70.4	1700	68995	10:25	10:27	
10:28			68998 Little Tint			
10:29	69.3	1700	68999 Clear			
10:30	69.6	1700	69001 Clear P.T well 13.6	10:31	10:33	
10:34	69.	1700	69004 Little tint			
10:35	69.6	1700	69006			
10:42	71.	1700	69018 Clear	10:43	10:45	
10:46	71.2	1700	69022 Little Tint			

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WELL DEVELOPMENT DATA SHEET

Date 3-28-06 Day of Week Tues Job # ____ Job Name ____ Rig # 201

Type of Development performed ____ Pump/~~Airlift Setting~~ 126'

Operator Butch Sand Content Measurement type ____

Pre Pumping Static Level 19.1 Measuring Point Top PVC Instrument Type ____

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.			Surging/Jetting From	To	Depth
								PSI
10:48	71.3	1700	69025	clear.				3
10:51	71.9	1700	69030	Clear		10:52	10:55	
10:54	70.1	1700	69033 5	Little tint				
10:55	71.4	1700	69035 5	clear	Trace			
11:01	73.6	1700	69045 5	clear	Trace	11:02	11:04	
11:05	71.4	1700	69048 5	Little tint	Trace			
11:06	71.8	1700		clear	Trace			
11:07	71.9	1700	69052	clear				
11:25	74.7	1700	69082			11:26	11:27	
11:28			69084	Little tint				
11:30	74.8	1700	69090	Clear				
11:35	74.8	1700	69096			11:36	11:38	
11:42	74.9	1700	69104 5	clear	Trace			
11:45	7	1700	69110	clear	Trace	11:54 ~~11:48~~	11:56	
11:53	76.3		69124 5					

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WELL DEVELOPMENT DATA SHEET

Date 3-28-06 Day of Week Tues Job # ________ Job Name ________ Rig # 201

Type of Development performed ________________ Pump/~~Airlift Setting~~ 126'

Operator Butch Sand Content Measurement type ________________

Pre Pumping Static Level ________ Measuring Point Top PVC Instrument Type ________

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.			Surging/Jetting From	To	Depth
11:57	74.4	1700	69127	Little tint				PSI 3
11:59	75.5	1700	69130 5		Trace			
12:01	75.7	1700	69133	Clear		12:02	12:04	
12:05	74.1	1700	69136	Little tint	Trace			
12:06				Clear				
12:10	75.9	1700	69145	Clear	Trace	12:11	12:13	
12:14		1700	69148	Little tint				
12:15	75.3	1700	69150	Clear				
12:18	75.4	1700	69154	Clear	Trace	12:19	12:21	
12:22	74.5	1700	69158	Trace tint				
12:23	74.6	1700	69160	Clear				
12:26	76.3	1700	69164 5	Clear	Trace			
12:34	77.3							
12:48	78.5	1700	69201	Clear	Trace	12:49	12:52	
12:53	75.8	1700	69204	Trace tint				

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Date 3-28-06 Day of Week Tues Job # ______ Job Name ______ Rig # 201

Type of Development performed ______ Pump/~~Airlift Setting~~ 126

Operator Butch Sand Content Measurement type ______

Pre Pumping Static Level 19.' Measuring Point Top PVC Instrument Type ______

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.	Surging/Jetting From	Surging/Jetting To	Depth
						PSI 3
12:54	75.8	1700	clear			
12:58	78.9	1700	69212.5 clear Trace	1:00	1:02	
1:03	76.1	1700	69217 Trace color	1:12	1:18	
1:19	75		69234 clear			
1:24			down			
2:30		1700	69241			
2:34		1700	69247.5 clear			
2:53	75.3		69284.5 clear Trace	2:56	2:59	
3:00	73.9	1700	69286 clear			
3:07	75.9	1700	69298 clear	3:10	3:12	
3:13	74.4	1700	69305 Little Tint			
3:14			clear			
3:15			69308			
3:38	77		69330 clear Pit well 14.	3:30	3:32	
3:35			69334			

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Date 3-28-06 Day of Week Tues Job # ________ Job Name ________ Rig # 201

Type of Development performed ________ Pump/~~Airlift Setting~~ 126'

Operator Botch Sand Content Measurement type ________

Pre Pumping Static Level 19.1 Measuring Point Top PVC Instrument Type ________

Time of Day	Pumping Level	GPM	Conditions of water: Sand Content Etc.			Surging/Jetting From	To	Depth
2:35	76.2	1650 1700	69337.5	clear	Trace			
3:37	76.2		69341	Clear		3:38	3:40	
3:41	75.5		69344	Clear				
3:45		1650 1700	69351	Clear	Trace	3:46	3:48	
3:49	74.7		69353.5	Clear				
3:50		1650 1700	69355	clear		4:00	4:02	
4:03	75.8		69375	Clear				
4:07	76.5		69381	clear	Trace	4:09	4:41	
4:42			69389	Clear	Trace			
4:45	71.6		69394					
4:55	72.2		69410					
5:05	72.3		69425					
5:15	73.3		69443					
5:25			694					
5:30			69460					

Appendix F
Geophysical Logs

PACIFIC SURVEYS

TEMPERATURE FLUID RESISTIVITY

Job No.	12496
File No.	
Company	GEOSCIENCE SUPPORT SERVICES
Well	SLANT WELL
Field	DOHENY STATE PARK
County	ORANGE
State	CA
Location	120 FT SOUTH OF MAIN LIFE GUARD TOWER, 60 FT NORTH OF THE NORTH BANK OF SAN JUAN CREEK
Other Services	NONE

Permanent Datum	G.L.	Elevation 0 above perm. datum	Elevation	KB
Log Measured From	G.L.			DF
Drilling Measured From	G.L.			GL

Date	04-06-06
Run Number	ONE
Depth Driller	350'
Depth Logger	347.5'
Bottom Logged Interval	344.2'
Top Log Interval	0'
Open Hole Size	N/A
Type Fluid	WATER
Density / Viscosity	N/A
Fluid Level	12'
Bentonite Seal	N/A
Time Well Ready	16:30
Time Logger on Bottom	17:00
Equipment Number	PS-3
Location	L.A.
Recorded By	RIDDER
Witnessed By	D. SMITH

Borehole Record				Tubing Record			
Run Number	Bit	From	To	Size	Weight	From	To
ONE	8"	0	175'				

Casing Record	Size	Wgt/Ft	Top	Bottom
Surface String	12"	N/A	0'	350'
Prot String				
Production String				
Liner				

<<< Fold Here >>>

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Comments

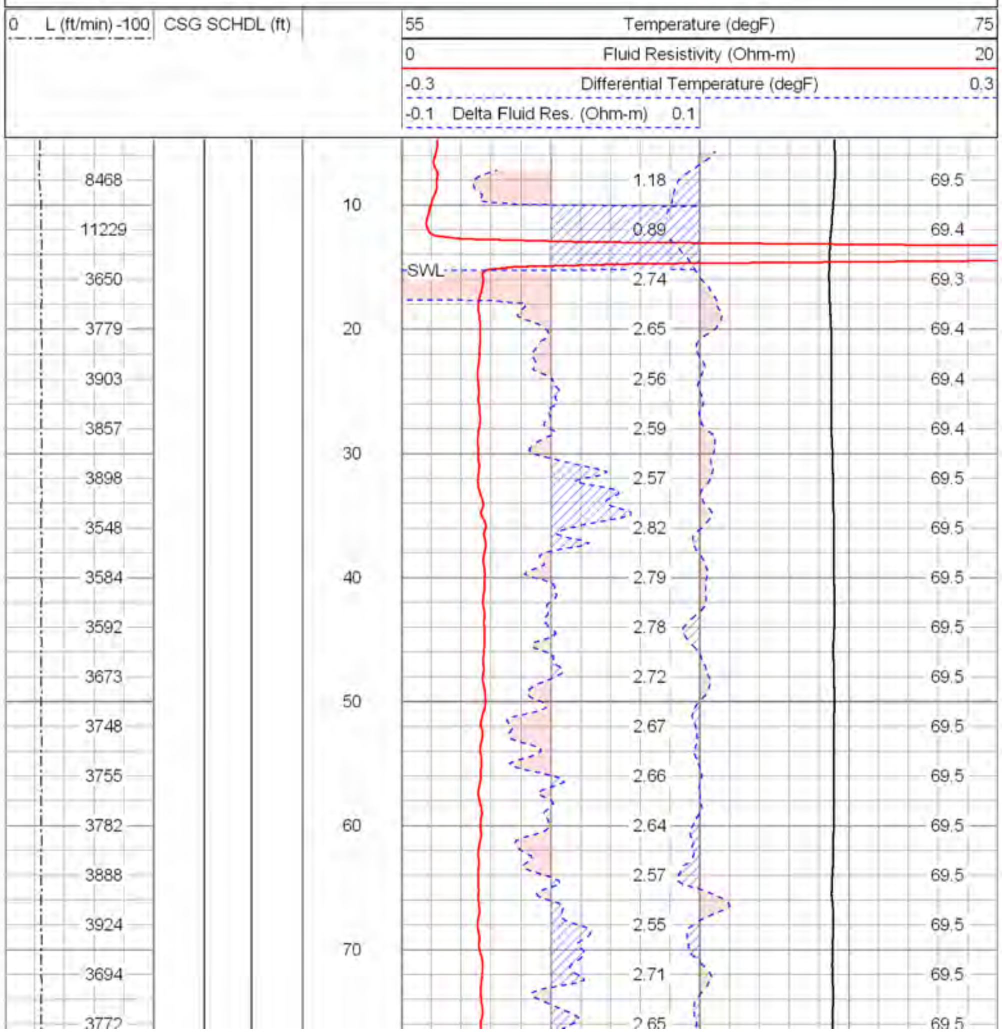
SLANT WELL IS 23 DEGREES FROM HORIZONTAL

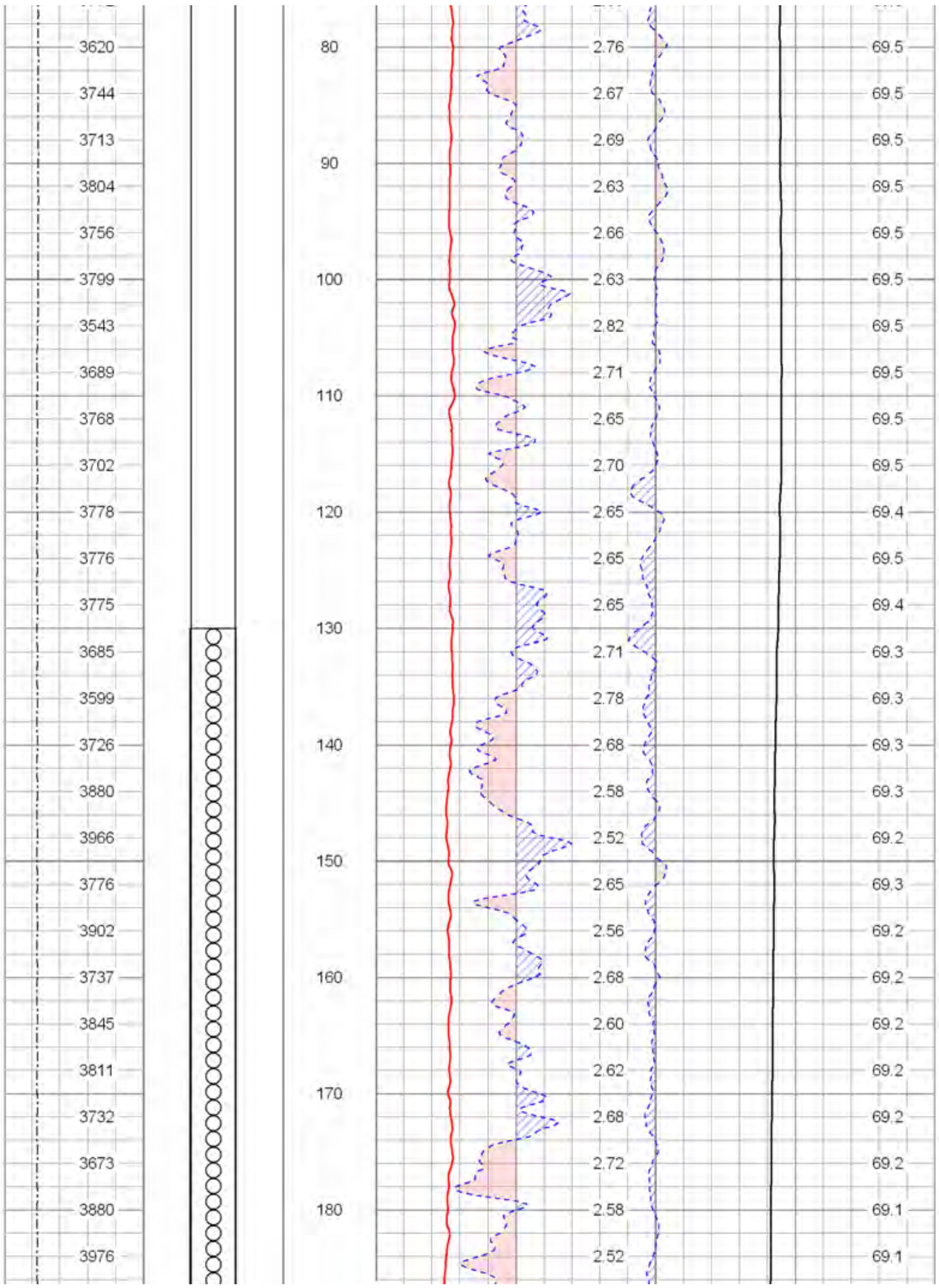
Temperature Calibration Report

Serial Number:	10
Tool Model:	MLS
Performed:	Thu Apr 06 12:28:15 2006

	Reference	Reading
Low Reference:	45.50 degF	1659.00cps
High Reference:	159.80 degF	4759.00cps
Gain:	0.04	
Offset:	-15.67	
Delta Spacing	2	

Database File:	12496.db
Dataset Pathname:	Geo/slant/run1/temp2
Presentation Format:	frttemp2
Dataset Creation:	Thu Apr 06 18:00:56 2006 by Log Warrior 7.0 STD Ope
Charted by:	Depth in Feet scaled 1:120

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3713
3804
3756
3799
3543
3689
3768
3702
3778
3776
3775
3685
3599
3726
3880
3966
3776
3902
3737
3845
3811
3732
3673
3880
3976
80
90
100
110
120
130
140
150
160
170
180
2.76
2.67
2.69
2.63
2.66
2.63
2.82
2.71
2.65
2.70
2.65
2.65
2.65
2.71
2.78
2.68
2.58
2.52
2.65
2.56
2.68
2.60
2.62
2.68
2.72
2.58
2.52
69.5
69.5
69.5
69.5
69.5
69.5
69.5
69.5
69.5
69.5
69.4
69.5
69.4
69.3
69.3
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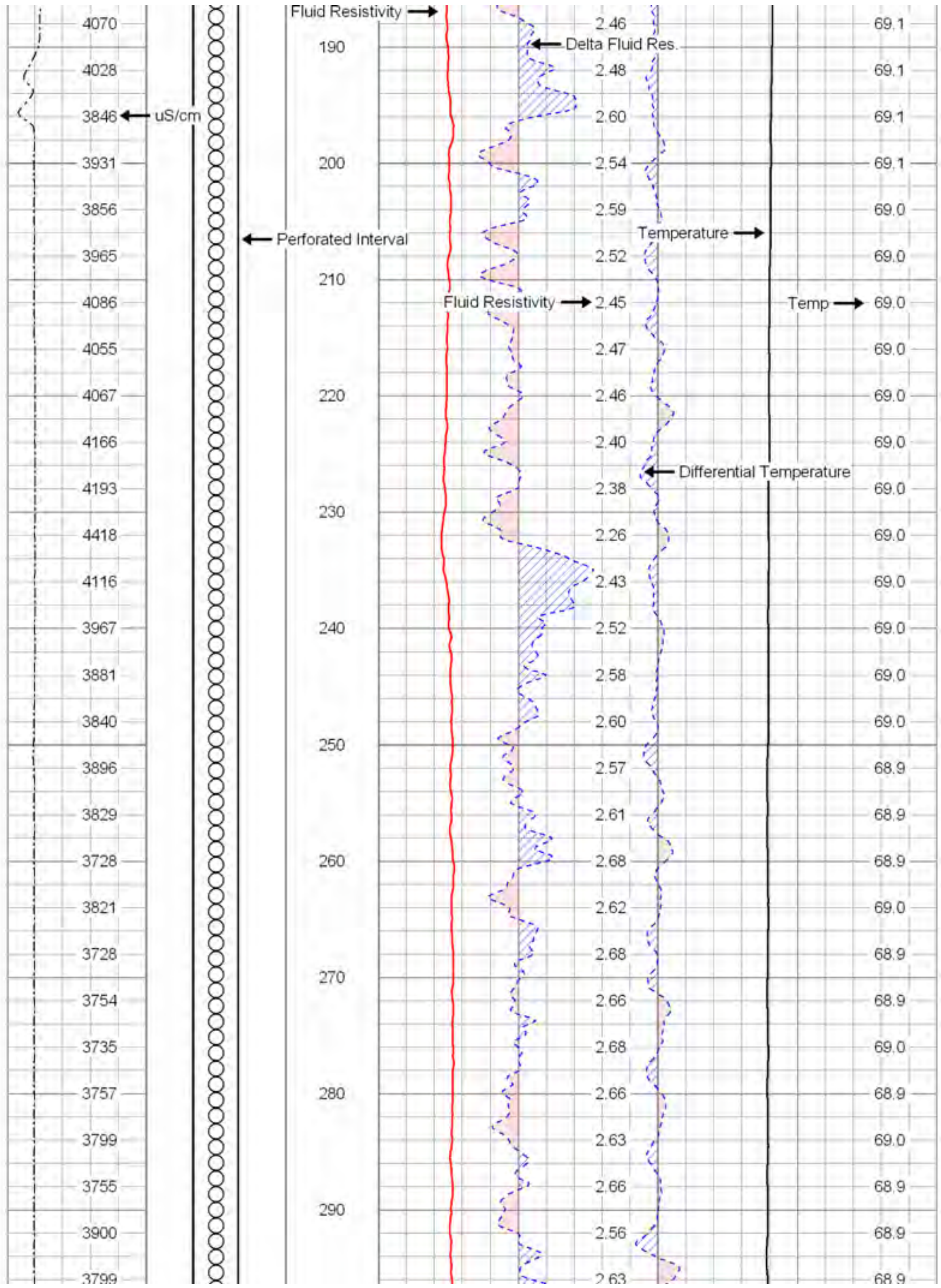
69.2
69.1
69.1


Fluid Resistivity
Delta Fluid Res.
uS/cm
Perforated Interval
Temperature
Fluid Resistivity
Temp
Differential Temperature
4070
4028
3846
3931
3856
3965
4086
4055
4067
4166
4193
4418
4116
3967
3881
3840
3896
3829
3728
3821
3728
3754
3735
3757
3799
3755
3900
3799
190
200
210
220
230
240
250
260
270
280
290
2.46
2.48
2.60
2.54
2.59
2.52
2.45
2.47
2.46
2.40
2.38
2.26
2.43
2.52
2.58
2.60
2.57
2.61
2.68
2.62
2.68
2.66
2.68
2.66
2.63
2.66
2.56
2.63
69.1
69.1
69.1
69.1
69.0
69.0
69.0
69.0
69.0
69.0
69.0
69.0
69.0
69.0
69.0
69.0
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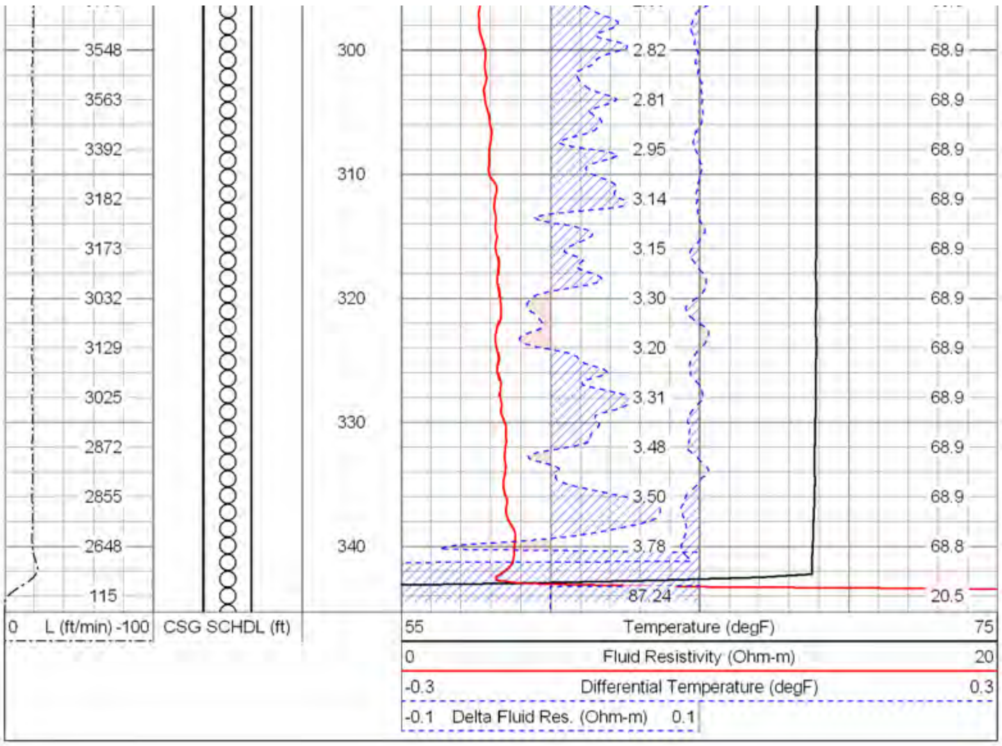
68.9
68.9
68.9



3548
3563
3392
3182
3173
3032
3129
3025
2872
2855
2648
115
300
310
320
330
340
2.82
2.81
2.95
3.14
3.15
3.30
3.20
3.31
3.48
3.50
3.78
87.24
68.9
68.8
20.5
0 L (ft/min) -100
CSG SCHDL (ft)
55 Temperature (degF) 75
0 Fluid Resistivity (Ohm-m) 20
-0.3 Differential Temperature (degF) 0.3
-0.1 Delta Fluid Res. (Ohm-m) 0.1

PACIFIC SURVEYS

TEMPERATURE FLUID RESISTIVITY

Job No. 12496	Company	GEOSCIENCE SUPPORT SERVICES
	Well	MW-1M
File No.	Field	DOHENY STATE PARK
	County	ORANGE State CA

Location: 120 FT SOUTH OF MAIN LIFE GUARD TOWER, 60 FT NORTH OF THE NORTH BANK OF SAN JUAN CREEK

Other Services: NONE

Permanent Datum	G.L.		Elevation	Elevation
Log Measured From	G.L.	0	above perm. datum	K.B.
Drilling Measured From	G.L.			D.F.
				G.L.

Date	04-06-06		
Run Number	ONE		
Depth Driller	131'		
Depth Logger	128'		
Bottom Logged Interval	128'		
Top Log Interval	0'		
Open Hole Size	10"		
Type Fluid	WATER		
Density / Viscosity	N/A		
Fluid Level	12'		
Bentonite Seal	N/A		
Time Well Ready	11:00		
Time Logger on Bottom	12:00		
Equipment Number	PS-3		
Location	L.A.		
Recorded By	RIDDER		
Witnessed By	D. SMITH		

Borehole Record				Tubing Record			
Run Number	Bit	From	To	Size	Weight	From	To
ONE	8"	0'	175'				

Casing Record	Size	Wgt/Ft	Top	Bottom
Surface String				
Prot. String	4"	N/A	0'	131'
Production String				
Liner				

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All interpretations are opinions based on inferences from electrical or other measurements and Pacific Surveys cannot and do not guarantee the accuracy or correctness of any interpretation, and we shall not, except in the case of gross or willful negligence on our part, be liable or responsible for any loss, costs, damages, or expenses incurred or sustained by anyone resulting from any interpretation made by any of our officers, agents or employees. These interpretations are also subject to Pacific Surveys' general terms and conditions set out in our current Price Schedule.

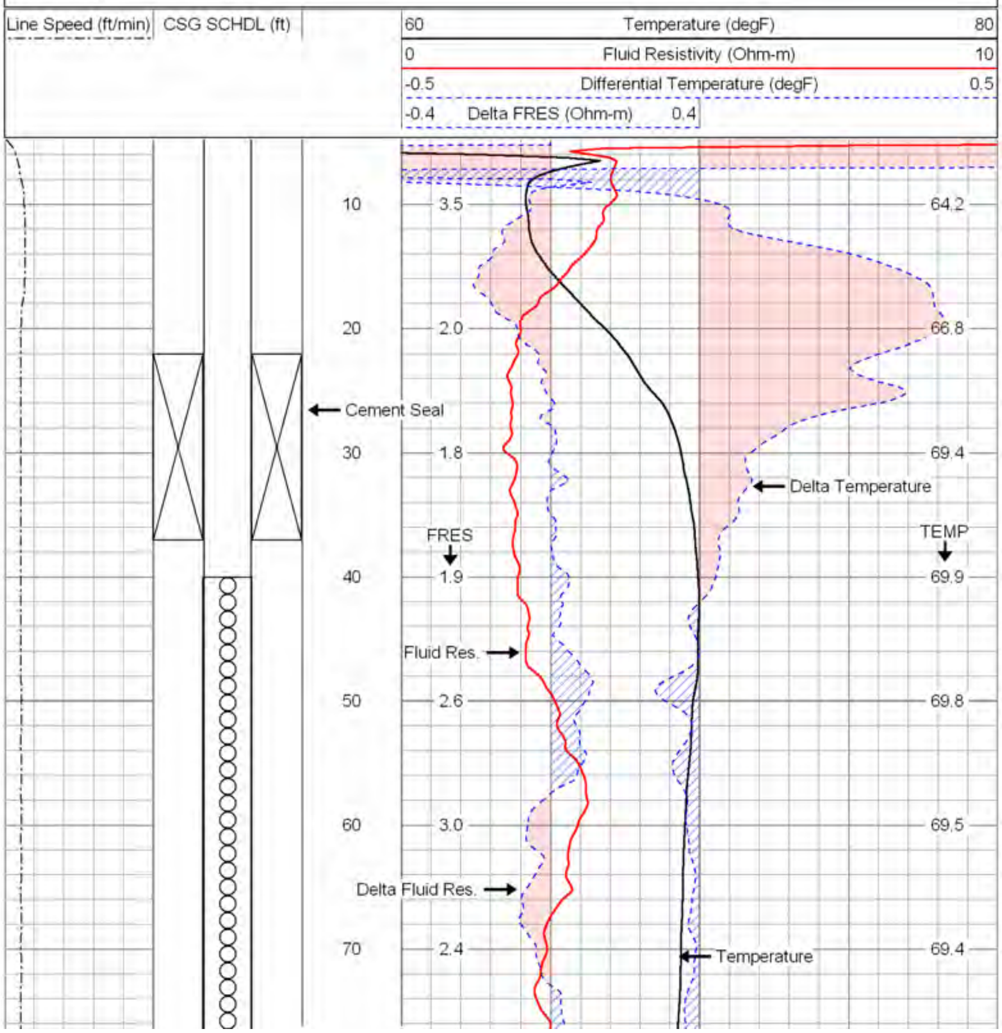
Comments

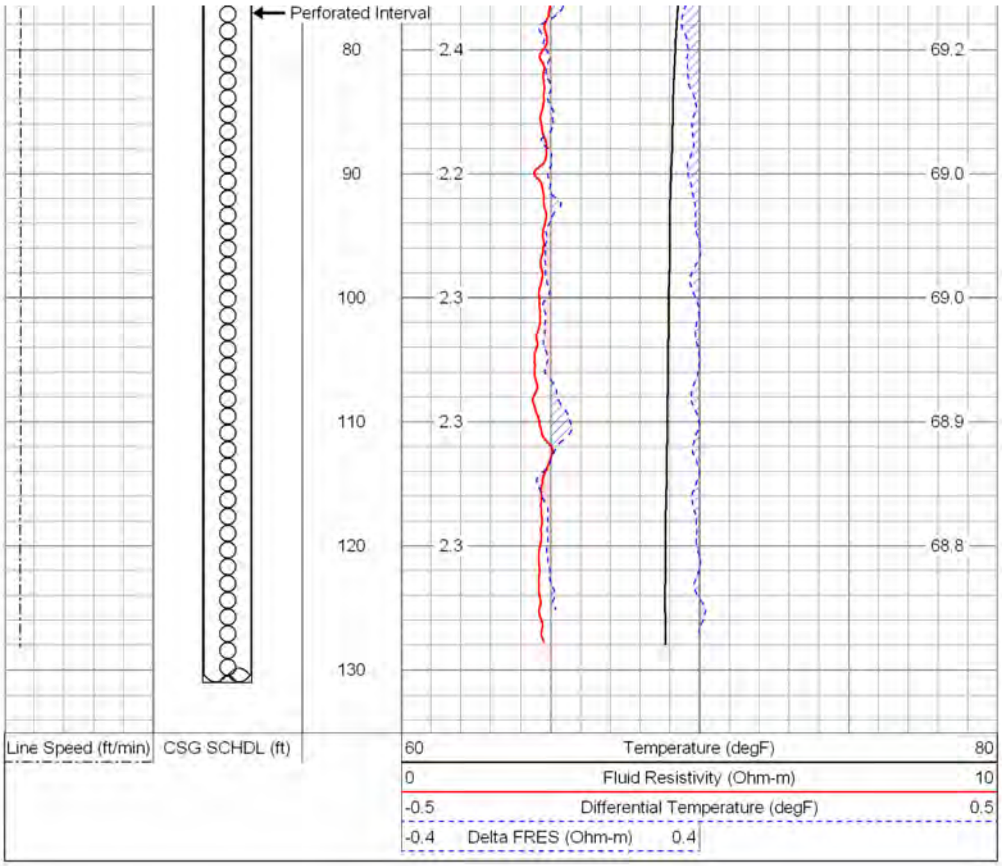
Temperature Calibration Report

Serial Number:	10
Tool Model:	MLS
Performed:	Thu Apr 06 12:28:15 2006

	Reference	Reading
Low Reference:	45.50 degF	1659.00cps
High Reference:	159.80 degF	4759.00cps
Gain:	0.04	
Offset:	-15.67	
Delta Spacing	2	

Database File:	12496.db
Dataset Pathname:	Geo/MW1M/run1/temp.1
Presentation Format:	frttemp2
Dataset Creation:	Wed Jun 21 19:05:38 2006 by Calc Warrior 7.0 STD Ope
Charted by:	Depth in Feet scaled 1:120





Perforated Interval
80
2.4
69.2
90
2.2
69.0
100
2.3
69.0
110
2.3
68.9
120
2.3
68.8
130
Line Speed (ft/min)
CSG SCHDL (ft)
60
Temperature (degF)
80
0
Fluid Resistivity (Ohm-m)
10
-0.5
Differential Temperature (degF)
0.5
-0.4
Delta FRES (Ohm-m)
0.4

PACIFIC SURVEYS

TEMPERATURE FLUID RESISTIVITY

Job No. 12496	Company	GEOSCIENCE SUPPORT SERVICES
	Well	MW-1D
File No.	Field	DOHENY STATE PARK
	County	ORANGE State CA

Location

120 FT SOUTH OF MAIN LIFE GUARD TOWER, 60 FT NORTH OF THE NORTH BANK OF SAN JUAN CREEK

Other Services: NONE

Permanent Datum	G.L.		Elevation	Elevation
Log Measured From	G.L.	0	above perm. datum	K.B. D.F. G.L.
Drilling Measured From	G.L.			

Date	04-06-06		
Run Number	ONE		
Depth Driller	168'		
Depth Logger	152'		
Bottom Logged Interval	152'		
Top Log Interval	0'		
Open Hole Size	10"		
Type Fluid	WATER		
Density / Viscosity	N/A		
Fluid Level	12'		
Bentonite Seal	N/A		
Time Well Ready	11:00		
Time Logger on Bottom	11:30		
Equipment Number	PS-3		
Location	L.A.		
Recorded By	RIDDER		
Witnessed By	D. SMITH		

Borehole Record				Tubing Record			
Run Number	Bit	From	To	Size	Weight	From	To
ONE	8"	0'	175'				

Casing Record	Size	Wgt/Ft	Top	Bottom
Surface String				
Prot. String	4"	N/A	0'	168'
Production String				
Liner				

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All interpretations are opinions based on inferences from electrical or other measurements and Pacific Surveys cannot and do not guarantee the accuracy or correctness of any interpretation, and we shall not, except in the case of gross or willful negligence on our part, be liable or responsible for any loss, costs, damages, or expenses incurred or sustained by anyone resulting from any interpretation made by any of our officers, agents or employees. These interpretations are also subject to Pacific Surveys' general terms and conditions set out in our current Price Schedule.

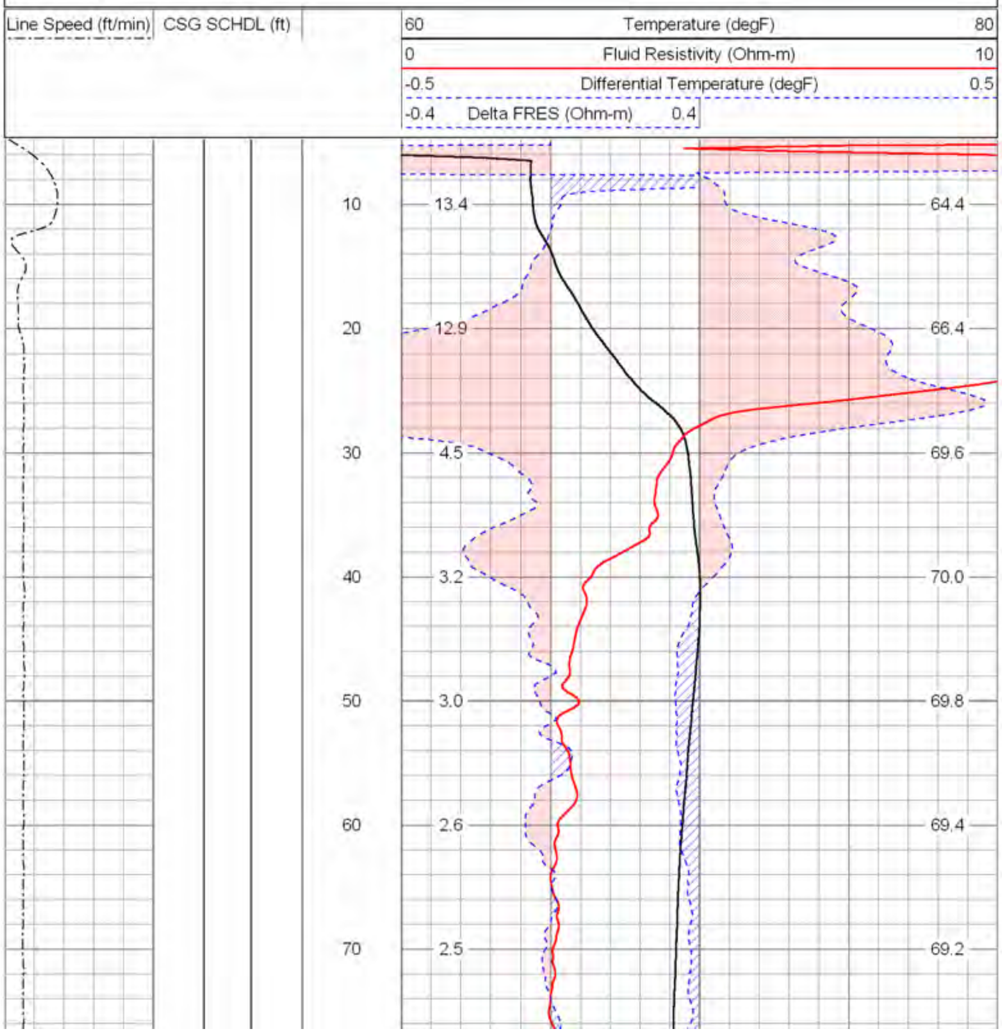
Comments

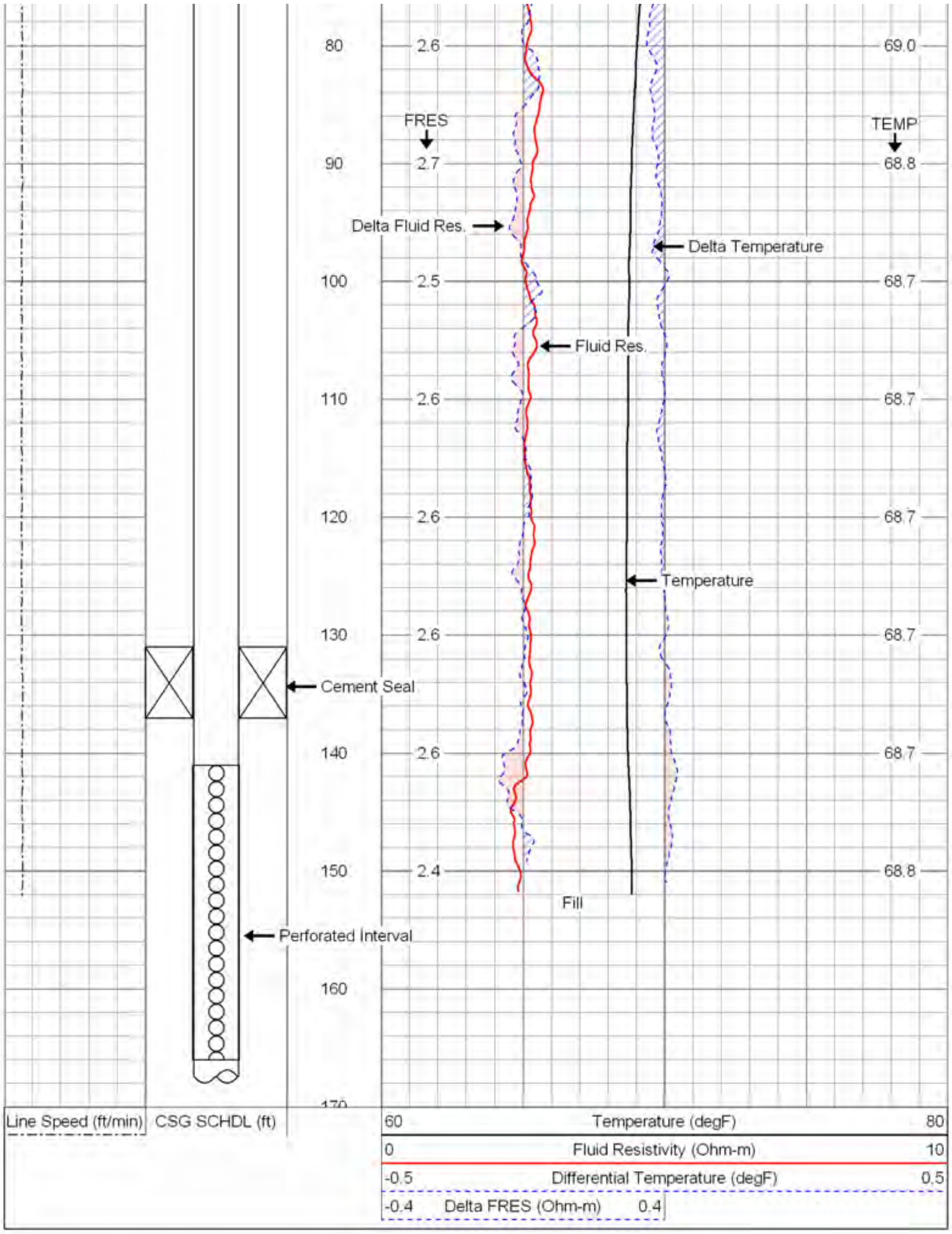
Temperature Calibration Report

Serial Number:	10
Tool Model:	MLS
Performed:	Thu Apr 06 12:28:15 2006

	Reference	Reading
Low Reference:	45.50 degF	1659.00cps
High Reference:	159.80 degF	4759.00cps
Gain:	0.04	
Offset:	-15.67	
Delta Spacing	2	

Database File:	12496.db
Dataset Pathname:	Geo/MW1D/run1/temp.1
Presentation Format:	SLANTW~1
Dataset Creation:	Wed Jun 21 19:05:11 2006 by Calc Warrior 7.0 STD Ope
Charted by:	Depth in Feet scaled 1:120




80
90
100
110
120
130
140
150
160
170
2.6
2.7
2.5
2.6
2.6
2.6
2.6
2.4
69.0
68.8
68.7
68.7
68.7
68.7
68.7
68.8
FRES
TEMP
Delta Fluid Res.
Delta Temperature
Fluid Res.
Temperature
Cement Seal
Fill
Perforated Interval
Line Speed (ft/min)
CSG SCHDL (ft)
60 Temperature (degF) 80
0 Fluid Resistivity (Ohm-m) 10
-0.5 Differential Temperature (degF) 0.5
-0.4 Delta FRES (Ohm-m) 0.4

PACIFIC SURVEYS

TEMPERATURE FLUID RESISTIVITY

Job No. 12535	Company	GEOSCIENCE SUPPORT SERVICES		
	Well	SLANT WELL		
File No.	Field	DOHENY STATE PARK		
	County	ORANGE	State	CA

Location

120 FT SOUTH OF MAIN LIFE GUARD TOWER, 60 FT NORTH OF THE NORTH BANK OF SAN JUAN CREEK

Other Services

NONE

				Elevation
Permanent Datum	G.L.		Elevation	K.B.
Log Measured From	G.L.	0	above perm. datum	D.F.
Drilling Measured From	G.L.			G.L.

Date	05-03-06		
Run Number	TWO		
Depth Driller	350'		
Depth Logger	347.9'		
Bottom Logged Interval	347.9'		
Top Log Interval	0'		
Open Hole Size	N/A		
Type Fluid	WATER		
Density / Viscosity	N/A		
Fluid Level	12'		
Bentonite Seal	N/A		
Time Well Ready	09:00		
Time Logger on Bottom	09:15		
Equipment Number	PS-3		
Location	L.A.		
Recorded By	RIDDER		
Witnessed By	D. SMITH		

Borehole Record				Tubing Record			
Run Number	Bit	From	To	Size	Weight	From	To
ONE	8"	0'	175'				

Casing Record	Size	Wgt/Ft	Top	Bottom
Surface String				
Prot. String	12"	N/A	0'	350'
Production String				
Liner				

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Comments

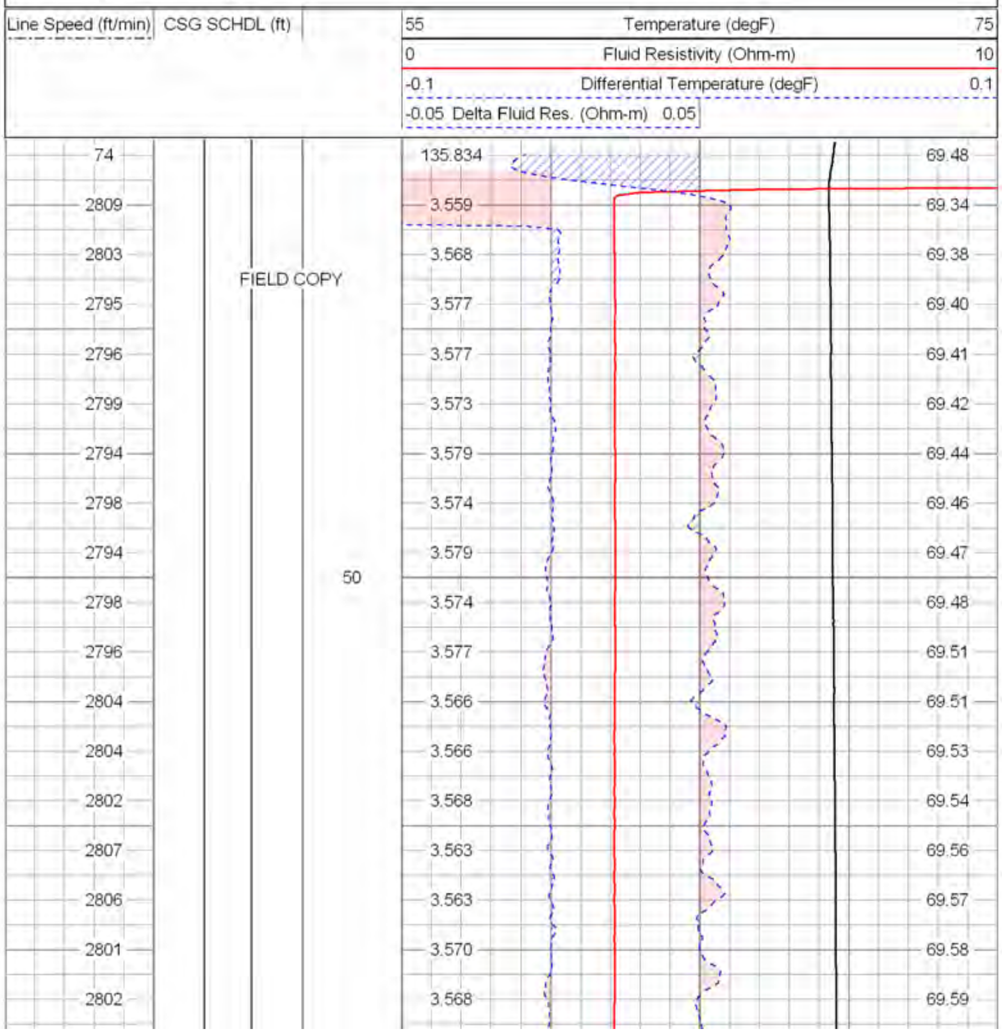
SLANT WELL IS 23 DEGREES FROM HORIZONTAL

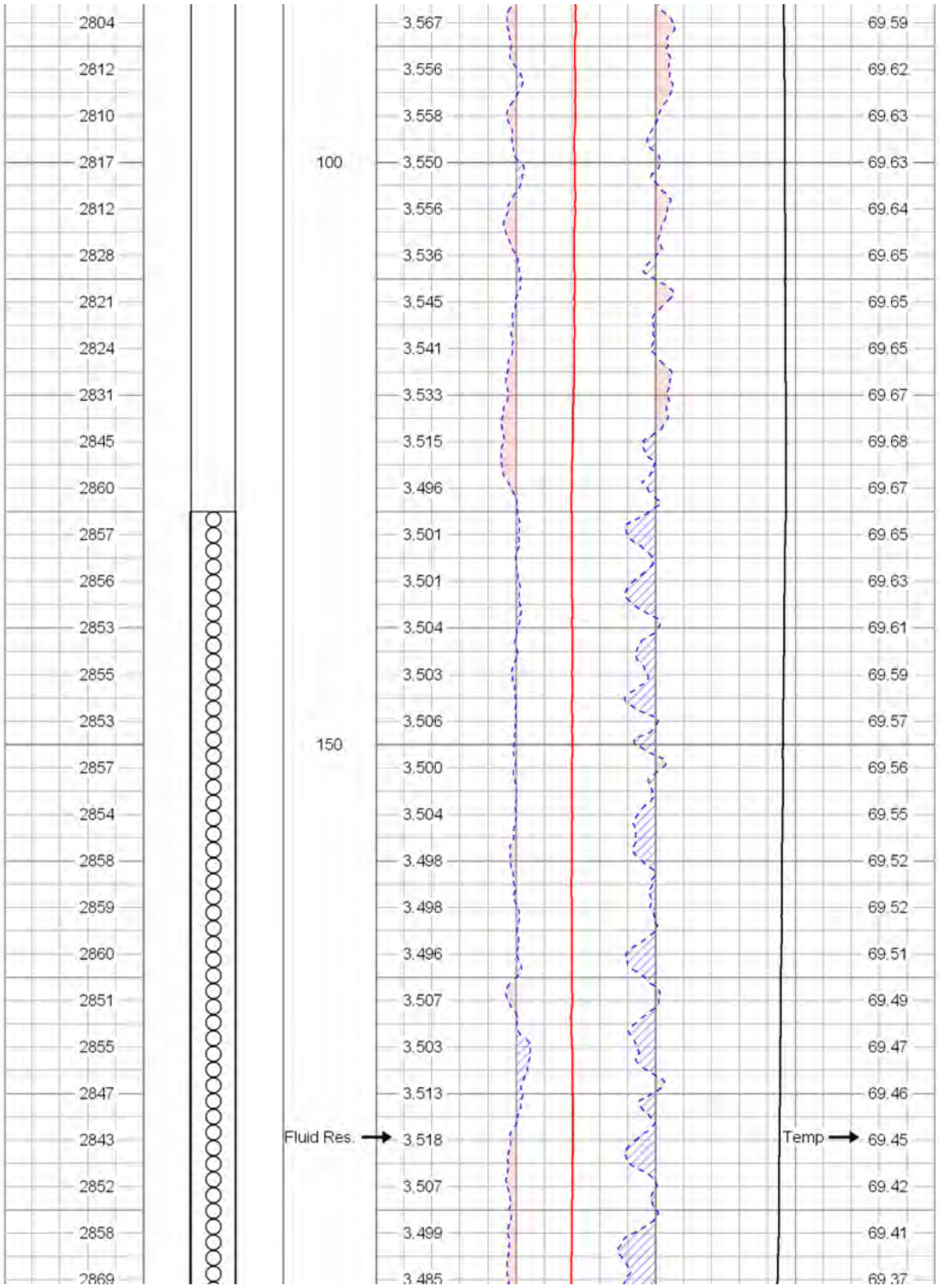
Temperature Calibration Report

Serial Number: 10
Tool Model: MLS
Performed: Thu Apr 06 12:28:15 2006

	Reference	Reading
Low Reference:	45.50 degF	1659.00cps
High Reference:	159.80 degF	4759.00cps
Gain:	0.04	
Offset:	-15.67	
Delta Spacing	2	

Database File:	12535.db
Dataset Pathname:	Geosci/Slant/run1/Temp_DWN3
Presentation Format:	frttemp2
Dataset Creation:	Wed May 03 11:24:18 2006 by Log Warrior 7.0 STD Ope
Charted by:	Depth in Feet scaled 1:120

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2812
2810
2817
2812
2828
2821
2824
2831
2845
2860
2857
2856
2853
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2853
2857
2854
2858
2859
2860
2851
2855
2847
2843
2852
2858
2869
100
150
Fluid Res.
3.567
3.556
3.558
3.550
3.556
3.536
3.545
3.541
3.533
3.515
3.496
3.501
3.501
3.504
3.503
3.506
3.500
3.504
3.498
3.498
3.496
3.507
3.503
3.513
3.518
3.507
3.499
3.485
Temp
69.59
69.62
69.63
69.63
69.64
69.65
69.65
69.65
69.67
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69.67
69.65
69.63
69.61
69.59
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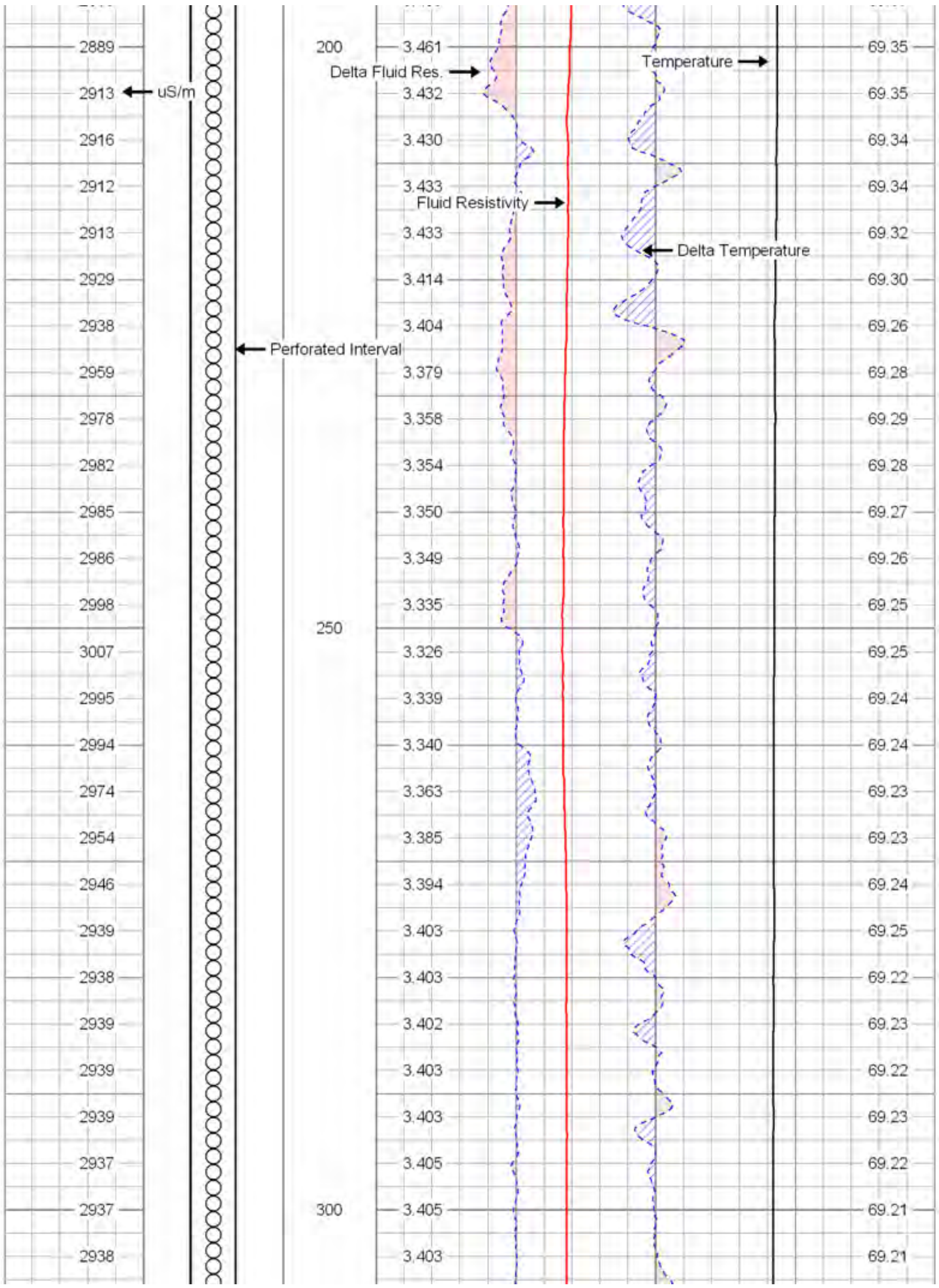
69.42
69.41
69.37



uS/m
Perforated Interval
Delta Fluid Res.
Fluid Resistivity
Temperature
Delta Temperature
200
250
300
2889
2913
2916
2912
2913
2929
2938
2959
2978
2982
2985
2986
2998
3007
2995
2994
2974
2954
2946
2939
2938
2939
2939
2939
2937
2937
2938
3.461
3.432
3.430
3.433
3.433
3.414
3.404
3.379
3.358
3.354
3.350
3.349
3.335
3.326
3.339
3.340
3.363
3.385
3.394
3.403
3.403
3.402
3.403
3.403
3.405
3.405
3.403
69.35
69.35
69.34
69.34
69.32
69.30
69.26
69.28
69.29
69.28
69.27
69.26
69.25
69.25
69.24
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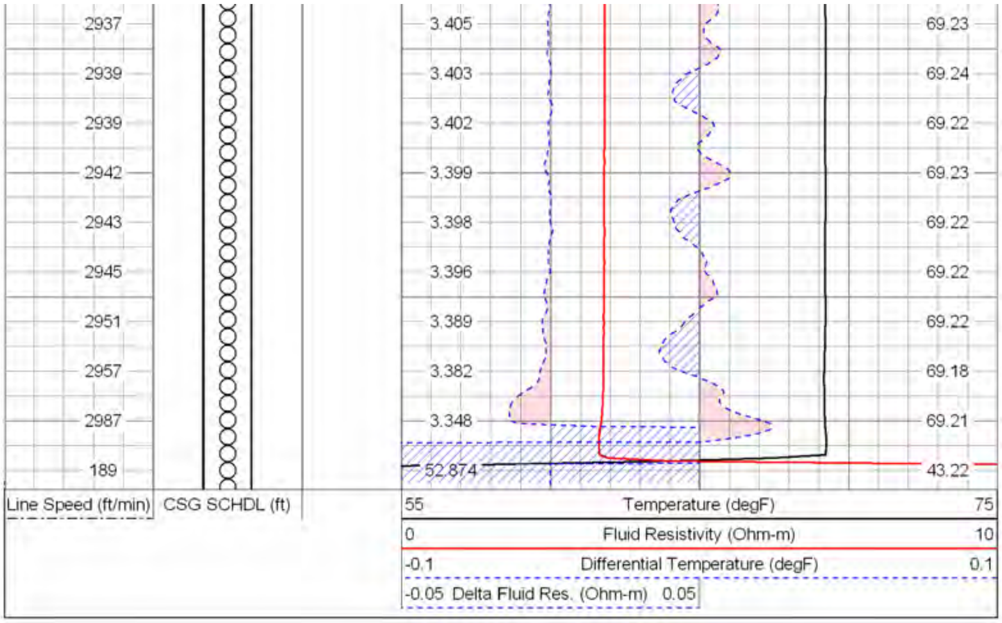
69.22
69.21
69.21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2942
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2945
2951
2957
2987
189
3.405
3.403
3.402
3.399
3.398
3.396
3.389
3.382
3.348
52.874
69.23
69.24
69.22
69.23
69.22
69.22
69.22
69.18
69.21
43.22
Line Speed (ft/min)
CSG SCHDL (ft)
55 Temperature (degF) 75
0 Fluid Resistivity (Ohm-m) 10
-0.1 Differential Temperature (degF) 0.1
-0.05 Delta Fluid Res. (Ohm-m) 0.05

PACIFIC SURVEYS

TEMPERATURE FLUID CONDUCTIVITY CORRECTED

Job No. 12535	Company	GEOSCIENCE SUPPORT SERVICES
	Well	SLANT WELL
File No.	Field	DOHENY STATE PARK
	County	ORANGE State CA

Location

120 FT SOUTH OF MAIN LIFE GUARD TOWER, 60 FT NORTH OF THE NORTH BANK OF SAN JUAN CREEK

Other Services: NONE

Permanent Datum	G.L.		Elevation		Elevation
Log Measured From	G.L.	0	above perm. datum	K.B.	
Drilling Measured From	G.L.			D.F.	
				G.L.	

Date	05-03-06		
Run Number	TWO		
Depth Driller	350'		
Depth Logger	347.9'		
Bottom Logged Interval	347.9'		
Top Log Interval	0'		
Open Hole Size	N/A		
Type Fluid	WATER		
Density / Viscosity	N/A		
Fluid Level	12'		
Bentonite Seal	N/A		
Time Well Ready	09:00		
Time Logger on Bottom	09:15		
Equipment Number	PS-3		
Location	L.A.		
Recorded By	RIDDER		
Witnessed By	D. SMITH		

Borehole Record				Tubing Record			
Run Number	Bit	From	To	Size	Weight	From	To
ONE	8"	0'	175'				

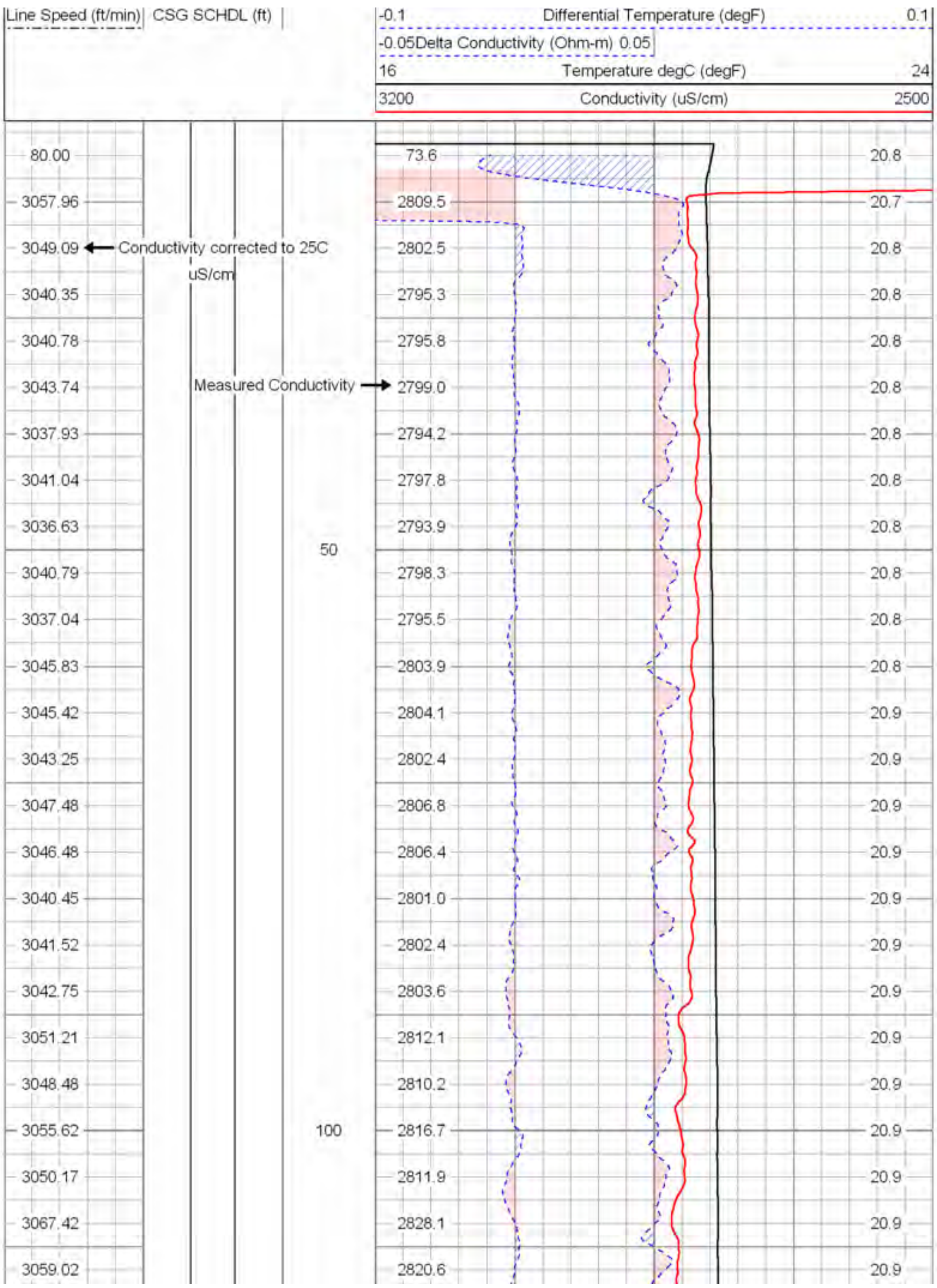
Casing Record	Size	Wgt/Ft	Top	Bottom
Surface String				
Prot. String	12"	N/A	0'	350'
Production String				
Liner				

<<< Fold Here >>>

Comments

SLANT WELL IS 23 DEGREES FROM HORIZONTAL

Database File:	12535.db
Dataset Pathname:	Geosci/Slant/run1/Temp_DWN3
Presentation Format:	frttemp2
Dataset Creation:	Wed May 03 11:24:18 2006 by Log Warrior 7.0 STD Ope
Charted by:	Depth in Feet scaled 1:120



Line Speed (ft/min)
CSG SCHDL (ft)
-0.1 Differential Temperature (degF) 0.1
-0.05 Delta Conductivity (Ohm-m) 0.05
16 Temperature degC (degF) 24
3200 Conductivity (uS/cm) 2500
80.00
3057.96
3049.09
Conductivity corrected to 25C uS/cm
3040.35
3040.78
3043.74
3037.93
3041.04
3036.63
3040.79
3037.04
3045.83
3045.42
3043.25
3047.48
3046.48
3040.45
3041.52
3042.75
3051.21
3048.48
3055.62
3050.17
3067.42
3059.02
50
100
Measured Conductivity
73.6
2809.5
2802.5
2795.3
2795.8
2799.0
2794.2
2797.8
2793.9
2798.3
2795.5
2803.9
2804.1
2802.4
2806.8
2806.4
2801.0
2802.4
2803.6
2812.1
2810.2
2816.7
2811.9
2828.1
2820.6
20.8
20.7
20.8
20.8
20.8
20.8
20.8
20.8
20.8
20.8
20.8
20.8
20.9
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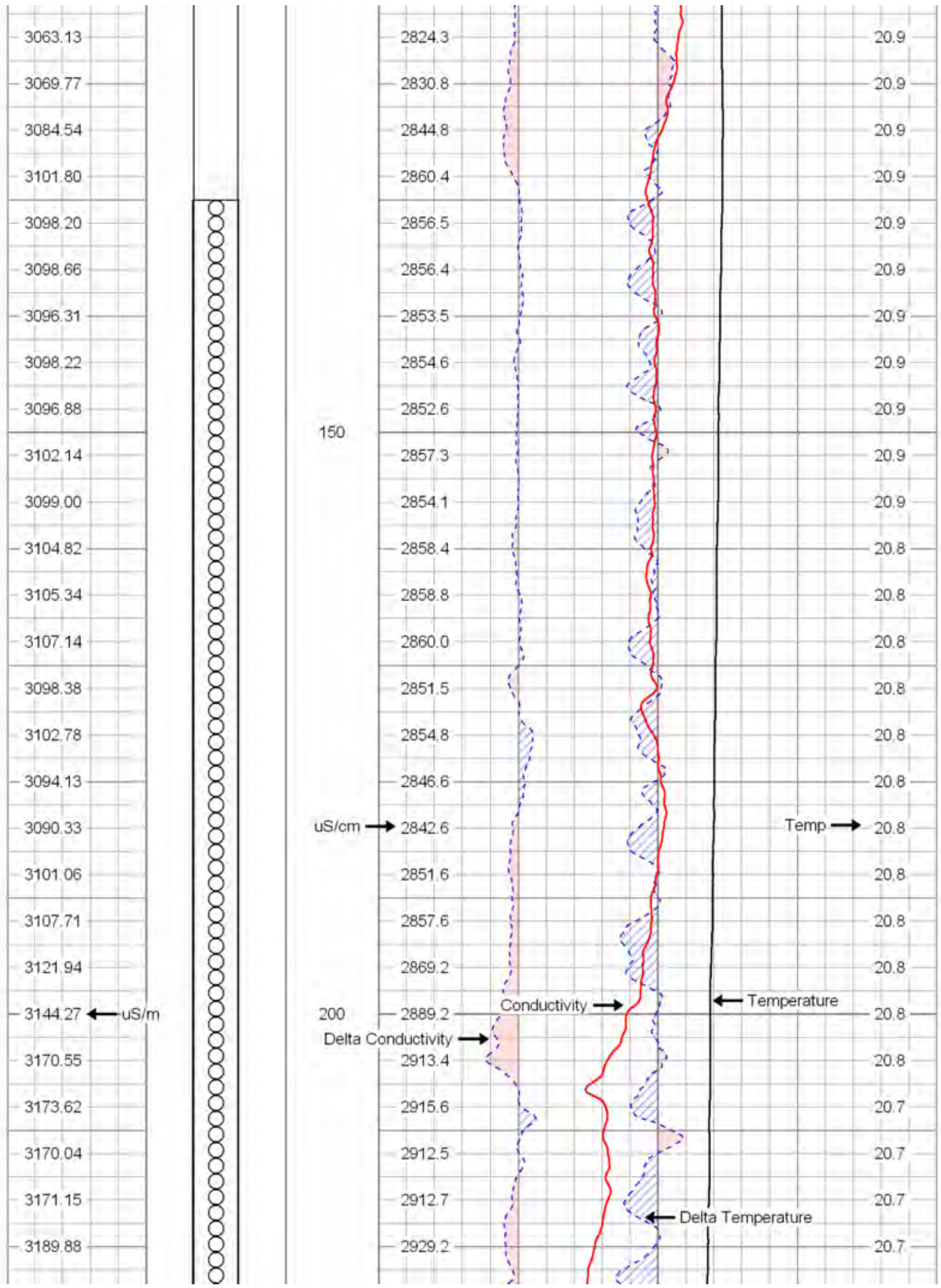
20.9


3063.13
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3084.54
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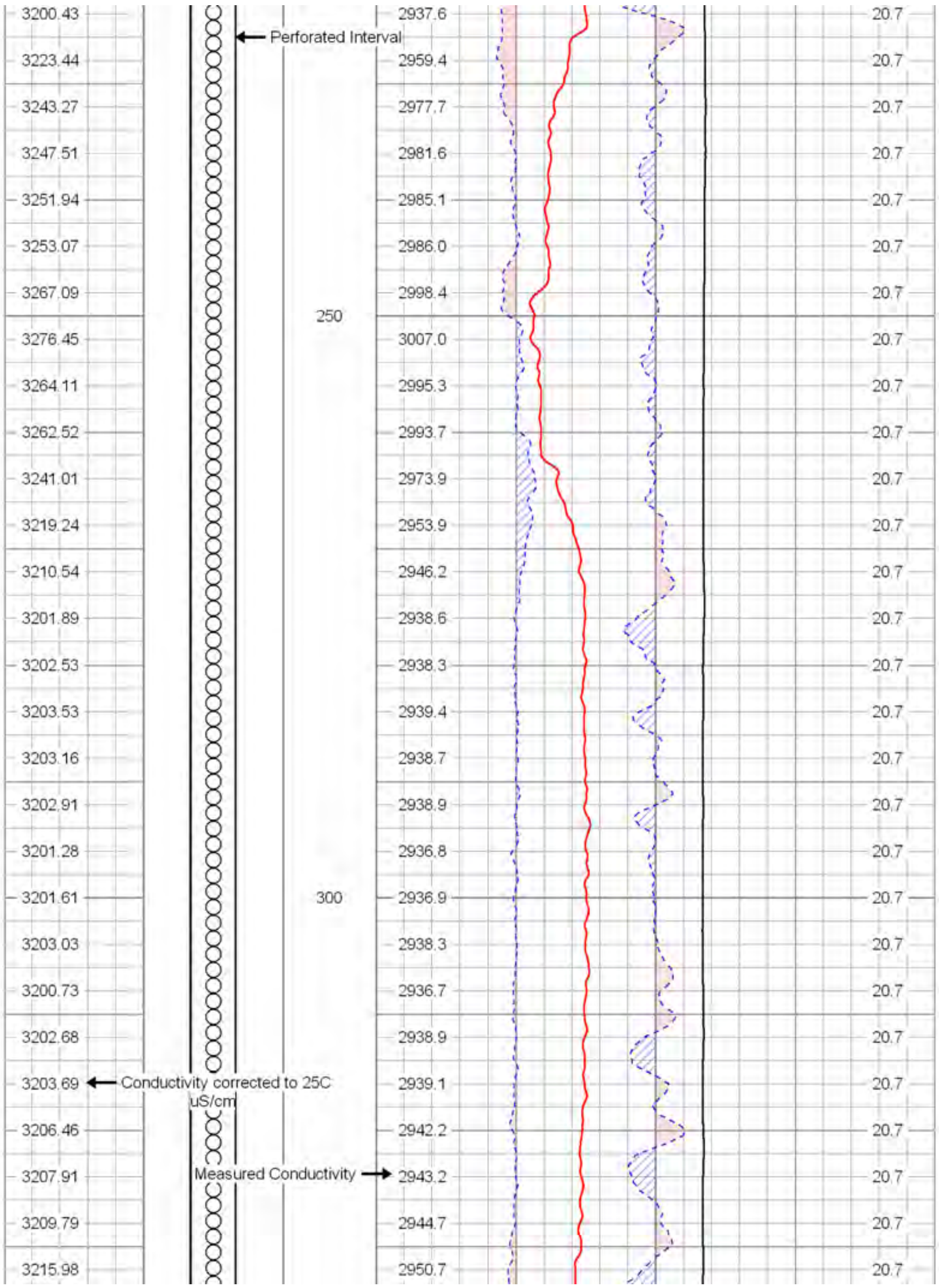
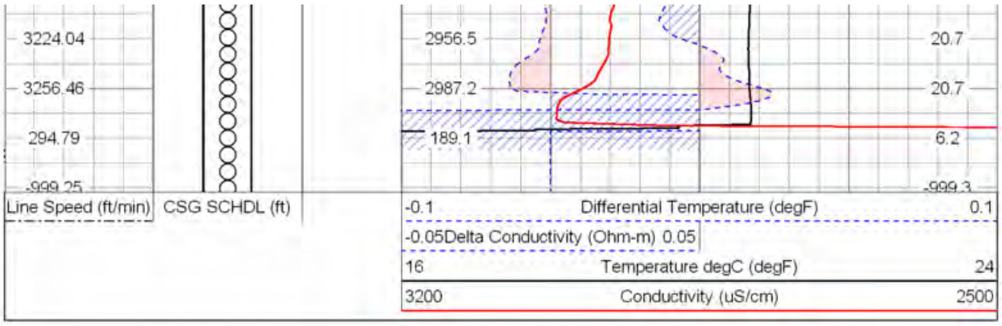
3098.20
3098.66
3096.31
3098.22
3096.88
3102.14
3099.00
3104.82
3105.34
3107.14
3098.38
3102.78
3094.13
3090.33
3101.06
3107.71
3121.94
3144.27
uS/m
3170.55
3173.62
3170.04
3171.15
3189.88
150
uS/cm
200
Delta Conductivity
2824.3
2830.8
2844.8
2860.4
2856.5
2856.4
2853.5
2854.6
2852.6
2857.3
2854.1
2858.4
2858.8
2860.0
2851.5
2854.8
2846.6
2842.6
2851.6
2857.6
2869.2
2889.2
2913.4
2915.6
2912.5
2912.7
2929.2
Conductivity
Temperature
Delta Temperature
Temp
20.9
20.8
20.7



Perforated Interval
250
300
Conductivity corrected to 25C uS/cm
Measured Conductivity
3200.43
3223.44
3243.27
3247.51
3251.94
3253.07
3267.09
3276.45
3264.11
3262.52
3241.01
3219.24
3210.54
3201.89
3202.53
3203.53
3203.16
3202.91
3201.28
3201.61
3203.03
3200.73
3202.68
3203.69
3206.46
3207.91
3209.79
3215.98
2937.6
2959.4
2977.7
2981.6
2985.1
2986.0
2998.4
3007.0
2995.3
2993.7
2973.9
2953.9
2946.2
2938.6
2938.3
2939.4
2938.7
2938.9
2936.8
2936.9
2938.3
2936.7
2938.9
2939.1
2942.2
2943.2
2944.7
2950.7
20.7


3224.04
3256.46
294.79
-999.25
2956.5
2987.2
189.1
20.7
20.7
6.2
-999.3
Line Speed (ft/min)
CSG SCHDL (ft)
-0.1 Differential Temperature (degF) 0.1
-0.05Delta Conductivity (Ohm-m) 0.05
16 Temperature degC (degF) 24
3200 Conductivity (uS/cm) 2500

Appendix G
Video Survey Reports

Pacific Surveys

a full service geophysical well logging company

Video Survey Report

Company:	Geoscience	**Date:**	06-Apr-06		
Well:	Dana Point Slant Well	**Run No.**	One	**Truck**	PS3
Field:	Dana Point	**Job Ticket:**	12496		
State:	California	**Total Depth:**	N/A		
		Water Level:	17.6 ft		
Location:	120 ft south of main Lifeguard tower, 60 ft north of the north b	**Operator:**	Ridder/Trad		
Zero Datum:	Ground Level	**Tool Zero:**	Side-Scan		
Reason for Survey:	Inspection of new Well construction				

Depth	Remarks		
17.6 ft	SWL: cloudy	**Perforation:**	
19.0 ft	Water clarity decreases: suspended particles and Bio-fouling	**Louvers**	132.50 ft to N/A
98.0 ft	Bio-fouling is still present		
127.0 ft	Bio-fouling is still present: no water movement		
131.1 ft	Collar staining of casing		
132.5 ft	Top of Louver: all perfs appear open		
135.0 ft	Cloudy: with light suspended particles	**Casing Size**	
150.0 ft	Biofouling	**12.00 in**	0.00 ft to 350.00ft
170.0 ft	Staining: reddish in color		
190.0 ft	Cloudy: water moves up and down periodically		
231.0 ft	Water appears to be moving down		
313.0 ft	Observed upward water movement		
316.0 ft	Gravel & sand on low side of well csg		
323.0 ft	Gravel & sand on low side of well csg ends		
330.0 ft	Sand is on low side of csg		
332.4 ft	Stopped: unable to proceed due to sand accumulation on low side of csg		

Notes: All depths are referenced to side-scan lens. Downview lens is 5" below side-scan.

800.919.7555
909.625.6262

4456 via st. ambrose
claremont ca 91711
www.pacificsurveys.com

fax: 909.399.3180

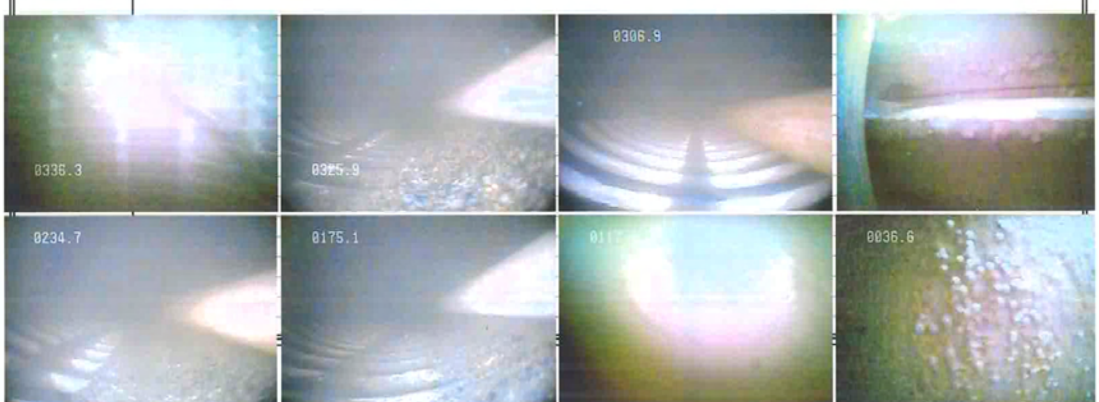
Pacific Surveys

a full service geophysical well logging company

Video Survey Report

Company:	Geoscience	**Date:**	16-May-06		
Well:	Dana Point Slant Well	**Run No.**	One	**Truck**	PS3
Field:	Dana Point	**Job Ticket:**	12565		
State:	California	**Total Depth:**	N/A		
		Water Level:	17.6 ft		
Location:	120 ft south of main Lifeguard tower,	**Operator:**	Ridder/Trad		
	60 ft north of the north bank of San Juan Creek				
Zero Datum:	Ground Level **Tool Zero:**	Side-Scan			
Reason for Survey:	Final inspection of new well construction				

Depth	Remarks		
0.0 ft	Start survey down: camera had difficulty going to bottom.	**Perforation:**	
	Used 1" PVC to push camera to bottom	**Louvers**	130.00 ft to 348.00ft
349.8 ft	Camera on bottom: moved camera to 341.8 ft and waited for water		
	to clear.		
341.8 ft	After 20 minutes resumed survey.		
315.0 ft	Out of sand. Water appears cloudy. Casing appears clear.		
306.0 ft	Water is cloudy.	**Casing Size**	
291.0 ft	Water is cloudy.	**12.00 in**	0.00 ft to 350.00ft
280-270 ft	Scrap marks on perfs from pump.		
266.0 ft	Small gravel collecting on low side.		
247.0 ft	Gravel pack is visible.		
222.0 ft	Fish.		
205.0 ft	Slight becomes slightly clearer.		
165.0 ft	Some scratching returning.		
166.0 ft	Gravel on low side decreasing.		
155.0 ft	Water is cloudy.		
131.4 ft	Perfs end.		
80.0 ft	Water is cloudy.		
65.0 ft	Water is cloudy.		
36.2 ft	Bubbles appearing.		



Notes: **All depths are referenced to side-scan lens. Downview lens is 5" below side-scan.**

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909.625.6262

4456 via st. ambrose
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www.pacificsurveys.com

fax: 909.399.3180

Appendix H
Well Completion Report

File Original with DWR

State of California

Well Completion Report

Refer to Instruction Pamphlet

No. e039649

Page 1 of 1

Owner's Well Number SL-1

Date Work Began 02/04/2006 Date Work Ended 5/18/2006

Local Permit Agency Orange County Health Care Agency Environmental Health Division

Permit Number 06-01-23 Permit Date 1/18/06

DWR Use Only – Do Not Fill In

State Well Number/Site Number

N W

Latitude Longitude

APN/TRS/Other

Geologic Log

Orientation: ○ Vertical ○ Horizontal ◉ Angle Specify 23

Drilling Method Dual Rotary Drilling Fluid Air/Water

Depth from Surface Feet	to Feet	Description (Describe material, grain size, color, etc)
5	40	Poorly graded sand, trace gravel
40	45	Poorly graded med. to coarse sand w/ fine to coarse gravel
45	50	Poorly graded gravel w/ sand, broken cobbles
50	55	Poorly graded sand w/ gravel and sandy clay balls
55	60	Clayey sand w/ gravel, interbedded w/ sand
60	65	No sample
65	70	Fat clay interbedded w/ sandy clay
70	80	Clayey fine sand
80	85	Clay
85	90	Clay w/ fine sand and trace fine gravel
90	97	Clayey fine to med. sand
97	99	Clay w/ fine sand
99	100	Poorly graded med. to coarse sand w/ fine to coarse gravel
100	180	Poorly graded sand w/ gravel
180	185	Clayey sand w/ gravel and broken cobbles
185	190	Poorly graded sand w/ gravel and trace cobbles
190	215	Poorly graded sand w/ gravel
215	220	Gravel w/ sand
220	235	Poorly graded sand w/ gravel
235	255	Gravel w/ sand and trace cobbles
255	260	Poorly graded sand w/ gravel
260	265	Gravel w/ sand
265	280	Poorly graded sand w/ trace gravel
280	295	Gravel w/ sand and trace cobbles
295	305	Poorly graded sand w/ trace gravel
305	350	Gravel w/ sand and cobbles
350	355	Fine-grained sand w/ trace silt and trace clay
355	362	Fine to med. sand, highly micaceous

Total Depth of Boring 362 Feet

Total Depth of Completed Well 350 Feet

Well Owner

Name Municipal Water District of Orange County

Mailing Address 10500 Ellis Avenue PO Box 20895

City Fountain Valley State CA Zip 92728

Well Location

Address Doheny State Beach, West of San Juan Creek Mouth

City Dana Point County Orange

Latitude 33 Deg. 27 Min. 43 Sec. N Longitude 117 Deg. 41 Min. 4 Sec. W

Datum NAD83 Decimal Lat. 33.46195371 Decimal Long. 117.684604

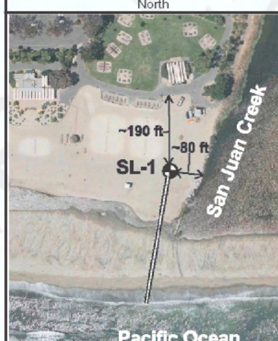
APN Book 85 Page 9 Parcel unknown

Township 8S Range 8W Section 23

Location Sketch

(Sketch must be drawn by hand after form is printed.)

North



Illustrate or describe distance of well from roads, buildings, fences, rivers, etc. and attach a map. Use additional paper if necessary. **Please be accurate and complete**

Activity

◉ New Well
○ Modification/Repair
○ Deepen
○ Other
○ Destroy (Describe procedures and materials under "GEOLOGIC LOG")

Planned Uses

○ Water Supply
☐ Domestic ☐ Public
☐ Irrigation ☐ Industrial
○ Cathodic Protection
○ Dewatering
○ Heat Exchange
○ Injection
○ Monitoring
○ Remediation
○ Sparging
◉ Test Well
○ Vapor Extraction
○ Other

Water Level and Yield of Completed Well

Depth to first water 7 vertical (Feet below surface)

Depth to Static Water Level 7 vertical (Feet) Date Measured 03/31/2006

Estimated Yield * 1,660 (GPM) Test Type Constant Rate

Test Length 120.0 (Hours) Total Drawdown 22 vertical (Feet)

*May not be representative of a well's long term yield.

Casings

Depth from Surface Feet	to Feet	Borehole Diameter (Inches)	Type	Material	Wall Thickness (Inches)	Outside Diameter (Inches)	Screen Type	Slot Size if Any (Inches)
7.7	97	24	Blank	316L Stainless Steel	5/16	12.75		
97	130	20	Blank	316L Stainless Steel	5/16	12.75		
130	350	20	Screen	316L Stainless Steel	5/16	12.75	Louver	0.094

Annular Material

Depth from Surface Feet	to Feet	Fill	Description
8	43	Cement	
43	45	Fine Sand	
45	362	Filter Pack	4x16

Attachments

☐ Geologic Log
☐ Well Construction Diagram
☐ Geophysical Log(s)
☐ Soil/Water Chemical Analyses
☐ Other

Attach additional information, if it exists.

Certification Statement

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief

Name Robert Longyear (Person, Firm or Corporation)

19700 SW Teton (Address) Tualatin (City) OR (State) 97062 (Zip)

Signed [signature] (C-57 Licensed Water Well Contractor) 5-18-06 (Date Signed) 69686 (C-57 License Number)

DWR 188 REV. 1/2006

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

Appendix I
Contractor's Supporting Data

Casing, Liner and Screen Installation Log Sheet

Hole #: ____________

Job #: ____________

Type: ____ casing/liner/screen	Type: ____ casing/liner/screen	Type: ____ casing/liner/screen
Diameter: 24"	Diameter: 20"	Diameter:
☒Temp ☐Permanent	☐Temp ☐Permanent	☐Temp ☐Permanent
Drive Shoe: Barber	Drive Shoe: Barber	Drive Shoe:
Setting Sub: —	Setting Sub: —	Setting Sub:
Date Started: 2/4/06	Date Started: / /	Date Started: / /
Length	**Length**	**Length**
1. 30.75	1. 40.37	1.
2. 20.2	2. 40.22	2.
3. 20.13 71.08	4 20.03	3.
4. 20.07 91.15	3 20.01	4.
5. 20.0 111.15	5. 20.0 140.63	5.
6. -7.01	6. 19.39 160.02	6.
7. Total length ~~103.44~~	7. 19.98 180.00	7.
8. 103.44	8. 19.99 ~~200~~ 199.99	8.
9. — sticky 6.00	9. 20.04 220.03	9.
10. 97.44	10. 20 = 240.03	10.
11. LF	11. 20.1 = 260.13	11.
12. [illegible]	12. 20.1 = 280.23	12.
13.	13. 20.1 = 300.33	13.
14.	14. 20.24 = 320.57	14.
15.	15. 20' = 340.57 cut	15. off 4' = 336.57
16.	~~16. 20'~~	~~16. 356.57~~
17.	17. 20'	17. 366.57
18.	18.	~~18.~~
19.	19.	19. 362. TD.
20. 300.33	20.	20.
21. 20.24 / 57.	21.	21. 20" casing
22. 320'	22.	22.
23.	23.	23.
24.	24.	24.
25.	25.	25.
26.	26.	26.
27.	27.	27.
28.	28.	28.
29.	29.	29.
Total Length:	Total Length:	Total Length:
Location of Bottom:	Location of Bottom:	Location of Bottom: 362'

Shift? N/D (D)	Date: 1/30/06	Day of Week: Mon	Job #: Dana Point	Rig # 4725 Well# ____

START	END	LABOR DESCRIPTION
7:00Am	7:00pm	site meeting & site prep.

Total Sub Length ____

Total Stabilizer Length ____

Total Bit Length ____

Driller: Dave Total Hrs ____ On Site ____ Helper: Robert Total Hrs ____ Onsite ____

Standby: ____ hrs Equipment Only: ____ hrs Helper: Phil Total Hrs ____ Onsite ____

Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: ____ End of Shift: ____
Sand	sacks	Pump	
Chips	sacks	Roll-Off Box	
Quickgel	sacks	Baker Tank	SWL (DBGS) Start of Shift: ____ End of Shift: ____
Cement Yards 48lb 96lb		Other:	

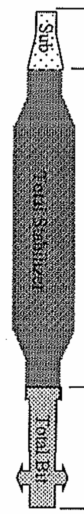
Shift? N/D

Date: 1/31/06 Day of Week: TUES Job #: Dana Point

Rig # 4775

Well# ______

START	END	LABOR DESCRIPTION
7:00am		Secure lay down yard & drill site, start plumbing
		in water from water source & prep drill pad
	7:30am	unload truck's



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

Driller: [illegible] Total Hrs _____ On Site _____ Helper: Robert Total Hrs _____ Onsite _____

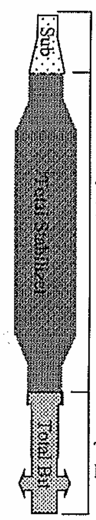
Standby: _____ hrs Equipment Only: _____ hrs Helper: Phil Total Hrs _____ Onsite _____

Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	Forklift / Backhoe	Hole (DBGS)
Sand	sacks	Pump	Start of Shift: ______
Chips	sacks	Roll-Off Box	End of Shift: ______
Quickgel	sacks	Baker Tank	SWL (DBGS)
Cement	Yards 48lb 96lb	Other:	Start of Shift: ______
			End of Shift: ______

Shift? N/D (D circled)	Date: 2/1/06 Day of Week: Wed Job #: [illegible]	Rig # 4775 Well# ____

START	END	LABOR DESCRIPTION
7:00		unload K-Rails & unload derrick & Platform
	9:30	w/ crane
9:30		Put K-Rails around site & put plastic where Rig
	6:10	goes
6:10	7:00	move Rig on drill site



Total Sub Length ____

Total Stabilizer Length ____

Total Bit Length ____

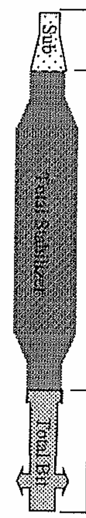
Driller: [illegible signature] Total Hrs ____ On Site ____ Helper: [illegible signature] Total Hrs ____ Onsite ____
Standby: ____ hrs Equipment Only: ____ hrs Helper: [illegible signature] Total Hrs ____ Onsite ____

Client Signature

General Materials			Rental Items Onsite?	Hole Information
Foam	gallons		Forklift / Backhoe	Hole (DBGS) · Start of Shift: ____ End of Shift: ____
Sand	sacks		Pump	
Chips	sacks		Roll-Off Box	
Quickgel	sacks		Baker Tank	SWL (DBGS) Start of Shift: ____ End of Shift: ____
Cement Yards	48lb	96lb	Other:	

Shift? N/D	Date: 2/3	Day of Week: Fri	Job #: Dana Point	Rig # 4775 Well#

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.I
7:10	7:30	Rig warm up / Paper work / safety meeting
7:30		change over to R/C on top head & air swivel
	10:30	Put up sound barriers, Put down Iron plates
		FOR drop box



Total Sub Length ______

Total Stabilizer Length ______

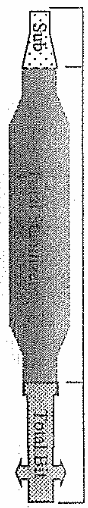
Total Bit Length ______

Driller: [illegible] Total Hrs _____ On Site _____ Helper: Alvarez Total Hrs _____ Onsite _____
Standby: _____ hrs Equipment Only: _____ hrs Helper: Hill Total Hrs _____ Onsite _____

Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	**Forklift / Backhoe**	**Hole (DBGS)** Start of Shift: ______
Sand	sacks	**Pump**	
Chips	sacks	**Roll-Off Box**	End of Shift: ______
Quickgel	sacks	**Baker Tank**	**SWL (DBGS)** Start of Shift: ______
Cement Yards 48lb 96lb		**Other:**	End of Shift: ______

Shift? N/D (D circled)		Date: 2-4-10 Day of Week: Sat Job #: Dana Point	Rig # 4775 Well#
START	**END**	**LABOR DESCRIPTION**	
7:00	7:10	P.S.S.I	
7:10	7:30	Paper work - Rig warm up - safety meet.	
7:30	1:00	Put tooling together & put in tower	
1:00	2:00	weld on 24" drive shoe	
2:00	2:35	start drilling & advancing 24" casing from Ø to 5'	
2:35	6:00	Trouble shoot drill rig jumping out of gear "Cushman Box"	



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

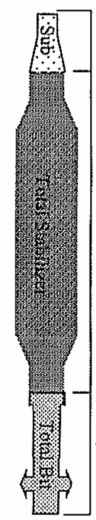
Driller: Russ Total Hrs ____ On Site ____ Helper: [illegible] Total Hrs ____ Onsite ____
Standby: ____ hrs Equipment Only: ____ hrs Helper: Phil Total Hrs ____ Onsite ____

Client Signature

General Materials	Rental Items Onsite?	Hole Information
Foam gallons	**Forklift / Backhoe**	**Hole (DBGS)** Start of Shift: Ø
Sand sacks	**Pump**	End of Shift: 5
Chips sacks	**Roll-Off Box**	
Quickgel sacks	**Baker Tank**	**SWL (DBGS)** Start of Shift: ____
Cement Yards 48lb 96lb	**Other:**	End of Shift: ____

Shift? N/D (D circled)	Date: 2-4-06 Day of Week: Sat Job #: Dana Point	Rig # 4775 Well# ________

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.I
7:10	7:30	Paper work - Rig warm up - safety meet.
7:30	1:00	Put tooling together & put in tower
1:00	2:00	weld on 24" drive shoe
2:00	2:35	Start drilling & advancing 24" casing from Ø to 5'
2:35	6:00	Trouble shoot drill rig jumping out of gear "Cushman Box"



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

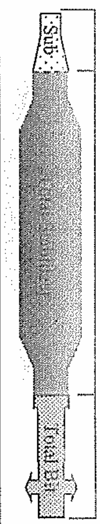
Driller: Rivas Total Hrs _____ On Site _____ Helper: Armando Total Hrs _____ Onsite _____
Standby: _____ hrs Equipment Only: _____ hrs Helper: Phil Total Hrs _____ Onsite _____

Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	**Forklift / Backhoe**	**Hole (DBGS)** Start of Shift: Ø End of Shift: 5'
Sand	sacks	**Pump**	
Chips	sacks	**Roll-Off Box**	
Quickgel	sacks	**Baker Tank**	**SWL (DBGS)** Start of Shift: ______ End of Shift: ______
Cement Yards 48lb 96lb		**Other:**	

Shift? N/D	Date: 2-5-06 Day of Week: SUN Job #: Dana Point	Rig # 4275 Well# ____

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.I
7:10	7:30	Paper work / safety meet /
7:30		Trouble shoot cushman Box on Rig From Jumping out
	8:30	of Gear
8:30	11:00	Pull out cushman Box
11:00		Pick up site & put up Fencing around site
	12:30	From pulling Box, Lock up site
		Cushman & associates Inc.
		Power Train Engineers
		32367 West 8 mile Rd.
		Livonia, Michigan, 48152
		www.cushman.com
		Phone -(248)-477-9900
		Fax (248)-477-7883
		Fax (403)-295-5810



Total Sub Length ______

Total Stabilizer Length ______

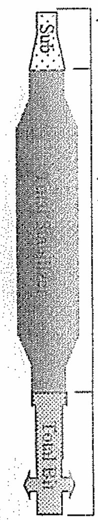
Total Bit Length ______

Driller: [signature] Total Hrs ____ On Site ____ Helper: [signature] Total Hrs ____ Onsite ____
Standby: ____ hrs Equipment Only: ____ hrs Helper: [signature] Total Hrs ____ Onsite ____

Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: ______
Sand	sacks	Pump	End of Shift: ______
Chips	sacks	Roll-Off Box	
Quickgel	sacks	Baker Tank	SWL (DBGS) Start of Shift: ______
Cement	Yards 48lb 96lb	Other:	End of Shift: ______

Shift? N/D		Date: 2/10 Day of Week: Mon Job #: Dana Point	Rig # 4225 Well# ______
START	**END**	**LABOR DESCRIPTION**	
7:00	7:10	P.S.S.I	
7:10	7:30	Paper work / safety meeting	
7:30		Plumb up pump in Baker tank & Roll off Box	
		For Flooded R/C, wrap up hyd. hoses on tower	
	5:30	For travel	
		PHil off duty	



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

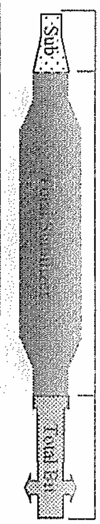
Driller: [signature] Total Hrs ____ On Site ____ Helper: [signature] Total Hrs ____ Onsite ____
Standby: ____ hrs Equipment Only: ____ hrs Helper: ______ Total Hrs ____ Onsite ____

Client Signature

General Materials	Rental Items Onsite?	Hole Information
Foam gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: ______
Sand sacks	Pump	End of Shift: ______
Chips sacks	Roll-Off Box	
Quickgel sacks	Baker Tank	SWL (DBGS) Start of Shift: ______
Cement Yards 48lb 96lb	Other:	End of Shift: ______

Shift? N/D	Date: 2/7 Day of Week: Tues Job #: Dana Parker	Rig # 4775 Well#

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.I
7:10	7:30	Paper work / safety meeting
7:30	8:30	Get part from united pipe
8:30		unload water tr. w/24" casing & put behind rig w/
	12:00	crane truck
12:00	3:00	Put in new dushman box
3:00	4:00	Start drilling from 5' to 15'
4:00	6:00	Put 24" casing w/rod in tower w/crane #2 casing



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

Driller: [signature] Total Hrs ______ On Site ______ Helper: [signature] Total Hrs ______ Onsite ______

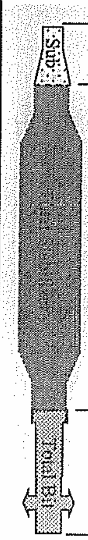
Standby ______ hrs Equipment Only: ______ hrs Helper: [signature] Total Hrs ______ Onsite ______

Client Signature

General Materials	Rental Items Onsite?	Hole Information
Foam gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: 5'
Sand sacks	Pump	End of Shift: 15'
Chips sacks	Roll-Off Box	
Quickgel sacks	Baker Tank	SWL (DBGS) Start of Shift: ______
Cement Yards 48lb 96lb	Other:	End of Shift: ______

Shift? N/D	Date: 2/8	Day of Week: Wed	Job #: [illegible]	Rig # 4775
				Well#

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.I
7:10	7:30	Paper work / safety meeting / Rig warm up
7:30	8:40	Level up #2 casing In mast. Before welding
8:40	9:25	weld on #2
9:25	11:00	Drill down #2 - 24" casing = 20.2
11:00	3:45	Put up #3 In [illegible]
3:45	5:30	weld up #3
5:30	7:00	Drill down TO 40'
		24" casing
		#1 - 30.75
		#2 - 20.2
		#3 - 20.13 = 71.08



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

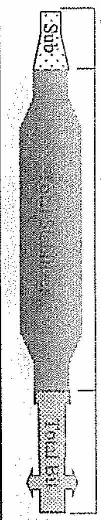
Driller: [signature] Total Hrs ____ On Site ____ Helper: [signature] Total Hrs ____ Onsite ____
Standby: ____ hrs Equipment Only: ____ hrs Helper: [signature] Total Hrs ____ Onsite ____

Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: 15'
Sand	sacks	Pump	End of Shift: 40'
Chips	sacks	Roll-Off Box	
Quickgel	sacks	Baker Tank	SWL (DBGS) Start of Shift: ______
Cement Yards 48lb 96lb		Other:	End of Shift: ______

Shift? N/D	Date: 2/9/06 Day of Week: Thurs. Job #: [illegible]	Rig # 4775 Well#

START	END	LABOR DESCRIPTION
7:00	7:10	R.S.S.I
7:10	7:30	Paper work / Safety meeting / Rig warm up
7:30	10:00	Start drilling from 40' to 55
10:00	10:45	Make J-Hook for casing & Rod's to put in Tower
10:45	1:15	Put Rod & casing in Tower
1:15	2:00	weld pipe
2:00	2:45	Drilldown 24" to 75'
2:45		Finish Wellding 5:45 pm
		Pick up Spit 6:00 pm
		24" casing
		#4 = 20.07 = 91.15
		#5 = 20' = 111.15



Total Sub Length ______

Total Stabilizer Length ______

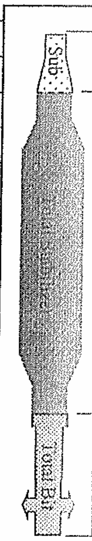
Total Bit Length ______

Driller: [signature] Total Hrs ____ On Site ____ Helper: [signature] Total Hrs ____ Onsite ____
Standby: ____ hrs Equipment Only: ____ hrs Helper: [signature] Total Hrs ____ Onsite ____

Client Signature

General Materials	Rental Items Onsite?	Hole Information
Foam gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: 40'
Sand sacks	Pump	End of Shift: ______
Chips sacks	Roll-Off Box	
Quickgel sacks	Baker Tank	SWL (DBGS) Start of Shift: ______
Cement Yards 48lb 96lb	Other:	End of Shift: ______

Shift? N/D		Date: 2-16 Day of Week: Fri Job #: 0063	Rig # 175 Well# SL-1
START	END	LABOR DESCRIPTION	
7:00	7:15	PSSP	
7:15	7:30	Warm up Rig Pump Water off Roll off	
7:30	8:15	Drill from 75-96	
8:45	9:00	Clean hole and fill with Fresh water	
9:00	1:15	Set casing cutter up for 24"	
1:15	6:00	trip tools out ~~[illegible]~~	
6:00	6:15	Pick up site off site	



Total Sub Length ______

Total Stabilizer Length ______

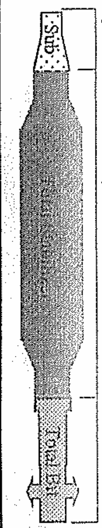
Total Bit Length ______

Driller: Robert Total Hrs 11.25 On Site _____ Helper: Armando Total Hrs _____ Onsite _____
Standby: _____ hrs Equipment Only: _____hrs Helper: Phil _____ Total Hrs _____ Onsite _____

Client Signature

General Materials				Rental Items Onsite?	Hole Information
Foam	gallons			Forklift / Backhoe	Hole (DBGS) Start of Shift: 75
Sand	sacks			Pump	End of Shift: 96
Chips	sacks			Roll-Off Box	
Quickgel	sacks			Baker Tank	SWL (DBGS) Start of Shift: ______
Cement				Other:	
	Yards	48lb	96lb		End of Shift: ______

Shift? N/D		Date: 2-11-06 Day of Week: Sat Job #: 0063	Rig # 4775 Well# SL-1
START	END	LABOR DESCRIPTION	
7:10	7:25	PSSI	
7:25	7:30	Warm up equipment	
7:30	8:30	~~[illegible] cutter in[illegible] bolt~~ & Sound hole	
		found 20' of Sand heaved up into casing	
8:30	3:30	forgo Shoe cut & start preping for 20"	
		casing installation	
3:30	5:45	Fab new hose bracket on rig & adjust	
		Hoses	
5:45	5:50	Pick up Site	



Total Sub Length ____

Total Stabilizer Length ____

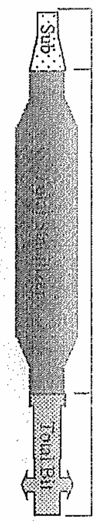
Total Bit Length ____

Driller: R.S. Total Hrs ____ On Site ____ Helper: Armando Total Hrs ____ Onsite ____
Standby: ____ hrs Equipment Only: ____ hrs Helper: Phil Total Hrs ____ Onsite ____

Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: 96'
Sand	sacks	Pump	End of Shift: 96'
Chips	sacks	Roll-Off Box	
Quickgel	sacks	Baker Tank	SWL (DBGS) Start of Shift: NA
Cement	Yards 48lb 96lb	Other:	End of Shift: NA

Shift? N/D		Date: 2-12-06 Day of Week: Sun Job #: 0063	Rig # 4775 Well# SL-1
START	**END**	**LABOR DESCRIPTION**	
7:10	7:25	PSSI	
7:25	7:30	Warm up equipment	
7:30	6:15	Run 20" Casing & tools	
6:15	6:30	Clean up Pick up Site	



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

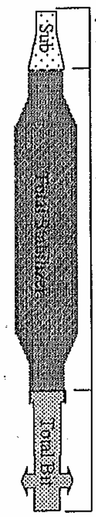
Driller: Roden Total Hrs ____ On Site ____ Helper: Armond Total Hrs ____ Onsite ____
Standby: ____ hrs Equipment Only: ____ hrs Helper: Phil Total Hrs ____ Onsite ____

Client Signature

General Materials	Rental Items Onsite?	Hole Information
Foam gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: 96'
Sand sacks	Pump	End of Shift: 96'
Chips sacks	Roll-Off Box	
Quickgel sacks	Baker Tank	SWL (DBGS) Start of Shift: N/A
Cement Yards 48lb 96lb	Other:	End of Shift: ______

Shift? N/D	Date: 2-12-06 Day of Week: Sun Job #: 0063	Rig # 4775 Well# SL-1

START	END	LABOR DESCRIPTION
7:10	7:25	PSSI
7:25	7:30	Warm up equipment
7:30	6:15	Run 20" Casing & tools
6:15	6:30	Clean up Pick up Site
		20" tools Bit 5.1
		Drill Rod 15.0
		3-20's
		Total 80.1



Total Sub Length X

Total Stabilizer Length X

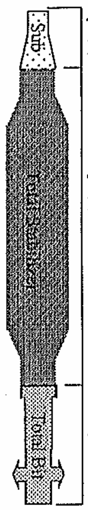
Total Bit Length 5.1

Driller: Roden Total Hrs ____ On Site ____ Helper: Armando Total Hrs ____ Onsite ____
Standby: ____ hrs Equipment Only: ____ hrs Helper: Phil Total Hrs ____ Onsite ____

Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: 96'
Sand	sacks	Pump	End of Shift: 96'
Chips	sacks	Roll-Off Box	
Quickgel	sacks	Baker Tank	SWL (DBGS) Start of Shift: N/A
Cement Yards 48lb 96lb		Other:	End of Shift: ____

Shift? N/D		Date: 2-13-06 Day of Week: Mon Job #:	Rig # 4775 Well# S2-1
START	**END**	**LABOR DESCRIPTION**	
7:00	7:15	PSSP	
7:15	11:45	Weld on 100' Piece of Casing & Wire Gen set	
11:45	12:00	drill out heave and advance Casing	
12:00	3:45	Weld on 120' piece & Prep to drill down	
3:45	4:15	drill down to 103 BGS	
4:15	5:00	Chang Water inlet Plumbing on diverter	
5:00	5:15	Pick up Site	



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

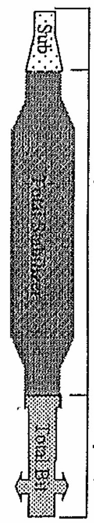
Driler: Robert Total Hrs ____ On Site ____ Helper: Armando Total Hrs ____ Onsite ____
Standby: ____ hrs Equipment Only: ____ hrs Helper: phil Total Hrs ____ Onsite ____

Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: 96
Sand	sacks	Pump	End of Shift: 103
Chips	sacks	Roll-Off Box	
Quickgel	sacks	Baker Tank	SWL (DBGS) Start of Shift: N/A
Cement	Yards 48lb 96lb	Other:	End of Shift: ______

Shift? N/D	Date: 2-14-06 Day of Week: Tue Job #: 0063	Rig # 4775 Well# SL-1

START	END	LABOR DESCRIPTION
7:00	7:15	PSSI
7:15	8:00	Trim 20" Casing & Mob load to beach
		from laydown yard
8:00	1:00	Unload pipe truck & weld on 140' Piece
1:00	1:30	drill ~~From~~ down 140' Piece
1:30	4:20	weld on 160' piece
4:20	4:45	drill down 160' piece
4:45	5:45	Pick up Site



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

Driller: Robert Total Hrs _____ On Site _____ Helper: Armando Total Hrs _____ Onsite _____
Standby: _____ hrs Equipment Only: _____ hrs Helper: Phil Total Hrs _____ Onsite _____

Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: ~~143~~ 103
Sand	sacks	Pump	End of Shift: 143
Chips	sacks	Roll-Off Box	
Quickgel	sacks	Baker Tank	SWL (DBGS) Start of Shift: ______
Cement Yards 48lb 96lb		Other:	End of Shift: ______

Shift? N/D		Date: 2-15-06 Day of Week: Wed Job #: 0063	Rig # 4775 Well# SL-1
START	**END**	**LABOR DESCRIPTION**	
7:00	7:15	PSSE	
7:15	7:30	Warm up equipment	
7:30	10:00	Weld on 180' Piece	
10:00	10:50	Set new roll off box	
10:50	12:00	drill down 180' Piece	
12:00	2:45	weld on 200' Piece	
2:45	3:05	drill down 200' Piece	
3:05	5:05	weld on 220' Piece	
5:05	5:35	drill down 220' Piece	
5:35	6:00	pick up silt dewater rolloff box	

Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

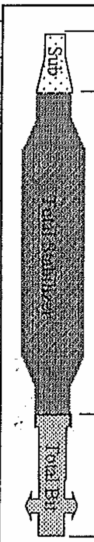
Driller: Robert Total Hrs _____ On Site _____ Helper: Armando Total Hrs _____ Onsite _____
Standby: _____ hrs Equipment Only: _____ hrs Helper: Phil Total Hrs _____ Onsite _____

Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: 143
Sand	sacks	Pump	End of Shift: 203
Chips	sacks	Roll-Off Box	
Quickgel	sacks	Baker Tank	SWL (DBGS) Start of Shift: ______
Cement Yards 48lb 96lb		Other:	End of Shift: ______

Shift? N/D	Date: 2/16	Day of Week: Thur	Job #: 0063	Rig # 4775 Well# SL #1

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.I
7:10	7:30	Paper work / safety meet.
7:30	8:35	Fix Pump To Pump out Rolloff Box shorted out
8:35	9:20	Put 20" casing In Tower
9:20	10:10	weld on #10
10:10		start Drilling from 203' to 223' Keep Plugging up
	1:00	w/ gravels
1:00	1:50	Put on centralizers on Rod
150		Get casing & Rod off 4723 & Put in Tower & grind
	3:15	Bevel on one end
3:15	4:00	weld on #11
4:00	6:00	start Milling from 223' to 236'



Total Sub Length ______

Total Stabilizer Length ______

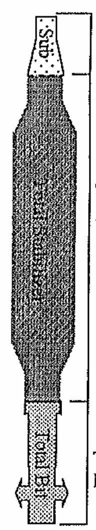
Total Bit Length ______

Driller: ______ Total Hrs ______ On Site ______ Helper: ______ Total Hrs ______ Onsite ______
Standby: ______ hrs Equipment Only: ______ hrs Helper: ______ Total Hrs ______ Onsite ______ Client Signature

General Materials	Rental Items Onsite?	Hole Information
Foam gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: 203'
Sand sacks	Pump	End of Shift: 236'
Chips sacks	Roll-Off Box	
Quickgel sacks	Baker Tank	SWL (DBGS) Start of Shift: ______
Cement Yards 48lb 96lb	Other:	End of Shift: ______

Shift? N/D (D circled)	Date: 2/17/06 Day of Week: FRI Job #: 0063	Rig # 4775 Well# SY #1

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.I
7:10	7:30	Paper work / safety meet. / Rig warm up
7:30	8:15	start GEN. FROM United Rent. Low Batt.
8:15	8:55	unplug bit
8:55	11:30	Drill from 236' to 245' pluging up w/ 4" plus cobbles
11:30	1:00	Put #12 in tower
1:00	1:50	weld on
1:50	2:05	start Drill from 245' to 247'
2:05	3:30	Plugged up w/ heaving gravel try to unplug
3:30		Put Tag line together & run down center of drill rod
	4:45	& Tag plug. 5' of plug
4:45	5:00	Flood rods try to unplug = got unplugged
5:00	6:00	Drill from 247' to 265'



Total Sub Length ______

Total Stabilizer Length ______

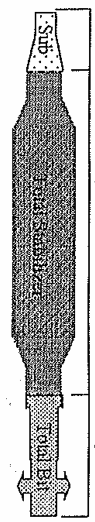
Total Bit Length ______

Driller: Vatery Total Hrs ____ On Site ____ Helper: Armando Total Hrs ____ Onsite ____
Standby: ___ hrs Equipment Only: ____ hrs Helper: [illegible] Total Hrs ____ Onsite ____

Client Signature

General Materials	Rental Items Onsite?	Hole Information
Foam gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: 236
Sand sacks	Pump	End of Shift: 265'
Chips sacks	Roll-Off Box	
Quickgel sacks	Baker Tank	SWL (DBGS) Start of Shift: ____
Cement Yards 48lb 96lb	Other:	End of Shift: ____

Shift? N/D		Date: 2/18/06 Day of Week: Sat Job #: 0063	Rig # 4775 Well# SL #1
START	**END**	**LABOR DESCRIPTION**	
7:00	7:10	P.S.S.I	
7:10	7:20	Paper work / safety meeting	
7:20	7:30	move 40' of drill rod to lay down yard	
7:30	9:30	Build new Torch Holder for casing trimmer	
9:30	11:00	Trim 20" casing in 1/2 - & Telescope Rods	
11:00	11:30	mob to site	
11:30	1:00	Put #13 into tower	
1:00	2:00	weld on	
2:00	3:30	Drill from 265' to 278	
3:30		Pluged up in bottom no air passes through cycone	
	4:45	Try to tag Bottom	
4:45		got unplugged start drilling drill to	
	6:45	280' pluging up sometimes w/ sands —	
		& gravels	
		Having sand's	
		305' - trying	
		tag bottom @ 296' = 9'	



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

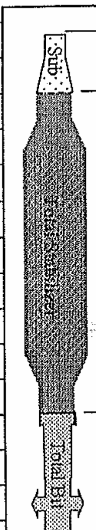
Driler: [signature] Total Hrs _____ On Site _____ Helper: [signature] Total Hrs _____ Onsite _____
Standby: _____ hrs Equipment Only: _____ hrs Helper: [signature] Total Hrs _____ Onsite _____

Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: 265'
Sand	sacks	Pump	End of Shift: 280'
Chips	sacks	Roll-Off Box	
Quickgel	sacks	Baker Tank	SWL (DBGS) Start of Shift: ______
Cement Yards 48lb 96lb		Other:	End of Shift: ______

Shift? N/(D)	Date: 2/19/06	Day of Week: Sun	Job #: 0063	Rig # 4775	Well# S/#1

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.I
7:10	7:45	Paper work / safety meet. / Equip. warm up
7:45	10:00	Start drilling from - 280' to 285 plugging up
10:00	11:00	Put # 14 in tower
11:00	12:00	weld on
12:00	4:45	Drill down from 285' to 305' w/ plug ups
4:45	5:30	Pick up lock up site



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

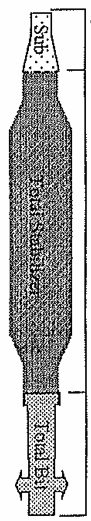
Driller: [signature] Total Hrs _____ On Site _____ Helper: Armando Total Hrs _____ Onsite _____
Standby: _____ hrs Equipment Only: _____ hrs Helper: Ali Total Hrs _____ Onsite _____

Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: 280'
Sand	sacks	Pump	End of Shift: 305'
Chips	sacks	Roll-Off Box	
Quickgel	sacks	Baker Tank	SWL (DBGS) Start of Shift: ______
Cement Yards 48lb 96lb		Other:	End of Shift: ______

Shift? N/D (D circled)	Date: 2/20	Day of Week: Mon	Job #: 0063	Rig # 4225 / Well# SL #1

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.I
7:10	8:00	Paper work / Equip warm up / safety meet
8:00	9:00	Put #15 in tower
9:00	10:15	weld on
10:15		Drill from 305' to 315' - Keep plugging up cobbles
	3:00	Keep flooding & unplugging
3:00		Lost Alternator on Rig Pull off & sent Gres to get
	5:00	new one & put on.
5:00	5:30	Pick up site



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

Driller: [signature] Total Hrs ____ On Site ____ Helper: [signature] Total Hrs ____ Onsite ____

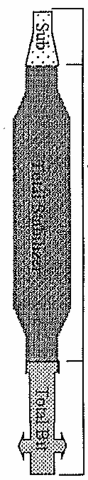
Standby: ____ hrs Equipment Only: ____ hrs Helper: [signature] Total Hrs ____ Onsite ____

Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: 305'
Sand	sacks	Pump	End of Shift: 315'
Chips	sacks	Roll-Off Box	
Quickgel	sacks	Baker Tank	SWL (DBGS) Start of Shift: ______
Cement Yards 48lb 96lb		Other:	End of Shift: ______

Shift? N/D (D circled)	Date: 2/21	Day of Week: Tues	Job #: 0063	Rig # 4775 / Well# SL #7

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.I
7:10	8:30	Paper work / Safety Meet / Equip warm up / Fix Hyd. LEAK in control Panel
8:30		unplug & mill from 315' TO 316' casing stop's not Enough
	2:30	drill + Hreen cut OFF 4' 20" WENT FROM 340.57 TO 336.57
2:30	3:00	get casing From lay down yard TO site
3:00	4:00	Put #16 In tower.
4:00	5:30	LEVEL up & WELD Can't LINE up casing HAVE TO move
		Rig



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

Driller: [signature] Total Hrs _____ On Site _____ Helper: [signature] Total Hrs _____ Onsite _____

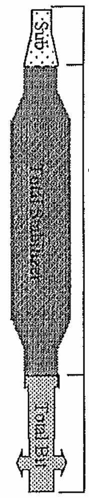
Standby: _____ hrs Equipment Only: _____ hrs Helper: [signature] Total Hrs _____ Onsite _____

Client Signature

General Materials				Rental Items Onsite?	Hole Information
Foam	gallons			Forklift / Backhoe	Hole (DBGS) Start of Shift: 315
Sand	sacks			Pump	End of Shift: 325
Chips	sacks			Roll-Off Box	
Quickgel	sacks			Baker Tank	SWL (DBGS) Start of Shift: ______
Cement	Yards	48lb	96lb	Other:	End of Shift: ______

Shift? N/D (D circled)	Date: 2/22/ Day of Week: THURs Job #: 0063	Rig # 4775 Well# SL #1

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.I
7:10		Pump out Roll off Box w/ Trash Pump Put on new Elec.
	8:30	Box on Pump Paper work / Equip [illegible] / [illegible]
8:30	10:30	Start Drilling From 337' TO 341'
10:30		Shut down & clean up site Put new plastic down
	1:45	For site meeting
1:45		Inspect 12" stainless pipe & have to go back to Rosco Moss
	3:00	TO GET FIXED
3:00	4:00	Put #17 in tower
4:00	4:40	weld on
4:40	5:30	Start Drilling From 341' TO 343'
5:30	6:00	Pick up site



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

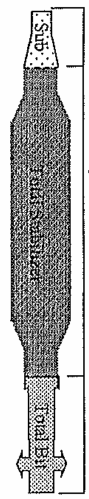
Driler: [signature] Total Hrs ____ On Site ____ Helper: [signature] Total Hrs ____ Onsite ____
Standby: ____ hrs Equipment Only: ____ hrs Helper: [signature] Total Hrs ____ Onsite ____

Client Signature

General Materials			Rental Items Onsite?	Hole Information
Foam	gallons		Forklift / Backhoe	Hole (DBGS) Start of Shift: 337'
Sand	sacks		Pump	End of Shift: 343'
Chips	sacks		Roll-Off Box	
Quickgel	sacks		Baker Tank	SWL (DBGS) Start of Shift: ______
Cement Yards	48lb	96lb	Other:	End of Shift: ______

Shift? N/D (D circled) | Date: 2/23/ | Day of Week: THUR | Job #: 0063 | Rig # 4775 | Well# SL#1

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.I
7:10		Pump out Roll off Box w/Trash Pump Put on new Elec.
	8:30	Box on Pump Paper work / Equip [illegible] / [illegible]
8:30	10:30	Start Drilling from 337' TO 341'
10:30		Shut down & clean up site Put new plastic down
	1:45	For site meeting
1:45		Inspect 12" Stainless Pipe & Have to go Back to Rosco Moss
	3:00	To get fixed
3:00	4:00	Put #17 in tower
4:00	4:40	weld on
4:40	5:30	Start Drilling from 341' to 343'
5:30	6:00	Pick up site



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

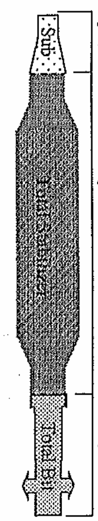
Driler: [illegible] Total Hrs ____ On Site ____ Helper: [illegible] Total Hrs ____ Onsite ____
Standby: ____ hrs Equipment Only: ____ hrs Helper: [illegible] Total Hrs ____ Onsite ____

Client Signature

General Materials			Rental Items Onsite?	Hole Information
Foam	gallons		Forklift / Backhoe	**Hole (DBGS)** Start of Shift: 337'
Sand	sacks		Pump	End of Shift: 343'
Chips	sacks		Roll-Off Box	
Quickgel	sacks		Baker Tank	**SWL (DBGS)** Start of Shift: ______
Cement Yards	48lb	96lb	Other:	End of Shift: ______

Shift? N/D	Date: 2/24	Day of Week: FRI	Job #: 0063	Rig # 4775 Well# SL#1

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.I
7:10	7:40	Paperwork / safety meet. / Equip warm up
7:40	9:45	unplug & start drilling From 343' to 362' TD.
9:45	10:00	clean Bottom of Hole
10:00	3:30	Trip out
3:30	4:30	"Build Tag Tool" & Tag Bottom
4:30	5:15	Bottom @ 350'
		358



Total Sub Length ______

Total Stabilizer Length ______

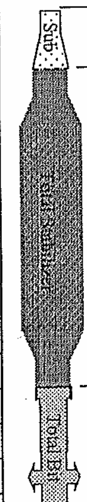
Total Bit Length ______

Driller: [signature] Total Hrs ____ On Site ____ Helper: Armando Total Hrs ____ Onsite ____
Standby: ____ hrs Equipment Only: ____ hrs Helper: Phil Total Hrs ____ Onsite ____

Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: 343'
Sand	sacks	Pump	End of Shift: 362' TD.
Chips	sacks	Roll-Off Box	
Quickgel	sacks	Baker Tank	SWL (DBGS) Start of Shift: ______
Cement Yards 48lb 96lb		Other:	End of Shift: ______

Shift? N/D	Date: 2/25 Day of Week: Sat Job #: 0063	Rig # 4725 Well# 2/ #0
START	**END**	**LABOR DESCRIPTION**
7:00	7:10	P.S.S.I
7:10		Flood Hole & move casing up & down about 6" to 7"
.		& after water running all night down hole approx. 5-10gpm
	10:00	ReTag @ 358' from 350' yesterday!
10:00		Decide to not cut off shoe 20" & prepare to
		Run 12" stainless pipe, & drain roll off box w/pump
	4:00	for them to pick up



Total Sub Length ______

Total Stabilizer Length ______

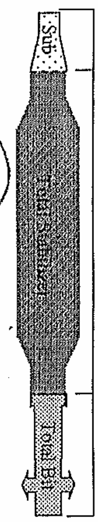
Total Bit Length ______

Driller: Andy Total Hrs _____ On Site _____ Helper: Armando Total Hrs _____ Onsite _____
Standby: _____ hrs Equipment Only: _____hrs Helper: Phil Total Hrs _____ Onsite _____
Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: ________
Sand	sacks	Pump	End of Shift: ________
Chips	sacks	Roll-Off Box	
Quickgel	sacks	Baker Tank	SWL (DBGS) Start of Shift: ________
Cement Yards 48lb 96lb		Other:	End of Shift: ________

Shift? N/D	Date: 2/26/01 Day of Week: Sun Job #: 0063	Rig # 4775 Well# S1 #1

START	END	LABOR DESCRIPTION
9:00		@ lay down yard Loading/water Truck w/12" screen
		& weld centralizers together 72 pieces, & Turn
		20" casing down Hole to keep moving freely
		Almond OFF duty.
		Phil OFF duty.



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

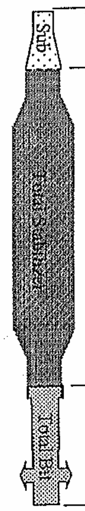
Driller: [signature] Total Hrs _____ On Site _____ Helper: ________ Total Hrs _____ Onsite _____
Standby: _____ hrs Equipment Only: _____ hrs Helper: ________ Total Hrs _____ Onsite _____

Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	**Forklift / Backhoe**	**Hole (DBGS)** Start of Shift: ________
Sand	sacks	**Pump**	End of Shift: ________
Chips	sacks	**Roll-Off Box**	
Quickgel	sacks	**Baker Tank**	**SWL (DBGS)** Start of Shift: ________
Cement Yards	48lb 96lb	**Other:**	End of Shift: ________

Shift? N/D (D circled)	Date: 2/27/?? Day of Week: Mon Job #: 0063	Rig # 4775 Well# SC#1

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.I
7:10	7:20	Paper work / safety meet.
7:20	8:00	Bring truck w/ screen to site
8:00	10:15	unload screen behind rig & decide how to run casing
10:15	11:30	Meet. w/ client
11:30	5:30	Start running 10" stainless screen #1



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

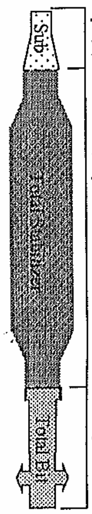
Driller: [illegible] Total Hrs _____ On Site _____ Helper: Armando Total Hrs _____ Onsite _____
Standby: _____ hrs Equipment Only: _____ hrs Helper: Phil Total Hrs _____ Onsite _____

Client Signature

General Materials	Rental Items Onsite?	Hole Information
Foam gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: ______ End of Shift: ______
Sand sacks	Pump	
Chips sacks	Roll-Off Box	
Quickgel sacks	Baker Tank	SWL (DBGS) Start of Shift: ______ End of Shift: ______
Cement Yards 48lb 96lb	Other:	

Shift? N/D	Date: 2/28/06 Day of Week: Tues Job #: 00163	Rig # 4775 Well# SL #1

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.I.
7:10	7:30	Paper work / safety meet / Rig warm up
7:30	8:30	Try to get hold up's about elevator for 12" screen
8:30	9:00	Go ahead & use small clamps for casing
9:00	6:20	Start Running screen from 20' to 120'



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

Driller: [signature] Total Hrs ____ On Site ____ Helper: [signature] Total Hrs ____ Onsite ____

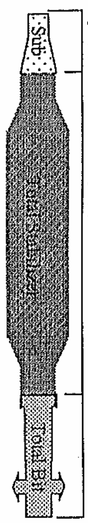
Standby: ____ hrs Equipment Only: ____ hrs Helper: [signature] Total Hrs ____ Onsite ____

Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: ______
Sand	sacks	Pump	End of Shift: ______
Chips	sacks	Roll-Off Box	
Quickgel	sacks	Baker Tank	SWL (DBGS) Start of Shift: ______
Cement	Yards 48lb 96lb	Other:	End of Shift: ______

Shift? N/D	Date: 3/1 Day of Week: WED Job #: 0063	Rig # 4225 Well# SI #1

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.I
7:10	7:30	PAPER work / Rig warm up / Safety meet
7:30		Start Running SCREEN FROM 120' TO 220.7
	1:00	Total SCREEN 220.7
1:00		Take water Truck to lay down rack TO Load
	1:30	REST OF Blank PIPE
1:30	4:00	Start Running Blank stainless FROM 220' TO 260'
4:00		Shift change w/ Robert & Marty



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

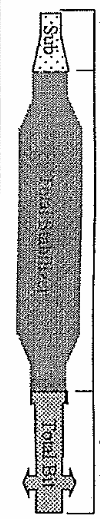
Driller: [signature] Total Hrs ______ On Site ______ Helper: [signature] Total Hrs ______ Onsite ______ Client Signature

Standby: ______ hrs Equipment Only: ______ hrs Helper: [signature] Total Hrs ______ Onsite ______

General Materials	Rental Items Onsite?	Hole Information
Foam gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: ______ End of Shift: ______
Sand sacks	Pump	
Chips sacks	Roll-Off Box	
Quickgel sacks	Baker Tank	SWL (DBGS) Start of Shift: ______ End of Shift: ______
Cement Yards 48lb 96lb	Other:	

Shift? N(D)		Date: 3-2-96 Day of Week: Thur. Job #: 0063	Rig # 4775 Well# 35W #1
START	**END**	**LABOR DESCRIPTION**	
7:00	7:30	on warm equipment, Safety meeting	
7:30		weld on blank SS casing from 260.64 To 280.64	
11:00		set up and weld blank SS casing from 280.64 To 300.64 ft	
1:30	1:45	lunch	
1:45		set up and weld blank SS casing from 300.64 To 320.64	
530	6:00	Place casing in Tower. clean site.	

SS. casing
'260.64
- 20.
- 20.
- 20.
Total 320.64



Total Sub Length ______
Total Stabilizer Length ______
Total Bit Length ______

Driller: Marty Total Hrs ____ On Site ____ Helper: Joe S. Total Hrs ____ Onsite ____
Standby: ____ hrs Equipment Only: ____ hrs Helper: phil Total Hrs ____ Onsite ____
Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	**Forklift / Backhoe**	**Hole (DBGS)** Start of Shift: ______
Sand	sacks	**Pump**	End of Shift: ______
Chips	sacks	**Roll-Off Box**	
Quickgel	sacks	**Baker Tank**	**SWL (DBGS)** Start of Shift: ______
Cement Yards 48lb 96lb		**Other:**	End of Shift: ______

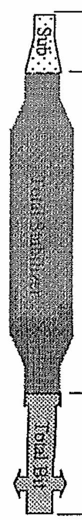
Richard
1-323-263-4111

Shift? N/(D)		Date: 3-3-06 Day of Week: Fri Job #: 0063	Rig # 4775 Well# SL#1
START	**END**	**LABOR DESCRIPTION**	
7:00	7:30	On site. Warm equipment	
7:30		set up and weld on SS blank from 320.64 To 340.61	
10:30	1:30	set up and weld on SS blank from 340.61 To 350.61	
1:30	2:15	lunch	
2:15		Tag sand w/ with 1" pvc at 366 ft from Top of	
	4:15	20' casing - Remove 1".	
4:15	5:45	Fab Tooling To hold 12" casing	
5:45		Clean site lock down.	

SS casing 320.64
\- 19.97
10.00
Total 350.61

1" PVC on site
Total = 41

SS.
mild casing 20.15
370.76



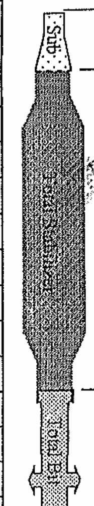
Total Sub Length ______
Total Stabilizer Length ______
Total Bit Length ______

Driller: Marty Total Hrs ____ On Site ____ Helper: Joe S. Total Hrs ____ Onsite ____
Standby: ____ hrs Equipment Only: ____ hrs Helper: phil Total Hrs ____ Onsite ____
Client Signature

General Materials	Rental Items Onsite?	Hole Information
Foam gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: ______
Sand sacks	Pump	End of Shift: ______
Chips sacks	Roll-Off Box	
Quickgel sacks	Baker Tank	SWL (DBGS) Start of Shift: ______
Cement Yards 48lb 96lb	Other:	End of Shift: ______

Shift? N/D (D circled)	Date: 3-4-06 Day of Week: Sat. Job #: 0063	Rig # 4775 Well # SL #1

START	END	LABOR DESCRIPTION
7:00		on site warm equipment.
		Complete Fabbing Tooling for 12" casing
		weld on 12" riser and 20" riser
	6:30	Pull casing back 1.6 ft. Run in 1" PVC.
		12" casing 370.76
		20' casing 376.57



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

Driller: Marty Total Hrs ____ On Site ____ Helper: Joe Total Hrs ____ Onsite ____
Standby: 1 hrs Equipment Only: ____ hrs Helper: phil Total Hrs ____ Onsite ____
Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: ______
Sand	sacks	Pump	End of Shift: ______
Chips	sacks	Roll-Off Box	
Quickgel	sacks	Baker Tank	SWL (DBGS) Start of Shift: ______
Cement Yards 48lb 96lb		Other:	End of Shift: ______

Shift? N/D	Date: 3-5-06 Day of Week: Sun Job #: 0063	Rig # 4775 Well# ____

START	END	LABOR DESCRIPTION
7:30	7:45	Preshift inspection
7:45	5:30	Install Filter Pack & remove Casing to 343 BGS
5:30	6:00	Pick up Site

Total Sub Length ____

Total Stabilizer Length ____

Total Bit Length ____

Driller: Robert Total Hrs ____ On Site ____ Helper: Joe Total Hrs ____ Onsite ____

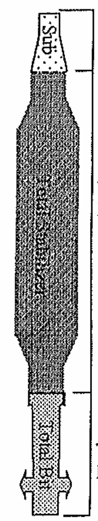
Standby: ____ hrs Equipment Only: ____ hrs Helper: Phil Total Hrs ____ Onsite ____

Client Signature

General Materials	Rental Items Onsite?	Hole Information
Foam gallons	Forklift / Backhoe	Hole (DBGS), Start of Shift: 360
Sand (1) sacks Super	Pump	End of Shift: 343
Chips sacks	Roll-Off Box	
Quickgel sacks	Baker Tank	SWL (DBGS) Start of Shift: N/A
Cement Yards 48lb 96lb	Other:	End of Shift: ____

Shift? N/D	Date: 3-6-06 Day of Week:	Job #: 0063	Rig # 4775 Well# SL-1

START	END	LABOR DESCRIPTION
7:00	11:00	Diagnose rig electrical Problem
11:00	6:30	Sand Pack & Pull casing from 343 - 316
6:30	6:45	Pick UP Site



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

Driller: Robert Total Hrs ____ On Site ____ Helper: Joe Total Hrs ____ Onsite ____
Standby: ____ hrs Equipment Only: ____ hrs Helper: Phil Total Hrs ____ Onsite ____

Client Signature

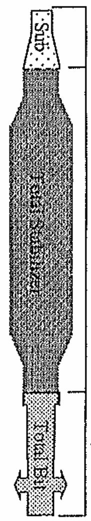
General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	Forklift / Backhoe	~~Hole~~ (DBGS) Casing Start of Shift: 310
Sand	sacks	Pump	End of Shift: ____
Chips	sacks	Roll-Off Box	
Quickgel	sacks	Baker Tank	SWL (DBGS) Start of Shift: ____
Cement	Yards 48lb 96lb	Other:	End of Shift: ____

Shift? N/D		Date: 3-7-06 Day of Week: Tue Job #: 0063	Rig # 4775 Well#
START	END	LABOR DESCRIPTION	
7:00	7:15	Preshift inspection	
7:15	5:00	Sand Pack and Pull Casing	

Total length to Start 373.46
1½ tremie removed

~~① 13.0~~
~~② 6.94~~
~~③ 23.85~~
~~④ 0.06~~ ~~45.79~~
~~⑤ 23.5~~
~~⑥ 12.85~~ ~~82.4~~
~~710.8~~

Transferred to casing sheet



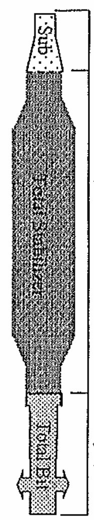
Total Sub Length ______
Total Stabilizer Length ______
Total Bit Length ______

Driller: Robert Total Hrs _____ On Site _____ Helper: ________ Total Hrs _____ Onsite _____
Standby: _____ hrs Equipment Only: _____ hrs Helper: ________ Total Hrs _____ Onsite _____
Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	Forklift / Backhoe	~~Hole~~ Csg (DBGS) Start of Shift: 310'
Sand	sacks	Pump	End of Shift: 265'
Chips	sacks	Roll-Off Box	
Quickgel	sacks	Baker Tank	SWL (DBGS) Start of Shift: NA
Cement Yards 48lb 96lb		Other:	End of Shift: ______

Shift? N/D	Date: 3/8	Day of Week: Wed	Job #: 1063	Rig # 4775 / Well# 51 #1

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.I
7:10	7:30	Paper work / Rig warm up / safety meet.
7:30		~~[illegible]~~ Tag Inside 12" Fill @ 273'
	12:30	Decide on what to do /
12:30	1:15	Get Rod together to trip in
1:15	2:30	Start tripping in w/ Drill Rod & Clean out 12"
2:30	5:30	Start developing from 320 to bottom
5:30		Pick up / Lock up site
		5 Hrs. well developing



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

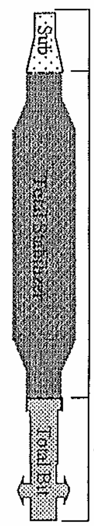
Driller: [illegible] Total Hrs ______ On Site ______ Helper: Joe Total Hrs ______ Onsite ______
Standby: ______ hrs Equipment Only: ______ hrs Helper: Phil Total Hrs ______ Onsite ______

Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: ~~265~~' 310'
Sand	sacks	Pump	End of Shift: 265
Chips	sacks	Roll-Off Box	
Quickgel	sacks	Baker Tank	SWL (DBGS) Start of Shift: ______
Cement Yards 48lb 96lb		Other:	End of Shift: ______

Shift? N/D	Date: 3/9/06 Day of Week: Thurs Job #: 0163	Rig # 4775 Well# 51 #1

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.F
7:10	7:30	Rig warm up / paperwork / safety meet.
7:30	10:15	~~Development~~ well Development
10:15	11:15	standby wait for Dennis
11:15	12:15	Lunch
12:15	1:15	Standby
1:15	1:30	Air Lifted
1:30	3:15	Pull casing Back
3:15	6:00	develop & move Injection
		~~3½~~ HRS of well development 5¾
		5:30 73" Jetting Tool w/ swabs



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

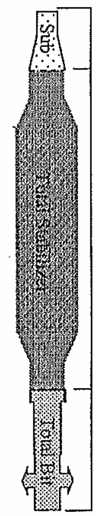
Driller: [signature] Total Hrs _____ On Site _____ Helper: [signature] Total Hrs _____ Onsite _____
Standby: _____ hrs Equipment Only: _____ hrs Helper: Dennis Total Hrs _____ Onsite _____

Client Signature

General Materials	Rental Items Onsite?	Hole Information
Foam gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: ______
Sand sacks	Pump	End of Shift: ______
Chips sacks	Roll-Off Box	
Quickgel sacks	Baker Tank	SWL (DBGS) Start of Shift: ______
Cement Yards 48lb 96lb	Other:	End of Shift: ______

Shift? N/D	Date: 3/10/06 Day of Week: FRI Job #: [illegible]	Rig # 4273 Well# S1#1

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.I
7:10	7:20	Paperwork / safety mtg. / Rig warm up
7:20	5:45	Develop well " Pull 60' - 20"
		2.5 HRS. Development 215' to 275'



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

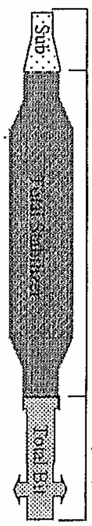
Driler: [illegible] Total Hrs ____ On Site ____ Helper: [illegible] Total Hrs ____ Onsite ____
Standby: ____ hrs Equipment Only: ____ hrs Helper: [illegible] Total Hrs ____ Onsite ____

Client Signature

General Materials			Rental Items Onsite?	Hole Information
Foam	gallons		Forklift / Backhoe	**Hole (DBGS)** Start of Shift: ______
Sand	sacks		Pump	End of Shift: ______
Chips	sacks		Roll-Off Box	
Quickgel	sacks		Baker Tank	**SWL (DBGS)** Start of Shift: ______
Cement	Yards 48lb 96lb		Other:	End of Shift: ______

Shift? N/D	Date: 3/11/06 Day of Week: Sat. Job #: 0063	Rig #	Well#

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.I.
7:10	7:20	Paper work / safety - Rig warm up
7:20		Develop From 195' to 215' w/ 15 min of Air lift Time
	8:30	~~Cut off casing~~ +
8:30	9:00	Cut off casing 20" + Break Tooling + set out of Tower
9:00	10:15	develop From 195' to 175' w/ 15 min of AirLift Time
10:15	10:50	Cut off casing + Break tooling + set out of Tower
10:50	11:35	Develop From 175' to 155' w/ 15 min Air lift time
11:35	12:05	Cut off casing + Break tooling + set out of Tower
12:05	1:15	Develop From 155' to 135' w/ 20 min Air lift time
1:15		Cut off casing + Break tooling + set out of Tower
	2:30	Develop From 135' to 115'
2:30	5:30	Pull Remaining 20" out of Hole
		2 Hrs well development



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

Driller: ______ Total Hrs ______ On Site ______ Helper: ______ Total Hrs ______ Onsite ______
Standby: ______ hrs Equipment Only: ______ hrs Helper: ______ Total Hrs ______ Onsite ______

Client Signature

General Materials	Rental Items Onsite?	Hole Information
Foam gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: ______
Sand sacks	Pump	End of Shift: ______
Chips sacks	Roll-Off Box	
Quickgel sacks	Baker Tank	SWL (DBGS) Start of Shift: ______
Cement Yards 48lb 96lb	Other:	End of Shift: ______

Shift? N/D | Date: 3/12 | Day of Week: Sun | Job #: 0063 | Rig # 4775 | Well# S1 #1

START	END	LABOR DESCRIPTION
9:00	9:20	Paper work / safety meet. / Rig warm up
9:20	10:00	Change lower drive jaws from 20" to 24"
10:00	11:10	weld on 24" Riser
11:10	5:15	start Pulling 24" casing w/sand pack up to 50'
5:15	5:30	pick up site
		54.75 HRS. LEFT ON Well development

Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

Driller: [signature] Total Hrs _____ On Site _____ Helper: [signature] Total Hrs _____ Onsite _____

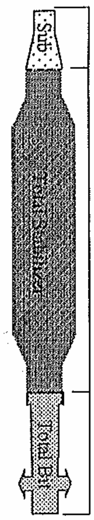
Standby: _____ hrs Equipment Only: _____ hrs Helper: [signature] Total Hrs _____ Onsite _____

Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: ______
Sand	sacks	Pump	End of Shift: ______
Chips	sacks	Roll-Off Box	
Quickgel	sacks	Baker Tank	SWL (DBGS) Start of Shift: ______
Cement Yards 48lb 96lb		Other:	End of Shift: ______

Shift? N/D (D circled)	Date: 3/[illegible]/13 Day of Week: [illegible] Job #: CCY-3	Rig # 4725 Well# 51 #1

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.E
7:10	7:30	Paper work / Rig warming / Safety meet
7:30	10:15	Trip to Bottom for development
10:15	10:45	Air Lift @ Bottom 350'
10:45	5:50	Drain Broken tank & Build & put together Defuser
5:50	6:05	Air lift from 347' to [illegible]
		5½ Hrs well development left



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

Driler: [signature] Total Hrs _____ On Site _____ Helper: [signature] Total Hrs _____ Onsite _____

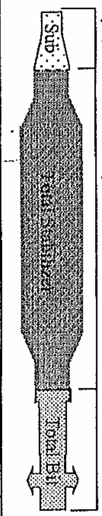
Standby: _____ hrs Equipment Only: _____ hrs Helper: [signature] Total Hrs _____ Onsite _____

Client Signature

General Materials				Rental Items Onsite?	Hole Information
Foam	gallons			Forklift / Backhoe	Hole (DBGS) Start of Shift: ______
Sand	sacks			Pump	End of Shift: ______
Chips	sacks			Roll-Off Box	
Quickgel	sacks			Baker Tank	SWL (DBGS) Start of Shift: ______
Cement	Yards	48lb	96lb	Other:	End of Shift: ______

Shift? N/D | Date: 3/14 | Day of Week: Tues | Job #: 13/3 | Rig # 4775 | Well# 5/#1

START	END	LABOR DESCRIPTION
7:00	7:10	J. S. S.
7:10	7:30	Paper work / Rig warm up / safety meet.
7:30	10:40	Start developing Hole from 344 to 290
10:40	12:10	Rig stopped Running Find problem
12:10	6:00	Air lift from 290 to 210
		44 HRS LEFT ON Well development
		discharged today 159,220 gal.



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

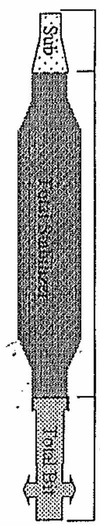
Driller: [illegible] Total Hrs _____ On Site _____ Helper: [illegible] Total Hrs _____ Onsite _____
Standby: _____ hrs Equipment Only: _____ hrs Helper: [illegible] Total Hrs _____ Onsite _____

Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: ______
Sand	sacks	Pump	End of Shift: ______
Chips	sacks	Roll-Off Box	
Quickgel	sacks	Baker Tank	SWL (DBGS) Start of Shift: ______
Cement Yards 48lb 96lb		Other:	End of Shift: ______

Shift? N/D	Date: 2/16 Day of Week: Wed Job #: 6063	Rig # 4225 Well# 5/#1

START	END	LABOR DESCRIPTION
7:00	7:10	J.S.S.T
7:10	7:50	equip work / safety meet / warm up
7:50	1:45	Air lift from 210' to 131'
1:45	4:30	Start swabbing hole from 131' to 171'
4:30	5:00	Pick up site
		8 1/2 HRS Developing
		35.5 HRS LEFT ON Developing well
		Discharge today 12,320
		~~13,298~~



Total Sub Length ______

Total Stabilizer Length ______

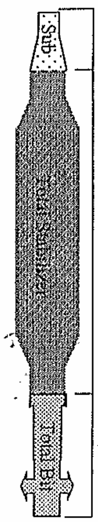
Total Bit Length ______

Driller: [illegible] Total Hrs ____ On Site ____ Helper: [illegible] Total Hrs ____ Onsite ____
Standby: ____ hrs Equipment Only: ____ hrs Helper: [illegible] Total Hrs ____ Onsite ____

Client Signature

General Materials	Rental Items Onsite?	Hole Information
Foam gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: ______ End of Shift: ______
Sand sacks	Pump	
Chips sacks	Roll-Off Box	
Quickgel sacks	Baker Tank	SWL (DBGS) Start of Shift: ______ End of Shift: ______
Cement Yards 48lb 96lb	Other:	

Shift? N/D (D)	Date: 3/16 Day of Week: Thur Job #: 00603	Rig # 4225 Well# 51 # 1
START	**END**	**LABOR DESCRIPTION**
7:10	7:30	P.S-S.I
7:30	8:00	Paper work / safety meeting / Rig warming
8:00	12:30	start developing well on bottom
12:30		Shut down move defuser, build Baffels in Baker tank
		& plumb in valve for water injection from water
	6:00	source for flushing fresh water to stream
		4.5 HRS Air Lifting
		Develop from 351 T 331'
		31 HRS. of developing left
		Discharge – 85,050 today



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

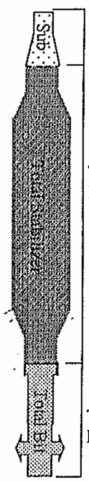
Driller: [signature] Total Hrs _____ On Site _____ Helper: [signature] Total Hrs _____ Onsite _____

Standby: _____ hrs Equipment Only: _____ hrs Helper: [signature] Total Hrs _____ Onsite _____

Client Signature

General Materials	Rental Items Onsite?	Hole Information
Foam gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: ______
Sand sacks	Pump	End of Shift: ______
Chips sacks	Roll-Off Box	
Quickgel sacks	Baker Tank	SWL (DBGS) Start of Shift: ______
Cement Yards 48lb 96lb	Other:	End of Shift: ______

Shift? N/(D)		Date: 3/17 Day of Week: FRI Job #: 0063	Rig # 4775 Well# S1#1
START	END	LABOR DESCRIPTION	
7:00	7:10	P.S.S.I	
7:10	7:30	PAPER WORK / safety meet. /	
7:30	9:30	Cut BaFFels TO Fit IN BaKER Tanks +weld in BaFFel Holders	
	~~9:30~~		
9:30		~~[illegible]~~ d Site PREP w/new Plastic under Equip. FOR NEWS	
		REPORTERS@10:30. Did not want to discharge BeFORE That.	
	12:30	Didn't want To muddy up CREEK	
12:30	1:00	Lunch	
1:00	1:30	Get Equip. Running	
1:30	4:00	Start AiRLiFTing FRom 351' TO 331'	
4:00	5:00	AiR lift FRom 331' TO 311'	
5:00	6:00	AiR lift FRom 311' TO 291'	
		4.5 HRS AiR LiFTing	
		26.5 HRS LeFT.	



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

Driller: [signature] Total Hrs _____ On Site _____ Helper: [signature] Total Hrs _____ Onsite _____
Standby: _____ hrs Equipment Only: _____hrs Helper: [signature] Total Hrs _____ Onsite _____

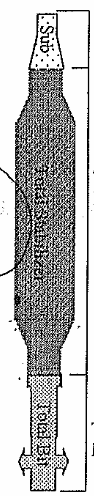
Client Signature

General Materials			Rental Items Onsite?	Hole Information
Foam	gallons		Forklift / Backhoe	Hole (DBGS) Start of Shift: ______
Sand	sacks		Pump	End of Shift: ______
Chips	sacks		Roll-Off Box	
Quickgel	sacks		Baker Tank	SWL (DBGS) Start of Shift: ______
Cement Yards	48lb	96lb	Other:	End of Shift: ______

Shift? N/D	Date: 3/18	Day of Week: sat.	Job #: 0063	Rig # 4075
				Well# S/#1

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.I.
7:10	7:40	Paperwork / Rig warmup / safety meet.
7:40	11:30	start Air Lift From 291' to 231'
11:30	2:00	Shut down For wedding on Beach next to site
2:00	6:00	Air Lift From 231' to 151'
		@ 151' Drawdown @ 25' Below Ground Level
		@ 229 Gpm
		874 Gallons on Hydrant
		16
		Hrs. Developing Time LEFT
		Discharge Today 155,880

Left margin notes: 4.3, 2.5, 4



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

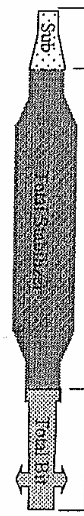
Driller: Andy ______ Total Hrs ______ On Site ______ Helper: Armando Total Hrs ______ Onsite ______
Standby: ______ hrs Equipment Only: ______ hrs Helper: Dustin Total Hrs ______ Onsite ______

Client Signature

General Materials				Rental Items Onsite?	Hole Information
Foam	gallons			Forklift / Backhoe	Hole (DBGS) Start of Shift: ______
Sand	sacks			Pump	End of Shift: ______
Chips	sacks			Roll-Off Box	
Quickgel	sacks			Baker Tank	SWL (DBGS) Start of Shift: ______
Cement	Yards	48lb	96lb	Other:	End of Shift: ______

Shift? N/D	Date: 3/19 Day of Week: Sun Job #: 0063	Rig # 4775 Well# SL #1

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.I
7:10	7:30	Paperwork / Rig warm up / safety meet.
7:30	8:00	Air Lift Hole From 151' to 350'
		Armando OFF Duty For 24 HRS.
		To Drive #4773 to Shop



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

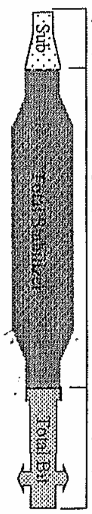
Driller: [signature] Total Hrs ____ On Site ____ Helper: [signature] Total Hrs ____ Onsite ____
Standby: ____ hrs Equipment Only: ____ hrs Helper: ________ Total Hrs ____ Onsite ____

Client Signature

General Materials		Rental Items Onsite?	Hole Information
Foam	gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: ______ End of Shift: ______
Sand	sacks	Pump	
Chips	sacks	Roll-Off Box	
Quickgel	sacks	Baker Tank	SWL (DBGS) Start of Shift: ______ End of Shift: ______
Cement Yards 48lb 96lb		Other:	

Shift? N/D | Date: 3/20 | Day of Week: Mon | Job #: 0063 | Rig # 4775 | Well# 51 #1

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.T
7:10	7:30	Paper work / safety meeting / Rig warm up
7:30	9:00	Air lift from 350' to 200'
9:00	11:00	Pull out rest of drill string
11:00	12:00	set up grout pumps & pump water through tremie
12:00	1:00	cement truck on site @ 12:15 & mix 2000 lbs. of 1/20
	[illegible]	sand in truck, & pump 5 sacks 1/20 sand down hole
1:00	1:25	Pump & grout from 55' to 6' 4 yards
1:25	5:00	Pull tremie & pull 24" casing
5:00	6:45	Tower down mast & clean up.



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

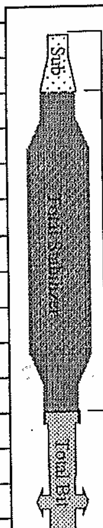
Driller: [signature] Total Hrs ______ On Site ______ Helper: [signature] Total Hrs ______ Onsite ______
Standby: ______ hrs Equipment Only: ______ hrs Helper: Justin Total Hrs ______ Onsite ______

Client Signature

General Materials	Rental Items Onsite?	Hole Information
Foam gallons	Forklift / Backhoe	Hole (DBGS) Start of Shift: ______ End of Shift: ______
Sand sacks	Pump	
Chips sacks	Roll-Off Box	
Quickgel sacks	Baker Tank	SWL (DBGS) Start of Shift: ______ End of Shift: ______
Cement Yards 48lb 96lb	Other:	

Shift? N/D	Date: 3/21/06 Day of Week: TUES Job #: 08063	Rig # 4775 Well# 51 #1

START	END	LABOR DESCRIPTION
7:00	7:10	P.S.S.T
7:10		Pick up site & move equip. OFF site



Total Sub Length ______

Total Stabilizer Length ______

Total Bit Length ______

Driller: [signature] Total Hrs ____ On Site ____ Helper: [signature] Total Hrs ____ Onsite ____
Standby: ____ hrs Equipment Only: ____ hrs Helper: ________ Total Hrs ____ Onsite ____

Client Signature

General Materials				Rental Items Onsite?	Hole Information
Foam	gallons			Forklift / Backhoe	Hole (DBGS) Start of Shift: ________
Sand	sacks			Pump	End of Shift: ________
Chips	sacks			Roll-Off Box	
Quickgel	sacks			Baker Tank	SWL (DBGS) Start of Shift: ________
Cement	Yards	48lb	96lb	Other:	End of Shift: ________

Appendix J
Pumping Test Data

GEOSCIENCE Support Services, Inc.
Ground Water Resources Development

TEL: (909) 920-0707
FAX: (909) 920-0403

PUMPING TEST DATA

Test Date: 29-Mar-06
Well Name/Number: MWDOC Test Slant Well SL-1
Circle Well Type: (Pumping) Observation (r = ft)
Circle Test Type: (Step Drawdown) Constant Rate Recovery Development
Static Water Level Depth: 20.90 ft below Reference Point: Reference Point Elevation: +4.00 lineal ft above ground level

Date and Time	Time Min Step	Time Min Total	Depth to Water (Lineal)	Depth to Water (Vertical)	Drawdown (Lineal)	Drawdown (Vertical)	Pumping Rate (gpm)	Sand Content	Totalizer (kgal)	Remarks and Other Data
3/29/2006 11:00	0	0	20.9	8.17	0.00	0.00	0	0	69473.5	Pump On
3/29/2006 11:02	2	2	31.2	12.19	10.30	4.02	750	5.3	69475.0	
3/29/2006 11:04	2	4	31.92	12.47	11.02	4.31	500	5.3	69476.0	
3/29/2006 11:06	2	6	31.93	12.48	11.03	4.31	500	0	69477.0	
3/29/2006 11:08	2	8	32.05	12.52	11.15	4.36	500	tr	69478.0	
3/29/2006 11:10	2	10	32.46	12.68	11.56	4.52	500	0	69479.0	
3/29/2006 11:15	5	15	33.16	12.96	12.26	4.79	500	0	69481.5	
3/29/2006 11:20	5	20	33.36	13.03	12.46	4.87	500	0	69484.0	
3/29/2006 11:25	5	25	33.36	13.03	12.46	4.87	500	0	69486.5	
3/29/2006 11:30	5	30	34.38	13.43	13.48	5.27	500	0	69489.0	
3/29/2006 11:35	5	35	34.38	13.43	13.48	5.27	500	0	69491.5	
3/29/2006 11:40	5	40	34.65	13.54	13.75	5.37	500	0	69494.0	
3/29/2006 11:50	10	50	35.26	13.78	14.36	5.61	500	0	69499.0	
3/29/2006 12:00	10	60	35.65	13.93	14.75	5.76	550	0	69504.5	
3/29/2006 12:10	10	70	36.26	14.17	15.36	6.00	500	0	69509.5	
3/29/2006 12:20	10	80	36.67	14.33	15.77	6.16	500	0	69514.5	Q_1 ave = 511 gpm
3/29/2006 12:30	10	90	46.61	18.21	25.71	10.05	1,000	0	69519.5	SC = 83 gpm/ft
3/29/2006 12:32	2	92	47.37	18.51	26.47	10.34	1,000	tr	69521.5	
3/29/2006 12:34	2	94	47.49	18.56	26.59	10.39	750	0	69523.0	
3/29/2006 12:36	2	96	47.95	18.74	27.05	10.57	1,250	0	69525.5	
3/29/2006 12:38	2	98	48.35	18.89	27.45	10.73	1,000	0	69527.5	
3/29/2006 12:40	2	100	48.65	19.01	27.75	10.84	1,000	0	69529.5	
3/29/2006 12:45	5	105	49.1	19.18	28.20	11.02	1,000	0	69534.5	
3/29/2006 12:50	5	110	49.68	19.41	28.78	11.25	1,100	0	69540.0	
3/29/2006 12:55	5	115	50.01	19.54	29.11	11.37	1,000	0	69545.0	
3/29/2006 13:00	5	120	50.42	19.70	29.52	11.53	1,000	0	69550.0	
3/29/2006 13:05	5	125	50.76	19.83	29.86	11.67	1,000	0	69555.0	
3/29/2006 13:10	5	130	51.22	20.01	30.32	11.85	1,000	0	69560.0	
3/29/2006 13:20	10	140	51.71	20.20	30.81	12.04	1,000	0	69570.0	
3/29/2006 13:30	10	150	52.32	20.44	31.42	12.28	1,000	0	69580.0	
3/29/2006 13:45	15	165	52.92	20.68	32.02	12.51	1,000	0	69595.0	
3/29/2006 14:00	15	180	53.54	20.92	32.64	12.75	1,000	0	69610.5	
3/29/2006 14:15	15	195	54	21.10	33.10	12.93	1,000	0	69625.5	
3/29/2006 14:30	15	210	54.52	21.30	33.62	13.14	1,000	0	69640.5	
3/29/2006 14:45	15	225	54.77	21.40	33.87	13.23	1,000	0	69655.5	
3/29/2006 15:00	15	240	66.04	25.80	45.14	17.64	1,000	0	69671.0	Q_2 ave = 1,010 gpm
3/29/2006 15:02	2	242	67.22	26.26	46.32	18.10	1,250	tr	69673.5	SC = 76 gpm/ft
3/29/2006 15:04	2	244	67.82	26.50	46.92	18.33	1,500	tr	69676.5	
3/29/2006 15:06	2	246	68	26.57	47.10	18.40	1,250	tr	69679.0	
3/29/2006 15:08	2	248	68.54	26.78	47.64	18.61	1,500	tr	69682.0	
3/29/2006 15:10	2	250	68.95	26.94	48.05	18.77	1,750	tr	69685.5	
3/29/2006 15:15	5	255	69.31	27.08	48.41	18.92	1,500	0	69693.0	
3/29/2006 15:20	5	260	69.52	27.16	48.62	19.00	1,500	0	69700.5	
3/29/2006 15:25	5	265	69.73	27.25	48.83	19.08	1,500	0	69708.0	
3/29/2006 15:30	5	270	70.24	27.44	49.34	19.28	1,600	0	69716.0	
3/29/2006 15:40	10	280	70.54	27.56	49.64	19.40	1,500	0	69731.0	
3/29/2006 16:00	20	300	70.7	27.62	49.80	19.46	1,500	0	69761.0	
3/29/2006 16:10	10	310	71.07	27.77	50.17	19.60	1,500	0	69776.0	
3/29/2006 16:20	10	320	71.28	27.85	50.38	19.69	1,550	0	69791.5	
3/29/2006 16:30	10	330	71.23	27.83	50.33	19.67	1,500	0	69806.5	
3/29/2006 16:45	15	345	74.82	29.23	53.92	21.07	1,600	tr	69830.0	Q_3 ave = 1,514 gpm
3/29/2006 16:50	5	350	74.96	29.29	54.06	21.12	1,600	tr	69838.0	SC = 77 gpm/ft
3/29/2006 16:55	5	355	75.3	29.42	54.40	21.26	1,600	tr	69846.0	
3/29/2006 17:00	5	360	75.4	29.46	54.50	21.29	1,600	tr	69854.0	
3/29/2006 17:05	5	365	75.46	29.48	54.56	21.32	1,600	tr	69862.0	
3/29/2006 17:10	5	370	75.48	29.49	54.58	21.33	1,600	0	69870.0	
3/29/2006 17:15	5	375	75.49	29.50	54.59	21.33	1,800	0	69879.0	
3/29/2006 17:25	10	385	75.48	29.49	54.58	21.33	1,650	0	69895.5	
3/29/2006 17:35	10	395	75.36	29.45	54.46	21.28	1,650	0	69912.0	
3/29/2006 17:45	10	405	75.32	29.43	54.42	21.26	1,600	0	69928.0	
3/29/2006 17:55	10	415	75.16	29.37	54.26	21.20	1,700	0	69945.0	
3/29/2006 18:00	5	420	74.86	29.25	53.96	21.08	1,650	0	69953.3	
3/29/2006 18:15	15	435	74.86	29.25	53.96	21.08	1,450	0	69975.0	
3/29/2006 18:30	15	450	74.43	29.08	53.53	20.92	1,658	0	70003.0	
3/29/2006 18:45	15	465	74.13	28.96	53.23	20.80	1,667	0	70028.0	
3/29/2006 19:00	15	480	74.02	28.92	53.12	20.76	1,667	0	70053.0	pump off
										Q_3 ave = 1,652 gpm
										SC = 80 gpm/ft

GEOSCIENCE Support Services, Inc.
Ground Water Resources Development
TEL: (909) 920-0707
FAX: (909) 920-0403

PUMPING TEST DATA

Test Date: 31-Mar-06 through 5-Apr-06

Well Name/Number: MWDOC Test Slant Well SL-1

Circle Well Type: (Pumping) Observation (r = ft)

Circle Test Type: Step Drawdown (Constant Rate) Recovery Development

Static Water Level Depth: 20.70 ft below Reference Point: Reference Point Elevation: +4.00 lineal ft above ground level

Date and Time	Time Min Step	Time Min Total	Lineal Depth to Water	Depth to Water (Vertical)	Drawdown (Lineal)	Drawdown (Vertical)	Pumping Rate	Sand Content	Totalizer	Remarks and Other Data
3/31/2006 9:00	0	0	20.70	8.09	0.00	0.00	1,737	tr	70055.0	Pump On
3/31/2006 9:20	20	20	-				1,700		70089.0	
3/31/2006 9:25	5	25	63.41	24.78	42.71	16.69	1,800		70098.0	
3/31/2006 9:30	5	30	65.22	25.48	44.52	17.40	1,700		70106.5	
3/31/2006 9:35	5	35	65.75	25.69	45.05	17.60	1,700		70115.0	
3/31/2006 9:40	5	40	66.27	25.89	45.57	17.81	1,800		70124.0	
3/31/2006 9:45	5	45	66.78	26.09	46.08	18.00	1,600		70132.0	
3/31/2006 9:50	5	50	67.10	26.22	46.40	18.13	1,700		70140.5	
3/31/2006 9:55	5	55	67.58	26.41	46.88	18.32	1,700		70149.0	
3/31/2006 10:00	5	60	68.07	26.60	47.37	18.51	1,700		70157.5	
3/31/2006 10:10	10	70	68.58	26.80	47.88	18.71	1,650		70174.0	
3/31/2006 10:20	10	80	69.21	27.04	48.51	18.95	1,700		70191.0	
3/31/2006 10:30	10	90	69.98	27.34	49.28	19.26	1,700		70208.0	
3/31/2006 10:40	10	100	70.51	27.55	49.81	19.46	1,700		70225.0	
3/31/2006 10:50	10	110	70.85	27.68	50.15	19.60	1,700		70242.0	
3/31/2006 11:00	10	120	71.33	27.87	50.63	19.78	1,700		70259.0	
3/31/2006 11:10	10	130	72.14	28.19	51.44	20.10	1,650		70275.5	
3/31/2006 11:20	10	140	72.31	28.25	51.61	20.17	1,800		70293.5	
3/31/2006 11:30	10	150	72.74	28.42	52.04	20.33	1,550		70309.0	
3/31/2006 11:45	15	165	73.22	28.61	52.52	20.52	1,667		70334.0	
3/31/2006 11:50	5	170	73.46	28.70	52.76	20.61	1,700		70342.5	
3/31/2006 12:00	10	180	74.00	28.91	53.30	20.83	1,700		70359.5	
3/31/2006 12:15	15	195	74.57	29.14	53.87	21.05	1,667		70384.5	
3/31/2006 12:40	25	220	75.52	29.51	54.82	21.42	1,720		70427.5	
3/31/2006 13:00	20	240	76.08	29.73	55.38	21.64	1,625		70460.0	
3/31/2006 13:15	15	255	76.35	29.83	55.65	21.74	1,667		70485.0	
3/31/2006 13:30	15	270	76.95	30.07	56.25	21.98	1,667		70510.0	
3/31/2006 13:45	15	285	77.22	30.17	56.52	22.08	1,667		70535.0	
3/31/2006 14:00	15	300	77.72	30.37	57.02	22.28	1,667		70560.0	
3/31/2006 14:16	16	316	78.12	30.52	57.42	22.44	1,688		70587.0	
3/31/2006 14:30	14	330	78.30	30.59	57.60	22.51	1,643		70610.0	
3/31/2006 14:45	15	345	78.65	30.73	57.95	22.64	1,667		70635.0	
3/31/2006 15:00	15	360	78.85	30.81	58.15	22.72	1,667		70660.0	
3/31/2006 15:15	15	375	79.02	30.88	58.32	22.79	1,633		70684.5	
3/31/2006 15:45	30	405	79.46	31.05	58.76	22.96	1,650		70734.0	
3/31/2006 16:00	15	420	79.52	31.07	58.82	22.98	1,667		70759.0	
3/31/2006 16:30	30	450	79.76	31.16	59.06	23.08	1,667		70809.0	
3/31/2006 17:00	30	480	79.45	31.04	58.75	22.96	1,667		70859.0	
3/31/2006 17:30	30	510	79.00	30.87	58.30	22.78	1,667		70909.0	
3/31/2006 18:00	30	540	78.60	30.71	57.90	22.62	1,667		70959.0	
3/31/2006 18:30	30	570	78.20	30.56	57.50	22.47	1,633		71008.0	
3/31/2006 19:00	30	600	77.40	30.24	56.70	22.15	1,667		71058.0	
3/31/2006 19:30	30	630	76.90	30.05	56.20	21.96	1,667		71108.0	
3/31/2006 20:00	30	660	76.30	29.81	55.60	21.72	1,667		71158.0	
3/31/2006 20:30	30	690	75.70	29.58	55.00	21.49	1,667		71208.0	
3/31/2006 21:00	30	720	75.20	29.38	54.50	21.29	1,667		71258.0	
3/31/2006 21:30	30	750	75.00	29.30	54.30	21.22	1,700		71309.0	
3/31/2006 22:00	30	780	74.70	29.19	54.00	21.10	1,667		71359.0	
3/31/2006 22:30	30	810	74.90	29.27	54.20	21.18	1,667		71409.0	
3/31/2006 23:00	30	840	75.30	29.42	54.60	21.33	1,667		71459.0	
3/31/2006 23:30	30	870	75.60	29.54	54.90	21.45	1,667		71509.0	
4/1/2006 0:00	30	900	76.40	29.85	55.70	21.76	1,667		71559.0	
4/1/2006 0:30	30	930	77.00	30.09	56.30	22.00	1,700		71610.0	
4/1/2006 1:00	30	960	77.90	30.44	57.20	22.35	1,667		71660.0	
4/1/2006 1:30	30	990	79.00	30.87	58.30	22.78	1,667		71710.0	
4/1/2006 2:00	30	1,020	79.70	31.14	59.00	23.05	1,667		71760.0	
4/1/2006 2:30	30	1,050	80.40	31.41	59.70	23.33	1,667		71810.0	
4/1/2006 3:00	30	1,080	81.20	31.73	60.50	23.64	1,667		71860.0	
4/1/2006 3:30	30	1,110	82.00	32.04	61.30	23.95	1,667		71910.0	
4/1/2006 4:00	30	1,140	82.30	32.16	61.60	24.07	1,633		71959.0	
4/1/2006 4:30	30	1,170	82.70	32.31	62.00	24.23	1,633		72008.0	
4/1/2006 5:00	30	1,200	82.98	32.42	62.28	24.33	1,667		72058.0	
4/1/2006 5:30	30	1,230	82.75	32.33	62.05	24.24	1,633		72107.0	
4/1/2006 6:00	30	1,260	82.50	32.24	61.80	24.15	1,650		72156.5	

GEOSCIENCE Support Services, Inc.
Ground Water Resources Development

TEL: (909) 920-0707
FAX: (909) 920-0403

PUMPING TEST DATA

Test Date: 31-Mar-06 through 5-Apr-06

Well Name/Number: MWDOC Test Slant Well SL-1

Circle Well Type: (Pumping) Observation (r = ft)

Circle Test Type: Step Drawdown (Constant Rate) Recovery Development

Static Water Level Depth: 20.70 ft below Reference Point: Reference Point Elevation: +4.00 lineal ft above ground level

Date and Time	Time Min Step	Time Min Total	Lineal Depth to Water	Depth to Water (Vertical)	Drawdown (Lineal)	Drawdown (Vertical)	Pumping Rate	Sand Content	Totalizer	Remarks and Other Data
4/1/2006 6:30	30	1,290	82.43	32.21	61.73	24.12	1,650		72206.0	
4/1/2006 7:00	30	1,320	82.00	32.04	61.30	23.95	1,633		72255.0	
4/1/2006 7:30	30	1,350	81.68	31.91	60.98	23.83	1,650		72304.5	
4/1/2006 8:00	30	1,380	80.86	31.59	60.16	23.51	1,650		72354.0	
4/1/2006 8:30	30	1,410	80.40	31.41	59.70	23.33	1,667		72404.0	
4/1/2006 9:00	30	1,440	79.83	31.19	59.13	23.10	1,650		72453.5	
4/1/2006 9:30	30	1,470	79.52	31.07	58.82	22.98	1,650		72503.0	
4/1/2006 10:00	30	1,500	79.14	30.92	58.44	22.83	1,733		72555.0	
4/1/2006 10:30	30	1,530	78.86	30.81	58.16	22.72	1,600		72603.0	
4/1/2006 11:00	30	1,560	78.53	30.68	57.83	22.60	1,667		72653.0	
4/1/2006 12:00	60	1,620	78.76	30.77	58.06	22.69	1,667		72753.0	
4/1/2006 13:00	60	1,680	79.13	30.92	58.43	22.83	1,650		72852.0	
4/1/2006 14:00	60	1,740	79.71	31.15	59.01	23.06	1,667		72952.0	
4/1/2006 15:00	60	1,800	80.32	31.38	59.62	23.30	1,658		73051.5	
4/1/2006 16:00	60	1,860	80.87	31.60	60.17	23.51	1,658		73151.0	
4/1/2006 17:00	60	1,920	80.70	31.53	60.00	23.44	1,650		73250.0	
4/1/2006 18:00	60	1,980	79.96	31.24	59.26	23.15	1,667		73350.0	
4/1/2006 19:00	60	2,040	79.31	30.99	58.61	22.90	1,650		73449.0	
4/1/2006 20:00	60	2,100	77.90	30.44	57.20	22.35	1,667		73549.0	
4/1/2006 21:00	60	2,160	76.96	30.07	56.26	21.98	1,667		73649.0	
4/1/2006 22:00	60	2,220	76.48	29.88	55.78	21.79	1,667		73749.0	
4/1/2006 23:00	60	2,280	76.04	29.71	55.34	21.62	1,667		73849.0	
4/2/2006 0:00	60	2,340	76.62	29.94	55.92	21.85	1,667		73949.0	
4/2/2006 1:00	60	2,400	77.60	30.32	56.90	22.23	1,667		74049.0	
4/2/2006 2:00	60	2,460	79.16	30.93	58.46	22.84	1,667		74149.0	
4/2/2006 3:00	60	2,520	80.54	31.47	59.84	23.38	1,667		74249.0	
4/2/2006 4:00	60	2,580	81.77	31.95	61.07	23.86	1,667		74349.0	
4/2/2006 5:00	60	2,640	82.68	32.31	61.98	24.22	1,633		74447.0	
4/2/2006 6:00	60	2,700	83.08	32.46	62.38	24.37	1,633		74545.0	
4/2/2006 7:00	60	2,760	82.89	32.39	62.19	24.30	1,650		74644.0	
4/2/2006 8:00	60	2,820	82.47	32.22	61.77	24.14	1,650		74743.0	
4/2/2006 9:00	60	2,880	81.57	31.87	60.87	23.78	1,650		74842.0	
4/2/2006 10:00	60	2,940	80.72	31.54	60.02	23.45	1,658		74941.5	
4/2/2006 11:00	60	3,000	80.13	31.31	59.43	23.22	1,658		75041.0	
4/2/2006 12:00	60	3,060	79.71	31.15	59.01	23.06	1,658		75140.5	
4/2/2006 13:00	60	3,120	79.59	31.10	58.89	23.01	1,658		75240.0	
4/2/2006 14:00	60	3,180	79.66	31.13	58.96	23.04	1,667		75340.0	
4/2/2006 15:10	70	3,250	80.24	31.35	59.54	23.26	1,657		75456.0	
4/2/2006 16:00	50	3,300	80.22	31.34	59.52	23.26	1,660		75539.0	
4/2/2006 17:00	60	3,360	80.48	31.45	59.78	23.36	1,650		75638.0	
4/2/2006 18:00	60	3,420	80.03	31.27	59.33	23.18	1,650		75737.0	
4/2/2006 19:00	60	3,480	79.46	31.05	58.76	22.96	1,667		75837.0	
4/2/2006 20:00	60	3,540	78.79	30.79	58.09	22.70	1,650		75936.0	
4/2/2006 21:00	60	3,600	77.94	30.45	57.24	22.37	1,667		76036.0	
4/2/2006 22:00	60	3,660	77.40	30.24	56.70	22.15	1,667		76136.0	
4/2/2006 23:00	60	3,720	77.12	30.13	56.42	22.05	1,667		76236.0	
4/3/2006 0:00	60	3,780	77.19	30.16	56.49	22.07	1,667		76336.0	
4/3/2006 1:00	60	3,840	77.42	30.25	56.72	22.16	1,667		76436.0	
4/3/2006 2:00	60	3,900	78.36	30.62	57.66	22.53	1,667		76536.0	
4/3/2006 3:00	60	3,960	79.76	31.16	59.06	23.08	1,667		76636.0	
4/3/2006 4:00	60	4,020	80.69	31.53	59.99	23.44	1,650		76735.0	
4/3/2006 5:00	60	4,080	81.79	31.96	61.09	23.87	1,650		76834.0	
4/3/2006 6:00	60	4,140	82.57	32.26	61.87	24.17	1,650		76933.0	
4/3/2006 7:00	60	4,200	82.83	32.36	62.13	24.28	1,650		77032.0	
4/3/2006 8:00	60	4,260	82.65	32.29	61.95	24.21	1,650		77131.0	
4/3/2006 9:00	60	4,320	82.44	32.21	61.74	24.12	1,650		77230.0	
4/3/2006 10:00	60	4,380	82.00	32.04	61.30	23.95	1,650		77329.0	
4/3/2006 11:00	60	4,440	81.44	31.82	60.74	23.73	1,650		77428.0	
4/3/2006 12:00	60	4,500	80.93	31.62	60.23	23.53	1,650		77527.0	
4/3/2006 13:00	60	4,560	80.23	31.35	59.53	23.26	1,650		77626.0	
4/3/2006 14:05	65	4,625	79.72	31.15	59.02	23.06	1,631		77732.0	
4/3/2006 15:00	55	4,680	80.17	31.32	59.47	23.24	1,709		77826.0	
4/3/2006 16:00	60	4,740	79.86	31.20	59.16	23.12	1,633		77924.0	
4/3/2006 17:00	60	4,800	79.81	31.18	59.11	23.10	1,700		78026.0	

GEOSCIENCE Support Services, Inc.
Ground Water Resources Development

TEL: (909) 920-0707
FAX: (909) 920-0403

PUMPING TEST DATA

Test Date: 31-Mar-06 through 5-Apr-06

Well Name/Number: MWDOC Test Slant Well SL-1

Circle Well Type: (Pumping) Observation (r = ft)

Circle Test Type: Step Drawdown (Constant Rate) Recovery Development

Static Water Level Depth: 20.70 ft below Reference Point: Reference Point Elevation: +4.00 lineal ft above ground level

Date and Time	Time Min Step	Time Min Total	Lineal Depth to Water	Depth to Water (Vertical)	Drawdown (Lineal)	Drawdown (Vertical)	Pumping Rate	Sand Content	Totalizer	Remarks and Other Data
4/3/2006 18:00	60	4,860	79.67	31.13	58.97	23.04	1,617		78123.0	
4/3/2006 19:00	60	4,920	79.61	31.11	58.91	23.02	1,650		78222.0	
4/3/2006 20:00	60	4,980	79.28	30.98	58.58	22.89	1,667		78322.0	
4/3/2006 21:00	60	5,040	78.51	30.68	57.81	22.59	1,667		78422.0	
4/3/2006 22:00	60	5,100	78.26	30.58	57.56	22.49	1,667		78522.0	
4/3/2006 23:00	60	5,160	77.72	30.37	57.02	22.28	1,667		78622.0	
4/4/2006 0:00	60	5,220	77.73	30.37	57.03	22.28	1,650		78721.0	
4/4/2006 1:00	60	5,280	77.14	30.14	56.44	22.05	1,667		78821.0	
4/4/2006 2:00	60	5,340	77.31	30.21	56.61	22.12	1,667		78921.0	
4/4/2006 3:00	60	5,400	78.35	30.61	57.65	22.53	1,650		79020.0	
4/4/2006 4:00	60	5,460	79.20	30.95	58.50	22.86	1,667		79120.0	
4/4/2006 5:00	60	5,520	79.98	31.25	59.28	23.16	1,650		79219.0	
4/4/2006 6:00	60	5,580	81.07	31.68	60.37	23.59	1,650		79318.0	
4/4/2006 7:00	60	5,640	81.73	31.93	61.03	23.85	1,650		79417.0	
4/4/2006 8:00	60	5,700	82.38	32.19	61.68	24.10	1,650		79516.0	
4/4/2006 9:00	60	5,760	82.18	32.11	61.48	24.02	1,633		79614.0	
4/4/2006 10:00	60	5,820	82.11	32.08	61.41	23.99	1,633		79712.0	
4/4/2006 11:00	60	5,880	81.83	31.97	61.13	23.89	1,683		79813.0	
4/4/2006 12:00	60	5,940	81.17	31.72	60.47	23.63	1,650		79912.0	
4/4/2006 13:00	60	6,000	80.95	31.63	60.25	23.54	1,650		80011.0	
4/4/2006 14:00	60	6,060	80.09	31.29	59.39	23.21	1,650		80110.0	
4/4/2006 15:00	60	6,120	79.06	30.89	58.36	22.80	1,667		80210.0	
4/4/2006 16:00	60	6,180	78.85	30.81	58.15	22.72	1,650		80309.0	
4/4/2006 17:00	60	6,240	78.05	30.50	57.35	22.41	1,667		80409.0	
4/4/2006 18:00	60	6,300	78.65	30.73	57.95	22.64	1,667		80509.0	
4/4/2006 19:00	60	6,360	78.32	30.60	57.62	22.51	1,650		80608.0	
4/4/2006 20:00	60	6,420	78.58	30.70	57.88	22.62	1,667		80708.0	
4/4/2006 21:00	60	6,480	78.38	30.63	57.68	22.54	1,667		80808.0	
4/4/2006 22:00	60	6,540	78.42	30.64	57.72	22.55	1,667		80908.0	
4/4/2006 23:00	60	6,600	78.11	30.52	57.41	22.43	1,650		81007.0	
4/5/2006 0:00	60	6,660	77.52	30.29	56.82	22.20	1,667		81107.0	
4/5/2006 1:00	60	6,720	77.30	30.20	56.60	22.12	1,650		81206.0	
4/5/2006 2:00	60	6,780	77.21	30.17	56.51	22.08	1,667		81306.0	
4/5/2006 3:00	60	6,840	77.35	30.22	56.65	22.13	1,667		81406.0	
4/5/2006 4:00	60	6,900	77.65	30.34	56.95	22.25	1,667		81506.0	
4/5/2006 5:00	60	6,960	78.16	30.54	57.46	22.45	1,667		81606.0	
4/5/2006 6:00	60	7,020	78.95	30.85	58.25	22.76	1,667		81706.0	
4/5/2006 7:30	90	7,110	80.49	31.45	59.79	23.36	1,656		81855.0	
4/5/2006 8:00	30	7,140	43.77	17.10	23.07	9.01	1,667		81905.0	Pump Off, Begin Recovery
4/5/2006 8:02	2	7,142	43.22	16.89	22.52	8.80				Q ave = 1,660 gpm
4/5/2006 8:04	2	7,144	42.91	16.77	22.21	8.68				SC = 71 gpm/ft
4/5/2006 8:06	2	7,146	41.21	16.10	20.51	8.01				
4/5/2006 8:08	2	7,148	40.86	15.97	20.16	7.88				
4/5/2006 8:10	2	7,150	40.91	15.98	20.21	7.90				
4/5/2006 8:15	5	7,155	39.71	15.52	19.01	7.43				
4/5/2006 8:20	5	7,160	38.45	15.02	17.75	6.94				
4/5/2006 8:25	5	7,165	38.02	14.86	17.32	6.77				
4/5/2006 8:30	5	7,170	37.98	14.84	17.28	6.75				
4/5/2006 8:40	10	7,180	36.42	14.23	15.72	6.14				
4/5/2006 8:50	10	7,190	35.82	14.00	15.12	5.91				
4/5/2006 9:00	10	7,200	35.12	13.72	14.42	5.63				
4/5/2006 9:15	15	7,215	34.60	13.52	13.90	5.43				
4/5/2006 9:35	20	7,235	33.52	13.10	12.82	5.01				
4/5/2006 9:45	10	7,245	33.59	13.12	12.89	5.04				
4/5/2006 10:00	15	7,260	33.02	12.90	12.32	4.81				
4/5/2006 10:15	15	7,275	32.29	12.62	11.59	4.53				
4/5/2006 10:30	15	7,290	32.20	12.58	11.50	4.49				
4/5/2006 10:45	15	7,305	31.49	12.30	10.79	4.22				
4/5/2006 11:30	45	7,350	31.02	12.12	10.32	4.03				
4/5/2006 12:00	30	7,380	30.29	11.84	9.59	3.75				

GEOSCIENCE Support Services, Inc.
Ground Water Resources Development
TEL: (909) 920-0707
FAX: (909) 920-0403

PUMPING TEST DATA

Test Date: 13-May-06 & 14-May-06
Well Name/Number: MWDOC Test Slant Well SL-1, **BELOW PACKER**
Circle Well Type: (Pumping) Observation (r = ft)
Circle Test Type: Step Drawdown (Constant Rate) Recovery Development
Static Water Level Depth: Reference Point Elevation:
Depth of Airline (v.ft bgs): 124.13 Depth of Pump Intake (v.ft bgs): 121.43

Date and Time	Time Min Step	Time Min Total	Airline (PSI)	Depth to Water Below Packer (ft bgs)	Lineal Depth to Water Above Packer (LF)	Depth to Water Above Packer (ft bgs)	Pumping Rate (gpm)	Sand Content	Totalizer	Remarks and Other Data
5/13/06 7:02			50.5	7.47	23.85	9.32	0		83773.0	Packer 73 PSI
5/13/06 7:20			50.5	7.47	23.97	9.37	0			
5/13/06 7:40			50.5	7.47	23.40	9.14	0			
5/13/06 7:58			50.5	7.47	23.08	9.02	0			
5/13/06 8:08			50.5	7.47	22.78	8.90	0			
5/13/06 8:10	0	1		7.47		8.90			83773.0	START TEST
5/13/06 8:12	2	2	6.5	109.12	28.86	11.28	1,000		83775.0	water dirty, packer 73 PSI
5/13/06 8:14	2	4	7.0	107.96	29.05	11.35	500	0.1	83776.0	water dirty, packer 73 PSI
5/13/06 8:16	2	6	6.5	109.12	29.30	11.45	500	0.1	83777.0	water dirty, packer 73 PSI
5/13/06 8:18	2	8	6.5	109.12	29.60	11.57	1,000	0.1	83779.0	cloudy
5/13/06 8:20	2	10	6.5	109.12	29.70	11.60	1,000	0.1	83781.0	cloudy
5/13/06 8:22	2	12	6.0	110.27	29.85	11.66	750	0.1	83782.5	clear
5/13/06 8:24	2	14	6.0	110.27	30.10	11.76	750	0.2	83784.0	packer 74 PSI
5/13/06 8:26	2	16	6.0	110.27	30.50	11.92	750	0.2	83785.5	
5/13/06 8:28	2	18	6.0	110.27	30.60	11.96	750	0.2	83787.0	
5/13/06 8:30	2	20	6.0	110.27	30.62	11.96	1,000	0.2	83789.0	
5/13/06 8:32	2	22	6.0	110.27	30.90	12.07	500	0.2	83790.0	
5/13/06 8:34	2	24	6.0	110.27	30.92	12.08	1,000	0.2	83792.0	
5/13/06 8:36	2	26	6.0	110.27	30.92	12.08	750	0.2	83793.5	
5/13/06 8:38	2	28	6.0	110.27	30.95	12.09	750	0.2	83795.0	
5/13/06 8:40	2	30	6.0	110.27	31.10	12.15	1,000	0.2	83797.0	
5/13/06 8:45	5	35	6.0	110.27	31.25	12.21	800	0.2	83801.0	
5/13/06 8:50	5	40	5.5	111.43	31.52	12.32	800	0.2	83805.0	
5/13/06 8:55	5	45	5.5	111.43	31.63	12.36	700	0.2	83808.5	
5/13/06 9:00	5	50	5.5	111.43	31.87	12.45	800	0.2	83812.5	
5/13/06 9:10	10	60	5.0	112.58	32.20	12.58	750	0.2	83820.0	Back PSI 25
5/13/06 9:20	10	70	5.0	112.58	32.24	12.60	800	0.2	83828.0	
5/13/06 9:30	10	80	5.0	112.58	32.25	12.60	800	0.2	83836.0	packer 74 PSI
5/13/06 9:45	15	95	5.0	112.58	32.85	12.84	800	0.2	83848.0	
5/13/06 10:00	15	110	5.0	112.58	32.90	12.86	800	0.2	83860.0	
5/13/06 10:15	15	125	5.0	112.58	33.37	13.04	767	0.2	83871.5	
5/13/06 10:30	15	140	4.0	114.89	33.70	13.17	800	0.2	83883.5	
5/13/06 10:35	5	145					700		83887.0	Turned down discharge
5/13/06 10:45	10	155	7.0	107.96	33.67	13.16	750	0.2	83894.5	
5/13/06 11:00	15	170	7.0	107.96	33.70	13.17	767	0.2	83906.0	Average 760 gpm since 10:35
5/13/06 11:30	30	200	7.0	107.96	34.27	13.39	733	0.2	83928.0	back PSI went up to 30
5/13/06 11:40	10	210					800		83936.0	check discharge rate
5/13/06 11:50	10	220					700		83943.0	check discharge rate
5/13/06 12:00	10	230	7.0	107.96	34.85	13.62	750	0.2	83950.5	
5/13/06 12:30	30	260	6.5	109.12	35.25	13.77	750	0.2	83973.0	packer 74 PSI, back PSI 30
5/13/06 13:00	30	290	6.5	109.12	36.13	14.12	733	0.2	83995.0	
5/13/06 13:30	30	320	6.5	109.12	36.70	14.34	733	0.2	84017.0	
5/13/06 14:00	30	350	6.5	109.12	37.10	14.50	767	0.2	84040.0	
5/13/06 14:30	30	380	6.5	109.12	37.15	14.52	733	0.2	84062.0	
5/13/06 15:00	30	410	7.0	107.96	37.66	14.71	733	0.2	84084.0	
5/13/06 16:00	60	470	7.0	107.96	37.50	14.65	733	0.2	84128.0	
5/13/06 17:00	60	530	6.5	109.12	37.10	14.50	742	0.2	84172.5	
5/13/06 18:00	60	590	6.5	109.12	36.10	14.11	742	0.2	84217.0	
5/13/06 19:00	60	650	6.5	109.12	34.65	13.54	733	0.2	84261.0	
5/13/06 20:00	60	710	7.0	107.96	33.27	13.00	733	0.2	84305.0	
5/13/06 21:00	60	770	7.5	106.81	32.66	12.76	750	0.2	84350.0	
5/13/06 22:00	60	830	7.5	106.81	32.13	12.55	733	0.2	84394.0	
5/13/06 23:00	60	890	7.0	107.96	33.33	13.02	742	0.2	84438.5	
5/14/06 0:00	60	950	6.5	109.12	34.17	13.35	742	0.2	84483.0	
5/14/06 1:00	60	1,010	6.5	109.12	35.81	13.99	733	0.2	84527.0	

GEOSCIENCE Support Services, Inc.
Ground Water Resources Development

TEL: (909) 920-0707
FAX: (909) 920-0403

PUMPING TEST DATA

Test Date: 13-May-06 & 14-May-06

Well Name/Number: MWDOC Test Slant Well SL-1, **BELOW PACKER**

Circle Well Type: (Pumping, circled) Observation (r = ft)

Circle Test Type: Step Drawdown (Constant Rate, circled) Recovery Development

Static Water Level Depth: Reference Point Elevation:

Depth of Airline (v.ft bgs): 124.13 Depth of Pump Intake (v.ft bgs): 121.43

Date and Time	Time Min Step	Time Min Total	Airline (PSI)	Depth to Water Below Packer (ft bgs)	Lineal Depth to Water Above Packer (LF)	Depth to Water Above Packer (ft bgs)	Pumping Rate (gpm)	Sand Content	Totalizer	Remarks and Other Data
5/14/06 2:00	60	1,070	6.1	110.04	38.28	14.96	733	0.2	84571.0	
5/14/06 3:00	60	1,130	6.0	110.27	40.06	15.65	733	0.2	84615.0	
5/14/06 4:00	60	1,190	6.0	110.27	40.53	15.84	742	0.2	84659.5	
5/14/06 5:00	60	1,250	5.5	111.43	40.99	16.02	733	0.2	84703.5	
5/14/06 6:00	60	1,310	5.5	111.43	40.42	15.79	742	0.2	84748.0	
5/14/06 7:00	60	1,370	6.0	110.27	39.84	15.57	733	0.2	84792.0	
5/14/06 8:00	60	1,430	6.5	109.12	38.30	14.97	733	0.2	84836.0	
5/14/06 9:00	60	1,490	6.0	110.27	37.40	14.61	733	0.2	84880.0	
5/14/06 10:00	60	1,550	6.0	110.27	36.15	14.12	733	0.2	84924.0	
5/14/06 11:00	60	1,610	6.0	110.27	35.47	13.86	742	0.2	84968.5	
5/14/06 12:00	60	1,670	6.0	110.27	35.56	13.89	742	0.2	85013.0	
5/14/06 13:00	60	1,730	6.0	110.27	36.76	14.36	733	0.2	85057.0	
5/14/06 14:00	60	1,790	6.0	110.27	36.81	14.38	733	0.2	85101.0	
5/14/06 15:00	60	1,850	6.5	109.12	37.10	14.50	733	0.2	85145.0	
5/14/06 16:00	60	1,910	6.5	109.12	37.88	14.80	733	0.2	85189.0	
5/14/06 17:00	60	1,970	6.0	110.27	36.92	14.43	733	0.2	85233.0	
5/14/06 18:00	60	2,030	6.0	110.27	36.15	14.12	733	0.2	85277.0	
5/14/06 19:00	60	2,090	6.0	110.27	35.20	13.75	742	0.2	85321.5	
5/14/06 20:00	60	2,150	6.0	110.27	34.02	13.29	742	0.2	85366.0	
5/14/06 21:00	60	2,210	6.0	110.27	32.58	12.73	733	0.2	85410.0	
5/14/06 22:00	60	2,270	6.0	110.27	31.76	12.41	733	0.2	85454.0	
5/14/06 23:00	60	2,330	6.0	110.27	32.50	12.70	742	0.2	85498.5	
5/15/06 0:00	60	2,390	5.5	111.43	33.17	12.96	742	0.2	85543.0	
5/15/06 1:00	60	2,450	5.0	112.58	34.47	13.47	733	0.2	85587.0	
5/15/06 2:00	60	2,510	5.0	112.58	37.46	14.64	733	0.2	85631.0	
5/15/06 3:00	60	2,570	5.0	112.58	38.14	14.90	733	0.2	85675.0	
5/15/06 4:00	60	2,630	5.0	112.58	40.17	15.70	725	0.2	85718.5	
5/15/06 5:00	60	2,690	5.0	112.58	40.89	15.98	725	0.2	85762.0	
5/15/06 6:00	60	2,750	5.0	112.58	40.97	16.01	733	0.2	85806.0	
5/15/06 7:00	60	2,810	5.0	112.58	40.21	15.71	733	0.2	85850.0	
5/15/06 8:00	60	2,870	5.5	111.43	39.40	15.39	733	0.2	85894.0	
5/15/06 8:10	10	2,880	5.5	111.43	39.10	15.28	700	0.2	85901.0	Pump Off, Q ave = 739 gpm
5/15/06 8:12	2	2,882	10.0	101.03	34.90	13.64				
5/15/06 8:14	2	2,884	16.0	87.17	34.55	13.50				
5/15/06 8:16	2	2,886	20.0	77.93	33.75	13.19				
5/15/06 8:18	2	2,888	20.5	76.78	33.55	13.11				
5/15/06 8:20	2	2,890	20.5	76.78	33.25	12.99				
5/15/06 8:25	5	2,895	49.5	9.79	32.50	12.70				
5/15/06 8:30	5	2,900	49.5	9.79	32.02	12.51				
5/15/06 8:35	5	2,905	49.5	9.79	31.55	12.33				
5/15/06 8:40	5	2,910	49.5	9.79	31.15	12.17				
5/15/06 8:50	10	2,920	49.5	9.79	30.15	11.78				
5/15/06 9:00	10	2,930	49.5	9.79	29.90	11.68				
5/15/06 9:10	10	2,940	50.0	8.63	29.19	11.41				
5/15/06 9:25	15	2,955	50.0	8.63	28.15	11.00				
5/15/06 9:40	15	2,970	50.0	8.63	27.80	10.86				
5/15/06 9:55	15	2,985	50.0	8.63	27.45	10.73				
5/15/06 10:10	15	3,000	50.0	8.63	26.50	10.35				
5/15/06 10:40	30	3,030	50.0	8.63	25.81	10.08				
5/15/06 11:10	30	3,060	50.0	8.63	25.05	9.79				
5/15/06 11:40	30	3,090	50.0	8.63	24.75	9.67				
5/15/06 12:10	30	3,120	50.0	8.63	24.43	9.55				