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OPERABLE UNIT 1 SOURCE AREA GROUNDWATER TREATMENT SYSTEM INSTALLATION REPORT

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
JET PROPULSION LABORATORY
PASADENA, CALIFORNIA

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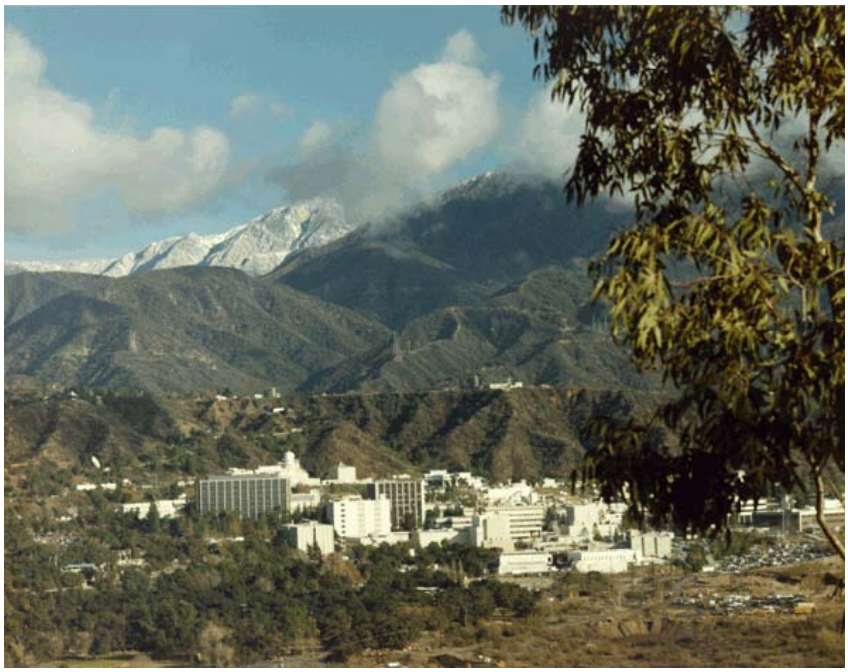

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Pasadena, California 91109

September 2008

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ACRONYMS AND ABBREVIATIONS

bgs	below ground surface
btoc	below top of casing
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
EM	electromagnetic imaging
EW	extraction well
FBR	fluidized bed reactor
FWEC	Foster Wheeler Environmental Corporation
GPR	ground penetrating radar
IW	injection well
JPL	Jet Propulsion Laboratory
LGAC	liquid-phase granular activated carbon
MCL	maximum contaminant levels
MW	monitoring well
NASA	National Aeronautics and Space Administration
NPL	National Priorities List
OU	operable unit
PVC	polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
RD/RA	Remedial Design Remedial Work Plan
RI	Remedial Investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
TCE	trichloroethene
U.S. EPA	United States Environmental Protection Agency
UV	ultraviolet
VOC	volatile organic compound

1.0 INTRODUCTION

This report was prepared for the National Aeronautics and Space Administration (NASA) to document installation of the response action in Operable Unit 1 (OU-1) source area groundwater at the Jet Propulsion Laboratory (JPL). The NASA-JPL site is on the United States Environmental Protection Agency (U.S. EPA) National Priorities List (NPL) and subject to the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA).

During historic operations at JPL, various chemicals (including chlorinated solvents, solid rocket fuel propellants, cooling tower chemicals, sulfuric acid, Freon™, and mercury) and other materials were used at the facility. During the 1940s and 1950s, many buildings at JPL maintained subsurface seepage pits for disposal of sanitary wastes and laboratory chemical wastes collected from drains and sinks within the buildings. The Remedial Investigation (RI) for OU-2 identified 40 seepage pits, five waste pits, and four discharge points at the facility that were used during historic operations (Foster Wheeler Environmental Corporation [FWEC], 1999a). Some of the seepage pits received volatile organic compounds (VOCs) and other waste materials which are currently found in groundwater beneath and adjacent to JPL. In the late 1950s and early 1960s, a sanitary sewer system was installed at JPL to handle sewage and wastewater, and the use of seepage pits for sanitary and chemical waste disposal was discontinued. Today, laboratory chemical wastes are either recycled or sent off-facility for treatment and disposal at regulated, Resource Conservation and Recovery Act (RCRA)-permitted hazardous waste facilities.

In 1980, the analyses of groundwater revealed the presence of VOCs in City of Pasadena water-supply wells located southeast of JPL in the Arroyo Seco. At about the same time, VOCs were detected in two water-supply wells used by the Lincoln Avenue Water Company, located east of the Arroyo Seco (FWEC, 1999b). As a result, NASA initiated an investigation to evaluate VOCs originating from the JPL facility.

In 1988, a Preliminary Assessment/Site Inspection was completed at JPL, which indicated that further site characterization was warranted (Ebasco, 1988). Subsequent site investigations were conducted at JPL (Ebasco, 1990a; Ebasco, 1990b) and VOCs were detected in on-facility groundwater at levels above drinking water standards. In 1992, JPL was placed on the NPL of sites subject to regulation under CERCLA (47180-47187 *Federal Register*, Vol. 57, No. 199 [1992]).

After being placed on the NPL, the nature and extent of chemicals in groundwater were investigated during the RI, which lasted from 1994 to 1998 (FWEC, 1999a; FWEC, 1999b). Additional groundwater data have been obtained from a long-term groundwater monitoring program in place at the facility since August 1996, which continues to be active. Based on the data collected during the RI and long-term groundwater monitoring, two VOCs (carbon tetrachloride and trichloroethene [TCE]) and perchlorate have been detected consistently in the source area at concentrations significantly

exceeding their respective state or federal maximum contaminant levels (MCLs). The highest concentrations of carbon tetrachloride and perchlorate at the JPL site are located in the north-central portion of the JPL facility, which is referred to as the "source area." The source area is the location where the majority of chemicals is dissolved in the groundwater, and is defined as an 8-acre by 100-ft-thick portion of the aquifer.

In the late 1990s and early 2000, NASA conducted pilot testing of several technologies to address dissolved perchlorate in source area groundwater. The technologies tested included reverse osmosis, a fluidized bed reactor (FBR), packed bed reactors, in situ bioremediation, and ion exchange (FWEC, 2000; NASA, 2003). Due to the depth and extent of the chemicals in groundwater, in situ (below ground) treatment is not cost-effective at the JPL facility; therefore, groundwater must be pumped from the ground, treated aboveground, and reinjected.

Based on these studies, NASA installed a demonstration treatment plant located on JPL in the source area in early 2005 (NASA, 2003; NASA, 2005). The demonstration study area location is illustrated in Figure 1-1. The demonstration study consists of two extraction wells, two injection wells, liquid-phase granular activated carbon (LGAC) treatment to remove VOCs, and an FBR to remove perchlorate, as depicted in Figure 1-2. This system was successful in the demonstration phase, so NASA prepared the Interim Record of Decision (ROD) (NASA, 2006a) and Remedial Design/Remedial Action (RD/RA) Work Plan (NASA, 2006b) for system expansion.

Construction associated with the system expansion was initiated in February 2007 and completed in January 2008. The as-built conditions of the demonstration system are documented in the Expanded Treatability Study Installation Report (NASA, 2005). This report documents the as-built conditions of the source area groundwater treatment expansion completed in January 2008. System expansion consisted of one additional extraction well (JPL-EW-03), one additional injection well (JPL-IW-03), new piping, and associated equipment. Figures 1-1 and 1-2 show the limits of demonstration study area and expansion area.

The remainder of this report is divided into three sections. Section 2.0 provides information pertaining to the installation of the new extraction and injection wells. Section 3.0 describes new electrical and pipeline construction efforts, and Section 4.0 provides references to documents cited in this report. The two appendices provide as-built records for the extraction and injection wells (Appendix 1) and the new electrical lines and pipelines (Appendix 2).

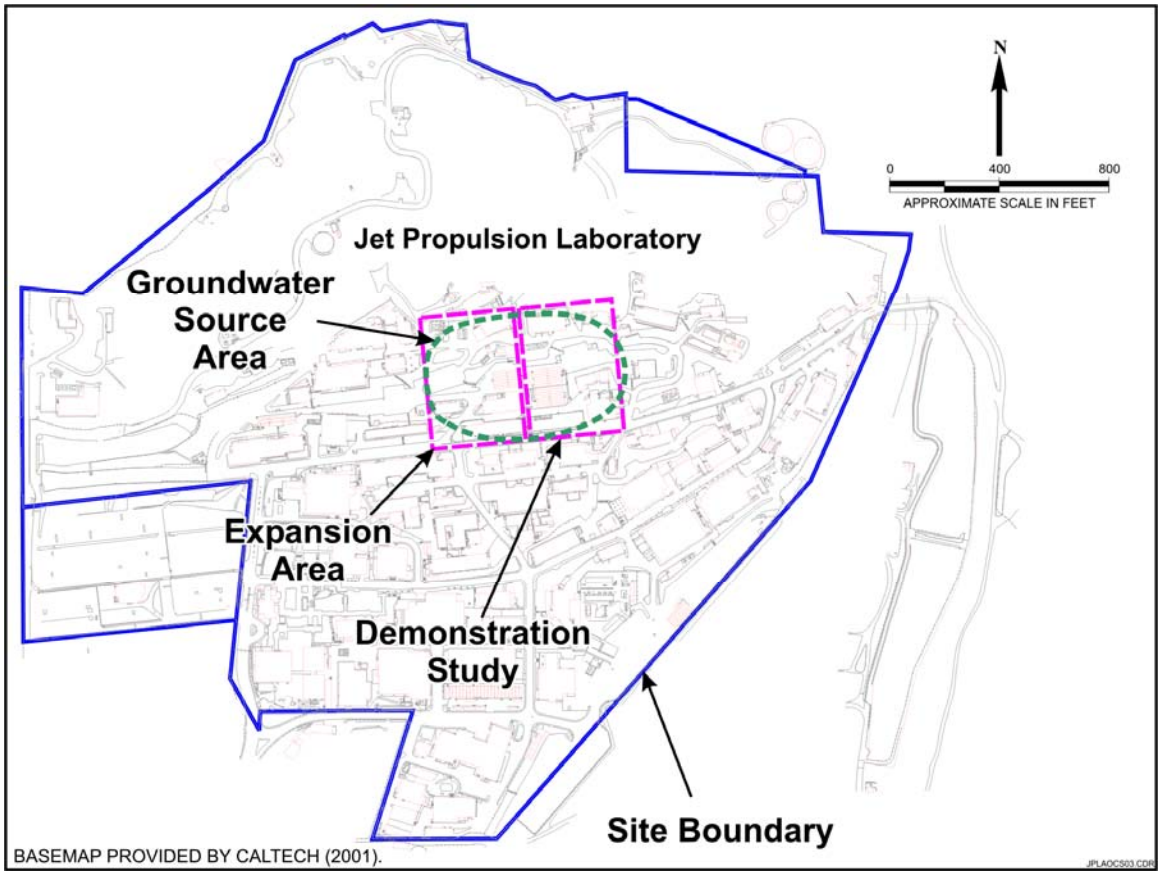


Figure 1-1. Location of the Groundwater Source Area, Demonstration Study, and Expansion Area

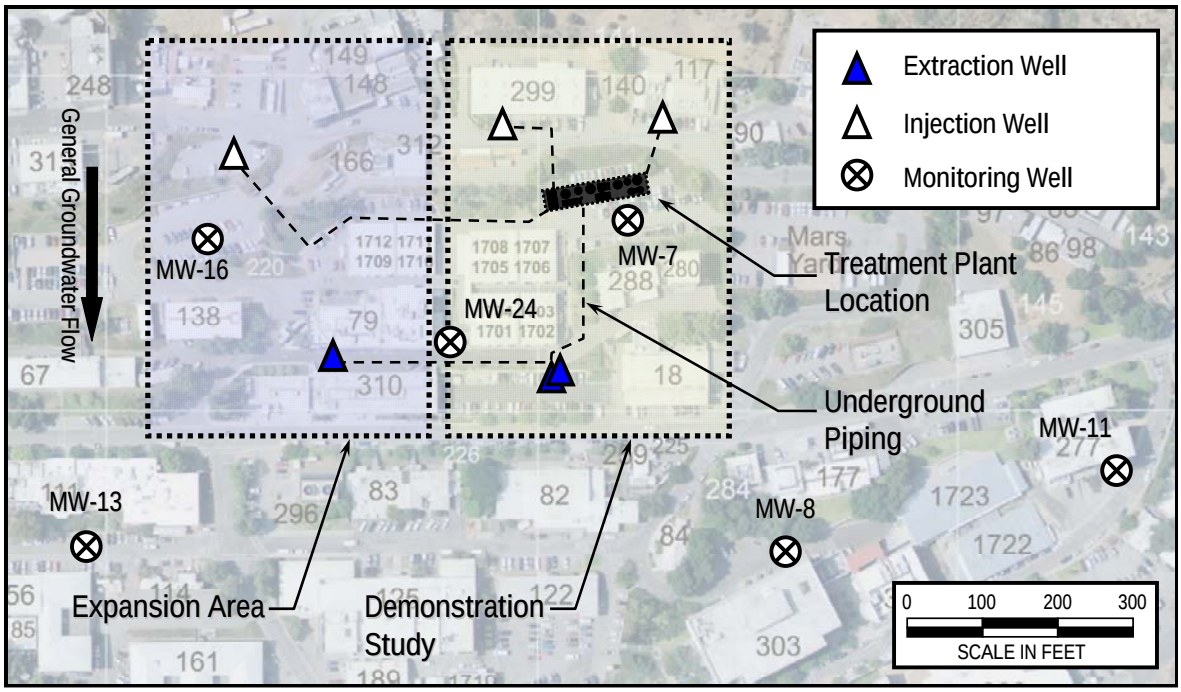


Figure 1-2. Layout of the Demonstration System and the Expansion Area

2.0 WELL INSTALLATION

One additional extraction well (JPL-EW-03) and one additional injection well (JPL-IW-03) were installed as part of the system expansion. JPL-EW-03 is located 330 ft west of the original two wells (JPL-EW-01 and JPL-EW-02) on Aero Road between Buildings 79 and 310. The new injection well is located upgradient of the extraction well (EW-03). JPL-IW-03 is located approximately 125 ft north of MW-16 in a parking lot west of the intersection of Surveyor and Pioneer Roads.

This section describes the well installation activities performed during the groundwater treatment system expansion.

2.1 Utility Locating

A full map review was conducted in the JPL map database and a geophysical utility survey was completed. The review and survey were conducted in order to allow drilling/construction operations to safely avoid any existing utilities. A utility survey utilizes electromagnetic utility locating instruments (i.e., ground penetrating radar [GPR], magnetometer, magnetic gradiometer, and/or electromagnetic imaging [EM]) to penetrate the ground surface and detect any buried utilities. These lines are then field marked with paint so that they are physically visible. Once all known utilities were located, the drilling locations were selected.

Prior to the initiation of drilling activities, an air knife subcontractor cleared the drilling location to a depth of approximately 5 ft below ground surface (bgs) and 36-inches in diameter at each proposed borehole location to verify that no underground utilities were present.

2.2 Drilling Method

The extraction well and injection wells were drilled using the mud-rotary method. The extraction well was drilled with a 9.875-inch-diameter pilot bit and reamed with a 15.5-inch-diameter bit. The injection well was drilled with a 12.25-inch-diameter pilot bit and reamed with an 18.5-inch-diameter bit. The drill rig used is pictured in Figure 2-1. A 20-foot surface casing was installed to maintain the integrity of the surface. Mud-rotary drilling requires the constant use of drilling mud and a mud shaker. The mud shaker is responsible for separating the drill cuttings and recycling the drilling mud. The bentonite drilling mud is monitored by the driller for viscosity, weight, wall cake thickness, water loss, sand content, and pH. This monitoring provides the driller with the ability to maintain borehole stability, fluid loss, and equipment integrity. The processed soil cuttings were removed and stored in roll-off bins.

Figure 2-1. Drilling Activities IW-03 March 5, 2007

All drilling equipment and materials (including drilling bits and pipes, drilling mud components, and backfill equipment) were either new or cleaned in the field using a high pressure steam cleaner. Water used during drilling and well construction activities was water from a nearby JPL fire hydrant.

When drilling was complete each well was surveyed using various down well geophysical logging techniques to assist field geologists in their evaluation. The following methods were used:

- **Gamma Log**. This method records the amount of natural gamma radiation emitted by the rocks surrounding the borehole. Clay bearing and shale bearing zones often emit relatively high gamma radiation because they include weathering products that include uranium and thorium.

- **Single-Point Resistance Log.** This method records the electrical resistance from points within the borehole to an electrical ground at the surface. Typically, resistance increases with increasing grain size and decreases with increasing borehole diameter, fracture density, and dissolved-solids concentrations of the water.

- **Caliper Log**. This method records borehole diameter. Changes in the borehole diameter are related to well construction, such as casing or drill-bit size, and to fracturing or caving along the borehole wall. Borehole diameter is useful in interpreting the other geophysical logs because it can affect the log response of the other methods. Caliper logs can detect poorly consolidated sands that tend to collapse in the borehole. These sands are generally very porous, water producing zones within the aquifer.

- **Spontaneous-Potential Log.** This method records potentials or voltages developed between the borehole fluid and the surrounding rock and fluids. Spontaneous-potential logs can be used in the determination of lithology and water quality.

The geophysical logs are included in Appendix 1-1.

2.3 Well Installation

JPL-EW-03 was constructed with a casing span of 0 ft bgs to 215 ft bgs with a 100-ft screened interval that spans from 215 ft bgs to 315 ft bgs. The casing material is 8-inch Schedule 80 polyvinyl chloride (PVC) and the screen is 8-inch 0.040″ slot wire-wrapped stainless steel with an 8-inch by 10 foot stainless steel sump. The filter pack in EW-03 consists of #8 mesh sand. The sand is uniform in size and slightly larger than the slots in the well screen. This allows fine-grained material to be removed during well development without entering the well and decreasing its effectiveness.

JPL-IW-03 was constructed with a casing span of 0 ft to 215 ft bgs with a 100-ft screened interval that spans from 215 ft bgs to 315 ft bgs. The casing material is 12-inch Schedule 80 PVC and the screen is a 12-inch 0.050″ slot wire-wrapped stainless steel with a 12-inch by 10 foot stainless steel sump. The larger screen slot size was chosen for the injection wells to allow for maximum flow into the aquifer. The filter pack in IW-3

consists of medium aquarium gravel. This gravel is large enough to not pass through the injection well screen and provides ample permeability for the injected treated water to move quickly into the aquifer.

In order to minimize bentonite sealing materials from permeating into the filter pack and potentially impacting the effectiveness of the well screen, the filter pack materials extend a minimum of 10-ft above the screen zone. The filter pack was placed from the surface using the tremie method.

A 5-ft thick transition seal consisting of ¼-inch, time release coated bentonite pellets was added on top of the filter pack. The purpose of the transition seal is to prevent the annular seal (e.g., liquid bentonite grout) from entering the filter pack. After the transition seal was in place, the annular seal was installed. The purpose of the annular seal is to eliminate the formation of a pathway between the screened zone and potential contamination from the surface and overlying materials. The annular seal was placed into the annular space above the transition seal to approximately the ground surface using the tremie method.

Table 2-1 provides a summary of the well construction details. Further details can be found on the boring logs in Appendix 1-2.

Table 2-1. OU-1 Well Construction Details

Well Number	Screen Depth (ft bgs)	Casing Depth (ft bgs)	Casing I.D. (inches)	Casing Material	Screen Material
JPL-EW-03	215 to 315	325	8	Sch. 80 PVC	Stainless Steel 0.040" slot
JPL-IW-03	215 to 315	325	12	Sch. 80 PVC	Stainless Steel 0.050" slot

2.4 Well Development

The purpose the well development procedure was to remove residual drilling mud to the extent practical, and establish hydraulic communication between the borehole wall and the filter pack material surrounding the well screen sections. Additionally, well development physically commingles the sorted gravel pack with the native formation, creating a hydraulic filter around the well screen which allows efficient passage of water into or out of the well. In general, the order of the development process for extraction and injection wells at JPL was as follows:

- Open-ended air lift pumping
- Mud dispersant treatment with swabbing
- Dual-swab airlift pumping
- Second mud dispersant treatment with swabbing (if necessary)
- Dual-swab airlift pumping (if second mud dispersant treatment is completed)

- Conventional pumping with submersible pump
- Video logging

EW-3 Development

The process for extraction well development requires less effort than injection wells since the well will be pumped during routine operation and will subsequently continue to be developed. The section below provides a summary of development activities performed at EW-3. Details of the well development are provided in Appendix 1-3.

First, aquifer sediments that accumulated on the bottom of the well were removed with an open-ended air lift system. Next, a mud dispersant was tremied into place at 20 ft intervals, followed by a half-hour of swabbing, or raising and lowering a rubber-disc swab tool. Once the mud dispersant was applied to the entire screened zone and sufficient contact time had transpired, a dual-swab airlift pumping system was lowered into the well. Dual-swab airlift pumping was initiated at the bottom of the well screen and progressed upwards. Each 20 ft zone was completed when the swabbing no longer increased turbidity readings. Following dual-swab air lift pumping, the screened interval purged using a submersible pump. Based on the amount of fines that were being recovered during purging, the pumping was occasionally discontinued to surge the interval being developed. Pumping was discontinued when surging no longer increased turbidity readings. A video log was completed to visually inspect the screened zone, filter pack, and well condition. During the video log, fine material (i.e., silt, clay, and drilling mud) was observed in the screen slots. Therefore, additional development activities followed. Removal of this material was completed by placing mud dispersant (i.e., via tremie) into the entire 100 ft screened interval, followed by a half hour of brushing for each 10 ft of screen (i.e., 5 hours total). Once the brushing was completed, a submersible pump was installed into the well and the well was purged to remove the fines. Based on the amount of fines that were being recovered during purging, the pumping was occasionally discontinued to surge the interval being developed. Pumping was discontinued when surging no longer increased turbidity readings. Lastly, a second video log was completed confirming complete cleaning of the screened zone.

IW-3 Development

The process for injection well development requires a higher level of effort than development of extraction wells. In order for the injection well to function properly, as much residual drilling mud as possible must be removed from the borehole wall, filter pack and screen zone. Incomplete removal of drilling fluids will cause flow barriers leading to decreased hydraulic conductivity and permeability, high entrance losses and low injection well yield. The primary result will be low injection flow rates, mounding, and high well-head pressures. The section below provides a summary of development activities performed at IW-3. Details of the well development are provided in Appendix 1-3.

First, aquifer sediments that accumulated on the bottom of the well were removed with an open-ended air lift system. Next a mud dispersant was tremied and swabbed into place at 10 ft intervals. The field geologist noted that the water levels were rising with each mud dispersant treatment, so the zones were purged using dual-swab air lift pumping before moving down to the next zone. This was repeated until reaching the bottom of the screened zone. The process described above was repeated starting at the bottom of the screen and moving upwards through the screened interval. Next, the screened zone was purged with the dual-swab air lift system from the top to the bottom of the screened zone. Another series of mud dispersant applications was performed in the upper, middle, and lower portion of the well that included a half hour of swabbing per zone. This procedure was followed by dual-swab airlift pumping in the bottom third of the well. Open-ended air lift pumping was utilized to remove sediments that accumulated on the bottom of the well. Another series of mud dispersant applications was performed in the upper, middle, and lower portion of the well that included a half hour of swabbing per zone. This procedure was followed by dual-swab airlift pumping from the bottom of the well. Next, dual-swab airlift pumping was performed from the top to the bottom and back to the top of the well screen.

Following dual-swab air lift pumping, the screened interval was purged using a submersible pump. Pumping was initiated at 30 gpm and increased to 130 gpm. Based on the amount of fines that were being recovered during purging, the pumping was occasionally discontinued to surge the interval being developed. The flow rate was increased when surging no longer increased turbidity readings. This process was repeated again, but with higher flowrates (i.e., 75 gpm, 150 gpm, and 300 gpm). Again, the flow rates were increased when surging no longer increased turbidity readings. Next, a video log was completed to visually inspect the screened zone, filter pack, and well condition. During the video log, fine material (i.e., silt, clay, and drilling mud) was observed in the screen slots. Therefore, additional development activities followed.

Removal of this material was completed by placing a concentrated dosage of mud dispersant (i.e., via tremie) into the entire 100 ft screened interval, followed by a half hour of brushing for each 10 ft of screen (i.e., 5 hours total). Once the brushing was completed, a submersible pump was installed into the well and the well was purged to remove the fines. Based on the amount of fines that were being recovered during purging, the pumping was occasionally discontinued to surge the interval being developed. Pumping was completed when surging no longer increased turbidity readings. Approximately 193,000 gallons of water were removed during this stage of development. Lastly, a second video log was completed to confirm complete cleaning of the screened zone.

IW-3 was constructed with a submersible pump, allowing periodic backflushing of the well to remove clogging material. Therefore, once the injection/extraction pipeline and associated wiring were completed, IW-3 was operated in extraction mode. The well was pumped from early October 2007 to mid-January 2008 removing an additional 1.1 million gallons of water from the well. The total amount of water removed from IW-3 prior to injection was 1.3 million gallons. Table 2-2 provides a summary of the well

development activities. The development logs for each well are available in Appendix 1-3.

Table 2-2. Well Development Summary

Well Number	Total Purge (gallons)	Water Level Start (ft btoc)	Water Level Finish (ft btoc)
JPL-EW-03	30,635	187.50	195.50
JPL-IW-03	192,786	237.00	213.00

The well development water was temporarily contained in 22,000-gallon Baker tanks (i.e., same tanks used to contain the used drilling mud), and was transferred to the OU-1 treatment system for processing.

The two wells installed as part of the OU-1 system expansion both have traffic-rated sub-surface well vaults. Table 2-3 provides a summary of the wellhead completions.

Table 2-3. Wellhead Completions

Well	Pump	Pressure Transducer	Well Seal	Union Present
EW-03	350 gpm	Down Well	Expansion	Yes
IW-03	300 gpm	Down Well	Expansion	Yes

3.0 OTHER CONSTRUCTION

Other construction activities associated with system expansion included electrical improvements and pipeline installation to connect the new injection and extraction wells to the existing treatment plant.

3.1 Electrical

The original electrical design submitted to JPL facilities and approved in August 2004 included electrical design elements associated with the system expansion. The electrical feed to the OU-1 treatment system is located at JPL Bank 14. The following field changes to the approved electrical design were necessary during system expansion:

- Changes in the routing and location of electrical conduit
- Use of above grade installation in some areas.

All changes were reviewed, and agreed upon, by JPL facilities and the electrical design firm, KSG. The revised electrical conduit location as-built drawings are included as Appendix 2-1.

3.2 Pipelines

The design of all pipelines associated with the OU-1 treatment system was approved by JPL facilities for construction in August 2004. Field changes to the routing of influent and effluent water pipelines were necessary during the system expansion. All changes were reviewed, and agreed upon, by JPL facilities and the civil engineer. As-built drawings of pipeline routes associated with the system expansion are included as Appendix 2-2.

Above grade plumbing was painted to provide ultraviolet (UV) light protection, while accommodating the JPL facility paint scheme.

Hydraulic testing was performed on the pipelines before they were put into operation. The hydraulic testing consisted of filling the lines to operating pressure and checking all joints for leaks or stress. All pipelines passed hydraulic testing, receiving approval from JPL. Expansion joints were installed to allow for movement.

4.0 REFERENCES

Ebasco. 1988. *Preliminary Assessment/ Site Inspection Report for Jet Propulsion Laboratory, Pasadena, California*. April.

Ebasco. 1990a. *Expanded Site Inspection Report for NASA-Jet Propulsion Laboratory, Pasadena, California*. May.

Ebasco. 1990b. *Supplemental Information to the Expanded Site Inspection Report for NASA-Jet Propulsion Laboratory, Pasadena, California*. November.

Foster Wheeler Environmental Corporation (FWEC). 1999a. *Final Remedial Investigation Report for Operable Unit 2: Potential On-Site Contaminant Source Areas.* National Aeronautics and Space Administration, Jet Propulsion Laboratory, Pasadena, CA. November.

Foster Wheeler Environmental Corporation (FWEC). 1999b. *Final Remedial Investigation Report for Operable Units 1 and 3: On-Site and Off-Site Groundwater*. National Aeronautics and Space Administration, Jet Propulsion Laboratory, Pasadena, CA. August.

Foster Wheeler Environmental Corporation (FWEC). 2000. *Draft Feasibility Study Report for Operable Units 1 and 3: On-Site and Off-Site Groundwater*. National Aeronautics and Space Administration, Jet Propulsion Laboratory, Pasadena, CA. January.

National Aeronautics and Space Administration (NASA). 2003. *Revised Final Operable Unit 1 Expanded Treatability Study Work Plan*. NASA Jet Propulsion Laboratory. NAS7.010106, NASA-JPL, SSIC No. 9661. October.

National Aeronautics and Space Administration (NASA). 2005. *Operable Unit 1 Expanded Treatability Study Installation Report, National Aeronautics and Space Administration Jet Propulsion Laboratory, Pasadena, California*. June.

National Aeronautics and Space Administration (NASA). 2006a. *Final Interim Record of Decision for the Operable Unit 1 Source Area Groundwater, National Aeronautics and Space Administration Jet Propulsion Laboratory, Pasadena, California*. December.

National Aeronautics and Space Administration (NASA). 2006b. *Final Operable Unit 1 Remedial Design/Remedial Action Work Plan, National Aeronautics and Space Administration Jet Propulsion Laboratory, Pasadena, California*. November.

Appendix 1-1

Geophysical Logs

welenco

5201 Woodmere Drive, Bakersfield, CA 93313-- www.welenco.com--(800) 445-9914
California Contractor's License No. 722373

ELECTRIC - GAMMA RAY - TEMP - CALIPER

FILING NO.

COMPANY Layne Christensen Company

WELL EW-3

FIELD JPL - Pasadena

STATE California COUNTY Los Angeles

LOCATION:
4800 Oak Grove, to rear of JPL Fire Station.

OTHER SERVICES:
None

JOB NO.
7240

SEC: 6 TWP: 1N RGE: 12W LAT.: 34° 12' 8.5" LONG.: 118° 10' 18.6" MERIDIAN.: San Bernardino

Permanent Datum: Ground Level, **Elev.** _____ **Ft. Elev.: K.B.** _____ **Ft.**
Log Measured From: Ground Level, 0 **Ft. Above Perm. Datum** **D.F.** _____ **Ft.**
Drilling Measured From: Ground Level **G.L.** _____ **Ft.**

Run	Elog	Caliper		
Date	Apr. 02, 2007	Apr. 02, 2007		
Depth-Driller	335 Ft	335 Ft	Ft	Ft
Depth-Logger	337 Ft	337 Ft	Ft	Ft
Top Logged Interval	0 Ft	0 Ft	Ft	Ft
Btm. Logged Interval	336 Ft	335 Ft	Ft	Ft
Casing-Driller	20 In @ 12 Ft	In @ Ft	In @ Ft	In @ Ft
Casing-Logger	20 In @ 12 Ft	In @ Ft	In @ Ft	In @ Ft
Bit Size	9 7/8 In	In	In	In
Time On Bottom	1:15 PM	2:00 PM		
Type Fluid In Hole	Bentonite			
Density / Viscosity				
pH / Fluid Loss	ml	ml	ml	ml
Source of Sample	Tank			
Rm @ Measured Temp.	5.0 @ 75 °F	@ °F	@ °F	@ °F
Rmf @ Measured Temp.	4.2 @ 75 °F	@ °F	@ °F	@ °F
Rmc @ Measured Temp.	@ °F	@ °F	@ °F	@ °F
Source Rmf / Rmc	meas			
Rm @ BHT	@ °F	@ °F	@ °F	@ °F
Time Since Circulation	1 Hr	Hr	Hr	Hr
Max. Rec. Temp.	73.4 °F	°F	°F	°F
Van No. / Location	LV-1 / Bfld			
Recorded By	Dan Ihde			
Witnessed By	Dave Conner			

Miscellaneous Information

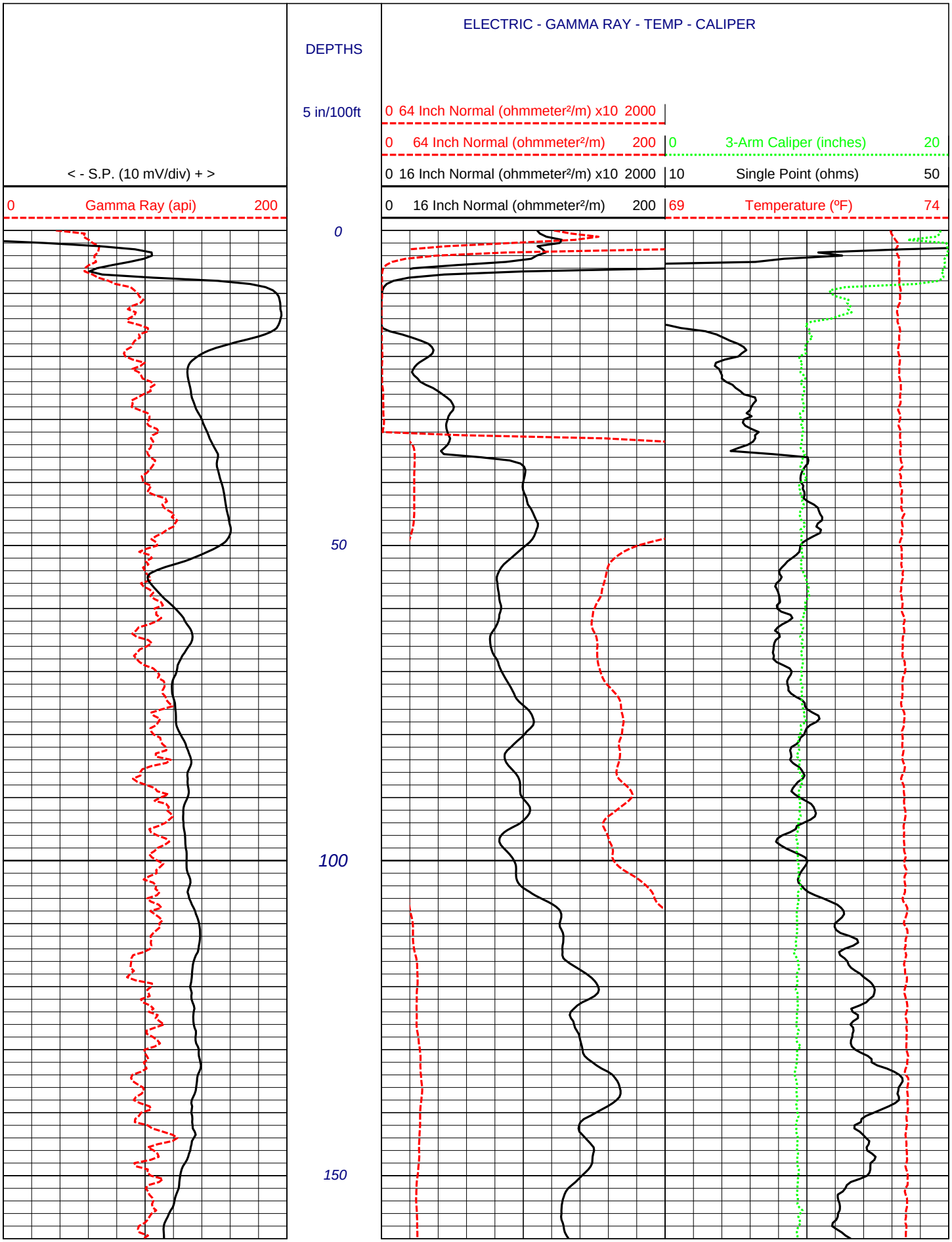
A recreational GPS accurate to +/- 45 feet set for Datum NAD27 was used to calculate Latitude, Longitude & Elevation values. The Section, Township, and Range then determined using the TRS program (TRS accuracy is not guaranteed). The TRS program converts Latitude and Longitude to Section, Township, and Range. The NOTICE at the bottom of this heading also applies.

Drilled by: Layne Christensen

NOTICE

All interpretations are opinions based on inferences from electrical and other measurements and we do not guarantee the accuracy or correctness of any verbal or written 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 one of our officers, agents or employees. These interpretations are also subject to our General Terms and Conditions as set out in our current Price Schedule.

welenco, inc. April 02, 2007



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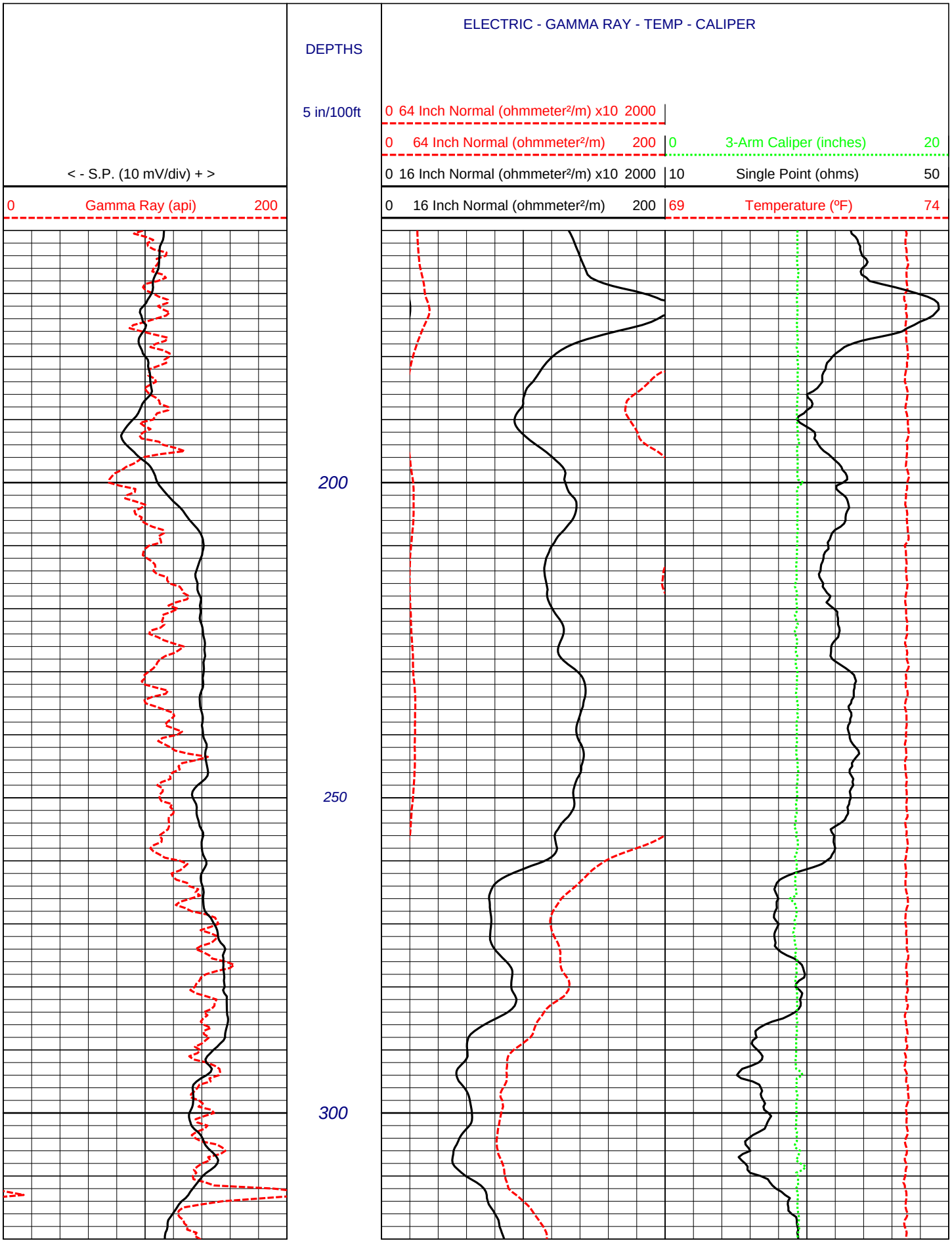

ELECTRIC - GAMMA RAY - TEMP - CALIPER
DEPTHS
5 in/100ft
0 64 Inch Normal (ohmmeter²/m) x10 2000
0 64 Inch Normal (ohmmeter²/m) 200
0 3-Arm Caliper (inches) 20
< - S.P. (10 mV/div) + >
0 16 Inch Normal (ohmmeter²/m) x10 2000
10 Single Point (ohms) 50
0 Gamma Ray (api) 200
0 16 Inch Normal (ohmmeter²/m) 200
69 Temperature (ºF) 74
200
250
300

ELECTRIC - GAMMA RAY - TEMP - CALIPER

DEPTHS

5 in/100ft

< - S.P. (10 mV/div) + >

0 Gamma Ray (api) 200

0 64 Inch Normal (ohmmeter²/m) x10 2000

0 64 Inch Normal (ohmmeter²/m) 200

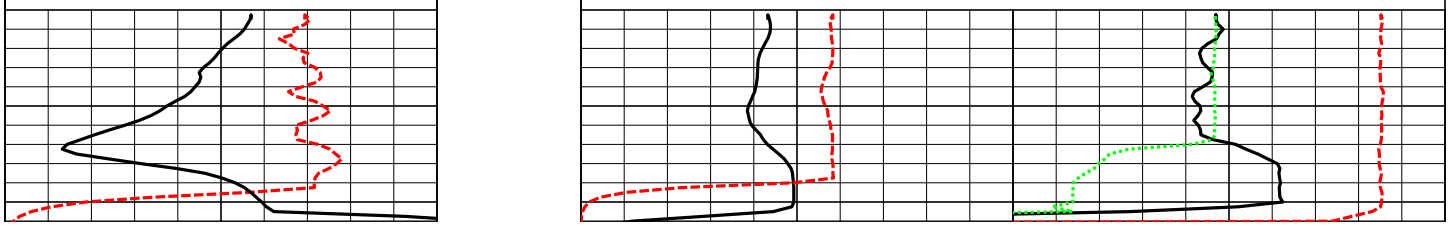
0 3-Arm Caliper (inches) 20

0 16 Inch Normal (ohmmeter²/m) x10 2000

10 Single Point (ohms) 50

0 16 Inch Normal (ohmmeter²/m) 200

69 Temperature (ºF) 74



Log Page No. 3 of 3 Pages

Page Length: 320 - 342 Feet (22 Feet)

Time: 02:53:59 PM

Date: Apr 02, 2007

welenco

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California Contractor's License No. 722373

ELECTRIC - GAMMA RAY - TEMP - CALIPER

FILING NO.

COMPANY Layne Christensen Company

WELL EW-3

FIELD JPL - Pasadena

STATE California COUNTY Los Angeles

LOCATION:
4800 Oak Grove, to rear of JPL Fire Station.

OTHER SERVICES:
None

JOB NO.
7240

SEC: 6 TWP: 1N RGE: 12W LAT.: 34° 12' 8.5" LONG.: 118° 10' 18.6" MERIDIAN.: San Bernardino

Permanent Datum: Ground Level, **Elev.** _____ **Ft. Elev.: K.B.** _____ **Ft.**
Log Measured From: Ground Level, 0 **Ft. Above Perm. Datum** **D.F.** _____ **Ft.**
Drilling Measured From: Ground Level **G.L.** _____ **Ft.**

Run	Elog	Caliper		
Date	Apr. 02, 2007	Apr. 02, 2007		
Depth-Driller	335 Ft	335 Ft	Ft	Ft
Depth-Logger	337 Ft	337 Ft	Ft	Ft
Top Logged Interval	0 Ft	0 Ft	Ft	Ft
Btm. Logged Interval	336 Ft	335 Ft	Ft	Ft
Casing-Driller	20 In @ 12 Ft	In @ Ft	In @ Ft	In @ Ft
Casing-Logger	20 In @ 12 Ft	In @ Ft	In @ Ft	In @ Ft
Bit Size	9 7/8 In	In	In	In
Time On Bottom	1:15 PM	2:00 PM		
Type Fluid In Hole	Bentonite			
Density / Viscosity				
pH / Fluid Loss	ml	ml	ml	ml
Source of Sample	Tank			
Rm @ Measured Temp.	5.0 @ 75 °F	@ °F	@ °F	@ °F
Rmf @ Measured Temp.	4.2 @ 75 °F	@ °F	@ °F	@ °F
Rmc @ Measured Temp.	@ °F	@ °F	@ °F	@ °F
Source Rmf / Rmc	meas			
Rm @ BHT	@ °F	@ °F	@ °F	@ °F
Time Since Circulation	1 Hr	Hr	Hr	Hr
Max. Rec. Temp.	73.4 °F	°F	°F	°F
Van No. / Location	LV-1 / Bfld			
Recorded By	Dan Ihde			
Witnessed By	Dave Conner			

Miscellaneous Information

A recreational GPS accurate to +/- 45 feet set for Datum NAD27 was used to calculate Latitude, Longitude & Elevation values. The Section, Township, and Range then determined using the TRS program (TRS accuracy is not guaranteed). The TRS program converts Latitude and Longitude to Section, Township, and Range. The NOTICE at the bottom of this heading also applies.

Drilled by: Layne Christensen

NOTICE

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welenco, inc. April 02, 2007

ELECTRIC - GAMMA RAY - TEMP - CALIPER

DEPTHS

Single Page

< - S.P. (10 mV/div) + >

0 Gamma Ray (api) 200

0 64 Inch Normal (ohmmeter²/m) x10 2000

0 64 Inch Normal (ohmmeter²/m) 200

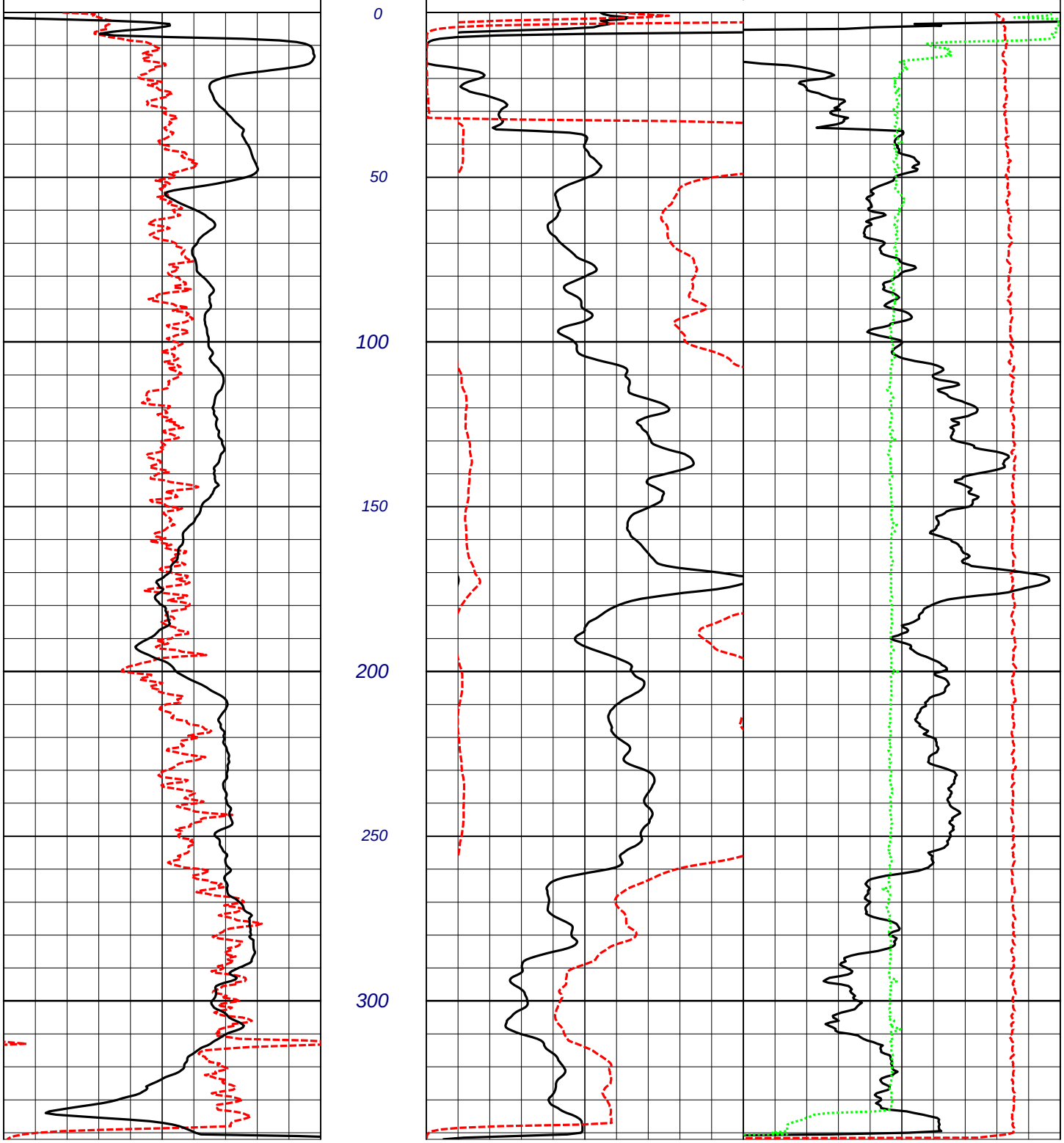
0 3-Arm Caliper (inches) 20

0 16 Inch Normal (ohmmeter²/m) x10 2000

10 Single Point (ohms) 50

0 16 Inch Normal (ohmmeter²/m) 200

69 Temperature (ºF) 74



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ELECTRIC - GAMMA - TEMP -CALIPER LOG

FILING NO.

COMPANY Layne Christensen Company

WELL IW-3

FIELD JPL Pasadena

STATE California COUNTY Los Angeles

LOCATION:
4800 Oak Grove

OTHER SERVICES:
None

JOB NO.
7190

SEC: 6 TWP: 1N RGE: 12W LAT.: 34° 12' 8.5" LONG.: 118° 10' 18.6" MERIDIAN.: San Bernardino

Permanent Datum: Ground Level, **Elev.** _____ **Ft. Elev.: K.B.** _____ **Ft.**
Log Measured From: Ground Level, 0 **Ft. Above Perm. Datum** **D.F.** _____ **Ft.**
Drilling Measured From: Ground Level **G.L.** _____ **Ft.**

Run	Elog	Caliper		
Date	Mar. 08, 2007	Mar. 08, 2007		
Depth-Driller	340 Ft	340 Ft	Ft	Ft
Depth-Logger	339 Ft	339 Ft	Ft	Ft
Top Logged Interval	0 Ft	0 Ft	Ft	Ft
Btm. Logged Interval	338 Ft	338 Ft	Ft	Ft
Casing-Driller	20 In @ 12 Ft	20 In @ 12 Ft	In @ Ft	In @ Ft
Casing-Logger	20 In @ 12 Ft	20 In @ 12 Ft	In @ Ft	In @ Ft
Bit Size	12 In	12 In	In	In
Time On Bottom	2:45 p.m.	3:25 p.m.		
Type Fluid In Hole	Bentonite			
Density / Viscosity				
pH / Fluid Loss	ml	ml	ml	ml
Source of Sample	Tank			
Rm @ Measured Temp.	8.4 @ 75 °F	@ °F	@ °F	@ °F
Rmf @ Measured Temp.	7.5 @ 75 °F	@ °F	@ °F	@ °F
Rmc @ Measured Temp.	@ °F	@ °F	@ °F	@ °F
Source Rmf / Rmc	Meas / Meas			
Rm @ BHT	@ °F	@ °F	@ °F	@ °F
Time Since Circulation	.5 Hr	Hr	Hr	Hr
Max. Rec. Temp.	81.3 °F	°F	°F	°F
Van No. / Location	L-23 / Bfld			
Recorded By	Craig Corbell			
Witnessed By	Terry DeVries			

Miscellaneous Information

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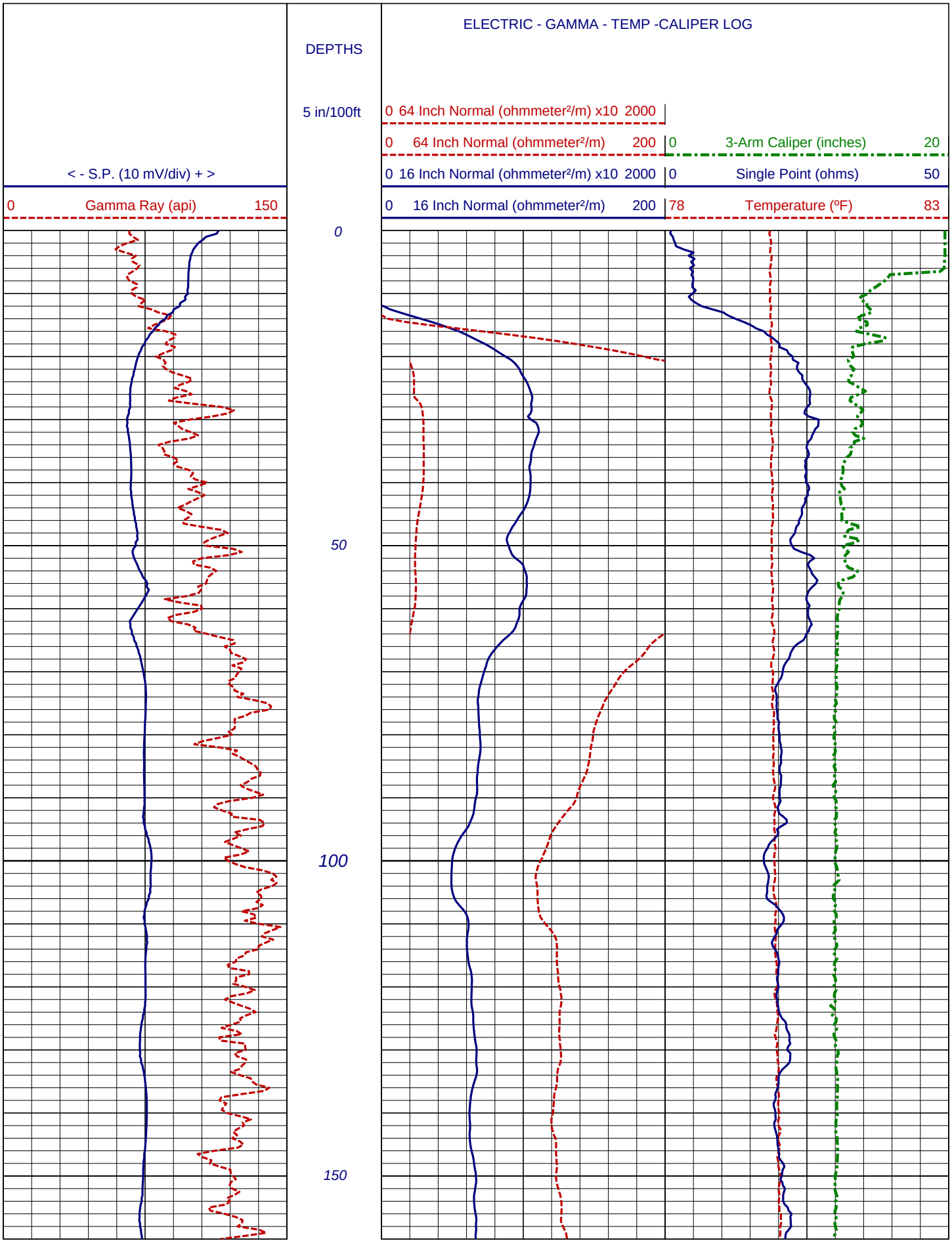
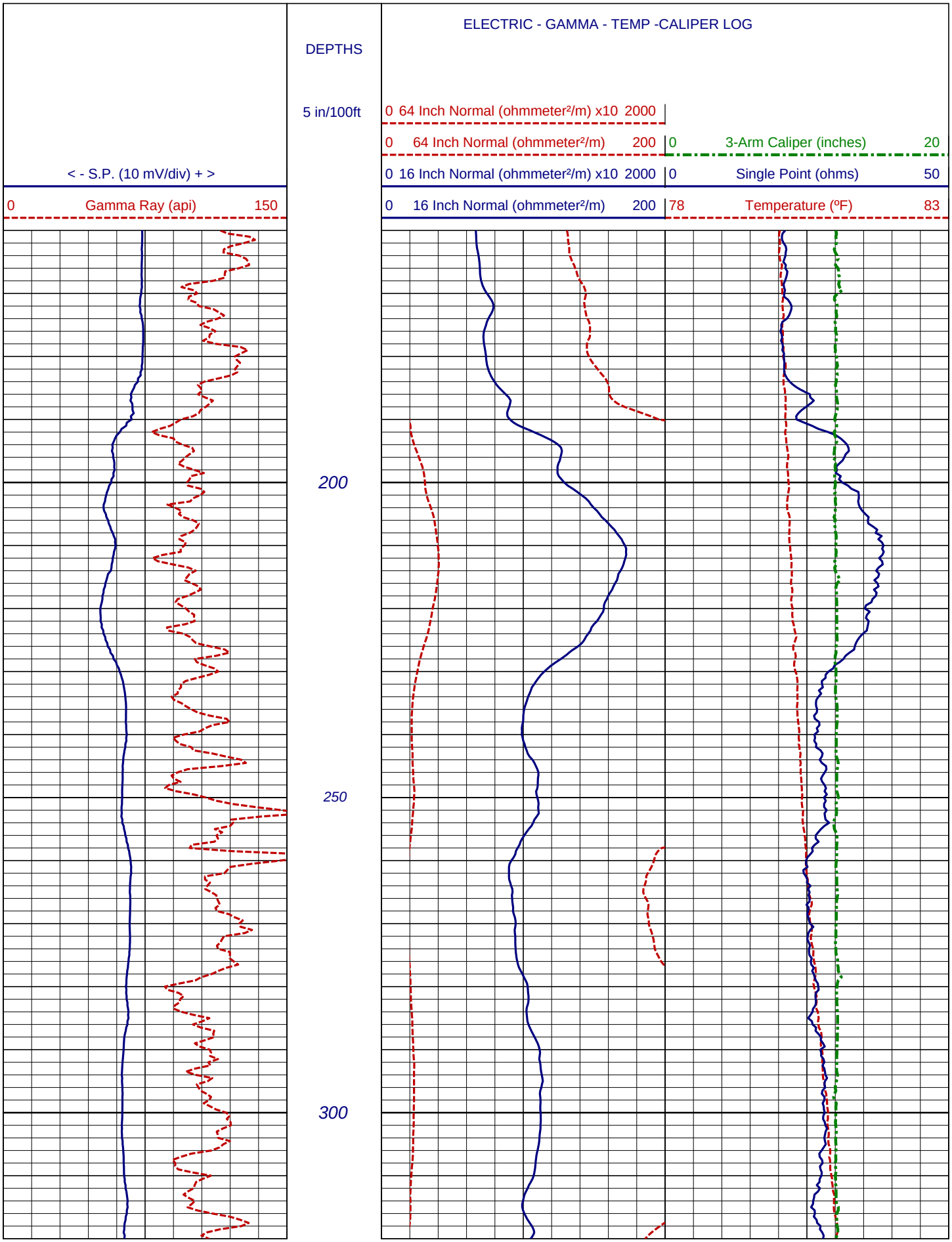
welenco, inc. March 08, 2007


ELECTRIC - GAMMA - TEMP -CALIPER LOG
DEPTHS
5 in/100ft
0 64 Inch Normal (ohmmeter²/m) x10 2000
0 64 Inch Normal (ohmmeter²/m) 200
0 3-Arm Caliper (inches) 20
< - S.P. (10 mV/div) + >
0 16 Inch Normal (ohmmeter²/m) x10 2000
0 Single Point (ohms) 50
0 Gamma Ray (api) 150
0 16 Inch Normal (ohmmeter²/m) 200
78 Temperature (ºF) 83
0
50
100
150


ELECTRIC - GAMMA - TEMP -CALIPER LOG
DEPTHS
5 in/100ft
0 64 Inch Normal (ohmmeter²/m) x10 2000
0 64 Inch Normal (ohmmeter²/m) 200
0 3-Arm Caliper (inches) 20
< - S.P. (10 mV/div) + >
0 16 Inch Normal (ohmmeter²/m) x10 2000
0 Single Point (ohms) 50
0 Gamma Ray (api) 150
0 16 Inch Normal (ohmmeter²/m) 200
78 Temperature (ºF) 83
200
250
300

ELECTRIC - GAMMA - TEMP -CALIPER LOG

DEPTHS

5 in/100ft

< - S.P. (10 mV/div) + >

0 Gamma Ray (api) 150

0 64 Inch Normal (ohmmeter²/m) x10 2000

0 64 Inch Normal (ohmmeter²/m) 200

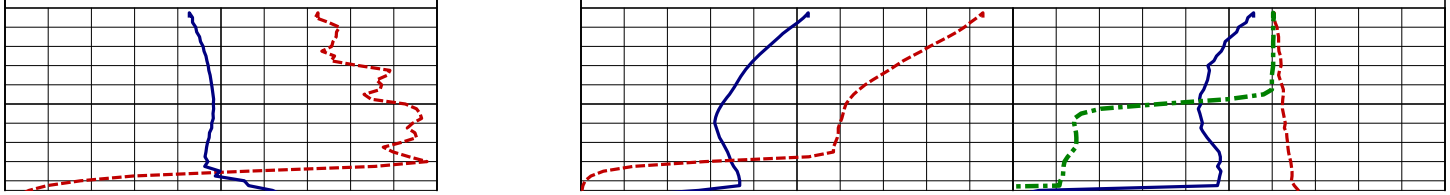
0 16 Inch Normal (ohmmeter²/m) x10 2000

0 16 Inch Normal (ohmmeter²/m) 200

0 3-Arm Caliper (inches) 20

0 Single Point (ohms) 50

78 Temperature (ºF) 83



Log Page No. 3 of 3 Pages

Page Length: 320 - 339 Feet (19 Feet)

Time: 03:54:47 PM

Date: Mar 08, 2007

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California Contractor's License No. 722373

3-ARM CALIPER LOG

FILING NO.

COMPANY Layne Christensen Company

WELL IW-3

FIELD JPL - Pasadena

STATE California COUNTY Los Angeles

LOCATION:
4800 Oak Grove, near building 325

OTHER SERVICES:
None

JOB NO.
7194

SEC: 6 TWP: 1N RGE: 12W LAT.: 34° 12' 8.5" LONG.: 118° 10' 18.6" MERIDIAN.: San Bernardino

Permanent Datum: Ground Level, **Elev.** _____ **Ft. Elev.: K.B.** _____ **Ft.**
Log Measured From: Ground Level, 0 **Ft. Above Perm. Datum** **D.F.** _____ **Ft.**
Drilling Measured From: Ground Level **G.L.** _____ **Ft.**

Date	Mar. 19, 2007			
Type Of Log	Caliper			
Run	One			
Depth-Driller	330 Ft	Ft	Ft	Ft
Depth-Logger	332 Ft	Ft	Ft	Ft
Top Logged Interval	10 Ft	Ft	Ft	Ft
Btm. Logged Interval	330 Ft	Ft	Ft	Ft
Type Fluid In Hole	Bentonite			
Fluid Level	Full Ft	Ft	Ft	Ft
Max Temp	N/A °F	°F	°F	°F
Operating Rig Time	1 Hr	Hr	Hr	Hr
Van No. / Location	LV-1 / Bfld			
Recorded By	Dan Ihde			
Witnessed By	Dave Conner	Scott Lowe		

RUN	BOREHOLE RECORD			CASING RECORD			
NO.	BIT	FROM	TO	SIZE	TYPE	FROM	TO
1	18 In	12 Ft	330 Ft	20 In	Steel	Surf Ft	12 Ft
2	In	Ft	Ft	In		Ft	Ft
3	In	Ft	Ft	In		Ft	Ft

Miscellaneous Information

Remarks:

A recreational GPS accurate to +/- 45 feet set for Datum NAD27 was used to calculate Latitude, Longitude & Elevation values. The Section, Township, and Range then determined using the TRS program (TRS accuracy is not guaranteed). The TRS program converts Latitude and Longitude to Section, Township, and Range. The NOTICE at the bottom of this heading also applies.

Caliper tool hung up at bottom of casing, had to stop and close tool.

Drilled by: Layne Christensen

Perforated Intervals:

Line Speed:

Borehole Volume Calculations:

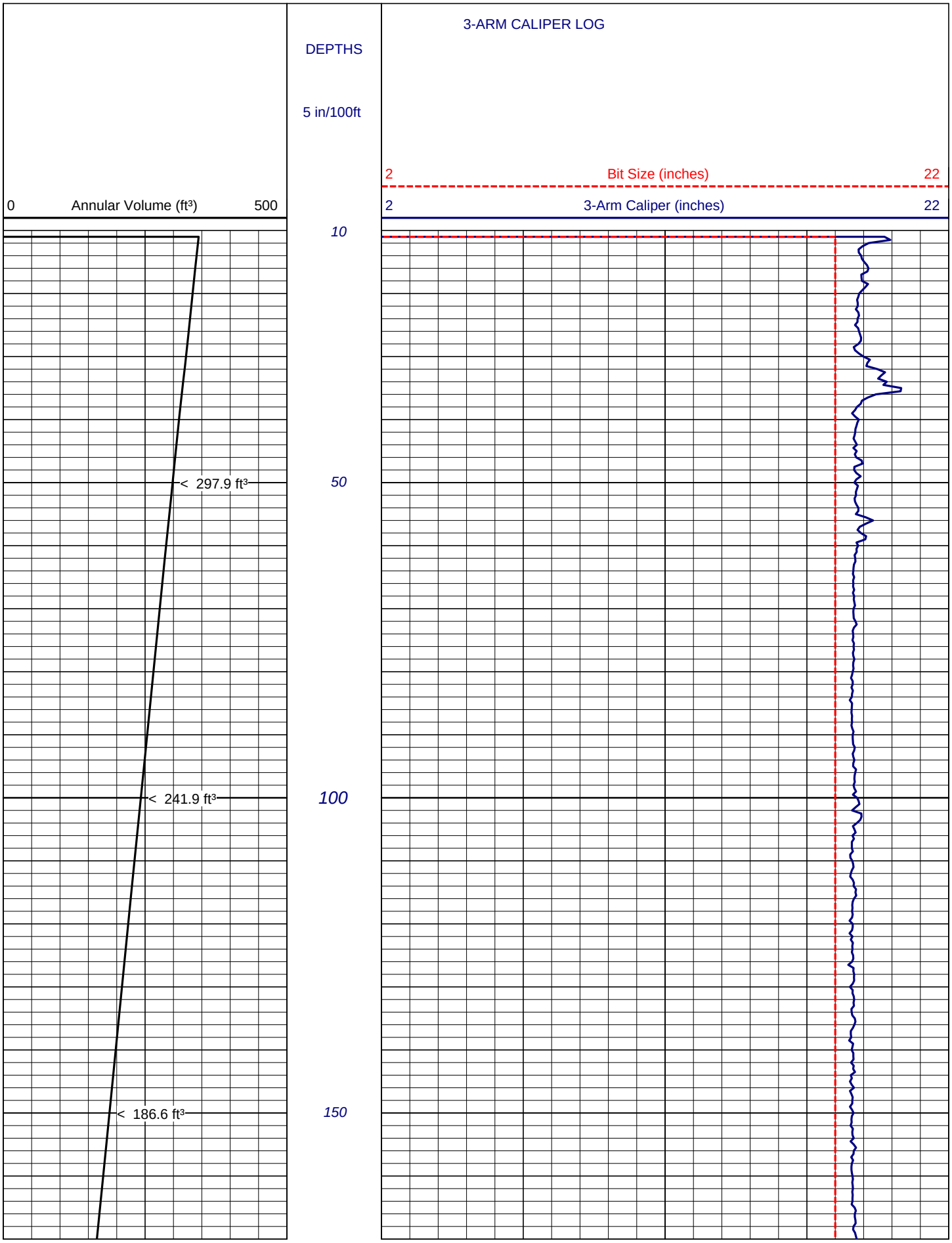
349 Cu. Ft. From 10' To 330' (12" Csg.)

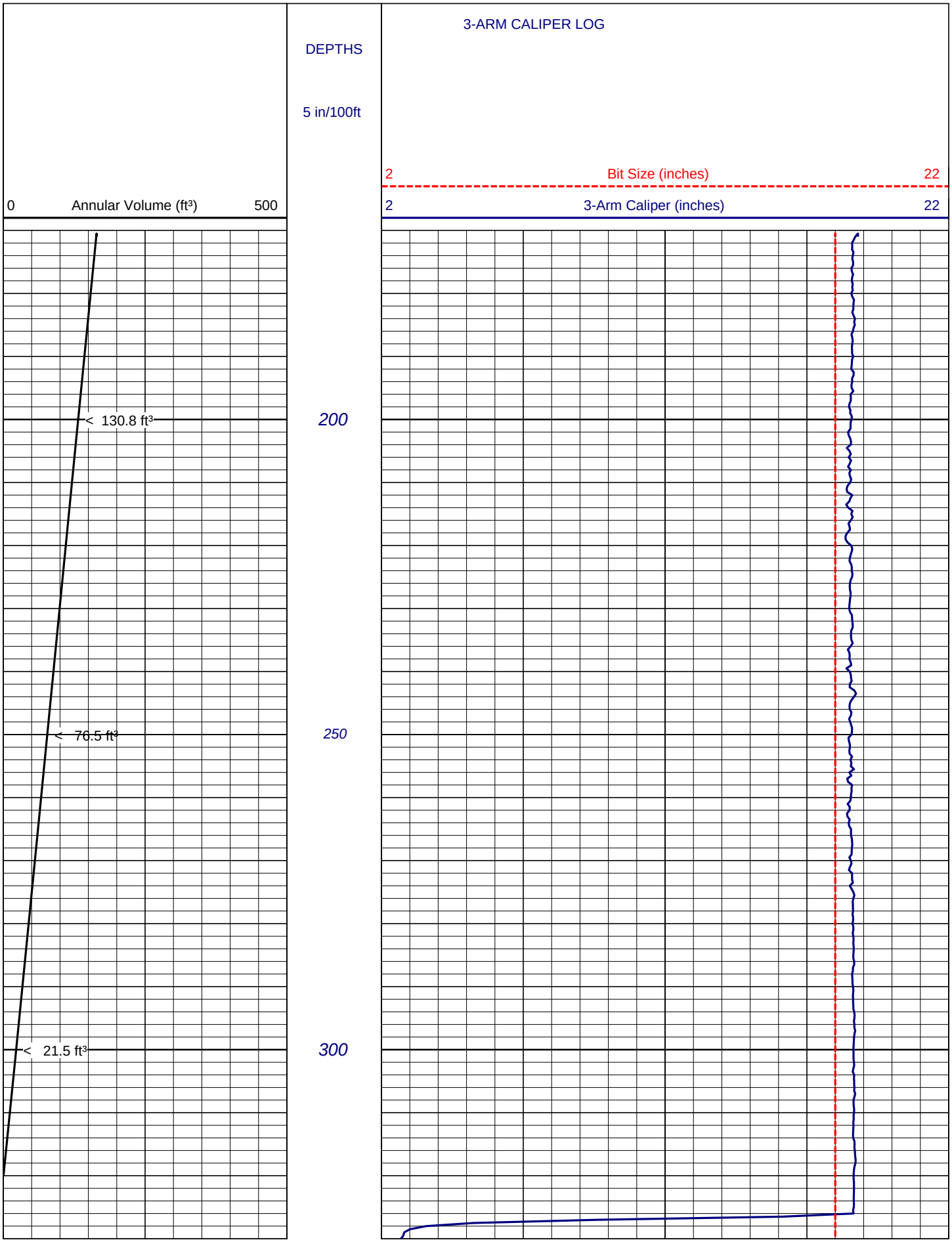
Total Annular Volume: 349 Cubic Feet Or 12.93 Cubic Yards

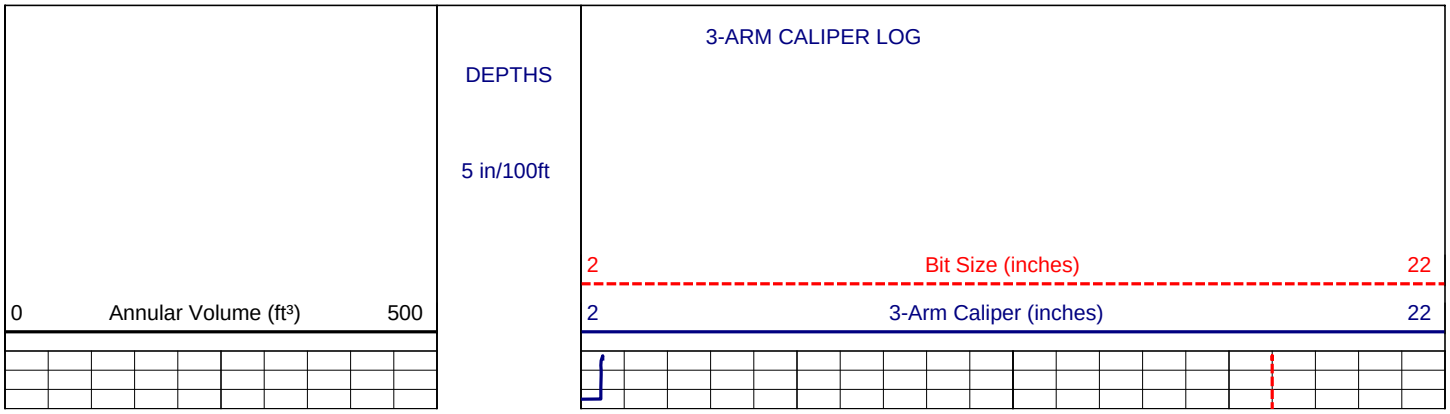
Other Information:

NOTICE: All interpretations are opinions based on inferences from electrical and other measurements and we do not guarantee the accuracy or correctness of any verbal or written 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 one of our officers, agents or employees. These interpretations are also subject to our General Terms and Conditions as set out in our current Price Schedule.

welenco, inc. March 19, 2007


3-ARM CALIPER LOG
DEPTHS
5 in/100ft
2
Bit Size (inches)
22
0
Annular Volume (ft³)
500
2
3-Arm Caliper (inches)
22
10
50
100
150
< 297.9 ft³
< 241.9 ft³
< 186.6 ft³


3-ARM CALIPER LOG
DEPTHS
5 in/100ft
2
Bit Size (inches)
22
0
Annular Volume (ft³)
500
2
3-Arm Caliper (inches)
22
< 130.8 ft³
200
< 76.5 ft³
250
< 21.5 ft³
300



Log Page No. 3 of 3 Pages Page Length: 330 - 336 Feet (6 Feet) Time: 04:20:50 PM Date: Mar 19, 2007

Appendix 1-2

Soil Boring Logs

NASA/JPL

Battelle

BORING LOG AND WELL COMPLETION DIAGRAM – JPL-EW-3

Borehole Location: JPL-EW-3 Project Location: NASA Jet Propulsion Lab. Project #: G486132 Geologist: D. Conner Drilling Contractor: Layne Christensen Driller: Terry Devries Reviewed by: C. Coonfare, P.G.	Sampler Type: Grab Sample from Shaker Screen Boring Diameter: 9 7/8" (Pilot) and 15.5" (Final) Drilling Method: Mud Rotary Drill Rig: Ingersoll-Rand TH-100 Hammer Type: Casing Hammer Date: 03/26/07 - 04/07/07 Total Depth: 335.0' bgs	Coordinates (NAD 83/NAVD 88) Northing: 1895819.259 Surface Elevation: 1199.259 Easting: 6509881.361 Borehole Abandoned: Yes No X Method: NA Monitoring Device Installed: Yes X No Type: 8'' Sch. 80 PVC 8'' wire wrapped s.s. screen

Depth (feet bgs)	USCS symbols	Sample description	Comments	Grading			Lithology	Well Completion
0		Grass surface.						
		Utility clearance with air knife from 0' to 5' bgs.	Set surface casing from 0' to 20' bgs.					Surface seal: 0-3' Concrete
5								
10	SM	Silty SAND: light orange brown to tannish brown (Dry: pale yellow 2.5Y 8/3), fine- to medium-grained sand with some fine- to coarse-gravel, 60% fine- to medium-grained sand, 40% silt, trace coarse-grained sand.			60	40		Bentonite/ Portland Grout seal: 3' - 200' 192.26 ft^3
15		As above.						
20		As above.						8'' Sch. 80 PVC Blank Casing 0' - 218'
25		As above.						
30	SM	Silty SAND: orange brown to tan brown (Dry: pale yellow 2.5Y 8/4), 70% medium-grained sand, 15% coarse-grained sand, 15% silt, angular grains, COBBLES at 30 - 35' bgs.	Viscosity: 36 seconds; Weight: 8.5 lbs. Wall cake: 2/32"; Water loss: 6.2 mL; Sand content: 0.5%; pH: 10		85	15		
35		As above.						
40	SP	Moderately graded SAND: pale yellow 2.5Y 8/4 (Dry), 60% coarse-grained, 35% fine- to medium-grained sand, granite and granodiorite chips and grains, less than 5% silt.			95	5		
45		As above.						
50	SM	Silty SAND with gravel and cobbles: orange (Dry: pale yellow 2.5Y 8/4), 80% medium- to coarse-grained, 20% silt, granodiorite chips, some chips to 3mm, micaceous.	Increased rig chatter at 52' bgs.		80	20	3 mm	
55		As above.						
60	SP	Gravelly SAND: pale yellow 2.5Y 8/4 (Dry), 80% coarse-grained sand, 20% fine gravel, micaceous.						

JPL-EW-3.CDR

NASA/JPL

Battelle

BORING LOG AND WELL COMPLETION DIAGRAM – JPL-EW-3

Borehole Location: JPL-EW-3 Project Location: NASA Jet Propulsion Lab. Project #: G486132 Geologist: D. Conner Drilling Contractor: Layne Christensen Driller: Terry Devries Reviewed by: C. Coonfare, P.G.	Sampler Type: Grab Sample from Shaker Screen Boring Diameter: 9 7/8" (Pilot) and 15.5" (Final) Drilling Method: Mud Rotary Drill Rig: Ingersoll-Rand TH-100 Hammer Type: Casing Hammer Date: 03/26/07 - 04/07/07 Total Depth: 335.0' bgs	Coordinates (NAD 83/NAVD 88) Northing: 1895819.259 Surface Elevation: 1199.259 Easting: 6509881.361 Borehole Abandoned: Yes No X Method: NA Monitoring Device Installed: Yes X No Type: 8'' Sch. 80 PVC 8'' wire wrapped s.s. screen

Depth (feet bgs)	USCS symbols	Sample description	Comments	Grading				Lithology	Well Completion
60	SP	Gravelly SAND: pale yellow 2.5Y 8/4 (Dry), 80% coarse-grained sand, 20% fine gravel, micaceous.		20	80				
65		As above.							
70	SP	White/buff grains with orange, grains up to 3mm in size, angular to subangular.		20	80		3 mm		Bentonite/ Portland Grout seal: 3' - 200' 192.26 ft^3
75		As above.							
80	SP	Slightly more coarse-grained than above, and angular chips up to 4mm in length.					4 mm		8'' Sch. 80 PVC Blank Casing 0' - 218'
85		As above.							
90	SM	Silty SAND: pale yellow 2.5Y 8/4 (Dry), 60% fines (fine-grained sand and silt), 30%medium-grained sand, 10% coarse-grained, angular to subangular, micaceous.			60	40			
95		As above.							
100	SM	Silty SAND: pale yellow 2.5Y 7/4 (Dry), 70% fines (fine-grained sand and silt) increase from above, 20% medium-grained sand, 10% coarse-grained sand, non-plastic fines, micaceous.			30	70			
105									
110	SP	Well sorted SAND: orangish brown to tan brown, (Dry: pale yellow 2.5Y 7/4), 70% medium-grained sand (poorly graded - similar size), granodiorite chips, micaceous.	Rig chatter at 112' bgs.						
115	SM	Silty SAND: orangish brown to tannish brown (Dry: very pale brown 10YR 7/4), 70% fine- to medium-grained sand, 20% non-plastic silt, 10% coarse-grained sand, angular to subangular grains.	Mud viscosity: 42 seconds; Mud weight: 8.8 lbs.; Wall cake: 1/16"; Water loss: 3.8 mL; Sand content: 1.0%; pH: 10		80	20			
120									

NASA/JPL

Battelle

BORING LOG AND WELL COMPLETION DIAGRAM – JPL-EW-3

Borehole Location: JPL-EW-3 Project Location: NASA Jet Propulsion Lab. Project #: G486132 Geologist: D. Conner Drilling Contractor: Layne Christensen Driller: Terry Devries Reviewed by: C. Coonfare, P.G.	Sampler Type: Grab Sample from Shaker Screen Boring Diameter: 9 7/8" (Pilot) and 15.5" (Final) Drilling Method: Mud Rotary Drill Rig: Ingersoll-Rand TH-100 Hammer Type: Casing Hammer Date: 03/26/07 - 04/07/07 Total Depth: 335.0' bgs	Coordinates (NAD 83/NAVD 88) Northing: 1895819.259 Surface Elevation: 1199.259 Easting: 6509881.361 Borehole Abandoned: Yes No X Method: NA Monitoring Device Installed: Yes X No Type: 8'' Sch. 80 PVC 8'' wire wrapped s.s. screen

Depth (feet bgs)	USCS symbols	Sample description	Comments	Grading				Lithology	Well Completion
120	SM	Silty SAND: orangish brown to tannish brown (Dry: very pale brown 10YR 7/4), 70% fine- to medium-grained sand, 20% non-plastic silt, 10% coarse-grained sand, angular to subangular grains.	Increase rig chatter.		80	20			
125		As above.							
130	SP	Well sorted SAND: orangish brown to tan brown, (Dry: pale yellow 2.5Y 7/4), 70% medium-grained sand (poorly graded - similar size), granodiorite chips, micaceous.	Increased rig chatter; more difficult drilling.						Bentonite/ Portland Grout seal: 3' - 200' 192.26 ft^3
135		Cobbles.							
140		Increase in grey/black grains, angular to subangular.	Still rig chater						8'' Sch. 80 PVC Blank Casing 0' - 218'
145		As above.							
150		Increase in silt content, finer-gained sand.							
155		As above.							
160	GP/ SP	Gravelly SAND: orange to light pink and white to light grey (Dry: pale yellow 2.5Y 7/3), 60% coarse-grained sand, 40% medium-grained sand, angular to subangular, micaceous, granodiorite grains.			100				
165		Gravels.							
170		Cobbles, grains up to 8 mm in length.	Increase rig chatter. Less rig chatter. Increase rig chatter.		100		8 mm		
175		As above.			100		6 mm		
180		Finer gravel than above. 6mm maximum grain size.							

JPL-EW-3.CDR

NASA/JPL

Battelle

BORING LOG AND WELL COMPLETION DIAGRAM – JPL-EW-3

Borehole Location: JPL-EW-3 Project Location: NASA Jet Propulsion Lab. Project #: G486132 Geologist: D. Conner Drilling Contractor: Layne Christensen Driller: Terry Devries Reviewed by: C. Coonfare, P.G.	Sampler Type: Grab Sample from Shaker Screen Boring Diameter: 9 7/8" (Pilot) and 15.5" (Final) Drilling Method: Mud Rotary Drill Rig: Ingersoll-Rand TH-100 Hammer Type: Casing Hammer Date: 03/26/07 - 04/07/07 Total Depth: 335.0' bgs	Coordinates (NAD 83/NAVD 88) Northing: 1895819.259 Surface Elevation: 1199.259 Easting: 6509881.361 Borehole Abandoned: Yes No X Method: NA Monitoring Device Installed: Yes X No Type: 8" Sch. 80 PVC 8" wire wrapped s.s. screen

Depth (feet bgs)	USCS symbols	Sample description	Comments	Grading				Lithology	Well Completion
180–185	SP	Gravelly SAND: orange to light pink and white to light grey (Dry: pale yellow 2.5Y 7/3), 60% coarse-grained sand, 40% medium-grained sand, angular to subangular, micaceous, granodiorite grains, 6 mm maximum grain size.	DTW: 187.50' bgs; noted during video logging of well on 6-11-07).		100		6 mm		
190–195	GP/SP	Poorly graded SAND with gravel: light orange-brown (Dry: pale yellow 2.5Y 7/3), 65% fine to coarse-grained sand, angular to subangular, 35% fine gravel, angular to subangular, granodiorite grains. As above.		35	65				Bentonite/ Portland Grout seal: 3' - 200' 192.26 ft^3
200–205	GP/SP	Poorly graded SAND with gravel: light orange (Dry: pale yellow 2.5Y 7/3), 65% fine- to coarse-grained sand, angular to subangular, 35% fine gravel, micaceous. Cobbles.	Increase rig chatter at 190' bgs. Continued rig chatter.	35	65				8" Sch. 80 PVC Blank Casing 0' - 218'
210–225	SP	Poorly graded gravel with SAND: 80% fine- to coarse-grained sand, 20% fine- to coarse-grained sand, angular to subangular, larger granodiorite chips/flakes than above, micaceous. As above. As above. Cobbles As above.	Increase rig chatter.		100				Filter pack: RMC #8 mesh sand 205' - 325' 125 ft^3 8" 0.040-slot, wire wrapped stainless steel screen: 218' - 318'
230	GP/SP	Poorly graded SAND with gravel: light orange brown, 70% fine to coarse-grained sand, 30% fine to coarse gravel, angular to subangular.	Increased rig chatter.	30	70				
235–240	GP	Boulders/cobbles.	Heavy rig chatter.						

JPL-EW-3.CDR

NASA/JPL

Battelle

BORING LOG AND WELL COMPLETION DIAGRAM – JPL-EW-3

Borehole Location: JPL-EW-3 Project Location: NASA Jet Propulsion Lab. Project #: G486132 Geologist: D. Conner Drilling Contractor: Layne Christensen Driller: Terry Devries Reviewed by: C. Coonfare, P.G.	Sampler Type: Grab Sample from Shaker Screen Boring Diameter: 9 7/8" (Pilot) and 15.5" (Final) Drilling Method: Mud Rotary Drill Rig: Ingersoll-Rand TH-100 Hammer Type: Casing Hammer Date: 03/26/07 - 04/07/07 Total Depth: 335.0' bgs	Coordinates (NAD 83/NAVD 88) Northing: 1895819.259 Surface Elevation: 1199.259 Easting: 6509881.361 Borehole Abandoned: Yes No X Method: NA Monitoring Device Installed: Yes X No Type: 8" Sch. 80 PVC 8" wire wrapped s.s. screen

Depth (feet bgs)	USCS symbols	Sample description	Comments	Grading				Lithology	Well Completion
240	GP/ SP	Poorly graded gravel with SAND: light orange brown, 60% fine- to coarse-grained angular to subangular gravel, 40% fine to coarse-grained sand; micaceous, greater percentage of dark grey colored grains.		60	40				
245		As above.							
250		As above.							
255		As above.	Moderate rig chatter.						
260		As above.	Heavy rig chatter.						
265		As above.	Rig chatter.						
270	SP	Poorly graded SAND with gravel: 75% fine to coarse-grained sand, 25% fine gravel.		25	75				Filter pack: RMC #8 mesh sand 205' - 325' 125 ft^3
275									8" 0.040-slot, wire wrapped stainless steel screen: 218' - 318'
280	GP	Sandy GRAVEL: light orange with brown and some dark grey grains, 70% fine gravel, 30% fine to coarse-grained sand, micaceous, angular to subangular.	Increased rig chatter	70	30				
285		As above.							
290		As above.							
295		As above.							
300		As above.							

JPL-EW-3.CDR

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BORING LOG AND WELL COMPLETION DIAGRAM – JPL-EW-3

Borehole Location: JPL-EW-3 Project Location: NASA Jet Propulsion Lab. Project #: G486132 Geologist: D. Conner Drilling Contractor: Layne Christensen Driller: Terry Devries Reviewed by: C. Coonfare, P.G.	Sampler Type: Grab Sample from Shaker Screen Boring Diameter: 9 7/8" (Pilot) and 15.5" (Final) Drilling Method: Mud Rotary Drill Rig: Ingersoll-Rand TH-100 Hammer Type: Casing Hammer Date: 03/26/07 - 04/07/07 Total Depth: 335.0' bgs	Coordinates (NAD 83/NAVD 88) Northing: 1895819.259 Surface Elevation: 1199.259 Easting: 6509881.361 Borehole Abandoned: Yes No X Method: NA Monitoring Device Installed: Yes X No Type: 8'' Sch. 80 PVC 8'' wire wrapped s.s. screen

Depth (feet bgs)	USCS symbols	Sample description	Comments	Grading				Lithology	Well Completion
300	GP	Sandy GRAVEL: light orange with brown and some dark grey grains, 70% fine gravel, 30% fine to coarse-grained sand, micaceous, angular to subangular.		70	30				Filter pack: RMC #8 mesh sand 205' - 325' 125 ft^3
305		As above.							
310	GP/ SP	SAND with gravels: light orange brown with some light green and dark grey grains, 80% fine to coarse-grained sand, 20% fine gravel, angular to subangular.		20	80				8'' 0.040-slot, wire wrapped stainless steel screen: 218' - 318'
315		As above.							
320		As above.							8'' stainless steel sump: 318' - 328'
325		As above.							
330		As above.							
335		As above.	Pilot hole completed 4/2/2007; reaming completed 4/7/2007.						

TD: 335' bgs.

JPL-EW-3.CDR

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BORING LOG AND WELL COMPLETION DIAGRAM – JPL-IW-3

Borehole Location: JPL-IW-3 Project Location: NASA Jet Propulsion Lab. Project #: G486132 Geologist: D. Conner Drilling Contractor: Layne Christensen Driller: Terry Devries Reviewed by: C. Coonfare, P.G.	Sampler Type: Grab Sample from Shaker Screen Boring Diameter: 12 1/4" (Pilot) and 18.5" (Final) Drilling Method: Mud Rotary Drill Rig: Ingersoll-Rand TH-100 Hammer Type: Casing Hammer Date: 03/01/07 - 3/16/07 Total Depth: 340.0' bgs	Coordinates (NAD 83/NAVD 88) Northing: 1896077.701 Surface Elevation: 1257.768 Easting: 6509737.272 Borehole Abandoned: Yes No X Method: NA Monitoring Device Installed: Yes X No Type: 12'' Sch. 80 PVC 12'' wire wrapped s.s. screen

Depth (feet bgs)	USCS symbols	Sample description	Comments	Grading				Lithology	Well Completion
0		4" Asphalt Surface (4 inches thick). Gravel base for pavement.							
	SP	Utility clearance with air knife from 0' to 5' bgs. SAND (Fill): orange brown, medium dense, slightly moist, fine- to coarse-grained sand with trace silt, micaceous.	Set surface casing from 0' to 20' bgs.						Surface seal: 0-3' Concrete Bentonite/ Portland Grout seal: 3' - 199.5' 212.47 ft^3
5									
10									
15	SP	Gravelly SAND: light tan to very light orange, (Dry: pale yellow 2.5Y 7/2), dioritic grains, 60% medium- to coarse- grained sand, 40% gravel, angular to subangular, 5-8 mm in length.	Mud viscosity: 50 seconds; Mud weight: 8.5 lbs; Wall cake: 2/32"; Water loss: 4.2 mL; Sand content:1%; pH: 10	40	60		8 mm		12" Sch. 80 PVC Casing
20									
25		As above.							
30		Increase in medium- to coarse-grained sand.							
35		As above.							
40		Increase in gravels, cobbles noted by driller. Angular grains up to 10mm.	At 40' bgs, heavy rig chatter and rig bounce.				10 mm		
45		As above.							
50	SP	Gravelly SAND: light tan to very light orange (Dry: pale yellow 2.5Y 7/3), 60% medium- to coarse-grained sand, 40% gravel, dioritic, angular to subangular, grains up to 10 mm in length.		40	60		10 mm		
55		As above.							
60									

JPL-IW-3.CDR

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BORING LOG AND WELL COMPLETION DIAGRAM – JPL-IW-3

Borehole Location: JPL-IW-3 Project Location: NASA Jet Propulsion Lab. Project #: G486132 Geologist: D. Conner Drilling Contractor: Layne Christensen Driller: Terry Devries Reviewed by: C. Coonfare, P.G.	Sampler Type: Grab Sample from Shaker Screen Boring Diameter: 12 1/4" (Pilot) and 18.5" (Final) Drilling Method: Mud Rotary Drill Rig: Ingersoll-Rand TH-100 Hammer Type: Casing Hammer Date: 03/01/07 - 3/16/07 Total Depth: 340.0' bgs	Coordinates (NAD 83/NAVD 88) Northing: 1896077.701 Surface Elevation: 1257.768 Easting: 6509737.272 Borehole Abandoned: Yes No X Method: NA Monitoring Device Installed: Yes X No Type: 12'' Sch. 80 PVC 12'' wire wrapped s.s. screen

Depth (feet bgs)	USCS symbols	Sample description	Comments	Grading				Lithology	Well Completion
60	SP	Gravelly SAND: light tan to very light orange, (Dry: pale yellow 2.5Y 7/3), 75% coarse-grained sand, 25% fine gravel, dioritic grains, angular to subangular some shards up to 12mm in length.	Mud viscosity: 41 sec.; Mud weight: 8.6 lbs.; Wall cake: 2/32"; Water loss: 4.6 mL; Sand content: 1.5%; pH: 10	25	75		12 mm		
65		As above.							
70	SP	60% coarse-grained SAND, 35% fine-gravel, 5% fine sand to silt (non-plastic).		35	60	5			Bentonite/ Portland Grout seal: 3' - 199.5' 212.47 ft^3
75		As above.							
80	GP	Sandy GRAVEL: light tan to very light orange (Dry: pale yellow 2.5Y 7/3), 60% fine-gravel, 40% coarse-grained sand, dioritic grains.		60	40				12" Sch. 80 PVC Casing
85		As above.							
90	SP	Gravelly SAND: pale yellow 2.5Y 7/3 (Dry), 70% coarse-grained sand, 20% medium- to fine-grained sand, 10% fine-gravel (up to 18mm in length), trace silt.		10	90		18 mm		
95									
100	SM	Silty SAND with fine gravels: pale yellow 2.5Y 7/3 (Dry) 70% coarse-grained sand (angular to subangular), 15% silt (fines) non-plastic,15% fine gravel.	Mud viscosity: 43 sec.; Mud weight: 8.7 lbs.; Wall Cake: 2/32"; Water loss: 4.6 mL; Sand content: 0.5%; pH: 10	15	70	15			
105		As above.							
110	SP	Gravelly SAND: light tan to very light orange (Dry: pale yellow 2.5Y 7/3), 70% coarse-grained sand, 25% fine-gravel, 5% silt.		25	70	5			
115		As above.							
120									

JPL-IW-3.CDR

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BORING LOG AND WELL COMPLETION DIAGRAM – JPL-IW-3

Borehole Location: JPL-IW-3 Project Location: NASA Jet Propulsion Lab. Project #: G486132 Geologist: D. Conner Drilling Contractor: Layne Christensen Driller: Terry Devries Reviewed by: C. Coonfare, P.G.	Sampler Type: Grab Sample from Shaker Screen Boring Diameter: 12 1/4" (Pilot) and 18.5" (Final) Drilling Method: Mud Rotary Drill Rig: Ingersoll-Rand TH-100 Hammer Type: Casing Hammer Date: 03/01/07 - 3/16/07 Total Depth: 340.0' bgs	Coordinates (NAD 83/NAVD 88) Northing: 1896077.701 Surface Elevation: 1257.768 Easting: 6509737.272 Borehole Abandoned: Yes No X Method: NA Monitoring Device Installed: Yes X No Type: 12'' Sch. 80 PVC 12'' wire wrapped s.s. screen

Depth (feet bgs)	USCS symbols	Sample description	Comments	Grading				Lithology	Well Completion
120	SM	Silty SAND with fine gravel: pale yellow 2.5Y 7/3 (Dry), 70% coarse-grained sand (angular to subrounded), 15% silt (non-plastic), 15% fine gravel.		15	70	15			
125		As above.							
130		Decrease in silt content.							Bentonite/ Portland Grout seal: 3' - 199.5' 212.47 ft^3
135		COBBLES and BOULDERS.	Rig chatter and bouncing.						
140	SP	Gravelly SAND with silt: pale yellow 2.5Y 7/3 (Dry), 80% coarse grained sand, 7-10% fine gravel, 7-10% medium-grained sand, 3-5% silt and very fine-grained sand.	Mud viscosity: 45 sec.; Mud weight: 8.9 lbs.; Wall cake: 2/32"; Water loss: 4.4 mL; Sand content: 2.5%; pH: 10	10	85	5			12" Sch. 80 PVC Casing
145	SP	SAND: 85% coarse-grained sand, 10% medium-grained sand, 5% trace fine gravel, angular to sub-angular.		5	95				
150	SM	Silty SAND: pale yellow 2.5Y 7/3 (Dry), 80% coarse-grained sand, angular to subangular, 15% fines (non-plastic silt and very fine-grained sand), 5% fine gravel.		5	80	15			
155		As above.							
160		As above.							
165		As above.							
170	SM	Silty SAND: light tan to very light orange, 60% fine- to medium-grained sand, 35% non-plastic fines, trace fine gravel (up to 10mm).		15	80	5	12 mm		
175	GP	Boulders/Cobbles: Cuttings 70% coarse-grained sand, 20% medium-grained, 10% silt, trace fine gravel (up to 4mm in size).	Very slow drilling due to boulders	3	90	7	4 mm		
180									

JPL-IW-3.CDR

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BORING LOG AND WELL COMPLETION DIAGRAM – JPL-IW-3

Borehole Location: JPL-IW-3 Project Location: NASA Jet Propulsion Lab. Project #: G486132 Geologist: D. Conner Drilling Contractor: Layne Christensen Driller: Terry Devries Reviewed by: C. Coonfare, P.G.	Sampler Type: Grab Sample from Shaker Screen Boring Diameter: 12 1/4" (Pilot) and 18.5" (Final) Drilling Method: Mud Rotary Drill Rig: Ingersoll-Rand TH-100 Hammer Type: Casing Hammer Date: 03/01/07 - 3/16/07 Total Depth: 340.0' bgs	Coordinates (NAD 83/NAVD 88) Northing: 1896077.701 Surface Elevation: 1257.768 Easting: 6509737.272 Borehole Abandoned: Yes No X Method: NA Monitoring Device Installed: Yes X No Type: 12'' Sch. 80 PVC 12'' wire wrapped s.s. screen

Depth (feet bgs)	USCS symbols	Sample description	Comments	Grading				Lithology	Well Completion
180–185	GP	Boulders/Cobbles: cuttings pale yellow 2.5Y 7/3 (Dry), 70% coarse-grained sand, 20% medium-grained sand, 10% silt, trace fine gravel (up to 4mm in size). As above.	Mud viscosity: 48 sec. Mud weight: 8.6 lbs. Wall cake: 2/32" Water loss: 5 mL Sand content: 2.5% pH: 10	3	90	7	4 mm		Bentonite/ Portland Grout seal: 3' - 199.5' 212.47 ft^3
190–195	SP/ SM	Poorly graded SAND: pale yellow 2.5Y 7/3, 70% coarse-grained sand, 20% medium-grained, 10% silt, trace fine-gravel (up to 4mm) As above.			90	10	4 mm		12" Sch. 80 PVC Casing
200–205	SP	Gravelly SAND: light tan to very light orange (Dry: pale yellow 2.5Y 7/3), 60% coarse-grained sand, 40% fine gravel, dioritic grains, angular to subangular. Increased amount of granitic chips and fragments.	Driller notes that drilling more difficult - harder material. Mud viscosity: 48 sec. Mud weight: 8.6 lbs. Wall cake: 2/32" Water loss: 5 mL Sand content: 2.5% pH: 10						Annular seal: 1/4" time released bentonite pellets: 199.5' - 204.5' 5.41 ft^3
210–215		Up to 10mm fragments. As above.	DTW: 213.00' bgs; noted prior to first injection 1-21-08.				10 mm		
220–225	SP	As above. As above.	Mud viscosity: 48 sec. Mud weight: 8.7 lbs. Wall cake: 2/32" Water loss: 4 mL Sand content: 3.0% pH: 10						12'' 0.050", Stainless Steel Wire Wrapped Screen: 215' - 315'
230–235		As above. As above.							Filter Pack: RMC medium aquarium sand: 204.5' - 340' 146.51 ft^3

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BORING LOG AND WELL COMPLETION DIAGRAM – JPL-IW-3

Borehole Location: JPL-IW-3 Project Location: NASA Jet Propulsion Lab. Project #: G486132 Geologist: D. Conner Drilling Contractor: Layne Christensen Driller: Terry Devries Reviewed by: C. Coonfare, P.G.	Sampler Type: Grab Sample from Shaker Screen Boring Diameter: 12 1/4" (Pilot) and 18.5" (Final) Drilling Method: Mud Rotary Drill Rig: Ingersoll-Rand TH-100 Hammer Type: Casing Hammer Date: 03/01/07 - 3/16/07 Total Depth: 340.0' bgs	Coordinates (NAD 83/NAVD 88) Northing: 1896077.701 Surface Elevation: 1257.768 Easting: 6509737.272 Borehole Abandoned: Yes No X Method: NA Monitoring Device Installed: Yes X No Type: 12'' Sch. 80 PVC 12'' wire wrapped s.s. screen

Depth (feet bgs)	USCS symbols	Sample description	Comments	Grading				Lithology	Well Completion
240	SP	SAND: pale yellow 2.5Y 7/3 (dry), 80% coarse-grained sand, 20% medium-grained sand, little to no silt, angular to subangular.			100				12'' 0.050", Stainless Steel Wire Wrapped Screen: 215' - 315'
245		As above.							
250		With granodiorite chips.	Mud viscosity: 48 sec. Mud weight: 9.6 lbs. Wall cake: 2/32" Water loss: 4.2 mL Sand content: 3.0% pH: 10						Filter Pack: RMC medium aquarium sand: 204.5' - 340' 146.51 ft^3
255		As above with minor increase in silt content, granodiorite chips, mostly tannish grey, some orange and black grains, angular to subangular.							
260	SP	As above.	Driller notes that material is more cemented.						
265		As above.							
270		As above with less silt.	Mud viscosity: 41 sec. Mud weight: 9.7 lbs. Wall cake: 2/32" Water loss: 4.0 mL Sand content: 3.0% pH: 10						
275		As above.							
280	SP	90% coarse-grained sand; 10% medium-grained sand; tannish grey with some orange, black grains, angular to subangular.			100				
285		As above.	Rig chatter.						
290	SP	80% coarse-grained sand; 10% medium-grained, 10% silt; granodiorite chips from boulders.			90	10			
295		As above.							
300									

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BORING LOG AND WELL COMPLETION DIAGRAM – JPL-IW-3

Borehole Location: JPL-IW-3 Project Location: NASA Jet Propulsion Lab. Project #: G486132 Geologist: D. Conner Drilling Contractor: Layne Christensen Driller: Terry Devries Reviewed by: C. Coonfare, P.G.	Sampler Type: Grab Sample from Shaker Screen Boring Diameter: 12 1/4" (Pilot) and 18.5" (Final) Drilling Method: Mud Rotary Drill Rig: Ingersoll-Rand TH-100 Hammer Type: Casing Hammer Date: 03/01/07 - 3/16/07 Total Depth: 340.0' bgs	Coordinates (NAD 83/NAVD 88) Northing: 1896077.701 Surface Elevation: 1257.768 Easting: 6509737.272 Borehole Abandoned: Yes No X Method: NA Monitoring Device Installed: Yes X No Type: 12'' Sch. 80 PVC 12'' wire wrapped s.s. screen

Depth (feet bgs)	USCS symbols	Sample description	Comments	Grading	Lithology	Well Completion
300	SP	SAND: pale yellow 2.5Y 7/3 (Dry), 80% coarse-grained sand; 10% medium-grained, 10% silt; granodiorite chips from boulders.	Mud viscosity: 42 sec. Mud weight: 9.4 lbs. Wall cake: 2/32" Water loss: 4.2 mL Sand content: 3.0% pH: 10	90 10		12'' 0.050", Stainless Steel Wire Wrapped Screen: 215' - 315'
305		As above.				
310	SP	Coarse-grained sand, but finer grained than at 300 - 305'.				Filter Pack: RMC medium aquarium sand: 204.5' - 340' 146.51 ft^3
315		As above.				
320	SP	Coarser-grained than above; granodiorite chips.				12'' Stainless Steel Sump 315' - 325'
325		As above.				
330	SP	As above.				
335		As above.				
340	SP	As above.	Pilot hole completed 3/8/2007; reaming completed 3/16/2007.			

TD: 340'bgs.

JPL-IW-3.CDR

Appendix 1-3

Well Development

Extraction Well #3 Development May 21 - June 11 and August 7 - 9, 2007

Day	Date	Time	Formula	Minutes	Pumping Flowrate (gpm)	Water Added from Fire Hydrant (gals)	Chemical Added NuWell-310 (gals)	Water Removed (gals)	Method	Water Removed by Zone (gals)	Staff
Tuesday	5/22/2007	12:50	770	60	27	--	--	1,618	Airlift at 285' - 305' (w/out artificial head)	3,590	D. Conner
		13:50	830								
		14:30	870	60	33	--	--	1,972	Airlift at 305' - 325' (w/out artificial head)		
		15:30	930								
				Daily Injection Total:		**0**	**Daily Pumping Total:**	**3,590**			
Wednesday	5/23/2007	14:30	--	--	--	100	2.0	--	Add dispersant 215' - 235'	--	D. Conner/S. Lowe
		14:40	880	Swab 215' - 225' and 225' - 235' for 1/2 hour each zone							
		15:40	940								
		15:42	--	--	--	100	2.0	--	Add dispersant 235' - 255'	--	
		15:50	950	Swab 235' - 245' and 245' - 255' for 1/2 hour each zone							
		16:50	1010								
				Daily Injection Total:		**200**	**Daily Pumping Total:**	**0**			
Thursday	5/24/2007	7:30	--	--	--	100	2.0	--	Add dispersant 255' - 275'	--	D. Conner
		8:00	480	Swab 255' - 265' and 265' - 275' for 1/2 hour each zone							
		9:00	540								
		9:20	--	--	--	100	2.0	--	Add dispersant 275' - 295'	--	
		9:40	580	Swab 275' - 285' and 285' - 295' for 1/2 hour each zone							
		10:40	640								
		10:50	--	--	--	100	2.0	--	Add dispersant 295' - 315'	--	
		11:00	660	Swab 295' - 305' and 305' - 315' for 1/2 hour each zone							
		12:00	720								
		13:15	795	60	39	--	--	2,363	Dual swab airlift at 295' - 315'	2362.5	
		14:15	855								
		14:35	875	40	40	--	--	1,587	Dual swab airlift at 275' - 295'	1586.5	
		15:15	915								
				Daily Injection Total:		**300**	**Daily Pumping Total:**	**3,949**			
Friday	5/25/2007	7:45	465	35	37	--	--	1,306	Dual swab airlift at 255' - 275'	1,306	D. Conner
		8:20	500								
		8:45	525	35	35	--	--	1,220	Dual swab airlift at 235' - 255'	1,220	
		9:20	560								
				Daily Injection Total:		**0**	**Daily Pumping Total:**	**2,526**			
Monday	5/28/2007	Developers remove air lift system.									
Tuesday	5/29/2007	11:00	660	60	30	--	--	1,800	Submersible pump	1,800	D. Conner
		12:00	720								
		13:18	798	59	30	--	--	1,770	Submersible pump	1,770	
		14:17	857								
				Daily Injection Total:		**0**	**Daily Pumping Total:**	**3,570**			
Monday	6/11/2007	Performed post development video log of EW-3.									D. Conner
		DTW: 187.50'; Water Condition: Clear (zero turbidity); Sump: 5' of material (fine sand, silt and clay); Screen: 10% clogged (drilling mud/clay); Filter pack: clean (as seen through clean perforations of screened zone). Well needs further development. Talk to Tom Nanchy at Layne.									
Tuesday	8/7/2007	--	--	--	--	--	--	2.5	--	Add dispersant 220' - 320'	--	D. Conner
		Brushed entire screened interval (1/2 hour per 10 feet of screen) for 5 hours.									
				Daily Injection Total:		**0**	**Daily Pumping Total:**	**0**			
Wednesday	8/8/2007	Installed submersible pump into well.									D. Conner
		--	--	--	--	--	--	--	17,000	Submersible pump	17,000	
				Daily Injection Total:		**0**	**Daily Pumping Total:**	**17,000**			
Tuesday	8/14/2007	Performed second video log of EW-3.									D. Conner
		DTW: 195.50'; Water Condition: Clear (zero turbidity); Screen: appears clean									

Development Total	
Water Added from Fire Hydrant (gals)	**500**
NuWell-310 (gals)	**12.5**
Water Removed (gals)	**30,635**

Injection Well #3 Development March 27 - May 4, August 9 - August 14, 2007, and October 3, 2007 - January 16, 2008.

Day	Date	Time	Formula	Minutes	Pumping Flowrate (gpm)	Water Added from Fire Hydrant (gals)	Fire Hydrant Pumping Flowrate (gpm)	Chemical Added NuWell-310 (gals)	Water Removed (gals)	Method	Water Removed by Zone (gals)	Staff
Tuesday	3/27/2007	12:25	745	21	12	--	--	--	262.5	Airlift at 291'	525	S. Lowe
		12:46	766									
		13:55	835	24	11	575	24	--	262.5	Airlift at 291'		
		14:19	859									
		15:30	930	96	55	5,005	52	--	5,250	Airlift at 292' - 304'	5,250	
		17:06	1026	**Daily Injection Total:**		**5,580**		**Daily Pumping Total:**	**5,775**			
Wednesday	3/28/2007	8:34	514	60	64	3,880	65	--	3,850	Airlift at 305' - 311'	3,850	S. Lowe
		9:34	574									
		11:07	667	83	59	4,640	56	--	4,900	Airlift at 312' - 325'	4,900	
		12:30	750	**Daily Injection Total:**		**8,520**		**Daily Pumping Total:**	**8,750**			
Thursday	3/29/2007	11:10	--	--	--	260	--	1.0	--	Add dispersant 215' - 225'	--	S. Lowe
		11:28	--	--	--	260	--	1.0	--	Add dispersant 225' - 235'	--	
		13:10	--	--	--	260	--	1.0	--	Add dispersant 235' - 245'	--	
		15:47	947	74	31	1,345	18	--	2,285	Dual swab airlift at 215' - 235'	2,285	
		17:01	1021	**Daily Injection Total:**		**2,385**		**Daily Pumping Total:**	**2,285**			
Friday	3/30/2007	7:35	455	119	26	3,585	30	--	3,105	Dual swab airlift at 215' - 245'	3,105	S. Lowe
		9:34	574									
		9:50	--	--	--	260	--	1.0	--	Add dispersant 245' - 255'	--	
		10:10	610	45	31	1,260	28	--	1,400	Dual swab airlift at 245' - 255'	1,400	
		10:55	655									
		11:30	--	--	--	260	--	1.0	--	Add dispersant 255' - 265'	--	
		13:32	--	--	--	260	--	1.0	--	Add dispersant 265' - 275'	--	
		13:25	805	85	35	2,150	25	--	2,975	Dual swab airlift at 255' - 275'	2,975	
		14:50	890									
		15:20	--	--	--	260	--	1.0	--	Add dispersant 275' - 285'	--	
		15:40	--	--	--	260	--	1.0	--	Add dispersant 285' - 295'	--	
				Daily Injection Total:		**8,035**		**Daily Pumping Total:**	**7,480**			
Monday	4/2/2007	11:18	678	88	54	4,310	49	--	4,725	Dual swab airlift at 275' - 295'	4,725	S. Lowe
		12:46	766									
		15:00	--	--	--	260	--	1.0	--	Add dispersant 295' - 305'	--	
		15:15	--	--	--	260	--	1.0	--	Add dispersant 305' - 315'	--	
		15:41	941	54	62	2,660	49	--	3,325	Dual swab airlift at 295' - 315'	3,325	
		16:35	995	**Daily Injection Total:**		**7,490**		**Daily Pumping Total:**	**8,050**			
Tuesday	4/3/2007	7:45	--	--	--	260	--	1.0	--	Add dispersant 305' - 315'	--	S. Lowe
		8:00	--	--	--	260	--	1.0	--	Add dispersant 295' -305'	--	
		10:15	615	75	42	3,000	40	--	3,150	Dual swab airlift at 295' - 315'	3,150	
		11:30	690									
		12:55	--	--	--	260	--	1.0	--	Add dispersant 285' - 295'	--	
		13:10	--	--	--	260	--	1.0	--	Add dispersant 275' - 285'	--	
		13:38	818	75	56	4,110	55	--	4,200	Dual swab airlift at 275' - 295'	4,200	
		14:53	893									
		15:30	--	--	--	260	--	1.0	--	Add dispersant 265' - 275'	--	
		15:50	--	--	--	260	--	1.0	--	Add dispersant 255' - 265'	--	
				Daily Injection Total:		**8,670**		**Daily Pumping Total:**	**7,350**			
Wednesday	4/4/2007	9:57	597	101	56	4,870	48	--	5,645	Dual swab airlift at 255' - 275'	5,645	S. Lowe
		11:38	698									
		12:45	--	--	--	100	--	1.0	--	Add dispersant 245' - 255'	--	
		13:00	--	--	--	100	--	1.0	--	Add dispersant 235' - 245'	--	
		13:15	--	--	--	100	--	1.0	--	Add dispersant 225' - 235'	--	
		13:30	--	--	--	100	--	1.0	--	Add dispersant 215' - 225"	--	
		14:15	855	70	48	2,770	40	--	3,325	Dual swab airlift at 235' - 255'	3,325	
		15:25	925	**Daily Injection Total:**		**8,040**		**Daily Pumping Total:**	**8,970**			
Thursday	4/5/2007	9:34	574	429	42	15,950	37	--	18,028	Dual swab airlift at 215' - 235'	18,028	S. Lowe
		16:43	1003	**Daily Injection Total:**		**15,950**		**Daily Pumping Total:**	**18,028**			
Friday	4/6/2007	7:15	435	485	31	16,970	35	--	14,990	Dual swab airlift at 235' - 295'	14,990	S. Lowe
		15:20	920	**Daily Injection Total:**		**16,970**		**Daily Pumping Total:**	**14,990**			
Monday	4/9/2007	8:30	510	390	38	14,440	37	--	14,700	Dual swab airlift at 275' - 315'	14,700	S. Lowe
		15:00	900	**Daily Injection Total:**		**14,440**		**Daily Pumping Total:**	**14,700**			

Day	Date	Time	Formula	Minutes	Pumping Flowrate (gpm)	Water Added from Fire Hydrant (gals)	Fire Hydrant Pumping Flowrate (gpm)	Chemical Added NuWell-310 (gals)	Water Removed (gals)	Method	Water Removed by Zone (gals)	Staff
Tuesday	4/10/2007	--	--	--	--	100	--	1.5	--	--	--	D. Conner
		Aqua-clear tremmied into upper portion of well screen and swabbed for 1/2 hour.										
		Development rig breaks down; mechanic onsite to fix rig.										
				Daily Injection Total:		**100**						
Wedensday	4/11/2007	--	--	--	--	100	--	1.5	--	--	--	D. Conner
		Aqua-clear tremmied into middle portion of well screen and swabbed for 1/2 hour.										
		--	--	--	--	100	--	1.5	--	--	--	
		Aqua-clear tremmied into lower portion of well screen and swabbed for 1/2 hour.										
				Daily Injection Total:		**200**						
Thursday	4/12/2007	8:30	510	58	11	--	--	--	638	Dual swab airlift at 305' - 325' (w/out artificial head)	3,613	D. Conner
		9:28	568									
		9:33	573	57	Record depth to water and recovery time.							
		10:30	630									
		10:40	640	30	Swab well for 1/2 hour.							
		11:10	670									
		11:50	710	25	17	--	--	--	425	Dual swab airlift at 315' - 325' (w/out artificial head)		
		12:15	735									
		13:31	811	50	44	2,055	41.1	--	2,200	Dual swab airlift at 315' - 325'		
		14:21	861									
		14:30	870	30	Swab well for 1/2 hour.							
		15:00	900									
		15:00	900	32	11	--	--	--	350	Dual swab airlift at 315' - 325' (w/out artificial head)		
		15:32	932									
		15:33	933	18	Record depth to water recovery time.							
		15:51	951									
				Daily Injection Total:		**2,055**		**Daily Pumping Total:**	**3,613**			
Friday	4/13/2007	7:30	450	30	Swab well for 1/2 hour.							D. Conner
		8:00	480									
		8:00	480	14	5	--	--	--	70	Dual swab airlift at 315' - 325' (w/out artificial head)	70	
		8:14	494									
		Remove dual swab and install open-ended air lift system to remove silt and mud in well sump.										
		10:30	630	242	16	4,415	18	--	3,955	Open-ended pipe air lift a 315' - 325'	3,955	
		14:32	872									
		14:43	883	22	11	--	--	--	242	Open-ended pipe air lift a 315' - 325' (w/out artificial head)	242	
		15:05	905									
				Daily Injection Total:		**4,415**		**Daily Pumping Total:**	**4,267**			
Monday	4/16/2007	Developers remove air lift system from IW-3 and set-up "Bore Blast" system; unit malfunctions.										
Tuesday	4/17/2007	Developers attempt "Bore Blast" system; unit malfunctions again.										
Wednesday	4/18/2007	13:50	830	30	Swab 215' - 225' and 225' - 235' for 1/2 hour.							D.Conner
		14:20	860		--	20	--	1	--	Tremmie Aqua-clear		
		14:30	870	30	Swab 235' - 245' and 245' - 255' for 1/2 hour.							
		15:00	900									
		15:10	910	30	Swab 255' - 265' and 265' - 275' for 1/2 hour.							
		15:40	940		--	20	--	1	--	Tremmie Aqua-clear		
		15:45	945	30	Swab 275' - 285' and 285' - 295' for 1/2 hour.							
		16:15	975									
		16:20	980	30	Swab 295' - 305' and 305' - 315' for 1/2 hour.							
		16:50	1010		--	20	--	1	--	Tremmie Aqua-clear		
				Daily Injection Total:		**60**		**Daily Pumping Total:**	**0**			
Thursday	4/19/2007	No site activities.										
Friday	4/20/2007	7:30	450	30	Swab well for 1/2 hour.						6,300	D. Conner
		8:00	480									
		8:00	480	180	35	5,400	30	--	6,300	Dual swab air lift at 315' - 325' (w/out artificial head)		
		11:00	660									
		Developers remove dual swab air lift system from well.										
				Daily Injection Total:		**5,400**		**Daily Pumping Total:**	**6,300**			
Monday	4/23/2007	Developers attempt "Bore Blast" system; unit malfunctions again.										
Tuesday	4/24/2007	10:56	656	24	--	1,440	60	Injection test to see if well takes water (from hydrant).				D. Conner
		11:20	680									
		11:21	DTW: 80' btoc									
		11:24	DTW: 94' btoc									
		12:16	DTW: 191' btoc									
		12:20	740	95	35	3,975	42	--	3,325	Dual swab air lift at 215' - 225' and 225' - 235'	3,325	
		13:55	835									
		14:25	865	155	21	3,260	21	--	3,255	Dual swab air lift at 235' - 245' and 245' - 255'	3,255	
		17:00	1020									
				Daily Injection Total:		**8,675**		**Daily Pumping Total:**	**6,580**			

Day	Date	Time	Formula	Minutes	Pumping Flowrate (gpm)	Water Added from Fire Hydrant (gals)	Fire Hydrant Pumping Flowrate (gpm)	Chemical Added NuWell-310 (gals)	Water Removed (gals)	Method	Water Removed by Zone (gals)	Staff
Wednesday	4/25/2007	7:30	450	30	Swab 235 - 245' and 245 - 255' for 1/2 hour.							D. Conner
		8:00	480									
		8:00	480	39	12	465	12	--	477	Dual swab air lift at 235' - 255'	477	
		8:39	519									
		9:04	544	147	13	1,445	10	--	1,911	Dual swab air lift at 255' - 275'	1,911	
		11:31	691									
		11:40	700	86	18	480	6	--	1,548	Dual swab air lift at 255' - 275'	1,548	
		13:06	786									
		13:30	810	102	19.5	1,260	12	--	1,989	Dual swab air lift at 275' - 295'	1,989	
		15:12	912									
		15:45	945	85	24	--	--	--	2,040	Dual swab air lift at 295' - 305' and 305' - 315'	2,040	
		17:10	1030									
				Daily Injection Total:		**3,650**		**Daily Pumping Total:**	**7,965**			
Thursday	4/26/2007	7:35	455	199	11	--	--	--	2,200	Dual swab airlift at 295' - 315' (w/out artificial head)	2,200	D. Conner
		10:54	654									
		11:18	678	120	21	2,605	22	--	2,460	Dual swab air lift at 275' - 295'	2,460	
		13:18	798									
		14:15	855	54	81	3,955	73	--	4,395	Dual swab air lift at 255' - 275'	7,503	
		15:09	909									
		16:00	960	64	49	2,750	43	--	3,108	Dual swab air lift at 255' - 275'		
		17:04	1024									
				Daily Injection Total:		**9,310**		**Daily Pumping Total:**	**12,163**			
Friday	4/27/2007	8:15	495	135	39	3,780	28	--	5,265	Dual swab air lift at 235 - 255'	5,265	D. Conner
		10:30	630									
		11:11	671	40	27	1,120	28	--	1,080	Dual swab air lift at 215 - 235'	1,080	
		11:51	711									
		Developers remove air lift system from IW-3 and install 50 h.p. submersible pump.										
				Daily Injection Total:		**4,900**		**Daily Pumping Total:**	**6,345**			
Monday	4/30/2007	Set submersible pump at 312' bgs for injection test.										
Tuesday	5/1/2007	8:45	525	15	30	--	--	--	450	Extraction at 312' using pump	450	S.Lowe
		9:00	540									
		9:00	540	105	35	--	--	--	3,675	Extraction at 312' using pump	3,675	
		10:45	645									
				Daily Injection Total:		**0**		**Daily Pumping Total:**	**4,125**			
Wednesday	5/2/2007	9:00	540	20	50	--	--	--	1,000	Extraction at 312' using pump	18,550	S.Lowe
		9:20	560									
		9:20	560	70	75	--	--	--	5,250	Extraction at 312' using pump		
		10:30	630									
		10:30	630	45	100	--	--	--	4,500	Extraction at 312' using pump		
		11:15	675									
		11:15	675	60	130	--	--	--	7,800	Extraction at 312' using pump		
		12:15	735									
		16:04	964	15	--	1,125	75	--	--	Injection at 312' using pump		
		16:19	979									
		16:26	986	15	--	1,425	95	--	--	Injection at 312' using pump		
		16:41	1001									
				Daily Injection Total:		**2,550**		**Daily Pumping Total:**	**18,550**			
Thursday	5/3/2007	8:50	530	30	75	--	--	--	2,250	Extraction at 312' using pump	17,700	S. Lowe
		9:20	560									
		9:24	564	30	--	2,700	90	--	--	Injection at 312' using pump		
		9:54	594									
		10:10	610	30	150	--	--	--	4,500	Extraction at 312' using pump		
		10:40	640									
		10:42	642	30	--	2,700	90	--	--	Injection at 312' using pump		
		11:12	672									
		11:30	690	15	300	--	--	--	4,500	Extraction at 312' using pump		
		11:45	705									
		11:50	710	30	--	2,700	90	--	--	Injection at 312' using pump		
		12:20	740									
		12:34	754	86	75	--	--	--	6,450	Extraction at 312' using pump		
		14:00	840									
				Daily Injection Total:		**8,100**		**Daily Pumping Total:**	**17,700**			
Friday	5/4/2007	9:15	555	120	--	10,800	90	--	--	Injection at 312' using pump	--	S.Lowe
		11:15	675									
				Daily Injection Total:		**10,800**		**Daily Pumping Total:**	**0**			

Development Subtotal	
Water Added from Fire Hydrant (gals)	**156,295.0**
NuWell-310 (gals)	**27.5**
Water Removed (gals)	**183,985.7**

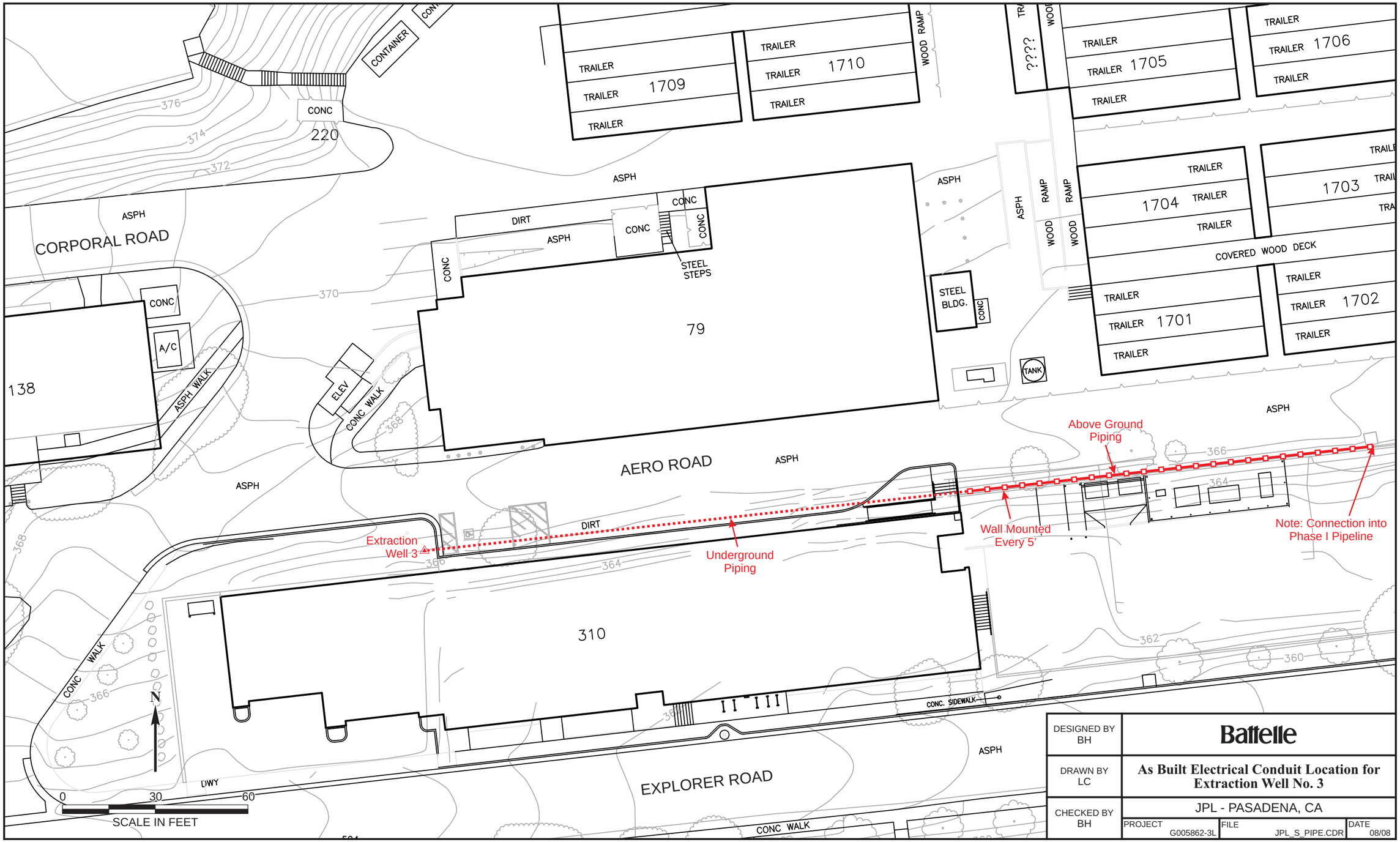
Day	Date	Time	Formula	Minutes	Pumping Flowrate (gpm)	Water Added from Fire Hydrant (gals)	Fire Hydrant Pumping Flowrate (gpm)	Chemical Added NuWell-310 (gals)	Water Removed (gals)	Method	Water Removed by Zone (gals)	Staff
Monday	6/11/2007	Performed post development video log of IW-3. DTW: 237.00'; Water Condition: Clear (zero turbidity); Sump: 5' of material (fine sand, silt, and clay); Screen: 10% clogged (drilling mud/clay); Filter Pack: Clean (as seen through clean portions of screen); D. Conner and Layne (T. Nanchy) decide that additional development needs to occur in order to remove material from screen slots (i.e. drilling mud).										D. Conner
Thursday	8/9/2007	Layne mobilizes equipment to IW-3. Baker delivers 21,000 gallon tank.										
		--	--	30	--	--	--	2.5	--	Add dispersant 215' - 225' and brush 1/2 hour	--	
		--	--	30	--	--	--	--	--	225' - 235' and brush 1/2 hour	--	
		--	--	30	--	--	--	--	--	235' - 245' and brush 1/2 hour	--	
		--	--	30	--	--	--	--	--	245' - 255' and brush 1/2 hour	--	
		--	--	30	--	--	--	--	--	255' - 265' and brush 1/2 hour	--	
		--	--	30	--	--	--	--	--	265' - 275' and brush 1/2 hour	--	
		--	--	30	--	--	--	--	--	275' - 285' and brush 1/2 hour	--	
		--	--	30	--	--	--	--	--	285' - 295' and brush 1/2 hour	--	
		Equipment problem on development rig (faulty hydraulic brake) requiring mechanic.										
Friday	8/10/2007	--	--	30	--	--	--	--	--	295' - 305' and brush 1/2 hour	--	D. Conner
		--	--	30	--	--	--	--	--	305' - 315' and brush 1/2 hour		
		--	--	--	--	--	--	**Daily Pumping Total:**	**8,800**	Extraction at 312' using pump; pumped until clear		
Monday	8/14/2007	Performed final video log of IW-3. DTW: 245.00'; Water Condition: Clear (zero turbidity); Sump: 10' of material (fine sand, silt, and clay); Screen: mild amounts of material (drilling mud/clay); Filter Pack: Clean (as seen through clean portions of screen).										D. Conner
Wednesday	10/3/2007	Initiated pumping with submersible pump installed in IW-3; purge water running to OU-1 treatment system.										
Wednesday	1/16/2008	Completed pumping development with IW-3 submersible pump. Approximately 1,100,000 gallons removed. Run 50 gpm injection test.										
		--	--	--	--	--	--	**Total Pumping:**	**1,100,000**	IW-3 submersible pump.	--	
Thursday	1/17/2008	Run 100 gpm injection test.										
Friday	1/18/2008	Run 250 - 300 gpm injection test.										
Monday	1/21/2008	Initiate normal injection operation.										

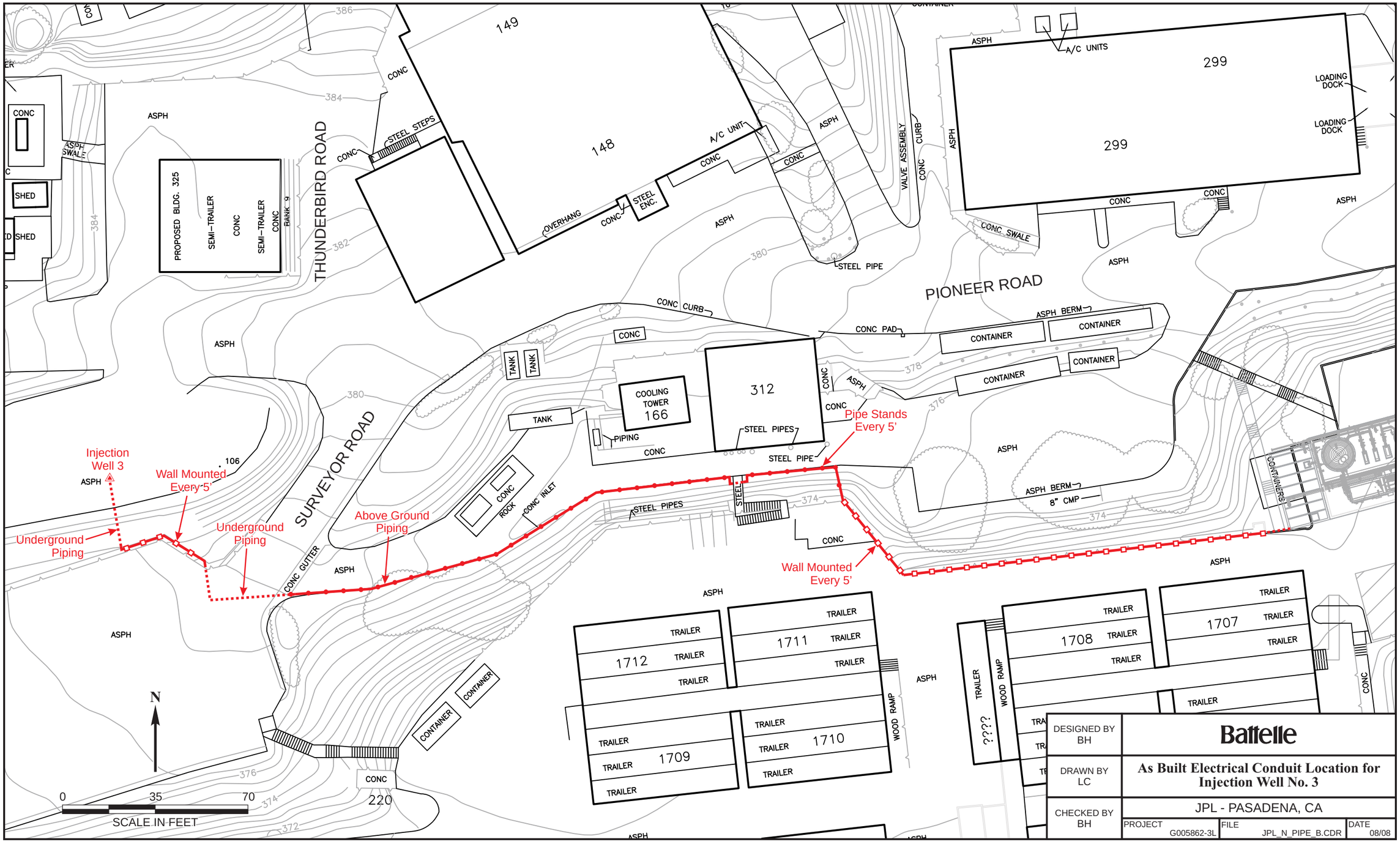
Development Total

Water Added from Fire Hydrant (gals)	**156,295**
NuWell-310 (gals)	**30.0**
Water Removed (gals)	**1,292,786**

Appendix 2-1

Electrical Drawings

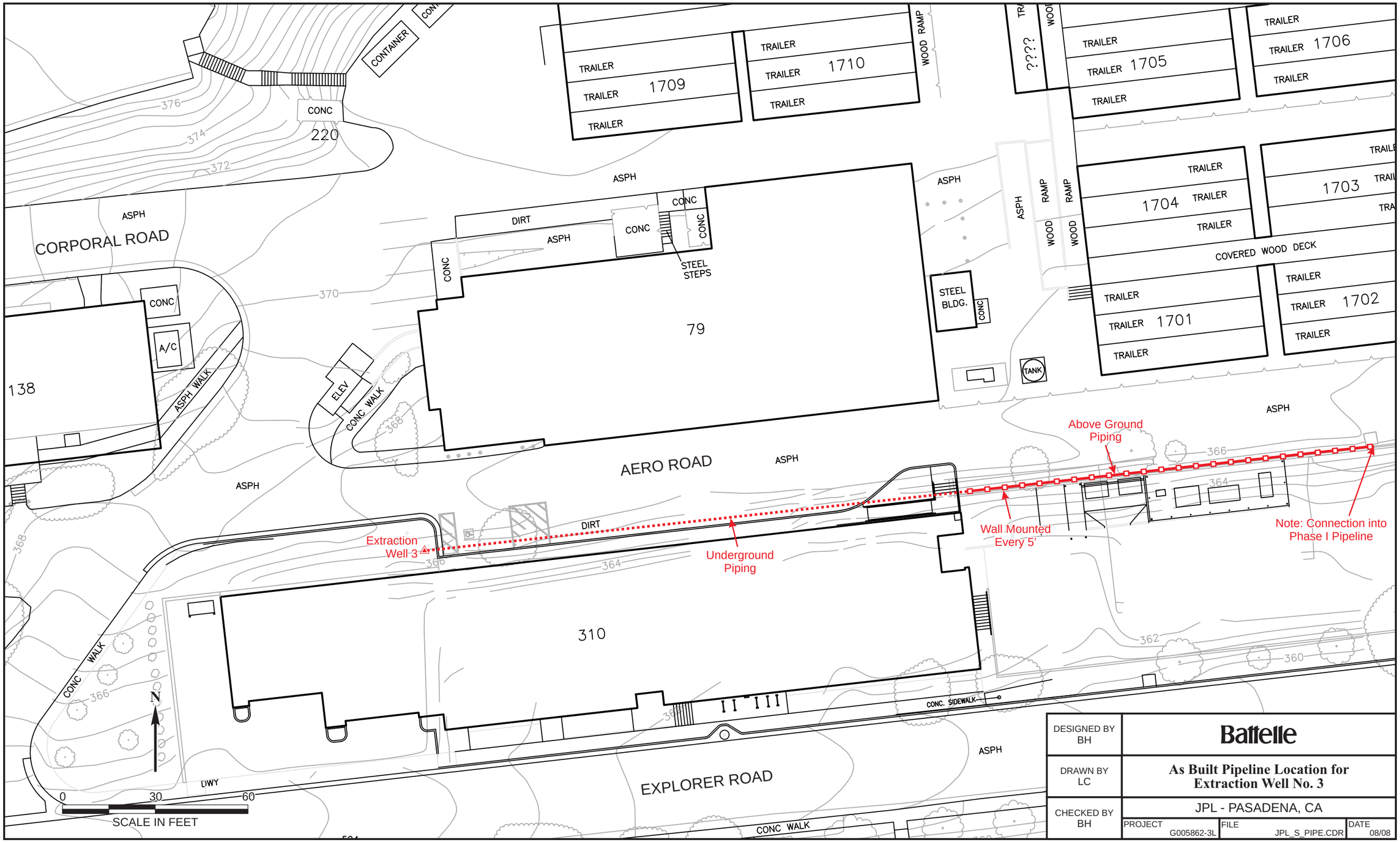

CONTAINER
CONC
220
TRAILER
1709
1710
WOOD RAMP
????
1705
1706
ASPH
CORPORAL ROAD
DIRT
CONC
STEEL STEPS
RAMP
WOOD
1704
1703
COVERED WOOD DECK
STEEL BLDG.
TANK
1701
1702
A/C
138
ASPH WALK
ELEV
CONC WALK
79
AERO ROAD
Above Ground Piping
Wall Mounted Every 5'
Note: Connection into Phase I Pipeline
Extraction Well 3
Underground Piping
310
CONC. SIDEWALK
EXPLORER ROAD
DWY
N
0
30
60
SCALE IN FEET
DESIGNED BY BH
DRAWN BY LC
CHECKED BY BH
Battelle
As Built Electrical Conduit Location for Extraction Well No. 3
JPL - PASADENA, CA
PROJECT G005862-3L
FILE JPL_S_PIPE.CDR
DATE 08/08

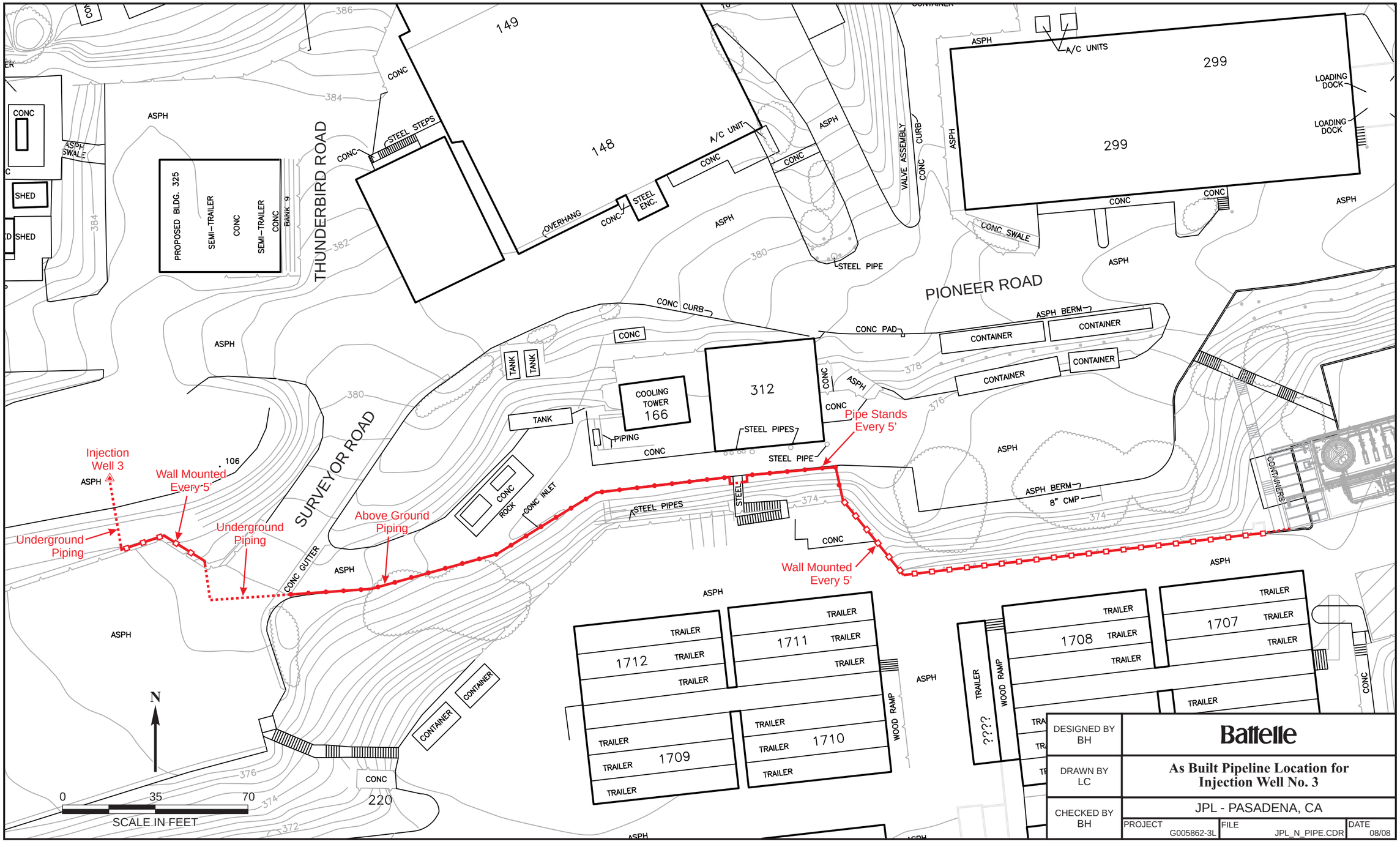


DESIGNED BY BH	Battelle		
DRAWN BY LC	As Built Electrical Conduit Location for Injection Well No. 3		
CHECKED BY BH	JPL - PASADENA, CA		
	PROJECT G005862-3L	FILE JPL_N_PIPE_B.CDR	DATE 08/08

Appendix 2-2

Pippeline Drawings


CONTAINER
CONC
220
TRAILER
1709
1710
WOOD RAMP
????
1705
1706
ASPH
CORPORAL ROAD
DIRT
CONC
STEEL STEPS
1704
1703
RAMP
WOOD
COVERED WOOD DECK
STEEL BLDG.
TANK
1701
1702
138
A/C
ASPH WALK
ELEV
CONC WALK
79
AERO ROAD
Above Ground Piping
Wall Mounted Every 5'
Note: Connection into Phase I Pipeline
Extraction Well 3
Underground Piping
310
CONC. SIDEWALK
EXPLORER ROAD
DWY
N
0
30
60
SCALE IN FEET
DESIGNED BY BH
DRAWN BY LC
CHECKED BY BH
Battelle
As Built Pipeline Location for Extraction Well No. 3
JPL - PASADENA, CA
PROJECT G005862-3L
FILE JPL_S_PIPE.CDR
DATE 08/08



DESIGNED BY BH	Battelle		
DRAWN BY LC	As Built Pipeline Location for Injection Well No. 3		
CHECKED BY BH	JPL - PASADENA, CA		
	PROJECT G005862-3L	FILE JPL_N_PIPE.CDR	DATE 08/08