

September 6, 2019  
10388.007

Mission Springs Water District  
66575 2<sup>nd</sup> Street  
Desert Hot Springs, California 92240

**VIA EMAIL/First Class**

**Attention: Danny Friend,  
Director of Engineering and Operations**

**Subject: Technical Memorandum –  
Monitoring Well Installations & Water-Levels Evaluation  
Mission Springs Water District  
Desert Hot Springs, Riverside County, California**

Dear Mr. Friend:

The Coachella Valley Conservation Commission (CVCC) intends to restore mesquite hummock habitat in the area of the Banning Fault, south of Desert Hot Springs, Riverside County, California. A key task in the restoration program is the removal of tamarisk trees that are thought to depress the water table in the area of the hummocks, leaving the root systems of mesquite plants out of touch with the water table. The mesquite hummock habitat is home to several endangered species. The work is guided by the Coachella Valley Multiple Species Habitat Conservation Plan (CVMSHCP).

This Technical Memorandum documents the results of monitoring well installation and water-level evaluation work performed between July 2018 and July 2019. The initial Technical Memorandum–Hydrogeological Evaluation & Well Siting (*EnviroLogic Resources, Inc.*, 2017) for Mission Springs Water District (MSWD) recommended the installation of two monitoring wells (TMW-1 and TMW-2) proximal to tamarisk stands in mesquite hummock habitat areas of the Banning Fault zone and Willow Hole Conservation area. Figure 1 shows the Willow Hole Conservation Area. The well specifications included deployment and operation of *In-Situ* Level TROLL<sup>®</sup> programmable pressure transducers to record water levels at specified intervals daily.

The wells were installed via Resonant Sonic-Rotary (or “sonic”) drilling methods in late July and early August, 2018. The pressure transducer logs were initiated soon thereafter. MSWD incorporated quarterly site visits into its routine periodic monitoring programs relating to

other MSWD operations. During the MSWD site visits, the TMW-1 and TMW-2 raw transducer data was downloaded to a mobile device with an *In-Situ* Wireless TROLL Communication device, and converted to a standard spreadsheet format (i.e. a comma separated value, or \*.csv, file).

Approximately eleven months of water level data were obtained between August 2018 and the latest MSWD transducer log downloads (July 9, 2019). We understand MSWD is in the process of transferring ownership of these two wells and transducer logging systems to CVCC administrator Coachella Valley Association of Governments (CVAG) for further use. The battery-life of the transducers could provide up to nine more years of data collection when operated and maintained in accordance with the manufacturer's product information and instruction manual documents.

## **MONITORING WELL INSTALLATIONS**

Standardized methods and procedures were developed into monitoring well specifications (MSWD, 2018) prior to commencement of this phase of field activities. This guide helped with field inspections, quality control, and sample collection, provided a consistent framework for description of geologic material, and helped to protect the health and safety of all site personnel. Relevant field methods and procedures are presented in Section 4 – Detailed Technical Provisions Monitoring Well Specifications (MSWD, 2018). Figure 2 shows the locations of monitoring wells TMW-1 and TMW-2.

In lieu of the planned air-rotary/casing hammer or dual-tube/percussion hammer drilling methods, the wells were installed by sonic drilling methods on the recommendation of the selected drilling contractor due to the potential for difficult drilling conditions (i.e., unconsolidated dune-type sediments) anticipated at the site. Prior to conducting subsurface explorations MSWD and/or CVAG arranged for public/private utility notifications in the work area to clear the proposed locations.

Where ground disturbances would occur during the initial mobilization onto the TMW-1 well site, equipment staging and setup, and shallower drilling, the Agua Caliente Band of Cahuilla Indians of the Palm Springs area observed these activities for cultural artifacts. CRM Tech, of Colton, California (CRM), was present for documenting archaeological evidence both prior to and during construction. Grinding-stone and mano (mortar- and pestle-like) remnants typical of local historical tribal use were identified by CRM, logged, geo-located by GPS, and removed for further study/testing. Possible plant residues composed mostly of ancient starch granules were observed on some polished remnant surfaces that could be analyzed for indications of specific seed and grain processing, for example. We understand some or all of the grinding-stone and/or mano remnants were or will be returned to the approximate discovery locations near TMW-1 after drilling activities, according to the CRM

---



forensic archaeologist.

Field conservation staff with CVCC/CVAG surveyed daily in and around both well sites for signs of sensitive, threatened, or endangered dune ecology species activity, including for certain rodents, birds, insects, snake, and lizards, prior to drilling operations and periodically. If and where encountered in the work zone, such were relocated nearby by CVCC/CVAG.

Drilling activities and associated field work (soil sampling and monitoring well installation) were performed at the well sites from July 30 to August 5; well development and transducer deployment was conducted from August 14 to August 18; and, logging of the two well transducers started by August 18, 2018. Original monitoring well TMW-2 was abandoned and replaced by sonic over-drilling at the same approximate location on August 16 and 17, after discussions with the well permitting agency, as its structural and performance integrity was compromised (inferred broken screen interval) as the screen interval was found to be full of grout on August 15, 2018, prior to planned well development work. During re-drilling of monitoring well TMW-2, an 8-inch drill stem was utilized for over-drilling the borehole versus the 6-inch diameter drill stem used originally. The attached field logs contain the construction details for monitoring wells TMW-1 and TMW-2.

### **Pilot-Boring Soil Sampling & Monitoring Well Installation**

Drilling and monitoring-well construction was performed by Yellow Jacket Drilling Services, LLC (YJD), of Rancho Cucamonga, California, using a sonic drilling rig between July 30, and August 18, 2018. The proposed boring/well locations in Desert Hot Springs, California, did not have to be relocated, except TMW-2 was moved approximately 5-feet west away from an apparent off-road trail. Monitoring well TMW-1 is located on CVAG property to the west of Palm Drive and approximately 125-feet north of 20<sup>th</sup> Avenue. Well TMW-2 is located approximately 200-feet to the west of Mountain View Drive. Both well sites were pre-selected by MSWD, CVCC/CVAG, and *EnviroLogic Resources* due to the proximity of invasive tamarisk groves scheduled for removal from the mesquite dune ecology, and our understanding of the geology presented in the initial technical memorandum (*EnviroLogic Resources*, 2017). Site access agreements were formalized between MSWD and CVAG for both monitoring wells TMW-1 and TMW-2.

Standardized protocols were employed during the soil-sampling operation. Relatively undisturbed, continuous soil cuttings were carefully extruded with vibration from the sonic drill rig 6-inch diameter inner core barrel into plastic core bags for discrete depth intervals. Soil samples were generally obtained and logged at 2-foot to 3-foot intervals, and a portion of each soil sample was also collected into re-sealable plastic bags for archiving and/or future study. The soil cores were screened for field moisture indications, and logged to record soil types, grain sizes, and other pertinent information.

---



Decontamination procedures were established to control the movement of potential contaminants to clean, uncontaminated areas and to prevent cross-contamination between wells and samples. Before and/or after each use, the sonic drilling equipment was decontaminated by using a high-pressure steam cleaner. Decontamination water was contained on a trailer-mounted tank and then transferred to a 55-gallon drum. The decontamination water was transferred by draining the trailer-mounted tank into 5-gallon buckets and emptying the buckets into the drum. Soil cuttings were also deposited into labeled 55-gallon drums. These investigative-derived wastes were temporarily stored on-site pending waste profiling/disposal management. Per YJD, the associated analytical results indicated the derived solid and liquid wastes are comprised of non-hazardous environmental media and debris. The materials were transported from the site and managed accordingly by the waste removal subcontractor selected by YJD.

The pilot soil borings for wells TMW-1 and TMW-2 were advanced to depths of 92.5- to 100.8-feet below grade, respectively. The bottom 50-feet of both monitoring wells were screened with 2-inch diameter, schedule 40 PVC slotted well screen, with 0.020-diameter slots connected to a blank riser casing and an end/bottom cap. A filter-pack was installed by pouring 8-20 silica sand between the well casing and the outer 6-inch diameter (8-inch during TMW-2 over-drilling) drill stem as the drill stem was extracted. The sand was placed to extend approximately 2-feet above the screen interval, with 2.5-feet each of transitional sand seal and granular bentonite seal above the filter pack sand. A weighted tape was used to measure the depth of sand during construction. Cement grout with approximate 5-percent bentonite additive was installed between the remaining blank portion of the 2-inch well casing and the 6-inch and 8-inch drill stem. The cement grout-with bentonite surface seal extends to approximately 1-foot below the ground surface. The surface of each monitoring well was completed with a nominal 18-inch height of blank riser casing fitted with a 2-inch diameter locking cap, shrouded in a 6-inch diameter circular locking, protective steel casing monument with a 24-inch height set in a concrete slab with protective corner bollards. The total completed depth of monitoring well TMW-1 is 100.60-feet; the total completed depth of well TMW-2 is 92.40-feet.

### **Well Development**

On August 14 and August 18, 2018, monitoring wells TMW-1 and TMW-2 were developed by bailing for 30-minutes, followed by swabbing up and down the screened interval for 60-minutes, and then purging with a portable submersible pump at 3.5- to 4.0-gallons per minute connected to nylon reinforced PVC discharge tubing. During purging, the pump was moved up and down within the well screened interval. Development was considered complete when at least three well volumes were pumped, the pumped water was mostly or completely free of sediment and appeared clear, and field parameters of groundwater temperature, pH, and

---



specific conductance had stabilized to within approximately 10% or less variability between measurements. Well purging and development water was temporarily added to 55-gallon drums, CVCC/CVAG field staff authorized ground discharge nearby the work areas, as the water appeared to be clean (no obvious odors, or other field indications of concern).

Only a few feet of water-level drawdown were observed during well purging and development activities.

- TMW-1 pre-development water level: 53.15-feet  
final purging measurement: 55.96-feet
- TMW-2: pre-development water level: 35.87-feet  
final purging measurement: 36.63-feet

This suggests that the specific capacity of the wells and the corresponding aquifer transmissivity values would be relatively high as would be expected in unconsolidated water-bearing sandy-gravelly sediments. During pilot-boring soil sampling, water-bearing silty clay, sandy silt, silty sand, medium-coarse sand, gravelly sand, and sandy gravel were recorded. The well development contractors stated these are two “good producing, clean” wells and, therefore, should perform adequately for the purposes of long-term monitoring/transducer logging.

### **Pressure Transducers Deployment & Logging**

The initial static water-level measurement in monitoring well TMW-1 after development and prior to its pressure transducer deployment was approximately 50.08-feet, which was used as the default starting point during programming of its transducer. For well TMW-2, the initial static water-level measurement was 36.58-feet, which was used as the default starting point for its transducer.

- TMW-1 static water level @ start of transducer logging: 50.08-feet
- TMW-2 static water level @ start of transducer logging: 36.58-feet

A vented Level TROLL 500 Data Logger<sup>®</sup> was procured by YJD through *In-Situ* of Fort Collins, Colorado, for each well per the Detailed Technical Provisions-Monitoring Well Specifications (MSWD, 2018), including the necessary communications cabling and connections. Wireless TROLL Com<sup>®</sup> communication devices were also procured and provided (one each) to MSWD and CVAG after transducer programming, deployment, startup and verification of logging. The pressure transducers are programmed to obtain a reading six (6) times per day, at four (4) hour intervals. The TMW-1 transducer log was

---

started on August 15, and TMW-2 logging on August 18, 2018. MSWD incorporated site visits to download the logging records during its routine periodic monitoring programs work relating to other projects. MSWD provided downloads toward the end of January, April, and July 2019. The last download from the TMW-1 and TMW-2 transducers occurred on July 9, 2019. By our understanding, the transfer of the monitoring wells and transducers ownership to CVCC/CVAG is to occur in later 2019, per joint agreement.

## **RESULTS**

Two monitoring wells were placed at the selected locations to provide data about changes in the groundwater table as a result of removing the tamarisk trees within the Banning Fault zone of the Willow Hole Conservation Area. Monitoring well TMW-2 was installed first, followed by TMW-1. Well TMW-1 was developed first, followed by TMW-2. Well TMW-2 was re-drilled by over-drilling after grout was discovered within the well during an attempt at development. Subsequent to successful development of the wells, water-level data recorders (i.e. pressure transducers) were lowered in place within the lower portion of the screened interval and initiated. Data transfers coordinated by MSWD were provided to *EnviroLogic Resources* for evaluation of approximately 11 months of water-level measurements in relation to the hydrological regimes that support mesquite hummocks in the CVMSHCP area and provide baseline data for the ongoing monitoring of mesquite hummocks. The boring logs showing lithologic descriptions and well completion information are included on the attached Figure 3 (TMW-1) and Figure 4 (TMW-2).

### **TMW-2 Formation Materials**

The maximum target depth for TMW-2 was 100-feet. During the pilot-borehole drilling of TMW-2, an aridisol paleosol was observed from 20- to 24-feet below grade surface (bgs) underlying medium-coarse sand and the approximately 5-feet thick surficial aridisol. More medium-coarse sand was observed to a depth of approximately 34-feet where a 1-foot thick, moist-wet, silty clay was encountered, below which borehole materials were wet. Groundwater within the TMW-2 pilot-hole was initially inferred to occur at a 34- to 36-foot depth range, after development the water table was measured within the completed well at 36.58-feet below the north top of casing during transducer deployment. Water-bearing medium-coarse sand was observed to approximately 80-feet bgs, with a 3-feet thick silty clay zone between approximately 53- to 56-feet (with apparent sand fissures, root clasts, mottling, and small black iron concretions). Smaller lens of sandy clay with gravel was observed in the TMW-2 pilot-borehole at 63-feet, coarse sand at 64-ft, and gravel/pebbles at 68-feet deep. Between 82-feet and the approximately total borehole depth of 92.5-feet, a silty sand with gravel was observed.

---

Given the occurrence of over 50-feet of apparent groundwater in the borehole, adequate water column thickness would be provided in the completed well (final TMW-2 total well depth of 92.4-feet) for good transducer operation and for any future monitoring/sampling use in studying the uppermost mesquite-dune aquifer. The formation materials encountered in TMW-2 are consistent with dune deposits overlying and interbedded with alluvial fan slopes, and intermittent stream to possibly shallow lake deposits.

### **TMW-1 Formation Materials**

The maximum target depth for TMW-1 was also 100-feet. During the pilot-borehole drilling of TMW-1, an aridisol paleosol was observed from 13- to 14-feet bgs, and another small aridisol lens at 15-feet, underlying medium-coarse sand and a shallower buried aridisol approximately 2-feet thick from 6- to 8-feet bgs. More medium-coarse sand was observed to a depth of approximately 24-feet, a gravel lens occurred at 24-feet and a very fine sand lens at 25-feet. Another aridisol paleosol was observed between depths of 25- to 30-feet overlying medium-coarse sand to a depth of 42-feet. A gravelly zone was observed with the coarse-medium sand between depths of 36- to 39-feet. From 42 to 43-feet deep, a silty clay zone was observed (with apparent sand fissures, root clasts, mottling, and mud lenses). Gravelly sand with clay was observed between 43- and 54-feet bgs, these materials were observed to be wet at a depth of 52-feet. Groundwater within the TMW-1 pilot-hole was initially inferred to occur at a 47.5- to 50-feet depth range, after development the water table was measured within the completed well at 50.08-feet below the north top of casing during transducer deployment. A 2-feet thick silty clay was noted from 54- to 56-feet overlying wet medium-coarse sand to a depth of 62-feet; a 2-feet thick clayey silt was observed from 62- to 64-feet. Medium-coarse sand was apparent between depths of 64- to 65-feet overlying silty clay to a depth of 68-feet, with a gravelly zone at 68-feet. Silty sand with clay occurred from 68- to 72-feet deep, and sandy silt with clay was noted from 72- to 74-feet. Medium-coarse sand was again encountered to a depth of approximately 90-feet, below which sandy gravel with cobbles was observed to a depth of 94-feet overlying silty clay with apparent manganese nodules to a pilot-borehole depth of 100.6-feet.

Given the occurrence of over 50-feet of apparent groundwater in the borehole, adequate water column thickness would be provided in the completed well (final TMW-1 total well depth of 100.6-feet) for good transducer operation and for any future monitoring/sampling use in studying the uppermost mesquite-dune aquifer. The formation materials encountered in TMW-1 from the surface to a depth of approximately 94-feet are also consistent with dune deposits overlying and interbedded with alluvial fan slopes, and intermittent stream to possible shallow lake deposits. However, the presence of several manganese-type nodules with diameters varying between 0.5- to 1.5-inches within the silty clay matrix observed from approximately 94- to 100-feet deep in the TMW-1 pilot-borehole indicates a change to deeper sediments of differing depositional environment (deeper lacustrine and/or marine

---

system) and likely to be older than the upper mesquite-dune system (estimated Pleistocene-Holocene unconsolidated valley fill).

For slow accretion manganese-type nodules to be encountered at an elevation approximately 600-feet above present-day sea level at the TMW-1 location indicates significant time for uplift to have occurred, as manganese-type nodules typically form very slowly at depths of at least a few hundred up to several thousands of feet underwater, most often in deep, passive, marine environments. Some manganese nodule deposits have been encountered in lacustrine depositional environment where hydrothermal venting may occur for very long periods at depth along volcanic areas. It is possible the manganese deposits also extend beneath the TMW-2 location, however, the pilot-borehole was not deep enough to intercept such materials, if evident.

A silty clay zone with sand fissures, root clasts, and mottling appeared within the materials retrieved from both pilot-boreholes that somewhat correlate with surface topography and apparent elevations. A few paleosols observed in the vadose zone may also reflect a similar topographic pattern. Gravelly zones do not appear to extend between well sites. Nor did either well appear to intercept deeper materials with evidence of faulting along the Banning Fault or its splays. The water table does not appear to coincide between the TMW-1 and TMW-2 sites, with monitoring well TMW-1 located close to (east of) Morongo Wash and its broad floodplain and well TMW-2 located in a smaller catchment area nearer (west of) Willow Hole.

## **Hydrogeology**

The primary aquifer system in the Coachella Valley is unconsolidated Pleistocene-Holocene valley fill. Groundwater recharge is primarily runoff from the surrounding mountains, local precipitation, irrigation return, stream flow from the Whitewater River and other rivers and creeks, and from imported Colorado River water supplied to spreading grounds throughout the Coachella Valley. Groundwater discharge is to evapotranspiration, underflow to the Salton Sea and Imperial Valley areas, and to pumping wells. A more detailed description of the local Coachella Valley and Mission Creek Subbasin geology was made in the initial technical memorandum (*EnviroLogic Resources*, 2017), including in relation to faulting. In some areas of the fault zone, the faults and fractures may act as conduits rather than barriers.

The shallow groundwater within the Seven Palms Ridge area of the Banning Fault zone where wells TMW-1 and TMW-2 are located are not mapped or identified as within a Bulletin 118 Groundwater Basin. Our evaluation confirms that groundwater is closer to the surface in the Banning Fault zone near the Mission Creek Subbasin. Within the fault zone, the geology appears to be discontinuous, meaning water-bearing layers of higher permeability and good transmissivity may abruptly terminate adjacent to lower permeability

---

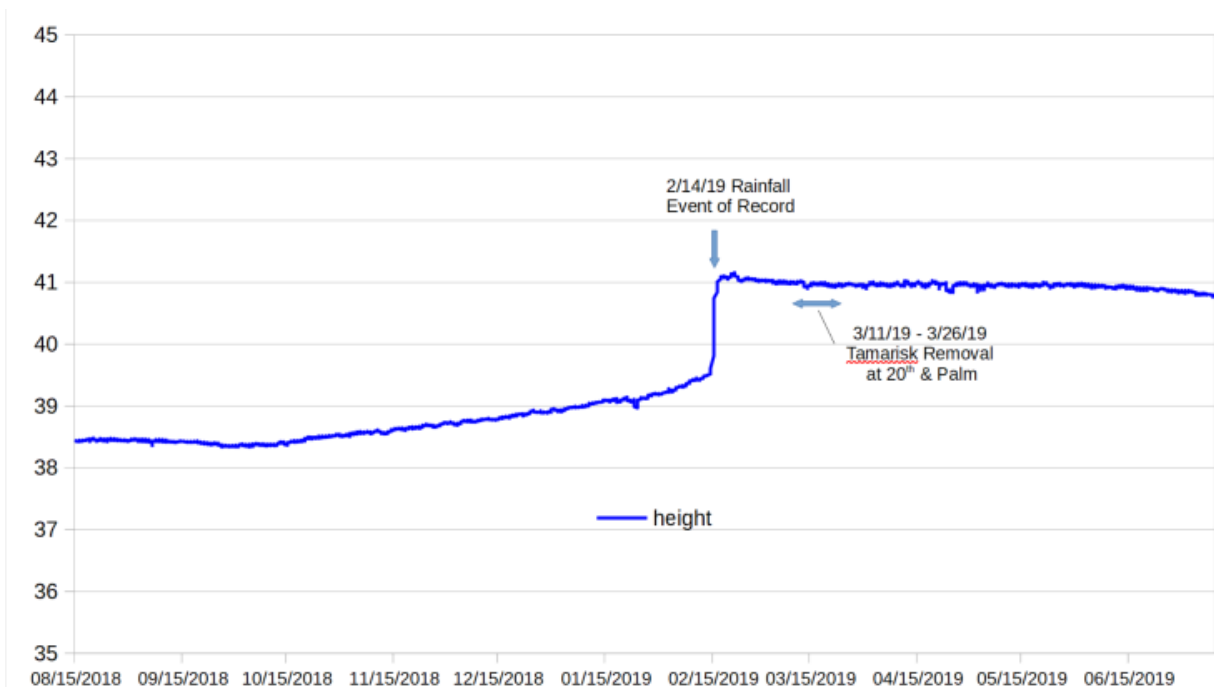


zones of poor transmissivity. This is evidenced by the differing water-level responses to a record rainfall event that occurred in mid-February, wherein well TMW-2 may be isolated with perched groundwater in relation to TMW-1 water-levels.

### Water-Level Trends

The transducer data is recorded and output to a comma-separated value (\*.csv) file format compatible with spreadsheet software. The following charts were made from the most recent data download by MSWD. The charts are marked with timelines for CVAG tamarisk removal work and significant rainfall events of record, relative to pressure and height of water column above the transducer elevation.

TMW-1



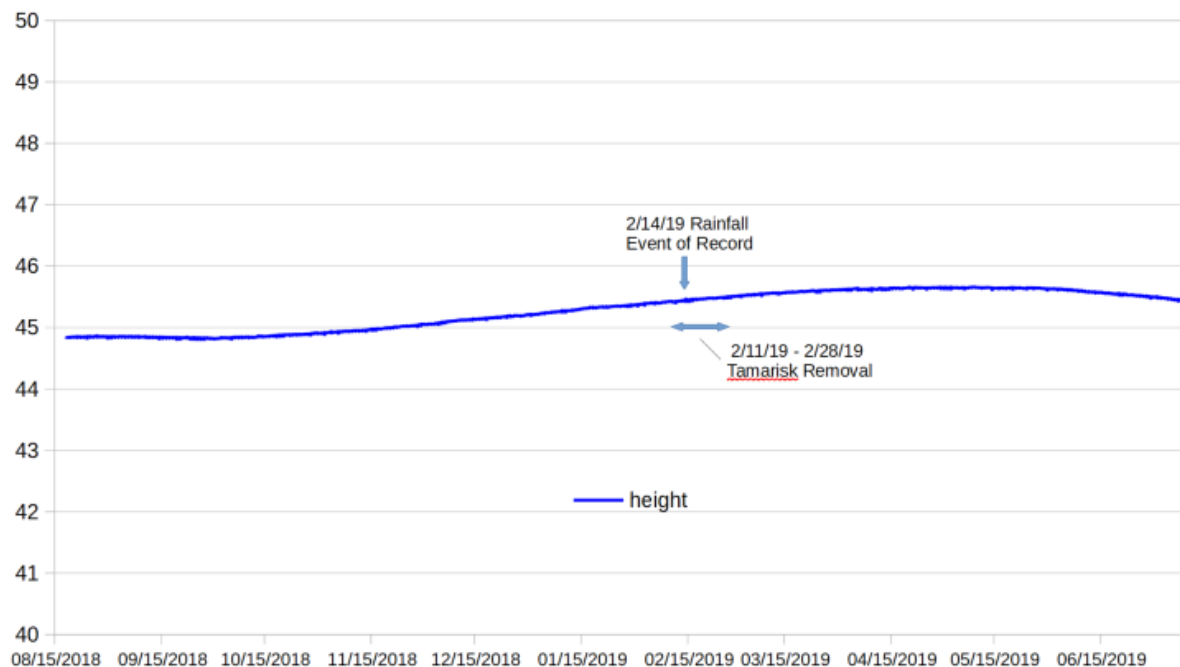
The daily total rainfall for February 14, 2019, was 3.69-inch, which was the third highest ever recorded for the Palm Springs area since 1925, and largest late-winter event.

It is apparent from these charts that the TMW-1 and TMW-2 well sites are not in direct hydrologic communication. While both trends show a response to the February 14<sup>th</sup> rainfall event of record, the TMW-1 site reflects a more immediate response and direct connection with recharge effects attributed to the Morongo Wash and its floodplain, with its groundwater elevation raised by nearly 2-feet within a day or two.

---



## TMW-2



Whereas, the TMW-2 site reflects a smaller magnitude response to the record rainfall event reasoned to occur given the well is located in a smaller catchment isolated between splays of the Banning Fault Zone, with its groundwater elevation raised in the range of 6- to 12-inches over a month or two.

The recent removal of tamarisk does not appear to have directly affected groundwater elevations at either the TMW-1 or TMW-2 well locations. Smaller magnitude earthquakes (i.e., > M2.5) were reported in the region (<http://scedc.caltech.edu/>) during the course of monitoring, including the time frame of the February 2019 record rainfall event; however, these earthquakes do not appear to have affected the transducer water-level records.

## RECOMMENDATIONS

The most recent transducer data was obtained within three to four months after tamarisk removal nearby and elsewhere in the region. The periodic monitoring program should be continued, including collection of water-level data for as long as possible after tamarisk removal. The longer the water level record, the higher the confidence in determining groundwater level trends and potential for longer-term response to tamarisk removal. Water-

---

---

Mr. Danny Friend  
September 6, 2019  
Page 11

level data collected from the transducers should provide information about whether tamarisk removal efforts locally and/or regional may affect groundwater levels over periods beyond three to four months.

## CONCLUSIONS

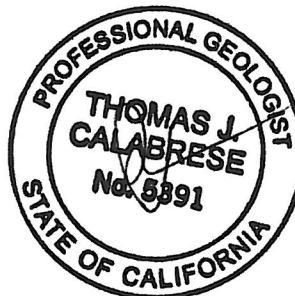
Two monitoring wells were installed to evaluate groundwater conditions in areas where tamarisk has since been removed. It is our understanding that additional tamarisk removal in the region is still underway. While these wells did not show a response to recent tamarisk removal by localized raising of the water table, continued data collection may provide the ability to further interpret the hydrologic regime of the unconsolidated valley fill and mesquite-dune aquifers within portions of the Banning Fault zone and the Willow Hole Conservation Area, as well as tamarisk removal over a broader/regional area. The additional understanding of the aquifer materials can also be useful in guiding future planned habitat restoration.

Thank you for the opportunity to provide these professional services. If you have any questions or comment, please call me at (213) 453-8765.

Sincerely,  
*EnviroLogic Resources, Inc.*

  
Jason C. Howard  
Project Hydrogeologist

  
Thomas J. Calabrese, RG  
Principal Hydrogeologist



JCH/

## Figures

- |          |                               |
|----------|-------------------------------|
| Figure 1 | Willow Hole Conservation Area |
| Figure 2 | Monitoring Well Locations     |
| Figure 3 | Boring Log for TMW-1          |
| Figure 4 | Boring Log for TMW-2          |



## REFERENCES

- California Department of Water Resources, 1964, Coachella Valley Investigation: Calif DWR Bulletin 108, July 1964, 145 p.
- California Department of Water Resources, 2003, California's Groundwater, Calif DWR Bulletin 118, October 2003, 208 p.
- Coachella Valley Water District, 2002, Coachella Valley Water Management Plan: CVWD report prepared with assistance from MWH and Water Consult, September 2002, 186p.
- Coachella Valley Water District, 2010, Engineer's report on water supply and replenishment assessment, Mission Creek Subbasin Area of Benefit, 2010-2011: CVWD report dated April 2010, 21p.
- Coachella Valley Water District, 2014, Engineer's report on water supply and replenishment assessment, Mission Creek Subbasin Area of Benefit, 2014-2015: CVWD report dated April 2014, 24p.
- EnviroLogic Resources, 2017, Technical Memorandum – Hydrogeological Evaluation and Monitoring Well Siting, Mission Springs Water District, Desert Hot Springs, Riverside County, California: consultant report dated December 2017.
- GSi/water, 2005, Results of Drilling, Construction and Testing 900 ft. Zone Well Desert Hot Springs, Riverside County California: Consultant report prepared for Mission Springs Water District, dated May 27, 2005.
- Mission Springs Water District (MSWD), 2017, Contract Documents & Specifications for the Construction of Willow Hole Groundwater Monitoring Wells. Detailed Technical Provisions, and Monitoring Wells Specifications: MSWD, Desert Hot Springs, California, Project Order No. 15-001-S document, dated January 2018.
- MWH, 2012, Coachella Valley Water Management Plan 2010 Update, Final Report: Consultant report prepared for Coachella Valley Water District, January 2012, 214p.
- MWH, 2013, Mission Creek and Garnet Hill Subbasins Water Management Plan Final Report: Consultant report dated January 2013.
- MWH, 2014, Technical Memorandum No.1 Preliminary Data Review and Documentation of Technical Methods: Consultant report dated October 16, 2014.
-

---



Mr. Danny Friend  
September 6, 2019  
Page 13

MWH, 2015, FINAL - Technical Memorandum No. 2 Ambient Water Quality: Consultant report dated February 27, 2015.

MWH, April 2015, Coachella Valley Groundwater Basin Salt and Nutrient Management Plan Draft: Consultant report dated April 2015, in association with: GEI Consultants, Inc., Krieger & Stewart, Inc., Michael Welch Consulting Engineer.

Proctor, R.J., 1968, Geology of the Desert Hot Springs-Upper Coachella Valley area, California: Calif Div of Mines and Geology Special Report 94, 42 p.

Psomas, 2011, 2010 Urban Water Management Plan: Consultant report prepared for Mission Springs Water District.

Psomas, 2013, Groundwater Flow Model of the Mission Creek, Garnet Hill and Upper Whitewater River Subbasins, Riverside County, California: Consultant report dated January 2013.

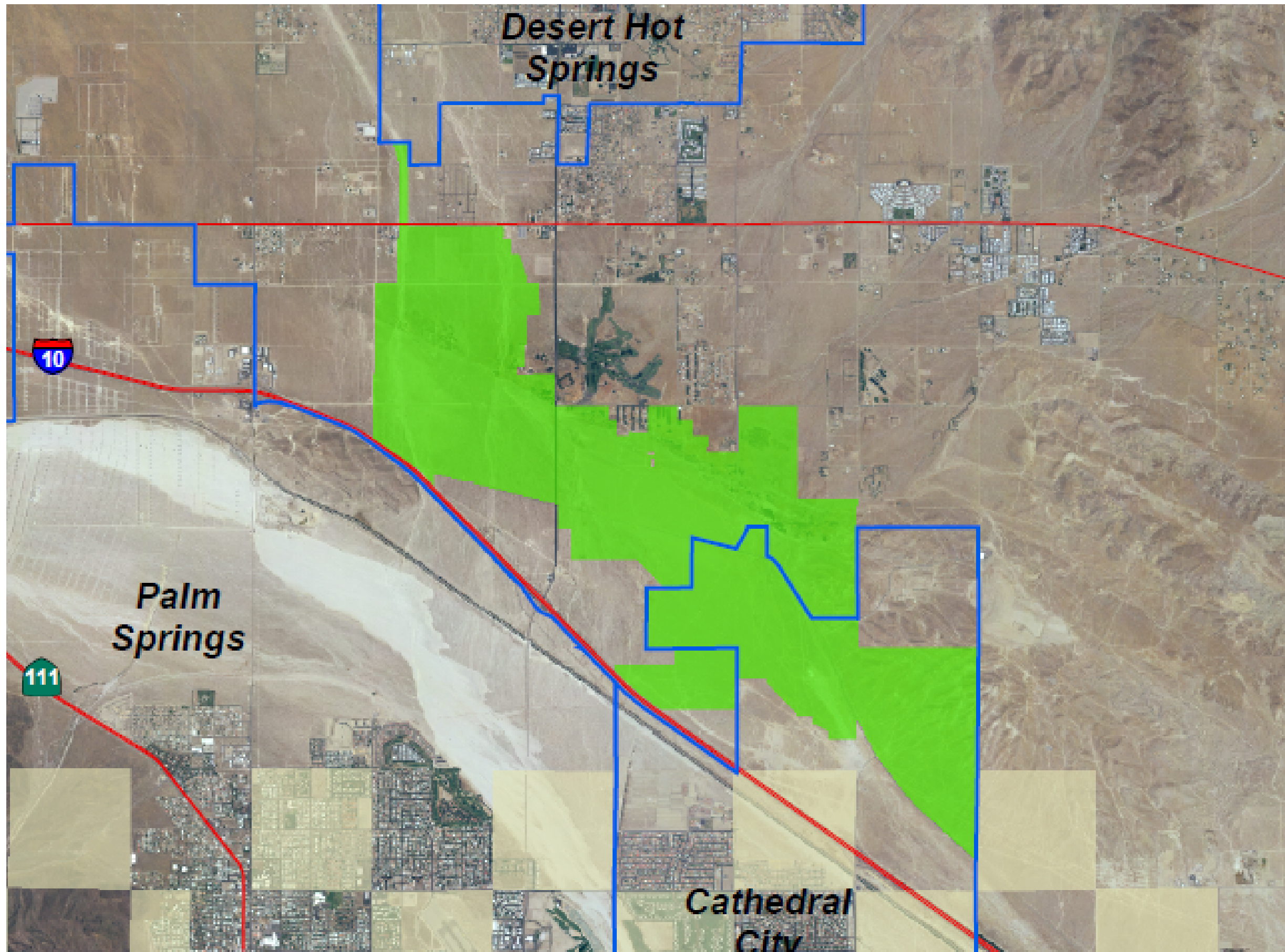
Tyley, Stephen J., 1974, Analog Model Study of the Ground-Water Basin of the Upper Coachella Valley, California: US Geological Survey Water-Supply Paper 2027.

---





## ***FIGURES***



T3S, R5E  
San Bernardino Meridian  
Riverside County,  
California

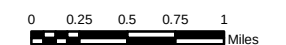
#### Explanation

|                                                                                                   |                                  |
|---------------------------------------------------------------------------------------------------|----------------------------------|
| <span style="border: 1px solid blue; display: inline-block; width: 15px; height: 10px;"></span>   | City Boundaries                  |
| <span style="background-color: yellow; display: inline-block; width: 15px; height: 10px;"></span> | Indian Reservations (Not a part) |
| <span style="background-color: green; display: inline-block; width: 15px; height: 10px;"></span>  | Willow Hole Conservation Area    |
| <span style="border-bottom: 2px solid red; display: inline-block; width: 15px;"></span>           | Major Roads                      |

This map was prepared for the purpose of identifying the location of general site features and water resources only and is not intended to provide a legal description or location of property ownership lines.



1 inch = 1 mile

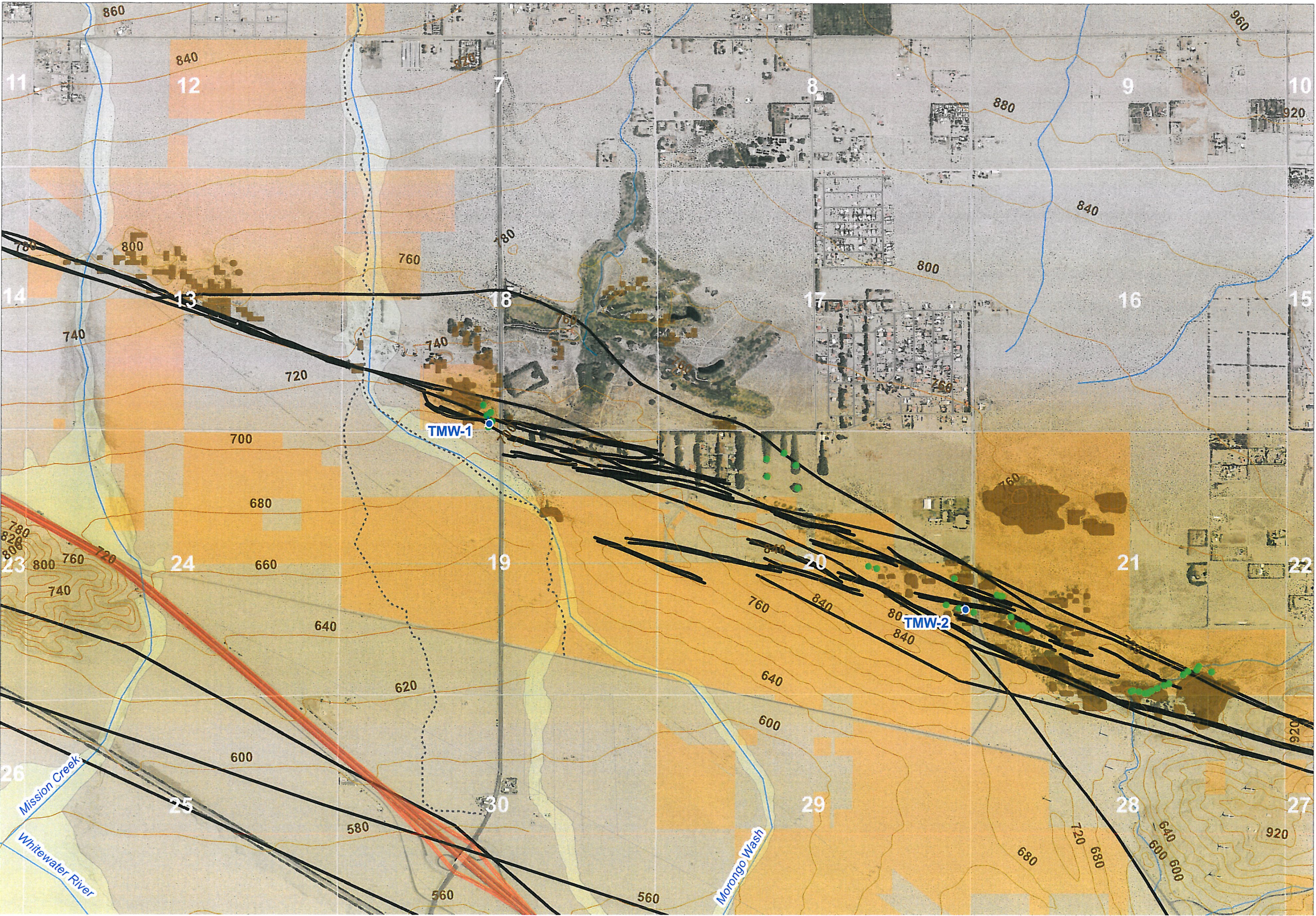


### FIGURE 1 WILLOW HOLE CONSERVATION AREA

Mission Springs Water District  
Desert Hot Springs  
Riverside County, California

World Geodetic System (WGS)  
Datum of 1984  
Prepared: July 21, 2017

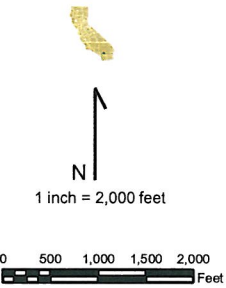
Sources: USGS aerial imagery, elevation, waterbodies, shapefiles (earthexplorer.usgs.gov); BLM CadNSDI PLSS (GeoCommunicator LSIS, 2017); available Riverside County roads, lakes, streams, GIS shapefiles (http://gis.rivcoit.org, 2017); Coachella Valley Multi-Species Habitat Conservation Plan, Willow Hole Conservation Area (CVAG, et al, 2007)



**T3S, R5E  
San Bernardino Meridian  
Riverside County,  
California**

- Explanation**
- Mesquite\_Hummocks
  - CVCC Property
  - Mapped Faults
  - Streams
  - Highways
  - Roads
  - Authorized\_Trails
  - Tamarisk
  - Monitoring Wells

This map was prepared for the purpose of identifying the location of general site features and water resources only and is not intended to provide a legal description or location of property ownership lines.



**FIGURE 2  
MONITORING  
WELL LOCATIONS**

**Mission Springs Water District  
Desert Hot Springs  
Riverside County, California**

World Geodetic System (WGS)  
Datum of 1984  
Prepared: July 21, 2017

Sources: USGS aerial imagery, elevation, waterbodies, shapefiles (earthexplorer.usgs.gov); BLM CadNSDI PLSS (GeoCommunicator LSIS, 2017); available Riverside County roads, lakes, streams, GIS shapefiles (http://gis.rivcoit.org, 2017); California Geological Survey faults (http://www.conservation.ca.gov/cgs); CVAG Tamarisk, Mesquite Hummocks, Roads shapefiles (Coachella Valley Association of Governments, 2017); Bulletin 118

**FIGURE 3 MONITORING WELL TMW-1**

|                                            |     |         |             |          |                                               |                   |             |                                                                                                   |          |                                       |                         |                |  |  |
|--------------------------------------------|-----|---------|-------------|----------|-----------------------------------------------|-------------------|-------------|---------------------------------------------------------------------------------------------------|----------|---------------------------------------|-------------------------|----------------|--|--|
| PROJECT NUMBER 10388.002                   |     |         |             |          | DRILLING COMPANY Yellow Jacket Drilling       |                   |             |                                                                                                   |          | COORDINATES 33.9036300 -116.502321087 |                         |                |  |  |
| PROJECT NAME Banning Fault Zone MWs        |     |         |             |          | DRILL RIG                                     |                   |             |                                                                                                   |          | COORD SYS Field GPS                   |                         |                |  |  |
| CLIENT Mission Springs Water District      |     |         |             |          | DRILLER Carlos                                |                   |             |                                                                                                   |          | SURFACE ELEVATION Approx. 700-feet    |                         |                |  |  |
| ADDRESS Desert Hot Springs, CA             |     |         |             |          | DRILLING METHOD Sonic                         |                   |             |                                                                                                   |          | WELL NTOC Not surveyed                |                         |                |  |  |
| START DATE 8/2/2018                        |     |         |             |          | TOTAL DEPTH 100.6                             |                   |             |                                                                                                   |          | LOGGED BY J. Howard                   |                         |                |  |  |
| COMPLETION DATE 8/4/2018                   |     |         |             |          | DIAMETER (borehole/well) 6-inch min. / 2-inch |                   |             |                                                                                                   |          | CHECKED BY T. Calabrese               |                         |                |  |  |
| COMPLETION Aboveground w/Locking Steel Lid |     |         |             |          | CASING PVC                                    |                   |             |                                                                                                   |          | SCREEN PVC 0.020-Factory Slotted      |                         |                |  |  |
| COMMENTS                                   |     |         |             |          |                                               |                   |             |                                                                                                   |          |                                       |                         |                |  |  |
| Depth (ft)                                 | PID | Samples | Sample Type | Analyses | Water                                         | Well Installation | Graphic Log | Material Description                                                                              | Moisture | Consistency                           | Additional Observations | Elevation (ft) |  |  |
| 10                                         |     |         |             |          |                                               |                   |             | light grey, aridisol topsoil, poorly graded, dune sand, dry, caliche at 6- to 8-ft                |          |                                       |                         | 690            |  |  |
| 20                                         |     |         |             |          |                                               |                   |             | light brown-grey, medium-coarse sand, dry                                                         |          |                                       |                         | 680            |  |  |
| 30                                         |     |         |             |          |                                               |                   |             | paleosol lens, dry, caliche                                                                       |          |                                       |                         | 670            |  |  |
| 40                                         |     |         |             |          |                                               |                   |             | light brown-grey, medium-coarse sand, dry; paleosol-caliche lens at 15-ft, gravel lens at 24-ft   |          |                                       |                         | 660            |  |  |
| 50                                         |     |         |             |          |                                               |                   |             | light brown, paleosol-caliche, w/minor dark peds, dry, very fine sand lens at 25-ft               |          |                                       |                         | 650            |  |  |
| 60                                         |     |         |             |          |                                               |                   |             | light brown-grey, medium-coarse sand, dry; gravelly from 36- to 39-ft                             |          |                                       |                         | 640            |  |  |
| 70                                         |     |         |             |          |                                               |                   |             | olive green-brown, silty clay, moist, mottled, w/sand fissures, root clasts, and mud lenses       |          |                                       |                         | 630            |  |  |
| 80                                         |     |         |             |          |                                               |                   |             | dark brown-grey, gravelly sand, with clay, moist-wet; 1"-3" diameter gravel, darkens/wet at 52-ft |          |                                       |                         | 620            |  |  |
| 90                                         |     |         |             |          |                                               |                   |             | olive brown, silty clay, damp-wet                                                                 |          |                                       |                         | 610            |  |  |
| 100                                        |     |         |             |          |                                               |                   |             | dark brown-grey, medium-coarse sand, wet                                                          |          |                                       |                         | 600            |  |  |
| 110                                        |     |         |             |          |                                               |                   |             | dark brown-olive, silty clay, moist-wet, gravel lens at 68-ft, 1"-3" diameter gravel, hard        |          |                                       |                         | 590            |  |  |
| 120                                        |     |         |             |          |                                               |                   |             | dark brown, silty sand, w/clay, wet                                                               |          |                                       |                         | 580            |  |  |
| 130                                        |     |         |             |          |                                               |                   |             | dark brown, sandy silt, w/clay, wet, hard                                                         |          |                                       |                         | 570            |  |  |
| 140                                        |     |         |             |          |                                               |                   |             | dark brown-grey, medium-coarse sand, wet                                                          |          |                                       |                         | 560            |  |  |
| 150                                        |     |         |             |          |                                               |                   |             | dark brown, sandy gravel, w/cobbles, and angular red rock fragments                               |          |                                       |                         | 550            |  |  |
| 160                                        |     |         |             |          |                                               |                   |             | medium brown, silt clay, w/several manganese-type nodules, 0.5" to 1" diameter nodules            |          |                                       |                         | 540            |  |  |
| 170                                        |     |         |             |          |                                               |                   |             | Termination Depth at: 100.6-ft                                                                    |          |                                       |                         | 530            |  |  |
| 180                                        |     |         |             |          |                                               |                   |             |                                                                                                   |          |                                       |                         | 520            |  |  |
| 190                                        |     |         |             |          |                                               |                   |             |                                                                                                   |          |                                       |                         | 510            |  |  |

**Disclaimer** This bore log is intended for environmental not geotechnical purposes.

Page 1 of 1

FIGURE 4 MONITORING WELL TMW-2

|                                                      |  |     |  |         |  |                                                        |  |          |  |       |  |                                              |  |             |  |                                                                                                                                |  |  |  |  |  |          |  |                                         |  |                         |  |                |  |  |  |  |  |  |  |
|------------------------------------------------------|--|-----|--|---------|--|--------------------------------------------------------|--|----------|--|-------|--|----------------------------------------------|--|-------------|--|--------------------------------------------------------------------------------------------------------------------------------|--|--|--|--|--|----------|--|-----------------------------------------|--|-------------------------|--|----------------|--|--|--|--|--|--|--|
| <b>PROJECT NUMBER</b> 10388.002                      |  |     |  |         |  | <b>DRILLING COMPANY</b> Yellow Jacket Drilling         |  |          |  |       |  | <b>COORDINATES</b> 33.8932480 -116.475979088 |  |             |  |                                                                                                                                |  |  |  |  |  |          |  |                                         |  |                         |  |                |  |  |  |  |  |  |  |
| <b>PROJECT NAME</b> Banning Fault Zone MWs           |  |     |  |         |  | <b>DRILL RIG</b>                                       |  |          |  |       |  | <b>COORD SYS</b> Field GPS                   |  |             |  |                                                                                                                                |  |  |  |  |  |          |  |                                         |  |                         |  |                |  |  |  |  |  |  |  |
| <b>CLIENT</b> Mission Springs Water District         |  |     |  |         |  | <b>DRILLER</b> Carlos (re-drill Jose)                  |  |          |  |       |  | <b>SURFACE ELEVATION</b> Approx. 750-feet    |  |             |  |                                                                                                                                |  |  |  |  |  |          |  |                                         |  |                         |  |                |  |  |  |  |  |  |  |
| <b>ADDRESS</b> Desert Hot Springs, CA                |  |     |  |         |  | <b>DRILLING METHOD</b> Sonic                           |  |          |  |       |  | <b>WELL NTOC</b> Not surveyed                |  |             |  |                                                                                                                                |  |  |  |  |  |          |  |                                         |  |                         |  |                |  |  |  |  |  |  |  |
| <b>START DATE</b> 7/30/2018 (re-drill 8/16/2018)     |  |     |  |         |  | <b>TOTAL DEPTH</b> 92.4                                |  |          |  |       |  | <b>LOGGED BY</b> J. Howard                   |  |             |  |                                                                                                                                |  |  |  |  |  |          |  |                                         |  |                         |  |                |  |  |  |  |  |  |  |
| <b>COMPLETION DATE</b> 8/1/2018 (re-drill 8/17/2018) |  |     |  |         |  | <b>DIAMETER (borehole/well)</b> 6-inch min. / 2-inch ( |  |          |  |       |  | <b>CHECKED BY</b> T. Calabrese               |  |             |  |                                                                                                                                |  |  |  |  |  |          |  |                                         |  |                         |  |                |  |  |  |  |  |  |  |
| <b>COMPLETION</b> Aboveground w/Locking Steel Lid    |  |     |  |         |  |                                                        |  |          |  |       |  | <b>CASING</b> PVC                            |  |             |  |                                                                                                                                |  |  |  |  |  |          |  | <b>SCREEN</b> PVC 0.020-Factory Slotted |  |                         |  |                |  |  |  |  |  |  |  |
| <b>COMMENTS</b>                                      |  |     |  |         |  |                                                        |  |          |  |       |  |                                              |  |             |  |                                                                                                                                |  |  |  |  |  |          |  |                                         |  |                         |  |                |  |  |  |  |  |  |  |
| Depth (ft)                                           |  | PID |  | Samples |  | Sample Type                                            |  | Analyses |  | Water |  | Well Installation                            |  | Graphic Log |  | Material Description                                                                                                           |  |  |  |  |  | Moisture |  | Consistency                             |  | Additional Observations |  | Elevation (ft) |  |  |  |  |  |  |  |
| 10                                                   |  |     |  |         |  |                                                        |  |          |  |       |  |                                              |  |             |  | light grey, aridisol topsoil, poorly graded, dune sand, dry, caliche at 4-ft                                                   |  |  |  |  |  |          |  |                                         |  |                         |  | 740            |  |  |  |  |  |  |  |
| 20                                                   |  |     |  |         |  |                                                        |  |          |  |       |  |                                              |  |             |  | light brown-grey, medium-coarse sand, dry                                                                                      |  |  |  |  |  |          |  |                                         |  |                         |  | 730            |  |  |  |  |  |  |  |
| 30                                                   |  |     |  |         |  |                                                        |  |          |  |       |  |                                              |  |             |  | light brown, aridisol-paleosol, dry, caliche @ 23-ft                                                                           |  |  |  |  |  |          |  |                                         |  |                         |  | 720            |  |  |  |  |  |  |  |
| 40                                                   |  |     |  |         |  |                                                        |  |          |  |       |  |                                              |  |             |  | light brown-grey, medium-coarse sand, dry; moistened at 34-ft                                                                  |  |  |  |  |  |          |  |                                         |  |                         |  | 710            |  |  |  |  |  |  |  |
| 50                                                   |  |     |  |         |  |                                                        |  |          |  |       |  |                                              |  |             |  | olive green-brown, silty clay, moist-wet; dark grey, medium-coarse sand, wet                                                   |  |  |  |  |  |          |  |                                         |  |                         |  | 700            |  |  |  |  |  |  |  |
| 60                                                   |  |     |  |         |  |                                                        |  |          |  |       |  |                                              |  |             |  | medium brown-olive, silty clay, moist-wet, mottling; w/sand fissures, root clasts, and small black iron-type concretions       |  |  |  |  |  |          |  |                                         |  |                         |  | 690            |  |  |  |  |  |  |  |
| 70                                                   |  |     |  |         |  |                                                        |  |          |  |       |  |                                              |  |             |  | dark grey, medium-coarse sand, wet; sandy clay lens w/gravel at 63-ft, reddish-brown, coarse sand lenses at 64-, 68, and 72-ft |  |  |  |  |  |          |  |                                         |  |                         |  | 680            |  |  |  |  |  |  |  |
| 80                                                   |  |     |  |         |  |                                                        |  |          |  |       |  |                                              |  |             |  | dark grey, pebbly medium-coarse sand, w/gravel, wet; small angular fragments and rounded larger gravel; 1"-3" diameter gravel  |  |  |  |  |  |          |  |                                         |  |                         |  | 670            |  |  |  |  |  |  |  |
| 90                                                   |  |     |  |         |  |                                                        |  |          |  |       |  |                                              |  |             |  | dark grey, silty sand, w/gravel, wet, hard                                                                                     |  |  |  |  |  |          |  |                                         |  |                         |  | 660            |  |  |  |  |  |  |  |
| 100                                                  |  |     |  |         |  |                                                        |  |          |  |       |  |                                              |  |             |  | Termination Depth at:92.4-ft                                                                                                   |  |  |  |  |  |          |  |                                         |  |                         |  | 650            |  |  |  |  |  |  |  |
| 110                                                  |  |     |  |         |  |                                                        |  |          |  |       |  |                                              |  |             |  |                                                                                                                                |  |  |  |  |  |          |  |                                         |  |                         |  | 640            |  |  |  |  |  |  |  |
| 120                                                  |  |     |  |         |  |                                                        |  |          |  |       |  |                                              |  |             |  |                                                                                                                                |  |  |  |  |  |          |  |                                         |  |                         |  | 630            |  |  |  |  |  |  |  |
| 130                                                  |  |     |  |         |  |                                                        |  |          |  |       |  |                                              |  |             |  |                                                                                                                                |  |  |  |  |  |          |  |                                         |  |                         |  | 620            |  |  |  |  |  |  |  |
| 140                                                  |  |     |  |         |  |                                                        |  |          |  |       |  |                                              |  |             |  |                                                                                                                                |  |  |  |  |  |          |  |                                         |  |                         |  | 610            |  |  |  |  |  |  |  |
| 150                                                  |  |     |  |         |  |                                                        |  |          |  |       |  |                                              |  |             |  |                                                                                                                                |  |  |  |  |  |          |  |                                         |  |                         |  | 600            |  |  |  |  |  |  |  |
| 160                                                  |  |     |  |         |  |                                                        |  |          |  |       |  |                                              |  |             |  |                                                                                                                                |  |  |  |  |  |          |  |                                         |  |                         |  | 590            |  |  |  |  |  |  |  |
| 170                                                  |  |     |  |         |  |                                                        |  |          |  |       |  |                                              |  |             |  |                                                                                                                                |  |  |  |  |  |          |  |                                         |  |                         |  | 580            |  |  |  |  |  |  |  |
| 180                                                  |  |     |  |         |  |                                                        |  |          |  |       |  |                                              |  |             |  |                                                                                                                                |  |  |  |  |  |          |  |                                         |  |                         |  | 570            |  |  |  |  |  |  |  |
| 190                                                  |  |     |  |         |  |                                                        |  |          |  |       |  |                                              |  |             |  |                                                                                                                                |  |  |  |  |  |          |  |                                         |  |                         |  | 560            |  |  |  |  |  |  |  |

**Disclaimer** This bore log is intended for environmental not geotechnical purposes.

Page 1 of 1