January 22, 2021

Ms. Renee Romero
New Mexico Environment Department
Petroleum Storage Tank Bureau
1914 West Second Street
Roswell, New Mexico 88201-1712

Re: Final Remediation Plan
Bell Gas #1186 (TR's Market), 101 Sun Valley Road, Alto, New Mexico
Facility #912, Release ID #4547, WPID #18033

Dear Ms. Romero:

Daniel B. Stephens & Associates, Inc. (DBS&A) is pleased to submit the enclosed *Final Remediation Plan* (FRP) for the above-referenced site, which was revised to address New Mexico Environment Department (NMED) Petroleum Storage Tank Bureau (PSTB) comments received January 15, 2021. The FRP has been prepared in accordance with your direction and applicable sections of the Petroleum Storage Tank Regulations. Pending approval of the FRP, DBS&A intends to invoice the full amount budgeted for Deliverable ID #18033-5.

Please contact us at (505) 822-9400 if you have any questions or require additional information.

Sincerely,

DANIEL B. STEPHENS & ASSOCIATES, INC.

Thomas Golden, P.E.
Project Engineer

Jeffrey Samson, P.E.
Staff Engineer

Jason Raucci, P.G.
Geologist

TG/ed
Enclosure
cc: Gary Harrell, Bell Gas, Inc.
Katherine MacNeil, NMED PSTB

Responses to Petroleum Storage Tank Bureau Comments Received January 15, 2021, Regarding Bell Gas #1186 (TR's Market) Final Remediation Plan

Daniel B. Stephens & Associates, Inc. (DBS&A) has prepared the following responses to questions posed by the New Mexico Environment Department (NMED) Petroleum Storage Tank Bureau (PSTB) in an email received January 15, 2021, regarding the *Final Remediation Plan* (FRP) for the Bell Gas #1186 (TR's Market) site. DBS&A submitted the original FRP on December 18, 2020. The PSTB's complete comment is provided in italics, followed by DBS&A's response in regular text. The FRP has been updated to include these responses.

Comments

Narrative

1. *Pg. 17, Section 4,.3.2 - Conveyance Line Piping and Trenching. No pressure testing of conveyance lines to test for leaks is mentioned in the narrative, nor is it mentioned in the Specification Section 22 05 03.02. Please explain.*

This remediation system will operate under vacuum, so pressure testing is not warranted. DBS&A will observe conveyance line installation during construction and confirm that standard industry practices are followed regarding conveyance pipe installation. Dedicated conveyance lines will be installed, so DBS&A can also monitor for evidence of dilution air leaks during regular system operation (whistling, diluted air samples, reduced vacuum, etc.). However, if the PSTB prefers that pressure testing be performed by the installation contractor, DBS&A will include that requirement and associated costs in the FRP implementation work plan. DBS&A would recommend that lines be tested at 15 pounds per square inch (psi) for one hour using an air compressor.

2. *Pg. 23, Section 5.2, last paragraph on air stripper effluent vapor samples seems to be an artifact of previous FRPs, please discuss vapor sampling post DTA Diffused Aeration Tank Stripper, and groundwater sampling post-transfer pump downstream of clarifier and post GAC cannisters.*

Occurrences of "air stripper" in Sections 5.3 and 5.4.1 have been replaced with "DTA". We intend to sample the vapor discharge from the diffused tank aerator (DTA) and add this mass contribution to the oxidizer effluent to ensure compliance with air quality permitting requirements.

Ports for water sampling will be provided throughout the treatment train to allow for sampling between individual treatment processes. The need to collect these interim samples will be discussed in the FRP implementation and other future O&M work plans. The primary reason for sampling between processes would be to investigate failure of an individual treatment process, so collection of interim samples will be minor in comparison to overall raw and treated water sampling.

Appendix A: Calculations

3. *Calculation Number: ES 14 0220-001 – "Actual Air flowrate (cubic feet per minute) on the inlet side of the pump"*

a. *Pg 3 of 3 shows V_{des} = 14.7*17 acfm/1.77 psi = 141 scfm –shouldn't flow rate for MW-1S be 17 scfm, corresponding to a flow rate of 141 acfm. The Design Conditions on the pg that follows Pg 3 of 3 of this calculation shows it as 141 acfm. Please clarify and revise sample calculation with regards to denoting cfm in scfm as/if appropriate.*

The calculation text for the sample calculation provided for MW-1S has been revised to show blower inlet flow of 141 actual cubic feet per minute (acfm) for that well.

b. *Pilot Test conditions show measured flow -Blower Effluent values expressed in acfm, shouldn't these values be expressed in scfm?*

No. The pilot test flow rate was measured in acfm, but on the discharge side of the blower (see Section 2.0 on page 1 of the calculation). In the sample calculation provided for MW-1S, the flow rate was first converted from acfm on the blower discharge (25 acfm) to standard cubic feet per minute (scfm) on the blower inlet (19 scfm), then it was adjusted slightly lower (19 to 17 scfm) to account for a reduction in the proposed applied well vacuum (20 to 18.5 or 19 inches per mercury [in Hg]). The blower inlet was then converted from 17 scfm to 141 acfm to arrive at a total flow of approximately 989 acfm. Due to extreme vacuum conditions, claw pumps are specified in blower inlet acfm (or inlet cubic feet per minute [icfm]). This differs from positive displacement blowers, which are typically specified in scfm.

c. *Assuming the gas constant, R, and the mass of the gas is also constant between the two locations (e.g. suction side and discharge side of pump), is it appropriate to assume the temperature on suction side of pump/blower ($T_{suction}$) is the same as the temperature on the discharge side of the pump/blower ($T_{discharge}$)? One would expect that the temperature on the discharge side of vacuum blower is considerably higher than the temperature of the air on inlet side of blower. Please clarify why you can assume the air temperature post blower will be the same as pre-blower, resulting in the T values cancelling out.*

The blower effluent flow rate provided by the pilot test contractor was temperature-corrected. Please see the paragraph above equation 6 on page 2 of the calculation, which provides the reasoning for excluding temperature changes that occur across the blower.

4. *Calculation Number: ES14 0220-002 – "Pressure losses and remediation system blower design"*

a. *Pg. 1 of 5 – Eq.1 for Reynolds number– should include dynamic viscosity not kinematic viscosity. Please revise equation and the note beneath regarding which type of viscosity is a parameter in the equation.*

The method (Section 3.0) has been revised to refer to dynamic viscosity.

b. *Pg. 2 of 5 and Pg. 3 of 5 – 4.0 Solution – it is mentioned that a 6" dia SCH 40 PVC MPE Manifold and 2" dia SCH 40 PVC conveyance lines from the wells will be used, yet the sample calculation uses a 3" dia conveyance line (e.g. average inside diameter is 3.042 inches). Engineering Dwg shows 2" dis SCH 40 PVC conveyance lines will be used. Please revise narrative of report and narrative of calculation so that there is no discrepancy between what is depicted in the dwgs and other part of FRP.*

The sample calculation text has been revised to describe conveyance pipe as 3-inch-diameter schedule (SCH) 40 polyvinyl chloride (PVC), in accordance with the rest of the design. DBS&A

reviewed the FRP engineering drawings and is not aware of any instances where conveyance pipe was shown as being 2-inch diameter SCH 40 PVC.

c. *Pg 4 of 5 and Pg 5 of 5 –regarding: $H_{maj(bldg.)}$ calculation*

The sample calculation text provided for the major pressure losses for the compound piping (first calculation on page 5) has been revised to match the actual calculation.

i. *the conversion of 0.0117 lbm/cu ft of air had been used throughout on Pg. 4 of 5, and then on pg 5 of 5 – shows a conversion of 0.06125 lbm/cu ft of air , which one is correct? Also, please include as part of this calculation a calculation of density of air in lbm/cu ft at the site conditions (elevation and temperature).*

The calculation text has been revised to consistently show air density of 0.0117 pound per cubic foot (lbm/cu ft). Due to the absolute pressure condition on the inlet side of the blower (approximately 1.7 pounds per square inch absolute [psia]), DBS&A assumed air properties were similar to conditions experienced at an elevation of 50,000 feet. Please see air density from engineering toolbox, which was added as a reference to the calculation: https://www.engineeringtoolbox.com/standard-atmosphere-d_604.html.

ii. *Darcy-Weisbach friction factor for 6" dia SCH 40 PVC is shown as 0.0250 on Pg 5 of 5, yet on Pg. 3 of 5 shows it to be 0.0269. Please clarify.*

The calculation text has been revised to consistently show a Darcy-Weisbach friction factor for 6-inch-diameter SCH 40 PVC of 0.0269.

iii. *Linear flow velocity for a 6" dia SCH 40 PVC shows 35.4 ft/sec on Pg. 5 of 5, yet on Pg. 3 of 5 the linear flow velocity for 6" SCH 40 PVC is shown as 83.1 ft/sec. Please clarify/revise as approriate.*

The calculation text has been revised to consistently show a linear flow velocity for a 6-inch-diameter SCH 40 PVC of 83.1.

iv. *D value (average inside pipe diameter) for the 6" dia pipe is shown as 3.998", it should be 6.031 inches.*

The calculation text has been revised to consistently show an actual pipe diameter for the manifold header of 6.031 inches.

Please revise all calculations as appropriate.

The calculation has been revised accordingly.

5. *Calculation Number: ES14 0220 00-003 – "Estimated hydrocarbon emissions from MPE treatment equipment"*

a. *Sources of Data – Multiphase Extraction Pilot Test Report, DBS&A, January 2019 is referenced, shouldn't it be July 2015 MPE pilot test report, EcoVac Services.*

The date of the multi-phase extraction (MPE) pilot test report has been corrected to reflect July 2015.

6. *Calculation Number: ES14 0220 00-005 – "Estimation of LNAPL volumes and cleanup times and expected removal time of LNAPL:"*

a. *Pg. 1 of 5 –Section 2.0 Given: Why is the downstream/discharge of the MPE blower (the total MPE blower effluent flow rate) assumed to be 160 actual cubic feet per minute from seven wells when the Calculation Number: ES14 0220-001 in the total MPE flow rate measured at the manifold (or upstream of inlet of blower) is 989 acfm, equivalent to 119 standard cubic feet per minute? Shouldn't the design blower inlet flow rate used in this calculation be either 119 scfm, or based off the June 2015 MPE pilot test total measured flow – Blower Effluent expressed in scfm? Please clarify whether the 175 cfm shown should be expressed in scfm. Pilot Test Conditions on page following Pg 3 of 3 of Calculation: ES14 0220-001 expresses it in 175 acfm. Please clarify and revise the measured flow -blower effluent as/if appropriate in Calculation Number: ES14 0220-001 and also this calculation.*

The blower effluent flow from the pilot test was correctly reported as 175 acfm. The assumed MPE blower effluent flow rate was reduced slightly from the pilot test due to reduced applied well vacuum. The pilot test was run at 20 in Hg, but DBS&A assumes the system will run between 18.5 and 19 in Hg. The value used in the calculation is believed to be conservative (i.e., increases the potential cleanup time).

b. *An initial soil vapor concentration Cppm(v) of 25,775 ppm(v) is assumed in sample calculation. Is this an average soil vapor concentration for all the wells tested during the June 2015 MPE pilot test, Ecovac Services? The highest Cppm(v)) for MW-1S was 6000 ppm(v).*

Laboratory sampling conducted during MPE pilot testing resulted in an average total petroleum hydrocarbon (TPH) gasoline range organics (GRO) concentration of 25,775 micrograms per liter (ug/L). Results from pilot testing on wells MW-2(S) and MW-10(S) were provided in the calculation (reference C or Table 3 from the pilot test report). The calculation was erroneously performed using that initial concentration in parts per million by volume (ppmv), so the calculation has been revised accordingly. The hypothetical light nonaqueous-phase liquid (LNAPL) cleanup time increased from 1.3 to 1.7 years. Due to this change, DBS&A revised the FRP text to say that the performance standard for reducing extracted soil vapor concentrations below 100 ppmv will be achieved within 3 years. DBS&A still expects to eliminate measurable LNAPL within two years as originally stated.

Appendix B: Engineering Drawings

7. ***Sheet 5 of 11:*** *A -5% slope is depicted, yet Calculation ES14 0220-004 uses -10%. This will alter the Mound Fill Depth and subsequent calculations that use this in dimensioning the mound infiltration gallery. Please clarify and revise calculation as/if appropriate.*

The 5 percent slope depicted on the infiltration gallery plan is the surface slope along the length of the mound (top deck). The 10 percent slope used in the calculation approximates the existing ground surface slope on which the mound will be built, which is across the width of the mound (these two slopes are at right angles).

The geometry of the Wisconsin mound calculation, which was used to size the infiltration gallery, assumes a level slope along the length of the mound, and a surface slope across the width of the mound. Actual design of the mound needed to account for available space, large trees, and variable topography, so the slope of the top of the mound is not level, but has a gentle 5 percent slope.

8. ***Sheet 8 of 11:*** *Please provide an additional legend on separate sheet for smaller elements on P&ID diagram that are not denoted.*

The piping and instrumentation diagram (P&ID) provided in the FRP was modified from the manufacturer P&ID, so DBS&A has limited ability to explain every symbol that was used on the original drawing. We included explanations (call outs) for the major components, so the treatment process can be clearly followed. DBS&A will attempt to acquire a legend from the manufacturer during implementation of the FRP. Alternatively, DBS&A would be happy to schedule a Teams call to review the P&ID in detail and address any other questions PSTB may have on the proposed design.

9. ***Sheet 9 of 11:*** *A Transfer pump from Clarifier is denoted, but not shown.*

Pump P-4 refers to the transfer pump that will convey water from the clarifier, through the bag filters, through the granular activated carbon (GAC) vessels, and ultimately discharge to the infiltration gallery. On the P&ID (Sheet 8 of 11), P-4 is shown immediately to the right of clarifier. On the mechanical site plan (Sheet 9 of 11), P-4 is also called out immediately to the right of clarifier. Similar to the transfer pump out of the knockout tank (P-1), it is covered up by other equipment and not visible in this view.

Appendix E: O&M Data Collection Form

10. *Under Statistics Menu – does another line have to be added for the discharge transfer pump post-classifier?*

During remediation system startup, the operations and maintenance (O&M) form will be modified to account for all critical remediation parameters. Adding data to track run time and motor starts for the post-clarifier (discharge) pump may be one of those modifications, but we won’t resolve that level of detail with the manufacturer until we implement the FRP.

Appendix F: Health and Safety Plan

11. *Include guidance for Field Personnel Related to the COVID-19 Pandemic.*

Standard guidance for field personnel related to Covid-19 has been added to the HASP.

Final Remediation Plan

Bell Gas #1186 (TR's Market)

101 Sun Valley Road

Alto, New Mexico

Prepared for **New Mexico Environment Department**

Petroleum Storage Tank Bureau

December 18, 2020

THOMAS A. GOLDEN
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Appendix

1. Introduction

On behalf of Bell Gas, Inc., Daniel B. Stephens & Associates, Inc. (DBS&A) has prepared this final remediation plan (FRP) for the Bell Gas site #1186 (TR's Market) in Alto, New Mexico (the site) (Figure 1). The plan was prepared in accordance with applicable sections of Part 119 of the New Mexico Petroleum Storage Tank Regulations (PSTR) and work plan ID (WPID) Number 18033 (DBS&A, 2017), which was approved by the New Mexico Environment Department (NMED) Petroleum Storage Tank Bureau (PSTB) on October 26, 2017 (NMED, 2017).

1.1 Site Summary

The site is currently an active Alon gasoline station and Chisum convenience store owned by Kendrick Oil Company. The site is located at 101 Sun Valley Road, just west of New Mexico Highway 48 (NM 48) and north of the entrance to the Alto Lakes Golf and Country Club in Alto, New Mexico (Figure 1). The property is bordered by a state highway to the east, a U.S. Post Office to the north, and high density residential, light commercial, and vacant land to the west and south.

According to historical reports, a tightness test conducted on the diesel underground storage tank (UST) in November 2007 resulted in the site receiving "suspected release" status. In February 2008, the tank was removed and the release confirmed. The remaining USTs were removed and replaced in April 2013.

1.2 Site History

A minimum site assessment (MSA) was conducted at the site by Sierra Environmental, Inc. (Sierra) in January 2009. According to Sierra, results of the MSA indicated that a release of less than 2,700 gallons of diesel fuel had occurred (SEI, 2009). Additional investigations performed by Sierra included an extended MSA in January 2011, an extended on-site investigation in July 2011, and a hydrogeologic investigation in February 2013. These investigations included the installation of 11 groundwater monitor wells, associated soil and groundwater sampling, and a three-day light nonaqueous-phase liquid (LNAPL) bail-down and recovery test (SEI, 2011a, 2011b, 2013). Based on current understanding of the site hydrogeology, DBS&A has added an "S" or a "D" in parentheses to these well designations to denote whether they are screened in the upper (S) or lower (D) aquifer unit.

On November 25, 2014, DBS&A submitted a proposal to the PSTB in response to the request for proposals (RFP) for responsible party (RP)-lead remediation services for the site. DBS&A was deemed to be the most responsive bidder by the PSTB in a letter dated January 16, 2015 and entered into a contract with the RP, Bell Gas, Inc., on February 25, 2015. The first work plan under this new contract included the installation of 8 new monitor wells (MW-1D, MW-2D, MW-5S, MW-6S, MW-6D, MW-9S, MW-12S, and MW-13S) and the abandonment of 2 existing monitor wells which had been completed across separate aquifer units (MW-5 and MW-6). This investigation refined the understanding of the site geology and confirmed the hydrogeologic conditions DBS&A had postulated based on previous data (DBS&A, 2015a).

In June 2015, DBS&A performed slug tests on 8 monitor wells at the site (DBS&A, 2015b). Both falling head and rising head slug tests were performed on each well. The results of these tests confirmed the hydrologic conditions that had been estimated based on LNAPL recovery at the site. Hydraulic conductivity was variable across the site and between wells completed in similar geologic units, indicating that hydraulic conductivity is influenced more by local fracture density than lithology. However, hydraulic conductivity values across the site were generally too low to support a remedial approach of groundwater extraction by whole fluids recovery (DBS&A, 2015b).

A multi-phase extraction (MPE) pilot test was completed at the site in June 2015 (DBS&A, 2015c). The purpose of the pilot test was to (1) demonstrate contaminant removal by multi-phase/dual-phase extraction processes, (2) provide valuable insight into the degree of connectivity between monitoring wells, and (3) collect field data (i.e., applied well vacuum, air flow rates, vapor concentrations, and water recovery rates) to support the design of the full-scale remediation system. Multi-phase fluid was extracted from 7 site wells throughout the three-day test. Results supported feasibility of the MPE remedial approach.

Groundwater is present within two distinct aquifer units at the site, with an additional hydraulic discontinuity located along the northern boundary of the site. Fluid levels have been observed to fluctuate by 10 to 15 feet over relatively short periods of time. Based on initial DBS&A site investigation activities, additional monitor wells were installed, which included MW-14S through MW-20S downgradient from known contamination, replacement monitor well MW-1S, and an additional upper aquifer well (MW-7S) in the vicinity of existing monitor well MW-7(D) (DBS&A, 2015d). The locations of existing and former monitor wells are provided on Figure 2.

Groundwater monitoring performed since 2015 has shown that LNAPL persists in both on-site wells and off-site well MW-10(S). Actionable dissolved-phase contamination is present in some upper-aquifer wells at the periphery of the LNAPL plume (MW-1S, MW-6S, and MW-8(S)), but does not appear to extend a significant distance to the east of wells MW-10(S) and MW-11(S). Actionable dissolved-phase contamination has also been present in the lower aquifer unit at monitor wells MW-1D, MW-6D, and MW-7(D).

1.3 Geology and Hydrogeology

The site is located on the eastern flank of the Sierra Blanca Mountains at an elevation of approximately 7,500 feet above mean sea level (msl). The Sierra Blanca range consists of a large stratovolcano complex of late Eocene to Oligocene age, characterized by a diverse suite of intrusive and extrusive igneous rocks. Based on geologic mapping of the area completed by the New Mexico Bureau of Geology and Mineral Resources, surficial geology in the site vicinity consists of the Cub Mountain Formation, an Eocene-age, heterolithic sedimentary unit exposed around the flanks of the Sierra Blanca volcanic complex. Also exposed nearby are sedimentary rocks of the Cretaceous-age Mesa Verde Group, and Quaternary/Tertiary pediment gravels. Mapping indicates that the site lies near the contact between the Cub Mountain Formation and the underlying Mesa Verde Group (Rowling, 2014).

The sedimentary rocks underlying the site consist largely of gray and yellowish-tan shales and claystones, interbedded with sandstone and minor conglomeratic lenses. These strata are related to either the lower Cub Mountain Formation or the upper Mesa Verde Group, which are lithologically similar. Igneous intrusions consisting of dikes, sills, and large masses are ubiquitous across the site and are locally cross-cut, disrupting or inflating the sedimentary section, making lateral correlations between boreholes difficult. Igneous rocks observed in boreholes consist of predominantly intrusive rocks of mafic composition although fine-grained igneous rocks of intermediate composition are found in boreholes and outcrops on the north side of the site (MW-6S and MW-9S). Cross-sections depicting the sub-surface geology of the site are presented in Figures 3a and 3b.

The hydrogeology of the site is complex, as groundwater is hosted largely within fractured bedrock of varying lithology, and aquifer properties are likely controlled by secondary porosity along fractures and bedding planes. Thin permeable sandstone beds and localized igneous intrusive bodies may also affect preferential flow paths. Borehole observations, well construction records, and monitoring data indicate that there are two distinct aquifer units present under the site. The presence of two distinct water-bearing zones was recorded during the drilling of original site well MW-1, but was not addressed in subsequent historical reports prior to 2014. Subsequent well installations by DBS&A have delineated the aquifer units. In 2015, DBS&A plugged and abandoned wells suspected of being completed across both aquifer zones, and replaced them with appropriate single-completion wells. Wells are now designated with an “S” or “D” to denote the aquifer zone of the screened interval.

The shallow, or upper, aquifer unit is encountered at depths of approximately 45 to 90 feet below ground surface (bgs). The majority of site wells are completed in this aquifer unit. Groundwater is likely present under largely unconfined conditions in the shallow aquifer. The groundwater flow direction in the shallow aquifer under the site is generally to the east with an overall average gradient of approximately 0.3 foot/foot (ft/ft), although the gradient has varied from 0.1 to 0.4 ft/ft since 2015. The current potentiometric surface suggests that wells MW-10S and MW-11S are located within a hydrologic trough created by persistent groundwater mounding on the east side of NM 48 (Figure 4a). A groundwater barrier or divide on the north side of the site is a persistent feature of the upper aquifer unit, with water level elevations typically 10 to 20 feet lower to the north of this feature (Figure 4a). The groundwater divide is tentatively interpreted to be associated with a fault structure as shown in the cross-section (Figure 3a), although its nature is not known for certain.

The lower aquifer is encountered at 110 to 130 feet bgs. Groundwater is likely present under confined or leaky-confined conditions in the lower aquifer. The gradient in the lower aquifer has been consistently one to two orders of magnitude lower than the upper aquifer, often with a markedly different flow direction. April 2020 data showed a groundwater flow direction to the northwest with a gradient of approximately 0.01 ft/ft (Figure 4b).

Historical data from site wells indicate that groundwater elevations in the upper aquifer unit may vary up to 20 feet over time, including fluctuations of 5 to 10 feet on time scales of weeks to months. Transducer data has been collected continuously on 15-minute intervals since July 2016 from wells MW-1(D), MW-4(S), and MW-6S, and confirm the high-amplitude fluctuations observed with static measurements. High water levels have typically been observed in the late summer through early autumn, after the typical monsoon season. However, the transducer data and well observations also suggest that additional sources of recharge likely affect water levels at the site, including snow melt and on-site anthropogenic sources.

1.4 Distribution of Contamination

1.4.1 Contaminants of Concern

The primary contaminants of concern (COCs) are diesel and gasoline fuel constituents, including benzene, toluene, ethylbenzene, and total xylenes (BTEX), methyl tertiary-butyl ether (MTBE), and naphthalenes. Multiple investigations conducted at the site indicate that contaminated soil is limited in extent, while groundwater contamination and LNAPL are present beneath the site and extend off-site to the south and northeast (Figure 5).

1.4.2 Distribution of Contaminants in Soil

Contamination of soil and bedrock materials has been documented in the tank pit and in the adjacent borehole for well MW-2(S). Field screening of soil and bedrock samples collected during the drilling of other site wells did not indicate the presence of vadose zone contamination above 100 parts per million by volume (ppmv). Contamination above then-current NMED Tier 1 risk-based screening levels (RBSLs) was indicated by laboratory analysis of samples collected near the water table interface in boreholes MW-4, MW-10, and MW-11 (SEI, 2011a, 2011b, 2013).

1.4.3 Nonaqueous-Phase Liquid Contamination

LNAPL persists in on-site monitor wells completed in the upper aquifer zone. During the most recent monitoring event in April 2020, LNAPL was present in the shallow aquifer in on-site wells MW-1S, MW-2(S), MW-3(S), MW-4(S), and MW-11(S), and off-site well MW-10(S). The horizontal extent of LNAPL is bounded in the upgradient direction by well MW-5S, in the downgradient direction by wells MW-12S, MW-14S, and MW-15S, cross-gradient to the north by wells MW-7S and MW-9S, and cross-gradient to the south by well MW-8(S) (Figure 6a). Monitor well MW-6S contained LNAPL during the July and October 2016 and March 2018 monitoring events, and the extent of LNAPL may be only partially delineated in this area. Wells MW-10(S) and MW-11(S) are situated in a hydraulic trough, which serves to discourage LNAPL migration to the east and northeast. Drainage in this trough appears to be generally northward, and there are currently no monitor well installations north of well MW-10(S).

LNAPL was analyzed by U.S. Environmental Protection Agency (EPA) method 8015D on August 14, 2018, for wells MW-2(S), MW-3(S), MW-10(S), and MW 11(S). Diesel was shown to be the predominant form of LNAPL, with only 6 percent gasoline found in wells MW-10(S) and MW-11(S). Wells closer to the former gasoline UST had higher percentages of gasoline, including a measurement of 44 percent in MW-2(S) (DBS&A, 2019A). The mixed release (diesel and gasoline) was first suspected following MPE pilot testing (DBS&A, 2015c).

LNAPL thicknesses measured in wells ranged from 0.01 foot in well MW-4 to 3.04 feet in MW-11(S) during the most recent groundwater monitoring event. In general, LNAPL thickness tends to fluctuate opposite of groundwater elevations when not influenced by a corrective action system. This trend has been apparent in wells MW-1S, MW-2(S), MW-6S, MW-10(S), and MW-11(S) (DBS&A, 2020). LNAPL thicknesses observed in well MW-4(S) have generally been much less since the wells were first hand-bailed in April 2015. The distribution of LNAPL in the shallow aquifer is shown on Figure 6a. LNAPL was historically observed in deep monitor well MW-6, but that well was shown to be screened across both water-bearing zones and was subsequently abandoned and replaced with wells MW-6S and MW-6D in May 2015; LNAPL has not been observed in well MW-6D.

Apparent LNAPL thickness in a well is typically greater than the actual thickness of mobile LNAPL in the surrounding formation. This effect may be enhanced where LNAPL exists under locally confined conditions, such as where a permeable fracture zone intersects the well bore. During the proposal process, DBS&A provided a calculation to estimate the LNAPL release volume using the November 2010 bail-down and recovery data and in-well LNAPL thicknesses. The calculation evaluates seven standard EPA methodologies and has been revised to incorporate recent site investigation data and current knowledge of the site lithology. Based on median values from the EPA Guidance, DBS&A estimates the actual LNAPL release volume is between 6,000 and 7,000 gallons (Appendix A).

1.4.4 Dissolved-Phase Contamination

Outside of the current extent of LNAPL, actionable dissolved-phase contamination has been observed primarily in three upper-aquifer wells (MW-6S, MW-7S, and MW-8(S)). Despite the occasional presence of residual LNAPL, and with the exception of total naphthalenes, contamination in MW-6S has decreased significantly since the well was installed. Concentrations of benzene and total naphthalenes remained above regulatory standards during the current monitoring event in MW-6S. MW-7S and MW-8(S) are located cross-gradient to the north and south of the LNAPL plume, respectively. Although dissolved-phase contaminant concentrations in these two wells have fluctuated since the wells were installed, COC concentrations in MW-7S and MW-8(S) were generally low relative to previous conditions during the April 2020 monitoring event. Benzene, MTBE, and total naphthalenes were above regulatory standards in MW-8(S), and all COC concentrations in MW-7S were below applicable regulatory standards (DBS&A, 2020).

Dissolved-phase hydrocarbon contamination does not appear to extend a significant distance to the east of wells MW-10(S) and MW-11(S). As previously discussed, the current potentiometric surface suggests that these two wells are located within a hydrologic trough, and persistent groundwater mounding on the east side of NM 48 may serve to discourage contaminant migration away from the site to the east (Figure 4a). This interpretation is reinforced by the fact that LNAPL accumulates in the vicinity of monitor wells MW-10(S) and MW-11(S). Drainage within this hydrologic trough has historically been roughly northward. The subsurface hydraulic discontinuity on the north side of the site appears to provide a barrier to contaminant migration in the vicinity of wells MW-6S and MW-9S. Ultimately, movement of LNAPL and dissolved-phase contaminants is most likely controlled by the potentiometric gradient combined with preferential flow paths within the fractured bedrock aquifer media.

Dissolved-phase contamination in the lower aquifer at monitor wells MW-1D, MW-6D, and MW-7(D) has been generally decreasing since 2015. Well MW-6D replaced monitor well MW-6, which contained more than 15 feet of accumulated LNAPL in April 2015 immediately prior to being abandoned. Current trends confirm that the contamination observed in well MW-6, which was screened across both aquifer units, represented cross-contamination from the upper aquifer and was not indicative of LNAPL in the lower aquifer. During the April 2020 monitoring event, COCs were not present at concentrations above the regulatory standard in any deep aquifer zone well (Figure 6b). Localized fracture connectivity and vertical gradients may allow downward movement of contaminants between the aquifer units, so trends in these wells will be monitored closely during the progress of remediation.

2. Contractor Qualifications

DBS&A is a licensed contractor in the State of New Mexico and holds a GS-29 license (License #89947). EnviroWorks, LLC of Edgewood, New Mexico has been selected to serve as the general contractor at the site and will coordinate conveyance line trenching and backfill, as well as installation of the remediation system and infiltration gallery. The equipment manufacturers will be Intellishare Environmental (Intellishare) of Menomonie, Wisconsin, and H2K Technologies (H2K) of Corcoran, Minnesota. All work will be performed under the supervision of a professional engineer licensed in the State of New Mexico.

3. Remediation Goals/Cleanup Standards

3.1 Exposure Pathways

Potential exposure pathways evaluated for this site include soil vapor, soil, and groundwater. Hydrocarbon contamination was not observed in shallow soil during drilling of well borings in August 2018, and the site is completely covered by asphalt and concrete pavement. Therefore, direct exposure to hydrocarbon-contaminated soil is not considered a complete potential exposure pathway at the site.

Petroleum hydrocarbon contaminants are likely widespread in bedrock fractures above the water table, which is encountered at a depth of 45 to 90 feet bgs under the site. Based on current EPA guidance, petroleum hydrocarbons at this depth are not considered a risk through the vapor intrusion pathway. Hydrocarbon contamination is not believed to extend under the Chisum convenience store structure, and no occupied buildings are present within the contaminant plume area. Therefore, vapor intrusion to an indoor air pathway is not considered a complete exposure pathway under current site conditions.

Potential groundwater impacts to municipal or domestic production wells constitute an exposure pathway. Numerous domestic and municipal wells are located within a 1-mile radius of the site (SEI, 2011a), including the well that provides drinking water to the convenience store at the site (located upgradient to the northwest from the known extent of contamination). Based on the distance and proximity of contamination to the nearest active domestic or municipal well, the risk to water production wells is minimal under current conditions. However, due to the nature of fracture flow in the vicinity of the site, the potential remains for contamination to reach a potable water source. Removal of on-site contaminant mass will minimize that threat.

3.2 Remediation Goals and Performance Standards

The primary remedial objective is to remove source area hydrocarbon mass in order to mitigate the impact of released petroleum hydrocarbons on groundwater resources and potential receptors. Dissolved-phase contamination will be monitored on a quarterly basis to assess plume stability and response to the source-area mitigation. DBS&A has observed that during previous remedial actions dissolved-phase hydrocarbon concentrations in groundwater decreased significantly following removal of the source area contaminant mass. During and after the remedial action, residual dissolved-phase hydrocarbons in groundwater will be allowed to naturally attenuate, with the goal of reaching New Mexico Water Quality Control Commission (NMWQCC) standards.

The following performance standards will be met to document the success of the remediation work performed:

- Within two years of system operation, document that measurable LNAPL is no longer present within the monitor well network; reduce extracted soil vapor concentrations to less than 100 ppmv of volatile organic compounds (VOCs) as measured by a photoionization detector (PID) within three years

- Maintain minimum run-time of 90 percent for major remediation equipment, which is achievable through proper preventive maintenance of equipment and the use of telemetry to provide instant notification of system shutdowns through text message and/or email

- Document, through laboratory testing, that extracted groundwater discharged to the on-site infiltration gallery has VOC concentrations less than NMWQCC standards and complies with requirements of the active discharge permit

- Document efficacy of the vapor treatment system by collecting system influent and effluent air samples at a minimum of once per month to demonstrate optimization of mass removal and destruction of contaminants prior to discharge to the atmosphere

Using the method outlined by Kroopnick (1998), DBS&A estimates that recoverable LNAPL can be removed within approximately 1.7 years (Appendix A). Although it may not be possible to remove all of the COCs from the subsurface, the selected method of remediation should provide the most cost-effective means of mitigating hydrocarbons at the site, while also protecting potential receptors and groundwater resources.

4. Description of Proposed Remediation System

4.1 Overview

The remediation system designed for the site is an MPE system that will use stinger tubes to extract emulsified fluids under high vacuum. Soil vapor, groundwater, and LNAPL will be routed through 3-inch polyvinyl chloride (PVC) conveyance lines to an equipment compound for separation and treatment. Due to the cost of new wells at the site, and limited drilling locations due to existing fuel facilities and right-of-way (ROW), 7 existing two-inch monitor wells will be used as extraction wells (Figure 7). The wells will be plumbed to a common manifold that will be located inside the primary MPE system equipment enclosure. The MPE system will consist of two extraction blowers (claw pumps), a vapor-liquid separator, an oil-water separator, diffused tank aerators (DTAs), a clarifier, two bag filters, and two liquid carbon vessels, as described below in Section 4.2. In addition to the MPE system enclosure, a thermal oxidizer, LNAPL storage tank, and the site electric service will be enclosed by an 8-foot-tall, gated chain link security fence.

The remediation system is designed to achieve the goals outlined in Section 3.2 through the following primary processes:

- Recovery of contaminant mass from the release area and vicinity using MPE, which will include both gasoline and diesel fuel constituents, as well as LNAPL and contaminants present in soil vapor and groundwater

- Enhancement of subsurface aerobic biodegradation of hydrocarbons in the vadose zone and capillary fringe through oxygenation of the subsurface

This remedial technology will be ideal at this site given both the nature of the release (mixed fuels) and the fact that discharge of large volumes of treated water is not feasible. Sanitary sewer disposal is not available, and site soil (and bedrock) will not allow infiltration of large volumes of water. The proposed remediation system is detailed in the engineering drawings (Appendix B), supporting calculations (Appendix A), product cut sheets (Appendix C), and technical specifications (Appendix D).

4.2 Aboveground Treatment Equipment

The proposed aboveground equipment, as shown in the mechanical series of the drawings (Appendix B), will include the following:

- *Inlet piping manifold:* MPE wells will be piped to a common piping manifold using dedicated schedule (SCH) 40 PVC conveyance lines. The conveyance piping will connect to the influent manifold, consisting of 6-inch SCH 40 PVC (minimum), with a hard-piped SCH 40 PVC riser and fittings. Each riser will include a vacuum gauge, isolation valve, sample port, and ¼-inch threaded plug for a manometer-type insertion flow meter. The manifold will be located inside the modified shipping container.

- *Modified shipping container:* MPE system components will be located within a modified shipping container, which provides more robust security for the equipment, improves noise control, keeps mechanical components out of the elements, and provides better heating, ventilation, and air conditioning (HVAC) controls. A shipping container simplifies installation as various components can be assembled and tested off-site by the equipment manufacturer, including electrical connections, process instrumentation, controls, and telemetry. The enclosure also allows the system to be more easily repurposed at another PSTB site in the future. The MPE system will include insulated floor, walls, and ceiling; nonskid bed liner on the floor; overhead lighting; wall-mounted electric heater, vent fan, sound-insulated inlet/outlet louvers, and thermostat; and lockable, double-access doors on both ends of the container.

- *MPE vacuum pumps:* System vacuum will be generated using two rotary claw pumps. Busch model MV1202A pumps, or equivalent, will each be capable of maintaining an extraction flow rate of 600 inlet cubic feet per minute (icfm) at 18.5 inches mercury (in. Hg) vacuum at an elevation of 7,500 feet above msl. Each pump will include a 30-horsepower (hp), 460-volt, three-phase variable speed motor, equipped with a variable frequency drive (VFD) located at the main control panel. A steel discharge silencer will be installed on the discharge side of the pumps. Pressure and vacuum gauges will be installed on the inlet and outlet of the pump, and a sample port will be installed on the discharge of each pump.

- *Thermal oxidizer*: The oxidizer used for treatment of extracted soil vapor will be an Intellishare model TO-500 thermal oxidizer designed to operate at concentrations between 0 and 50 percent of the lower explosive limit (LEL) and rated at a maximum 500 standard cubic feet per minute (scfm). The base and reactor will be composed of A36 carbon steel, with a 300-series stainless steel stack. The treatment unit will discharge through a stack that will vent at a height of 14 to 15 feet above the ground surface.

- *Vapor-liquid separator:* The inlet piping manifold will connect to a 220-gallon vapor-liquid separator, including a 55-gallon liquid holding capacity, designed for minimum 99 percent moisture removal. The vapor-liquid separator will include a liquid coalescing media internal to the separator. External devices will include a 6-inch sediment clean-out port, sight tube with a 3-point level switch, vacuum relief valve, and bottom drain valve. A condensate transfer pump will transfer liquids to the oil-water separator.

- *Oil-water separator*: H2K will provide a model LLS8 oil-water separator, which is designed to separate 20 micron and larger droplets of LNAPL using a slant-rib coalescing media. The separator includes an adjustable skimming weir and will be elevated so it can gravity drain LNAPL to a separate product holding tank. External devices will include a sight tube with a 3-point level switch, bottom drain valve, and a vent line plumbed outside the modified shipping container.

- *Product storage tank:* H2K will provide a 300-gallon, UL 142 double-wall tank that will be installed by the general contractor (EnviroWorks, LLC) outside the modified shipping container. The tank will include high and high-high level controls, and will be provided with vents, isolation valves, and insulation and heat trace rated for a Class 1, Division 1 hazardous area. Exterior, enamel paint will match the other MPE system components.

- *Diffused tank aerator*: VOC removal will be accomplished using a DTA-2 diffused aeration tank capable of 98 percent removal of lighter hydrocarbons, such as BTEX and

MTBE, and 85 to 88 percent removal of heavier hydrocarbons, such as naphthalenes. The diffused aerator allows the system to operate in heavy fouling conditions, which should minimize maintenance from precipitation of total dissolved solids (TDS), which are relatively high at this site. The tank will be constructed of 304 stainless steel, including two aeration chambers, six aeration diffusers, and a cover. The DTA-2 includes a 90 scfm blower that passes through both aeration chambers (180 scfm equivalent flow). It will be stand-mounted so that fluids will gravity drain from the oil-water separator, through the DTA, and into the clarifier.

- *Settling and filtration*: Solids, including metals and other inorganic constituents, will be removed using an H2K model IPC-40, inclined plate clarifier constructed of 304 stainless steel. The clarifier is designed for 90 percent removal of 20 micron and larger solids at a flow rate of 7.5 gallons per minute, and includes an adjustable skimming weir and a solids collection sump. Water will be pumped from a clear well in the clarifier through two Pentair model L-88 bag filter assemblies piped in parallel into two liquid granular activated carbon (GAC) vessels. Each bag filter assembly is rated for 150 pounds per square inch (psi), constructed of 304 stainless steel, and houses a #2 size filter. Pressure gauges with bleed and air relief valves will be provided for each filter assembly, and a differential pressure transmitter across the bag filters will be wired to the control panel.

- *Liquid GAC vessels*: Two H2K model LC-005 liquid-phase GAC vessels will be provided in series (lead-lag) to polish VOCs in groundwater prior to discharge. GAC will be necessary due to relatively high naphthalene concentrations seen in extracted fluids. Each vessel is rated for 60 psi and includes 500 pounds of 8x30 mesh reactivated carbon. The vessels will be constructed of carbon steel, and will be provided on a skid assembly with lifting lugs to assist with replacement of carbon during ongoing system operation and maintenance (O&M). Pressure gages and sample ports on the inlet and outlet of each vessel will allow for assessment of breakthrough concentrations that would necessitate replacement of the filter media. Based on proprietary calculations completed by H2K, the lead carbon absorber will breakthrough in 2 to 5 years of constant flow.

- *Control panel:* An integrated control panel for both the vapor extraction and groundwater treatment components of the MPE system will be installed on the outside of the modified shipping container. A National Electrical Manufacturers Association (NEMA) 4 enclosure, or equivalent enclosure rated for outdoor use, will be provided with an interior swing door. A fused main disconnect will be located in a separate enclosure mounted next to the control panel. The panel will have circuit breakers for protection of all motors. Each motor will have a Hand-Off-Auto switch with green run light indicators. Red lights will be labeled for all alarms. The panel will include intrinsically safe barriers for all switches and surge and lightning protection for the controls and telephone line. The system will be controlled with an Allen Bradley programmable logic control (PLC) that has data logging capability and a touch-screen graphical user interface.

4.3 Wells, Stinger Tubes, Conveyance Piping, Trenching, and the Infiltration Gallery

The proposed remediation system will operate with 7 existing monitor wells, including MW-1S, MW-2(S), MW-3(S), MW-4(S), MW-6S, MW-10(S), and MW-11(S) (Figure 7 and Appendix B). DBS&A anticipates that the radius of influence (ROI) during system operations will vary depending on the connectivity of individual fractures between wells across the site. MPE pilot testing showed that the ROI could vary from 30 to 60 feet, although the well network and fluid levels in site wells were not optimal at the time of testing (DBS&A, 2015c). DBS&A intends to evaluate vacuum and groundwater concentrations during ongoing O&M and will make recommendations for new wells on an as-needed basis.

4.3.1 Stinger Tubes

Emulsified fluids will be extracted from each well using stinger tubes, which will be constructed of 20 feet of flexible tubing and sections of threaded SCH 40 PVC piping. Construction details and lengths are provided in the drawings together with details on the wellhead assemblies (Appendix B). The stinger tubes have been sized for the maximum depth to water observed in the historical record, and the flexible tubing will allow the stingers to be adjusted during each site visit based on changes in the static water level (if needed). Target depth for the stinger tube will be 2 feet below the static water table. Holes will be drilled in the bottom 3 feet of the stinger tube to assist with generating emulsification and provide some flexibility with system operation.

Fresh air may also be introduced to the well casing, if air flow through the well screen is insufficient to emulsify and transport fluids. A ¼-inch ball valve will be connected to the well casing and vented inside the well vault so that make-up air can be adjusted coincident with stinger tube adjustment. A ½-inch aluminum compressor muffler will be installed on each fresh air line to minimize noise generated during system operation. If the fresh air valve does not provide sufficient make-up air to facilitate emulsification, a 1-inch high density polyethylene (HDPE) contingency line will be available to supply forced air to each well. The contingency line with be installed between the modified shipping container and each well during FRP implementation, and a compressor could be placed inside the container and operated on an as-needed basis.

4.3.2 Conveyance Line Piping and Trenching

Details of conveyance piping trenches are shown on the drawings (Appendix B). The conveyance piping for extraction wells will be 3-inch-diameter SCH 40 PVC. Conveyance piping, contingency piping, and electric conduit will be placed below ground in trenches and supported within plastic spacers. In trenches installed through existing pavement, anchored piping circuits will be backfilled using flowable fill. Native soil (or engineered fill) will be used to backfill trenches installed on vacant land, and compacted to a minimum 90 percent relative compaction as determined using ASTM International (ASTM) method D 698 for standard proctor testing. The non-paved surfaces will be brought to grade with native soil to match the existing land surface. Paved surfaces will be machine-cut and replaced with similar material and thickness to the existing conditions.

Due to existing site topography, conveyance piping will generally drain toward the equipment compound, although high vacuum conditions will allow for removal of accumulated fluids, if present within the conveyance piping. Isolation valves installed within the well vault will allow each well to extract either emulsified fluids (through the stinger) or soil vapor only (through the well casing).

4.3.3 Infiltration Gallery

Treated water will be routed to an infiltration gallery using 4-inch-diameter SCH 40 PVC, with a cleanout installed on the east side of the mound. The gallery will be located south of the existing convenience store on land that is owned by Kendrick Oil Company. Due to the presence of bedrock within 2 to 4 feet of ground surface, a mound-type system will be installed. This will provide additional infiltration capacity and be more cost-effective than having to excavate through bedrock over a relatively large area. The absorption bed will be approximately 100 feet long by 12 feet wide, with an overall infiltration width of approximately 32 feet (Appendix B). A total of three dosing lines will be installed, consisting of 1.25-inch SCH 40 PVC, perforated along the length.

Design of the mound system is documented in the calculations (Appendix A). Dimensions are similar to the infiltration gallery that was modeled near Eagle Creek (DBS&A, 2019b). Surface soils are similar and are presumed to have similar hydraulic properties to those at the modeled site. The conclusion from the Eagle Creek modeling was that mounding above the water table may limit infiltration after long term system operation; however, depth to water at the proposed infiltration gallery is 10 times greater than the Eagle Creek location (approximately 50 feet bgs, rather than 5 feet bgs). Therefore, groundwater mounding is not likely to limit the capacity of the proposed infiltration gallery.

4.4 Utility Requirements/Utility Clearances

Otero County Electric Cooperative is the electric service provider in Alto, New Mexico. New 480-volt three-phase electric service will be required for the remediation system, which will be supplied through buried lines and an aboveground transformer. DBS&A will need to coordinate specific details with the utility service provider during implementation of the FRP. Natural gas will be supplied for the thermal oxidizer by Zia Natural Gas using an existing 2-inch natural gas main located immediately east of the remediation system.

New Mexico One-Call will be contacted prior to subsurface excavation activities. Special care will be required during trench installation, due to extensive active buried utilities on-site in the vicinity of the remediation system. The locations of known utilities were determined as part of a subsurface utility engineering (SUE) survey, as shown on Drawing G-2 (Appendix B). Conveyance piping may need to be installed under the proposed modified shipping container, depending on the location and depth of existing utilities in the landscaping east of the remediation compound.

4.5 As-Built Report Preparation and Submittal

Following implementation of the FRP, record drawings signed and sealed by DBS&A's Engineer of Record will be prepared and submitted to the NMED PSTB project manager as part of an as-built report. The report will conform to the requirements of 20.5.119.1925.D NMAC and will include, but not be limited to, the following:

- Area/vicinity map
- Detailed site diagram with locations of underground utilities and other subsurface structures on or adjacent to the site's property boundaries, buildings, monitor wells, storage tanks and lines, sumps, impoundments, pit areas, water lines, and other relevant structures
- Summary of site conditions
- Any deviations from the drawings and specifications included in the FRP
- Tabulation of pertinent data including, but not limited to, flow rates, pressures, temperatures, contaminant concentrations, and groundwater elevations at startup
- Boring logs and well completion diagrams
- Inventory of purchased equipment
- Discussion of the data collection methods
- Laboratory results with chain of custody records and laboratory quality assurance/quality control (QA/QC)

- Well completion diagrams
- Characterization of wastes, including handling and disposal
- Elevation survey results
- Detailed description of remediation system and as-built drawings
- Modifications to or variances from the remedial design
- Discussion of system startup and shakedown
- Identification and explanation of operational adjustments made for optimum system performance
- Discussion of the observed performance of the remedial system, including handling, treatment, or disposal of byproducts generated by the remedial system implementation
- Discussion of the remedial system's performance criteria
- Summary and recommendations
- Familiarity statement by the DBS&A qualified representative

4.6 Operations

Operation of the remediation system will include initial startup activities and regular maintenance. Safety controls will be installed to automatically shut down the system under certain circumstances, including malfunction or failure of any integral system component or loss of power. System monitoring objectives include tracking the progress of hydrocarbon mass removal, maximizing extracted vapor and water treatment efficiency, and documenting compliance with permits issued for this project. Additionally, controls will be implemented to protect equipment from weather and vandalism.

Progress of the source area abatement will be evaluated by monitoring the concentration of VOCs in the extracted vapor, from both the system as a whole and from individual wells, and documenting system efficiency under different well operating configurations. The total mass of VOCs, chemical composition of extracted vapors, and concentration of COCs in extracted fluids will be quantified and tracked. To document hydrocarbon recovery efficiency during both the startup and routine phases of operations, influent and effluent vapor will be tested daily for the first week of operations, weekly for the remainder of the first month, and biweekly thereafter. Extracted vapor concentrations are expected to be at their highest levels during the first month of system operation. Influent and effluent samples of extracted and treated fluids will be collected concurrent with vapor sampling activities. Vapor and fluid samples will be collected and analyzed according the procedures and methods specified in Sections 5.2 and 5.3.

To ensure that the project objectives are achieved, an authorized representative of DBS&A will have direct supervisory control over all aspects of the project. All drilling, construction, and equipment setup activities conducted during the project will be performed under the direction of a New Mexico-licensed professional engineer. All activities proposed in this FRP will be conducted in accordance with DBS&A standard operating procedures (SOPs), applicable federal and state regulations, and with frequent communication with the PSTB project manager and other stakeholders.

4.7 Contingency Plan

If there is a change in site conditions that threatens public health, safety, or the environment, DBS&A will re-evaluate the extraction well network. The most likely change in conditions would be a substantial change in groundwater elevation or flow direction, or identification of additional LNAPL present north of existing well MW-10(S). Additional vertical wells could be installed to maintain control of the LNAPL plume, or piping could be extended to additional existing wells.

DBS&A intends to install a single 1-inch HDPE contingency line to each extraction well. If warranted by either a change in site conditions or required remedial goals, natural attenuation of dissolved-phase contaminants could be accelerated using injection of an amendment, such as ozone. This amendment could be applied continuously through the contingency line.

5. Remediation System Operation and Maintenance

5.1 Overview

O&M of the remediation system and monitoring of the subsurface conditions is required at regular intervals to accomplish the following tasks:

- Collect system operation data
- Maximize the system's mechanical performance
- Optimize the MPE operating configurations
- Document soil vapor quality in response to system operation
- Document groundwater quality in response to system operation
- Perform general equipment preventive maintenance
- Establish optimal extraction rates to maximum contaminant mass removal
- Demonstrate that the remediation system is complying with conditions of the site-specific NMED Ground Water Quality Bureau (GWQB) discharge permit

5.2 Extracted Soil Vapor

Hydrocarbon concentrations in extracted soil vapor and treated vapor discharge will be measured to document system effectiveness, regulatory compliance, and hydrocarbon recovery rates. Total ionizable VOC concentrations will be measured using a PID during each O&M event. DBS&A proposes that influent and effluent air samples from the system be collected and analyzed for total petroleum hydrocarbons (TPH) and BTEX using EPA methods 8015B and 8021, respectively, on the following schedule:

- *Startup and shakedown:* Collect system influent/effluent samples within 4 hours of startup and again approximately 48 and 96 hours after startup

- *Second week to end of first month:* Collect system influent/effluent samples weekly until the end of the first month of operation

- *Remainder of first quarter and subsequent quarters of O&M:* Collect one influent and one effluent sample every two weeks

Field and laboratory analytical data will be used to optimize system operation and to calculate system efficiency, extraction rates, emission rates, and quantities of recovered hydrocarbons. Soil vapor concentrations from individual wells will only be available when static water levels drop below stinger depths; those concentrations will be documented when data collection is feasible.

5.3 Extracted Groundwater

Hydrocarbon concentrations for raw and treated water will be measured to document system effectiveness, regulatory compliance, and hydrocarbon recovery rates. DBS&A will also provide information necessary to document compliance with the approved discharge of treated groundwater. Specific requirements will be provided in the FRP implementation work plan but may include the following:

- Periodic (monthly) flow discharge readings

- Laboratory testing of treated groundwater discharge to be performed weekly during the first month and biweekly thereafter, similar to the vapor sampling schedule

- Notification of any system changes or faults

To meet NMED regulations, raw and treated water samples will be collected and analyzed for the site's COCs. In addition, DTA effluent vapor samples will be collected on the same sampling schedule and analyzed for VOCs and TPH using EPA methods 8021 and 8015, respectively. Samples will be analyzed at Hall Environmental Analysis Laboratory (HEAL) in Albuquerque, New Mexico. Field and laboratory analytical data will be used to optimize system operation, demonstrate compliance with discharge requirements, and to calculate system efficiency, extraction rates, emission rates, and quantities of recovered hydrocarbons.

5.4 MPE Treatment System Operation and Maintenance

MPE system startup will require daily site visits for the first five days of operation to document system performance and hydrocarbon recovery rates. During this initial startup period, the system will be adjusted to obtain optimum performance and maximize hydrocarbon removal from the site. Applied vacuum and resultant flow rates and vapor concentrations will be recorded using a form similar to the example provided in Appendix E. Vacuum from and fluid levels in surrounding wells will be observed to determine the ROI for each treatment well, if possible (the existing well network may limit data collection).

After the startup period, the system will be operated and maintained for optimal efficiency. O&M and evaluation of the MPE system will be performed on a monthly, quarterly, and annual basis. Informal electronic reports on system performance will be provided to the PSTB project manager on a monthly basis. Quarterly reports will be provided both electronically (as a compiled PDF) and in hard copy, unless otherwise requested.

In case of a change in site conditions that threatens public health, safety, and welfare or the environment, the system will be shut down immediately. The change in conditions will be evaluated and, if necessary, modifications will be made to the system and its operations to remedy the risk to the public or the environment.

5.4.1 Biweekly Activities

DBS&A proposes to perform the following activities on a biweekly basis:

- Measure MPE well flow rates and vacuum
- Adjust and maintain vapor flow rates at design specifications
- Adjust flow rates and applied well vacuum to maximize mass removal rates
- Empty knockout tank and dispose of condensate as required

- Collect, recycle, and dispose of LNAPL (if applicable); check and clean filters
- Respond to system shutdowns
- Conduct other miscellaneous activities necessary to ensure efficient and effective system performance
- Perform routine preventive maintenance on all equipment and motors
- Collect influent and effluent vapor samples for laboratory analysis of TPH and BTEX in accordance with EPA methods 8015B and 8021, respectively
- Collect raw and treated water samples and DTA effluent vapor samples for laboratory analysis of VOCs, TDS, chlorides, and any other parameters specified in the groundwater discharge permit.
- Record periodic field measurements of temperature, pH, dissolved oxygen, conductivity, and oxidation/reduction potential (ORP)
- Calculate system extraction and emission rates and destruction efficiency

5.4.2 Quarterly Activities

On a quarterly basis, DBS&A will evaluate the efficacy of coalescing media and filters and will replace those materials that exhibit a decrease in performance. DBS&A will also prepare and submit a report to the PSTB documenting all O&M activities and groundwater monitoring results for the previous quarter. Reports will include:

- Identification and explanation of any operational adjustments made for system optimization
- Discussion of actual system operation and effectiveness compared to expected parameters used for the remedial design
- Evaluation of contaminant reduction
- Familiarity statement by the DBS&A project manager
- Description of actions taken or future plans for the recovery of contaminant mass

- Summary and recommendations

5.5 One Year of Quarterly Monitoring and Reporting

Subsequent to system installation, DBS&A will initiate quarterly groundwater monitoring in accordance with DBS&A SOPs. During the first year of quarterly monitoring, the 25 groundwater monitor wells associated with the site will be gauged (Figure 2). All wells that do not contain LNAPL will be sampled. In the event that remedial activities cause a decrease in site concentrations, the sampling program may be adjusted in future years. For example, the wells along NM 48 where contaminants have consistently been below laboratory reporting limits could be eliminated from the regular sampling program.

Fluid levels will be gauged in each well using an electronic interface probe to determine if LNAPL is present and to determine the depth to water. If detected by the interface probe, the LNAPL thickness will be measured to within 0.01 foot. The interface probe will be decontaminated before each measurement using a solution of deionized water and Liquinox (or equivalent) soap.

Prior to sampling, the wells will be purged, using dedicated, disposable, polyethylene hand bailers, by bailing a minimum of three casing volumes or until groundwater chemistry has stabilized. If a well is purged dry, it will be sampled when the well has recharged. During purging groundwater field parameters (dissolved oxygen [DO], oxidation/reduction potential [ORP], electrical conductivity [EC], pH, and temperature) will be measured using a YSI Professional or equivalent device.

After purging, wells without LNAPL will be sampled for laboratory analysis, providing they contain a sufficient amount of groundwater. To minimize volatilization and ensure sample integrity, dedicated, disposable, polyethylene bottom-emptying devices will be used to transfer groundwater samples from the bailers to the appropriate containers. Samples collected for VOC analysis will be transferred from bailers into laboratory-prepared 40-milliliter (mL) glass sample bottles that contain mercuric chloride as a preservative. The bottled groundwater samples will be labeled and preserved on ice in an insulated cooler for delivery to HEAL in Albuquerque, New Mexico, for analysis. Groundwater samples will be analyzed for VOCs using

EPA method 8260B (full list). Groundwater samples will be accompanied by full chain of custody documentation at all times.

Following completion of each quarter of sampling and O&M, and upon receipt of laboratory analytical reports, DBS&A will prepare and submit to the NMED PSTB project manager a quarterly monitoring report conforming to 20.5.119.1926 NMAC. The report will include, but not be limited to, the following:

- Area/vicinity map
- Detailed site diagram with locations of buildings, monitor wells, storage tanks and lines, sumps, impoundments, pit areas, water lines, and other relevant structures
- Summary of site conditions
- Discussion of the sampling collection procedures
- Laboratory results with chain of custody records and quality assurance information
- Groundwater elevation map
- Groundwater contaminant and isoconcentration maps with contaminant concentrations for each well (baseline data will be included as a separate appendix in each report)
- Tabulation and graphs of recent and historical (including baseline) groundwater elevations, LNAPL levels (if applicable), and contaminant concentrations in each well, such as the following tables and graphs:
  - Groundwater analytical chemistry
  - Soil vapor analytical chemistry
  - Fluid level measurements and groundwater elevations
  - Summary of LNAPL recovery
  - System operations data
  - Cumulative mass removal
  - Well circuit soil vapor field screening data

  - Groundwater elevation and LNAPL thickness over time for each well containing LNAPL
- Identification and explanation of any operational adjustments made for system optimization
- Characterization of wastes, including handling and disposal
- Elevation survey results
- Documentation of purchased remediation equipment
- Discussion of actual system operation and effectiveness compared to expected parameters used for the remedial design
- Evaluation of contaminant reduction
- Any deviations from the drawings and specifications included in the FRP
- Description of actions taken or future plans for the recovery of contaminant mass
- Summary and recommendations

5.6 Health and Safety Requirements

DBS&A will update the current site-specific health and safety plan (HASP) for the proposed field activities at the site related to the remediation system installation and operation pursuant to the requirements of CFR 1910.120. The current HASP is provided as Appendix F. A copy of the HASP will be kept on-site during all field activities.

6. Permits

6.1 Ground Water Quality Bureau Discharge Permit

Discharge of treated water to the on-site infiltration gallery will require an NMED GWQB discharge permit. A copy of the permit application is included in Appendix G. Due to the amount of time required to acquire the discharge permit, and the fact that the permit needs to be approved prior to implementation of corrective action, DBS&A intends to submit the application at the same time as the FRP. Future correspondence regarding additional public notice, supplemental information, and permit approval will be provided to the PSTB electronically and documented in subsequent reports.

6.2 Air Quality Bureau Notice of Intent

DBS&A reviewed current guidance from the NMED Air Quality Bureau (AQB) regarding air permitting, which states that "facilities that emit less than 10 tons per year of any criteria pollutant do not need an air quality permit nor do they need a Notice of Intent (NOI)". After the system is implemented, DBS&A will monitor remediation system emissions, which are typically multiple orders of magnitude below regulatory standards, and will submit the relevant paperwork if required. However, a draft NOI permit application has not been included in this FRP.

6.3 Office of the State Engineer Well Permits

Permits from the Office of the State Engineer (OSE) may be required in the future if additional wells are constructed at the site. Permit applications will be submitted upon approval of the work plan for well installation, and permit approvals will be provided with subsequent reports.

7. Notifications

DBS&A has provided provide public notice in accordance with 20.5.119.1923.D.10 NMAC. Legal notice of the submission of the remediation plan will be published twice in the Ruidoso News, on December 16 and December 23, 2020. The format for the legal notice follows the guidelines dictated in 20.5.119.1923.D.10.b NMAC. The legal notices were submitted to PSTB for prior approval and translation. The certified affidavit of publication for each legal notice will be provided to the PSTB project manager following the second date of publication and issuance of the affidavit.

Certified letters containing the legal notice were sent to owners and occupants of affected and adjacent properties. The list of addresses was compiled from Lincoln County Assessor data and through additional contacts with property owners and occupants. A total of 10 letters were sent to the owners and occupants of 13 parcels on December 9, 2020. DBS&A will update the PSTB project manager when return receipts from the certified letters are received.

A copy of the text of the legal notices (English and Spanish), a list of certified letter addresses, and a map indicating which residences and businesses received certified letters are provided in Appendix H.

Notices of submission of the remediation plan are posted at the site near the proposed location of the remediation equipment on the east side of the current gas station facility and in a prominent location near the convenience store entrance where they can be easily seen by the public. Signs were posted 48-hours prior to the date of this FRP. Photographic documentation of the sign placement is provided in Appendix H.

8. Implementation Schedule

A schedule for implementing this FRP is provided in Appendix I. Implementation milestones include the following:

- Approval of the FRP
- Procurement of major remediation equipment
- Installation of conveyance piping and the infiltration gallery
- Installation of remediation equipment
- System startup
- Submittal of the as-built report and record drawings
- Quarterly O&M and reporting

9. Evaluation of Remedial Actions

Remediation system performance will be evaluated annually in accordance with 20.5.119.127 NMAC. The system evaluation will be incorporated into the fourth quarter monitoring report and submitted to the NMED PSTB project manager. This evaluation will provide NMED with the information necessary to determine whether the remedial approach undertaken is successful in achieving the remedial action objectives. Key elements of the report include the following:

- Contaminant plume maps with contaminant levels from each well
- Evaluation of MPE system performance based on mass of fuel compounds removed and volume of groundwater treated and discharged
- Summary and recommendations

In the event that the data collected during the first six months of operation suggest that the system as installed has not been effective at removing or reducing contaminant mass, DBS&A may propose an alternative approach or change to the existing remediation plan. A variety of technologies could augment the removal. DBS&A believes that the remedial approach documented in this FRP is a prudent and cost-effective approach to achieve removal of contaminant mass in the most expeditious time frame and to ultimately bring the site to closure.

10. Statement of Familiarity

This FRP was prepared on behalf of Bell Gas, Inc., RP for the Bell Gas #1186 (TR's market) site. Preparation of all engineering drawings and specifications was conducted under the direction and supervision of Thomas Golden, a New Mexico-Licensed Professional Engineer (License #22750).

Thomas Golden, P.E.
Project Engineer

December 18, 2020
Date

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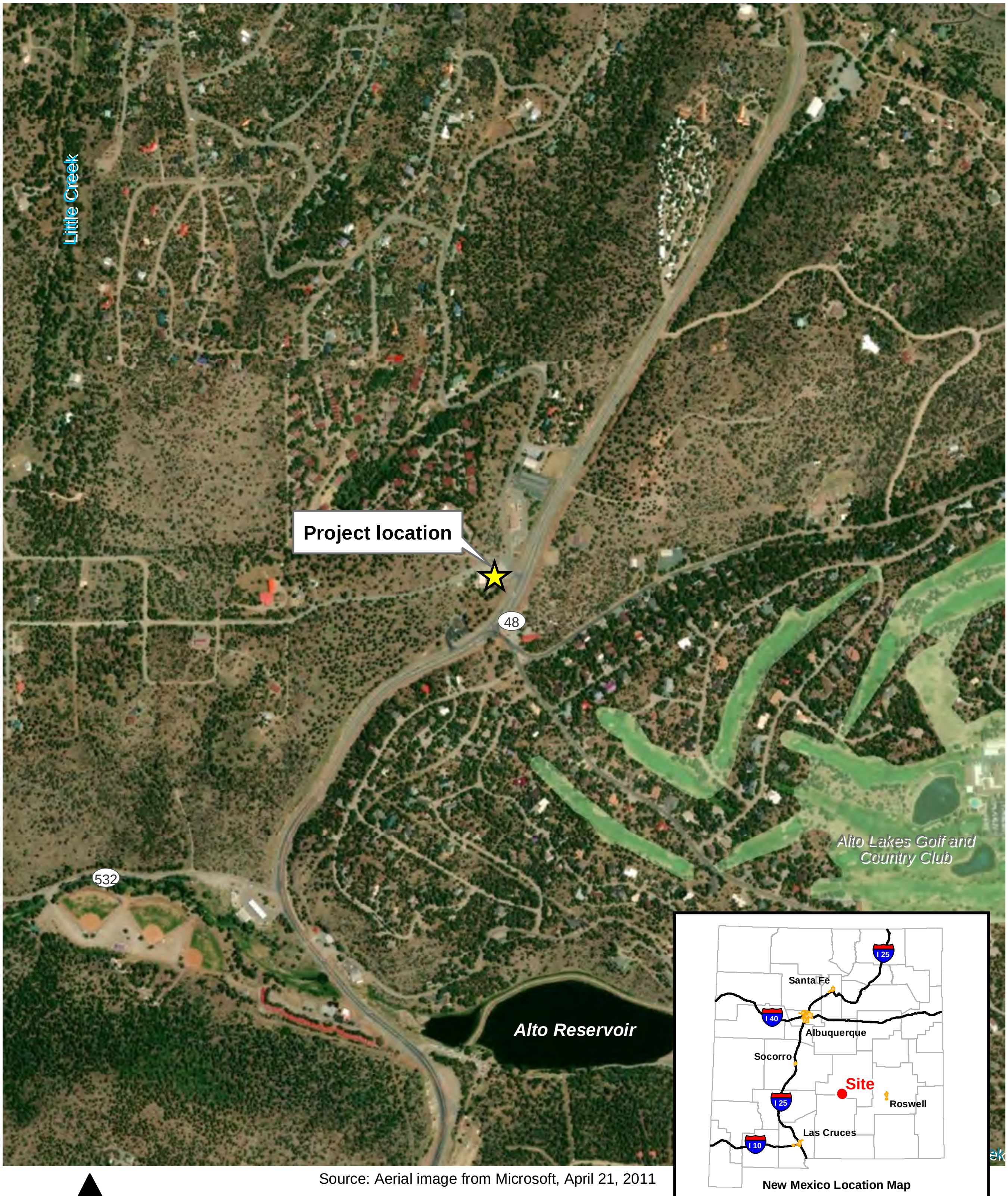
SEI. 2013. *Hydrogeologic investigation report, Bell Gas #1186 (TR's Market)*. April 12, 2013.

Figures



Source: Aerial image from Microsoft, April 21, 2011

N

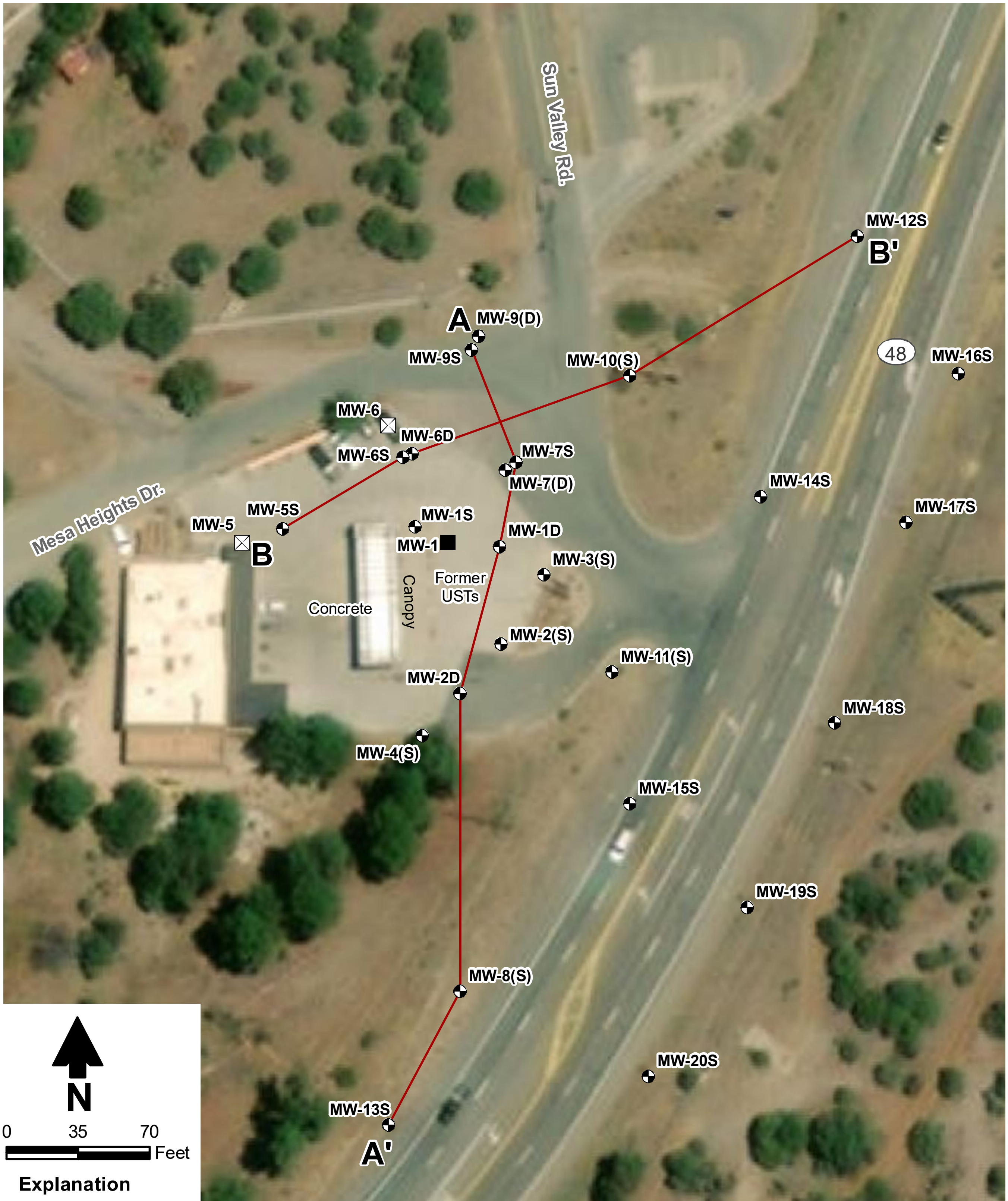
0 500 1000 Feet

\\ss6abq\Data\S\Projects\ES14.0220_Bell_Gas_1186\GIS\MXDs\Site_maps\Area_map.mxd

BELL GAS #1186
ALTO, NEW MEXICO
Area Map

Daniel B. Stephens & Associates, Inc.
6/26/2015 JN ES14.0220.00

Figure 1



Source: Aerial image from Microsoft, April 21, 2011

Explanation

- Monitor well
- Destroyed monitor well
- Abandoned monitor well
- A — A' Cross section line

Note: 1. Gas station facilities were replaced in 2013 and differ slightly from what is shown on this aerial photograph.

BELL GAS #1186

ALTO, NEW MEXICO

Site Map with Cross Section Locations

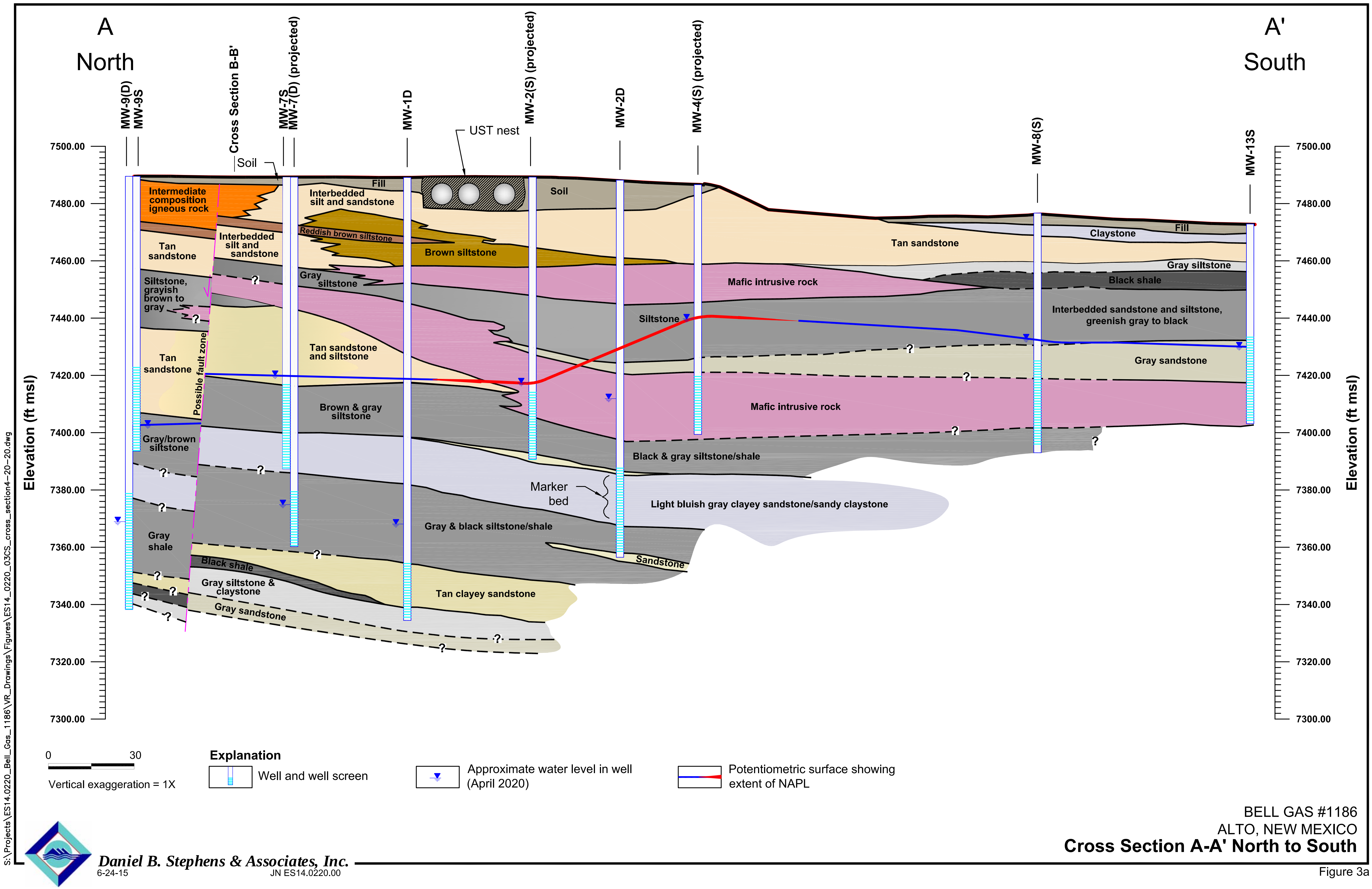
Daniel B. Stephens & Associates, Inc.

12/16/2020

JN ES14.0220.00

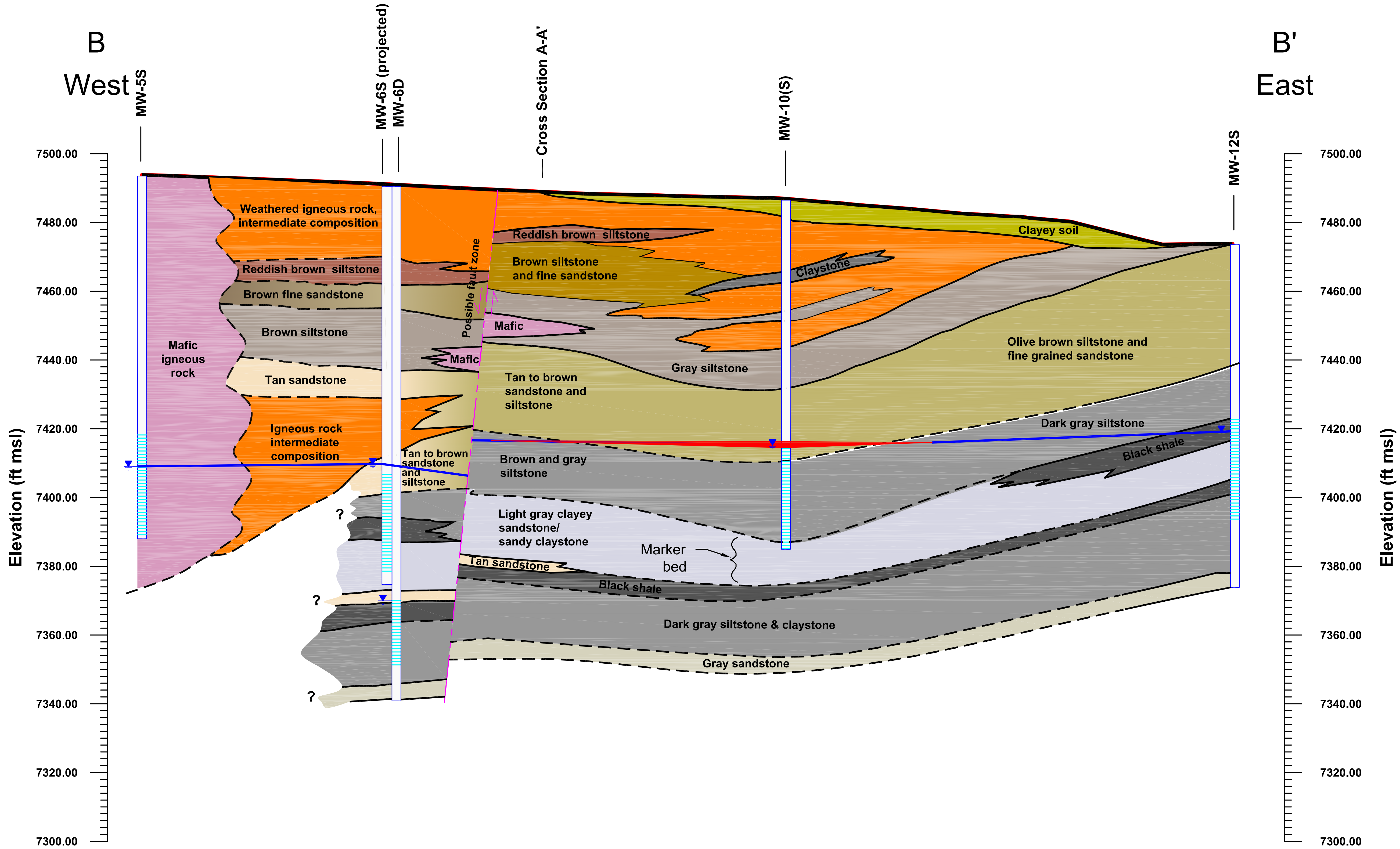
Figure 2

S:\Projects\ES14.0220_Bell_Gas_1186\GIS\MXDs\Site_maps\Site_map_w_XSection.mxd



Cross Section A-A' North to South

Figure 3a



0 30
Vertical exaggeration = 1X

Explanation

Well and well screen

Approximate water level in well (April 2020)

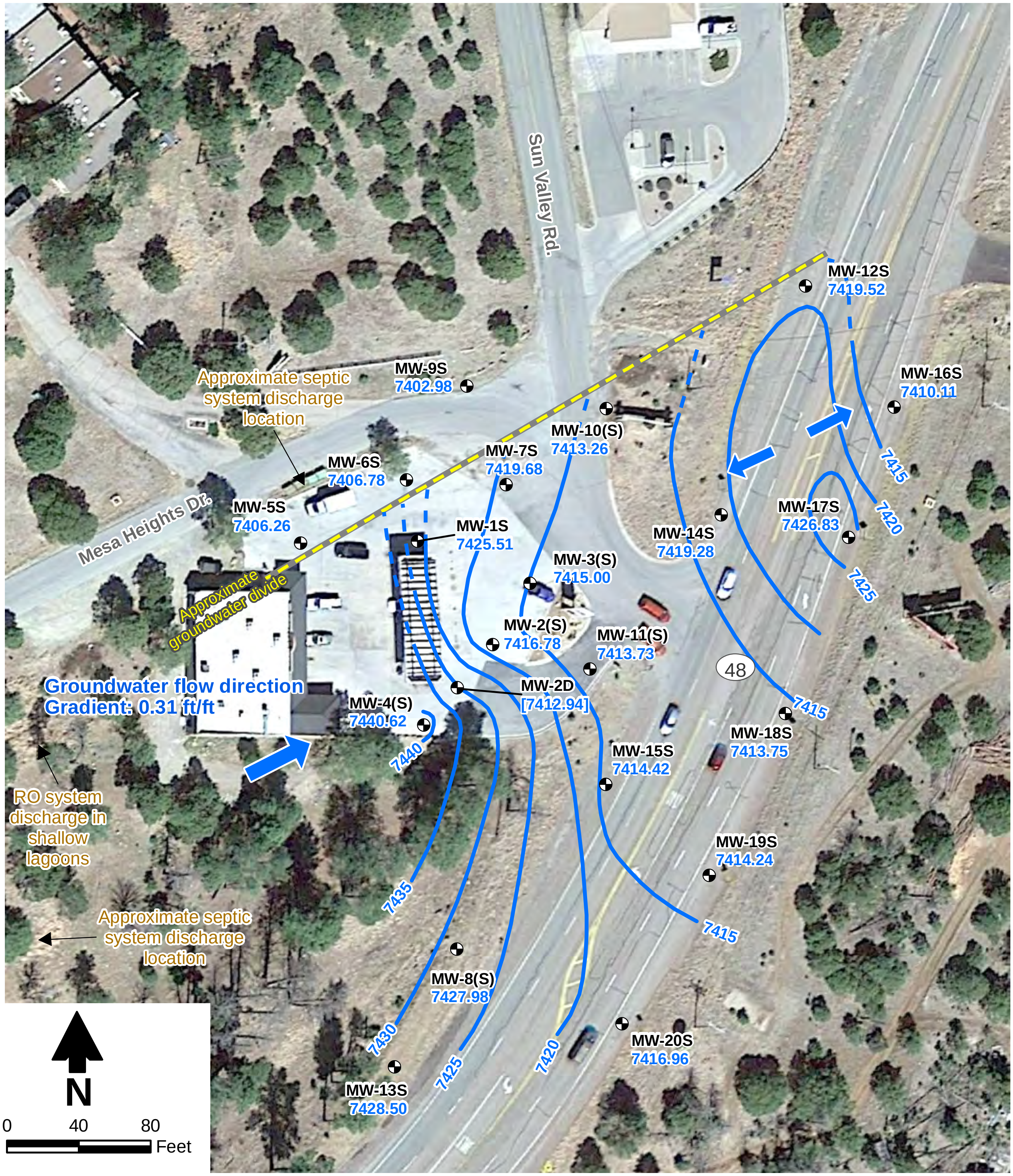
Potentiometric surface showing extent of NAPL

BELL GAS #1186
ALTO, NEW MEXICO
Cross Section B-B' West to East

Daniel B. Stephens & Associates, Inc.
6-24-15 JN ES14.0220.00

Figure 3b

S:\Projects\ES14.0220_Bell_Gas_1186\VR_Drawings\Figures\ES14_0220_03CS_cross_section4-20-20.dwg



Source: Aerial image from Google Earth dated March 2016

Explanation

- Monitor well
- Potentiometric surface elevation contour (ft msl)
- **MW-2(S)** Monitor well designation
- **7416.78** Potentiometric surface elevation (ft msl)
- **[7412.94]** Potentiometric surface elevation not used for contouring

BELL GAS #1186
ALTO, NEW MEXICO

Potentiometric Surface Elevations in the Upper Aquifer
April 13, 2020

Daniel B. Stephens & Associates, Inc.
4/27/2020 JN ES14.0220.00

Figure 4a

S:\Projects\ES14.0220_Bell_Gas_1186\GIS\MXDs\Fluid_levels\GWE_upper_2020-04.mxd

Source: Aerial image from Google Earth dated March 2016

Explanation

⊕	Monitor well
—	Potentiometric surface elevation contour (ft msl)
MW-6D	Monitor well designation
7367.07	Potentiometric surface elevation (ft msl)
[7375.10]	Potentiometric surface elevation not used for contouring

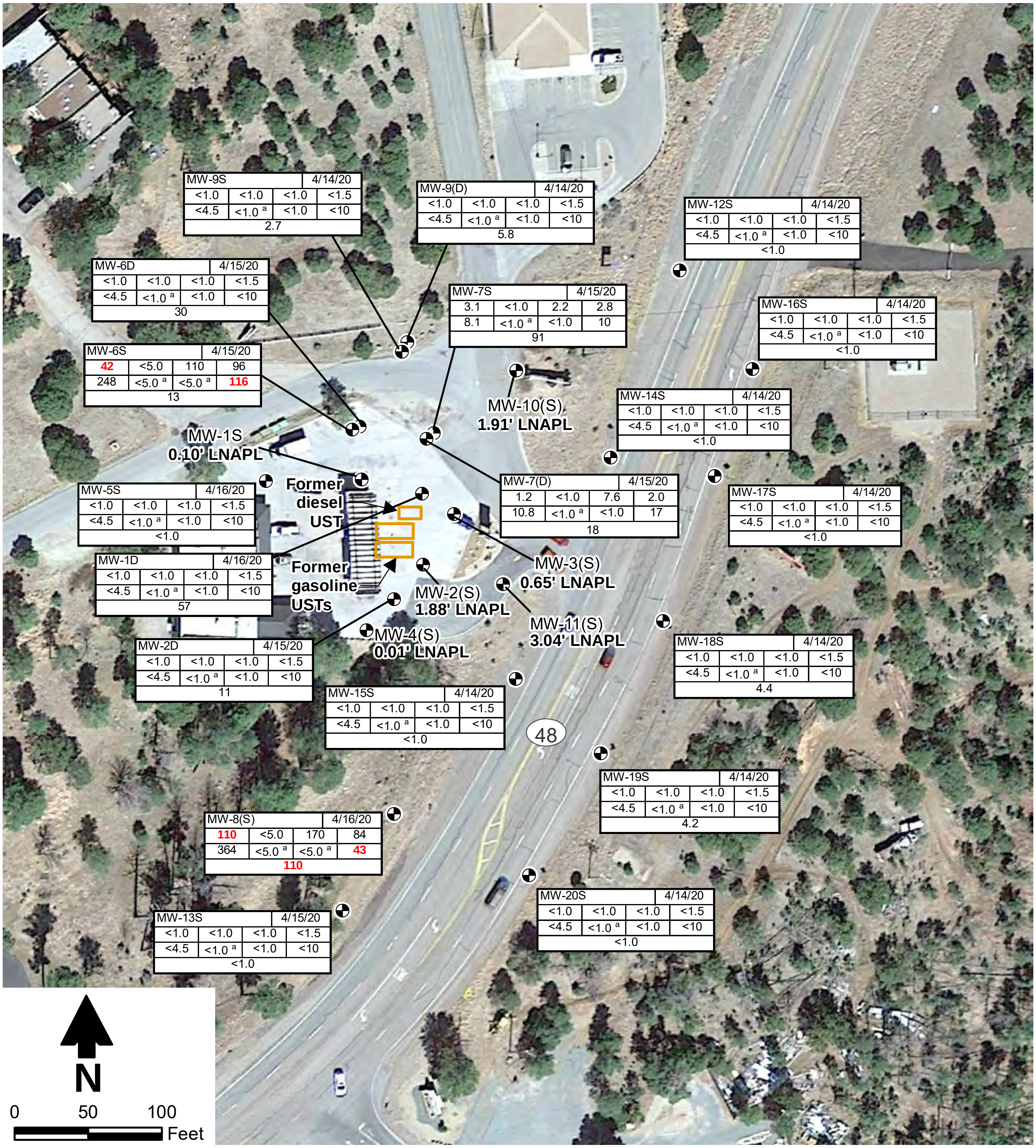
BELL GAS #1186
ALTO, NEW MEXICO

Potentiometric Surface Elevations in the Lower Aquifer April 13, 2020

Daniel B. Stephens & Associates, Inc.
5/15/2020 JN ES14.0220.00

Figure 4b

\\ss6abq\Data$\Projects\ES14.0220_Bell_Gas_1186\GIS\MXDs\Fluid_levels\GWE_lower_2020-04.mxd



Source: Aerial image from Google Earth dated March 2016

Explanation

⊕ Monitor well

Location designation		Sample Date	
Benzene	Toluene	Ethylbenzene	Total Xylenes
BTEX	EDB	EDC	Total Naphthalenes
MTBE			

Notes: 1. All concentrations reported in micrograms per liter (µg/L)
2. **RED** indicates concentration that exceeds NMWQCC standard
3. [a] Laboratory reporting limit is equal to or greater than applicable standard
4. LNAPL = Light nonaqueous-phase liquid

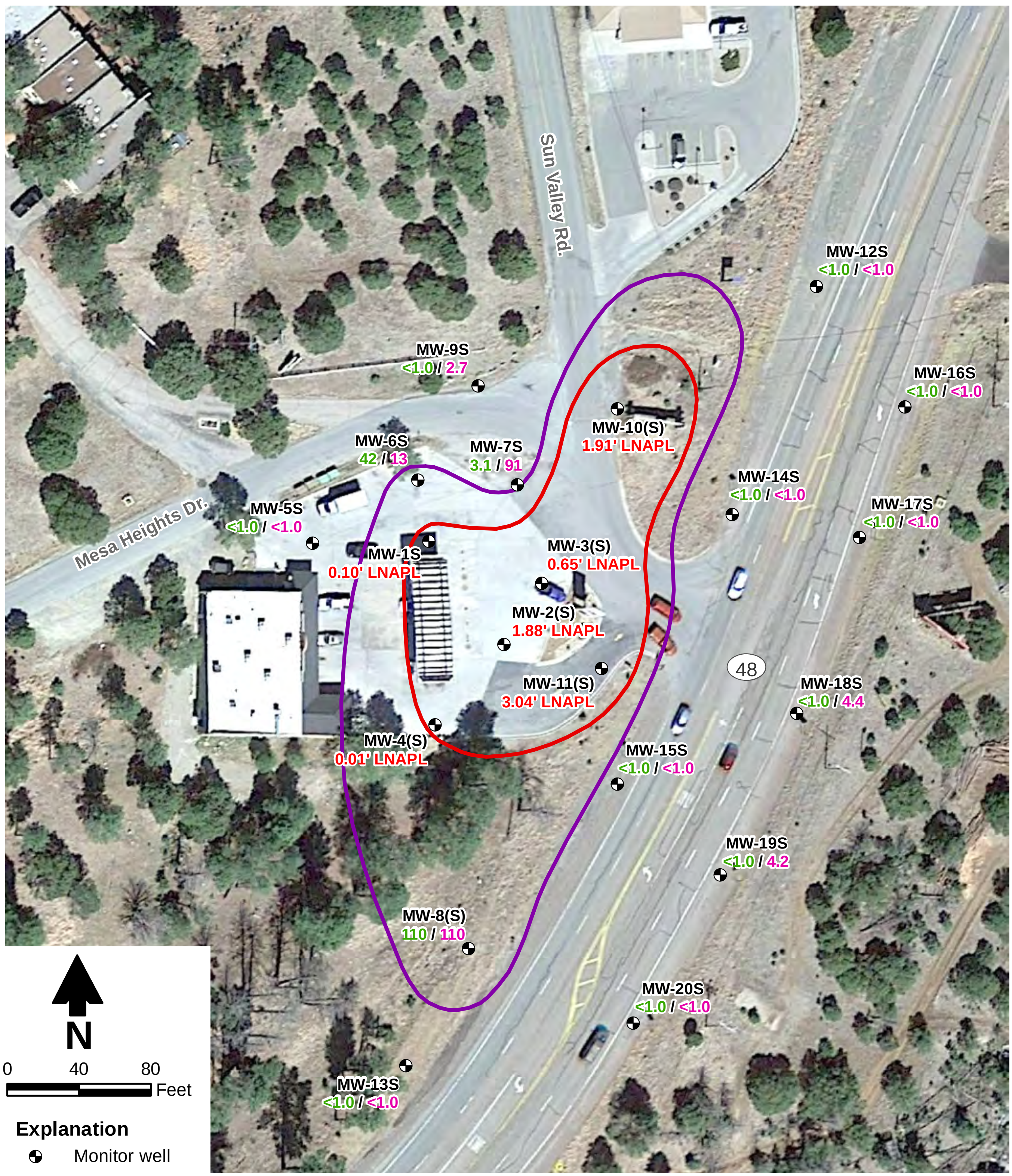
BELL GAS #1186
ALTO, NEW MEXICO

Distribution of Dissolved-Phase Contaminants April 14 through 16, 2020

Daniel B. Stephens & Associates, Inc.
4/30/2020 JN ES14.0220.00

Figure 5

S:\Projects\ES14.0220_Bell_Gas_1186\GIS\MXDs\Chemistry\DPC_2020-04.mxd



Explanation

- Monitor well
- Approximate extent of actionable DPC
- Approximate extent of LNAPL

MW-8(S) Monitor well designation

110 / 110 Benzene/MTBE concentrations in micrograms per liter (µg/L)

Notes: 1. DPC = Dissolved-phase contamination
2. LNAPL = Light nonaqueous-phase liquid
3. Wells with actionable contamination have one or more constituents above applicable groundwater standards.

Source: Aerial image from Google Earth dated March 2016

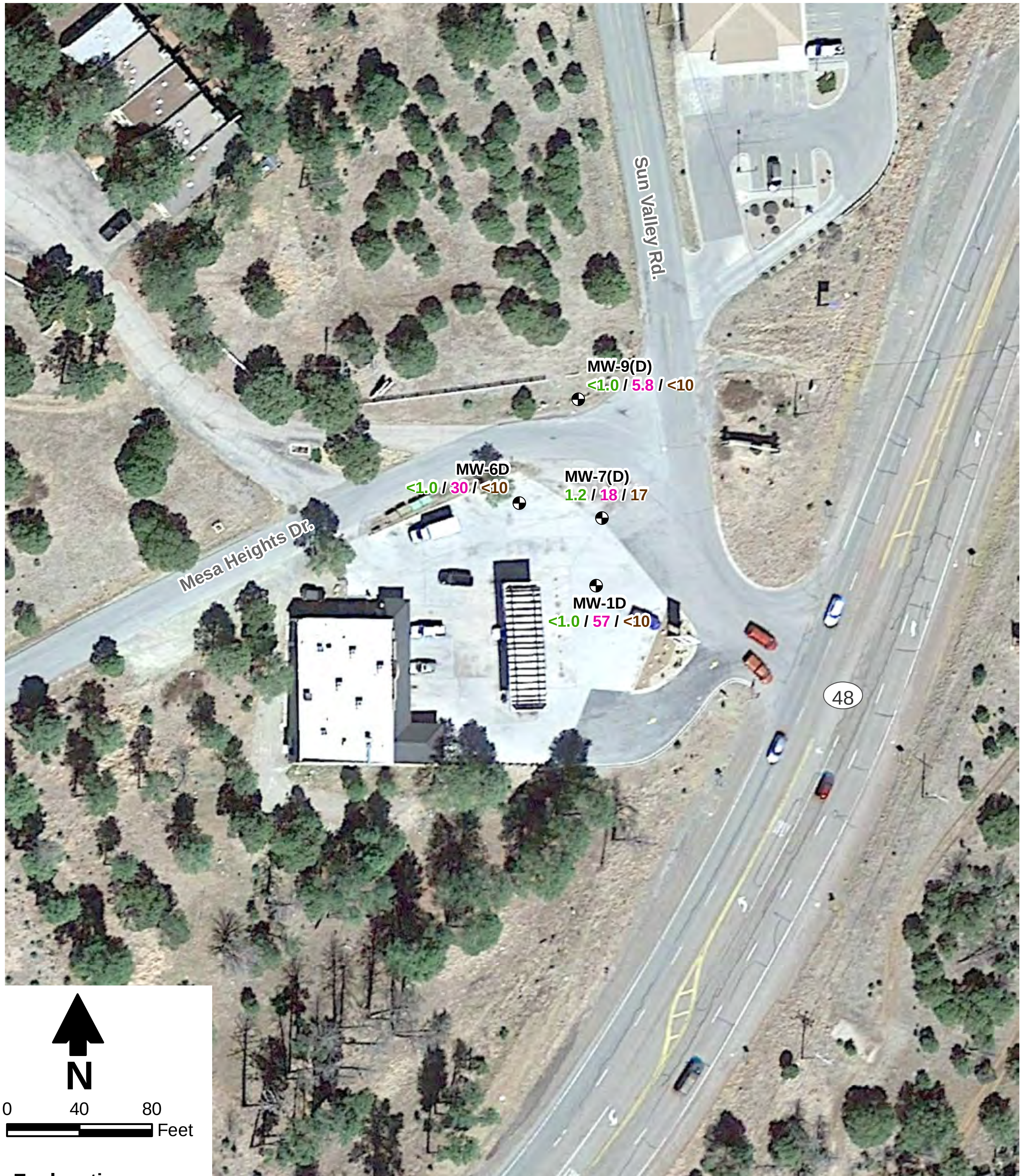
BELL GAS #1186
ALTO, NEW MEXICO

LNAPL and Dissolved-Phase Plumes Upper Aquifer Unit

S:\Projects\ES14.0220_Bell_Gas_1186\GIS\MXDs\Chemistry\Plume_upper_2020-04.mxd

Daniel B. Stephens & Associates, Inc.
5/14/2020 JN ES14.0220.00

Figure 6a



Source: Aerial image from Google Earth dated March 2016

Explanation

- Monitor well
- Approximate extent of actionable DPC
- **MW-1D** Monitor well designation
- **<1.0 / 57 / <10** Benzene/MTBE/total naphthalenes concentrations in micrograms per liter (µg/L)

Notes: 1. DPC = Dissolved-phase contamination
2. Wells with actionable contamination have one or more constituents above applicable groundwater standards.

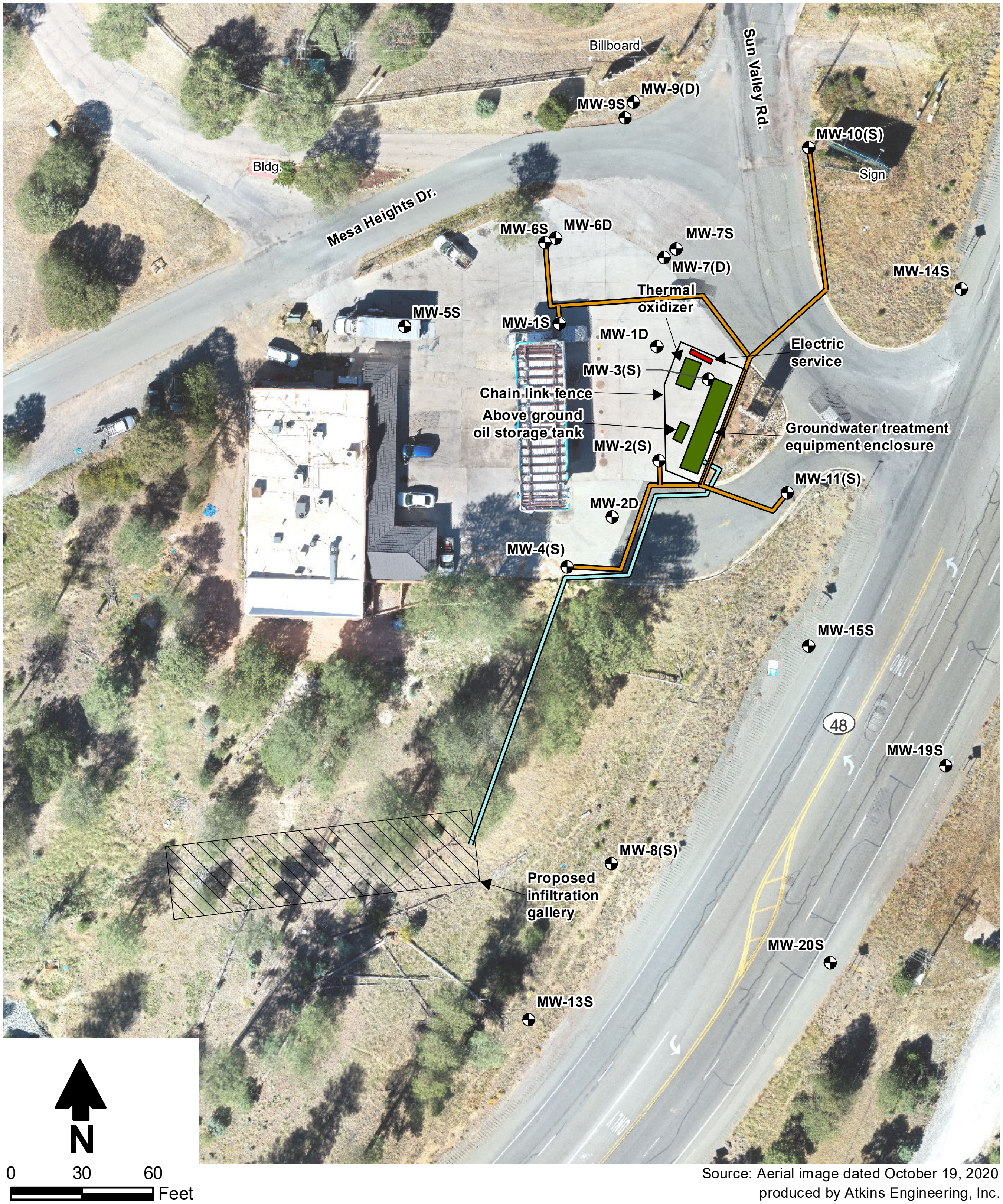
BELL GAS #1186
ALTO, NEW MEXICO

Dissolved-Phase Plume
Lower Aquifer Unit

Daniel B. Stephens & Associates, Inc.
4/30/2020 JN ES14.0220.00

Figure 6b

S:\Projects\ES14.0220_Bell_Gas_1186\GIS\MXDs\Chemistry\Plume_lower_2020-04.mxd



Source: Aerial image dated October 19, 2020 produced by Atkins Engineering, Inc.

Explanation

- Monitor well
- Conveyance line
- Treated water discharge

S:\Projects\ES14.0220_Bell_Gas_1186\GIS\MXDs\Engineering\Proposed_system_layout.mxd

BELL GAS #1186
ALTO, NEW MEXICO

Remediation System Layout

Daniel B. Stephens & Associates, Inc.
12/17/2020 JN ES14.0220.00

Figure 7

Appendix A

Calculations

Calculation Cover Sheet

Daniel B. Stephens & Associates, Inc.

Project Name Bell Gas #1186 Project Number ES14.0220

Calculation Number ES14.0220-001 Discipline Engineering No. of Sheets 3

PROJECT: Bell Gas #1186 Remediation System

THOMAS A. GOLDEN NEW MEXICO 22750 12/18/2020 PROFESSIONAL ENGINEER

SITE: Alto, New Mexico

SUBJECT: Determine actual air flowrate (cubic feet per minute) on the inlet side of the pump

SOURCES OF DATA: A. Multiphase pilot test report, Ecovac Services, 2015.

SOURCES OF FORMULAE & REFERENCES:

1.Fundamentals of Fluid Mechanics, 6th edition, Bruce Munson, Donald Young, Theodore Okiishi, and Wade Huebsch, John Wiley &Sons, Inc, 2009.

☐ Preliminary Calculation ☒ Final Calculation Supersedes Calculation No. ____________

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
0	Final Remediation Plan	JS	12/10/2018	TH	12/11/2018	TG	10/15/2020

1.0 OBJECTIVE

Calculate the volume of air pumped in one minute on the suction side of the pump to use in design of the multiphase extraction (MPE) system.

2.0 GIVEN

Data from the MPE pilot test report[A] provide vacuum applied by the pump and volumetric flow rate measurements taken from a 3-inch effluent stack on the discharge side of the pump (effluent) for each individual well used in the study. The measurements were made with a Dwyer hand held anemometer that provides temperature-corrected flow measurements in units of actual cubic feet per minute (acfm). Based on MPE pilot testing data, the total flow rate on the discharge side of the pump was approximately 175 acfm. The applied vacuum during the MPE pilot test was 20 inches of mercury (in Hg). The pressure on the discharge side of the blower was assumed to be atmospheric, and based on an elevation of 7,485 feet above mean sea level, the absolute pressure is assumed to be 11.1 pounds per square inch (psi).

3.0 METHOD

Begin by converting the applied vacuum at the pump, psi_{app}, to absolute pressure under vacuum, $psi_{abs\ vac}$ using equations 1 and 2, including a unit conversion for the applied vacuum from in Hg to psi.

$$psi_{app} = Hg_{app} x \frac{0.4912\ psi}{inches\ of\ Hg} \qquad \text{eqn. 1}$$

$$psi_{abs\ vac} = psi_{atm} - psi_{app} \qquad \text{eqn. 2}$$

Use the ideal gas law[1] to relate the pressure, temperature and flow measurements between the discharge side of the pump and the suction side of the pump. The ideal gas law is defined below in equation 3.

$$\rho = \frac{p}{RT} \qquad \text{eqn. 3}$$

Where:
ρ = density of fluid
p = absolute pressure of fluid
R = ideal gas constant for air
T = absolute temperature of fluid

Given that density is equal to mass/volume, equation 3 can be rearranged in the form which includes volume as shown below in equation 4.

$$p_sV_s = m_sR_sT_s \quad \text{eqn. 4}$$

Where:
p_s = pressure on the suction side of the pump
V_s = volume on suction side of the pump
m_s = mass of gas on suction side of the pump
R_s = gas constant for air
T_s = absolute temperature on suction side of the pump

Equation 5 relates the flow on the suction side of the pump to the discharge side of the pump through properties of conservation of energy.

$$\frac{p_sV_s}{m_sRT_s} = \frac{p_dV_d}{m_dR_dT_d} \quad \text{eqn 5.}$$

Where:
p_d = pressure on the discharge side of the pump
V_d = volume on the discharge side of the pump
m_d = mass of gas on discharge side of the pump
R_d = gas constant for air
T_d = absolute temperature on discharge side of the pump (Kelvin)

Assuming that the gas constant, the temperature (initial blower effluent was temperature-corrected), and the mass of gas are constant between the two locations, equation 5 simplifies to equation 6 below.

$$p_sV_s = p_dV_d \quad \text{eqn 6.}$$

Substitute $psi_{abs\ vac}$ for p_s and the site's atmospheric pressure for p_d. Using the volumetric flowrate on the discharge side of the pump (effluent), V_d, rearrange equation 6 to solve for the volumetric flowrate on the suction side (inlet), V_s.

$$V_s = \frac{p_dV_d}{p_{abs\ vac}} \quad \text{eqn 7.}$$

4.0 SOLUTION

Following the methodology outlined above, the absolute pressure in psi on the inlet side of the blower is calculated using equations 1 and 2 as follows:

$$psi_{app} = 20\ inches\ of\ Hg\ x\ \frac{0.4912\ psi}{inches\ of\ Hg} = 9.824\ psi$$

$$psi_{abs\ vac} = 11.1\ psi - 9.8\ psi = 1.276\ psi$$

Project No. ES14.0220 | Date 12/10/2018

Subject Pressure losses and remediation system blower design | Sheet 3 of 3

By J. Samson | Checked By T. Hopkins | Calculation No. ES14.0220-001

Using equation 7 and the calculated $psi_{abs\ vac}$, solve for the volumetric flowrate on the suction side of the blower (inlet flow) in acfm.

$$V_s = \frac{11.1\ psi\ x\ 175\ acfm}{1.276\ psi} = 1{,}521\ acfm$$

Equation 6 can then be used to normalize the flow rate for individual wells to calculate inlet flow in standard cubic feet per minute (scfm), based on a standard atmospheric pressure of 14.7 psi. For example, the blower effluent flow for MW-1S measured during MPE pilot testing was approximately 25 acfm. Blower inlet flow calculated using equation 7 is approximately 217 acfm. Calculate the standard inlet flow, $V_{in\text{-}std}$:

$$V_{in-std} = \frac{1.276\ psi\ x\ 217\ acfm}{14.7\ psi} = 19\ scfm$$

DBS&A will use rotary claw compressors (pumps) to generate the required vacuum for system operation, anticipated to be between 18.5 and 19 in Hg. Due to the slight reduction in vacuum from the MPE pilot test (20 in Hg), DBS&A reduced the design inlet flowrate by approximately 2 scfm per well. Therefore, the design flowrate for MW-1S will be 17 scfm. Claw pumps are specified in units of acfm at the inlet. Use equation 6 to calculate the design flowrate, V_{des}, for MW-1S assuming absolute pressure at the inlet of 1.77 psi corresponding to 19 in Hg applied at the site elevation:

$$V_{des} = \frac{14.7\ psi\ x\ 17\ scfm}{1.77\ psi} = 141\ acfm$$

Supporting calculations are attached for the seven wells proposed for use with this remediation system. Total blower inlet air flow is calculated to be **989 acfm** at approximately 19 in Hg applied vacuum. Based on this calculation, the remediation equipment manufacturer intends to provide two claw pumps, each rated for flow of 600 acfm, resulting in total inlet capacity of 1200 acfm at applied well vacuum of 18.5 in Hg.

Pilot test conditions

11.1 psi, atmospheric pressure at elevation
20.0 HGV, applied wellhead vacuum
9.8 psi, applied vacuum
1.3 psia, vacuum pump inlet

Standard conditions

14.7 psi
70 °F

System design conditions

19.0 HGV, applied pump vacuum
9.3 psi, applied pump vacuum
1.8 psia, vacuum pump inlet

	PILOT TEST CONDITIONS			**DESIGN CONDITIONS**	
Well	**Measured Flow - Blower Effluent (acfm)**	**Blower Inlet Flow (acfm)**	**Standard Inlet Flow (scfm)**	**Standard Inlet Flow (scfm)**	**Blower Inlet Flow (acfm)**
MW-1S	25	217	19	17	141
MW-2S	25	217	19	17	141
MW-3S	30	261	23	21	175
MW-4S	30	261	23	21	175
MW-6S	25	217	19	17	141
MW-10S	20	174	15	13	108
MW-11S	20	174	15	13	108
Total	175	1521	132	119	989

Note: Dwyer anemometer compensates for temperature

July 03, 2015

Mr. Thomas Golden, PE
Daniel B. Stephens & Associates, Inc.
6020 Academy Road NE, Suite 100
Albuquerque, NM 87109
505.353.9075
tgolden@dbstephens.com

Subject: June 16, 17, & 18, 2015 EFR®/Pilot Test Report
Bell Gas #1186
101 Sun Valley Road
Alto, New Mexico

Dear Mr. Golden:

Please find attached the data summary for the EFR®/Pilot Test event conducted at the subject site on June 16, 17, & 18, 2015. The EFR® event was implemented in monitor well MW-2S on June 16, 2015; in monitor well MW-10S on June 17, 2015; and in monitor wells MW-3S, MW-6D, MW-6S, MW-4S, and MW-11S on June 18, 2015. EFR® is a mobile multi-phase/dual-phase extraction technology shown to be effective for mass removal of hydrocarbons in the soils/groundwater, and is used to gather the necessary data to generate effective remediation strategies.

EFR®

The main purposes of the EFR® events were to 1) achieve contaminant removal by multi-phase/dual-phase extraction process, 2) reduce the initial aerial and vertical extent of the plume, and **3) collect field data (i.e. radius of influence, air-flow rates, vapor concentrations, water recovery rates, etc.), for full-scale remediation**.

June 16, 2015 - Event 1
MW-2S

EFR® was performed for 8 hours at monitor well MW-2S on June 16, 2015. Separate-phase hydrocarbons (SPH) (gasoline) were detected in monitor well MW-2S prior to completion of the event at a thickness of 1.01 feet. SPH was not detected in MW-2S upon conclusion of the event.

A calculated total of 6.0 pounds of petroleum hydrocarbons (approximately 1.0 equivalent gallon of hydrocarbon) in vapor concentrations were removed during the EFR® event on June 16, 2015.

The hydrocarbon removal rate (in vapors) varied from a low of 0.4 pounds per hour (lbs/hr) at several times during the MW-2S extraction event, to a high of 2.8 pounds per hour (lbs/hr) at the beginning of the MW-2S extraction event. The removal rate was low and showed a decreasing trend initially, and then a relatively steady trend during remainder of the extraction from MW-2S.

Vapor concentrations varied from a high of 6,000 parts per million by volume (PPM_V) (total hydrocarbons) at the beginning of the MW-2S extraction event, to a low of 1,400 PPMv 2 hours into the MW-2S extraction event. As with the removal rates, the concentrations were low. The concentration showed a decreasing trend throughout the MW-2S event.

The range of vacuum readings recorded during this EFR® event from the extraction well is detailed in the attached EFR® Field Data Sheet and summarized below:

Extraction Well	Vacuum Readings
Truck	20 inches of mercury
MW-2S	12 to 14 inches of mercury

Vacuum Influence

Differential pressures from the nearest monitor wells were recorded during this event to assess the vacuum induced by EFR® in the vadose zone. A vacuum influence was observed at a distance of 60 feet from MW-2S in MW-4S, and a possible slight influence was observed at a distance of 103 feet from MW-2S in MW-6S. An influence was not observed at a distance of 40, 55, or 145 feet from MW-2S in shallow wells MW-3S, MW-11S, or MW-10S, respectively. An influence was not observed at a distance of 33 or 45 feet in deep wells MW-2D or MW-1D, respectively. The differential pressure data are detailed in the attached table and summarized below:

Monitor Well	Maximum Change	Nearest Extraction Well (Approx. Distance)
MW-2D	0.00 inches of water	MW-2S (33 feet)
MW-4S	-0.14 inches of water	MW-2S (60 feet)
MW-11S	0.00 inches of water	MW-2S (55 feet)
MW-3S	0.00 inches of water	MW-2S (40 feet)
MW-1D	0.00 inches of water	MW-2S (45 feet)
MW-6S	-0.03 inches of water	MW-2S (103 feet)
MW-10S	0.00 inches of water	MW-2S (145 feet)

It should be noted that the slight influence observed in MW-6S occurred only during three of the early event readings. It should also be noted that the influence observed in MW-4S was observed when the stinger was ~78 feet below ground surface, and the influence was no longer observed after the stinger was lowered to 81 feet.

Groundwater Drawdown

Groundwater levels were recorded in the extraction wells and surrounding wells during these two events to assess the groundwater drawdown created by EFR®.

A groundwater drawdown was observed at a distance of 33, 40, 60, 103, and 145 feet from MW-2S in MW-2D, MW-3S, MW-4S, MW-6S, and MW-10S, respectively. A groundwater drawdown was not observed at a distance of 45 or 55 feet from MW-2S in MW-1D or MW-11S, respectively. The groundwater drawdown data are summarized below:

Monitor Well	Maximum Change	Nearest Extraction Well (Approx. Distance)
MW-2S	-12.88 feet	Extraction Well
MW-2D	-0.18 feet	MW-2S (33 feet)
MW-4S	-0.86 feet	MW-2S (60 feet)
MW-11S	0.17 feet	MW-2S (55 feet)
MW-3S	-2.03 feet	MW-2S (40 feet)
MW-1D	0.07 feet	MW-2S (45 feet)
MW-6S	-0.01 feet	MW-2S (103 feet)
MW-10S	-0.36 feet	MW-2S (145 feet)

It should be noted that a groundwater drawdown was observed even where a vacuum influence was not observed.

Disposition of Fluids

Approximately 69 gallons (based on gauging the truck after the events) of fluids were extracted from the monitoring well during this event. The yield was very low. The fluids were off loaded to a tank on-site.

June 17, 2015 - Event 2
MW-10S

EFR® was performed for 8 hours at monitor well MW-10S on June 17, 2015. Separate-phase hydrocarbons (SPH) (diesel fuel) were detected in monitor well MW-10S prior to completion of the event at a thickness of 3.79 feet. SPH was detected in MW-10S upon conclusion of the event at a thickness of 10.18 feet. It appears product was "pulled" into the well during this event.

A calculated total of 87.3 pounds of petroleum hydrocarbons (approximately 14.4 equivalent gallons of hydrocarbons) in vapor concentrations, in addition to 11 gallons of liquid phase SPH, were removed during the EFR® event on June 17, 2015.

The hydrocarbon removal rate (in vapors) varied from a low of 2.0 pounds per hour (lbs/hr) in the middle of the extraction event (this corresponded to a lowering of the stinger from 75 to 78 feet), to a high of 23.2 pounds per hour (lbs/hr) near the beginning of the extraction event. The removal rate showed a relatively steady trend when the stinger was at the same depth, but the removal rate was much lower when the stinger depth was lowered from 75 to 78 feet bgs. during the extraction.

Vapor concentrations varied from a high of 70,000 parts per million by volume (PPM_V) (total hydrocarbons) 2 hours into the extraction event, to a low of 10,000 PPMv in the middle of the extraction event. The concentrations increased during the first 2 hours on the event, then decreased throughout the remaining time of the event.

The range of vacuum readings recorded during this EFR® event from the extraction wells are detailed in the attached EFR® Field Data Sheet and summarized below:

Extraction Well	Vacuum Readings
Truck	20 inches of mercury
MW-10S	5 to 7 inches of mercury

Vacuum Influence

Differential pressures from the nearest monitor wells were recorded during this event to assess the vacuum induced by EFR® in the vadose zone. A vacuum influence was observed at a distance of 79, 115, 130, and 185 feet from MW-10S in monitor wells MW-9S, MW-6S, MW-12S, and MW-5S, respectively. A slight influence was observed at a distance of 77 and 110 feet from MW-10S in deep wells MW-7D and MW-6D. The differential pressure data are detailed in the attached table and summarized below:

Monitor Well	Maximum Change	Nearest Extraction Well (Approx. Distance)
MW-3S	0.00 inches of water	MW-10S (108 feet)
MW-7D	-0.03 inches of water	MW-10S (77 feet)
MW-6D	-0.04 inches of water	MW-10S (110 feet)
MW-6S	-0.15 inches of water	MW-10S (115 feet)
MW-5S	-0.05 inches of water	MW-10S (185 feet)
MW-9S	-0.07 inches of water	MW-10S (79 feet)
MW-9D	0.00 inches of water	MW-10S (77 feet)
MW-12S	-0.10 inches of water	MW-10S (130 feet)

The vacuum influence from MW-6S and MW-12S were consistent throughout the extraction from MW-10S. The influence observed in MW-5S and MW-9S was not as consistent.

Groundwater Drawdown

Groundwater levels were recorded in the extraction wells and surrounding wells during this event to assess the groundwater drawdown created by EFR®. A significant groundwater drawdown was observed at a distance of 108 and 115 feet from MW-10S in MW-3S and MW-6S, respectively; and a groundwater drawdown was observed at a distance of 77, 79, and 185 feet from MW-10S in MW-9D (deep well), MW-9S, and MW-5S, respectively. The groundwater drawdown data are summarized below:

Monitor Well	Maximum Change	Nearest Extraction Well (Approx. Distance)
MW-10S	-3.97 feet	Extraction Well
MW-3S	-2.34 feet	MW-10S (108 feet)
MW-7D	0.13 feet	MW-10S (77 feet)
MW-6D	0.00 feet	MW-10S (110 feet)

MW-6S	-2.77 feet	MW-10S (115 feet)
MW-5S	-0.06 feet	MW-10S (185 feet)
MW-9S	-0.01 feet	MW-10S (79 feet)
MW-9D	-0.02 feet	MW-10S (77 feet)
MW-12S	0.00 feet	MW-10S (130 feet)

The groundwater extraction rate was much higher from MW-10S which is potentially the reason for the greater groundwater drawdown observed during extraction form MW-10S as compared to that from MW-2S.

Disposition of Fluids
Approximately 265 gallons (based on gauging the truck after the events) of fluids were extracted from the monitoring well during this event. The fluids were off loaded to a tank on-site.

June 18, 2015 - Events 3 thru 7
MW-3S, MW-6D, MW-6S, MW-4S, and MW-11S
EFR® was performed for 6 hours at monitor wells MW-3S (1 hour), MW-6D (1.5 hours), MW-6S (1 hour), MW-4S (1 hour), and MW-11S (1.5 hours) on June 18, 2015. Separate-phase hydrocarbons (SPH) (diesel fuel) were detected in monitor well MW-3S, MW-4S, and MW-11S prior to completion of the event at a thickness of 0.22, 0.32, and 3.67 feet, respectively. SPH was detected in monitor wells MW-4S and MW-11S, at a thickness of 0.03 and 0.31 feet, respectively, upon conclusion of the event.

The main purpose of these events was to remove hydrocarbon mass from the area of these wells.

A calculated total of 23.4 pounds of petroleum hydrocarbons (approximately 3.9 equivalent gallons of hydrocarbons) in vapor concentrations, in addition to 19 gallons of liquid phase SPH, were removed during the EFR® event on June 18, 2015.

The hydrocarbon removal rate (in vapors) varied from a low of 0.1 pounds per hour (lbs/hr) during the extraction from MW-6D, to a high of 16.3 pounds per hour (lbs/hr) near the beginning of the extraction from MW-3S. The removal rate showed a relatively stable trend during all five extraction events. The removal rate was significantly higher from MW-3S, than the other four wells. The removal rate was very low from MW-6D and MW-4S.

Vapor concentrations varied from a high of 34,000 parts per million by volume (PPM_V) (total hydrocarbons) near the beginning of extraction from MW-3S, to a low of 300 PPMv at the beginning of the extraction from MW-6D. The concentrations also remained relatively steady during extraction from all five wells. Concentrations were significantly higher from MW-3S, and higher from MW-11S, than from the other three wells. Concentrations were very low from MW-6D.

The range of vacuum readings recorded during this EFR® event from the extraction wells are detailed in the attached EFR® Field Data Sheet and summarized below:

Extraction Well	Vacuum Readings
Truck	20 inches of mercury
MW-3S	13 inches of mercury
MW-6D	5 inches of mercury
MW-6S	13 inches of mercury
MW-4S	8 inches of mercury
MW-11S	7 inches of mercury

EFR®/Pilot Test Event Conclusions

The following conclusions are based on the results of the EFR®/Pilot Test events completed June 16 to 18, 2015.

June 16, 2015

1. SPH was eliminated from MW-2S during extraction.
2. A total of 6.0 pounds of hydrocarbon, equivalent to 1.0 gallons of gasoline, was extracted during this event.
3. A vacuum influence was observed at a distance of 60 feet in MW-4S, but this influence was lost when the stinger was lowered from 73 to 78 feet bgs.
4. After an initial decrease, extraction vapor concentrations remained relatively steady, even after lowering the stingers. The extraction vapor concentrations were elevated, but not extremely high, especially for a gasoline contaminated area.
5. A significant groundwater drawdown was observed at a maximum distance of 145 feet from MW-2S, indicating a significant "pull" toward the extraction well.
6. The groundwater extraction rate was very low, 0.14 gpm.
7. Based on the low air flow rates, the low groundwater extraction rates, the in-well vacuum, and knowledge of the geology at the site, groundwater flow appears to be dominated by flow through fractures.
8. Based on the in-well vacuum, the permeability of the formation near MW-2S is relatively low.

June 17, 2015

1. The SPH thickness measured in MW-10S increased from 3.79 feet to 10.18 feet during extraction. It appears the EFR® extraction had a significant "pull" on the product into the well.
2. A total of 87.3 pounds of hydrocarbon, equivalent to 14.4 gallons of gasoline, in addition to 11 gallons of liquid phase diesel fuel was extracted during this event.
3. A consistent vacuum influence was observed at a maximum distance of 130 feet in MW-12S. There appeared to be a greater vacuum influence radially (more wells and greater distances) during extraction from MW-10S than from MW-2S.
4. Extraction vapor concentrations were extremely high, and decreased significantly when the stinger was lowered from 75 to 78 feet bgs. The optimum stinger depth for maximum hydrocarbon removal from MW-10S is at the 75 foot depth or less under current conditions.

5. A significant groundwater drawdown was observed at a maximum distance of 115 feet from MW-10S in MW-6S. The significant groundwater drawdown was also observed in MW-3S. MW-6S and MW-3S may be in the suspected (DBS) faulted zone. There appears to a good groundwater connection in the area of these wells.
6. The groundwater extraction rate was significantly higher from MW-10S than from MW-2S.
7. As with MW-2S, groundwater flow appears to be dominated by flow through fractures and possibly thin ‘stringers”, but is much greater possible due to the faulted zone. The flow rates from MW-10S was 0.55 gpm.
8. Based on the in-well vacuum, the permeability of the formation near MW-10S is moderate.

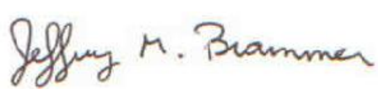
June 18, 2015

1. A total of 23.4 pounds of hydrocarbon, equivalent to 3.9 gallons of gasoline, in addition to 19 gallons of liquid phase diesel fuel was extracted during these events.

Thank you for this opportunity. We look forward to working with you again in the future to provide innovative and cost effective environmental solutions at this and other sites.

Sincerely,

EcoVac Services



Jeff Brammer, P.G.
Western Regional Manager, Hydrogeologist

Attachments:
EFR® Field Data Sheets

ATTACHMENT 1

FIELD DATA SHEETS

EFR® FIELD DATA SHEET

Client: DBS	Facility Name: Bell Gas #1186		Event #: 1
Facility Address: 101 Sun Valley Rd., Alto, NM		Technician: Mosley	Date: 06/16/15

Extraction Well(s)	Time hh:mm	Extraction Well-head Vacuum (in. Hg)									Vacuum Truck Exhaust				
		Inlet	MW-2S								Concentration PPM	Offgas Velocity FT/MIN	Flow Rate CFM	Removal Rate LBS/HR	Interval Removal LBS
Start Time:	7:15														
MW-2S	7:30	20	14								6,000	800	39	2.8	0.7
	7:45	20	14								4,100	750	37	1.8	0.4
	8:00	20	14								3,400	500	25	1.0	0.2
	8:15	20	14								2,600	500	25	0.8	0.2
	8:45	20	14								1,800	500	25	0.5	0.3
	9:15	20	14								1,400	500	25	0.4	0.2
	9:45	20	12								2,600	600	29	0.9	0.5
	10:15	20	12								2,400	500	25	0.7	0.3
	11:15	20	12								2,200	500	25	0.6	0.6
	11:45	20	12								2,000	500	25	0.6	0.3
	12:45	20	12								1,700	400	20	0.4	0.4
	13:15	20	12								3,000	400	20	0.7	0.3
	13:45	20	12								3,000	400	20	0.7	0.3
	14:15	20	12								2,600	450	22	0.7	0.3
	14:45	20	12								2,200	450	22	0.6	0.3
	15:15	20	12								2,000	450	22	0.5	0.3
	15:45	20	12								1,800	400	20	0.4	0.2

Well Gauging Data:			Before EFR® Event			After EFR® Event			Corr. DTW Change (ft)
Well No.	Diam.	TD (ft)	DTS (ft)	DTW (ft)	SPH (ft)	DTS (ft)	DTW (ft)	SPH (ft)	
MW-2S	2"		70.13	71.14	1.01	-	83.16	0.00	-12.88

Vacuum Truck Information	
Subcontractor:	AllVac
Truck Operator:	Mosley
Truck No.:	153
Vacuum Pumps:	Becker
Pump Type:	Twin LC-44s
Tank Capacity (gal.):	2,894
Stack I.D. (inches)	3.0

Well ID	Breather Port	Stinger Depth
MW-2S	0 (closed)	73'

Recovery/Disposal Information		
Hydrocarbons (vapor):	6.0	pounds
Hydrocarbons (liquid):		gallons
Total Hydrocarbons:	1.0	equiv. gallon
Molecular Weight Utilized:	75	g/mole
Disposal Facility:	On-site	
Manifest Number:		
Total Liquids Removed:	69	gallons

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Time:	7:15-15:45
# Pumps:	2
RPMs:	1,000
Time:	
# Pumps:	
RPMs:	

Notes:

At 9:15 lowered stinger to 78'
At 11:45 lowered stinger to 81'
At 13:45 lowered stinger to 84'

Differential Pressure and Groundwater Drawdown Data Recorded During EFR®
Event No. 1 - June 16, 2015
Daniel B. Stephens
Alto, NM

DIFFERENTIAL PRESSURE DATA

		Well Designation:						
		MW-2D	MW-4S	MW-11S	MW-3S	MW-1D	MW-6S	MW-10S
Nearest Extraction Well:		MW-2S	MW-2S	MW-2S	MW-2S	MW-2S	MW-2S	MW-2S
Approximate Distance:		33 feet	60 feet	55 feet	40 feet	45 feet	103 feet	145 feet
Time	Elapsed Time	Differential Pressures (inches of water):						
7:45	0.5 hrs.	0.00	-0.05	0.00	0.00	0.00	0.00	0.00
8:15	1.0 hr.	0.00	-0.10	0.00	0.00	0.00	-0.03	0.00
8:45	1.5 hrs.	0.00	-0.14	0.00	0.00	0.00	-0.03	0.00
9:15	2.0 hrs.	0.00	-0.08	0.00	0.00	0.00	0.00	0.00
9:45	2.5 hrs.	0.00	-0.05	0.00	0.00	0.00	0.00	0.00
10:15	3.0 hrs.	0.00	-0.11	0.00	0.00	0.00	0.00	0.00
10:45	3.5 hrs.	0.00	-0.11	0.00	0.00	0.00	0.00	0.00
11:15	4.0 hrs.	0.00	-0.11	0.00	0.00	0.00	-0.03	0.00
11:45	4.5 hrs.	0.00	-0.10	0.00	0.00	0.00	0.00	0.00
12:15	5.0 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12:45	5.5 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13:15	6.0 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13:45	6.5 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14:15	7.0 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14:45	7.5 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15:15	8.0 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15:45	8.5 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum Change:		0.00	-0.14	0.00	0.00	0.00	-0.03	0.00

GROUNDWATER DRAWDOWN DATA

		Well Designation:						
		MW-2D	MW-4S	MW-11S	MW-3S	MW-1D	MW-6S	MW-10S
Nearest Extraction Well:		MW-2S	MW-2S	MW-2S	MW-2S	MW-2S	MW-2S	MW-2S
Approximate Distance:		33 feet	60 feet	55 feet	40 feet	45 feet	103 feet	145 feet
Time	Elapsed Time	Depth to Liquid (feet below top of casing):						
Prior to EFR®		72.87	55.92	67.68	71.16	118.38	83.58	71.75
After EFR®		73.05	56.78	67.51	73.19	118.31	83.59	72.11
Maximum Change:		-0.18	-0.86	0.17	-2.03	0.07	-0.01	-0.36

EFR® FIELD DATA SHEET

Client: DBS	Facility Name: Bell Gas #1186	Event #: 2
Facility Address: 101 Sun Valley Rd., Alto, NM	Technician: Mosley	Date: 06/17/15

Extraction Well(s)	Time hh:mm	Extraction Well-head Vacuum (in. Hg)								Vacuum Truck Exhaust				
Start Time:	8:30	Inlet	MW-10S							Concentration PPM	Offgas Velocity FT/MIN	Flow Rate CFM	Removal Rate LBS/HR	Interval Removal LBS
MW-10S	8:45	20	7							40,000	450	22	14.4	3.6
	9:00	20	7							50,000	450	22	18.0	4.5
	9:15	20	7							56,000	450	22	20.1	5.0
	9:30	20	7							60,000	400	20	19.2	4.8
	10:00	20	7							58,000	500	25	23.2	11.6
	10:30	20	7							50,000	400	20	16.0	8.0
	11:00	20	7							70,000	400	20	22.4	11.2
	11:30	20	7							58,000	400	20	18.5	9.3
	12:00	20	7							55,000	400	20	17.6	8.8
	12:30	20	7							10,000	250	12	2.0	1.0
	13:00	20	5							20,000	250	12	4.0	2.0
	13:30	20	5							26,000	250	12	5.2	2.6
	14:00	20	5							20,000	250	12	4.0	2.0
	14:30	20	5							22,000	250	12	4.4	2.2
	15:00	20	5							22,000	250	12	4.4	2.2
	15:30	20	5							22,000	250	12	4.4	2.2
	16:00	20	5							20,000	250	12	4.0	4.0
	16:30	20	5							20,000	300	15	4.8	2.4

Well Gauging Data:			Before EFR® Event			After EFR® Event			Corr. DTW
Well No.	Diam.	TD (ft)	DTS (ft)	DTW (ft)	SPH (ft)	DTS (ft)	DTW (ft)	SPH (ft)	Change (ft)
MW-10S	2"		72.11	75.90	3.79	75.12	85.30	10.18	-3.97

Vacuum Truck Information		Well ID	Breather Port	Stinger Depth	Recovery/Disposal Information		
Subcontractor:	AllVac	MW-10S	0 (closed)	75'	Hydrocarbons (vapor):	87.3	pounds
Truck Operator:	Mosley				Hydrocarbons (liquid):	11.0	gallons
Truck No.:	153				Total Hydrocarbons:	25.4	equiv. gallon
Vacuum Pumps:	Becker				Molecular Weight Utilized:	103	g/mole
Pump Type:	Twin LC-44s				Disposal Facility:	On-site	
Tank Capacity (gal.):	2,894				Manifest Number:		
Stack I.D. (inches)	3.0				Total Liquids Removed:	265	gallons

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Time:	8:30-16:30
# Pumps:	2
RPMs:	1,000
Time:	
# Pumps:	
RPMs:	

Notes:
At 12:30 lowered stinger to 78'
At 12:30 gauged MW-10S, 74.50 - 79.85 (5.35' SPH)

Gauged truck after rest period at end of day = 11 gallons SPH
Product appears to be diesel fuel

Differential Pressure and Groundwater Drawdown Data Recorded During EFR®
Event No. 2 - June 17, 2015
Daniel B. Stephens
Alto, NM

DIFFERENTIAL PRESSURE DATA

		Well Designation:							
		MW-3S	MW-7D	MW-6D	MW-6S	MW-5S	MW-9S	MW-9D	MW-12S
Nearest Extraction Well:		MW-10S	MW-10S	MW-10S	MW-10S	MW-10S	MW-10S	MW-10S	MW-10S
Approximate Distance:		108 feet	77 feet	110 feet	115 feet	185 feet	79 feet	77 feet	130 feet
Time	Elapsed Time	Differential Pressures (inches of water):							
9:00	0.5 hrs.	0.00	0.00	0.00	-0.05	0.00	0.00	0.00	-0.06
9:30	1.0 hr.	0.00	-0.03	0.00	-0.13	-0.04	-0.04	0.00	-0.08
10:00	1.5 hrs.	0.00	0.00	0.00	-0.13	-0.04	0.00	0.00	-0.05
10:30	2.0 hrs.	0.00	0.00	0.00	-0.08	-0.05	0.00	0.00	-0.04
11:00	2.5 hrs.	0.00	0.00	0.00	-0.11	-0.05	0.00	0.00	-0.04
11:30	3.0 hrs.	0.00	0.00	0.00	-0.13	-0.05	0.00	0.00	0.00
12:00	3.5 hrs.	0.00	0.00	0.00	-0.05	0.00	0.00	0.00	0.00
12:30	4.0 hrs.	0.00	0.00	0.00	-0.04	0.00	0.00	0.00	-0.03
13:00	4.5 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.03
13:30	5.0 hrs.	0.00	0.00	0.00	-0.04	0.00	0.00	0.00	0.00
14:00	5.5 hrs.	0.00	0.00	-0.04	-0.15	-0.03	-0.03	0.00	-0.08
14:30	6.0 hrs.	0.00	0.00	0.00	-0.13	-0.03	-0.02	0.00	-0.05
15:00	6.5 hrs.	0.00	-0.03	-0.03	-0.11	0.00	-0.04	0.00	-0.10
15:30	7.0 hrs.	0.00	0.00	0.00	-0.05	0.00	-0.02	0.00	-0.03
16:00	7.5 hrs.	0.00	0.00	0.00	0.00	0.00	-0.04	0.00	0.00
16:30	8.0 hrs.	0.00	0.00	0.00	0.00	0.00	-0.07	0.00	-0.08
Maximum Change:		0.00	-0.03	-0.04	-0.15	-0.05	-0.07	0.00	-0.10

GROUNDWATER DRAWDOWN DATA

		Well Designation:							
		MW-3S	MW-7D	MW-6D	MW-6S	MW-5S	MW-9S	MW-9D	MW-12S
Nearest Extraction Well:		MW-10S	MW-10S	MW-10S	MW-10S	MW-10S	MW-10S	MW-10S	MW-10S
Approximate Distance:		108 feet	77 feet	110 feet	115 feet	185 feet	79 feet	77 feet	130 feet
Time	Elapsed Time	Depth to Liquid (feet below top of casing):							
Prior to EFR®		71.16	113.17	120.54	83.58	85.45	85.67	118.62	55.15
After EFR®		73.50	113.04	120.54	86.35	85.51	85.68	118.64	55.15
Maximum Change:		-2.34	0.13	0.00	-2.77	-0.06	-0.01	-0.02	0.00

EFR® FIELD DATA SHEET

Client: DBS	Facility Name: Bell Gas #1186	Event #: 3, 4, & 5
Facility Address: 101 Sun Valley Rd., Alto, NM	Technician: Mosley	Date: 06/18/15

Extraction Well(s)	Time hh:mm	Extraction Well-head Vacuum (in. Hg)									Vacuum Truck Exhaust				
		Inlet	MW-3S	MW-6D	MW-6S						Concentration PPM	Offgas Velocity FT/MIN	Flow Rate CFM	Removal Rate LBS/HR	Interval Removal LBS
Start Time:	7:30														
MW-3S	7:45	20	13								20,000	750	37	12.0	3.0
	8:00	20	13								34,000	600	29	16.3	4.1
	8:15	20	13								32,000	600	29	15.3	3.8
	8:30	20	13								30,000	600	29	14.4	3.6
MW-6D	8:45	20		5							300	300	15	0.1	0.0
	9:00	20		5							350	300	15	0.1	0.0
	9:15	20		5							400	400	20	0.1	0.0
	9:30	20		5							500	300	15	0.1	0.0
	9:45	20		5							400	400	20	0.1	0.0
	10:00	20		5							500	400	20	0.2	0.0
MW-6S	10:15	20			13						7,200	500	25	2.9	0.7
	10:30	20			13						7,000	500	25	2.8	0.7
	10:45	20			13						7,200	500	25	2.9	0.7
	11:00	20			13						6,600	500	25	2.6	0.7

Well Gauging Data:			Before EFR® Event			After EFR® Event			Corr. DTW
Well No.	Diam.	TD (ft)	DTS (ft)	DTW (ft)	SPH (ft)	DTS (ft)	DTW (ft)	SPH (ft)	Change (ft)
MW-3S	2"		71.68	71.90	0.22	-	74.84	0.00	-3.13
MW-4S	2"		56.60	56.92	0.32				
MW-6S	2"		-	83.70	0.00	-	86.90	0.00	-3.20
MW-6D	2"		-	120.56	0.00	-	119.51	0.00	1.05
MW-11S	2"		69.98	73.65	3.67				

Vacuum Truck Information	
Subcontractor:	AllVac
Truck Operator:	Mosley
Truck No.:	153
Vacuum Pumps:	Becker
Pump Type:	Twin LC-44s
Tank Capacity (gal.):	2,894
Stack I.D. (inches)	3.0

Well ID	Breather Port	Stinger Depth
MW-3S	0 (closed)	73'
MW-6D	0 (closed)	123'
MW-6S	0 (closed)	85'

Recovery/Disposal Information		
Hydrocarbons (vapor):	17.5	pounds
Hydrocarbons (liquid):		gallons
Total Hydrocarbons:	2.9	equiv. gallon
Molecular Weight Utilized:	103	g/mole
Disposal Facility:	On-site	
Manifest Number:		
Total Liquids Removed:	56	gallons

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Time:	7:30-11:00
# Pumps:	2
RPMs:	1,000
Time:	
# Pumps:	
RPMs:	

Notes:
MW-6S fluid level was 83.65 prior to MW-6D extraction. Lowered 0.05' during extraction from MW-6D

Liquid SPH in truck was from MW-3S (see note on following sheet)

EFR® FIELD DATA SHEET

Client: DBS	Facility Name: Bell Gas #1186		Event #: 6 & 7
Facility Address: 101 Sun Valley Rd., Alto, NM		Technician: Mosley	Date: 06/18/15

Extraction Well(s)	Time hh:mm	Extraction Well-head Vacuum (in. Hg)									Vacuum Truck Exhaust				
		Inlet	MW-4S	MW-11S							Concentration PPM	Offgas Velocity FT/MIN	Flow Rate CFM	Removal Rate LBS/HR	Interval Removal LBS
Start Time:	11:15														
MW-4S	11:30	20	8								1,600	600	29	0.8	0.2
	11:45	20	8								2,400	600	29	1.2	0.3
	12:00	20	8								1,000	600	29	0.5	0.1
	12:15	20	8								800	600	29	0.4	0.1
MW-11S	12:30	20		7							9,000	300	15	2.2	0.5
	12:45	20		7							14,000	400	20	4.5	1.1
	13:00	20		7							16,000	400	20	5.1	1.3
	13:15	20		7							12,000	400	20	3.8	1.0
	13:30	20		7							16,000	400	20	5.1	1.3

Well Gauging Data:			Before EFR® Event			After EFR® Event			Corr. DTW
Well No.	Diam.	TD (ft)	DTS (ft)	DTW (ft)	SPH (ft)	DTS (ft)	DTW (ft)	SPH (ft)	Change (ft)
MW-4S	2"		56.60	56.92	0.32	64.12	64.15	0.03	-7.48
MW-11S	2"		69.98	73.65	3.67	70.94	71.25	0.31	-0.46

Vacuum Truck Information	
Subcontractor:	AllVac
Truck Operator:	Mosley
Truck No.:	153
Vacuum Pumps:	Becker
Pump Type:	Twin LC-44s
Tank Capacity (gal.):	2,894
Stack I.D. (inches)	3.0

Well ID	Breather Port	Stinger Depth
MW-4S	0 (closed)	58'
MW-11S	0 (closed)	73'

Recovery/Disposal Information		
Hydrocarbons (vapor):	5.9	pounds
Hydrocarbons (liquid):		gallons
Total Hydrocarbons:	1.0	equiv. gallon
Molecular Weight Utilized:	103	g/mole
Disposal Facility:	On-site	
Manifest Number:		
Total Liquids Removed:	101	gallons

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Time:	7:30-11:00
# Pumps:	2
RPMs:	1,000
Time:	
# Pumps:	
RPMs:	

Notes:

Had 19 gallons of SPH in truck at the conclusion of extraction on from the five wells

Munson • Young • Okiishi • Huebsch

FUNDAMENTALS OF FLUID MECHANICS

SIXTH EDITION

To Erik and all others who possess the curiosity, patience, and desire to learn

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Cover: photo shows the development of vortices which the water strider uses for moving on the surface of water by the transfer of momentum from the movement of its legs to the shed vortices (i.e. rowing). The fluid dynamics are visualized by adding thymol blue to the water surface. For more on water striders, see the following in this text: Problem 1.103 in Chapter 1; Fluids in the News titled "Walking on water" in Sect. 1.9; and Video V10.3 "Water strider" in Chapter 10. Photo courtesy of David L. Hu and John W. M. Bush, MIT.

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■ **TABLE 1.5**
Approximate Physical Properties of Some Common Liquids (BG Units)

(See inside of front cover.)

■ **TABLE 1.6**
Approximate Physical Properties of Some Common Liquids (SI Units)

(See inside of front cover.)

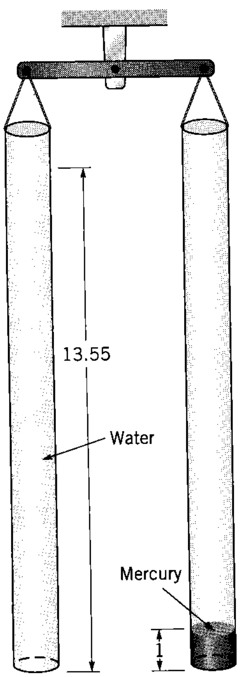
1.4.2 Specific Weight

Specific weight is weight per unit volume; specific gravity is the ratio of fluid density to the density of water at a certain temperature.

The *specific weight* of a fluid, designated by the Greek symbol γ (gamma), is defined as its *weight* per unit volume. Thus, specific weight is related to density through the equation

$$\gamma = \rho g \tag{1.6}$$

where g is the local acceleration of gravity. Just as density is used to characterize the mass of a fluid system, the specific weight is used to characterize the weight of the system. In the BG system, γ has units of lb/ft^3 and in SI the units are N/m^3. Under conditions of standard gravity ($g = 32.174\ \text{ft/s}^2 = 9.807\ \text{m/s}^2$), water at 60 °F has a specific weight of $62.4\ \text{lb/ft}^3$ and $9.80\ \text{kN/m}^3$. Tables 1.5 and 1.6 list values of specific weight for several common liquids (based on standard gravity). More complete tables for water can be found in Appendix B (Tables B.1 and B.2).



1.4.3 Specific Gravity

The *specific gravity* of a fluid, designated as *SG*, is defined as the ratio of the density of the fluid to the density of water at some specified temperature. Usually the specified temperature is taken as 4 °C (39.2 °F), and at this temperature the density of water is $1.94\ \text{slugs/ft}^3$ or $1000\ \text{kg/m}^3$. In equation form, specific gravity is expressed as

$$SG = \frac{\rho}{\rho_{H_2O@4\,°C}} \tag{1.7}$$

and since it is the *ratio* of densities, the value of *SG* does not depend on the system of units used. For example, the specific gravity of mercury at 20 °C is 13.55. This is illustrated by the figure in the margin. Thus, the density of mercury can be readily calculated in either BG or SI units through the use of Eq. 1.7 as

$$\rho_{Hg} = (13.55)(1.94\ \text{slugs/ft}^3) = 26.3\ \text{slugs/ft}^3$$

or

$$\rho_{Hg} = (13.55)(1000\ \text{kg/m}^3) = 13.6 \times 10^3\ \text{kg/m}^3$$

It is clear that density, specific weight, and specific gravity are all interrelated, and from a knowledge of any one of the three the others can be calculated.

1.5 Ideal Gas Law

Gases are highly compressible in comparison to liquids, with changes in gas density directly related to changes in pressure and temperature through the equation

$$\rho = \frac{p}{RT} \tag{1.8}$$

where p is the absolute pressure, ρ the density, T the absolute temperature,[2] and R is a gas constant. Equation 1.8 is commonly termed the ***ideal*** or *perfect gas law*, or the *equation of state* for

[2]We will use T to represent temperature in thermodynamic relationships although T is also used to denote the basic dimension of time.

Calculation Cover Sheet

Daniel B. Stephens & Associates, Inc.

Project Name Bell Gas #1186 Project Number ES14.0220

Calculation Number ES14.0220-002 Discipline Engineering No. of Sheets 5

PROJECT: Bell Gas #1186 Remediation System

SITE: Bell Gas #1186 / TR'S Market, Alto, New Mexico

SUBJECT: Determine pressure losses and size blowers for the multiphase remediation system.

SOURCES OF DATA:

A. Computer Applications in Hydraulic Engineering, 6th edition, Haestad Methods, Inc, 2004, Table 1-2:Typical Roughness Coefficients

B. Fundamentals of Fluid Mechanics, 2nd edition, Bruce Munson, Donald Young and Theodore Okiishi, John Wiley & Sons, Inc, 1994

C. Multiphase Pilot Test Report, Ecovac Services, 2015.

D. Engineering toolbox - Properties of US standard atmosphere

SOURCES OF FORMULAE & REFERENCES:

1. Computer Applications in Hydraulic Engineering, 6th edition, Haestad Methods, Inc, 2004.
2. Water Resources Engineering, Ralph Wurbs and Wesley James, Prentice Hall, 2002.

☐ Preliminary Calculation ☒ Final Calculation Supersedes Calculation No. ____________

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
0	Final Remediation Plan	JS	12/3/2018	TH	12/6/2018	TG	10/19/2020
1	PSTB comments					TG	1/19/2021

Project No. ES14.0220 Date 12/3/2018

Subject Pressure losses and remediation system blower design Sheet 1 of 5

By J. Samson Checked By T. Hopkins Calculation No. ES14.0220-02

1.0 OBJECTIVE

Calculate the amount of pressure loss within the multiphase pipe network, and use this information to size a system blower.

2.0 GIVEN

Multiphase conveyance pipe consisting of 1-inch SCH 40 PVC stinger tube, 3-inch SCH 40 PVC conveyance line, and manifold piping consisting of 6-inch SCH 40 PVC; minor loss coefficients, K, for fittings within the system; individual well air flowrates; and Darcy Weisbach roughness coefficient of 0.000005 for plastic pipe. To account for multiphase flow, the Darcy Weisbach friction factor is increased by 25%, per industry guidance. The design applied well vacuum will be 19 inches Mercury, or 259 inches water column (in H_2O).

3.0 METHOD

Use the Darcy-Weisbach equation[2] to determine the amount of pressure loss within a given system. This equation is dependent on fluid properties (density and dynamic viscosity of the fluid), pipe material properties (expressed through the Darcy-Weisbach friction factor), pipe length, and pipe diameter. The Darcy-Weisbach friction factor[1] is dependent on the Darcy-Weisbach roughness coefficient[A], pipe diameter, and the Reynolds number[1].

The first step in determining the major and minor pressure losses within a given system is to determine the Reynolds number for the system. This unitless number describes the type of flow within the system. Reynolds numbers above 4000 describe fully-developed turbulent flow[1]. In order to determine the Reynolds number, three variables are needed: the dynamic viscosity of the fluid, the characteristic length/diameter ratio of the pipe, and the average fluid velocity.

$$\mathrm{Re} = \frac{\rho V D}{\mu} \qquad \text{eqn. 1}$$

Where
Re = Reynolds number
ρ = Fluid density
V = Fluid velocity
D = Pipe diameter
μ = Dynamic viscosity

Calculate the Darcy-Weisbach friction factor.

$$f = \frac{1.325}{\left[\ln\left(\frac{k}{3.7D} + \frac{5.74}{\mathrm{Re}^{0.9}}\right)\right]^2} \qquad \text{eqn. 2}$$

Where f = Darcy-Weisbach friction factor
k = Darcy-Weisbach roughness coefficient
Re = Reynolds number
D = Pipe diameter

Calculate major pressure losses within the system.

$$H_{maj} = \frac{flV^2}{D2g} \quad \text{eqn. 3}$$

Where H_{maj} = Major headlosses
f = Darcy-Weisbach friction factor
l = pipe length
D = Hydraulic diameter
V = Fluid velocity
g = Gravitational acceleration

Minor pressure losses are dependent on the type of fitting and the velocity head of the fluid flowing through the pipe network.

Calculate minor pressure losses within the system. The values of K are additive.

$$H_{\min} = K_m \frac{V^2}{2g} \quad \text{eqn. 4}$$

Where H_{minor} = Minor head losses
K_m = Minor loss coefficient for fittings

Use the major and minor pressure losses, together with the design vacuum applied at the extraction well, to determine the expected blower operating vacuum.

4.0 SOLUTION

The Bell Gas site will consist of a multiphase extraction (MPE) system connected to seven vertical wells with depths to groundwater ranging from 50 to 95 feet in recent years within a horizontal distance of 200 feet. In order to extract multiphase fluid from these depths each of the existing monitor wells will be outfitted with 1-inch SCH 40 PVC stinger tubes. A MPE pilot test was completed in June, 2015 in order to determine the required wellhead vacuum and individual well flowrates[C]. During the test flow measurements were taken on the discharge side of the pump, and for design purposes were adjusted to represent the flowrate on the inlet side in calculation ES14.0220-01. The flow from each extraction well is brought to the surface by the 1-inch stinger tube where it will be conveyed to a 6-inch SCH 40 PVC MPE manifold by 3-inch-diameter SCH 40 PVC conveyance lines ranging in length from 25 feet to 170 feet.

Example calculations are provided below for MW-1S. The vacuum applied to the wells during the MPE test was used as the well head vacuum, and therefore the calculation only focuses on the pressure losses associated with flow through the horizontal conveyance and manifold piping. Calculations for all MPE lines are provided in the attached spreadsheet. The following equations display significant digits carried through in the spreadsheet.

First, determine the linear flow velocity and Reynold's number for the conveyance line and manifold at the anticipated flow rate. Average inside diameter is 3.042 and 6.031 inches for the pipe materials specified. Assume a dynamic viscosity and air density of 3.56 E-7 lbf*sec/ft^2 and 3.64 E-4 slug/ft^3, respectively, corresponding to an elevation of 7,485 feet above mean sea level, and an absolute inlet pressure of 1.5 psi.

V_{3PVC} = Q / A = (141 ft^3/min) * (min / 60 sec) / (π / 4 * (3.042 in / 12 in/ft)^2) = 46.7 ft/sec
V_{6PVC} = Q / A = (989 ft^3/min) * (min / 60 sec) / (π / 4 * (6.031 in / 12 in/ft)^2) = 83.1 ft/sec

Re_{3PVC} = ρ * V * D / μ = (3.64 E-4 slug/ft^3) * (46.7 ft/sec) * (3.042 in / 12 in/ft) / (3.56 E-7 lbf*sec/ft^2) = 12,085
Re_{6PVC} = ρ * V * D / μ = (3.64 E-4 slug/ft^3) * (83.1 ft/sec) * (6.031 in / 12 in/ft) / (3.56 E-7 lbf*sec/ft^2) = 42,670

The Reynold's numbers calculated above are indicative of turbulent flow. Use the calculated Reynolds numbers and a Darcy-Weisbach roughness coefficient of 0.000005[A] to calculate the Darcy-Weisbach friction factor following eqn. 2:

$$f_{3PVC} = \frac{1.325}{\left[ln\left(\frac{0.000005}{3.7x(3.042/12)} + \frac{5.74}{12{,}085^{0.9}}\right)\right]^2} = 0.0294$$

$$f_{6PVC} = \frac{1.325}{\left[ln\left(\frac{0.000005}{3.7x(6.031/12)} + \frac{5.74}{42{,}670^{0.9}}\right)\right]^2} = 0.0216$$

The friction factors were increased by a factor of 25% to account for the presence of multiphase fluid in the conveyance lines, resulting in the friction factors below.

$$f_{3PVC} = 0.0294 \times 1.25 = 0.0368$$

$$f_{6PVC} = 0.0216 \times 1.25 = 0.0269$$

The schedule of pipe and fittings for the site is presented in Table 1 below. The length of each pipe circuit was measured using GIS software.

Table 1: Pipe and fitting schedule for the MPE system

Pipe Circuit	Circuit Length (ft)	90° Elbow		Gate Valve (1/2 open)		Slip Tees (Branch Flow)		Exit		Flowrate
		#	K	#	K	#	K	#	K	acfm
MW-1S	160	4	1.5	1	2.1	0	2.0	1	1.00	141
MW-2S	30	3	1.5	1	2.1	0	2.0	1	1.00	141
MW-3S	55	3	1.5	1	2.1	0	2.0	1	1.00	175
MW-4S	90	4	1.5	1	2.1	0	2.0	1	1.00	175
MW-6S	185	5	1.5	1	2.1	0	2.0	1	1.00	141
MW-10S	165	6	1.5	1	2.1	0	2.0	1	1.00	108
MW-11S	45	5	1.5	1	2.1	0	2.0	1	1.00	108
Manifold	25	0	1.5	0	2.1	7	2.0	0	1.00	989

Calculate major pressure losses for each pipe circuit using equation 3 together with the circuit length and flow rates from Table 1, the specific weight of air, and the Darcy friction factor calculated above. A sample calculation for pipe circuit MW-1S is provided with data summarized in Table 3 below:

$$H_{major} = \frac{0.0368 x 160 ft\ x\ 46.7^2 \frac{ft^2}{s^2}}{\frac{3.041\ in}{12\ in/ft} x\ 2\ x\ 32.2 \frac{ft}{s^2}} = 786.6\ ft\ air$$

Convert this head loss from units of feet of air to units of inches of water.

$$786.6\ ft\ air\ x \frac{0.0117\ lbm/ft^3 air}{62.37\ lbm/ft^3 water} x \frac{12\ in}{ft} = 1.77\ in\ water$$

Calculate minor pressure losses using equation 4 for fittings on the SVE-1 pipe circuit and data from Table 1. A sample calculation for pipe circuit SVE-1 is provided with data summarized in Table 2 below:

K_m = (4 * 1.5) + (1 * 2.1) + (1 * 1) = 9.1

$$H_{minor} = \frac{9.1\ x\ 46.7^2 \frac{ft^2}{s^2}}{2\ x\ 32.2 \frac{ft}{s^2}} x \frac{0.0117\ lbm/ft^3 air}{62.37\ lbm/ft^3 water} x \frac{12\ in}{ft} = 0.69\ in\ water$$

The total design pressure loss for the MW-1S pipe circuit before the manifold will be the sum of the major and minor losses:

$H_{H\text{-}1}$ = 1.77 + 0.69 = **2.47 in H_2O**

Table 2: Pipe circuit pressure losses

Pipe Circuit	Circuit Length, ft	Flow Rate, scfm	Major Pressure Loss, in H_2O	Minor Pressure Loss, in H_2O	Total Pressure Loss, in H_2O
MW-1S	160	141	1.77	0.69	2.47
MW-2S	30	141	0.33	0.58	0.91
MW-3S	55	175	0.88	0.89	1.77
MW-4S	90	175	1.44	1.06	2.50
MW-6S	185	141	2.05	0.81	2.86
MW-10S	165	108	1.15	0.54	1.69
MW-11S	45	108	0.31	0.47	0.79

The blower will need to be sized for the pipe circuit with the largest vacuum from this branched flow SVE system. Therefore, use the total pressure loss from pipe circuit MW-6S as the MPE system design pressure loss, **ΔP = 2.86 in H_2O**.

Calculate major pressure losses for the compound piping using equation 3 together with an approximate length of 6-inch PVC pipe and flow rate in the compound from Table 1, specific weight of air, and Darcy friction factor calculated above.

$$H_{maj(bldg)} = \frac{0.0269 x 25 ft\ x\ 83.1^2 \frac{ft^2}{s^2}}{\frac{6.031\ in}{12\ in/ft} x\ 2\ x\ 32.2 \frac{ft}{s^2}} x \frac{0.0117\ lbm/ft^3 air}{62.37\ lbm/ft^3 water} x \frac{12\ in}{ft} = 0.43\ in\ water$$

Calculate minor pressure losses using equation 4 for fittings on the 4-inch PVC compound pipe using data in Table 1, as well as adding an entrance (K=0.5) and exit (K=1.0) loss out of the moisture separator.

$$K_m = (7 * 2.0) + 0.5 + 1.0 = 15.5$$

$$H_{\min(bldg)} = \frac{15.5\ x\ 83.1^2 \frac{ft^2}{s^2}}{2\ x\ 32.2 \frac{ft}{s^2}} x \frac{0.0117\ lbm/ft^3 air}{62.37\ lbm/ft^3 water} x \frac{12\ in}{ft} = 3.75\ in\ water$$

The total design pressure loss for the PVC pipe in the compound will be the sum of the major and minor losses:

$$\Delta H_{bldg} = 0.32 + 3.75 = \mathbf{\Delta H_{bldg} = 4.08\ in\ H_2O.}$$

Calculate the expected MPE blower total operating vacuum using the design pressure losses calculated above and the expected extraction well vacuum:

$$H_{sys} = 2.86\ in\ H_2O + 4.08\ in\ H_2O + 258.6\ in\ H_2O = \mathbf{265.5\ in\ H_2O}$$

Daniel B. Stephens & Associates, Inc.

Major Headloss Calculations

MPE COMPOUND PIPING

CONSTANTS

Pipe Roughness	smooth			
e/d	smooth		Altitude (ft)	7485
Dynamic Viscosity, u	3.56E-07	lbf-sec/ft^2		
k, Roughness Height, ft	5.00E-06			
Air Density	1.17E-02	lbm/ft^3 =	3.64E-04	slugs/ft^3
Water Density	62.37	lbm/ft^3		
Gravitational Acceleration,g	32.17	ft/s^2		

Major Headlosses

$$h_L = f(\frac{L}{D})v^2 / 2g$$

Stinger tube pipe, dia =	1.049	in (1" PVC SCH 40)
pipe, dia =	1.913	in (2" PVC SCH 40)
Conveyance pipe, dia =	3.042	in (3" PVC SCH 40)
pipe, dia =	3.998	in (4" PVC SCH 40)
Manifold conveyance pipe, dia =	6.031	in (6" PVC SCH 40)

Table 1. Major Headlosses - horizontal run

Piping Run	Run Length,L (ft)	Flow Rate Q (cfm)	Actual Pipe Diameter, D (in)	Actual Pipe Diameter, D (ft)	X-Sectional Area, A (ft^2)	Velocity V (ft/min)	Velocity V (ft/s)	Reynolds #	Friction Factor, f	L/D	hL (ft air)	hL (ft water)	hL (in water)	hL (in Hg)
MW-1S	160	141	3.042	0.254	0.050	2800	46.7	12,085	0.0368	631.2	786.589	0.15	1.77	0.13
MW-2S	30	141	3.042	0.254	0.050	2800	46.7	12,085	0.0368	118.3	147.5	0.03	0.33	0.02
MW-3S	55	175	3.042	0.254	0.050	3459	57.7	14,929	0.0348	217.0	390.3	0.07	0.88	0.06
MW-4S	90	175	3.042	0.254	0.050	3459	57.7	14,929	0.0348	355.0	638.6	0.12	1.44	0.11
MW-6S	185	141	3.042	0.254	0.050	2800	46.7	12,085	0.0368	729.8	909.5	0.17	2.05	0.15
MW-10S	165	108	3.042	0.254	0.050	2141	35.7	9,242	0.0396	650.9	510.3	0.10	1.15	0.08
MW-11S	45	108	3.042	0.254	0.050	2141	35.7	9,242	0.0396	177.5	139.2	0.03	0.31	0.02
Manifold	25	989	6.031	0.503	0.198	4987	83.1	42,670	0.0269	49.7	143.9	0.03	0.32	0.02

Minor Headloss Calculations

SVE Compound Piping

CONSTANTS

Appurtenance	Minor Loss Coeff. (Kl)
90° elbow	1.5
45° elbow	0.4
Branch Flow (BF) Tees	2
Butterfly valves	1.2
Gate Valves (1/2 Closed)	2.1
Flow Meter	0.64
Entrance	0.5
Expansion - 1" to 2"	0.55
Expansion - 4" to 6"	0.66
Exit	1

Minor Headlosses

$$h_L = k_L v^2 / 2g$$

Table 2. Minor Headlosses

			Quantinty of Appurtenances											
Piping Run	90° Elbow	45° Elbow	Slip Tees (Branch Flow)	Butterfly Valve (Fully Open)	Gate Valve (1/2 Closed)	Flow Meter	Expansion	Entrance	Exit	Kl Sum	Velocity,v (ft/S)	hL (ft air)	hL (ft water)	hL (in water)
MW-1S	4	0	0	0	1	0	0	0	1	9.1	46.7	308.1	0.06	0.69
MW-2S	3	0	0	0	1	0	0	0	1	7.6	46.7	257.3	0.05	0.58
MW-3S	3	0	0	0	1	0	0	0	1	7.6	57.7	392.7	0.07	0.89
MW-4S	4	0	0	0	1	0	0	0	1	9.1	57.7	470.2	0.09	1.06
MW-6S	5	0	0	0	1	0	0	0	1	10.6	46.7	358.9	0.07	0.81
MW-10S	6	0	0	0	1	0	0	0	1	12.1	35.7	239.6	0.05	0.54
MW-11S	5	0	0	0	1	0	0	0	1	10.6	35.7	209.9	0.04	0.47
Manifold	0	0	7	0	0	0	0	1	1	15.5	83.1	1664.4	0.31	3.75

Total Design Headloss

SVE Compound Piping

Table 3. Total Headlosses

	hL	hL	hL	
	(ft air)	(ft water)	(in water)	
Piping Run				
MW-1S	1094.7	0.2	2.47	
MW-2S	404.8	0.1	0.91	
MW-3S	782.9	0.1	1.77	
MW-4S	1108.8	0.2	2.50	
MW-6S	1268.4	0.2	2.86	
MW-10S	749.9	0.1	1.69	
MW-11S	349.0	0.1	0.79	
Manifold	1808.3	0.3	4.08	
Total Design Headloss	3076.7	0.58	6.94	in H2O
			0.51	in Hg

Sixth Edition

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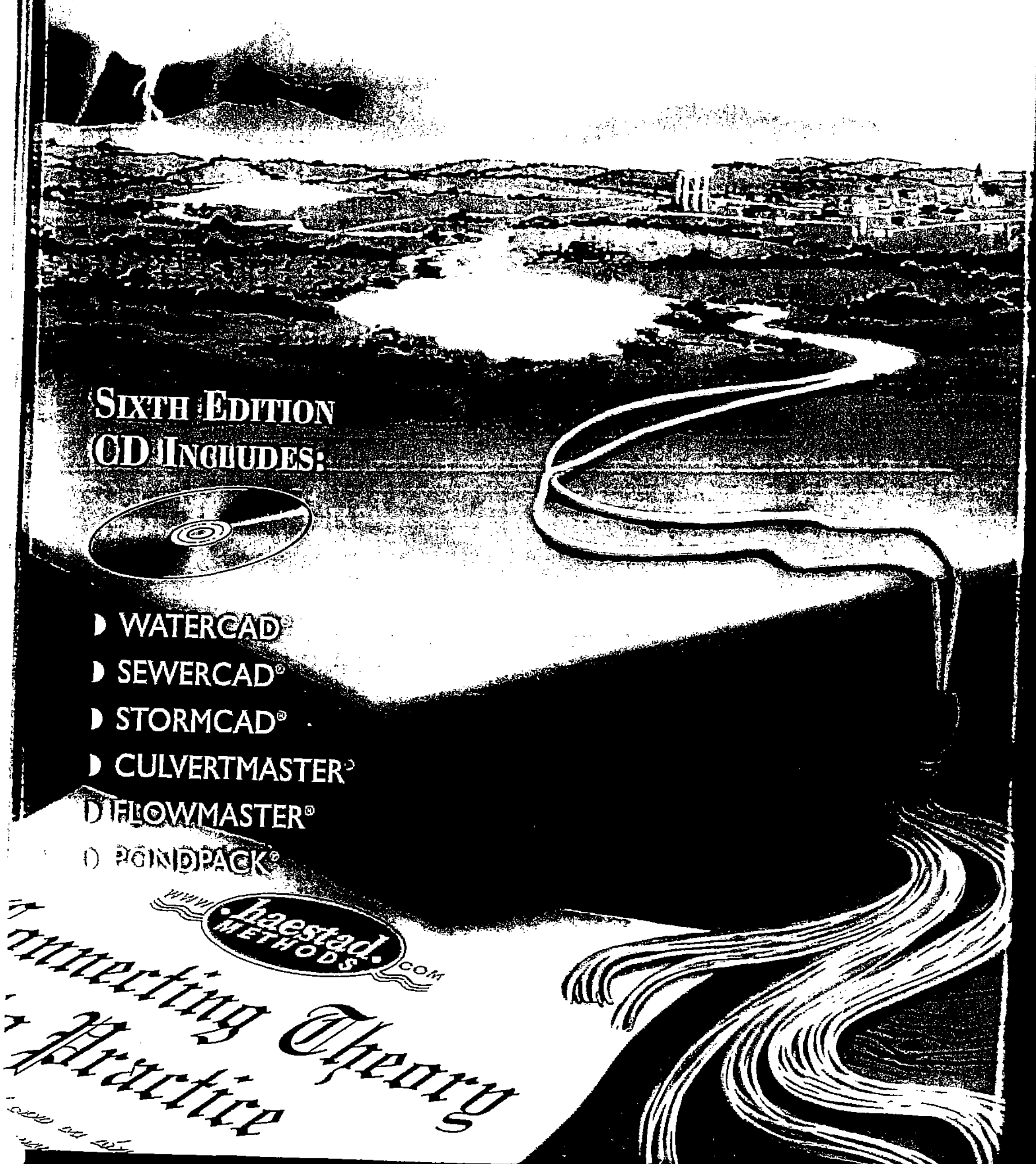
CONNECTING THEORY TO PRACTICE



Computer Applications in Hydraulic Engineering

Sixth Edition

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given particle in the direction of flow, and at other times detract from it. The result is that velocity distributions captured at different times will be quite different from one another, and will be far more chaotic than the velocity distribution of a laminar flow section.

By strict interpretation, the changing velocities in turbulent flow would cause it to be classified as unsteady flow. Over time, however, the average velocity at any given point within the section is essentially constant, so the flow is assumed to be steady.

The velocity at any given point within the turbulent section will be closer to the mean velocity of the entire section than with laminar flow conditions. Turbulent flow velocities are closer to the mean velocity because of the continuous mixing of flow, particularly the mixing of low-velocity flow near the channel walls with the higher-velocity flow toward the center.

To classify flow as either turbulent or laminar, an index called the ***Reynolds number*** is used. It is computed as follows:

$$Re = \frac{4VR}{\nu}$$

where
Re = Reynolds number (unitless)
V = average velocity (m/s, ft/s)
R = hydraulic radius (m, ft)
ν = kinematic viscosity (m^2/s, ft^2/s)

If the Reynolds number is below 2,000, the flow is generally laminar. For flow in closed conduits, **if the Reynolds number is above 4,000, the flow is generally turbulent.** Between 2,000 and 4,000, the flow may be either laminar or turbulent, depending on how insulated the flow is from outside disturbances. In open channels, laminar flow occurs when the Reynolds number is less than 500 and turbulent flow occurs when it is above 2,000. Between 500 and 2,000, the flow is transitional.

Example 1-1: Flow Characteristics

A rectangular concrete channel is 3 m wide and 2 m high. The water in the channel is 1.5 m deep and is flowing at a rate of 30 m^3/s. Determine the flow area, wetted perimeter, and hydraulic radius. Is the flow laminar or turbulent?

Solution

From the section's shape (rectangular), we can easily calculate the area as the rectangle's width multiplied by its depth. Note that the depth used should be the actual depth of flow, not the total height of the cross-section. The wetted perimeter can also be found easily through simple geometry.

$$A = 3.0 \text{ m} \times 1.5 \text{ m} = 4.5 \text{ m}^2$$

$$P_w = 3.0 \text{ m} + 2 \times 1.5 \text{ m} = 6.0 \text{ m}$$

Table 1-2: Typical Roughness Coefficients

Material	Manning's Coefficient n	Hazen-Williams C	Darcy-Weisbach Roughness Height k (mm)	k (ft)
Asbestos cement	0.011	140	0.0015	0.000005
Brass	0.011	135	0.0015	0.000005
Brick	0.015	100	0.6	0.002
Cast-iron, new	0.012	130	0.26	0.00085
Concrete:				
Steel forms	0.011	140	0.18	0.006
Wooden forms	0.015	120	0.6	0.002
Centrifugally spun	0.013	135	0.36	0.0012
Copper	0.011	135	0.0015	0.000005
Corrugated metal	0.022	–	45	0.15
Galvanized iron	0.016	120	0.15	0.0005
Glass	0.011	140	0.0015	0.000005
Lead	0.011	135	0.0015	0.000005
Plastic	**0.009**	**150**	**0.0015**	**0.000005**
Steel:				
Coal-tar enamel	0.010	148	0.0048	0.000016
New unlined	0.011	145	0.045	0.00015
Riveted	0.019	110	0.9	0.003
Wood stave	0.012	120	0.18	0.0006

1.5 Pressure Flow

For pipes flowing full, many of the friction loss calculations are greatly simplified because the flow area, wetted perimeter, and hydraulic radius are all functions of pipe radius (or diameter). Table 1-3 presents the three pipe friction loss equations that are commonly used to design pressure pipe systems.

There is much more information presented about pressure piping systems in Chapter 6, including further discussion on pumping systems, minor losses, and network analysis.

Table 1-3: Three Pipe Friction Loss Equations

Equation	Q (m³/s); D (m)	Q (cfs); D (ft)	Q (gpm); D (in.)
Darcy-Weisbach	$S_f = \frac{0.083 f Q^2}{D^5}$	$S_f = \frac{0.025 f Q^2}{D^5}$	$S_f = \frac{0.031 f Q^2}{D^5}$
Hazen-Williams	$S_f = \frac{10.7}{D^{4.87}}\left(\frac{Q}{C}\right)^{1.852}$	$S_f = \frac{4.73}{D^{4.87}}\left(\frac{Q}{C}\right)^{1.852}$	$S_f = \frac{10.5}{D^{4.87}}\left(\frac{Q}{C}\right)^{1.852}$
Manning	$S_f = \frac{10.3(nQ)^2}{D^{5.33}}$	$S_f = \frac{4.66(nQ)^2}{D^{5.33}}$	$S_f = \frac{13.2(nQ)^2}{D^{5.33}}$

FUNDAMENTALS OF FLUID MECHANICS

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B

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COVER PHOTO Visualization of the flow around a flattened ellipsoid at a 10° angle of attack. Dye injection in the hydrodynamic tunnel of the ONERA. (Courtesy Bureau National d'Études et de Recherches Aerospatiales, Châtillion, Hauts-de-Seine.)

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B

■ **TABLE B.3**

Physical Properties of Air at Standard Atmospheric Pressure (BG Units)[a]

Temperature (°F)	Density, ρ (slugs/ft³)	Specific Weight[b], γ (lb/ft³)	Dynamic Viscosity, μ (lb·s/ft²)	Kinematic Viscosity, ν (ft²/s)	Specific Heat Ratio, k (—)	Speed of Sound, c (ft/s)
−40	2.939 E − 3	9.456 E − 2	3.29 E − 7	1.12 E − 4	1.401	1004
−20	2.805 E − 3	9.026 E − 2	3.34 E − 7	1.19 E − 4	1.401	1028
0	2.683 E − 3	8.633 E − 2	3.38 E − 7	1.26 E − 4	1.401	1051
10	2.626 E − 3	8.449 E − 2	3.44 E − 7	1.31 E − 4	1.401	1062
20	2.571 E − 3	8.273 E − 2	3.50 E − 7	1.36 E − 4	1.401	1074
30	2.519 E − 3	8.104 E − 2	3.58 E − 7	1.42 E − 4	1.401	1085
40	2.469 E − 3	7.942 E − 2	3.60 E − 7	1.46 E − 4	1.401	1096
50	2.420 E − 3	7.786 E − 2	3.68 E − 7	1.52 E − 4	1.401	1106
60	2.373 E − 3	7.636 E − 2	3.75 E − 7	1.58 E − 4	1.401	1117
70	2.329 E − 3	7.492 E − 2	3.82 E − 7	1.64 E − 4	1.401	1128
80	2.286 E − 3	7.353 E − 2	3.86 E − 7	1.69 E − 4	1.400	1138
90	2.244 E − 3	7.219 E − 2	3.90 E − 7	1.74 E − 4	1.400	1149
100	2.204 E − 3	7.090 E − 2	3.94 E − 7	1.79 E − 4	1.400	1159
120	2.128 E − 3	6.846 E − 2	4.02 E − 7	1.89 E − 4	1.400	1180
140	2.057 E − 3	6.617 E − 2	4.13 E − 7	2.01 E − 4	1.399	1200
160	1.990 E − 3	6.404 E − 2	4.22 E − 7	2.12 E − 4	1.399	1220
180	1.928 E − 3	6.204 E − 2	4.34 E − 7	2.25 E − 4	1.399	1239
200	1.870 E − 3	6.016 E − 2	4.49 E − 7	2.40 E − 4	1.398	1258
300	1.624 E − 3	5.224 E − 2	4.97 E − 7	3.06 E − 4	1.394	1348
400	1.435 E − 3	4.616 E − 2	5.24 E − 7	3.65 E − 4	1.389	1431
500	1.285 E − 3	4.135 E − 2	5.80 E − 7	4.51 E − 4	1.383	1509
750	1.020 E − 3	3.280 E − 2	6.81 E − 7	6.68 E − 4	1.367	1685
1000	8.445 E − 4	2.717 E − 2	7.85 E − 7	9.30 E − 4	1.351	1839
1500	6.291 E − 4	2.024 E − 2	9.50 E − 7	1.51 E − 3	1.329	2114

[a]Based on data from R. D. Blevins, *Applied Fluid Dynamics Handbook*, Van Nostrand Reinhold Co., Inc., New York, 1984.

[b]Density and specific weight are related through the equation $\gamma = \rho g$. For this table $g = 32.174$ ft/s².

■ Phy

Ter

[a]Bas

[b]Der

July 03, 2015

Mr. Thomas Golden, PE
Daniel B. Stephens & Associates, Inc.
6020 Academy Road NE, Suite 100
Albuquerque, NM 87109
505.353.9075
tgolden@dbstephens.com

Subject: June 16, 17, & 18, 2015 EFR®/Pilot Test Report
Bell Gas #1186
101 Sun Valley Road
Alto, New Mexico

Dear Mr. Golden:

Please find attached the data summary for the EFR®/Pilot Test event conducted at the subject site on June 16, 17, & 18, 2015. The EFR® event was implemented in monitor well MW-2S on June 16, 2015; in monitor well MW-10S on June 17, 2015; and in monitor wells MW-3S, MW-6D, MW-6S, MW-4S, and MW-11S on June 18, 2015. EFR® is a mobile multi-phase/dual-phase extraction technology shown to be effective for mass removal of hydrocarbons in the soils/groundwater, and is used to gather the necessary data to generate effective remediation strategies.

EFR®

The main purposes of the EFR® events were to 1) achieve contaminant removal by multi-phase/dual-phase extraction process, 2) reduce the initial aerial and vertical extent of the plume, and **3) collect field data (i.e. radius of influence, air-flow rates, vapor concentrations, water recovery rates, etc.), for full-scale remediation**.

June 16, 2015 - Event 1
MW-2S

EFR® was performed for 8 hours at monitor well MW-2S on June 16, 2015. Separate-phase hydrocarbons (SPH) (gasoline) were detected in monitor well MW-2S prior to completion of the event at a thickness of 1.01 feet. SPH was not detected in MW-2S upon conclusion of the event.

A calculated total of 6.0 pounds of petroleum hydrocarbons (approximately 1.0 equivalent gallon of hydrocarbon) in vapor concentrations were removed during the EFR® event on June 16, 2015.

The hydrocarbon removal rate (in vapors) varied from a low of 0.4 pounds per hour (lbs/hr) at several times during the MW-2S extraction event, to a high of 2.8 pounds per hour (lbs/hr) at the beginning of the MW-2S extraction event. The removal rate was low and showed a decreasing trend initially, and then a relatively steady trend during remainder of the extraction from MW-2S.

Vapor concentrations varied from a high of 6,000 parts per million by volume (PPM_V) (total hydrocarbons) at the beginning of the MW-2S extraction event, to a low of 1,400 PPMv 2 hours into the MW-2S extraction event. As with the removal rates, the concentrations were low. The concentration showed a decreasing trend throughout the MW-2S event.

The range of vacuum readings recorded during this EFR® event from the extraction well is detailed in the attached EFR® Field Data Sheet and summarized below:

Extraction Well	Vacuum Readings
Truck	20 inches of mercury
MW-2S	12 to 14 inches of mercury

Vacuum Influence

Differential pressures from the nearest monitor wells were recorded during this event to assess the vacuum induced by EFR® in the vadose zone. A vacuum influence was observed at a distance of 60 feet from MW-2S in MW-4S, and a possible slight influence was observed at a distance of 103 feet from MW-2S in MW-6S. An influence was not observed at a distance of 40, 55, or 145 feet from MW-2S in shallow wells MW-3S, MW-11S, or MW-10S, respectively. An influence was not observed at a distance of 33 or 45 feet in deep wells MW-2D or MW-1D, respectively. The differential pressure data are detailed in the attached table and summarized below:

Monitor Well	Maximum Change	Nearest Extraction Well (Approx. Distance)
MW-2D	0.00 inches of water	MW-2S (33 feet)
MW-4S	-0.14 inches of water	MW-2S (60 feet)
MW-11S	0.00 inches of water	MW-2S (55 feet)
MW-3S	0.00 inches of water	MW-2S (40 feet)
MW-1D	0.00 inches of water	MW-2S (45 feet)
MW-6S	-0.03 inches of water	MW-2S (103 feet)
MW-10S	0.00 inches of water	MW-2S (145 feet)

It should be noted that the slight influence observed in MW-6S occurred only during three of the early event readings. It should also be noted that the influence observed in MW-4S was observed when the stinger was ~78 feet below ground surface, and the influence was no longer observed after the stinger was lowered to 81 feet.

Groundwater Drawdown

Groundwater levels were recorded in the extraction wells and surrounding wells during these two events to assess the groundwater drawdown created by EFR®.

A groundwater drawdown was observed at a distance of 33, 40, 60, 103, and 145 feet from MW-2S in MW-2D, MW-3S, MW-4S, MW-6S, and MW-10S, respectively. A groundwater drawdown was not observed at a distance of 45 or 55 feet from MW-2S in MW-1D or MW-11S, respectively. The groundwater drawdown data are summarized below:

Monitor Well	Maximum Change	Nearest Extraction Well (Approx. Distance)
MW-2S	-12.88 feet	Extraction Well
MW-2D	-0.18 feet	MW-2S (33 feet)
MW-4S	-0.86 feet	MW-2S (60 feet)
MW-11S	0.17 feet	MW-2S (55 feet)
MW-3S	-2.03 feet	MW-2S (40 feet)
MW-1D	0.07 feet	MW-2S (45 feet)
MW-6S	-0.01 feet	MW-2S (103 feet)
MW-10S	-0.36 feet	MW-2S (145 feet)

It should be noted that a groundwater drawdown was observed even where a vacuum influence was not observed.

Disposition of Fluids

Approximately 69 gallons (based on gauging the truck after the events) of fluids were extracted from the monitoring well during this event. The yield was very low. The fluids were off loaded to a tank on-site.

June 17, 2015 - Event 2
MW-10S

EFR® was performed for 8 hours at monitor well MW-10S on June 17, 2015. Separate-phase hydrocarbons (SPH) (diesel fuel) were detected in monitor well MW-10S prior to completion of the event at a thickness of 3.79 feet. SPH was detected in MW-10S upon conclusion of the event at a thickness of 10.18 feet. It appears product was “pulled” into the well during this event.

A calculated total of 87.3 pounds of petroleum hydrocarbons (approximately 14.4 equivalent gallons of hydrocarbons) in vapor concentrations, in addition to 11 gallons of liquid phase SPH, were removed during the EFR® event on June 17, 2015.

The hydrocarbon removal rate (in vapors) varied from a low of 2.0 pounds per hour (lbs/hr) in the middle of the extraction event (this corresponded to a lowering of the stinger from 75 to 78 feet), to a high of 23.2 pounds per hour (lbs/hr) near the beginning of the extraction event. The removal rate showed a relatively steady trend when the stinger was at the same depth, but the removal rate was much lower when the stinger depth was lowered from 75 to 78 feet bgs. during the extraction.

Vapor concentrations varied from a high of 70,000 parts per million by volume (PPM_V) (total hydrocarbons) 2 hours into the extraction event, to a low of 10,000 PPMv in the middle of the extraction event. The concentrations increased during the first 2 hours on the event, then decreased throughout the remaining time of the event.

The range of vacuum readings recorded during this EFR® event from the extraction wells are detailed in the attached EFR® Field Data Sheet and summarized below:

Extraction Well	Vacuum Readings
Truck	20 inches of mercury
MW-10S	5 to 7 inches of mercury

Vacuum Influence

Differential pressures from the nearest monitor wells were recorded during this event to assess the vacuum induced by EFR® in the vadose zone. A vacuum influence was observed at a distance of 79, 115, 130, and 185 feet from MW-10S in monitor wells MW-9S, MW-6S, MW-12S, and MW-5S, respectively. A slight influence was observed at a distance of 77 and 110 feet from MW-10S in deep wells MW-7D and MW-6D. The differential pressure data are detailed in the attached table and summarized below:

Monitor Well	Maximum Change	Nearest Extraction Well (Approx. Distance)
MW-3S	0.00 inches of water	MW-10S (108 feet)
MW-7D	-0.03 inches of water	MW-10S (77 feet)
MW-6D	-0.04 inches of water	MW-10S (110 feet)
MW-6S	-0.15 inches of water	MW-10S (115 feet)
MW-5S	-0.05 inches of water	MW-10S (185 feet)
MW-9S	-0.07 inches of water	MW-10S (79 feet)
MW-9D	0.00 inches of water	MW-10S (77 feet)
MW-12S	-0.10 inches of water	MW-10S (130 feet)

The vacuum influence from MW-6S and MW-12S were consistent throughout the extraction from MW-10S. The influence observed in MW-5S and MW-9S was not as consistent.

Groundwater Drawdown

Groundwater levels were recorded in the extraction wells and surrounding wells during this event to assess the groundwater drawdown created by EFR®. A significant groundwater drawdown was observed at a distance of 108 and 115 feet from MW-10S in MW-3S and MW-6S, respectively; and a groundwater drawdown was observed at a distance of 77, 79, and 185 feet from MW-10S in MW-9D (deep well), MW-9S, and MW-5S, respectively. The groundwater drawdown data are summarized below:

Monitor Well	Maximum Change	Nearest Extraction Well (Approx. Distance)
MW-10S	-3.97 feet	Extraction Well
MW-3S	-2.34 feet	MW-10S (108 feet)
MW-7D	0.13 feet	MW-10S (77 feet)
MW-6D	0.00 feet	MW-10S (110 feet)

MW-6S	-2.77 feet	MW-10S (115 feet)
MW-5S	-0.06 feet	MW-10S (185 feet)
MW-9S	-0.01 feet	MW-10S (79 feet)
MW-9D	-0.02 feet	MW-10S (77 feet)
MW-12S	0.00 feet	MW-10S (130 feet)

The groundwater extraction rate was much higher from MW-10S which is potentially the reason for the greater groundwater drawdown observed during extraction form MW-10S as compared to that from MW-2S.

Disposition of Fluids
Approximately 265 gallons (based on gauging the truck after the events) of fluids were extracted from the monitoring well during this event. The fluids were off loaded to a tank on-site.

June 18, 2015 - Events 3 thru 7
MW-3S, MW-6D, MW-6S, MW-4S, and MW-11S
EFR® was performed for 6 hours at monitor wells MW-3S (1 hour), MW-6D (1.5 hours), MW-6S (1 hour), MW-4S (1 hour), and MW-11S (1.5 hours) on June 18, 2015. Separate-phase hydrocarbons (SPH) (diesel fuel) were detected in monitor well MW-3S, MW-4S, and MW-11S prior to completion of the event at a thickness of 0.22, 0.32, and 3.67 feet, respectively. SPH was detected in monitor wells MW-4S and MW-11S, at a thickness of 0.03 and 0.31 feet, respectively, upon conclusion of the event.

The main purpose of these events was to remove hydrocarbon mass from the area of these wells.

A calculated total of 23.4 pounds of petroleum hydrocarbons (approximately 3.9 equivalent gallons of hydrocarbons) in vapor concentrations, in addition to 19 gallons of liquid phase SPH, were removed during the EFR® event on June 18, 2015.

The hydrocarbon removal rate (in vapors) varied from a low of 0.1 pounds per hour (lbs/hr) during the extraction from MW-6D, to a high of 16.3 pounds per hour (lbs/hr) near the beginning of the extraction from MW-3S. The removal rate showed a relatively stable trend during all five extraction events. The removal rate was significantly higher from MW-3S, than the other four wells. The removal rate was very low from MW-6D and MW-4S.

Vapor concentrations varied from a high of 34,000 parts per million by volume (PPMV) (total hydrocarbons) near the beginning of extraction from MW-3S, to a low of 300 PPMv at the beginning of the extraction from MW-6D. The concentrations also remained relatively steady during extraction from all five wells. Concentrations were significantly higher from MW-3S, and higher from MW-11S, than from the other three wells. Concentrations were very low from MW-6D.

The range of vacuum readings recorded during this EFR® event from the extraction wells are detailed in the attached EFR® Field Data Sheet and summarized below:

Extraction Well	Vacuum Readings
Truck	20 inches of mercury
MW-3S	13 inches of mercury
MW-6D	5 inches of mercury
MW-6S	13 inches of mercury
MW-4S	8 inches of mercury
MW-11S	7 inches of mercury

EFR®/Pilot Test Event Conclusions

The following conclusions are based on the results of the EFR®/Pilot Test events completed June 16 to 18, 2015.

June 16, 2015

1. SPH was eliminated from MW-2S during extraction.
2. A total of 6.0 pounds of hydrocarbon, equivalent to 1.0 gallons of gasoline, was extracted during this event.
3. A vacuum influence was observed at a distance of 60 feet in MW-4S, but this influence was lost when the stinger was lowered from 73 to 78 feet bgs.
4. After an initial decrease, extraction vapor concentrations remained relatively steady, even after lowering the stingers. The extraction vapor concentrations were elevated, but not extremely high, especially for a gasoline contaminated area.
5. A significant groundwater drawdown was observed at a maximum distance of 145 feet from MW-2S, indicating a significant “pull” toward the extraction well.
6. The groundwater extraction rate was very low, 0.14 gpm.
7. Based on the low air flow rates, the low groundwater extraction rates, the in-well vacuum, and knowledge of the geology at the site, groundwater flow appears to be dominated by flow through fractures.
8. Based on the in-well vacuum, the permeability of the formation near MW-2S is relatively low.

June 17, 2015

1. The SPH thickness measured in MW-10S increased from 3.79 feet to 10.18 feet during extraction. It appears the EFR® extraction had a significant “pull” on the product into the well.
2. A total of 87.3 pounds of hydrocarbon, equivalent to 14.4 gallons of gasoline, in addition to 11 gallons of liquid phase diesel fuel was extracted during this event.
3. A consistent vacuum influence was observed at a maximum distance of 130 feet in MW-12S. There appeared to be a greater vacuum influence radially (more wells and greater distances) during extraction from MW-10S than from MW-2S.
4. Extraction vapor concentrations were extremely high, and decreased significantly when the stinger was lowered from 75 to 78 feet bgs. The optimum stinger depth for maximum hydrocarbon removal from MW-10S is at the 75 foot depth or less under current conditions.

5. A significant groundwater drawdown was observed at a maximum distance of 115 feet from MW-10S in MW-6S. The significant groundwater drawdown was also observed in MW-3S. MW-6S and MW-3S may be in the suspected (DBS) faulted zone. There appears to a good groundwater connection in the area of these wells.
6. The groundwater extraction rate was significantly higher from MW-10S than from MW-2S.
7. As with MW-2S, groundwater flow appears to be dominated by flow through fractures and possibly thin ‘stringers”, but is much greater possible due to the faulted zone. The flow rates from MW-10S was 0.55 gpm.
8. Based on the in-well vacuum, the permeability of the formation near MW-10S is moderate.

June 18, 2015

1. A total of 23.4 pounds of hydrocarbon, equivalent to 3.9 gallons of gasoline, in addition to 19 gallons of liquid phase diesel fuel was extracted during these events.

Thank you for this opportunity. We look forward to working with you again in the future to provide innovative and cost effective environmental solutions at this and other sites.

Sincerely,

EcoVac Services

Jeffrey M. Brammer

Jeff Brammer, P.G.
Western Regional Manager, Hydrogeologist

Attachments:
EFR® Field Data Sheets

ATTACHMENT 1

FIELD DATA SHEETS

EFR® FIELD DATA SHEET

Client: DBS	Facility Name: Bell Gas #1186		Event #: 1
Facility Address: 101 Sun Valley Rd., Alto, NM		Technician: Mosley	Date: 06/16/15

Extraction Well(s)	Time hh:mm	Extraction Well-head Vacuum (in. Hg)								Vacuum Truck Exhaust				
		Inlet	MW-2S							Concentration PPM	Offgas Velocity FT/MIN	Flow Rate CFM	Removal Rate LBS/HR	Interval Removal LBS
Start Time:	7:15													
MW-2S	7:30	20	14							6,000	800	39	2.8	0.7
	7:45	20	14							4,100	750	37	1.8	0.4
	8:00	20	14							3,400	500	25	1.0	0.2
	8:15	20	14							2,600	500	25	0.8	0.2
	8:45	20	14							1,800	500	25	0.5	0.3
	9:15	20	14							1,400	500	25	0.4	0.2
	9:45	20	12							2,600	600	29	0.9	0.5
	10:15	20	12							2,400	500	25	0.7	0.3
	11:15	20	12							2,200	500	25	0.6	0.6
	11:45	20	12							2,000	500	25	0.6	0.3
	12:45	20	12							1,700	400	20	0.4	0.4
	13:15	20	12							3,000	400	20	0.7	0.3
	13:45	20	12							3,000	400	20	0.7	0.3
	14:15	20	12							2,600	450	22	0.7	0.3
	14:45	20	12							2,200	450	22	0.6	0.3
	15:15	20	12							2,000	450	22	0.5	0.3
	15:45	20	12							1,800	400	20	0.4	0.2

Well Gauging Data:			Before EFR® Event			After EFR® Event			Corr. DTW
Well No.	Diam.	TD (ft)	DTS (ft)	DTW (ft)	SPH (ft)	DTS (ft)	DTW (ft)	SPH (ft)	Change (ft)
MW-2S	2"		70.13	71.14	1.01	-	83.16	0.00	-12.88

Vacuum Truck Information	
Subcontractor:	AllVac
Truck Operator:	Mosley
Truck No.:	153
Vacuum Pumps:	Becker
Pump Type:	Twin LC-44s
Tank Capacity (gal.):	2,894
Stack I.D. (inches)	3.0

Well ID	Breather Port	Stinger Depth
MW-2S	0 (closed)	73'

Recovery/Disposal Information		
Hydrocarbons (vapor):	6.0	pounds
Hydrocarbons (liquid):		gallons
Total Hydrocarbons:	1.0	equiv. gallon
Molecular Weight Utilized:	75	g/mole
Disposal Facility:	On-site	
Manifest Number:		
Total Liquids Removed:	69	gallons

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Time:	7:15-15:45
# Pumps:	2
RPMs:	1,000
Time:	
# Pumps:	
RPMs:	

Notes:

At 9:15 lowered stinger to 78'
At 11:45 lowered stinger to 81'
At 13:45 lowered stinger to 84'

Differential Pressure and Groundwater Drawdown Data Recorded During EFR®
Event No. 1 - June 16, 2015
Daniel B. Stephens
Alto, NM

DIFFERENTIAL PRESSURE DATA

		Well Designation:						
		MW-2D	MW-4S	MW-11S	MW-3S	MW-1D	MW-6S	MW-10S
Nearest Extraction Well:		MW-2S	MW-2S	MW-2S	MW-2S	MW-2S	MW-2S	MW-2S
Approximate Distance:		33 feet	60 feet	55 feet	40 feet	45 feet	103 feet	145 feet
Time	Elapsed Time	Differential Pressures (inches of water):						
7:45	0.5 hrs.	0.00	-0.05	0.00	0.00	0.00	0.00	0.00
8:15	1.0 hr.	0.00	-0.10	0.00	0.00	0.00	-0.03	0.00
8:45	1.5 hrs.	0.00	-0.14	0.00	0.00	0.00	-0.03	0.00
9:15	2.0 hrs.	0.00	-0.08	0.00	0.00	0.00	0.00	0.00
9:45	2.5 hrs.	0.00	-0.05	0.00	0.00	0.00	0.00	0.00
10:15	3.0 hrs.	0.00	-0.11	0.00	0.00	0.00	0.00	0.00
10:45	3.5 hrs.	0.00	-0.11	0.00	0.00	0.00	0.00	0.00
11:15	4.0 hrs.	0.00	-0.11	0.00	0.00	0.00	-0.03	0.00
11:45	4.5 hrs.	0.00	-0.10	0.00	0.00	0.00	0.00	0.00
12:15	5.0 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12:45	5.5 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13:15	6.0 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13:45	6.5 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14:15	7.0 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14:45	7.5 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15:15	8.0 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15:45	8.5 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum Change:		0.00	-0.14	0.00	0.00	0.00	-0.03	0.00

GROUNDWATER DRAWDOWN DATA

		Well Designation:						
		MW-2D	MW-4S	MW-11S	MW-3S	MW-1D	MW-6S	MW-10S
Nearest Extraction Well:		MW-2S	MW-2S	MW-2S	MW-2S	MW-2S	MW-2S	MW-2S
Approximate Distance:		33 feet	60 feet	55 feet	40 feet	45 feet	103 feet	145 feet
Time	Elapsed Time	Depth to Liquid (feet below top of casing):						
Prior to EFR®		72.87	55.92	67.68	71.16	118.38	83.58	71.75
After EFR®		73.05	56.78	67.51	73.19	118.31	83.59	72.11
Maximum Change:		-0.18	-0.86	0.17	-2.03	0.07	-0.01	-0.36

EFR® FIELD DATA SHEET

Client: DBS	Facility Name: Bell Gas #1186	Event #: 2
Facility Address: 101 Sun Valley Rd., Alto, NM	Technician: Mosley	Date: 06/17/15

Extraction Well(s)	Time hh:mm	Extraction Well-head Vacuum (in. Hg)		Vacuum Truck Exhaust				
Start Time:	8:30	Inlet	MW-10S	Concentration PPM	Offgas Velocity FT/MIN	Flow Rate CFM	Removal Rate LBS/HR	Interval Removal LBS
MW-10S	8:45	20	7	40,000	450	22	14.4	3.6
	9:00	20	7	50,000	450	22	18.0	4.5
	9:15	20	7	56,000	450	22	20.1	5.0
	9:30	20	7	60,000	400	20	19.2	4.8
	10:00	20	7	58,000	500	25	23.2	11.6
	10:30	20	7	50,000	400	20	16.0	8.0
	11:00	20	7	70,000	400	20	22.4	11.2
	11:30	20	7	58,000	400	20	18.5	9.3
	12:00	20	7	55,000	400	20	17.6	8.8
	12:30	20	7	10,000	250	12	2.0	1.0
	13:00	20	5	20,000	250	12	4.0	2.0
	13:30	20	5	26,000	250	12	5.2	2.6
	14:00	20	5	20,000	250	12	4.0	2.0
	14:30	20	5	22,000	250	12	4.4	2.2
	15:00	20	5	22,000	250	12	4.4	2.2
	15:30	20	5	22,000	250	12	4.4	2.2
	16:00	20	5	20,000	250	12	4.0	4.0
	16:30	20	5	20,000	300	15	4.8	2.4

Well Gauging Data:			Before EFR® Event			After EFR® Event			Corr. DTW
Well No.	Diam.	TD (ft)	DTS (ft)	DTW (ft)	SPH (ft)	DTS (ft)	DTW (ft)	SPH (ft)	Change (ft)
MW-10S	2"		72.11	75.90	3.79	75.12	85.30	10.18	-3.97

Vacuum Truck Information	
Subcontractor:	AllVac
Truck Operator:	Mosley
Truck No.:	153
Vacuum Pumps:	Becker
Pump Type:	Twin LC-44s
Tank Capacity (gal.):	2,894
Stack I.D. (inches)	3.0

Well ID	Breather Port	Stinger Depth
MW-10S	0 (closed)	75'

Recovery/Disposal Information		
Hydrocarbons (vapor):	87.3	pounds
Hydrocarbons (liquid):	11.0	gallons
Total Hydrocarbons:	25.4	equiv. gallon
Molecular Weight Utilized:	103	g/mole
Disposal Facility:	On-site	
Manifest Number:		
Total Liquids Removed:	265	gallons

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Time:	8:30-16:30
# Pumps:	2
RPMs:	1,000
Time:	
# Pumps:	
RPMs:	

Notes:
At 12:30 lowered stinger to 78'
At 12:30 gauged MW-10S, 74.50 - 79.85 (5.35' SPH)

Gauged truck after rest period at end of day = 11 gallons SPH
Product appears to be diesel fuel

Differential Pressure and Groundwater Drawdown Data Recorded During EFR®
Event No. 2 - June 17, 2015
Daniel B. Stephens
Alto, NM

DIFFERENTIAL PRESSURE DATA

		Well Designation:							
		MW-3S	MW-7D	MW-6D	MW-6S	MW-5S	MW-9S	MW-9D	MW-12S
Nearest Extraction Well:		MW-10S	MW-10S	MW-10S	MW-10S	MW-10S	MW-10S	MW-10S	MW-10S
Approximate Distance:		108 feet	77 feet	110 feet	115 feet	185 feet	79 feet	77 feet	130 feet
Time	Elapsed Time	Differential Pressures (inches of water):							
9:00	0.5 hrs.	0.00	0.00	0.00	-0.05	0.00	0.00	0.00	-0.06
9:30	1.0 hr.	0.00	-0.03	0.00	-0.13	-0.04	-0.04	0.00	-0.08
10:00	1.5 hrs.	0.00	0.00	0.00	-0.13	-0.04	0.00	0.00	-0.05
10:30	2.0 hrs.	0.00	0.00	0.00	-0.08	-0.05	0.00	0.00	-0.04
11:00	2.5 hrs.	0.00	0.00	0.00	-0.11	-0.05	0.00	0.00	-0.04
11:30	3.0 hrs.	0.00	0.00	0.00	-0.13	-0.05	0.00	0.00	0.00
12:00	3.5 hrs.	0.00	0.00	0.00	-0.05	0.00	0.00	0.00	0.00
12:30	4.0 hrs.	0.00	0.00	0.00	-0.04	0.00	0.00	0.00	-0.03
13:00	4.5 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.03
13:30	5.0 hrs.	0.00	0.00	0.00	-0.04	0.00	0.00	0.00	0.00
14:00	5.5 hrs.	0.00	0.00	-0.04	-0.15	-0.03	-0.03	0.00	-0.08
14:30	6.0 hrs.	0.00	0.00	0.00	-0.13	-0.03	-0.02	0.00	-0.05
15:00	6.5 hrs.	0.00	-0.03	-0.03	-0.11	0.00	-0.04	0.00	-0.10
15:30	7.0 hrs.	0.00	0.00	0.00	-0.05	0.00	-0.02	0.00	-0.03
16:00	7.5 hrs.	0.00	0.00	0.00	0.00	0.00	-0.04	0.00	0.00
16:30	8.0 hrs.	0.00	0.00	0.00	0.00	0.00	-0.07	0.00	-0.08
Maximum Change:		0.00	-0.03	-0.04	-0.15	-0.05	-0.07	0.00	-0.10

GROUNDWATER DRAWDOWN DATA

		Well Designation:							
		MW-3S	MW-7D	MW-6D	MW-6S	MW-5S	MW-9S	MW-9D	MW-12S
Nearest Extraction Well:		MW-10S	MW-10S	MW-10S	MW-10S	MW-10S	MW-10S	MW-10S	MW-10S
Approximate Distance:		108 feet	77 feet	110 feet	115 feet	185 feet	79 feet	77 feet	130 feet
Time	Elapsed Time	Depth to Liquid (feet below top of casing):							
Prior to EFR®		71.16	113.17	120.54	83.58	85.45	85.67	118.62	55.15
After EFR®		73.50	113.04	120.54	86.35	85.51	85.68	118.64	55.15
Maximum Change:		-2.34	0.13	0.00	-2.77	-0.06	-0.01	-0.02	0.00

EFR® FIELD DATA SHEET

Client: DBS	Facility Name: Bell Gas #1186		Event #: 3, 4, & 5
Facility Address: 101 Sun Valley Rd., Alto, NM		Technician: Mosley	Date: 06/18/15

Extraction Well(s)	Time hh:mm	Extraction Well-head Vacuum (in. Hg)									Vacuum Truck Exhaust				
		Inlet	MW-3S	MW-6D	MW-6S						Concentration PPM	Offgas Velocity FT/MIN	Flow Rate CFM	Removal Rate LBS/HR	Interval Removal LBS
Start Time:	7:30														
MW-3S	7:45	20	13								20,000	750	37	12.0	3.0
	8:00	20	13								34,000	600	29	16.3	4.1
	8:15	20	13								32,000	600	29	15.3	3.8
	8:30	20	13								30,000	600	29	14.4	3.6
MW-6D	8:45	20		5							300	300	15	0.1	0.0
	9:00	20		5							350	300	15	0.1	0.0
	9:15	20		5							400	400	20	0.1	0.0
	9:30	20		5							500	300	15	0.1	0.0
	9:45	20		5							400	400	20	0.1	0.0
	10:00	20		5							500	400	20	0.2	0.0
MW-6S	10:15	20			13						7,200	500	25	2.9	0.7
	10:30	20			13						7,000	500	25	2.8	0.7
	10:45	20			13						7,200	500	25	2.9	0.7
	11:00	20			13						6,600	500	25	2.6	0.7

Well Gauging Data:			Before EFR® Event			After EFR® Event			Corr. DTW Change (ft)
Well No.	Diam.	TD (ft)	DTS (ft)	DTW (ft)	SPH (ft)	DTS (ft)	DTW (ft)	SPH (ft)	
MW-3S	2"		71.68	71.90	0.22	-	74.84	0.00	-3.13
MW-4S	2"		56.60	56.92	0.32				
MW-6S	2"		-	83.70	0.00	-	86.90	0.00	-3.20
MW-6D	2"		-	120.56	0.00	-	119.51	0.00	1.05
MW-11S	2"		69.98	73.65	3.67				

Vacuum Truck Information		Well ID	Breather Port	Stinger Depth	**Recovery/Disposal Information**		
Subcontractor:	AllVac	MW-3S	0 (closed)	73'	Hydrocarbons (vapor):	17.5	pounds
Truck Operator:	Mosley	MW-6D	0 (closed)	123'	Hydrocarbons (liquid):		gallons
Truck No.:	153	MW-6S	0 (closed)	85'	Total Hydrocarbons:	2.9	equiv. gallon
Vacuum Pumps:	Becker				Molecular Weight Utilized:	103	g/mole
Pump Type:	Twin LC-44s				Disposal Facility:	On-site	
Tank Capacity (gal.):	2,894				Manifest Number:		
Stack I.D. (inches)	3.0				Total Liquids Removed:	56	gallons

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Time:	7:30-11:00	Notes:
# Pumps:	2	MW-6S fluid level was 83.65 prior to MW-6D extraction. Lowered 0.05'
RPMs:	1,000	during extraction from MW-6D
Time:		
# Pumps:		Liquid SPH in truck was from MW-3S (see note on following sheet)
RPMs:		

EFR® FIELD DATA SHEET

Client: DBS	Facility Name: Bell Gas #1186		Event #: 6 & 7
Facility Address: 101 Sun Valley Rd., Alto, NM		Technician: Mosley	Date: 06/18/15

Extraction Well(s)	Time hh:mm	Extraction Well-head Vacuum (in. Hg)			Vacuum Truck Exhaust				
		Inlet	MW-4S	MW-11S	Concentration PPM	Offgas Velocity FT/MIN	Flow Rate CFM	Removal Rate LBS/HR	Interval Removal LBS
Start Time:	11:15								
MW-4S	11:30	20	8		1,600	600	29	0.8	0.2
	11:45	20	8		2,400	600	29	1.2	0.3
	12:00	20	8		1,000	600	29	0.5	0.1
	12:15	20	8		800	600	29	0.4	0.1
MW-11S	12:30	20		7	9,000	300	15	2.2	0.5
	12:45	20		7	14,000	400	20	4.5	1.1
	13:00	20		7	16,000	400	20	5.1	1.3
	13:15	20		7	12,000	400	20	3.8	1.0
	13:30	20		7	16,000	400	20	5.1	1.3

Well Gauging Data:			Before EFR® Event			After EFR® Event			Corr. DTW
Well No.	Diam.	TD (ft)	DTS (ft)	DTW (ft)	SPH (ft)	DTS (ft)	DTW (ft)	SPH (ft)	Change (ft)
MW-4S	2"		56.60	56.92	0.32	64.12	64.15	0.03	-7.48
MW-11S	2"		69.98	73.65	3.67	70.94	71.25	0.31	-0.46

Vacuum Truck Information	
Subcontractor:	AllVac
Truck Operator:	Mosley
Truck No.:	153
Vacuum Pumps:	Becker
Pump Type:	Twin LC-44s
Tank Capacity (gal.):	2,894
Stack I.D. (inches)	3.0

Well ID	Breather Port	Stinger Depth
MW-4S	0 (closed)	58'
MW-11S	0 (closed)	73'

Recovery/Disposal Information		
Hydrocarbons (vapor):	5.9	pounds
Hydrocarbons (liquid):		gallons
Total Hydrocarbons:	1.0	equiv. gallon
Molecular Weight Utilized:	103	g/mole
Disposal Facility:	On-site	
Manifest Number:		
Total Liquids Removed:	101	gallons

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Time:	7:30-11:00
# Pumps:	2
RPMs:	1,000
Time:	
# Pumps:	
RPMs:	

Notes:

Had 19 gallons of SPH in truck at the conclusion of extraction on from the five wells

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U.S. Standard Atmosphere

Properties of US standard atmosphere ranging *-5000 to 250000 ft* altitude

A "Standard Atmosphere" can be regarded as an average pressure, temperature and air density for various altitudes.

The "*U.S. Standard Atmosphere 1976"* is an atmospheric model of how the pressure, temperature, density, and viscosity of the Earth's atmosphere changes with altitude. It is defined as having a temperature of *288.15 K (15 ^{o}C, 59 ^{o}F)* at the sea level *0 km geo-potential height* and *101325 Pa (1013.25 hPa, 1013.25 mbar, 760 mm Hg, 29.92 in Hg)*.

The atmosphere are divided in

- the **Troposphere** - ranging *0 to 11 km (36.000 ft)* altitude
- the **Stratosphere** - ranging *11 to to 51 km (167.000 ft)* altitude
- the **Mesosphere** - ranging *51 to 71 km (232.000 ft)* altitude
- the **Ionosphere** - ranging above *71 km (above 232.000 ft)* altitude

U.S. Standard Atmosphere Air Properties - Imperial (BG) Units

Geo-potential Altitude above Sea Level - *h* - (ft)	Temperature - *t* - (^{o}F)	Acceleration of Gravity - *g* - (ft/s^2)	Absolute Pressure - *p* - (lb/in^2)	Density - *ρ* - (10^{-4} slugs /ft^3) (lbs/ft3)	Dynamic Viscosity - *μ* - (10^{-7} lb s/ft^2) (10^{-7} slug /(ft s))
-5000	76.84	32.189	17.554	27.45 0.0883	3.836
0	59	32.174	14.696	23.77 0.0765	3.737

Geo-potential Altitude above Sea Level - *h* - (ft)	Temperature - *t* - (^oF)	Acceleration of Gravity - *g* - (ft/s^2)	Absolute Pressure - *p* - (lb/in^2)	Density - *ρ* - (10^{-4} slugs $/ft^3$) (lbs/ft3)	Dynamic Viscosity - *μ* - (10^{-7} lb s/ft^2) (10^{-7} slug /(ft s))
5000	41.17	32.159	12.228	20.48 0.0659	3.637
10000	23.36	32.143	10.108	17.56 0.0565	3.534
15000	5.55	32.128	8.297	14.96 0.0481	3.430
20000	-12.26	32.112	6.759	12.67 0.0408	3.324
25000	-30.05	32.097	5.461	10.66 0.0343	3.217
30000	-47.83	32.082	4.373	8.91 0.0287	3.107
35000	-65.61	32.066	3.468	7.38 0.0237	2.995
40000	-69.70	32.051	2.730	5.87 0.0189	2.969
45000	-69.70	32.036	2.149	4.62 0.0149	2.969
50000	-69.70	32.020	1.692	3.64 0.0117	2.969
60000	-69.70	31.990	1.049	2.26 0.00727	2.969
70000	-67.42	31.959	0.651	1.39 0.00447	2.984
80000	-61.98	31.929	0.406	0.86 0.00277	3.018
90000	-56.54	31.897	0.255	0.56 0.0018	3.052
100000	-51.10	31.868	0.162	0.33 0.00106	3.087
150000	19.40	31.717	0.020	0.037 0.000119	3.511
200000	-19.78	31.566	0.003	0.0053 0.0000171	3.279
250000	-88.77	31.415	0.000	0.00065 0.00000209	2.846

U.S. Standard Atmosphere Air Properties - SI Units

Geo potential Altitude above Sea Level - *h* - (m)	Temperature - *t* - (^oC)	Acceleration of Gravity - *g* - (m/s^2)	Absolute Pressure - *p* - (10^4 N/m^2)	Density - *ρ* - (kg/m^3)	Dynamic Viscosity - *μ* - (10^{-5} N s/m^2)
-1000	21.50	9.810	11.39	1.347	1.821
0	15.00	9.807	10.13	1.225	1.789
1000	8.50	9.804	8.988	1.112	1.758
2000	2.00	9.801	7.950	1.007	1.726
3000	-4.49	9.797	7.012	0.9093	1.694
4000	-10.98	9.794	6.166	0.8194	1.661
5000	-17.47	9.791	5.405	0.7364	1.628
6000	-23.96	9.788	4.722	0.6601	1.595
7000	-30.45	9.785	4.111	0.5900	1.561

Geo potential Altitude above Sea Level - *h* - (m)	Temperature - *t* - (^oC)	Acceleration of Gravity - *g* - (m/s^2)	Absolute Pressure - *p* - (10^4 N/m^2)	Density - *ρ* - (kg/m^3)	Dynamic Viscosity - *μ* - (10^{-5} $N\ s/m^2$)
8000	-36.94	9.782	3.565	0.5258	1.527
9000	-43.42	9.779	3.080	0.4671	1.493
10000	-49.90	9.776	2.650	0.4135	1.458
15000	-56.50	9.761	1.211	0.1948	1.422
20000	-56.50	9.745	0.5529	0.08891	1.422
25000	-51.60	9.730	0.2549	0.04008	1.448
30000	-46.64	9.715	0.1197	0.01841	1.475
40000	-22.80	9.684	0.0287	0.003996	1.601
50000	-2.5	9.654	0.007978	0.001027	1.704
60000	-26.13	9.624	0.002196	0.0003097	1.584
70000	-53.57	9.594	0.00052	0.00008283	1.438
80000	-74.51	9.564	0.00011	0.00001846	1.321

US Atmosphere - Temperature vs. Elevation

The roughness component in the Darcy-Weisbach equation is a function of both the channel material and the Reynolds number, which varies with velocity and hydraulic radius.

$$V = \sqrt{\frac{8g}{f} RS}$$

where
V = flow velocity (m/s, ft/s)
g = gravitational acceleration (m/s^2, ft/s^2)
f = Darcy-Weisbach friction factor (unitless)
R = hydraulic radius (m, ft)
S = friction slope (m/m, ft/ft)

The Darcy-Weisbach friction factor, *f*, can be found using the Colebrook-White equation for fully developed turbulent flow, as follows:

Free Surface

$$\frac{1}{\sqrt{f}} = -2\log\left(\frac{k}{12R} + \frac{2.51}{Re\sqrt{f}}\right)$$

Full Flow (Closed Conduit)

$$\frac{1}{\sqrt{f}} = -2\log\left(\frac{k}{14.8R} + \frac{2.51}{Re\sqrt{f}}\right)$$

where
k = roughness height (m, ft)
R = hydraulic radius (m, ft)
Re = Reynolds number (unitless)

This iterative search for the correct value of *f* can become quite time-consuming for hand computations and computerized solutions of many pipes. Another method, developed by Swamee and Jain, solves directly for *f* in full-flowing circular pipes. This equation is:

$$f = \frac{1.325}{\left[\log_e\left(\frac{k}{3.7D} + \frac{5.74}{Re^{0.9}}\right)\right]^2}$$

where
f = friction factor (unitless)
k = roughness height (m, ft)
D = pipe diameter (m, ft)
Re = Reynolds number (unitless)

Typical Roughness Factors

Typical pipe roughness values for each of these methods are shown in Table 1-2. These values will vary depending on the manufacturer, workmanship, age, and other factors. For this reason, the following table should be used only as a guideline.

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CHAPTI

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Replacing the dependent variable with the nonrepeating independent variable μ gives

$$\pi_2 = \mu V^a D^b \rho^c$$

$$F^0L^0T^0 = FL^{-2}T(LT^{-1})^a(L)^b(FL^{-4}T^2)^c$$

$$F\!: \quad 0 = 1 + c \qquad c = -1$$

$$T\!: \quad 0 = 1 - a - 2 \qquad a = -1$$

$$L\!: \quad 0 = -2 - 1 + b + 4 \qquad b = -1$$

$$\pi_2 = \frac{\mu}{VD\rho} = \frac{1}{\text{Re}} \tag{3.24}$$

where Re is the Reynolds number. Selecting ℓ as the next nonrepeating variable gives

$$\pi_3 = \ell V^a D^b \rho^c$$

$$F^0L^0T^0 = L(LT^{-1})^a L^b (FL^{-4}T^2)^c$$

$$F\!: \quad 0 = c \qquad c = 0$$

$$T\!: \quad 0 = -a \qquad a = 0$$

$$L\!: \quad 0 = 1 + b \qquad b = -1$$

$$\pi_3 = \frac{L}{D} \tag{3.25}$$

The remaining nonrepeating variable is ε, so that

$$\pi_4 = \varepsilon V^a D^b \rho^c$$

solving for exponents gives

$$\pi_4 = \frac{\varepsilon}{D} \tag{3.26}$$

where π_4 is the relative roughness of the pipe.

The equation for the pressure drop in a pipe (Eq. 3.22) can be written in terms of

$$\frac{\Delta P}{\rho V^2} = \phi\left(\frac{1}{\text{Re}}, \frac{L}{D}, \frac{\varepsilon}{D}\right) \tag{3.27}$$

Equation 3.27 forms the basis for the Darcy–Weisbach equation for headloss ($h_f = \Delta P/\gamma$) in a pipe

$$h_L = f\frac{L}{D}\frac{V^2}{2g} \tag{3.28}$$

where the friction factor (f) is a function of Re and ε/D and is given in the Moody chart presented in Chapter 4.

Daniel B. Stephens & Associates, Inc.

Calculation Cover Sheet

Project Name Bell Gas #1186 Project Number ES14.0220.00

Calculation Number ES14.0220.00-003 Discipline Engineering No. of Sheets 2

PROJECT: Bell Gas #1186 Remediation System

THOMAS A. GOLDEN NEW MEXICO 22750 PROFESSIONAL ENGINEER 12/18/2020

SITE: Bell Gas #1186 / TR'S Market, Alto, New Mexico

SUBJECT: Estimated hydrocarbon emissions from MPE treatment equipment

SOURCES OF DATA:
A. Multi-Phase Extraction Pilot Test Report, DBS&A, July 2015
B. Diffused Tank Aerator Model Calculations, H2K Technologies, Inc., December 2018
C. Natural gas thermal oxidizer equipment specifications, Intellishare Environmental, August 2019

SOURCES OF FORMULAE & REFERENCES:

☐ Preliminary Calculation ☒ Final Calculation Supersedes Calculation No. ____________

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
0	Final Remediation Plan	TH	8/10/2020	JS	10/19/2020	TG	12/10/2020

1.0 OBJECTIVE

Calculate the estimated hydrocarbon emission rates for a future multi-phase extraction (MPE) system at the Bell Gas #1186 site in Alto, New Mexico with and without thermal oxidizer vapor treatment, based on MPE pilot test data[A] and diffused aerator tank water treatment equipment modeling[B]. The results will be compared to the limits of 10 pounds per hour and 10 tons per year, under which the New Mexico Environment Department (NMED) Air Quality Bureau does not require an air quality permit or a Notice of Intent to Discharge.

2.0 GIVEN

1. Laboratory results for influent soil vapor samples from MPE pilot test data[A].
2. The combined standard inlet design flow is 119 standard cubic feet per minute (scfm).
3. The estimated destruction efficiency for the multi-phase treatment equipment is 99%[C].
4. Model results of total volatile organic compound (VOC) emission rates for the diffused tank aeration (DTA) water treatment equipment based on laboratory measured groundwater contamination concentrations[B].

3.0 METHOD

Hydrocarbon emission rates are calculated based on the estimated effluent hydrocarbon constituent concentrations and proposed air flow rates. Effluent concentrations were estimated based on measured influent concentrations from MPE pilot testing and in the case of oxidizer vapor treatment the minimum equipment destruction efficiency, DE, provided by the manufacturer using equation 1.

$$C_{eff} = C_{\inf} \cdot (1 - DE) \quad \text{eqn. 1}$$

The effluent concentration is converted to a volume of air under standard conditions using equation 2.

$$C_{std} = C_{eff} \cdot \left(\frac{P_{std}}{P_{lab}} \cdot \frac{T_{lab}}{T_{std}} \right) \quad \text{eqn. 2}$$

The anticipated vapor treatment equipment is estimated to operate with a flow rate of approximately 119 scfm. Modeled diffused aerator tank emissions will be considered after vapor treatment equipment calculations and evaluated to see if aerator operation will boost emissions above NMED limits.

4.0 SOLUTION

A sample calculation for estimating emission rates of total petroleum hydrocarbon gasoline range organics (TPH GRO) is provided below. Samples were collected during MPE pilot testing, and the results are provided on attached spreadsheets. The average influent TPH (GRO) concentration from two wells at two different times , C_{inf}, was 25,775 micrograms per liter (µg/L). This value represents a concentration prior to vapor treatment.

Assuming that effluent concentrations, C_{eff}, would be reduced by 99 percent following vapor treatment (the minimum destruction efficiency reported by the oxidizer manufacturer). Calculate an approximate treated TPH (GRO) concentration using equation 1:

$$C_{eff} = C_{inf} * (1 - 0.99) = 25{,}775\ \mu\frac{g}{L} * 0.01 = 257.8\ \mu g/L$$

Calculate the TPH (GRO) concentration under standard conditions for the raw influent, $C_{inf(std)}$, and treated vapor effluent, $C_{eff(std)}$, using equation 2 and assuming the absolute pressure and temperature at the laboratory (5,200 feet above mean sea level) are 12.4 pounds per square inch (psi) and 70 degrees Fahrenheit (°F), respectively, using the TPH (GRO) effluent concentration calculated above:

Raw Influent:

$$C_{\mathrm{inf}(std)} = C_{inf} \times \left(\frac{P_{std}}{P_{lab}} \times \frac{T_{lab}}{T_{std}}\right) = 25{,}775\ \mu g/L \times \left(\frac{14.7\ psi}{12.4\ psi} \times \frac{530\ R}{530\ R}\right) = 30{,}556\ \mu g/L$$

Treated Vapor Effluent:

$$C_{eff(std)} = C_{eff} \times \left(\frac{P_{std}}{P_{lab}} \times \frac{T_{lab}}{T_{std}}\right) = 257.8\ \mu g/L \times \left(\frac{14.7\ psi}{12.4\ psi} \times \frac{530\ R}{530\ R}\right) = 305.6\ \mu g/L$$

Calculate emissions rates with (treated) and without (raw) oxidizer vapor treatment in pounds per hour (lb/hr) and tons per year (ton/yr) assuming a discharge air flow rate, Q_{out}, of 119 scfm:

Emissions(raw) = Q_{out} * $C_{inf(std)}$ = 119 scfm * 30,556 µg/L * (28.317 L/ft^3) * (60 min/hr) *

(pound/ 454 grams) * (gram / 10^6 µg) = 13.6 lb/hr

Emissions(raw) = 13.6 lb/hr * 8760 hr/yr * ton/2000 lb = 59.6 ton/yr

Emissions(treated) = Q_{out} * $C_{eff(std)}$ = 119 scfm * 305.6 µg/L * (28.317 L/ft^3) * (60 min/hr) *

(pound/ 454 grams) * (gram / 10^6 µg) = 0.136 lb/hr

Emissions(treated) = 0.136 lb/hr * 8760 hr/yr * ton/2000 lb = 0.596 ton/yr

The above calculation assumes the system will be run continuously (24-hours per day). The individual well concentrations also represent what would be taken in by the system during initial operations. Over time with consistent system operation, concentrations typically drop significantly. Sustained operation of Intellishare equipment at other sites has yielded consistent removal rates >99.5% which would further reduce emissions of treated vapor from the thermal oxidizer.

The values above represent hypothetical emissions at startup; actual emissions will ultimately decrease over time as the system operates. If the process air stream is treated with an oxidizer, this calculation shows that treated soil vapor will be below the New Mexico Environment Department's air permitting standards of 10 lb/hr and 10 ton/yr, while the untreated raw vapor TPH (GRO) exceeds these values. Hypothetical emissions for other monitored VOCs, including benzene, toluene, ethylbenzene, and total xylenes, are presented in the attached table and are below the regulatory limits with and without oxidizer treatment.

Modeled air emissions for the DTA-2 water treatment equipment are 0.1 lb/day, 0.0042 lb/hr, or 0.184 ton/yr total VOC, which would make an insignificant addition to air emissions from the thermal oxidizer and not increase emissions above NMED air permitting standards.

Hypothetical Emissions Analysis
Based on MPE Pilot Test Analytical Organic Chemistry Data for Soil Vapor
Bell Gas, Alto, New Mexico

Laboratory Analytical Results	Benzene	Toluene	Ethylbenzene	Total Xylenes	TPH (GRO)
Average Raw Influent from MPE Pilot Test (µg/L)	285	283	152	425	25775
Average Raw Influent from MPE Pilot Test at STP (µg/L)	338	335	180	504	30556
Treated Effluent (µg/L)	2.85	2.83	1.52	4.25	257.8
Treated Effluent at STP (µg/L)	3.38	3.35	1.80	5.04	305.6
Hypothetical Emissions					
Average Raw Influent (lb/hr)	0.151	0.149	0.080	0.225	13.6
Average Raw Influent (ton/yr)	0.660	0.654	0.351	0.984	59.6
Average Treated Effluent (lb/hr)	0.002	0.001	0.0008	0.002	0.136
Average Treated Effluent (ton/yr)	0.007	0.007	0.004	0.010	0.596

TPH (GRO) = Total Petroleum Hydrocarbons gasoline range organics

Estimated Flow (SCFM)
119

Estimated Flow (ACFM)
141

Approximate Vapor Treatment Equipment Destruction Efficiency (Thermal Mode)
99%

Conversions

453.59	gram / lb
1000000	ug / gram
60	min / hr
28.3	liter / cubic foot
8760	hr/yr
2000	lb/ton

Flow Conversions

12.4	absolute air pressure at 5200 ft msl (Lab in Albuquerque)
14.7	absolute air pressure at 0 ft msl
70	°F, standard temperature
70	°F, assumed lab temperature
460	°R

Multi-Phase Extraction

Pilot Test Report

Bell Gas #1186 (Former TR's Market)

Alto, New Mexico

Prepared for **New Mexico Environment Department**
Roswell, New Mexico

July 23, 2015

Daniel B. Stephens & Associates, Inc.

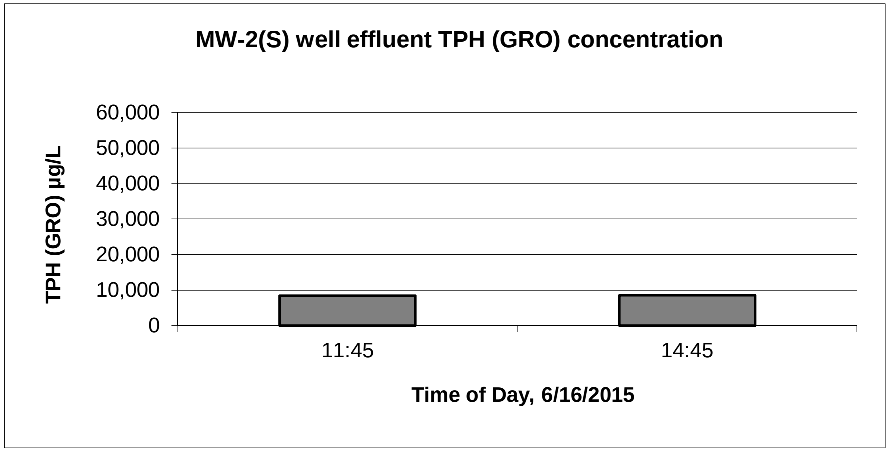
6020 Academy NE, Suite 100 • Albuquerque, New Mexico 87109

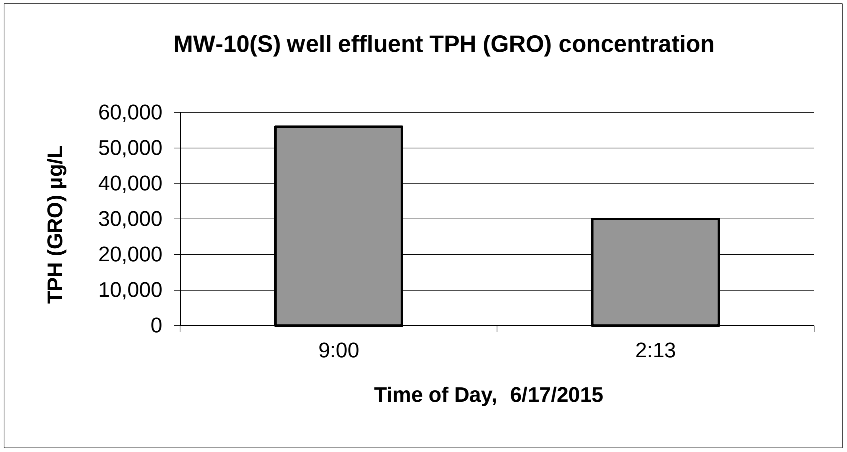
Table 3. Summary of Analytical Organic Chemistry Data for Soil Vapor
Bell Gas #1186, Alto, New Mexico

Sampling Point	Date Sampled	Concentration [a] (µg/L)						
		Benzene	Toluene	Ethylbenzene	Total Xylenes	BTEX	MTBE	TPH GRO
MW-2(S) @ 11:45	6/16/2015	150	320	74	310	854	<12	8,500
MW-2(S) @ 14:45	6/16/2015	130	340	92	380	942	<12	8,600
MW-10(S) @ 9:00	6/17/2015	570	290	220	510	1,590	<25	56,000
MW-10(S) @ 2:13	6/17/2015	290	180	220	500	1,190	<12	30,000

[a] Analyzed in accordance with U.S. Environmental Protection Agency (EPA) methods 8021B for volatile organic compounds (VOCs) and 8015B for TPH GRO.

µg/L = Micrograms per liter
BTEX = Benzene, toluene, ethylbenzene, and total xylenes
MTBE = Methyl tertiary-butyl ether
TPH = Total petroleum hydrocarbons
GRO = Gasoline range organics





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Diffused Tank Aerator Model Calculations 12/12/2018 15:52

Water flow Rate (GPM)	5	Air Temperature (F)	56
Water Temperature (F)	56	Safety Factor (%)	0

Compound DTA Model	Influent Conc (ug/l)	Effluent Conc (ug/l)	Removal Efficiency (%)	Off-Gas Conc (ug/l)	Off-Gas Emmisions (lb/day)	Airflow (cfm)
DRO as Naphthalene						
HDTA-2	680	80	88.28	2.23	0.036	180
HDTA-4	680	9	98.63	1.24	0.040	360
HDTA-6	680	1	99.84	0.84	0.041	540
HDTA-8	680	1	99.98	0.63	0.041	720
HDTA-10	680	1	100.00	0.50	0.041	900
HDTA-16	680	1	100.00	0.32	0.041	1440

Compound DTA Model	Influent Conc (ug/l)	Effluent Conc (ug/l)	Removal Efficiency (%)	Off-Gas Conc (ug/l)	Off-Gas Emmisions (lb/day)	Airflow (cfm)
Benzene						
HDTA-2	220	4	98.00	0.80	0.013	180
HDTA-4	220	1	99.96	0.41	0.013	360
HDTA-6	220	1	100.00	0.27	0.013	540
HDTA-8	220	1	100.00	0.20	0.013	720
HDTA-10	220	1	100.00	0.16	0.013	900
HDTA-16	220	1	100.00	0.10	0.013	1440

Compound DTA Model	Influent Conc (ug/l)	Effluent Conc (ug/l)	Removal Efficiency (%)	Off-Gas Conc (ug/l)	Off-Gas Emmisions (lb/day)	Airflow (cfm)
Toluene						
HDTA-2	890	17	98.10	3.24	0.052	180
HDTA-4	890	1	99.96	1.65	0.053	360
HDTA-6	890	1	100.00	1.10	0.053	540
HDTA-8	890	1	100.00	0.83	0.053	720
HDTA-10	890	1	100.00	0.66	0.053	900
HDTA-16	890	1	100.00	0.41	0.053	1440

Compound DTA Model	Influent Conc (ug/l)	Effluent Conc (ug/l)	Removal Efficiency (%)	Off-Gas Conc (ug/l)	Off-Gas Emmisions (lb/day)	Airflow (cfm)
Xylene						
HDTA-2	220	3	98.50	0.80	0.013	180
HDTA-4	220	1	99.98	0.41	0.013	360
HDTA-6	220	1	100.00	0.27	0.013	540
HDTA-8	220	1	100.00	0.20	0.013	720
HDTA-10	220	1	100.00	0.16	0.013	900
HDTA-16	220	1	100.00	0.10	0.013	1440

Compound DTA Model	Influent Conc (ug/l)	Effluent Conc (ug/l)	Removal Efficiency (%)	Off-Gas Conc (ug/l)	Off-Gas Emmisions (lb/day)	Airflow (cfm)
Total VOC						
HDTA-2	2,010	104	95	7.08	0.1	180
HDTA-4	2,010	12	99	3.71	0.1	360
HDTA-6	2,010	4	100	2.48	0.1	540
HDTA-8	2,010	4	100	1.86	0.1	720
HDTA-10	2,010	4	100	1.49	0.1	900
HDTA-16	2,010	4	100	0.93	0.1	1440

INTELLISHARE ENVIRONMENTAL

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Date:	1/8/19
ISE Proposal No:	N-19-1718
Client Project ID:	Alto, NM
Proposal For:	Tom Golden DB Stephens

Phone:
Fax:
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Proposed Solution: Model 500 CFM Thermal Oxidizer

Intellishare Environmental specializes in the engineering and manufacturing of clean air solutions for the environmental remediation industry. We offer new, used, rental and lease programs to fit any budget or application.

Thank you for the opportunity to provide the following proposal for your project. At Intellishare Environmental, every client is important. Please contact me with any additional questions you may have regarding this information.

Kind Regards,

John Strey
Principal

500 CFM Oxidizer Process Information

▪ Maximum Air Flow Capacity:	500 SCFM
▪ Minimum Air Flow:	200 SCFM
▪ Max Gas Pre-Heater Input:	1,500,000 @ 500 CFM
▪ Minimum Thermal Operating Temperature:	1400 degrees F.
▪ Average Thermal Operating Temperature:	1400-1500 degrees F.
▪ Maximum Thermal Operating Temperature:	1600 degrees F.
▪ Minimum Catalyst Operating Temperature:	600 degrees F.
▪ Average Catalyst Operating Temperature:	650-950 degrees F.
▪ Maximum Catalyst Operating Temperature:	1100 degrees F.
▪ Estimated Destruction Efficiency:	>99%
▪ Time to Reach Operating Temperature:	15 minutes from cold start
▪ Inlet Connection:	6” 150# Flanged
▪ Foot Print:	W=7’, L=12’, H=8’
▪ Stack Height Required:	15’ AGL
▪ Weight:	4000 lbs
▪ Electrical Voltage:	480/3/60
▪ Electrical Amperage:	30

Equipment Specification

Reactor: The reactor housing will be constructed of 7 gauge rolled steel. The Inlet and outlet connections are flanged. . The exterior is painted standard ISE gray.

High Temperature Refractory: All internal reactor surfaces are completely insulated with a ceramic insulation media rated for 2200 deg F. A coating is applied to the insulation to increase the mechanical integrity and extend the life of the insulation.

Gas Pre-Heater: The unit will come equipped as standard with a direct gas fired primary air burner with combustion air blower.

Fuel Gas Piping Assembly: The fuel gas piping assembly is pre-piped. The gas train will meet all code requirements and is suitable for FM approval. All components are rated for outdoor operation and continuous use.

Main Control Panel: The main control panel shall be Nema 4 construction and shall be pre-wired to all components. The PLC based control panel features alarm detection and an hour meter to record run time. Temperature control will be provided with approved temperature control devices and limit switches. The control panel shall be UL labeled and listed as an assembly.

Flame Arrestor: A flame arrestor will be supplied and mounted to the inlet of the oxidizer and utilized to prevent flame propagation to the source. A spiral crimped aluminum element shall be removable for inspection and cleaning.

Purge/Automatic Dilution Control: A purge and dilution valve control assembly with C1, D2, GD actuator will be mounted between the VLS and MPE blower. Once the fresh air purge is complete the dilution control will be enabled. The oxidizer outlet temperature controller, included in the control cabinet, is wired to automatically modulate the electric actuator and control the dilution air valve when VOC concentrations exceed the temperature set-point.

Process Isolation Valve: A control valve assembly with C1, D2, GD actuator will be mounted between the VLS and MPE blower. Once the fresh air purge is complete the process control will be enabled. The oxidizer outlet temperature controller, included in the control cabinet, is wired to automatically modulate the electric actuator and control the process air valve when VOC concentrations exceed the temperature set-point.

Exhaust Stack: A stainless steel exhaust stack will be supplied and shall terminate at 15' above grade level (AGL). The exhaust stack will be equipped with sample ports for field testing.

Chart Recorder: A 2 pen chart recorder will be installed in the main control panel and will record and display the oxidizer inlet and outlet temperature and air flow in SCFM. The chart recorder will be paperless with removable SD card.

Daniel B. Stephens & Associates, Inc.

Calculation Cover Sheet

Project Name Bell Gas #1186 Project Number ES14.0220

Calculation Number ES11.0220-004 Discipline Engineering No. of Sheets ______

PROJECT: Bell Gas #1186 Remediation System
SITE: Bell Gas #1186 / TR'S Market, Alto, New Mexico
SUBJECT: Design a Wisconsin mound-type infiltration gallery for treated water discharge.
SOURCES OF DATA: A. Map: Remediation System Layout B. AutoCAD drawing: Infiltration Gallery Plan C. Soil Laboratory Report: Bell Gas samples, October 1, 2018
SOURCES OF FORMULAE & REFERENCES: 1. Wisconsin Mound Soil Absorption System: Siting, Design and Construction Manual, Converse and Tyler, 2000.

THOMAS A. GOLDEN
NEW MEXICO
22750
12/18/2020
PROFESSIONAL ENGINEER

☐ Preliminary Calculation ☒ Final Calculation Supersedes Calculation No. ______

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
0	Final Remediation Plan	TH	10/14/2020	JS	12/2/2020	TG	12/10/2020

Project No. ES14.0220	Date 10/14/2020
Subject Infiltration Gallery Design (Wisconsin Mound)	Sheet 1 of 4
By J. Samson/T. Hopkins Checked By	Calculation No. ES14.0220-004

1.0 OBJECTIVE

Design a Wisconsin mound-type infiltration gallery at the site, south of the current gasoline service station, to handle treated water discharged from the on-site remediation system [A].

2.0 GIVEN

Groundwater will be extracted using stinger tubes as part of a multi-phase extraction system, with a total flow rate, Q_{tot}, of up to 1,500 gallons per day (gpd). Surface soil is thin, and bedrock is found within 2 to 4 feet of ground surface. Topography slopes 10% to the southwest at the proposed location of the infiltration gallery [B].

3.0 METHOD

Subsurface lithology at the site is inadequate for an in-ground infiltration gallery, so a mound-style system will be utilized to discharge treated groundwater. Determine the dimensions of the mound system using the Wisconsin Mound Soil Absorption System Guidance [1,2]. These references provide a means for estimating system loading rates based on the soil profile, subsurface geology, and proposed fill materials. The mound system is sized based on these loading rates, and geometry is utilized together with site topography to dimension the system. The design method prescribed by the Wisconsin Mound guidance is presented below.

4.0 SOLUTION

The hydraulic linear loading rate (LLR) is the volume of effluent (gallons) applied per day per linear foot of the mound system. The applicable rate is a function of the speed and direction of effluent movement away from the absorption bed. The guidance recommends that a LLR of 3 to 4 gallons per day per linear foot (gpd/lf) be utilized for impermeable surfaces (where flow beneath the mound is primarily horizontal), while the LLR for more permeable surfaces (where flow is primarily vertical) should be limited to 8 to 10 gpd/lf [1]. Due to limited surface soil and the presence of fractured bedrock within 4 feet of the surface, a LLR of 5 gpd/lf will be utilized for design.

The basal area is a tilled or plowed area below the constructed mound, or the area enclosed by B (A + I + J) in Figure 1 below. Since the texture of the topsoil is sandy clay with soil structure between granular and platy, assume a basal loading rate (BLR) of 0.3 gpd/ft^2 based on Wisconsin mound guidance [1].

The recommended sand loading rate (SLR), applicable to the engineered fill material that will constitute the majority of the mound system, is 1.0 gpd/ft^2. This value is applicable to domestic wastewater from typical septic tank systems. Due to the nature of the proposed discharge (treated groundwater), a higher value of 1.2 gpd/ft^2 will be used for the SLR in this calculation [1].

Determine the absorption area width (A):
A = LLR / SLR
A = 5 gpd/lf / 1.2 gpd/ft^2 = 4.2 feet

Due to available space and site topography, the total flow rate will be split into three segments so that the design flow rate, Q_{design}, for each of three absorption beds will be 500 gpd.
Determine the absorption area length (B):
B = Q_{design} / LLR
B = 500 gpd/ 5 gpd/lf = 100 feet

The remainder of these calculations help determine the overall geometry of the mound. Actual dimensions of side slopes will vary slightly based on actual site topography. Determine the basal width (A+I):

A + I = LLR / BLR
A + I = 5 gpd/lf / 0.3 gpd/ft^2 = 16.7 feet

Assume a mound fill depth (D) of 3 feet.

From AutoCAD determine the average site slope is 10 percent [B].

Determine the mound fill depth down slope (E), which is a function of the existing surface topography:

E = D + s * A = 3 feet + 0.1 foot/foot * 4.2 feet = 3.4 feet

Mound fill depths are shown on Figure 2. F represents the thickness of the sand loading layer immediately surrounding the leach field lateral, G represents the amount of native cover on the sloped sides of the mound, and H is the amount of native cover on the top of the mound. The H dimension is typically greater than the G dimension to promote runoff from the top of the mound. Assume the following:

F = 0.75 foot (6 inches of aggregate below and 1 inch above the pipe, plus the pipe diameter)
G = 0.5 foot
H = 1 foot

J and I represent the upgradient and downgadient slope widths of the mound, respectively, while K represents the width of the slope on the sides of the mound. These widths are necessary to determine the overall length and width of the mound. Determine the up slope width (J). Assume that all mound side slopes (ss) are 2:1 (horizontal:vertical). Use Table 3 in the guidance to obtain a slope correction factor (SCF) of 0.77 based on existing surface topography of approximately 10 percent.[1]

J = ss(D+F+G)(SCF) = 2*(3+0.75+0.5)*0.77 = 6.5 feet.

Determine the end slope width (K):

K = ss((D+E)/2+F+H) = 2*((3 feet+3.4 feet)/2+ 0.75 feet+1 feet) = 10 feet

Determine the down slope width (I). Assume a slope correction factor (SCF) of 1.44 from Table 3 of the guidance[1]:

I = ss(E+F+G)(SCF) = 2*(3.4 feet+0.75 feet+0.5 feet)*1.44= 13 feet

Determine the overall length (L) of the system:

L = (B+2K) = (100 feet+2*10 feet) = 120 feet

The total flow was divided into three absorption beds which will be joined together. The overall length of the system will remain the same. Determine the overall width (W) of the system:

W = I+3*A+J = 13 feet + 3*4.2 feet + 6.5 feet = 32 feet

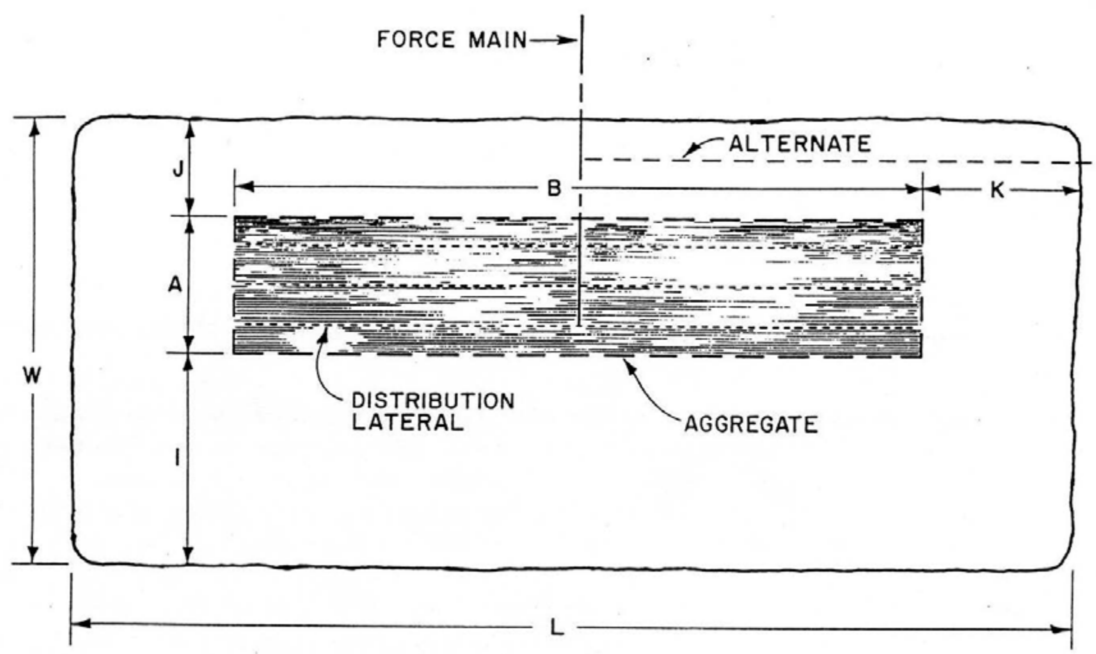


Figure 1: Wisconsin mound dimensions, plan view.

Project No. ES14.0220 Date 10/14/2020

Subject Infiltration Gallery Design (Wisconsin Mound) Sheet 4 of 4

By J. Samson/T. Hopkins Checked By Calculation No. ES14.0220-004

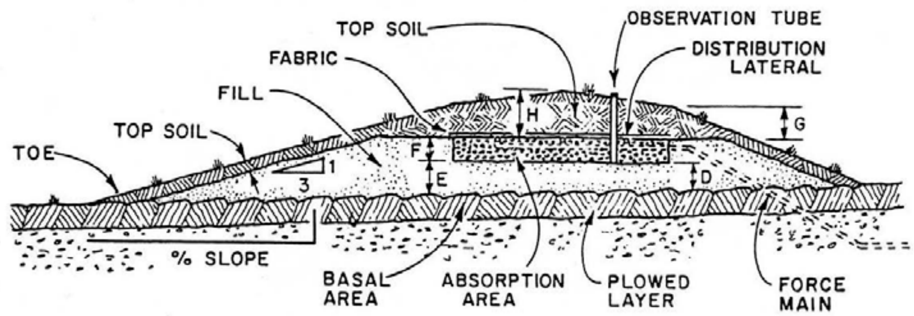


Figure 2: Wisconsin mound dimensions, section view.

Figures 1 and 2 above show the dimensions of the mound system, including the thicknesses of the engineered sand fill and top soil above the absorption area.

Wisconsin Mound Guidance

Step 1: Evaluate the quantity and quality of the wastewater generated.

1500 gpd, total flow rate expected

500 Q, Design Flow Rate (gpd) for each absorption bed

Step 2: Evaluate the soil profile for design linear loading rate and soil loading rate.

5	Linear loading rate (gpd/lf)	WM pg 16
0.3	Basal Loading rate (gpd/ft^2)	WM pg 10

Step 3: Sand Fill Loading Rate.

1.2	Sand loading rate (gpd/ft^2)	WM pg 13

Step 4: Determine absorption area width (A)

A= LLR/SLR — WM pg 16

A= 4.2 ft

Step 5: Determine absorption area length (B)

B= Q/LLR — WM pg 16

B= 100 ft

Step 6: Determine the basal width(A+I)

A+I=LLR/BLR

A+I= 16.7 ft — WM pg 17

I= 12.5 ft

Step 7: Determine the minimum mound fill depth (D)

D= 3.0 ft — WM pg 17

Step 8: Determine mound fill depth down slope (E)

slope = 0.100 — from ACAD

E=D+slope(A) — WM pg 17

E= 3.4 ft

Step 9: Determine mound fill depths (F), (G), and (H)

F=	0.75	ft	WM pg 17
G=	0.5	ft	WM pg 17
H=	1	ft	WM pg 17

Step 10: Determine the up slope width(J)

Slope Correction factor — 0.77 (Table 4 for 10% slope)

J=ss(D+F+G)(SCF) — WM pg 23

ss= 2 :1 — mound side slope

J= 6.5 ft

Step 11: Determine the end slope width (K)

K=ss((D+E)/2+F+H)				WM pg 23
ss=	2	:1		mound side slope
K=	10.0	ft		

Step 12: Determine the down slope width (I)

	Slope Correction factor		1.44	(Table 4 for 10% slope)
I=ss(E+F+G)(SCF)				WM pg 23
ss=	2	:1		mound side slope
I=	13.4	ft		

Step 13: Overall length and width (L+W)

3 absorption bed widths required for total flow

L=B+2K			WM pg 24
L=	**120**	**ft**	
W=I+A+J			WM pg 24
W=	**32**	**ft**	

Laboratory Report for

Daniel B. Stephens & Associates, Inc.

(Bell Gas #1186, ES14.0220.00)

October 1, 2018

Daniel B. Stephens & Associates, Inc.

4400 Alameda Blvd. NE, Suite C • Albuquerque, New Mexico 87113

October 1, 2018

Tom Golden
Daniel B. Stephens & Associates, Inc.
6020 Academy Road NE
Albuquerque, New Mexico 87109
(505) 822-9400

Re: DBS&A Laboratory Report for the Daniel B. Stephens & Associates, Inc. Bell Gas #1186, ES14.0220.00 Project

Dear Mr. Golden:

Enclosed is the report for Daniel B. Stephens & Associates, Inc. Bell Gas #1186, ES14.0220.00 project samples. Please review this report and provide any comments as samples will be held for a maximum of 30 days. After 30 days samples will be returned or disposed of in an appropriate manner.

All testing results were evaluated subjectively for consistency and reasonableness, and the results appear to be reasonably representative of the material tested. However, DBS&A does not assume any responsibility for interpretations or analyses based on the data enclosed, nor can we guarantee that these data are fully representative of the undisturbed materials at the field site. We recommend that careful evaluation of these laboratory results be made for your particular application.

The testing utilized to generate the enclosed report employs methods that are standard for the industry. The results do not constitute a professional opinion by DBS&A, nor can the results affect any professional or expert opinions rendered with respect thereto by DBS&A. You have acknowledged that all the testing undertaken by us, and the report provided, constitutes mere test results using standardized methods, and cannot be used to disqualify DBS&A from rendering any professional or expert opinion, having waived any claim of conflict of interest by DBS&A.

We are pleased to provide this service to DBS&A and look forward to future laboratory testing on other projects. If you have any questions about the enclosed data, please do not hesitate to call.

Sincerely,

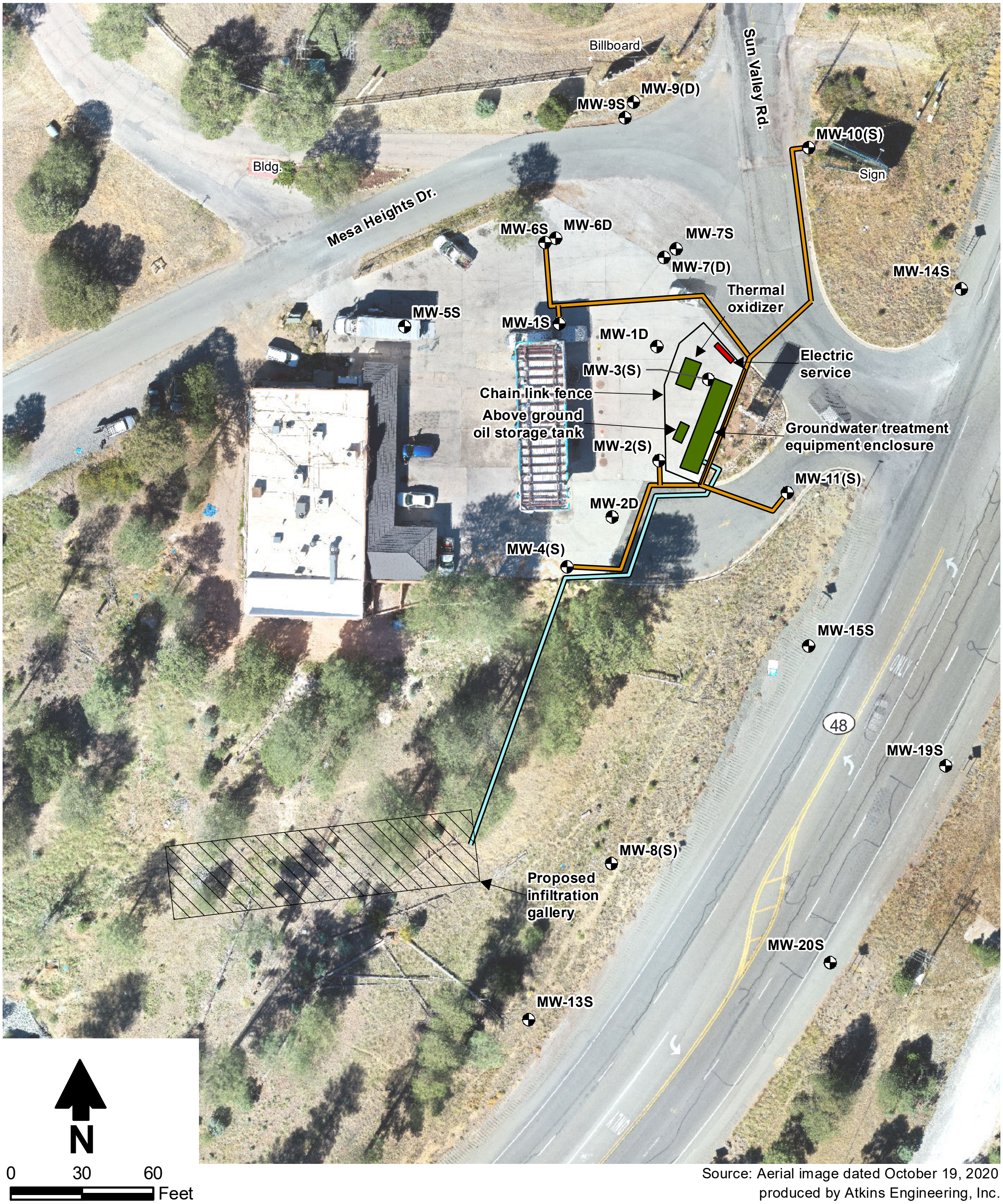
DANIEL B. STEPHENS & ASSOCIATES, INC.
SOIL TESTING & RESEARCH LABORATORY

Joleen Hines
Laboratory Manager

Enclosure

Daniel B. Stephens & Associates, Inc.
Soil Testing & Research Laboratory
4400 Alameda Blvd. NE, Suite C
Albuquerque, NM 87113
505-889-7752
FAX 505-889-0258

Summaries



Source: Aerial image dated October 19, 2020 produced by Atkins Engineering, Inc.

Explanation

- Monitor well
- Conveyance line
- Treated water discharge

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BELL GAS #1186
ALTO, NEW MEXICO
Remediation System Layout

Daniel B. Stephens & Associates, Inc.
12/10/2020
JN ES14.0220.00

Figure 9

10' 0' 5' 10'
SCALE: 1" = 10'

REV. NO.	DATE	DESCRIPTION	APPROVED BY

DATE OF ISSUE: 12/10/2020
DESIGNED BY: TG, TH
DRAWN BY: CK, JA
CHECKED BY: JS
APPROVED BY: TG

DBS&A
Daniel B. Stephens & Associates, Inc.

101 S□N VALLEY RD
ALTO, NM 88312

RESPONSIBLE PARTY REMEDIATION
BELL GAS #1186 □TR'S MARKET
ALTO, NM

INFILTRATION GALLERY PLAN

SHEET 5 OF 11
DWG □O. C-2
JOB □O. ES14.0220

S:\PROJECTS\ES14.0220_BELL_GAS_1186\CAD\PRODUCTION\C-4 INFILTRATION GALLERY PLAN - BELL GAS.DWG December 9, 2020 - 2:14 PM BY: ARELLANO, JEFFREY

Summary of Particle Size Characteristics

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c	Method	ASTM Classification	USDA Classification	
1	2.4E-81	0.050	0.090	3.8E+79	6.7E+77	WS/H	Sandy lean clay s(CL)	Loam	(Est)

d_{50} = Median particle diameter

Est = Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{60})}$$

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

#15.24

WISCONSIN MOUND SOIL ABSORPTION SYSTEM:

SITING, DESIGN AND CONSTRUCTION MANUAL

BY

James C. Converse and E.Jerry Tyler[1]

January , 2000[2]

The Wisconsin mound wastewater soil treatment system was developed in the 1970s to overcome some limitations of in-ground trench and bed units and the Nodak system (Witz, 1974). The objective of the mound, as with other soil-based units, is to treat and disperse domestic and commercial wastewater on-site via subsurface in an environmentally acceptable manner and to protect the public health.

The Wisconsin mound has been widely accepted and incorporated in many state and local regulations. In 1980 it was incorporated into the Wisconsin Administrative code. Mound technology was successfully implemented in Wisconsin partially because of an extensive educational program offered during the introduction of the mound concept. For the mounds to continue as a viable "tool" in treating and dispersing on-site wastewater, the soil evaluator, designer, installer, regulator and manager must understand the principles of operation, design, installation and management of the system.

Mounds in some areas have not been as successful as in Wisconsin, primarily because of the lack of trained professionals and/or unproven design modifications. Education of all parties involved is essential and care must be taken when making modifications.

Figure 1 shows the components of a Wisconsin mound system. It consists of a septic tank, a dosing chamber and the mound. The septic tank removes solids by settling and floatation with some of the solids transformed into soluble material which pass to the dosing chamber. The

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[1] James C. Converse, Professor, Biological Systems Engineering and E.Jerry Tyler, Professor, Soil Science Department, University of Wisconsin-Madison. Member and Director, respectively, of Small Scale Waste Management Project. Research supported by the College of Agricultural and Life Sciences.

[2] This is an updated version of the 1990 mound manual with the same name. It should be used in place of earlier versions.

Note: Names of products and equipment mentioned in this publication are for illustrative purposes and do not constitute and endorsement, explicitly or implicitly.

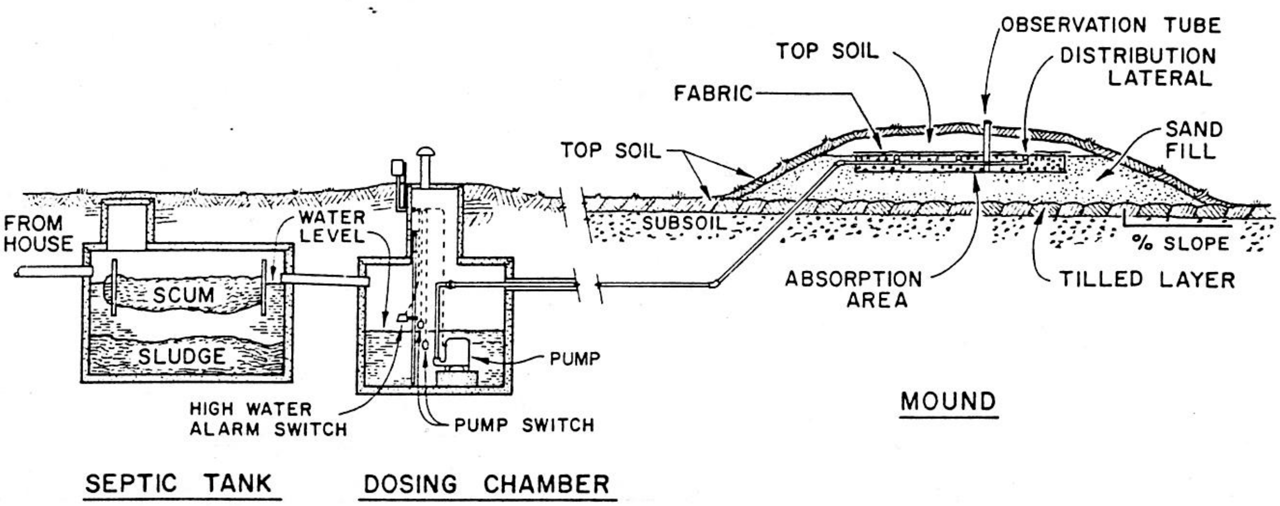


Fig. 1. Schematic of the Wisconsin mound system showing septic tank, dosing and mound.

dosing chamber contains a pump or siphon, which transfers effluent, under pressure, to a distribution network of small diameter pipes with small perforations which distributes the effluent uniformly over the absorption area of the mound. The effluent infiltrates into and percolates through the mound sand and native soil, the pathogens are removed, the organic matter is assimilated, nitrogen is transformed to nitrate and phosphorus is retained in the native soil and may slowly migrate depending on the soil properties..

Originally, the Wisconsin mound was designed for specific soil and site limitations for wastewater flows of less than 750 gpd (Converse et al., 1975 a, b, c; Converse, 1978). Based on further research and evaluation, the mound technology was expanded to larger systems and more difficult soil and site conditions (Converse and Tyler, 1986a and b; Tyler and Converse, 1985; and Converse and Tyler, 1987). The new criteria were incorporated into a siting, design and construction manual (Converse and Tyler, 1990). Many changes have taken place in on-site technology recently especially in sand filter technology. Since the mound is a combination of a single pass sand filter and dispersal unit, many of the sand filter research findings should be implemented into mound technology. **Thus, the purpose of this publication is to incorporate new findings into the siting, design and construction of mounds receiving septic tank effluent.**

WASTEWATER SOURCE

The wastewater quality and quantity is extremely important to ascertain before designing a soil based on-site wastewater treatment system. The design and performance of the mound system, as well as other soil based treatment systems, is based on typical domestic waste water which has been pretreated by passing the waste water through a septic tank. Typical domestic effluent will have a biochemical oxygen demand (BOD) in the range of 150 - 250 mg/L and total suspended solids (TSS) in range of 50 - 100 mg/L. Fats oils and greases (FOG) are typically below 15 mg/L. These numbers will vary somewhat depending on household activity, water conservation activities and the biological activity in the septic tank.

The mound is suitable for final treatment and dispersal of highly pretreated effluent from such units as aerobic units, sand filters, peat filters and biofilters which typically produce effluent with BOD and TSS less than 25 mg/L. For this quality of waste water, the sand loading rate can be increased over that used for septic tank effluent and the separation distance can be reduced depending on code requirements. Current thinking is to double the loading rate and reduce the separation distance by 12" (Wisc. Adm. Code, 2000).

High strength wastewastes, such as from restaurants, must either 1) be pretreated to similar BOD, TSS and FOG strengths of septic tank effluent from domestic wastewater before it is applied to the mound or 2) the loading rate to the sand must be reduced significantly so that the organic loading rate to the mound is at or less than that from domestic wastewaster. Extreme care must be exercised when working with non- domestic wastewater.

The design loading rates are based on 150 gpd/bedroom resulting in 450 gpd for a 3 bedroom home. If the mound, as well as other soil based units, is loaded at 450 gpd on a regular basis, it will likely fail. The daily average flow is expected to be no more than about 60% of design or 270 gpd. If water meter readings are used in the design process, the design flow rate must be adjusted upward by at least the same percentage or typically 1.5 - 2 times the meter reading.

The focus of this publication is on domestic septic tank effluent. Adjustments can be made to the design for the highly pretreated effluent and high strength wastes as previously stated.

PRETREATMENT

The septic tank serves as a pretreatment unit for all soil absorption units, including the mound, and its primary function is to remove solids via settling and floatation. New technologies can be incorporated into the septic tank with the most common being effluent filters and pump vaults. Converse (1999) provides information relative to effluent filters and other components related to septic tanks. The dosing chamber/vault is also an essential component to the mound system. It provides a home for the pump and controls, stores effluent and can provide extra storage during down time. With new technology, pump vaults can be incorporated within a septic tank, thus eliminating a tank. The following are several options available for consideration (Converse, 1999):

1. A single compartment septic tank with an effluent filter followed by a single compartment pump chamber.

2. A double compartment tank with the first compartment containing an effluent filter serving as the septic tank and the second compartment serving as the pump chamber.

3. A double compartment tank with both compartments serving as a septic tank with an effluent filter at the outlet of second compartment, followed by single compartment pump chamber. This may be the desired alternative as a modified aerobic unit, such as a Nibbler Jr. (NCS, 1998) or similar product, could be placed in the second compartment to reduce the organic load to the mound if the mound should ever develop a clogging mat, pond and breakout. The conversion would cause minimal disturbance as a tank is already available. Converse et al., (1998) discuss renovation of clogged soil absorption units utilizing aeration.

4. A single compartment tank with a pump vault within the septic tank. The effluent filter is incorporated into the pump vault that suspends from the outlet of the septic tank. An alternative is a double compartment septic tank with a hole in the center of the middle wall to connect the two compartments together in the clear zone and the pump vault in the second compartment. This unit will not provide extra storage capacity as will the individual tank.

Recent research on single pass sand filters shows that short frequent doses to the sand filter with closely spaced orifices (4 - 6 ft^2/orifice) improves effluent quality (Darby et al., 1996). Short frequent doses requires time dosing instead of demand dosing. Most mounds are demand dosed with larger areas/orifice of 15 to 20 ft^2/orifice. This results in a large quantity of effluent discharged at once and applied less uniformly on the infiltrative surface than for sand filters. This large quantity of effluent moves through the sand rapidly (assuming no ponded condition), allowing insufficient time for the biota to cleanse the effluent totally. This forces fecal coliforms and pathogens further into the soil profile. Short frequent doses and more closely spaced orifices allows the effluent to be retained in the sand/soil for longer periods. Converse et al. (1994) suggested that the reason for some fecal coliforms found deep in the soil profile beneath mounds was due to large infrequent doses. **Designers should use smaller doses and more closely spaced orifices. They should consider time dosing in distributing the effluent to the mound.** Timed dosing requires that surge capacity be incorporated into the septic tank and/or pump chamber to store the peak flows until it is dosed into the mound and requires control panels which have become very user friendly. Converse (1999) discusses the various options including pump vaults, effluent filters and time/demand dosing. Pressure distribution and dose volumes are discussed in detail by Converse (2000).

SITING CRITERIA

A designer of on-site wastewater treatment and dispersal systems must have a basic understanding of wastewater movement into and through the soil. The designer should work closely with the site evaluator to make sure he/she understand how effluent will move into the soil and away from the system. This understanding is based on information collected during the site evaluation.

Figure 2 shows a schematic of effluent movement within and away from mound systems under various soil profiles. Depending on the type of profile, the effluent moves away from the unit vertically, horizontally or a combination of both. These concepts are true for all on-site systems.

The siting and design concepts presented here and elsewhere results in soil treatment/dispersal units that are long and narrow (Converse et al., 1989; Tyler et.al., 1986). The more restrictive the soil profile, the narrower and longer the soil treatment/dispersal unit will be. If these concepts are not followed, then the system may not perform as expected. **The sizing and configuration of all soil absorption units , including the mound, is based on how the effluent moves away from the unit and the rate at which it moves away. Not all of these concepts will apply to all soil and site conditions as soil treatment/dispersal units are not compatible to all sites and should not be used on such sites.**

Separation distances:

Codes, regulating on-site systems, require a depth of soil or soil and sand fill to treat effluent before it reaches a limiting condition such as bedrock or high water table or other restrictive layers. Figure 3 shows the relationship between the type of system best suited for the site and the location of the limiting condition beneath the ground surface where 3 ft of separation is required. This figure can be used for other separation distances which may vary from 1-4 ft depending on the code requirement.

For the mound unit, this separation distance consists of the distance from the ground surface to the limiting condition below the ground surface plus the depth of sand between the ground surface and the infiltrative surface within the mound (sand/aggregate interface or the exposed surface of chamber units. For example, if the code requires 3 ft of suitable soil and the limiting condition is 20" beneath the ground surface, the sand fill depth between the ground surface and the infiltrative surface is 16" for mounds receiving septic tank effluent.

Distance to Water Table:

A distinction should be made between permanent water table and seasonal saturation. Seasonal saturation is the depth at which the soil is saturated for a period of time (days to weeks) primarily during the spring months. This may occur at other times during wet periods and at other locations. Permanent water table relates to a water table that is present all the time. The level

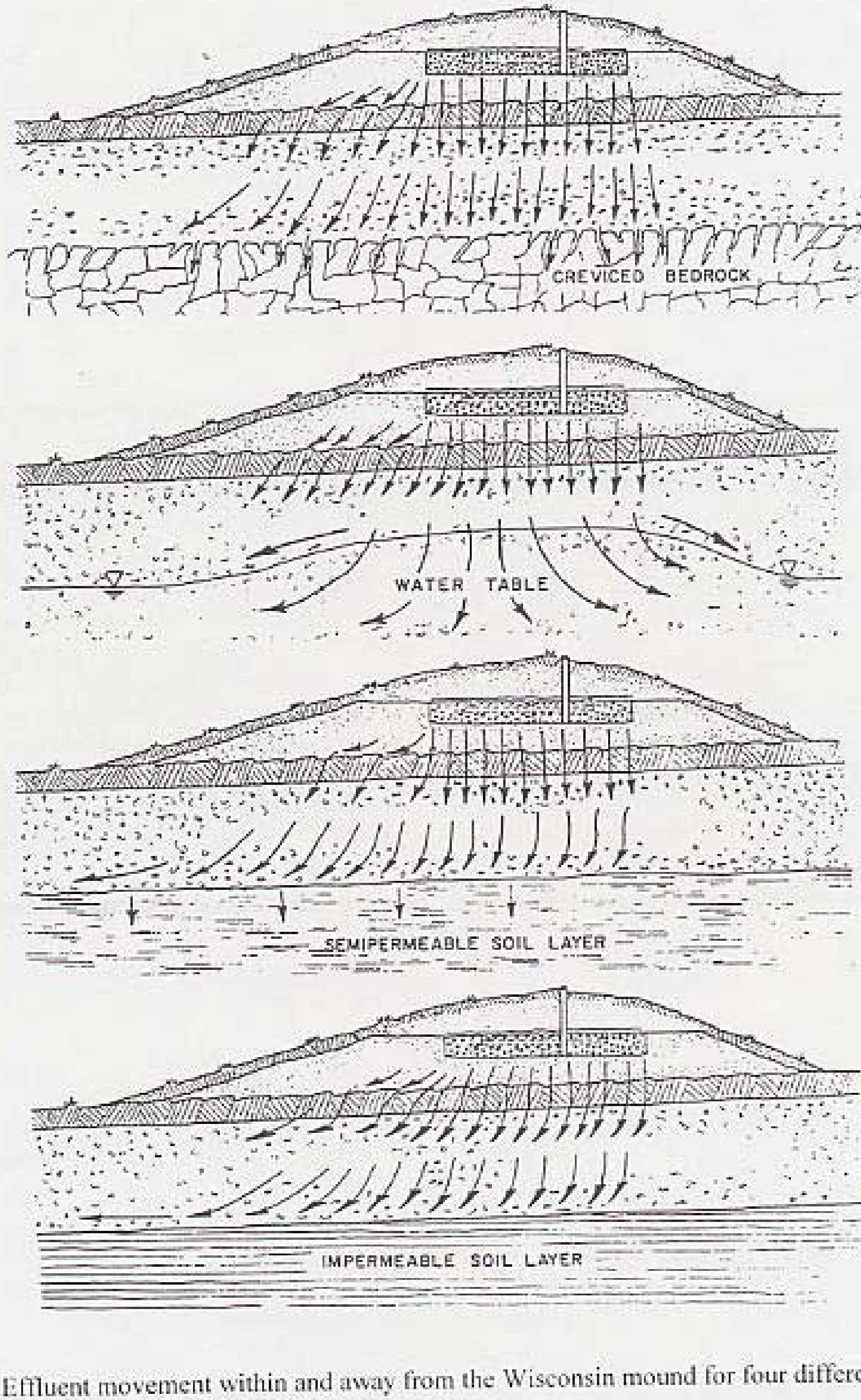


Fig. 2. Effluent movement within and away from the Wisconsin mound for four different types of soil profiles.

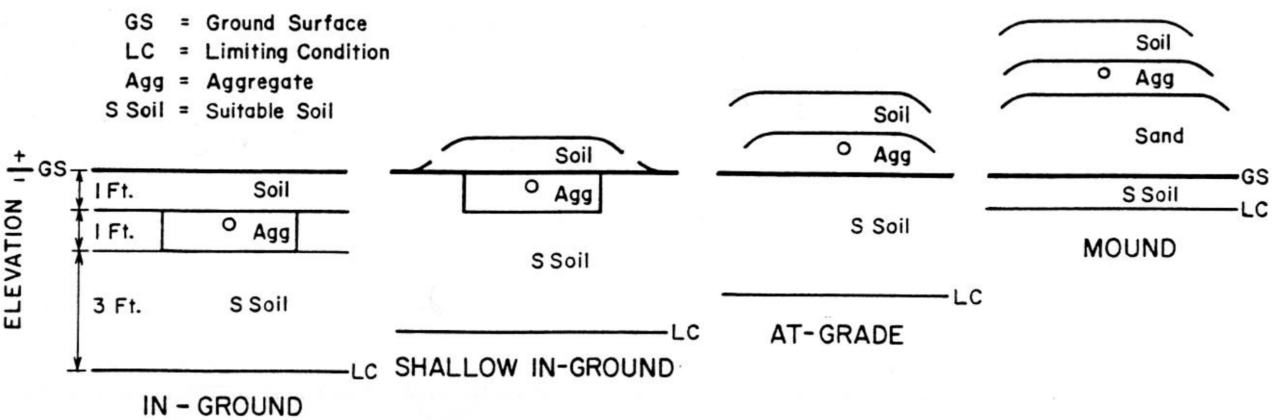


Fig. 3. Cross section of four soil absorption units in relation to ground surface and limiting conditions.

may vary depending on precipitation and other factors. All research relating to mounds has been done on seasonally saturated sites. This is important to understand as mounds may perform differently when placed on sites with permanent water table than on sites with shallow seasonal saturation. For example, stress at the toe will be more continuous with a shallow permanent high water table than with seasonal saturation.

Seasonal saturation is determined by 1) redoxmorphoric features (soil color, greys and reds, previously known as mottles) or 2) direct observation via a soil boring or observation wells. Landscape features and native vegetation type also give an indication of soil moisture conditions. If the redoxmorphoric features extend into the top soil, it is difficult to estimate the distance of seasonal saturation beneath the ground surface as it is impossible to detect redoxmorphoric features because of the predominate blackish color in the top soil. In these situations direct observation is the best method but the window of opportunity is very limited.

During seasonal saturation the mound is under stress and there is the possibility of toe leakage. Leakage will be a function of the saturation depth, soil permeability, soil loading rate and linear loading rate. In Wisconsin, very few mounds have had toe leakage because mounds are long and narrow on sites with a high potential for toe leakage. The recommended depth to seasonal saturation is 10 in. beneath the ground surface (Table 1). It is extremely important to note that as the depth to seasonal saturation decreases (< 10 in.), the chance of toe leakage during seasonal saturation increases greatly. To minimize toe leakage under these conditions, the linear loading rate (to be discussed later) must be decreased resulting in longer mounds. The mound will also be taller to compensate for the reduced soil separation distance.

Table 1. Recommended soil and site criteria for the Wisconsin mound system.

Parameter	
Depth to high water table	10 in.
Depth to crevice bedrock	24 in.[a]
Depth to non-crevice bedrock	10 in.
Permeability of top horizon	0.3 gpd/ft^2
Site Slope	Note[b]
Filled site	Yes[c]
Over old system	Yes[d]
Flood Plain	No

[a] Depth recommended if the crevices are open. If the crevices are filled with soil, may consider reducing depth to 18".
[b] Note: Slope is not a factor in the performance of mound. Slope may be limited due to safe construction techniques.
[c] Suitable according to soil criteria (texture, structure, consistence).
[d] The area and back fill must be treated as fill as it is a disturbed site.

Depth to Bedrock:

Bedrock should be classified as crevice, non-crevice semi-permeable or non-crevice impermeable. Bedrock has been defined where at least 50% of the material by volume is rock (Wisc. Adm. Code, 1983). Once the effluent reaches the bedrock, treatment may or may not take place depending on the bedrock characteristics. In crevice bedrock where the crevices are filled with soil the flow is concentrated in the crevices which may reduce treatment effectiveness but it will be more effective than bedrock with open crevices. Therefore, some credit should be given to filled crevices (see footnote a in Table 1).

Soil Permeability:

Table 2 gives the recommended soil loading rate based on soil texture and structure for the mound basal area. This table assumes that the soil consistence is loose, friable or firm and not very firm. In very firm conditions, water movement is very slow and the site is not recommended for mound placement. Since the basal area receives effluent low in BOD and TSS, the loading rate can be increased compared to soils receiving septic tank effluent. In the past effluent quality has not been taken into consideration when sizing the basal area and the soil loading rates have been the same as for septic tank effluent. This change will reduce the basal area required but will be more in line with loading rates of highly preteated effluent. In most cases the mound footprint will not change because of the recommended 3:1 side slopes. The 3:1 slope was selected for mowing safety.

Slopes:

Site slopes are not a limitation for on-site soil units. Slope limitations are primarily for construction safety concern. Systems on steep slopes with slowly permeable soils should be long and narrow to reduce the possibility of toe leakage. A 25% limit is recommended which is based on construction concerns (Table 1) and not soil and hydraulic properties.

Filled areas:

Fill is defined as the soil placed to raise the elevation of the site. Textures range from sand to clay or a mixture of textures. Structure is often massive (structureless) or platy. Under these circumstances the permeability of the soil is reduced and variable. A more intensive soil evaluation must be done because of the increased variability encountered in filled sites over naturally occurring sites. Many more observations are generally needed for filled sites compared to non-filled sites and the site evaluator must be knowledgeable of the ramifications of fill.

Flood Plains:

It is not recommended to install any soil absorption system in a flood plain, drainage ways or depressions unless flood protection is provided.

Horizontal Separation Distances:

The same separation distances used for other soil based dispersal units should be used for the mound unit. On sloping sites the up slope and end distances should be measured from the up slope edge or ends of the aggregate to the respective features and the down slope distance should be measured from the down slope toe of the mound to the respective features. As with all soil based dispersal units on sloping sites where the flow away from the unit is primarily horizontal, a greater down slope horizontal separation distance may be appropriate to avoid weeping into a ditch or basement that may be located down slope.

Sites with Trees and Large Boulders:

Generally, sites with large trees, numerous smaller trees or large boulders are less desirable for mound systems because of the difficulty in preparing the site. If a more desirable site is not available, the trees must be cut at ground level leaving the stumps in place. Boulders should not be removed. If the tree stumps and/or boulders occupy a significant amount of the surface area, (in most cases they do not) the size of the mound basal area should be increased to provide sufficient soil to accept the effluent. The site evaluator should provide location and size information about trees and boulders.

Table 2. Design basal loading rates for mound systems for soil horizons

with loose, very friable, friable and firm consistence. These values assume wastewater has been highly pretreated with BOD and TSS < 25 mg/L and based on 150 gpd/bedroom.

	Structure					
	0		pl		bk, pr or gr	
Texture	sg	m	1	2 & 3	1	2 & 3
	gpd/ft^2					
cos	1.6	-	-	-	-	-
s	1.2	-	-	-	-	-
fs	0.9	-	-	-	-	-
vfs	0.6	-	-	-	-	-
lcos	1.4	-	-	-	-	-
ls	1.0	-	-	-	-	-
lfs	0.9	-	-	-	-	-
lvfs	0.6	-	-	-	-	-
cosl	-	0.6	0.5	0.0	0.7	1.0
sl	-	0.5	0.4	0.0	0.6	0.9
fsl	-	0.5	0.4	0.0	0.6	0.8
vfsl	-	0.4	0.3	0.0	0.6	0.8
l	-	0.5	0.5	0.0	0.6	0.8
sil	-	0.2	0.3	0.0	0.3	0.8
si	-	0.0	0.0	0.0	0.3	0.6
scl	-	0.0	0.0	0.0	0.3	0.6
cl	-	0.0	0.0	0.0	0.3	0.6
sicl	-	0.0	0.0	0.0	0.3	0.6
sc	-	0.0	0.0	0.0	0.0	0.3
sic	-	0.0	0.0	0.0	0.0	0.3
c	-	0.0	0.0	0.0	0.0	0.3

As with all soil based treatment/dispersal units, a mound system must be sized and configured to match the soil and site conditions and the volume and quality of wastewater applied to it. It is imperative that the designer have sufficient information about the quality and quantity of effluent, soil and site features and understands the mound operating principles and movement of effluent away from the system. The designer, in cooperation with the soil scientist or site evaluator, must accurately estimate the design basal loading rate (Table 2), determine the direction of flow away from the system (Fig. 2) and estimate the linear loading rate, before the mound can be designed.

The design consists of estimating the 1) sand media loading rate, 2) basal (soil) loading rate and 3) linear loading rate for the site. Once these three design rates are determined, the mound can be sized for the site. Fig. 4 shows a cross section and plan view of the mound on a sloping site and shows dimensions that must be determined.

Sand Media Loading Rate:

The design sand loading rate for the absorption area (aggregate/sand interface or chamber bottom/sand interface) is dependent upon the quality of the effluent applied and the type and quality of the fill material. This design assumes that the effluent quality is septic tank effluent from domestic waste water. If high strength wastes from commercial establishments is the source, such as from restaurants, the loading rates must be adjusted based on wastewater strength with comparable organic loading rates (BOD, TSS, FOG) (Siegrist et al., 1985) resulting in lower loading rates or the wastewater pretreated equal to or less than typical domestic septic tank effluent quality. If highly pretreated effluent (BOD and TSS < 25 mg/L and very low FOG) is used, the loading rate of 2.0 gpd/ft^2 is reasonable. Separation distances may be reduced depending upon the fecal coliform count of the effluent (Converse and Tyler, 1998).

The purpose of the sand fill, along with the native soil, is to treat the effluent to an acceptable level. A very coarse sand will not provide adequate treatment and it may not be practical to use a median to fine sand because of the very low loading rate required to minimize clogging. Thus, the sand must be selected that provides satisfactory treatment and allows for a reasonable loading rate.

During the initial development of the mound, medium sand (USDA classification) was considered suitable for mound fill but it was soon shown that premature clogging resulted for sand fill that was on the fine side of medium. Bank run sand, which was classified as medium sand, was also found unsuitable, in most cases, as it was usually poorly sorted (high uniformity coefficient) and contained a lot of fines. Currently**, the recommendation is to use a coarse sand with a minimum amount of fines (< 5%)** which appears to give acceptable treatment at an acceptable loading rate and reasonable cost. Standard classifications, such as USDA, are not suitable as they are very broad. For example, a sand classified as coarse sand may or may not be

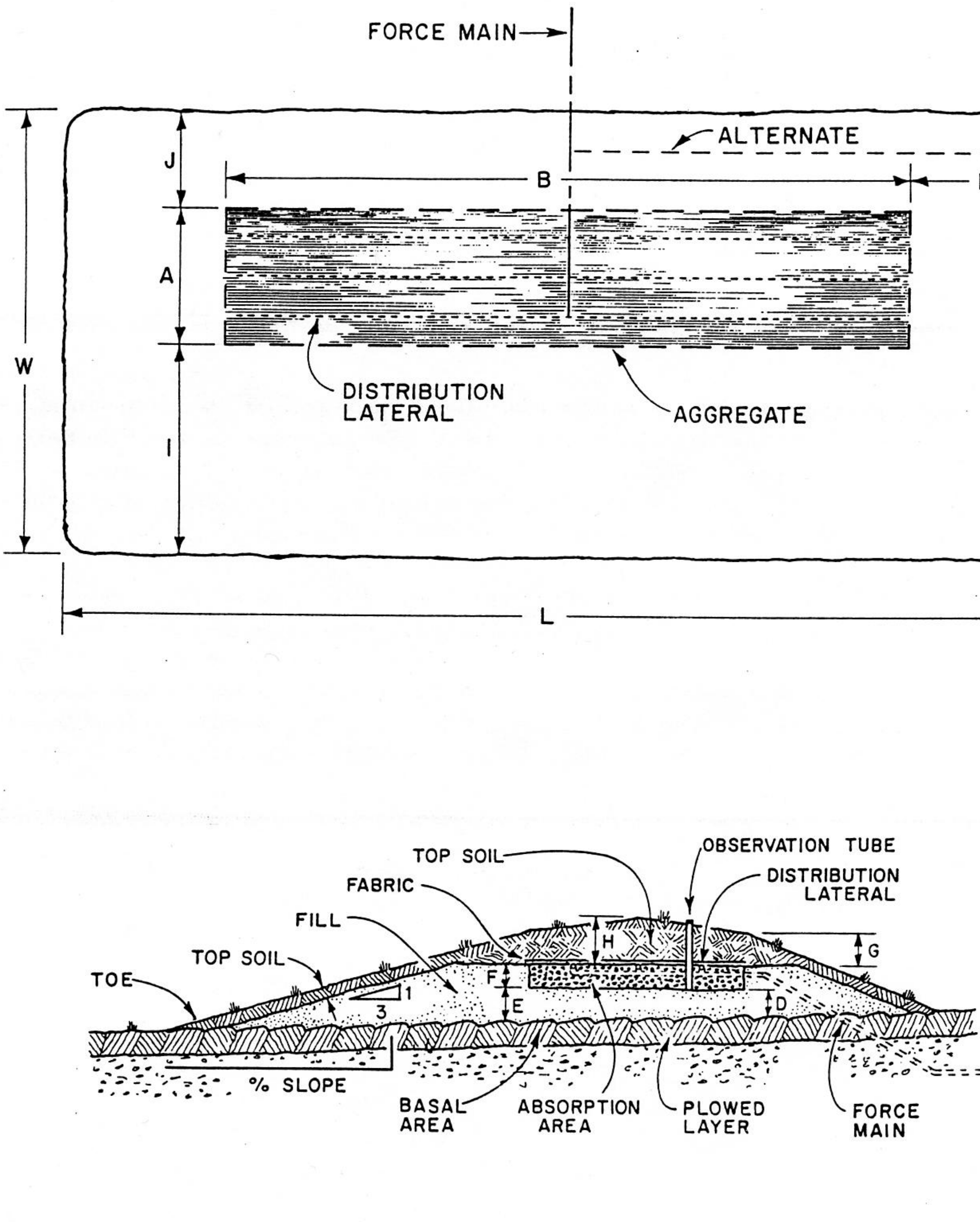


Fig. 4. Cross section and plan view of a mound system on a sloping site.

acceptable while a sand classified as medium sand may be as it depends upon a combination of various sand fractions.

Figure 5 can be used as a guide for selecting a suitable mound sand fill. Based on a sieve analysis of the total sample, the sand fill specification should fit between the ranges given in Fig. 5. In addition, the sand fill must not have more than 20% (by wt) material that is greater than 2 mm in diameter (coarse fragments) which includes stone, cobbles and gravel. Also, there must not be more than 5% silt and clay (<0.53 mm, 270 mesh sieve) in the fill. **Less would be better.** C-33 specification (ASTM, 1984) for fine aggregate does fit within this guideline but the coarser (>2 mm) and finer (<0.053 mm) fractions must be evaluated to make sure they meet the limits. A sand with an effective diameter (D_{10}) of 0.15 - 0.30 mm and uniformity coefficient (D_{60}/D_{10}) between 4 and 6 fit within these guidelines provided the coarser (>2 mm) and finer (0.053 mm) fractions meet the guideline. **Although these guidelines give a range, it is best to stay on the coarse side (left curve with effective diameter close to 0.30 mm and uniformity coefficient of 4.0) than to be on the fine side (near the right curve).** The single pass sand filter recommends a coarser sand with less fine material with effective diameter of 0.30 mm and uniformity coefficient of <4.0 and 0-2% passing the 100 mesh sieve and 0-1% passing the 200 mesh sieve (Orenco, 1998). Since the mound is a sand filter, the material recommended for sand filters would be suitable. The recommended sand filter loading rate is slightly higher than for mounds. The sand filter utilizes timed dosing with small frequent doses and less area/orifice, which enhances treatment quality, instead of demand dosing with large infrequent dosing.

The recommended design loading rate for a sand fill that meets the mound sand fill specification (Fig. 5) is 1.0 gpd/ft^2 for typical domestic septic tank effluent. Some designers may feel more comfortable using a design loading rate of 0.8 gpd/ft^2 . Experience has shown that a clogging mat may form at this interface and lead to back up or breakout of septic tank effluent requiring corrective action. Based on many years of experience, some mounds have failed via clogging. Initial design called for a loading rates of 1.2 gpd/ft^2. Reducing the sand loading rate does not substantially increase construction costs.

The 1.0 gpd/ft^2 loading rate assumes that there is a safety factor. It assumes, for design purposes, that a home generates 75 gpcd with two people per bedroom or 150 gallons per bedroom per day with the actual flow in the range of 50 to 60% of design. Converse and Tyler (1987) found, based on water meter readings in the home, that the waste water generated averaged 47% of design with a range of 29 to 82%. However, some designers like to use the flow generated based on water meter readings or use the number of people per house times the estimated average of 50 gpd/c for design purposes. **If this approach is used, then a factor of safety of 1.5 to 2 must be incorporated or the design loading rate in gpd/ft^2 reduced accordingly.** Similar procedures should be followed for commercial establishments including lower loading rates due to the higher strengths effluents as discussed previously.

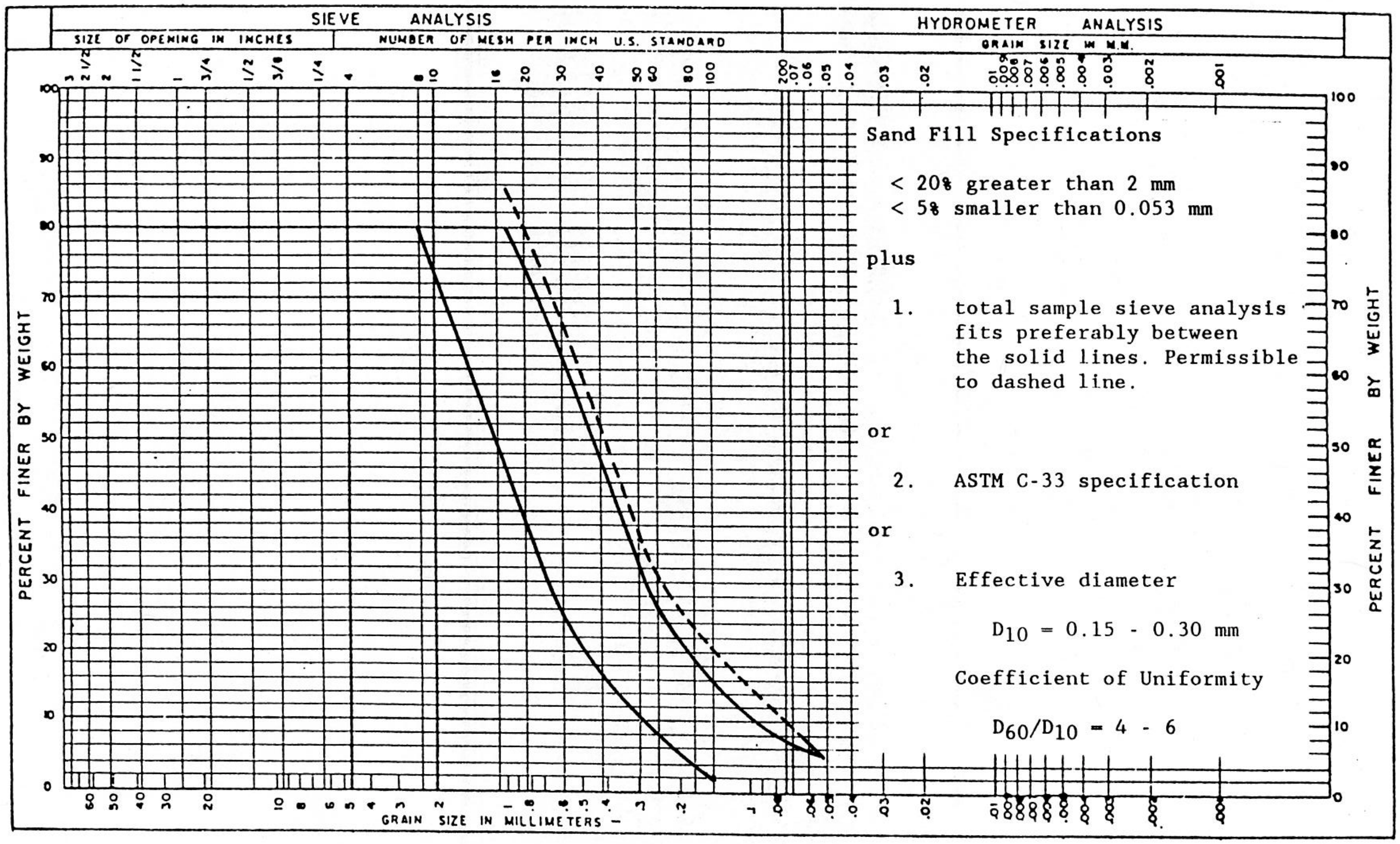


Figure 5. A guideline for the selection of the sand fill for Wisconsin Mounds. The total sample sieve analysis contains 20% or less material larger than 2.0 mm and contains 5% or less material finer than 0.053 mm plus one of the three additional specifications listed in figure. The fraction greater than 2 mm can have stones and cobbles.

Basal Loading Rate:

The basal area (sand/soil interface in Fig. 4) is the area enclosed by B(A+I) for sloping sites and B(A+I+J) for level sites where J = I for level sites. In the past basal loading rates assumed a clogging mat would form. Experience has shown that the clogging mat will not form at this interface because most of the organic matter (BOD and TSS) have been removed as it passes through the sand. Thus, the basal loading rate (gpd/ft^2) be higher than for septic tank effluent. Table 2 provides basal loading rates for septic tank effluent after having passed through the mound sand. These values assigned to the basal loading rate (BOD and TSS < 30 mg/L) should be used with some caution because there is limited experience. Also, the basal dimension (I) calculated by these numbers is usually less than the value calculated for the side slope (3:1) except in very slowly permeable soils.

Hydraulic Linear Loading Rate:

The hydraulic linear loading rate is the volume of effluent (gallons) applied per day per linear foot of the system along the natural contour (gpd/ft). The design hydraulic linear loading rate is a function of effluent movement rate away from the system and the direction of movement away from the system (horizontal, vertical or combination, Fig. 2). If the movement is primarily vertical (Fig. 2a), then the hydraulic linear loading rate is not critical. If the movement is primarily horizontal (Fig. 2d), the hydraulic linear loading rate is extremely important. Figure 6 illustrates the effect of hydraulic linear loading rate on the configuration selected. Other factors such as gas transfer beneath the absorption area suggest that the absorption area width be relatively narrow regardless of the hydraulic linear loading rate (Tyler et al., 1986).

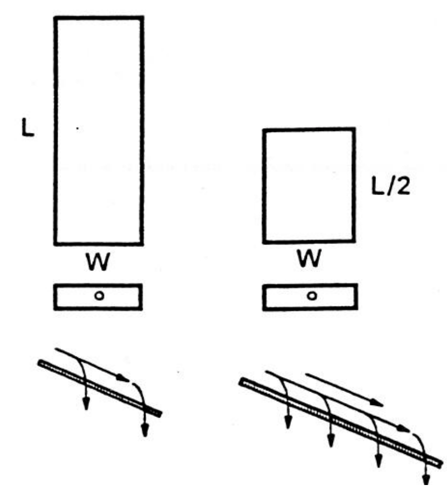


Fig. 6. The effect of linear loading rate based on system configuration on a sloping site. The sand or soil loading rates (gpd/ft^2) are the same but the linear loading rate for the right figure is twice that of the left figure. The soil may not be able to move the effluent away from the system fast enough resulting in back up and breakout at the mound toe. This is more critical as mounds are

placed on more difficult sites (shallow seasonal saturation and slowly permeable soils).
It is somewhat difficult to estimate the hydraulic linear loading rate for a variety of soil and flow conditions but based on the authors' experience "good estimates" can be given. If the flow is primarily vertical (Fig. 2a), then the hydraulic linear loading rate can be high but the gaseous linear loading rate (oxygen transfer to meet the oxygen demand) should be limited to 8-10 gpd/ft of typical domestic septic tank effluent. The slower the gas transport or the higher the wastewater BOD, the narrow the absorption area needed in order to meet the oxygen demand beneath the absorption area. If the flow is primarily horizontal, because of a shallow restrictive layer or limiting condition such as seasonal saturation or bedrock (Fig. 2d), then the linear loading rate should be in the range of 3-4 gpd/ft, resulting in long and narrow systems. Converse (1998) gives a more detailed explanation and provides two examples of estimating linear loading rate.

Sizing the Mound:

Figure 4 shows the cross section and plan view of the mound for sloping site. The dimensions are based on the site conditions and loading rates which are site specific. Prior to designing, the designer needs to determine the following loading rates:

Design Flow Rate - gpd
Sand loading rate - gpd/ft^2
Basal loading rate - gpd/ft^2
Hydraulic linear loading rate - gpd/ft

Absorption Area Width (A): The width of the absorption area is a function of the hydraulic linear loading rate and the design sand loading rate.

A = (Hydraulic Linear Loading Rate / Sand Loading Rate) = (gpd/ft)/ (gpd/ft^2) = ft

Note: If the designer doesn't feel comfortable with using linear loading rate, he/she can select a width. It is recommended that width be less than 10 ft which may be to wide for some sites. Selecting a width, in essence, is selecting a linear loading rate. If the sand loading rate is 1.0 gpd/ft^2 then the linear loading rate and width values are the same.

Absorption Area Length (B): The length of the absorption area, along the natural surface contour, is a function of the design flow rate (gpd) and the linear loading rate (gpd/lf).

B= (Design Flow Rate / Hydraulic Linear Loading Rate) = (gpd)/ (gpd/ft) = ft

Basal Length (B) and Width (I, A and J): The basal length is (B) and the basal width for sloping sites is (I + A) and for level sites it is (I + A +J). The width is based on the linear loading rate and the basal loading rate for highly pretreated effluent (Table 2).

For sloping sites:

I +A = (Hydraulic Linear Loading Rate / Basal Loading Rate) = (gpd/ft)/(gpd/ft^2) = ft

For level sites:

I+A+J = (Hydraulic Linear Loading Rate / Basal Loading Rate) = (gpd/ft)/(gpd/ft^2) = ft

Slope Widths (I and J) : For sloping sites the down slope width (I) is a function of the mound depth at the down slope edge of the absorption area, desired side slope, normally 3:1 and the down slope correction factor. Up slope width (J) is a function of the mound depth at the up slope edge of the absorption area, the desired side slope, normally 3:1 and up slope correction factor. For level sites the slope widths (I) and (J) are equal and a function of the mound depth at the edge of the absorption area and the desired side slope, normally 3:1.

Slope Length (K): The slope length (K) is a function of the mound depth at the center of the absorption area and the desired mound end slope, normally 3:1. Steep end and side slopes are not recommended if the mound is to be mowed due to safety considerations. Typical dimensions are 8 - 12 ft.

Depth D: This depth of the sand fill is a function of the suitable soil separation depth required by code and the depth of the limiting condition from the soil surface. If the required separation distance from the absorption surface to the limiting condition, such as bedrock or seasonal saturation, is 3 ft and the limiting condition is 1 ft beneath the ground surface, then (D) must be a minimum of 2 ft which is measured at the up slope edge of the absorption area.

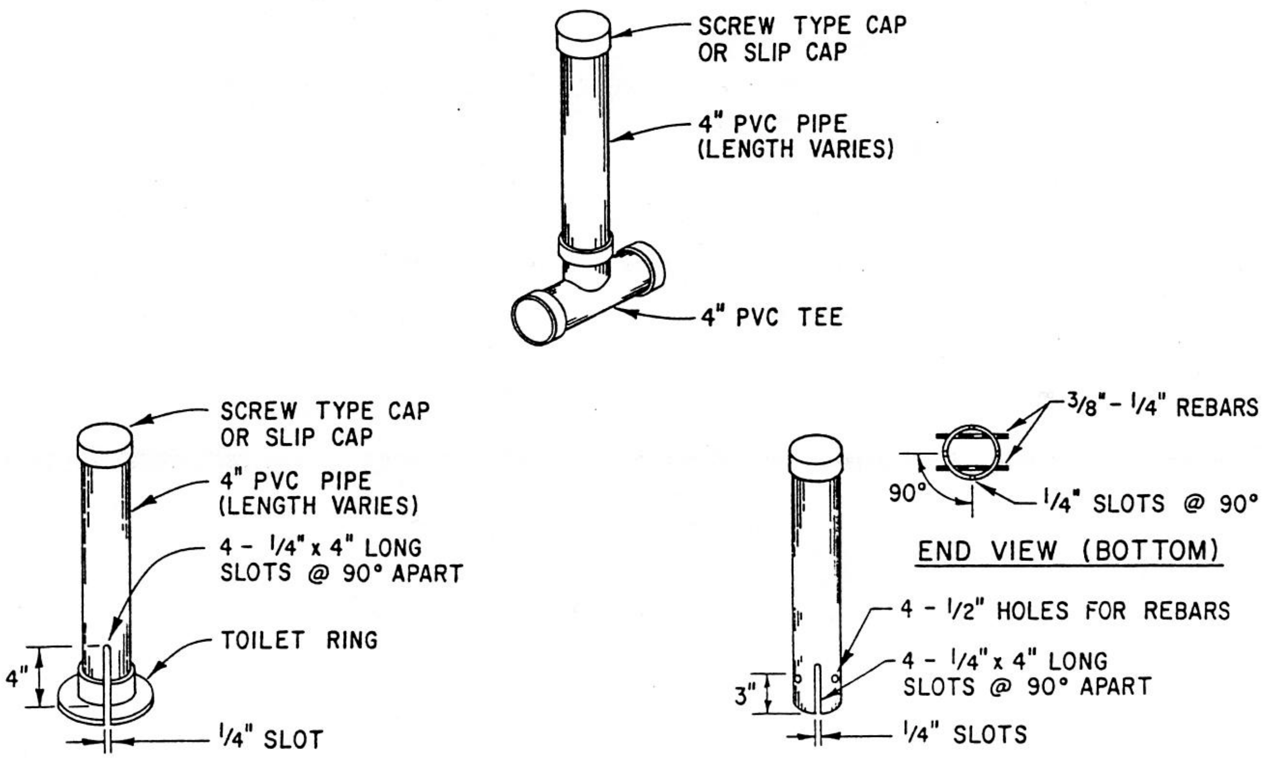
Depth E: This depth is a function of the surface slope and width of the absorption area (A) as the absorption area must be level.

Depth F: This depth is at least 9 in. with a minimum of 6 in. of aggregate beneath the distribution pipes, approximately 2" for the distribution pipe and 1" of aggregate over the pipe.

Depth G and H: The recommended depth for (G) and (H) for the soil cover is 6" and 12", respectively. The (H) depth is greater than the (G) depth to provide a crown to promote runoff from the mound top. For narrow absorption areas, 6" of difference is not required. Depths in earlier mound versions were 12 and 18" for cold climates. **Shallower depths are being recommended to allow for more oxygen diffusion to the absorption area.**

Mound Cover: The purpose of the mound soil cover is to provide a medium for a vegetative cover and protection. Any soil cover that will support a suitable vegetative cover and allow the mound to breathe is satisfactory. **It is important that the mound be able to breathe to allow oxygen to diffuse into and below the absorption area.** Clay loam, silty clay loam and clay soils restricts oxygen diffusion. Thicker soil covers also reduce oxygen transfer. The recommended mound cover consists of the sandy loam, loamy sands and silt loams. These coarser soils will not shed the precipitation as well as heavier soils and will not hold as much moisture during the summer dry periods but the benefits of breathing is probably superior to the negatives. If the soil cover does not support good vegetative cover, other means, such as decorative stone, must be implemented to avoid surface erosion.

Observation Tubes: It is essential that all soil absorption systems, including mounds, have observation tubes extending from the infiltrative surface (aggregate/sand interface for mounds) to or above the ground surface to observe ponding at the infiltrative surface. Tubes should be placed at approximately 1/4 and 3/4 points along the length of the absorption area. Fig. 7 illustrates three methods of anchoring the observation tubes. **The bottom 4" must have perforations in the sides to allow ponded effluent to enter and exit the pipes. Ponded**



OBSERVATION WELLS

effluent will not enter from the bottom of the pipe.

Fig. 7. Three methods of securing observation tubes.

Effluent Distribution Network: Pressure distribution network is essential for distributing the septic tank effluent. Gravity flow is unacceptable as it will not distribute the effluent uniformly over the infiltrative surface or along the length of the mound (Converse, 1974, Machmeier and Anderson, 1988). Otis (1981) provides design criteria and examples for pressure distribution. Converse (2000) discusses pressure distribution and provides a design example for the new criteria.

DESIGN EXAMPLE

Design an on-site system based on the following soil profile description.

Site Criteria

1. Soil Profile - Summary of 3 soil pits evaluations.

   A. 0 - 6 in. 10YR6/4&2/1; silt loam (Sil); strong, moderate, angular blocky structure; friable consistence.

   E. 6 -11 in. 10YR5/3; silt loam (Sil); moderate, fine platy structure; firm consistence.

   B. 11-20 in. 10YR6/3; silty clay loam (Sicl); moderate, fine, subangular blocky structure; firm consistence; few, medium, distinct mottles starting at 11".

   C. 20-36 in. 10YR5/3; silty clay (sic); massive structure; very firm consistence; many, medium, prominent mottles.

2. Slope 20%

3. The area available consists of 170 ft along the contour and 50 ft along the slope. There are 3 medium size trees in the area.

4. The establishment generates 300 gallons of wastewater of domestic septic tank effluent per day based on water meter readings.

Step 1. Evaluate the quantity and quality of the wastewater generated.

For all on-site systems a careful evaluation must be done on the quantity of wastewater generated. As indicated earlier, most code values have a factor of safety built into the flows generated daily. These are the values that are typically used for design. It is appropriate for the designer to assess if the code value is appropriate for the given facility and if not, work with the regulators on a suitable number. If metered values are used, a suitable factor of safety must be added to the daily average flow such as 50 to

100%. The average flow should be based on a realistic period of time and not be, for example, an average of six months of very low daily flow rates and 6 months of very high flow rates in which case then the high flow rates should be used for design plus the factor of safety. **It is best to over design rather than under design even though the cost is greater but system performance and longevity should be greater.**

Effluent quality must also be assessed. If it is typical domestic septic tank effluent, these sizing criteria may be used. If it is commercial septic tank effluent, lower loading rates (gpd/ft^2) must be used (Siegrist, et al., 1985) or the effluent pretreated to acceptable BOD and TSS. Use a factor of safety of 150%.

Design Flow Rate = 300 gpd X 1.5 = 450 gpd.

Typical design flows are 150 gpd/bedroom.

(Experience has shown that some mounds designed at 150 gpd/bedroom have ponded even though the actual flow was probably well below the design).

Step 2. Evaluate the soil profile and site description for design linear loading rate and soil loading rate.

For this example and convenience the one soil profile description is representative of the site. A minimum of 3 evaluations must be done on the site. More may be required depending on the variability of the soil. The soil evaluator must do as many borings as required to assure that the evaluation is representative of the site. Soil pits are better than borings but a combination are satisfactory. In evaluating this soil profile, the following comments can be made:

The silt loam (A) horizon (0 - 6") is relatively permeable because of its texture, structure and consistence. The effluent flow through this horizon should be primarily vertical.

The silt loam (E) horizon (6 - 11") has a platy structure and firm consistence. The consistence will slow the flow and the platy structure will imped vertical flow and cause the flow to move horizontally. If this layer is tilled, the platy structure will be rearranged and the flow will be primarily vertical. **Thus, tillage must be done at least 11 in. deep on this site to rearrange the platy structure.** If the structure in this horizon was not platy, then tillage would be limited to 5-6" in-depth.

The silty clay loam (B) horizon (11-20 in.) is slowly permeable because of the texture and firm consistence. The flow will be a combination of vertical and horizontal flow in the upper portion and primarily horizontal flow in the lower portion of the horizon due to the nature of the next lower horizon. During wet weather the “B” horizon may be saturated with all flow moving horizontally.

The silty clay (C) horizon (20 - 36 in.) will accept some vertical flow as the effluent moves horizontally down slope in the upper horizons. The flow through this profile will be similar to the cross section shown in Fig. 2c and during seasonal saturation as shown in Fig. 2b.

Based on experience a properly designed mound system should function on this site. It meets the minimum site recommendations found in Table 1.

Linear loading rates range from about 1 - 10 gpd/lf. Since this site has a very shallow seasonal saturation and a very slowly permeable horizon at about 20", and seasonal saturation at 11", the linear loading value for this site should be 3-4 gpd/lf.

Linear Loading Rate = 4 gpd/lf

Note: LLR = 3 could be used for a more conservative design and less risk of toe leakage especially during seasonal saturation.

A basal loading rate for the soil horizon in contact with the sand (basal area) is selected based on the surface horizon (A). Use table 2 to determine the design basal loading rate.

Basal Loading Rate = 0.8 gpd/ft^2

Step 3. Select the sand fill loading rate.

The section entitled “Sand Fill Loading Rate” and Fig. 6 give guidelines for selecting a suitable sand fill for the mound. Other fills may be used but caution should be used as performance data is very limited with the other fills.

Sand Loading Rate = 1.0 gpd/ft^2

No absorption area credit is given for use of chambers in mounds.

Step 4. Determine the absorption area width (A).

A = Linear Loading Rate / Sand Loading Rate

= 4 gpd/ft / 1.0 gpd/ft^2
= 4 ft (Since this appears to be the weak point in the mound, consider making it 6 ft wide. A 6 ft wide absorption area would give a sand loading rate of

0.67 gpd/gpd/ft^{2}.   The linear loading rate will remain at 4 gpd/lf . However, increasing the area will require more orifices in the pressure distribution network).

Step 5. Determine the absorption area length (B).

B = Design Flow Rate / Linear Loading Rate

= 450 gpd / 4 gpd/lf
= 113 ft.

Step 6. Determine the basal width (A + I).

The basal area required to absorb the effluent into the natural soil is based on the soil at the sand/soil interface and not on the lower horizons in the profile. An assessment of the lower horizons was done in Step 2 when the linear loading rate was estimated.

A + I = Linear Loading Rate / Basal Loading Rate

= 4 gpd/ft / 0.8 gpd/ft^2
= 5.0 ft (The effluent should be absorbed into the native soil, within a 5 ft.)

Since A = 4 ft

I = 5.0' - 4.0' = 1 ft. (“I” will also be calculated based on side slope)

Step 7. Determine the mound fill depth (D).

Assuming the code requires 3 ft of suitable soil and soil profile indicates 11 in. of suitable soil then:

D =36" - 11" = 25 in.

Step 8. Determine mound fill depth (E).

For a 20% slope with the bottom of the absorption area level then:

E = D + 0.20(A)
= 25" + 0.20 (48")
= 35 in.

Step 9. Determine mound depths (F), (G) and (H)

F = 9 in. (6 in. of aggregate, 2 in. for pipe and 1 in. for aggregate cover over pipe)

G = 6 in.

H = 12 in.

These depths have changed from 12 and 18" so as to allow more oxygen to diffuse into and beneath the absorption area. Sand filters have only 6" of cover and freezing is not a problem as long as the distribution network drains after each dose. Granted most sand filters are below grade which may be a factor.

Step 10. Determine the up slope width (J)

Using the recommended mound side slope of 3:1 then:

J = 3 (D + F+ G) (Slope Correction Factor from Table 3)

= 3(25" + 9"+ 6") (0.625)
= 6.25 ft or 6 ft

Step 11. Determine the end slope length (K).

Using the recommended mound end slope of 3:1 then:

K = 3((D + E)/2 + F + H)

= 3 ((25" + 35")/2 + 9" + 12")
= 12.75 ft or 13 ft

Step 12. Determine the down slope width (I)

Using the recommended mound side slope of 3:1 then:

I = 3(E + F + G) (Slope Correction Factor from Table 3)
= 3(35" + 9" + 6")(2.5)
= 37.5 ft.

Since the I dimension becomes quite large on steeper slopes, it may be desirable to make the down slope steeper such as 2:1 and not mow the mound. If the natural slope is 6% instead of 20% the mound width would be 28 ft (9 + 4 + 15).

Step 13. Overall length and width (L + W)

L = B + 2K

= 113 + 2(13)
= 139 ft

W = I + A + J

= 31 + 4 + 6
= 41 ft

Step 14. Design a Pressure Distribution Network

A pressure distribution network, including the distribution piping, dosing chamber and pump, must be designed. A design example is presented by Converse, 2000. Items to consider when designing the pressure distribution network.

- Using 3/16" holes instead of 1/4" holes with an effluent filter in the tank.

- Using 6 ft^2/orifice instead of the typical 15 - 20 ft^2/orifice that has been used.

- Provide easy access to flush the laterals such as turn-ups at end of laterals.

- Dose volume at 5 times the lateral pipe volume and not to exceed 20% of the design flow and not dose at the previously recommended 1/4 the design flow or 10 times the lateral void volume.

- Timed dosing which requires surge capacity in the septic tank/pump chamber. With the configuration of the mound (long and narrow), the dose volume is larger than for sand filter and time dosing may not be appropriate if larger dose volumes are required due to 5 times the lateral volume.

MOUND PERFORMANCE

The first Wisconsin mound system of the current design was installed in 1973. In Wisconsin there are over 30,000 mounds based on estimates by state regulators. Many other states have adopted the technology. Proper siting of all soils absorption units, including the mound, is essential otherwise the system will not function as planned.

In Wisconsin the mound system has a success rate of over 95% based on a survey by Converse and Tyler (1986b). This success rate is due in part to a very strong educational program relating to siting, design and construction.

A mound can fail either at the 1) aggregate or chamber/sand interface due to a clogging mat, 2) at the sand/soil interface due to the inability of the soil to accept the influent or 3) plugging of the pressure distribution network. Converse and Tyler (1989) discuss the mechanism that may cause failure and methods to rectify the problem. Another alternative (not discussed in that publication) to renovate mounds, that have severe ponding, is to introduce highly pretreated

Table 4. Down slope and up slope correction factors

Slope %	Down Slope Correction Factor	Up Slope Correction Factor
0	1.00	1.00
1	1.03	0.97
2	1.06	0.94
3	1.10	0.92
4	1.14	0.89
5	1.18	0.88
6	1.22	0.85
7	1.27	0.83
8	1.32	0.80
9	1.38	0.79
10	1.44	0.77
11	1.51	0.75
12	1.57	0.73
13	1.64	0.72
14	1.72	0.71
15	1.82	0.69
16	1.92	0.68
17	2.04	0.66
18	2.17	0.65
19	2.33	0.64
20	2.50	0.62
21	2.70	0.61
22	2.94	0.60
23	3.23	0.59
24	3.57	0.58
25	4.00	0.57

effluent to the mound by installing an aerobic unit, Nibbler Jr (NCS, 1998) or equivalent between the septic tank and pump chamber (Converse et al., 1998).

Converse et al., (1994) evaluated 13 mound systems for performance based on fecal coliform movement, nitrogen and chloride movement beneath the mound. Some fecals were found outside the 3 ft treatment zone beneath the system. The cause, though not definitive, may be related to the large infrequent doses of septic tank effluent to the mound which is typical of demand dosing and the large orifice spacing (15 to 20 ft^2).

MOUND CONSTRUCTION

A construction plan for any on-site system is essential. A clear understanding between the site evaluator, the designer, contractor and inspector is critical if a successful system is installed. It is important that the contractor and inspector understand the principles of operation of the mound system before construction commences otherwise the system will not function as intended. It is also important to anticipate and plan for the weather. It is best to be able to complete the mound before it rains on it. The tilled area (basal area) and the absorption area must be protected from rain by placing sand on the tilled area and aggregate on the absorption area prior to precipitation. There are several different ways to construct a mound as long as the basic principles and concepts are not violated. The following are suggested construction steps:

1. The mound must be placed on the contour. Measure the average ground surface elevation prior to tillage along the up slope edge of the absorption area. This contour will serve as the base line for determining the elevation of the bottom of the absorption area.

2. Grass, shrubs and trees must be cut close to the ground surface and removed from the site. In wooded areas with excess litter, it is recommended to rake the majority of it from the site. Do not pull out the stumps and do not remove the sod or the top soil or boulders.

3. Determine where the force main from the pump chamber enters the mound. It will either be center feed or end feed. For long mounds, center feed is preferred and all end feeds can be made into center feed. For center feed the force main can enter from the up slope center (preferred), the down slope center or exit the native soil at the end and be placed horizontally on a slight slope in the sand beneath the aggregate or just up slope of the aggregate. If it must be brought in from the down slope side, especially on slowly permeable soils with high seasonal saturation where the effluent flow may be horizontal, it should be brought in perpendicular to the side of the mound with minimal disturbance to the down slope area. All vehicular traffic must be kept in a very narrow corridor. Minimal damage is done if the soil is dry. Soil should be packed around the pipe and anti-seep collars should be installed to minimize effluent and water following the pipe. Entering from the down slope center should be the last choice on sites that are slowly permeable with shallow seasonal saturation.

4. The footprint of the mound must be tilled only when the soil moisture is within a satisfactory range. The satisfactory moisture range, to a depth of 6-7", is defined as where the soil will crumble and not form a wire when rolled between the palms. The purpose of tillage is to roughen the surface to allow better infiltration into the top soil. It also provides more contact

between the sand and the soil. Excessive tillage will destroy soil structure and reduce infiltration. The preferred method is using chisel teeth mounted on a backhoe which can be easily remove, followed by a chisel plow pulled behind a tractor, followed by the backhoe bucket with short teeth which requires flipping the soil. Normally it takes much longer to use the backhoe bucket than a chisel teeth mounted on the backhoe with the added cost quickly recovered. Moldboard plows have been used successfully but are the least preferred. Rototillers are prohibited on structured soils but may be used on unstructured soils such as sand to break up the vegetation. However, they are not recommended. All tilling must be done following the contour.

If a platy structure is present in the upper horizons, the tillage depth should be deep enough to try to break it up without bringing an excessive amount of subsoil to the surface. Deep tilling for the sake of deep tilling is not recommended. Till around the stumps without exposing an excessive amount of roots. Chisel teeth, mounded on a backhoe, is the preferred and an easier method for tilling around stumps. Stumps are not to be removed but some small ones may be inadvertently pulled out during tilling. If so, remove them from the site. If there are an excessive number of stumps and large boulders, the basal area should be enlarged or another site selected but that is the rare occasion.

5. Once the site has been tilled, a layer of sand must be placed before it rains. Driving on the exposed tilled soil is prohibited so as not to compact it or rut it up. Sand should be placed with a backhoe (preferred) or placed with a blade and track type tractor. A wheeled tractor will rut up the surface. **All work is to be done from the up slope side so as not to compact the down slope area especially if the effluent flow is horizontally away from the mound.**

6. Place the proper depth of sand, then form the absorption area with the bottom area raked level. The sand should be reasonably compacted in the trench area to minimize settling. A good backhoe operator can form the trench with minimal hand work.

7. Place a clean sound aggregate to the desired depth. **Limestone is not recommended.** If chambers are used, proper procedures must be performed to keep the chambers from settling into the sand. Procedures are available from the manufacturers that include compacting the sand to a certain specification and placing a coarse netting on the compacted surface prior to chamber placement.

8. Place the pressure distribution network with holes located downward and cover it with 1 in. of aggregate. Connect the force main to the distribution network. If chambers are used, the pressure distribution laterals must be suspended from the chambers with holes upward. Provisions must be made to allow the laterals to drain after dosing. This is accomplished by having several holes located downward or sloping the pipe in the chamber toward the force main. The laterals and force main must drain after each dose.

9. Cover the aggregate with a geotextile synthetic fabric.

10. Place suitable soil cover on the mound. There should be 6" on the sides and shoulder (G) and 12" on the top center (H) after settling. The soil cover should support vegetation. If not provisions must be made to control erosion.

11. Final grade the mound and area so surface water moves away from and does not accumulate on the up slope side of the mound. Use lightweight equipment.

12. Seed and mulch the entire exposed area to avoid erosion. Advise the homeowner on proper landscaping. The top of the mound becomes dry during the summer and the down slope toe may be wet during the wet seasons. Avoid deep rooted vegetation on the top of the mound to minimize root penetration into the distribution network (Schutt, K., et al. 1981)

13. Inform homeowner about the type of system, maintenance requirements and do's and don'ts associated with on-site soil based systems.

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Daniel B. Stephens & Associates, Inc.

Calculation Cover Sheet

Project Name Bell Gas #1186 Project Number ES14.0220

Calculation Number ES14.0220-005 Discipline Engineering No. of Sheets 5

PROJECT: Bell Gas #1186 Remediation System

THOMAS A. GOLDEN NEW MEXICO 22750 PROFESSIONAL ENGINEER 12/18/2020

SITE: Bell Gas #1186 / TR'S Market, Alto, New Mexico

SUBJECT: Estimation of LNAPL volumes and cleanup times and expected removal time of LNAPL

SOURCES OF DATA:
A. DBS&A summary of fluid levels through April 2020
B. GIS map document Thiessen Polygons.mxd
C. MPE pilot test soil vapor laboratory concentrations, June 2015

SOURCES OF FORMULAE & REFERENCES:
1. How To Effectively Recover Free Product At Leaking Underground Storage Tank Sites: A Guide For State Regulators (EPA 510-R-96-001), September 1996
2. A practical approach to the design, operation and monitoring of in-situ soil venting systems, Ground Water Monitoring Review, Spring Issue, 1990, p. 159-177
3. Selecting the Appropriate Abatement Technology, Kroopnick, Dr. Peter M., November 1998

☐ Preliminary Calculation ☒ Final Calculation Supersedes Calculation No. ______

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
0	Proposal Presentation	KI	11/18/14	JS	1/5/15	TG	1/6/15
1	Final Remediation Plan					TG	12/16/2020
2	PSTB comments					TG	1/19/2021

1.0 OBJECTIVES

Estimate the volume of light non-aqueous phase liquid (LNAPL) present at the site and the expected LNAPL removal time.

2.0 GIVEN

Groundwater and LNAPL level measurements from 2018 to 2020[A]. Assume the total multi-phase extraction (MPE) blower effluent flow rate is 160 actual cubic feet per minute (acfm) from seven wells.

3.0 METHOD

To calculate LNAPL volume, the thickness and areal extent of LNAPL are multiplied (volume = area x thickness). Since the thickness varies across the site, Theissen polygons are used to estimate spatially varying quantities. Perpendicular bisectors to lines connecting locations where the quantity of interest (here, LNAPL thickness) is known are drawn. The perpendicular bisectors and their intersections with each other and the LNAPL boundary define polygons, each with one known value of LNAPL thickness, that are used to estimate the extent of each known value. ArcGIS was used to generate initial Theissen polygons which were manually refined to eliminate polygons that exist outside the extent of the plume. The Theissen polygon on the leading edge of the plume (which is not defined by current wells and is therefore estimated) was split into two separate polygons. This was done to allow a more conservative assignment of product thickness to the leading edge of the plume.

EPA document 510-R-96-001, *How To Effectively Recover Free Product At Leaking Underground Storage Tank Sites: A Guide For State Regulators*[1], presents seven methods for estimating product thickness in a subsurface formation. These methods are based on a variety of material properties, including fluid densities, surface tension, displacement pressure, and coefficients, such as the “formation factor”. Values for these material properties were estimated based on site-specific conditions. The equations and definitions for the methods are presented together in Appendix 1, as well as in the spreadsheet PSH_calcs.xls. The thickness at each well is calculated with each method presented. The median of the calculated thicknesses (excluding negative calculated values) is used as the LNAPL thickness.

After the thickness is estimated, a volume of product for each polygon can be determined by multiplying the median product thickness by the areal extent of the corresponding Theissen polygon[B] and the soil porosity. The assumed effective soil porosity for this site is 10%. For this analysis, it will be conservatively assumed that 90% of the available LNAPL volume is recoverable. It will also be assumed that the maximum daily LNAPL removal rate is governed by the concept that 100 liters of vapor is required to remove one gram of LNAPL[2].

To calculate the time needed to remove the recoverable LNAPL, first determine the expected initial influent concentration of TPH by converting the field measurements for TPH reported in parts per million by volume (ppmv) to mass concentrations. Use the calculated volume of LNAPL to estimate a total mass of contaminant that requires removal. Kroopnick[3] states that the concentration of organic vapors observed historically at soil vapor extraction sites decreases exponentially with time and can be described by the formula:

$$C_t = C_0\, e^{(-RF*t)} \qquad \text{[eqn. 1]}$$

Where: C_t = vapor concentration of a contaminant at time, t
C_0 = initial vapor contaminant concentration
RF = removal factor

This behavior can be modeled to estimate a time for LNAPL removal. For each simulated day of system operation, the estimated initial mass of recoverable LNAPL is reduced by the LNAPL removed on the previous day. At the same time, the initial concentration is reduced according to equation 1. The removal factor, RF, is then adjusted by trial and error (or using the Excel Solver utility) to force the vapor concentration and mass of LNAPL remaining to simultaneously approach zero.

4.0 SOLUTION

Calculate an estimated LNAPL thickness for each polygon using the seven methods presented in EPA document 510-R-96-001. The results of this analysis are presented below for the polygon based on well MW-2(S); results for all polygons are given in attached spreadsheets at the end of this calculation.

Table 1: Summary of product thickness estimation methods for MW-2

Method	Thickness (ft)
Method of de Pastrovich (1979)	0.42
Method of Hall, et. al. (1984)	1.62
Method of Blake and Hall (1984)	0.35
Method of Ballestero et. al. (1994)	0.35
Method of Schiegg (1985)	-2.56
Method of Farr et. al. (1990)	0.18
Method of Lenhard and Parker (1990)	-1.16

Only positive estimated values of LNAPL thickness will be considered valid. Compute the median LNAPL thickness for all positive values:

$$H_{f,\text{Median from EPA guidance}} = \text{MEDIAN}(0.46,1.62,0.35,0.35,0.18) = 0.35 \text{ feet}$$

Once thickness is determined, use GIS software to determine the MW-2 areal extent of LNAPL[B]:

$A_{Polygon}$ = 3,680 ft^2

Calculate the estimated volume of LNAPL within the polygon using the LNAPL formation thickness, polygon area, and assumed effective soil porosity, ϕ, of 10%.

$V_{LNAPL\ from\ EPA\ guidance} = H_f * A_{Polygon} * \phi = 0.35\ ft * 3{,}680\ ft^2 * 0.10 * 7.481\ gal/ft^3 = 950\ \ gal$

Calculate the recoverable volume of LNAPL:

$V_{rec} = V_{LNAPL\ from\ EPA\ guidance} * 0.90 = 950\ gal * 0.50 = 855\ gal$

Results are summarized in Table 2.

Table 2: Summary of monitoring well LNAPL calculations

Well	Effective Formation Thickness (ft)	Calculated LNAPL Volume (gallons)	Recoverable LNAPL Volume (gallons)
MW-1S	0.05	70	63
MW-2(S)	0.35	950	855
MW-3(S)	0.87	3,450	3,105
MW-4(S)	0.01	9	8
MW-10(S)	0.42	1,752	1,577
MW-11(S)	0.09	176	158
	Total	**6,408**	**5,767**

The following calculations conservatively utilize a blower effluent well flow of 160 ft^3/min (acfm).

Compute the volume of air that passes through the system per day:

$V_{air} = 160\ ft^3/min * 60\ min/hr * 24\ hr/day = 230{,}400\ ft^3/day$

Compute the maximum mass of contaminant removed per day based on assumptions stated above:

$R_{max} = (230{,}400\ ft^3/day) * (100\ L / 3.5336\ ft^3) * (1\ gr / 100\ L) = 65{,}203\ gr/day$

$R_{max} = (65{,}203\ gr/day) * (0.002205\ lb/gr) =$ $\mathbf{R_{max} = 144\ lb/day}$

Assume the initial soil vapor concentration, C_0, is approximately 25,775 micrograms per liter (µg/L), which is the average TPH GRO concentration from the four laboratory samples collected during MPE pilot testing[C].

Based on the method described by Kroopnick[3], model MPE system performance (see Cleanup time estimation.xls). Assuming approximately 5,767 gallons are recoverable, convert the volume into a mass assuming a specific gravity for LNAPL of 0.83:

$$M_{rec} = \gamma_{LNAPL} * V_{rec} = (62.4 \text{ lb/ft}^3 * 0.83) * (\text{ft}^3 / 7.4805 \text{ gal}) * (5{,}767 \text{ gal}) = 39{,}930 \text{ lb}$$

Assuming that 90 percent of the (rounded) total volume of LNAPL will be recoverable is extremely conservative with regard to cleanup time estimation.

Two time steps are calculated below using computed values for the maximum vapor extraction flow rate, 160 ft^3/min (acfm), initial vapor concentration, 25,775 µg/L, and maximum daily removal based on the vapor extraction flow rate, 144 lb/day.

After one day, the total mass of LNAPL remaining will be reduced by the maximum daily removal:

$$M_{rem}(1 \text{ day}) = M_{rec} - R_{max} = 39{,}930 \text{ lb} - 144 \text{ lb} = 39{,}786 \text{ lb}$$

After one day, the vapor concentration will be reduced according to equation 1 (note that the removal factor for this equation has already been set, as described below):

$$C_1 = C_0\, e^{(-RF*1)} = (25{,}775\ \mu g/L) * e\,(-0.0069835 * 1) = 25{,}596\ \mu g/L$$

Subsequent time steps can be treated similarly; however, after some time, the vapor concentration will not be sufficient for the maximum mass to be removed and R_{max} will not apply. Thus for each time step, the removal rate must be calculated. Consider the time step at 200 days – the removal rate can be calculated based on the vapor concentration and flow rate at that time step:

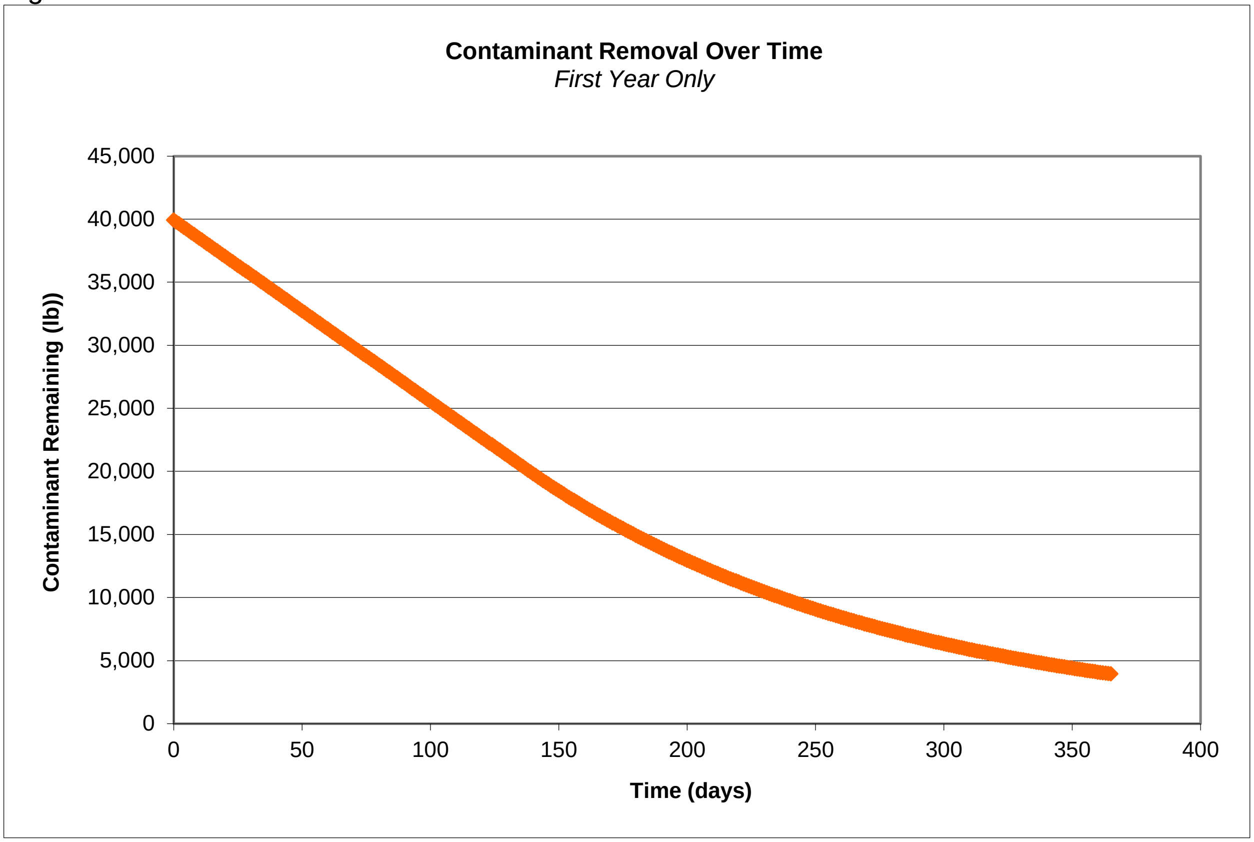
$$R_{200} = C_{200} * V_{air}$$
$$R_{200} = (6{,}377\ \mu g/L) * (28.3 \text{ L/ft}^3) * (160 \text{ ft}^3/\text{min}) * (\text{lb} / 453{,}592{,}370\ \mu g) * (1{,}440 \text{ min/day})$$
$$R_{200} = 92 \text{ lb/day}$$

The mass remaining at the next time step (201 days) will be equal to the mass remaining at the current time step minus the removal rate at the current time step (200 days):

$$M_{201} = M_{200} - R_{200} = 12{,}952 \text{ lb} - 92 \text{ lb} = 12{,}861 \text{ lb}$$

Using a spreadsheet (Cleanup time estimate.xls) these values can be calculated and the removal factor, RF, can be determined by adjusting the value until both the LNAPL mass remaining and the vapor concentration simultaneously approach zero. For this system, RF is determined to be 0.0069835 using the SOLVER function.

Figure 1 estimates the modeled removal of the LNAPL contaminant with time:



This figure illustrates how the mass of contaminant remaining asymptotically approaches zero. Therefore, use 2-log removal as an estimation of the total cleanup time. For this system, the amount of recoverable LNAPL mass remaining is less than 1% of the initial recoverable mass (39,930 lb * .01 = 399 lb) after 637 days or approximately **1.7 years**.

While all calculations presented above are based on industry standard practice, it should be noted that these are theoretical removal rates based on an assumed linear rate of removal (i.e. doubling the well flow doubles the concentration received). These calculations included several conservative assumptions, and also ignore the fact that contaminant mass will be removed in more than just vapor phase using the MPE system.

Table 2. Summary of measured product thickness, NAPL Volume, and recoverable NAPL

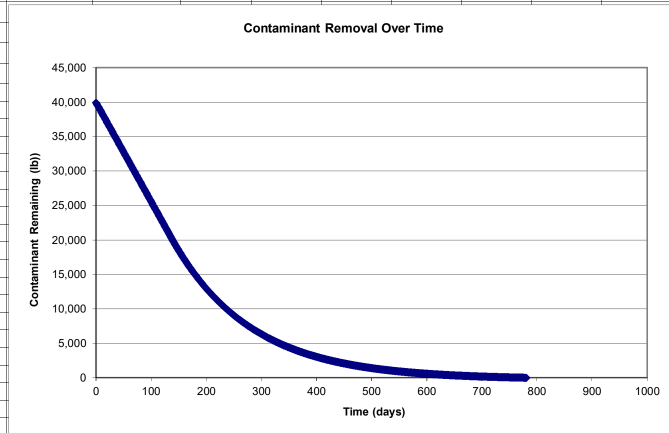
			Calculated from EPA document		
Well	Area	Measured NAPL well thickness[A]	Median NAPL formation thickness	Median NAPL volume	Recoverable NAPL volume
	ft^2	ft	ft	gal	gal
MW-1S	1,847	0.30	0.05	70	63
MW-2(S)	3,680	2.03	0.35	950	855
MW-3(S)	5,310	5.11	0.87	3,450	3,105
MW-4(S)	2,472	0.03	0.01	9	8
MW-10(S)	5,626	2.44	0.42	1,752	1,577
MW-11(S)	2,723	2.67	0.09	176	158
Totals	21,658			6,408	5,767

Notes

A. Measured NAPL = thickness in the well casing (average from 2018 - 2020)

Time (days)	Contaminant Remaining (pounds)	MPE Flowrate (acfm)	MPE Vapor Concentration (μg/L)	Daily Removal (lbs/day)	Daily Emissions (lbs/day)
0	39,930	160	25,775	144	1
1	39,786	160	25,596	144	1
2	39,642	160	25,418	144	1
3	39,498	160	25,241	144	1
4	39,355	160	25,065	144	1
5	39,211	160	24,891	144	1
6	39,067	160	24,717	144	1
7	38,923	160	24,545	144	1
8	38,780	160	24,374	144	1
9	38,636	160	24,205	144	1
10	38,492	160	24,036	144	1
11	38,348	160	23,869	144	1
12	38,205	160	23,703	144	1
13	38,061	160	23,538	144	1
14	37,917	160	23,374	144	1
15	37,773	160	23,212	144	1
16	37,630	160	23,050	144	1
17	37,486	160	22,890	144	1
18	37,342	160	22,730	144	1
19	37,198	160	22,572	144	1
20	37,055	160	22,415	144	1
21	36,911	160	22,259	144	1
22	36,767	160	22,104	144	1
23	36,623	160	21,950	144	1
24	36,480	160	21,798	144	1
25	36,336	160	21,646	144	1
26	36,192	160	21,495	144	1
27	36,048	160	21,346	144	1
28	35,905	160	21,197	144	1
29	35,761	160	21,050	144	1
30	35,617	160	20,903	144	1
31	35,473	160	20,758	144	1
32	35,330	160	20,613	144	1
33	35,186	160	20,470	144	1
34	35,042	160	20,327	144	1
35	34,898	160	20,186	144	1
36	34,755	160	20,045	144	1
37	34,611	160	19,906	144	1
38	34,467	160	19,767	144	1
39	34,324	160	19,630	144	1
40	34,180	160	19,493	144	1
41	34,036	160	19,358	144	1
42	33,892	160	19,223	144	1
43	33,749	160	19,089	144	1
44	33,605	160	18,956	144	1
45	33,461	160	18,824	144	1
46	33,317	160	18,693	144	1
47	33,174	160	18,563	144	1
48	33,030	160	18,434	144	1
49	32,886	160	18,306	144	1
50	32,742	160	18,178	144	1
51	32,599	160	18,052	144	1
52	32,455	160	17,926	144	1
53	32,311	160	17,801	144	1
54	32,167	160	17,678	144	1
55	32,024	160	17,555	144	1
56	31,880	160	17,432	144	1
57	31,736	160	17,311	144	1
58	31,592	160	17,191	144	1
59	31,449	160	17,071	144	1
60	31,305	160	16,952	144	1
61	31,161	160	16,834	144	1
62	31,017	160	16,717	144	1
63	30,874	160	16,601	144	1
64	30,730	160	16,485	144	1
65	30,586	160	16,370	144	1
66	30,442	160	16,257	144	1
67	30,299	160	16,143	144	1
68	30,155	160	16,031	144	1
69	30,011	160	15,920	144	1
70	29,867	160	15,809	144	1
71	29,724	160	15,699	144	1
72	29,580	160	15,589	144	1
73	29,436	160	15,481	144	1
74	29,292	160	15,373	144	1
75	29,149	160	15,266	144	1
76	29,005	160	15,160	144	1
77	28,861	160	15,055	144	1
78	28,717	160	14,950	144	1
79	28,574	160	14,846	144	1
80	28,430	160	14,742	144	1
81	28,286	160	14,640	144	1
82	28,142	160	14,538	144	1
83	27,999	160	14,437	144	1
84	27,855	160	14,336	144	1
85	27,711	160	14,237	144	1
86	27,567	160	14,137	144	1
87	27,424	160	14,039	144	1
88	27,280	160	13,941	144	1
89	27,136	160	13,844	144	1
90	26,992	160	13,748	144	1
91	26,849	160	13,652	144	1
92	26,705	160	13,557	144	1
93	26,561	160	13,463	144	1
94	26,417	160	13,369	144	1
95	26,274	160	13,276	144	1
96	26,130	160	13,184	144	1
97	25,986	160	13,092	144	1
98	25,842	160	13,001	144	1
99	25,699	160	12,911	144	1
100	25,555	160	12,821	144	1
101	25,411	160	12,731	144	1
102	25,267	160	12,643	144	1
103	25,124	160	12,555	144	1
104	24,980	160	12,467	144	1
105	24,836	160	12,381	144	1
106	24,692	160	12,295	144	1

k=	0.0069835		Contaminant removed in first year =	35,994	lb		
1 m^3 =	35.31	ft^3	Estimated first year removal rate =	18.0	ton/yr	4.108871	lb/hr
1 lb =	453,592	mg	Contaminant removed in second year =	3,809	lb		
γ_w =	62.4	lb/ft^3	Estimated second year removal rate =	1.9	ton/yr	0.434872	lb/hr
1 ft^3 =	7.48	gal	Contaminant removed in life of project =	10.0	tons		
1 day =	1,440	min					
1 ton =	2000	lb					



Time (days)	Contaminant Remaining (pounds)	MPE Flowrate (acfm)	MPE Vapor Concentration (µg/L)	Daily Removal (lbs/day)	Daily Emissions (lbs/day)
107	24,549	160	12,209	144	1
108	24,405	160	12,124	144	1
109	24,261	160	12,040	144	1
110	24,117	160	11,956	144	1
111	23,974	160	11,873	144	1
112	23,830	160	11,790	144	1
113	23,686	160	11,708	144	1
114	23,542	160	11,627	144	1
115	23,399	160	11,546	144	1
116	23,255	160	11,465	144	1
117	23,111	160	11,385	144	1
118	22,967	160	11,306	144	1
119	22,824	160	11,228	144	1
120	22,680	160	11,149	144	1
121	22,536	160	11,072	144	1
122	22,392	160	10,995	144	1
123	22,249	160	10,918	144	1
124	22,105	160	10,842	144	1
125	21,961	160	10,767	144	1
126	21,817	160	10,692	144	1
127	21,674	160	10,618	144	1
128	21,530	160	10,544	144	1
129	21,386	160	10,470	144	1
130	21,242	160	10,397	144	1
131	21,099	160	10,325	144	1
132	20,955	160	10,253	144	1
133	20,811	160	10,182	144	1
134	20,667	160	10,111	144	1
135	20,524	160	10,041	144	1
136	20,380	160	9,971	143	1
137	20,236	160	9,901	142	1
138	20,094	160	9,832	141	1
139	19,953	160	9,764	140	1
140	19,812	160	9,696	139	1
141	19,673	160	9,629	138	1
142	19,534	160	9,562	138	1
143	19,397	160	9,495	137	1
144	19,260	160	9,429	136	1
145	19,125	160	9,363	135	1
146	18,990	160	9,298	134	1
147	18,856	160	9,233	133	1
148	18,723	160	9,169	132	1
149	18,591	160	9,105	131	1
150	18,460	160	9,042	130	1
151	18,330	160	8,979	129	1
152	18,201	160	8,917	128	1
153	18,073	160	8,855	127	1
154	17,946	160	8,793	126	1
155	17,819	160	8,732	126	1
156	17,694	160	8,671	125	1
157	17,569	160	8,611	124	1
158	17,445	160	8,551	123	1
159	17,322	160	8,491	122	1
160	17,200	160	8,432	121	1
161	17,079	160	8,373	120	1
162	16,958	160	8,315	120	1
163	16,839	160	8,257	119	1
164	16,720	160	8,200	118	1
165	16,602	160	8,143	117	1
166	16,485	160	8,086	116	1
167	16,368	160	8,030	115	1
168	16,253	160	7,974	115	1
169	16,138	160	7,918	114	1
170	16,024	160	7,863	113	1
171	15,911	160	7,809	112	1
172	15,799	160	7,754	112	1
173	15,687	160	7,700	111	1
174	15,577	160	7,647	110	1
175	15,467	160	7,594	109	1
176	15,357	160	7,541	108	1
177	15,249	160	7,488	108	1
178	15,141	160	7,436	107	1
179	15,034	160	7,384	106	1
180	14,928	160	7,333	105	1
181	14,823	160	7,282	105	1
182	14,718	160	7,231	104	1
183	14,614	160	7,181	103	1
184	14,511	160	7,131	103	1
185	14,408	160	7,081	102	1
186	14,306	160	7,032	101	1
187	14,205	160	6,983	100	1
188	14,105	160	6,935	100	1
189	14,005	160	6,886	99	1
190	13,906	160	6,838	98	1
191	13,807	160	6,791	98	1
192	13,710	160	6,743	97	1
193	13,613	160	6,697	96	1
194	13,516	160	6,650	96	1
195	13,421	160	6,604	95	1
196	13,326	160	6,558	94	1
197	13,231	160	6,512	94	1
198	13,138	160	6,467	93	1
199	13,045	160	6,422	92	1
200	12,952	160	6,377	92	1
201	12,861	160	6,333	91	1
202	12,770	160	6,289	90	1
203	12,679	160	6,245	90	1
204	12,589	160	6,201	89	1
205	12,500	160	6,158	89	1
206	12,412	160	6,115	88	1
207	12,324	160	6,073	87	1
208	12,236	160	6,031	87	1
209	12,150	160	5,989	86	1
210	12,063	160	5,947	86	1
211	11,978	160	5,906	85	1
212	11,893	160	5,864	84	1
213	11,809	160	5,824	84	1
214	11,725	160	5,783	83	1

Time (days)	Contaminant Remaining (pounds)	MPE Flowrate (acfm)	MPE Vapor Concentration (µg/L)	Daily Removal (lbs/day)	Daily Emissions (lbs/day)
215	11,642	160	5,743	83	1
216	11,559	160	5,703	82	1
217	11,477	160	5,663	81	1
218	11,396	160	5,624	81	1
219	11,315	160	5,585	80	1
220	11,234	160	5,546	80	1
221	11,155	160	5,507	79	1
222	11,075	160	5,469	79	1
223	10,997	160	5,431	78	1
224	10,919	160	5,393	78	1
225	10,841	160	5,355	77	1
226	10,764	160	5,318	76	1
227	10,687	160	5,281	76	1
228	10,612	160	5,244	75	1
229	10,536	160	5,208	75	1
230	10,461	160	5,172	74	1
231	10,387	160	5,136	74	1
232	10,313	160	5,100	73	1
233	10,240	160	5,065	73	1
234	10,167	160	5,029	72	1
235	10,094	160	4,994	72	1
236	10,023	160	4,960	71	1
237	9,951	160	4,925	71	1
238	9,880	160	4,891	70	1
239	9,810	160	4,857	70	1
240	9,740	160	4,823	69	1
241	9,671	160	4,789	69	1
242	9,602	160	4,756	68	1
243	9,534	160	4,723	68	1
244	9,466	160	4,690	67	1
245	9,398	160	4,657	67	1
246	9,331	160	4,625	67	1
247	9,265	160	4,593	66	1
248	9,199	160	4,561	66	1
249	9,133	160	4,529	65	1
250	9,068	160	4,498	65	1
251	9,003	160	4,466	64	1
252	8,939	160	4,435	64	1
253	8,875	160	4,404	63	1
254	8,812	160	4,374	63	1
255	8,749	160	4,343	62	1
256	8,686	160	4,313	62	1
257	8,624	160	4,283	62	1
258	8,563	160	4,253	61	1
259	8,502	160	4,224	61	1
260	8,441	160	4,194	60	1
261	8,380	160	4,165	60	1
262	8,321	160	4,136	59	1
263	8,261	160	4,107	59	1
264	8,202	160	4,079	59	1
265	8,143	160	4,050	58	1
266	8,085	160	4,022	58	1
267	8,027	160	3,994	57	1
268	7,970	160	3,966	57	1
269	7,913	160	3,939	57	1
270	7,856	160	3,911	56	1
271	7,800	160	3,884	56	1
272	7,744	160	3,857	55	1
273	7,688	160	3,830	55	1
274	7,633	160	3,804	55	1
275	7,579	160	3,777	54	1
276	7,524	160	3,751	54	1
277	7,470	160	3,725	54	1
278	7,417	160	3,699	53	1
279	7,364	160	3,673	53	1
280	7,311	160	3,647	52	1
281	7,258	160	3,622	52	1
282	7,206	160	3,597	52	1
283	7,154	160	3,572	51	1
284	7,103	160	3,547	51	1
285	7,052	160	3,522	51	1
286	7,001	160	3,498	50	1
287	6,951	160	3,473	50	0
288	6,901	160	3,449	50	0
289	6,852	160	3,425	49	0
290	6,802	160	3,401	49	0
291	6,753	160	3,378	49	0
292	6,705	160	3,354	48	0
293	6,657	160	3,331	48	0
294	6,609	160	3,308	48	0
295	6,561	160	3,285	47	0
296	6,514	160	3,262	47	0
297	6,467	160	3,239	47	0
298	6,420	160	3,217	46	0
299	6,374	160	3,194	46	0
300	6,328	160	3,172	46	0
301	6,282	160	3,150	45	0
302	6,237	160	3,128	45	0
303	6,192	160	3,106	45	0
304	6,147	160	3,085	44	0
305	6,103	160	3,063	44	0
306	6,059	160	3,042	44	0
307	6,015	160	3,021	43	0
308	5,972	160	3,000	43	0
309	5,929	160	2,979	43	0
310	5,886	160	2,958	43	0
311	5,843	160	2,937	42	0
312	5,801	160	2,917	42	0
313	5,759	160	2,897	42	0
314	5,717	160	2,877	41	0
315	5,676	160	2,857	41	0
316	5,635	160	2,837	41	0
317	5,594	160	2,817	41	0
318	5,554	160	2,797	40	0
319	5,513	160	2,778	40	0
320	5,473	160	2,759	40	0
321	5,434	160	2,739	39	0
322	5,394	160	2,720	39	0

Time (days)	Contaminant Remaining (pounds)	MPE Flowrate (acfm)	MPE Vapor Concentration (µg/L)	Daily Removal (lbs/day)	Daily Emissions (lbs/day)		
323	5,355	160	2,701	39	0		
324	5,316	160	2,683	39	0		
325	5,278	160	2,664	38	0		
326	5,240	160	2,645	38	0		
327	5,201	160	2,627	38	0		
328	5,164	160	2,609	38	0		
329	5,126	160	2,590	37	0		
330	5,089	160	2,572	37	0		
331	5,052	160	2,555	37	0		
332	5,015	160	2,537	36	0		
333	4,979	160	2,519	36	0		
334	4,942	160	2,502	36	0		
335	4,906	160	2,484	36	0		
336	4,871	160	2,467	35	0		
337	4,835	160	2,450	35	0		
338	4,800	160	2,433	35	0		
339	4,765	160	2,416	35	0		
340	4,730	160	2,399	35	0		
341	4,696	160	2,382	34	0		
342	4,661	160	2,366	34	0		
343	4,627	160	2,349	34	0		
344	4,594	160	2,333	34	0		
345	4,560	160	2,317	33	0		
346	4,527	160	2,300	33	0		
347	4,494	160	2,284	33	0		
348	4,461	160	2,269	33	0		
349	4,428	160	2,253	32	0		
350	4,396	160	2,237	32	0		
351	4,364	160	2,222	32	0		
352	4,332	160	2,206	32	0		
353	4,300	160	2,191	32	0		
354	4,268	160	2,175	31	0		
355	4,237	160	2,160	31	0		
356	4,206	160	2,145	31	0		
357	4,175	160	2,130	31	0		
358	4,145	160	2,116	30	0		
359	4,114	160	2,101	30	0		
360	4,084	160	2,086	30	0		
361	4,054	160	2,072	30	0		
362	4,024	160	2,057	30	0		
363	3,995	160	2,043	29	0		
364	3,965	160	2,029	29	0		
365	3,936	160	2,015	29	0		Year 1
366	3,907	160	2,001	29	0		
367	3,878	160	1,987	29	0		
368	3,850	160	1,973	28	0		
369	3,821	160	1,959	28	0		
370	3,793	160	1,946	28	0		
371	3,765	160	1,932	28	0		
372	3,737	160	1,919	28	0		
373	3,710	160	1,905	27	0		
374	3,682	160	1,892	27	0		
375	3,655	160	1,879	27	0		
376	3,628	160	1,866	27	0		
377	3,601	160	1,853	27	0		
378	3,575	160	1,840	26	0		
379	3,548	160	1,827	26	0		
380	3,522	160	1,814	26	0		
381	3,496	160	1,802	26	0		
382	3,470	160	1,789	26	0		
383	3,444	160	1,777	26	0		
384	3,419	160	1,764	25	0		
385	3,393	160	1,752	25	0		
386	3,368	160	1,740	25	0		
387	3,343	160	1,728	25	0		
388	3,318	160	1,716	25	0		
389	3,293	160	1,704	25	0		
390	3,269	160	1,692	24	0		
391	3,245	160	1,680	24	0		
392	3,220	160	1,668	24	0		
393	3,196	160	1,657	24	0		
394	3,173	160	1,645	24	0		
395	3,149	160	1,634	24	0		
396	3,125	160	1,622	23	0		
397	3,102	160	1,611	23	0		
398	3,079	160	1,600	23	0		
399	3,056	160	1,589	23	0		
400	3,033	160	1,578	23	0		
401	3,010	160	1,567	23	0		
402	2,988	160	1,556	22	0		
403	2,965	160	1,545	22	0		
404	2,943	160	1,534	22	0		
405	2,921	160	1,524	22	0		
406	2,899	160	1,513	22	0		
407	2,877	160	1,503	22	0		
408	2,856	160	1,492	21	0		
409	2,834	160	1,482	21	0		
410	2,813	160	1,471	21	0		
411	2,792	160	1,461	21	0		
412	2,771	160	1,451	21	0		
413	2,750	160	1,441	21	0		
414	2,729	160	1,431	21	0		
415	2,709	160	1,421	20	0		
416	2,688	160	1,411	20	0		
417	2,668	160	1,401	20	0		
418	2,648	160	1,391	20	0		
419	2,628	160	1,382	20	0		
420	2,608	160	1,372	20	0		
421	2,588	160	1,363	20	0		
422	2,569	160	1,353	19	0		
423	2,549	160	1,344	19	0		
424	2,530	160	1,334	19	0		
425	2,511	160	1,325	19	0		
426	2,492	160	1,316	19	0		
427	2,473	160	1,307	19	0		
428	2,454	160	1,298	19	0		
429	2,435	160	1,289	19	0		
430	2,417	160	1,280	18	0		

Time (days)	Contaminant Remaining (pounds)	MPE Flowrate (acfm)	MPE Vapor Concentration (µg/L)	Daily Removal (lbs/day)	Daily Emissions (lbs/day)
431	2,398	160	1,271	18	0
432	2,380	160	1,262	18	0
433	2,362	160	1,253	18	0
434	2,344	160	1,244	18	0
435	2,326	160	1,236	18	0
436	2,308	160	1,227	18	0
437	2,291	160	1,219	18	0
438	2,273	160	1,210	17	0
439	2,256	160	1,202	17	0
440	2,238	160	1,193	17	0
441	2,221	160	1,185	17	0
442	2,204	160	1,177	17	0
443	2,187	160	1,169	17	0
444	2,170	160	1,160	17	0
445	2,154	160	1,152	17	0
446	2,137	160	1,144	16	0
447	2,121	160	1,136	16	0
448	2,104	160	1,128	16	0
449	2,088	160	1,121	16	0
450	2,072	160	1,113	16	0
451	2,056	160	1,105	16	0
452	2,040	160	1,097	16	0
453	2,024	160	1,090	16	0
454	2,009	160	1,082	16	0
455	1,993	160	1,075	15	0
456	1,978	160	1,067	15	0
457	1,962	160	1,060	15	0
458	1,947	160	1,052	15	0
459	1,932	160	1,045	15	0
460	1,917	160	1,038	15	0
461	1,902	160	1,030	15	0
462	1,887	160	1,023	15	0
463	1,872	160	1,016	15	0
464	1,858	160	1,009	15	0
465	1,843	160	1,002	14	0
466	1,829	160	995	14	0
467	1,814	160	988	14	0
468	1,800	160	981	14	0
469	1,786	160	974	14	0
470	1,772	160	968	14	0
471	1,758	160	961	14	0
472	1,744	160	954	14	0
473	1,731	160	948	14	0
474	1,717	160	941	14	0
475	1,704	160	934	13	0
476	1,690	160	928	13	0
477	1,677	160	922	13	0
478	1,663	160	915	13	0
479	1,650	160	909	13	0
480	1,637	160	902	13	0
481	1,624	160	896	13	0
482	1,611	160	890	13	0
483	1,599	160	884	13	0
484	1,586	160	878	13	0
485	1,573	160	871	13	0
486	1,561	160	865	12	0
487	1,548	160	859	12	0
488	1,536	160	853	12	0
489	1,524	160	847	12	0
490	1,511	160	842	12	0
491	1,499	160	836	12	0
492	1,487	160	830	12	0
493	1,475	160	824	12	0
494	1,464	160	818	12	0
495	1,452	160	813	12	0
496	1,440	160	807	12	0
497	1,428	160	801	12	0
498	1,417	160	796	11	0
499	1,405	160	790	11	0
500	1,394	160	785	11	0
501	1,383	160	779	11	0
502	1,372	160	774	11	0
503	1,360	160	769	11	0
504	1,349	160	763	11	0
505	1,338	160	758	11	0
506	1,328	160	753	11	0
507	1,317	160	747	11	0
508	1,306	160	742	11	0
509	1,295	160	737	11	0
510	1,285	160	732	11	0
511	1,274	160	727	10	0
512	1,264	160	722	10	0
513	1,253	160	717	10	0
514	1,243	160	712	10	0
515	1,233	160	707	10	0
516	1,223	160	702	10	0
517	1,213	160	697	10	0
518	1,203	160	692	10	0
519	1,193	160	687	10	0
520	1,183	160	682	10	0
521	1,173	160	678	10	0
522	1,163	160	673	10	0
523	1,153	160	668	10	0
524	1,144	160	664	10	0
525	1,134	160	659	9	0
526	1,125	160	654	9	0
527	1,115	160	650	9	0
528	1,106	160	645	9	0
529	1,097	160	641	9	0
530	1,088	160	636	9	0
531	1,078	160	632	9	0
532	1,069	160	628	9	0
533	1,060	160	623	9	0
534	1,051	160	619	9	0
535	1,042	160	615	9	0
536	1,034	160	610	9	0
537	1,025	160	606	9	0
538	1,016	160	602	9	0

Time (days)	Contaminant Remaining (pounds)	MPE Flowrate (acfm)	MPE Vapor Concentration (µg/L)	Daily Removal (lbs/day)	Daily Emissions (lbs/day)
539	1,007	160	598	9	0
540	999	160	594	9	0
541	990	160	589	8	0
542	982	160	585	8	0
543	973	160	581	8	0
544	965	160	577	8	0
545	957	160	573	8	0
546	948	160	569	8	0
547	940	160	565	8	0
548	932	160	561	8	0
549	924	160	557	8	0
550	916	160	553	8	0
551	908	160	550	8	0
552	900	160	546	8	0
553	892	160	542	8	0
554	885	160	538	8	0
555	877	160	535	8	0
556	869	160	531	8	0
557	861	160	527	8	0
558	854	160	523	8	0
559	846	160	520	7	0
560	839	160	516	7	0
561	831	160	513	7	0
562	824	160	509	7	0
563	817	160	505	7	0
564	809	160	502	7	0
565	802	160	498	7	0
566	795	160	495	7	0
567	788	160	492	7	0
568	781	160	488	7	0
569	774	160	485	7	0
570	767	160	481	7	0
571	760	160	478	7	0
572	753	160	475	7	0
573	746	160	471	7	0
574	740	160	468	7	0
575	733	160	465	7	0
576	726	160	462	7	0
577	719	160	458	7	0
578	713	160	455	7	0
579	706	160	452	7	0
580	700	160	449	6	0
581	693	160	446	6	0
582	687	160	443	6	0
583	681	160	440	6	0
584	674	160	437	6	0
585	668	160	433	6	0
586	662	160	430	6	0
587	656	160	427	6	0
588	649	160	424	6	0
589	643	160	422	6	0
590	637	160	419	6	0
591	631	160	416	6	0
592	625	160	413	6	0
593	619	160	410	6	0
594	613	160	407	6	0
595	608	160	404	6	0
596	602	160	401	6	0
597	596	160	399	6	0
598	590	160	396	6	0
599	585	160	393	6	0
600	579	160	390	6	0
601	573	160	388	6	0
602	568	160	385	6	0
603	562	160	382	5	0
604	557	160	380	5	0
605	551	160	377	5	0
606	546	160	374	5	0
607	540	160	372	5	0
608	535	160	369	5	0
609	530	160	367	5	0
610	524	160	364	5	0
611	519	160	361	5	0
612	514	160	359	5	0
613	509	160	356	5	0
614	504	160	354	5	0
615	499	160	352	5	0
616	494	160	349	5	0
617	489	160	347	5	0
618	484	160	344	5	0
619	479	160	342	5	0
620	474	160	339	5	0
621	469	160	337	5	0
622	464	160	335	5	0
623	459	160	332	5	0
624	454	160	330	5	0
625	450	160	328	5	0
626	445	160	326	5	0
627	440	160	323	5	0
628	436	160	321	5	0
629	431	160	319	5	0
630	426	160	317	5	0
631	422	160	314	5	0
632	417	160	312	4	0
633	413	160	310	4	0
634	408	160	308	4	0
635	404	160	306	4	0
636	400	160	304	4	0
637	395	160	301	4	0
638	391	160	299	4	0
639	387	160	297	4	0
640	382	160	295	4	0
641	378	160	293	4	0
642	374	160	291	4	0
643	370	160	289	4	0
644	365	160	287	4	0
645	361	160	285	4	0
646	357	160	283	4	0

Time (days)	Contaminant Remaining (pounds)	MPE Flowrate (acfm)	MPE Vapor Concentration (µg/L)	Daily Removal (lbs/day)	Daily Emissions (lbs/day)		
647	353	160	281	4	0		
648	349	160	279	4	0		
649	345	160	277	4	0		
650	341	160	275	4	0		
651	337	160	273	4	0		
652	333	160	271	4	0		
653	329	160	270	4	0		
654	325	160	268	4	0		
655	322	160	266	4	0		
656	318	160	264	4	0		
657	314	160	262	4	0		
658	310	160	260	4	0		
659	306	160	259	4	0		
660	303	160	257	4	0		
661	299	160	255	4	0		
662	295	160	253	4	0		
663	292	160	251	4	0		
664	288	160	250	4	0		
665	284	160	248	4	0		
666	281	160	246	4	0		
667	277	160	244	4	0		
668	274	160	243	3	0		
669	270	160	241	3	0		
670	267	160	239	3	0		
671	263	160	238	3	0		
672	260	160	236	3	0		
673	257	160	234	3	0		
674	253	160	233	3	0		
675	250	160	231	3	0		
676	247	160	230	3	0		
677	243	160	228	3	0		
678	240	160	226	3	0		
679	237	160	225	3	0		
680	234	160	223	3	0		
681	230	160	222	3	0		
682	227	160	220	3	0		
683	224	160	219	3	0		
684	221	160	217	3	0		
685	218	160	216	3	0		
686	215	160	214	3	0		
687	212	160	213	3	0		
688	208	160	211	3	0		
689	205	160	210	3	0		
690	202	160	208	3	0		
691	199	160	207	3	0		
692	196	160	205	3	0		
693	193	160	204	3	0		
694	191	160	202	3	0		
695	188	160	201	3	0		
696	185	160	200	3	0		
697	182	160	198	3	0		
698	179	160	197	3	0		
699	176	160	196	3	0		
700	173	160	194	3	0		
701	171	160	193	3	0		
702	168	160	191	3	0		
703	165	160	190	3	0		
704	162	160	189	3	0		
705	160	160	188	3	0		
706	157	160	186	3	0		
707	154	160	185	3	0		
708	152	160	184	3	0		
709	149	160	182	3	0		
710	146	160	181	3	0		
711	144	160	180	3	0		
712	141	160	179	3	0		
713	139	160	177	3	0		
714	136	160	176	3	0		
715	133	160	175	3	0		
716	131	160	174	2	0		
717	128	160	172	2	0		
718	126	160	171	2	0		
719	124	160	170	2	0		
720	121	160	169	2	0		
721	119	160	168	2	0		
722	116	160	167	2	0		
723	114	160	165	2	0		
724	111	160	164	2	0		
725	109	160	163	2	0		
726	107	160	162	2	0		
727	104	160	161	2	0		
728	102	160	160	2	0		
729	100	160	159	2	0		
730	98	160	157	2	0		Year 2
731	95	160	156	2	0		
732	93	160	155	2	0		
733	91	160	154	2	0		
734	89	160	153	2	0		
735	86	160	152	2	0		
736	84	160	151	2	0		
737	82	160	150	2	0		
738	80	160	149	2	0		
739	78	160	148	2	0		
740	76	160	147	2	0		
741	73	160	146	2	0		
742	71	160	145	2	0		
743	69	160	144	2	0		
744	67	160	143	2	0		
745	65	160	142	2	0		
746	63	160	141	2	0		
747	61	160	140	2	0		
748	59	160	139	2	0		
749	57	160	138	2	0		
750	55	160	137	2	0		
751	53	160	136	2	0		
752	51	160	135	2	0		
753	49	160	134	2	0		
754	47	160	133	2	0		

Time (days)	Contaminant Remaining (pounds)	MPE Flowrate (acfm)	MPE Vapor Concentration (µg/L)	Daily Removal (lbs/day)	Daily Emissions (lbs/day)												
755	45	160	132	2	0												
756	43	160	131	2	0												
757	42	160	130	2	0												
758	40	160	130	2	0												
759	38	160	129	2	0												
760	36	160	128	2	0												
761	34	160	127	2	0												
762	32	160	126	2	0												
763	31	160	125	2	0												
764	29	160	124	2	0												
765	27	160	123	2	0												
766	25	160	122	2	0												
767	23	160	122	2	0												
768	22	160	121	2	0												
769	20	160	120	2	0												
770	18	160	119	2	0												
771	16	160	118	2	0												
772	15	160	117	2	0												
773	13	160	117	2	0												
774	11	160	116	2	0												
775	10	160	115	2	0												
776	8	160	114	2	0												
777	6	160	113	2	0												
778	5	160	113	2	0												
779	3	160	112	2	0												
780	2	160	111	2	0												
781	0	160	110	2	0												

Notes on SVE time estimation:

Based on method described by Peter Kroopnick, Pollution Engineering, November 1998, pp. 36-40.

Assumes that vapor concentrations experience first order decay $C_t=C_oe^{-kt}$
where:
C_t is the concentration at time t
C_o is the initial vapor concentration
t is the time in days
k is the decay factor days^{-1}

For each day the initial mass of PSH is reduced by the PSH removed on the previous day. k is adjusted to force the vapor concentration and mass of PSH remaining to approximately zero at the same time.

Assumptions:

25,775	μg/L, estimated initial PSH vapor concentration
5,767	gallons, 90% of estimated initial PSH volume
0.83	estimated PSH specific gravity
39,930	pounds, estimated initial total PSH mass
144	pounds, estimated daily maximum removal rate of PSH

Conversion Factors:

453,592	milligrams per pound
62.4	lb/ft^3, specific weight of water
7.48	gallons per ft^3
1,440	minutes per day
35.31	ft^3 per m^3

Contaminant	Concentration (ppmv)	Concentration (µg/L)
TPH**	6,129	25,775
Benzene**	285	1,198

Assumptions

*	Applies to all wells
**	Average measured TPH concentrations from June 2015 pilot test
103	Approximate molecular weight of fuel
29	Molecular weight of air
1.184	g/L, air density

Conversion Factors

3.785	L/gallon
7.481	gallons/cubic foot
1.00E+09	µg/kg
2.2	lb/kg
2000	lb/ton
60	min/hr
24	hr/day
365.25	day/yr

Calculations by Well from EPA Guidance

MW-1S

Daniel B. Stephens & Associates, Inc.

Variables for MW-1S

Value	Units	Symbol	Description
3.03		β_{ao}	air-oil scaling factor
1.49		β_{ow}	oil-water scaling factor
0.033		D	function of interfluid displacement pressure and hydrostatics
0.17	g/cm^3	$\Delta\rho$	density difference between water and hydrocarbon (ρ_w-ρ_o)
12.5	cm (fine sand)	F	formation factor
980	cm/s^2	g	acceleration of gravity
0	cm	h_a	distance from the water table to bottom of mobile hydrocarbon
70	cm (fine sand)	$h_{c,dr}$	average water capillary height under drainage conditions
9.1	cm	H_o	hydrocarbon thickness measured in the well
6.51	cm H2O	P^{ow}_d	water-hydrocarbon displacement pressure
5.21	cm H2O	P^{ao}_d	air-hydrocarbon displacement pressure
1.00	g/cm^3	ρ_w	density of water
0.83	g/cm^3 (diesel)	ρ_o	density of hydrocarbon liquid
0.100		ϕ	soil porosity
72	dynes/cm	σ_{aw}	surface tension of water
23.8	dynes/cm (diesel)	σ_{ao}	surface tension of hydrocarbon
48.2	dynes/cm	σ_{ow}	hydrocarbon-water interfacial tension
0.091		S_r	residual saturation
7.6	cm	x	distance from the water table to interface between free product and groundwater in the well -- x is equal to the product of the thickness of the hydrocarbon and the hydrocarbon density

Explanation:

Color	Meaning
Yellow	Value from EPA 510-R-96-001 Appendix
Pink	Value from field approximations
Blue	Calculated value

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THICKNESS CALCULATIONS FOR MW-1S

From How to Effectively Recover Free Product At Leaking Underground Storage Tank Sites:
A Guide for State Regulators. (EPA 510-R-96-001). September 1996.

0.02	Average of the 5 methods with reasonable values (ft)
0.05	Median of the 4 methods with positive thicknesses (ft)
0.03	Min of the 4 methods with positive thicknesses (ft)
0.06	Max of the 4 methods with positive thicknesses (ft)

Method of de Pastrovich (1979)

$$H_f = \frac{H_0(\rho_w - \rho_o)}{\rho_o}$$

H_f = 1.87 cm in formation
0.06 ft in formation

Method of Hall, et. al. (1984)

$$H_f = H_0 - F$$

H_f = -3.36 cm in formation
-0.11 ft in formation

Method of Blake and Hall (1984)

$$H_f = H_o - (x + h_a)$$

H_f = 1.554 cm in formation
0.051 ft in formation

Method of Ballestero et. al. (1994)

$$H_f = ((1 - \rho_o) \bullet H_0) - h_a$$

H_f = 1.554 cm in formation
0.051 ft in formation

Method of Schiegg (1985)

$$H_f = H_0 - 2(h_{c,dr})$$

H_f = -130.9 cm in formation
-4.293 ft in formation

Method of Farr et. al. (1990)

$$H_f = \emptyset(1 - S_r)D\left[\frac{H_0}{D} - 1\right]$$

$$D = \frac{P_d^{ow}}{\Delta\rho g} - \frac{P_d^{ao}}{\rho_o g}$$

D = 0.03267
H_f = 0.82822 cm in formation
0.03 ft in formation

Method of Lenhard and Parker (1990)

$$H_f = \left[\frac{\rho_0 \beta_{ao} H_0}{\rho_0 \beta_{ao} - \beta_{ow}(1 - \rho_0)}\right] - h_{c,dr}$$

$$\beta_{ao} = \frac{\sigma_{aw}}{\sigma_{ao}} \qquad \beta_{ow} = \frac{\sigma_{aw}}{\sigma_{ow}}$$

β_{ao} = 3.02521
β_{ow} = 1.493776
H_f = -59.8272 cm in formation
-1.96 ft in formation

MW-2(S)

Variables for MW-2(S)

Value	Units	Symbol	Description
3.03		β_{ao}	air-oil scaling factor
1.49		β_{ow}	oil-water scaling factor
0.033		D	function of interfluid displacement pressure and hydrostatics
0.17	g/cm^3	$\Delta\rho$	density difference between water and hydrocarbon (ρ_w-ρ_o)
12.5	cm (fine sand)	F	formation factor
980	cm/s^2	g	acceleration of gravity
0	cm	h_a	distance from the water table to bottom of mobile hydrocarbon
70	cm (fine sand)	$h_{c,dr}$	average water capillary height under drainage conditions
61.874	cm	H_o	hydrocarbon thickness measured in the well
6.51	cm H2O	P^{ow}_d	water-hydrocarbon displacement pressure
5.21	cm H2O	P^{ao}_d	air-hydrocarbon displacement pressure
1.00	g/cm^3	ρ_w	density of water
0.83	g/cm^3 (diesel)	ρ_o	density of hydrocarbon liquid
0.100		ϕ	soil porosity
72	dynes/cm	σ_{aw}	surface tension of water
23.8	dynes/cm (diesel)	σ_{ao}	surface tension of hydrocarbon
48.2	dynes/cm	σ_{ow}	hydrocarbon-water interfacial tension
0.091		S_r	residual saturation
51.4	cm	x	distance from the water table to interface between free product and groundwater in the well -- x is equal to the product of the thickness of the hydrocarbon and the hydrocarbon density

Explanation:

Colour	Meaning
Yellow	Value from EPA 510-R-96-001 Appendix
Pink	Value from field approximations
Blue	Calculated value

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THICKNESS CALCULATIONS FOR MW-2(S)

From How to Effectively Recover Free Product At Leaking Underground Storage Tank Sites: A Guide for State Regulators. (EPA 510-R-96-001). September 1996.

0.58	Average of the 5 methods with positive thicknesses (ft)
0.35	Median of the 5 methods with positive thicknesses (ft)
0.18	Min of the 5 methods with positive thicknesses (ft)
1.62	Max of the 5 methods with positive thicknesses (ft)

Method of de Pastrovich (1979)

$$H_f = \frac{H_0(\rho_w - \rho_o)}{\rho_o}$$

H_f = 12.67 cm in formation
0.42 ft in formation

Method of Hall, et. al. (1984)

$$H_f = H_0 - F$$

H_f = 49.37 cm in formation
1.62 ft in formation

Method of Blake and Hall (1984)

$$H_f = H_o - (x + h_a)$$

H_f = 10.52 cm in formation
0.35 ft in formation

Method of Ballestero et. al. (1994)

$$H_f = ((1 - \rho_o) \bullet H_0) - h_a$$

H_f = 10.52 cm in formation
0.35 ft in formation

Method of Schiegg (1985)

$$H_f = H_0 - 2(h_{c,dr})$$

H_f = -78.13 cm in formation
-2.563 ft in formation

Method of Farr et. al. (1990)

$$H_f = \emptyset(1 - S_r)D\left[\frac{H_0}{D} - 1\right]$$

$$D = \frac{P_d^{ow}}{\Delta\rho g} - \frac{P_d^{ao}}{\rho_o g}$$

D = 0.03267
H_f = 5.621413 cm in formation
0.18 ft in formation

Method of Lenhard and Parker (1990)

$$H_f = \left[\frac{\rho_0\beta_{ao}H_0}{\rho_0\beta_{ao} - \beta_{ow}(1 - \rho_0)}\right] - h_{c,dr}$$

$$\beta_{ao} = \frac{\sigma_{aw}}{\sigma_{ao}} \qquad \beta_{ow} = \frac{\sigma_{aw}}{\sigma_{ow}}$$

β_{ao} = 3.02521
β_{ow} = 1.493776
H_f = -1.16387 cm in formation
-0.04 ft in formation

MW-3(S)

Variables for MW-3(S)

Value	Units	Symbol	Description
3.03		β_{ao}	air-oil scaling factor
1.49		β_{ow}	oil-water scaling factor
0.033		D	function of interfluid displacement pressure and hydrostatics
0.17	g/cm^3	$\Delta\rho$	density difference between water and hydrocarbon (ρ_w-ρ_o)
12.5	cm (fine sand)	F	formation factor
980	cm/s^2	g	acceleration of gravity
0	cm	h_a	distance from the water table to bottom of mobile hydrocarbon
70	cm (fine sand)	$h_{c,dr}$	average water capillary height under drainage conditions
155.75	cm	H_o	hydrocarbon thickness measured in the well
6.51	cm H2O	P^{ow}_d	water-hydrocarbon displacement pressure
5.21	cm H2O	P^{ao}_d	air-hydrocarbon displacement pressure
1.00	g/cm^3	ρ_w	density of water
0.83	g/cm^3 (diesel)	ρ_o	density of hydrocarbon liquid
0.100		ϕ	soil porosity
72	dynes/cm	σ_{aw}	surface tension of water
23.8	dynes/cm (diesel)	σ_{ao}	surface tension of hydrocarbon
48.2	dynes/cm	σ_{ow}	hydrocarbon-water interfacial tension
0.091		S_r	residual saturation
129.3	cm	x	distance from the water table to interface between free product and groundwater in the well -- x is equal to the product of the thickness of the hydrocarbon and the hydrocarbon density

Explanation:

Color	Meaning
Yellow	Value from EPA 510-R-96-001 Appendix
Pink	Value from field approximations
Blue	Calculated value

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THICKNESS CALCULATIONS FOR MW-3(S)

From How to Effectively Recover Free Product At Leaking Underground Storage Tank Sites:
A Guide for State Regulators. (EPA 510-R-96-001). September 1996.

0.75	Average of the 5 methods with reasonable values (ft)
0.87	Median of the 7 methods with positive thicknesses (ft)
0.46	Min of the 7 methods with positive thicknesses (ft)
4.70	Max of the 7 methods with positive thicknesses (ft)

Method of de Pastrovich (1979)

$$H_f = \frac{H_0(\rho_w - \rho_o)}{\rho_o}$$

H_f = 31.90 cm in formation
1.047 ft in formation

Method of Hall, et. al. (1984)

$$H_f = H_0 - F$$

H_f = 143.25 cm in formation
4.7 ft in formation

Method of Blake and Hall (1984)

$$H_f = H_o - (x + h_a)$$

H_f = 26.48 cm in formation
0.869 ft in formation

Method of Ballestero et. al. (1994)

$$H_f = ((1 - \rho_o) \bullet H_0) - h_a$$

H_f = 26.48 cm in formation
0.869 ft in formation

Method of Schiegg (1985)

$$H_f = H_0 - 2(h_{c,dr})$$

H_f = 15.75 cm in formation
0.52 ft in formation

Method of Farr et. al. (1990)

$$H_f = \emptyset(1 - S_r)D\left[\frac{H_0}{D} - 1\right]$$

$$D = \frac{P_d^{ow}}{\Delta\rho g} - \frac{P_d^{ao}}{\rho_o g}$$

D = 0.03267
H_f = 14.15 cm in formation
0.46 ft in formation

Method of Lenhard and Parker (1990)

$$H_f = \left[\frac{\rho_0 \beta_{ao} H_0}{\rho_0 \beta_{ao} - \beta_{ow}(1 - \rho_0)}\right] - h_{c,dr}$$

$$\beta_{ao} = \frac{\sigma_{aw}}{\sigma_{ao}} \qquad \beta_{ow} = \frac{\sigma_{aw}}{\sigma_{ow}}$$

β_{ao} = 3.02521
β_{ow} = 1.493776
H_f = 103.28 cm in formation
3.39 ft in formation

MW-4(S)

Variables for MW-4(S)

Value	Units	Symbol	Description
3.03		β_{ao}	air-oil scaling factor
1.49		β_{ow}	oil-water scaling factor
0.033		D	function of interfluid displacement pressure and hydrostatics
0.17	g/cm^3	$\Delta\rho$	density difference between water and hydrocarbon (ρ_w-ρ_o)
12.5	cm (fine sand)	F	formation factor
980	cm/s^2	g	acceleration of gravity
0	cm	h_a	distance from the water table to bottom of mobile hydrocarbon
70	cm (fine sand)	$h_{c,dr}$	average water capillary height under drainage conditions
0.9144	cm	H_o	hydrocarbon thickness measured in the well
6.51	cm H2O	P^{ow}_d	water-hydrocarbon displacement pressure
5.21	cm H2O	P^{ao}_d	air-hydrocarbon displacement pressure
1.00	g/cm^3	ρ_w	density of water
0.83	g/cm^3 (diesel)	ρ_o	density of hydrocarbon liquid
0.100		ϕ	soil porosity
72	dynes/cm	σ_{aw}	surface tension of water
23.8	dynes/cm (diesel)	σ_{ao}	surface tension of hydrocarbon
48.2	dynes/cm	σ_{ow}	hydrocarbon-water interfacial tension
0.091		S_r	residual saturation
0.8	cm	x	distance from the water table to interface between free product and groundwater in the well -- x is equal to the product of the thickness of the hydrocarbon and the hydrocarbon density

Explanation:

- Yellow: Value from EPA 510-R-96-001 Appendix
- Pink: Value from field approximations
- Blue: Calculated value

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THICKNESS CALCULATIONS FOR MW-4(S)

From How to Effectively Recover Free Product At Leaking Underground Storage Tank Sites:
A Guide for State Regulators. (EPA 510-R-96-001). September 1996.

0.00	Average of the 4 methods with positive thicknesses (ft)
0.01	Median of the 4 methods with positive thicknesses (ft)
0.00	Min of the 4 methods with positive thicknesses (ft)
0.01	Max of the 4 methods with positive thicknesses (ft)

Method of de Pastrovich (1979)

$$H_f = \frac{H_0(\rho_w - \rho_o)}{\rho_o}$$

H_f = 0.19 cm in formation
0.01 ft in formation

Method of Hall, et. al. (1984)

$$H_f = H_0 - F$$

H_f = -11.59 cm in formation
-0.38 ft in formation

Method of Blake and Hall (1984)

$$H_f = H_o - (x + h_a)$$

H_f = 0.155 cm in formation
0.01 ft in formation

Method of Ballestero et. al. (1994)

$$H_f = ((1-\rho_o) \bullet H_0) - h_a$$

H_f = 0.155 cm in formation
0.01 ft in formation

Method of Schiegg (1985)

$$H_f = H_0 - 2(h_{c,dr})$$

H_f = -139.1 cm in formation
-4.56 ft in formation

Method of Farr et. al. (1990)

$$H_f = \emptyset(1 - S_r)D\left[\frac{H_0}{D} - 1\right]$$

$$D = \frac{P_d^{ow}}{\Delta\rho g} - \frac{P_d^{ao}}{\rho_o g}$$

D = 0.03267
H_f = 0.08 cm in formation
0.00 ft in formation

Method of Lenhard and Parker (1990)

$$H_f = \left[\frac{\rho_0\beta_{ao}H_0}{\rho_0\beta_{ao} - \beta_{ow}(1-\rho_0)}\right] - h_{c,dr}$$

$$\beta_{ao} = \frac{\sigma_{aw}}{\sigma_{ao}} \qquad \beta_{ow} = \frac{\sigma_{aw}}{\sigma_{ow}}$$

β_{ao} = 3.02521
β_{ow} = 1.493776
H_f = -68.98 cm in formation
-2.26 ft in formation

MW-10(S)

Variables for MW-10(S)

Value	Units	Symbol	Description
3.03		β_{ao}	air-oil scaling factor
1.49		β_{ow}	oil-water scaling factor
0.033		D	function of interfluid displacement pressure and hydrostatics
0.17	g/cm^3	$\Delta\rho$	density difference between water and hydrocarbon (ρ_w-ρ_o)
12.5	cm (fine sand)	F	formation factor
980	cm/s^2	g	acceleration of gravity
0	cm	h_a	distance from the water table to bottom of mobile hydrocarbon
70	cm (fine sand)	$h_{c,dr}$	average water capillary height under drainage conditions
74.371	cm	H_o	hydrocarbon thickness measured in the well
6.51	cm H2O	$P^{ow}{}_d$	water-hydrocarbon displacement pressure
5.21	cm H2O	$P^{ao}{}_d$	air-hydrocarbon displacement pressure
1.00	g/cm^3	ρ_w	density of water
0.83	g/cm^3 (diesel)	ρ_o	density of hydrocarbon liquid
0.100		ϕ	soil porosity
72	dynes/cm	σ_{aw}	surface tension of water
23.8	dynes/cm (diesel)	σ_{ao}	surface tension of hydrocarbon
48.2	dynes/cm	σ_{ow}	hydrocarbon-water interfacial tension
0.091		S_r	residual saturation
61.7	cm	x	distance from the water table to interface between free product and groundwater in the well -- x is equal to the product of the thickness of the hydrocarbon and the hydrocarbon density

Explanation:

Color	Meaning
Yellow	Value from EPA 510-R-96-001 Appendix
Pink	Value from field approximations
Blue	Calculated value

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THICKNESS CALCULATIONS FOR MW-10(S)

From How to Effectively Recover Free Product At Leaking Underground Storage Tank Sites:
A Guide for State Regulators. (EPA 510-R-96-001). September 1996.

0.67	Average of the 6 methods with positive thicknesses (ft)
0.42	Median of the 6 methods with positive thicknesses (ft)
0.22	Min of the 6 methods with positive thicknesses (ft)
2.03	Max of the 6 methods with positive thicknesses (ft)

Method of de Pastrovich (1979)

$$H_f = \frac{H_0(\rho_w - \rho_o)}{\rho_o}$$

H_f = 15.23 cm in formation
0.5 ft in formation

Method of Hall, et. al. (1984)

$$H_f = H_0 - F$$

H_f = 61.87 cm in formation
2.03 ft in formation

Method of Blake and Hall (1984)

$$H_f = H_o - (x + h_a)$$

H_f = 12.64 cm in formation
0.41 ft in formation

Method of Ballestero et. al. (1994)

$$H_f = ((1 - \rho_o) \bullet H_0) - h_a$$

H_f = 12.64 cm in formation
0.41 ft in formation

Method of Schiegg (1985)

$$H_f = H_0 - 2(h_{c,dr})$$

H_f = -65.63 cm in formation
-2.15 ft in formation

Method of Farr et. al. (1990)

$$H_f = \emptyset(1 - S_r)D\left[\frac{H_0}{D} - 1\right]$$

$$D = \frac{P_d^{ow}}{\Delta\rho g} - \frac{P_d^{ao}}{\rho_o g}$$

D = 0.03267
H_f = 6.76 cm in formation
0.22 ft in formation

Method of Lenhard and Parker (1990)

$$H_f = \left[\frac{\rho_0 \beta_{ao} H_0}{\rho_0 \beta_{ao} - \beta_{ow}(1 - \rho_0)}\right] - h_{c,dr}$$

$$\beta_{ao} = \frac{\sigma_{aw}}{\sigma_{ao}} \qquad \beta_{ow} = \frac{\sigma_{aw}}{\sigma_{ow}}$$

β_{ao} = 3.02521
β_{ow} = 1.493776
H_f = 12.74 cm in formation
0.42 ft in formation

MW-11(S)

Variables for MW-11(S)

Value	Units	Symbol	Description
3.03		β_{ao}	air-oil scaling factor
1.49		β_{ow}	oil-water scaling factor
0.033		D	function of interfluid displacement pressure and hydrostatics
0.17	g/cm^3	$\Delta\rho$	density difference between water and hydrocarbon (ρ_w-ρ_o)
12.5	cm (fine sand)	F	formation factor
980	cm/s^2	g	acceleration of gravity
0	cm	h_a	distance from the water table to bottom of mobile hydrocarbon
70	cm (fine sand)	$h_{c,dr}$	average water capillary height under drainage conditions
81.382	cm	H_o	hydrocarbon thickness measured in the well
6.51	cm H2O	P^{ow}_d	water-hydrocarbon displacement pressure
5.21	cm H2O	P^{ao}_d	air-hydrocarbon displacement pressure
1.00	g/cm^3	ρ_w	density of water
0.83	g/cm^3 (diesel)	ρ_o	density of hydrocarbon liquid
0.100		ϕ	soil porosity
72	dynes/cm	σ_{aw}	surface tension of water
23.8	dynes/cm (diesel)	σ_{ao}	surface tension of hydrocarbon
48.2	dynes/cm	σ_{ow}	hydrocarbon-water interfacial tension
0.091		S_r	residual saturation
67.5	cm	x	distance from the water table to interface between free product and groundwater in the well -- x is equal to the product of the thickness of the hydrocarbon and the hydrocarbon density

Explanation:

Color	Meaning
Yellow	Value from EPA 510-R-96-001 Appendix
Pink	Value from field approximations
Blue	Calculated value

Daniel B. Stephens & Associates, Inc.

THICKNESS CALCULATIONS FOR MW-11(S)

From How to Effectively Recover Free Product At Leaking Underground Storage Tank Sites:
A Guide for State Regulators. (EPA 510-R-96-001). September 1996.

0.77	Average of the 6 methods with positive thicknesses (ft)
0.50	Median of the 6 methods with positive thicknesses (ft)
0.24	Min of the 6 methods with positive thicknesses (ft)
2.26	Max of the 6 methods with positive thicknesses (ft)

Method of de Pastrovich (1979)

$$H_f = \frac{H_0(\rho_w - \rho_o)}{\rho_o}$$

H_f = 16.67 cm in formation
0.55 ft in formation

Method of Hall, et. al. (1984)

$$H_f = H_0 - F$$

H_f = 68.88 cm in formation
2.26 ft in formation

Method of Blake and Hall (1984)

$$H_f = H_o - (x + h_a)$$

H_f = 13.83 cm in formation
0.454 ft in formation

Method of Ballestero et. al. (1994)

$$H_f = ((1 - \rho_o) \bullet H_0) - h_a$$

H_f = 13.83 cm in formation
0.454 ft in formation

Method of Schiegg (1985)

$$H_f = H_0 - 2(h_{c,dr})$$

H_f = -58.62 cm in formation
-1.92 ft in formation

Method of Farr et. al. (1990)

$$H_f = \emptyset(1 - S_r)D\left[\frac{H_0}{D} - 1\right]$$

$$D = \frac{P_d^{ow}}{\Delta\rho g} - \frac{P_d^{ao}}{\rho_o g}$$

D = 0.03267
H_f = 7.39 cm in formation
0.24 ft in formation

Method of Lenhard and Parker (1990)

$$H_f = \left[\frac{\rho_0\beta_{ao}H_0}{\rho_0\beta_{ao} - \beta_{ow}(1 - \rho_0)}\right] - h_{c,dr}$$

$$\beta_{ao} = \frac{\sigma_{aw}}{\sigma_{ao}}$$

$$\beta_{ow} = \frac{\sigma_{aw}}{\sigma_{ow}}$$

β_{ao} = 3.02521
β_{ow} = 1.493776
H_f = 20.54 cm in formation
0.67 ft in formation

References

APPENDIX

APPENDIX

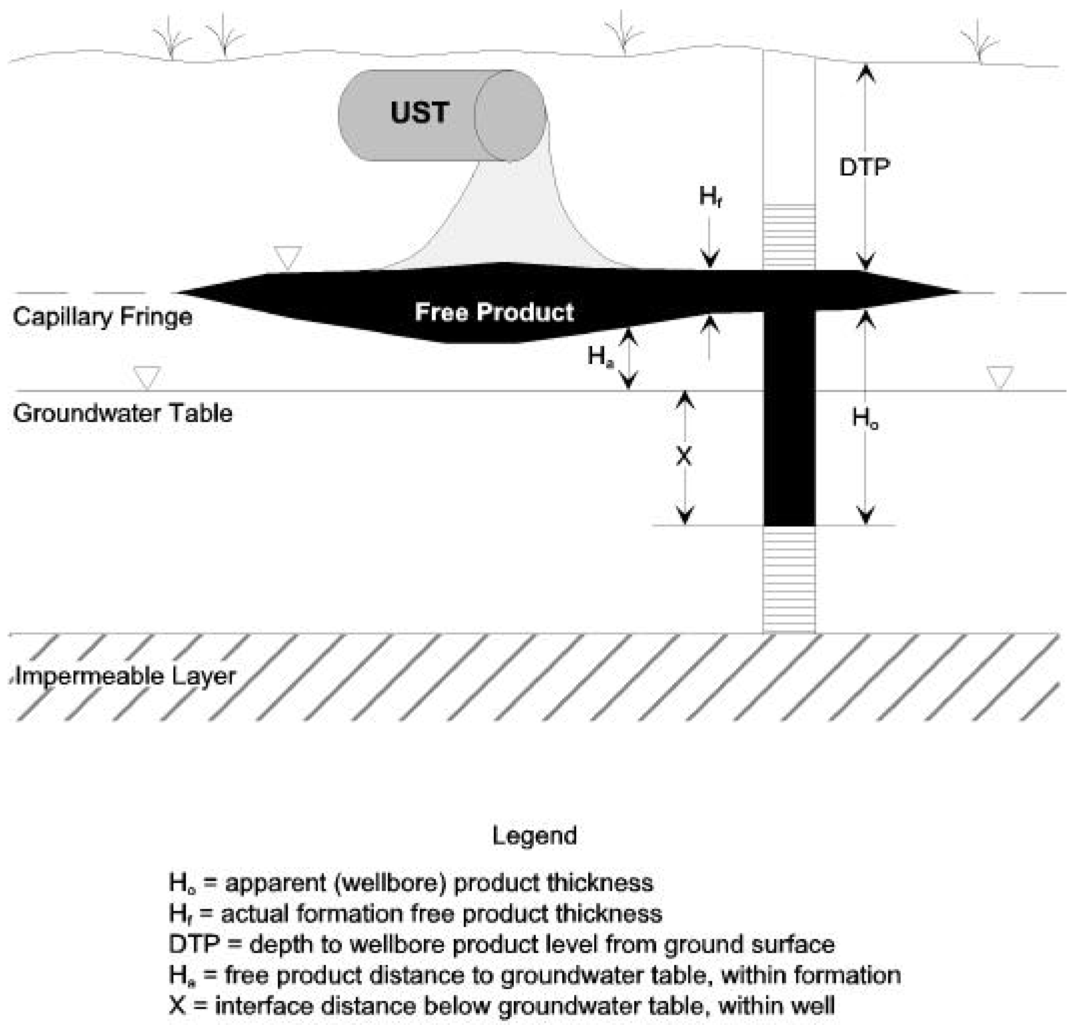
Chapter IV presented various methods for estimating the volume of free product in the subsurface. The results of seven methods were compared for data representative of the same site conditions. Each of these methods are described in greater detail in this Appendix. To facilitate comparison, a uniform terminology has been adopted. Exhibit A-1 lists the variables that appear in the various equations. Exhibit A-2 is a diagram showing the relationship of the variables and characteristics of free product in the vicinity of a monitor well. Experimental data from Abdul *et al*. (1989) and parameter values for the example calculations are presented in Exhibit A-3.

Exhibit A-1
Variables Appearing in Volume Estimation Equations

b_{ao}	=	air-oil scaling factor
b_{ow}	=	oil-water scaling factor
D	=	function of interfluid displacement pressures and hydrostatics
Δr	=	density difference between water and hydrocarbon ($r_w - r_o$)
F	=	formation factor
g	=	acceleration of gravity
h_a	=	distance from water table to bottom of mobile hydrocarbon
$h_{c,dr}$	=	average water capillary height under drainage conditions
H_f	=	thickness of mobile hydrocarbon in the adjacent formation
H_o	=	hydrocarbon thickness measured in the well
P_d^{ow}	=	water-hydrocarbon displacement pressure
P_d^{ao}	=	air-hydrocarbon displacement pressure
r_w	=	density of water
r_o	=	density of the hydrocarbon liquid
V_o	=	volume of hydrocarbon in the adjacent formation per unit area
f	=	soil porosity
s_{aw}	=	surface tension of water (= 72 dynes/cm @ 20°C)
s_{ao}	=	surface tension of hydrocarbon
s_{ow}	=	hydrocarbon-water interfacial tension (= $s_{aw} - s_{ao}$)
S_r	=	residual saturation
x	=	distance from water table to interface between free product and groundwater in the well-- x is equal to the product of the thickness of the hydrocarbon and the hydrocarbon density ($H_o - r_o$)

Exhibit A-2

Relationship of Variables and Characteristics
of Free Product in the Vicinity of a Monitor Well



Modified from Ballestero *et al.* (1994).

Exhibit A-3

Parameters and Experimental Data Used In Calculating Free Product Thickness Based on Measurements of Free Product in Monitor Wells

Parameters listed in the following table correspond to the variables appearing in the seven equations described previously.

Parameter Values

r_o = 0.84 gm/cm^3	s_{aw} = 72 dynes/cm	f =0.424
r_w = 1.00 gm/cm^3	s_{ao} = 22 dynes/cm	S_r = 0.091
F = 7.5 (med.sand)	s_{ow} = 40 dynes/cm	P_d^{ao} = 5.21 cm H_2O
$h_{c,dr}$ = 17	b_{ao} =2.25	P_d^{ow} = 6.51 cm H_2O
g = 980 cm/s^2	b_{ow} =1.8	D = 0.035

The data appearing in the following table are from Abdul *et al.* (1989). Their experiment essentially involved introducing dyed diesel fuel into an acrylic column containing well-graded sand and a minature monitor well. The cylinder was initially filled with water from the bottom and then allowed to drain until equilibrium was reached. Diesel fuel was then allowed to infiltrate from the surface. The height of diesel fuel in the sand and well was measured and recorded. The experiment was repeated 5 times.

Experimental Data

Trial Number	**H_o (cm)**	**h_a (cm)**	**x [$H_o \cdot r_o$] (cm)**
1	6	17	5.04
2	63	9	52.92
3	68	6.5	57.12
4	73	2	61.32
5	84	0	70.56

Method of de Pastrovich (1979)

$$H_f \quad = \quad \frac{H_o\left(r_w - r_o\right)}{r_o}$$

This method depends only upon the density (r_o) of the liquid hydrocarbon relative to the density of water. For a hydrocarbon liquid with a density of 0.8, and assuming that the density of water (r_w) is equal to 1, the hydrocarbon thickness in the formation (the actual thickness) is only one-fourth the thickness measured in the well (the apparent thickness). Stated another way, the hydrocarbon thickness measured in the well is four times greater than the actual thickness in the formation. The principal weakness of this method is that it does not account for the effects of different soil types. Exhibit III-12 illustrates that in general, the ratio of apparent to true free product thickness increases as soil grain size decreases. Thus, this method may be more accurate in finer grained soil (*e.g*., silt, clay) than in coarser-grained soil (*e.g*., sand, loam)

Method of Hall, *et al.* (1984)

$$H_f \quad = \quad H_o - F$$

This method depends upon a "formation factor" (*F*), which is apparently empirical, and not related to any other type of formation factor (*e.g*., those found in petroleum literature) (Ballestero *et al*., 1994). For a fine sand, *F* is equal to 12.5 cm; for a medium sand, *F* is equal to 7.5 cm; and for a coarse sand, *F* is equal to 5 cm. The principal weakness of this method is in selecting an appropriate value for F, especially when the soil is either not one of the three types mentioned above or is layered. Hall *et al*. (1984) also report that there must be a minimum thickness of hydrocarbon in the well for this method to be valid. For a fine sand, the minimum thickness is equal to 23 cm; for a medium sand, the minimum thickness is equal to 15 cm; and for a coarse sand, the minimum thickness is equal to 8 cm.

Method of Blake and Hall (1984)

$$H_f = H_o - \left(x + h_a\right)$$

This method is relatively straightforward, depending only upon measured lengths, however, the parameter h_a is difficult to accurately measure especially in the field. Ballestero *et al*. (1994) indicate that h_a should equal the height of the water capillary fringe when the thickness of hydrocarbon in the formation is relatively small since no pore water is displaced. As the thickness of free product builds up, the water capillary fringe becomes depressed as pore water is displaced and the value of h_a diminishes. When the hydrocarbon lens reaches the water table, the value of h_a becomes zero. At this point, the thickness of hydrocarbon in the formation is equal to the distance between the top of the free product layer and the true elevation of the water table. Both of these measurements can be obtained using the methodology illustrated in Exhibit III-10.

Method of Ballestero *et al*. (1994)

$$H_f = \left(\left(1 - r_o\right) \cdot H_o\right) - h_a$$

This method is essentially equivalent to the method of Blake and Hall (1984) when an actual measurement of their parameter "*x*" is not available, but the product density and thickness of product in the monitor well are known. Recall that x is equal to the product of the thickness of the hydrocarbon in the well and the hydrocarbon density ($H_o \cdot r_o$). Rearranging the above equation and substituting x for ($H_o \cdot r_o$) yields the same equation. The principal limitation of this method (as well as the method of Blake and Hall) is that the parameter h_a is difficult to measure in the field. When h_a has decreased to zero, the thickness of the free product layer in the soil is equal to the distance between the top of the free product layer measured in the well and the true (corrected) elevation of the water table. Both of these measurements can be obtained using the methodology illustrated in Exhibit III-10.

Method of Schiegg (1985)

$$H_f \quad = \quad H_o - 2\left(h_{c,dr}\right)$$

This method essentially attempts to correct the exaggerated thickness of free product in a well by subtracting a constant (2 $h_{c,dr}$) that depends on the soil type. The finer the soil, the greater the constant. Typical values of $h_{c,dr}$, as reported by Bear (1972), are 2-5 cm for coarse sand, 12-35 cm for medium sand, and 35-70 for fine sand. The principal weakness of this method is that it relies on a parameter that is difficult to accurately determine. Values for $h_{c,dr}$ vary by a factor of 2 over the range from low to high. Also, it is possible for this method to yield a negative value if there is only a thin layer of free product in the well.

Method of Farr *et al*. (1990)

$$V_o \quad = \quad f\left(1 - S_r\right) D\left[\left(\frac{H_o}{D}\right) - 1\right]$$

$$D \quad = \quad \frac{P_d^{ow}}{\Delta r\ g} - \frac{P_d^{ao}}{r_o\ g}$$

This method is dependent upon conditions of static equilibrium. Farr *et al*. (1990) present several variations of this equation for different soil types and different extent of liquid hydrocarbon in the unsaturated zone. The above equation is based on equation #15 in their paper, which is valid for unconsolidated sand with very uniform pore sizes. The principal limitation of this method is in obtaining values for P_d^{ow} and P_d^{ao}, neither of which is easily measured in the field. Ballestero *et al*. (1994) present and discuss this method, however there is a discrepancy in the formulation of the “D” term, which is not possible to resolve based on the information provided. Ballestero *et al*. (1994) also mistakenly assume that H_f and V_o are equivalent. The relationship between H_f and V_o is discussed later in this Appendix.

Method of Lenhard and Parker (1990)

$$H_f = \frac{r_o \, b_{ao} \, H_o}{b_{ao} \, r_o - b_{ow} \left(1 - r_o\right)}$$

- oil-water capillary fringe thickness

$$b_{ao} = \frac{s_{aw}}{s_{ao}}$$

$$b_{ow} = \frac{s_{aw}}{s_{ow}}$$

This method is dependent upon conditions of static equilibrium; it assumes a theoretical, vertical saturation profile based on generalized capillary pressure relationships. Extensions of this method allow consideration of residual oil trapped above and below the mobile zone by a fluctuating water table. The principal limitations of this method are that it does not account for dynamic conditions or small-scale heterogeneities, and few of the parameters can be measured in the field. Parameters from published literature for pure compounds may be substituted but it is uncertain how applicable such values are to aged mixtures of petroleum hydrocarbons in the subsurface.

Relationship Between V_o and H_f

Although both the thickness of hydrocarbon in the soil (H_f) and specific oil volume (V_o) can be expressed in dimensions of length [L], they are not equivalent terms. Vertical integration of the hydrocarbon content in the soil yields the volume (V_o) of hydrocarbon in the medium per unit area, whereas H_f is merely the corrected thickness of the free product layer in the geologic formation. V_o actually has dimensions of L^3/L^2 and is commonly expressed in terms of cubic feet per square foot. To determine H_f, V_o must be divided by the effective porosity. In the unsaturated zone, effective porosity is equal to the product of porosity [f] times the quantity 'one minus the residual saturation' ($1-S_r$). The length dimension of the V_o term is equivalent to the height that a specified volume of liquid hydrocarbon would rise in an empty box measuring one unit of length on each side. The length dimension of the H_f term is equivalent to the height that the same specified volume of liquid hydrocarbon would rise in the same box filled with a porous media (*e.g.*, sand) of porosity f and residual saturation S_r. Obviously, the height of the rise in the box filled with a porous media would be higher than in the empty box. To illustrate this point, consider an empty box that measures one unit of length on each side. Take a specific volume of liquid and pour it into the box. The depth of liquid in the box is equivalent to the specific volume of the liquid. Now consider the same box but this time it is filled with marbles that are packed so that the pore spaces represent only 25 percent of the total volume. If the same volume of liquid is poured into this box, the height of the liquid will be four times greater than the height in the empty box.

Relevance To Free Product Recovery

Each of the above methods for determining volume of free product has its strengths and weaknesses. In general, none of the methods is particularly reliable under any given set of conditions either in the field or in the laboratory. Although there have been some creative attempts to compensate for the limitations of some of the methods, it is not usually possible to predict the accuracy. For example, Huntley *et al*. (1992) apply the methods of Farr *et al*. (1990) and Lenhard and Parker (1990) to a stratified system, with each layer represented by its own specific capillary pressure-saturation curves. The profiles generated by the layered model match measured hydrocarbon saturations better than the use of a single “average” layer. However, the study indicates that predicted saturations can be erroneous if the system is not in equilibrium, and hence in violation of the assumption of hydrostatic pressure distribution. These non-equilibrium effects can be caused by rising or falling water table elevations. Unfortunately, like anisotropy, non-equilibrium is most often the rule, and isotropy and equilibrium are the exceptions. To estimate the volume of free product in the subsurface, no one method should be relied on exclusively. Select the methods that are most appropriate to the site conditions and determine a volume using each method. In this way a reasonable range of values can be established.

(3)

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A Practical Approach to the Design, Operation, and Monitoring of In Situ Soil-Venting Systems

by P.C. Johnson, C.C. Stanley, M.W. Kemblowski, D.L. Byers, and J.D. Colthart

Abstract

When operated properly, in situ soil venting or vapor extraction can be one of the most cost-effective remediation processes for soils contaminated with gasoline, solvents, or other relatively volatile compounds. The components of soil-venting systems are typically off-the-shelf items, and the installation of wells and trenches can be done by reputable environmental firms. However, the design, operation, and monitoring of soil-venting systems are not trivial. In fact, choosing whether or not venting should be applied at a given site is a difficult decision in itself. If one decides to utilize venting, design criteria involving the number of wells, well spacing, well location, well construction, and vapor treatment systems must be addressed. A series of questions must be addressed to decide if venting is appropriate at a given site and to design cost-effective in situ soil-venting systems. This series of steps and questions forms a "decision tree" process. The development of this approach is an attempt to identify the limitations of in situ soil venting, and subjects or behavior that are currently difficult to quantify and for which future study is needed.

Introduction

When operated properly, in situ soil venting or vapor extraction can be a cost-effective remediation process for soils contaminated with gasoline, solvents, or other relatively volatile compounds. A "basic" system, such as the one shown in Figure 1, couples vapor extraction (recovery) wells with blowers or vacuum pumps to remove vapors from the vadose zone and thereby reduce residual levels of soil contaminants. More complex systems incorporate trenches, air injection wells, passive wells, and surface seals. Above-ground treatment systems condense, adsorb, or incinerate vapors; in some cases vapors are simply emitted to the atmosphere through diffuser stacks. In situ soil venting is an especially attractive treatment option because the soil is treated in place, sophisticated equipment is not required, and the cost is typically lower than other options.

The basic phenomena governing the performance of soil-venting systems are easily understood. By applying a vacuum and removing vapors from extraction wells, vapor flow through the unsaturated soil zone is induced. Contaminants volatilize from the soil matrix and are swept by the carrier gas flow (primarily air) to the extraction wells or trenches. Many complex processes occur on the microscale, however, the three main factors that control the performance of a venting operation are the chemical composition of the contaminant, vapor flow rates through the unsaturated zone, and the flow path of carrier vapors relative to the location of the contaminants.

The components of soil-venting systems are typically off-the-shelf items, and the installation of wells and trenches can be done by reputable environmental firms. However, the design, operation, and monitoring of soil-venting systems is not trivial. In fact, choosing whether or not venting should be applied at a given site is a difficult question in itself. If one decides to utilize venting, design criteria involving the number of wells, well spacing, well location, well construction, and vapor treatment systems must be addressed. It is the current state-of-the-art that such questions are answered more by experience than by rigorous logic. This is evidenced by published soil venting "success stories" (see Hutzler et al. 1988 for a good review), which rarely include insight into the design process.

In this paper, a series of questions are presented that must be addressed to:

- Decide if venting is appropriate at a given site.
- Design cost-effective in situ soil-venting systems.

This series of steps and questions forms a "decision tree" process. The development of this approach is an attempt to identify the limitations of in situ soil venting, and subjects or behavior that are currently difficult to quantify and for which future study is needed.

The "Practical Approach"

Figure 2 presents a flow chart of the process discussed in this paper. Each step of the flow chart will be discussed in detail, and where appropriate, examples are given.

The Site Characterization

Whenever a soil contamination problem is detected or suspected, a site investigation is conducted to characthen Figure 8 predicts that ~ 100 l-air/g-gasoline will be required. This is the minimum amount of vapor required, because it is based on an equilibrium-based model. The necessary minimum average vapor flow rate is then equal to the spill mass times the minimum required vapor flow/mass gasoline divided by the desired duration of venting. Use of this approach is illustrated in the service station site example provided at the end of this paper.

Figure 8 also illustrates that there is a practical limit to the amount of residual contaminant that can be removed by venting alone. For example, it will take a minimum of 100 l-vapor/g-gasoline to remove 90 percent of the weathered gasoline defined in Table 2, while it will take about 200 l-air/g-gasoline to remove the remaining 10 percent. In the case of gasoline, by the time 90 percent of the initial residual has been removed, the residual consists of relatively insoluble and non-volatile compounds. It is important to recognize this limitation of venting, and when setting realistic cleanup target levels, they should be based on the potential environmental impact of the residual rather than any specific total residual hydrocarbon levels. Because mandated cleanup levels are generally independent of the remediation method, this also indicates that soil venting will often be one of many processes used during a given site remediation. It is not difficult to envision that in the future soil venting may be followed or coupled with enhanced biodegradation to achieve lower cleanup levels.

It is appropriate to mention at this point that the mathematical models presented in this paper are being used as "tools" to help plan and design venting system. As with any models, they are mathematical descriptions of processes that at best approximate real phenomena, and care should be taken not to misapply or misinterpret the results.

Are There Likely to Be Any Negative Effects of Soil Venting?

It is possible that venting will induce the migration of off-site contaminant vapors toward the extraction wells. This may occur at a service station, which is often in close proximity to other service stations. If this occurs, one could spend a lot of time and money to unknowingly clean up someone else's problem. The solution is to establish a "vapor barrier" at the perimeter of the contaminated zone. This can be accomplished by allowing vapor flow into any perimeter ground water monitoring wells (which often have screened intervals extending above the saturated zone), which then act as passive air supply wells. In other cases it may be necessary to install passive air injection wells, or trenches, as illustrated in Figure 9a.

As pointed out by Johnson et al. (1988), the application of a vacuum to extraction wells can also cause a water table rise. In many cases contaminated soils lie just above the water table and they become water saturated, as illustrated in Figure 9b. The maximum rise occurs at, or below the vapor extraction well, where the water table rise will be equal to the vacuum at that point

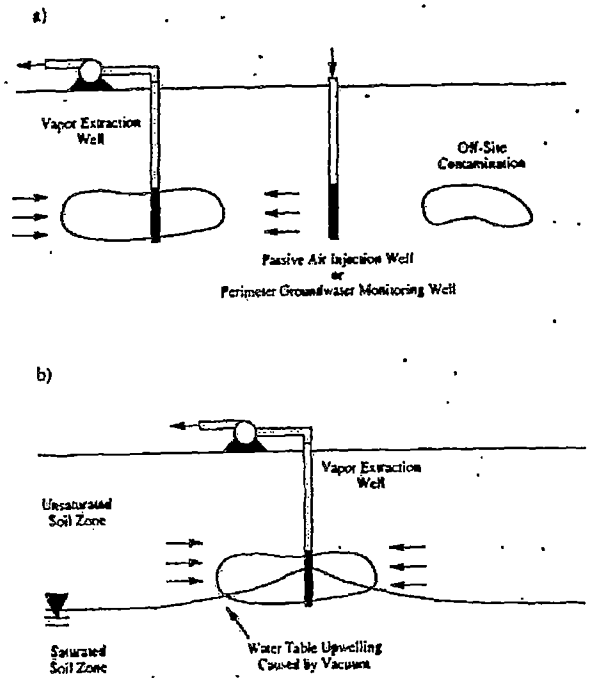


Figure 9. (a) Use of passive vapor wells to prevent migration of off-site contaminant vapors. (b) Water table rise caused by the applied vacuum.

expressed as an equivalent water column height (i.e., in ft H_2O). The recommended solution to this problem is to install a dewatering system, with ground water pumping wells located as close to vapor extraction wells as possible. The dewatering system must be designed to ensure that contaminated soils remain exposed to vapor flow. Other considerations not directly related to venting system design, such as soluble plume migration control and free-liquid product yield, will also be factors in the design of the ground water pumping system.

Design Information

If venting is still a remediation option after answering the questions above, then more accurate information must be collected. Specifically, the soil permeability to vapor flow, vapor concentrations, and aquifer characteristics need to be determined. These are obtained by two field experiments: air permeability and ground water pumping tests, described briefly next.

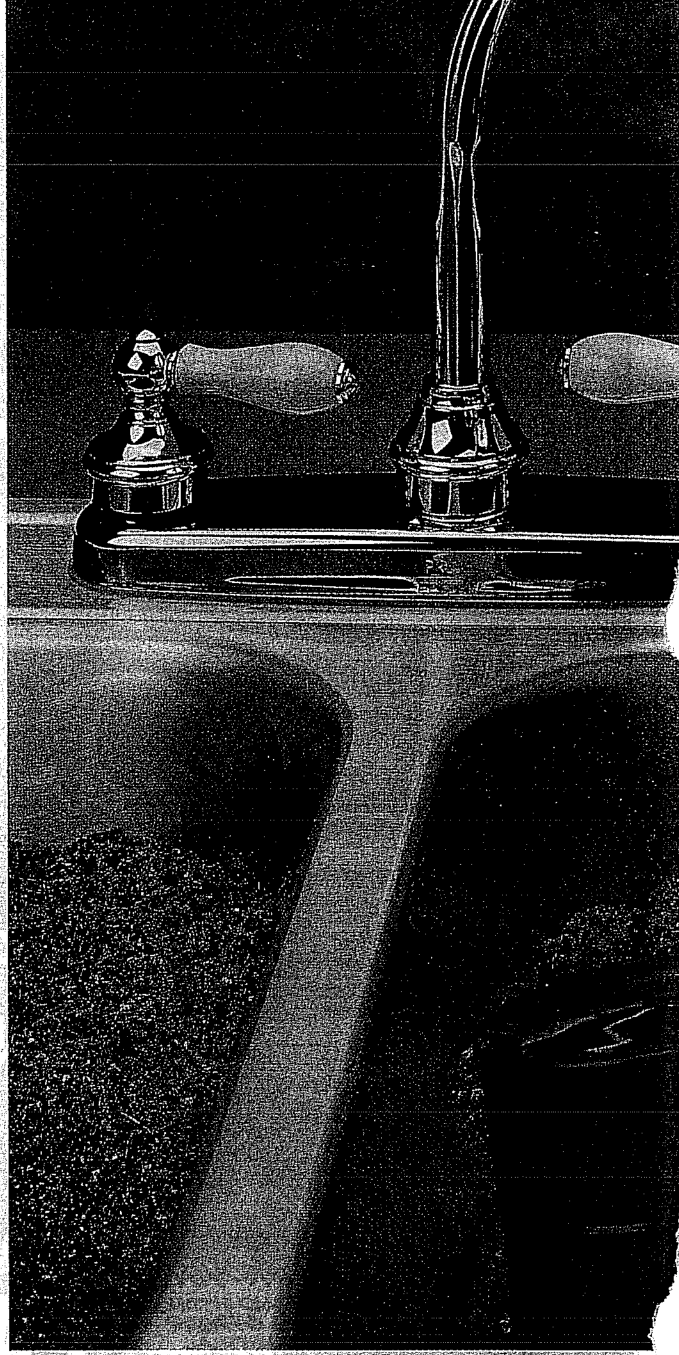
Air Permeability Tests

Figure 10 depicts the setup of an air permeability test. The object of this experiment is to remove vapors at a constant rate from an extraction well, while monitoring with time the transient subsurface pressure distribution at fixed points. Effluent vapor concentrations are also monitored. It is important that the test be conducted properly to obtain accurate design information. The extraction well should be screened through the soil zone that will be vented during the actual operation. In many cases existing ground water monitoring wells are sufficient, if their screened sections extend above the water table. Subsurface pressure monitoring probes can be

Selecting the Appropriate Abatement Technology

Estimating the life-cycle costs of treating hydrocarbon vapors extracted from soil.

by Dr. Peter M. Kroopnick

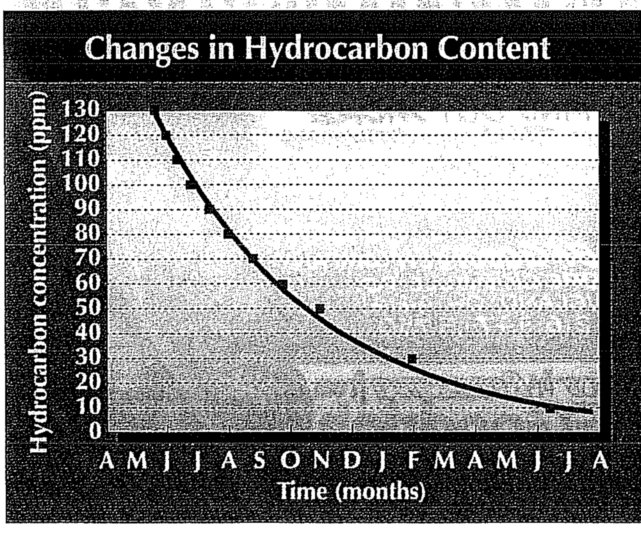


Vapor extraction systems commonly are used to remediate soil contaminated with volatile and semivolatile hydrocarbons. The source of this contamination usually is a leak from an underground storage tank (UST), although accidental spills from pipelines and aboveground tanks also are common. The typical vapor extraction system consists of a vacuum pump attached to shallow extraction wells completed in the vadose zone. The rate of extraction depends on the diffusion and advection of vapor from the contaminated zone, and on the bulk permeability of the soil.

Control of emissions from soil-vent systems increasingly is required. In these cases, the factor that limits the rate of hydrocarbon extraction very often is not the rate of extraction from the ground, but rather the capacity of the abatement device. The concentration of hydrocarbon in the extracted vapor usually is high at the beginning of a remediation and displays an exponential decrease over time (Kroopnick, 1995). There are various strategies for selecting the technology and capacity for the treatment system based on life-cycle costing principles. The devices discussed are vapor-phase granular activated carbon, catalytic oxidation with and without a heat recovery system and thermal oxidation.

Vapor removal from the vadose zone

A soil-vent feasibility study often is performed to determine the site-specific parameters necessary to design a successful and efficient soil-vent system. The key parameters that must be determined are the location of the contaminant, the permeability of the various soil layers and the ability to induce air flow preferentially through the contaminated area. It also is important to ascertain the actual hydrocarbon concentra-



• *Figure 1. Changes in hydrocarbon content of a vapor-stream during a soil-vent cleanup (squares). The solid line represents an exponential decay with a removal factor of 0.38 per day.*

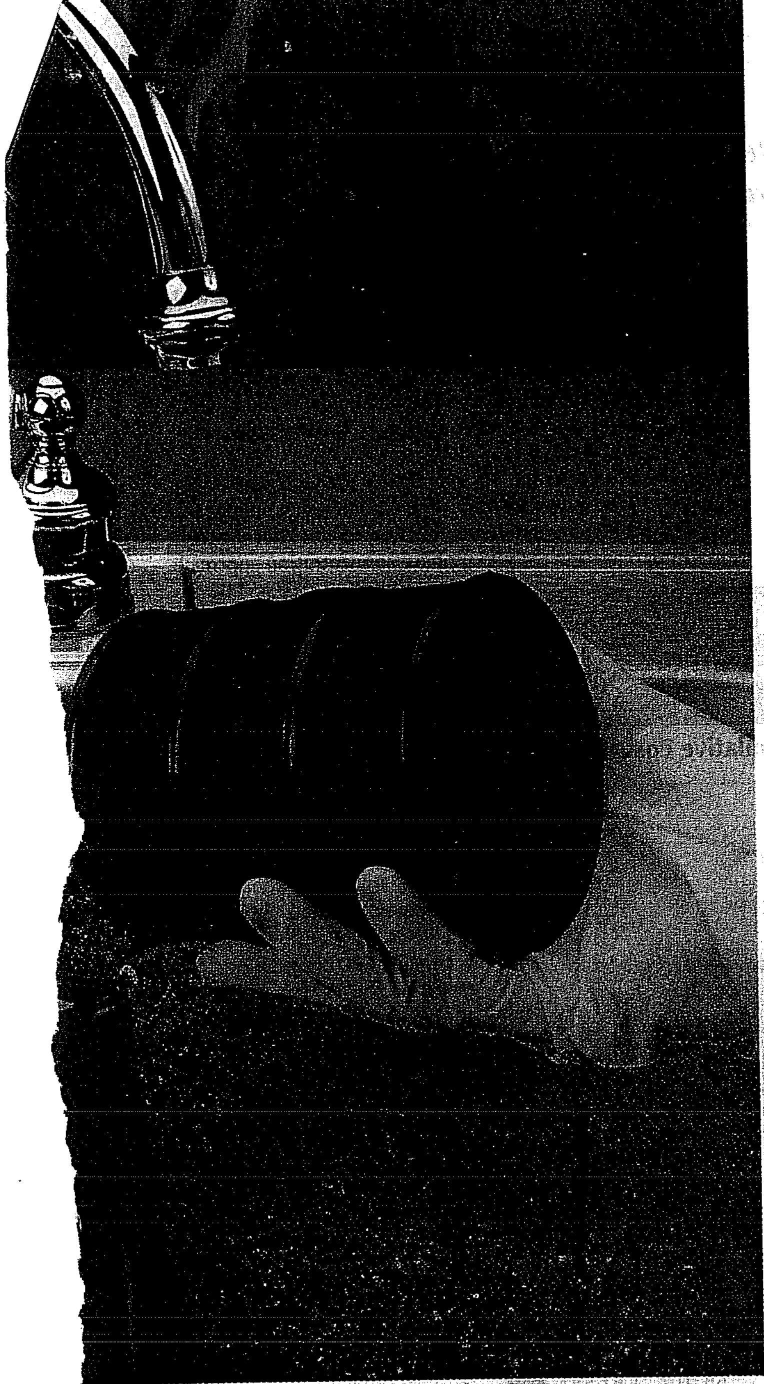


Table 1. Vapor Abatement Cost Analysis Program Input Data Worksheet

Site name:			
Shaded items are model inputs	Devices		
Device parameters	Unit 1	Unit 2	
Maximum device flow rate (scfm)	200	200	A
Maximum device HC concentration (ppmV)	3900	7500	B
Maximum device HC concentration (%LFL) *D = B/13,000*	30%	30%	D
Maximum HC removal (pounds/day) *E = A*B*.016/mol.wt.*	147	284	E
Installation costs Engineering design			F
Equipment purchase			G
Permitting			H
Utilities			I
Installation construction			J
Supplies			K
Startup			L
Total installation costs *M = F+G+H+I+J+K+L*			M
Ongoing costs (monthly)			
Unit lease (purchase price/12)			N
Maintenance vists			O
Sampling per Air Board			P
Disposables (fixed monthly)			Q
Disposables (per pound of carbon)			R
Daily costs (except fuel) *S = (N+O+P+Q)/30*			
Fuel costs @ zero HC concentration ($/day)			T
Fuel cost @ max. HC concentration (see E)			U
Efficiency factor *V = 1-U/T*			V
Daily operating cost, zero HC *W = S+T*			W
Daily operating cost, max. HC *X = W-Y*E*			X
Fuel factor *Y = T*V/E*			Y
Site parameters Total mass to be removed (pounds)	40,000	40,000	
Starting concentration (ppmV)	10,000	10,000	
Molecular weight of contaminant	85	85	
Expected flow rate (scfm)	200	200	
Interest rate for NPV calculation	10%	10%	
VACAP output Cleanup time (to 99%)			
Total cost			
Total cost as NPV			

tion and expected flow rate so the appropriate vacuum pump and emissions-control device can be selected. The cost effectiveness of a venting system thus depends on the quality of the design and its engineering and construction.

Two factors are critical to effective design and operation. The first is the extraction system itself, which includes the number, spacing and location of the extraction wells, as well as the size and type of the manifold and its layout. The second is the vapor treatment system. Carbon generally is inexpensive to purchase, install and permit. However, when high levels of volatile organic compounds (VOCs) are present, carbon can be extremely expensive to recycle. On the other hand, although thermal or catalytic oxidation systems require higher capital expenditure and take time to permit, they are relatively inexpensive to operate because they do not generate hazardous waste. Table 1 illustrates the operating cost categories and parameters for two hypothetical abatement methods. Determining which method to use requires a thorough understanding of the changes in VOC concentration that occur during the soil venting process.

The change in the hydrocarbon content in the vapor stream during a soil-vent cleanup is shown in Figure 1. The site is a retail service station with two vapor-extraction wells. The change in discharge concentrations of hydrocarbons over time, measured with a portable photoionization detector (PID) instrument, indicates a decrease from 130 parts per million by volume (ppmv) to 10 ppmv during the first two months of operation. Following a rapid initial decrease, a slow (asymptotic) decline toward the baseline value is observed. This is typical for soil-vent remediation systems. For comparison, an exponential decay curve of the form:

$$C_t = C_0 \exp(-RF \cdot t)$$

where C_t equals the concentration of hydrocarbon in the vapor phase at time t, C_0 equals the initial concentration at time 0, t equals time and RF is the removal factor, also is shown.

This exponential decay is observed at many sites.

A mathematical model simulates the cost of treating extracted volatiles.

Buscheck and Peargin (1991) conducted a survey of 143 operating vapor extraction systems and found two distinct decay patterns. The first conforms to the exponential model, while the second exhibits a decay with a non-zero asymptote for the mass removal. This latter pattern usually occurs in non-homogeneous formations where slow diffusion from the less permeable zone limits the rate of cleanup (Tormey et al., 1992).

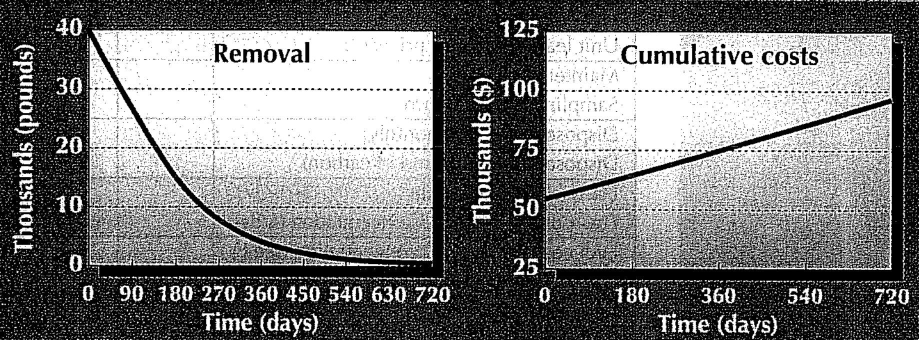
Simulating a remediation

In most cases, the hydrocarbon concentration decreases very rapidly at startup and is followed by an asymptotic approach to zero. To estimate the life-cycle costs for operating an abatement device, this exponential change with time first must be simulated for each site. Exact mathematical models have been proposed for these systems (Johnson et al., 1988). However, because the field data needed to run an exact model usually are not obtainable, we have taken an empirical approach for the purpose of developing a cost analysis methodology.

The model chosen for this simulation is a first order decay process in which the amount of material removed at each time step is calculated based on the assumption that the total remaining mass and the vapor phase concentration approach zero simultaneously. The simulation is performed on a personal computer using a spreadsheet, or with an in-house program called the Vapor Abatement Cost Analysis Program (VACAP) (Kroopnick, 1995). Site-specific data must be obtained for the initial concentration of hydrocarbon in the extractable vapor and for the total amount of contamination to be treated. For each abatement device, information is required for the rate of flow through the device, and for the maximum hydrocarbon concentration the device safely can process.

A critical part of the simulator is the removal rate factor (RF), equivalent to the exponential decay factor in the equation. In the models shown, the RF is adjusted to force both the mass of hydrocarbon remaining and the current concentration to simultaneously approach zero. Figure 2 shows a simulation for a catalytic oxidizer with a heat exchanger. For each time step, the hydrocarbon concentration in the vapor phase is decreased using the equation. If the current concentration is greater than the abatement unit can handle, it must be diluted to an acceptable level. In that case, the effective flow from the soil is reduced as shown in the daily flow column of Figure 2. This dilution usually is accomplished by opening a bleed

Results for VACAP Analysis of a Catalytic Oxicizer with a Heat Exchanger



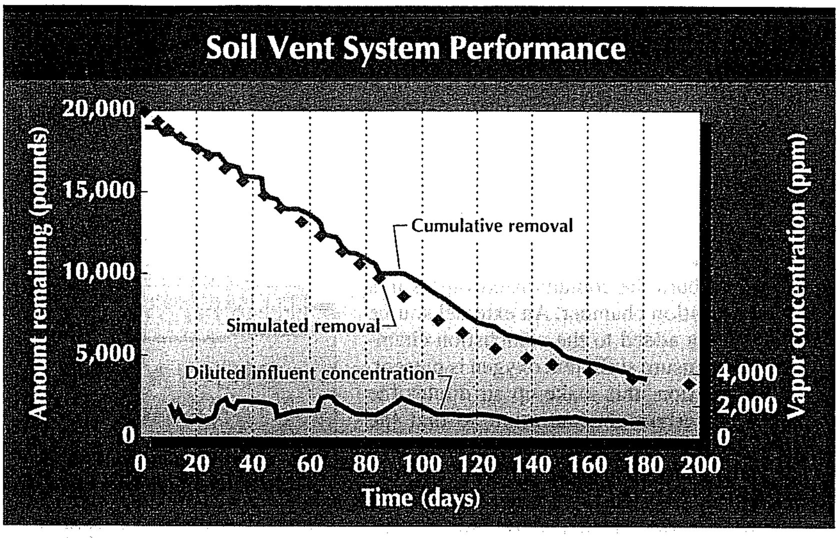
Time (days)	Contaminant left (pounds)	Daily removal (pounds/day)	Daily flow (cfm)	Vapor concentration (ppmv)	Daily cost ($)	Cumulative cost ($)	Cost NPV @10%
0	40,000	0.0	0	10,000	49	54,950	54,950
30	35,652	144.9	96	8090	52	56,495	56,488
60	31,303	144.9	118	6545	52	58,040	58,014
90	26,955	144.9	146	5295	52	59,585	59,528
120	22,607	144.9	181	4284	52	61,130	61,029
150	18,388	129.7	200	3466	54	62,695	62,537
180	14,894	104.9	200	2804	58	64,373	64,140
210	12,066	84.9	200	2268	61	66,154	65,828
240	9779	68.7	200	1835	63	68,019	67,581
270	7929	55.6	200	1485	65	69,951	69,383
300	6432	45.0	200	1201	67	71,939	71,221
330	5220	36.4	200	972	68	73,971	73,085
360	4241	29.4	200	786	69	76,039	74,966
390	3448	23.8	200	636	70	78,136	78,858
420	2806	19.3	200	515	71	80,256	78,756
450	2288	15.6	200	416	72	82,396	80,654
480	1868	12.6	200	337	72	84,551	82,551
510	1528	10.2	200	272	72	86,718	84,444
540	1253	8.3	200	220	73	88,895	86,329
570	1031	6.7	200	178	73	91,081	88,206
600	851	5.4	200	144	73	93,273	90,073
630	706	4.4	200	117	73	95,470	91,930
660	588	3.5	200	94	73	97,672	93,775
690	493	2.9	200	76	74	99,877	95,607
720	416	2.3	200	62	74	102,085	97,427

Figure 2. Results for the VACAP analysis of a catalytic oxidizer with a heat exchanger.

valve and is simulated as shown in Figure 2 by decreasing the total flow of air into the unit.

If the newly calculated concentration is less than the maximum the abatement unit can handle, the entire process stream is admitted to the unit, and the amount of hydrocarbon removed for that time step is subtracted from the remaining mass. For the unit in this example, the maximum influent concentration of 3900 ppmv is reached after 150 days, as shown in Figure 2. The effects of variable geologic conditions are considered by adjusting the decay factor by approximately ±10 percent to simulate the relative effects of very permeable sand or much less permeable clay.

Figure 3 shows actual data and a simulation for a retail petroleum site where the defective UST was removed and four vapor extraction wells were installed. The underlying soil were of mixed lithology, ranging from silty clay to sandy gravel, and had concentrations of total petroleum hydrocarbons as gasoline in excess of 11,000 mg/kg. Initial mass balance calculations indicated that approximately 20,000 pounds of hydrocarbon could be recovered. Vapor concentrations from the wells initially exceeded 20,000 ppmv of gasoline, and were diluted by manually opening a bleed valve until the vapor concentration remained below 3900 ppmv on day 110. See the lowest curve in Figure 3. The upper curve shows the decrease in total mass. Note that the curve is nearly linear between days 30 and 110. This is due to the nearly constant removal rate, which was controlled by the dilution process. The results of the VACAP model are shown by the diamond symbols and appear to match the observed removal rate.

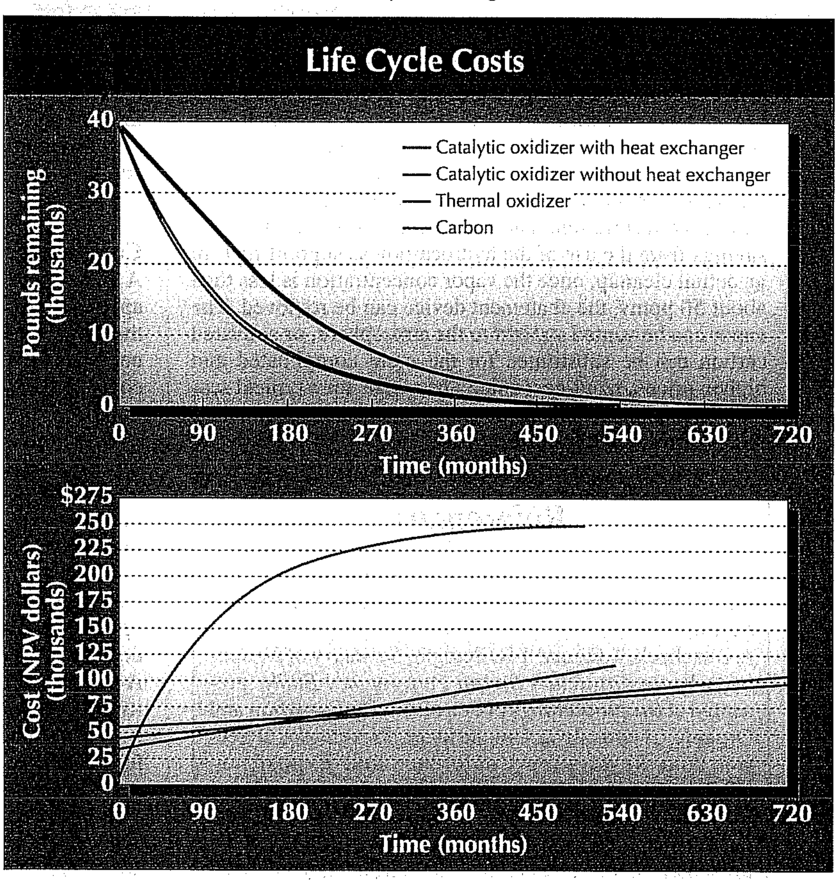


• *Figure 3. Comparison of VACAP model with data collected during remediation of a site contaminated by a leaking UST.*

Abatement devices

The assumptions for estimating the costs and treatment capacity for each unit must be based on vendor and engineering experience. The worksheet can be used to evaluate and compare total costs to treat a volatile contaminant.

Vapor-phase activated carbon is used as the baseline abatement technology. In our experience, the adsorption efficiency of carbon is about 25 percent for most hydrocarbons. For the sake of comparison, the maximum flow rate through the carbon has been established to be 200 standard cubic feet per minute (scfm). Due to safety standards, the maximum hydrocarbon concentration in the process stream will be kept below 100 percent of the lower flammability limit (LFL).



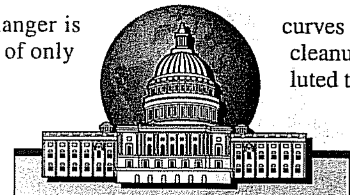
• ***Figure 4. The upper figure shows the decrease in the mass remaining versus time. The lower figure shows the increasing cumulative costs for each of the three abatement devices. Note: Figures are for illustrative purposes only.***

The catalytic oxidizer is a natural gas heated unit. The gasoline generates a rise in temperature across the catalyst equivalent to about 20°F for each one percent of LFL. Thus, a process stream of 30 percent of LFL causes the catalyst temperature to rise from a light off point of 650°F to 1250°F. This represents the maximum temperature the unit can sustain without damaging the catalyst. Installation costs can be based on experience at similar sites. Catalyst replacement every six months to 12 months of operation also must be considered. The equivalent cost savings for the amount of hydrocarbon usable as fuel could be as high as 90 percent as a result of using a heat exchanger, which preheats the process stream with the

Using the model, it is possible to compute the total cost of running designated equipment.

exhaust gas. A unit without the heat exchanger is less expensive, but results in an efficiency of only about 25 percent.

A thermal oxidizer unit uses natural gas to burn the contaminated vapors in a combustion chamber. An external source of air is added to the combustion chamber to ensure sufficient oxygen is present. In addition, this make-up air dilutes the hydrocarbon concentration so that the maximum contaminant level is estimated to be about 60 percent of LFL. Support fuel is required at all times to keep the combustion chamber above 1400°F. The effectiveness of a heat exchanger is similar to a catalytic unit.



REGULATORY IMPACT

The following regulation applies to hydrocarbon vapors:

▶ The Federal Clean Air Act, administered by local air pollution control agencies

Life-cycle costs

The proposed simulation model now can be used to compute the life-cycle costs for each of the abatement units. The user should first fill in the data in Figure 1. For each time step of the simulation, the daily cost is calculated based on the daily cost with no hydrocarbons in the process stream, minus the amount of fuel recovered from the current hydrocarbon concentration. The fuel factor represents the cost savings from the use of the hydrocarbon as support fuel. In an actual cleanup, once the vapor concentration is less than about 50 ppmv, the abatement device can be removed. The vapor can be vented straight to the atmosphere, or activated carbon can be substituted for the more complicated and higher-priced, fixed-cost units. The results for a typical scenario are presented in Figure 2.

For a relatively permeable formation, the time decay curves appear to be linear during the early part of the cleanup. This is because the process stream is diluted to meet the maximum hydrocarbon levels permitted by each unit. During this early stage, the number of pounds removed per day is constant for each abatement unit, and the relative slopes of the four curves reflect the flow rate and concentration for each device. The life-cycle costs for this simulation represent the sum of all the daily costs. The times and life-cycle costs to achieve removal of 99 percent of the contaminant mass indicate that while the carbon system achieves cleanup in the least time, 526 days, it will cost more than twice as much as any of the other alternatives considered here. See Figure 4. Net present value costs also are given, assuming a rather high inflation rate of 10 percent to emphasize the advantage of using current dollars to pay for future costs. The thermal unit requires 543 days but costs less. The catalytic system without a heat exchanger takes 728 days and costs still less, while using a heat exchanger reduces the final cost even further.

Conclusions

A mathematical model has been developed and shown applicable to vapor extraction of small sites. It calculates the expected time required to extract the volatile components adsorbed to soil, and then uses the time-dependent concentration data to drive an economic model that computes the total cost to run the designated equipment. The assumptions inherent in the model and the estimated performance characteristics for the various abatement devices must be developed for each site, but usually can be estimated from prior experience. The life-cycle model indicates that vapor phase carbon can be used to remediate a site very quickly, but the associated costs are more than twice that of the other abatement units. The thermal oxidizer initially appears to be very cost-effective, but this advantage decreases with respect to the catalytic unit for longer times. A heat exchanger raises the initial capital cost but pays for itself in about 200 days.

These evaluations should be considered generic and used for illustrative purposes only, because actual site conditions may vary considerably with respect to geologic complexity, quantity of material to be treated and chemical composition of the contaminant. The final decision as to the most appropriate abatement device also should take into account whether time or cost is the most important parameter, and whether the treated vapor stream complies with local air discharge regulations.

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Reader Interest Review

Please circle the appropriate number on the Reader Service Card to indicate the level of interest in the article.

High **206** Medium **207** Low **208**

Table 1. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-1	74–104	7490.01	01/01/09	75.74	---	0.00	7414.27
			09/01/10	58.27	54.04	4.23	7434.91
			08/01/11	Not measured			
			10/01/11	69.75	69.59	0.16	7420.38
			02/01/13	76.85	72.24	4.61	7416.62
			04/08/15	Well destroyed			
MW-1S	60–90	7490.76	10/05/15	62.78	---	0.00	7427.98
			07/19/16	66.44	66.40	0.04	7424.35
			10/13/16	62.40	62.28	0.12	7428.46
			01/30/17	59.93	59.74	0.19	7430.99
			04/11/17	68.77	68.55	0.22	7422.17
			12/12/17	67.50	66.99	0.51	7423.68
			03/06/18	64.33	---	0.00	7426.43
			06/11/18	73.14	72.55	0.59	7418.11
			08/14/18	66.01	---	0.00	7424.75
			09/25/18	61.17	---	0.00	7429.59
			01/28/20	66.41	66.19	0.22	7424.53
			04/13/20	65.33	65.23	0.10	7425.51
MW-1D	134.5–154.5	7488.70	05/12/15	118.51	---	0.00	7370.19
			06/15/15	118.38	---	0.00	7370.32
			07/15/15	113.10	---	0.00	7375.60
			08/18/15	105.76	---	0.00	7382.94
			09/08/15	110.53	110.52	0.01	7378.18
			10/05/15	116.38	---	0.00	7372.32
			07/21/16	124.10	---	0.00	7364.60
			10/13/16	116.74	---	0.00	7371.96

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MW-1D (cont.)	134.5–154.5	7488.70	01/30/17	114.05	---	0.00	7374.65
			04/11/17	123.25	---	0.00	7365.45
			12/12/17	124.76	---	0.00	7363.94
			03/06/18	122.09	---	0.00	7366.61
			06/11/18	128.81	---	0.00	7359.89
			09/25/18	116.78	---	0.00	7371.92
			01/28/20	125.68	---	0.00	7363.02
			04/13/20	120.93	---	0.00	7367.77
MW-2(S)	67–97	7488.05	01/01/09	73.74	69.08	4.66	7418.04
			09/01/10	72.24	57.30	14.94	7427.76
			08/01/11	Not measured			
			10/01/11	79.99	70.34	9.65	7415.78
			02/01/13	90.30	72.31	17.99	7412.14
			04/08/15	79.11	60.45	18.66	7423.87
			05/12/15	68.73	68.52	0.21 [c]	7419.49
			06/15/15	71.14	70.13	1.01	7417.72
			07/15/15	67.13	64.82	2.31	7422.77
			08/18/15	64.47	63.33	1.14	7424.49
			09/08/15	67.44	66.77	0.67	7421.15
			10/05/15	69.89	68.96	0.93	7418.90
			07/18/16	77.80	71.22	6.58	7415.51
			10/14/16	73.66	71.65	2.01	7416.00
			01/30/17	66.26	63.42	2.84	7424.06
			04/11/17	75.47	73.34	2.13	7414.28
			12/12/17	79.27	74.93	4.34	7412.25
			03/06/18	74.21	72.91	1.30	7414.88

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MW-2(S) (cont.)	67–97	7488.05	06/11/18	79.00	77.96	1.04	7409.88
			08/14/18	68.01	66.36	1.65	7421.36
			09/25/18	64.26	62.09	2.17	7425.53
			01/28/20	76.82	72.70	4.12	7414.53
			04/13/20	72.77	70.89	1.88	7416.78
MW-2D	100–130	7487.73	05/12/15	71.81	---	0.00	7415.92
			06/15/15	72.87	---	0.00	7414.86
			07/15/15	70.48	---	0.00	7417.25
			08/18/15	65.14	---	0.00	7422.59
			09/05/15	67.48	---	0.00	7420.25
			10/05/15	71.27	---	0.00	7416.46
			07/21/16	75.19	---	0.00	7412.54
			10/12/16	72.35	---	0.00	7415.38
			01/30/17	67.87	---	0.00	7419.86
			04/11/17	74.47	---	0.00	7413.26
			12/12/17	75.96	---	0.00	7411.77
			03/06/18	74.97	---	0.00	7412.76
			06/11/18	78.37	---	0.00	7409.36
			09/25/18	71.52	---	0.00	7416.21
			01/28/20	75.81	---	0.00	7411.92
			04/13/20	74.79	---	0.00	7412.94
MW-3(S)	65–95	7487.37	01/01/09	73.59	---	0.00	7413.78
			09/01/10	65.00	63.55	1.45	7423.53
			08/01/11	Not measured			
			10/01/11	77.93	70.81	7.12	7415.14
			02/01/13	79.80	76.50	3.30	7410.21

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MW-3(S) (cont.)	65–95	7487.37	04/08/15	73.96	69.81	4.15	7416.73
			05/12/15	70.36	70.31	0.05 [c]	7417.05
			06/15/15	71.21	71.16	0.05	7416.20
			07/15/15	66.80	---	0.00	7420.57
			08/18/15	66.29	63.83	2.46	7423.05
			09/08/15	68.45	68.16	0.29	7419.15
			10/05/15	71.27	70.81	0.46	7416.47
			07/18/16	74.31	74.04	0.27	7413.28
			10/14/16	71.53	71.45	0.08	7415.90
			01/30/17	64.75	---	0.00	7422.62
			04/11/17	73.96	73.86	0.10	7413.49
			12/12/17	75.80	75.47	0.33	7411.83
			03/06/18	79.39	72.00	7.39	7413.89
			06/11/18	80.52	77.25	3.27	7409.47
			08/14/18	76.65	68.55	8.10	7417.20
			09/25/18	75.13	66.72	8.41	7418.97
			01/28/20	77.45	74.61	2.84	7412.19
			04/13/20	72.89	72.24	0.65	7415.00
MW-4(S)	66–86	7487.02	08/01/11	69.65	66.18	3.47	7420.15
			10/01/11	65.20	61.00	4.20	7425.18
			02/01/13	71.00	64.51	6.49	7421.21
			04/08/15	50.29	48.25	2.04	7438.36
			05/12/15	51.17	51.16	0.01 [c]	7435.86
			06/15/15	56.16	55.92	0.24	7431.05
			07/15/15	45.72	45.69	0.03	7441.32
			08/18/15	44.97	44.93	0.04	7442.08

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MW-4(S) (cont.)	66–86	7487.02	09/08/15	49.85	49.81	0.04	7437.20
			10/05/15	54.89	54.86	0.03	7432.15
			07/18/16	58.50	58.48	0.02	7428.54
			10/14/16	49.55	49.48	0.07	7437.53
			01/30/17	42.94	42.92	0.02	7444.10
			04/11/17	57.03	56.96	0.07	7430.05
			12/12/17	51.94	51.92	0.02	7435.10
			03/06/18	47.26	47.19	0.07	7439.82
			06/11/18	59.30	59.24	0.06	7427.77
			09/25/18	40.87	40.86	0.01	7446.16
			01/28/20	47.75	47.73	0.02	7439.29
			04/13/20	46.41	46.40	0.01	7440.62
MW-5	88–108	7494.20	08/01/11	92.89	---	0.00	7401.31
			10/01/11	93.01	---	0.00	7401.19
			02/01/13	102.33	---	0.00	7391.87
			04/08/15	87.20	---	0.00	7407.00
			05/12/15	Well plugged and abandoned			
MW-5S	75–105	7493.40	05/12/15	84.35	---	0.00	7409.05
			06/15/15	85.45	---	0.00	7407.95
			07/15/15	85.21	---	0.00	7408.19
			08/18/15	79.80	---	0.00	7413.60
			09/08/15	80.13	---	0.00	7413.27
			10/05/15	82.98	--	0.00	7410.42
			07/19/16	87.34	--	0.00	7406.06
			10/12/16	84.12	--	0.00	7409.28
			01/30/17	87.62	--	0.00	7405.78

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MW-5S (cont.)	75–105	7493.40	04/11/17	89.76	--	0.00	7403.64
			12/12/17	90.42	--	0.00	7402.98
			03/06/18	93.02	--	0.00	7400.38
			06/11/18	97.06	--	0.00	7396.34
			09/25/18	87.70	--	0.00	7405.70
			01/28/20	88.08	--	0.00	7405.32
			04/13/20	87.14	--	0.00	7406.26
MW-6	113–133	7491.66	08/01/11	126.16	125.96	0.20	7365.66
			10/01/11	126.94	122.76	4.18	7368.15
			02/01/13	128.40	127.94	0.46	7363.64
			04/08/15	106.36	90.92	15.44	7397.96
			05/09/15	Well plugged and abandoned			
MW-6S	83–113	7490.87	05/12/15	81.34	---	0.00	7409.53
			06/15/15	83.58	---	0.00	7407.29
			07/15/15	83.03	---	0.00	7407.84
			08/18/15	77.57	---	0.00	7413.30
			09/08/15	78.30	---	0.00	7412.57
			10/05/15	81.15	---	0.00	7409.72
			07/19/16	86.44	85.91	0.53	7404.86
			10/14/16	82.43	82.25	0.18	7408.59
			01/30/17	86.16	---	0.00	7404.71
			04/11/17	88.63	---	0.00	7402.24
			12/12/17	89.81	---	0.00	7401.06
			03/06/18	94.72	94.68	0.04	7396.18
			06/11/18	97.37	---	0.00	7393.50
			09/25/18	86.16	---	0.00	7404.71

Table 1. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-6S (cont.)	83–113	7490.87	01/28/20	86.23	---	0.00	7404.64
			04/13/20	84.09	---	0.00	7406.78
MW-6D	120–140	7490.70	05/12/15	120.71	---	0.00	7369.99
			06/15/15	120.54	---	0.00	7370.16
			07/15/15	115.50	---	0.00	7375.20
			08/18/15	108.51	---	0.00	7382.19
			09/08/15	112.78	---	0.00	7377.92
			10/05/15	118.55	---	0.00	7372.15
			07/19/16	126.70	---	0.00	7364.00
			10/12/16	119.54	---	0.00	7371.16
			01/30/17	116.57	---	0.00	7374.13
			04/11/17	125.35	---	0.00	7365.35
			12/12/17	126.77	---	0.00	7363.93
			03/06/18	124.26	---	0.00	7366.44
			06/11/18	131.47	---	0.00	7359.23
			09/25/18	119.33	---	0.00	7371.37
			01/28/20	126.92	---	0.00	7363.78
			04/13/20	123.63	---	0.00	7367.07
MW-7(S)	70–100	7488.61	10/05/15	75.44	---	0.00	7413.17
			07/20/16	73.60	---	0.00	7415.01
			10/13/16	70.56	---	0.00	7418.05
			01/30/17	68.39	---	0.00	7420.22
			04/11/17	71.35	---	0.00	7417.26
			12/12/17	72.52	---	0.00	7416.09
			03/06/18	72.61	---	0.00	7416.00
			06/11/18	73.29	---	0.00	7415.32

Table 1. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-7(S) (cont.)	70–100	7488.61	09/25/18	68.03	---	0.00	7420.58
			01/28/20	70.28	---	0.00	7418.33
			04/13/20	68.93	---	0.00	7419.68
MW-7(D)	110–130	7488.74	08/01/11	126.58	---	0.00	7362.16
			10/01/11	123.09	---	0.00	7365.65
			02/01/13	Dry			
			04/08/15	112.77	---	0.00	7375.97
			05/12/15	112.68	---	0.00	7376.06
			06/15/15	113.17	---	0.00	7375.57
			07/15/15	111.02	---	0.00	7377.72
			08/18/15	101.47	---	0.00	7387.27
			09/08/15	104.30	---	0.00	7384.44
			10/05/15	108.79	---	0.00	7379.95
			07/20/16	117.39	---	0.00	7371.35
			10/13/16	111.69	---	0.00	7377.05
			01/30/17	112.46	---	0.00	7376.28
			04/11/17	112.45	---	0.00	7376.29
			12/12/17	112.80	---	0.00	7375.94
			03/06/18	115.81	---	0.00	7372.93
			06/11/18	116.67	---	0.00	7372.07
			09/25/18	113.26	---	0.00	7375.48
			01/28/20	114.67	---	0.00	7374.07
			04/13/20	113.64	---	0.00	7375.10
MW-8(S)	51–81	7476.30	02/01/13	54.76	---	0.00	7421.54
			04/08/15	47.47	47.45	0.02	7428.85
			05/12/15	45.67	---	0.00	7430.63

Table 1. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-8(S) (cont.)	51–81	7476.30	06/15/15	49.13	---	0.00	7427.17
			07/15/15	46.44	---	0.00	7429.86
			08/18/15	45.03	---	0.00	7431.27
			09/08/15	46.81	---	0.00	7429.49
			10/05/15	49.19	---	0.00	7427.11
			07/21/16	51.20	---	0.00	7425.10
			10/12/16	48.86	---	0.00	7427.44
			01/30/17	45.05	---	0.00	7431.25
			04/11/17	50.26	---	0.00	7426.04
			12/12/17	50.71	---	0.00	7425.59
			03/06/18	49.44	---	0.00	7426.86
			06/11/18	53.44	---	0.00	7422.86
			09/25/18	46.29	---	0.00	7430.01
			01/28/20	50.37	---	0.00	7425.93
			04/13/20	48.32	---	0.00	7427.98
MW-9S	66–96	7489.08	05/12/15	86.41	---	0.00	7402.67
			06/15/15	85.67	---	0.00	7403.41
			07/15/15	85.83	---	0.00	7403.25
			08/18/15	84.98	---	0.00	7404.10
			09/08/15	85.50	---	0.00	7403.58
			10/05/15	85.72	---	0.00	7403.36
			07/20/16	86.10	---	0.00	7402.98
			10/12/16	85.85	---	0.00	7403.23
			01/30/17	86.23	---	0.00	7402.85
			04/11/17	86.06	---	0.00	7403.02
			12/12/17	86.12	---	0.00	7402.96

Table 1. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-9S (cont.)	66–96	7489.08	03/06/18	86.51	---	0.00	7402.57
			06/11/18	86.80	---	0.00	7402.28
			09/25/18	86.42	---	0.00	7402.66
			01/28/20	86.10	---	0.00	7402.98
			04/13/20	86.10	---	0.00	7402.98
MW-9(D)	110–150	7488.58	02/01/13	131.69	---	0.00	7356.89
			04/08/15	119.96	119.94	0.02	7368.64
			05/12/15	118.47	---	0.00	7370.11
			06/15/15	118.62	---	0.00	7369.96
			07/15/15	113.72	---	0.00	7374.86
			08/18/15	106.25	---	0.00	7382.33
			09/08/15	111.38	---	0.00	7377.20
			10/05/15	116.53	---	0.00	7372.05
			07/20/16	123.99	---	0.00	7364.59
			10/12/16	116.85	---	0.00	7371.73
			01/30/17	115.08	---	0.00	7373.50
			04/11/17	123.81	---	0.00	7364.77
			12/12/17	125.05	---	0.00	7363.53
			03/06/18	122.36	---	0.00	7366.22
			06/11/18	128.81	---	0.00	7359.77
			09/25/18	117.92	---	0.00	7370.66
			01/28/20	126.47	---	0.00	7362.11
			04/13/20	121.52	---	0.00	7367.06
MW-10(S)	72–102	7486.69	02/01/13	84.83	75.31	9.52	7409.67
			04/08/15	79.72	71.45	8.27	7413.75
			05/12/15	74.41	70.78	3.63 [c]	7415.26

Table 1. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-10(S) (cont.)	72–102	7486.69	06/15/15	75.35	71.75	3.60	7414.29
			07/15/15	69.31	67.12	2.19	7419.18
			08/18/15	66.88	66.11	0.77	7420.44
			09/08/15	71.49	69.88	1.61	7416.52
			10/05/15	72.26	72.26	Sheen [d]	7414.43
			07/19/16	79.63	74.01	5.62	7411.67
			10/14/16	75.43	72.75	2.68	7413.46
			01/30/17	66.83	66.04	0.79	7420.51
			04/11/17	77.33	74.18	3.15	7411.94
			12/12/17	81.40	75.46	5.94	7410.16
			03/06/18	74.30	73.75	0.55	7412.84
			06/11/18	84.74	77.24	7.50	7408.10
			08/14/18	70.03	69.56	0.47	7417.05
			09/25/18	69.33	68.64	0.69	7417.93
			01/29/20	79.70	76.20	3.50	7409.86
			04/13/20	75.00	73.09	1.91	7413.26
MW-11(S)	72–102	7483.31	02/01/13	74.13	---	0.00	7409.18
			04/08/15	74.76	66.43	8.33	7415.38
			05/12/15	68.70	67.20	1.50 [c]	7415.84
			06/15/15	72.18	67.68	4.50	7414.82
			07/15/15	65.85	63.69	2.16	7419.23
			08/18/15	59.65	59.58	0.07	7423.72
			09/08/15	64.37	64.26	0.11	7419.03
			10/05/15	69.87	67.20	2.67	7415.63
			07/19/16	75.82	70.11	5.71	7412.17
			10/14/16	72.63	67.43	5.20	7414.94

Table 1. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-11(S) (cont.)	72–102	7483.31	01/30/17	66.20	60.69	5.51	7421.63
			04/11/17	74.19	69.61	4.58	7412.88
			12/12/17	74.03	71.61	2.42	7411.26
			03/06/18	72.50	70.17	2.33	7412.72
			06/11/18	77.16	74.16	3.00	7408.61
			08/14/18	69.14	67.50	1.64	7415.51
			09/25/18	67.97	65.45	2.52	7417.41
			01/28/20	74.70	71.21	3.49	7411.47
			04/13/20	72.07	69.03	3.04	7413.73
MW-12S	51–81	7473.70	05/12/15	64.58	---	0.00	7409.12
			06/15/15	55.15	---	0.00	7418.55
			07/15/15	51.00	---	0.00	7422.70
			08/18/15	50.57	---	0.00	7423.13
			09/08/15	53.41	---	0.00	7420.29
			10/05/15	54.99	---	0.00	7418.71
			07/20/16	59.99	---	0.00	7413.71
			10/12/16	54.20	---	0.00	7419.50
			01/30/17	48.84	---	0.00	7424.86
			04/11/17	58.63	---	0.00	7415.07
			12/12/17	59.98	---	0.00	7413.72
			03/06/18	53.66	---	0.00	7420.04
			06/11/18	62.97	---	0.00	7410.73
			09/25/18	51.32	---	0.00	7422.38
			01/28/20	58.68	---	0.00	7415.02
			04/13/20	54.18	---	0.00	7419.52
MW-13S	39.5–69.5	7472.44	05/12/15	55.01	---	0.00	7417.43

Table 1. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-13S (cont.)	39.5–69.5	7472.44	06/15/15	44.78	---	0.00	7427.66
			07/15/15	43.94	---	0.00	7428.50
			08/18/15	40.21	---	0.00	7432.23
			09/08/15	43.03	---	0.00	7429.41
			10/05/15	44.73	---	0.00	7427.71
			07/21/16	46.22	---	0.00	7426.22
			10/11/16	44.99	---	0.00	7427.45
			01/30/17	42.66	---	0.00	7429.78
			04/11/17	46.08	---	0.00	7426.36
			12/12/17	46.79	---	0.00	7425.65
			03/06/18	48.28	---	0.00	7424.16
			06/11/18	48.22	---	0.00	7424.22
			09/25/18	44.68	---	0.00	7427.76
			01/28/20	44.69	---	0.00	7427.75
			04/13/20	43.94	---	0.00	7428.50
MW-14S	42–72	7476.16	10/05/15	56.54	---	0.00	7419.62
			07/19/16	58.24	---	0.00	7417.92
			10/11/16	56.18	---	0.00	7419.98
			01/30/17	51.38	---	0.00	7424.78
			04/11/17	57.93	---	0.00	7418.23
			12/12/17	58.43	---	0.00	7417.73
			03/06/18	57.17	---	0.00	7418.99
			06/11/18	59.07	---	0.00	7417.09
			09/25/18	55.09	---	0.00	7421.07
			01/28/20	57.69	---	0.00	7418.47
			04/13/20	56.88	---	0.00	7419.28

Table 1. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-15S	46–76	7474.33	10/05/15	58.08	---	0.00	7416.25
			07/19/16	61.65	---	0.00	7412.68
			10/11/16	58.77	---	0.00	7415.56
			01/30/17	54.62	---	0.00	7419.71
			04/11/17	60.81	---	0.00	7413.52
			12/12/17	62.35	---	0.00	7411.98
			03/06/18	61.68	---	0.00	7412.65
			06/11/18	64.73	---	0.00	7409.60
			09/25/18	58.38	---	0.00	7415.95
			01/28/20	62.24	---	0.00	7412.09
			04/13/20	59.91	---	0.00	7414.42
MW-16S	58–88	7475.36	10/05/15	62.72	---	0.00	7412.64
			07/20/16	64.22	---	0.00	7411.14
			10/11/16	65.91	---	0.00	7409.45
			01/30/17	63.82	---	0.00	7411.54
			04/11/17	63.72	---	0.00	7411.64
			12/12/17	67.48	---	0.00	7407.88
			03/06/18	65.28	---	0.00	7410.08
			06/11/18	66.78	---	0.00	7408.58
			09/25/18	64.16	---	0.00	7411.20
			01/28/20	65.45	---	0.00	7409.91
			04/13/20	65.25	---	0.00	7410.11
MW-17S	54–84	7477.94	10/05/15	53.13	---	0.00	7424.81
			07/20/16	53.77	---	0.00	7424.17
			10/11/16	53.69	---	0.00	7424.25
			01/30/17	48.78	---	0.00	7429.16

Table 1. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

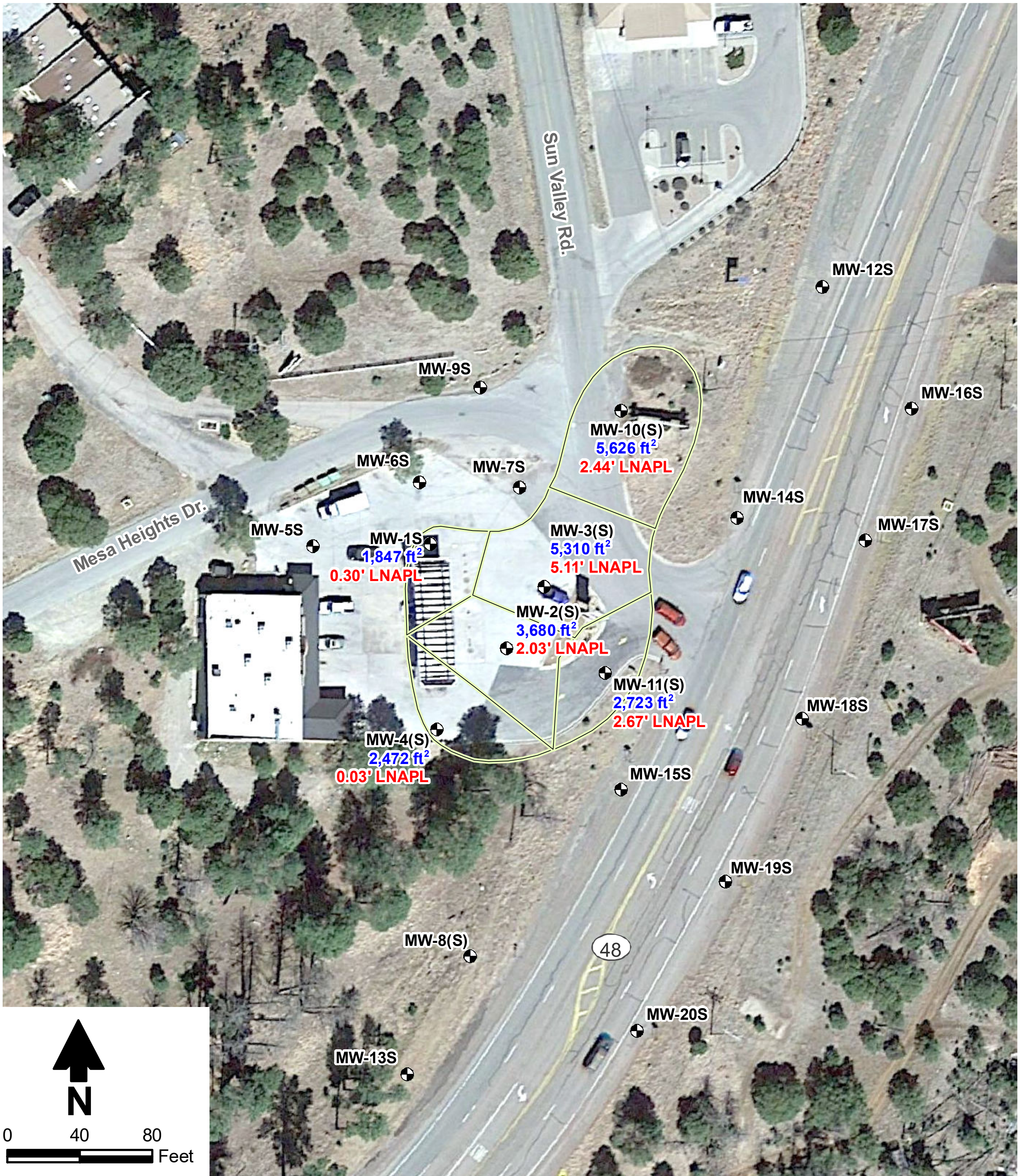
Well Name	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-17S (cont.)	54–84	7477.94	04/11/17	53.33	---	0.00	7424.61
			12/12/17	54.57	---	0.00	7423.37
			03/06/18	52.80	---	0.00	7425.14
			06/11/18	56.06	---	0.00	7421.88
			09/25/18	49.35	---	0.00	7428.59
			01/28/20	52.75	---	0.00	7425.19
			04/13/20	51.11	---	0.00	7426.83
MW-18S	53–83	7479.31	10/05/15	64.21	---	0.00	7415.10
			07/20/16	67.13	---	0.00	7412.18
			10/11/16	64.94	---	0.00	7414.37
			01/30/17	62.36	---	0.00	7416.95
			04/11/17	66.28	---	0.00	7413.03
			12/12/17	67.83	---	0.00	7411.48
			03/06/18	67.39	---	0.00	7411.92
			06/11/18	69.94	---	0.00	7409.37
			09/25/18	64.80	---	0.00	7414.51
			01/28/20	67.73	---	0.00	7411.58
			04/13/20	65.56	---	0.00	7413.75
MW-19S	55–85	7478.75	10/05/15	62.55	---	0.00	7416.20
			07/20/16	65.98	---	0.00	7412.77
			10/11/16	63.28	---	0.00	7415.47
			01/30/17	59.33	---	0.00	7419.42
			04/11/17	65.31	---	0.00	7413.44
			12/12/17	66.67	---	0.00	7412.08
			03/06/18	66.25	---	0.00	7412.50
			06/11/18	69.22	---	0.00	7409.53

Table 1. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-19S (cont.)	55–85	7478.75	09/25/18	63.02	---	0.00	7415.73
			01/28/20	66.62	---	0.00	7412.13
			04/13/20	64.51	---	0.00	7414.24
MW-20S	42–72	7477.13	10/05/15	56.93	---	0.00	7420.20
			07/20/16	62.12	---	0.00	7415.01
			10/11/16	58.39	---	0.00	7418.74
			01/30/17	57.84	---	0.00	7419.29
			04/11/17	60.96	---	0.00	7416.17
			12/12/17	62.6	---	0.00	7414.53
			03/06/18	63.11	---	0.00	7414.02
			06/11/18	65.13	---	0.00	7412.00
			09/25/18	59.13	---	0.00	7418.00
			01/28/20	62.66	---	0.00	7414.47
			04/13/20	60.17	---	0.00	7416.96
RECW		7297.72	08/14/18	10.66	---	0.00	7287.06

[a] Surveyed by Cobb-Fendley, April, May, and October, 2015, unless otherwise noted.
[b] Groundwater elevation (GWE) corrected for LNAPL thickness using the following equation:
GWE = TOC Elevation - (DTW - (LNAPL thickness x SG)).
SG = 0.80 for wells MW-2(S), MW-3(S), and MW-4(S), and 0.82 for all other wells
[c] Fluid levels gauged after periodic recovery of LNAPL. LNAPL thickness not believed to be representative of static conditions.
[d] Measurable LNAPL thickness in bailer during LNAPL recovery.

ft bgs = Feet below ground surface
ft msl = Feet above mean sea level
ft btoc = Feet below top of casing
DTW = Depth to water
LNAPL = Light nonaqueous-phase liquid
NA = Not available
RECW = Ruidoso Eagle Creek well



Source: Aerial image from Google Earth dated March 2016

Explanation

Monitor well

LNAPL plume - Thiessen polygon

MW-1S Monitor well designation
1,847 ft² Area of Thiessen polygon
0.30' LNAPL Average LNAPL thickness (2018-2020)

Note: 1. LNAPL = Light nonaqueous-phase liquid

BELL GAS #1186
ALTO, NEW MEXICO

LNAPL Plume Area and Average In-Well Thickness (2018 - 2020)

Daniel B. Stephens & Associates, Inc.
12/16/2020 JN ES14.0220.00

Figure 1

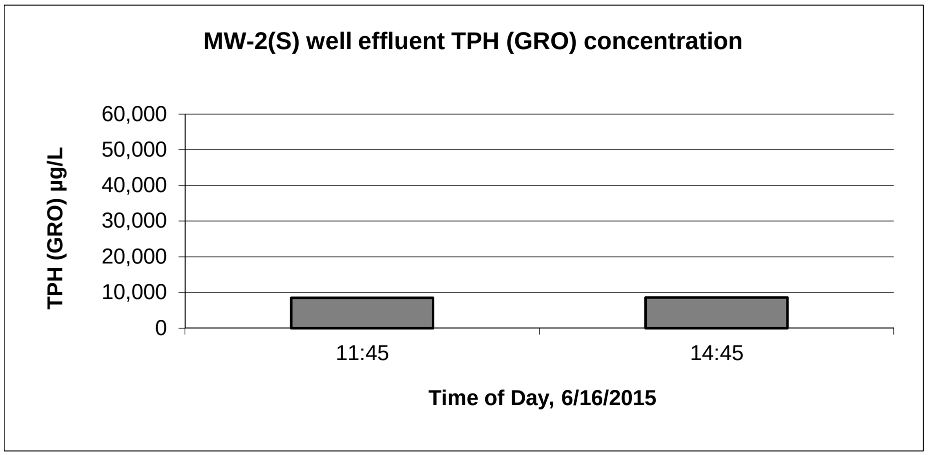
S:\Projects\ES14.0220_Bell_Gas_1186\GIS\MXDs\Final_Remediation_Plan\Plume_upper_2020-04.mxd

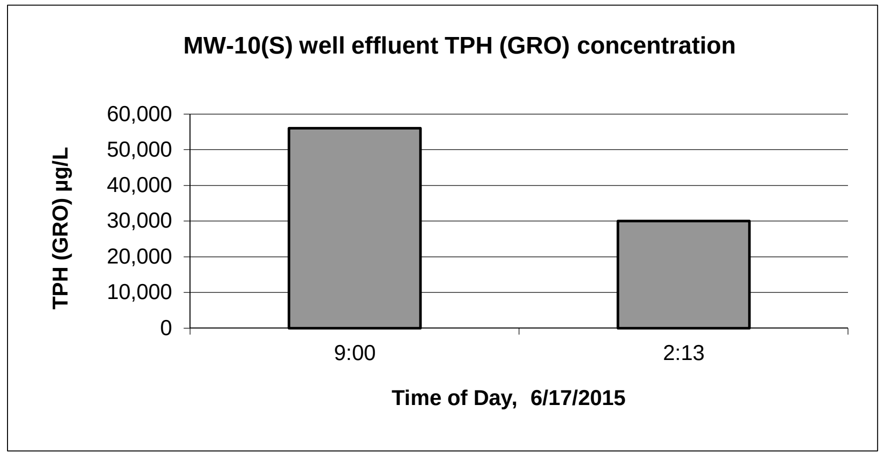
Table 3. Summary of Analytical Organic Chemistry Data for Soil Vapor
Bell Gas #1186, Alto, New Mexico

Sampling Point	Date Sampled	Concentration (µg/L)[a]						
		Benzene	Toluene	Ethyl-benzene	Total Xylenes	BTEX	MTBE	TPH (GRO)
MW-2(S) @ 11:45	06/16/15	150	320	74	310	854	<12	8,500
MW-2(S) @ 14:45	06/16/15	130	340	92	380	942	<12	8,600
MW-10(S) @ 9:00	06/17/15	570	290	220	510	1,590	<25	56,000
MW-10(S) @ 2:13	06/17/15	290	180	220	500	1,190	<12	30,000

[a] Analyzed in accordance with U.S. Environmental Protection Agency (EPA) methods 8021B for VOCs and 8015B for TPH (GRO).

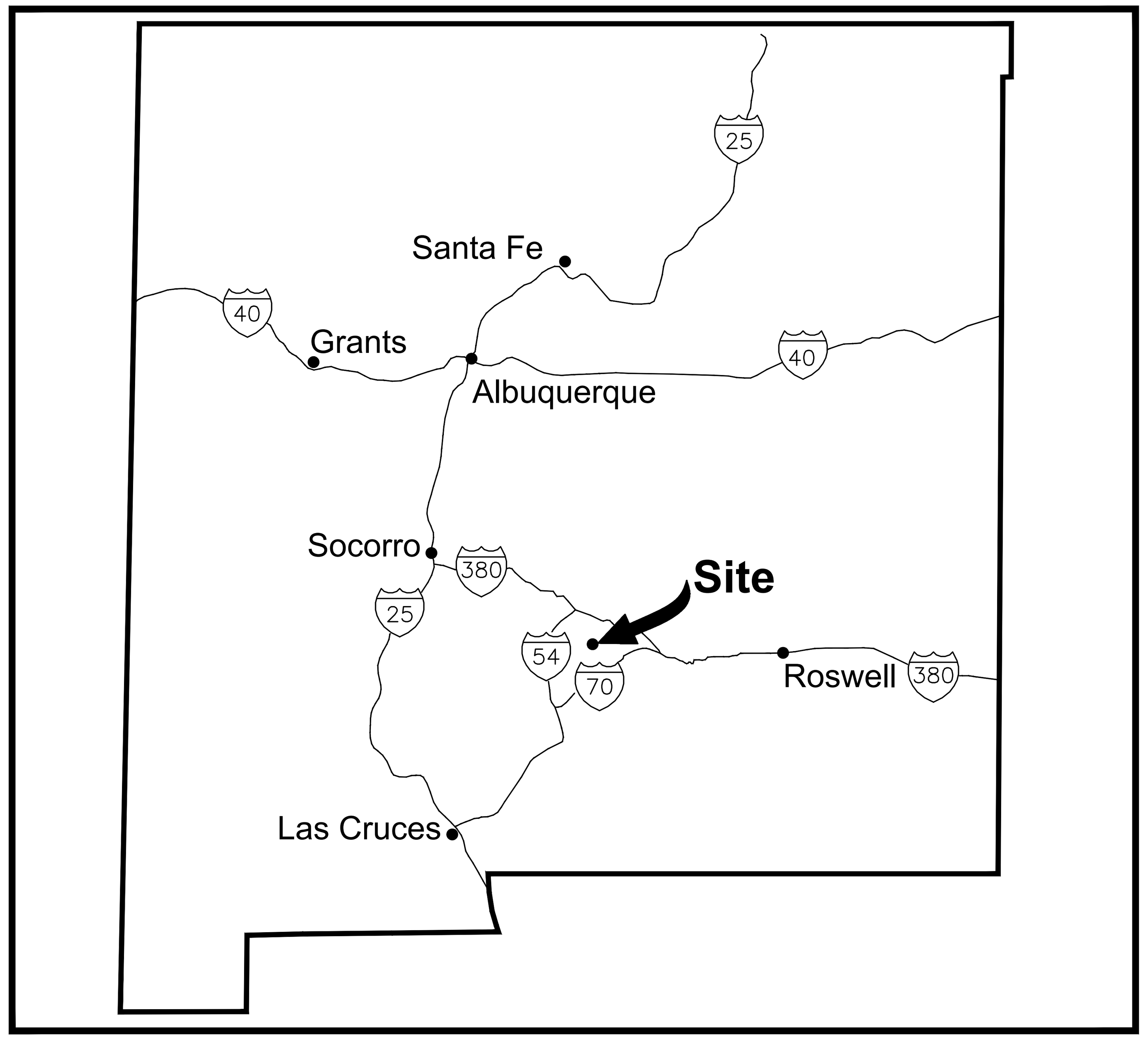
µg/L = Micrograms per liter
BTEX = Benzene, toluene, ethylbenzene, and total xylenes
MTBE = Methyl tertiary-butyl ether
TPH = Total petroleum hydrocarbons
GRO = Gasoline range organics



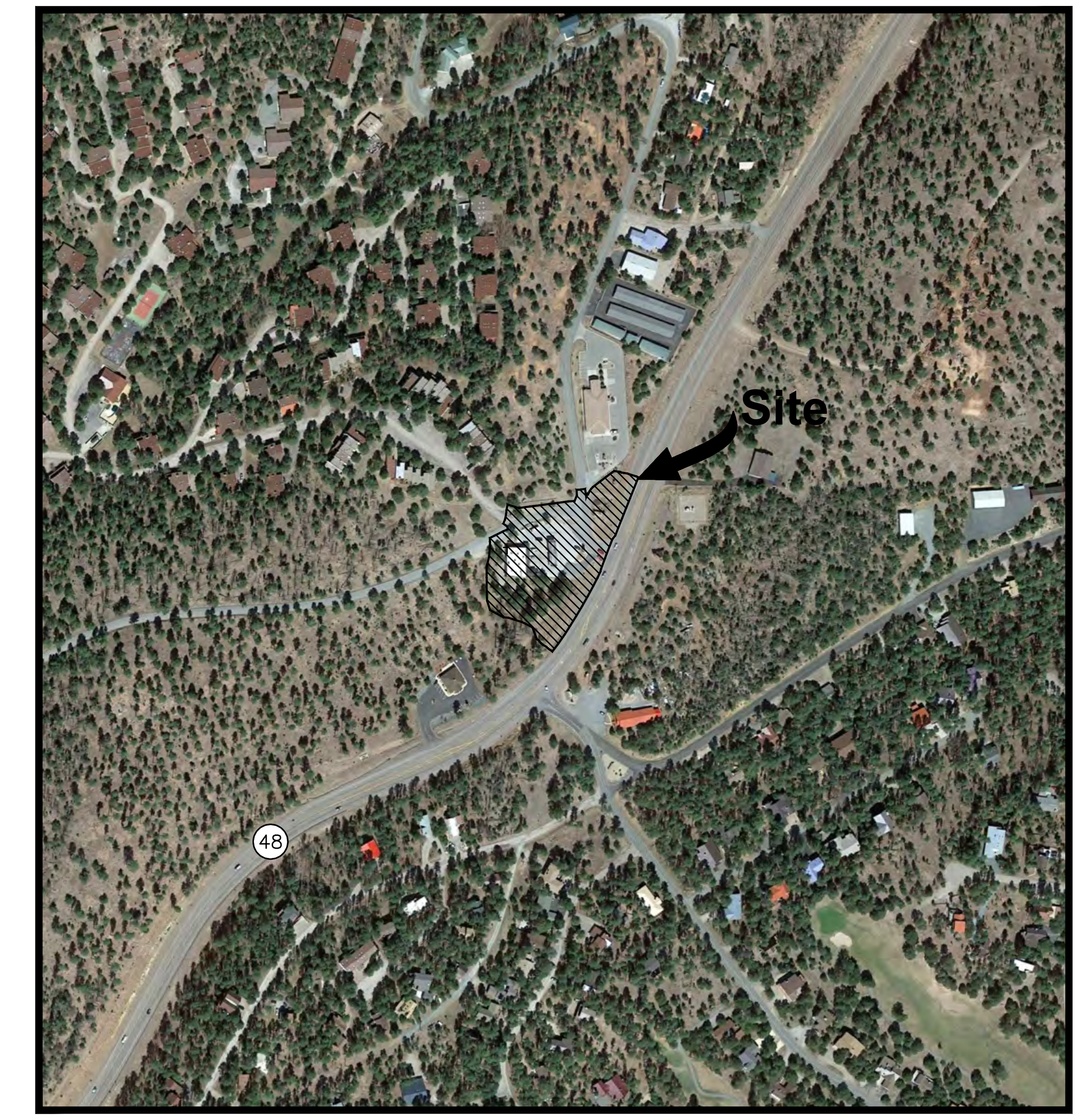


Appendix B

Engineering Drawings



VICINITY MAP
NTS



SITE MAP
NTS

RESPONSIBLE PARTY REMEDIATION
BELL GAS #1186

ALTO, NEW MEXICO

PREPARED FOR NEW MEXICO ENVIRONMENT DEPARTMENT
PETROLEUM STORAGE TANK BUREAU

		INDEX OF DRAWINGS	REVISION
		GENERAL	
1	G-0	COVER SHEET AND INDEX	0
2	G-1	GENERAL NOTES & LEGEND	0
3	G-2	GENERAL SITE PLAN AND SURVEY CONTROL	0
		CIVIL	
4	C-1	REMEDIATION SITE PLAN	0
5	C-2	INFILTRATION GALLERY PLAN	0
6	C-3	CIVIL DETAILS I	0
7	C-4	CIVIL DETAILS II	0
		MECHANICAL	
8	M-1	PROCESS AND INSTRUMENTATION DIAGRAM	0
9	M-2	MECHANICAL SITE PLAN	0
		STRUCTURAL	
10	S-0	GENERAL STRUCTURAL AND SPECIAL INSPECTION TABLE NOTES	0
11	S-1	FOUNDATION PLAN AND DETAIL	0

REFERENCE AERIAL TOPO BASED ON NOVEMBER 11, 2020 AERIAL SURVEY BY ATKINS ENGINEERING ASSOCIATES, INC.

REV. NO.	DATE	DESCRIPTION	APPROVED BY

DATE OF ISSUE: 12/18/2020
DESIGNED BY: TG, TH
DRAWN BY: CK, JA
CHECKED BY: JS
APPROVED BY: TG

THOMAS A. GOLDEN, NEW MEXICO, 22750, PROFESSIONAL ENGINEER, 12/18/2020

DBS&A
Daniel B. Stephens & Associates, Inc.

101 SUN VALLEY RD
ALTO, NM 88312

RESPONSIBLE PARTY REMEDIATION
BELL GAS #1186 / TR'S MARKET
ALTO, NM

COVER SHEET AND INDEX

SHEET 1 OF 11
DWG NO. G-0

JOB NO.
ES14.0220

S:\PROJECTS\ES14.0220_BELL_GAS_1186\CAD\PRODUCTION\G-0 TITLE SHEET - BELL GAS.DWG December 17, 2020 - 2:14 PM BY: SAMSON, JEFFREY

GENERAL CONSTRUCTION NOTES:

A. ALL WORK ON THIS PROJECT SHALL BE PERFORMED IN ACCORDANCE WITH APPLICABLE FEDERAL, STATE AND LOCAL LAWS, ORDINANCES, AND REGULATIONS CONCERNING CONSTRUCTION SAFETY AND HEALTH.

B. THE CONTRACTOR IS RESPONSIBLE FOR OBTAINING ALL REQUIRED CONSTRUCTION PERMITS AND APPROVALS OF LIKE KIND PRIOR TO START OF CONSTRUCTION.

C. PROJECT DOCUMENTS CONSIST OF THESE DRAWINGS, PROJECT SPECIFICATIONS, PROJECT CONTRACTS, AND ANY AND ALL SUBSEQUENT EXECUTED PROJECT DOCUMENTATION ISSUED AS, OR WITH, CHANGE ORDERS, AND RFI'S (REQUEST FOR INFORMATION.) THE CONTRACTOR SHALL REVIEW ALL PROJECT DOCUMENTS AND VERIFY ALL DIMENSIONS, QUANTITIES, AND FIELD CONDITIONS. ANY CONFLICTS OR OMISSIONS WITH THE DOCUMENTS SHALL BE REPORTED TO THE ENGINEER/PROJECT MANAGER FOR CLARIFICATION PRIOR TO PERFORMANCE OF ANY WORK IN QUESTION. IN THE EVENT THE CONTRACTOR DOES NOT NOTIFY THE ENGINEER/PROJECT MANAGER, THE CONTRACTOR ASSUMES FULL RESPONSIBILITY AND ANY AND ALL EXPENSE FOR ANY REVISIONS NECESSARY OR CORRECTIONAL WORK REQUIRED.

D. THE LOCATION OF BURIED UTILITIES ARE BASED UPON INFORMATION PROVIDED TO THE ENGINEER BY OTHERS AND MAY NOT REFLECT ACTUAL FIELD CONDITIONS. EXISTING BURIED UTILITIES SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO CONSTRUCTION. THE CONTRACTOR SHALL USE ANY MEANS APPROVED BY THE ENGINEER/PROJECT MANAGER TO LOCATE UNDERGROUND UTILITIES INCLUDING, BUT NOT LIMITED TO, ELECTRONIC LOCATING EQUIPMENT AND/OR POT HOLING. ANY DAMAGE TO ANY OTHER UTILITIES AND/OR COLLATERAL DAMAGE CAUSED BY THE CONTRACTOR SHALL BE THE FULL RESPONSIBILITY OF THE CONTRACTOR.

E. EXISTING FENCING THAT IS NOT DESIGNATED FOR REMOVAL SHALL NOT BE DISTURBED. ANY FENCING THAT IS DISTURBED OR ALTERED BY THE CONTRACTOR SHALL BE RESTORED TO ITS ORIGINAL CONDITION AT THE CONTRACTOR'S EXPENSE. IF THE CONTRACTOR DESIRES TO REMOVE FENCING TO ACCOMMODATE CONSTRUCTION ACTIVITIES, THE CONTRACTOR SHALL OBTAIN THE OWNER'S WRITTEN PERMISSION BEFORE FENCE IS REMOVED. CONTRACTOR SHALL RESTORE THE FENCE TO ITS ORIGINAL CONDITION AT THE EARLIEST OPPORTUNITY TO THE SATISFACTION OF THE OWNER. WHILE ANY FENCING IS REMOVED, THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR SECURITY OF THE SITE UNTIL THE FENCE IS RESTORED.

F. AT THE END OF EACH WORK DAY, THE CONTRACTOR SHALL CLEAN AND PICK UP THE WORK AREA TO THE SATISFACTION OF THE ENGINEER/PROJECT MANAGER. AT NO TIME SHALL THE WORK BE LEFT IN A MANNER THAT COULD ENDANGER THE WORKERS OR THE PUBLIC.

G. ALL MATERIALS AND WORKMANSHIP SHALL CONFORM TO PROJECT SPECIFICATIONS AND DRAWINGS, AS AMENDED AND REVISED BY THE ENGINEER. ALL INSTALLATION DETAILS ARE TYPICAL AND MAY BE CHANGED TO BETTER FIT EXISTING LOCAL CONDITIONS UPON APPROVAL BY THE ENGINEER.

H. ONLY THE CONTRACTOR SHALL BE RESPONSIBLE FOR SAFETY OF ALL WORK. ALL WORK, INCLUDING WORK WITHIN TRENCHES, SHALL BE IN ACCORDANCE WITH THE OCCUPATIONAL SAFETY AND HEALTH ACT (OSHA).

I. REFERENCES MADE TO STANDARD SPECIFICATIONS AND STANDARD DRAWINGS REFER TO THE NEW MEXICO CHAPTER OF THE AMERICAN PUBLIC WORKS ASSOCIATION (APWA–NM) STANDARDS FOR PUBLIC WORKS CONSTRUCTION.

J. THE CONTRACTOR SHALL NOT INSTALL ITEMS AS SHOWN ON THESE PLANS WHEN IT IS OBVIOUS THAT FIELD CONDITIONS ARE DIFFERENT THAN SHOWN IN THE PLANS. SUCH CONDITIONS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER IN A TIMELY MANNER. IN THE EVENT THE CONTRACTOR DOES NOT NOTIFY THE ENGINEER IN A TIMELY MANNER, THE CONTRACTOR ASSUMES FULL RESPONSIBILITY AND EXPENSE FOR ANY REVISIONS NECESSARY, INCLUDING ENGINEERING DESIGN FEES.

K. EXISTING SITE IMPROVEMENTS WHICH ARE DAMAGED OR DISPLACED BY THE CONTRACTOR SHALL BE REMOVED AND REPLACED BY THE CONTRACTOR AT THE CONTRACTOR'S EXPENSE. REPAIRS SHALL BE APPROVED BY THE OWNER PRIOR TO CONSTRUCTION OF THE REPAIRS. REPAIRS SHALL BE ACCEPTED BY THE OWNER PRIOR TO FINAL PAYMENT.

WORK WITHIN ADJACENT RIGHT–OF–WAY

L. PRIOR TO BEGINNING ANY CONSTRUCTION ACTIVITIES WITHIN ADJACENT RIGHT–OF–WAYS OR WITHIN PROPERTY NOT OWNED BY THE OWNER OF THE PROJECT SITE, THE CONTRACTOR SHALL ASSURE THAT ALL PERMITS AND PERMISSIONS REQUIRED HAVE BEEN OBTAINED IN WRITING.

SURVEY MONUMENTS, PROPERTY CORNERS, BENCHMARKS

M. THE CONTRACTOR SHALL NOTIFY THE OWNER AT LEAST SEVEN (7) DAYS BEFORE BEGINNING ANY CONSTRUCTION ACTIVITY THAT COULD ENDANGER OR DISPLACE SURVEY MONUMENTS, PROPERTY CORNERS, OR PROJECT BENCHMARKS SO THESE ITEMS MAY BE RELOCATED.

N. ANY SURVEY MONUMENTS, PROPERTY CORNERS, OR BENCHMARKS THAT ARE NOT IDENTIFIED FOR RELOCATION ARE THE RESPONSIBILITY OF THE CONTRACTOR TO PRESERVE AND PROTECT. RELOCATION OR REPLACEMENT OF THESE ITEMS SHALL BE DONE BY THE OWNER'S SURVEYOR AT THE EXPENSE OF THE CONTRACTOR.

DESIGN SURVEY

O. DESIGN SURVEY WAS PERFORMED NOVEMBER 2020 BY ATKINS ENGINEERING ASSOCIATES, INC. (AEA) USING DRONE TECHNOLOGY. THIS INCLUDES INTEGRATION OF SURVEY PERFORMED APRIL 2015 BY COBB FENDLEY. ANY DISCREPANCIES BETWEEN THE ENGINEER'S DESIGN AND EXISTING SITE CONDITIONS SHALL BE BROUGHT TO THE ENGINEER'S ATTENTION IMMEDIATELY. SURVEY DATA COLLECTED IN NAD83 NEW MEXICO STATE PLANE CENTRAL COORDINATES.

PAVEMENT

P. WHEN ABUTTING NEW PAVEMENT TO EXISTING PAVEMENT, CUT EXISTING PAVEMENT EDGE TO A NEAT, STRAIGHT LINE AS NECESSARY TO REMOVE ANY BROKEN OR CRACKED PAVEMENT AND MATCH NEW PAVEMENT ELEVATION TO EXISTING.

Q. ALL UTILITIES AND UTILITY SERVICE LINES SHALL BE INSTALLED AND APPROVED PRIOR TO PAVING.

CONSTRUCTION LIMITS

R. SHALL BE AS SHOWN ON PLANS.

UTILITIES

S. UTILITY LINES, PIPELINES, OR UNDERGROUND UTILITY LINES SHOWN ON THESE DRAWINGS ARE SHOWN IN AN APPROXIMATE LOCATION ONLY BASED ON THE INFORMATION PROVIDED TO THE ENGINEER BY OTHERS. THIS INFORMATION MAY BE INACCURATE OR INCOMPLETE. ADDITIONALLY, UNDERGROUND LINES MAY EXIST THAT ARE NOT SHOWN. THE CONTRACTOR SHALL VERIFY THE LOCATION OF ANY UTILITY LINE, PIPELINE, OR UNDERGROUND UTILITY LINE IN OR NEAR THE AREA OF THE WORK IN ACCORDANCE WITH CHAPTER 62, ARTICLE 14–1, THROUGH 14–8, NMSA 1978.

T. THE CONTRACTOR SHALL CONTACT THE STATEWIDE UTILITY LOCATOR SERVICE AT 811 AT LEAST FIVE WORKING DAYS BEFORE BEGINNING CONSTRUCTION. AFTER THE UTILITIES ARE SPOTTED, THE CONTRACTOR SHALL EXPOSE ALL PERTINENT UTILITIES TO VERIFY THEIR VERTICAL AND HORIZONTAL LOCATION. IF A CONFLICT EXISTS BETWEEN EXISTING UTILITIES AND PROPOSED CONSTRUCTION, THE CONTRACTOR SHALL NOTIFY THE ENGINEER SO THAT THE CONFLICT CAN BE RESOLVED WITH MINIMAL DELAY.

U. THE CONTRACTOR SHALL EXERCISE DUE CARE TO AVOID DISTURBING ANY EXISTING UTILITIES, ABOVE OR BELOW GROUND. UTILITIES THAT ARE DAMAGED BY CARELESS CONSTRUCTION SHALL BE REPAIRED OR REPLACED AT THE CONTRACTOR'S EXPENSE.

V. THE CONTRACTOR SHALL COORDINATE ANY REQUIRED UTILITY INTERRUPTIONS WITH THE OWNER AND AFFECTED UTILITY COMPANY A MINIMUM OF FIVE (5) WORKING DAYS BEFORE THE INTERRUPTION.

W. THE CONTRACTOR SHALL MAINTAIN A RECORD DRAWING SET OF PLANS AND PROMPTLY LOCATE ALL UTILITIES, EXITING OR NEW, IN THEIR CORRECT LOCATION, HORIZONTAL AND VERTICAL. THIS RECORD SET OF DRAWINGS SHALL BE MAINTAINED ON THE PROJECT SITE AND SHALL BE AVAILABLE TO THE OWNER AND ENGINEER AT ANY TIME DURING CONSTRUCTION. RECORD INFORMATION SHALL INCLUDE HORIZONTAL AND VERTICAL COORDINATE CALLOUTS, LINE SIZES, LINE TYPES, BURIAL DEPTHS, AND ALL OTHER PERTINENT INSTALLATION INFORMATION. IN ADDITION ALL ITEMS THAT ARE INSTALLED EXACTLY AS DESIGNED SHALL BE NOTED AS SUCH.

EROSION CONTROL, ENVIRONMENTAL PROTECTION, AND STORM WATER POLLUTION PREVENTION PLAN

X. THE CONTRACTOR SHALL CONFORM TO ALL LINCOLN COUNTY, STATE OF NEW MEXICO, AND FEDERAL DUST AND EROSION CONTROL REGULATIONS. THE CONTRACTOR SHALL PREPARE AND OBTAIN ANY DUST CONTROL OR EROSION CONTROL PERMITS FROM THE APPROPRIATE REGULATORY AGENCIES.

Y. THE CONTRACTOR SHALL PROMPTLY REMOVE OR STABILIZE ANY MATERIAL EXCAVATED WITHIN THE RIGHT–OF–WAY OR ADJACENT PROPERTY TO KEEP IT FROM WASHING OFF THE PROJECT SITE.

Z. THE CONTRACTOR SHALL ENSURE THAT NO SOIL ERODES FROM THE SITE ONTO ADJACENT PROPERTY BY CONSTRUCTION OF TEMPORARY EROSION CONTROL BERMS OR INSTALLING SILT FENCES AT THE PROPERTY LINES (OR LIMITS OF CONSTRUCTION WHERE DESIGNATED) AND WETTING SOIL TO PREVENT IT FROM BLOWING.

AA. WATERING, AS REQUIRED FOR CONSTRUCTION DUST CONTROL, SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION AND NO MEASUREMENT OR PAYMENT SHALL BE MADE. CONSTRUCTION AREAS SHALL BE WATERED FOR DUST CONTROL IN COMPLIANCE WITH CITY, COUNTY AND STATE ORDINANCES. THE CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATING WITH THE OWNER, FOR AVAILABILITY AND USE OF WATER. THE CONTRACTOR SHALL BE RESPONSIBLE FOR SUPPLYING ALL EQUIPMENT AND MATERIALS NECESSARY FOR OBTAINING, METERING, AND PAYING FOR WATER.

AB. THE CONTRACTOR SHALL PROPERLY HANDLE AND DISPOSE OF ALL ASPHALT AND CONCRETE REMOVED ON THE PROJECT BY HAULING TO AN APPROVED DISPOSAL SITE IN ACCORDANCE WITH THE REQUIREMENTS OF LINCOLN COUNTY.

AC. ALL WASTE PRODUCTS FROM THE CONSTRUCTION SITE, INCLUDING ITEMS DESIGNED FOR REMOVAL, CONSTRUCTION WASTE, CONSTRUCTION EQUIPMENT WASTE PRODUCTS (OIL, GAS, TIRES, ETC.), DRILLING MUD AND WATER, GARBAGE, GRUBBING, EXCESS CUT MATERIAL, VEGETATIVE DEBRIS, ETC. SHALL BE APPROPRIATELY DISPOSED OF OFFSITE AT NO ADDITIONAL COST TO THE OWNER. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO OBTAIN ANY PERMITS REQUIRED FOR HAUL OR DISPOSAL OF WASTE PRODUCTS. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO ENSURE THAT THE WASTE DISPOSAL SITE COMPLIES WITH APPROPRIATE REGULATIONS REGARDING THE ENVIRONMENT, ENDANGERED SPECIES, AND ARCHAEOLOGICAL RESOURCES.

AD. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE CLEANUP AND REPORTING OF SPILLS OF HAZARDOUS MATERIALS ASSOCIATED WITH THE CONSTRUCTION SITE. HAZARDOUS MATERIALS INCLUDES GASOLINE, DIESEL FUEL, MOTOR OIL, SOLVENTS, CHEMICALS, PAINT, ETC. WHICH MAY BE A THREAT TO THE ENVIRONMENT. THE CONTRACTOR SHALL REPORT THE DISCOVERY OF PAST OR PRESENT SPILLS TO THE NEW MEXICO HAZARDOUS WASTE BUREAU AT 1–505–476–6000 AND THE ENGINEER.

AE. THE CONTRACTOR SHALL COMPLY WITH ALL APPLICABLE REGULATIONS CONCERNING SURFACE AND GROUND WATER. CONTACT WITH SURFACE WATER BY CONSTRUCTION EQUIPMENT AND PERSONNEL SHALL BE MINIMIZED. EQUIPMENT MAINTENANCE AND REFUELING OPERATIONS SHALL BE PERFORMED IN AN ENVIRONMENTALLY SAFE MANNER IN COMPLIANCE WITH CITY, COUNTY, STATE, AND EPA REGULATIONS.

AF. THE CONTRACTOR SHALL COMPLY WITH ALL APPLICABLE REGULATIONS CONCERNING CONSTRUCTION NOISE AND HOURS OF OPERATION AS STATED IN THE SPECIFICATIONS OR IMPOSED BY THE OWNER, CITY OR COUNTY AUTHORITIES.

TRAFFIC CONTROL

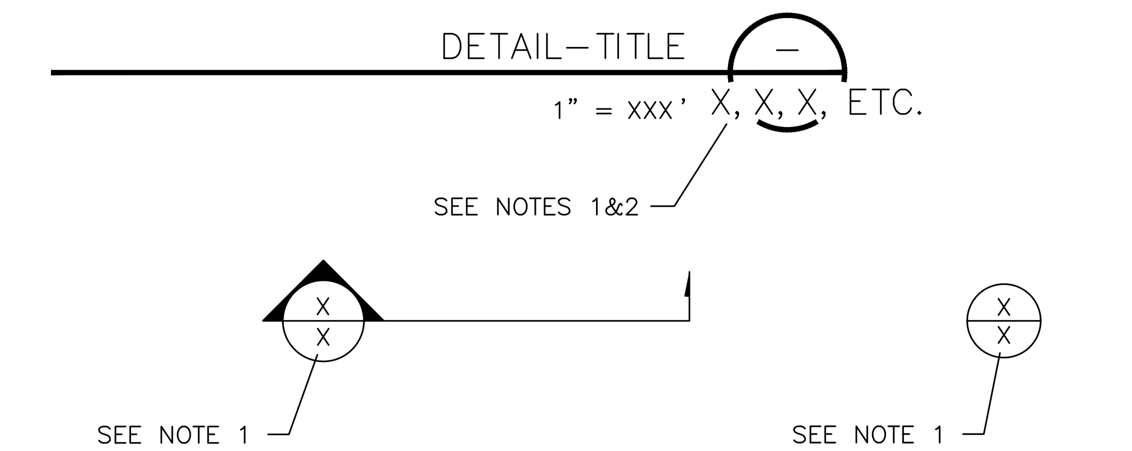
AG. THE CONTRACTOR SHALL PROVIDE ALL REQUIRED TRAFFIC CONTROL PLANS AND TRAFFIC CONTROL EQUIPMENT. ALL SIGNS, BARRICADES, CHANNELIZATION DEVICES, SIGN FRAMES AND ERECTION OF SUCH DEVICES SHALL CONFORM TO THE REQUIREMENTS OF "MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES FOR STREETS AND HIGHWAYS" LATEST EDITION. TRAFFIC CONTROL PLANS SHALL BE APPROVED BY THE COUNTY AND NMDOT PRIOR TO CONSTRUCTION.

MISCELLANEOUS SYMBOLS:

NOTE: SYMBOLS ARE NOT SHOWN TO SCALE ON PLAN OR PROFILE DRAWINGS, AND INDICATE APPROXIMATE LOCATION ONLY.

SYMBOL	DESCRIPTION
—— OHP —— OHP ——	EXISTING OVERHEAD ELECTRICAL LINE
—— UGP —— UGP ——	EXISTING UNDERGROUND ELECTRICAL LINE
—— GAS —— GAS ——	EXISTING GAS LINE
—— S —— S ——	EXISTING SEWER LINE
—— T —— T ——	EXISTING COMMUNICATION LINE
—— W —— W ——	EXISTING WATER LINE
—— C —— C ——	MPE CONVEYANCE LINE
—— W —— W ——	EFFLUENT DISCHARGE LINE
——o——o——o	CHAIN LINK FENCE
—— — — ——	PROPERTY LINE
7510	EXISTING MAJOR CONTOUR LINE AND ELEVATION DESIGNATION
7502	EXISTING MINOR CONTOUR LINE AND ELEVATION DESIGNATION
7510	DESIGN MAJOR CONTOUR LINE AND ELEVATION DESIGNATION
7502	DESIGN MINOR CONTOUR LINE AND ELEVATION DESIGNATION
	ARMORING
	CONCRETE
	CLEAN–OUTS
	BOLLARD
	SURVEY MONUMENT
E	EXISTING ELECTRICAL BOX
	EXISTING POWER POLE
S	EXISTING SEWER MANHOLE
TS	EXISTING COMMUNICATION MANHOLE
	EXISTING TELEPHONE POLE
	EXISTING GUY WIRE
	EXISTING SIGN
	EXISTING MONITOR WELL
W	EXISTING WATER METER

LEGEND:



NOTES:

1. IF SECTION, DETAIL, SCHEMATIC, OR DIAGRAM IS DRAWN ON THE SAME SHEET THAT IT IS TAKEN FROM, THE SHEET NUMBER SHALL BE REPLACED WITH A HYPHEN.

2. IF THE SECTION, DETAIL, SCHEMATIC, OR DIAGRAM IS REFERENCED ON MULTIPLE SHEETS, ALL SHEETS SHOULD BE LISTED TO THE OUTSIDE RIGHT OF THE DETAIL–TITLE BUBBLE, AND SEPARATED WITH A COMMA.

ABBREVIATIONS:

APWA	AMERICAN PUBLIC WORKS ASSOCIATION
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
CONC	CONCRETE
CY	CUBIC YARDS
DIA	DIAMETER
DR	DIMENSION RATIO
ELEV	ELEVATION
FT	FEET
GA	GAUGE
GAL	GALVANIZED
HDPE	HIGH DENSITY POLYETHYLENE
ID	INNER DIAMETER
INV	INVERT ELEVATION
MAX	MAXIMUM
MIN	MINIMUM
MPE	MULTI–PHASE EXTRACTION
MW	MONITOR WELL
NMED	NEW MEXICO ENVIRONMENT DEPARTMENT
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTER DIAMETER
PSI	POUNDS PER SQUARE INCH
PVC	POLY VINYL CHLORIDE
SCH	SCHEDULE
STD	STANDARD
SVE	SOIL VAPOR EXTRACTION
TYP	TYPICAL
UPC	UNIFORM PLUMBING CODE
W/	WITH

REV. NO.	DATE	DESCRIPTION	APPROVED BY

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DRAWN BY: CK, JA
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APPROVED BY: TG

THOMAS A. GOLDEN, NEW MEXICO, 22750, PROFESSIONAL ENGINEER, 12/18/2020

DBS&A engineering hydrology geoscience
DBS&A Daniel B. Stephens & Associates, Inc.

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RESPONSIBLE PARTY REMEDIATION
BELL GAS #1186 / TR'S MARKET
ALTO, NM

GENERAL NOTES AND LEGEND

SHEET 2 OF 11
DWG NO. G-1

JOB NO. ES14.0220

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RESPONSIBLE PARTY REMEDIATION
BELL GAS #1186 / TR'S MARKET
ALTO, NM

GENERAL SITE PLAN

SHEET 3 OF 11
DWG NO. G-2

JOB NO.
ES14.0220

S:\PROJECTS\ES14.0220_BELL_GAS_1186\CAD\PRODUCTION\G-2 GENERAL SITE PLAN - BELL GAS.DWG December 17, 2020 - 2:14 PM BY: SAMSON, JEFFREY

KEY NOTES

1. 3" SCH 40 PVC CONVEYANCE LINE (4/C-3)
2. MPE RECOVERY WELL ACCESS VAULT (1/C-3)
3. 4" SCH 40 PVC TREATED EFFLUENT DISCHARGE TO INFILTRATION GALLERY (–/C-2)
4. REMEDIATION EQUIPMENT COMPOUND (–/M-2)
5. MPE MANIFOLD INSIDE CONTAINER
6. MODIFIED SHIPPING CONTAINER
7. THERMAL OXIDIZER
8. MPE CONVEYANCE TRENCH (3/C-3)
9. CONCRETE-FILLED STEEL BOLLARD (TYP OF 8) (3/C-4)
10. CONNECT NATURAL GAS SERVICE LINE TO EXISTING GAS LINE

S:\PROJECTS\ES14.0220_BELL_GAS_1186\CAD\PRODUCTION\C-1 REMEDIATION SITE PLAN - BELL GAS.DWG December 17, 2020 - 2:14 PM BY: SAMSON, JEFFREY

REV. NO.	DATE	DESCRIPTION	APPROVED BY

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DRAWN BY: CK, JA
CHECKED BY: JS
APPROVED BY: TG

THOMAS A. GOLDEN, NEW MEXICO, 22750, PROFESSIONAL ENGINEER, 12/18/2020

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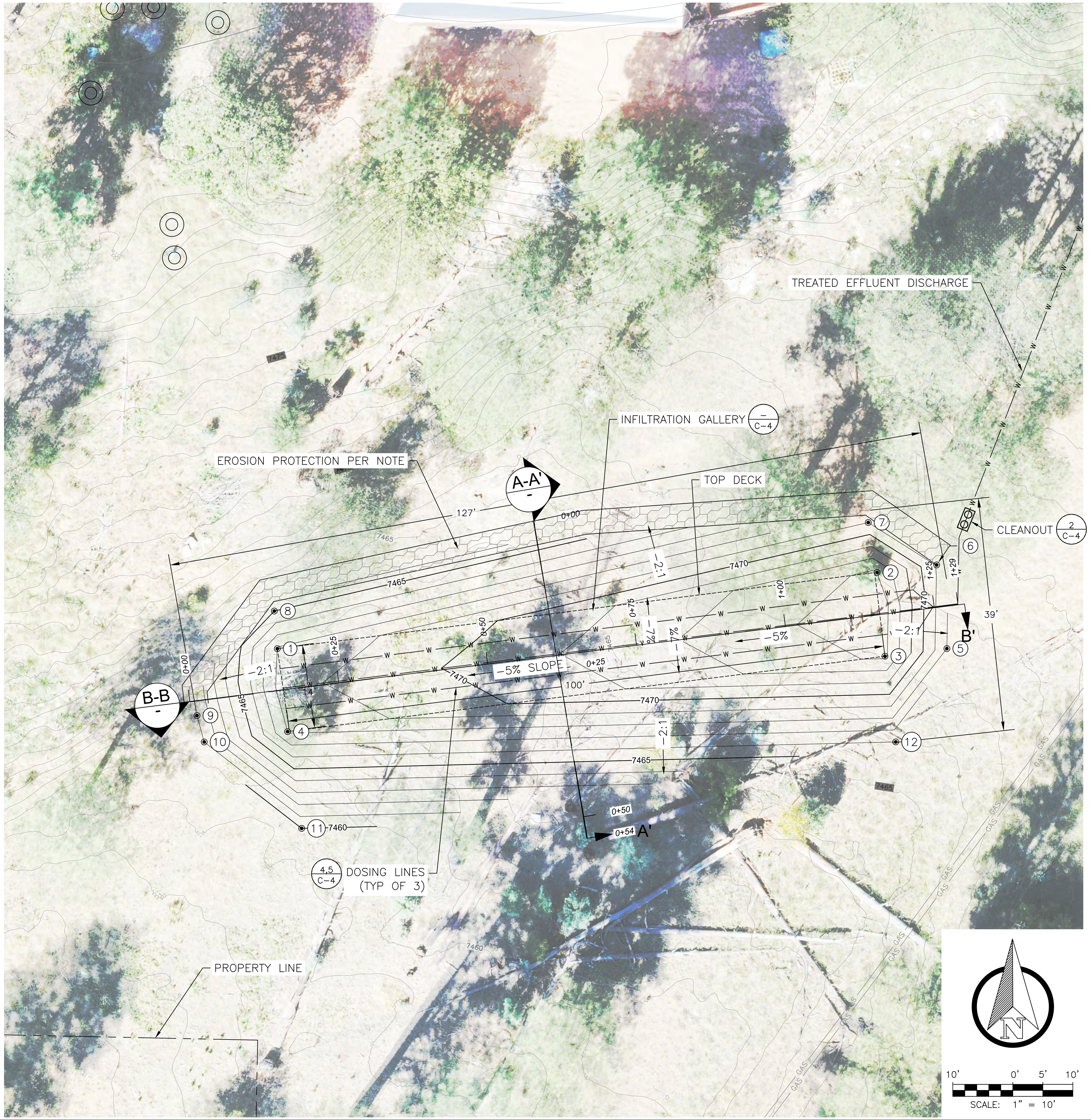
RESPONSIBLE PARTY REMEDIATION
BELL GAS #1186 / TR'S MARKET
ALTO, NM

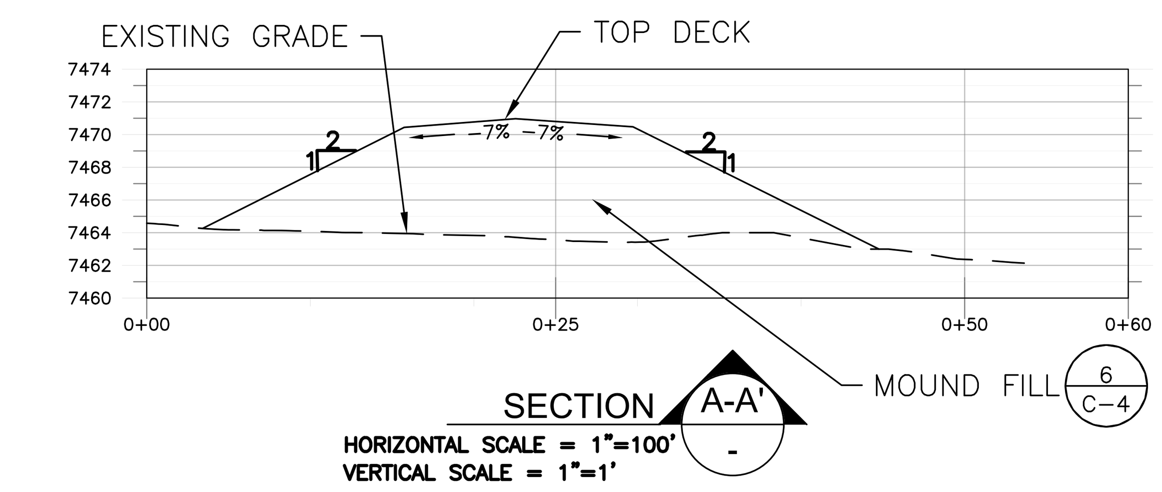
REMEDIATION SITE PLAN

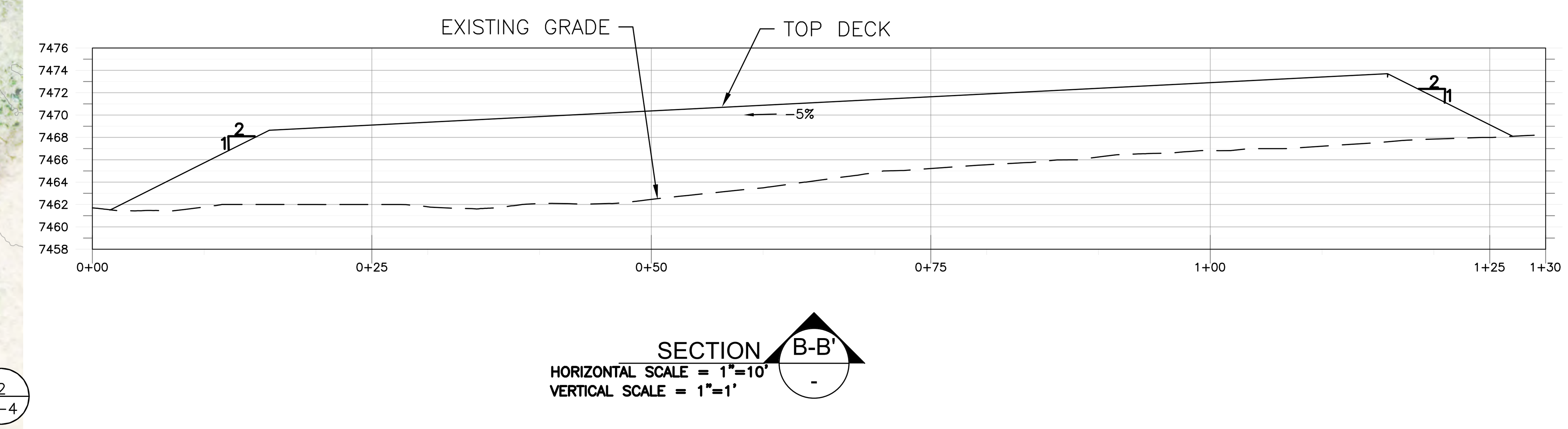
SHEET 4 OF 11
DWG NO. C-1

JOB NO. ES14.0220

NOTE:
ARMOR TOE OF NORTHERN SLOPE WITH APPROXIMATELY 20 CY OF CRUSHED ROCK (D50=6"). EXACT LOCATION OF ROCK TO BE FIELD APPROVED BY ENGINEER







Point Table				
Point #	Elevation	Northing	Easting	Description
1	7469.00	875127.35	1815541.97	TOP DECK
2	7473.00	875140.07	1815641.88	TOP DECK
3	7473.00	875126.10	1815643.19	TOP DECK
4	7468.00	875113.54	1815543.68	TOP DECK
5	7468.00	875127.37	1815653.51	TOE OF SLOPE
6	7469.00	875141.32	1815651.80	TOE OF SLOPE
7	7469.00	875148.38	1815640.41	TOE OF SLOPE
8	7465.00	875133.63	1815541.46	TOE OF SLOPE
9	7461.00	875116.22	1815528.59	TOE OF SLOPE
10	7461.00	875111.81	1815529.79	TOE OF SLOPE
11	7460.00	875097.41	1815546.02	TOE OF SLOPE
12	7466.00	875111.82	1815644.99	TOE OF SLOPE

MATERIAL QUANTITIES	
MATERIAL	QUANTITY
INFILTRATION PEA GRAVEL	12 CY
TOP SOIL	120 CY
ENGINEERED FILL	610 CY
CRUSHED ROCK	20 CY

S:\PROJECTS\ES14.0220_BELL_GAS_1186\CAD\PRODUCTION\C-4 INFILTRATION GALLERY PLAN – BELL GAS.DWG December 17, 2020 – 2:14 PM BY: SAMSON, JEFFREY

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RESPONSIBLE PARTY REMEDIATION
BELL GAS #1186 / TR'S MARKET
ALTO, NM

INFILTRATION GALLERY PLAN

SHEET 5 OF 11
DWG NO. C-2

JOB NO.
ES14.0220

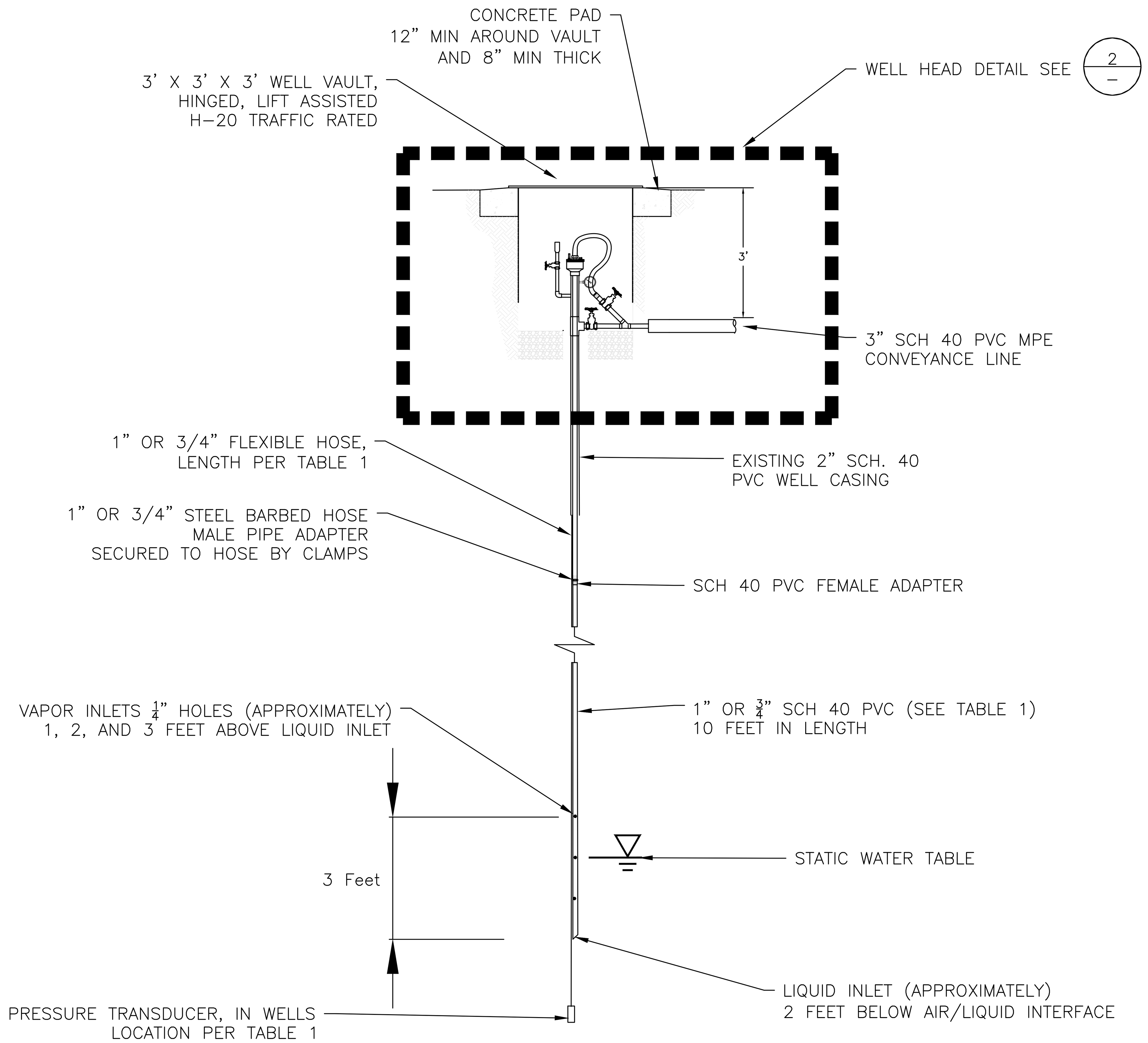
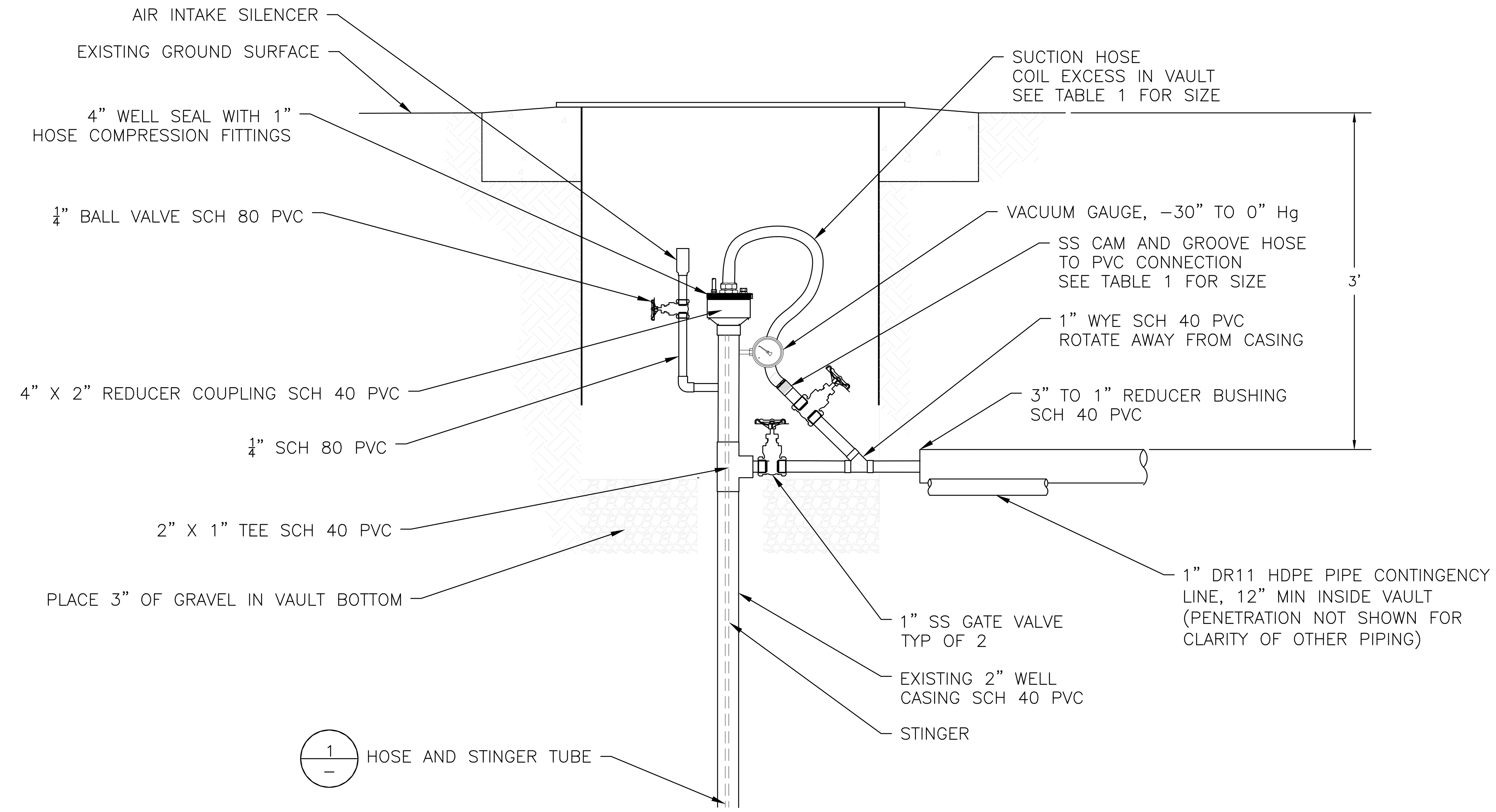


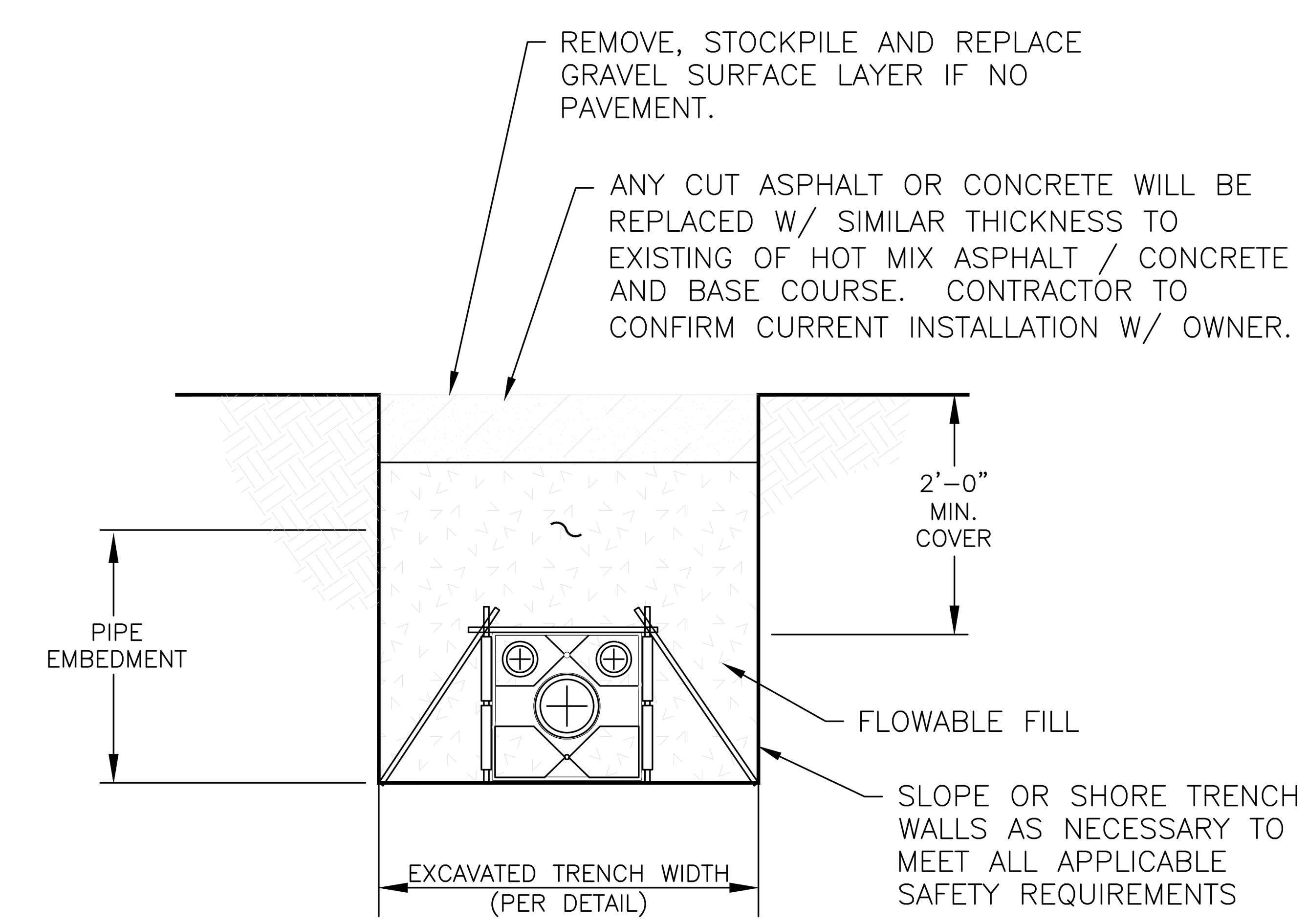
TABLE 1

WELL NAME	TOTAL WELL DEPTH (FT)	STINGER DIA. (IN)	MAX/MIN DTW (FT BGS)	FLEX HOSE (FT)	PVC STINGER (FT)	TOTAL LENGTH (FT)	TRANSDUCER
MW-1S	90	1	75/60	20	65	85	NO
MW-2S	97	1	80/65	20	70	90	NO
MW-3S	95	1	80/65	20	70	90	NO
MW-4S	86	¾	60/40	20	50	70	YES
MW-6S	113	¾	100/80	20	85	105	YES
MW-10S	102	¾	85/65	20	75	95	YES
MW-11S	102	1	80/65	20	70	90	NO

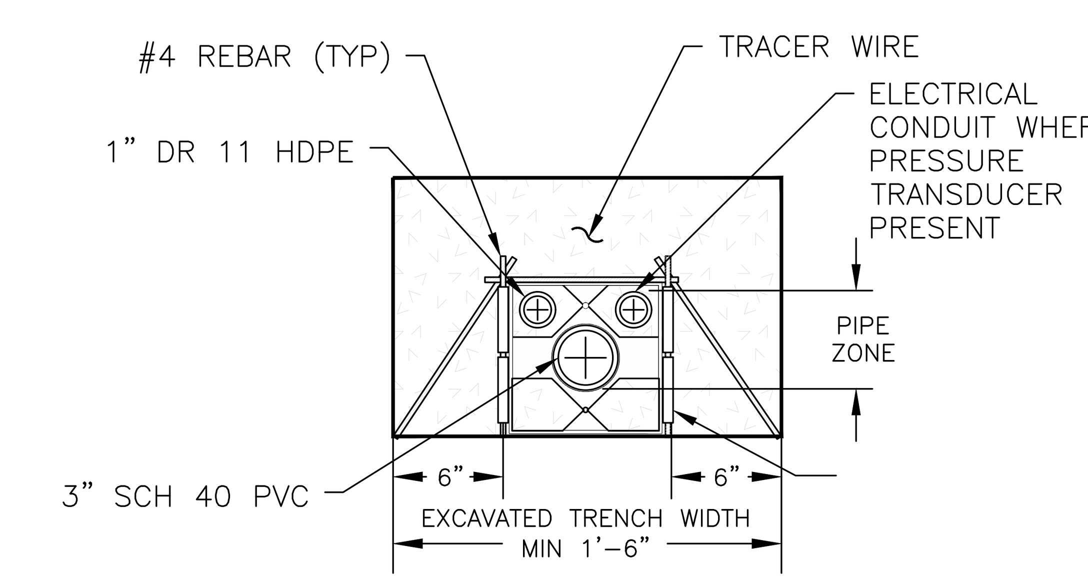
TYPICAL MULTI-PHASE EXTRACTION HOSE, STINGER TUBE, AND VAULT 1 / -
NTS



MPE WELL HEAD DETAIL 2 / -
TYPE OF 7 NTS



TYPICAL MPE PIPING TRENCH SECTION 3 / C-1
NTS



NOTE:
WHEN 2 OR MORE PIPES IN TRENCH, PLACE PIPES SIDE BY SIDE WHERE POSSIBLE. SEE DRAWING C-1 FOR CONVEYANCE LINE LAYOUT

MPE PIPING CONFIGURATION 4 / C-1
NTS

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THOMAS A. GOLDEN NEW MEXICO 22750 12/18/2020 PROFESSIONAL ENGINEER

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RESPONSIBLE PARTY REMEDIATION
BELL GAS #1186 / TR'S MARKET
ALTO, NM

CIVIL DETAILS I

SHEET 6 OF 11
DWG NO. C-3

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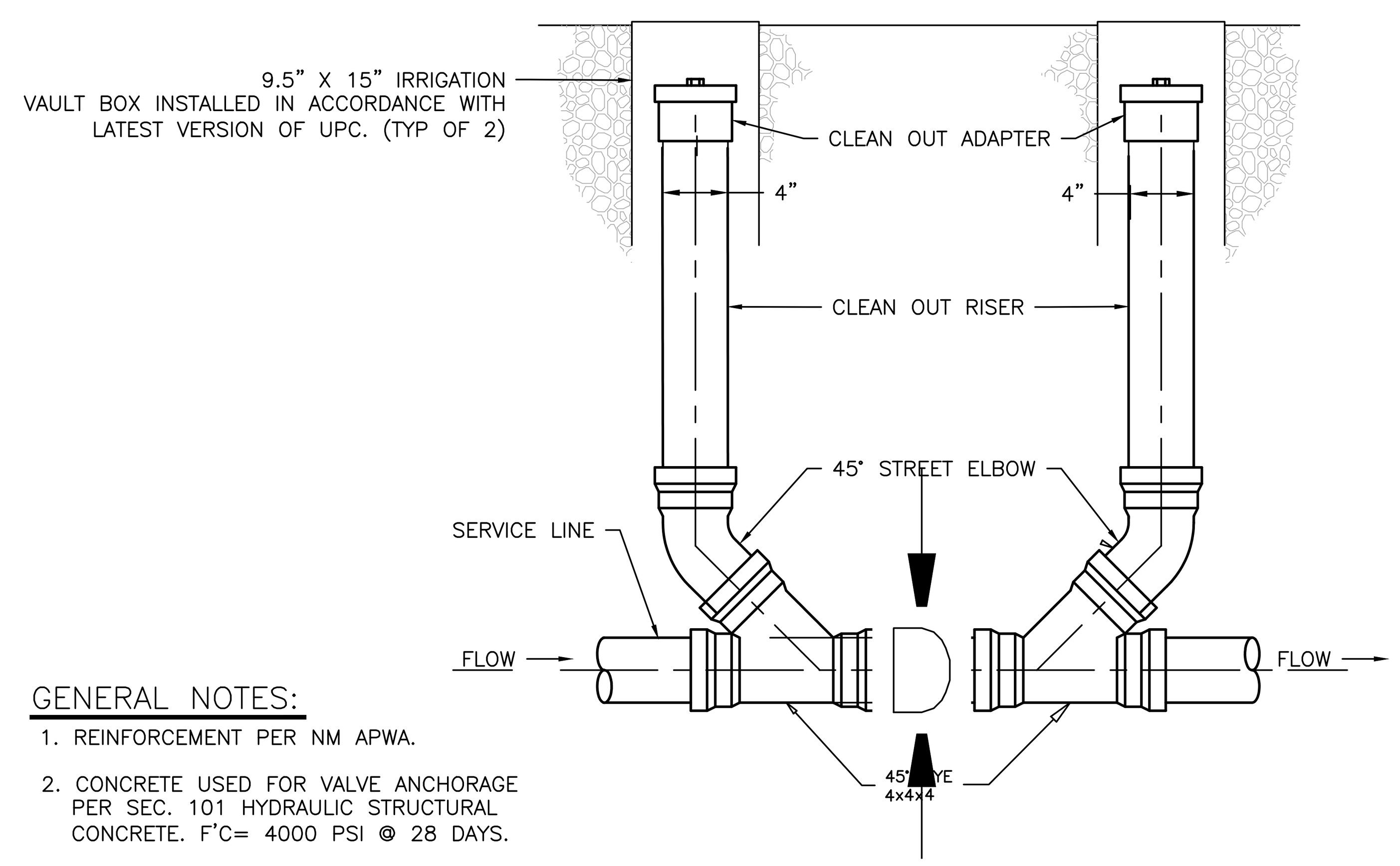
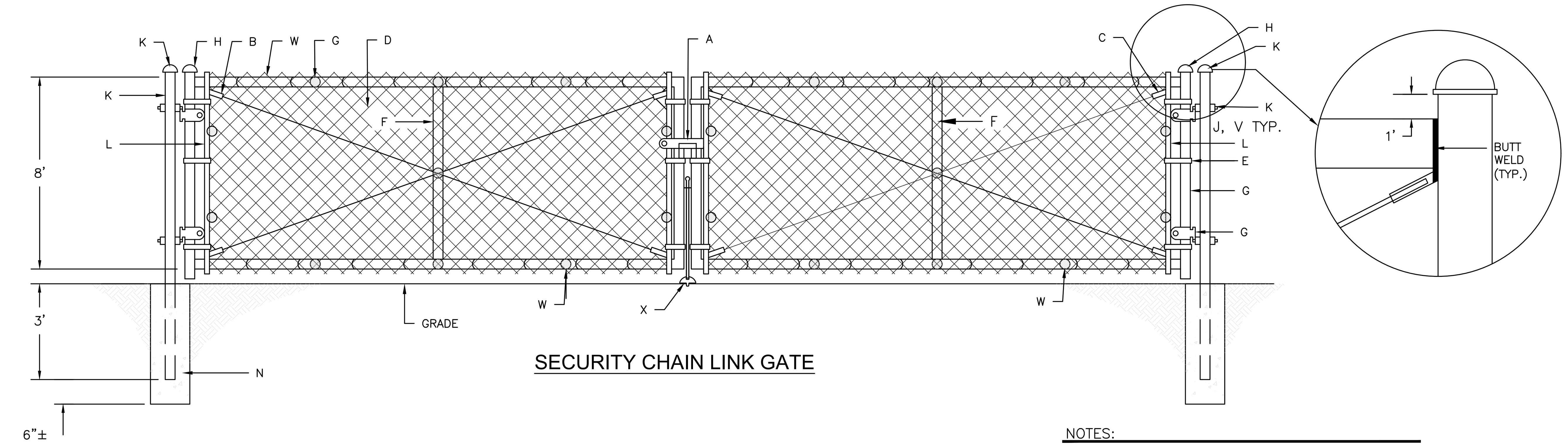


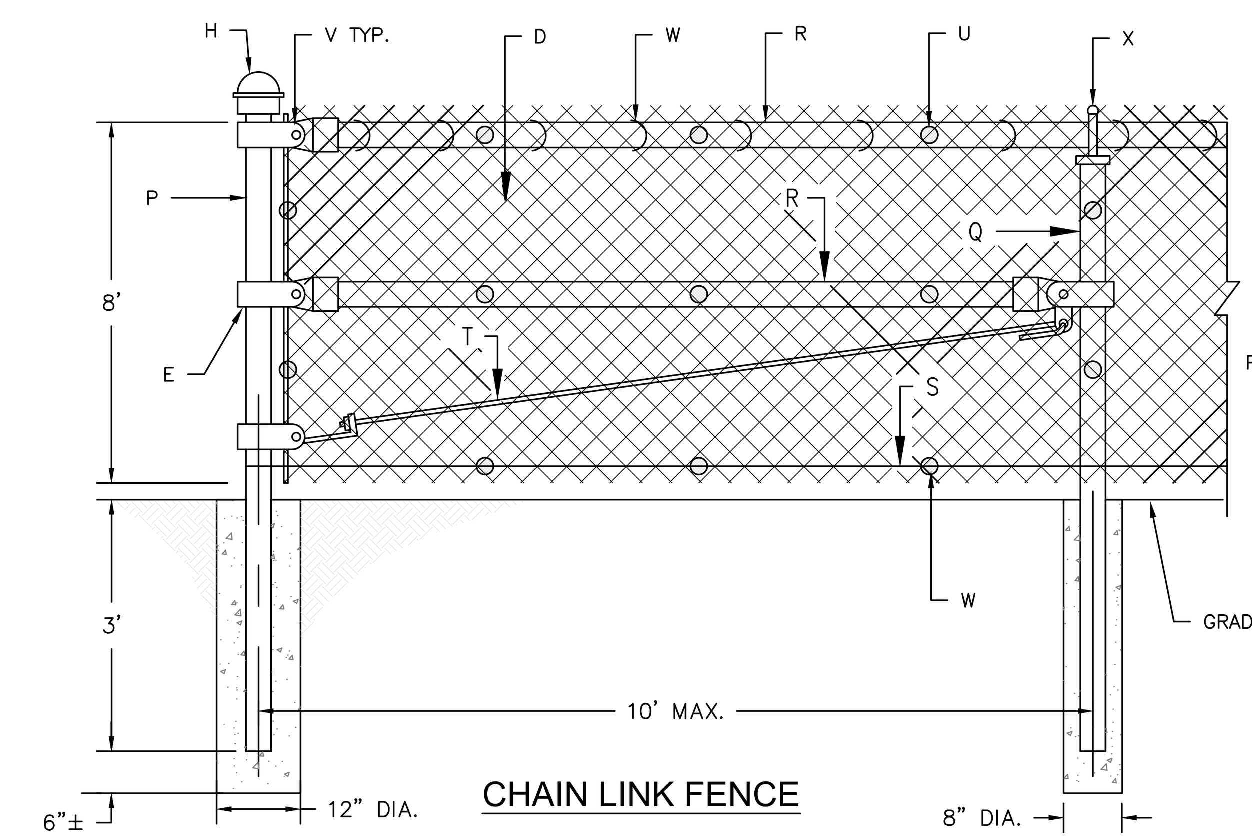
GENERAL NOTES:

1. REINFORCEMENT PER NM APWA.
2. CONCRETE USED FOR VALVE ANCHORAGE PER SEC. 101 HYDRAULIC STRUCTURAL CONCRETE. F'C= 4000 PSI @ 28 DAYS.

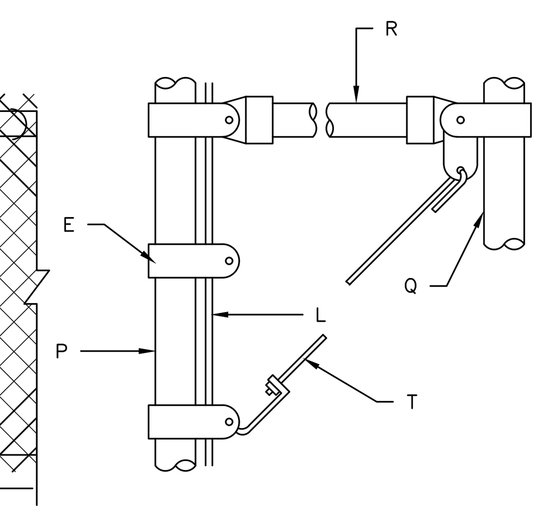
CLEANOUT DETAIL 1 / C-2
NTS



SECURITY CHAIN LINK GATE



CHAIN LINK FENCE



BRACE DETAIL

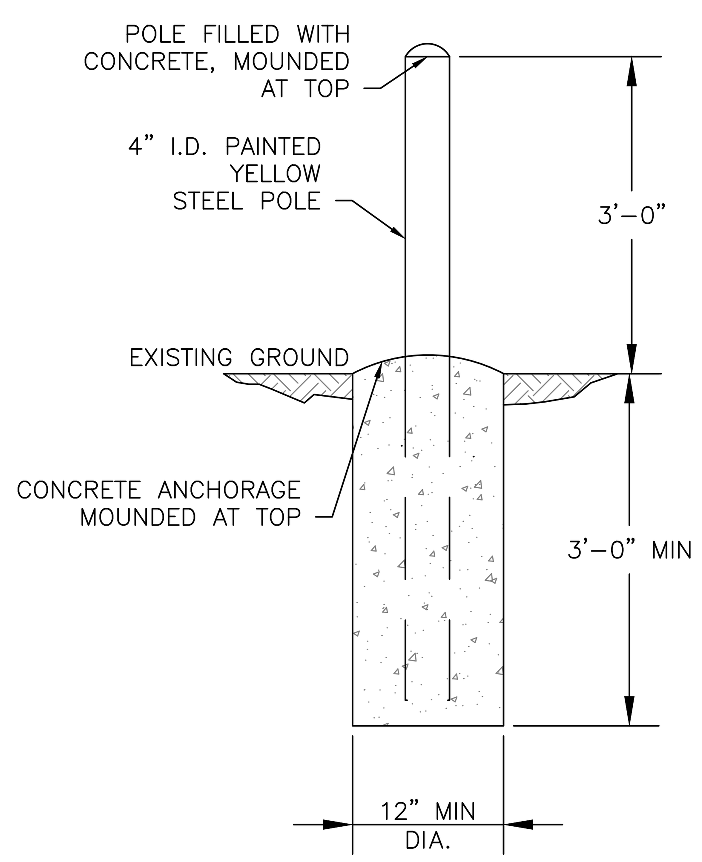
NOTES:

1. CONTRACTOR TO PROVIDE ONE 20' GATE AND ONE 4' GATE AT THE LOCATIONS SHOWN ON THE FENCE REPLACEMENT PLAN.
2. SINGLE LEAF GATES SHALL BE USED ON OPENINGS LESS THAN 12'. FOR GATES 12' OR MORE, DOUBLE LEAF GATES SHALL BE USED, WITH A CENTER LOCK POST INSERTED IN A CENTER STOP.
3. MESH IS FLUSH WITH GRADE LEVEL.
4. ALL METAL ITEMS, INCLUDING PIPE, SHALL BE GAL STEEL.
5. ALL PIPE SHALL BE NOMINAL SIZE, SCH. 40.

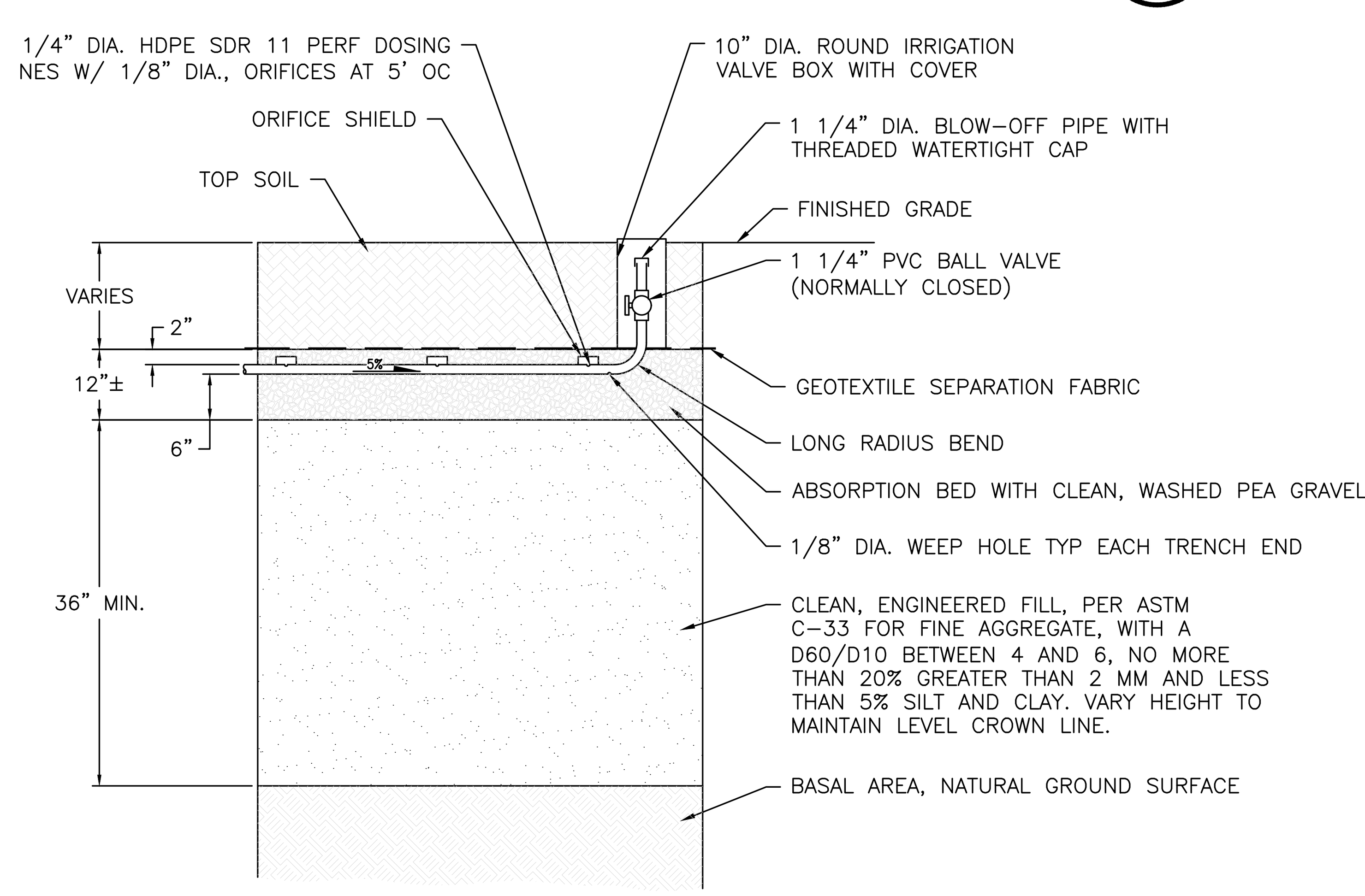
CONSTRUCTION NOTES:

A. GATE LATCH WITH VANDAL PROOF SHIELD & PADLOCK (PADLOCK TO BE FURNISHED BY THE OWNER).
B. 2- 3/8" TRUSS RODS, WELDED AT CORNERS.
C. 2- 3/8" THREADED TRUSS RODS AND BRACKET ATTACHMENT.
D. 2" NO. 9 GAUGE CHAIN LINK GAL WIRE FABRIC.
E. STEEL TENSION BANDS AT 18" OR LESS O.C.
F. BRACE, 1 1/4" DIA., WELDED TO FRAME.
G. GATE FRAME, 2" DIA. (2.375" O.D.) WELDED.
H. MALLEABLE ACORN CAP.
J. 4" J-BOLT, THREADED.
K. 3 1/2" GATE POST (4" O.D.) WITH WELDED STEEL CAP.
L. TENSION BAR 1/4" X 3/4".
M. GATE CLAMP.
N. 12" DIA. HOLES, FILLED WITH PORTLAND CEMENT CONC.
P. CORNER POST 2 1/2" DIA. (2.875" O.D.).
Q. LINE POST 2" DIA. (2.375" O.D.).
R. TOP AND BRACE RAILS 1 1/4" DIA. (1.660" O.D.).
S. WIRE REINFORCEMENT, 9 GAUGE, INSTALL 3" ABOVE BOTTOM OF FABRIC.
T. TRUSS ROD 3/8" DIA.
U. FABRIC SHALL BE TACK WELDED TWO PLACES TO EACH TENSION BAR AND THREE PLACES TO ALL TOP AND BRACE RAILS BETWEEN POSTS.
V. ALL NUTS, BOLTS, AND OTHER CONSTRUCTION SHALL BE TACK WELDED.
W. WIRE TIES, 9 GA. GAL STEEL AT 18" O.C.
X. MUSHROOM-TYPE CENTER STOP.

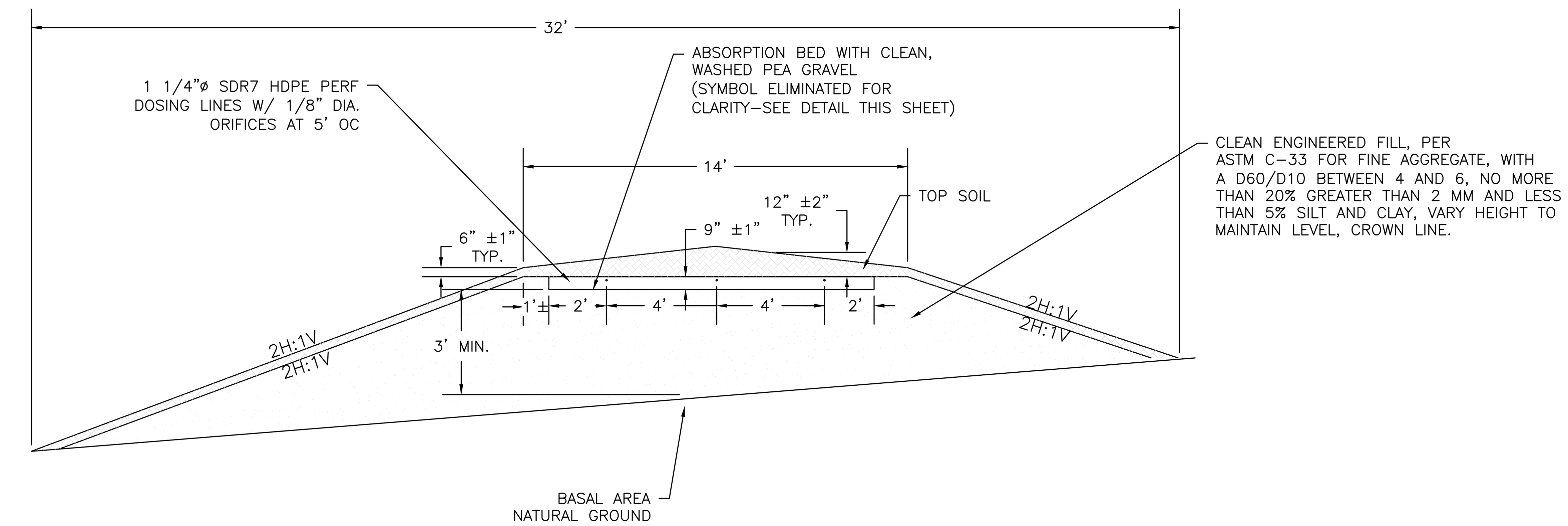
SECURITY FENCE DETAIL 2 / M-2
NTS



TYPICAL BOLLARD DETAIL 3 / M-2
NTS



MOUND CROSS-SECTION LENGTHWISE B-B' 4 / C-2
NTS



MOUND CROSS SECTION 5 / C-2
NTS

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RESPONSIBLE PARTY REMEDIATION
BELL GAS #1186 / TR'S MARKET
ALTO, NM

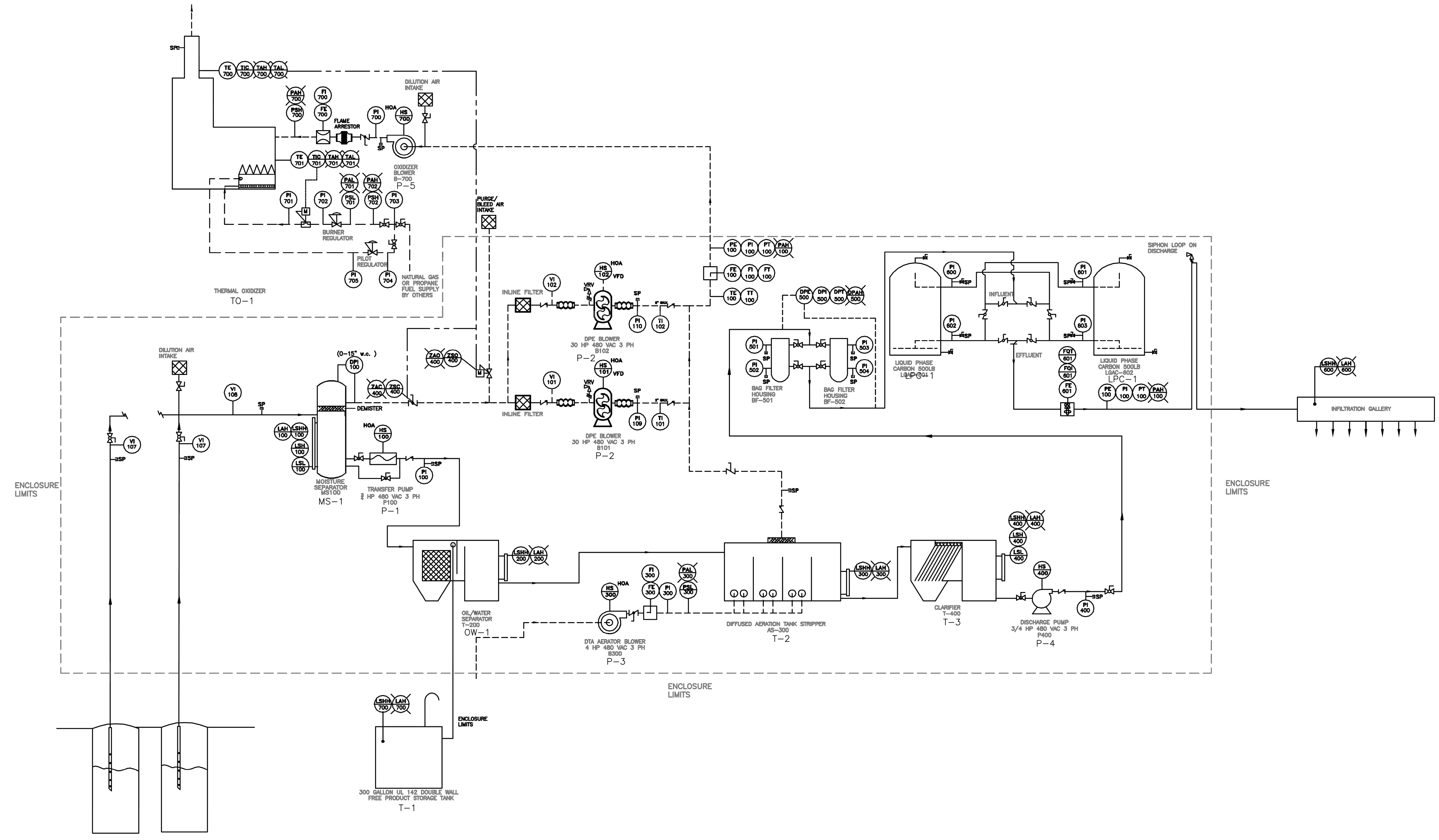
CIVIL DETAILS II

SHEET 7 OF 11
DWG NO. C-4
JOB NO. ES14.0220

S:\PROJECTS\ES14.0220_BELL_GAS_1186\CAD\PRODUCTION\C-3 CIVIL DETAILS 2 -- BELL GAS_1_29697_9947.SV$.DWG December 17, 2020 - 2:14 PM BY: SAMSON, JEFFREY

MS-1	P-1	P-2	P-3	P-4	P-5
MOISTURE SEPARATOR H2K MODEL VLS-220 30" DIA X 72" VERTICAL HEIGHT 55 GALLON LIQUID HOLDING CAPACITY	MOISTURE SEPARATOR TRANSFER PUMP MOYNO 500 SERIES MODEL 344 ¾ HP/460 VAC/3 PH/TEFC MOTOR 10 GPM AT 40 PSI DIFFERENTIAL	ROTARY CLAW COMPRESSOR BUSCH MODEL MV1202A 30HP/460VAC/3PH/TEFC MOTOR 600 ICFM AT 18.5"Hg VACCUME	SINGLE STAGE REGENERATIVE BLOWER FPZ MODEL K005-MS 4HP/230/460 VAC/3 PH/TEFC MOTOR 90 CFM AT 80" H20 COLUMN	TRANSFER PUMP AMT MODEL 489 ¾ HP/230/460 VAC/3 PH/TEFC MOTOR 10 GPM @ 82' TDH	COMBUSTION AIR BLOWER PROVIDED BY INTELLISHARE 2HP/460 VAC/3 PH/60 HZ

LPC-1	TO-1	OW-1	T-1	T-2	T-3
LIQUID PHASE CARBON VESSEL H2K TECH MODEL LC-005 60 PSI DESIGN PRESSURE 500 LBS 8X30 MESH REACTIVATED CARBON IN EACH VESSEL	THERMAL OXIDIZER W/ CATALYTIC OPTION PROVIDED BY INTELLISHARE 200-500 SCFM 650-1740 DEGREES F MAX 50% LEL	H2K MODEL LLS8 OIL/WATER SEPARATOR 304 SS CONSTRUCTION 100% REMOVAL OF 20 MICRON AND LARGER DROPLETS AT 25 GPM W SG= 0.75 SIGHT GLASS WITH SS LEVEL SWITCHES	PRODUCT STORAGE TANK 300 GALLON UL 142 DOUBLE WALL TANK 38.5" DIA X 68" LENGTH HORIZONTAL TANK 120 VAC HEAT TRACE 1" POLYURETHANE INSULATION	DIFFUSED AERATION TANK H2K MODEL DTA-2 TWO AERATION CHAMBERS SIX NON-FOULING SS DIFFUSERS SIGHT GLASS WITH SS LEVEL SWITCHES	INCLINED PLATE CLARIFIER H2K MODEL IPC-40 90% REMOVAL OF 20 MICRON AND LARGER SOLIDS AT 7.5 GPM SIGHT GLASS WITH SS LEVEL SWITCHES



PROCESS AND INSTRUMENTATION DIAGRAM (1)

NTS (-)

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THOMAS A. GOLDEN, NEW MEXICO, 22750, PROFESSIONAL ENGINEER, 12/18/2020

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BELL GAS #1186 / TR'S MARKET
ALTO, NM

PROCESS AND INSTRUMENTATION DIAGRAM

SHEET 8 OF 11
DWG NO. M-1

JOB NO.
ES14.0220

S:\PROJECTS\ES14.0220_BELL_GAS_1186\CAD\PRODUCTION\M-1 PID — BELL GAS.DWG December 17, 2020 — 2:14 PM BY: SAMSON, JEFFREY

S:\PROJECTS\ES14.0220_BELL_GAS_1186\CAD\PRODUCTION\M-2 MECHANICAL SITE PLAN - BELL GAS.DWG December 18, 2020 - 2:14 PM BY: SAMSON, JEFFREY

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RESPONSIBLE PARTY REMEDIATION
BELL GAS #1186 / TR'S MARKET
ALTO, NM

MECHANICAL SITE PLAN

SHEET 9 OF 11
DWG NO. M-2

JOB NO.
ES14.0220

GENERAL CRITERIA

1. WHERE DISCREPANCIES OCCUR BETWEEN PLAN, DETAILS, GENERAL STRUCTURAL NOTES AND SPECIFICATIONS, MORE STRINGENT REQUIREMENTS SHALL GOVERN.

2. THE STRUCTURAL DRAWINGS AND SPECIFICATIONS REPRESENT THE FINISHED STRUCTURE, AND, EXCEPT WHERE SPECIFICALLY SHOWN, DO NOT INDICATE THE METHOD OR MEANS OF CONSTRUCTION. THE CONTRACTOR SHALL SUPERVISE AND DIRECT THE WORK AND SHALL BE SOLELY RESPONSIBLE FOR ALL CONSTRUCTION MEANS, METHODS, PROCEDURES, TECHNIQUES, AND SEQUENCE. ALL APPLICABLE SAFETY REGULATIONS AND OSHA REQUIREMENTS TO BE FOLLOWED STRICTLY.

3. THE GENERAL CONTRACTOR SHALL CHECK AND VERIFY ALL DIMENSIONS AND GRADE CONDITIONS, (BOTH NEW AND EXISTING) REPORTING ANY DISCREPANCIES TO DBSA PRIOR TO ORDERING MATERIALS OR PROCEEDING WITH ANY PHASE OF THE WORK.

4. DO NOT SCALE DIMENSIONS FROM DRAWINGS. THE CONTRACTOR SHALL REQUEST, FROM THE STRUCTURAL ENGINEER, NECESSARY DIMENSIONS NOT SHOWN ON THE DRAWINGS.

5. IF ANY BIDDER IS IN DOUBT AS TO THE INTENT OF THE PLANS OR SPECIFICATIONS, THEY SHALL REQUEST AN INTERPRETATION FROM THE STRUCTURAL ENGINEER IN WRITING AT LEAST TEN (10) DAYS PRIOR TO THE SCHEDULED BID DATE.

6. THIS PROJECT REQUIRES SPECIAL INSPECTIONS AS DESCRIBED IN CHAPTER 17 OF IBC. SEE STATEMENT OF SPECIAL INSPECTIONS FOR REQUIRED INSPECTIONS. CONTRACTOR SHALL COORDINATE WITH SPECIAL INSPECTOR ALL WORK REQUIRING SPECIAL INSPECTIONS AND TESTING.

7. GENERAL CONTRACTOR SHALL PROVIDE DETAILED SHOP DRAWING FOR ALL STRUCTURE. SHOP DRAWINGS SHALL BE ORIGINALS (NOT COPIES AND/OR A DERIVATIVE OF ANY CONSTRUCTION DOCUMENT). SHOP DRAWINGS SHALL BE THOROUGHLY REVIEWED BY THE GENERAL CONTRACTOR PRIOR TO SUBMITTAL TO DESIGN TEAM. DESIGN TEAM WILL HAVE A MINIMUM OF TWO WEEKS REVIEW SCHEDULE. GENERAL CONTRACTOR IS TO COORDINATE WILL ALL SUBCONTRACTORS AND SUPPLIERS AND INCORPORATE ALL INFORMATION INTO SHOP DRAWINGS PRIOR TO SUBMITTAL TO DESIGN TEAM.

8. GENERAL CONTRACTOR SHALL COORDINATE ALL SUPPORT REQUIREMENTS (FRAMING, LOCATION, CONNECTION DETAILS…) FOR ALL EQUIPMENT. THIS INCLUDES EQUIPMENT SUPPORTED BY THE BUILDING STRUCTURE OR ON THE BUILDING SITE. SUBMITTALS SHALL INDICATE ALL INFORMATION APPLICABLE FOR COORDINATION WITH ALL PARTIES.

9. CAST-IN-PLACE ANCHORS SHALL BE HELD IN PLACE WITH STEEL TEMPLATES PROVIDED BY THE STEEL FABRICATOR. THE GENERAL CONTRACTOR SHALL SURVEY THE ANCHOR LOCATIONS AFTER CASTING FOR COORDINATION WITH THE STEEL FABRICATOR. MODIFICATION TO THE ANCHOR BOLTS ARE NOT ALLOWED WITHOUT WRITTEN CONSENT BY THE STRUCTURAL ENGINEER OF RECORD.

FOUNDATIONS

1. MINIMUM SUBGRADE PREPARATION REQUIREMENTS ARE AS FOLLOWS: COMPACT ALL FILL UNDER BUILDING TO 95% MAXIMUM DENSITY AS DETERMINED BY ASTM D698. PLACE IN LAYERS OF 8" MAXIMUM LOOSE THICKNESS. VERIFY FIELD DENSITY, ASTM D1556, WITH AT LEAST ONE TEST PER 2000 SQUARE FEET PER LAYER. SEE SPECIFICATIONS FOR OTHER TESTING REQUIREMENTS.

2. UTILITY LINES SHALL NOT BE PLACED THROUGH OR BELOW FOUNDATIONS WITHOUT APPROVAL OF THE STRUCTURAL ENGINEER. CONTRACTOR SHALL SUBMIT DETAILED DRAWINGS OF ALL SUCH CONDITIONS PRIOR TO CONSTRUCTION.

CAST-IN-PLACE CONCRETE / REINFORCING STEEL

1. CONCRETE COMPRESSIVE STRENGTH IN 28 DAYS:
   SITE CONCRETE,EQUIP PAD — 4000 PSI, NORMAL WEIGHT
2. REINFORCING:
   ASTM A615 - GRADE 60 TYPICAL
   IF REINFORCING LAP REQUIREMENTS ARE NOT SPECIFIED IN DRAWINGS PROVIDE LAPS PER ACI 318, PROVIDE MINIMUM LAPS OF:
   FOOTINGS — 30 BAR DIAMETER (18" MIN)
   SLAB-ON-GRADE BARS — ALL — 30 BAR DIA'S (18" MIN)
   ALL BARS SHALL BE CONTINUOUS AROUND CORNERS.

3. CLEAR COVER FROM FACE OF CONCRETE:
   CAST-IN-PLACE CONCRETE (measure to outermost reinforcing):
   CONCRETE CAST AGAINST SOIL — 3"
   SLABS EXPOSED TO EARTH AND WEATHER — 1-1/2"

4. ALL CONCRETE SHALL HAVE 5% ENTRAINED AIR (+- 1 ½%)

5. WHERE SCHEDULED BARS ARE NOT PRESENT, PROVIDE CONTINUOUS #5 TOP AND BOTTOM BARS TO SUPPORT STIRRUPS AS REQUIRED FOR THE LENGTH OF THE STIRRUP SPACING IN ALL BEAMS.

6. BAR SUPPORTS FOR CONCRETE EXPOSED TO VIEW SHALL HAVE PLASTIC COATED LEGS OR BE HOT DIP GALVANIZED AFTER FABRICATION.

7. MECHANICAL AND ELECTRICAL CONDUIT IN SLABS SHALL RUN UNDER TOP LAYER OF SLAB REINFORCING. PROVIDE A MINIMUM OF 1-1/2" CLEAR BETWEEN CONDUITS AND BETWEEN REINFORCING AND ADJACENT CONDUITS PARALLEL TO REINFORCING. IF MAXIMUM SIZE OF CONDUIT EXCEEDS ONE THIRD OF THE SLAB DEPTH, ADDITIONAL FRAMING OR REINFORCING MAY BE NECESSARY AT ENGINEER'S DISCRETION

8. FOR SLABS-ON-GRADE, SLAB AND GRADE BEAM REINFORCING SHALL BE HELD IN PLACE BY BAR SUPPORTS WITH SAND PLATES, OR PRECAST CONCRETE BAR SUPPORTS AS DESCRIBED IN CHAPTER 3 OF THE CRSI MANUAL OF STANDARD PRACTICE. BAR SUPPORTS SHALL BE SPACED AT A MAXIMUM OF 4'-0" OC BOTH WAYS. ROCKS, CMU, OR CLAY BRICK WILL NOT BE USED AS SUPPORTS.

9. REBAR SHALL NOT BE HEATED WITH A TORCH IN THE FIELD.

10. ALL CONCRETE EDGES SHALL HAVE A 3/4" CHAMFER UNLESS NOTED OTHERWISE.

11. ALL CEMENT IN EXPOSED TO GROUND CONCRETE SHALL BE TYPE II.

12. CALCIUM CHLORIDE IS NOT ALLOWED IN ANY CONCRETE.

CONCRETE JOINTS

1. CONTRACTOR SHALL PROVIDE NECESSARY CONSTRUCTION JOINTS IN MONOLITHIC CONCRETE POURS SO THAT THE QUALITY OF PLACEMENT AND FINISH MEETS THE REQUIREMENTS OF PLANS AND SPECIFICATIONS. THE CONTRACTOR SHALL SUBMIT A PLAN SHOWING THE LOCATION OF ALL CONSTRUCTION AND CONTROL JOINTS TO THE STRUCTURAL ENGINEER FOR REVIEW. CONTROL JOINTS SHALL BE INSTALLED WITHIN 7 HOURS OF START OF POUR.

2. THERE SHALL BE NO HORIZONTAL CONSTRUCTION JOINTS IN CONCRETE POURS. ALL VERTICAL CONSTRUCTION JOINTS IN SLABS AND BEAMS SHALL BE MADE WITH BULKHEADS. ADDITIONAL REINFORCING AT CONSTRUCTION JOINTS SHALL BE AS SPECIFIED BY THE STRUCTURAL ENGINEER. SEE TYPICAL CONSTRUCTION JOINT DETAILS.

3. ALL SLAB-ON-GRADE REQUIRE CONSTRUCTION JOINTS UNLESS SPECIFICALLY NOTED THAT THEY ARE NOT NEEDED ON PLAN. CONSTRUCTION JOINTS SHALL BE 1/8"x1/3 THE SLAB DEPTH MINIMUM.

4. CONTROL JOINT SPACING SHALL MEET THE MINIMUM RECOMMENDATIONS OF ACI 360R-06.

5. NO ADDITIONAL WATER (TO ORIGINAL MIX DESIGN) IS ALLOWED TO BE ADDED TO ANY SLAB-ON-GRADE CONCRETE, NO EXCEPTIONS. GENERAL CONTRACTOR IS TO KEEP RECORDS OF ALL POURS VERIFYING THAT NO ADDITIONAL WATER HAS BEEN ADDED TO SLAB-ON-GRADE MIX.

EPOXY AND EPOXY GROUT

1. ANCHOR BOLTS, REINFORCING STEEL, THREADED RODS, STAIR HANDRAILS, AND OTHER EMBEDDED STEEL ITEMS SHALL BE SET INTO HARDENED CONCRETE WITH EPOXY OR EPOXY GROUT ONLY WHERE DETAILED ON THE DRAWINGS OR WHERE APPROVED BY THE ENGINEER.

2. MANUFACTURER'S DATA FOR ALL EPOXY AND EPOXY GROUT SHALL BE SUBMITTED TO THE ENGINEER FOR APPROVAL PRIOR TO INSTALLATION.

3. ACCEPTABLE EPOXY PRODUCTS ARE:
   HILTI HIT-HY200, HILTI HSE2421, SIMPSON STRONG-TIE ET-HP OR APPROVED EQUAL. IN USING THE ABOVE PRODUCTS, FOLLOW STRICTLY THE MANUFACTURER'S SPECIFICATIONS AND DIRECTIONS FOR MIXING AND APPLICATION. HEED ALL LABEL WARNINGS. INSTALL IN ACCORDANCE WITH APPLICABLE SAFETY LAWS.

4. ALL EPOXY AND EPOXY GROUT SHALL DEVELOP A MINIMUM COMPRESSIVE STRENGTH OF 8,000 PSI AND TENSILE STRENGTH OF 2,300 PSI.

5. ALL HOLES SHALL BE DRILLED WITH A DIAMETER NO LARGER THAN 1/8" GREATER THAN THE DIAMETER OF THE STEEL MEMBER BEING INSTALLED.

6. ALL HOLES SHALL BE CLEANED WITH COMPRESSED AIR AND SHALL BE DRY PRIOR TO INSTALLATION OF EPOXY. HOLES SHALL BE FREE OF ALL DELETERIOUS MATERIAL SUCH AS LAITANCE, DUST, DIRT, AND OIL.

7. CONTRACTOR PERFORMING EPOXY WORK SHALL BE AN APPROVED CONTRACTOR BY THE MANUFACTURER FURNISHING THE EPOXY MATERIALS, AND SHALL HAVE NO LESS THAN FIVE YEARS EXPERIENCE IN THE VARIOUS TYPES OF EPOXY RELATED WORK REQUIRED IN THIS PROJECT. A NOTARIZED CERTIFICATION FROM THE MANUFACTURER ATTESTING TO THE TRAINING SHALL BE SUBMITTED TO THE ENGINEER/ARCHITECT ALONG WITH THE PROPOSAL TO DO THE WORK.

REPRODUCTION NOTE

THE USE OF REPRODUCTIONS OF THESE CONTRACT DRAWINGS BY ANY CONTRACTOR, SUBCONTRACTOR, ERECTOR, FABRICATOR, OR MATERIAL SUPPLIER IN LIEU OF PREPARATION OF SHOP DRAWINGS SIGNIFIES HIS ACCEPTANCE OF ALL INFORMATION SHOWN HEREIN AS CORRECT, AND OBLIGATES HIMSELF TO ANY JOB EXPENSE, REAL OR IMPLIED, ARISING DUE TO ANY ERRORS THAT MAY OCCUR HEREIN.

ENGINEER'S REVIEW OF SHOP DRAWINGS

THE REVIEW BY THE ENGINEER OF DRAWINGS, DATA, OR SAMPLES SUBMITTED BY THE CONTRACTOR WILL COVER ONLY THE GENERAL CONFORMITY TO THE DRAWING AND SPECIFICATIONS. THE ENGINEER'S REVIEW WILL NOT CONSTITUTE AN APPROVAL OF DIMENSIONS, QUANTITIES, AND DETAILS OF THE MATERIAL, EQUIPMENT, DEVICE OR ITEM SHOWN. THE REVIEW OF DRAWINGS AND SCHEDULES WILL BE GENERAL AND NOT CONSTRUED:

A. AS PERMITTING ANY DEPARTURE FROM THE CONTRACT REQUIREMENTS
B. AS RELIEVING THE CONTRACTOR OF RESPONSIBILITY FOR ANY ERRORS, INCLUDING DETAILS, DIMENSIONS AND MATERIALS
C. AS APPROVING DEPARTURES FROM DETAILS FURNISHED BY THE ENGINEER, EXCEPT AS OTHERWISE PROVIDED HEREIN.

SCHEDULE OF STRUCTURAL SPECIAL INSPECTIONS

1. **SPECIAL INSPECTIONS / TESTING** - "SPECIAL STRUCTURAL INSPECTION" SHALL NOT RELIEVE THE OWNER OR THEIR AGENT FROM REQUESTING THE JURISDICTION BUILDING DEPARTMENT INSPECTIONS REQUIRED BY SECTION 110 OF THE IBC.

2. **REPORTING FOR SPECIAL INSPECTION** - SPECIAL INSPECTION AND TESTING REPORTS SHALL BE COMPLETED AND DISTRIBUTED AT THE COMPLETION OF EACH TASK. IF A TASK IS TO TAKE LONGER THAN (3) DAYS, PROVIDE REPORTS FOR EACH DAY. PROVIDE COPIES OF REPORTS TO: CONTRACTOR, OWNER, MECHANICAL AND STRUCTURAL ENGINEER OF RECORD. SPECIAL INSPECTOR TO KEEP A NON-COMPLIANCE LIST DOCUMENTING ITEMS INSPECTED NOT MEETING APPROVED CONSTRUCTION DOCUMENTS AND WHEN / HOW RESOLVED.

3. SEE ARCHITECTURAL, MECHANICAL, ELECTRICAL, AND PLUMBING CONSTRUCTION DOCUMENTS FOR ADDITIONAL NON-STRUCTURAL SPECIAL INSPECTION ITEMS

IN ACCORDANCE WITH IBC 2018, THE FOLLOWING TYPES OF WORK REQUIRE SPECIAL INSPECTIONS AND TESTING:

SPECIAL INSPECTIONS AND TESTS OF CONCRETE CONSTRUCTION

SPECIAL INSPECTION REQUIRED Y/N	TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION	REFERENCE STANDARD	IBC REFERENCE
Y	1.INSPECT REINFORCEMENT, INCLUDING PRESTRESSING TENDONS, AND VERIFY PLACEMENT.	----	X	ACI 318 CH. 20, 25.2, 25.3, 26.5.1-26.5.3	1908.4
	2.REINFORCING BAR WELDING:				
N	a. VERIFY WELDABILITY OF REINFORCING BARS OTHER THAN ASTM A 706.	----	X	AWS D1.4 ACI 318:26.5.4	----
N	b.INSPECT SINGLE-PASS FILLET WELDS, MAXIMUM 5/16"	----	X		
N	c.INSPECT ALL OTHER WELDS.	X	----		
N	3.INSPECT ANCHORS CAST IN CONCRETE.	----	X	ACI 318: 17.8.2	----
	4.INSPECTION OF ANCHORS POST-INSTALLED IN HARDENED CONCRETE MEMBERS.				
N	a. ADHESIVE ANCHORS INSTALLED IN HORIZONTALLY OR UPWARDLY INCLINED ORIENTATIONS TO RESIST SUSTAINED TENSION LOADS.	X	----	ACI 318: 17.8.2.4	----
N	b. MECHANICAL ANCHORS AND ADHESIVE ANCHORS NOT DEFINED IN 4.A.	----	X	ACI 318: 17.8.2	----
Y	5.VERIFY USE OF REQUIRED DESIGN MIX.	----	X	ACI 318: CH. 19, 26.4.3, 26.4.4	1904.1, 1904.2, 1908.2, 1908.3
Y	6.PRIOR TO CONCRETE PLACEMENT, FABRICATE SPECIMENS FOR STRENGTH TESTS, PERFORM SLUMP AND AIR CONTENT TESTS, AND DETERMINE THE TEMPERATURE OF THE CONCRETE.	X	----	ASTM C 172 ASTM C 31 ACI 318: 26.4.5, 26.12	1908.10
N	7.INSPECT CONCRETE AND SHOTCRETE PLACEMENT FOR PROPER APPLICATION TECHNIQUES.	X	----	ACI 318: 26.4.5	1908.6,1908.7, 1908.8
Y	8.VERIFY MAINTENANCE OF SPECIFIED CURING TEMPERATURE AND TECHNIQUES.	----	X	ACI 318: 26.4.7 - 26.4.9	1908.9
	9.INSPECT PRESTRESSED CONCRETE FOR:				
N	a.APPLICATION OF PRESTRESSING FORCES.	X	----	ACI 318: 26.9.2.1	----
N	b.GROUTING OF BONDED PRESTRESSING TENDONS	X	----	ACI 318: 26.9.2.3	----
N	10.INSPECT ERECTION OF PRECAST CONCRETE MEMBERS.	----	X	ACI 318: CH. 26.9	----
N	11. VERIFY IN-SITU CONCRETE STRENGTH, PRIOR TO STRESSING OF TENDONS IN POST-TENSIONED CONCRETE AND PRIOR TO REMOVAL OF SHORES AND FORMS FROM BEAMS AND STRUCTURAL SLABS.	----	X	ACI 318: 26.10.2	----
Y	12. INSPECT FORMWORK FOR SHAPE, LOCATION AND DIMENSIONS OF THE CONCRETE MEMBER BEING FORMED.	----	X	ACI 318: 26.10.1 (b)	----

HEATLY ENGINEERING INC
120 Vassar Dr SE Suite 220
Albuquerque, NM 87106

REV. NO.	DATE	DESCRIPTION	APPROVED BY

DATE OF ISSUE: 12/11/2020
DESIGNED BY: MH
DRAWN BY: KS
CHECKED BY: MH
APPROVED BY: SH

SCOTT EDWARD HEATLY — STATE OF NEW MEXICO — 13856 — REGISTERED PROFESSIONAL ENGINEER — 12/11/20

DBS&A — Daniel B. Stephens & Associates, Inc

101 SUN VALLEY ROAD
ALTO, NM 88312

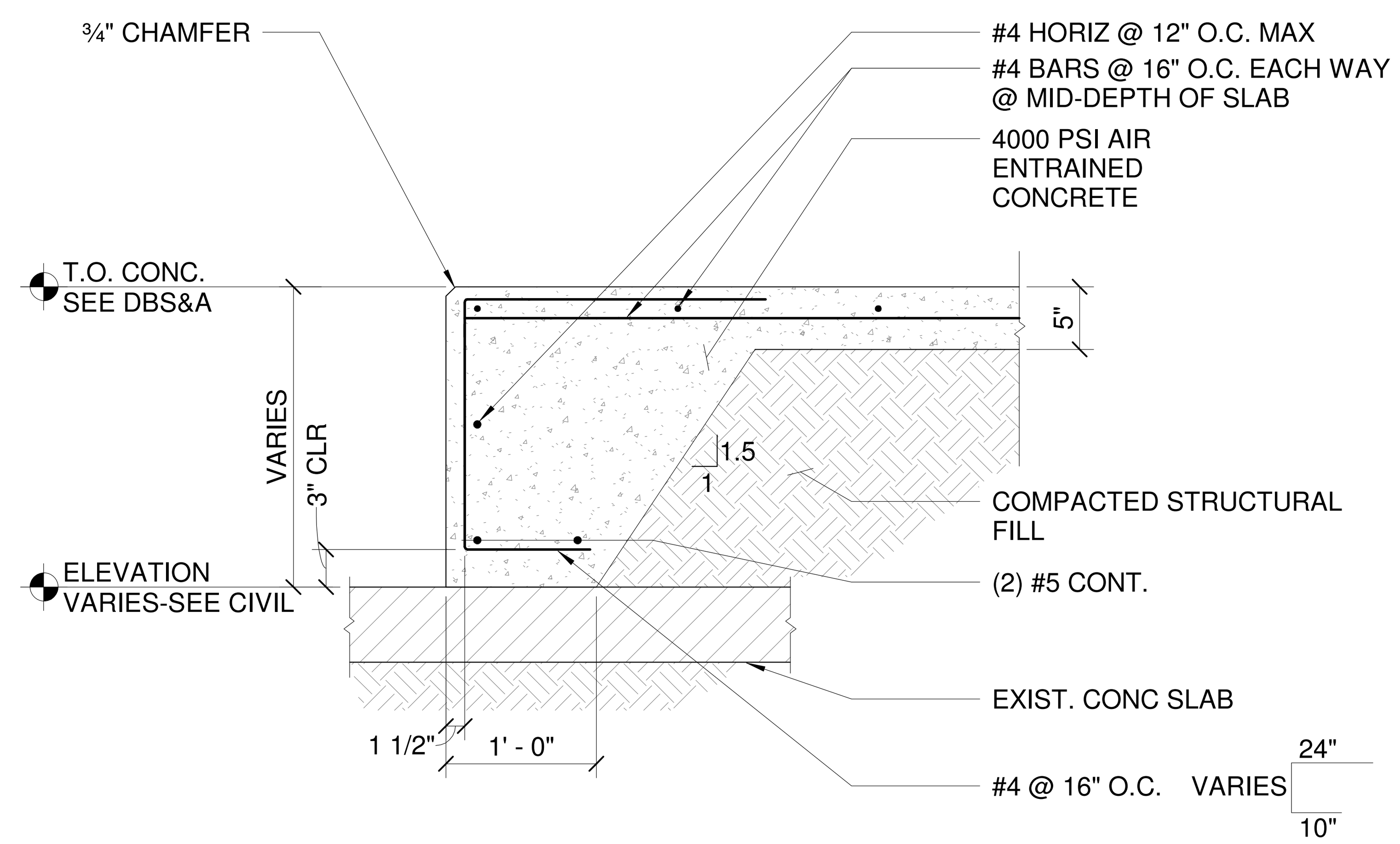
RESPONSIBLE PARTY REMEDIATION
BELL GAS #1186 / TR'S MARKET
ALTO, NM

GENERAL STRUCTURAL AND SPECIAL INSPECTION TABLE NOTES

SHT. 10 OF 11
DWG NO. S-0
JOB NO. ES14.0220.00

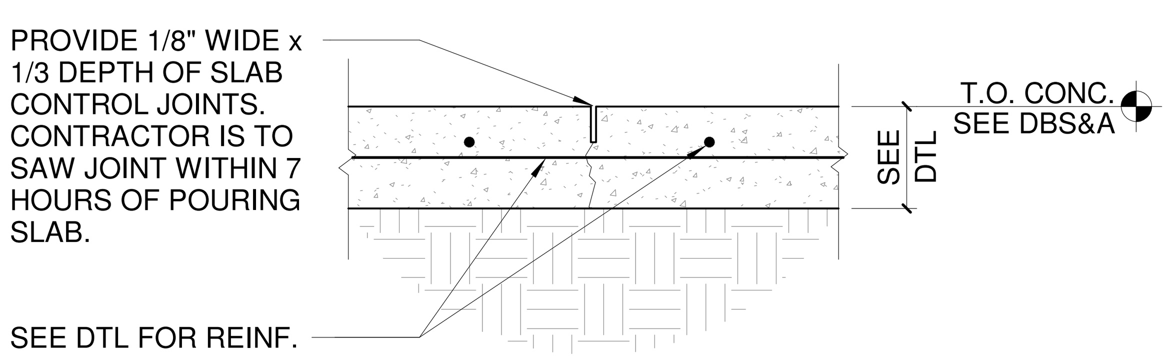
GENERAL SHEET NOTES

A. GENERAL CONTRACTOR SHALL VERIFY ALL DIMENSIONS IN THE FIELD AND COMPARE TO DBS&A AND STRUCTURAL DRAWINGS AND NOTIFY DBS&A PRIOR TO THE START OF CONSTRUCTION OF ANY DISCREPANCIES.
B. SINCE A GEOTECHNICAL REPORT WAS NOT PROVIDED DOCUMENTING EXISTING SUBSURFACE CONDITIONS, DBS&A SHALL ASSUME ALL LIABILITY FOR SUBSURFACE CONDITIONS, FOUNDATION MOVEMENT AND FOR ANY CRACKING AND/OR DIFFERENTIAL SETTLEMENT OF THE EXISTING SLAB-ON-GRADE.
C. HEATLY ENGINEERING IS NOT RESPONSIBLE FOR ANY CRACKING, CHIPPING, SPALLING, OR OTHER DEFICIENCIES ON EXISTING CONCRETE SLAB AS WE CANNOT WARRANT ITS CONDITION OR DESIGN CAPACITY.
D. CJ DESIGNATES A SLAB/CONTROL JOINT.

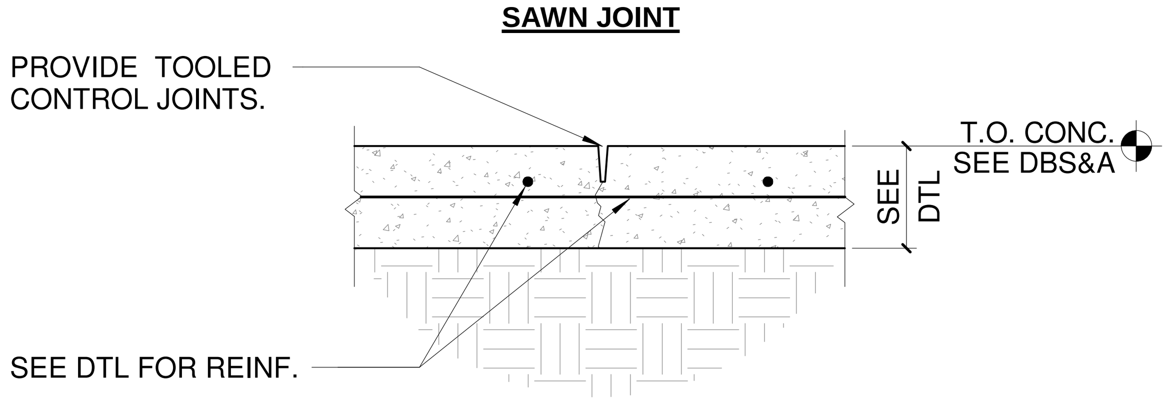


2 EQUIPMENT PAD DETAIL
1" = 1'-0"

NOTE: 1. CONTRACTOR CAN USE EITHER, SAWN OR TOOLED JOINT
2. TROWEL OUT ROLLER MARKS AFTER TOOLING.
3. SEE PLAN FOR LOCATION AND QUANTITY.



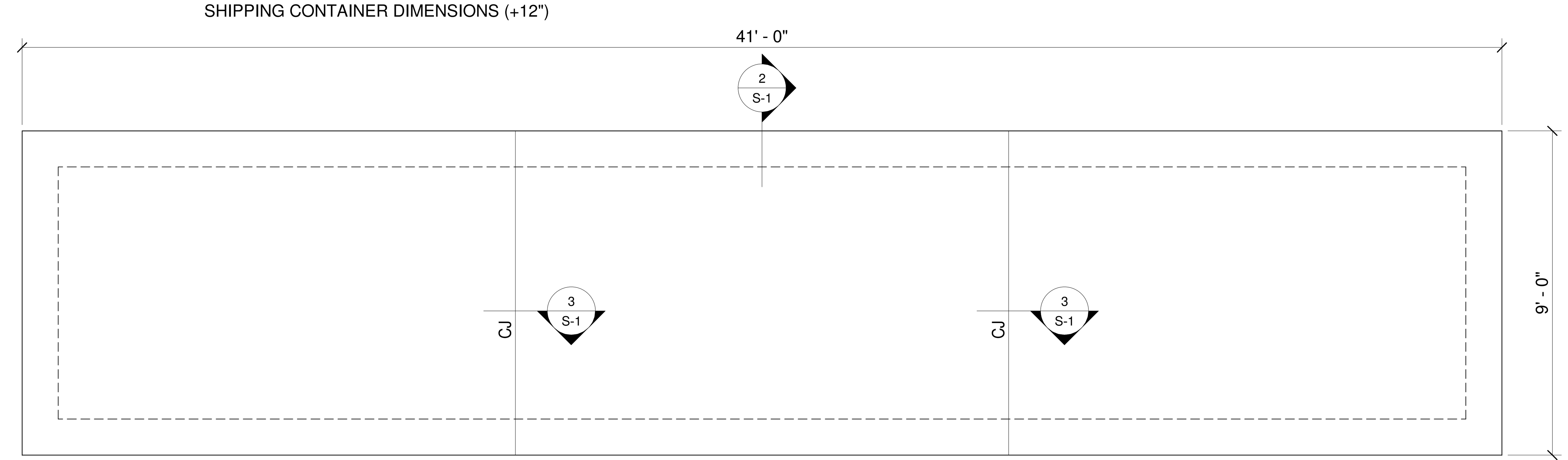
SAWN JOINT



TOOLED JOINT

3 TYPICAL SLAB/CONTROL JOINT
1 1/2" = 1'-0"

NOTE: 1. FINAL DIMENSIONS TO BE VERIFIED WITH SHIPPING CONTAINER DIMENSIONS (+12")



1 EQUIPMENT PAD PLAN
3/8" = 1'-0"

HEATLY ENGINEERING INC
120 Vassar Dr SE Suite 220
Albuquerque, NM 87106

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DBS&A Daniel B. Stephens & Associates, Inc

101 SUN VALLEY ROAD
ALTO, NM 88312

RESPONSIBLE PARTY REMEDIATION
BELL GAS #1186 / TR'S MARKET
ALTO, NM

FOUNDATION PLAN AND DETAIL

SHT. 11 OF 11
DWG NO. S-1

JOB NO.
ES14.0220.00

Appendix C

Product Cut Sheets

H2K Technologies, Inc.
7550 Commerce St.
Corcoran, MN 55340
Office: 763-746-9900
Fax: 763-746-9903
www.H2KTech.com

January 7, 2019

To: Thomas Golden, P.E.
Daniel B. Stephens & Associates, Inc.
6020 Academy Road NE, Suite 100 | Albuquerque, New Mexico 87109
T (505) 822-9400 | D (505) 353-9075 | M (505) 249-9402
Email: tgolden@geo-logic.com

Project Name: BELL GAS #1186
Project Location: Alto, NM
Quote Number: 5256

Dear Tom,
Below is a quote you requested for the above referenced project. Quote is per the specifications with exceptions as noted. We appreciate the opportunity to bid on this project, please call or email with any questions.

Description/Pricing

Dual Phase Extraction Equipment

(1) Inlet manfold, 6" main with (7) 2" takeoffs
- Sch 80 PVC pipe and fittings, dual phase configuration with over the top inlets to manifold
- (7) 2"PVC ball valves, manual operator, ss shaft, Teflon seat
- (7) Vacuum gages
- (7) Sample ports

DPE inlet manifold will terminate through the wall or the floor.

(1) Air dilution intake line
- 4" PVC butterfly valve
- 4" Filter/silencer, Solberg FS-365P-400

(1) Moisture separator, H2K model VLS-220
- Welded steel construction with external enamel finish
- Tangential inlet and demister for 99%+ moisture removal
- 30" Dia x 72" high vertical tank
- 220 gallon total capacity, 55 gallon liquid holding capacity
- Full vacuum design rating
- Epoxy lined, enamel exterior finish
- PVC site glass with ss low/high/high-high level switch assembly and union for easy removal
- Polypropylene demister element
- Acquiescence plate to isolate condensate water from turbulent airflow
- 1" Brass drain valve
- 6" plate flange inlet and outlet connections
- 6" Plate flanged cleanout port
- Sloped bottom for solids removal
- Vacuum gage on separator inlet & outlet, 0-100 "wc vacuum
- Sample port on separator intake

(1) Moisture Separator pump, Moyno 500 series model 344 progressive cavity pump
- 3/4 hp, 460VAC, 3Ø, TEFC motor
- 10 gpm at 40 psi differential pressure
- Cast iron housing, carbon steel rotor, NBR rubber stator
- Pump re-circulation loop with ball valve
- Flexible connectors on pump inlet and outlet
- Throttle valve, check valve, sample port & pressure gage on discharge

(1) Isolation and Purge/Bleed vapor control valves, mounted on vacuum side of blowers, controlled by oxidizer
- Supplied by others

(2) Inline vacuum filter on blower intake, Solberg CT-235P-400C with replaceable polyester element
- Differential pressure gage installed across filter

(2) Rotary claw compressor, Busch model MV1202A, to include:
- Cast iron housing, cast iron machined rotors
- 30 HP, 460VAC, 3Ø, TEFC motor
- Capable of 600 ICFM at 18.5” Hg vacuum at 7500’ elevation
- Factory mounted cooling shroud with integral fan
- Silencer on blower discharge
- Temperature gauge on discharge, 50-550 F
- Vacuum relief valve on blower inlet
- Sample port on blower discharge
- Pressure gage blower inlet and outlet
- 4” CI butterfly valve on inlet
- 4” check valve on blower inlet

Note: We have operated multiple liquid ring pumps at elevation before and they fail for various reasons within two years as the manufacturer requires higher maintenance under what they consider extreme operating conditions, shorter oil changes, more frequent filter changes. An oil sealed rotary vane pump is not recommended as the TPH may thin the oil causing a breakdown of the lubricating properties with constant operation. This may scour the compression chamber of break the vanes from hot spots, which will cause the unit to lose vacuum over time. With both the liquid ring and the oil lubricated vane the manufacturers will not stand behind it, so the risk is passed on and we are not willing to warranty. We have operated claw blowers up to 8,000’ elevation without any issues, so those we do stand behind.

(1) Pressure transmitter on blower discharge, Foxboro IDP-10 transmitter, 4-20 mADC output, loop powered, local LCD display, NEMA 4X, ClassI, Div 2 rated

(1) Temperature transmitter on blower discharge, RTD with 4-20 mADC output

(1) Air flow transmitter on combined blower discharge, Dwyer DS-300-4 pitot tube with Foxboro IDP-10 transmitter, 4-20 mADC output, loop powered, local LCD display, NEMA 4X, ClassI, Div 2 rated

Water Treatment Equipment

(1) H2K Technologies model LLS8, oil/water separator
- 304 stainless steel construction
- 100% removal of 20 micron & larger droplets at 25 gpm w/ SG=0.75
- PVC slant rib coalescing media
- Adjustable skimming weir
- Gravity drain from skimmer into product holding tank
- Solids collection sump
- Clearwell for pumping directly from separator
- PVC site glass with ss low, high & high-high pump out level switch assembly, union mounted

Vapor tight gasketed cover, Buna-N Gasket
1” PVC vent line, plumbed to exterior
2” Brass ball valve, clearwell drain
Sample port on inlet
2” PVC ball valve on discharge

(1) Product storage tank, 300 gallon, UL 142 double wall tank (OUTSIDE OF ENCLOSURE)
Welded steel horizontal tank with enamel external finish
38.5” dia. x 68” long horizontal tank
High/high and high level switches
Normal vent with riser pipe
Emergency vent
Check valve and isolation valve on product inlet
120 VAC heat trace for class I, Div 1 hazardous location
1” polyurethane insulation, UV resistant, R-7 on tank

(1) H2K Technologies model DTA-2 Diffused Aeration Tank, each including:
304 Stainless steel welded construction
(2) Aeration chambers
(6) Non-fouling 304 Stainless Steel aeration diffusers
Quick connections for easy lateral removal
Counter current water and air flow to provide maximum flow path across each aeration chamber
Hinged 304 Stainless steel cover
Provides easy access to aeration chambers and diffusers
Off gas nozzle with polypropylene demister element
(1) Pump out clearwell
Site glass with ss high/high-high-low pump out level switches
Unit will be stand mounted to allow gravity drain from oil/water separator thru DTA into clarifier
Welded steel stand with enamel finish, walking platform for access into DTA for cleaning

(1) FPZ model K05-MS single stage regenerative blower
90 cfm @ 80” wc
4 hp, 230/460VAC 3 ph, TEFC motor
Aluminum wheel and housing
Interconnecting ducting to diffused air inlet
High & Low blower pressure switches

(1) H2K Technologies model IPC-40, inclined plate clarifier
304 stainless steel construction
90% removal of 20 micron & larger solids 7.5 gpm
PVC slant tube coalescing media
Adjustable skimming weir
Solids collection sump
Clearwell for pumping directly from clarifier
PVC site glass with ss low, high & high-high pump out level switch assembly, union mounted
Vapor tight gasketed cover, Buna-N Gasket
1” PVC vent line, plumbed to exterior
2” Brass ball valve, clearwell drain
Sample port on inlet
2” PVC ball valve on discharge

(1) Transfer pump, AMT model 489
10 gpm @ 82' TDH
Cast iron bronze fitted
3/4 HP, 208-230/460VAC, 3Ø, TEFC motor

2” PVC Isolation ball valve on inlet
1” Brass ball valve on discharge
1” Brass Check valve on pump discharge
Sample port on pump discharge
Pressure gage on pump discharge, ss, liquid filled

(2) Pentair L-88 Bag filter assembly piped in parallel, with the following:
304SS construction, 150 psi
Each unit houses (1) #2 size filer bag, swing bolt clamped lid
2” NPT inlet and outlet connections
(4) 2” PVC ball valves for isolation for inf. and eff. of each housing & bypass
(2) 1/2" drain valves, (2) Pressure gauges with bleed valve, air release valves

(1) DP transmitter across bag filters, Foxboro IDP-10 DP transmitter,
4-20 mADC output, loop powered, local LCD display, NEMA 4X, Class I, Div 2 rated

(1) Flow totalizer, total gallons, with pulse output

(1) Pressure switch on discharge, Barksdale model D1T

(2) H2K Tech model LC-005 liquid Phase Carbon vessels, each with:
Carbon steel construction, 60 psi design pressure
Epoxy resin lining, epoxy/urethane exterior finish
Forkliftable skid, lifting lugs
500 lbs. 8x30 mesh reactivated carbon in each
2” 150 lb. flanged inlet and outlet
PVC hub and lateral internals
3/4” Air bleed valve with galvanized piping
(2) 12”x16” manways
1” drain valve with galvanized piping
Pressure gage on inlet of each vessel
Sample port on inlet and outlet of each vessel
2” Camlock fititngs on inlet and outlet of each vessel
(3) 2” PVC reinforced hoses with camlock fittings for connection

Note: Modeling with DRO as Naphthalene at 150 ug/l at 10 gpm, the lead carbon adsorber will breakthrough beyond 1 ug/l in 5 years of constant flow. Modeling with BTEX as Benzene at 50 ppb at 10 gpm, the lead carbon adsorber will breakthrough beyond 1 ug/l in 2 years of constant flow. The BTEX loading does not affect the DRO removal substantially.

(1) Siphon break on discharge of vessels

(1) Vented Stand pipe on discharge of vessels with high/high level switch

(1) Pressure transmitter on discharge, Foxboro IDP-10 DP transmitter,
4-20 mADC output, loop powered, local LCD display, NEMA 4X, Class I, Div 2 rated

(1) High/High level switch for use in infiltration gallery

Controls

(1) Low Voltage Control Panel
For operation on 120 VAC, 1Ø,15 Amp incoming electrical service. To control (2) 30 HP DPE blower, (1) 5 HP air stripper blower, (2) pumps. To be mounted and wired on the enclosure exterior wall. To include:
QTY DESCRIPTION

1 Enclosure, NEMA 4, 36"h, 36"w, 12"d with inner door mounted switches and indicators
1 Enclosure vent fan with thermostat and inlet/outlet louvers
1 Allen Bradley Micrologix 1400 PLC, with input & output as required for system operation
1 8" Color operator interface terminal, with embedded web browser for local & remote viewing of system status & alarms
1 Ethernet switch
1 Industrial cell modem, to allow email/text alarm callout and remote system access
Cell carrier service to be direct paid by client
7 Switch; three position; Hand-Off-Auto
1 Light (red/LED); alarms, individual alarms called out on interface
1 Pushbutton (red/NO); alarm Reset
3 Motor run time meters
2 Emergency stop button on panel door and in treatment room
6 Intrinsically safe barrier, 2 Channel - for pressure and level switches
Relay logic and timers as required
Engraved laminated legends for all door mounted devices
Terminal blocks for external connections and fusing as required
Color-coded wiring with wire markers at all terminations
Fully documented, assembled, wired, programmed and pre-shipment test
1 UL 698A serialized label

(1) 480-120 VAC transformer NEMA 3R mounted under breaker panel
To power lights and controls

(1) Panel board 480VAC 3phase in NEMA 3R enclosure mounted next to control panel, includes:
1 Circuit breaker "Main Breaker"; 480V 3P200A 10K
4 Circuit breaker 480V 3P10A 15K; Pumps
2 Circuit breaker 480V 3P60A 15K; SVE blower
1 Circuit breaker 480V 3P20A 15K; AS blower
1 Circuit breaker 480V 3P50A 15K; Oxidizer
2 Circuit breaker 480V 2P20A 15K; Heaters

(1) Panel board 120VAC 1phase in NEMA 3R enclosure mounted next to control panel, includes:
1 Circuit breaker 120V 1P10A 15K; control power
3 Circuit breaker 120V 1P15A 15K; vent fans
1 Circuit breaker 120V 1P15A 15K; Lighting

(1) High Voltage Motor Control Panel
For operation on 480 VAC, 3Ø, 200 Amp incoming electrical service. To feed (2) 30 HP DPE blower, (1) 5 HP air stripper blower, (2) pumps, & (1) oxidizer. Furnished mounted and wired on the enclosure exterior wall. To include:

QTY	DESCRIPTION
1	Enclosure, NEMA 4, 48"h, 36"w, 8"d with outer door mounted switches and indicators
1	Power distribution terminal block (65-335A) 3 pole; L1, L2, L3
1	Power distribution terminal block, 1 pole; Neutral
2	Variable Frequency drive for DPE blowers, 30 hp 480 VAC, ABB or Yaskawa with panel mounted interface on inner door
1	Vent fan with thermostat and inlet/outlet louvers
1	Motor starter: Contactor 11A FLA/Overload relay 6-11A, 3Ø; AS Blower
2	Motor starter: Contactor 6A FLA/Overload relay 3-6A, 3Ø; pumps
3	Motor starter: Contactor 23A FLA3Ø; heaters
	Engraved laminated legends for all door mounted devices
	Terminal blocks for external connections and fusing as required
	Color-coded wiring with wire markers at all terminations
	Fully documented, assembled, wired, programmed and pre-shipment test
1	UL 508 serialized label

Enclosure

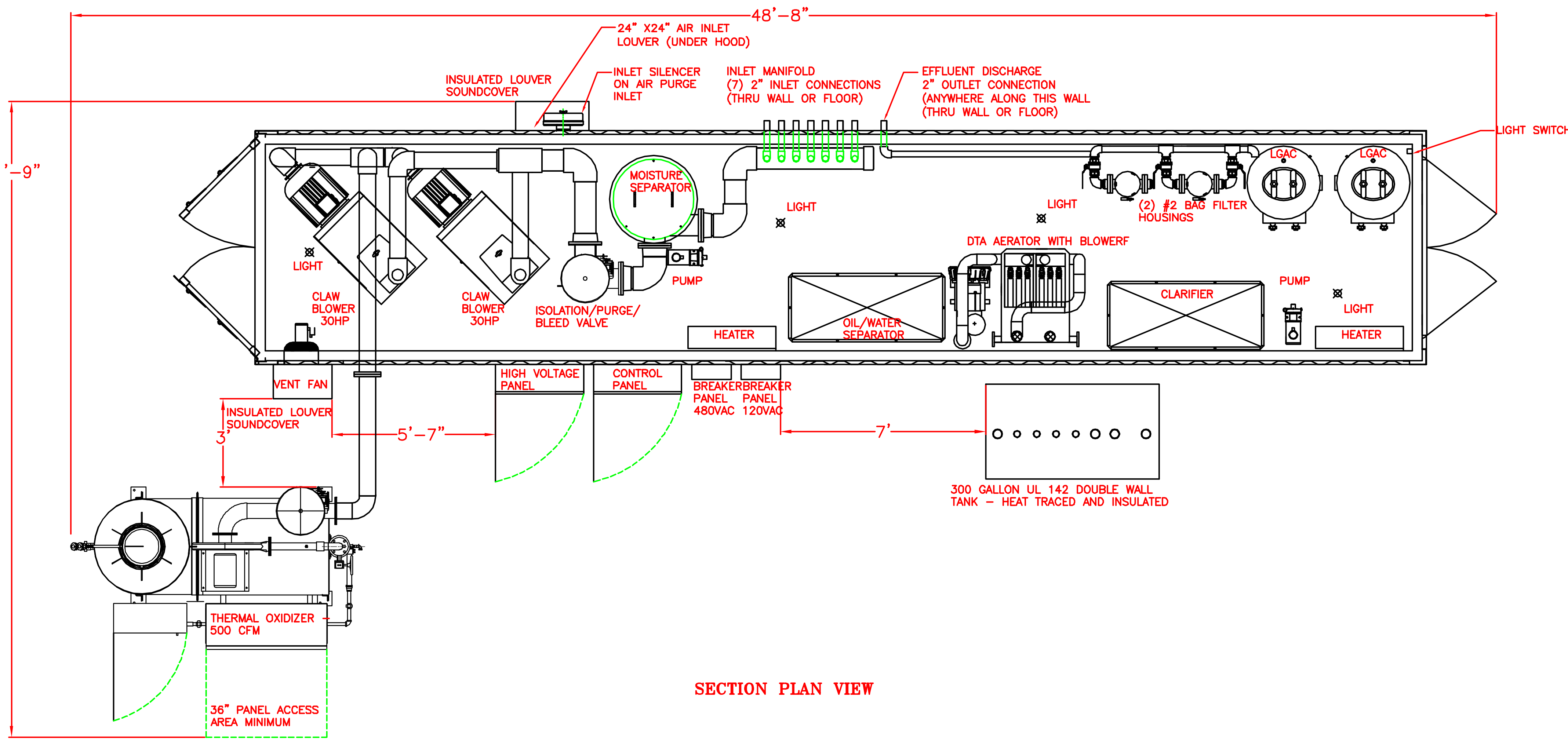
(1) Modified Cargo box enclosure system, 8’ wide x 40’ long x 8’6” high outside dimension

- Includes equipment installation and wiring
- **Welded steel Sea container with 2” fir decking**
- Floor sealed with non-skid bed liner
- Exterior painted as required to match existing color
- R-13 Insulation walls and ceiling with 2x4 furring and plywood interior
- Floor box or wall penetrations for incoming and outgoing lines as needed
- Anchor lugs and lifting eyes
- Double rear doors with cam lock
- (2) 36” x 6’-8” double insulated steel access door on other end
- Sound insulated louver covers for vent air intake and exhaust louvers
- Mounting of all equipment
- Spray urethane insulation under cargo box
- 2” Containment lip around interior of building (approx. 280 gallons totalvolume)
- (1) Floor sump w/ high level switch
- (2) Wall mounted explosion proof electric convection heater with thermostat, 3600 Watt
- (4) Ceiling mounted explosion proof lights with vapor globe and wall switch
- (1) Explosion proof 16” vent fan with inlet & outlet louvers, wall-mount cabinet, and thermostat

DPE and GWTS will be installed, piped and wired in enclosure, control panel will be mounted and wired on outside of enclosure. Piping will be schedule 40 black iron DPE discharge, Schedule 80 PVC for DPE inlet and water. Wiring will be per NEC for Class I, Div 2 Group D hazardous environment inside enclosure, outside enclosure shall be considered non-classified beyond 3’ from any opening.

Spares

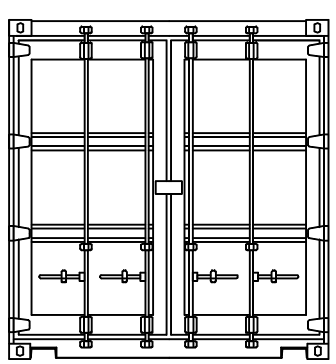
(1) Set of (6) diffusers for DTA, (1) case (25) 25 micron filter bags, (2) sets of oil for blowers, (2) sets of filter elements for all filters



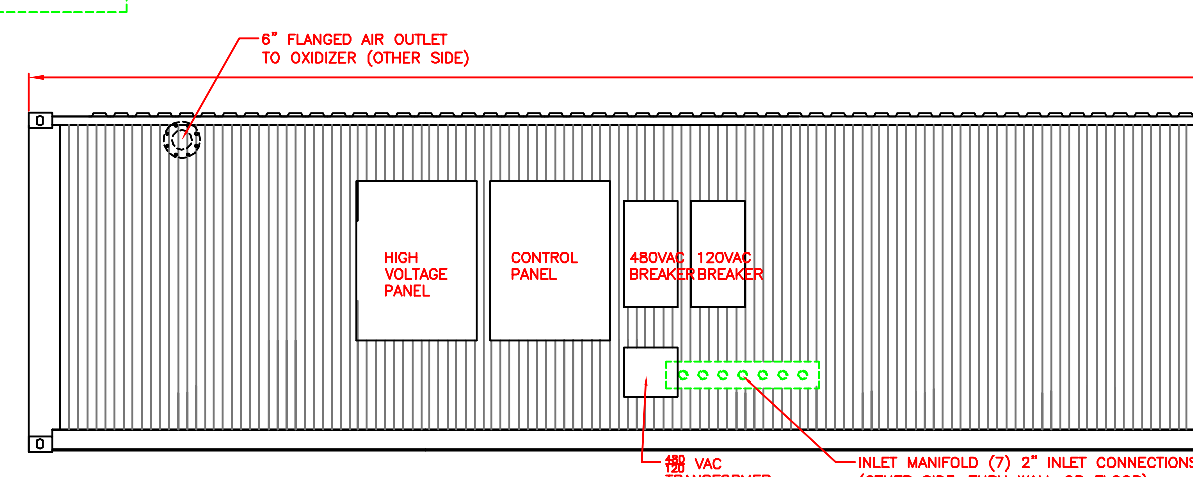
SECTION PLAN VIEW

NOTE:
1. DPE AND GWTS WILL BE MOUNTED, PIPED AND WIRED IN INSIDE ENCLOSURE, CONTROL PANEL WILL BE MOUNTED AND WIRED ON THE OUTSIDE OF THE ENCLOSURE.
2. WIRING WILL BE PER NEC FOR A CLASS I, DIV 2 AREA INSIDE THE ENCLOSURE AND NON-CLASSIFIED OUTSIDE THE ENCLOSURE BEYOND 3' FROM ANY OPENING.
3. PIPING WILL BE SCHEDULE 80 PVC FOR SVE INTAKE & WATER, SCHEDULE 40 BLACK IRON FOR SVE DISCHARGE.

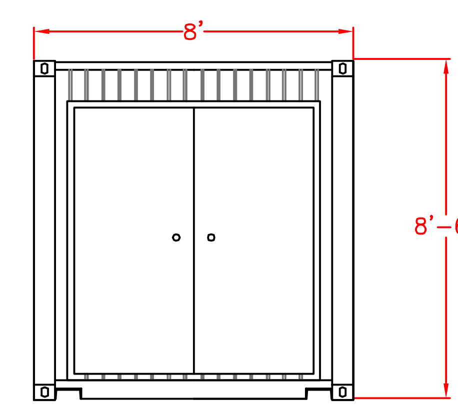
CONTAINER MODIFICAITONS
1. ADD DOUBLE DOORS TO END OF ENCLOSURE
2. ADD 14" X 14" OPENING FOR VENT FAN
3. ADD 24"X24" OPENING FOR INLET COOLING AIR
4. FRAME WALLS AND CEILING WITH 2X4 CONSTRUCTION R13 INSULATION.
5. INTERIOR FINISH WALLS AND CEILING TO BE 1/2" BCX PLYWOOD, PAINTED WHITE
6. FLOOR COATED WITH BEDLINER
7. SPRAY FOAM INSULATION UNDERSIDE OF CONTAINER
8. INTERIOR DIMENSIONS APPROX 7' WIDE X 38'-8"' LONG X 7'-6" HIGH



LEFT END VIEW



FRONT ELEVATION VIEW



RIGHT END VIEW

REVISIONS			
REV	DESCRIPTION	DATE	DWN

UNLESS SPECIFIED OTHERWISE
* DIMENSIONS ARE IN INCHES
* DO NOT SCALE DRAWING

DRAWN BY: TP
DESIGNED BY: GH
PROJECT MGR.: MK
DATE: 10/13/2016
PROJECT NO.: 4824

H2K Technologies, Inc.
7550 COMMERCE ST, COROCORAN, MN 55340,Tel: 763-746-9900

PROJECT TITLE:
D.B. STEPHENS

DRAWING TITLE:
DPE/GWTS MODIFIED CARGO BOX ENCLOSURE LAYOUT ALTA, NM

SHEET 1 OF 1
DRAWING NO.:
5256-01

VLS Series
Vapor/Liquid Separators

Features & Specifications

• All Welded Steel construction, ASTM A-36 sheet steel
• 17” Hg vacuum design rating (optional full vacuum design available)
• Polypropylene demister element covering entire separator cross section to minimizes vapor velocity & maximize water coalescing
• Tangential inlet utilizing centrifugal force for gross water/air separation (95%+ By Volume)
• 2” PVC site glass with unions for easy removal
• Steel baffle cover over water holding volume to prevent re-entrainment of water into air stream
• Stainless steel hermetically sealed float rod assembly (single or multiple floats)
• All zinc plated steel hardware
• Enamel external finish (optional internal & external finishes available)
• 99% + moisture removal of 10 micron and larger droplets (due to coalescing)
• Optional air filter with polyester element sized for specific blower, housed in separator (polyester element standard)
• 2” NPT half coupling for pump out or gravity drain, ¼” NPT gage port on inlet
• Neoprene full face top cover gasket

H2K Technologies, Inc.

Applications

• Soil vapor extraction
• Dual phase extraction
• Liquid ring pump
•Vacuum or pressure
• Blowers-Side Channel/regenerative,

multi-stage regenerative, positive displacement, and centrifugal
• Industrial industry
• Remediation industry
• Vapor GAC
• Bio venting systems
• Excavation venting

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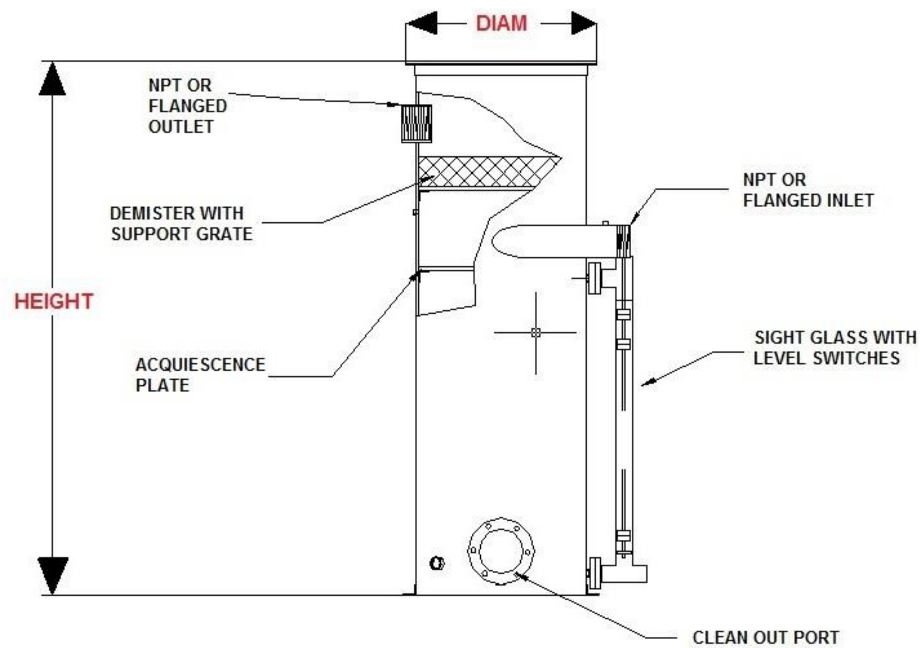
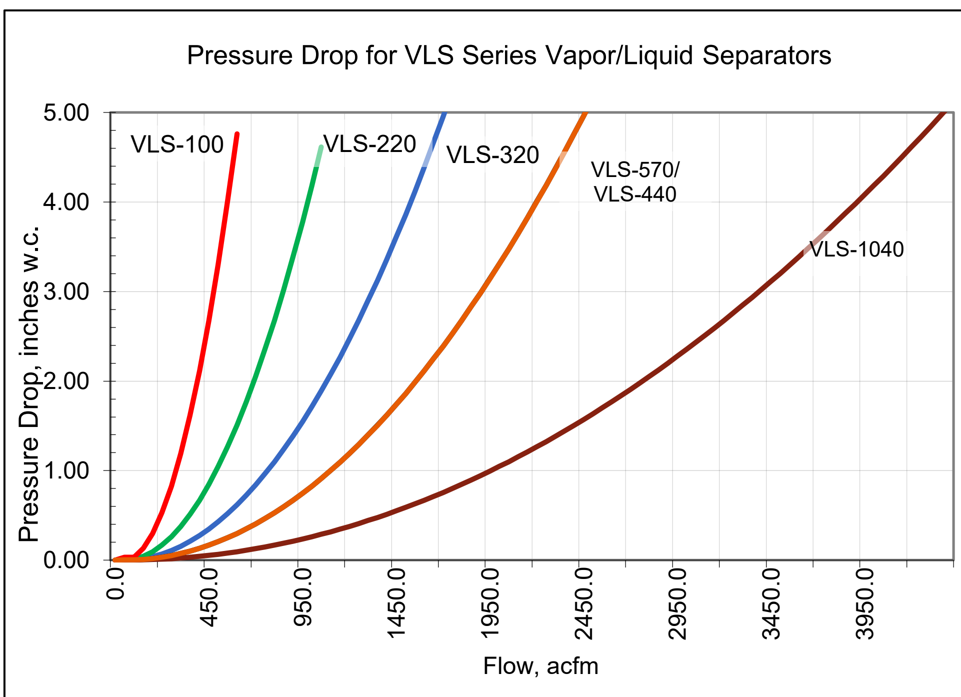
Sales@H2KTech.com

Model Number	Inlet/Outlet Connection	Height In.	Diam. In.	Rated Flow SCFM	Separator Total Volume Gallons	Liquid Holding Volume Gallons	Shipping Weight Lbs.	Operating Weight Lbs.	Vacuum/ Rating, "Hg/PSI
VLS-033	3" FPT	30	18	500	33	10	50	160	17"Hg/9psi
VLS-082	4" FPT	44	24	500	82	30	90	325	17"Hg/9psi
VLS-100	4"/6" FPT	50	22	650	100	40	140	480	30"Hg/9psi
VLS-220	8"/10" 150 lb flange	72	30	1440	220	75	350	1,020	30"Hg/9psi
VLS-320	10"/12" 150lb flange	72	36	2600	320	110	450	1,356	30"Hg/9psi
VLS-440	12" 150lb flange	74	42	2600	440	150	625	1,860	17"Hg/9psi
VLS-570	12" 150 lb flange	74	48	2600	570	195	860	2,465	17"Hg/9psi
VLS-1040	16" Duct flange	84	60	4500	1,040	200	1,250	2,978	10"Hg/5psi
VLS-1500	20" Duct flange	85	72	7000	1,500	440	1,525	5,325	10"Hg/5psi
VLS-3055	32" Duct flange	96	96	11,000	3,055	780	1,820	8,532	10"Hg/5psi





Options

- Stainless steel or Fiberglass re-enforced plastic construction (low pressure)
- Stainless steel coalescer media
- ASME designed & stamped for vacuum or pressure
- Full vacuum design
- Immersion heaters, NEMA 4 or NEMA 7 for freeze protection
- 1" recirculation port for pumping under high vacuum
- Air filter material and sizes
- Enamel internal finish, epoxy coatings or hot dipped galvanized finish
- Flanged or NPT inlet and outlet connections
- Flow, pressure, level & temperature gages or transmitters
- Heat trace for classified or non-classified electrical areas for freeze protection
- Clean out Ports
- Internal aeration diffuser for low level stripping or iron oxidation
- DP gage across filter, demister or both
- R-5 insulation with jacket, (steel or aluminum jacket)
- Vacuum relief valve

Additional Photos

Mink

Claw Vacuum Pump

MV 1202 A

Latest claw vacuum technology

- **Quiet:**
  lowest sound level due to a state-of-the art acoustic design, can be installed at workstations
- **Efficient:**
  low energy consumption, minimized operating costs
- **Compact:**
  smallest footprint in its performance class

The Mink MV 1202 A is the largest dry claw vacuum pump of the proven Mink series from Busch.

Mink claw vacuum technology from Busch offers the highest level of energy efficiency for industrial vacuum generation combined with the lowest level of maintenance as well as consistent performance. The MV 1202 A size now also offers these advantages for applications requiring high pumping speeds.

Due to the sophisticated claw vacuum technology, Mink vacuum pumps achieve an extremely high level of efficiency, which has a positive effect on energy consumption and performance. In practice, this means potentially great energy-savings and a consistently high performance compared to conventional vacuum generators.

An additional benefit of claw vacuum technology is that it is virtually maintenance-free due to the principle of contact-free operation: none of the moving parts inside the vacuum pump come into contact with each other, meaning there is no wear at all.

The need for maintenance, such as the inspection or replacement of worn parts, is completely eliminated. Due to the completely dry compression without the need for any operating fluids in the compression chamber, there are no costs for purchase, provision or disposal. Mink claw vacuum pumps are air-cooled.

The high operational reliability and long life cycles of Mink claw vacuum pumps are also a result of their non-contact compression without operating fluids. Due to wear-free operation, vacuum and suction performance remain consistently high throughout a life cycle of the pump. A smart silencer concept enables quiet operation

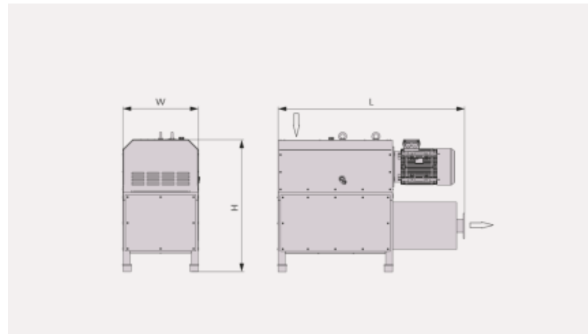
Mink

Claw Vacuum Pump

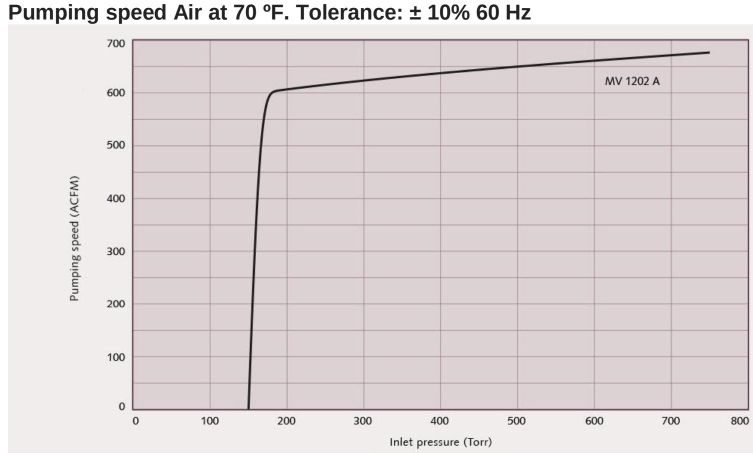
MV 1202 A

Technical specifications
With Mink vacuum pumps, two claw shaped rotors turn in opposite directions inside the housing. Due to the shape of these claw rotors, the air or gas is sucked in, compressed and discharged. The claw rotors do not come in contact with each other or with the cylinder in which they are rotating. Tight clearances between the claw rotors and the housing optimize the internal seal and provide a consistently high pumping speed. A synchronization gearbox ensures exact synchronization of the claw rotors. Mink vacuum pumps are driven by a directly flange-mounted motor.

Industrial vacuum generation for many applications
Mink claw vacuum pumps are available in a wide range of sizes. Special models for certain applications such as dust and gas explosion protection, high water vapor content, gas tightness, increased oxygen content etc., are also available.



Pumping speed Air at 70 ºF. Tolerance: ± 10% 60 Hz



Technical data	**Mink MV 1202 A**	60 Hz
Max. pumping speed	ACFM	677
Ultimate pressure	Torr	150 (24” Hg Vac)
Nominal motor rating	kW (HP)	22.0 (29.5)
Nominal motor speed	RPM	3600
Sound level (ISO 2151)*	dB(A)	82
Approximate weight	Lbs.	1654
Dimensions (L x W x H)	inches	63 13/16 x 26 3/8 x 47 5/8
Gas inlet / outlet		DN 100. PN 10/16 / DN 100. PN 10/16

INTELLISHARE ENVIRONMENTAL

CLEAN AIR SOLUTIONS

1422 Indianhead Drive E
Menomonie, WI 54751 USA

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E-Mail:	jstrey@intellishare-env.com
Website:	www.intellishare-env.com

Date:	1/8/19
ISE Proposal No:	N-19-1718
Client Project ID:	Alto, NM
Proposal For:	Tom Golden DB Stephens

Phone:
Fax:
E-Mail:

Proposed Solution: Model 500 CFM Thermal Oxidizer

Intellishare Environmental specializes in the engineering and manufacturing of clean air solutions for the environmental remediation industry. We offer new, used, rental and lease programs to fit any budget or application.

Thank you for the opportunity to provide the following proposal for your project. At Intellishare Environmental, every client is important. Please contact me with any additional questions you may have regarding this information.

Kind Regards,

John Strey
Principal

500 CFM Oxidizer Process Information

▪ Maximum Air Flow Capacity:	500 SCFM
▪ Minimum Air Flow:	200 SCFM
▪ Max Gas Pre-Heater Input:	1,500,000 @ 500 CFM
▪ Minimum Thermal Operating Temperature:	1400 degrees F.
▪ Average Thermal Operating Temperature:	1400-1500 degrees F.
▪ Maximum Thermal Operating Temperature:	1600 degrees F.
▪ Minimum Catalyst Operating Temperature:	600 degrees F.
▪ Average Catalyst Operating Temperature:	650-950 degrees F.
▪ Maximum Catalyst Operating Temperature:	1100 degrees F.
▪ Estimated Destruction Efficiency:	>99%
▪ Time to Reach Operating Temperature:	15 minutes from cold start
▪ Inlet Connection:	6" 150# Flanged
▪ Foot Print:	W=7', L=12', H=8'
▪ Stack Height Required:	15' AGL
▪ Weight:	4000 lbs
▪ Electrical Voltage:	480/3/60
▪ Electrical Amperage:	30

Equipment Specification

Reactor: The reactor housing will be constructed of 7 gauge rolled steel. The Inlet and outlet connections are flanged. . The exterior is painted standard ISE gray.

High Temperature Refractory: All internal reactor surfaces are completely insulated with a ceramic insulation media rated for 2200 deg F. A coating is applied to the insulation to increase the mechanical integrity and extend the life of the insulation.

Gas Pre-Heater: The unit will come equipped as standard with a direct gas fired primary air burner with combustion air blower.

Fuel Gas Piping Assembly: The fuel gas piping assembly is pre-piped. The gas train will meet all code requirements and is suitable for FM approval. All components are rated for outdoor operation and continuous use.

Main Control Panel: The main control panel shall be Nema 4 construction and shall be pre-wired to all components. The PLC based control panel features alarm detection and an hour meter to record run time. Temperature control will be provided with approved temperature control devices and limit switches. The control panel shall be UL labeled and listed as an assembly.

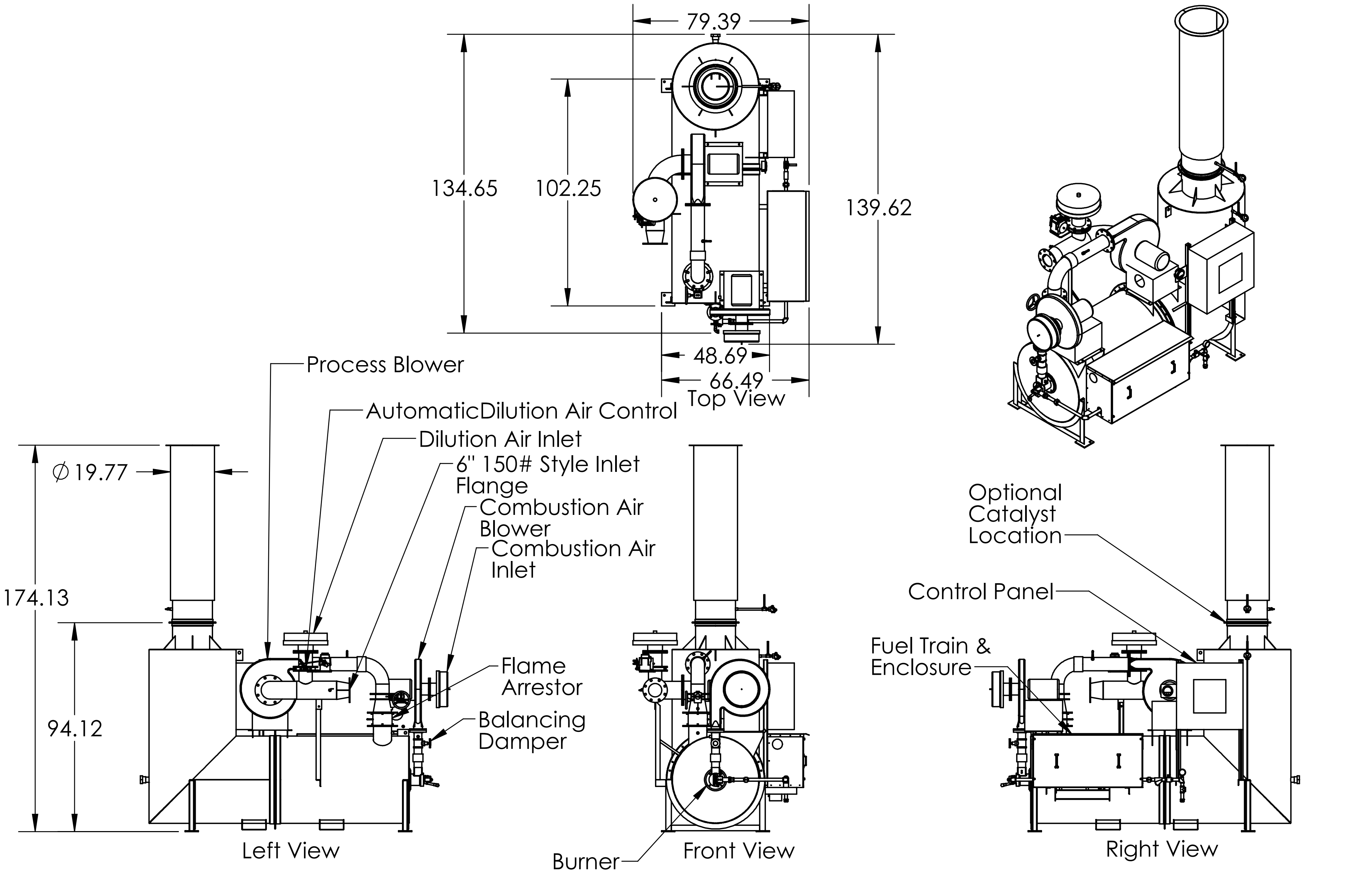
Flame Arrestor: A flame arrestor will be supplied and mounted to the inlet of the oxidizer and utilized to prevent flame propagation to the source. A spiral crimped aluminum element shall be removable for inspection and cleaning.

Purge/Automatic Dilution Control: A purge and dilution valve control assembly with C1, D2, GD actuator will be mounted between the VLS and MPE blower. Once the fresh air purge is complete the dilution control will be enabled. The oxidizer outlet temperature controller, included in the control cabinet, is wired to automatically modulate the electric actuator and control the dilution air valve when VOC concentrations exceed the temperature set-point.

Process Isolation Valve: A control valve assembly with C1, D2, GD actuator will be mounted between the VLS and MPE blower. Once the fresh air purge is complete the process control will be enabled. The oxidizer outlet temperature controller, included in the control cabinet, is wired to automatically modulate the electric actuator and control the process air valve when VOC concentrations exceed the temperature set-point.

Exhaust Stack: A stainless steel exhaust stack will be supplied and shall terminate at 15' above grade level (AGL). The exhaust stack will be equipped with sample ports for field testing.

Chart Recorder: A 2 pen chart recorder will be installed in the main control panel and will record and display the oxidizer inlet and outlet temperature and air flow in SCFM. The chart recorder will be paperless with removable SD card.



Unit Weight lbs.	Burner Size BTU	Combustion Air Blower HP	Process Blower HP	Standard Catalyst Vol. ft^3	Max. Catalyst Vol. ft^3	Process Inlet Dia. Inches	Stack Dia. Inches OD
4000	1,500,000	2	3	0.764	1.646	6	19.77

INTELLISHARE ENVIRONMENTAL
CLEAN AIR SOLUTIONS

TO500 Sales

TITLE: 500 THERMAL / CATALYTIC OXIDIZER SALES DRAWING
DRAWING NO.: TO500 Sales
SCALE: NTS
DRAWN: HVA DATE: 3/31/2006
CHECKED: DATE:
APPROVED: DATE:
LAST DRAWN BY: Henry A DATE: 5/29/2009

Contact
Intellishare Environmental, Inc.
E4803 395th Ave. - Menomonie, WI 54751
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Phone: 715-233-6115 Fax: 715-232-0669

REV.: A
SOURCE:
PAGE 1 OF 1
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LLS Series
Oil/Water Separators

Features & Specifications

• Removal of free phase gasoline (0.75 SG) product to less than 10 ppm or less typical
• Solids collection sump with sludge drain
• Set up standard for pump out or gravity drain
• PVC coalescing media with ¾" spacing for resistance to plugging from solids or oil & grease (optional 1/4" spacing media available for higher removal efficiencies)
• Full removable top cover with quick release latches for easy access to entire separator for cleaning
• PVC adjustable height skimmer with gravity drain outlet
• PVC site glass
• 2" PVC site glass with flange connections for easy removal
• Epoxy coating inside & out on all steel units with urethane top coat on exterior
• Clear-well for pumping directly from unit
• Stainless steel hermitically sealed float rod assembly (single or multiple floats for gravity or pump operation)
• All zinc plated steel hardware
• Neoprene D gasket on cover for vapor tight seal
• All Welded Steel construction, ASTM A-36 sheet steel, or Fiberglass re-enforced plastic (FRP) construction on some models
• Removable media packs for cleaning and access to solids collection sump

H2K Technologies, Inc.

Applications

• Oil/Water separation

• Wastewater treatment

• Light non-aqueous phase product removal

• Free Phase product separation

• Oil & Grease separation

• Dense non-aqueous phase product removal

• Groundwater treatment

• Solid settling

• Mixed oil grease, product & solids

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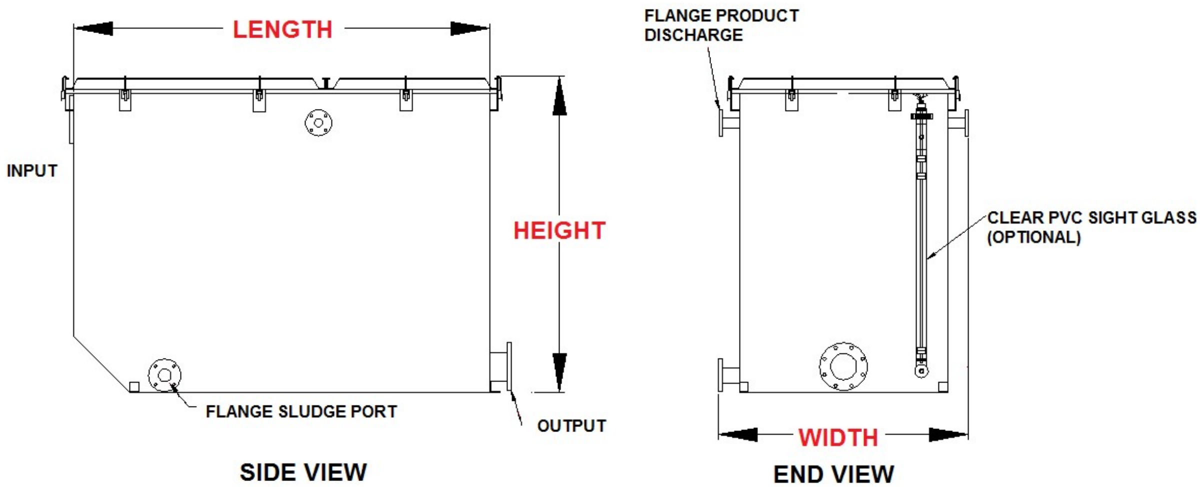
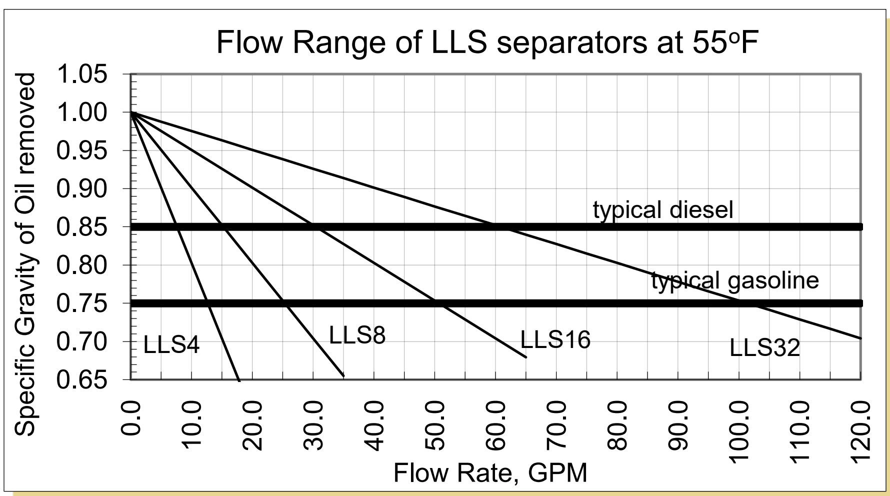
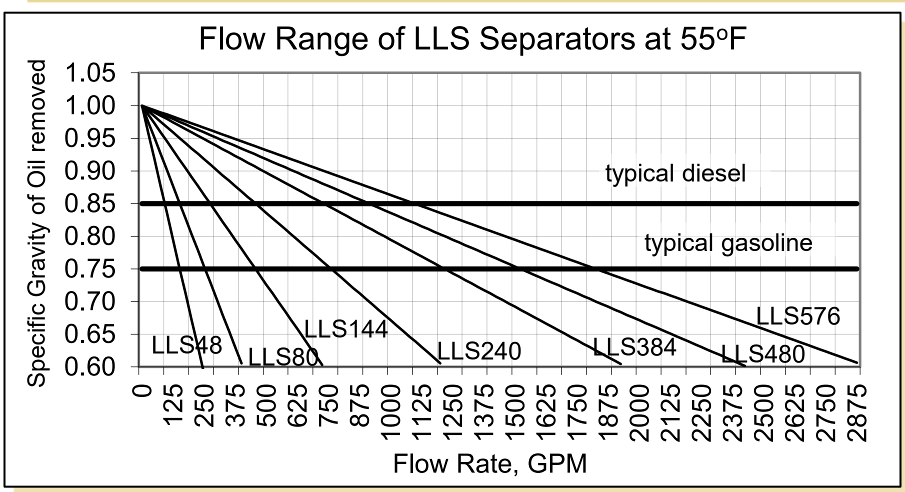
Model Number	Inlet/Outlet Connection	Height In.	Length In.	Dim Width In.	Skimmer Outlet Dia. In.	Media Horizontal Surface Area Ft^2	GPM at 0.75 S.G. oil, 55°F (typical gasoline)	Shipping Weight Lbs.	Operating Weight Lbs.	Clearwell Volume Gallons	Standard Material
LLS4	2" FPT	34	60	28	2"	192	13	95	976	45	FRP
LLS8	2" FPT	47	60	28	2"	384	25	170	1,635	65	FRP
LLS16	3" FPT	47	64	52	2"	768	50	325	3,432	162	FRP
LLS32	4" FPT	47	92	52	2"	1536	100	445	5,292	195	FRP
LLS48	6" 150 lb flng	72	100	52	2"	2304	150	2,100	9,193	271	Steel
LLS80	6" 150 lb flng	72	124	52	2"	3840	250	2,650	12,134	271	Steel
LLS144	8" 150 lb flng	100	133	100	4"	6912	450	7,582	42,966	1,716	Steel
LLS240	10" 150 lb flng	100	166	100	4"	11520	760	9,100	52,125	1,716	Steel
LLS384	10" 150 lb flng	100	202	100	4"	18432	1200	9,627	57,172	1,716	Steel
LLS480	10" 150 lb flng	100	256	100	4"	23040	1500	13,057	82,356	2,145	Steel
LLS576	12" 150 lb flng	100	292	100	6"	27648	1800	14,260	90,000	2,544	Steel







Options

- Stainless steel construction
- Integral product storage sump with level switches
- Elevation stand for gravity drain
- Sludge pumps
- Flow, pressure, level & temperature gages or transmitters
- Immersion heaters, NEMA 4 or NEMA 7 for freeze protection
- ¼" spaced PVC media for higher removal efficiencies
- Media racks to ease removal of media for cleaning
- ¾" Polypropylene media in lieu of PVC
- R-5 insulation with jacket, (steel or aluminum jacket)
- Product storage drums and tanks, single or double wall, typical UL 142
- Oil reservoir trough for pumping product directly from skimmer with level switch(es)

Additional Photos

DTA Series
Diffused Aeration Tank Stripper

Features & Specifications *(Patent pending)*

- 304 Stainless steel welded tank construction
- Clearwell for pump out or gravity drain discharge
- (2) 304 Stainless steel fouling-resistant coarse bubble diffusers per chamber with PVC risers
and unions above the water line for easy removal
- Centrifugal pressure blower operating under forced or induced draft, welded steel volute and stand, aluminum wheel, special coatings available
- Full removable top cover for easy access to entire cross section, D-ring buna-N cover gasket
- Over and under weirs and baffles to distribute water across each chamber for maximum residence time, aeration and removal efficiency
- Stainless steel hermetically sealed float rod assembly (single or multiple floats for pump control)
- 6" High steel skid125 lb flanged influent & effluent connections with conical gussets
- Flanged air inlet with diffuser for distribution
- Steel skid with C6x8.2 joists and frame members
continuously welded at the ends, 3/16" steel deck with 1" fillet welds every 12" on center, fork pockets
- PVC air inlet transition piping with flexible coupling for vibration isolation
- Polypropylene demister on vapor discharge to remove 99% 0f 10 micron and larger droplets
- ¾" Drain valves for sump and aeration chambers
- Internal PVC air distributor header
- Clearwell for pumping directly from unit
- 2" PVC Sump level site glass with flange connections for easy removal

H2K Technologies, Inc.

Applications

- Groundwater /wastewater treatment
- Radon removal
- Removal of dissolved chlorinated organic compounds from water (TCE, PCE, TCA, DCA…)
- Removal of gasoline range organics (BTEX compounds), DRO & other hydrocarbons from water (including MTBE)
- Iron oxidation for subsequent filtration
- H2S Removal
- Carbon dioxide removal
- Methane removal
- THM's

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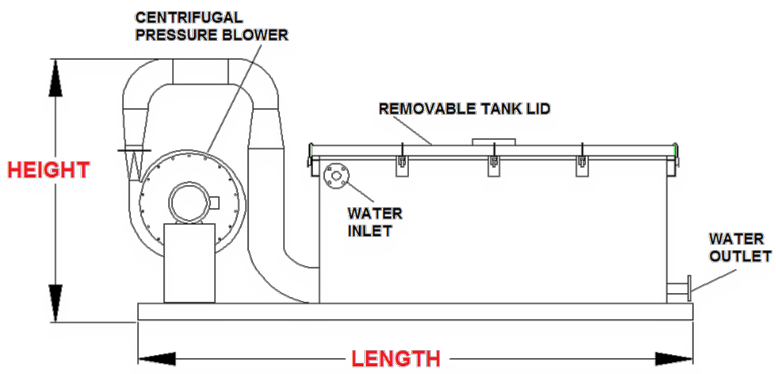
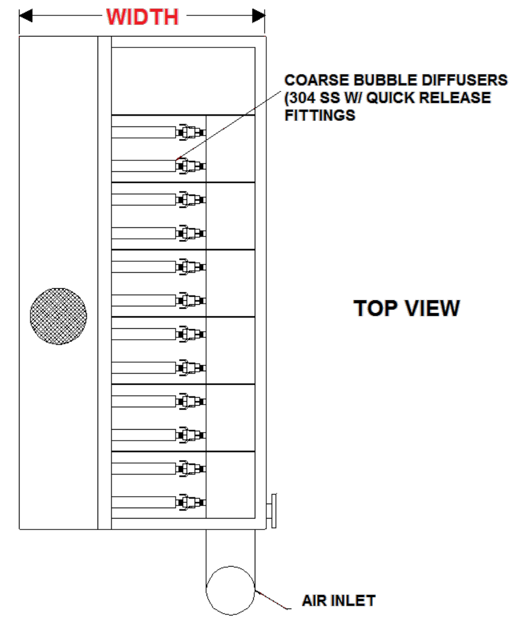
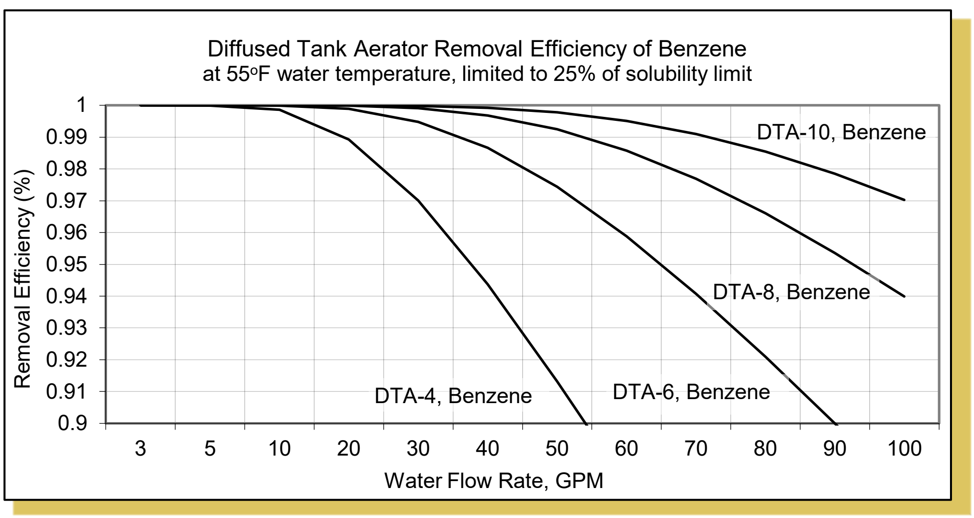
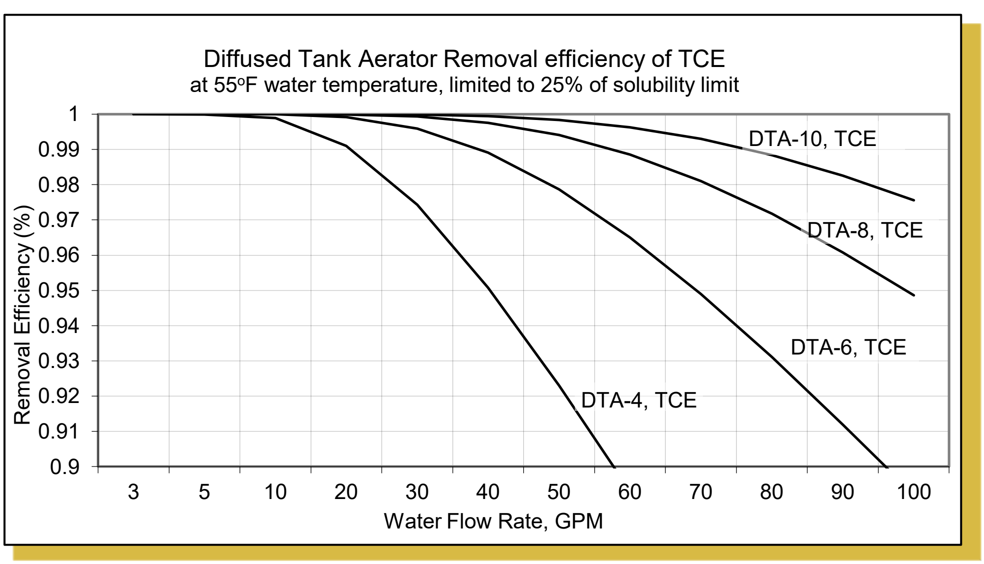
Model Number	Number of aeration chambers	Liquid Flow Range, GPM	Air flow SCFM	Length Feet	Height Feet	Width Feet	Inlet/Outlet connection, Standard	Vapor discharge connection, inches	Standard sump holding capacity Gallons	Shipping Weight Lbs.	Operating Weight Lbs.
DTA-4	4	1-225	320	10.5	5.5	3.5	2" FPT	(2) 4"	35	1,790	3,200
DTA-6	6	1-225	480	12.5	6	4	2" FPT	(2) 8"	40	2,665	6,240
DTA-8	8	1-225	640	14.5	6	4	2" FPT	(2) 8"	40	2,980	7,820
DTA-10	10	1-450	800	11.5	6	8	2" FPT	(2) 10"	80	3,570	9,250
DTA-12	12	1-450	960	12.5	6	8	4" 150lb flng	(2) 10"	80	3,990	10,100
DTA-16	16	1-450	1,280	15.5	6	8	4" 150 lb flng	(2) 10"	80	4,690	11,230



SIDE VIEW







Options

- Epoxy painted steel, fiberglass reinforced plastic construction or welded polypropylene construction
- Larger clearwell for more pump down volume
- High flow units up to 300 gpm
- Sound enclosure with urethane sound insulation to reduce sound level 10-15 dBA at 3
- Centrifugal discharge pump & level controls
- Heat trace or immersion heaters for classified or non-classified electrical areas for freeze protection
- Induced draft blower configuration for humidity
- R-5 insulation with jacket, (FRP or aluminum jacket)
- Custom control panel to control blower, pump and other equipment if required
- Process duct heater to lower humidity in off gas vapor before vapor GAC treatment
- Off gas ducting, FRP, PVC, coated or hot dipped galvanized steel construction
- Enclosures or trailer for freeze protection or mobility
- Flow, pressure, level & temperature gages or transmitters

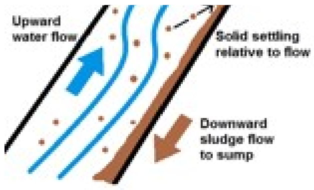
Additional Photos

IPC Series – Inclined Plate Clarifiers & DAF Tanks

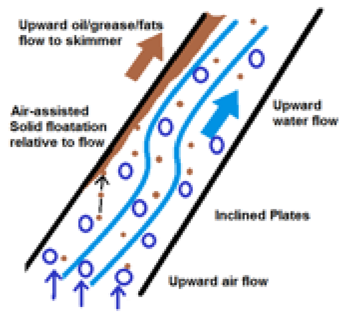
H2K's inclined plate clarifiers and dissolved air floatation tanks are designed for removing large quantities of suspended solids from an industrial water/wastewater process. These units include an internal Lamella-style plate pack to provide better settling and solids removal than a settling tank.

Data sheet for Inclined Plate Clarifiers & DAF Tanks

Inclined Plate Clarifiers are typically utilized in environments with high solids loading which would otherwise overload a sand filter or bag filter. Water enters the clarifier and flows upward through a series of inclined settling plates, which provide a surface to collect sediment and allow it to settle to the collection hopper at the base of the tank. The plate pack is designed to be removable via lifting lugs at the top of the pack to allow maintenance and cleaning. Solids are typically drained from the collection hopper via manual drain or pumped to a filter press with a pneumatic pump. Clarifier design is customized for every project; water residence time, plate spacing, plate angle, shell material are all designed to provide the best results for your project. Inclined plate clarifiers are often installed upstream of sand filters to reduce backwash water demand.



Dissolved Air Floatation Tanks are similar to inclined plate clarifiers, but the separation mechanics are very different. A DAF is typically used to remove fats, oils, and greases (FOG) from a water process using tiny air bubbles floating upwards through the separation chamber. Air is pressurized & dissolved in a side chamber and released at the base of the tank. The released air sticks to suspended FOG to enhance floatation and separation from water. Similarly to a clarifier, H2K Tech's DAF tanks still use a plate pack to enhance separation, but the solids are collected on the top plate and carried top the top of the tank. The separated floating oils, grease, and solids are skimmed from the top of the tank and carried to a collection chamber on the side of the tank.



Design Considerations & Construction Options

H2K inclined plate clarifiers come with a variety options to maximize performance for specific conditions. Each project is reviewed by our experienced engineering team which allows a custom clarifier design built for your specific process. Some of these design considerations include:

- **Inlet flash/floc chambers** are commonly used to add chemicals to the process to enhance settling and solids removal. Applications that require flash & floc tanks include polymer injection for increased settling rate and acid/caustic injection for metals precipitation. These processes use a metering pump to inject chemicals into the flash tank where they are blended into process with a high speed mixer. Water then travels through an under-weir to the floc chamber where a low speed mixer ensures complete entrainment as it enters the clarifier plate pack.

- **Solids management** is important to consider in system design. Clarifiers can be designed for manual solids removal by a service technician at regular intervals, but a couple options exist to automate and simplify solids management. One common method is to pump settled solids through a filter press with a diaphragm pump. The filter press compacts and dries solids to minimize volume of disposed sediment. Another option is to install a sludge auger which solids to thicken at the bottom of the clarifier for easy transfer into drums for disposal.

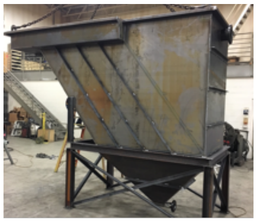
Pumps, controls, and system integration are other benefits of working with H2K on clarifier design. While we manufacture and sell individual pieces of equipment, our strength is in turnkey system design and construction. We will gladly review your entire process and can recommend a complete package to include feed/discharge pumps, industrial control panels, and other treatment equipment including sand filters, oil/water separators, carbon vessels, and more.

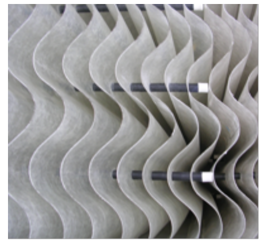
Sample Projects

Backwash water reclamation – This clarifier was installed as part of a larger backwash water reclamation project in conjunction with downstream sand filters and carbon vessels. This unit processed water at 100 GPM to remove suspended solids from process backwash water. This system allowed the client to reduce their water usage 2 million gallons a month by reusing

Industrial wastewater DAF tank – This DAF tank was installed as part of a wastewater treatment plant for the removal of fats, oils, and grease. This unit utilized a side-mounted air compression chamber and a top-mounted skimmer arm assembly to enhance FOG removal. Solids were skimmed off the top of the unit into a collection chamber on the side of the unit for manual collection into drums.

backwash water from other processes.





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LC Series
Liquid Phase GAC Carbon Vessel

H2K Technologies, Inc.

Applications

- Remediation industry
- Industrial waste water
- Removal of dissolved gasoline range organics (BTEX compounds), & other hydrocarbons from water (including MTBE)
- Removal of dissolved chlorinated organic compounds from water
- Removal of dissolved pesticides and other semi-volatile organic compounds from water
- Liquid phase granular activated carbon, virgin or reactivated
- Drinking water for dissolved organics
- Impregnated granular activated carbon
- Excavation dewatering
- Impregnated activated clays/zeolite

Features & Specifications

- All Welded Steel construction, ASTM SA-516 Gr. 70 sheet steel shell
- ASTM SA-516 Gr. 70 steel standard flanged & dished heads
- Tnemec series 20 pota-pox Polyamide epoxy lining certified per NSF std. 61 for potable water service
- Epoxy/urethane external finish for corrosion and UV resistance
- Fork tubes for easy lifting
- ¾” Drain valve
- Sample/pressure taps above & below the bed
- (2) 12” x 16” elliptical access manways
- Inverted bottom head (on LC-020 & smaller) for less than 8’ overall height to allow easy transport
- (2) 12” x 16” elliptical manways with full faced neoprene gasket and zinc plated hardware
- PVC hub and slotted lateral underdrain for distribution at high and low flow rates
- Optional air filter with polyester element sized for specific blower, housed in separator (polyester element standard)

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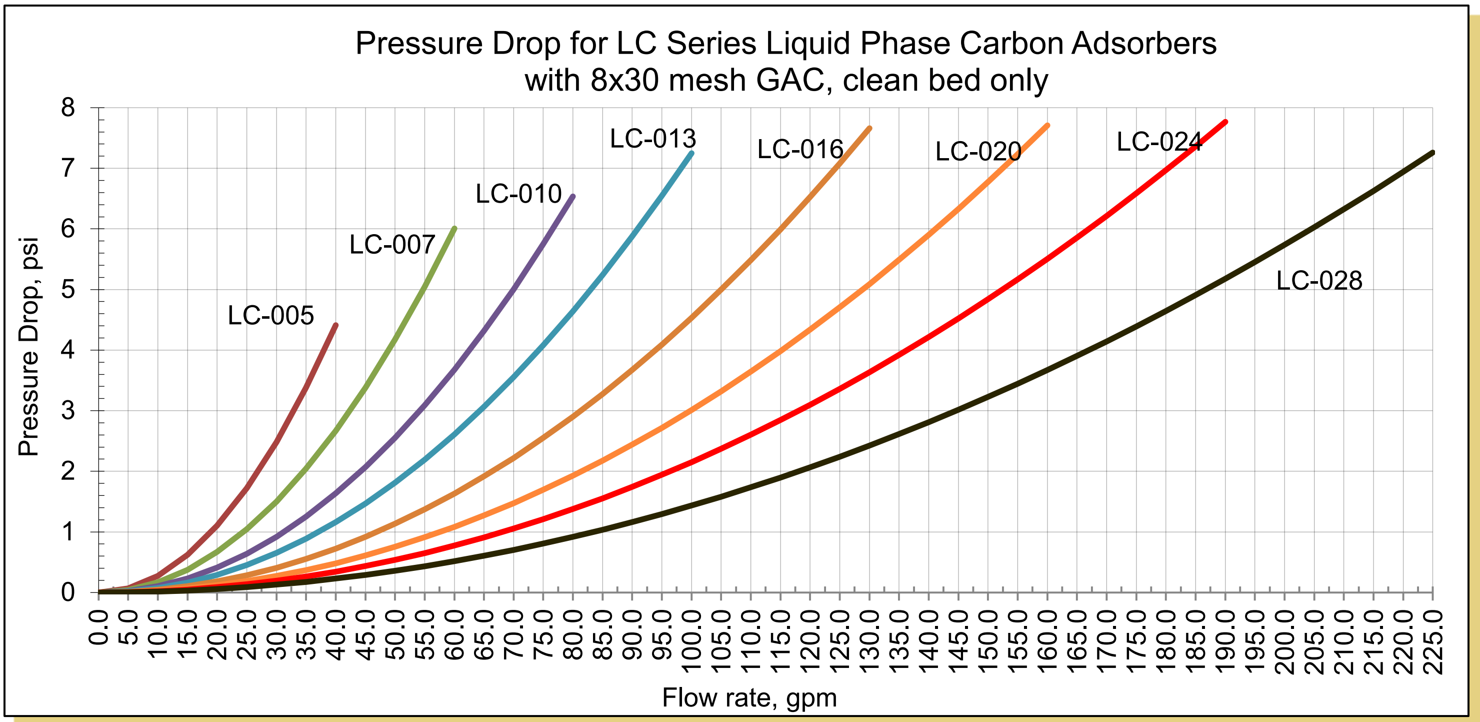
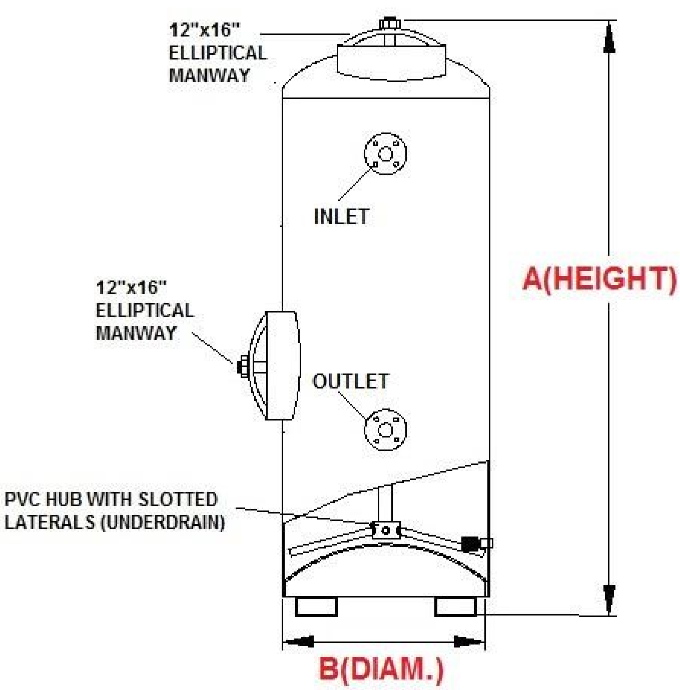
Model Number	Inlet/Outlet Connection	Height In.	Diam In.	Rated Flow GPM	Carbon Capacity Lbs.	Empty Weight Lbs.	Loaded Weight Lbs.	Operating Weight Lbs.	Spent & Drained Weight Lbs.	Pressure Rating, PSI
LC-003	1" FPT (top I/O)	36½	24 ¼	10	200	65	205	425	355	10 psi
LC-005	2" 150 lb flng	84	30	40	500	680	1,200	2,380	1,380	90 psi
LC-007	2" 150 lb flng	84	36	57	1,000	880	1,880	3,680	2,280	90 psi
LC-010	4" 150 lb flng	84	40	78	1,250	1,030	2,280	4,980	2,780	90 psi
LC-013	4" 150 lb flng	84	48	101	1,500	1,280	2,780	6,280	3,380	90 psi
LC-016	4" 150 lb flng	84	54	125	1,750	1,480	3,280	7,580	3,880	90 psi
LC-020	4" 150 lb flng	86	60	157	2,500	1,650	4,150	9,650	5,150	75 psi
LC-024	4" 150 lb flng	86	66	192	3,750	2,950	6,550	15,850	9,575	75 psi
LC-028	4" 150 lb flng	126	72	226	5,000	4,000	9,000	24,000	14,000	75 psi





Options

- ASME designed & stamped
- Stainless steel internals, 316 or 304 ss
- Piping header for series lead/lag, parallel or standby operation of (2), (3), or more vessels
- Skid assemblies for single or multiple vessels
- Bed sampling ports
- Heat trace or immersion heaters for classified or non-classified electrical areas for freeze protection
- R-5 insulation with jacket, (steel or aluminum jacket)
- Vinyl ester interior lining for corrosive or high abrasion service
- Pressure relief assemblies, PRV or rupture disk
- FRP construction for corrosive environments
- Interior lining Holiday spark testing
- Flow, pressure, level & temperature gages or transmitters
- Flanged or NPT inlet and outlet connections or additional manways

Additional Photos

UL 142 Aboveground Flammable Liquid Tanks

Ten things to know about these Listed products.

Fire code officials and contractors who are involved with designing, installing and approving installations that contain aboveground flammable liquid tanks are used to seeing shop fabricated tanks that bear a UL Listing (Certification) Mark. However, they may not fully understand what the certification covers, or some key installation considerations that are applicable for the installation of the tank and related system.

This article describes ten items one should know about these certified tanks and related code applications.

1. Codes recognize the use of UL 142 listed tanks

The NFPA 30 Flammable and Combustible Liquids Code requires atmospheric tanks to be designed and constructed in accordance with one of several recognized engineering standards, one of which is the UL 142, Standard for Safety for Steel Aboveground Tanks for Flammable and Combustible Liquids. The International Fire Code in turn requires tanks to be designed, constructed and installed in accordance with NFPA 30.

2. Types of tanks covered by ul 142

UL 142 includes requirements that cover steel primary, secondary and diked type atmospheric storage tanks intended for noncorrosive, stable flammable and combustible liquids that have a specific gravity not exceeding 1.0 in aboveground applications. UL 142 includes requirements for tanks fabricated in a combination of various shapes (cylindrical, rectangular or round) and orientations (horizontal, vertical) with or without multiple compartments.

UL 142 covers shop fabricated tanks only, and does not cover portable tanks intended for transporting flammable or combustible liquids (such as shipping containers), or mobile use applications (such as mounted on a trailer).

3. UL 142 requirements

UL 142 includes requirements that manufacturers use to design and fabricate aboveground steel tanks, and that certification organizations such as UL use to investigate and List (certify) these tanks. The standard includes a comprehensive set of requirements in the following areas:

- Construction requirements – These include specification for the tank materials, joints, connections, fittings, manholes (if provided), fill, drain and gauge openings, and painting. They also include specific construction requirements for the primary and secondary containment means, supports, etc.
- Performance tests – These requirements include tank leakage, hydrostatic strength, top loading, buoyancy, hydrostatic load, tank support load, and lift lug tests that are designed to verify that the tank design does not exhibit signs of leakage and/or structural damage as a result of these tests.
- Markings and production line test – UL 142 requires tanks to include specific markings discussed below. In addition, 100% of production of each Listed primary and secondary containment tank must be tested for leakage by the manufacturer.

4. Listing marks

Aboveground tanks that have been found to comply with applicable UL 142 requirements include a UL Listing Mark permanently affixed to the tank. The Listing Mark includes the UL symbol, the word "LISTED," a control number and the name of the tank construction as indicated in the manufacturer's Listings (e.g. Secondary Containment Aboveground Tank, Generator Base Tank, etc.)

5. Product categories

Information on tanks certified in accordance with UL 142 can be found in the Online Certifications Directory at www.ul.com/database. The guide information for the Aboveground Flammable-liquid Tanks (EEEV) product category includes useful information on the products covered under this category. In addition, the Special-purpose Tanks (EFVT) product category covers Listed UL 142 aboveground steel tanks that include generator base, work-top, lube oil, waste oil, day/utility and other special-purpose type tanks.

6. Features covered

The basic features of tanks covered by the UL 142 Listing include all containment spaces and their respective openings (manways, emergency vents, normal vents, fill/withdraw, gauging, monitoring and other functional openings) with connections (threaded- or flanged-type fittings) and integral tank accessories such as ladders, stairs, lifting lugs and heating coils or hot wells.

All primary-tank compartment(s) are provided with openings to accommodate filling, withdrawing and inventory control; and all secondary-tank interstitial spaces are provided with openings for leak-detection monitoring.

7. Features not covered

UL 142 tank Listings covers the features and accessories described above, which are described in the individual Listings. Any other accessories or components that are shipped with the tanks, attached to the tanks or added to the tanks are not included in the scope of the tank Listing. It is anticipated that the code authority will approve the use and/or installation of any such accessories independent of the tank Listing.

8. Venting and leak detection

All primary-tank compartment(s) are provided with normal and emergency vent openings. All secondary-tank interstitial space(s) are provided with emergency vent openings. It is anticipated that venting will be provided at the actual installation in accordance with applicable code requirements.

9. Intended use

UL 142 Listed tanks are intended for installation in accordance with a variety of installation codes, including NFPA 30, NFPA 30A, NFPA 31, NFPA 37, NFPA 1 and the International Fire Code. They have not been investigated for use underground. However, they are suitable for use in UL 2245 Listed below grade vaults as allowed by the applicable installation code.

10. UL 80 Tanks

In comparison to UL 142, the UL 80 Standard for Steel Tanks for Oil-Burner Fuels and Other Combustible Liquids covers aboveground 60 to 660 gallon steel tanks intended for the storage of heating fuels for oil burning equipment, diesel fuels for compression ignition engines and new and used motor oils at automotive service stations.

INNOVATIONS IN DUAL-PHASE REMEDIATION SYSTEMS

AUTO TRACKER™

Floating Extraction Inlets track changing water levels to maintain optimum performance

QED Environmental Systems

How to Supercharge Your Dual-Phase Extraction Project

The patented AutoTracker™ Floating Extraction Inlet optimizes dual-phase extraction and bio-slurping system performance by assuring proper air-to-water ratios even as water levels change.

Groundwater fluctuations can cause severe disruptions for dual-phase extraction and bio-slurping systems using a fixed entrainment drop pipe.

When the water table falls below the elevation of a fixed extraction inlet, groundwater recovery ceases and treatment efficiency decreases. When the water level rises above the end of a fixed inlet, vapor recovery becomes impossible. AutoTracker Floating Extraction Inlets eliminate these common causes of system shutdowns and missed recovery goals.

Background

Dual-phase extraction (DPE) is the simultaneous recovery of gases and liquids from the same remediation well without the use of pumps and controls at each well. High velocity vapor flow entrains the water and allows it to be extracted from depths beyond the static suction capability of the vacuum source.

With the right site conditions and with the gas and liquid inlets properly positioned, this can be a highly effective method of contaminant recovery from both the saturated and vadose zones. However, installation of systems with a fixed entrainment tube can be complicated and time-consuming, and changing liquid levels in the remediation well can cause costly downtime and necessitate frequent site visits for maintenance, increasing both O&M and life cycle costs.

AutoTracker™ (U.S. Patent Number 6,520,259) Floating Extraction Inlets from QED will deliver optimum performance from your DPE system by continuously and automatically reacting to changes in well level, positioning gas and liquid inlets properlyand allowing the system to function at peak efficiency at all times. Case studies (see back cover for details) with AutoTracker show that you can:

- **Cut O&M costs by 20% instantly**
- **Clean up your site 33% faster**
- **Save 1/2 of the life cycle cost**.

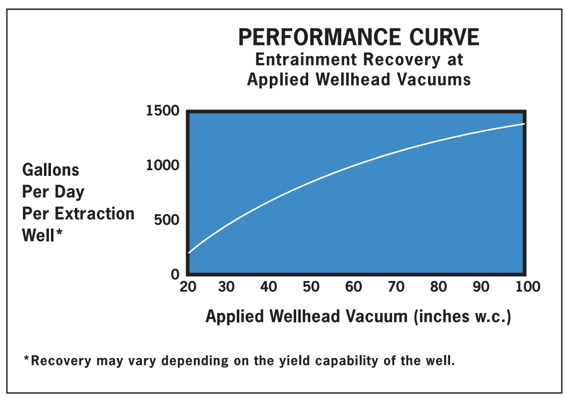
AutoTracker Applications:

Dual-phase extraction (DPE)

This extraction method was developed primarily for treatment of soils and aquifers contaminated by volatile hydrocarbons and other chemicals, by means of recovering soil vapor and groundwater from the vadose and saturated zones.

Bio-slurping

This method combines bioventing with free product recovery. An inlet positioned right at the liquid surface recovers any floating product, along with soil vapor and only minimal groundwater. Air drawn into the soil to replace the evacuated soil gas stimulates bioremediation by supplying oxygen to in-situ microbes; limiting groundwater extraction helps prevent the creation of a smear zone that could otherwise be caused by the floating layer contacting fresh soil horizons.



SPECIFICATIONS

Model No	Floating Inlet Travel Range	Minimum Well Depth Below Top of Casing Needed to Achieve Full Travel Range	Elevation Range of Floating Inlet Travel with Minimum Well Depth	Float Length	Floating section O.D.	Weight
AT-5	5 ft	13' 9"	8' 9" - 13' 9"	33-1/2"	2.80" max.	5.8#
AT-10	10 ft	23' 9"	13' 9" - 23' 9"	33-1/2"	2.80" max.	5.8#

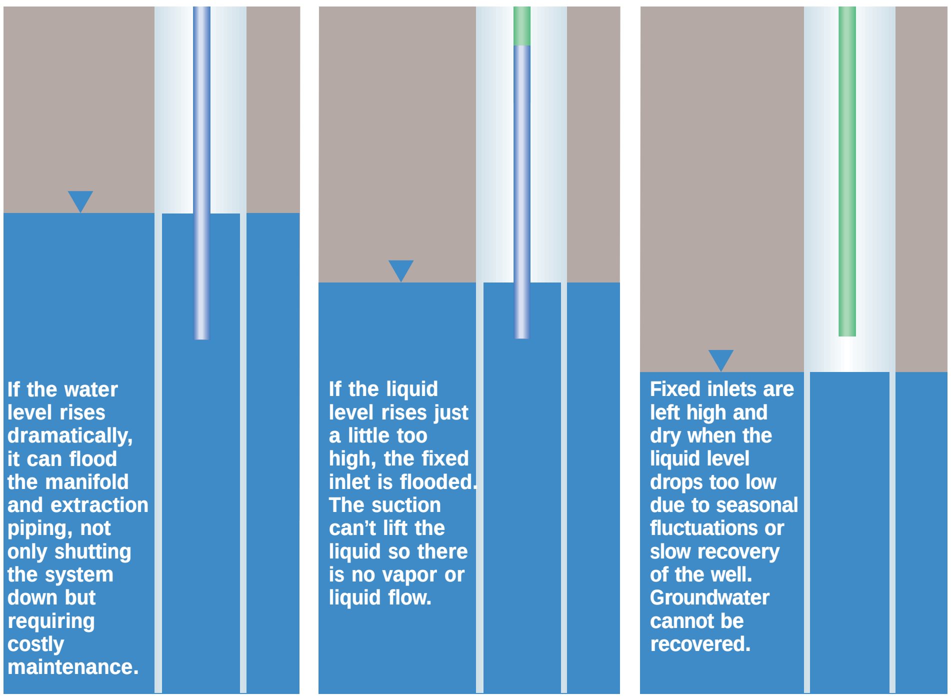
AutoTracker includes floating inlet, telescoping PVC connecting pipe, and well cap and bottom fitting for attachment to locally provided 2" PVC drop pipe.

THE PROBLEM WITH CONVENTIONAL FIXED DROP PIPE SYSTEMS

The operation of a conventional fixed drop pipe DPE system depends on precise positioning of the inlet at or just below the water table. It is this positioning which allows the system to recover both vapor and liquid, entraining them into a high-velocity stream that lifts the water from greater depths than possible by suction effects alone.

When inlet position and blower vacuum are properly adjusted, this type of system is very effective. However, even small changes in well liquid level can shut the operation down, causing major disruption in recovery and treatment schedules.

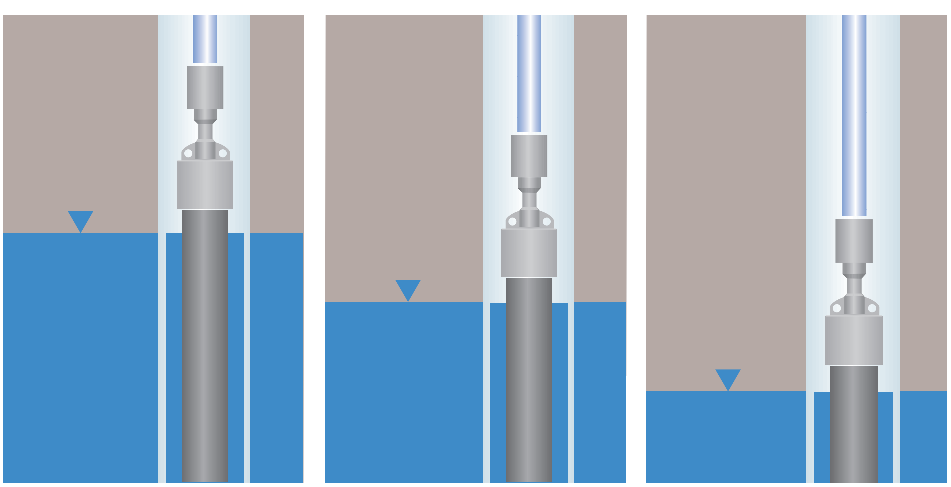
Liquid Choking | **Deadhead** | **Dry Recovery**



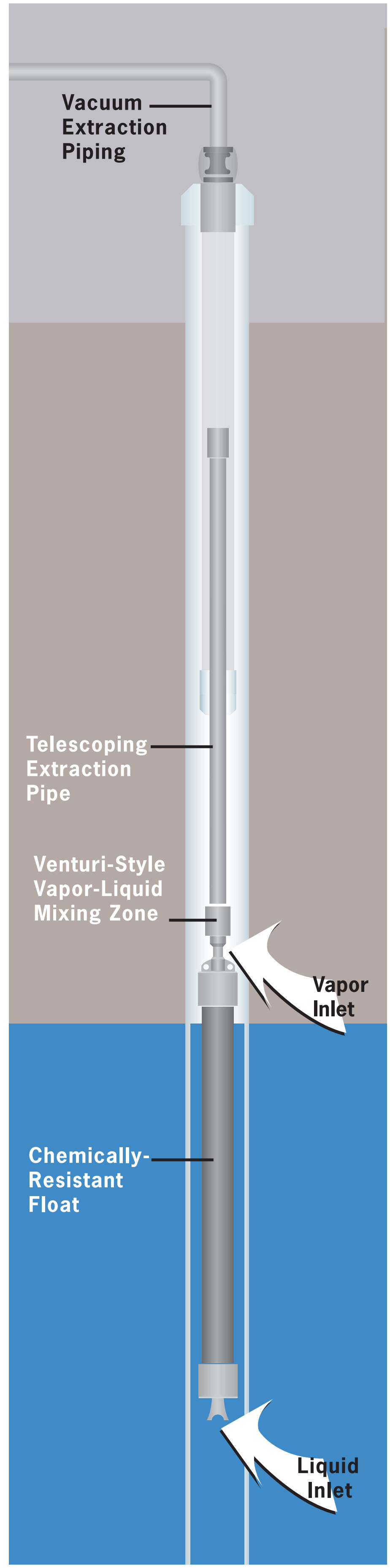
AUTO TRACKER ELIMINATES THESE PROBLEMS

With its telescoping drop tube, the patented AutoTracker Floating Extraction Inlet automatically follows the water level, positioning air and water inlets properly at all times and preventing liquid choking, deadhead and dry recovery conditions.

In addition to minimizing operational downtime and maintenance requirements, AutoTracker systems are much faster and easier to install and start. There's no need for tedious, time-consuming adjustment of inlet positioning – the float positions itself, automatically and instantly. The only adjustment required is setting the vacuum level on the blower to deliver the desired liquid and vapor flow rates.



AutoTracker positions inlets for optimal performance at any well level.



CASE STUDY

Superfund Site

AutoTracker™ Floating Extraction Inlets were added to a DPE system at a remediation site in mid-Michigan following several years of operational problems caused by fluctuating water table levels. Installation was straightforward and system performance improved immediately, reducing on-site maintenance, labor and O&M costs and greatly improving groundwater recovery. Ongoing savings were so dramatic that payback for the initial capital cost was achieved in just 4 months! Projected over the project life cycle, cost savings should surpass $600,000, with an expected 10-year reduction in time to reach the remediation target.

Site Background Data:

- 12 well dual-phase extraction system
- 2-acre encapsulation and treatment cell
- Well depths: 20-40 feet bgs; static water level: 15-20 feet bgs
- Approx. 30,000 cubic yards of soils contaminated with chlorinated solvents
- 25 HP rotary lobe blower used
- Each well extracts 20-30 scfm of vapor at 10-13" Hg
- Recovered vapor & groundwater treated with vapor/liquid phase activated carbon

History Prior to AutoTracker Installation:

- System operated 1999-2001 with fixed entrainment tubes
- Water level changes caused by seasonal fluctuations and/or blower shutdown resulted in dry recovery, deadhead and liquid choking conditions
- O&M costs increased by need for frequent manual adjustment and maintenance
- Air/groundwater recovery rates decreased due to extensive system downtime

AutoTracker Performance:

- Floating Extraction Inlets installed summer 2002
- O&M costs reduced 20% due primarily to reduced labor
- Payback period less than 4 months
- Groundwater recovery rates nearly doubled
- Groundwater recovery cost per gallon reduced 59%
- Estimated project duration cut from 30 to 20 years
- Estimated life cycle cost savings: over $600,000

Cost Savings Demonstration

Parameter	Before Conversion to AutoTracker™	After Conversion to AutoTracker™
Annual O&M	$44,500	$35,500
Groundwater Recovery	460 gal/day	914 gal/day
Cost/Gallon Recovered	$0.27	$0.11
Capital Cost for 12 AutoTrackers	na	$3,000
Payback Period	na	4 months
Estimated O&M Duration	30 years	20 years
Life Cycle Cost	$1,335,000	$710,000

AUTO TRACKER™

QED®
Innovative Environmental Products

P.O. Box 3726
Ann Arbor, MI 48106-3726 USA
Phone: 800-624-2026
Fax: 734-995-1170
www.qedenv.com
info@qedenv.com

Your Single Source...

HDPE Product Catalog

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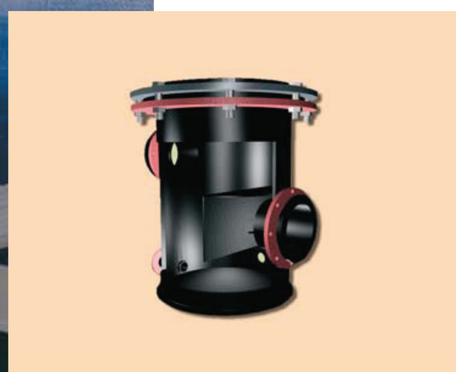
- > Accessories



ISCO INDUSTRIES

800-345-ISCO

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Coming through.

Version 2.2 2007

www.isco-pipe.com

High-Density Polyethylene Pipe

Introduction

ISCO Industries, LLC is the largest high-density polyethylene pipe distributor in North America. ISCO can serve your needs anywhere in the USA and internationally. ISCO offers a complete package of HDPE piping products. Butt fusion machines are offered for sale or rental. Fusion technicians are available to provide on-site training or assistance to your project. Please call 1-800-345-ISCO for all your HDPE piping needs.

Some of The Characteristics of HDPE Pipe are:

- Economical
- Corrosion Resistant
- Zero Leak-Rate
- Hydraulically Smooth
- Fatigue and Surge Resistant
- Long Design Life
- Tappable
- Chemically Resistant
- Easily Installed
- Small to Large Diameters
- Non-Toxic, Non-Tasting
- Lightweight
- Reliable
- Flexible and Coilable
- Heat Fused
- Mechanically Joined (As Needed)
- Strong and Ductile
- Weather Resistant
- Impact Resistant
- Freeze Resistant
- Durable
- Abrasion Resistant
- Inert
- Self Restrained Pipe (Monolithic)
- Listed and Approved

Important Standards for High Density Polyethylene (HDPE) Pipe

Standards important for HDPE pipe relate to the resin the pipe is made from and the standards related to manufacturing sizes and tolerances. The American Society of Testing Materials (ASTM) standard for resin from which the pipe is made is **ASTM D 3350-05**, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials. This standard defines the physical properties of the resin that the pipe is made from.

Pipe dimensions and manufacturing requirements:

ASTM F 714-05 Standard Specification for Polyethylene (PE) Pipe (SDR-PR) Based on Outside Diameter. This standard is used for most large diameter HDPE pipe (4" to 63") applications other than gas pipe.

ASTM D 2513-05 Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings. Polyethylene pipe and other plastic for natural gas distribution are described in great detail in this standard.

ASTM D 3035-03a Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter. Most HDPE water tubing (1/2 inch to 3") is made to the dimensions in this standard. While pipe sizes up to 24" are provided, very little large diameter pipe is made to this standard.

Intallation Standards:

ASTM D 2321-05 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications

ASTM D 2774-04 Standard Practice for Underground Installation of Thermoplastic Pressure Piping

ASTM F 1962 Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit under Obstacles, Including River Crossings

ASTM F 585-94 Standard Practice for Insertion of Flexible Polyethylene Pipe into Existing Sewers

American Water Works Association Standards

ANSI/AWWA C 901-2005 Polyethylene Pressure Pipe and Tubing, .5 in (13 mm) Through 3 in. (76 mm) for Water Services

ANSI/AWWA C 906-2006 Polyethylene Pipe and Fittings, 4 in (100 mm) Through 63 In (1,575 mm) for Water Distribution

Pipe Joining Standards:

ASTM F 2620 – Standard Practice for Heat Fusion of Polyethylene Pipe and Fittings

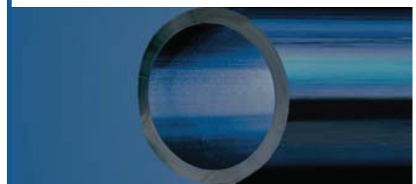
ASTM D 2657 – Standard Practice of Heat Fusion Joining of Polyolefin Pipe and Fittings

ASTM F 1290 – Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings

Fitting Standards

ASTM D 3261 Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Butt Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

ASTM F 1055 Standard Specification for Electrofusion Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing



HDPE Pipe

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HDPE Pipe

Specifications for HDPE Pipe

The physical properties of high-density polyethylene pipe are described using ASTM D 3350-05, “Standard Specification for Polyethylene Plastic Pipe and Fittings Materials”. Recently this standard was changed. The two key areas changed are, density and slow crack growth. In the 05 version, the cell classifications for density were increased from four cells to seven cells defining the density ranges for various resins.

New high performance bimodal resins, PE 4710 resins, have higher PENT test values. Slow crack grow properties can now be defined using eight cells.

As of December 2006, most HDPE pipe is made from resin with a cell classification of PE 345464C. The pipe is labeled as PE3408/3608. The physical properties for PE 345464C are:

PROPERTY VALUE		SPECIFICATION	UNIT	NOMINAL VALUE
Material Designation		PPI / ASTM		PE3408
Material Designation		PPI / ASTM		PE 3408/3608
Cell Classification		ASTM D 3350		345464C
Density	(3)	ASTM D 1505	g/cm3	0.941-943
Melt Index	(4)	ASTM D 1238	gm/ 10 min	0.05 -.11
Flexural Modulus	(5)	ASTM D 790	psi	110,000 to 140,000
Tensile Strength	(4)	ASTM D 638	psi	3,200
Slow Crack Growth				
ESCR		ASTM D 1693	hours in 100% igepal	>5,000
PENT	(6)	ASTM F 1473	hours	>100
HDB @ 73 deg F	(4)	ASTM D 2837	psi	1,600
UV Stabilizer	(C)	ASTM D 1603	%C	2 to 2.5%

The density provided is without carbon black. Typical HDPE pipe has a density of .955 to .957 with carbon black.

Types of Polyethylene Pipe

All polyethylene (PE) is not the same. In ASTM D 3350-05, low density PE is defined as having a density range of 0.919 to 0.925 g/cc; medium density has a range of 0.926 to 0.940 g/cc and high density is defined with a range from 0.941 to 0.955. All densities are without carbon black.

Density influences key properties in polyethylene materials. As the density increases, the tensile strength increases; also chemical resistance increases.

Medium density PE resins have been used for gas distribution. This original selection was made based on superior slow crack growth properties of medium density resins. Medium density pipe is designated as PE 2406 and PE 2708.

Today new bimodal resins are being used in gas distribution because of higher pressure ratings plus superior slow crack growth. These resins are designated PE 3408, PE 3608, PE 3708, PE 3710 and PE 4710.

Slow Crack Growth

The Pent test is used to determine stress crack resistance for PE resins. The PENT test is conducted in accordance with ASTM F 1473, "Standard Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins". This test uses a solid sample of material which is notched and tested.

The PENT test is a good test of slow crack growth. Scratches and gouges can cause crack propagation. Materials with high PENT numbers are less likely to fail because of slow crack growth.

Traditional PE 3408/3608 resins have PENT test values of about 100 hours. New bimodal resins used to make PE 3710 and PE 4710 pipes have values ranging from 600 hours to several thousand hours.

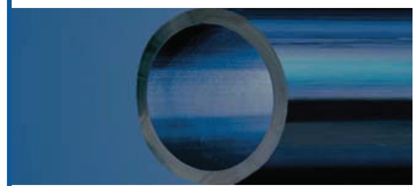
Physical Properties of PE 4710

HDPE pipe with a designation of PE 4710 is made from resin with a cell classification of PE 445474C or PE 445574C. We suggest using a specification calling for a minimum cell classification of PE 445474 C or higher. Both cell classifications can be used if specified in this way. The pipe is labeled as PE 4710. The physical properties for PE 445474C are provided below:

PROPERTY VALUE		SPECIFICATION	UNIT	NOMINAL VALUE
Material Designation		PPI / ASTM		PE 4710
Cell Classification		ASTM D 3350		445474 C
Density	(4)	ASTM D 1505	g/cm3	0.947-955
Melt Index	(4)	ASTM D 1238	gm/ 10 min	<.15
Flexural Modulus	(5)	ASTM D 790	psi	110,000 to 160,000
Tensile Strength	(5)	ASTM D 638	psi	3500-4000
Slow Crack Growth				
ESCR		ASTM D 1693	hours in 100% igepal	>5,000
PENT	(7)	ASTM F 1473	hours	>500
HDB @ 73 deg F	(4)	ASTM D 2837	psi	1,600
UV Stabilizer	(C)	ASTM D 1603	%C	2 to 2.5 %

The density provided is without carbon black. Typical PE 4710 HDPE pipe has a density of 0.956 to 0.964 with carbon black.

To be called a PE 4710, the pipe and resin has substantiation at 50 years.



HDPE Pipe

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HDPE Pipe

PE 3608/3408 IPS HDPE Pipe Sizes

Pressure Rating	Nominal Size	3/4"	1"	1 1/4"	1 1/2"	2"	3"	4"	5"	5"	6"	7"	8"	10"	12"	14"	16"	18"
	Actual O.D.	1.05"	1.315"	1.66"	1.90"	2.375"	3.50"	4.50"	5.375"	5.563"	6.625"	7.125"	8.625"	10.75"	12.75"	14.00"	16.00"	18.00"
DR 7 (267psi)	Min. wall	0.150"	0.188"	0.237"	0.271"	0.339"	0.500"	0.643"	0.768"	0.795"	0.946"	1.018"	1.232"	1.536"	1.821"	2.000"	2.286"	2.571"
	Average I.D.	0.732"	0.917"	1.157"	1.325"	1.656"	2.440"	3.137"	3.747"	3.878"	4.619"	4.967"	6.013"	7.494"	8.889"	9.760"	11.154"	12.549"
	Weight lb/lf	0.184	0.289	0.460	0.603	0.943	2.047	3.384	4.830	5.172	7.336	8.195	12.433	19.314	27.170	32.758	42.786	54.151
DR 7.3 (254psi)	Min. wall	0.144"	0.180"	0.227"	0.260"	0.325"	0.479"	0.616"	0.736"	0.762"	0.908"	0.976"	1.182"	1.473"	1.747"	1.918"	2.192"	2.466"
	Average I.D.	0.745"	0.933"	1.178"	1.348"	1.685"	2.484"	3.193"	3.814"	3.947"	4.701"	5.056"	6.120"	7.628"	9.047"	9.934"	11.353"	12.773"
	Weight lb/lf	0.178	0.279	0.444	0.582	0.762	1.656	2.737	4.663	4.182	5.932	8.200	10.054	15.618	21.970	26.489	34.598	43.788
DR 9 (200psi)	Min. wall	0.117"	0.146"	0.184"	0.211"	0.264"	0.389"	0.500"	0.597"	0.618"	0.736"	0.792"	0.958"	1.194"	1.417"	1.556"	1.778"	2.000"
	Average I.D.	0.803"	1.005"	1.269"	1.452"	1.816"	2.676"	3.440"	4.109"	4.253"	5.064"	5.447"	6.593"	8.218"	9.747"	10.702"	12.231"	13.760"
	Weight lb/lf	0.150	0.234	0.372	0.488	0.762	1.656	2.737	3.903	4.182	5.932	6.863	10.054	15.618	21.970	26.489	34.598	43.788
DR 11 (160psi)	Min. wall	0.095"	0.120"	0.151"	0.173"	0.216"	0.318"	0.409"	0.489"	0.506"	0.602"	0.648"	0.784"	0.977"	1.159"	1.273"	1.455"	1.636"
	Average I.D.	0.848"	1.062"	1.340"	1.534"	1.917"	2.825"	3.633"	4.339"	4.491"	5.348"	5.752"	6.963"	8.678"	10.293"	11.302"	12.916"	14.531"
	Weight lb/lf	0.125	0.197	0.312	0.409	0.639	1.387	2.294	3.272	3.505	4.971	5.750	8.425	13.089	18.412	22.199	28.994	36.696
DR 13.5 (128psi)	Min. wall	---	---	---	---	0.176"	0.259"	0.333"	0.398"	0.412"	0.491"	0.528"	0.639"	0.796"	0.944"	1.037"	1.185"	1.333"
	Average I.D.	---	---	---	---	2.002"	2.950"	3.793"	4.531"	4.689"	5.585"	6.006"	7.271"	9.062"	10.748"	11.801"	13.487"	15.173"
	Weight lb/lf	---	---	---	---	0.531	1.153	1.906	2.718	2.912	4.130	4.779	7.001	10.875	15.298	18.445	24.092	30.491
DR 15.5 (110psi)	Min. wall	---	---	---	---	0.153"	0.226"	0.290"	0.347"	0.359"	0.427"	0.460"	0.556"	0.694"	0.823"	0.903"	1.032"	1.161"
	Average I.D.	---	---	---	---	2.050"	3.021"	3.885"	4.640"	4.802"	5.719"	6.150"	7.445"	9.280"	11.006"	12.085"	13.812"	15.538"
	Weight lb/lf	---	---	---	---	0.467	1.015	1.678	2.396	2.564	3.637	3.985	6.164	9.576	13.471	16.242	21.214	26.849
DR 17 (100psi)	Min. wall	---	---	---	---	0.140"	0.206"	0.265"	0.316"	0.327"	0.390"	0.419"	0.507"	0.632"	0.750"	0.824"	0.941"	1.059"
	Average I.D.	---	---	---	---	2.079"	3.064"	3.939"	4.705"	4.869"	5.799"	6.236"	7.549"	9.409"	11.160"	12.254"	14.005"	15.755"
	Weight lb/lf	---	---	---	---	0.429	0.932	1.540	2.197	2.353	3.338	3.860	5.657	8.788	12.362	14.905	19.467	24.638
DR 19 (89psi)	Min. wall	---	---	---	---	---	---	0.237"	0.283"	0.293"	0.349"	0.375"	0.454"	0.566"	0.671"	0.737"	0.842"	0.947"
	Average I.D.	---	---	---	---	---	---	3.998"	4.775"	4.942"	5.886"	6.330"	7.663"	9.551"	11.327"	12.438"	14.215"	15.992"
	Weight lb/lf	---	---	---	---	---	---	1.387	1.980	2.120	3.007	3.478	5.097	7.918	11.138	13.429	17.540	22.199
DR 21 (80psi)	Min. wall	---	---	---	---	---	---	0.214"	0.256"	0.265"	0.315"	0.339"	0.411"	0.512"	0.607"	0.667"	0.762"	0.857"
	Average I.D.	---	---	---	---	---	---	4.046"	4.832"	5.001"	5.956"	6.406"	7.754"	9.665"	11.463"	12.587"	14.385"	16.183"
	Weight lb/lf	---	---	---	---	---	---	1.262	1.801	1.929	2.736	3.165	4.637	7.204	10.134	12.218	15.959	20.198
DR 26 (64 psi)	Min. wall	---	---	---	---	---	---	0.173"	0.207"	0.214"	0.255"	0.274"	0.332"	0.413"	0.490"	0.538"	0.615"	0.692"
	Average I.D.	---	---	---	---	---	---	4.133"	4.937"	5.109"	6.085"	6.544"	7.922"	9.873"	11.710"	12.858"	14.695"	16.532"
	Weight lb/lf	---	---	---	---	---	---	1.030	1.470	1.574	2.233	2.582	3.784	5.878	8.269	9.970	13.022	16.480
DR 32.5 (51 psi)	Min. wall	---	---	---	---	---	---	0.138"	0.165"	0.171"	0.204"	0.219"	0.265"	0.331"	0.392"	0.431"	0.492"	0.554"
	Average I.D.	---	---	---	---	---	---	4.206"	5.024"	5.200"	6.193"	6.660"	8.062"	10.049"	11.918"	13.087"	14.956"	16.826"
	Weight lb/lf	---	---	---	---	---	---	0.831	1.186	1.270	1.801	2.083	3.053	4.742	6.671	8.044	10.506	13.296

- **Items highlighted in Blue indicates standard stocking items that are more readily available.**
- **Pressures are based on using water at 23°C (73°F).**
- **Average inside diameter calculated using nominal OD and minimum wall plus 6% for use in estimating fluid flows. Actual ID will vary.**
- **Other piping sizes or DR's may be available upon request.**
- **Standard Lengths:**
  40' for 2"-24"
  50' for 26" and larger
  Coils available for 3/4"-6"(8" by special order)

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HDPE Fabricated and Molded Fittings

Pressure Ratings for Molded and Fabricated Fittings

Fittings serve the purpose of creating a change in direction in a short distance. There are two basic types of fittings, molded and fabricated. Molded fittings are made by injection molding. These fittings are fully pressure rated. The body of a molded fitting is thicker (greater OD except at ends) than pipe to maintain the pressure rating.

Fabricated fittings have reduced pressure rating because miter cuts create a change in the diameter of the fitting at this point. Stress is increased because of changes in flow direction. The larger the angle of the miter cut, the greater the stress and the greater the need to decrease the pressure rating to maintain a 2 to 1 safety factor.

In this Fitting Section, mitered fittings are shown with traditional three-piece 45 degree and five-piece 90 degree ells. Newly added are two-piece 45 degree ells and three-piece 90 degree ells. To maintain a 2 to 1 safety factor, the two-piece 45 degree ells and the three-piece 90 degree ells have a lower pressure rating for the same wall thickness (DR) than do the three-piece 45 degree and five-piece 90 degree ells.

The pressure ratings are based on standards for design established by the American Society of Mechanical Engineers (ASME). These standards are in ASME B31.3 paragraph number 304.2. Equations 4a and 4b are used to determine pressure ratings.

For five-piece mitered 90 degree and three-piece 45 degree ells based on 22.5 degree miter joints, the derating factor is 25% of the pressure rating of the pipe. A DR 11 wall thickness has a pressure rating of 160 psi. Fittings made from DR 11 pipe have a pressure rating of 120 psi. The 25% derating factor is based on a 2 to 1 safety factor.

For three-piece mitered 90 degree and two-piece 45 degree ells based 45 degree miter cuts, the derating factor is 38%. Fittings made from DR 11 pipe have a pressure rating of 100 psi. The 38% derating factor is based on a 2 to 1 safety factor.

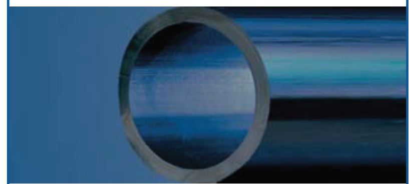
Derating factors for fittings are provided in Table 1, Derating Factors for HDPE Fittings. This table can assist in the selection of the correct fitting for a given application based on pressure rating requirements. Derating factor is the percentage that the pressure rating is lowered.

Table 1: Derating Factors For HDPE Fittings

Description	Industry Practice	Derating ASME B31.3
Fabricated 90 degree Ell - Five Segment	25%	25%
Fabricated 90 degree Ell Three	25%	38%
Fabricated 45 degree Ell Three	25%	25%
Fabricated 45 degree Ell Two	25%	38%
Fabricated 22.5 degree Ell Two	25%	25%
Fabricated Tees, Three Piece	25%	25%
Fabricated Tees, Two Piece	50%	25%
Fabricated Cross	50%	50%
Fabricated Wye, Three piece	40%	40%
Fabricated Wye, Two piece	50%	50%
Reducing Tee	none	none
Fabricated Cleanouts	***see note**	***see note**
Concentric Reducers	none	none
Transition Fittings	none	none
MJ Adapters	none	none
Bell MJ Adapters	none	none
Flange Adapters	none	none
Stub Ends	none	none
Molded Caps	none	none
Wall Anchors	none	none
Blind Flanges	***see note**	***see note**

Molded fittings such as 90 degree ells, 45 degree ells, tees, reducers, and end caps are normally not derated. These fittings have been designed and made with the needed radius and material in critical areas to handle the pressure for the thickness of the fitting. These fittings do not require derating when used at 73 degrees F with water or approved chemical service.

***NOTE: Plastic blind flanges are normally used for gravity or low pressure applications. Fabricated caps are typically designed to handle the required pressure. Blind Flanges and fabricated caps pressure ratings vary with size, type of material and thickness. Please indicate pressure requirements when ordering.**



HDPE Fabricated and Molded Fittings

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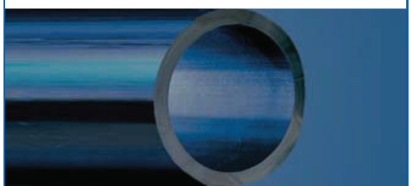

HDPE Fabricated and Molded Fittings

ASME B 31.3 provides calculations to estimate derating factors for metal fittings. These values are applied to HDPE fittings in the table (refer to table 1). These ratings result in a 2 to 1 safety factor.

New three-piece miter 90 degree ells and two-piece 45 degree ells have been derated differently than ASME calculations by some HDPE fabricators. Using the BSME 31.3 method, its appears that the safety factor is less than 2 to 1.

ISCO Industries recognizes that these fittings are satisfactory for many applications using a lower derating factor and lower safety factor. This note has been provided to make you aware that critical applications may be better handled with five-piece mitered 90 degree ells. Critical applications are those that have high flow velocity (above 5 fps), higher temperature and those that may endanger people or the environment. Use good engineering judgment in the selection of fittings for your application.

Please call ISCO at 1-800-345-ISCO or go to our web site (www.isco-pipe.com) and use “Ask an Engineer” to answer your questions and get additional information.

TRANSITION FITTINGS

Transition fittings are mechanical connections between metal pipe and HDPE pipe. These fittings are used in a large number of applications. A common use is in natural gas systems to change from HDPE pipe to steel pipe where the pipe goes above ground.

Transition fittings for natural gas service are required to meet the requirements of ASTM D 2513, “Standard Specifications for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings”. Within this specification there are provisions for mechanical joints. The specification indicates that the mechanical connection must: 1) provide a seal plus resistance to force on the pipe which will cause permanent deformation of the pipe, 2) provide a seal only, and 3) provide a seal plus a pipe restraint.

Not all transition fittings will meet the requirements of ASTM 2513. If you need transitions that meet ASTM 2513, ask for this requirement.

Central Plastics test their products using ASTM D 638 tensile test. This testing qualifies their fittings as providing a seal plus resistance to force which will cause permanent deformation.

Quick burst test per ASTM D1599 are used to proof that the transition fittings provide a seal and resist axial pullout forces.

Transition fittings are made from different metals. Carbon steel is the standard. If you need greater corrosion resistance, please request stainless steel transition fittings.

Carbon Steel Transition Fittings

Features:

Compression design effectively resists creep and pullout
Carbon steel per ASTM A-53, Sch. 40 steel pipe
O-Ring design for added protection
Meets ASTM 2513
No Weld Design
Size range 3/4" through 12"
No shear points
Available with AWWA pipe

Stainless Steel Transition Fittings

Features:

Compression design effectively resists creep and pullout
Stainless Steel 304 Body (316 Available)
O-Ring design for added protection
Meets ASTM 2513
No Weld Design
Size range 3/4" through 2"
No shear points
Available with AWWA pipe

Threads per ANSI B1.20.1

HDPE Fabricated and Molded Fittings

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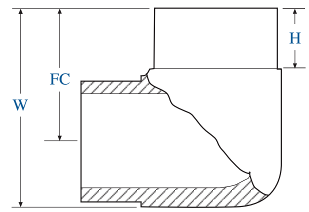
IPS
HDPE
Fittings

IPS Fittings Molded 90° Ell

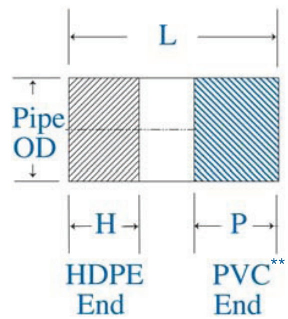


IPS Fittings Molded 90° Ell

Nominal Size(in)	Pipe OD(in)	DR	Pressure Rating	Part #	Dimensions H (in)	FC (in)	W (in)	Weight Lbs.	Shipping Method
3/4	1.05	11	160	ISMF9007511IPS	2.05	2.68	3.2	0.05	UPS
1	1.315	11	160	ISMF900111IPS	2.17	2.91	3.57	0.1	UPS
1-1/4	1.66	11	160	ISMF9012511IPS	2.44	3.35	4.18	0.15	UPS
1-1/2	1.9	11	160	ISMF901511IPS	2.64	3.7	4.65	0.22	UPS
2	2.375	09	200	ISMF900209IPS	2.5	4.25	5.815	0.5	UPS
		11	160	ISMF900211IPS	"	"	"	0.43	"
3	3.5	09	200	ISMF900309IPS	3	5.25	7.4	1.5	UPS
		11	160	ISMF900311IPS	"	"	"	1.2	"
		17	100	ISMF900317IPS	"	"	"	0.8	"
4	4.5	09	200	ISMF900409IPS	3	5.875	8.25	3	UPS
		11	160	ISMF900411IPS	"	"	"	2.4	"
		17	100	ISMF900417IPS	"	"	"	1.6	"
6	6.625	09	200	ISMF900609IPS	4.125	8	12.5	7	UPS
		11	160	ISMF900611IPS	"	"	"	6.7	"
		17	100	ISMF900617IPS	"	"	"	4.8	"
8	8.625	11	160	ISMF900811IPS	6	12	16.5	15	UPS
		17	100	ISMF900817IPS	"	"	"	10	"
10	10.75	11	160	ISMF901011IPS	6	13.25	18.875	27	UPS
		17	100	ISMF901017IPS	"	"	"	18	"
12	12.75	11	160	ISMF901211IPS	7.5	15.88	22.555	41	UPS
		17	100	ISMF901217IPS	"	"	"	27	"

IPS
HDPE
Fittings

IPS HDPE to PVC Transition Fitting



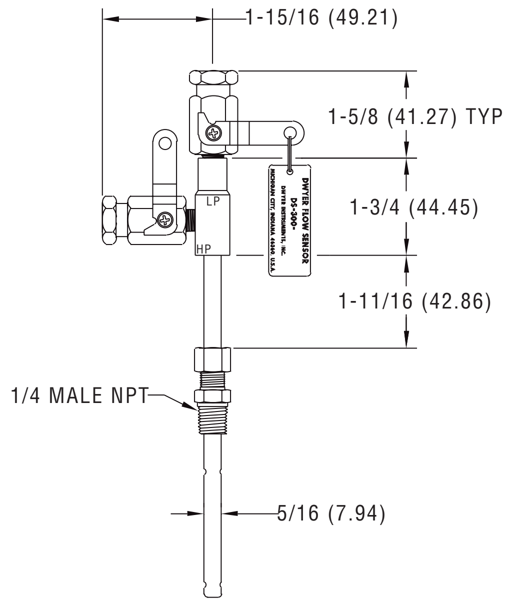
IPS HDPE To PVC Transition Fitting

Nominal Size (in)	Pipe OD (in)	Material	Part #	Dimensions H (in)	L (in)	P (in)	Weight Lbs.	Shipping Method
3/4	1.05	Steel	ISFFTF003/4PVC	3	8	3	0.7	UPS
		Stainless Steel	ISFFTF003/4PVCS		"	"	"	"
1	1.315	Steel	SFFTF0111PVC	3	8.5	3	0.8	UPS
		Stainless Steel	ISFFTF0111PVCSS		"	"	"	"
1 1/4	1.66	Steel	ISFFTF01.25PVC	4	11.5	4	1	UPS
		Stainless Steel	ISFFTF01.25PVCS		"	"	"	"
1 1/2	1.9	Steel	ISFFTF01.5PVC	4	12	4	1.25	UPS
		Stainless Steel	ISFFTF01.50PVCS		"	"	"	"
2	2.375	Steel	ISFFTF0211PVC	4	12.5	4	1.5	UPS
		Stainless Steel	ISFFTF0211PVCSS		"	"	"	"
3	3.5	Steel	ISFFTF0311PVC	4.5	14	4.5	3	UPS
		Stainless Steel	ISFFTF0311PVCSS		"	"	"	"
4	4.5	Steel	ISFFTF0411PVC	4.5	15	4.5	5	UPS
		Stainless Steel	ISFFTF0411PVCSS		"	"	"	"

**** PVC available as SCH 40 or SCH 80.**

Series DS-300 Flow Sensors

Installation and Operating Instructions Flow Calculations



Series DS-300 Flow Sensors are averaging pitot tubes that provide accurate, convenient flow rate sensing. When purchased with a Dwyer Capsuhelic® for liquid flow or Magnehelic® for air flow, differential pressure gage of appropriate range, the result is a flow-indicating system delivered off the shelf at an economical price. Series DS-300 Flow Sensors are designed to be inserted in the pipeline through a compression fitting and are furnished with instrument shut-off valves on both pressure connections. Valves are fitted with 1/8˝ female NPT connections. Accessories include adapters with 1/4˝ SAE 45° flared ends compatible with hoses supplied with the Model A-471 Portable Capsuhelic® kit. Standard valves are rated at 200°F (93.3°C). Where valves are not required, they can be omitted at reduced cost. Series DS-300 Flow Sensors are available for pipe sizes from 1˝ to 10˝.

INSPECTION

Inspect sensor upon receipt of shipment to be certain it is as ordered and not damaged. If damaged, contact carrier.

INSTALLATION

General - The sensing ports of the flow sensor must be correctly positioned for measurement accuracy. The instrument connections on the sensor indicate correct positioning. The side connection is for total or high pressure and should be pointed upstream. The top connection is for static or low pressure.

Location - The sensor should be installed in the flowing line with as much straight run of pipe upstream as possible. A rule of thumb is to allow 10 - 15 pipe diameters upstream and 5 downstream. The table below lists recommended up and down piping.

PRESSURE AND TEMPERATURE

Maximum: 200 psig (13.78 bar) at 200°F (93.3°C).

Upstream and Downstream Dimensions in Terms of Internal Diameter of Pipe*

Upstream Condition	Minimum Diameter of Straight Pipe		
	Upstream		Downstream
	In-Plane	Out of Plane	
One Elbow or Tee	7	9	5
Two 90° Bends in Same Plane	8	12	5
Two 90° Bends in Different Plane	18	24	5
Reducers or Expanders	8	8	5
All Valves**	24	24	5

* Values shown are recommended spacing, in terms of internal diameter for normal industrial metering requirements. For laboratory or high accuracy work, add 25% to values.

** Includes gate, globe, plug and other throttling valves that are only partially opened. If valve is to be fully open, use values for pipe size change. **CONTROL VALVES SHOULD BE LOCATED AFTER THE FLOW SENSOR.**

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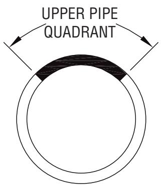
POSITION

Be certain there is sufficient clearance between the mounting position and other pipes, walls, structures, etc, so that the sensor can be inserted through the mounting unit once the mounting unit has been installed onto the pipe.

Flow sensors should be positioned to keep air out of the instrument connecting lines on liquid flows and condensate out of the lines on gas flows. The easiest way to assure this is to install the sensor into the pipe so that air will bleed into, or condensate will drain back to, the pipe.

For Air or Gas Flow

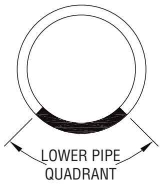
Install in upper quadrant of pipe



Condensate drains back to pipe

For Liquid or Steam Flow

Install in lower quadrant of pipe



Air bleeds back to pipe

INSTALLATION

1. When using an A-160 thred-o-let, weld it to the pipe wall. If replacing a DS-200 unit, an A-161 bushing (1/4″ x 3/8″) will be needed.

2. Drill through center of the thred-o-let into the pipe with a drill that is slightly larger than the flow sensor diameter.

3. Install the packing gland using proper pipe sealant. If the packing gland is disassembled, note that the tapered end of the ferrule goes into the fitting body.

4. Insert sensor until it bottoms against opposite wall of the pipe, then withdraw 1/16″ to allow for thermal expansion.

5. Tighten packing gland nut finger tight. Then tighten nut with a wrench an additional 1-1/4 turns. Be sure to hold the sensor body with a second wrench to prevent the sensor from turning.

INSTRUMENT CONNECTION

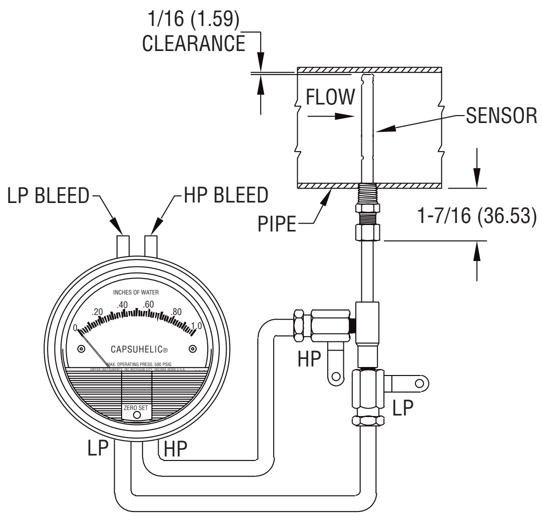
Connect the slide pressure tap to the high pressure port of the Magnehelic® (air only) or Capsuhelic® gage or transmitting instrument and the top connection to the low pressure port.

See the connection schematics below.

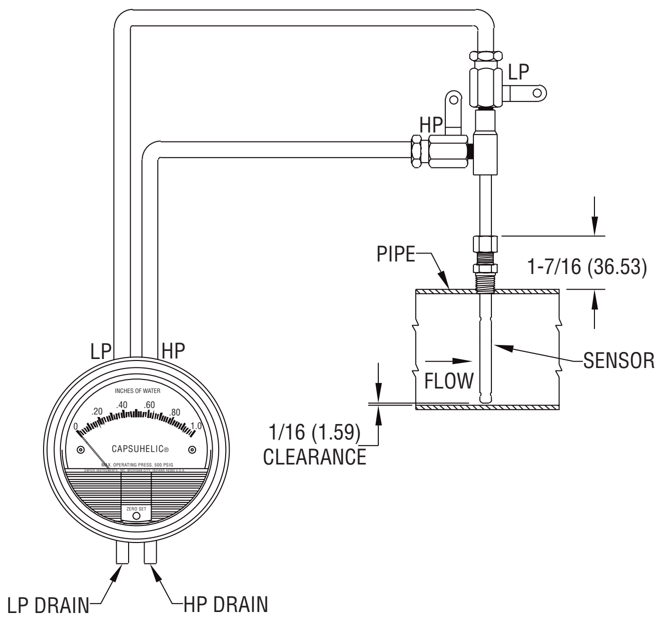
Bleed air from instrument piping on liquid flows. Drain any condensate from the instrument piping on air and gas flows.

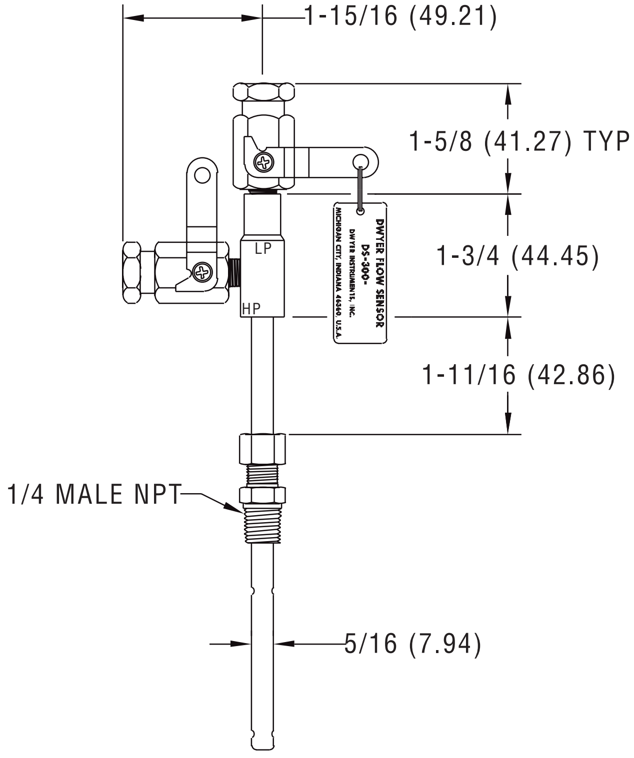
Open valves to instrument to place flow meter into service. For permanent installations, a 3-valve manifold is recommended to allow the gage to be zero checked without interrupting the flow. The Dwyer A-471 Portable Test Kit includes such a device.

Water Flow



Air or Gas Flow





Flow Calculations and Charts

The following information contains tables and equations for determining the differential pressure developed by the DS-300 Flow Sensor for various flow rates of water, steam, air or other gases in different pipe sizes.

This information can be used to prepare conversion charts to translate the differential pressure readings being sensed into the equivalent flow rate. When direct readout of flow is required, use this information to calculate the full flow differential pressure in order to specify the exact range of Dwyer Magnehelic® or Capsuhelic® gage required. Special ranges and calculations are available for these gages at minimal extra cost. See bulletins A-30 and F-41 for additional information on Magnehelic® and Capsuhelic® gages and DS-300 flow sensors.

For additional useful information on making flow calculations, the following service is recommended: Crane Valve Co. Technical Paper No. 410 "Flow of Fluids Through Valves, Fittings and Pipe." It is available from Crane Valve Company, www.cranevalve.com.

Using the appropriate differential pressure equation from Page 4 of this bulletin,calculate the differential pressure generated by the sensor under normal operating conditions of the system. Check the chart below to determine if this value is within the recommended operating range for the sensor. Note that the data in this chart is limited to standard conditions of air at 60°F (15.6°C) and 14.7 psia static line pressure or water at 70°F (21.1°C). To determine recommended operating ranges of other gases, liquids an/or operating conditions, consult factory.

Note: the column on the right side of the chart which defines velocity ranges to avoid. Continuous operation within these ranges can result in damage to the flow sensor caused by excess vibration.

Pipe Size (Schedule 40)	Flow Coefficient "K"	Operating Ranges Air @ 60°F & 14.7 psia (D/P in. W.C.)	Operating Ranges Water @ 70°F (D/P in. W.C.)	Velocity Ranges Not Recommended (Feet per Second)
1	0.52	1.10 to 186	4.00 to 675	146 to 220
1-1/4	0.58	1.15 to 157	4.18 to 568	113 to 170
1-1/2	0.58	0.38 to 115	1.36 to 417	96 to 144
2	0.64	0.75 to 75	2.72 to 271	71 to 108
2-1/2	0.62	1.72 to 53	6.22 to 193	56 to 85
3	0.67	0.39 to 35	1.43 to 127	42 to 64
4	0.67	0.28 to 34	1.02 to 123	28 to 43
6	0.71	0.64 to 11	2.31 to 40	15 to 23
8	0.67	0.10 to 10	0.37 to 37	9.5 to 15
10	0.70	0.17 to 22	0.60 to 79	6.4 to 10

FLOW EQUATIONS

1. Any Liquid

$$Q\ (GPM) = 5.668 \times K \times D^2 \times \sqrt{\Delta P / S_f}$$

2. Steam or Any Gas

$$Q\ (lb/Hr) = 359.1 \times K \times D^2 \times \sqrt{p \times \Delta P}$$

3. Any Gas

$$Q\ (SCFM) = 128.8 \times K \times D^2 \times \sqrt{\frac{P \times \Delta P}{(T + 460) \times S_s}}$$

DIFFERENTIAL PRESSURE EQUATIONS

1. Any Liquid

$$\Delta P\ (in.\ WC) = \frac{Q^2 \times S_f}{K^2 \times D^4 \times 32.14}$$

2. Steam or Any Gas

$$\Delta P\ (in.\ WC) = \frac{Q^2}{K^2 \times D^4 \times p \times 128{,}900}$$

3. Any Gas

$$\Delta P\ (in.\ WC) = \frac{Q^2 \times S_s \times (T + 460)}{K^2 \times D^4 \times P \times 16{,}590}$$

Technical Notations

The following notations apply:

ΔP = Differential pressure expressed in inches of water column
Q = Flow expressed in GPM, SCFM, or PPH as shown in equation
K = Flow coefficient— See values tabulated on Pg. 3.
D = Inside diameter of line size expressed in inches.

For square or rectangular ducts, use: $D = \sqrt{\frac{4 \times Height \times Width}{\pi}}$

P = Static Line pressure (psia)
T = Temperature in degrees Fahrenheit (plus 460 = °Rankine)
p = Density of medium in pounds per square foot
S_f = Sp Gr at flowing conditions
S_s = Sp Gr at 60°F (15.6°C)

SCFM TO ACFM EQUATION

$$SCFM = ACFM \times \left(\frac{14.7 + PSIG}{14.7}\right) \left(\frac{520^*}{460 + °F}\right)$$

$$ACFM = SCFM \times \left(\frac{14.7}{14.7 + PSIG}\right) \left(\frac{460 + °F}{520}\right)$$

$$\text{POUNDS PER CUBIC FOOT STD.} = \text{POUNDS PER CUBIC FOOT ACT.} \times \left(\frac{14.7}{14.7 + PSIG}\right) \left(\frac{460 + °F}{520^*}\right)$$

$$\text{POUNDS PER CUBIC FOOT ACT.} = \text{POUNDS PER CUBIC FOOT STD.} \times \left(\frac{14.7 + PSIG}{14.7}\right) \left(\frac{520^*}{460 + °F}\right)$$

1 Cubic foot of air = 0.076 pounds per cubic foot at 60° F (15.6°C) and 14.7 psia.
* (520°= 460 + 60°) Std. Temp. Rankine

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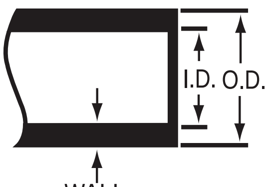
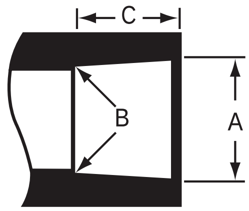
ASTM STANDARD DIMENSIONS

SCHEDULE 40 PIPE DIMENSIONS ASTM D 1785



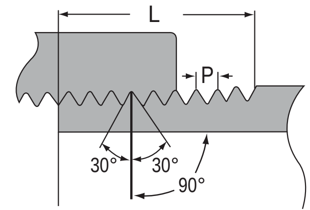
Nominal Pipe Size In.	Mean Outside Diameter In.	O. D. Tolerance In.	Minimum Wall Thickness In.
1/8	0.405	± 0.004	0.068
1/4	0.540	± 0.004	0.088
3/8	0.675	± 0.004	0.091
1/2	0.840	± 0.004	0.109
3/4	1.050	± 0.004	0.113
1	1.315	± 0.005	0.133
1-1/4	1.660	± 0.005	0.140
1-1/2	1.900	± 0.006	0.145
2	2.375	± 0.006	0.154
2-1/2	2.875	± 0.007	0.203
3	3.500	± 0.008	0.216
4	4.500	± 0.009	0.237
5	5.563	± 0.010	0.258
6	6.625	± 0.011	0.280
8	8.625	± 0.015	0.322
10	10.750	± 0.015	0.365
12	12.750	± 0.015	0.408

SCHEDULE 40 SOCKET DIMENSIONS ASTM D 2466



Nominal Size In.	Diameter			Socket Length Minimum C
	Entrance A	Bottom B	Tolerance A	
1/8	0.417	0.401	± 0.004	0.500
1/4	0.552	0.536	± 0.004	0.500
3/8	0.687	0.671	± 0.004	0.594
1/2	0.848	0.836	± 0.004	0.688
3/4	1.058	1.046	± 0.004	0.719
1	1.325	1.310	± 0.005	0.875
1-1/4	1.670	1.655	± 0.005	0.938
1-1/2	1.912	1.894	± 0.006	1.094
2	2.387	2.369	± 0.006	1.156
2-1/2	2.889	2.868	± 0.007	1.750
3	3.516	3.492	± 0.008	1.875
4	4.518	4.491	± 0.009	2.000
5	5.583	5.553	± 0.010	3.000
6	6.647	6.614	± 0.011	3.000
8	8.655	8.610	± 0.015	4.000
10	10.780	10.735	± 0.015	5.000
12	12.780	12.735	± 0.015	6.000

AMERICAN NATIONAL STANDARD TAPER PIPE THREADS (NPT) ANSI B1.20.1, ASTM F 1498



Nominal Size In.	Threads Per Inch.	Effective Thread Length L	Pitch Of Thread P
1/8	27	0.2639	0.03704
1/4	18	0.4018	0.05556
3/8	18	0.4078	0.05556
1/2	14	0.5337	0.07143
3/4	14	0.5457	0.07143
1	11-1/2	0.6828	0.08696
1-1/4	11-1/2	0.7068	0.08696
1-1/2	11-1/2	0.7235	0.08696
2	11-1/2	0.7565	0.08696
2-1/2	8	1.1375	0.12500
3	8	1.2000	0.12500
4	8	1.3000	0.12500
5	8	1.4063	0.12500
6	8	1.5125	0.12500
8	8	1.7125	0.12500

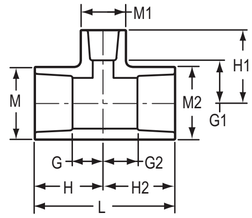
Molded Schedule 40 products are manufactured to ASTMD 2466 for use with pipe manufactured to ASTM D1785. Certain products carry reduced pressure handling capability and have maximum internal pressure ratings at 73° F noted.

Fabricated Schedule 40 pressure fittings (part numbers ending with "F") are manufactured to Spears® specifications for use with pipe manufactured to ASTM D1785. See publication FAB-7, General Specifications for Standard Fabricated Fittings for additional information.

All specified Schedule 40 products are manufactured from materials certified by NSF for use in potable water service.

PVC WHITE SCHEDULE 40 FITTINGS
UNIONS & SADDLES

REDUCING TEE **(continued)**
Socket x Socket x Socket



Part Number	Size	G	G1	G2	H	H1	H2	L	M	M1	M2	Approx. Wt. (Lbs.)
401-527[1]	6x6x1-1/2	1-3/8	3-7/8	1-3/8	4-27/32	5-3/16	4-27/32	9-11/16	7-1/4	2-11/16	7-1/4	3.60
401-528	6x6x2	1-3/8	3-19/32	1-3/8	4-27/32	4-31/32	4-27/32	9-11/16	7-3/16	2-11/16	7-3/16	3.39
401-529	6x6x2-1/2	2	3-15/16	2	5-1/2	5-15/16	5-1/2	10-15/16	7-3/16	3-15/16	7-3/16	4.29
401-530	6x6x3	2	3-23/32	2	5	5-19/32	5	10	7-1/4	4	7-1/4	3.89
401-532	6x6x4	2-17/32	3-5/8	2-17/32	6	5-5/8	6	12-1/16	7-3/16	5	7-3/16	4.54
401-533[1]	6x6x5	3-1/2	4-1/2	3-1/2	7	7-1/2	7	14	7-3/16	7-3/16	7-3/8	8.46
401-535[1]	6x6x8	5-3/8	5-1/2	5-3/8	8-7/8	9-1/2	8-7/8	17-3/4	9-1/2	9-3/4	9-1/2	19.21
401-537[1]	6x6x10	8	5-13/16	8	11-3/8	10-13/16	11-3/8	22-3/4	11-1/2	11-9/16	11-1/2	38.30
401-578[1]	8x8x2	2	5-7/8	2	6	7	6	12	9-1/4	4	9-1/4	11.71
401-579[1]	8x8x2-1/2	2	5-5/16	2	6	7-5/16	6	12	9-5/16	4	9-5/16	6.62
401-580	8x8x3	1-31/32	4-3/4	1-31/32	6-1/32	6-3/4	6-1/32	12-1/16	9-11/32	4	9-11/32	6.44
401-582	8x8x4	2-17/32	4-11/16	2-17/32	6-17/32	6-11/16	6-17/32	13-1/16	9-9/32	4-31/32	9-9/32	7.02
401-583[1]	8x8x5	3-21/32	5-1/4	3-21/32	7-21/32	8-1/4	7-21/32	15-5/16	9-5/16	7-1/4	9-5/16	10.60
401-585	8x8x6	3-5/8	4-3/4	3-5/8	7-21/32	7-25/32	7-21/32	15-11/32	9-11/32	7-1/4	9-11/32	8.90
401-589[1]	8x8x10	6-23/32	5-11/16	6-23/32	11-7/32	10-1/2	11-7/32	22-7/16	11-9/16	11-9/16	11-9/16	34.76
401-621F	10x10x2	4-7/8	7-1/4	4-7/8	10-1/8	9	10-1/8	20-1/4	11-1/2	2-11/16	11-1/2	19.60
401-623[1]	10x10x3	3-13/16	7	3-13/16	9-3/8	9	9-3/8	18-3/4	12	7-1/2	12	25.54
401-624[1]	10x10x4	3-27/32	7-3/8	3-27/32	9-11/32	9-3/8	9-11/32	18-11/16	12	7-1/2	12	25.63
401-628[1]	10x10x8	5-3/4	7-3/16	5-3/4	10-7/8	11-1/4	10-7/8	21-11/16	11-11/16	11-11/16	11-1/2	29.85
401-661F	12x12x2	5-1/4	8-1/4	5-1/4	11-1/2	10	11-1/2	23	13-1/2	2-11/16	13-1/2	25.00
401-663F	12x12x3	5-3/4	9	5-3/4	12	11-1/4	12	23	13-1/2	3-15/16	13-1/2	31.41
401-664F	12x12x4	7	9-5/16	7	13-1/4	11-9/16	13-1/4	26-1/2	13-9/16	5	13-9/16	32.40
401-666[1]	12x12x6	4-7/8	8-5/16	4-7/8	11-7/16	11-3/4	11-7/16	22-13/16	14-1/4	9-3/4	14-1/4	44.02
401-668	12x12x8	4-27/32	7-1/8	4-27/32	11-13/32	11-1/8	11-13/32	22-13/16	14-1/4	9-3/4	14-1/4	40.00
401-670	12x12x10	6-13/16	7-3/8	6-13/16	12-13/16	13-1/4	12-13/16	25-5/8	13-3/4	13-3/4	13-3/4	50.00
401-670F	12x12x10	10-1/4	10-3/8	10-1/4	16-1/2	15-5/8	16-1/2	33	13-9/16	11-1/2	13-9/16	50.00
401-676F	12x12x16	18-1/2	12-3/4	18-1/2	30-1/4	20-3/4	30-1/4	60-1/2	14-1/8	17	14-1/8	144.87
401-678F	12x12x18	14-1/4	13	17-7/8	23-1/4	22	23-7/8	47-3/4	19-1/8	19-1/8	19-1/8	252.00
401-691F	14x14x2	6	9-1/4	6	13	11	13	26	14-7/8	2-3/4	14-7/8	35.53
401-693F	14x14x3	6-1/2	9-9/16	6-1/2	13-1/2	11-13/16	13-1/2	27	14-7/8	3-15/16	14-7/8	38.35
401-694F	14x14x4	7-1/2	10	7-1/2	14-1/2	12-1/4	14-1/2	29	14-7/8	5	14-7/8	38.58
401-696F	14x14x6	8	10-1/4	8	15	13-1/2	15	30	14-7/8	7-1/8	14-7/8	45.70
401-698F	14x14x8	9-1/8	10-1/2	9-3/32	16-1/8	14-3/4	16-3/32	32-3/16	14-7/8	9-3/8	14-7/8	51.99

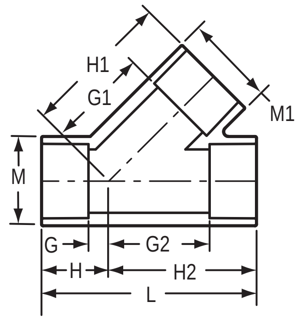
[1] Oultet sized with bushing

Made in the U.S.A.

WYE

Socket x Socket x Socket

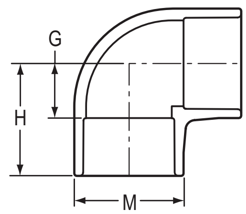
Pressure Rating
1/2" - 2" 235 psi @ 73°F
2-1/2" - 6" 200 psi @ 73°F
8" & Up 100 psi @ 73°F



Part Number	Size	G	G1	G2	H	H1	H2	L	M	M1	Approx. Wt. (Lbs.)
475-005	1/2	1/4	1-3/16	1-3/16	1-1/8	2-1/16	2-1/16	3-3/16	1-5/32	1-5/32	.12
475-007	3/4	1/8	1-9/16	1-9/16	1-1/8	2-9/16	2-9/16	3-11/16	1-3/8	1-3/8	.18
475-010	1	9/32	1-13/16	1-13/16	1-13/32	2-15/16	2-15/16	4-11/32	1-23/32	1-23/32	.31
475-012	1-1/4	3/8	2-1/4	2-1/4	1-5/8	3-1/2	3-1/2	5-1/8	2-1/16	2-1/16	.50
475-015	1-1/2	1/2	2-19/32	2-9/16	1-7/8	3-31/32	3-15/16	5-13/16	2-11/32	2-11/32	.69
475-020	2	19/32	3-7/32	3-7/32	2-1/8	4-3/4	4-3/4	6-7/8	2-7/8	2-7/8	1.20
475-025	2-1/2	1	5-1/4	4-3/4	3	7-1/4	6-3/4	9-3/4	4-1/8	4-1/8	2.59
475-030	3	11/16	4-5/8	4-3/16	2-19/32	6-17/32	6-3/32	8-11/16	4-5/32	4-5/32	2.68
475-040	4	7/8	6	5-3/8	3-1/8	8-1/4	7-5/8	10-3/4	5-9/32	5-9/32	4.76
475-050F	5	3-3/4	10-1/8	9-5/16	6-3/4	13-1/8	12-5/16	19-1/8	6-1/16	6-1/16	13.26
475-060	6	1-5/16	8-21/32	8-1/16	4-5/16	11-21/32	11-1/16	15-3/8	7-9/16	7-9/16	12.09
475-080	8	1-3/4	11-1/2	11-9/16	5-3/4	15-17/32	15-19/32	21-5/16	9-3/4	9-3/4	25.76
475-080F	8	5-1/2	13-1/2	13-1/2	9-3/4	17-3/4	17-3/4	27-1/2	9-1/4	9-1/4	25.46
475-100	10	2-1/2	16-7/8	13-31/32	7-1/2	22-1/8	18-31/32	26-15/32	11-9/16	11-9/16	26.92
475-100F	10	6-7/8	16-7/8	16-7/8	12-1/8	22-1/8	22-1/8	34-1/4	11-1/2	11-1/2	45.11
475-120	12	2-11/16	16-1/8	16-7/32	8-3/4	22-7/32	22-9/32	31-1/32	13-21/32	13-21/32	41.85
475-120F	12	6-3/4	19-3/4	19-3/4	13	26	26	39	13-9/16	13-9/16	63.02
475-140F	14	6-7/8	21-1/8	21-1/8	13-7/8	28-1/8	28-1/8	42	14-7/8	14-7/8	90.24
475-160F	16	8-1/2	26-1/4	24-1/2	16-1/2	34-1/4	32-1/2	49	17	17	93.06
475-180F	18	9	28	27-3/4	18	37	36-3/4	54-3/4	19-1/8	19-1/8	151.20
475-200F	20	11-7/16	30-5/16	30-5/16	21-7/16	40-5/16	40-5/16	61-3/4	21-3/16	21-3/16	191.78
475-240F	24	11-3/4	34-3/4	34-3/4	25-3/4	46-3/4	46-3/4	70-1/2	25-3/8	25-3/8	420.00

PVC WHITE SCHEDULE 40 FITTINGS UNIONS & SADDLES

90° ELBOW
Socket x Socket

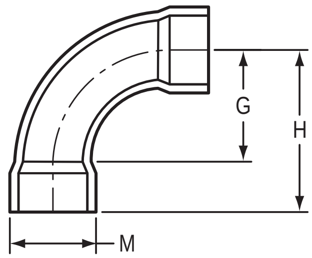


Part Number	Size	G	H	M	Approx. Wt. (Lbs.)
406-003	3/8	3/8	1-1/8	7/8	.03
406-005	1/2	1/2	1-1/4	1-1/16	.05
406-007	3/4	9/16	1-1/2	1-5/16	.07
406-010	1	11/16	1-13/16	1-5/8	.12
406-012	1-1/4	31/32	2-5/32	2	.20
406-015	1-1/2	1-1/16	2-3/8	2-7/32	.25
406-020	2	1-9/32	2-21/32	2-3/4	.37
406-025	2-1/2	1-15/16	3-7/32	3-5/16	.71
406-030	3	1-7/8	3-25/32	3-31/32	1.04
406-040	4	2-1/2	4-1/2	5	1.71
406-045F	4-1/2	7-1/8	9-5/8	5-1/2	3.13
406-050	5	3-1/16	6-1/8	6-5/32	3.58
406-060	6	3-1/2	6-29/32	7-9/32	5.03
406-080	8	4-7/16	8-15/32	9-5/16	8.75
406-100	10	5-29/32	10-7/8	11-5/8	17.82
406-100F	10	9-1/2	14-3/4	11-1/2	17.40
406-120	12	7-1/16	13-9/16	14-1/4	27.98
406-120F	12	10-1/2	16-3/4	13-9/16	25.94
406-140F	14	12-1/4	19-1/4	14-7/8	47.26
406-160F	16	14-1/8	22-1/8	17	69.70
406-180F	18	17-1/4	26-1/4	19-1/8	104.20
406-200F	20	18-3/4	28-3/4	21-3/16	131.93
406-240F	24	22-1/4	34-1/4	25-3/8	216.00

PVC WHITE SCHEDULE 40 FITTINGS UNIONS & SADDLES

LONG SWEEP ELBOW

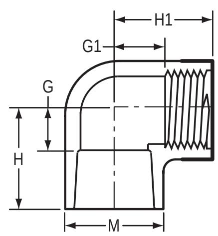
Socket x Socket



Part Number	Size	G	H	M	Approx. Wt. (Lbs.)
406-025LSF	2-1/2	5-7/16	7-7/16	3-1/4	1.26
406-030LSF	3	6-5/8	8-5/8	3-15/16	1.87
406-040LSF	4	8-3/8	10-5/8	5	2.69
406-060LSF	6	12-5/8	15-7/8	7-3/16	6.92
406-080LSF	8	22-9/16	26-13/16	9-1/4	19.43

90° ELBOW

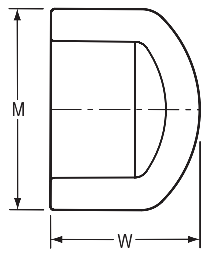
Socket x SR Fipt



Part Number		Size	G	G1	H	H1	M	Approx. Wt. (Lbs.)
407-005	407-005SR	1/2	1/2	9/16	1-1/4	1-1/4	1-1/16	.06
407-007	407-007SR	3/4	9/16	17/32	1-9/16	1-9/32	1-5/16	.08
407-010	---	1	11/16	21/32	1-13/16	1-9/16	1-5/8	.14
407-012	---	1-1/4	15/16	1-1/4	2-1/4	2-1/4	2	.25
407-015	---	1-1/2	1	1-1/16	2-5/16	2	2-1/4	.25
407-020	---	2	1-3/16	1-5/16	2-3/8	2-3/8	2-23/32	.46
407-025	---	2-1/2	1-1/2	1-1/2	3-1/2	3-1/16	3-5/16	.94
407-030	---	3	1-13/16	1-31/32	3-11/16	3-21/32	4	1.14
407-040	---	4	2-5/16	2-15/32	4-5/16	3-15/16	5-1/16	1.85

PVC WHITE SCHEDULE 40 FITTINGS
UNIONS & SADDLES

CAP
Socket



Part Number	Size	M	W	Approx. Wt. (Lbs.)
447-003	3/8	7/8	1	.01
447-005	1/2	1-3/32	1-1/32	.02
447-007	3/4	1-5/16	1-5/16	.04
447-010	1	1-9/16	1-9/16	.06
447-012	1-1/4	1-31/32	1-3/4	.09
447-015	1-1/2	2-1/4	1-7/8	.11
447-020	2	2-23/32	2-1/32	.17
447-025	2-1/2	3-5/16	2-9/16	.33
447-030	3	4	2-29/32	.49
447-040	4	5-1/16	3-1/8	.85
447-045F	4-1/2	5-1/4	3-1/4	.31
447-050	5	6-5/32	4-1/2	1.43
447-060	6	7-1/4	5	2.36
447-080	8	9-5/16	6-3/8	4.35
447-100F	10	11-13/16	5-1/4	5.22
447-120F	12	13-7/8	6-3/4	8.22
447-140F	14	15	7-3/8	8.75
447-160F	16	17	9	12.15
447-180F	18	19-1/16	9	17.58
447-200F	20	21-3/16	12-1/4	26.48
447-240F	24	25-1/2	13-1/2	40.26

Made in the U.S.A.

SPEARS®

THERMOPLASTIC FLANGES

MADE IN THE U.S.A. WITH PRIDE

TECHNICAL INFORMATION WEIGHTS & DIMENSIONS

January 1, 2009

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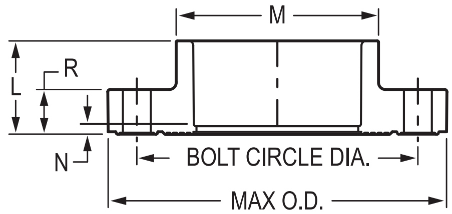
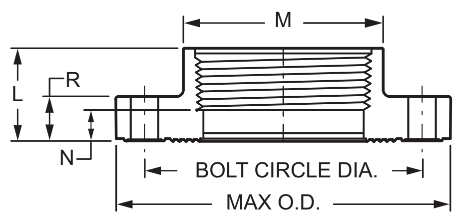
F O P
Socket



P N		S		M	N	R	C	N	S	M	M O	A	
P C	CP C											P C	CP C
851-005	851-005C	1/2	1-1/16	1-9/32	1/8	9/16	2-3/8	4	1/2	2	3-1/2	.22	.24
851-007	851-007C	3/4	1-3/16	1-1/2	1/8	5/8	2-3/4	4	1/2	2	3-7/8	.31	.31
851-010	851-010C	1	1-5/16	1-13/16	3/16	3/4	3-1/8	4	1/2	2-1/4	4-1/4	.44	.47
851-012	851-012C	1-1/4	1-7/16	2-7/32	3/16	23/32	3-1/2	4	1/2	2-1/4	4-5/8	.41	.42
851-015	851-015C	1-1/2	1-23/32	2-1/2	1/4	3/4	3-7/8	4	1/2	2-1/2	5	.61	.64
851-020	851-020C	2	1-27/32	3	3/8	13/16	4-3/4	4	5/8	3	6	.82	.95
851-025	851-025C	2-1/2	2-1/4	3-1/2	1/2	1	5-1/2	4	5/8	3-1/4	7	1.63	1.67
851-030	851-030C	3	2-5/16	4-9/32	15/32	1-1/16	6	4	5/8	3-1/4	7-1/2	1.73	1.83
851-040	851-040C	4	2-5/8	5-7/16	1/4	1-1/4	7-1/2	8	5/8	3-1/2	9	2.88	3.00
851-050	851-050C	5	3-1/4	6-3/8	1/4	1	8-1/2	8	3/4	3-3/4	10-1/8	3.00	3.17
851-060	851-060C	6	3-1/4	7-9/16	1/4	1-3/8	9-1/2	8	3/4	4	11	4.06	4.34
851-080	851-080C	8	4-9/16	9-3/4	9/16	1-7/16	11-3/4	8	3/4	4-1/2	13-1/2	7.63	7.36

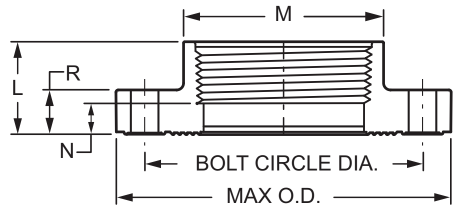
F O P
Fipt



P N		S		M	N	R	C	N	S	M	M O	A	
P C	CP C											P C	CP C
852-005	852-005C	1/2	1-1/16	1-5/16	9/32	9/16	2-3/8	4	1/2	2	3-1/2	.21	.22
852-007	852-007C	3/4	1-3/16	1-17/32	15/32	5/8	2-3/4	4	1/2	2	3-7/8	.30	.32
852-010	852-010C	1	1-5/16	1-13/16	7/16	3/4	3-1/8	4	1/2	2-1/4	4-1/4	.41	.48
852-012	852-012C	1-1/4	1-3/8	2-7/32	17/32	23/32	3-1/2	4	1/2	2-1/4	4-5/8	.44	.46
852-015	852-015C	1-1/2	1-3/4	2-1/2	19/32	3/4	3-7/8	4	1/2	2-1/2	5	.64	.74

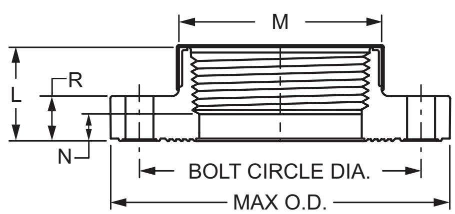
PVC & CPVC INJECTION MOLDED CLASS 150 FLANGES

F O P **(continued)**
Fipt



P N		S		M	N	R	C	N	S	M	M O	A	
P C	CP C											P C	CP C
852-020	852-020C	2	1-27/32	3	7/8	7/8	4-3/4	4	5/8	3	6	.96	1.00
852-025	852-025C	2-1/2	2-1/4	3-1/2	15/16	1	5-1/2	4	5/8	3-1/4	7	1.65	1.41
852-030	852-030C	3	2-5/16	4-9/32	29/32	1-1/16	6	4	5/8	3-1/4	7-1/2	1.83	1.86
852-040	852-040C	4	2-1/16	5-7/16	5/16	1-1/4	7-1/2	8	5/8	3-1/2	9	2.79	2.86
852-060F	852-060CF	6	7	7-1/4	5-1/2	1-1/4	9-1/2	8	3/4	4	11	7.16	7.69
852-080F	852-080CF	8	8-15/16	9-11/16	7-3/16	1-3/8	11-3/4	8	3/4	4-1/2	13-1/2	13.41	13.92
852-100F	852-100CF	10	10-1/2	11-9/16	8-9/16	1-11/16	14-1/4	12	7/8	5	16	20.65	20.72

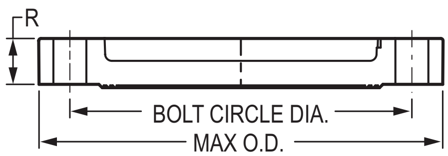
S R
F O P
SR Fipt



P N		S		M	N	R	C	N	S	M	M O	A	
P C	CP C											P C	CP C
852-005SR	852-005CSR	1/2	1-3/32	1-7/32	11/32	9/16	2-3/8	4	1/2	2	3-1/2	.20	.22
852-007SR	852-007CSR	3/4	1-3/16	1-3/8	7/16	5/8	2-3/4	4	1/2	2	3-7/8	.27	.30
852-010SR	852-010CSR	1	1-7/16	1-23/32	17/32	21/32	3-1/8	4	1/2	2-1/4	4-1/4	.37	.39
852-012SR	852-012CSR	1-1/4	1-9/16	2-1/16	19/32	21/32	3-1/2	4	1/2	2-1/4	4-5/8	.49	.52
852-015SR	852-015CSR	1-1/2	1-3/4	2-7/16	3/4	3/4	3-7/8	4	1/2	2-1/2	5	.63	.67
852-020SR	852-020CSR	2	1-7/8	3-1/32	7/8	11/16	4-3/4	4	5/8	3	6	.99	1.06
852-025SR	852-025CSR	2-1/2	2-1/8	3-19/32	3/8	1	5-1/2	4	5/8	3-1/4	7	1.58	1.69
852-030SR	852-030CSR	3	2-5/16	4-9/32	15/16	1-1/16	6	4	5/8	3-1/4	7-1/2	1.79	1.94
852-040SR	852-040CSR	4	2-1/2	5-1/4	1	1-5/32	7-1/2	8	5/8	3-1/2	9	2.74	2.89

PVC & CPVC INJECTION MOLDED CLASS 150 FLANGES

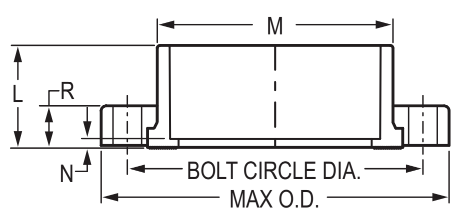
IN F ANGE



P N		S	R	C	N	S	M	M O	A	
P C	CP C								P C	CP C
853-005	853-005C	1/2	9/16	2-3/8	4	1/2	2	3-1/2	.21	.21
853-007	853-007C	3/4	5/8	2-3/4	4	1/2	2	3-7/8	.28	.30
853-010	853-010C	1	3/4	3-1/8	4	1/2	2-1/4	4-1/4	.41	.47
853-012	853-012C	1-1/4	23/32	3-1/2	4	1/2	2-1/4	4-5/8	.37	.40
853-015	853-015C	1-1/2	3/4	3-7/8	4	1/2	2-1/2	5	.62	.64
853-020	853-020C	2	13/16	4-3/4	4	5/8	3	5-15/16	.83	.88
853-025	853-025C	2-1/2	1	5-1/2	4	5/8	3-1/4	7	1.61	1.63
853-030	853-030C	3	1-1/16	6	4	5/8	3-1/4	7-5/8	1.56	1.64
853-040	853-040C	4	1-1/4	7-1/2	8	5/8	3-1/2	9	2.84	2.98
853-060	853-060C	6	1-3/8	9-1/2	8	3/4	4	11	4.36	4.45
853-080	853-080C	8	1-7/16	11-3/4	8	3/4	4-1/2	13-1/2	6.83	7.20
853-100	853-100C	10	1-11/16	14-1/4	12	7/8	5	16	11.32	11.80
853-120	853-120C	12	1-11/16	17	12	7/8	5	19	15.49	17.58

F S S

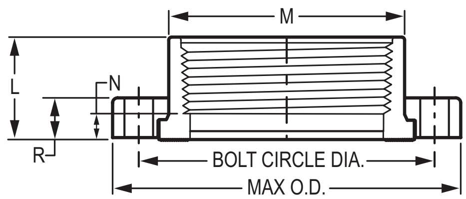
(Two Piece)
Socket



P N		S		M	N	R	C	N	S	M	M O	A	
P C	CP C											P C	CP C
854-005	854-005C	1/2	1-1/32	1-7/32	5/32	17/32	2-3/8	4	1/2	2	3-1/2	.19	.20
854-007	854-007C	3/4	1-1/8	1-7/16	5/32	9/16	2-3/4	4	1/2	2	3-7/8	.26	.27
854-010	854-010C	1	1-9/32	1-3/4	5/32	5/8	3-1/8	4	1/2	2-1/4	4-1/4	.36	.37
854-012	854-012C	1-1/4	1-13/32	2-5/32	5/32	11/16	3-1/2	4	1/2	2-1/4	4-5/8	.46	.45
854-015	854-015C	1-1/2	1-17/32	2-7/16	3/16	3/4	3-7/8	4	1/2	2-1/2	5	.56	.60
854-020	854-020C	2	1-11/16	2-15/16	3/16	13/16	4-3/4	4	5/8	3	6	.85	.91

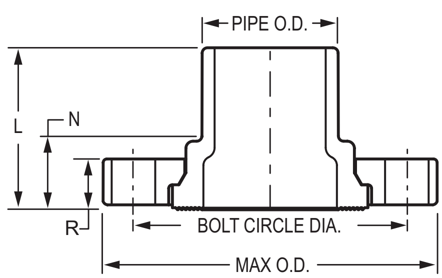
PVC & CPVC INJECTION MOLDED CLASS 150 FLANGES

F S S
(Two Piece)
Fipt



P N		S		M	N	R	C	N	S	M	M O	A	
P C	CP C											P C	CP C
855-005	855-005C	1/2	1-1/32	1-7/32	9/32	17/32	2-3/8	4	1/2	2	3-1/2	.19	.20
855-007	855-007C	3/4	1-5/32	1-3/8	13/32	9/16	2-3/4	4	1/2	2	3-7/8	.27	.28
855-010	855-010C	1	1-1/4	1-3/4	5/16	5/8	3-1/8	4	1/2	2-1/4	4-1/4	.36	.39
855-012	855-012C	1-1/4	1-3/8	2-1/8	13/32	11/16	3-1/2	4	1/2	2-1/4	4-5/8	.46	.47
855-015	855-015C	1-1/2	1-15/32	2-7/16	13/32	3/4	3-7/8	4	1/2	2-1/2	5	.55	.61
855-020	855-020C	2	1-9/16	2-31/32	1/2	13/16	4-3/4	4	5/8	3	6	.87	.94
855-025	855-025C	2-1/2	2	3-9/16	7/16	1	5-1/2	4	5/8	3-1/4	7	1.22	1.50
855-030	855-030C	3	2-1/8	4-1/4	1/2	1-1/16	6	4	5/8	3-1/4	7-1/2	1.73	1.79
855-040	855-040C	4	2-1/16	5-1/4	3/8	1-1/4	7-1/2	8	5/8	3-1/2	9	2.61	2.78
855-060F	855-060CF	6	7	7-1/4	5-1/2	1-1/4	9-1/2	8	3/4	4	11	7.62	7.69
855-080F	855-080CF	8	8-15/16	9-11/16	7-3/16	1-3/8	11-3/4	8	3/4	4-1/2	13-1/2	12.84	13.92
855-100F	855-100CF	10	10-1/2	11-9/16	8-9/16	1-11/16	14-1/4	12	7/8	5	16	20.65	20.72

F S S
(Two Piece)
Spigot

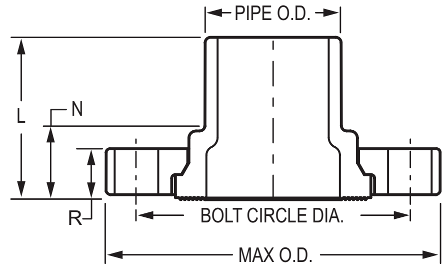


P N		S		N	R	C	N	S	M	M O	A	
P C	CP C										P C	CP C
856-005	856-005C	1/2	1-3/4	29/32	17/32	2-3/8	4	1/2	2	3-1/2	.20	.21
856-007	856-007C	3/4	1-15/16	31/32	9/16	2-3/4	4	1/2	2	3-7/8	.29	.30
856-010	856-010C	1	2-3/16	1-1/32	5/8	3-1/8	4	1/2	2-1/4	4-1/4	.39	.41
856-012	856-012C	1-1/4	2-11/32	1-3/32	11/16	3-1/2	4	1/2	2-1/4	4-5/8	.50	.50

PVC & CPVC INJECTION MOLDED CLASS 150 FLANGES

F S S **(continued)**

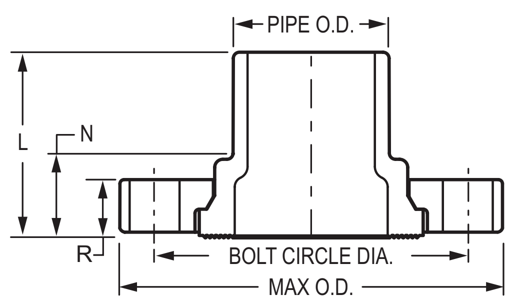
(Two Piece)
Spigot



P N		S		N	R	C	N	S	M	M O	A	
P C	CP C										P C	CP C
856-015	856-015C	1-1/2	2-5/8	1-9/32	3/4	3-7/8	4	1/2	2-1/2	5	.60	.65
856-020	856-020C	2	2-7/8	1-11/32	13/16	4-3/4	4	5/8	3	6	.94	1.00
856-025	856-025C	2-1/2	3-1/16	1-9/32	1	5-1/2	4	5/8	3-1/4	7	1.29	1.54
856-030	856-030C	3	3-3/8	1-7/16	1-1/16	6	4	5/8	3-1/4	7-1/2	1.82	1.88
856-040	856-040C	4	3-7/8	1-5/8	1-1/4	7-1/2	8	5/8	3-1/2	9	2.93	3.12
856-060	856-060C	6	4-3/4	1-25/32	1-9/32	9-1/2	8	3/4	4	11	4.62	4.79
856-080	856-080C	8	5-7/8	1-15/16	1-3/8	11-3/4	8	3/4	4-1/2	13-1/2	7.95	8.17
856-100	856-100C	10	8	2-1/4	1-5/8	14-1/4	12	7/8	5	16	15.61	16.09
856-120	856-120C	12	8-1/2	2-3/16	1-5/8	17	12	7/8	5	19	21.31	22.70

F S S
with Multi-Bolt Pattern Ring

(Two Piece)
Spigot



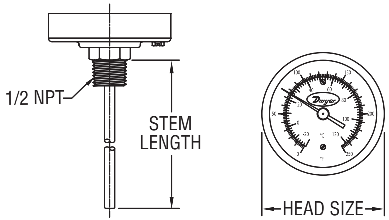
P N		S		N	R	C		N	S	M O	A	
P C	CP C					M	M				P C	CP C
M856-020	M856-020C	2	2-7/8	1-11/32	13/16	4-1/2	4-15/16	4	5/8	6	.94	1.00
M856-030	M856-030C	3	3-3/8	1-7/16	1-1/16	5-13/16	6-11/32	8	5/8	7-1/2	1.82	1.96
M856-040	M856-040C	4	3-7/8	1-5/8	1-1/4	7-3/32	7-1/2	8	5/8	9	2.98	3.24
M856-060	M856-060C	6	4-3/4	1-25/32	1-9/32	9-7/32	9-1/2	8	3/4	11	4.77	5.21
M856-080	M856-080C	8	5-7/8	1-15/16	1-3/8	11-1/2	11-3/4	8	3/4	13-1/2	7.95	8.32

Dwyer®

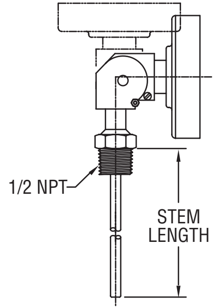
BIMETAL THERMOMETER

2″, 3″ or 5″ Dial, Dual Scale, ±1% FS Accuracy, External Reset

Scan here to watch product video



Back Connection



Adjustable Angle Connection

The **SERIES BT** Bimetal Thermometers offer accurate, reliable service even in the toughest environments. These corrosion resistant units are constructed from stainless steel and are hermetically sealed to prevent crystal fogging.

FEATURES/BENEFITS
- Hermetically sealed
- Adjustable dial position models

APPLICATIONS
- Chiller or boiler water temperature monitoring
- Treatment plant temperature monitoring

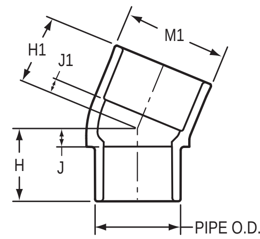
SPECIFICATIONS
Wetted Materials: 304 SS.
Housing Material: Series 300 SS.
Lens: Glass.
Accuracy: ±1% full-scale.
Response Time: ≤ 40 seconds.
Temperature Limits: Head: 200°F (93°C); Stem: Not to exceed 50% over-range or 1000°F (538°C) or 800°F (427°C) continuously.
Process Connection: 1/4″ NPT on 2″ dial size; 1/2″ NPT on 3″ or 5″ dial size.
Stem Diameter: 1/4″ OD.
Immersion Depth: Minimum 2″ in liquids, 4″ in gas.

MODEL CHART

Model	Dial Size	Stem Length	Connection	Range °F (°C)	Degree Div °F (°C)	Model	Dial Size	Stem Length	Connection	Range °F (°C)	Degree Div °F (°C)
BTB22551*	2″	2-1/2″	Back	0 to 250	2	**BTB3605D**	3″	6″	Back	0 to 250 (-20 to 120)	2 (2)
BTB2405D	2″	4″	Back	0 to 250 (-20 to 120)	2 (2)	**BTA54010D**	5″	4″	Adjustable	0 to 200 (-20 to 100)	2 (2)
BTB2409D	2″	4″	Back	200 to 1000 (100 to 550)	10 (5)	**BTA5405D**	5″	4″	Adjustable	0 to 250 (-20 to 120)	2 (2)
BTB32510D	3″	2-1/2″	Back	0 to 200 (-20 to 100)	2 (2)	**BTA5407D**	5″	4″	Adjustable	50 to 550 (10 to 290)	5 (5)
BTB3255D	3″	2-1/2″	Back	0 to 250 (-20 to 120)	2 (2)	**BTA56010D**	5″	6″	Adjustable	0 to 200 (-20 to 100)	2 (2)
BTB3257D	3″	2-1/2″	Back	50 to 550 (10 to 290)	5 (5)	**BTA5605D**	5″	6″	Adjustable	0 to 250 (-20 to 120)	2 (2)
BTB34010D	3″	4″	Back	0 to 200 (-20 to100)	2 (2)	**BTA5607D**	5″	6″	Adjustable	50 to 550 (10 to 290)	5 (5)
BTB3405D	3″	4″	Back	0 to 250 (-20 to 120)	2 (2)	**BTC3255D**	3″	2-1/2″	Lower	0 to 250 (-20 to 120)	2 (2)
BTB3407D	3″	4″	Back	50 to 550 (10 to 290)	5 (5)						

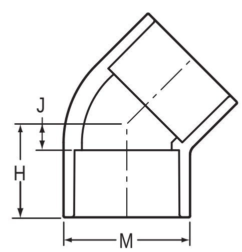
*Model offered in Fahrenheit scale only.

22-1/2° STREET ELBOW
Spigot x Socket



Part Number	Size	H	H1	J	J1	M1	Approx. Wt. (Lbs.)
442-005	1/2	1-1/16	1	1/4	1/4	1-5/32	.05
442-010	1	1-15/32	1-3/8	11/32	9/32	1-11/16	.13
442-012	1-1/4	1-1/2	1-3/8	3/16	1-11/16	2-1/16	.20
442-015	1-1/2	1-7/8	1-11/16	15/32	11/32	2-5/16	.26
442-020	2	1-15/16	1-19/32	9/16	1/4	2-7/8	.39
442-025F	2-1/2	4-1/8	2-3/4	1-3/4	3/4	3-1/4	.81
442-030	3	2-1/2	2-5/16	21/32	7/16	4-5/32	.95
442-040	4	4-3/8	2-7/8	1-7/8	5/8	5-1/4	2.14
442-060	6	5-11/16	3-15/16	2-3/8	7/8	7-5/8	5.87
442-080	8	7-3/8	5-1/8	3-1/8	1-1/8	9-3/4	11.34

45° ELBOW
Socket x Socket



Part Number	Size	H	J	M	Approx. Wt. (Lbs.)
417-005	1/2	1	7/32	1-1/8	.04
417-007	3/4	1-1/4	5/16	1-5/16	.06
417-010	1	1-3/8	5/16	1-5/8	.10
417-012	1-1/4	1-5/8	3/8	1-31/32	.14
417-015	1-1/2	1-3/4	7/16	2-7/32	.19
417-020	2	2	5/8	2-3/4	.30
417-025	2-1/2	2-7/16	11/16	3-11/32	.56
417-030	3	2-27/32	27/32	4	.80
417-040	4	3-3/32	1-3/32	5-1/32	1.22
417-045F	4-1/2	4-3/8	1-7/8	5-1/2	1.59
417-050	5	4-3/8	1-3/8	6-1/16	2.41
417-060	6	5-7/8	1-13/16	7-5/16	3.45
417-080	8	6-7/16	2	9-9/32	6.56
417-100	10	8-1/8	3-1/8	11-1/2	20.72

ENERGY AND COMFORT

Ventilation Test Instruments

Model 9545

Features and Benefits

- Simple to operate
- Accurate air velocity measurement
- Simultaneously measure temperature and velocity
- Displays up to three measurements simultaneously
- Measures humidity (Model 9545 and 9545-A)
- Calculates volumetric flow and actual/standard velocity
- Data log 12,700+ samples and 100 test IDs
- LogDat2™ downloading software included
- Articulated probe versions available (9535-A and 9545-A)

Applications

- HVAC system performance
- Commissioning
- Plant maintenance
- Critical environment certification
- Duct traverses

VelociCalc® Air Velocity Meters

Models 9535, 9535-A, 9545 and 9545-A

The Models 9535 and 9545 air velocity meters are like having multiple meters—for the price of just one. These meters simultaneously measure and data log several ventilation parameters using a single probe with multiple sensors. Both models measure velocity, temperature and calculate flow. The Model 9545 also measures relative humidity, and calculates dew point, and wet bulb temperature. Models 9535 and 9545 have telescopic straight probes; Models 9535-A and 9545-A have telescopic articulated probes.

TRUST. SCIENCE. INNOVATION.

Specifications

VelociCalc Models 9535 and 9545

Velocity

Range 0 to 6,000 ft/min (0 to 30 m/s)
Accuracy[1&2] ±3% of reading or ±3 ft/min (±0.015 m/s), whichever is greater
Resolution 1 ft/min (0.01 m/s)

Duct Size

Dimensions 1 to 250 inches in increments of 0.1 in. (1 to 635 cm in increments of 0.1 cm)

Volumetric Flow Rate

Range Actual range is a function of velocity and duct size

Temperature

Range (9535 and 9535-A) 0 to 200 °F (-18 to 93°C)
Range (9545 and 9545-A) 14 to 140°F (-10 to 60°C)
Accuracy[3] ±0.5°F (±0.3°C)
Resolution 0.1°F (0.1°C)

Relative Humidity (9545 only)

Range 0 to 95% RH
Accuracy[4] ±3% RH
Range 0.1% RH

Instrument Temperature Range

Operating (Electronics) 40 to 113°F (5 to 45°C)
Model 9535 Operating (Probe) 0 to 200°F (-18 to 93°C)
Model 9545 Operating (Probe) 14 to 140°F (-10 to 60°C)
Storage -4 to 140°F (-20 to 60°C)

Data Storage Capabilities

Range 12,700+ samples and 100 test IDs

Logging Interval

1 second to 1 hour

Time Constant

User selectable

External Meter Dimensions

3.3 in. x 7.0 in. x 1.8 in. (8.4 cm x 17.8 cm x 4.4 cm)

Meter Weight with Batteries

0.6 lbs. (0.27 kg)

Meter Probe Dimensions

Probe Length 40 in. (101.6 cm)
Probe Diameter of Tip 0.28 in. (7.0 mm)
Probe Diameter of Base 0.51 in. (13.0 mm)

Articulating Probe Dimensions

Articulating Section Length 7.8 in. (19.7 cm)
Diameter of Articulating Knuckle 0.38 in. (9.5 mm)

Power Requirements

Four AA-size batteries or AC adapter

	9535, 9535-A	9545, 9545-A
Velocity	●	●
Temperature	●	●
Flow	●	●
Humidity, wet bulb, dew point		●
Probe	Straight or -A articulated	Straight or -A articulated
Variable time constant	●	●
Manual data logging	●	●
Auto save data logging		●
Statistics	●	●
Review data	●	●
LogDat2 downloading software	●	●
Certificate of Calibration	●	●

[1] Temperature compensated over an air temperature range of 40 to 150°F (5 to 65°C).
[2] The accuracy statement begins at 30 ft/min through 6,000 ft/min (0.15 m/s through 30 m/s).
[3] Accuracy with instrument case at 77°F (25°C), add uncertainty of 0.05°F/°F (0.03°C/°C) for change in instrument temperature.
[4] Accuracy with probe at 77°F (25°C). Add uncertainty of 0.1% RH/°F (0.2% RH/°C) for change in probe temperature. Includes 1% hysteresis.

Specifications are subject to change without notice.

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P/N 2980569 Rev A Printed in U.S.A.

Series LPG3 Low Pressure Gage

1.6% FS Accuracy in a 2-1/2" Gage

Series LPG3 Low Pressure Gages are designed to be especially sensitive with an elastic element that expands and contracts with very small changes in pressure for ASME Grade A accuracy. This series is meant for the measurement of low pressures of gases and liquids and is ideal for air flow indicators, liquid level indicators and draft gages. Our new low pressure gages are available in 2-1/2" dial with either a bottom or back connection option.

California Residents: Click Here for Proposition 65 WARNING.

Specifications

Service:	Compatible gases and liquids.
Wetted Materials:	Brass.
Housing Materials:	Steel with black finish.
Lens:	Polycarbonate.
Accuracy:	1.6 % FS. ANSI B40.1 Grade 1A.
Pressure Limit:	110%.
Temperature Limits:	-40 to 150°F (-40 to 65°C).
Size:	2-1/2" (63 mm)
Process Connections:	1/4" NPT, bottom or back.
Weight:	6.5 oz (184 g).

Differential pressure switch for air, flue and exhaust gases

AA-A2...

DUNGS®

UL Listed
- UL 353
- File # MH 16628

CSA Certified
- CSA C22.2 No. LR 53222
- Certification # 201527

FM Approved
- Class 3510, 3530
- File # J.I. 1T7A8.AF

European models tested to EN1854 per Gas Appliance Directive 90/396/ EEC and per Pressure Equipment Directive 97/23/EC.

DUNGS is an ISO 9001 manufacturing facility.

Description

AA-A2... differential pressure switches are field adjustable, compact pressure switches for automatic burner controls. Available with hose or NPT threaded connections.

AA-A2-4... differential pressure switches are suitable for making and/or breaking a circuit when the medium pressure changes relative to the set point. AA-A2-4... versions feature hose connections.

AA-A2-6... differential pressure switches are suitable for making and/or breaking a circuit when the medium pressure changes relative to the set point. AA-A2-6... versions feature NPT threaded connections that also include a test button in the lower housing.

Application

Differential pressure monitoring in firing, ventilation and air-conditioning systems. The AA-A2... can be used as a pressure, vacuum or differential pressure switch for air and non-aggressive gases. Not suitable for natural gas, propane, butane and other combustable gases.

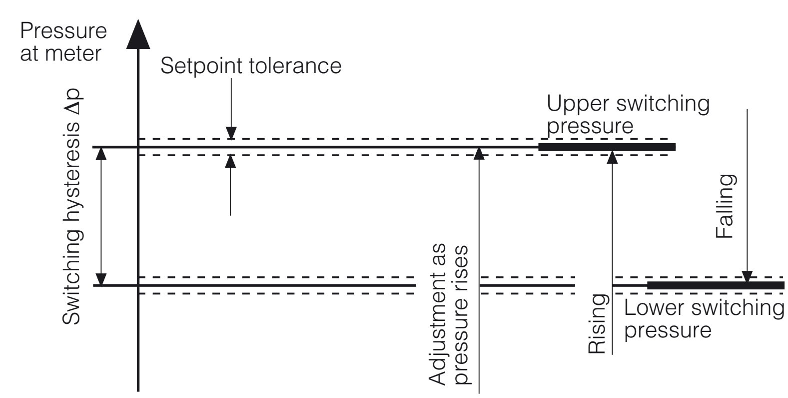
Printed in Germany • Rösler Druck • Edition 10.02 • Nr. 226 358

AA-A2… SPDT differential pressure switch in pressure and vacuum ranges. The differential pressure acts via the diaphragm against the force of the setting spring on the microswitch. The pressure switch operates without any auxiliary power

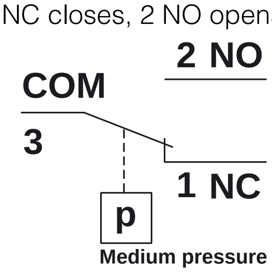
Specifications	AA-A2-4… Hose connection	AA-A2-6… Threaded connection
Max. operating pressure	7 PSI (500 mbar)	
Pressure connection	5/32" (4.6 mm) dia. positive 5/32" (4.6 mm) dia. negative	1/4" NPT positive 1/8" NPT negative 5/32" (4.6 mm) test connection
Temperature range	Ambient temperature Medium temperature	-40 °F to +140 °F (-40 °C to +60 °C) -40 °F to +140 °F (-40 °C to +60 °C)
Materials	Housing: Switch: Diaphragm: Switching contact:	Polycarbonate Polycarbonate NBR-based rubber Silver (Ag)
Electrical ratings	AC eff. DC	min. 24 V max. 250 V min. 24 V max. 48 V
Current ratings	AC 5 A resistive @ 120 VAC AC 2.5 A inductive @ 120 VAC DC min. 20 mA @ 24 VDC DC max. 1 A @ 48 VDC	
Electrical connection	Screw terminals via 1/2" NPT conduit connection	
Enclosure rating	NEMA Type 4	
Setting tolerance	± 15% switching point deviation referred to set point, adjusted as pressure rises, vertical diaphragm position	
Installation position	Multipoised	

⚠ **Installation position**
Standard installation position is **vertical** upright diaphragm. When installed **horizontally**, the pressure switch switches at a pressure higher by approx. 0.2 in. W.C. When installed **upside down**, the pressure switch switches at a pressure lower by approx. 0.2 in. W.C. When installed in **other positions**, the pressure switch switches at pressure deviating from the set reference value by max. ± 0.2 in. W.C.

Definition of switching hysteresis Δp
The pressure difference between the upper and lower switching pressures.



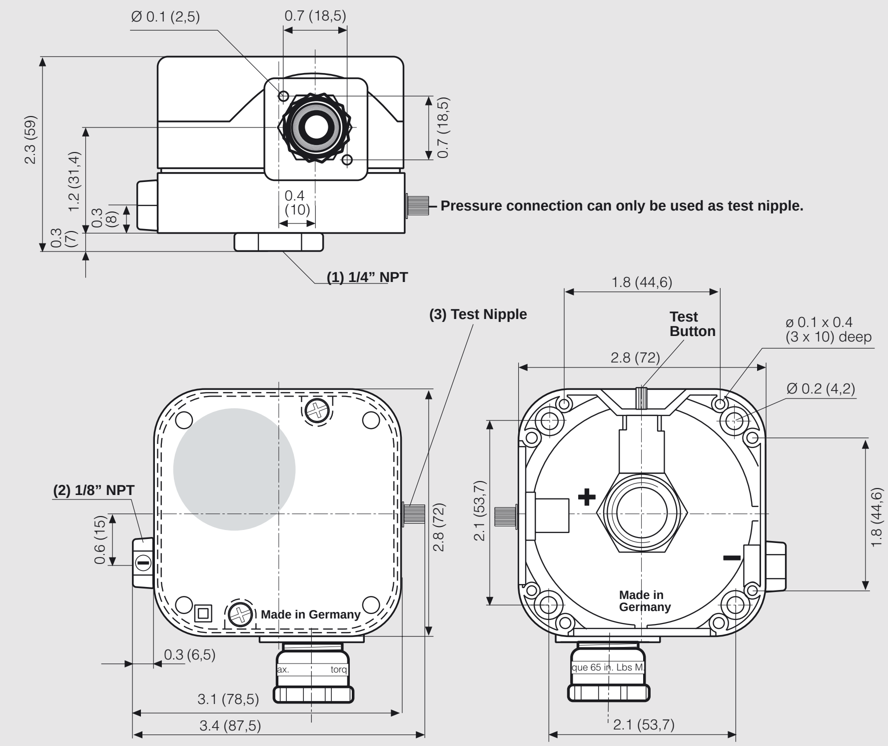
AA-A2… switching function
As pressure rises:
1 NC opens, 2 NO closes
As pressure falls:
1 NC closes, 2 NO opens



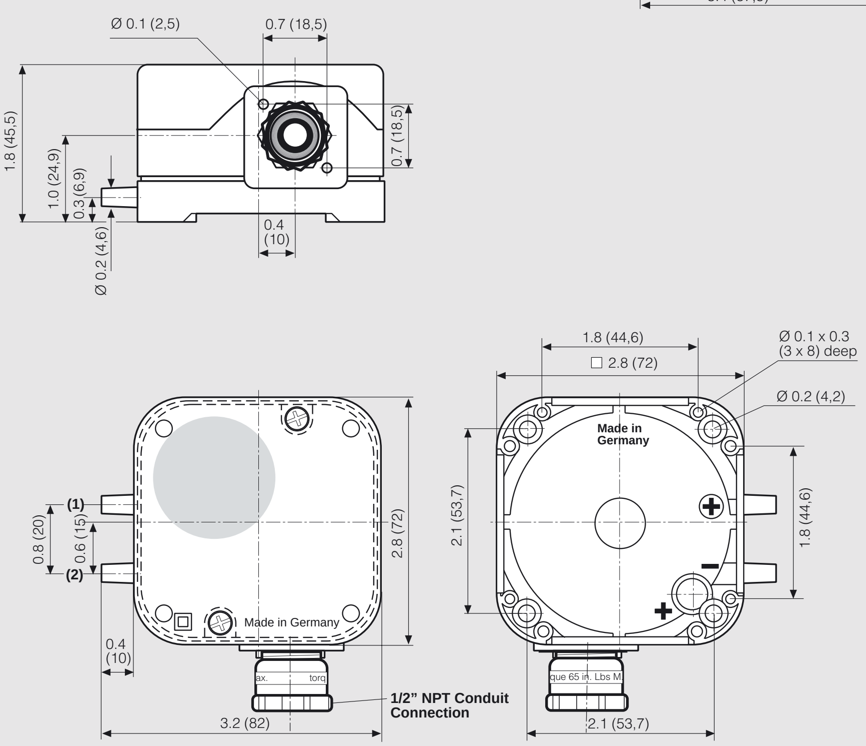
Dimensions inch (mm)

1 Pressure connection (+)
2 Pressure connection (–)
3 Test nipple p (+)

AA-A2-6… Threaded connection



AA-A2-4… hose connection



A2 test button

The AA-A2-6… threaded version is equipped with a test button.
When the test button is pressed, the connection to the **1/4" NPT** pressure connection is interrupted and the pressure below the diaphragm is relieved. The microswitch of the pressure switch changes the contact position from NO to NC. If the test button is released, the pressure below the diaphragm is built up again and the microswitch changes to its original position.

Differential pressure switch for air, flue and exhaust gases

AA-A2…

DUNGS®

Type	Version	Description	Order No.	Setting range In. W.C	Switching difference In. W.C.
AA-A2-4-...	AA-A2-4-2	Hose connection	46012-2	0.16 - 1.2"	≤ 0.12"
	AA-A2-4-3	Hose connection	46012-3	0.4 - 4"	≤ 0.20"
	AA-A2-4-5	Hose connection	46012-5	2 - 20"	≤ 0.40"
	AA-A2-4-6	Hose connection	46012-6	12 - 60"	≤ 1.20"
AA-A2-6-...	AA-A2-6-2	Threaded connection	46020-2	0.16 - 1.2"	≤ 0.12"
	AA-A2-6-3	Threaded connection	46020-3	0.4 - 4"	≤ 0.20"
	AA-A2-6-5	Threaded connection	46020-5	2 - 20"	≤ 0.40"
	AA-A2-6-6	Threaded connection	46020-6	12 - 60"	≤ 1.20"

Accessories for pressure switch	Order No.
Klima-Set (Duct mounting kit)	46000-5
Replacement cover	D228 732
Mounting bracket (metal)	D230 289
Mounting bracket (plastic)	D230 273
120 VAC light mounting set	D231 772
24 V light mounting set	D231 774
Replacement conduit adapter	46000-14
Electrical plug	D239 659
DIN connector	D210 318

We reserve the right to make any changes in the interest of technical progress.

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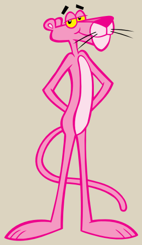
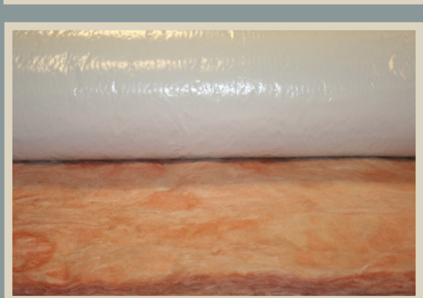


SoftR® Duct Wrap White PSK

Enhanced Product Now Available

The SoftR® Duct Wrap product line is providing consistent enhancements that will further meet your needs. Read below for details on SoftR® Duct Wrap with white PSK facing:



Features/Benefits:

- Light reflectance
- Professional appearance with white vinyl facing
- Excellent water vapor permanence
- Extremely resistant to water and inorganic chemical environments
- Easy to clean surface
- Highly resistant to deterioration by exposure to UV light
- Tough and highly resistant to damage such as punctures
- Dimensional stability helps resist wrinkling and sagging
- Durable to help resist environmental stress-cracking or yellowing

Uses:

- External insulation on heating and air conditioning ducts
- Surfaces where temperature or condensation needs to be controlled.
- Professional appearance makes it suited for exposed applications, boiler and equipment rooms, and high humidity applications.
- Offered in R4.2, R6 and R8 in either 4' or 5' wide rolls.

This isn't all. We will continue bringing you new and innovative products.

Look what's coming Next!

To learn more about Owens Corning™ SoftR® Duct Wrap go to www.owenscorningcommercial.com or call 1-800-GET-PINK®

Appendix D

Technical Specifications

Table of Contents

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SECTION 22 05 03.01

HIGH DENSITY POLYETHYLENE PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. HDPE pipe.
2. HDPE fittings.
3. HDPE burial.
4. HDPE joining.
5. HDPE testing.

B. Related Sections:
1. Section 31 23 17 - Trenching and Backfill

1.2 REFERENCES

A. ASTM International:
1. ASTM D1248 - Standard Specification for Polyethylene Molding and Extrusion Materials.
2. ASTM D2239 - Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameters.
3. ASTM D2122 - Determining Dimensions of Thermoplastic Pipe and Fittings.
4. ASTM D2241 - Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
5. ASTM D2447 - Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter.
6. ASTM D2513 - Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
7. ASTM D2609 - Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe.
8. ASTM D2657 - Standard Practice for Heat-Joining Polyolefin Pipe and Fittings.
9. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
10. ASTM D2774 - Underground Installation of Thermoplastic Pressure Piping.
11. ASTM D2837 - Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pressure Piping.
12. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
13. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fitting Materials.
14. ASTM F412 - Standard Terminology Relating to Plastic Piping System.

15. ASTM F1248 - Standard Test Method for Determination of Environmental Stress Crack Resistance (ESCR) of Polyethylene Pipe.

B. American Water Works Association:
   1. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, ½ in. through 3 in., for Water Service.

1.3 SUBMITTALS

A. Product Data: Submit data on pipe sizes, materials and fittings. Submit manufacturers catalog information.

1.4 QUALITY ASSURANCE

A. Manufacturer Quality Assurance:
   1. Manufacturer shall maintain a continuous quality control program.
   2. Material certification shall be included verifying that the materials have been tested for conformance with ASTM D3350 and that the pipe material has exceeded 5,000 hours without failure when tested under F1248.

B. HDPE pipe and fittings shall be provided from one approved manufacturer.

C. Maintain one copy of each document on site.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five years documented experience.

B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. All necessary precautions shall be taken to prevent damage or contamination to pipe and other materials during shipment and delivery.

B. All materials shall be securely fastened to truck or rail car to prevent movement or damage during shipment.

C. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

E. All pipe materials shall be handled in such a manner as to prevent damage. HDPE pipe shall not be dropped, rolled or pushed off from any height during delivery, storage or installation.

F. All pipe materials shall be stored off the ground in a dry location.

G. All pipe materials shall be stored in such a manner as to prevent sagging or bending.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 COORDINATION

A. Coordinate installation of buried piping with trenching.

PART 2 PRODUCTS

2.1 POLYETHYLENE PRODUCTS

A. Manufacturers:
   1. ISCO Industries.
   2. Polypipe, Inc.
   3. Performance Pipe, Inc.
   4. Substitutions: Permitted with the Engineer's approval.

B. Polyethylene Pipe: Pipe shall be provided in diameters, pressure classes, and dimension ratios (DR) as shown on the plans and in accordance with ASTM D3035. Also:
   1. HDPE pipe shall be manufactured from extra high molecular weight polyethylene pipe materials meeting the requirements of cell classification PE345464C Standard PE Code Designation PE3408 as defined by ASTM D3350.
   2. Fittings: AWWA C901, molded.
   3. Joints: Butt fusion by a qualified technician, trained by an approved manufacturer's representative, and in accordance with the manufacturer's recommended procedures.

C. Typical Material Physical Properties: All pipe and fitting materials shall meet these typical physical properties:

D. HDPE Fittings:
   1. The fittings shall be manufactured from the same cell class resin and fully pressure rated to the same pressure rating as the designed piping system.
   2. Shall have a controlled outside diameter and produced to the SDR/DR rating for the pressure specified by the Engineer.
   3. Shall be specifically manufactured to the standardized dimensions noted on the Drawings.

4. Where applicable, fittings shall meet the requirement of AWWA C901 or AWWA C906.
5. Butt fusion fittings shall be manufactured from the same material as the extruded pipe.
6. Shall be rated for the pressure service at least equal to that of the system pipe.
7. Shall have outlets manufactured to the same DR as that of system pipe.
8. Molded fittings shall be manufactured in accordance with ASTM D3261.
9. Socket fittings shall be manufactured in accordance with ASTM D2683.

2.2 UNDERGROUND PIPE MARKERS

A. Plastic Ribbon Tape: Bright colored, continuously printed, detectable metallic, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

B. Tracer wire:
   1. #12 AWG Copper Clad Steel, High Strength with minimum 450 lb. break load, with minimum 30 mil HDPE insulation thickness.
   2. HDPE insulation intended for direct bury, color coated per APWA standard for the specific utility being marked.

2.3 BEDDING AND COVER MATERIALS

A. Bedding, cover, and backfill shall be as specified in Sections 31 23 17 and as indicated on the Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Contractor shall inspect all piping to assure that the piping is free from defects in material and workmanship.

B. Compatibility of all pipe and fittings shall be verified.

C. Pipe, fittings and accessories that are cracked, damaged, not identified or in poor condition shall be rejected.

D. The Engineer shall have free access to all joints and test joints for determining the suitability of the joining process.

E. Where construction restrictions limit inspection of joints, the Engineer may have the person joining the pipe and or fittings perform a test joint in the presence of the Engineer.

F. The Engineer shall determine the method of testing either by visual examination or bent strap testing.

G. Verify excavations are to required grade, dry, and not over-excavated.

H. Verify trenches are ready to receive piping.

3.2 PREPARATION

A. Remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - BURIED PIPING SYSTEMS

A. Verify connection size, location, and inverts are as indicated on Drawings.

B. Joining
1. The pipe and fittings shall be heat fused creating a homogeneous joint.
2. Joining shall be in accordance with the manufacturer's heat fusion recommendations.
3. Joints shall not be of the solvent welded type.
4. Each person making heat fusion joints shall demonstrate proficiency by making joints and test the trial fusion by bent strap testing in accordance with ASTM D2657.
5. Trial joints shall be allowed to cool completely prior to testing and shall not fail at the joint.
6. During construction, at the Engineer's discretion, a trial fusion shall be made which shall then be allowed to cool and destructively bent strap tested.
7. If the trial fusion should fail, additional trial fusions shall be made and tested until successful fusions are completed.
8. The procedure used to join the trial fusion shall be used for the balance of the day's work, proved the procedure is within the limitations recommended by the manufacturer.
9. The Engineer shall have the authority to disallow any installer's from completing heat fusion of polyethylene pipe if that technician has consecutively failed trial joints.
10. Any person deemed unqualified by the Engineer will require training per Manufacturer's guidelines at the expense of the Contractor and training shall be documented and submitted to the Engineer.
11. The equipment used to make the heat fusion joint shall be capable of recording the heating and fusion pressures used to join the pipe, recording heater temperature, and storing this information for retrieval.
12. Each field fusion shall be recorded by such equipment and this information shall be made available to the Engineer's representative.

C. Excavate pipe trench in accordance with Section 31 23 17.

D. Install pipe as indicated on Drawings.

E. Install pipe to allow for expansion and contraction without stressing pipe or joints.

F. Install detectable plastic ribbon tape continuously 12 inches above pipeline; coordinate with Section 31 23 17.

3.4 BURIAL

A. All polyethylene pipe must be installed to minimize shear and tensile stresses.

B. Pipe shall be installed in a trench as specified in the construction drawings.

C. Minimum burial depth is specified in the Drawings.

D. The Contractor shall take care to insure haunching material is well placed as to not disturb the pipeline.

E. Final backfill material may consist of the excavated material as specified in the Drawings provided it is free of unsuitable matter, such as clumps of clay, stones, construction debris, and frozen clods of dirt, unless final backfill is under a roadway.

F. Final backfill material shall be compacted as shown on the Drawings. Proctor density shall be determined by ASTM D698 for compaction and density of soils.

G. All polyethylene pipe shall use warning tape and tracer wire for future location.

END OF SECTION

SECTION 22 05 03.02

PVC PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Pipe and pipe fittings for the following system:
   1. Multi-phase extraction system

B. Related Sections:
   1. Section 22 05 23 - General Duty Valves.
   2. Section 31 23 17 - Trenching and Backfill.

C. ASTM International:
   1. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
   2. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
   3. ASTM D2464 - Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
   4. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
   5. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.

1.2 SUBMITTALS

A. Product Data: Submit data on pipe sizes, materials and fittings. Submit manufacturers catalog information.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

B. Protect piping from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

1.5 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.6 COORDINATION

A. Coordinate installation of buried piping with trenching.

PART 2 PRODUCTS

2.1 PVC PRODUCTS

A. PVC Pipe: ASTM D1785, Schedule 40, polyvinyl chloride (PVC) material.
   1. Fittings:ASTM D2466, Schedule 40, PVC.
   2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2.2 UNDERGROUND PIPE MARKERS

A. Plastic Ribbon Tape: Bright colored, continuously printed, detectable metallic, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

B. Tracer wire:
   1. #12 AWG Copper Clad Steel, High Strength with minimum 450 lb. break load, with minimum 30 mil HDPE insulation thickness.
   2. HDPE insulation intended for direct bury, color coated per APWA standard for the specific utility being marked.

2.3 BEDDING AND COVER MATERIALS

A. Bedding, cover, and backfill shall be as specified in Section 31 23 17 and as indicated on the Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify excavations are to required grade, dry, and not over-excavated.

B. Verify trenches are ready to receive piping.

3.2 PREPARATION

A. Remove burrs.

B. Remove dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - BURIED PIPING SYSTEMS

A. Verify connection sizes, locations, and inverts are as indicated on Drawings.

B. Excavate pipe trench in accordance with Section 31 23 17.

C. Install pipe to promote water to drain toward the well by maintaining a minimum slope of 1%.

D. Pipes to be secured in place by Snap-Loc spacers and rebar as shown on the Drawings. Spacers shall be stacked no more than 2 high to minimize the width of the trench and the volume of soil required for excavation.

E. Install plastic ribbon tape continuously buried 12 inches, above pipe line; coordinate with Section 31 23 17.

F. Pipe Cover and Backfilling:
   1. Backfill trench in accordance with Section 31 23 17 and as indicated on the Drawings.

3.4 INSTALLATION - ABOVE GROUND PIPING

A. Route piping in orderly manner and maintain appropriate gradients. Route parallel and perpendicular to fences and equipment.

B. Install piping to maintain headroom without interfering with use of space or taking more space than necessary.

C. Group piping whenever practical at common elevations.

D. Sleeve pipe passing through partitions, walls and floors.

E. Provide clearance in hangers and from structure and other equipment for access to valves and fittings. Provide access where valves and fittings are not accessible.

F. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

G. Install valves in accordance with the manufacturer's instructions.

H. Insulate piping as shown in the Drawings.

END OF SECTION

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SECTION 22 05 19

GAUGES AND SENSORS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
  1. Analog dial-type vacuum gauges.

B. Accessories to be furnished and installed at the locations indicated on Drawings.

C. Allowances:
  1. Gauges and sensors shall be considered incidental.

1.2 REFERENCES

A. Except as modified or supplemented herein, all gauges shall conform to the requirements of:
  1. ANSI/ASME B40.100
  2. ANSI Grade 2A or better

1.3 SUBMITTALS

A. Shop Drawings: Required.

B. Product Data: Required.

C. Manufacturer's Installation Instructions: Required.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Required.

B. Operation and Maintenance Data: Required.

1.5 WARRANTY

A. Furnish manufacturer's warranty.

PART 2 PRODUCTS

2.1 VACUUM GAUGES

A. Manufacturers:

1. Dwyer Series SG3 Industrial Pressure Gauge.
2. Substitutions: Permitted with the Engineer's approval.

2.2 GAUGE AND SENSOR CONSTRUCTION:

A. Dwyer Series SG3
   1. Unless otherwise specified, gauges shall be indicating dial type with:
      a. Drawn steel housing.
      b. Polycarbonate lens.

2.3 OPERATION

A. The dial shall be 1.5 inches diameter with a white background and black markings.

B. The units of measurement shall be indicated on the dial face.

C. Subdivisions of scale shall conform to the requirements of the governing standard.

D. Point travel shall be not less than 200 degrees or more than 270 degrees.

E. Connection shall be 1/4 in. male NPT.

2.4 MOUNTING

A. The mounting configuration of each gauge shall be as indicated on the Drawings.

B. Connections
   1. As necessary, depending on the thickness class and size of the gauged pipe, a tap or saddle shall be located on the pipe, fitting or appurtenance to be gauged.
   2. The attachment shall be made by an appropriately sized NPT nipple in the tap or saddle.
   3. Nipples or elbows or combination thereof shall be long enough such that the edge of the gauge case does not contact the pipe; however, in no case shall the distance from the edge of the pipe to the centerline of the gauge exceed 6 inches without prior approval of the Engineer.

PART 3 EXECUTION

3.1 INSTALLATION

A. Gauges shall be installed at the locations indicated on the Drawings.

B. Gauges shall be installed per the manufacturer's guidelines and directions.

C. All gauges shall be installed in the vertical upright position, unless indicated otherwise in the Drawings.

D. Threaded connections shall be assembled using Teflon thread tap or Teflon thread sealer, as specified in the miscellaneous piping section.

3.2 FIELD QUALITY CONTROL

A. Test: Verify all gauge and sensor installations are free from leaks.

3.3 SCHEDULE

Gauge ID	Range	Manufacturer	Model	Count
VG-301	-30 to 0" Hg	Dwyer	SG3-B10121N	7

END OF SECTION

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SECTION 22 05 23

GENERAL DUTY VALVES

PART 1 GENERAL

1.1 SUMMARY

A. Furnish all labor, materials, equipment, and incidentals required to install valves necessary for the multi-phase extraction and treatment system, including but not limited to wells, piping, and equipment.

B. Section Includes:
   1. Gate valves.
   2. Ball valves.

1.2 REFERENCES

A. ASTM International:
   1. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

1.3 SUBMITTALS

A. Product Data: Submit manufacturers catalog information with valve data and ratings for each service.

B. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves.

B. Operation and Maintenance Data: Submit installation instructions, spare parts lists, exploded assembly views.

1.5 QUALITY ASSURANCE

A. Maintain one copy of each document on site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Do not install valves underground when bedding is wet or frozen.

1.8 WARRANTY

A. Furnish one year manufacturer warranty for valves excluding packing.

PART 2 PRODUCTS

2.1 GATE VALVES

A. Manufacturers:
   1. Aloyco, Model 110.
   2. Substitutions: Permitted with the Engineer's approval.

B. Stainless steel, Class 150 construction, flexible wedge disc, rising stem, threaded ends.

2.2 Ball Valves

A. Manufacturers:
   1. U.S. Plastic Corporation, Series 638
   2. Substitutions: Permitted with the Engineer's approval.

B. SCH 80 PVC, pressure class 125 psi at 73°F, max temperature 140°F, in compliance with ASTM F1970, FNPT dimensions ASTM D2467.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify piping system is ready for valve installation.

3.2 INSTALLATION

A. Install valves with stems upright or horizontal, not inverted, unless indicated otherwise on the Drawings.

B. Install valves with clearance for installation of insulation and allowing access.

C. Provide access where valves and fittings are not accessible.

3.3 VALVE APPLICATIONS

A. Install valves at locations indicated on the Drawings in accordance with this Section.

B. Install ball, butterfly, or gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.

C. Install ball, butterfly, or globe valves for throttling, bypass, or manual flow control services.

D. Install vertical ball check valves on discharge of condensate transfer pumps.

E. Install lug end butterfly valves adjacent to equipment when functioning to isolate equipment.

END OF SECTION

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SECTION 31 10 00

SITE CLEARING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Removing surface debris.
   2. Removing designated paving, curbs, and sidewalks.
   3. Removing designated trees, shrubs, and other plant life.
   4. Removing abandoned utilities.
   5. Excavating topsoil.

B. Related Sections:
   1. Section 31 23 17 - Trenching and Backfill

1.2 DEFINITIONS

A. Clearing: Clearing is the removal from the ground surface and disposal of trees, brush, shrubs, down timber, decayed wood, other vegetation, concrete, rubbish, and debris, as well as the removal of fences, stockpiled materials, and incidental structures.

B. Grubbing: Grubbing is the removal and disposal of all stumps, buried logs, roots, matted roots, and organic materials.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with applicable State of New Mexico Standard Specifications.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 DISPOSITION OF TREES AND SHRUBS

A. General
   1. Trees and shrubs within the limits of work shall be removed only where shown on the Drawings. Do not cut or damage trees unless so indicated or unless written permission has been obtained from the affected property owner.
   2. Removal of small trees and shrubs will be necessary for installation of the proposed infiltration gallery.

B. Trees and Shrubs To Be Removed

1. Trees and shrubs felled within the limits of work shall have their stumps grubbed and removed to a licensed disposal site. Depressions created by such removal shall be filled with suitable backfill and compacted to match properties of existing terrain.

3.2 CLEARING AND GRUBBING

A. Clear all items specified herein to the limits indicated or as directed by the ENGINEER and stockpile cleared and grubbed material onsite. Do not start earthwork operations in areas where clearing and grubbing is not complete, with the exception that stumps and large roots may be removed concurrent with excavation. Comply with erosion and sediment control and storm water management measures.

B. Clear and grub areas to be excavated, areas to receive fill, and areas upon which structures are to be constructed, as directed by the ENGINEER. Remove all trees, stumps, and root mats in these areas and dispose of them offsite at no cost to the property owner. Depressions made by the removal of stumps or roots shall be filled with suitable backfill.

C. The CONTRACTOR shall clear, grub, and strip the site area to the limits of disturbance shown on the Contract Drawings. Clearing and grubbing shall not be performed more than 60 days before excavation is to begin.

END OF SECTION

SECTION 31 23 17

TRENCHING AND BACKFILL

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. This Section shall be supplemental to 701 of the New Mexico Standard Specifications for Public Works Construction. Section 701 shall apply except as modified in this Section.

B. Related Sections:
   1. Section 22 05 03.01 - HDPE Pipe
   2. Section 22 05 03.02 - PVC Piping
   3. Section 31 10 00 - Site Clearing
   4. Section 31 23 24 - Flowable Fill

1.2 REFERENCES

A. New Mexico Standard Specifications for Public Works Construction:
   1. Section 701 - Trenching, Excavation and Backfill

1.3 DEFINITIONS

A. Utility: Any buried pipe, duct, conduit, or cable.

B. Trench Zone: The trench zone includes the portion of the trench from the top of the pipe zone to the existing surface.

C. Pipe Zone: The pipe zone shall include the full width of trench from the bottom of the pipe or conduit to a horizontal level 12 inches above the top of the pipe. Where multiple pipes or conduits are placed in the same trench, the pipe zone shall extend from the bottom of the lowest pipes to a horizontal level 12 inches above the top of the highest or topmost pipe.

D. Pipe Bedding: The pipe bedding shall be defined as a layer of material immediately below the bottom of the pipe or conduit and extending over the full trench width in which the pipe is bedded. Thickness of pipe bedding shall be as shown on the drawings or as described in these specifications.

E. Excess Excavated Material
   1. The Contractor shall make the necessary arrangements for and shall remove and dispose of all excess excavated material.
   2. No excavated material shall be deposited on private property unless written permission from the Engineer is secured by the Contractor.

1.4 TRENCH SAFETY

A. All excavations shall be performed, protected, and supported as required for safety. In all cases, Contractor shall ensure that all excavation and trenching methods meet or exceed safety requirements as set forth by local, state and federal agencies.

B. Barriers shall be placed at each end of all excavations and at such places as may be necessary along excavations to warn all traffic of such excavations.

C. No trench or excavation shall remain open and exposed to vehicular or foot traffic during non-working hours. The trench or excavation shall be fenced off, or covered with steel plates, spiked in place, or backfilled.

D. The Contractor shall notify the Engineer of all work-related accidents which may occur to persons or property at or near the project site, and shall provide the Engineer with a copy of all accident reports. All accident reports shall be signed by the Contractor or its authorized representative and submitted to the Engineer within twenty-four (24) hours of the accident's occurrence.

1.5 ACCESS

A. Unobstructed access must be provided to all driveways or other property or facilities that require routine use. Temporary closures of driveways will be required - timing of the closure must be coordinated with the Engineer and/or the Owner.

1.6 PERMITS

A. The Contractor shall keep a copy of all the required permits in the job site and comply with all the terms and conditions of said permits.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with applicable State of New Mexico Standard Specifications for Public Works Construction.

1.8 COORDINATION

A. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.

PART 2 PRODUCTS

2.1 FILL MATERIALS

A. Flowable Fill: Trenches in existing pavement to be backfilled with flowable fill per Specification 31 23 24 and the Drawings.

B. Native Backfill: Trenches in undisturbed ground can be backfilled with native soil in accordance with this specification.

C. The Contractor shall dispose of the excess trench excavation material as specified in the Section 1.3.E.

PART 3 EXECUTION

3.1 TRENCHING

A. Excavation for pipe, fittings, and appurtenances shall be open trench to the depth and in the direction necessary for the proper installation of the facilities as shown on the plans.

B. Trench banks shall be kept as near to vertical as possible and shall be properly braced and sheeted.

3.2 BRACING

A. The Contractor's design and installation of bracing and shoring shall be consistent with OSHA rules, orders, and regulations.

B. Excavations shall be so braced, sheeted, and supported that they will be safe such that the walls of the excavation will not slide or settle and all existing improvements of any kind, either on public or private property, will be fully protected from damage.

C. The sheeting, shoring, and bracing shall be arranged so as not to place any stress on portions of the completed work until the general construction thereof has proceeded far enough to provide ample strength.

D. Care shall be exercised in the drawing or removal of sheeting, shoring, bracing, and timbering to prevent the caving or collapse of the excavation faces being supported.

3.3 TRENCH WIDTHS

A. Excavation and trenching shall be true to line with a minimum width of the largest outside diameter of the pipe(s) and spacer(s) + 12 inches and a maximum width of the largest outside diameter of the pipe + 24 inches. Trench widths are diagramed on the Drawings.

3.4 LENGTH OF OPEN TRENCH

A. The maximum allowable length of open trench shall be the distance necessary to accommodate the amount of pipe installed in a single day. Open trench during non-working hours shall be fenced off, or covered with steel plates

3.5 GRADE

A. Excavate the trench to the lines and grades shown on the Drawings with allowance for pipe thickness and for pipe base or special bedding.

B. The trench bottom shall be graded to provide a smooth, firm, and stable foundation that is free from rocks and other obstructions and shall be at a reasonably uniform grade.

3.6 CORRECTION OF OVER EXCAVATION

A. Where excavation is inadvertently carried below the design trench depth, suitable provision shall be made by the Contractor to adjust the excavation, as directed by the Engineer, to meet requirements incurred by the deeper excavation.

B. Over excavations shall be corrected by backfilling with approved graded crushed rock or gravel and shall be compacted to provide a firm and unyielding subgrade or foundation, as directed by the Engineer.

3.7 FOUNDATION STABILIZATION

A. Whenever the trench bottom does not afford a sufficiently solid and stable base to support the pipe or appurtenances, the Contractor shall excavate to a depth below the design trench bottom, as directed by the Engineer, and the trench bottom shall be backfilled with 3/4-inch rock and compacted to provide uniform support and a firm foundation.

B. Where rock is encountered, it shall be removed to a depth at least 6 inches below the trench bottom and the trench shall be backfilled with 3/4-inch crushed rock or other suitable bedding material to provide uniform support and a firm foundation.

C. If excessively wet, soft, spongy, unstable, or similarly unsuitable material is encountered at the surface upon which the bedding material is to be placed, the unsuitable material shall removed to a depth as determined in the field by the Engineer and replaced by crushed rock to provide uniform support and a firm foundation.

3.8 PLACEMENT

A. Trenches in high traffic areas and adjacent to existing pavement: backfilled with flowable fill per Specification 31 23 24 Flowable Fill.

B. Trenches adjacent to native soil: backfilled with native soil in accordance with this specification.

3.9 EXCAVATED MATERIAL

A. All excavated material shall not be stockpiled in a manner that will create an unsafe work area or obstruct sidewalks or driveways.

B. In confined work areas, the Contractor may be required to stockpile the excavated material off-site, as determined by the Engineer.

C. Rock excavation is defined as boulders, sedimentary, or igneous rock that cannot be removed without continuous use of pneumatic tools or blasting.

D. Excavated material shall be disposed of at the Contractor's expense.

3.10 PLACING OF PIPE BEDDING

A. Place the thickness of pipe bedding material over the full width of trench necessary to produce the required bedding thickness when the material is compacted to the specified relative density. Native backfill in trenches installed through vacant land will be compacted to minimum 90 percent relative compaction as determined with a standard proctor (ASTM D 698). Grade the top of the pipe bedding ahead of the pipe to provide firm, uniform support along the full length of pipe.

3.11 BACKFILLING WITHIN PIPE ZONE

A. After pipe has been installed in the trench, place pipe zone material simultaneously on both sides of the pipe, keeping the level of backfill the same on each side. Carefully place the material around the pipe so that the pipe barrel is completely supported and that no voids or uncompacted areas are left beneath the pipe. Use particular care in placing material on the underside of the pipe to prevent lateral movement during subsequent backfilling.

3.12 BACKFILLING WITHIN TRENCH ZONE

A. Push the backfill material carefully onto the backfill previously placed in the pipe zone. Do not permit free fall of the material until at least 2 feet of cover is provided over the top of the pipe. Do not drop sharp, heavy pieces of material directly onto the pipe or the tamped material around the pipe.

B. The remaining portion of the trench to the street zone or ground surface, as the case may be, shall be backfilled, compacted and/or consolidated by approved methods to obtain the specified relative compaction.
   1. Compaction using vibratory equipment, tamping rollers, pneumatic tire rollers, or other mechanical tampers shall be done with the type and size of equipment necessary to accomplish the work. The backfill shall be placed in horizontal layers of not greater than 12-inches depth. Each layer shall be evenly spread, properly moistened, and compacted to the specified relative density as given on the drawings. The Contractor shall repair or replace any utility, pipe, fittings, manholes, or structures as directed by the Engineer damaged by the Contractor's operations.

3.13 REPLACEMENT OF ASPHALT CEMENT

A. Perform replacement of asphalt cement in accordance with New Mexico Standard Specifications for Public Works Construction, Section 701 and as specified on the Drawings.

END OF SECTION

SECTION 31 23 24

FLOWABLE FILL

PART 1 GENERAL

1.1 Summary

A. Section Includes:
   1. Flowable fill

B. Related Sections:
   1. Section 31 23 17 - Trenching and Backfill.

1.2 References

A. ASTM International:
   1. ASTM C33 - Standard Specification for Concrete Aggregates.
   2. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
   3. ASTM C150 - Standard Specification for Portland Cement.
   4. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
   5. ASTM C403/C403M - Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance.
   6. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.

1.3 Definitions

A. Utility: Any buried pipe, duct, conduit, manhole, tank, or cable.

B. Excavatable Flowable Fill: Lean cement concrete fill used where future excavation may be required such as fill for utility trenches, bridge abutments, and culverts.

C. Non-Excavatable Flowable Fill: Lean cement concrete fill used where future excavation is not anticipated such as fill below structure foundations and filling abandoned utilities.

1.4 Submittals

A. Mix Design:
   1. Submit flowable a fill mix design for each specified strength. Submit separate mix designs when admixtures are require for the following:
      a. Flowable fill work during hot and cold weather;
      b. Air entrained flowable fill work;
   2. Identify design mix ingredients, proportions, properties, admixtures, and tests.
   3. Compressive strength at 1 day and 7 days. Report compressive strength of each specimen and average specimen compressive strength.
   4. Submit test results to certify flowable fill mix design properties meet or exceed specified requirements.

B. Delivery Tickets:
1. Submit duplicate delivery tickets indicating actual materials delivered to Project site.

1.5 Environmental Requirements

A. Do not install flowable fill during inclement weather or when ambient temperature is less than 40°F.

1.6 Field Measurements

A. Verify field measurements before installing flowable fill to establish quantities required to complete the Work.

PART 2 PRODUCTS

2.1 Flowable Fill

A. Flowable Fill: Excavatable type.
1. Standard NMDOT flowable fill mix is preferred.

2.2 Materials

A. Portland Cement: ASTM C150 Type I/II - Normal/Moderate.

B. Fine Aggregates: ASTM C33.

C. Water: Clean and not detrimental to concrete.

2.3 Admixtures

A. Air Entrainment: ASTM C260.

2.4 Mixes

A. Mix and deliver flowable fill in accordance with ASTM C94/C94M, Option C.

B. Flowable Fill Design Mix:

Item	Excavatable
Cement Content	As specified by manufacturer
Fly Ash Content	As specified by manufacturer
Water Content	As specified by manufacturer
Air Entrainment	15–35 percent
28 Day Compressive Strength	Maximum 100 psi.
Unit Mass (Wet)	80–110 pcf
Temperature, Minimum at point of delivery	50°F

C. Provide water content in design mix to produce self-leveling, flowable fill material at time of placement.

D. Design mix air entrainment and unit mass are for laboratory design mix and source quality control only.

2.5 Source Quality Control

A. Test and analyze properties of flowable fill design mix and certify results for the following:
   1. Design mix proportions by weight of each material.
   2. Aggregate: ASTM C33 for material properties and gradation.
   3. Properties of plastic flowable fill design mix including:
      a. Temperature.
      b. Slump.
      c. Air entrainment.
      d. Wet unit mass.
      e. Yield.
      f. Cement factor.
   4. Properties of hardened flowable fill design mix including:
      a. Compressive strength at 1 day and 7 days. Report compressive strength of each specimen and average specimen compressive strength.
      b. Unit mass for each specimen and average specimen unit mass at time of compressive strength testing.

B. Prepare delivery tickets containing the following information:
   1. Project Designation.
   2. Date.
   3. Time.
   4. Class and Quantity of flowable fill.
   5. Actual batch proportions.
   6. Free moisture content of aggregate.
   7. Quantity of water withheld.

PART 3 EXECUTION

3.1 Examination

A. Verify trenching specified in Section 31 23 17 is complete.

B. Verify utility installation is complete and tested before placing flowable fill.

C. Verify excavation is dry.

3.2 Preparation

A. Support and restrain utilities and piping to prevent movement and flotation during installation of flowable fill as specified in the Drawings.

B. Protect structures and utilities from damage caused by hydraulic pressure of flowable fill before fill hardens.

C. Protect utilities to prevent intrusion of flowable fill.

3.3 Installation - Fill, Bedding, and Backfill

A. Place flowable fill in lifts to prevent lateral pressures from exceeding structural capacity of structures and utilities.

B. Place flowable fill evenly on both sides of utilities to maintain alignment.

C. Place flowable fill to elevations indicated on Drawings without vibration or other means of compaction.

3.4 Field Quality Control

A. Perform inspection and testing in accordance with ASTM C94/C94M.
   1. Take samples for tests for every 30 cubic yards of flowable fill, or fraction thereof, installed each day.
   2. Sample, prepare and test four compressive strength test cylinders in accordance with ASTM D4832. Test one specimen at 3 days, and one at 7 days.
   3. Measure temperature at point of delivery when samples are prepared.

B. Defective Flowable Fill: Fill failing to meet the following test requirements or fill delivered without the following documentation.
   1. Test Requirements:
      a. Minimum temperature at point of delivery.
      b. Compressive strength requirements for each type of fill.
   2. Documentation: Duplicate delivery tickets.

C. The Contractor may cover the flowable fill within 24 hours after placement if a person weighing at least 150 pounds stands on a 4-inch by 4-inch wooden block and does not sink in the material more than 1 inch.

3.5 Cleaning

A. Remove spilled and excess flowable fill from Project site.

B. Restore facilities and site areas damaged or contaminated by flowable fill installation to existing condition before installation and as directed by the Engineer.

END OF SECTION

SECTION 33 56 13

ABOVEGROUND HYDROCARBON STORAGE TANK

PART 1 GENERAL

1.1 SUMMARY

A. This specification covers a horizontal, double-walled, cylindrical tank. The tank is designed for aboveground, horizontal installation, and is capable of containing nonaqueous-phase liquid (NAPL) at atmospheric pressure. Extracted fluids (gasoline and diesel fuel) will be transferred to this tank from an oil-water separator

1.2 MATERIALS

A. The material used shall be welded steel.

1.3 DIMENSIONS AND TOLERANCES

A. All dimensions will be taken with the tank in the horizontal position, unfilled. Tank dimensions will represent the exterior measurements.

1.4 SUBMITTALS

A. Product Data: Submit complete information concerning materials of construction, fabrication, and fitting installation locations.

1.5 SCHEDULING

A. Schedule prior to connecting piping work.

1.6 COORDINATION

A. Coordinate work with location and placement of utilities.

PART 2 PRODUCTS

2.1 TANKS

A. Manufacturers:
   1. Kohlhaas Corporation
   2. Hughes Tank Company
   3. Willborn Tank and Fuel Systems
   4. Mills Equipment Company
   5. Substitutions: Permitted with approval of Engineer.

B. Product Description:
1. Welded steel tank 300-gallon double-walled tank.
2. Tank shall conform to the UL 142, Standard for Safety for Steel Aboveground Tanks for Flammable and Combustible Liquids
3. Tank shall have an enamel external finish
4. Check valve and isolation valve on product inlet
5. High/high and high level switches
6. Normal vent with riser pipe
7. Emergency vent

2.2 WORKMANSHIP

A. The finished tank wall shall be free, as practicable, of visual defects such as foreign inclusions, air bubbles, pinholes, pimples, crazing, cracking and delaminating that will impair the serviceability of the vessel.

B. All edges where openings are cut into the tanks shall be trimmed smooth.

2.3 THREADED BULKHEAD FITTINGS

A. Furnish threaded bulkhead fittings as required to connect tank to piping as indicated on the Drawings.

B. Openings are female national pipe thread (FPNT)

PART 3 EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. Inspect tanks for damage.

B. Store products in areas protected from weather, moisture, or possible damage; do not store products directly on ground; handle products to prevent damage to interior or exterior surfaces.

3.2 EXAMINATION

A. Verify layout and orientation of tank accessories and piping connections prior to placement.

3.3 INSTALLATION

A. Install NAPL storage tank as indicated on the Drawings and in accordance with manufacturer's instructions.

B. Connect piping to tank.

C. Install tank accessories not factory-mounted to complete installation.

3.4 Schedules

A. Storage Tank Schedule:

Stored Material	Tank Type & Number	Tank Dimensions (Nominal)	Tank Size (Capacity)
NAPL	T-1	38” dia. & 68” long	300 gallons

END OF SECTION

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SECTION 44 11 37

MULTI-PHASE EXTRACTION SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the equipment and installation of a multi-phase extraction (MPE) System.

B. Related Sections:

1. Section 22 05 03.01 - High Density Polyethylene Pipe
2. Section 22 05 03.02 - PVC Piping
3. Section 22 05 19 - Gauges and Sensors
4. Section 22 05 23 - General Duty Valves
5. Section 33 56 13 - Aboveground Hydrocarbon Storage Tanks

C. Acronym Definitions

1. scfm - standard cubic feet per minute
2. icfm - inlet cubic feet per minute
3. ppmv - parts per million by volume
4. VOC - volatile organic compound
5. TPH - total petroleum hydrocarbons
6. in. - inch
7. HP - horsepower
8. MPE - multi-phase extraction
9. VFD - variable frequency drive
10. gpm - gallons per minute
11. gpd - gallons per day
12. NAPL - nonaqueous-phase liquid
13. GAC - granular activated carbon
14. WC - water column
15. amsl – above mean sea level

1.2 PERFORMANCE REQUIREMENTS

A. The system shall remove up to 1,200 icfm of soil vapor at an applied well vacuum of 18.5 inches mercury at the site elevation of 7,500 feet amsl. Soil vapor will be treated using a conventional thermal oxidizer. The system shall have a minimum of 99% destruction efficiency of incoming soil vapor concentrations. Under no circumstances shall the discharge to the atmosphere, from all vapor streams, exceed the New Mexico Environment Department limits of 10 lbs/hr and 10 tons/year of a regulated air contaminant, using average hourly flow rates and data from laboratory samples collected and analyzed using standard EPA methods.

B. Approximately 1,500 gpd of extracted liquids (groundwater and NAPL) will be processed in batches of approximately 5 gpm. Emulsified fluids will be separated; petroleum hydrocarbons (NAPL) will be stored in an external 300-gallon storage tank. Extracted groundwater will be treated for petroleum hydrocarbons using diffused aeration, filtration (clarifier and bag filter), and GAC polishing before discharge. Treated water will gravity drain to an infiltration gallery south of the site.

C. The soil vapor and groundwater treatment equipment will be co-located within the same modified shipping container, complete with electrical, controls, and a cellular-based telemetry system.

1.3 SUBMITTALS

A. The Manufacturer shall submit the following:
1. Shop Drawings: Provide equipment dimensions, process connections, electrical diagrams, piping and instrumentation diagram, and all information necessary to relate the equipment to the specifications.
2. Product Data: Submit system performance, noise data, and removal rates for benzene and gasoline range organics.
3. Design Data: Provide basis of design to include flow rates and removal rates. Include calculations for removal rates.
4. Test Reports: Indicate flow rates, power consumption, and removal rate.
5. Manufacturer's Installation Instructions and Operation Manuals: Submit 1 copy of each equipment's installation instruction and operation manual
6. Manufacturer's Field Reports: Provide data from installed systems with removal rates, operating costs, and length of operation.

1.4 DELIVERY, STORAGE, AND HANDLING

A. The Contractor will be responsible for safe and timely transportation of all necessary equipment and appurtenances to the site. The Contractor's representative on site will inspect for damage and assumes the responsibility for any issues which may arise from equipment transportation.

B. The Contractor will be responsible for providing any equipment required for system unloading and temporary storage.

1.5 ENVIRONMENTAL REQUIREMENTS

A. All equipment supplied should be manufactured to perform in the anticipated weather conditions at the site, which may include low temperatures of -10°F and high temperatures of 100°F.

B. The equipment should be designed to operate at an elevation of 7,500 feet without adverse effect to performance and operation.

1.6 SCHEDULING

A. Schedule for construction, delivery, and startup to be coordinated with the Engineer. The Manufacturer is to provide the initial schedule and any changes.

1.7 COORDINATION

A. Coordinate work with the Engineer and other Contractors as required.

PART 2 PRODUCTS

2.1 MULTI-PHASE EXTRACTION EQUIPMENT

A. Suppliers:
1. H2K Technologies, Inc.
7550 Commerce St.
Corcoran, MN 55340
Phone: 1.763.746.9900
Fax: 1.7637469903
www.H2Ktech.com
2. Intellishare Environmental, Inc.
E4803 395th Avenue
Menomonie, WI 54751 USA
Contact: John Strey
Phone: 1.715.233.6115
Fax: 1.715.232.0669
www.intellishare-env.com

2.2 COMPONENTS

A. The MPE system shall consist of the following components:
1. An equipment enclosure containing claw vacuum pumps, a vapor-liquid separator, an oil/water separator, and water treatment equipment, including diffused tank aerators, clarifier, bag filters, and liquid GAC vessels.
2. Inlet manifold
   a. Located inside the container with seven connections.
   b. Each connection will possess an isolation valve, pressure gauge, and sample port.
3. A separate skid mounted thermal oxidizer with option to run in catalytic mode.
   a. Skids shall be constructed of a welded steel frame covered by a welded steel plate
   b. VOC removal efficiency shall be greater than 99%
4. A 300-gallon welded steel product (NAPL) storage tank outside of the equipment enclosure
5. Control panels and local instrumentation and controls with the ability to be remotely accessed
6. Interconnected process piping

7. Electrical power connections
8. Natural gas feed connections

B. Modified Cargo box equipment enclosure
   1. Will reduce noise and mitigate vandalism and theft of remediation equipment.
   2. Outside dimensions: 8' wide x 40' long x 8'6" high
   3. Exterior
      a. Paint color to match thermal oxidizer
      b. Double-rear door with cam lock (gorilla door)
      c. 6-foot double-swing locking steel access door
   4. Interior
      a. Floor sealed with non-skid bed liner
      b. Insulated floor, walls, and ceiling
      c. Overhead lighting
      d. Wall-mounted electric heater
      e. Vent fan, sound-insulated inlet/outlet louvers, and thermostat

C. Moisture Separator: A vapor-liquid separator shall be located on the inlet of the system and provide sufficient storage for 55 gallons of accumulated liquid. The vapor liquid separator shall include a liquid coalescing media internal to the separator and three-point liquid level switches mounted inside a clear PVC site glass mounted on the outside of the tank. The separator shall have a moisture pump and bottom drain.

D. Claw Vacuum Pumps
   1. Rotary claw compressors:
      a. The two (2) claw compressors shall be the Busch model 1202A with a 30-hp TEFC variable speed motor and a VFD located at the main control panel or equivalent. They will be rated for 600 icfm with an applied vacuum of 18.5 inches Hg at 7500 feet elevation.
   2. Filter, Discharge Silencer, Gauges and Sampling Port: A particulate filter shall be located on the inlet of the blower and the discharge of the blower will include a premium chamber discharge silencer, pressure gauge, temperature gauge, and sample port.

E. Oil/water Separator
   1. 304 stainless steel construction
   2. Capable of 100% removal of 20 micro or larger droplets at 25 gpm
   3. PVC site glass with ss low, high, and high-high pump out level switch assembly

F. Diffused Aeration Tank
   1. 304 welded stainless steel construction
   2. 90 cfm blower at 80-in. WC
   3. Non-fouling 304 Stainless Steel aeration diffusers

G. Inclined Plate Clarifier
   1. Minimum 90% removal of 20 micron & larger solids at 7.5 gpm
   2. PVC site glass with stainless steel low, high & high-high pump out level switch
   3. Transfer pump capable of 10 gpm with sample port on discharge end

H. Bag Filter Assembly
1. 304 stainless steel construction
2. Each unit houses (1) #2 size filer bag, swing bolt clamped lid

I. Activated Carbon Vessels
1. Carbon steel construction, 60 psi design pressure
2. 500 lbs. 8x30 mesh reactivated carbon in each
3. Pressure gage on inlet of each vessel
4. Sample port on inlet and outlet of each vessel

J. Thermal Oxidizer
1. Oxidizer Reactor: The reactor housing will be constructed of 7 gauge rolled steel. The Inlet and outlet connections are flanged. The reactor will be painted ISE standard grey two component paint.
2. Gas Pre-Heater: The unit will come equipped as standard with a direct gas fired air burner with combustion air blower and 2hp TEFC motor.
3. Flame Arrestor: A flame arrestor will be supplied and mounted to the inlet of the oxidizer and utilized to prevent flame propagation to the source. A spiral crimped aluminum element shall be removable for inspection and cleaning.
4. Exhaust Stack: The stack for the discharge of cleaned gases shall be self supporting and made of stainless steel. The stack shall terminate at approximately 14.5' above grade and is supplied with sampling ports.

K. Control System
1. Main Control System: A Nema 4 control panel shall be completely assembled, wired and mounted at eye level. Control panel components shall include, power distribution circuit with solid state PID temperature controller, flame safety programmer with built in purge timer, Allen Bradley programmable logic controller with Ethernet card, operator and alarm lights and an hour meter to record system run time. The control panel shall be UL 508 approved as an assembly. All wiring shall be consistent with standards set forth in the NEC.
2. Automatic Purge Control: The oxidizer shall be purged with fresh air prior to the introduction of contaminated vapors per NFPA 86. To accomplish this, the combustion air blower will be enabled for a specified time. Once complete, the system shall enable the pre-heat mode.
3. Temperature Control: Combustion chamber temperature shall be continuously monitored via thermocouple. The thermocouple and digital indicating temperature controller enable a 4-20 ma PID loop with the variable frequency tertiary air fan to maintain the combustion chamber set-point temperature.
4. The control panel shall contain an illuminated selector switch indicating power Hand/Off/Auto, status/alarm lights, motor starter, control relays, and terminal blocks factory assembled and tested. The enclosure shall be rated NEMA 4 and constructed of steel.

L. Telemetry
1. A cellular modem will be provided to allow remote access to system controls. The telemetry system will provide data access, the ability to be notified of alarm conditions via text or email, and the ability to remote start equipment in the event of a power failure.

2.3 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Electrical Characteristics: In accordance with the components described above, including all motors and controls.

B. Disconnect Switch: Factory mounted disconnect switches on all individual pieces of equipment.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

3.2 INSTALLATION

A. Contractor to install in accordance with the approved project plans, including all piping and ancillary equipment, and manufacturer's instructions. Contractor shall be responsible for unloading all equipment delivered to the site prior to installation.

3.3 FIELD QUALITY CONTROL

A. All field inspecting, testing, adjusting, and balancing shall be performed by the Supplier for the equipment to function as designed.

3.4 SUPPLIER'S FIELD SERVICES

A. The Contractor is responsible for delivery of all multi-phase extraction and treatment equipment.

B. Start-up training to include minimum 3-days on-site, including inspection of system installation, verification of safety controls, and staff training to optimize the system operation.

END OF SECTION

Appendix E

O&M Data Collection Form

Site: Bell Gas #1146 **Project No:** ES14.0220

Staff: ______

Date/Time on site: ______ **off site:** ______

(use value of no reading (NR) or not active (NA) if applicable for each entry)

SERVICE GAS METER READING: ______ cubic feet

SERVICE ELECTRIC METER READING: ______ kWh

System Data

Main Menu Time captured: ______		**Statistics Menu**		
OX OUTLET TEMP (°F):	______	MPE Vacuum Blower	HOURS: ______	CYCLES: ______
OX INLET TEMP (°F):	______	DTA Blower	HOURS: ______	CYCLES: ______
OX Natural Gas Valve (%)	______	MS Transfer Pump	HOURS: ______	CYCLES: ______
OX Dilution Air (%)	______	LNAPL Transfer Pump	HOURS: ______	CYCLES: ______
		DTA Transfer Pump	HOURS: ______	CYCLES: ______
		Treated Water Totalizer	Gallons: ______	

System Control Panel Main Menu

Sample point	Vacuum (in Hg)	Pressure (in H_2O/psi)	Temp. (°F)	Flow (scfm)	Motor (amps)
MPE combined influent		NA			
MPE pump effluent	NA				
DTA blower	NA				

Well Transducers

Transducer water level (ft. below top of casing)	
MW-4(S)	
MW-6(S)	
MW-10(S)	

KNOCKOUT TANK: ______ inches Product Storage Tank: ______ ft. below measuring point

MPE Wells

Well	Vacuum (in Hg)	HC Conc (ppm-v)	VelociCalc (cfm)	Velocity (ft/min)	Stinger Set (ft.)	Remarks
Ox Effluent	NA		NA	NA	NA	
MW-1S						
MW-2S						
MW-3S						
MW-4S						
MW-6S						
MW-10S						
MW-11S						
MPE combined					NA	

LABORATORY SAMPLES COLLECTED (list times):

______ Oxidizer Effluent (vapor) ______ MPE combined (vapor) ______ DA Tank Influent

______ GAC Effluent (water)

NOTES (leaks? corrosion? potential concerns? sampling problems?):

______

______

______

Appendix F

Health and Safety Plan

HEALTH AND SAFETY PLAN

Bell Gas #1186 (TR's Market)
101 Sun Valley Road Alto, NM

December 18, 2020
PROJECT NO. ES14.0220.00

PREPARED BY:

Daniel B. Stephens & Associates, Inc., a Geo-Logic Company
6020 Academy NE Suite 100
Albuquerque, NM 87109
(505) 822-9400

Geo-Logic ASSOCIATES

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Appendix

Site Health and Safety Plan Summary

This summary provides critical, site-specific health and safety information that all site workers should be familiar with. This summary is an integral part of the site-specific health and safety plan (HASP) and must be attached to the complete plan.

Site Name and Location

Bell Gas #1186 (TR's Market), 101 Sun Valley Road Alto, NM

Project Personnel *(refer to Section 3 for description of duties)*

Project Manager (PM): Tom Golden

Site Safety Officer (SSO): Jeffrey Samson

Site Supervisor: Jeffrey Samson

Emergency Response

Table S-1 lists the Emergency Contacts that might be needed in the event of a site emergency. The complete Emergency Response Plan is provided as Appendix B of this plan.

Site Activities and Hazard Assessment

Table S-2 identifies each of the tasks that will be performed during the field program and the hazards associated with each task. Table S-3 identifies the appropriate personal protective equipment (PPE) to be used for each task, including respiratory protection, and the air monitoring equipment that will be used. Air monitoring is further discussed in Section 7.1 of this plan. In the event that new tasks become necessary or new hazards are encountered, the SSO will update Tables S-2 and S-3 accordingly, and will notify all site workers of the changes.

Contaminants of Concern

Tables S-4 and S-5 identify the contaminants of concern that might reasonably be encountered during site activities and provide summaries of the chemical properties and worker exposure/ health information, respectively. This information is typically summarized from safety data sheets (SDSs) and other sources.

Hospital Route

Figure S-1 depicts the route and provides written instructions from the site to the hospital.

Medical Monitoring *(refer to GLA Policy)*

All site workers must be currently participating in a medical monitoring program that includes baseline and annual medical evaluation and testing.

Site Control Plan *(refer to Section 9 of this plan)*

Site control measures will be implemented during any activity that presents a hazard to workers outside the immediate work area or to unauthorized personnel in the vicinity. These measures can range from erecting barricades or barriers to prevent unauthorized entry, to establishing and enforcing work zones to mitigate the spread of contaminants beyond the work area.

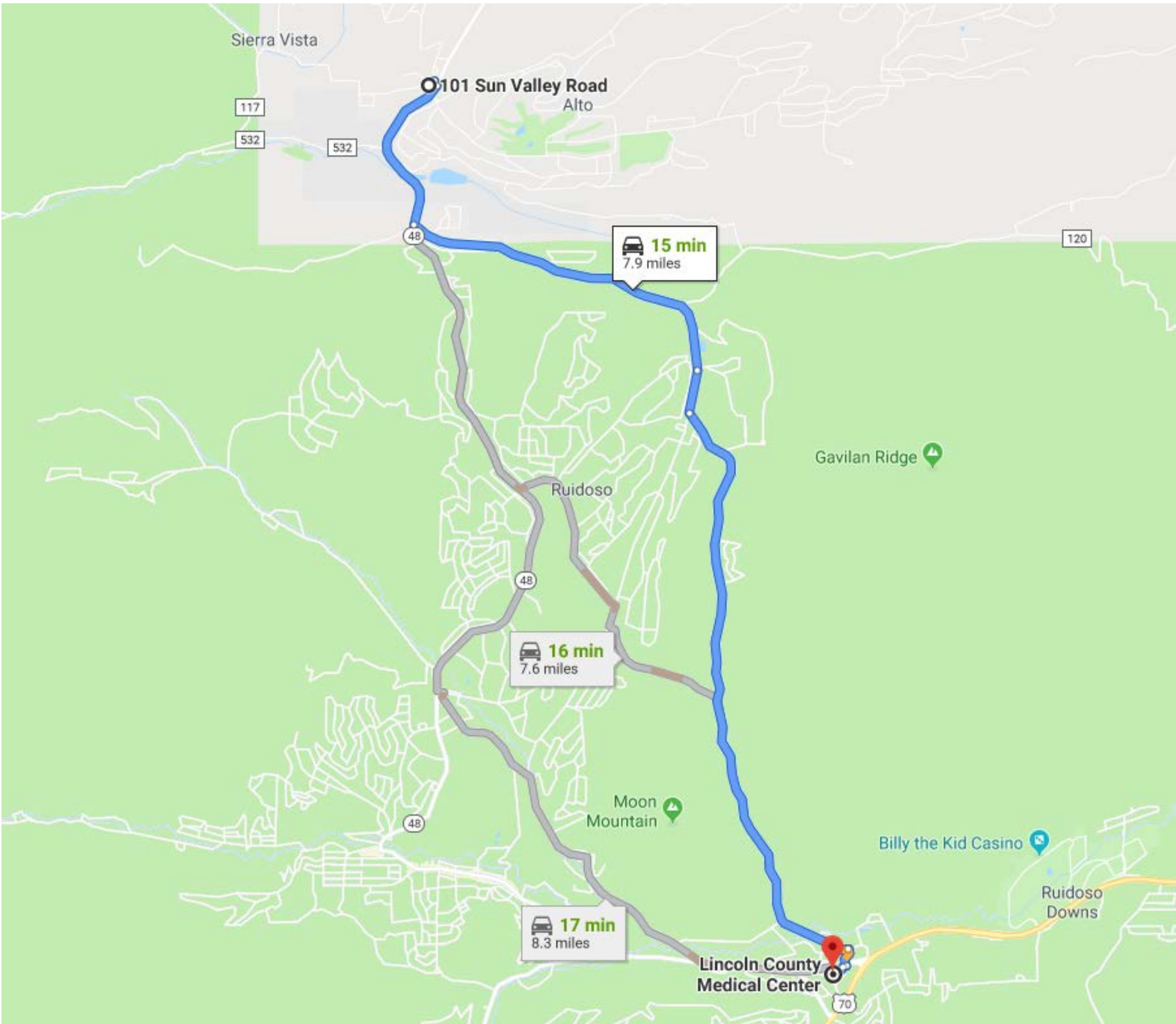
As all work is occurring on private property with minimal truck traffic anticipated, a traffic control plans is not required for this site.

Confined Spaces *(refer to Section 10 of this plan)*

No confined space entries will be performed during this investigation. In the event that confined space entries become necessary, this site-specific HASP will be amended. Confined space entries can only be performed by trained personnel in accordance with the GLA Confined Space Entry Program.

Figure S-1. Hospital Route

The nearest hospital with emergency services is Lincoln County Medical Center located at 211 Sudderth Dr. Ruidoso, NM 88345. The map to the hospital is shown on this page, written directions are located on the following page.



101 Sun Valley Rd

Alto, NM 88312

Take Mesa Heights Dr to NM-48 S/Billy the Kid Trail

43 s (423 ft)

1. Head northeast on Mesa Heights Dr toward Alto Alps Rd

   226 ft

2. Turn right onto Sun Valley

   197 ft

3. Turn right onto NM-48 S/Billy the Kid Trail

   2 min (1.1 mi)

Follow Gavilan Canyon Rd to your destination in Ruidoso

13 min (6.7 mi)

4. Turn left onto Gavilan Canyon Rd

   2.3 mi

5. Continue onto Hull Rd

   0.3 mi

6. Slight left onto Gavilan Canyon Rd

   4.0 mi

7. Turn right onto N Sutton Dr

   Pass by Subway (on the left)

   0.1 mi

8. Turn right

   108 ft

9. Turn left

   Destination will be on the left

   338 ft

Lincoln County Medical Center

211 Sudderth Dr, Ruidoso, NM 88345

Table S-1. Emergency Resources

Location and Number of Nearest Telephone: GLA and Contractor Vehicles

In Case of Fire or Explosion (Telephone Number):

Call Fire Dept: ____________________ 911

Call Police/Sheriff: ____________________ 911

In Case of Personal Injury or Exposure (Telephone Number):

Call Hospital: __________ Lincoln County Medical Center, (575) 257-8200 phone

Call Poison Control Center: ____________________ (800) 432-6866

Call Ambulance: ____________________ 911

Call Air Ambulance: ____________________ 911

GLA and Other Contacts

GLA (specific office): ____________________ Albuquerque (505) 822-9400

GLA Project Manager: ____________________ Tom Golden (505) 249-9402

GLA H&S Committee Member: ____________________ Chad Johannesen (505) 250-4630

GLA Corporate Program Administrator: __________ Russell Granfors (cell) (602) 659-7131

Human Resources Manager: ____________________ Maria Robles, Ontario: (909) 626-2282

Medical Contact: __________ WorkCare, Dr. Peter Greaney (Anaheim, CA) (800) 455-6155

Client Contact: ____________________ Gary Harrell (575) 622-4800

Regulatory Contact (if appropriate): ____________________ Renee Romero (575) 291-2109

Emergency Response Telephone Numbers

Local Chemical Emergency Response Team: ____________________ 911

National Response Center, Oil & Toxic Chemical Spills: __________ (800) 424-8802

CHEMTREC (24-hour): ____________________ (800) 424-9300

Other Contacts: ____________________

____

____

Table S-2. Proposed Tasks and Hazard Assessment

Potential Hazards	*Proposed Tasks*		
	Groundwater Sampling	MPE System Installation and Operation	Trenching and Excavations
Heavy equipment		X	X
Hazardous energy		X	X
Pinch points		X	X
Unstable ground			X
Noise hazards (>85 dbA)		X	X
Eye hazards	X	X	X
Head hazards		X	X
Dermal contact	X	X	X
Slips, trips, and/or falls	X	X	X
Heavy lifting	X	X	X
Vehicle traffic	X	X	X
Unauthorized site entry		X	X
Buried utilities		X	X
Overhead utilities		X	X
Respiratory Concerns			
Particulates			X
Vapors and/or gases	X	X	X
Oxygen depletion			
Asbestos			
Contaminated soil or liquids	X	X	X
Explosive atmospheres			
Heat/cold stress	X	X	X
Sunburn	X	X	X
Electrical hazards		X	
Compressed air or gases	X	X	
Fire hazards (hot work)		X	
Chemical hazards (other than COCs)	X	X	
Insects and vermin	X	X	X
Confined spaces			
Ionizing Radiation			
Unexploded Ordnance/Munitions			
HAZARD RANKING (Low, Medium, High)	Low	Low-Medium	Medium

dBA = A-weighted decibels
COCs = Contaminants of concern

Table S-3. Requirements for Personal Protective Equipment and Air Monitoring

Personal Protective Equipment	*Proposed Tasks*		
	Groundwater Sampling	MPE System Installation and Operation	Trenching and Excavations
Level D (Long pants, shirt, steel-toed boots, and safety glasses)	Minimum required for all site activities		
Hard hat		X	X
Hearing protection		X	X
Faceshield			
Respiratory Protection	(Selection matrix and cartridge change schedule in Project Files)		
Half-mask with organic vapor/HEPA cartridge			X
Full-face with organic vapor/HEPA cartridge			
Cartridge change schedule			Breakthrough, 8 hours, or end of shift
Air Monitoring Equipment			
Particulate monitor			X
Photoionization detector		X	X
Flame-ionization detector			
Combustible gas indicator			
O_2 monitor			
Colorimetric tubes			
H_2S detector			
Methane gas monitor			
Other ___________________			

HEPA = High-efficiency particulate air
O_2 = Oxygen
H_2S = Hydrogen sulfide

Table S-4. Chemical and Physical Properties for Primary Contaminants of Concern

Compound	Vapor Pressure (mm Hg)	Vapor Density [a] (air=1)	Specific Gravity	Odor Threshold [b] (ppm)	LEL-UEL (%)	Ionization Potential (eV)	Physical Description
Silica, crystalline as respirable dust **[Ca]**	NA	NA	2.66	NA	Unknown	NA	Colorless, odorless solid - a component of many mineral dusts.
Benzene **[Ca]**	75	2.7	0.88	24–119 (P)	1.2–7.8	9.24	Colorless to light yellow liquid with aromatic odor
Toluene	21	3.18	0.87	1.6 (G)	1.1–7.1	8.82	Colorless liquid with a sweet, pungent, benzene-like odor
Ethylbenzene	7	3.66	0.87	0.092–0.6 (G)	0.8–6.7	8.76	Colorless liquid with an aromatic odor
Xylene (o-, m-, p-isomers)	7–9	3.66	0.86–0.88	0.62–20 (G)	0.9–1.1	8.44–8.56	Colorless liquid with an aromatic odor (p-Xylene is a solid below 56°F)
Methyl tertiary butyl ether (MTBE) **[Ca]**	8.5–10	3.1	0.74	0.053 (G)	NA	NA	Clear, colorless, low viscosity liquid with a terpene-like odor
Tertiary butyl alcohol (TBA)	40-42	2.55	0.79	21.5	2.4-8		
Gasoline **[Ca]**	38–300	NA	0.72–0.76	0.3 (G)	1.4–7.6	NA	Clear liquid with a characteristic odor
Diesel fuel	NA	<1	0.81	NA	0.7 [a]	NA	Clear white liquid with kerosene odor

Sources: NIOSH *Pocket Guide to Chemical Hazards* (2013 - accessed online).

[a] Vapor density data from *Groundwater Chemicals Desk Reference* (Montgomery, 2000) and product material safety data sheets.

[b] Odor threshold data from (1) MSA *RESPONSE® Guide*, on-line at http://webapps.msanet.com/responseguide/ChemicalDatabase.aspx, and (2) 3M *Respirator Selection Guide* (2012).

mm Hg = Millimeters of mercury
ppm = Parts per million
LEL/UEL = Lower explosive limit/Upper explosive limit
eV = Electron volts
NA = Not available or unknown
[Ca] = Known or suspected carcinogen

Table S-5. Exposure Limit, Hazard, and First Aid Information for Primary Contaminants of Concern

Compound	Applicable Exposure Limit	IDLH	Primary Acute Symptoms from Inhalation and Dermal Exposures	Target Organs	First Aid
Silica, crystalline as respirable dust **[Ca]**	0.05 mg/m^3 [a]	50 mg/m^3	Cough, dyspnea (breathing difficulty), wheezing; decreased pulmonary function, progressive respiratory symptoms (silicosis); irritation eyes	Eyes, respiratory system	*Eyes:* irrigate immediately; *Skin:* no recommendation; *Breathing:* remove to fresh air; *Ingestion:* no recommendation
Benzene **[Ca]**	0.1 ppm [a] 1.0 ppm [b]	500 ppm	Irritates eyes, skin, and nose; causes headache, nausea, giddiness, staggered gait, weakness, exhaustion; dermatitis	Eyes, skin, respiratory system, blood, CNS, bone marrow	*Eyes:* irrigate immediately; *Skin:* soap wash immediately; *Breathing:* remove to fresh air, provide respiratory support; *Ingestion:* medical attention immediately
Toluene	100 ppm [a] 150 ppm [b]	500 ppm	Irritates eyes and nose; causes headache, weakness, fatigue	Eyes, skin, respiratory system, CNS, liver, kidneys	As above
Ethylbenzene	100 ppm [a,c] 125 ppm [b]	800 ppm	Irritates eyes, skin and mucous membranes	Eyes, skin, respiratory system, CNS	As above
Xylene, o-, m-, p-	100 ppm [a,c] 150 ppm [b]	900	Irritates eyes, skin, nose and throat; causes dizziness, excitement	Eyes, skin, respiratory system, CNS, GI tract, blood, liver, kidneys (o-, m- and p-Xylene)	As above
Methyl tertiary butyl ether (MTBE) **[Ca]**	50 ppm [d]	NE	Irritates eyes, skin, and respiratory tract	Eyes, skin, respiratory system, CNS	As above
Gasoline **[Ca]**	300 ppm [a]	NE.	Irritates eyes, skin, mucous membrane; causes dermatitis, headache, weakness, exhaustion, blurred vision, dizziness, slurred speech, confusion, convulsions; possible liver, kidney damage	Eyes, skin, respiratory system, CNS, liver, kidneys	As above
Diesel fuel	10 ppm [a,c,e] 15 ppm [b,e]	NE	Irritates eyes, skin, and upper respiratory tract; CNS depression	Eyes, skin, respiratory system	As above

Sources: NIOSH *Pocket Guide to Chemical Hazards* (2013- accessed on-line) and manufacturer's safety data sheets (SDS); MSA *Response®* Guide (2013 - accessed on-line)

[a] National Institute of Safety and Health recommended exposure limit (NIOSH REL) - 10-hour time-weighted average (TWA)
[b] NIOSH short-term exposure limit (STEL) - 15 minute TWA - not to be exceeded
[c] Occupational Safety and Health Administration permissible exposure limit (OSHA PEL) - 8-hour TWA
[d] American Conference for Governmental Industrial Hygienists (ACGIH) - 8-hr TWA
[e] No exposure limit established; limits for naphthalene presented as a guide only

mg/m^3 = Milligrams per cubic meter
ppm = Parts per million
[Ca] = Known or suspected carcinogen
CNS = Central nervous system
CVS = Cardiovascular system
NE = None established

Site-Specific Health and Safety Plan

Project Name: Bell Gas #1186 FRP Implementation
Project Location: 101 Sun Valley Road Alto, NM
GLA Project Manager: Tom Golden

1. INTRODUCTION

This Health and Safety Plan (HASP) establishes the responsibilities, requirements, and procedures for Geo-Logic Associates (GLA) personnel while performing surface and subsurface investigations at the above-named site. The HASP summary is an integral part of this HASP and must be attached for the plan to be considered complete.

The objective of this HASP is to establish a safe work environment for all site personnel, provide a uniform and concise plan of action in an emergency, and furnish the necessary guidance to adhere to these policies. This HASP meets the requirements set forth by the Occupational Safety and Health Administration (OSHA) in Title 29 of the Code of Federal Regulations (CFR), Part 1910.120 (Hazardous Waste Operations and Emergency Response) and 29 CFR, Part 1926 (Safety and Health Regulations for Construction). This HASP is designed to augment the health and safety policies and procedures established in the GLA Health and Safety Program Manual (H&S Manual).

Safety is considered a priority during all field activities. Field personnel will not perform any task for which they have not received adequate training, or which they personally feel is unsafe.

2. DESCRIPTION OF SITE ACTIVITIES

The project will include DBS&A observation of the following activities: trenching and installation of buried and above ground conveyance pipelines, and installation of treatment equipment; and DBS&A performance of groundwater sampling and remediation system sampling.

Table S-2 in the HASP summary identifies the tasks that will be performed during the field program and the hazards associated with those tasks. The measures that will be employed to protect worker safety are described in Table S-3 and Sections 4 and 5 of this plan. Assuming that the site tasks do not change and that data from follow-up testing do not change the hazard assessment, this HASP will also apply to any subsequent field events. This HASP must be revised to address activities beyond those described above and listed in Tables S-2 and S-3.

The specific field activities are described in detail in the scope of work and the related sampling and analysis plan. The site-specific field methods and procedures are based on standard procedures established by GLA and applicable regulatory agency guidance.

The site is considered an uncontrolled hazardous waste site. All workers and visitors are subject to the OSHA requirements for hazardous waste workers in 29 CFR 1910.120.

The site is an active gas station. Workers must be aware of traffic and pedestrians entering and exiting the site.

Nearest telephone:	GLA and Contractor personnel
Nearest water:	Potable water will be supplied
Nearest bathroom facilities:	Chisum Convenience Store
Nearest fire extinguisher:	GLA and Contractor vehicles
Nearest first aid kit:	GLA and Contractor vehicles
Warning/method signal for site evacuation:	Verbal

3. PROJECT PERSONNEL

The H&S manual establishes the roles and responsibilities for health and safety at various levels within the company. The GLA personnel responsible for the activities at the site are listed in the HASP summary. Their roles are described in the following subsections.

3.1 Project Manager

The Project Manager (PM) is responsible for implementing the GLA H&S Program at the site and designating the Site Safety Officer (SSO). The PM will oversee the preparation of this site-specific HASP, ensuring that the hazards associated with each task have been identified and that appropriate protective measures have been established. The PM will approve the final HASP.

3.2 Site Safety Officer

The SSO will be responsible for ensuring that all personnel entering an active work area comply with this HASP, meet appropriate OSHA medical and safety training requirements, and use the required level of personal protective equipment (PPE). The SSO will conduct site safety meetings prior to the start of work and before the start of each new activity. Workers will acknowledge their attendance by signing the tailgate safety meeting form (Appendix A). Accidents or incidents at the job site that affect or could potentially affect worker safety will be documented using the GLA I Illnesses, Injury, and Unusual Occurrence Report.

In accordance with the Hazard Communication standard (29 CFR 1910.1200), the SSO will coordinate with contractor representatives to identify hazardous materials being used on the site and to ensure that safety data sheets (SDSs [formerly referred to as material safety data sheets, or MSDSs]) are available for each material. Site workers will be briefed on hazardous materials at the job site. The SSO will maintain SDSs for the hazardous chemicals routinely used at the site; the contractor will maintain SDSs for the hazardous chemicals they bring to the site.

To maintain a safe job site, all potentially dangerous conditions or practices must be corrected before proceeding with field work. The SSO will notify contractors and the PM of any unsafe work practices, and will stop all work on DBS&A projects if contractors do not abide by this plan.

The SSO will establish the initial level of PPE and respiratory protection and will upgrade or downgrade levels of protection in response to changes in field conditions. Information and guidance concerning the PPE Program and the Respiratory Protection Program are found in the H&S manual.

The SSO will establish the physical limits of the work areas at the site and will instruct all personnel and visitors on the boundaries of the exclusion zones. Only authorized personnel will be allowed in active work areas. It is also the responsibility of the SSO to ensure that all personnel enter and leave active work areas through the decontamination station, if necessary. Specific site control measures are addressed in Section 9 of this plan.

3.3 Site Supervisor

The Site Supervisor is responsible for directing all field activities at the site and ensuring that the scope of work is completed. The Site Supervisor will serve as the SSO in his/her absence.

3.4 Site Workers and Visitors

Additional workers and visitors may be authorized to enter the site under the direction of the PM or the SSO. All workers must be properly trained in their assigned duties, including standard safety procedures. All workers and visitors entering the work zone will be familiar with the contents of this site-specific HASP and will sign the plan acceptance form (Appendix A). Constructive comments regarding the HASP should be directed to the PM, the SSO, or the GLA H&S Program Coordinator.

3.5 Contractors

Contractors to GLA are obligated to comply with OSHA regulations and standard industry safety practices for their profession. If a contractor proposes changes in the HASP, the SSO will obtain permission from the H&S Program Coordinator and the PM, and this authorization will be documented in the project site log. A modification to the HASP will be issued reflecting the changes. Additional contractor responsibilities are described in Section 14 of the H&S manual.

4. GENERAL HAZARD REVIEW AND ASSESSMENT

The hazard review for the site is based on GLA's experience conducting similar field operations at similar sites. Table S-2 in the HASP summary identifies the hazards associated with each task and provides a hazard ranking (from low to high) for each task. The controls (elimination, substitution, engineering, administrative, or PPE) that will be employed to protect worker safety are described in Sections 4 and 5 of this plan. Table S-3 in the HASP summary lists the PPE required to protect workers during each task and identifies the air monitoring equipment that will be used on site.

Tables S-4 and S-5 in the site HASP summary provide information on the physical and chemical characteristics, symptoms of exposure, and first aid procedures for each of the contaminants known or suspected to be present at the site. The OSHA permissible exposure limits (PELs) or the National Institute of Occupational Safety and Health (NIOSH) recommended exposure limits (RELs) for each contaminant of concern are also presented in Table S-5. The PEL and REL are levels to which one may be exposed for 8 hours per day, 5 days per week for one's working lifetime without resulting in adverse health effects.

4.1 Sunburn and Temperature Hazards

Sunburn is perhaps the most common hazard for field site workers. Sunburn is caused by overexposure to ultraviolet (UV) radiation from the sun. Chronic overexposure to sunlight, especially the UV-B component, accelerates skin aging and increases the risk of skin cancer. The following guidelines can be used to avoid overexposure to UV rays from the sun:

- Wear protective clothing (long sleeves, hats with protective brims, and long pants) that provides the most coverage, and is consistent with the job to be performed.
- Protect eyes with UV-absorbing sunglasses or tinted safety glasses.
- Use a commercial sunscreen with a skin protection factor (SPF) of at least 30 and protection against both UV-A and UV-B rays. Sunscreen should be applied 15 to 30 minutes before exposure and reapplied at 60- to 90-minute intervals. If possible, avoid exposure to the sun between 10:00 a.m. and 2:00 p.m., as rays are the most powerful during this period.

Heat stress is often the most critical hazard for field site workers. The effects can range from transient heat fatigue to serious illness and even death. Heat stress is caused by a number of interacting factors including environmental conditions, clothing, workload, and the individual characteristics of the worker. Because heat stress is fairly common during the summer and fall, preventive measures and alertness are especially important during these seasons.

Protective clothing and equipment affect the way the body controls its temperature. A previous heat injury (including sunburn) can also increase an individual’s susceptibility to further heat injury. Workers who have suffered a previous heat injury or who have sunburn must be especially vigilant in preventing heat stress and injury.

In order to ensure against heat stress-related problems, personnel should take frequent breaks in shaded areas. Workers should wear loose fitting clothing (except around rotating equipment) and will unzip or remove coveralls during breaks. Cool drinking water with added electrolytes will be made available and sufficient amounts of fluids should be consumed to avoid dehydration.

During hot weather, heat stress monitoring will be part of the daily regimen. GLA personnel will count their pulse rate for 30 seconds as early as possible in the rest period. If the pulse rate exceeds 110 beats per minute (bpm), the length of the next work period will be reduced by 20 minutes and the heat stress parameters will be observed again at that time. If the pulse rate at the beginning of the next test period exceeds 100 bpm and the last reading was over 110 bpm, the work cycle will be reduced by one-third. Whenever the pulse rate is elevated, work should not be resumed until the pulse rate is below 100 beats per minute. These heat stress indicators shall be observed at least once every hour.

During cold weather, GLA personnel should wear multilayer, wind-resistant outfits and drink warm fluids. Warm shelter will be available during breaks.

4.2 Weather Hazards

In addition to the hazards of UV radiation from the sun and extreme ambient temperatures, general weather conditions may present a hazard to field workers. Rain and snow may result in muddy, slippery conditions that make foot and vehicle travel hazardous. Lightning and tornadoes, common summertime phenomena, can be extremely hazardous. In the event of adverse weather (e.g., high wind and airborne dust, lightning, extreme cold or heat, or rain) that could compromise worker's health and safety during outdoor activities, the SSO will shut down operations. Additional safety measures for weather-related hazards are described in the H&S manual.

If lightning is visible and the sound of thunder is heard less than 30 seconds after lightning is observed, stop field operations and move to a sturdy, completely enclosed building. If a sturdy shelter is not available, get inside a hardtop automobile and keep the windows up. Automobiles offer excellent lightning protection.

In the event of a tornado, move to a pre-designated shelter. If an underground shelter is not available, move to an interior room or hallway on the lowest floor and get under a sturdy piece of furniture. Stay away from windows. If caught outside or in a vehicle, do not try to outrun a tornado in your car; instead, lie flat in a nearby ditch or depression. Remember that flying debris from tornadoes causes most deaths and injuries.

4.3 Biological Hazards

Venomous snakes and arthropods (e.g., insects, spiders, ticks, scorpions, and centipedes) create a hazard when their habitats are disturbed. Awareness and avoidance are the best defenses. Fieldwork shall be performed in a manner that minimizes disturbances of these creatures. Should a bite or sting occur, first aid shall be immediately applied and medical treatment sought as soon as possible.

The feces and urine of some desert rodents may be carriers of the hantavirus, and fleas on living or dead animals may carry bubonic plague. Both hantavirus and bubonic plague occur in New Mexico and the southwestern United States. Field workers should avoid all contact with rodent nests, droppings, or bodies. Professional medical treatment should be sought immediately if a worker suffers an animal bite of any kind.

Important Note: Any individual with a known allergy to wasps and bees must notify the SSO and/or PM/task leader prior to working at the project site. If an individual has a history of allergic reactions to insect bites or is subject to attacks of hay fever or asthma, or if they are not promptly relieved of symptoms after first aid is administered, a physician will be called or immediate emergency medical treatment will be sought. In a highly sensitive person, do not wait for symptoms to appear, as delay can be fatal.

4.4 Emergency Response

Table S-1 in the HASP summary lists the names and telephone numbers of people and agencies that might be contacted in the event of an emergency. The emergency response (ER) plan is included as Appendix B. The ER plan includes instructions and procedures for emergency vehicular access, evacuation procedures for personnel, methods of containing a fire, and instructions on how to handle a variety of specific medical emergencies.

5. TASK-SPECIFIC SAFETY GUIDELINES

Table S-2 in the HASP summary identifies each of the tasks that will be performed during the field investigation and the physical and chemical hazards associated with each task. Table S-3 in the site HASP summary identifies the requirements for PPE, and the air monitoring that will be performed. This section identifies the measures that will be taken to eliminate or minimize potential exposures to site workers for each task listed in Tables S-2 and S-3.

5.1 Groundwater Sampling

Groundwater samples will be collected from groundwater monitoring wells. Prior to sampling, water level measurements will be collected using a water level indicator. Physical hazards may include any of those identified in Table S-2. Chemical hazards associated with groundwater sampling include potential skin and eye contact with contaminated groundwater and sample preservatives. Attention to site conditions, good housekeeping, and use of standard safety procedures will help to control or minimize the physical and chemical hazards. Appropriate PPE for groundwater sampling is described in Table S-3.

5.2 Installation and Operation of MPE System

Site activities will include installation and operation of a full scale multiphase extraction (MPE) system. Chemical hazards associated with this work include inhalation of organic vapors. Physical hazards may include typical construction hazards due to work with and around heavy equipment; heat stress; trips, falls, and slips; and electrical hazards when working in and around open electrical panels. Use caution when working around blower discharge piping; it is insulated but may be hot. Blowers have sound attenuating enclosures, but ear protection may be needed when working around equipment. Remediation well vaults are located in an active gas station parking lot and in the shoulder of adjacent roadways so utilize reflective safety vests and traffic cones when working in well vaults.

Appropriate PPE will include safety glasses or goggles, steel-toed boots, and long-legged pants. Air monitoring will be conducted using a PID to monitor organic vapors in the breathing zones of workers and around piping joints. Diligent air monitoring and the use of appropriate PPE and standard safety procedures will minimize the risk of exposure and physical injury. Work in and around electrical panels shall be conducted by qualified professionals and shall include locking and tagging of affected equipment.

5.3 Excavating and Trenching Activities

Excavating and trenching operations will be conducted using a backhoe or a larger excavator (trackhoe). The hazards associated with excavating operations at this site will be primarily physical (e.g., slips, trips, falls, etc.), as identified in Table S-2. Chemical hazards associated with excavating and trenching activities include potential skin and eye contact with airborne particulates and contaminated soil. Attention to site conditions, good housekeeping, and use of standard safety procedures will help to control or minimize the physical and chemical hazards. Appropriate PPE for groundwater sampling will include that described in Table S-3.

Any excavation/trenching operations will be performed in accordance with OSHA regulations in 29 CFR 1926, Subpart P (Excavations). Properly trained contractor personnel will operate excavating equipment; at no time will an employee of GLA operate excavating equipment. Personnel should be sure they have eye contact with equipment operators before approaching heavy equipment. Never approach equipment from or work within an operator's blind spots. GLA employees will be familiar with and avoid hazards associated with work near or in trenches.

A “competent person” trained to interpret soil conditions and to identify the proper safety protection devices or procedures needed for each particular situation shall be in charge of all excavation and trenching activities at the job site. “Competent person” means one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them. The GLA competent person shall be designated by the PM and will be familiar with their role and responsibilities (refer to the H&S manual). All site workers should be familiar with basic soil mechanics related to excavations (refer to the H&S manual) and pay particular attention to identify evidences of distress in the excavation.

The following safety guidelines and practices can be used to mitigate some of the hazards associated with excavation activities:

- Contact the local utility locator to identify and mark the locations of any underground cables, pipes, or utility installations in the area of the proposed excavation. Discuss the locations of utilities with the property owner to identify private utilities.
- Take additional precautions when excavating a backfilled trench, or when working near railroads, highways, or other sources of vibrations.
- Provide appropriate and adequate barricades and warning lights to prevent accidental entry by workers and unauthorized persons, animals, or vehicles.
- Do not leave a hazard unguarded. Secure the site or surround the excavation with plastic high-visibility fencing to prevent accidental entry.
- If personnel are required to enter a trench or excavation that is greater than 5 feet in depth or excavated in soft or unstable materials, the sides of the excavation will be shored or sloped in accordance with OSHA regulations in 29 CFR Part 1926.652.
- If the excavation cannot be sloped adequately (usually at 1.5 horizontal to 1 vertical), trench boxes, shoring, sheeting, bracing, or other equivalent methods are required to keep the trench wall from collapsing.
- When workers are required to enter trenches that are 4 feet or greater in depth, an adequate means of exit, such as ladders or steps, shall be provided. Exit points shall be spaced no more than 50 feet apart.
- If the trench is 4 feet or more in depth and hazardous atmospheres exist or could reasonably be expected to exist, the trench shall be considered a confined space. Workers entering the trench shall be properly trained in confined space entries, and atmospheric testing for oxygen content, flammability, and organic or other vapors shall be performed before entering the trench. For additional information on the GLA Confined Space Program, refer to the H&S manual or contact the H&S Program Coordinator.

6. STANDARD SAFE WORK PRACTICES

The following guidelines are meant to cover operations by GLA field staff and GLA contractors during field activities at the site. GLA contractors may choose to establish and enforce more stringent safety guidelines for personnel under their employ. Health and safety issues for other personnel working or visiting at the site *and not involved in the site activities* are the responsibility of the Client and their respective contractors, not GLA.

Prior to the initiation of any on-site activities, the SSO will conduct a safety meeting to discuss the contents of this site-specific HASP, describe the field activities, identify any high-risk activities, and familiarize personnel with emergency procedures, including the route to the hospital. The GLA field supervisor will establish that all equipment is in good condition. The GLA supervisor should properly and thoroughly instruct the contractor on exactly what results are to be accomplished and point out all known safety hazards.

During the field activities, all participants will be expected to follow standard safe work practices as outlined below:

- Do not eat, drink, smoke, or chew tobacco in the work area.
- Avoid contact with potentially contaminated substances.
- Report any unsafe conditions to the SSO.
- Be aware of the physical characteristics of investigations, including:
  - Wind direction in relation to the contaminated area
  - Accessibility to associates, equipment, vehicles, etc.
  - Communication
  - Areas of known or suspected contamination
  - Site access
  - Nearest water sources
- Dispose of all wastes generated during field activities in accordance with applicable regulatory guidelines.

7. AIR AND NOISE MONITORING

This section describes the measures that will be taken to protect workers from exposures to hazardous atmospheres and noise during the site activities.

7.1 Air Monitoring

This site is contaminated with fuel-related petroleum hydrocarbons (gasoline, diesel) and the potential exists for the development of toxic or explosive atmospheres in or near excavation. Excavation activities also have the potential to create hazardous levels of dust and airborne particulates. Respiratory protection will be used if air monitoring shows the presence of a hazardous atmosphere at concentrations above occupational exposure limits.

Respiratory protection will be used in accordance with OSHA regulations in 29 CFR 1910.134 and the GLA Respiratory Protection Program Plan. All persons using respiratory protection must be medically cleared to do so and should be aware of the following important definitions:

- Assigned protection factor (APF) is the level of protection that a respirator or class of respirators is expected to provide to employees and is used to select the appropriate class of respirators. Level C PPE includes an air-purifying respirator (APR). A half-face APR has an APF of 10; a full-facepiece APR has an APF of 50.

- Maximum use concentration (MUC) is the maximum atmospheric concentration of a hazardous substance from which an employee can expect to be protected when wearing a respirator. The MUC is calculated by multiplying the occupational exposure limit by the APF. For example, in the case of benzene, OSHA has established a permissible exposure level (PEL) of 1 ppm (for an 8-hour time-weighted average [TWA)]), and a short-term exposure limit (STEL) of 5 ppm. Therefore, the MUC for benzene is 10 ppm for a half-face APR and 50 ppm for a full-facepiece APR. The half-face and full-facepiece APRs may be used for short periods of time (up to 15 minutes) in benzene concentrations up to 50 and 250 ppm, respectively (STEL x APF).

Table S-3 in the HASP summary identifies each of the tasks to be performed at the site and the air monitoring requirements for each task. Targets of such monitoring may include organic vapors, particulates, combustible gases, and oxygen. Table S-4 lists each of the contaminants of concern for the site. Table 1 lists the types of hazardous atmospheres that could be present at a site, the air monitoring equipment used for each, and the action levels to be used at this site. When in use, all meters will be calibrated daily in accordance with manufacturer's instructions.

Table 1. Air Monitoring Equipment, Action Levels, and Protective Measures

Hazard	Equipment	Action Levels in BZ	Action Response
Organic Vapors	PID, FID	Background	Level D PPE
		OEL of most toxic contaminant sustained for 5 minutes	Use Level C respiratory protection; evaluate specific compounds.
		MUC for respiratory protection in use.	Stop work; upgrade to Level B
	Colorimetric (Drager) Tubes	Chemical specific: >1 ppm for benzene >1 ppm for vinyl chloride >1 ppm for 1,1-DCE	Use Level C respiratory protection if compounds exceed OELs.
Particulates	Dust Monitor	Visible dust	Suppress with water
		<5 mg/m3	Level D PPE
		>5 mg/m3	Use Level C respiratory protection
Flammable/explosive Atmosphere	Explosimeter	<10% scale reading	Proceed with work
		10 - 15% scale reading	Stop work
		>15% scale reading	Evacuate site
Oxygen-deficient Atmosphere	Oxygen Meter	19.5 -- 23.5%	Normal - continue work
		<19.5%	Evacuate - oxygen deficient
		>23.5%	Evacuate - fire hazard
Ionizing radiation	Gamma radiation meter	>0.1 millirem/hr	Radiation sources may be present
		>1 millirem/hr	Evacuate - radiation hazard

BZ = Breathing zone
PID = Photoionization detector
FID = Flame ionization detector
PPE = Personal protective equipment
OEL = Occupational exposure limit
MUC = Maximum use concentration
ppm = Parts per million
mg/m^3 = Milligrams per cubic meter
1,1-DCE = 1,1-Dichloroethene

The SSO or his/her designee will obtain PID readings of organic vapor concentrations in the breathing zone of the workers. Readings will be made at the working face of the excavation as the excavation progresses. The person making the PID measurements will determine the extent of the affected area, record the readings, and advise workers of the results.

7.1.1 Organic Vapors

The need for respiratory protection from toxic vapors is based on the most hazardous constituent that is likely to be present or known to be present, based on soil, soil gas, and/or groundwater sampling. Table S-4 lists each of the volatile contaminants of concern for the site.

A release of gasoline has occurred at this site. Gasoline is a complex mixture of petroleum hydrocarbons, additives, and blending agents, whose composition varies widely. The most hazardous constituent is benzene, a known human carcinogen. A PID will be used to monitor organic vapor concentrations; in the absence of other data, the PID readings are assumed to be due to benzene. If testing shows that benzene is not present or does not occur at significant concentrations, toluene, the next most volatile aromatic hydrocarbon in gasoline would be considered the most hazardous constituent. The OSHA PEL and STEL for benzene are 1 ppm and 5 ppm, respectively. The OSHA PEL for toluene is 200 ppm.

Assuming the presence of benzene, work will stop and workers in the affected area will upgrade to Level C respiratory protection if PID readings exceed 1 meter unit (usually parts per million by volume or ppmv) above background in the breathing zone for 5 minutes, or if unusual or unpleasant odors are detected. Workers will leave the work zone when PID readings exceed the MUC for the respiratory protection being used (10 ppm for a half-face APR; 50 ppm for a full-face APR). All personnel within the work zone will continue to wear respiratory protection until vapor levels dissipate below 1 meter unit. APRs will be equipped with organic vapor cartridges that will be changed at the end of each 8-hour shift.

A benzene-specific colorimetric tube (e.g., Draeger) can be used to determine whether benzene is present and at what concentration. If the colorimetric tube indicates that benzene concentration exceeds 1 ppm, all personnel within the affected area must use respiratory protection. If the colorimetric tube indicates that benzene is not present, exposure levels for toluene will be used to determine the need for respiratory protection. The SSO will periodically check for the presence of benzene using a colorimetric tube.

All personnel should be aware that the detection capabilities of PIDs may be enhanced or dampened by high humidity or by the presence of certain gases, such as methane. Direct evidence of contamination, such as visible staining of soils or strong odors, should be used to further evaluate these quantitative instrument readings.

7.1.2 Combustible and Oxygen-Deficient Atmospheres

An instrument or instruments capable of detecting combustible gases and oxygen levels will be used during excavation activities. The instrument(s) shall be placed as close to the working face of the excavation, as possible. The lower explosive limit (LEL) and the upper explosive limit (UEL) for benzene are 1.2 percent and 7.8 percent, respectively. Similar values are published for gasoline (NIOSH Pocket Guide). Excavation operations will be suspended when combustible gas measurements are at or between the LEL and the UEL.

Normal atmosphere contains between 20.8 and 21 percent oxygen. The atmosphere is oxygen-deficient if it contains less than 19.5 percent oxygen, and oxygen-enriched if it contains more than 22 percent oxygen. Oxygen-deficient atmospheres may be created when oxygen is displaced by other gases, or consumed by bacterial activities. Oxygen-enriched atmospheres can be created by certain chemical reactions and present a significant fire and explosion risk. Excavating operations will be suspended when readings indicate oxygen levels at or below 19.5 percent and at or above 22 percent.

7.1.3 Particulates

When respirable dust is considered a potential hazard (e.g. excavating operations), direct-reading personal dust monitors (e.g., Thermo Scientific pDR-1500 personal DataRAM) should be used to identify and quantify airborne dust concentrations that a worker is exposed to while working. NIOSH has established a recommended exposure limit (REL) for crystalline silica as respirable dust of 0.05 milligrams per cubic meter (mg/m^3). This value is 10-hour TWA concentration for a 40-hour workweek. NIOSH recommends the use of N95 or more efficient filters for protection against respirable dust. The MUC for crystalline silica as respirable dust is 0.5 mg/m^3 for a half-face APR and 2.5 mg/m^3 for a full-face APR. Supplied air respirators must be used if airborne concentrations of crystalline silica exceed 2.5 mg/m^3 (NIOSH Pocket Guide, 2013). Respirator cartridges and filters will be changed each day.

7.2 Noise Monitoring

All site personnel who are exposed to average noise levels of 85 A-weighted decibels (dBA) or greater during an 8-hour workday must participate in their company's Hearing Protection Program. Workers must use appropriate hearing protection whenever noise levels exceed 90 dBA. The GLA H&S Program Coordinator has used a noise meter to survey a variety of equipment that may be used during the site activities and found that work around heavy equipment is most likely to require hearing protection. Noise levels are highest near the engines and compressors, but generally do not exceed 85 dBA in the typical operator locations (e.g., behind the excavator). When a noise meter is not available, the following rule of thumb should be used: if it seems loud or you cannot carry on a normal conversation, hearing protection should be worn.

8. PROTECTIVE EQUIPMENT

PPE requirements for each task are described in Table S-3. At a minimum, the following PPE shall be used by personnel while working at the site:

- Steel-toed/steel-shanked work boots
- Long pants
- Protective eyewear
- Hard hat (when needed)
- Chemical-resistant gloves (when needed)
- Hearing protection (when needed)

Level C PPE will include Level D equipment plus a full- or half-face air-purifying respirator with appropriate cartridges and prefilters. Workers using respiratory protection should be familiar with guidelines to determine that the equipment being used for respiratory protection is providing adequate protection, as discussed in Section 7.1. Chemical-resistant coveralls and/or gloves will be worn whenever conditions require GLA field personnel to come in direct contact with potentially contaminated materials.

GLA will supply employees with PPE that meets requirements established by NIOSH or the American National Standards Institute (ANSI), and that meet current OSHA criteria. Employees will be trained in the selection, care, and use of PPE, as described in the H&S manual.

8.1 Disposal of Contaminated Clothing or Equipment

All potentially contaminated clothing, Tyvek coveralls, gloves, paper towels, and other expendable items will be placed in garbage bags for disposal. Fresh Tyvek coveralls and work gloves should be donned at the start of each workday or when otherwise required.

8.2 Decontamination Procedures

Specific personnel decontamination procedures are based on the personal level of protection. When using Level D protection, a personnel decontamination system (PDS) is not required. However, because project personnel wearing Level D protection may need to upgrade to Level C if site conditions change, a PDS may be established based on specific site characteristics.

The decontamination stations for Level C decontamination may include (1) a segregated equipment drop for hand tools and monitoring equipment, (2) a wash and rinse for gloves and disposable booties (if worn), (3) a removal station for gloves and disposable booties (if worn), (4) a removal station for respiratory protection, hard hat, safety glasses, and Tyvek suits, and (5) a station to wash and rinse hands and face. Specific procedures and the sequence of events will be determined based on the potential hazards identified at the site. The stations listed are a guide to the selection of adequate decontamination procedures.

When a PDS is set up, the SSO or his/her designee has the responsibility for operating the decontamination station. This person will make sure that all personnel enter and leave active work areas through the PDS, that all personnel decontaminate properly, and that disposable items are bagged. The SSO will assist on-site workers in changing cartridges, masks, gloves, or other pieces of safety equipment, and monitor the length of work periods. Disposable items will be placed in plastic bags and properly disposed of. Non-disposable items will be properly cleaned and dried according to manufacturer's specifications and stored for future use.

Decontamination procedures, which are based on guidelines appropriate for low-level contamination, will be required for all reusable equipment used for sampling, personal protection, and field monitoring. Sampling equipment will be decontaminated between each sample. High-pressure steam cleaners, alconox detergent solution, and deionized water rinses may be used. If necessary, personnel will decontaminate equipment at a specified decontamination area before leaving the site. Field monitoring equipment will be cleaned daily; additional cleaning and recalibration will be performed if contamination affects operation.

9. SITE CONTROL

Barricades, caution tape, or other necessary means shall be used when necessary to prevent unauthorized access into the work area. The SSO will establish the physical limits of the work areas at the site and instruct all personnel and visitors concerning the boundaries of the exclusion zones.

At a minimum, a 15-foot-wide primary exclusion area will be established around the perimeter of active machinery. GLA personnel will enter the primary exclusion zone only when absolutely necessary for the performance of the task at hand. A secondary exclusion zone will be established around the general work area. If necessary, the work area will be marked off with temporary barriers and caution tape. Only authorized personnel will be allowed in active work areas.

Traffic control plans may be required for all sites where work activities may impact traffic flow on adjacent roadways. These plans must be submitted to and approved by the local traffic control authority. The PM or their designee will be responsible for ensuring that the necessary site control measures and plans are prepared and implemented.

10. CONFINED SPACE ENTRY

No confined spaces have been identified at the site and no confined space entries are anticipated during the field activities. However, any confined spaces identified as the work progresses shall be properly marked and managed accordingly. GLA has developed and implemented a Confined Space Entry Program Plan that provides policies and procedures to be followed for confined space entries, including air monitoring, participant training and duties, and authorizing and permitting confined space entries.

If confined space entries become necessary, the SSO will contact the PM and this site-specific HASP will be amended accordingly. The SSO will ensure that entries are performed in accordance with the GLA Confined Space Entry Program Plan. If necessary, the SSO will contact the local fire department to coordinate the entry and rescue requirements.

11. SPILL PREVENTION

Minor spills of potentially contaminated soil, residual free product, or groundwater may occur during site work. If a spill occurs, site personnel will use best judgment and available materials to contain and prevent it from spreading. All contained soil and liquids will be disposed of in compliance with federal, state, and local requirements.

12. SAFETY MEETINGS

A site safety or “tailgate” safety meeting will be held before the start of work for the project and before the start of each new activity. All personnel directly involved in the work are required to attend. This HASP and all pertinent health and safety issues will be discussed during the initial briefing or meetings. The tailgate meeting will also address specific issues regarding on-site health and safety, such as the proposed work and associated hazards, recent problems, and any accidents or incidents. All personnel will acknowledge their attendance by signing the safety meeting form (Appendix A).

13. TRAINING REQUIREMENTS

Before entering the site, workers will have received the necessary training required by OSHA for workers at potentially hazardous waste sites [29 CFR 1910.120(e)], including 40 hours of formal instruction and a minimum of 3 days of field experience under the supervision of a trained and experienced worker. Additionally, site supervisors will have completed an 8-hour health and safety supervisor training course. Before starting work, each worker will receive site-specific hazard recognition and emergency response training.

In the event that organic vapor concentrations in the work zone require an upgrade to Level C PPE, only workers who are trained and medically cleared to wear a respirator will be allowed in the work zone.

GLA’s contractors will certify, by name, that each of their employees who will perform field work at a hazardous waste project site has received the applicable health and safety training listed above.

14. MEDICAL MONITORING REQUIREMENTS

All medical monitoring will be performed in accordance with 29 CFR 1910.120(f), 29 CFR 1910.134 (Respiratory Protection), and 29 CFR 1910.95 (Occupational Noise Exposure). The PM must identify any chemicals of concern that might require monitoring (e.g., lead or PCBs) before and after the site activities.

The GLA medical monitoring program is directed by WorkCare in Anaheim, California. In the event of a chemical exposure resulting in symptoms or illness, the SSO may contact Dr. Peter Greaney at WorkCare (800-455-6155) to obtain guidance for recommended testing protocols.

15. HOSPITAL AND EVACUATION ROUTE

If a medical emergency occurs during work at the site, the Lincoln County Medical Center in Alto, NM is the closest emergency room facility. Figure S-1 in the HASP summary provides a computer-generated route map from the site to the hospital, with driving directions. All workers should be familiar with the location of this facility. The SSO will perform a pre-activity physical route check to determine any planning modifications required. If the evacuation route needs to be modified, this HASP will be corrected, and all workers will be notified of the changes. All workers should be familiar with the location of this facility.

Appendix A

Health and Safety Forms

Geo-Logic ASSOCIATES

Health and Safety Plan Acceptance Form

Instructions: This form is to be completed by each person prior to beginning work at the subject hazardous waste site. THIS FORM IS TO BE MAINTAINED IN THE PROJECT FILES.

Project ______________________________

Job No. ______________________________

Location ______________________________

By my signature below, I acknowledge that I have read and understand the contents of the Health & Safety Plan for this project. I agree to perform my work in accordance with the plan.

Signature	Print Name	Company	Date

Geo-Logic ASSOCIATES

Tailgate Safety Meeting

Project ID:______________________ Day: ______________________

Location:______________________ Date: ______________________

Project Manager:______________________ Team Leader: ______________________

Health & Safety Officer:______________________ No. of Personnel Present: ______________________

Check Topics Discussed

Scheduled Activities:______________________

Chemical/Physical Hazards
- Contaminants of Concern
- Safety Data Sheets
- Overhead & Underground Utilities
- Extraordinary Site Conditions
- Lifting/Slips/Trips/Falls
- Heat/Cold Stress (Inc. Sunburn)
- Other:______________________

First Aid
- Facilities/Kits/Eyewashes

Personal Protective Equipment - Level D
- Hard Hats/Hearing Protection
- Steel-Toed Boots
- Glasses/Goggles/Shields
- Gloves
- Contingency: Level C
- Respirators & Tyvek/Saranex

Emergency Procedures/Site Safety
- "Buddy System"
- Communication
- Facility-Specific Regulations
- Rally Point

Vehicle/Heavy Equipment
- Operation & Inspection
- Preventive Maintenance
- Rotating Augers/Moving Parts

Sanitation & Hygiene
- Drinking Water/Fluids
- Restrooms
- Personal Cleanliness

Housekeeping
- Waste Containers
- Waste Materials
- Waste Water/Decon. Water

Fire Prevention
- Locations of Extinguishers
- Smoking
- Hot Work
- Explosive & Flammable Liquids
- Other:______________________

Emergency Facilities (and Directions)
- Name:______________________
- Address:______________________

Safety Meeting Attendees:

Name	Signature	Name	Signature

Geo-Logic ASSOCIATES

Illnesses, Injury, and Unusual Occurrence Report

Date of Event: ______________________________ Report Number: ____________________

1. Name of the Site: ____

2. Name of individual(s) injured, ill, or exposed:

____

____

3. Provide a brief, but concise description of the event:

____

____

4. Damaged Property:

____

____

5. Damage to equipment and the type of equipment:

____

____

6. Did this accident involve a motor vehicle? Yes _________ No _________

   Any motor vehicle accident, regardless of fault, which involves a company vehicle, rental vehicle, or personal vehicle, while the employee is acting in the course of employment must be accompanied by a police report, unless the police refuse to respond to the scene of the accident. In addition, draw a simple illustration of the scene on the reverse side of this form.

7. Action taken/additional employee training:

____

8. Name and Signature: ______________________________Name (print)

   ______________________________Signature

   ______________________________Date Completed

Diagram 1:

Diagram 2:

Daily Site Safety Checklist

Job Name and Number: ____

Person Completing Form: ________________________ **Date(s):** ______________

Instructions: Use form for up to five consecutive days. Write in date, place checkmark to indicate item has been completed. Deficiencies must be corrected. Completed form to be maintained with the Project files with copy to H&S Program Coordinator.

Checklist Item	Date				
The HASP (including emergency phone numbers) has been reviewed and signed by GLA staff, subcontractors, & visitors and is available on site					
Hazardous chemicals have been discussed and SDSs are available for each hazardous chemical on site.					
Tailgate Safety Meeting has been conducted for all site workers and visitors (and updated as necessary)					
Copies of Hospital Route map and emergency phone numbers are available in all vehicles					
DBS&A personnel and subcontractors have discussed hazards associated with Site-specific work					
Potential slips, trips, or fall hazards have been identified and mitigated where possible					
Site control measures have been established for present conditions (e.g., safety cones or caution tape)					
Proper PPE has been identified and is being used for present conditions					
Personnel monitoring is being conducted for present conditions					
An operating, fully-charged cell phone is available on site					
A fully-stocked first aid kit and eye wash bottle are readily available					
Fully-charged fire extinguishers are available for use.					
All workers and visitors have training appropriate for assigned tasks					
Equipment on-site has been inspected and is in safe working order					
Electrical power operated tools are properly grounded and used with a GFCI					
Excavated soils are properly stored and labeled					
Excavations are properly shored/sloped and barricaded					
Used disposable PPE and garbage are bagged for proper disposal					
All Health and Safety concerns have been communicated to the Site H&S Officer and the Project Manager					

Project Health and Safety Checklist

The Project Manager and their designated site supervisors and safety officers are responsible for the implementation of the company health and safety program. This form has been designed to help the Project Manager meet the health and safety guidelines established by the company in accordance with OSHA regulations and accepted protocols. If you have any questions, contact the H&S Program Coordinator.

Project Planning

_ Do all of the workers at the site have the required or appropriate level of safety training for the site and the assigned tasks (e.g., current 40-hour training, 8-hour Supervisor training, 3-day supervised training)?

_ Has an OSHA-trained Supervisor been designated for the site?

_ Has a Safety Officer been designated for the site?

_ Has a Competent Person been designated for the site (required at construction/excavation sites)?

_ Do field personnel have current first aid/CPR training?

_ Are there any health hazards at the site that require workers to be medically monitored (e.g., excessive noise, possible respirator use, or potential for exposure to hazardous contaminants)?

_ Are there any special health hazards at the site that require baseline testing before and follow-up testing after field activities (e.g., cadmium or PCBs)?

Site H&S Plans

_ Has a site-specific H&S Plan been prepared? *[Required for all Hazwoper sites; Company policy requires completion of the H&S Plan Summary at a minimum.]*

_ Has the site H&S Plan been reviewed and approved by the PM?

_ Have all site workers been briefed on the contents of the site H&S Plan and signed-off on the Plan?

_ Have Tailgate Safety Meetings been held as necessary (e.g., prior to the start of activities, when activities or conditions change, or when new workers come on site) and have those present signed the attendance sheet?

_ Do site workers understand the site hazards and know the route to the hospital?

_ Have clearances been obtained for underground utilities?

Documentation

The following documentation should be available at the field site or in the office for inspection:

_ Site-specific H&S Plan signed by site workers **(must be available at the field site)**

_ Utility Clearance Form **(must be available at the field site)**

_ MSDSs for hazardous chemicals used on-site **(must be available at the field site)**

_ Tailgate Safety Meeting forms signed by site workers (current one in the field and completed forms in the project file)

_ Records of excavation inspections by Competent Person (current one in the field and completed forms in the project file)

_ Copies of Accident/Incident or Chemical Exposure reports (submitted to H&S Program)

_ Results of any safety inspections (project and/or program files)

Appendix B

Emergency Response Plan

Emergency Response Plan

PURPOSE AND SCOPE

The following Emergency Response Plan has been developed to include instruction and procedures for emergency vehicular access, evacuation procedures for personnel, methods of containing a fire, and medical emergencies. All extraordinary conditions that require concise and timely action must be dealt with in a manner that minimizes the health and safety risks to the immediate site personnel and the general public.

GENERAL RESPONSE CONSIDERATIONS

All on-site personnel shall be familiar with the Emergency Response Plan described herein. This section will be maintained in the field office.

Due to the nature of the site, the emergencies or extraordinary conditions that may arise are more than likely limited to personnel accidents requiring first aid, exposure to contaminated sediments, and potential fire near mechanical equipment. The following procedures shall be implemented in the event of an emergency:

- First aid or other appropriate initial action will be administered by those closest to the accident/event. This assistance will be coordinated by the Site Safety Officer (SSO) and will be conducted in a manner so that those rendering assistance are not placed in a situation of unacceptable risk. The primary concern is to avoid placing a greater number of workers in jeopardy.
- Personnel shall report all accidents and unusual events to the SSO, the subcontractor Health and Safety representative, and the Project Manager (PM).

The SSO and other on-site personnel are responsible for conducting the emergency response in an efficient, rapid, and safe manner. The SSO will decide if off-site assistance and/or medical treatment is required and shall be responsible for alerting off-site authorities and arranging for their assistance. The SSO, in coordination with the contractor Health and Safety representative, will provide an Accident/Incident Report to the PM that includes the following:

- A description of the emergency (including date, time and duration)
- Date, time and names of all persons/agencies notified and their response
- A description of corrective actions implemented or other resolution of the incident

All workers at the site are responsible for conducting themselves in a mature, calm manner in the event of an accident/unusual event. All personnel must conduct themselves in a manner to avoid spreading the danger to themselves and to surrounding workers.

RESPONSIBILITIES

The SSO shall have responsibility for directing response activities in the event of an emergency. He/she will:

- Assess the situation
- Determine required response measures
- Notify appropriate response teams
- Determine and direct on-site personnel during the emergency

The SSO shall coordinate the response activities of on-site personnel with those of public agencies.

PUBLIC RESPONSE AGENCIES

The site-specific HASP includes a list of public response agencies to be contacted and who may, depending on the nature of the situation, assume authority for emergency response. The HASP presents local emergency numbers, including local hospitals (which includes the poison control center), ambulance service, fire and police departments, and others. In addition, nationwide hotline numbers for emergency assistance are listed. These phone lists should be retained by all field personnel and posted by the phone in all field trailers.

The hospital location is outlined in the HASP. The SSO will provide directions and/or maps to these facilities to all field personnel.

Prior to the initiation of all on-site work, the local police and fire department will be notified, if deemed necessary. This notification will take the form of a letter describing both on-site and off-site activities. If requested, a briefing will be held to further explain the type of activities and equipment that are associated with each project. Emergency procedures also will be discussed.

ACCIDENTS AND NON-ROUTINE EVENTS

Several types of emergencies are outlined in the following subsections. These are not intended to cover all potential situations, and the corresponding response procedures should be followed using common sense. Every accident is a unique event that must be dealt with by trained personnel working in a calm, controlled manner. In the event of an accident/unusual event, the prime consideration is to provide the appropriate initial response to assist those in jeopardy without placing additional personnel at an unnecessary risk. Employees shall be instructed to report all injuries and illnesses to the SSO.

Worker Injury

If a person working on the site is physically injured, appropriate first aid procedures shall be followed. Depending on the severity of the injury, emergency medical response may be sought. If the employee can be moved, he/she will be taken to the edge of the work area where contaminated clothing (if any) will be removed, and emergency first aid administered. If necessary, transportation to local emergency medical facility will be provided as soon as possible.

If a worker can only be moved by emergency medical personnel, the SSO will decide what protective equipment, if any, is required to be worn by emergency personnel. Each work area will have extra equipment available for emergencies.

If the injury to the worker involves chemical exposure, the first aid procedures summarized in Table S-5 should generally be initiated as soon as possible, including the following:

- **Eye Exposure:** If contaminated solid or liquid gets into the eyes, wash eyes immediately at the emergency eyewash station using water and lifting the lower and upper lids occasionally. Obtain medical attention immediately if symptoms warrant.

- **Skin Exposure:** If contaminated solid or liquid gets on the skin, wash skin immediately at the decontamination station using soap and water. Obtain medical attention immediately if symptoms warrant.

- **Inhalation:** If a person inhales large amounts of organic vapor, move him/her to fresh air at once. If breathing has stopped, perform cardiopulmonary resuscitation (CPR), as per American Red Cross standard first aid instruction. Keep the affected person warm and at rest. Obtain medical attention as soon as possible.

- **Ingestion:** If a contaminated solid or liquid is swallowed, medical attention shall be obtained immediately by consulting the Poison Control Center as outlined in the site-specific HASP.

Temperature-Related Problems

Adverse weather conditions are important considerations in planning and conducting site operations. Hot or cold weather can cause physical discomfort, loss of efficiency, and personal injury. One or more of the following control measures shall be employed to help control heat stress:

- Provide adequate non-alcoholic liquids to replace lost body fluids. Employees must replace water and salt lost through perspiration. Employees will be encouraged to drink more than the amount required to satisfy thirst, as thirst satisfaction is not an accurate indicator of adequate salt and fluid replacement.

- Replacement fluids can be a 0.1 percent salt solution, commercial mixes such as GatoradeTM or Quick KickTM, or a combination of these with fresh water.
- Establish a work regimen that will provide adequate rest periods for cooling down.
- Take rest breaks in a cool, shaded area during hot periods.
- Employees shall not be assigned other tasks during rest periods.
- Inform all employees of the importance of adequate rest, acclimation, and proper diet in the prevention of heat stress.

Adverse Weather

In addition to the hazards of UV radiation from the sun and extreme ambient temperatures, general weather conditions may present a hazard to field workers. Rain may result in muddy, slippery conditions that make foot and vehicle travel hazardous. Lightning and tornadoes, common summertime phenomena, can be extremely hazardous. In the event of adverse weather (e.g., high wind and airborne dust, lightning, extreme cold or heat, or rain) that could compromise worker's health and safety during outdoor activities, the SSO will shut down operations. Safety precautions for lightning and tornadoes can be found in the H&S manual.

Fires

The potential for fires involving hazardous chemicals must be addressed during the preliminary site-specific evaluation of all hazards. Personnel in each work group will be knowledgeable in fire extinguishing techniques. They shall be instructed in proper use and maintenance of the appropriate fire extinguishers supplied at the work site.

Vehicle Accidents

Posted speed limits will be observed. All vehicles will be required to meet applicable state inspection standards. All drivers will be required to have a good driving record and must have all necessary licenses to operate their vehicle.

The phone numbers of the SSO, the field office, and subcontractor Health and Safety representative will be carried in each vehicle at the site. These numbers may also be provided to all police, fire, rescue, and emergency agencies in the area.

Upon notification of an accident, the PM will make available any personnel and equipment at his or her disposal to aid in the cleanup. For example, the following equipment may be supplied:

- Sorbent materials to contain/control liquids
- Front-end loaders to pick up solids
- Dust-suppression materials to control dust

- Trucks to haul collected material
- Appropriate protective gear for cleanup workers

The supervision and operation of all emergency response personnel and equipment will be coordinated through the authorities at the scene of the accident.

Appendix C

Guidance for Field Personnel: COVID-19

Geo-Logic ASSOCIATES

Guidance for Field Personnel

Outlined below are guidelines for field staff to implement that will help to mitigate exposure to COVID-19 when engaged in fieldwork.

For all employee mobilization and project site work, the following mitigation measures shall be implemented:

- It is preferable for staff to travel to project work sites in a company owned vehicle or privately owned vehicle by themselves with Project Manager approval. A maximum of 2 individuals per vehicle is allowed as long as the individuals have talked with each other confirming that they are COVID-19 symptom-free and are comfortable riding together. If they are not comfortable traveling together then they will need to address this concern with the Project Manager.
- Vehicle surfaces shall be disinfected prior to entering the cab and when exiting the cab.
- When traveling by vehicle, wear (nitrile, latex or vinyl) gloves when refueling and sanitize hands when complete.
- Make as few stops as possible during travels to limit exposures to public areas.
- Maintain a distance of 6 ft. between on-site workers whether it is in the field or in a meeting setting (video meetings and conference calls are preferable) – also when travelling and in public spaces.
- Avoid social greetings (e.g. shaking hands).
- Carry a supply of facial tissues, properly dispose of them in a receptacle after use and sanitize hands once complete.
- If you feel unwell or develop COVID-19 symptoms, contact your supervisor/project manager immediately.
- If a subcontractor, client or client contractor exhibits COVID-19 symptoms, confirmed or presumptive to be COVID-19, remove yourself from the area. Notify your supervisor/project manager immediately of the potential exposure.
- GLA employees will wear gloves while on-site and wash and/or sanitize their hands upon removing them.
- Bring water, meals and snacks with you to avoid stopping at stores or restaurants. Dine in your vehicle or outside alone. If with someone, observe social distancing of at least 6 ft. Avoid using the project trailer or site facilities for eating and do not eat in groups.
- Since access to running water for hand washing may be impracticable, obtain alcohol-based hand sanitizers and/or wipes prior to site visit. Consider purchase of 5-gallon (or greater volume) water jugs to provide sufficient water for frequent handwashing.
- Instead of using a common drinking water source like a cooler, personnel should use individual water bottles.
- Any trash collected from the jobsite must be changed frequently by someone wearing nitrile, latex or vinyl gloves.
- Practice social distancing when conducting Daily Tailgate Safety Meetings.

- Do not circulate sign in sheets but have one person document those in attendance on the sheet.
- The on-site trailer/facilities (at GLA controlled sites) shall be cleaned on a daily basis with surfaces disinfected several times a day on an ongoing basis. Personal sanitation and cleaning supplies shall be made available on site (i.e. hand sanitizer and sanitizing wipes) and used frequently to wipe down surfaces such as handles on doors, desks, fridges, microwaves, light switches, thermostats, and other equipment that personnel come in contact with.
- Tools and equipment shall be disinfected often and at the end of use.
- Any portable jobsite toilets should be cleaned by the leasing company at least twice per week and disinfected on the inside. If the toilet is the responsibility of a contractor, ask the contractor to have it cleaned twice a week. Make sure that hand sanitizer dispensers are always filled, and if not, notify the responsible party. Frequently touched items (i.e. door pulls and toilet seats) will require disinfecting.
- GLA staff should avoid independent hotels, book rooms at reputable hotel chains. Verify with the hotel that appropriate protocols are in place to limit the potential exposure and spread of the virus.
- If an overnight stay is required in a hotel, disinfected wipes shall be available to clean common touched surfaces in the hotel room (i.e light switches, remote control, doorknobs, thermostat, toilet handle etc.).
- Several local and state government agencies are recommending face covering or facemasks to reduce the spread and exposure to COVID-19. Field employees should carry disposable or reusable facemasks that can be used for this purpose. If facemasks are not available, a scarf, bandana, or other face covering is sufficient. The CDC is currently not recommending the use of N95 respirators to prevent the spread of COVID-19. Nevertheless, employees should wear minimum N95 respirators if required by the work.
- GLA staff should carry the essentials services letter explaining why they are considered an essential employee.

Appendix G

Permits

December 18, 2020

Mr. Lochlin Farrell
New Mexico Environment Department
Ground Water Quality Bureau
P.O. Box 5469
Santa Fe, New Mexico 87502

Re: Discharge Permit Application
Bell Gas #1186 (TR's Market), 101 Sun Valley Road, Alto, New Mexico

Dear Mr. Farrell:

Daniel B. Stephens & Associates, Inc. (DBS&A) is pleased to submit this discharge permit application associated with our proposed soil and groundwater remediation system at the above-referenced site. The site had a documented release of petroleum hydrocarbons and is regulated by the Petroleum Storage Tank Bureau. Emulsified fluids (soil vapor, nonaqueous-phase liquid [NAPL], and groundwater) will be brought to the surface under high vacuum from a total of 7 wells. Hydrocarbons will be treated using diffused aeration and carbon filtration. Total dissolved solid (TDS) concentrations are expected to be reduced by removing calcium and carbonate through the aeration and settling processes. A maximum of 1,500 gallons per day of treated water will be discharged on-site, south of the existing gasoline service station.

Please contact me at (505) 822-9400 if you have any questions or require additional information.

Sincerely,

DANIEL B. STEPHENS & ASSOCIATES, INC.

Thomas Golden, P.E.
Project Engineer

Jeffrey Samson, P.E.
Staff Engineer

TG/ed
Enclosures
cc: Gary Harrell, Bell Gas, Inc.
Renee Romero, NMED PSTB

NEW MEXICO ENVIRONMENT DEPARTMENT
GROUND WATER QUALITY BUREAU

GROUND WATER DISCHARGE PERMIT APPLICATION

Instructions for completing the application are included in the form itself and in the Supplemental Instructions found at the back of the application. You may fill out the application manually, or a Microsoft Word version may be downloaded from www.env.nm.gov (Ground Water Quality) and filled out electronically. Timely processing of this application is contingent upon the technical completeness of the submission. Failure to provide all of the information pursuant to Section 20.6.2.3106 NMAC, following notice of technical deficiency, may result in denial of the application.

Send two complete paper copies AND one electronic copy of this application, with the filing fee to:

Program Manager
Ground Water Pollution Prevention Section
New Mexico Environment Department
P.O. Box 5469
Santa Fe, NM 87502

Introduction

Facility Name: Bell Gas #1186 / TR's Market

GWQB – Date of Receipt
(Department use only)

For Existing Discharge Permits:

DP Number: ________________
Expiration Date: ________________

Type of Discharge (*check one*):

- [ ] Domestic
- [x] Industrial
- [ ] Agricultural
- [ ] Mining

Type of Application (*check appropriate box*)

- [x] New – new facility
- [ ] New – existing (unpermitted) facility
- [ ] Renewal only
- [ ] Modification only
  "modification" includes a change in the location of a discharge, and/or increase in the quantity of the discharge, and/or a change in the quality of the discharge.
- [ ] Renewal and Modification

If this application is to *modify* or *renew and modify* a Discharge Permit, what is the reason for modification of the Discharge Permit? Describe the proposed changes that would result in modification, meaning a change in the location of a discharge, and/or an increase in the quantity of the discharge, and/or a change in the quality of the discharge.

Fees Included with Application

All applicants are required to submit a **$100 Application Filing Fee**. An additional fee will be assessed prior to permit issuance. Permit fees are listed in section 20.6.2.3114 NMAC. **Make checks payable to: NMED-Ground Water Quality Bureau**

Application Checklist

The following checklist has been provided to assist in ensuring that the application is complete prior to submission (*check all that apply*):

☑	Part I. Administrative Completeness ☑ $100 Application Filing Fee ☑ A. General Information ☑ B. Public Notice Information ☑ C. Public Notice Preparation
☑	Part II. Technical Completeness ☑ A. Discharge Volume and Description ☑ B. Identification and Physical Description of Facility ☑ C. Flow Metering ☑ D. Ground Water Monitoring ☑ E. Engineering and Surveying (electronic copies) ☑ F. Land Application Area
☐	Part III. Site-Specific Proposals
☑	Part IV. Electronic (PDF) format of Maps and Logs is required (additional paper copies of maps and logs are optional and may be requested by the Department if required for review) ☑ A. Surface Soil Survey and Vadose Zone Geology ☑ B. Location Map ☑ C. Flood Zone Map

Copies of Application

An applicant applying for a Discharge Permit shall submit **two paper copies of the signed application, and an electronic copy of the signed application including all supporting documentation,** to the address listed below.

- [x] Two paper copies – completed and signed
- [x] Electronic copy in portable document format (PDF) of the signed application and all supporting documentation (designs, maps, logs), on the following media *(choose one)*:
  - [ ] Compact disc (CD)/DVD
  - [x] Flash drive

Send application and fees to the following address:
Program Manager
Ground Water Pollution Prevention Section
New Mexico Environment Department
P.O. Box 5469
Santa Fe, NM 87502

Applicant's Signature

Signature must be that of the person listed as the legally responsible party on this application (Part I, 2a).

I, the applicant, attest under penalty of law to the truth of the information and supporting documentation contained in this application for a Ground Water Discharge Permit.

Signature: Gary Harrell Date: 12-14-20

Printed Name: Gary Harrell Title: Vice President

Part I. Administrative Completeness

General Information

1. Facility Information

See Supplemental Instructions to determine what constitutes a "facility." The physical address must be provided. If the facility does not have an address, the location can be described by road intersections, mile posts, or landmarks, as appropriate. See Supplemental Instructions for additional information.

Facility Name	Bell Gas #1186 (TR's Market) Site
Discharge Permit #	
Physical Address	101 Sun Valley Rd. Alto, New Mexico 88312
County	Lincoln County
Type of Facility	Soil and groundwater remediation
Driving Directions	From Carrizozo, East on US-380, south on NM-37, south on NM-48 to site

2. Contact Information

a) Applicant Information The applicant is the person or entity (e.g., corporation, partnership, organization, *municipality*, etc.) legally responsible for the discharge and for complying with the terms of the Discharge Permit. If the applicant is an entity, then the name and title of a contact person must be provided. This application must be signed by the applicant or contact person named here.

Applicant Name	Bell Gas, Inc.			Title		
Mailing Address	PO Box 490					
	City	Roswell	State	NM	Zip	88202
Contact Person	Gary Harrell			Title	Vice President	
Contact Information	Office Number	(575) 622-4800	Fax Number			
	Cell Number	(575) 626-7563	E-mail	garyharrell1@juno.com		

b) Facility Operator/Manager Information Provide the contact information for the facility operator or manager below. If the facility is required to have an operator certified by the State of New Mexico, please include the certification level of the operator named here.

Name	NMED PSTB, Attn. Renee Romero			Title	Project Manager	
Mailing Address	2905 Rodeo Park Drive East, Building 1					
	City	Santa Fe	State	NM	Zip	87505
Contact Information	Office Number	(575) 291-2109	Fax Number			
	Cell Number	(575) 624-6123	E-mail	d.renee.romero@state.nm.us		
	Cell Number		E-mail			
Certification Level (if applicable)	N/A					

c) Consultant's Information (if applicable) If the consultant is a company or organization, then the name and title of a contact person must be provided here.

Company Name (1)	Daniel B. Stephens & Associates, Inc.				
Company Contact	Thomas Golden, P.E.				
Mailing Address	6020 Academy Road NE, Suite 100				
	City: Albuqerque	State: NM	Zip: 87109		
Contact Information	Office Number	505-822-9400	Fax Number	505-822-8877	
	Cell Number	505-249-9402	E-mail	tgolden@geo-logic.com	

Company Name (2)	Daniel B. Stephens & Associates, Inc.				
Company Contact	Jeffrey Samson				
Mailing Address	6020 Academy Road NE, Suite 100				
	City: Albuquerque	State: NM	Zip: 87109		
Contact Information	Office Number	505-822-9400	Fax Number	505-822-8877	
	Cell Number	505-252-1279	E-mail	jsamson@geo-logic.com	

d) Permit Contact Information (if applicable) If someone other than the contacts listed above is a primary contact for this application and/or facility, list here.

Name ______________________ Title ______________

Mailing Address ______________________________

City ____________ State ____________ Zip ____________

Contact Information
Office Number ____________ Fax Number ____________
Cell Number ____________ E-mail ____________

Facility Affiliation ______________________________

3. Ownership and Real Property Agreements [20.6.2.7HH NMAC]

The applicant owns (check as appropriate):

- ☐ The facility
- ☐ All discharge sites
- ☐ Some discharge sites

If someone other than the applicant owns the facility or any of the discharge sites, provide ownership information below. For any portion of the facility where the applicant is not the owner of record, the applicant shall submit a copy of any lease agreement or other agreement which authorizes the use of the real property for the duration of the term of the requested permit (typically five years). Lease prices or other prices may be redacted.

The responsible party for remediation is Bell Gas, Inc. (applicant). The remediation system (facility) is funded by the Corrective Action Fund, administered by the Petroleum Storage Tank Bureau (PSTB). The site is currently owned and operated by Kendrick Oil Company (property owner, but not a responsible party for this site). DBS&A is the consultant for both Bell Gas and PSTB (for this site) and the main contact for all paperwork associated with this application. Agreements in Attachment 1.

- If more than one person has ownership interest, or a partnership exists, list all persons with an ownership interest.
- If a corporate entity holds an ownership interest, provide the name of the corporate entity and the entity's registered agent as filed with the New Mexico Public Regulation Commission.

Name	NMED PSTB, Attn. Renee Romero			Title	Project Manager
Mailing Address	2905 Rodeo Park Drive East, Building 1				
	City: Santa Fe	State: NM		Zip	87505
Contact Information	Office Number	(575) 291-2109		Fax Number	
	Cell Number	(575) 624-6123		E-mail	d.renee.romero@state.nm.us
Owns	☑ The facility			☐ A discharge site	
	☑ Attached – lease (or other authorized use) agreement				

Name	Kendrick Oil Company			Title	
Mailing Address	13025 Quaker				
	City: Lubbock	State: TX		Zip	79423
Contact Information	Office Number	(806) 722-1274		Fax Number	
	Cell Number			E-mail	jblackburn@kendrickoil.com
Owns	☐ The facility			☑ A discharge site	
	☑ Attached – lease (or other authorized use) agreement				

4. Public Notice Information

a) Proposed Maximum Daily Discharge Volume: 1500 gallons per day

Note: Use the information from Part II.A.2 following its completion.

b) Depth-to-Most-Shallow Ground Water: 45-90 feet

Note: Use the information from Part II.A.2 following its completion.

c) Pre-Discharge Total Dissolved Solids Concentration in Ground Water

[Subsection C of 20.6.2.3106 NMAC]

Provide the concentration of total dissolved solids (TDS) in ground water prior to discharging from the facility. *Note: This information is likely the same as that submitted in the first application for a Discharge Permit for this facility.*

- Pre-discharge TDS concentration in ground water: 1,772 mg/L (ppm)

  ☑ Attached – Copy of laboratory analysis report (if available)
- From what source was the sample collected (e.g., upgradient monitoring well, on-site supply well, nearest well within a one-mile radius of the facility)?

  monitor wells on-site

5. Facility Location

In the table below, describe the location for the entire facility by listing the Township, Range, and Section, and/or latitude and longitude for the locations of all components of the processing, treatment, storage, and/or disposal system. See Supplemental Instructions for additional information. [Paragraph (2) and (5) of Subsection C of 20.6.2.3106 NMAC]

Component[1] ID	Town ship	Range	Section(s)	Latitude	Longitude
Treatment Systen	10 South	13 East	34	33.404863 N	105.675451 W
Infiltration gallery	10 South	13 East	34	33.404344 N	105.675969 W
300 Gal. Tank	10 South	13 East	34	33.404863 N	105.675451 W
Monitoring Wells	10 South	13 East	34	See Table 4 (varie	

[1] Components include: septic tanks, impoundments, treatment systems, irrigation sites, leachfields, monitoring wells, mine stockpiles, etc. Additional examples are listed in the Supplemental Instructions. Each component should have a unique ID, for example septic tank-1, monitoring well-3, etc.

6. Processing, Treatment, Storage, and Disposal System

Briefly describe how wastewater, sludge, etc. is processed, treated, stored, and/or disposed of at your facility. Include each component listed in the table above.

Petroleum contaminated groundwater (and nonaqueous-phase liquid [NAPL]) will be processed through a containerized treatment system provided by H2K Technologies. The water treatment system includes an oil/water separator, diffused aeration tank, an inclined plate clarifier, a bag filter assembly, and liquid carbon vessels for polishing. Treated water will be routed and discharged directly to an on-site infiltration gallery, located on vacant land south of the treatment system. Groundwater is sampled from on-site monitor wells.

7. Public Notice Preparation [20.6.2.3108 NMAC]

Once NMED has determined that your application is administratively complete, you must complete the applicant's public notice requirements of Section 20.6.2.3108 NMAC. Language for notifications will be mailed to you with an administratively complete determination. Note: Guidance and instructions for completion of applicant's public notice can also be found at the following link: *https://www.env.nm.gov/gwb/NMED-GWQB-PublicNotice.htm*. The information requested below will be used by NMED to approve or reject the proposed public notice newspaper and signage posting locations in accordance with Subsection A of 20.6.2.3108 NMAC. Note: Other requirements of Section 20.6.2.3108 NMAC not listed here, such as certified mailings to nearby landowners, may also apply.

a) Public Notice Posting Locations

Select the type of application you are submitting and provide the requested information. Language to be used in the required notifications will be included in the administratively complete packet.

☐ Renewal Application

1. Following receipt of an administrative completeness determination from NMED, the applicant is required to provide public notice of this application by placing a 2 inch by 3 inch display ad (classified or legal sections are not acceptable) in a newspaper of general circulation in the location of the proposed discharge. Indicate the newspaper in which you intend to place the ad. [Subsection C of 20.6.2.3108 NMAC]

Newspaper: ____________________

☑ New Application, Modification Application, or Renewal with Modification Application

1. Following receipt of an administrative completeness determination from NMED, the applicant is required to provide public notice of this application by placing a display ad (classified or legal sections are not acceptable) in a newspaper of general circulation in the location of the proposed discharge. Indicate the newspaper in which you intend to place the ad. [Paragraph (4) of Subsection B of 20.6.2.3108 NMAC]

Newspaper: Ruidoso News

2. Following receipt of an administrative completeness determination from NMED, the applicant is required to post a sign(s) (2 feet x 3 feet in size) for 30 days in a location conspicuous to the public at or near the facility. One sign must be posted for each 640 contiguous acres or less. NMED may require additional postings for facilities of more than 640 acres or when the discharge site(s) is not located on contiguous properties. Indicate the location(s) where you intend to display the sign(s). [Paragraph (1) of Subsection B of 20.6.2.3108 NMAC]

Note: Conspicuous location means a location where the sign is visible and legible to the public and the public has access (e.g., at facility entrance on public road).

- Is the entire facility (including all components and discharge sites) contained within **less than** 640 acres, and is the acreage contiguous?

☑ Yes - Indicate a sign location below.
☐ No – Indicate **two** sign locations below.

Sign Location(s): Storefront window

3. Following receipt of an administrative completeness determination from NMED, the applicant is required to post an additional notice (a flyer 8.5” X 11” or larger) for 30 days at an off-site location conspicuous to the public (e.g., public library). Indicate the location where you intend to display the flyer. [Paragraph (1) of Subsection B of 20.6.2.3108 NMAC]

Note: The U.S. Postal Service no longer allows the posting of flyers in post offices.

Flyer Location: Ruidoso Public Library

b) Mailing Instructions

a) The administrative completeness determination letter, including public notice instructions, should be sent to:

☐ Applicant ☑ Consultant

Part II. Technical Completeness

1. Discharge Volume and Description

a. Date of Initial Discharge at the Facility [Subsections A and B of 20.6.2.3106 NMAC]

Date of Initial Discharge: 8/1/2021

b. Determination of Maximum Daily Discharge Volume [Subsection C of 20.6.2.3106 NMAC]

See Supplemental Instructions for more information.

1. **Proposed maximum daily discharge volume:** 1,500 gallons per day.

(*Note: Use this volume to complete Part I.4.a (Public Notice).*

- Describe the methods and calculations used to determine this volume. Acceptable methods are described in the Supplemental Instructions. If you are relying on metered flows, attach a two-year record of meter readings.

Emulsified fluids will be extracted using stinger tubes under high vacuum, generating water, NAPL, and soil vapor. Pilot testing was completed in June 2015 (see Attachment 2) that produced a little more than 300 gallons from 2 wells in 8 hours. Different operational conditions were evaluated, generating more water than anticipated from full scale remediation system operation. DBS&A expects to generate no more than 200 gallons per day of groundwater, on average, from 7 total remediation wells. The infiltration gallery has been sized for 1,500 gallons per day, and the treatment system will process in batches.

- Describe what generates the wastewater, sludge, or other discharges processed and/or disposed of at your facility. Identify all sources (e.g., RV spaces, mobile homes, shower facilities, laundromat, restaurant, backwash systems, septage haulers, contaminated media, etc.). See Supplemental Instructions.

Diesel and gasoline fuels leaked from underground storage tanks and have contaminated groundwater. Emulsified fluids will be extracted and treated using an on-site water treatment system. Treated water will be discharged to an infiltration gallery.

2. **Identify other wastewater or stormwater discharges at the facility** not described in this application and indicate what other permits apply to them. Examples include discharges from small septic systems covered by Liquid Waste Permits, discharges to surface waters under a NPDES permit, a discharge covered by a separate Discharge Permit, etc. Be sure these other discharge locations are identified on the site map required in item Part II.B.1.

Other Discharges	Permit Number

2. Identification and Physical Description of Facility

[Subsection C of 20.6.2.3106 NMAC]

a. Scaled Map

Provide a clear and legible scaled electronic map of the components of your proposed system and relevant surrounding features, indicating the location of all the following features present at the site:

- overall facility layout
- treatment units
- lagoons
- tanks
- sumps
- land application fields
- domestic wastewater re-use areas
- pits
- stockpiles
- leachfields
- sludge drying beds
- fences
- roads
- buildings
- supply wells
- monitoring wells
- extraction/injection wells
- arroyos
- nearby water bodies such as ponds or canals
- property boundaries
- other permitted discharges
- required setbacks
- north arrow

b. Description of Components

Provide descriptive details of all components of your processing, treatment, storage, and/or disposal system. Include all components listed in the table of Part I.5.

Component	Status[1]	Date of installation or construction (mm/dd/yyyy)	Description (construction material, liner type, irrigation method, capacity, dimensions, area, model number, etc.)
Treatment Sy:	Proposed	N/A	H2K Technologies Oil/water separator LLS8, H2K Tech Diffused Aeration Tank DTA-2,
			H2K Tech Inclined plate clarifier IPC-40, Pentair L-88 Bag filter assembly,
			H2K Tech Liquid Phase Carbon vessels LC-005
300 Gal. Tank	Proposed	N/A	UL 142 double wall tank, steel (for NAPL storage)
Infiltration gall	Proposed	N/A	Buried pipe network
Monitoring We	Existing in use	2009-2015	MW-1S,1D,2S,2D,3S,4S,5S,6S,6D,7S,7D,8S,9S,9D,10S,11S,13S (figure attached)

[1] Status = **proposed**; **existing in use**; **existing not in use**, but proposed for use; **abandoned** without closure, not proposed for use; or **closed**

3. Flow Metering

Describe the facility's flow metering system. See Supplemental Instructions for more information.

Meter ID[1]	Proposed or Existing?	Influent or Effluent?	Location Description	Flow Type[2]	Meter Type[3]	Supporting Documents Attached
Meter-1	Proposed	Effluent	Discharge from treated water tank	Pumped	Closed-pipe	Manufacturer P&ID

[1] Meter ID means the numbering or labeling system used to individually identify each meter (e.g., Meter-1, Irrigation Meter-1, etc.).
[2] Flow type - **gravity** flow or pressurized (**pumped**) flow
[3] Meter type - **open channel** such as a weir or flume, or a **closed-pipe** velocity meter such as an electromagnetic meter

4. Discharge Quality

Indicate the expected quality of the discharge (wastewater, leachate, sludge, etc.) that is generated, stored, treated, processed and/or discharged at your facility.

Note: Not all facilities need to characterize influent quality. See Supplemental Instructions for additional guidance.

Contaminants	**Contaminants**	
	Incoming (Influent)	Final (Effluent)
Nitrate as Nitrogen (NO_3-N, mg/L)[1]	1.9	<1.0
Total Kjeldahl Nitrogen (TKN, mg/L)[1]	1.7	<1.0
Total Dissolved Solids (TDS, mg/L)[1]	1,772	1,000
Chloride (Cl, mg/L)[1]	398	300 - 400
Total Suspended Solids (TSS, mg/L)[2]	N/A	<30 mg/L
Biochemical Oxygen Demand (BOD, mg/L)[2]	N/A	<30 mg/L
Fecal Coliform Bacteria (CFU/100 mL)[2]	N/A	N/A
pH[3]	7	7
Metals (attach list)[3]	*See Table 2	*See Table 2
Organic Compounds (attach list)[3]	*See Table 3	*See Table 3

1. Include for <u>all</u> domestic systems.
2. Include for domestic systems that use an advanced treatment process.
3. Include for industrial or mining systems if these are contaminants of concern. If metals or organic compounds are present in the discharge, attach a list of influent and effluent concentrations for each metal/organic compound.

5. Ground Water Monitoring

Discharge Permits typically require that ground water samples be collected quarterly from properly constructed monitoring wells located downgradient from discharge locations. The samples must be analyzed for contaminants of concern. For most domestic and agricultural Discharge Permits, the typical contaminants of concern are total Kjeldahl nitrogen (TKN), nitrate-nitrogen (NO_3-N), total dissolved solids (TDS), and chloride (Cl). For most industrial Discharge Permits, typical contaminants of concern are volatile and semi-volatile organic compounds (VOC's), polynuclear aromatic hydrocarbons (PAH's), polychlorinated biphenyls (PCB's), metals, and radionuclides. See Supplemental Instructions for additional information.

a. Depth-to-Most-Shallow Ground Water [Subsection C of 20.6.2.3106 NMAC]

1. **Facilities *with* on-site monitoring wells**

Provide the depth-to-most-shallow ground water from the most recent ground water levels obtained from monitoring wells at the facility. Depth-to-ground water shall be measured to the nearest 0.01 feet using standard methods and techniques [Subsection B of 20.6.2.3107 NMAC].

Depth-to-ground water is: 45-90 feet

Note: Use this depth to complete Part I.4.b (Public Notice).

2. **Facilities *without* on-site monitoring wells**

If a facility does not have a monitoring well intersecting most-shallow ground water, provide depth-to-most-shallow ground water for all wells on file located within one mile of the boundary of the facility. This information can be obtained from the Office of the State Engineer (http://www.ose.state.nm.us).

Depth-to-ground water is: N/A____ feet

Note: Use the range of depths from these records to complete Part I.4.b (Public Notice).

☐ Attached – Records from the Office of the State Engineer, including the following:
- location of each well by latitude/longitude and township, range, and section
- use of each well
- depth to ground water in each well
- total depth of each well

b. Ground Water Flow Direction [Subsection C of 20.6.2.3106 NMAC]

1. **Facilities with *three or more* on-site monitoring wells**

Provide ground water flow direction beneath the facility on a ground water elevation contour map. The ground water elevation contour map shall be developed based upon the most recent ground water levels and survey data obtained from on-site monitoring wells.

Flow Direction Generally East (see maps)

☑ Included – Ground water contour map from on-site monitoring wells

☑ Included – Monitoring well survey

☐ No survey has been conducted

☐ Survey previously submitted on ______ (date)

This information is provided in Attachment 3.

2. **Facilities with *less than three* on-site monitoring wells**

If a facility does not have at least three monitoring wells intersecting most-shallow ground water, provide ground water flow direction based upon either the most recent regional water level data or published hydrogeologic information. Attach the sources of information used to determine ground water flow direction. *Select all that apply.*

☐ Ground water flow direction of the most-shallow ground water beneath the facility based upon the *most recent regional water level data* is _____.
-- Reference: _____ (attach relevant portions)

☐ Attached - Survey data from nearby monitoring wells and a *ground water elevation contour map* indicating the direction of ground water flow.

☐ Ground water flow direction of the most-shallow ground water beneath the facility based upon *published hydrogeologic information* is _____.

-- Reference: _____ (attach relevant portions)

c. Monitoring Well Construction and Identification [Subsection C of 20.6.2.3106 NMAC; Subsection A of 20.6.2.3107 NMAC]

1. **For existing monitoring wells**
   Submit construction logs for all existing, on-site monitoring wells, which indicate the date of installation and well driller.

   ☑ Included - Construction logs for each existing monitoring well.

   ☐ Previously Submitted
   Date _____

This information is provided in Attachment 4.

2. **For all monitoring wells -** Identify proposed and existing monitoring well (MW) locations.

MW ID[1]	Proposed or Existing?	Location Description[2] AND Latitude and Longitude	Screen Interval (ft)	Depth to Water
		*See Figure 2 and Table 4 for a complete lis		

[1] MW ID (Monitoring Well ID) is the numbering or labeling system used to identify a MW (e.g., MW-1, MW-2, etc.).
[2] Example: 60 feet south of the top inside edge of the berm of Wastewater Impoundment-1

d. Past Ground Water Monitoring Results

This item applies only to existing facilities seeking renewal and/or modification of a Discharge Permit that required ground water monitoring. See Supplemental Instructions for additional information.

1. **Attach a graph or table showing all analytical results from ground water monitoring**.

e. Engineering and Surveying

Proposed New Structures or Improvements to Existing Structures

Include electronic plans and specifications for any *proposed* new structures or improvements to existing structures. All final plans and specifications must bear the stamp of a New Mexico licensed Professional Engineer.

- Proposed plans and specifications included (*Select all that apply)*

  ☑ Included for new structure(s)

  ☐ Included for improvements to an existing structure

  ☐ No proposals for new or improved structures

Drawings and specifications for the proposed treatment equipment are provided in Attachment 5

f. Land Application Area Information

For facilities proposing to apply reclaimed or treated wastewater to a land application area, provide calculations showing that nitrogen loading does not exceed 200 lbs/acre/year or that the amount of total nitrogen in the combined application of wastewater and fertilizer does not exceed by more than 25% the amount reasonably expected to be taken up by the crop(s) and removed by harvesting in any 12-month period. Forms to assist in these calculations can be found at: https://www.env.nm.gov/gwb/FORMS/NewMexicoEnvironmentDepartment-GroundWaterQualityBureau-Forms.htm.

☐ Attached – Nitrogen loading calculations

Part III. Additional Proposals and Conditions (if applicable)

In the space provided, propose revisions or additions to the standard Discharge Permit requirements. If you propose any revisions or additions, also provide the rational for your proposal.

Part IV. Maps and Logs to be Attached

1. Surface Soil Survey and Vadose Zone Geology

[Subsection C of 20.6.2.3106 NMAC]

☑ Attached - Most recent regional soil survey map and associated descriptions identifying surface soil type(s).

☑ Attached - Lithologic logs for all existing on-site monitoring wells (if available).

2. Topographic Map [Subsection C of 20.6.2.3106 NMAC]

☑ Attached - Location map with topographic surface contours identifying all of the following features located within a one-mile radius of the facility:

- watercourses
- lakebeds
- sinkholes
- playa lakes
- springs (springs used to provide water for human consumption shall be so denoted)
- wells supplying water for a public water system
- private domestic water wells
- irrigation supply wells
- ditch irrigation systems
- acequias
- irrigation canals
- drains

3. Flood Zone Map [Subsection C of 20.6.2.3106 NMAC]

☑ Attached - Most recent 100-year flood zone map developed by the federal emergency management administration (FEMA) documenting flood potential for the facility.

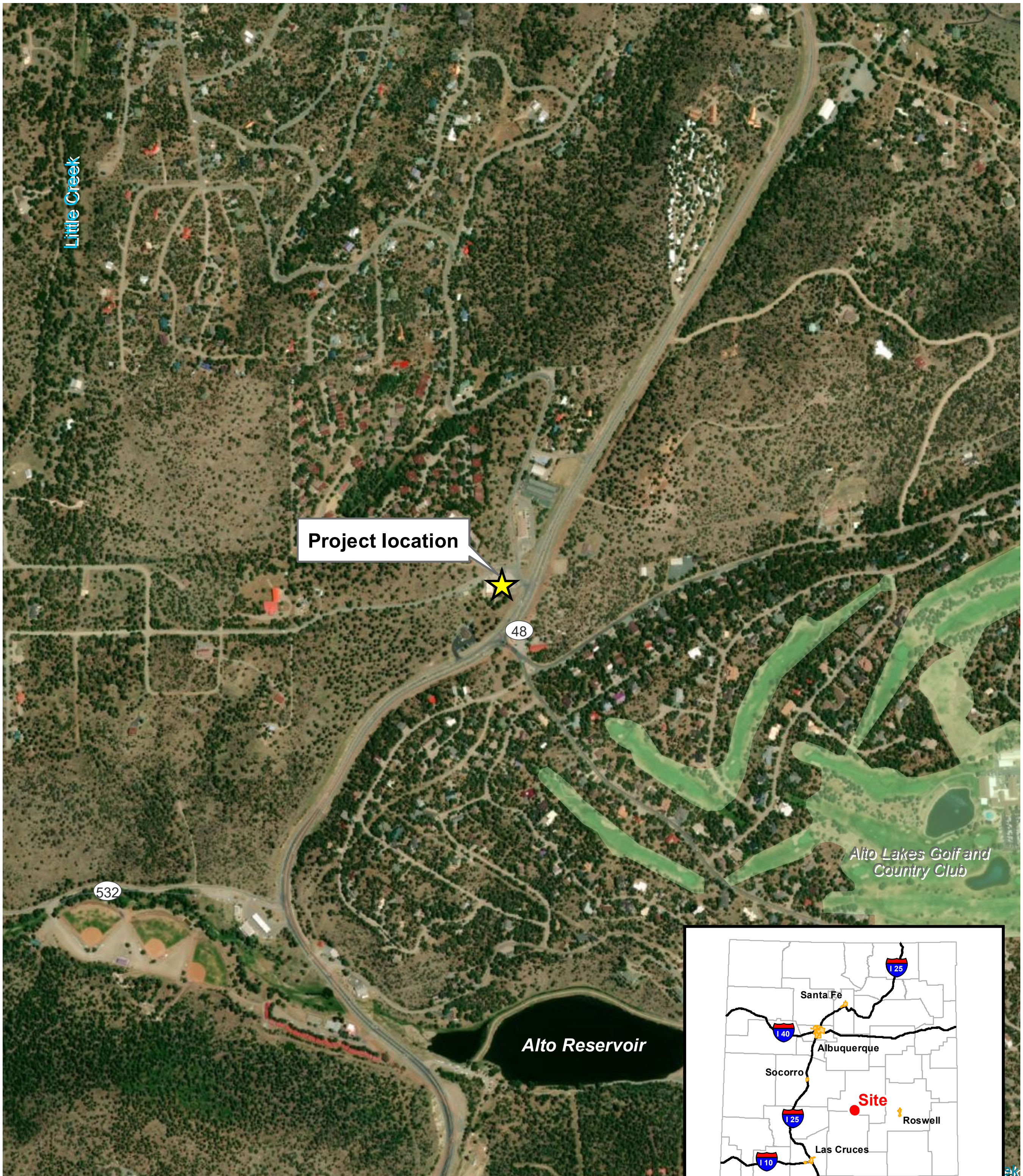
Describe any engineered measures used for flood protection.

The proposed facilities are not located within a recognized flood zone. Storm water will be routed around the proposed infiltration gallery to minimize changes in natural drainage patterns.

4. Additional Information

Describe any additional relevant information.

Figures



Source: Aerial image from Microsoft, April 21, 2011

N

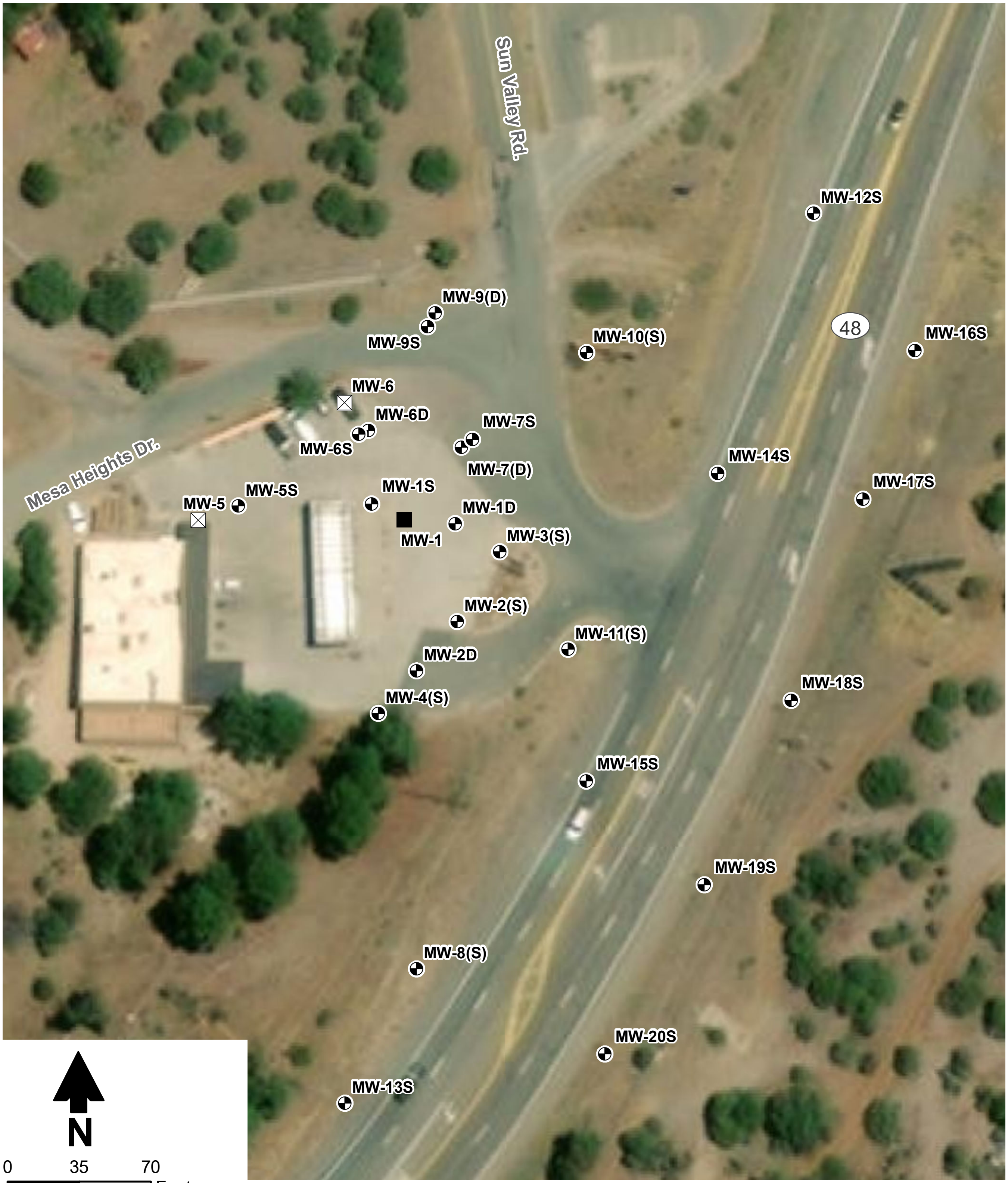
0 500 1000
Feet

\\ss6abq\Data\S\Projects\ES14.0220_Bell_Gas_1186\GIS\MXDs\Site_maps\Area_map.mxd

BELL GAS #1186
ALTO, NEW MEXICO
Area Map

Daniel B. Stephens & Associates, Inc.
6/26/2015 JN ES14.0220.00

Figure 1



Source: Aerial image from Microsoft, April 21, 2011

Explanation

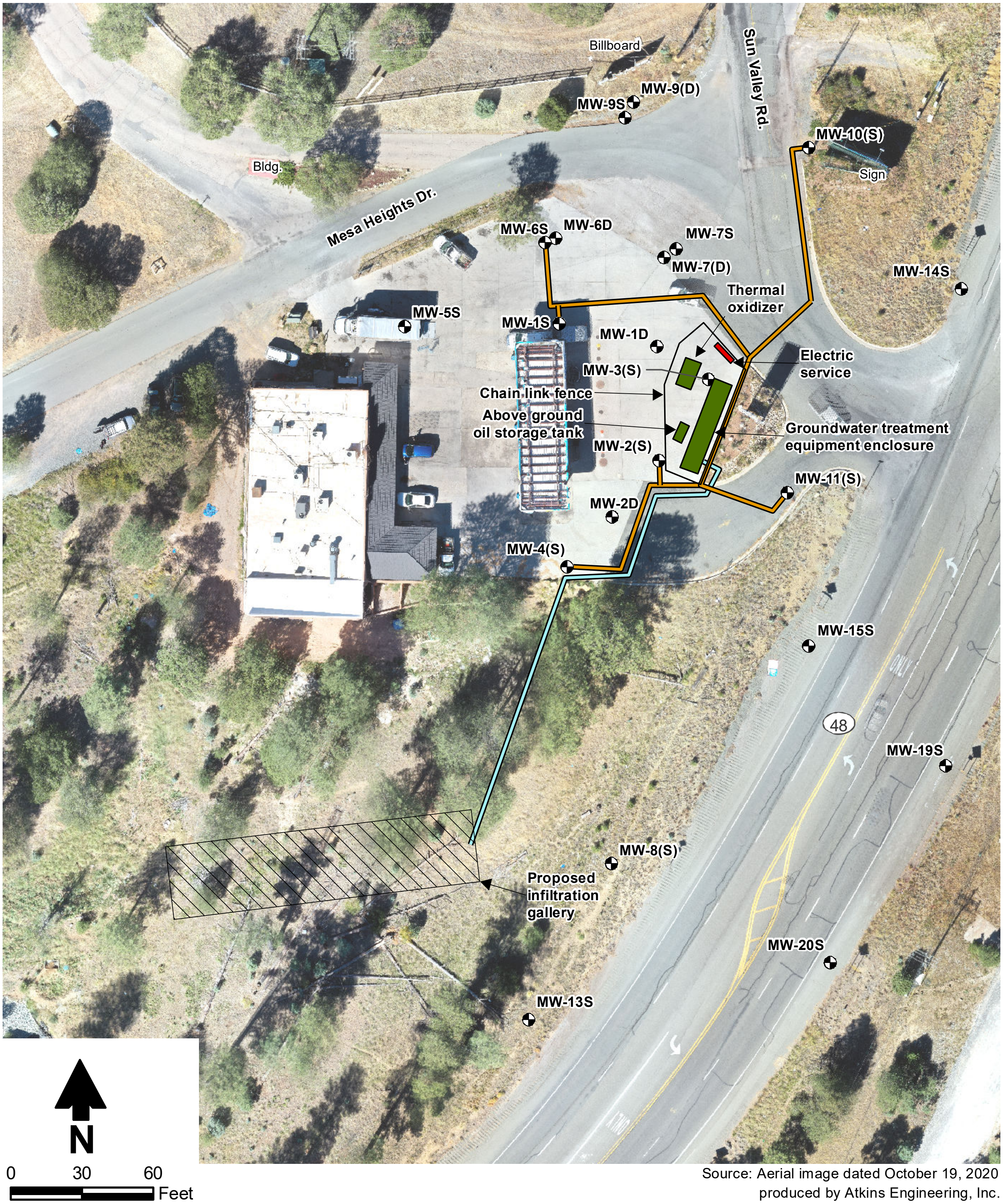
- Monitor well
- Destroyed monitor well
- Abandoned monitor well

\\ss6abq\Data\S\Projects\ES14.0220_Bell_Gas_1186\GIS\MXDs\Site_maps\Site_map.mxd

BELL GAS #1186
ALTO, NEW MEXICO
Site Map

Daniel B. Stephens & Associates, Inc.
4/18/2016 JN ES14.0220.00

Figure 2



Source: Aerial image dated October 19, 2020 produced by Atkins Engineering, Inc.

Explanation

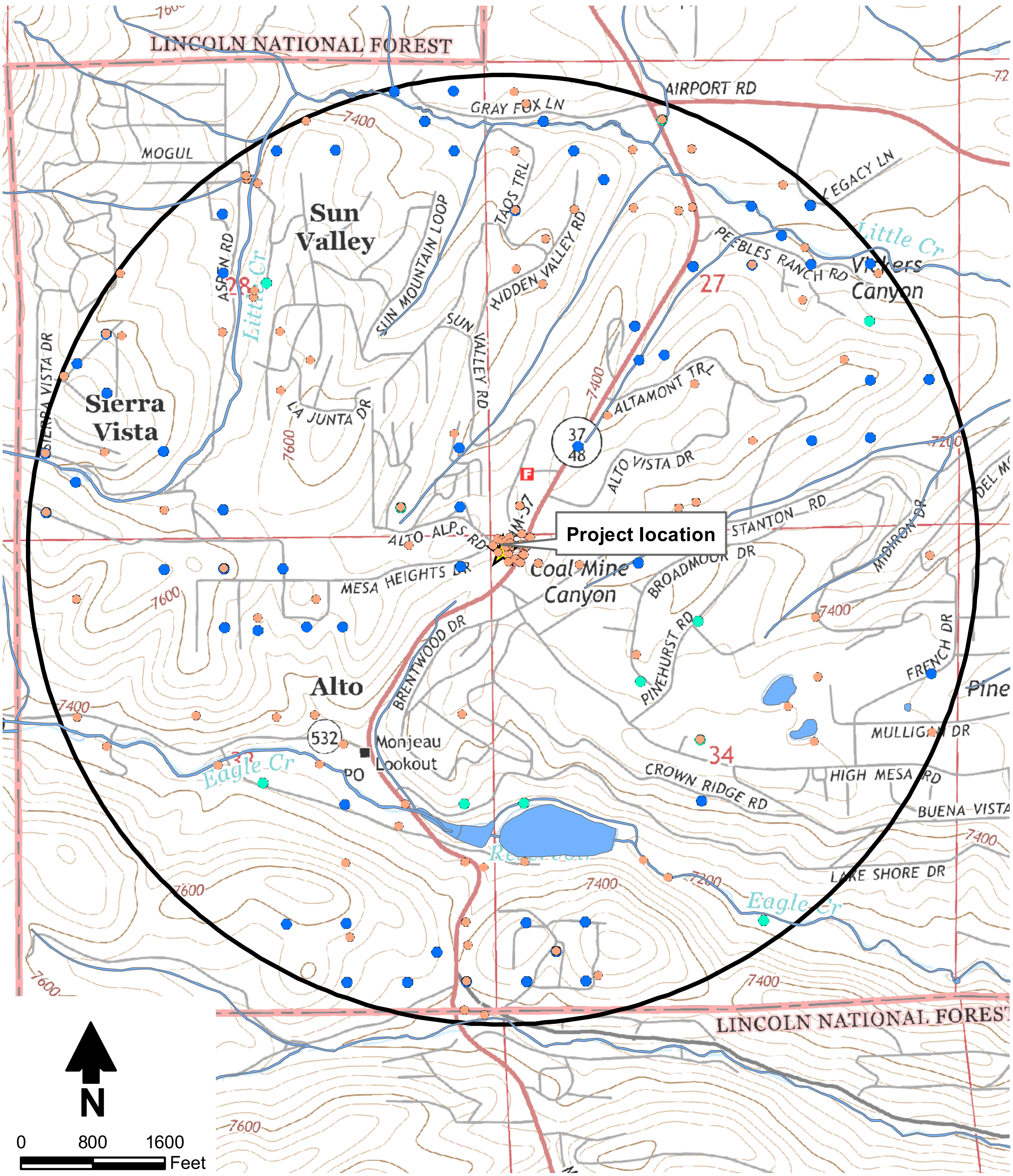
- Monitor well
- Conveyance line
- Treated water discharge

S:\Projects\ES14.0220_Bell_Gas_1186\GIS\MXDs\Engineering\Proposed_system_layout.mxd

BELL GAS #1186
ALTO, NEW MEXICO
Remediation System Layout

Daniel B. Stephens & Associates, Inc.
12/10/2020 JN ES14.0220.00

Figure 3



Explanation

- Domestic well
- Public use well
- Well (other)
- Wetland
- One mile radius

Source: U.S. Geological Survey 7.5 minute quadrangle maps for NM Angus, US Topo 2013, Published 20180821, Accessed at http://rgis.unm.edu/ on November 4, 2020

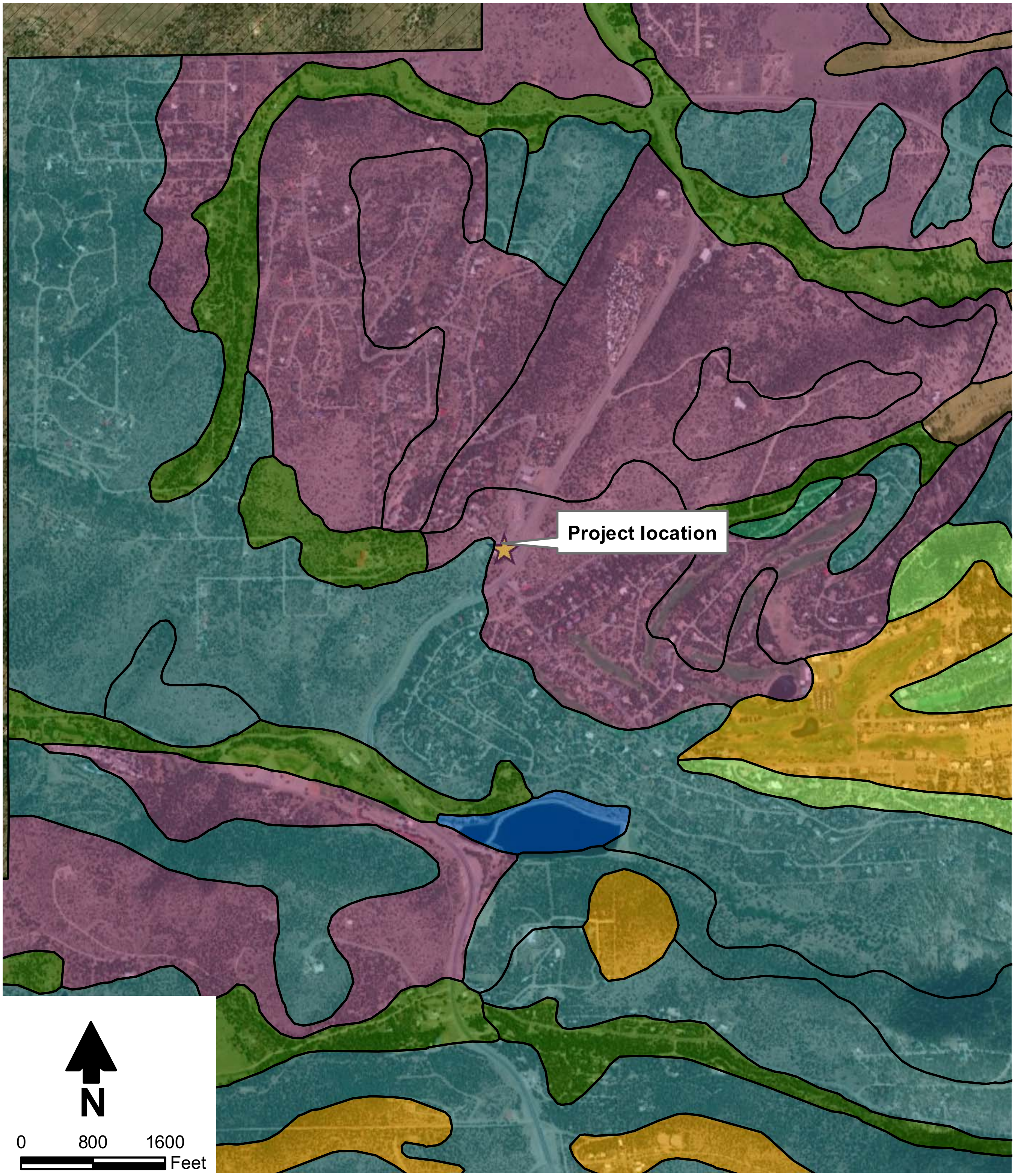
Wetland data: U.S Fish & Wildlife Service
New Mexico Wetlands, Published October 2020
Accessed at https://www.fws.gov/ on November 4, 2020
Well Data: New Mexico Office of the State Engineer (OSE)
Accessed at https://www.ose.state.nm.us/ on November 4, 2020

BELL GAS #1186
ALTO, NEW MEXICO
Topographic Map

Daniel B. Stephens & Associates, Inc.
11/6/2020
JN ES14.0220.00

Figure 4

\\ss6abq\Data\S\Projects\ES14.0220_Bell_Gas_1186\GIS\MXDs\Final_Remediation_Plan\FigX_Topographic_Map.mxd



Source: United States Department of Agriculture (USDA) Web Soil Survey (WSS) Accessed from https://websoilsurvey.sc.egov.usda.gov/ on November 6, 2020

Explanation

- Gavilan loam
- Gavilan very gravelly loam
- Monjeau-Docdee complex
- Nolten loam
- Paco loam
- Ruidoso clay loam
- Sampson loam
- Water
- No Digital Data Available

BELL GAS #1186
ALTO, NEW MEXICO
Soils Map

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Daniel B. Stephens & Associates, Inc.
11/6/2020 JN ES14.0220.00

Figure 5

Source: Panel 1895D
National Flood Insurance Rate Map
Lincoln County, New Mexico, November 16, 2011
Accessed at https://msc.fema.gov on November 6,2020

N

0 800 1600 Feet

Explanation

One mile radius

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.

BELL GAS #1186
ALTO, NEW MEXICO
FEMA Floodplain Map

Daniel B. Stephens & Associates, Inc.
11/6/2020 JN ES14.0220.00

Figure 6

\\ss6abq\DataS\Projects\ES14.0220_Bell_Gas_1186\GIS\MXDs\Final_Remediation_Plan\FigX_FEMA_Flood_Map.mxd

Tables

Table 1. Summary of Cation-Anion Analytical Chemistry Data for Groundwater
Bell Gas #1186, Alto, New Mexico

Well Name	Date Sampled	Concentration [a] (mg/L)											
		Na [a]	Ca [a]	Mg [a]	K [a]	F [b]	Cl [b]	HCO3 [c]	SO4 [b]	Nitrate+Nitrite (as N) [b]	TKN [d]	TDS [e]	Groundwater Water Type [f]
NMWQCC Standard [g]		*None*	*None*	*None*	*None*	*1.6*	*250*	*None*	*600*	*10*	*None*	*1,000*	*N/A*
Shallow On-Site Wells (Avg)		156	342	68	6	0.3	**398**	571	351	2.6	1.7	**1,772**	
MW-1S	10/07/15	*160*	*300*	*67*	*5.0*	*0.31*	**420**	826.7	5.4	<1.0	5.6	**1,630**	Ca-Na-Mg-HCO3-Cl
MW-1D	10/07/15	110	290	71	5.7	0.11	**400**	334.8	380	<1.0	<1.0	**1,640**	Ca-Mg-Cl-SO4-HCO3
MW-2D	10/07/15	81	270	65	6.5	0.16	170	297.6	**640**	<1.0	1.3	**1,470**	Ca-Mg-SO4-HCO3-Cl
MW-5S	10/07/15	240	550	100	3.6	<0.10	**460**	498.6	**1100**	**11**	1.4	**2,880**	Ca-Na-SO4-Cl
MW-6S	10/07/15	190	280	54	5.7	0.19	**450**	660.9	30	<1.0	<2.0	**1,470**	Ca-Na-Cl-HCO3
MW-6D	10/07/15	120	330	72	6.9	0.17	**500**	469.4	200	<1.0	<2.0	**1,780**	Ca-Mg-Cl-HCO3
MW-7S	10/07/15	92	310	67	12	0.33	**380**	213.4	590	<1.0	<5.0	**1,630**	Ca-Mg-SO4-Cl
MW-7D	10/07/15	57	210	58	5.8	0.19	**330**	389.7	140	<1.0	<5.0	**1,120**	Ca-Mg-Cl-HCO3
MW-8S [h]	10/06/15	190	520	100	9.5	<0.10	**1,300**	507.0	33	<1.0	<5.0	**3,220**	Ca-Cl
MW-9S	10/06/15	100	270	51	4.2	<2.0	**280**	656.3	29	<1.0	<2.0	**1,250**	Ca-Na-Mg-HCO3-Cl
MW-9D	10/06/15	82	400	93	7.0	<0.10	**390**	167.6	**910**	<1.0	<5.0	**1,830**	Ca-Mg-SO4-Cl
MW-13S [h]	10/06/15	180	930	190	11.0	<0.10	**2,400**	267.4	180	<2.0	<5.0	**5,130**	Ca-Mg-Cl

[a] Samples analyzed in accordance with EPA Method 6010B.
[b] Samples analyzed in accordance with EPA Method 300.0.
[c] Samples analyzed in accordance with SM 2320B (mg/L as $CaCO_3$).
[d] Samples analyzed in accordance with SM 4500 NORG C.
[e] Samples analyzed in accordance with SM 2540C.
[f] Water type calculated by AquaChem based on an analysis of major cations and anions.
[g] NMWQCC = New Mexico Water Quality Control Commission
[h] Wells near infiltration gallery (not included in the TDS average calculation)

mg/L = Milligrams per liter
Na = Sodium
Ca = Calcium
Mg = Magnesium
K = Potassium
F = Fluoride
Cl = Chloride

HCO3 = Bicarbonate
SO4 = Sulfate
N = Nitrogen
TKN = Total Kjeldahl Nitrogen
TDS = Total dissolved solids
N/A = Not applicable
RECW = Ruidoso Eagle Creek well

Table 2. Summary of Analytical Inorganic Chemistry Data for Groundwater Bell Gas #1168, Alto, New Mexico

Well Name	Date Sampled	Concentration (mg/L)		
		Iron [a]	Manganese [a]	Lead
NMWQCC Standard [c]		*1.0*	*0.2*	*0.015*
Estimated treated effluent		<0.1	<0.2	<0.0050
Average raw influent		0.36	**5.3**	<0.0050
MW-2(S) [c]	06/16/15	0.049	**3.1**	<0.0050
MW-3(S) + [c, d]	06/18/15	0.16	**4.8**	<0.0050
MW-10(S) [c]	06/17/15	0.87	**8.1**	<0.0050

Bold indicates that value exceeds applicable standard.

[a] Samples analyzed in accordance with EPA method 200.7.

[b] New Mexico Water Quality Control Commission (NMWQCC) standard, unless otherwise noted.

[c] Sample collected during multi-phase extraction pilot testing.

[d] Composite sample collected using varying amounts of groundwater from all wells listed.

mg/L = Milligrams per liter
TDS = Total dissolved solids
NA = Not analyzed

Table 4. Summary of Groundwater Analytical Organic Chemistry Data
Bell Gas #1186, Alto, New Mexico

Well Name	Date Sampled	Concentration (µg/L) [a]								
		Benzene	Toluene	Ethyl-benzene	Total Xylenes	BTEX	MTBE	EDB	EDC	Total Naphthalenes
NMWQCC Standard [b]		*5*	*1,000*	*700*	*620*	*None*	*100*	*0.05*	*5*	*30*
Estimated treated effluent		<1	<10	<5	<20	<36	<1	<0.01	<1	<30
Estimated raw water influent		**220**	**890**	400	**2,500**	3,960	22	<10 [e]	<10 [e]	**680**
MW-2(S)	06/16/15 [d]	**170**	**890**	400	**2,500**	3,960	<50	<50 [e]	<50 [e]	**680**
MW-3(S) + [c]	06/18/15 [d]	**52**	160	290	**960**	1,462	<10	<10 [e]	<10 [e]	**560**
MW-10(S)	06/17/15 [d]	**220**	210	300	**1,000**	1,730	22	<20 [e]	<20 [e]	**480**

Bold indicates values that exceed applicable standards.

[a] Samples analyzed in accordance with EPA method 8260B, unless otherwise noted.

[b] New Mexico Water Quality Control Commission (NMWQCC) standard, unless otherwise noted.

[c] Composite sample collected using varying amounts of groundwater extracted from monitor wells MW-3(S), MW-4(S), MW-6S, MW-6D, and MW-11(S).

[d] Sample collected during multi-phase extraction pilot testing.

[e] Laboratory reporting limit is equal or greater than the NMWQCC standard.

µg/L = Micrograms per liter
BTEX = Benzene, toluene, ethylbenzene, and total xylenes
MTBE = Methyl tertiary-butyl ether
EDB = 1,2-Dibromoethane
EDC = 1,2-Dichloroethane
TPH = Total petroleum hydrocarbons
GRO = Gasoline range organics
DRO = Diesel range organics
NAPL = Nonaqueous-phase liquid
NA = Not analyzed

Table 4. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Latitude and Longitude	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-1S	33.404966 -105.675633	60–90	7490.76	10/05/15	62.78	---	0.00	7427.98
				07/19/16	66.44	66.40	0.04	7424.35
				10/13/16	62.40	62.28	0.12	7428.46
				01/30/17	59.93	59.74	0.19	7430.99
				04/11/17	68.77	68.55	0.22	7422.17
				12/12/17	67.50	66.99	0.51	7423.68
				03/06/18	64.33	---	0.00	7426.43
				06/11/18	73.14	72.55	0.59	7418.11
				08/14/18	66.01	---	0.00	7424.75
				09/25/18	61.17	---	0.00	7429.59
				01/28/20	66.41	66.19	0.22	7424.53
				04/13/20	65.33	65.23	0.10	7425.51
MW-1D	33.40493968 -105.6755058	134.5–154.5	7488.70	05/12/15	118.51	---	0.00	7370.19
				06/15/15	118.38	---	0.00	7370.32
				07/15/15	113.10	---	0.00	7375.60
				08/18/15	105.76	---	0.00	7382.94
				09/08/15	110.53	110.52	0.01	7378.18
				10/05/15	116.38	---	0.00	7372.32
				07/21/16	124.10	---	0.00	7364.60
				10/13/16	116.74	---	0.00	7371.96
				01/30/17	114.05	---	0.00	7374.65
				04/11/17	123.25	---	0.00	7365.45
				12/12/17	124.76	---	0.00	7363.94
				03/06/18	122.09	---	0.00	7366.61
				06/11/18	128.81	---	0.00	7359.89
				09/25/18	116.78	---	0.00	7371.92
				01/28/20	125.68	---	0.00	7363.02
				04/13/20	120.93	---	0.00	7367.77

Table 4. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Latitude and Longitude	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-2(S)	33.404808	67–97	7488.05	01/01/09	73.74	69.08	4.66	7418.04
	-105.6755039			09/01/10	72.24	57.30	14.94	7427.76
				08/01/11	Not measured			
				10/01/11	79.99	70.34	9.65	7415.78
				02/01/13	90.30	72.31	17.99	7412.14
				04/08/15	79.11	60.45	18.66	7423.87
				05/12/15	68.73	68.52	0.21 [c]	7419.49
				06/15/15	71.14	70.13	1.01	7417.72
				07/15/15	67.13	64.82	2.31	7422.77
				08/18/15	64.47	63.33	1.14	7424.49
				09/08/15	67.44	66.77	0.67	7421.15
				10/05/15	69.89	68.96	0.93	7418.90
				07/18/16	77.80	71.22	6.58	7415.51
				10/14/16	73.66	71.65	2.01	7416.00
				01/30/17	66.26	63.42	2.84	7424.06
				04/11/17	75.47	73.34	2.13	7414.28
				12/12/17	79.27	74.93	4.34	7412.25
				03/06/18	74.21	72.91	1.30	7414.88
				06/11/18	79.00	77.96	1.04	7409.88
				08/14/18	68.01	66.36	1.65	7421.36
				09/25/18	64.26	62.09	2.17	7425.53
				01/28/20	76.82	72.70	4.12	7414.53
				04/13/20	72.77	70.89	1.88	7416.78
MW-2D	33.40474264	100–130	7487.73	05/12/15	71.81	---	0.00	7415.92
	-105.6755693			06/15/15	72.87	---	0.00	7414.86
				07/15/15	70.48	---	0.00	7417.25
				08/18/15	65.14	---	0.00	7422.59
				09/05/15	67.48	---	0.00	7420.25

Table 4. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Latitude and Longitude	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-2D (cont.)	33.40474264 -105.6755693	100–130	7487.73	10/05/15	71.27	---	0.00	7416.46
				07/21/16	75.19	---	0.00	7412.54
				10/12/16	72.35	---	0.00	7415.38
				01/30/17	67.87	---	0.00	7419.86
				04/11/17	74.47	---	0.00	7413.26
				12/12/17	75.96	---	0.00	7411.77
				03/06/18	74.97	---	0.00	7412.76
				06/11/18	78.37	---	0.00	7409.36
				09/25/18	71.52	---	0.00	7416.21
				01/28/20	75.81	---	0.00	7411.92
				04/13/20	74.79	---	0.00	7412.94
MW-3(S)	33.40490139 -105.6754349	65–95	7487.37	01/01/09	73.59	---	0.00	7413.78
				09/01/10	65.00	63.55	1.45	7423.53
				08/01/11	Not measured			
				10/01/11	77.93	70.81	7.12	7415.14
				02/01/13	79.80	76.50	3.30	7410.21
				04/08/15	73.96	69.81	4.15	7416.73
				05/12/15	70.36	70.31	0.05 [c]	7417.05
				06/15/15	71.21	71.16	0.05	7416.20
				07/15/15	66.80	---	0.00	7420.57
				08/18/15	66.29	63.83	2.46	7423.05
				09/08/15	68.45	68.16	0.29	7419.15
				10/05/15	71.27	70.81	0.46	7416.47
				07/18/16	74.31	74.04	0.27	7413.28
				10/14/16	71.53	71.45	0.08	7415.90
				01/30/17	64.75	---	0.00	7422.62
				04/11/17	73.96	73.86	0.10	7413.49
				12/12/17	75.80	75.47	0.33	7411.83

Table 4. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Latitude and Longitude	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-3(S) (cont.)	33.40490139 -105.6754349	65–95	7487.37	03/06/18	79.39	72.00	7.39	7413.89
				06/11/18	80.52	77.25	3.27	7409.47
				08/14/18	76.65	68.55	8.10	7417.20
				09/25/18	75.13	66.72	8.41	7418.97
				01/28/20	77.45	74.61	2.84	7412.19
				04/13/20	72.89	72.24	0.65	7415.00
MW-4(S)	33.40468544 -105.6756309	66–86	7487.02	08/01/11	69.65	66.18	3.47	7420.15
				10/01/11	65.20	61.00	4.20	7425.18
				02/01/13	71.00	64.51	6.49	7421.21
				04/08/15	50.29	48.25	2.04	7438.36
				05/12/15	51.17	51.16	0.01[c]	7435.86
				06/15/15	56.16	55.92	0.24	7431.05
				07/15/15	45.72	45.69	0.03	7441.32
				08/18/15	44.97	44.93	0.04	7442.08
				09/08/15	49.85	49.81	0.04	7437.20
				10/05/15	54.89	54.86	0.03	7432.15
				07/18/16	58.50	58.48	0.02	7428.54
				10/14/16	49.55	49.48	0.07	7437.53
				01/30/17	42.94	42.92	0.02	7444.10
				04/11/17	57.03	56.96	0.07	7430.05
				12/12/17	51.94	51.92	0.02	7435.10
				03/06/18	47.26	47.19	0.07	7439.82
				06/11/18	59.30	59.24	0.06	7427.77
				09/25/18	40.87	40.86	0.01	7446.16
				01/28/20	47.75	47.73	0.02	7439.29
				04/13/20	46.41	46.40	0.01	7440.62
MW-5S	33.40496475 -105.6758531	75–105	7493.40	05/12/15	84.35	---	0.00	7409.05
				06/15/15	85.45	---	0.00	7407.95

Table 4. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Latitude and Longitude	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-5S (cont.)	33.40496475 -105.6758531	75–105	7493.40	07/15/15	85.21	---	0.00	7408.19
				08/18/15	79.80	---	0.00	7413.60
				09/08/15	80.13	---	0.00	7413.27
				10/05/15	82.98	--	0.00	7410.42
				07/19/16	87.34	--	0.00	7406.06
				10/12/16	84.12	--	0.00	7409.28
				01/30/17	87.62	--	0.00	7405.78
				04/11/17	89.76	--	0.00	7403.64
				12/12/17	90.42	--	0.00	7402.98
				03/06/18	93.02	--	0.00	7400.38
				06/11/18	97.06	--	0.00	7396.34
				09/25/18	87.70	--	0.00	7405.70
				01/28/20	88.08	--	0.00	7405.32
				04/13/20	87.14	--	0.00	7406.26
MW-6S	33.40506066 -105.6756596	83–113	7490.87	05/12/15	81.34	---	0.00	7409.53
				06/15/15	83.58	---	0.00	7407.29
				07/15/15	83.03	---	0.00	7407.84
				08/18/15	77.57	---	0.00	7413.30
				09/08/15	78.30	---	0.00	7412.57
				10/05/15	81.15	---	0.00	7409.72
				07/19/16	86.44	85.91	0.53	7404.86
				10/14/16	82.43	82.25	0.18	7408.59
				01/30/17	86.16	---	0.00	7404.71
				04/11/17	88.63	---	0.00	7402.24
				12/12/17	89.81	---	0.00	7401.06
				03/06/18	94.72	94.68	0.04	7396.18
				06/11/18	97.37	---	0.00	7393.50
				09/25/18	86.16	---	0.00	7404.71

Table 4. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Latitude and Longitude	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-6S (cont.)	33.40506066 -105.6756596	83–113	7490.87	01/28/20	86.23	---	0.00	7404.64
				04/13/20	84.09	---	0.00	7406.78
MW-6D	33.4050654 -105.6756442	120–140	7490.70	05/12/15	120.71	---	0.00	7369.99
				06/15/15	120.54	---	0.00	7370.16
				07/15/15	115.50	---	0.00	7375.20
				08/18/15	108.51	---	0.00	7382.19
				09/08/15	112.78	---	0.00	7377.92
				10/05/15	118.55	---	0.00	7372.15
				07/19/16	126.70	---	0.00	7364.00
				10/12/16	119.54	---	0.00	7371.16
				01/30/17	116.57	---	0.00	7374.13
				04/11/17	125.35	---	0.00	7365.35
				12/12/17	126.77	---	0.00	7363.93
				03/06/18	124.26	---	0.00	7366.44
				06/11/18	131.47	---	0.00	7359.23
				09/25/18	119.33	---	0.00	7371.37
				01/28/20	126.92	---	0.00	7363.78
				04/13/20	123.63	---	0.00	7367.07
MW-7(S)	33.405053 -105.675478	70–100	7488.61	10/05/15	75.44	---	0.00	7413.17
				07/20/16	73.60	---	0.00	7415.01
				10/13/16	70.56	---	0.00	7418.05
				01/30/17	68.39	---	0.00	7420.22
				04/11/17	71.35	---	0.00	7417.26
				12/12/17	72.52	---	0.00	7416.09
				03/06/18	72.61	---	0.00	7416.00
				06/11/18	73.29	---	0.00	7415.32
				09/25/18	68.03	---	0.00	7420.58
				01/28/20	70.28	---	0.00	7418.33

Table 4. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Latitude and Longitude	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-7(S) (cont.)	33.405053 -105.675478	70–100	7488.61	04/13/20	68.93	---	0.00	7419.68
MW-7(D)	33.40504233 -105.6754953	110–130	7488.74	08/01/11	126.58	---	0.00	7362.16
				10/01/11	123.09	---	0.00	7365.65
				02/01/13	Dry			
				04/08/15	112.77	---	0.00	7375.97
				05/12/15	112.68	---	0.00	7376.06
				06/15/15	113.17	---	0.00	7375.57
				07/15/15	111.02	---	0.00	7377.72
				08/18/15	101.47	---	0.00	7387.27
				09/08/15	104.30	---	0.00	7384.44
				10/05/15	108.79	---	0.00	7379.95
				07/20/16	117.39	---	0.00	7371.35
				10/13/16	111.69	---	0.00	7377.05
				01/30/17	112.46	---	0.00	7376.28
				04/11/17	112.45	---	0.00	7376.29
				12/12/17	112.80	---	0.00	7375.94
				03/06/18	115.81	---	0.00	7372.93
				06/11/18	116.67	---	0.00	7372.07
				09/25/18	113.26	---	0.00	7375.48
				01/28/20	114.67	---	0.00	7374.07
				04/13/20	113.64	---	0.00	7375.10
MW-8(S)	33.40434202 -105.6755723	51–81	7476.30	02/01/13	54.76	---	0.00	7421.54
				04/08/15	47.47	47.45	0.02	7428.85
				05/12/15	45.67	---	0.00	7430.63
				06/15/15	49.13	---	0.00	7427.17
				07/15/15	46.44	---	0.00	7429.86
				08/18/15	45.03	---	0.00	7431.27

Table 4. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Latitude and Longitude	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-8(S) (cont.)	33.40434202	51–81	7476.30	09/08/15	46.81	---	0.00	7429.49
	-105.6755723			10/05/15	49.19	---	0.00	7427.11
				07/21/16	51.20	---	0.00	7425.10
				10/12/16	48.86	---	0.00	7427.44
				01/30/17	45.05	---	0.00	7431.25
				04/11/17	50.26	---	0.00	7426.04
				12/12/17	50.71	---	0.00	7425.59
				03/06/18	49.44	---	0.00	7426.86
				06/11/18	53.44	---	0.00	7422.86
				09/25/18	46.29	---	0.00	7430.01
				01/28/20	50.37	---	0.00	7425.93
				04/13/20	48.32	---	0.00	7427.98
MW-9S	33.40520422	66–96	7489.08	05/12/15	86.41	---	0.00	7402.67
	-105.6755486			06/15/15	85.67	---	0.00	7403.41
				07/15/15	85.83	---	0.00	7403.25
				08/18/15	84.98	---	0.00	7404.10
				09/08/15	85.50	---	0.00	7403.58
				10/05/15	85.72	---	0.00	7403.36
				07/20/16	86.10	---	0.00	7402.98
				10/12/16	85.85	---	0.00	7403.23
				01/30/17	86.23	---	0.00	7402.85
				04/11/17	86.06	---	0.00	7403.02
				12/12/17	86.12	---	0.00	7402.96
				03/06/18	86.51	---	0.00	7402.57
				06/11/18	86.80	---	0.00	7402.28
				09/25/18	86.42	---	0.00	7402.66
				01/28/20	86.10	---	0.00	7402.98
				04/13/20	86.10	---	0.00	7402.98

Table 4. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Latitude and Longitude	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-9(D)	33.40522251 -105.6755366	110–150	7488.58	02/01/13	131.69	---	0.00	7356.89
				04/08/15	119.96	119.94	0.02	7368.64
				05/12/15	118.47	---	0.00	7370.11
				06/15/15	118.62	---	0.00	7369.96
				07/15/15	113.72	---	0.00	7374.86
				08/18/15	106.25	---	0.00	7382.33
				09/08/15	111.38	---	0.00	7377.20
				10/05/15	116.53	---	0.00	7372.05
				07/20/16	123.99	---	0.00	7364.59
				10/12/16	116.85	---	0.00	7371.73
				01/30/17	115.08	---	0.00	7373.50
				04/11/17	123.81	---	0.00	7364.77
				12/12/17	125.05	---	0.00	7363.53
				03/06/18	122.36	---	0.00	7366.22
				06/11/18	128.81	---	0.00	7359.77
				09/25/18	117.92	---	0.00	7370.66
				01/28/20	126.47	---	0.00	7362.11
				04/13/20	121.52	---	0.00	7367.06
MW-10(S)	33.40516838 -105.6752946	72–102	7486.69	02/01/13	84.83	75.31	9.52	7409.67
				04/08/15	79.72	71.45	8.27	7413.75
				05/12/15	74.41	70.78	3.63 [c]	7415.26
				06/15/15	75.35	71.75	3.60	7414.29
				07/15/15	69.31	67.12	2.19	7419.18
				08/18/15	66.88	66.11	0.77	7420.44
				09/08/15	71.49	69.88	1.61	7416.52
				10/05/15	72.26	72.26	Sheen [d]	7414.43
				07/19/16	79.63	74.01	5.62	7411.67
				10/14/16	75.43	72.75	2.68	7413.46

Table 4. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Latitude and Longitude	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-10(S) (cont.)	33.40516838 -105.6752946	72–102	7486.69	01/30/17	66.83	66.04	0.79	7420.51
				04/11/17	77.33	74.18	3.15	7411.94
				12/12/17	81.40	75.46	5.94	7410.16
				03/06/18	74.30	73.75	0.55	7412.84
				06/11/18	84.74	77.24	7.50	7408.10
				08/14/18	70.03	69.56	0.47	7417.05
				09/25/18	69.33	68.64	0.69	7417.93
				01/29/20	79.70	76.20	3.50	7409.86
				04/13/20	75.00	73.09	1.91	7413.26
MW-11(S)	33.40476987 -105.6753265	72–102	7483.31	02/01/13	74.13	---	0.00	7409.18
				04/08/15	74.76	66.43	8.33	7415.38
				05/12/15	68.70	67.20	1.50 [c]	7415.84
				06/15/15	72.18	67.68	4.50	7414.82
				07/15/15	65.85	63.69	2.16	7419.23
				08/18/15	59.65	59.58	0.07	7423.72
				09/08/15	64.37	64.26	0.11	7419.03
				10/05/15	69.87	67.20	2.67	7415.63
				07/19/16	75.82	70.11	5.71	7412.17
				10/14/16	72.63	67.43	5.20	7414.94
				01/30/17	66.20	60.69	5.51	7421.63
				04/11/17	74.19	69.61	4.58	7412.88
				12/12/17	74.03	71.61	2.42	7411.26
				03/06/18	72.50	70.17	2.33	7412.72
				06/11/18	77.16	74.16	3.00	7408.61
				08/14/18	69.14	67.50	1.64	7415.51
				09/25/18	67.97	65.45	2.52	7417.41
				01/28/20	74.70	71.21	3.49	7411.47
				04/13/20	72.07	69.03	3.04	7413.73

Table 4. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Latitude and Longitude	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-12S	33.40535404 -105.6749296	51–81	7473.70	05/12/15	64.58	---	0.00	7409.12
				06/15/15	55.15	---	0.00	7418.55
				07/15/15	51.00	---	0.00	7422.70
				08/18/15	50.57	---	0.00	7423.13
				09/08/15	53.41	---	0.00	7420.29
				10/05/15	54.99	---	0.00	7418.71
				07/20/16	59.99	---	0.00	7413.71
				10/12/16	54.20	---	0.00	7419.50
				01/30/17	48.84	---	0.00	7424.86
				04/11/17	58.63	---	0.00	7415.07
				12/12/17	59.98	---	0.00	7413.72
				03/06/18	53.66	---	0.00	7420.04
				06/11/18	62.97	---	0.00	7410.73
				09/25/18	51.32	---	0.00	7422.38
				01/28/20	58.68	---	0.00	7415.02
				04/13/20	54.18	---	0.00	7419.52
MW-13S	33.40416245 -105.6756877	39.5–69.5	7472.44	05/12/15	55.01	---	0.00	-55.01
				06/15/15	44.78	---	0.00	-44.78
				07/15/15	43.94	---	0.00	-43.94
				08/18/15	40.21	---	0.00	-40.21
				09/08/15	43.03	---	0.00	-43.03
				10/05/15	44.73	---	0.00	-44.73
				07/21/16	46.22	---	0.00	-46.22
				10/11/16	44.99	---	0.00	-44.99
				01/30/17	42.66	---	0.00	-42.66
				04/11/17	46.08	---	0.00	-46.08
				12/12/17	46.79	---	0.00	-46.79

Table 4. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Latitude and Longitude	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-13S (cont.)	33.40416245 -105.6756877	39.5–69.5	7472.44	03/06/18	48.28	---	0.00	-48.28
				06/11/18	48.22	---	0.00	-48.22
				09/25/18	44.68	---	0.00	-44.68
				01/28/20	44.69	---	0.00	-44.69
				04/13/20	43.94	---	0.00	-43.94
MW-14S	33.405005 -105.675086	42–72	7476.16	10/05/15	56.54	---	0.00	7419.62
				07/19/16	58.24	---	0.00	7417.92
				10/11/16	56.18	---	0.00	7419.98
				01/30/17	51.38	---	0.00	7424.78
				04/11/17	57.93	---	0.00	7418.23
				12/12/17	58.43	---	0.00	7417.73
				03/06/18	57.17	---	0.00	7418.99
				06/11/18	59.07	---	0.00	7417.09
				09/25/18	55.09	---	0.00	7421.07
				01/28/20	57.69	---	0.00	7418.47
				04/13/20	56.88	---	0.00	7419.28
MW-15S	33.404593 -105.675299	46–76	7474.33	10/05/15	58.08	---	0.00	7416.25
				07/19/16	61.65	---	0.00	7412.68
				10/11/16	58.77	---	0.00	7415.56
				01/30/17	54.62	---	0.00	7419.71
				04/11/17	60.81	---	0.00	7413.52
				12/12/17	62.35	---	0.00	7411.98
				03/06/18	61.68	---	0.00	7412.65
				06/11/18	64.73	---	0.00	7409.60
				09/25/18	58.38	---	0.00	7415.95
				01/28/20	62.24	---	0.00	7412.09
				04/13/20	59.91	---	0.00	7414.42

Table 4. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Latitude and Longitude	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-16S	33.405168 -105.674770	58–88	7475.36	10/05/15	62.72	---	0.00	7412.64
				07/20/16	64.22	---	0.00	7411.14
				10/11/16	65.91	---	0.00	7409.45
				01/30/17	63.82	---	0.00	7411.54
				04/11/17	63.72	---	0.00	7411.64
				12/12/17	67.48	---	0.00	7407.88
				03/06/18	65.28	---	0.00	7410.08
				06/11/18	66.78	---	0.00	7408.58
				09/25/18	64.16	---	0.00	7411.20
				01/28/20	65.45	---	0.00	7409.91
				04/13/20	65.25	---	0.00	7410.11
MW-17S	33.404969 -105.674854	54–84	7477.94	10/05/15	53.13	---	0.00	7424.81
				07/20/16	53.77	---	0.00	7424.17
				10/11/16	53.69	---	0.00	7424.25
				01/30/17	48.78	---	0.00	7429.16
				04/11/17	53.33	---	0.00	7424.61
				12/12/17	54.57	---	0.00	7423.37
				03/06/18	52.80	---	0.00	7425.14
				06/11/18	56.06	---	0.00	7421.88
				09/25/18	49.35	---	0.00	7428.59
				01/28/20	52.75	---	0.00	7425.19
				04/13/20	51.11	---	0.00	7426.83
MW-18S	33.404700 -105.674970	53–83	7479.31	10/05/15	64.21	---	0.00	7415.10
				07/20/16	67.13	---	0.00	7412.18
MW-18S (cont.)	33.404700 -105.674970	53–83	7479.31	10/11/16	64.94	---	0.00	7414.37
				01/30/17	62.36	---	0.00	7416.95
				04/11/17	66.28	---	0.00	7413.03
				12/12/17	67.83	---	0.00	7411.48

Table 4. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Latitude and Longitude	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)
MW-18S (cont.)	33.404700 -105.674970	53–83	7479.31	03/06/18	67.39	---	0.00	7411.92
				06/11/18	69.94	---	0.00	7409.37
				09/25/18	64.80	---	0.00	7414.51
				01/28/20	67.73	---	0.00	7411.58
				04/13/20	65.56	---	0.00	7413.75
MW-19S	33.4044527 -105.675111	55–85	7478.75	10/05/15	62.55	---	0.00	7416.20
				07/20/16	65.98	---	0.00	7412.77
				10/11/16	63.28	---	0.00	7415.47
				01/30/17	59.33	---	0.00	7419.42
				04/11/17	65.31	---	0.00	7413.44
				12/12/17	66.67	---	0.00	7412.08
				03/06/18	66.25	---	0.00	7412.50
				06/11/18	69.22	---	0.00	7409.53
				09/25/18	63.02	---	0.00	7415.73
				01/28/20	66.62	---	0.00	7412.13
				04/13/20	64.51	---	0.00	7414.24
MW-20S	33.404226 -105.675272	42–72	7477.13	10/05/15	56.93	---	0.00	7420.20
				07/20/16	62.12	---	0.00	7415.01
				10/11/16	58.39	---	0.00	7418.74
				01/30/17	57.84	---	0.00	7419.29
				04/11/17	60.96	---	0.00	7416.17
				12/12/17	62.6	---	0.00	7414.53
				03/06/18	63.11	---	0.00	7414.02
				06/11/18	65.13	---	0.00	7412.00
				09/25/18	59.13	---	0.00	7418.00
				01/28/20	62.66	---	0.00	7414.47
				04/13/20	60.17	---	0.00	7416.96

Table 4. Summary of Historical Fluid Level Measurements
Bell Gas #1186, Alto, New Mexico

Well Name	Latitude and Longitude	Screened Interval (ft bgs)	Top of Casing Elevation [a] (ft msl)	Date Measured	Depth to Water (ft btoc)	Depth to LNAPL (ft btoc)	LNAPL Thickness (feet)	Groundwater Elevation [b] (ft msl)

[a] Surveyed by Cobb-Fendley, April, May, and October, 2015, unless otherwise noted.

[b] Groundwater elevation (GWE) corrected for LNAPL thickness using the following equation:
GWE = TOC Elevation - (DTW - (LNAPL thickness x SG)).
SG = 0.80 for wells MW-2(S), MW-3(S), and MW-4(S), and 0.82 for all other wells

[c] Fluid levels gauged after periodic recovery of LNAPL. LNAPL thickness not believed to be representative of static conditions.

[d] Measurable LNAPL thickness in bailer during LNAPL recovery.

ft bgs = Feet below ground surface
ft msl = Feet above mean sea level
ft btoc = Feet below top of casing
DTW = Depth to water
LNAPL = Light nonaqueous-phase liquid
NA = Not available
RECW = Ruidoso Eagle Creek well

Attachment 1

Access Agreements and Contracting Documents

Consulting Agreement to provide Environmental Engineering Services

Daniel B. Stephens and Associates, Inc. (DBS&A) is a corporation engaged in the business of arranging and implementing corrective action activities at petroleum contaminated sites in the State of New Mexico. Bell Gas, Inc. (Client) is the property owner, business owner, business operator, or property administrator, who is eligible for reimbursement from the New Mexico Ground Water Protection Act (GWPA), Corrective Action Fund (Fund) for the clean up of releases from petroleum UST systems. Client and DBS&A desire to enter into an agreement under which DBS&A shall arrange for contractors or itself conduct certain corrective action at a petroleum contaminated site owned by Client. The parties hereby agree as follows:

1. **Site.** The property at which DBS&A will perform services is located at: Bell Gas #1186 (TR's Market) Site (Facility #: 912, Release ID #: 4547), 101 Sun Valley Road, Alto, New Mexico.

2. **Services.** DBS&A will provide personnel, services, and materials (Work) needed to complete work pre-approved by the New Mexico Environment Department (NMED) in accordance with all applicable rules and regulations. DBS&A will perform only Work that is pre-approved for reimbursement under the GWPA Fund, unless separate, specific arrangements, are made in advance between Client and DBS&A.

3. **Fees.**

a. Payments for all pre-approved Work from the Fund will be assigned directly to DBS&A from NMED.

b. DBS&A agrees to accept as payment that amount pre-approved by NMED and reimbursed from the Fund. Where the reimbursement amount is reduced by the Client's obligation to pay a deductible, as established by the Fund, DBS&A will be paid by Client (terms net 30 days) for any difference between the approved costs and the reimbursement amount. ~~In the event that the Fund cannot, or does not, reimburse DBS&A within one hundred and twenty (120) days after DBS&A's submission of an invoice to NMED, Client agrees to pay DBS&A the full invoice amount upon written notice. When DBS&A receives reimbursement from the Fund, DBS&A shall reimburse Client for those invoices, as specified above, which Client has paid DBS&A.~~

c. If DBS&A observes, or has reason to believe, that the Fund will be unable to make a reimbursement, as set forth in 3.b., then both parties covenant and agree to negotiate all, or any additional, Work, and the payment therefor, prior to any duty being imposed on DBS&A to perform such Work.

4. **Conditions Precedent to DBS&A's Performance.** This agreement may be terminated by either party, by written notice to the other party, immediately upon the verified discovery of a misleading, inaccurate, or untrue representation made by either party hereto which substantially affects the ability of a party to perform under this agreement.

5. **Limitation on Services to be Performed by DBS&A.**

a. During the performance of the Work, materials other than petroleum or petroleum products, including Hazardous Material, may be discovered at the Site. DBS&A and Client agree that the discovery of any Hazardous Material constitutes a " Changed Condition," as hereinafter defined. If DBS&A discovers a Hazardous Material on or about the Site in the performance of the Work, DBS&A agrees to notify Client as soon as practically possible and to take such measures as, in DBS&A's professional judgement, are necessary to preserve and protect the health and safety of Site personnel and the public, as well as owners and occupants of adjacent properties. ~~Client agrees to reimburse DBS&A for the reasonable cost of implementing such measures.~~

b. DBS&A shall be responsible for restoring the Site to its pre-work condition, normal use excepted, as soon as practical upon completion of the Work.

c. DBS&A and its contractors shall not be responsible for damage or injury to any underground improvement or condition if such improvement or condition was not disclosed, in writing, to DBS&A or where the location of improvements and conditions were erroneously staked or shown on plans or the information furnished either by the Client or its agents and contractors or by a utility company or governmental entity, unless such damage was due to the negligence of DBS&A, or its agents, employees and/or contractors.

d. Notwithstanding the provisions of Paragraph 5.c., DBS&A and its subcontractors shall take reasonable precautions to prevent damage to any underground improvements and conditions at the site including obtaining field stakings and marked drawings from utility companies or governmental authorities disclosing the location of said improvements and conditions.

e. Notwithstanding anything contained herein to the contrary, DBS&A and its contractors shall in no way be deemed to be (i) an owner or operator of the Site, or of any UST system, (ii) a person arranging for the treatment, disposal or transportation of any Hazardous Materials, or a transporter of Hazardous Materials, or (iii) a person who generates, treats, transports or stores any Hazardous Materials. Client shall retain all right, title, and interest to any portion of the Site, including without limitation any soil, ground water or UST system removed, transported, replaced or altered in connection with the Work, and DBS&A shall not have any right, title, or interest therein. Client, at DBS&A's

request shall promptly execute and deliver to DBS&A all manifests and similar documentation confirming such removal or transportation of any portion of the Site to another location, including without limitation any landfill. Client hereby names and appoints and constitutes DBS&A as its attorney-in-fact to execute and deliver all such manifests and documentation.

6. Covenants of Client. Client covenants and agrees:

a. Client shall not do anything to seek reimbursement from the fund on behalf of itself for any person other than DBS&A for the Work at the Site, nor do anything to change the designation of DBS&A as the party to be reimbursed by the Fund.

b. Client has not and shall not take any action, or fail to take any action, or do or fail to do anything, at any time, that would cause the Site or Work to no longer be eligible for reimbursement under the Fund.

c. Client, at DBS&A's request shall execute promptly and deliver to DBS&A all applications and authorizations required by the applicable governmental agencies for the procurement by DBS&A of all permits and approvals necessary for the completion of the Work. Client, at DBS&A's request shall further execute all documents necessary for the submission of all reports and all other filings to applicable governmental agencies required in connection with the completion of the Work.

d. Client will indemnify, defend, and hold harmless DBS&A from and against all claims, demands, causes of action, losses, and judgements, including reasonable attorneys' fees and expenses which DBS&A may suffer or be liable for, because of injury to persons, or death, or property damage resulting from Client's negligence, intentional acts or failure to comply with the laws of the State of New Mexico.

e. Client understands that DBS&A will not be held responsible for current or pre-existing conditions on the Site. Further, in the event conditions change at the Site, during, or as the result of, an NMED approved delay or extension in the prosecution of Work, DBS&A will not be held responsible or liable for those changes or any resulting damages.

7. Representation and Covenants of DBS&A.

a. DBS&A shall comply with all applicable federal, state, and local laws and ordinances, including those addressing environmental compliance, worker health, and safety in the performance of the Work.

b. DBS&A warrants that it shall use that degree of care and skill ordinarily exercised under similar circumstances by members of its profession.

c. DBS&A shall maintain all records necessary to verify and validate costs to be reimbursed by the Fund and shall provide copies of said records to client upon request.

8. **Changed Condition.** In the event that there is a Changed Condition, which materially affects the performance of the Work by DBS&A, Client and DBS&A shall reevaluate promptly the scope of the Work and the compensation payable to DBS&A under this Agreement. In the event that Client and DBS&A do not renegotiate the terms of this Agreement satisfactory to both parties hereto as a result of such Changed Condition, then either party hereto shall be entitled to terminate this agreement by notice to the other party within thirty (30) days after the determination that this Agreement cannot be renegotiated in a manner satisfactory to all parties hereto. For the purpose of this Agreement the term "Changed Condition" shall include, but is not limited to: (i) a change in any local, state or federal law, rule or regulation materially affecting the performance of the Work by DBS&A; (ii) the requirement by any governmental agency to modify this scope or objectives of the Work after the Work commences; (iii) the determination by DBS&A that the State for whatever reason, including the unavailability of funds, will not fully or timely (within 120 days of any reimbursement application) reimburse DBS&A from the Fund for the performance of the Work, except for the standard deductibles established by the Fund; (iv) the institution of any legal proceeding or administrative action which caused the cessation of Work at the Site for a time period of thirty (30) days or more: or (v) the existence of an concealed or unknown condition existing within the Site not disclosed, in writing, to DBS&A prior to its commencement of the Work.

9. **Termination**. If either party terminates the whole or any part of this Agreement for any reason whatsoever, Client shall be required to pay DBS&A any amounts due under this Agreement for Work performed through the effective termination date. The parties agree that DBS&A shall be allowed to complete the task in process to enable it to submit a claim for reimbursement for the Work completed. If Client refuses to allow DBS&A to complete the task in process, to such state as would allow an application for reimbursement, Client shall be held liable for the costs for the task in progress. In the event of such termination, DBS&A shall not have any further obligations under this Agreement, except that it, at Client's request, shall furnish Client with all reports, data and other information obtained by DBS&A pertaining to petroleum UST systems or any Hazardous Materials located at the Site.

10. **Miscellaneous.**

a. Any amount subsequently reimbursed under the Fund for Work performed by DBS&A shall be passed onto DBS&A.

b. Cost of Collection: Notwithstanding anything contained herein to the contrary, should it become necessary for either party to collect any amounts due under this Agreement through an attorney, by legal proceeding, or otherwise, the losing party shall pay all costs of collecting, including costs incurred in connection with probate proceedings or bankruptcy or other creditors rights proceedings. Such cost of collection shall in all cases include the reasonable fees and disbursements of attorneys, paralegal or other legal advisors, whether prior to or at trial, or in appellate proceedings.

In the event a Party seeks to enforce the terms and conditions of this Agreement against the other in a legal or administrative procedure, the prevailing party shall be entitled to its reasonable attorney's fees and costs.

c. Entire Agreement: This Agreement, together with any attached exhibits, constitutes the entire and complete contract of the Parties, exclusive of any other oral or written communication. This Agreement cannot be changed, waived, released, or discharged orally or by the conduct of any party. Any change waiver, release, or discharge must be in writing signed by each Party.

d. Assignment: Client hereby assigns, sets over and transfers its right to reimbursement for the site rehabilitation described in this Agreement to DBS&A. If such payments are received by or payable to Client, Client hereby agrees that said payments will be endorsed to the order of and promptly delivered to DBS&A.

Any assignment of this Agreement, including any monies due or to become due to DBS&A hereunder, without DBS&A's written consent shall be void. This agreement shall inure to the benefit of and be binding upon the successors and assigns of the parties.

e. Waiver and Delay: No waiver or any breach or delay in enforcing the terms of this Agreement by DBS&A or Client shall be construed as a waiver of any subsequent breach.

f. Governing Law: The validity, construction and enforcement of, and the remedies under, this Agreement shall be governed in accordance with the laws of the State of New Mexico.

g. Any notices to be given to either party hereunder shall be written and sent to the addresses or such other address designated by the addressees:

Client:

Bell Gas, Inc.
P O Box 490
Roswell, NM 88202
Office (575) 622-4800
Fax (575) 627-7002

Client Representative:

Gary Harrell, Vice President

Cell (575) 626-7563
garyharrell1@juno.com

For DBS&A:
Daniel B. Stephens & Associates, Inc.
6020 Academy Road NE, Suite 100
Albuquerque, NM 87109
Phone: (505) 822-9400
Fax: (505) 822-8877
Attention: Michael D. McVey

(signatures next page)

IN WITNESS WHEREOF, the parties have caused this Agreement to be executed as of this 25 day of February, ~~2014.~~ 2015

Daniel B. Stephens & Associates, Inc.:

by: [signature]
James Kelsey, Senior Vice President

Witness: [signature]

Client: Bell Gas, Inc.:

by: Gary Hanell, Vice President

Witness: [signature]

Notarized Signature Not Required

NEW MEXICO
ENVIRONMENT DEPARTMENT

2905 Rodeo Park Drive East
Building 1
Santa Fe, New Mexico 87505-6313
Phone (505) 476-4397 Fax (505) 476-4374
www.env.nm.gov

SUSANA MARTINEZ
Governor

JOHN A. SANCHEZ
Lt. Governor

BUTCH TONGATE
Cabinet Secretary

J. C. BORREGO
Deputy Secretary

October 26, 2017

Gary Harrell
Bell Gas, Inc.
P.O. Box 490
Roswell, NM 88202

Re: Approval of Phase 3 Fixed-Price Workplan for Bell Gas #1186 (TRs Market), 101 Sun Valley Rd., Alto, New Mexico

Facility #: 912 Release ID #: 4547 WPID #: 18033

Dear Mr. Harrell:

The New Mexico Environment Department (Department) approves the fixed-price workplan dated October 6, 2017 which was submitted on your behalf by Daniel B. Stephens & Associates, Inc. (DBS&A). This workplan is for Phase 3 activities consisting of quarterly groundwater monitoring and development of a Final Remediation Plan at the Bell Gas #1186 site. Work shall be performed in accordance with the workplan and current Contractor Fee Schedule.

The total budget approved for this workplan shall not exceed including New Mexico Gross Receipts Tax. Please refer to the following table for a breakdown of the expected deliverables and dates of completion. The dates listed in the table are the current deadlines in the applicable portion of the corrective action timeline for the subject site. These deliverables document completion of individual performance criteria.

Deliverable Name	Estimated Date of Deliverable	Deliverable ID
First Quarter Groundwater Monitoring, NAPL Recovery and Report	01-20-18	18033-1
Second Quarter Groundwater Monitoring, NAPL Recovery and Report	04-20-18	18033-2

Deliverable Name	Estimated Date of Deliverable	Deliverable ID
Third Quarter Groundwater Monitoring, NAPL Recovery and Report	07-20-18	18033-3
Fourth Quarter Groundwater Monitoring, NAPL Recovery and Report	10-22-18	18033-4
Final Remediation Plan Development and submittal	11-20-18	18033-5
*Contingency- GWQB Discharge Permitting	11-20-18	18033-6
*Contingency	11-20-18	18033-7

**NOTE: DBS&A shall notify the Department in writing or by electronic mail and receive Department approval prior to expenditure of any contingency set-aside funds. The approved budgets for these deliverables are not-to-exceed amounts for the period covered by the subject workplan.*

Please be reminded that Section 74-6B-7.F (NMSA 1978) of the Ground Water Protection Act does not allow the Department to authorize payments in excess of the funds available. This means that approval of the workplan does not guarantee reimbursement from the Corrective Action Fund (Fund). Furthermore, the Department must receive all claims for reimbursement within 90 days of the date of notice of deliverable approval.

To facilitate reimbursement, if a deliverable represents a reduced scope of work that requires a reduction in the amount to be claimed, the notification of the modified costs must be submitted to the Department with the deliverable.

The Department has reviewed the current statement of qualifications of DBS&A's authorized representative, the project professional engineer, and the individual with direct, responsible supervisory control of this workplan. In accordance with 20.5.16.9 NMAC, the Department has determined that DBS&A is currently a qualified firm to perform the scope of work as described in the approved workplan. Our records indicate the work was awarded through a competitive contractor selection process.

Substantial compliance is required for reimbursement and will be determined on a site-by-site basis prior to disbursement from the Fund. In accordance with 20.5.17.11 NMAC, the owner or operator shall request a compliance determination before submitting the initial request for payment of the costs of corrective action, other than the costs of an MSA.

Please submit a request for compliance determination, if you have not already done so, to the Petroleum Storage Tank Bureau, 2905 Rodeo Park Drive East, Building 1, Santa Fe, New Mexico 87505. It is in your best interest to submit your request as soon as possible to ensure that any work that you undertake is reimbursable.

You may begin work immediately. Approval of this workplan is contingent upon all work being performed on this site in accordance with all local, state and federal regulations, including 29 CFR 1910 governing occupation health and safety. The Department expects DBS&A to complete the work as outlined within the approved budget. All change orders must be approved in writing prior to the work being performed.

If you have any questions, please contact the project manager, D. Renee Romero at (575) 291-2109. Thank you for your continued voluntary cooperation.

Sincerely,

Dana Bahar
Bureau Chief
Petroleum Storage Tank Bureau

DB:DRR:cv

cc: Thomas A. Golden, Daniel B. Stephens & Associates, Inc. (via email)
Lorena Goerger, Manager, Remedial Action Program (via email)
Sarah McGrath, Geoscientist Supervisor (via email)
Katherine MacNeil, Environmental Engineer (via email)
D. Renee Romero, Project Manager (via email)

cc w/encl: PSTB Master File Santa Fe

NEW MEXICO
ENVIRONMENT DEPARTMENT

SUSANA MARTINEZ
Governor
JOHN A. SANCHEZ
Lieutenant Governor

Roswell Field Office
1914 West Second Street
Roswell, New Mexico 88201
Telephone (575) 623-6123 Fax (575) 624-2023
www.nmenv.state.nm.us

RYAN FLYNN
Cabinet Secretary
BUTCH TONGATE
Deputy Secretary

January 16, 2015

Mr. Gary Harrell
Bell Gas, Inc.
P.O. Box 490
Roswell, NM 88202

RE: Proposal Evaluation for Phase 3, 4 & 5 Remediation at the Bell Gas #1186 (TR's Market) Site, 101 Sun Valley Road, Alto, New Mexico

Facility #: 912 Release ID #: 4547

Dear Mr. Harrell:

The New Mexico Environment Department (Department) has evaluated the proposals received in response to the request for proposal (RFP) dated November 25, 2014. The proposal submitted by Daniel B. Stephens & Associates, Inc. has been found to be the most responsive based on technical merit and cost effectiveness. Proposal evaluation is weighted 70% for technical merit and 30% for cost effectiveness. Therefore, the Department selected proposal may not be the lowest cost proposal.

The exclusive intent of this letter is to inform you of the results of the RFP evaluation process. This letter does not constitute a workplan approval letter. Within 30 days of receipt of this correspondence, please provide written notification to the Department of having entered into a contract with a Department qualified firm.

The Department expects completion of work as defined in the Daniel B. Stephens & Associates, Inc. proposal and within the proposal amount. Please direct the selected firm to submit a workplan to the Department for approval. All work must be approved in writing prior to the work being performed.

Part or all of the cost for corrective action may be eligible for reimbursement from the Corrective Action Fund (CAF). In accordance with 20 NMAC 5.17.301.D.5 to qualify for reimbursement from the CAF, the owner or operator must use the contractor selected by the Department. Please refer to 20 NMAC 5.17 of the New Mexico Underground Storage Tank Regulations for eligibility requirements.

If you have any questions, please contact me at (575) 624-6123. Thank you for your continued voluntary cooperation.

Sincerely,

Sarah McGrath for

D. Renee Romero
Project Manager
Petroleum Storage Tank Bureau

DRR:tp

cc: Danny Kendrick, Kendrick Oil
Jeff Cotter, AMEC Environment and Infrastructure, Inc.
Jackie D. Atkins, Atkins Engineering Associates, Inc.
Thomas Golden, Daniel B. Stephens & Associates, Inc.
Jay T. Snyder, EA Engineering, Science, and Technology, Inc.
Clay Kilmer, Golder Associates Inc.
Mr. Joe Tracy, INTERA Incorporated
Karl E. Tonander, Souder, Miller & Associates, Las Cruces
David Wagner, Western Technologies
Dana Bahar, Bureau Chief
Lorena Goerger, Manager, Remedial Action Program
Sarah McGrath, Geoscientist Supervisor
PSTB Master File Santa Fe

ACCESS AGREEMENT

This Agreement is made by Kendrick Oil Company ("Owner") and Daniel B. Stephens & Associates, Inc. ("Contractor") on behalf of Bell Gas, Inc. Owner and Contractor agree to the terms set forth below in this Agreement.

1. The Kendrick Oil Company_and the real estate located at 101 Sun Valley Road, Alto, New Mexico (the "Property"). The Contractor plans to install a remediation system on the Property. Owner agrees to give the Contractor access to the Property for the following purposes:

   - Drilling and monitor well installation on the property. Monitor wells will be installed to facilitate ongoing investigation activities associated with hydrocarbon contamination at the site. Monitor wells may also be used in the future as multi-phase extraction wells. Wells will be installed flush with the existing parking lot surface with minimal impact to pedestrian and vehicular traffic. Wells on undeveloped portion of the Property will be installed with above ground vaults and steel bollards to assist with locating the wells. The Property Owner will be contacted prior to completion of any work. The property will be restored, as close as possible, to pre-entry conditions following removal of any installed wells, including meticulous replacement of concrete where applicable.
   - Trenching on the property. Conveyance lines will be buried below grade in trenches and run from remediation equipment to monitor wells and to an infiltration gallery. Trenches dug in concrete will be covered with concrete to match existing. Any landscaping disturbed during construction activities will be replaced.
   - Installation of remediation equipment enclosures. Temporary equipment enclosure(s) will be located on the property to facilitate cleanup of soil and groundwater and collection of free phase hydrocarbons. Equipment will be located as inconspicuously as possible in consultation with representatives of the Owner, while considering access to remediation wells and utilities.
   - Infiltration gallery installation. An infiltration gallery will be installed for discharge of treated water. Conveyance lines on-site will be buried below grade in trenches and run from treatment equipment to the infiltration gallery. When complete, the infiltration gallery design will be submitted to the Property Owner for comment. Any ground vegetation (grass, etc.) disturbed during construction activities will be reseeded following installation of the infiltration gallery.
   - Routine groundwater and vapor monitoring and general well maintenance or repair, if required. Monitoring activities will include gauging fluid levels in the monitor well(s) and collecting groundwater and/or vapor samples for laboratory analysis on a regular basis.

   Access and use of the Property for the purposes described above will be coordinated by the Contractor with the Owner a minimum of 4 days in advance of any activity covered by this Agreement. All equipment will be located and all work will be conducted as shown on Exhibit A attached to this Agreement to the extent practicable. Contractor will make a diligent and concerted effort to refrain from interfering with areas outside the immediate work area. All work will be conducted in an efficient, courteous manner and with minimal disruption and inconvenience to the patrons, invitees, employees, agents and representatives of the Owner.

2. The Contractor's activities and work on the Property will be conducted consistent with Occupational Health and Safety Regulations (See 29 CFR Section 1910.120) and that all appropriate actions will

be taken to assure the safety of the patrons, invitees, employees, agents and representatives of the Owner.

Owner may observe activities on the Property, consistent with Occupational Health and Safety Regulations (see 29 CFR § 1910.120). Should the property owner choose to collect and analyze split samples, the Owner is responsible for the provision of, and costs associated with any equipment, accessories, and laboratory costs required for such split samples.

3. The Contractor agrees to send Owner's representative (identified below) a copy of the results of analysis from any sampling activities conducted on the Property at no charge to Owner.

4. Installations on the Property will be placed to minimize interference with the movement of vehicles and other regular activities on the Property. Following completion of the project, the Contractor will properly abandon all wells, remove equipment, all materials, trash, fencing, and other associated items. The Contractor will otherwise return the property as close as possible to the pre-entrance condition.

5. The Contractor will provide written or oral notice to Owner of its entrance onto the Property. The notice shall be given to Owner's representative who is:

   Name: Joe B Blackburn
   Address Line 1: 13025 Quaker, Lubbock, TX 79423
   Address Line 2:
   Email: jblackburn@kendrickoil.com
   Work phone: 806-722-1274

6. The Contractor agrees to indemnify and hold harmless and to insure Owner against liability, claims, damages, losses or expenses, only to the extent that the liability, damages, losses, or costs are caused by, or arise out of, the acts or omissions of the Contractor or its officers, employees, or agents. Contractor agrees to name Owner as additional insureds and to deliver a certificate of insurance for this purpose. Contractor further agrees to indemnify and hold Owner harmless from any and all claims arising for damage to person or property arising from or related to its activities on the Property.

7. This Agreement is binding upon and is for the benefit of the parties and each of their authorized officers, employees, contractors, and representatives.

Kendrick Oil Company

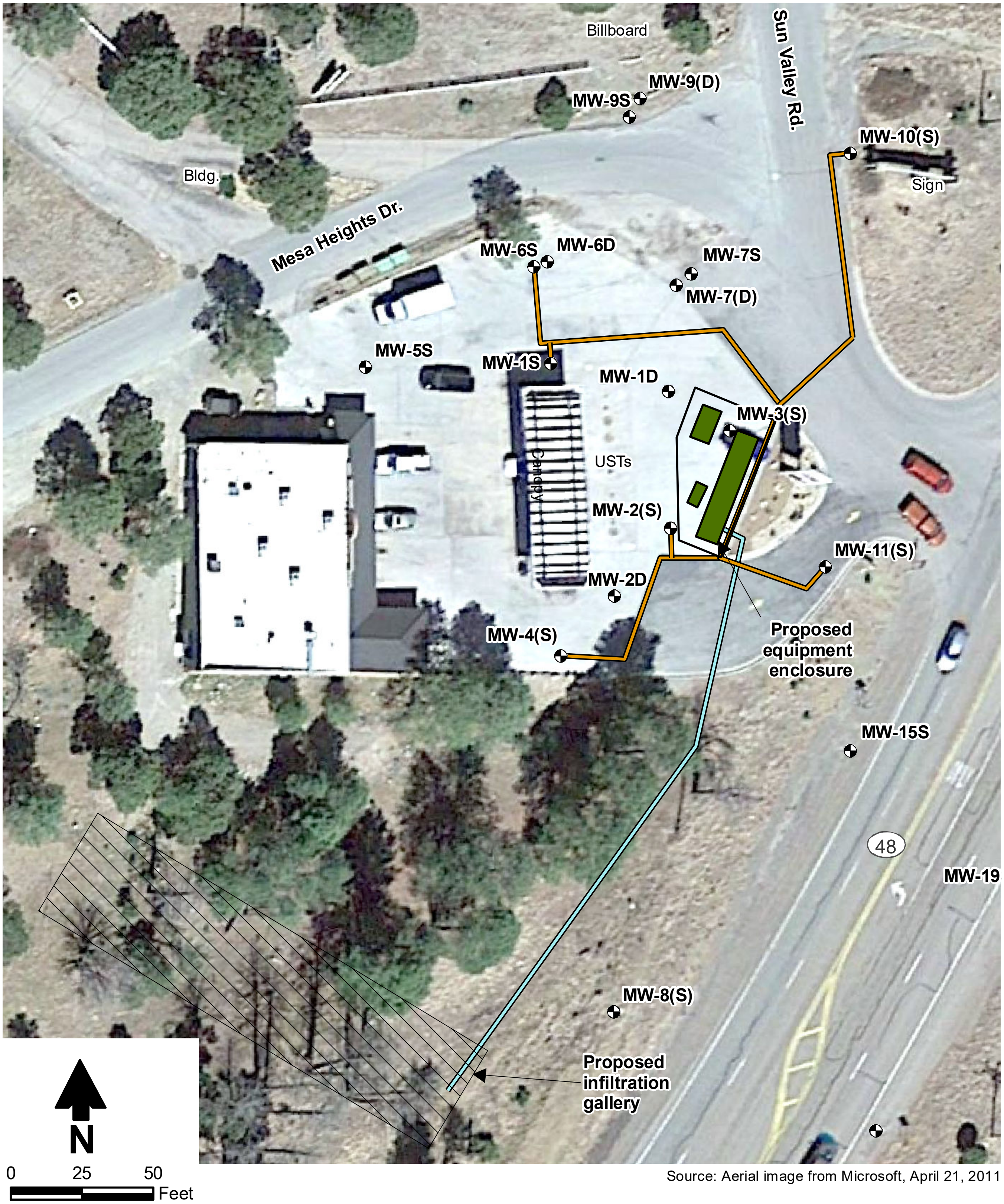
By Joe B Blackburn

Dated 9/17/2020

Daniel B. Stephens & Associates, Inc.

By [signature]

Dated 9/18/2020



Source: Aerial image from Microsoft, April 21, 2011

Explanation

- Monitor well
- Conveyance line
- Treated water discharge

S:\Projects\ES14.0220_Bell_Gas_1186\GIS\MXDs\Engineering\Proposed_system_layout.mxd

BELL GAS #1186
ALTO, NEW MEXICO
Remediation System Layout

Daniel B. Stephens & Associates, Inc.
9/15/2020 JN ES14.P220

Figure 9

Attachment 2

MPE Pilot Test Report

July 03, 2015

Mr. Thomas Golden, PE
Daniel B. Stephens & Associates, Inc.
6020 Academy Road NE, Suite 100
Albuquerque, NM 87109
505.353.9075
tgolden@dbstephens.com

Subject: **June 16, 17, & 18, 2015 EFR®/Pilot Test Report**
Bell Gas #1186
101 Sun Valley Road
Alto, New Mexico

Dear Mr. Golden:

Please find attached the data summary for the EFR®/Pilot Test event conducted at the subject site on June 16, 17, & 18, 2015. The EFR® event was implemented in monitor well MW-2S on June 16, 2015; in monitor well MW-10S on June 17, 2015; and in monitor wells MW-3S, MW-6D, MW-6S, MW-4S, and MW-11S on June 18, 2015. EFR® is a mobile multi-phase/dual-phase extraction technology shown to be effective for mass removal of hydrocarbons in the soils/groundwater, and is used to gather the necessary data to generate effective remediation strategies.

EFR®

The main purposes of the EFR® events were to 1) achieve contaminant removal by multi-phase/dual-phase extraction process, 2) reduce the initial aerial and vertical extent of the plume, and **3) collect field data (i.e. radius of influence, air-flow rates, vapor concentrations, water recovery rates, etc.), for full-scale remediation**.

June 16, 2015 - Event 1
MW-2S

EFR® was performed for 8 hours at monitor well MW-2S on June 16, 2015. Separate-phase hydrocarbons (SPH) (gasoline) were detected in monitor well MW-2S prior to completion of the event at a thickness of 1.01 feet. SPH was not detected in MW-2S upon conclusion of the event.

A calculated total of 6.0 pounds of petroleum hydrocarbons (approximately 1.0 equivalent gallon of hydrocarbon) in vapor concentrations were removed during the EFR® event on June 16, 2015.

The hydrocarbon removal rate (in vapors) varied from a low of 0.4 pounds per hour (lbs/hr) at several times during the MW-2S extraction event, to a high of 2.8 pounds per hour (lbs/hr) at the beginning of the MW-2S extraction event. The removal rate was low and showed a decreasing trend initially, and then a relatively steady trend during remainder of the extraction from MW-2S.

Vapor concentrations varied from a high of 6,000 parts per million by volume (PPM_V) (total hydrocarbons) at the beginning of the MW-2S extraction event, to a low of 1,400 PPMv 2 hours into the MW-2S extraction event. As with the removal rates, the concentrations were low. The concentration showed a decreasing trend throughout the MW-2S event.

The range of vacuum readings recorded during this EFR® event from the extraction well is detailed in the attached EFR® Field Data Sheet and summarized below:

Extraction Well	Vacuum Readings
Truck	20 inches of mercury
MW-2S	12 to 14 inches of mercury

Vacuum Influence

Differential pressures from the nearest monitor wells were recorded during this event to assess the vacuum induced by EFR® in the vadose zone. A vacuum influence was observed at a distance of 60 feet from MW-2S in MW-4S, and a possible slight influence was observed at a distance of 103 feet from MW-2S in MW-6S. An influence was not observed at a distance of 40, 55, or 145 feet from MW-2S in shallow wells MW-3S, MW-11S, or MW-10S, respectively. An influence was not observed at a distance of 33 or 45 feet in deep wells MW-2D or MW-1D, respectively. The differential pressure data are detailed in the attached table and summarized below:

Monitor Well	Maximum Change	Nearest Extraction Well (Approx. Distance)
MW-2D	0.00 inches of water	MW-2S (33 feet)
MW-4S	-0.14 inches of water	MW-2S (60 feet)
MW-11S	0.00 inches of water	MW-2S (55 feet)
MW-3S	0.00 inches of water	MW-2S (40 feet)
MW-1D	0.00 inches of water	MW-2S (45 feet)
MW-6S	-0.03 inches of water	MW-2S (103 feet)
MW-10S	0.00 inches of water	MW-2S (145 feet)

It should be noted that the slight influence observed in MW-6S occurred only during three of the early event readings. It should also be noted that the influence observed in MW-4S was observed when the stinger was ~78 feet below ground surface, and the influence was no longer observed after the stinger was lowered to 81 feet.

Groundwater Drawdown

Groundwater levels were recorded in the extraction wells and surrounding wells during these two events to assess the groundwater drawdown created by EFR®.

A groundwater drawdown was observed at a distance of 33, 40, 60, 103, and 145 feet from MW-2S in MW-2D, MW-3S, MW-4S, MW-6S, and MW-10S, respectively. A groundwater drawdown was not observed at a distance of 45 or 55 feet from MW-2S in MW-1D or MW-11S, respectively. The groundwater drawdown data are summarized below:

Monitor Well	Maximum Change	Nearest Extraction Well (Approx. Distance)
MW-2S	-12.88 feet	Extraction Well
MW-2D	-0.18 feet	MW-2S (33 feet)
MW-4S	-0.86 feet	MW-2S (60 feet)
MW-11S	0.17 feet	MW-2S (55 feet)
MW-3S	-2.03 feet	MW-2S (40 feet)
MW-1D	0.07 feet	MW-2S (45 feet)
MW-6S	-0.01 feet	MW-2S (103 feet)
MW-10S	-0.36 feet	MW-2S (145 feet)

It should be noted that a groundwater drawdown was observed even where a vacuum influence was not observed.

Disposition of Fluids

Approximately 69 gallons (based on gauging the truck after the events) of fluids were extracted from the monitoring well during this event. The yield was very low. The fluids were off loaded to a tank on-site.

June 17, 2015 - Event 2

MW-10S

EFR® was performed for 8 hours at monitor well MW-10S on June 17, 2015. Separate-phase hydrocarbons (SPH) (diesel fuel) were detected in monitor well MW-10S prior to completion of the event at a thickness of 3.79 feet. SPH was detected in MW-10S upon conclusion of the event at a thickness of 10.18 feet. It appears product was "pulled" into the well during this event.

A calculated total of 87.3 pounds of petroleum hydrocarbons (approximately 14.4 equivalent gallons of hydrocarbons) in vapor concentrations, in addition to 11 gallons of liquid phase SPH, were removed during the EFR® event on June 17, 2015.

The hydrocarbon removal rate (in vapors) varied from a low of 2.0 pounds per hour (lbs/hr) in the middle of the extraction event (this corresponded to a lowering of the stinger from 75 to 78 feet), to a high of 23.2 pounds per hour (lbs/hr) near the beginning of the extraction event. The removal rate showed a relatively steady trend when the stinger was at the same depth, but the removal rate was much lower when the stinger depth was lowered from 75 to 78 feet bgs. during the extraction.

Vapor concentrations varied from a high of 70,000 parts per million by volume (PPM_V) (total hydrocarbons) 2 hours into the extraction event, to a low of 10,000 PPMv in the middle of the extraction event. The concentrations increased during the first 2 hours on the event, then decreased throughout the remaining time of the event.

The range of vacuum readings recorded during this EFR® event from the extraction wells are detailed in the attached EFR® Field Data Sheet and summarized below:

Extraction Well	Vacuum Readings
Truck	20 inches of mercury
MW-10S	5 to 7 inches of mercury

Vacuum Influence

Differential pressures from the nearest monitor wells were recorded during this event to assess the vacuum induced by EFR® in the vadose zone. A vacuum influence was observed at a distance of 79, 115, 130, and 185 feet from MW-10S in monitor wells MW-9S, MW-6S, MW-12S, and MW-5S, respectively. A slight influence was observed at a distance of 77 and 110 feet from MW-10S in deep wells MW-7D and MW-6D. The differential pressure data are detailed in the attached table and summarized below:

Monitor Well	Maximum Change	Nearest Extraction Well (Approx. Distance)
MW-3S	0.00 inches of water	MW-10S (108 feet)
MW-7D	-0.03 inches of water	MW-10S (77 feet)
MW-6D	-0.04 inches of water	MW-10S (110 feet)
MW-6S	-0.15 inches of water	MW-10S (115 feet)
MW-5S	-0.05 inches of water	MW-10S (185 feet)
MW-9S	-0.07 inches of water	MW-10S (79 feet)
MW-9D	0.00 inches of water	MW-10S (77 feet)
MW-12S	-0.10 inches of water	MW-10S (130 feet)

The vacuum influence from MW-6S and MW-12S were consistent throughout the extraction from MW-10S. The influence observed in MW-5S and MW-9S was not as consistent.

Groundwater Drawdown

Groundwater levels were recorded in the extraction wells and surrounding wells during this event to assess the groundwater drawdown created by EFR®. A significant groundwater drawdown was observed at a distance of 108 and 115 feet from MW-10S in MW-3S and MW-6S, respectively; and a groundwater drawdown was observed at a distance of 77, 79, and 185 feet from MW-10S in MW-9D (deep well), MW-9S, and MW-5S, respectively. The groundwater drawdown data are summarized below:

Monitor Well	Maximum Change	Nearest Extraction Well (Approx. Distance)
MW-10S	-3.97 feet	Extraction Well
MW-3S	-2.34 feet	MW-10S (108 feet)
MW-7D	0.13 feet	MW-10S (77 feet)
MW-6D	0.00 feet	MW-10S (110 feet)

MW-6S	-2.77 feet	MW-10S (115 feet)
MW-5S	-0.06 feet	MW-10S (185 feet)
MW-9S	-0.01 feet	MW-10S (79 feet)
MW-9D	-0.02 feet	MW-10S (77 feet)
MW-12S	0.00 feet	MW-10S (130 feet)

The groundwater extraction rate was much higher from MW-10S which is potentially the reason for the greater groundwater drawdown observed during extraction form MW-10S as compared to that from MW-2S.

Disposition of Fluids
Approximately 265 gallons (based on gauging the truck after the events) of fluids were extracted from the monitoring well during this event. The fluids were off loaded to a tank on-site.

June 18, 2015 - Events 3 thru 7
MW-3S, MW-6D, MW-6S, MW-4S, and MW-11S
EFR® was performed for 6 hours at monitor wells MW-3S (1 hour), MW-6D (1.5 hours), MW-6S (1 hour), MW-4S (1 hour), and MW-11S (1.5 hours) on June 18, 2015. Separate-phase hydrocarbons (SPH) (diesel fuel) were detected in monitor well MW-3S, MW-4S, and MW-11S prior to completion of the event at a thickness of 0.22, 0.32, and 3.67 feet, respectively. SPH was detected in monitor wells MW-4S and MW-11S, at a thickness of 0.03 and 0.31 feet, respectively, upon conclusion of the event.

The main purpose of these events was to remove hydrocarbon mass from the area of these wells.

A calculated total of 23.4 pounds of petroleum hydrocarbons (approximately 3.9 equivalent gallons of hydrocarbons) in vapor concentrations, in addition to 19 gallons of liquid phase SPH, were removed during the EFR® event on June 18, 2015.

The hydrocarbon removal rate (in vapors) varied from a low of 0.1 pounds per hour (lbs/hr) during the extraction from MW-6D, to a high of 16.3 pounds per hour (lbs/hr) near the beginning of the extraction from MW-3S. The removal rate showed a relatively stable trend during all five extraction events. The removal rate was significantly higher from MW-3S, than the other four wells. The removal rate was very low from MW-6D and MW-4S.

Vapor concentrations varied from a high of 34,000 parts per million by volume (PPM_V) (total hydrocarbons) near the beginning of extraction from MW-3S, to a low of 300 PPMv at the beginning of the extraction from MW-6D. The concentrations also remained relatively steady during extraction from all five wells. Concentrations were significantly higher from MW-3S, and higher from MW-11S, than from the other three wells. Concentrations were very low from MW-6D.

The range of vacuum readings recorded during this EFR® event from the extraction wells are detailed in the attached EFR® Field Data Sheet and summarized below:

Extraction Well	Vacuum Readings
Truck	20 inches of mercury
MW-3S	13 inches of mercury
MW-6D	5 inches of mercury
MW-6S	13 inches of mercury
MW-4S	8 inches of mercury
MW-11S	7 inches of mercury

EFR®/Pilot Test Event Conclusions

The following conclusions are based on the results of the EFR®/Pilot Test events completed June 16 to 18, 2015.

June 16, 2015

1. SPH was eliminated from MW-2S during extraction.
2. A total of 6.0 pounds of hydrocarbon, equivalent to 1.0 gallons of gasoline, was extracted during this event.
3. A vacuum influence was observed at a distance of 60 feet in MW-4S, but this influence was lost when the stinger was lowered from 73 to 78 feet bgs.
4. After an initial decrease, extraction vapor concentrations remained relatively steady, even after lowering the stingers. The extraction vapor concentrations were elevated, but not extremely high, especially for a gasoline contaminated area.
5. A significant groundwater drawdown was observed at a maximum distance of 145 feet from MW-2S, indicating a significant "pull" toward the extraction well.
6. The groundwater extraction rate was very low, 0.14 gpm.
7. Based on the low air flow rates, the low groundwater extraction rates, the in-well vacuum, and knowledge of the geology at the site, groundwater flow appears to be dominated by flow through fractures.
8. Based on the in-well vacuum, the permeability of the formation near MW-2S is relatively low.

June 17, 2015

1. The SPH thickness measured in MW-10S increased from 3.79 feet to 10.18 feet during extraction. It appears the EFR® extraction had a significant "pull" on the product into the well.
2. A total of 87.3 pounds of hydrocarbon, equivalent to 14.4 gallons of gasoline, in addition to 11 gallons of liquid phase diesel fuel was extracted during this event.
3. A consistent vacuum influence was observed at a maximum distance of 130 feet in MW-12S. There appeared to be a greater vacuum influence radially (more wells and greater distances) during extraction from MW-10S than from MW-2S.
4. Extraction vapor concentrations were extremely high, and decreased significantly when the stinger was lowered from 75 to 78 feet bgs. The optimum stinger depth for maximum hydrocarbon removal from MW-10S is at the 75 foot depth or less under current conditions.

5. A significant groundwater drawdown was observed at a maximum distance of 115 feet from MW-10S in MW-6S. The significant groundwater drawdown was also observed in MW-3S. MW-6S and MW-3S may be in the suspected (DBS) faulted zone. There appears to a good groundwater connection in the area of these wells.
6. The groundwater extraction rate was significantly higher from MW-10S than from MW-2S.
7. As with MW-2S, groundwater flow appears to be dominated by flow through fractures and possibly thin ‘stringers”, but is much greater possible due to the faulted zone. The flow rates from MW-10S was 0.55 gpm.
8. Based on the in-well vacuum, the permeability of the formation near MW-10S is moderate.

June 18, 2015

1. A total of 23.4 pounds of hydrocarbon, equivalent to 3.9 gallons of gasoline, in addition to 19 gallons of liquid phase diesel fuel was extracted during these events.

Thank you for this opportunity. We look forward to working with you again in the future to provide innovative and cost effective environmental solutions at this and other sites.

Sincerely,

EcoVac Services

Jeffrey M. Brammer

Jeff Brammer, P.G.
Western Regional Manager, Hydrogeologist

Attachments:
EFR® Field Data Sheets

ATTACHMENT 1

FIELD DATA SHEETS

EFR® FIELD DATA SHEET

Client: DBS	Facility Name: Bell Gas #1186		Event #: 1
Facility Address: 101 Sun Valley Rd., Alto, NM		Technician: Mosley	Date: 06/16/15

Extraction Well(s)	Time hh:mm	Extraction Well-head Vacuum (in. Hg)								Vacuum Truck Exhaust				
		Inlet	MW-2S							Concentration PPM	Offgas Velocity FT/MIN	Flow Rate CFM	Removal Rate LBS/HR	Interval Removal LBS
Start Time:	7:15													
MW-2S	7:30	20	14							6,000	800	39	2.8	0.7
	7:45	20	14							4,100	750	37	1.8	0.4
	8:00	20	14							3,400	500	25	1.0	0.2
	8:15	20	14							2,600	500	25	0.8	0.2
	8:45	20	14							1,800	500	25	0.5	0.3
	9:15	20	14							1,400	500	25	0.4	0.2
	9:45	20	12							2,600	600	29	0.9	0.5
	10:15	20	12							2,400	500	25	0.7	0.3
	11:15	20	12							2,200	500	25	0.6	0.6
	11:45	20	12							2,000	500	25	0.6	0.3
	12:45	20	12							1,700	400	20	0.4	0.4
	13:15	20	12							3,000	400	20	0.7	0.3
	13:45	20	12							3,000	400	20	0.7	0.3
	14:15	20	12							2,600	450	22	0.7	0.3
	14:45	20	12							2,200	450	22	0.6	0.3
	15:15	20	12							2,000	450	22	0.5	0.3
	15:45	20	12							1,800	400	20	0.4	0.2

Well Gauging Data:			Before EFR® Event			After EFR® Event			Corr. DTW Change (ft)
Well No.	Diam.	TD (ft)	DTS (ft)	DTW (ft)	SPH (ft)	DTS (ft)	DTW (ft)	SPH (ft)	
MW-2S	2"		70.13	71.14	1.01	-	83.16	0.00	-12.88

Vacuum Truck Information	
Subcontractor:	AllVac
Truck Operator:	Mosley
Truck No.:	153
Vacuum Pumps:	Becker
Pump Type:	Twin LC-44s
Tank Capacity (gal.):	2,894
Stack I.D. (inches)	3.0

Well ID	Breather Port	Stinger Depth
MW-2S	0 (closed)	73'

Recovery/Disposal Information		
Hydrocarbons (vapor):	6.0	pounds
Hydrocarbons (liquid):		gallons
Total Hydrocarbons:	1.0	equiv. gallon
Molecular Weight Utilized:	75	g/mole
Disposal Facility:	On-site	
Manifest Number:		
Total Liquids Removed:	69	gallons

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Time:	7:15-15:45
# Pumps:	2
RPMs:	1,000
Time:	
# Pumps:	
RPMs:	

Notes:

At 9:15 lowered stinger to 78'
At 11:45 lowered stinger to 81'
At 13:45 lowered stinger to 84'

Differential Pressure and Groundwater Drawdown Data Recorded During EFR®
Event No. 1 - June 16, 2015
Daniel B. Stephens
Alto, NM

DIFFERENTIAL PRESSURE DATA

		Well Designation:						
		MW-2D	MW-4S	MW-11S	MW-3S	MW-1D	MW-6S	MW-10S
Nearest Extraction Well:		MW-2S	MW-2S	MW-2S	MW-2S	MW-2S	MW-2S	MW-2S
Approximate Distance:		33 feet	60 feet	55 feet	40 feet	45 feet	103 feet	145 feet
Time	Elapsed Time	Differential Pressures (inches of water):						
7:45	0.5 hrs.	0.00	-0.05	0.00	0.00	0.00	0.00	0.00
8:15	1.0 hr.	0.00	-0.10	0.00	0.00	0.00	-0.03	0.00
8:45	1.5 hrs.	0.00	-0.14	0.00	0.00	0.00	-0.03	0.00
9:15	2.0 hrs.	0.00	-0.08	0.00	0.00	0.00	0.00	0.00
9:45	2.5 hrs.	0.00	-0.05	0.00	0.00	0.00	0.00	0.00
10:15	3.0 hrs.	0.00	-0.11	0.00	0.00	0.00	0.00	0.00
10:45	3.5 hrs.	0.00	-0.11	0.00	0.00	0.00	0.00	0.00
11:15	4.0 hrs.	0.00	-0.11	0.00	0.00	0.00	-0.03	0.00
11:45	4.5 hrs.	0.00	-0.10	0.00	0.00	0.00	0.00	0.00
12:15	5.0 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12:45	5.5 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13:15	6.0 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13:45	6.5 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14:15	7.0 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14:45	7.5 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15:15	8.0 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15:45	8.5 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum Change:		0.00	-0.14	0.00	0.00	0.00	-0.03	0.00

GROUNDWATER DRAWDOWN DATA

		Well Designation:						
		MW-2D	MW-4S	MW-11S	MW-3S	MW-1D	MW-6S	MW-10S
Nearest Extraction Well:		MW-2S	MW-2S	MW-2S	MW-2S	MW-2S	MW-2S	MW-2S
Approximate Distance:		33 feet	60 feet	55 feet	40 feet	45 feet	103 feet	145 feet
Time	Elapsed Time	Depth to Liquid (feet below top of casing):						
Prior to EFR®		72.87	55.92	67.68	71.16	118.38	83.58	71.75
After EFR®		73.05	56.78	67.51	73.19	118.31	83.59	72.11
Maximum Change:		-0.18	-0.86	0.17	-2.03	0.07	-0.01	-0.36

EFR® FIELD DATA SHEET

Client: DBS	Facility Name: Bell Gas #1186	Event #: 2
Facility Address: 101 Sun Valley Rd., Alto, NM	Technician: Mosley	Date: 06/17/15

Extraction Well(s)	Time hh:mm	Extraction Well-head Vacuum (in. Hg)		Vacuum Truck Exhaust				
Start Time:	8:30	Inlet	MW-10S	Concentration PPM	Offgas Velocity FT/MIN	Flow Rate CFM	Removal Rate LBS/HR	Interval Removal LBS
MW-10S	8:45	20	7	40,000	450	22	14.4	3.6
	9:00	20	7	50,000	450	22	18.0	4.5
	9:15	20	7	56,000	450	22	20.1	5.0
	9:30	20	7	60,000	400	20	19.2	4.8
	10:00	20	7	58,000	500	25	23.2	11.6
	10:30	20	7	50,000	400	20	16.0	8.0
	11:00	20	7	70,000	400	20	22.4	11.2
	11:30	20	7	58,000	400	20	18.5	9.3
	12:00	20	7	55,000	400	20	17.6	8.8
	12:30	20	7	10,000	250	12	2.0	1.0
	13:00	20	5	20,000	250	12	4.0	2.0
	13:30	20	5	26,000	250	12	5.2	2.6
	14:00	20	5	20,000	250	12	4.0	2.0
	14:30	20	5	22,000	250	12	4.4	2.2
	15:00	20	5	22,000	250	12	4.4	2.2
	15:30	20	5	22,000	250	12	4.4	2.2
	16:00	20	5	20,000	250	12	4.0	4.0
	16:30	20	5	20,000	300	15	4.8	2.4

Well Gauging Data:			Before EFR® Event			After EFR® Event			Corr. DTW
Well No.	Diam.	TD (ft)	DTS (ft)	DTW (ft)	SPH (ft)	DTS (ft)	DTW (ft)	SPH (ft)	Change (ft)
MW-10S	2"		72.11	75.90	3.79	75.12	85.30	10.18	-3.97

Vacuum Truck Information		Well ID	Breather Port	Stinger Depth
Subcontractor:	AllVac	MW-10S	0 (closed)	75'
Truck Operator:	Mosley			
Truck No.:	153			
Vacuum Pumps:	Becker			
Pump Type:	Twin LC-44s			
Tank Capacity (gal.):	2,894			
Stack I.D. (inches)	3.0			

Recovery/Disposal Information		
Hydrocarbons (vapor):	87.3	pounds
Hydrocarbons (liquid):	11.0	gallons
Total Hydrocarbons:	25.4	equiv. gallon
Molecular Weight Utilized:	103	g/mole
Disposal Facility:	On-site	
Manifest Number:		
Total Liquids Removed:	265	gallons

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Time:	8:30-16:30
# Pumps:	2
RPMs:	1,000
Time:	
# Pumps:	
RPMs:	

Notes:
At 12:30 lowered stinger to 78'
At 12:30 gauged MW-10S, 74.50 - 79.85 (5.35' SPH)

Gauged truck after rest period at end of day = 11 gallons SPH
Product appears to be diesel fuel

Differential Pressure and Groundwater Drawdown Data Recorded During EFR®
Event No. 2 - June 17, 2015
Daniel B. Stephens
Alto, NM

DIFFERENTIAL PRESSURE DATA

		Well Designation:							
		MW-3S	MW-7D	MW-6D	MW-6S	MW-5S	MW-9S	MW-9D	MW-12S
Nearest Extraction Well:		MW-10S	MW-10S	MW-10S	MW-10S	MW-10S	MW-10S	MW-10S	MW-10S
Approximate Distance:		108 feet	77 feet	110 feet	115 feet	185 feet	79 feet	77 feet	130 feet
Time	Elapsed Time	Differential Pressures (inches of water):							
9:00	0.5 hrs.	0.00	0.00	0.00	-0.05	0.00	0.00	0.00	-0.06
9:30	1.0 hr.	0.00	-0.03	0.00	-0.13	-0.04	-0.04	0.00	-0.08
10:00	1.5 hrs.	0.00	0.00	0.00	-0.13	-0.04	0.00	0.00	-0.05
10:30	2.0 hrs.	0.00	0.00	0.00	-0.08	-0.05	0.00	0.00	-0.04
11:00	2.5 hrs.	0.00	0.00	0.00	-0.11	-0.05	0.00	0.00	-0.04
11:30	3.0 hrs.	0.00	0.00	0.00	-0.13	-0.05	0.00	0.00	0.00
12:00	3.5 hrs.	0.00	0.00	0.00	-0.05	0.00	0.00	0.00	0.00
12:30	4.0 hrs.	0.00	0.00	0.00	-0.04	0.00	0.00	0.00	-0.03
13:00	4.5 hrs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.03
13:30	5.0 hrs.	0.00	0.00	0.00	-0.04	0.00	0.00	0.00	0.00
14:00	5.5 hrs.	0.00	0.00	-0.04	-0.15	-0.03	-0.03	0.00	-0.08
14:30	6.0 hrs.	0.00	0.00	0.00	-0.13	-0.03	-0.02	0.00	-0.05
15:00	6.5 hrs.	0.00	-0.03	-0.03	-0.11	0.00	-0.04	0.00	-0.10
15:30	7.0 hrs.	0.00	0.00	0.00	-0.05	0.00	-0.02	0.00	-0.03
16:00	7.5 hrs.	0.00	0.00	0.00	0.00	0.00	-0.04	0.00	0.00
16:30	8.0 hrs.	0.00	0.00	0.00	0.00	0.00	-0.07	0.00	-0.08
Maximum Change:		0.00	-0.03	-0.04	-0.15	-0.05	-0.07	0.00	-0.10

GROUNDWATER DRAWDOWN DATA

		Well Designation:							
		MW-3S	MW-7D	MW-6D	MW-6S	MW-5S	MW-9S	MW-9D	MW-12S
Nearest Extraction Well:		MW-10S	MW-10S	MW-10S	MW-10S	MW-10S	MW-10S	MW-10S	MW-10S
Approximate Distance:		108 feet	77 feet	110 feet	115 feet	185 feet	79 feet	77 feet	130 feet
Time	Elapsed Time	Depth to Liquid (feet below top of casing):							
Prior to EFR®		71.16	113.17	120.54	83.58	85.45	85.67	118.62	55.15
After EFR®		73.50	113.04	120.54	86.35	85.51	85.68	118.64	55.15
Maximum Change:		-2.34	0.13	0.00	-2.77	-0.06	-0.01	-0.02	0.00

EFR® FIELD DATA SHEET

Client: DBS	Facility Name: Bell Gas #1186		Event #: 3, 4, & 5
Facility Address: 101 Sun Valley Rd., Alto, NM		Technician: Mosley	Date: 06/18/15

Extraction Well(s)	Time hh:mm	Extraction Well-head Vacuum (in. Hg)									Vacuum Truck Exhaust				
		Inlet	MW-3S	MW-6D	MW-6S						Concentration PPM	Offgas Velocity FT/MIN	Flow Rate CFM	Removal Rate LBS/HR	Interval Removal LBS
Start Time:	7:30														
MW-3S	7:45	20	13								20,000	750	37	12.0	3.0
	8:00	20	13								34,000	600	29	16.3	4.1
	8:15	20	13								32,000	600	29	15.3	3.8
	8:30	20	13								30,000	600	29	14.4	3.6
MW-6D	8:45	20		5							300	300	15	0.1	0.0
	9:00	20		5							350	300	15	0.1	0.0
	9:15	20		5							400	400	20	0.1	0.0
	9:30	20		5							500	300	15	0.1	0.0
	9:45	20		5							400	400	20	0.1	0.0
	10:00	20		5							500	400	20	0.2	0.0
MW-6S	10:15	20			13						7,200	500	25	2.9	0.7
	10:30	20			13						7,000	500	25	2.8	0.7
	10:45	20			13						7,200	500	25	2.9	0.7
	11:00	20			13						6,600	500	25	2.6	0.7

Well Gauging Data:			Before EFR® Event			After EFR® Event			Corr. DTW Change (ft)
Well No.	Diam.	TD (ft)	DTS (ft)	DTW (ft)	SPH (ft)	DTS (ft)	DTW (ft)	SPH (ft)	
MW-3S	2"		71.68	71.90	0.22	-	74.84	0.00	-3.13
MW-4S	2"		56.60	56.92	0.32				
MW-6S	2"		-	83.70	0.00	-	86.90	0.00	-3.20
MW-6D	2"		-	120.56	0.00	-	119.51	0.00	1.05
MW-11S	2"		69.98	73.65	3.67				

Vacuum Truck Information		Well ID	Breather Port	Stinger Depth	**Recovery/Disposal Information**		
Subcontractor:	AllVac	MW-3S	0 (closed)	73'	Hydrocarbons (vapor):	17.5	pounds
Truck Operator:	Mosley	MW-6D	0 (closed)	123'	Hydrocarbons (liquid):		gallons
Truck No.:	153	MW-6S	0 (closed)	85'	Total Hydrocarbons:	2.9	equiv. gallon
Vacuum Pumps:	Becker				Molecular Weight Utilized:	103	g/mole
Pump Type:	Twin LC-44s				Disposal Facility:	On-site	
Tank Capacity (gal.):	2,894				Manifest Number:		
Stack I.D. (inches)	3.0				Total Liquids Removed:	56	gallons

ECOVAC SERVICES	Time:	7:30-11:00	Notes:
www.ecovacservices.com	# Pumps:	2	MW-6S fluid level was 83.65 prior to MW-6D extraction. Lowered 0.05'
405-895-9990	RPMs:	1,000	during extraction from MW-6D
	Time:		
	# Pumps:		Liquid SPH in truck was from MW-3S (see note on following sheet)
	RPMs:		

EFR® FIELD DATA SHEET

Client: DBS	Facility Name: Bell Gas #1186	Event #: 6 & 7
Facility Address: 101 Sun Valley Rd., Alto, NM	Technician: Mosley	Date: 06/18/15

Extraction Well(s)	Time hh:mm	Extraction Well-head Vacuum (in. Hg)									Vacuum Truck Exhaust				
		Inlet	MW-4S	MW-11S							Concentration PPM	Offgas Velocity FT/MIN	Flow Rate CFM	Removal Rate LBS/HR	Interval Removal LBS
Start Time:	11:15														
MW-4S	11:30	20	8								1,600	600	29	0.8	0.2
	11:45	20	8								2,400	600	29	1.2	0.3
	12:00	20	8								1,000	600	29	0.5	0.1
	12:15	20	8								800	600	29	0.4	0.1
MW-11S	12:30	20		7							9,000	300	15	2.2	0.5
	12:45	20		7							14,000	400	20	4.5	1.1
	13:00	20		7							16,000	400	20	5.1	1.3
	13:15	20		7							12,000	400	20	3.8	1.0
	13:30	20		7							16,000	400	20	5.1	1.3

Well Gauging Data:			Before EFR® Event			After EFR® Event			Corr. DTW
Well No.	Diam.	TD (ft)	DTS (ft)	DTW (ft)	SPH (ft)	DTS (ft)	DTW (ft)	SPH (ft)	Change (ft)
MW-4S	2"		56.60	56.92	0.32	64.12	64.15	0.03	-7.48
MW-11S	2"		69.98	73.65	3.67	70.94	71.25	0.31	-0.46

Vacuum Truck Information	
Subcontractor:	AllVac
Truck Operator:	Mosley
Truck No.:	153
Vacuum Pumps:	Becker
Pump Type:	Twin LC-44s
Tank Capacity (gal.):	2,894
Stack I.D. (inches)	3.0

Well ID	Breather Port	Stinger Depth
MW-4S	0 (closed)	58'
MW-11S	0 (closed)	73'

Recovery/Disposal Information		
Hydrocarbons (vapor):	5.9	pounds
Hydrocarbons (liquid):		gallons
Total Hydrocarbons:	1.0	equiv. gallon
Molecular Weight Utilized:	103	g/mole
Disposal Facility:	On-site	
Manifest Number:		
Total Liquids Removed:	101	gallons

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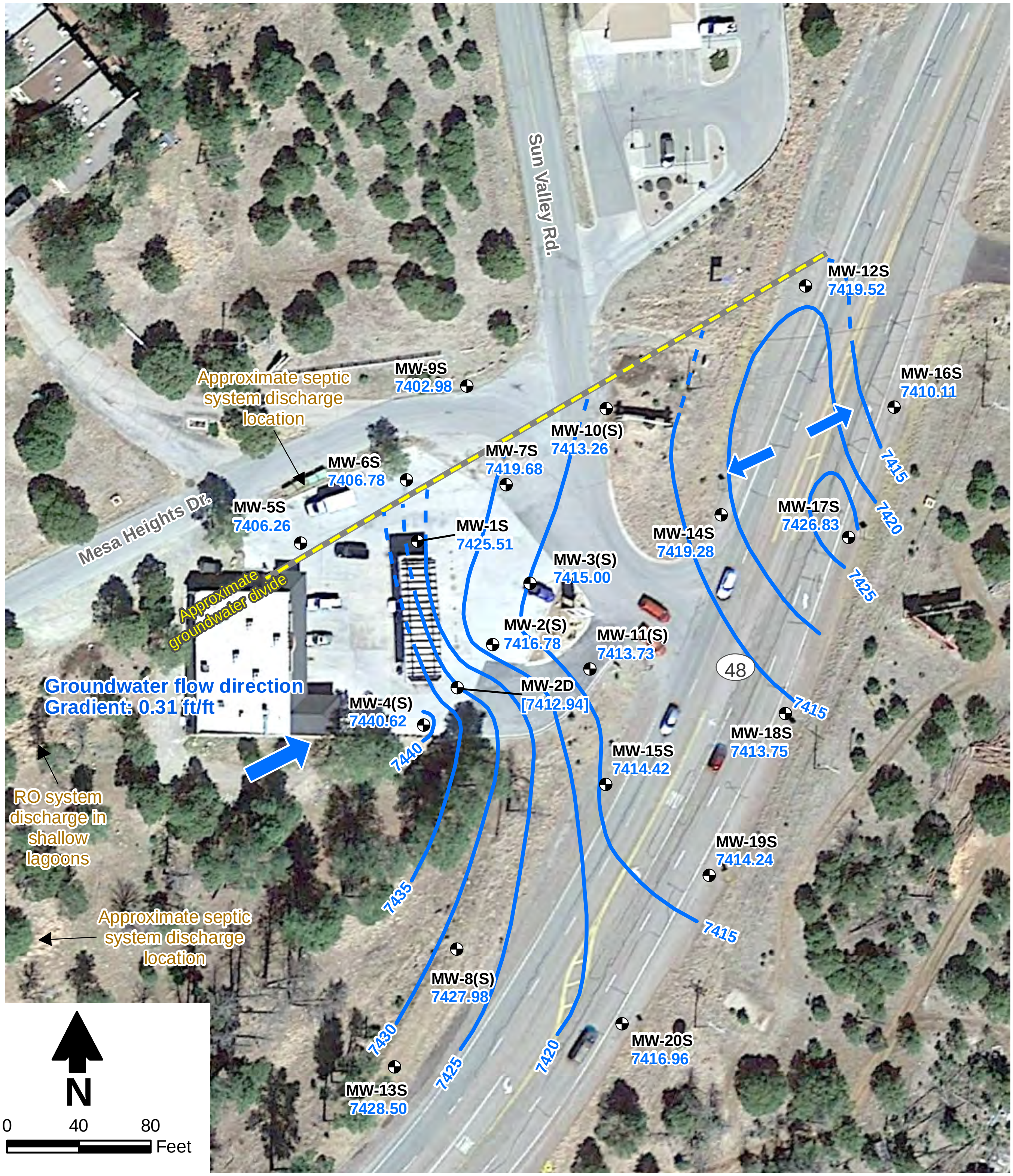
Time:	7:30-11:00
# Pumps:	2
RPMs:	1,000
Time:	
# Pumps:	
RPMs:	

Notes:

Had 19 gallons of SPH in truck at the conclusion of extraction on from the five wells

Attachment 3

Summary of Fluid Levels and Monitor Well Survey



Explanation

- Monitor well
- Potentiometric surface elevation contour (ft msl)
- **MW-2(S)** Monitor well designation
- **7416.78** Potentiometric surface elevation (ft msl)
- **[7412.94]** Potentiometric surface elevation not used for contouring

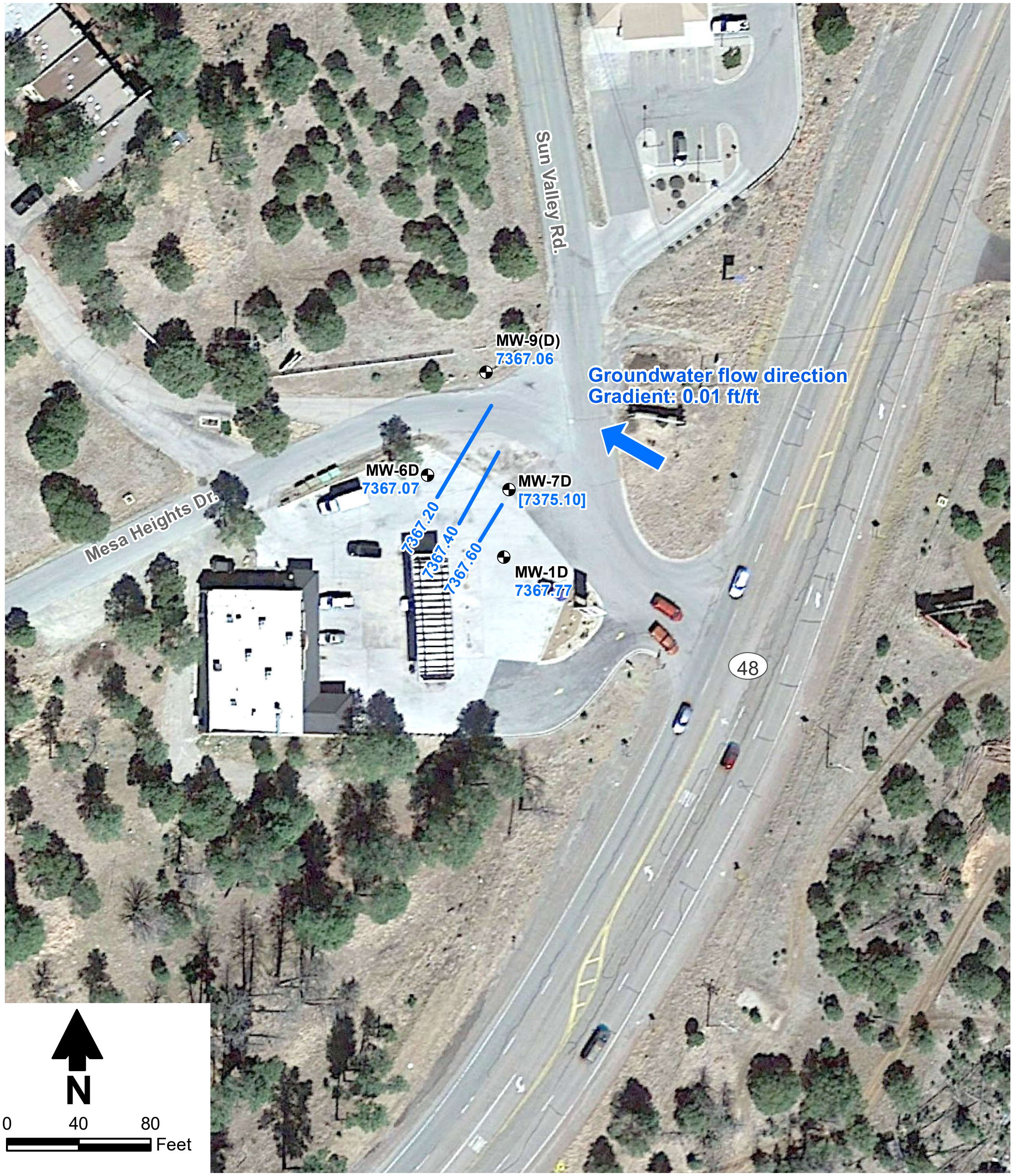
BELL GAS #1186
ALTO, NEW MEXICO

Potentiometric Surface Elevations in the Upper Aquifer
April 13, 2020

Daniel B. Stephens & Associates, Inc.
4/27/2020 JN ES14.0220.00

Figure 3a

S:\Projects\ES14.0220_Bell_Gas_1186\GIS\MXDs\Fluid_levels\GWE_upper_2020-04.mxd



Source: Aerial image from Google Earth dated March 2016

Explanation

⊕	Monitor well
—	Potentiometric surface elevation contour (ft msl)
MW-6D	Monitor well designation
7367.07	Potentiometric surface elevation (ft msl)
[7375.10]	Potentiometric surface elevation not used for contouring

BELL GAS #1186
ALTO, NEW MEXICO

Potentiometric Surface Elevations in the Lower Aquifer April 13, 2020

Daniel B. Stephens & Associates, Inc.
5/15/2020 JN ES14.0220.00

Figure 3b

\\ss6abq\Data$\Projects\ES14.0220_Bell_Gas_1186\GIS\MXDs\Fluid_levels\GWE_lower_2020-04.mxd

CobbFendley

May 20, 2015

Mr. Tom Golden, PE
Daniel B. Stephens & Associates, Inc.
6020 Academy Road. NE, Suite 100
Albuquerque, New Mexico 87109

Survey Report - Bell Gas No. 1186 New Monitor Wells @ Alto, New Mexico

The following is a summary of the results obtained during our recent field surveys on the requested new monitor wells and associated facilities:

Bell Gas No. 1186 New Monitor Wells - Alto, New Mexico
Monitor Well Data: Surveyed on May 19, 2015

New Mexico State Plane Coordinates – NAD 83, Central Zone
NAVD 88 Elevations

Well	Northing	Easting	Elevation	Feature
MW-1D	875344.786	1815733.740	7488.826	CL CAP PVC CASING
MW-1D			7488.698	N. EDGE PVC CASING
MW-1D	875344.804	1815733.819	7489.155	CL STEEL COVER
MW-1D			7489.104	TOP OF CONCRETE
MW-2D	875272.987	1815714.752	7487.875	CL CAP PVC CASING
MW-2D			7487.729	N. EDGE PVC CASING
MW-2D	875272.926	1815714.760	7487.960	CL STEEL COVER
MW-2D			7487.994	TOP OF CONCRETE
MW-5S	875353.322	1815627.703	7493.537	CL CAP PVC CASING
MW-5S			7493.399	N. EDGE PVC CASING
MW-5S	875353.330	1815627.713	7493.843	CL STEEL COVER
MW-5S			7493.845	TOP OF CONCRETE
MW-6D	875390.297	1815691.259	7490.822	CL CAP PVC CASING
MW-6D			7490.696	N. EDGE PVC CASING
MW-6D	875390.297	1815691.331	7491.047	CL STEEL COVER
MW-6D			7491.046	TOP OF CONCRETE
MW-6S	875388.546	1815686.564	7490.999	CL CAP PVC CASING
MW-6S			7490.874	N. EDGE PVC CASING
MW-6S	875388.556	1815686.619	7491.252	CL STEEL COVER
MW-6S			7491.285	TOP OF CONCRETE
MW-9S	875440.969	1815720.150	7489.216	CL CAP PVC CASING
MW-9S			7489.081	N. EDGE PVC CASING
MW-9S	875441.009	1815720.162	7489.390	CL STEEL COVER
MW-9S			7489.287	GROUND

MW-12S	875496.525	1815908.744	7473.835	CL CAP PVC CASING
MW-12S			7473.701	N. EDGE PVC CASING
MW-12S	875496.471	1815908.711	7473.995	CL STEEL COVER
MW-12S			7473.947	ASPHALT
MW-13S	875061.681	1815679.796	7472.564	CL CAP PVC CASING
MW-13S			7472.436	N. EDGE PVCCASING
MW-13S	875061.688	1815679.743	7472.844	CL STEEL COVER
MW-13S			7472.673	GROUND

I, Randolph C. Hewitt, New Mexico Professional Surveyor No. 14730, do hereby certify that this Survey Report was prepared by me or under my direct supervision based on an actual survey on the ground as described herein; that I am responsible for this survey; and that the survey and report meet the minimum standards for surveying in New Mexico.

RC Hewitt

May 20, 2015

Randolph C. Hewitt, NMPS No. 14730 — Date

April 15, 2015

Mr. Tom Golden, PE
Daniel B. Stephens & Associates, Inc.
6020 Academy Road. NE, Suite 100
Albuquerque, New Mexico 87109

Survey Report - Bell Gas No. 1186 Existing Monitor Wells @ Alto, New Mexico

The following is a summary of the procedures used and the results obtained during our recent field surveys on the requested monitor wells and associated facilities:

1. The scope of work called for CobbFendley to survey approximately 10 existing monitor wells and to conduct a topographic survey sufficiently covering the entire site. In addition, a minimum of 3 control points were to be established on site suitable for future construction activities and monitor well observations. The surveys were to be tied to the previously established control on site produced by Sierra Environmental, Inc. if possible.

2. The survey control points were observed utilizing a combination of GPS static and RTK procedures. These observations were conducted using Trimble R8 GNSS receivers in which the data was collected at 5 second epochs using a 12° mask. The horizontal coordinates were fixed horizontally to the 2nd order NGS control station "Westbox". The elevations were derived by holding the published elevations fixed for the monitor wells provided by Daniel B. Stephens & Associates per the report titled "Sierra Environmental, Inc., Monitor Well Locations and Elevations, Bell Gas Number 1186, Alto, New Mexico". The existing monitor well elevations were utilized due to the apparent destruction of the project benchmark "TBM-ALTO66" (not recovered) as described in said report. All control data was processed and adjusted utilizing Trimble Business Center software.

3. The survey data is provided in the following format:

    - New Mexico State Plane Coordinates - NAD 83 (NSRS 1992), Central Zone*
    - New Mexico State Plane Coordinates - NAD 83 (NSRS 1992), Central Zone* modified to surface local project coordinates (Project Combined Factor = 1.000419055 at an origin of 0,0)
    - Elevations referred to NAVD 88 and modeled by GEOID 12A
    - Coordinates and elevations expressed in U.S. Survey Feet

    (*Note - the above-mentioned report erroneously referred to the horizontal coordinates as being New Mexico Coordinate System Eastern Zone, NAD 83)

4. Attached as additional reference information are the following:

    - Coordinate and elevation listing of all surveyed monitor well data in N.M. State Plane grid coordinates and NAVD 88 elevations
    - Control point data in both New Mexico State Plane grid coordinates & elevations and modified (surface) coordinates & elevations
    - Control Point Description Sheets

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I, Randolph C. Hewitt, New Mexico Professional Surveyor No. 14730, do hereby certify that this Survey Report was prepared by me or under my direct supervision based on an actual survey on the ground as described herein; that I am responsible for this survey; and that the survey and report meet the minimum standards for surveying in New Mexico.

RC Hewitt

April 16, 2015

Randolph C. Hewitt, NMPS No. 14730 Date

Bell Gas No. 1186 Existing Monitor Wells - Alto, New Mexico
Monitor Well Data: Surveyed on April 9, 2015

New Mexico State Plane Coordinates – NAD 83, Central Zone
NAVD 88 Elevations

Well	Northing	Easting	Elevation	Feature
MW-2	875296.877	1815734.591	7488.180	CL CAP PVC CASING
MW-2			7488.054	N. EDGE PVC CASING
MW-2	875296.902	1815734.623	7488.298	CL STEEL COVER
MW-2			7488.296	N. EDGE STEEL CASING
MW-2			7488.291	TOP OF CONCRETE
MW-3	875330.973	1815755.438	7487.354	CL CAP PVC CASING
MW-3			7487.365	N. EDGE PVC CASING
MW-3	875330.885	1815755.491	7487.609	CL STEEL COVER
MW-3			7487.611	N. EDGE STEEL CASING
MW-3			7487.490	TOP OF CONCRETE
MW-4	875252.071	1815696.063	7487.154	CL CAP PVC CASING
MW-4			7487.024	N. EDGE PVC CASING
MW-4	875252.054	1815696.107	7487.718	CL STEEL COVER
MW-4			7487.680	N. EDGE STEEL CASING
MW-4			7487.805	TOP OF CONCRETE
MW-5	875346.403	1815608.033	7494.322	CL CAP PVC CASING
MW-5			7494.196	N. EDGE PVC CASING
MW-5	875346.312	1815607.972	7494.563	CL STEEL COVER
MW-5			7494.572	N. EDGE STEEL CASING
MW-5			7494.497	TOP OF CONCRETE

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Well	Northing	Easting	Elevation	Feature
MW-6	875403.903	1815679.391	7491.802	CL CAP PVC CASING
MW-6			7491.664	N. EDGE PVC CASING
MW-6	875403.914	1815679.417	7492.000	CL STEEL COVER
MW-6			7491.978	N. EDGE STEEL CASING
MW-6			7491.859	TOP OF CONCRETE
MW-7	875382.153	1815736.719	7488.854	CL CAP PVC CASING
MW-7			7488.742	N. EDGE PVC CASING
MW-7	875382.244	1815736.723	7488.954	CL STEEL COVER
MW-7			7488.923	N. EDGE STEEL CASING
MW-7			7489.001	TOP OF CONCRETE
MW-8	875127.212	1815714.654	7476.385	CL CAP PVC CASING
MW-8			7476.300	N. EDGE PVC CASING
MW-8	875127.255	1815714.662	7476.664	CL STEEL COVER
MW-8			7476.678	N. EDGE STEEL CASING
MW-8			7476.681	GROUND
MW-9	875447.642	1815723.780	7488.673	CL CAP PVC CASING
MW-9			7488.582	N. EDGE PVC CASING
MW-9	875447.649	1815723.836	7489.060	CL STEEL COVER
MW-9			7489.058	N. EDGE STEEL CASING
MW-9			7489.149	GROUND
MW-10	875428.354	1815797.720	7486.801	CL CAP PVC CASING
MW-10			7486.694	N. EDGE PVC CASING
MW-10	875428.357	1815797.778	7486.973	CL STEEL COVER
MW-10			7486.972	N. EDGE STEEL CASING
MW-10			7486.958	GROUND
MW-11	875283.301	1815788.801	7483.404	CL CAP PVC CASING
MW-11			7483.313	N. EDGE PVC CASING
MW-11	875283.161	1815788.778	7483.635	CL STEEL COVER
MW-11			7483.629	N. EDGE STEEL CASING
MW-11			7483.606	TOP OF ASPHALT

October 19, 2015

Mr. Tom Golden, PE
Daniel B. Stephens & Associates, Inc.
6020 Academy Road. NE, Suite 100
Albuquerque, New Mexico 87109

Survey Report - Bell Gas No. 1186 New Monitor Wells @ Alto, New Mexico

The following is a summary of the results obtained during our recent field surveys on the requested new monitor wells and associated facilities:

Bell Gas No. 1186 New Monitor Wells - Alto, New Mexico
Monitor Well Data: Surveyed on October 15, 2015

New Mexico State Plane Coordinates – NAD 83, Central Zone
NAVD 88 Elevations

Well	Northing	Easting	Elevation	Feature
MW-1S	875354.449	1815692.693	7490.377	CL CAP PVC CASING
MW-1S			7490.246	N.EDGE PVC CASING
MW-1S	875354.373	1815692.707	7490.743	CL STEEL COVER
MW-1S			7490.762	TOP OF CONCRETE
MW-7S	875385.973	1815741.934	7488.463	CL CAP PVC CASING
MW-7S			7488.334	N. EDGE PVC CASING
MW-7S	875385.905	1815742.010	7488.708	CL STEEL COVER
MW-7S			7488.608	TOP OF ASPHALT
MW-14S	875369.227	1815861.794	7475.983	CL CAP PVC CASING
MW-14S			7475.857	N. EDGE PVC CASING
MW-14S	875369.244	1815861.826	7476.245	CL STEEL COVER
MW-14S			7476.156	TOP OF ASPHALT
MW-15S	875218.908	1815797.611	7473.881	CL CAP PVC CASING
MW-15S			7473.732	N. EDGE PVC CASING
MW-15S	875218.981	1815797.482	7474.440	CL STEEL COVER
MW-15S			7474.333	TOP OF ASPHALT
MW-16S	875429.296	1815958.059	7474.979	CL CAP PVC CASING
MW-16S			7474.866	N. EDGE PVC CASING
MW-16S	875429.261	1815957.960	7475.373	CL STEEL COVER
MW-16S			7475.363	TOP OF ASPHALT
MW-17S	875356.603	1815932.610	7477.612	CL CAP PVC CASING
MW-17S			7477.486	N. EDGE PVC CASING
MW-17S	875356.489	1815932.628	7478.010	CL STEEL COVER
MW-17S			7477.938	TOP OF ASPHALT

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Well	Northing	Easting	Elevation	Feature
MW-18S	875258.378	1815897.619	7478.783	CL CAP PVC CASING
MW-18S			7478.643	N. EDGE PVC CASING
MW-18S	875258.390	1815897.604	7479.328	CL STEEL COVER
MW-18S			7479.309	TOP OF ASPHALT
MW-19S	875168.284	1815855.143	7478.335	CL CAP PVC CASING
MW-19S			7478.151	N. EDGE PVC CASING
MW-19S	875168.261	1815855.154	7478.737	CL STEEL COVER
MW-19S			7478.747	TOP OF ASPHALT
MW-20S	875085.649	1815806.614	7476.795	CL CAP PVC CASING
MW-20S			7476.659	N. EDGE PVC CASING
MW-20S	875085.584	1815806.614	7477.141	CL STEEL COVER
MW-20S			7477.126	TOP OF ASPHALT

I, Randolph C. Hewitt, New Mexico Professional Surveyor No. 14730, do hereby certify that this Survey Report was prepared by me or under my direct supervision based on an actual survey on the ground as described herein; that I am responsible for this survey; and that the survey and report meet the minimum standards for surveying in New Mexico.

RC Hewitt

October 19, 2015

Randolph C. Hewitt, NMPS No. 14730 Date

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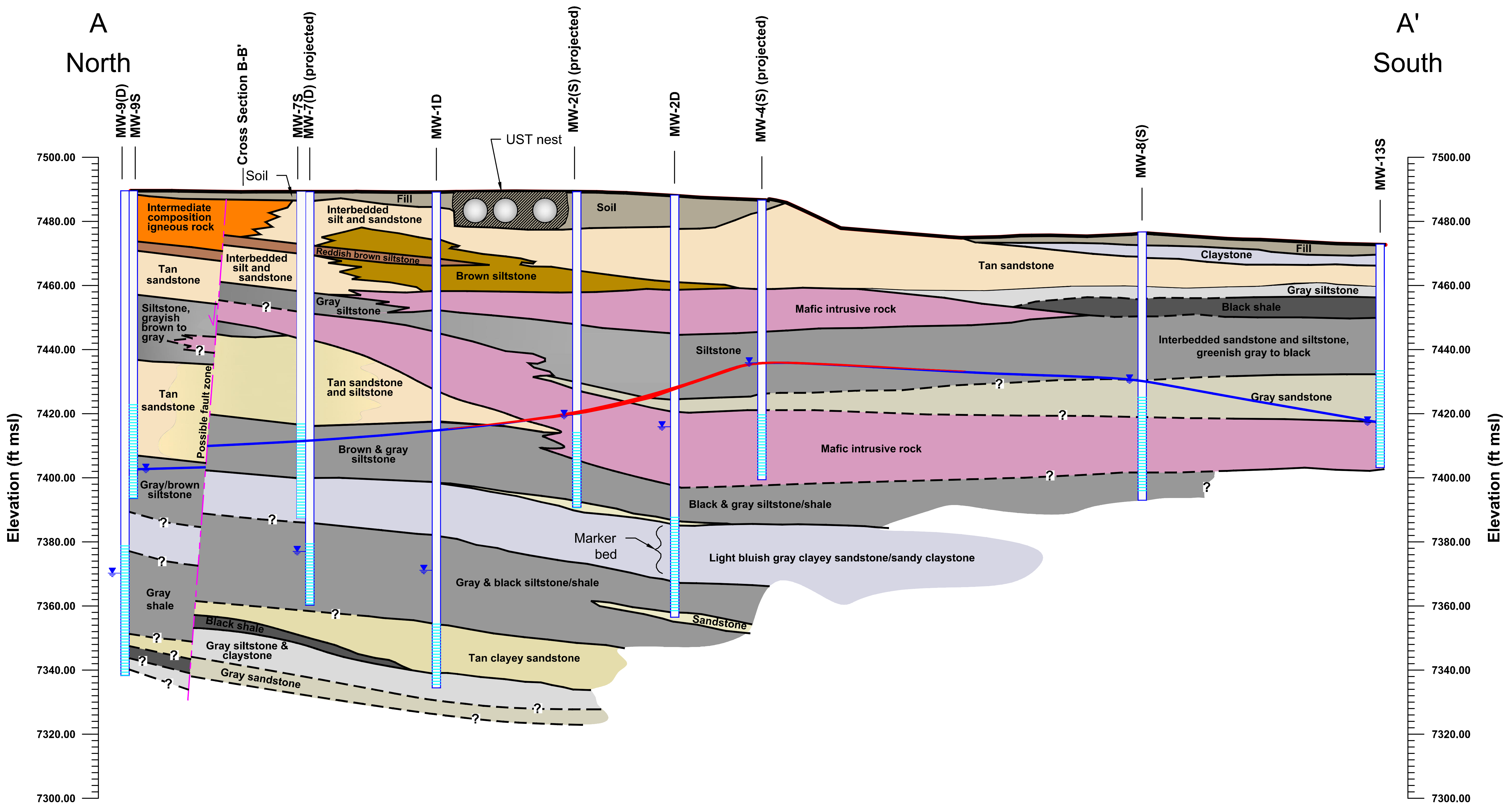
Attachment 4

Lithologic Cross Sections, Soil Boring Logs, and Monitor Well Completion Diagrams



Explanation

Well and well screen

Approximate water level in well (May 2015)

Potentiometric surface showing extent of NAPL

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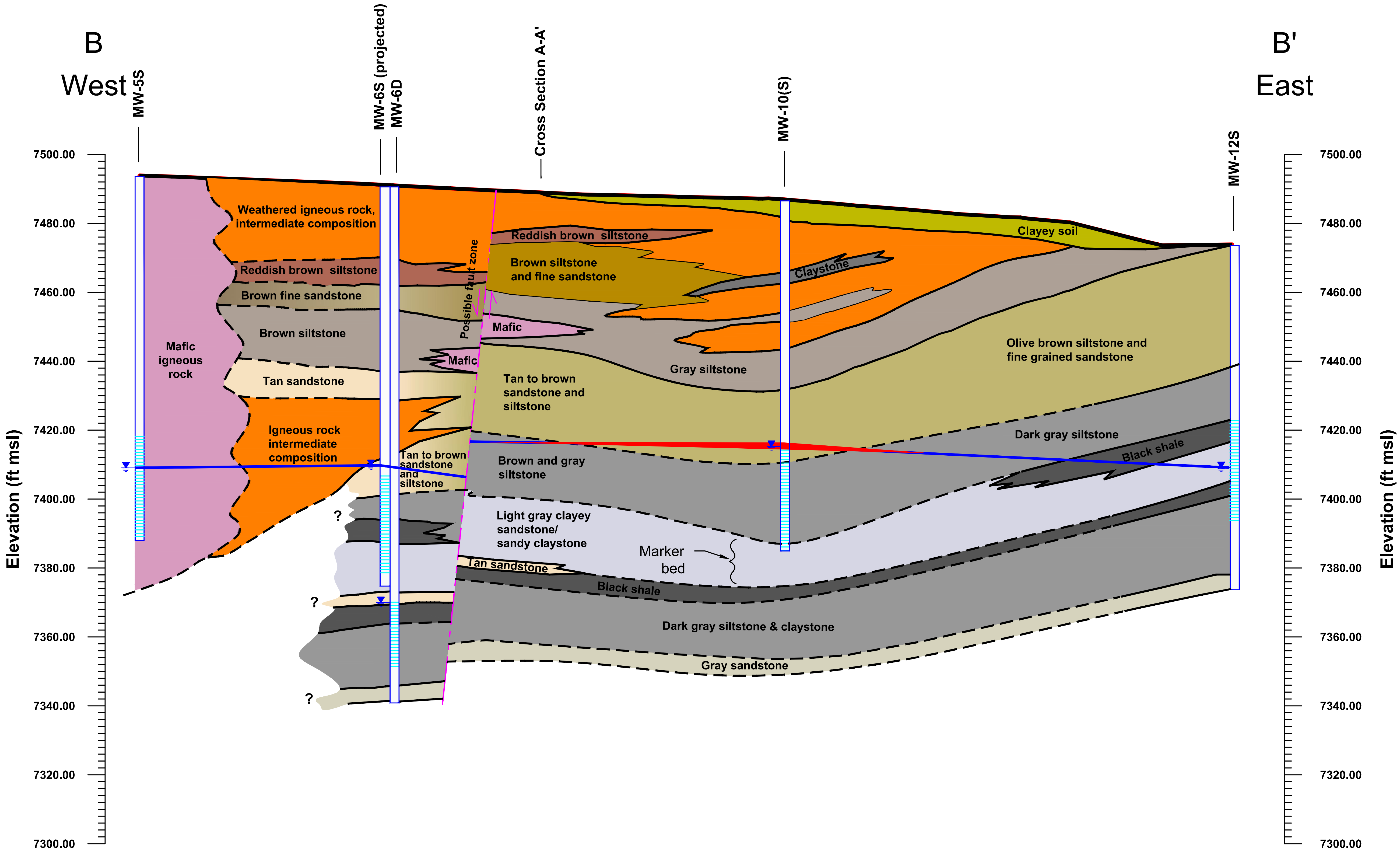
6-24-15
JN ES14.0220.00

BELL GAS #1186
ALTO, NEW MEXICO
Cross Section A-A' North to South

Figure 6a



0 30
Vertical exaggeration = 1X

Explanation

Well and well screen

Approximate water level in well (May 2015)

Potentiometric surface showing extent of NAPL

BELL GAS #1186
ALTO, NEW MEXICO
Cross Section B-B' West to East

Daniel B. Stephens & Associates, Inc.
6-24-15
JN ES14.0220.00

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Figure 6b

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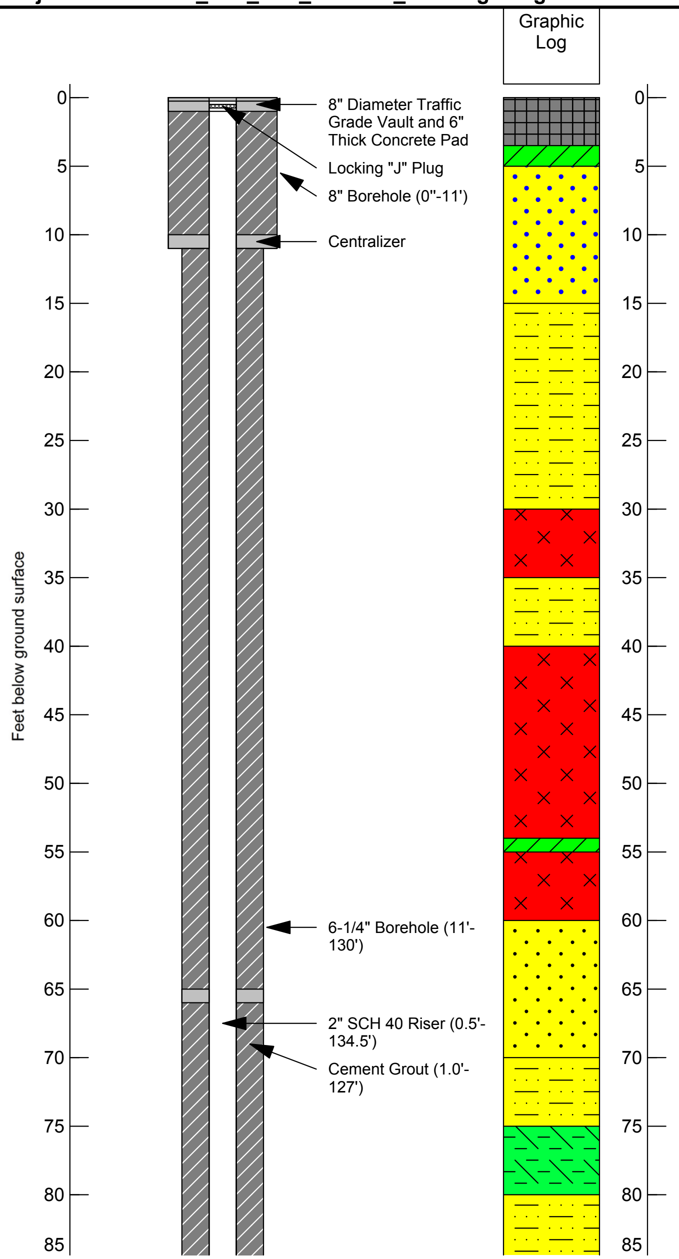

Sample Interval (ft bgs)	USCS Symbol	Lithology Interval	Comments and Lithology
0-5		0-3.5	Concrete, fill
	CL	3.5-5	Sandy clay, dark reddish brown 5YR 3/2, very fine grained, sub-rounded grains, very poor plasticity, slightly moist
5-10		5-6	Sandstone, brownish yellow 10YR 5/4, fine to medium grained, poorly cemented, massive
		6-10	Sandstone, gray 7.5YR 5/1, very fine to medium grained, massive
10-15		10-15	Sandstone, brownish yellow 10YR 5/4, fine to medium grained,poorly cemented, massive
15-20		15-20	Siltstone, dark brown (10YR 3/3) to dark reddish brown (5 YR 3/3). Well indurated, common iron and manganese staining. Hydrocarbon odor.
20-25		20-25	Siltstone, olive brown (2.5Y 4/3) to black. Massive to laminated, moderately well indurated, pervasive iron and manganese staining. Hydrocarbon odor.
25-30		25-30	as above
30-35		30-35	Mafic intrusive igneous rock, dark grayish brown (10YR 4/3), heavily altered and degraded, porphyritic with lath-shaped or blocky feldspar phenocrysts up to 5 mm. Hydrocarbon odor.
35-40		35-40	Siltstone, olive brown (2.5Y 4/3) to black. Massive to laminated, moderately well indurated, pervasive iron and manganese staining. Hydrocarbon odor.
40-45		40-45	Mafic intrusive igneous rock, very dark bluish gray (10B 3/1), porphyritic with lath-shaped or blocky feldspar phenocrysts up to 2 mm, locally altered to dark brown (7.5 YR 3/3). Hydrocarbon odor.
45-50		45-50	as above
50-54		50-54	as above
54-55		54-55	Sandy clay, olive gray (5Y 5/2), very poor rock recovery consisting of sparse fragments of mafic intrusive rocks as above. Hydrocarbon odor.
55-60		55-60	Mafic intrusive igneous rock, similar to above, pervasively decomposed, dark brown (7.5 YR 3/3). Hydrocarbon odor.
60-65		60-65	Sandstone, light yellowish brown (2.5 Y 6/4) poorly lithified to unlithified, medium grained, well sorted with up to 10% fine fraction, rounded to rub-rounded quartz sand.Hydrocarbon odor.
65-70		65-70	Similar to above, color change to brownish yellow (10 YR 6/6). Hydrocarbon odor.
70-75		70-75	SIltstone, dark grayish brown (2.5Y 4/3), strongly lithified with some poorly lithified clay in cuttings. Slight hydrocarbon odor.
75-80		75-80	Clay shale, black, weakly cemented. Poor rock recovery.
80-85		80-85	Siltstone and fine-grained sandstone, silstones have variegated color from black to light bluish gray, laminated to structureless, well indurated, iron oxide staining in viens. Sandstones are relatively sparse, very fine- to fine-grained, typically yellow

Geologist: J. Fisher, J. Raucci
Driller: North Star
Date completed: 5/7/2015

Drilling method: Sonic drilling to 11', downhole air hammer to total depth.
SR = Solid Recovery
MSR = Modified Solid Recovery
RQD = Rock Quality Designation
Sampling method: Cuttings

DTW= Depth to water measured below top of casing (feet)
New Mexico State Plane Coordinates - NAD 83, Central Zone
Northing: 875344.786 Elevation: 7488.698
Easting: 1815733.740

BELL GAS #1186
ALTO, NEW MEXICO

Well Completion Diagram and Geologic Log: MW-1D

Daniel B. Stephens & Associates, Inc.
6/19/2015 JN ES14.0220

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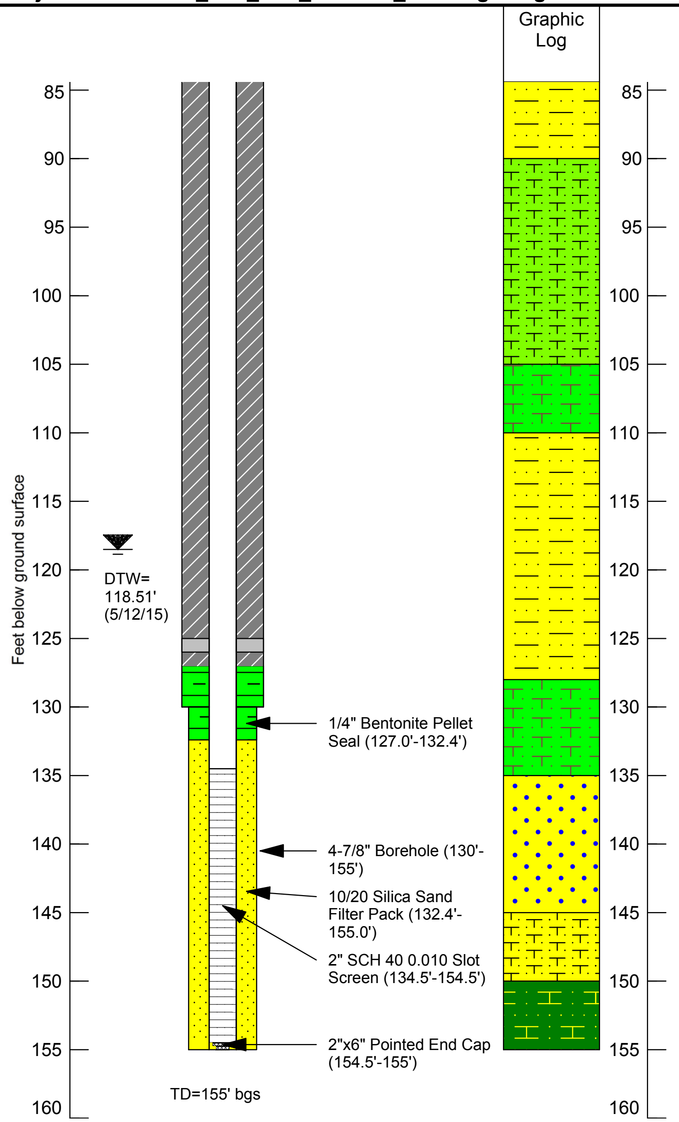

Sample Interval (ft bgs)	USCS Symbol	Lithology Interval	Comments and Lithology
85-90		85-90	as above
90-95		90-95	Sandy claystone, light greenish gray (10Y 8/1), poorly lithified, up to 40% silt and fine-graned sand, sparse dark mineral grains. Possibly tuffaceous. Poor rock recovery.
95-100		95-100	as above
100-105		100-105	as above
105-110		105-110	Claystone, silty, bluish gray (10B 6/1). Moderately indurated, laminated to structureless. Orange iron oxide staining in thin veins
110-124		110-124	Siltstone, similar to above, but siltier, harder, and darker color (very dark bluish gray to black).
124-128		124-128	as above
128-135		128-135	Claystone, dark gray (2.5Y 4/1). silty, weakly to moderately indurated, poor rock recovery
135-140		135-140	Sandstone, grayish brown (2.5 Y 5/2), medium grained, sub rounded, well sorted, slightly silty, weakly to moderately indurated.
140-140		140-145	Similar to above, becoming clayey and very weakly lithified, poor rock recovery
145-150		145-150	Clayey, silty sandstone, similar to above, interbedded or in gradiational contact with black shale
150-155		150-155	Silty claystone, dark gray, 10 YR 4/1. Very poor rock recovery. Likely a poorly lithified or decomposed shale interval.

Geologist: J. Fisher, J. Raucci
Driller: North Star
Date completed: 5/7/2015

Drilling method: Sonic drilling to 11', downhole air hammer to total depth.
SR = Solid Recovery
MSR = Modified Solid Recovery
RQD = Rock Quality Designation
Sampling method: Cuttings

DTW= Depth to water measured below top of casing (feet)
New Mexico State Plane Coordinates - NAD 83, Central Zone
Northing: 875344.786 Elevation: 7488.698
Easting: 1815733.740

BELL GAS #1186
ALTO, NEW MEXICO

Well Completion Diagram and Geologic Log: MW-1D

Daniel B. Stephens & Associates, Inc.
6/19/2015 JN ES14.0220

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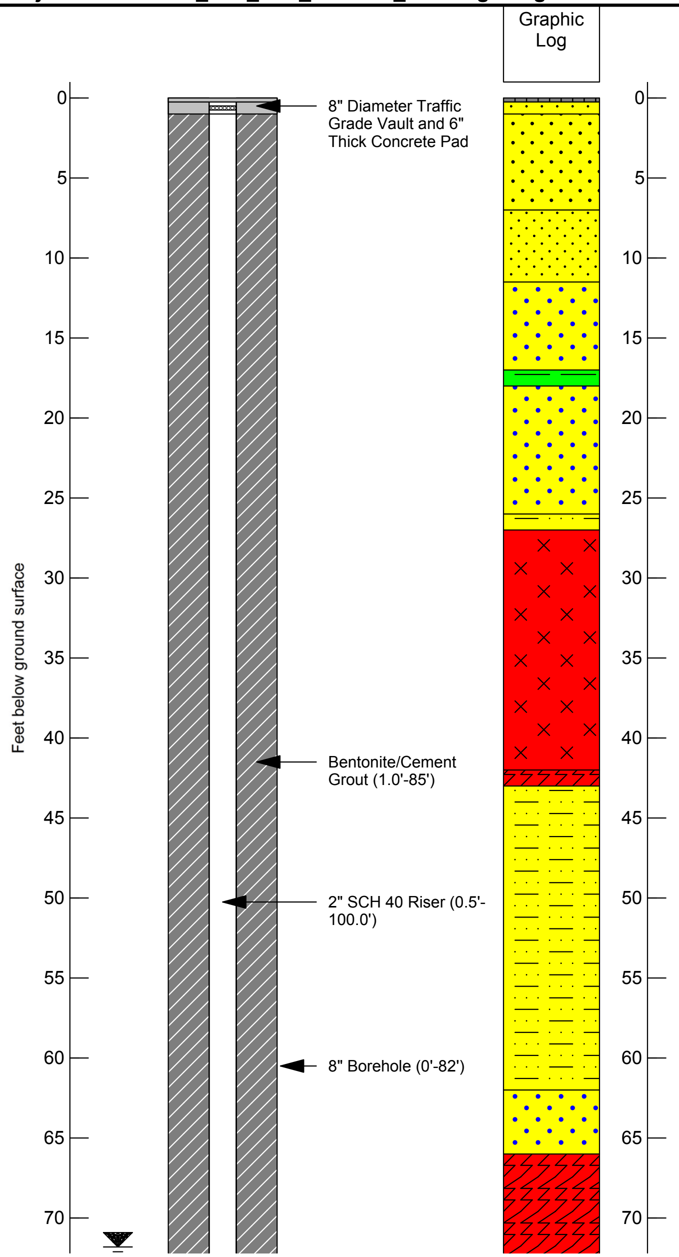


SR (ft)	MSR (ft)	RQD (%)	RQD Desc	Sample Interval (ft bgs)	USCS Symbol	Lithology Interval	Comments and Lithology
				0-5		0-0.25	Concrete
					SW	0.25-1.0	Sand with gravel, brown 7.5YR 5/2, fine to coarse grained, well graded, sub-angular, dry
					SP	1.0-5	Sand with silt, gray 10YR 5/1, very fine to fine grained, poorly graded, sub-angular, slighlty moist, strong hc odor
				5-10	SP	5-10	Sand with clay, dark gray 7.5YR 5/1, very fine to fine grained, poorly graded, sub-angular, slight plasticity, slightly moist, strong hc odor
					SW		Sand with gravel, yellowish brown 10YR 5/4, fine to coarse grained, well graded, angular to sub-angular, slightly moist, slight hc odor
				10-15	SW SW		Sand with silt, greenish gray gley1 6/1, very fine to medium grained, well graded, sub-round to sub-angular, slightly moist, mild hc odor
						10-11.5	Sand with silt and gravel,brown 10YR 4/3, very fine to very coarse, well graded, sub-round to sub-angular, slightly moist, slight hc odor
						11.5-17	Sand stone, very pale brown 10YR 8/1, very fine to fine grained, sub-round to sub-angular
				15-18			
						17-18	Shale, light gray 2.5Y 7/1
				18-25		18-24	Sand stone, very pale brown 10YR 8/1, very fine to fine grained, sub-round to sub-angular
						24-26	Sand stone, light greenish gray gley1 7/1, very fine grained, sub-round
				25-30			
						26-27	Siltstone, light brownish gray 10YR 6/2
						27-42	Mafic intrusive igneous rock, greenish gray gley 1 6/1, massive and crystaline, vesicles filled with calcite. Trachybasalt of the Sierra Blanca volcanic suite.
				30-31		30-31	as above
				31-32.5		31-32.5	as above
				32.5-35		32.5-35	as above
				35-45			Mafic intrusive rock similar to above , gray 10YR 5/1 (outer "rind") greenish gray gley 1 6/1 (inside), massive, fractured, vesicles filled with calcite
						42-43	
						43-45	Siltstone, gray 5Y 5/1, massive
				45-55		45-55	as above, moderately fractured from 52-54 feet
				55-65		55-62	Siltstone, gray 5Y 5/1, slightly weathered, highly fractured from 56-62 feet, massive, calcite veins in fractures
						62-63	Sandstone, dark gray 10YR 5/1, fine grained, moderately fractured, massive, calcite cement and veins
						63-66	Sandstone, light gray gley1 6/N, fine to coarse grained, slightly decomposed, laminated to thin-bedded with siltstone stringers
				65-75			
						66-78	Mafic intrusive rock, dark grayish brown 2.5Y 5/2, massive and crystaline, vesicles filled with calcite, sparse pyrite mineralization. Water production noted during drilling around 75'. Hydrocarbon odor.

Geologist: M. Nauck, J. Raucci
Driller: North Star
Date completed: 4/24/2015

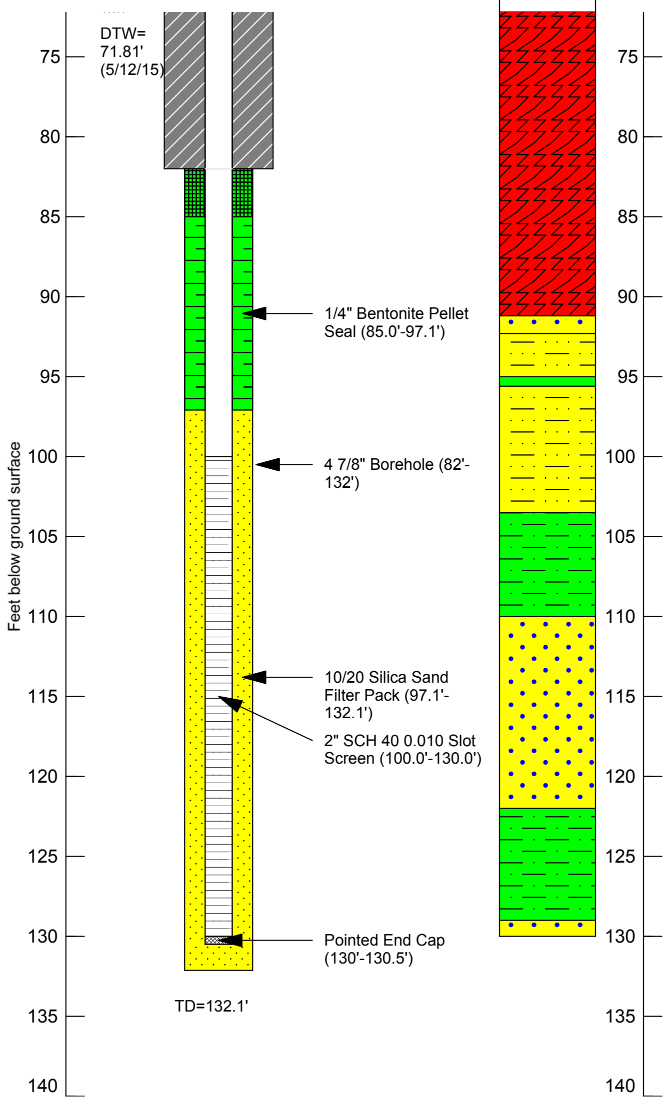
Drilling method: Sonic drilling to 82', rock core drilling to total depth.
SR = Solid Recovery
MSR = Modified Solid Recovery
RQD = Rock Quality Designation
Sampling method: Sonic core to 82', PQ core 82' - 96.5'; HQ core 96.5 - 130

DTW= Depth to water measured below top of casing (feet)
New Mexico State Plane Coordinates - NAD 83, Central Zone
Northing: 875272.987 Elevation: 7487.729
Easting: 1815714.752

BELL GAS #1186
ALTO, NEW MEXICO

Well Completion Diagram and Geologic Log: MW-2D

Daniel B. Stephens & Associates, Inc.
6/17/2015 JN ES14.0220



SR (ft)	MSR (ft)	RQD (%)	RQD Desc	Sample Interval (ft bgs)	USCS Symbol	Lithology Interval	Comments and Lithology
				75-82			
						78-82	as above; decomposed interval, recovered as sub-angular to sub-rounded blocks with fine-grained interstitial material
3.2	2.04	41	Poor	82-87		82-87	Basaltic intrusive rock *PQ core 82' - 96.5'
4.13	3.97	79	Good	87-92		87-91.2	as above
						91.2 - 92	Sandstone, light brownish gray (10Y 6/2), very fine grained, welll sorted, laminated and moderately well lithified
						92-92.3	as above
4	3.67	81	Good	92-96.5		92.3-95	Siltstone, bluish gray (10B 6/1). Finely laminated, well lithified, with minor coaraser-grained intervals up to medium sand. Abundant calcit-fille dfractires, locally pervasive pyrite mineralization
						95-95.6	Black shale, heavily fractured, brittle and friable.
						95.6-96.5	Siltstone and v. fine sandstone, similar to above intervals, mottled color ranging from pale brown to light gray
2.87	2.2	44	Poor	96.5-97 97-102			*HQ core 96.5 - 130
						96.5-97	Siltstone, bluish gray to greenish gray (5PB 6/1 to 10Y 6/1), similar to above but massive
						97-102	Siltstone, bluish gray (5PB 6/1). Finely laminated, well lithified, massive to faintly laminated. Fractures and dark alteration colors at 101'.
7.66	7.12	71	Fair	102-112		102-103.5	similar to above but dark to very dark gray grading downward to black shale at 103'. Heavily fractured at 103', gradational contact with underling unit.
						103.5-110	Mudstone, gray (Gley 1 N6). silty with minor sand. Moderately lithified and coarsening downward, gradational with underlying unit.
						110-112	Sandstone, bluish gray (5PB 5/1), fine-grained grading downward to medium-to-coarse grained, poorly sorted, weakly to moderately lithified, possibly tuffaceous or volcaniclastic in origin
1.65	1.65	17	Very Poor	112-122		112-122	Sandstone, light gray (Gley1 7N), generally fine to medium grained but poorly sorted with sparse angular clasts to 3mm. Significant fine-grained material, possibly tuffaceous. Moderately lithified to 114', then weakly lithified and friable. pervasive iron oxide staining and alteration of mineral grains below 114', becoming coarse-grained and pebbly with sub-angular to sub-rounded chert pebebles up to 2 cm diameter. Poorly lithified and disintigrated below 115', minimal recovery suggests a gravelly interval.
6.34	4.36	55	Fair	122-130		122-129	Silty mudstone (shale), black (Gley 1 2.5N), Finely laminated to massive, wavy laminations common. Fractures are typically mineralized, with calcite fracture fill, orange oxidation staining and microcystaline pyrite. Heavily fractured and disintigrated at 129', potential fault contact with underlying unit.
						129-130	Sandstone, light bluish gray (Gley 2 10B 8/1) mottled with tan, similar to sandstones above: fine-grained, moderatley well sorted, abundant oragne oxidation staining, friable, non calcareous, significant fine fraction, potentially tuffaceous. Water production noted around 130'.

Geologist: M. Nauck, J. Raucci
Driller: North Star
Date completed: 4/24/2015

Drilling method: Sonic drilling to 82', rock core drilling to total depth.
SR = Solid Recovery
MSR = Modified Solid Recovery
RQD = Rock Quality Designation
Sampling method: Sonic core to 82', PQ core 82' - 96.5'; HQ core 96.5 - 130

DTW= Depth to water measured below top of casing (feet)
New Mexico State Plane Coordinates - NAD 83, Central Zone
Northing: 875272.987 Elevation: 7487.729
Easting: 1815714.752

BELL GAS #1186
ALTO, NEW MEXICO

Well Completion Diagram and Geologic Log: MW-2D

Daniel B. Stephens & Associates, Inc.
6/17/2015 JN ES14.0220

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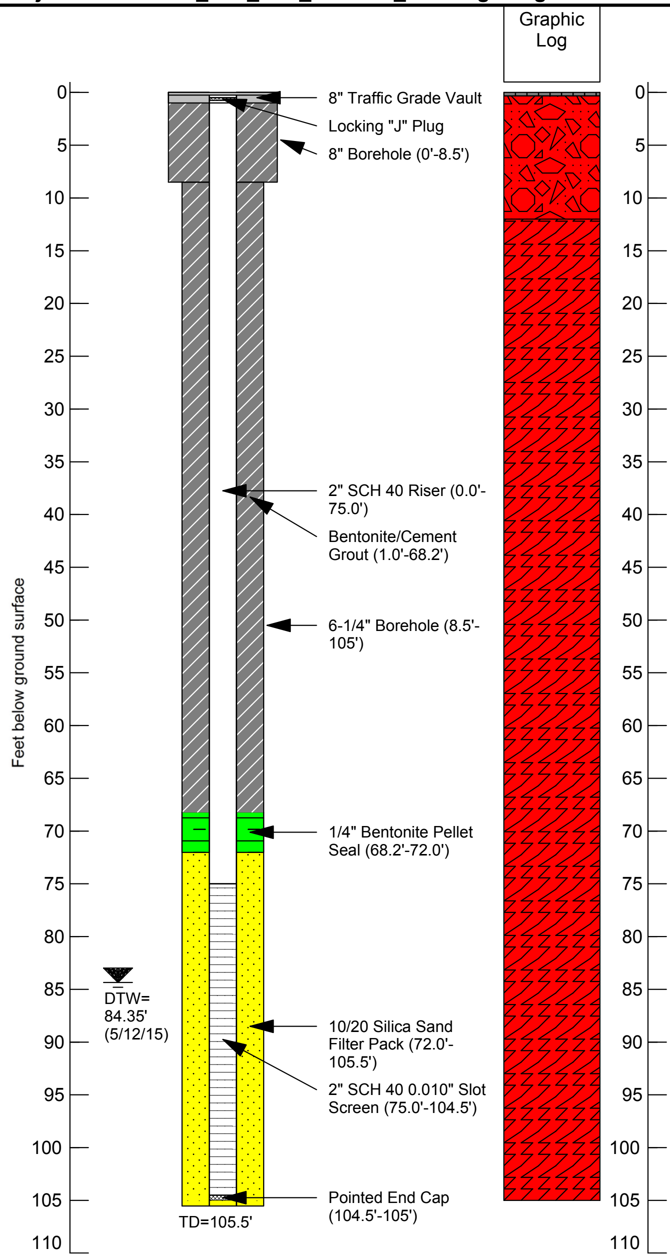

Sample Interval (ft bgs)	USCS Symbol	Lithology Interval	Comments and Lithology
0-5		0-0.33	Concrete
		0.33-5	Heavily weathered igneous rock, basaltic composition, coarse-grained porphyritic with feldspar and pyroxene phenocrysts up to 4mm in laths and irregular masses in a dark, fine-grained groundmass with abundant clay alteration material. Recovered as sub-angular blocks and cobbles in a clayey matrix, light olive brown (2.5Y 5/3). In-situ weathering of igneous rock material.
5-10		5-10	As above
10-36		10-12	As above
		12-36	Basaltic intrusive rock, bluish gray (5B 5/1), aphanic to porphyritic with lath-shaped or blocky feldpar phenocrysts up to 2mm in a fine-grained groundmass. Secondary calcite present in veins and as phenocryst replacement; very sparse pyrite mineralization.
36-105		36-105	As above

Geologist: M. Nauck, J. Raucci
Driller: North Star
Date completed: 4/28/2015

Drilling method: Sonic drilling to 8.5', downhole air hammer to total depth

Sampling method: Cuttings

DTW= Depth to water measured below top of casing (feet)
New Mexico State Plane Coordinates - NAD 83, Central Zone
Northing: 875353.322 Elevation: 7493.399
Easting: 1815627.703

BELL GAS #1186
ALTO, NEW MEXICO

Well Completion Diagram and Geologic Log: MW-5S

Daniel B. Stephens & Associates, Inc.
6/19/2015 JN ES14.0220

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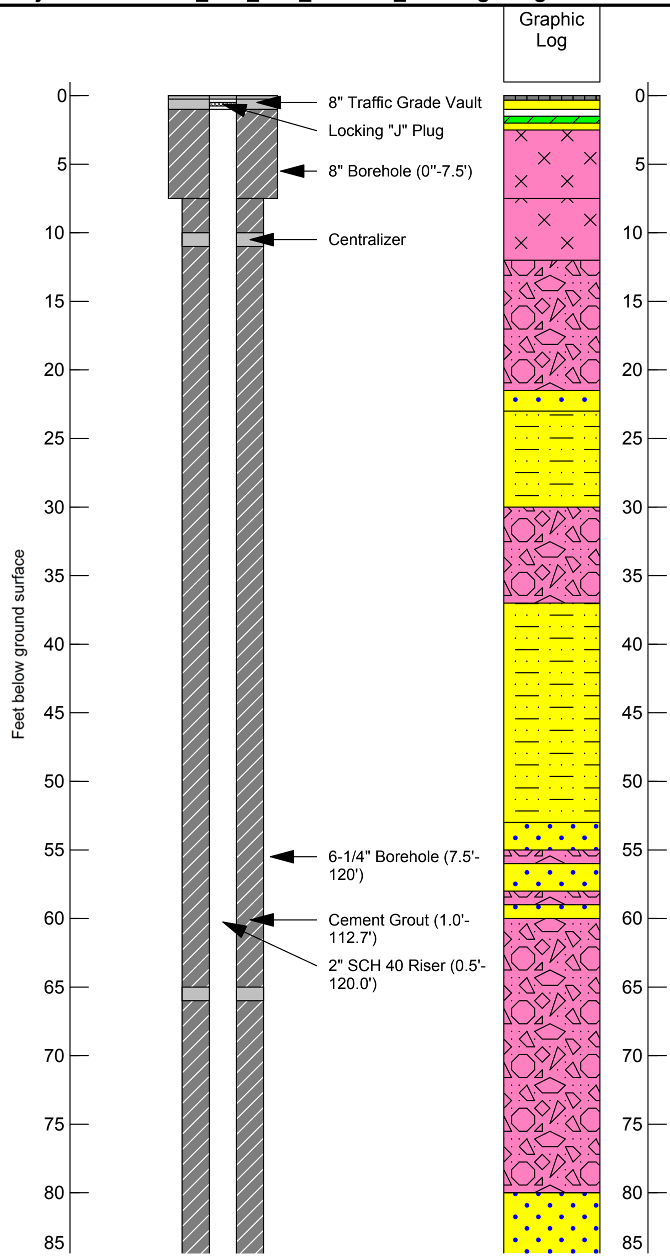

Sample Interval (ft bgs)	USCS Symbol	Lithology Interval	Comments and Lithology
0-2.5		0-0.33	Concrete
		0.33-1	Sandstone, white 5YR 8/1, fine grained, sub-rounded, calcareous
	CL	1.5-2	Sandy clay, dark reddish brown 5YR 3/2, slightly plastic, slightly moist; sand is fine grained, sub-rounded
2.5-5		2-2.5	Sandstone, brownish yellow 10YR 5/4, very fine to medium grained, massive, non-calcareous
		2.5-5	Decomposed fine-grained igneous rocks. Recovered as sub-anglular to sub-rounded blocks and cobbles up to 8 cm in a light-yellowish brown clayey sand matrix. Rocks are olive-brown (2.5 Y 4/3), fine-grained, sparse white non-calcareous crystal masses up to 2mm; abundant dark reddish-brown alteration minerals in sheets and irregular concretions.
5-7.5		5-7.5	as above
7.5-13		7.5-13	Heavily altered,decomposed fine-grained igneous rocks, similar to above. Olive-brown (2.5 Y 4/3), fine-grained, with pervasive orange to dark reddish brown alteration colors and mineralization in sheets and irregular boxwork
13-20		13-20	Similar to above, but largely unaltered. Fine-grained igneous rock of intermediate composition, composed of interlocking light and dark mineral grains
20-21.5		20-21.5	as above
21.5-23		21.5-23	Sandstone, light olive brown (2.5Y 5/4), medium grained, moderately sorted, moderately to well-indurated, non-calcarous
23-30		23-30	Siltstone and claystone, brown (10YR 5/3), well-lithified, non-calcareous
30-37		30-37	Sandstone, light and olive brown to olive (2.5Y 5/3 to 5Y 4/4). Very fine grained, well sorted, well indurated. Abundant igneous rock material similiar to above.
37-40		37-40	Siltstone, dark reddish brown (5YR 3/3), well lithified, massive to laminated, non-calcareous.
40-53		40-53	Siltstone - variagated color from bluish gray to tan to dark reddish brown similar to above. Moderately lithified, laminated, non-calcareous.
53-60		53-60	sandstone, pale yellow (2.5 Y 7/4), fine-grained, hard, pervasive orange and black oxidation staining, sparse garnet mineraization due to contact metaphorism with adjacent igneous rocks. abundant cuttings of fine-grained intermediate igneous rocks similar to above
60-71		60-71	Fine-grained igneous rock of intermediate composition, composed of interlocking light and dark mineral grains
71-72.5		71-72.5	Felsic igneous rock. greenish gray (10BG 5/1), fine-grained to aphanitic, predominantly plagioclase feldspar with ~15% dark minerals. orange oxidation staining common.
72.5-80		72.5-80	Fine-grained igneous rock of intermediate composition, similar to above
80-91		80-91	Sandstone and siltstone, color variagated but overall grayish brown (2.5Y 5/2), fine-grained, well cemented

Geologist: J. Fisher, J. Raucci
Driller: North Star
Date completed: 5/5/2015

Drilling method: Sonic drilling to 7.5', downhole air hammer to total depth.
SR = Solid Recovery
MSR = Modified Solid Recovery
RQD = Rock Quality Designation
Sampling method: Cuttings

DTW= Depth to water measured below top of casing (feet)
New Mexico State Plane Coordinates - NAD 83, Central Zone
Northing: 875390.297 Elevation: 7490.696
Easting: 1815691.259

BELL GAS #1186
ALTO, NEW MEXICO

Well Completion Diagram and Geologic Log: MW-6D

Daniel B. Stephens & Associates, Inc.
6/19/2015 JN ES14.0220

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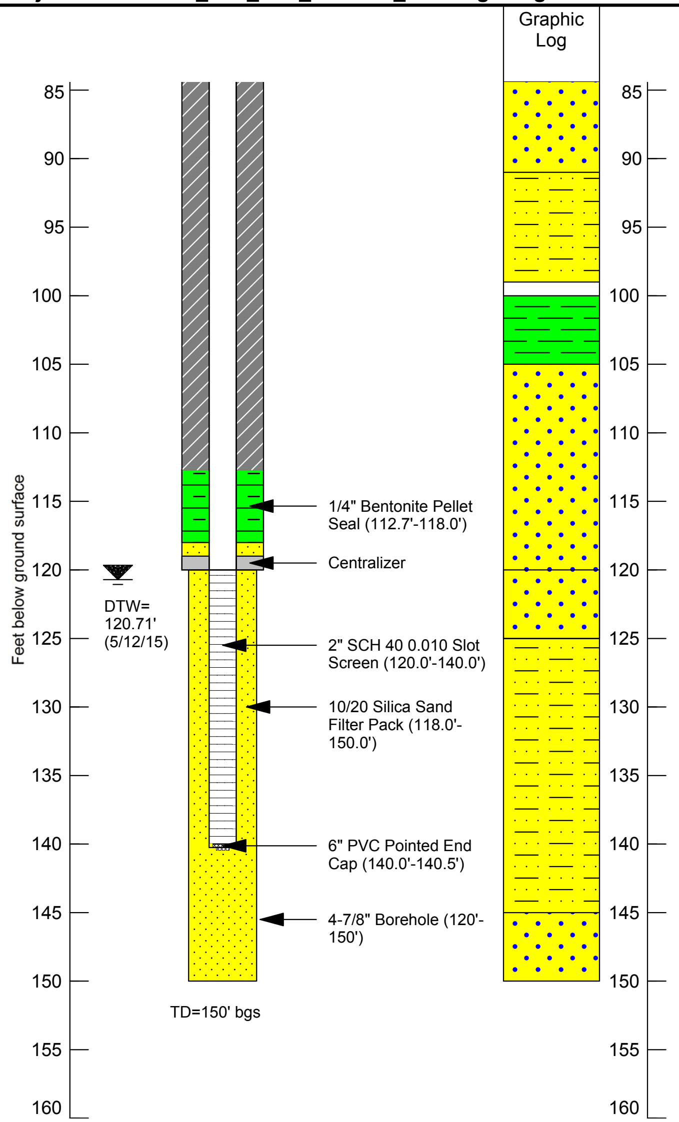

Sample Interval (ft bgs)	USCS Symbol	Lithology Interval	Comments and Lithology
91-99		91-99	Siltstone and fine-grained sandstone, gray (Gley 1 5/N). Well-indurated, some iron oxide staining, locaized pyrite mineralization
		99-100	No recovery
100-105		100-105	Claystone and siltstone (shale), black. moderately to well indurated, shaley fracture to blocky
105-120		105-120	Clayey sandstone, silty, bluish gray 10B 6/1. Fine-grained. Weakly lithified, poor rock recovery. Abundant orange oxidation staining, sparse fine-gained dark rock fragments. Possibly tuffaceous
120-125		120-125	Sandstone. light brownish gray (2.5 Y 6/2) to pale yellow (2.5Y 7/3). Fine grained, well sorted, moderately lithified. Abundant oxidation staining in viens and color bands.
125-130		125-130	Siltstone, black (Gley 2.5N). Moderately to well indurated, crudely laminated, sparse red oxidation staining
130-135		130-135	Siltstone and claystone, similar to above
135-140		135-140	as above
140-145		140-145	Similar to above, slightly coarser texture (silt to very fine sand) and slight color change (5YR 2.5/1)
145-150		145-150	Sandstone. dark gray (2.5Y 4/1). fine- grained, well sorted,well indurated. sheet-like accumulations of finely crystaline dark minerals

Geologist: J. Fisher, J. Raucci
Driller: North Star
Date completed: 5/5/2015

Drilling method: Sonic drilling to 7.5', downhole air hammer to total depth.
SR = Solid Recovery
MSR = Modified Solid Recovery
RQD = Rock Quality Designation
Sampling method: Cuttings

DTW= Depth to water measured below top of casing (feet)
New Mexico State Plane Coordinates - NAD 83, Central Zone
Northing: 875390.297 Elevation: 7490.696
Easting: 1815691.259

BELL GAS #1186
ALTO, NEW MEXICO

Well Completion Diagram and Geologic Log: MW-6D

Daniel B. Stephens & Associates, Inc.
6/19/2015 JN ES14.0220

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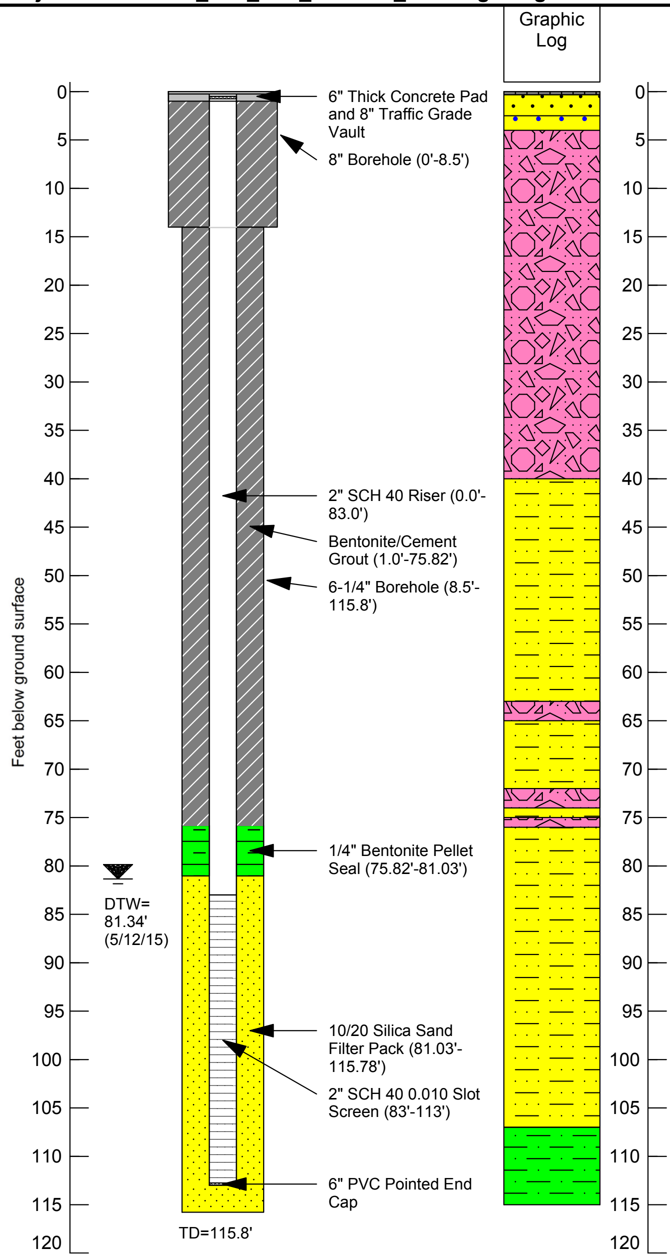

Sample Interval (ft bgs)	USCS Symbol	Lithology Interval	Comments and Lithology
0-4	SP	0-0.33	Concrete
		0.33-2.5	Silty sand, dark reddish gray 5YR 7/2, very fine grained, poorly graded, sub-angular, slightly moist
		2.5-4	Sandstone, light brownish gray 10YR 6/2, fine grained, laminated, highly decomposed, moderately disintegrated, unfractured
4-14		4-14	Igneous rock, intermediate compsotion, gray 2.5Y 6/2, fine-grained to aphanitic
14-40		14-40	Igneous rock, intermediate compsotion, gray 2.5Y 6/2, aphanitic, competent, secondary calcite crystals up to 1mm
40-63		40-63	Siltstone and very fine-grained sandstone, olive gray (5Y 5/2), well lithified, iron and manganese staining throughout
63-80		63-80	SIltstone and fine-grained sandstone, olive brown to dark grayish brown (2.5Y 4/2 to 4/3), well indurated with common manganese precipitation; abundant fragments of andesitic ingneous rock, strong hydrocarbon odor from cyclone between 70-80.
86-100		86-100	SIltstone, light olive brown (2.5Y 5/4), well indurated, interbedded with minor, friable fine-grained sandstone.
100-107		100-107	Siltstone, bluish gray (10B 6/1) to dark gray (2.5Y 4/1), finely laminated, moderately well indurated
107-115		107-115	Mudstone, light brown to pale yellow (2.5Y 7/2 to 7/3), massive, conchoidal fracture typical. Sparse iron oside staining. Abundant chips of mafic ingeous rock, indicating a thin dike or sill in this interval.

Geologist: M. Nauck, J. Raucci
Driller: North Star
Date completed: 4/30/2015

Drilling method: Sonic drilling to 14', downhole air hammer to total depth

Sampling method: Cuttings

DTW= Depth to water measured below top of casing (feet)
New Mexico State Plane Coordinates - NAD 83, Central Zone
Northing: 875388.546 Elevation: 7490.874
Easting: 1815686.564

BELL GAS #1186
ALTO, NEW MEXICO

Well Completion Diagram and Geologic Log: MW-6S

Daniel B. Stephens & Associates, Inc.
6/19/2015 JN ES14.0220

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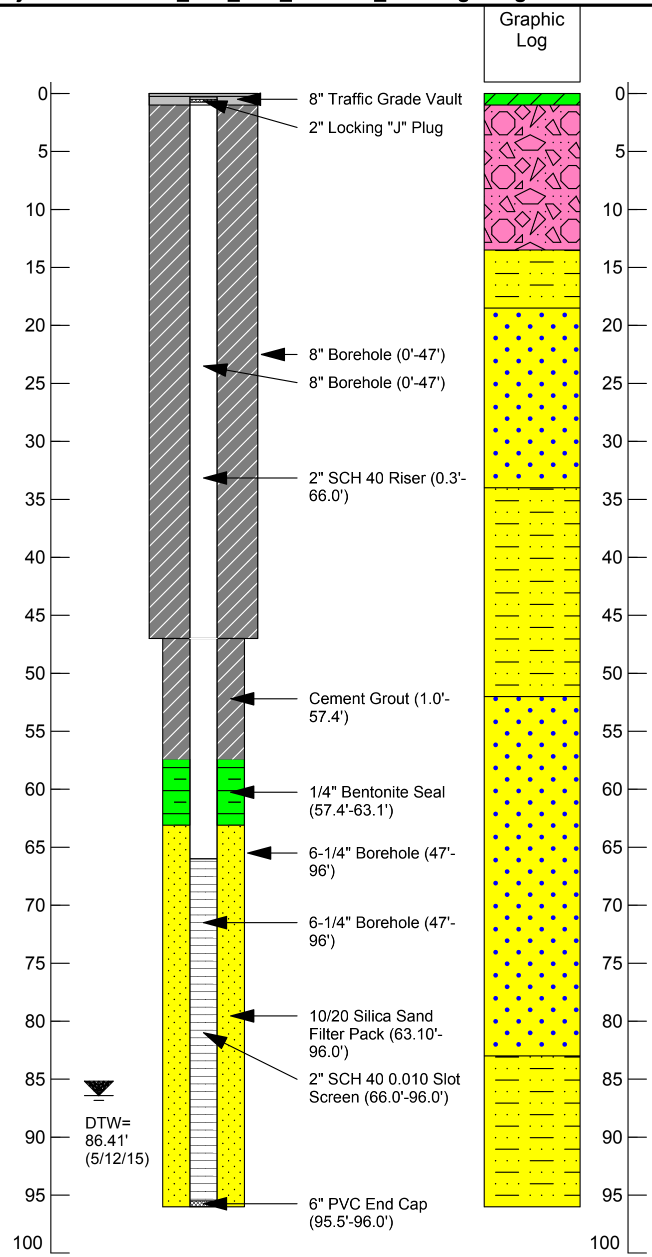


Sample Interval (ft bgs)	USCS Symbol	Lithology Interval	Comments and Lithology
0-5	CL	0-1	Lean clay with sand and gravel, dark brown 7.5YR 3/3, fine to coarse grained, sub round sachands and gravels, moderate plasticity, slightly moist, gravels up to 1.5"
		1-5	Igneous rock light olive gray 5Y 7/2, fine grained, mafic to intermediate composition, moderately decomposed and disentigrated, slightly fractured.
5-8		3-8	Igneous rock as above, severely decomposed and disentigrated
8-14		8-13.5	Igneous rock as above, moderately decomposed and disentigrated
14-15		13.5-	Siltstone, very plale brown 10YR 7/3, very fine grained, laminated, moderately indurated Siltstone, as above
15-18.5		15-18.5	Siltstone, very plale brown 10YR 7/3, laminated, moderately indurated, color change to dark reddish brown 5YR 3/3 at 17'
18-21.5		18-31.5	Sandstone, light yellowish brown 2.5Y 6/4, very fine grained, calcite and manganese veins
21.5-24			as above
24-28			as above
28-31			as above
31-34		31.5-36.5	Sandstone, light yellowish brown 2.5Y 6/4, very fine to fine grained, massive, highly fractured, calcite and manganese veins
34-40		36.5-	Siltstone, grayish brown 10YR5/2, massive, unfractured
40-43		-44	as above
43-47		43-44	as above
		44-47	Siltstone, gray 2.5Y 5/1, massive, moderately fractured, some chlorite and calcite mineralization
47-52		47-52	Siltstone, grayish brown 10YR 5/2
52-83		52-83	Sandstone, light yellowish brown 2.5Y 6/4, calcite and manganese veins
83-96		83-96	Siltstone, grayish brown 10YR 5/2

Geologist: J. Fisher, J. Raucci
Driller: North Star
Date completed: 5/7/2015

Drilling method: Sonic drilling to 47', downhole air hammer to total depth

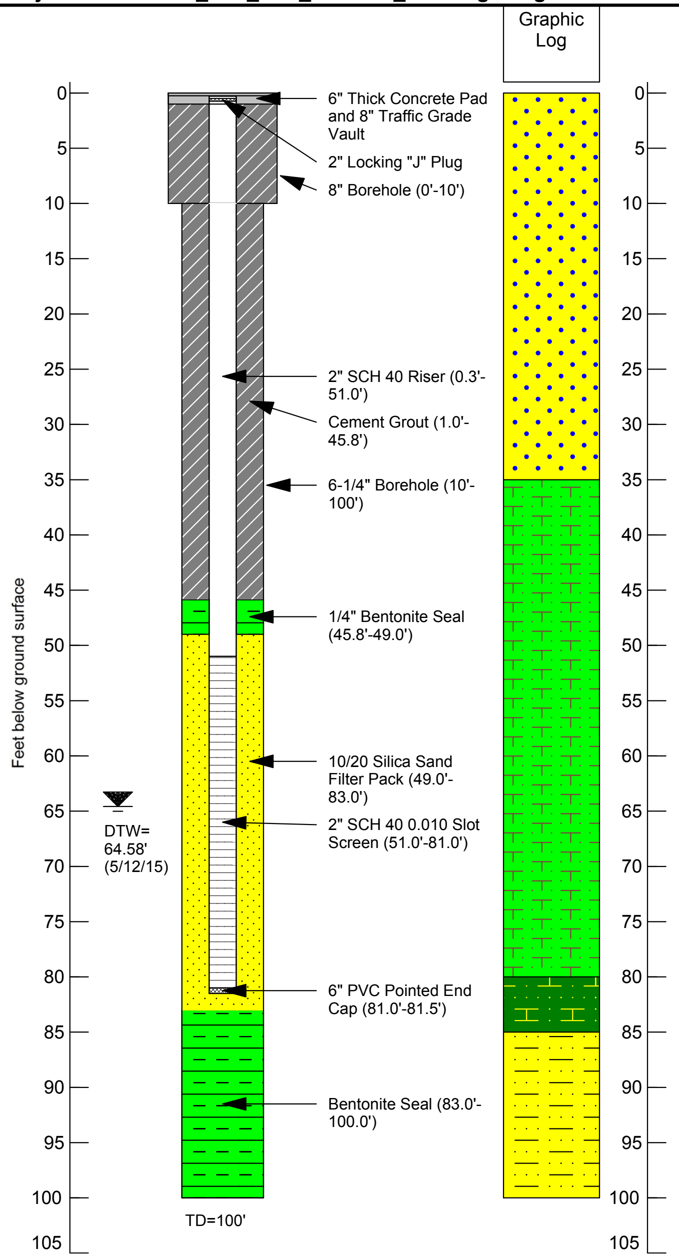
Sampling method: Cuttings

DTW= Depth to water measured below top of casing (feet)
New Mexico State Plane Coordinates - NAD 83, Central Zone
Northing: 875440.969 Elevation: 7489.081
Easting: 1815720.150

BELL GAS #1186
ALTO, NEW MEXICO

Well Completion Diagram and Geologic Log: MW-9S

Daniel B. Stephens & Associates, Inc.
6/17/2015 JN ES14.0220



Sample Interval (ft bgs)	USCS Symbol	Lithology Interval	Comments and Lithology
0-10		0-10	Sandstone, light olive brown (2.5 Y 5/4), fine-grained, sub-rounded, moderately indurated, arkosic or lithic in composition
10-15		10-15	similar to above, slightly finer grained (siltstone to fine sandstone), slight color change to olive yellow (5Y 6/6)
15-20		15-20	Sandstone, olive brown (2.5 Y 4/4), fine-grained, sub-rounded, moderately indurated, similar to above
20-25		20-25	Sandstone and siltstone, olive brown (2.5 Y 4/3), very fine grained sandstone and siltstone, similar to above
25-30		25-30	as above
30-35		30-35	as above
35-40		35-40	Claystone (shale), very dark gray (2.5Y 3/1) to black, with some lighter colored material (dark olive gray, 5Y 3/2), moderately indurated
40-45		40-45	Claystone (shale), dark bluish gray (10B 4/1), weakly to moderately indurated, weakly laminated, abundant oxidation staining, platy fracture
45-50		45-50	similar to above, slightly darker color, harder
50-55		50-55	similar to above, moderately to well indurated w/ crude conchoidal fracture
55-60		55-60	Claystone with silt and fine sand, light bluish gray (5PB 7/1) with some tan to orange color mottling. Weakly lithified with very poor rock recovery
60-65		60-65	similar to above, darker color (bluish gray 5PB 5/1 to gray Gley N5)
65-70		65-70	Claystone, black (Gley N2.5). Weakly lithified with poor rock recovery, some silt and sand, sparse oxidation staining and calcite
70-75		70-75	similar to above, color change to gray (10YR 6/1),
75-80		75-80	similar to above, slight color change to light gray (7.5YR 7/1), becoming predominantly silty with minor fine sand, continued very poor rock recovery
80-85		80-85	Clayey siltstone, gray (5PB 6/1), similar to above, minor fine sand, weakly to moderately lithified with improved rock recovery
85-90		85-90	Siltstone, dark bluish gray (10B 4/1) to black, moderately well indurated
90-95		90-95	Siltstone and claystone, color somewhat variagated but predominantly dark gray to black (7.5 YR 2.5/1), moderately indurated, abundant oxidation staining
95-100		95-100	similar to above but slightly coarser texture, siltstone and very fine-grained sandstone. moderately well indurated

Geologist: J. Fisher, J. Raucci
Driller: North Star
Date completed: 5/9/2015

Drilling method: Sonic drilling to 10', downhole air hammer to total depth

Sampling method: Cuttings

DTW= Depth to water measured below top of casing (feet)
New Mexico State Plane Coordinates - NAD 83, Central Zone
Northing: 875496.525 Elevation: 7473.701
Easting: 1815908.744

BELL GAS #1186
ALTO, NEW MEXICO

Well Completion Diagram and Geologic Log: MW-12S

Daniel B. Stephens & Associates, Inc.
6/17/2015 JN ES14.0220

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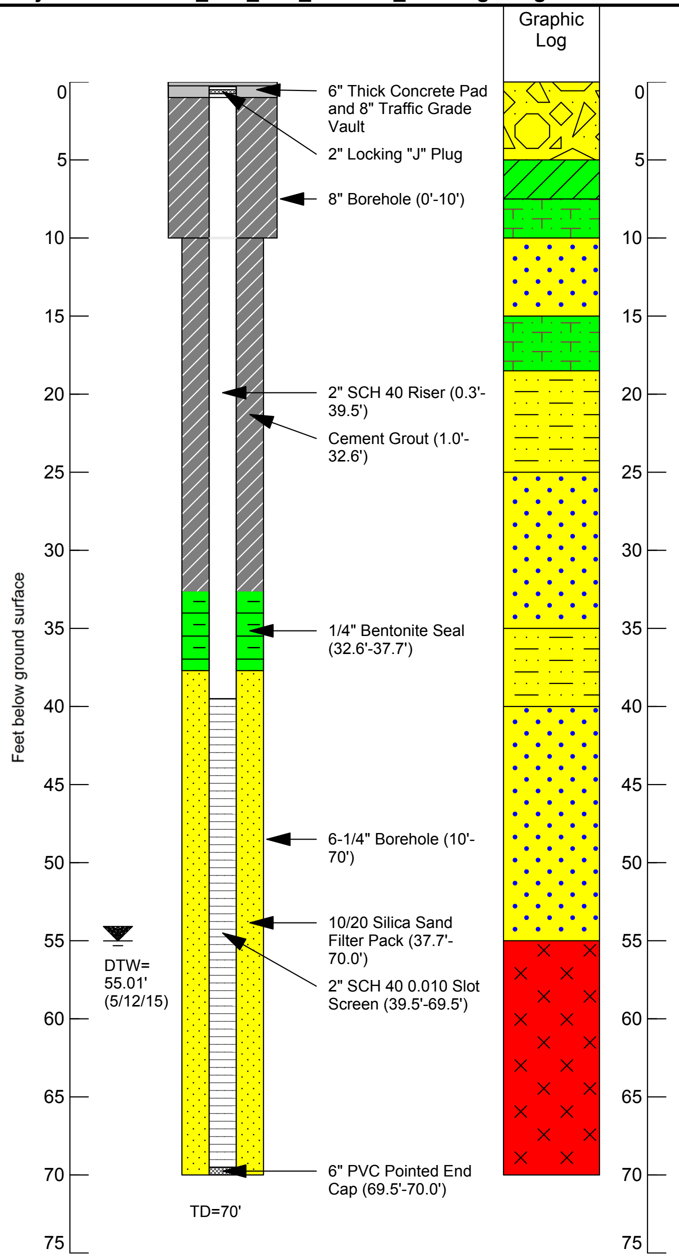

Sample Interval (ft bgs)	USCS Symbol	Lithology Interval	Comments and Lithology
0-5		0-5	unconsolidated construction fill material
5-7.5	CL	5-7.5	Sandy clay, yellowish brown (10YR 5/6). partially consilidated, structureless to blocky. Likely derived from pervasive in-situ weathering of bedrock material
7.5-10		7.5-10	Claystone, olive (5Y 5/3). Moderately indurated, hackly fracture pattern.
10-15		10-15	Sandstone, yellowish brown (10YR 5/4). Fine-grained, well-sorted, rounded, well induratred.
15-18.5		15-18.5	Claystone, light olive brown (2.5Y 5/3). silty, laminated, moderately indurated.
			Interbedded with siltstone, black (5YR 2.5/1). Well indurated
18.5-20		18.5-20	Siltstone, black, as above
20-25		20-25	Siltstone, similar to above but slight color change to dark reddish brown (5YR 3/2)
25-30		25-30	Sandstone, dark gray (7.5 YR 4/1). Very fine-grained, moderately indurated, structureless in cuttings
30-35		30-35	Sandstone and siltstone, olive (5Y 5/4) to gray (10YR 5/1). very fine-grained sand and silt, weakly indurated, crudely laminated
35-40		35-40	SIltsone, dark gray to black (7.5 YR 4/1 - 2.5/1). Some iron oxide staining, structureless to crudely laminated, moderately indurated.
40-45		40-45	Sandstone and siltstone, olive gray (5Y 4/2), very fine to fine-grained, well sorted, rounded, well indurated.
45-50		45-50	Sandstone, similar to above but slightly lighter color (5Y 5/2), with orange oxidation staining becoming common
50-55		50-55	Similar to above; sandstones are somewhat coarser (fine to medium-grained) and interbedded with gray and dark red siltstones; more abundant oxidation staining in viens and mineral grain alteration in sandstones
55-60		55-60	Mafic intrusive igneous rock. Porphyritic, with lath-shaped to blocky feldspar phenocyrsts up to 2mm in a black aphanitic groundmass.
60-65		60-65	as above
65-70		65-70	as above

Geologist: J. Fisher, J. Raucci
Driller: North Star
Date completed: 5/10/2015

Drilling method: Sonic drilling to 10', downhole air hammer to total depth

Sampling method: Cuttings

DTW= Depth to water measured below top of casing (feet)
New Mexico State Plane Coordinates - NAD 83, Central Zone
Northing: 875061.681 Elevation: 7472.436
Easting: 1815679.796

BELL GAS #1186
ALTO, NEW MEXICO

Well Completion Diagram and Geologic Log: MW-13S

Daniel B. Stephens & Associates, Inc.
6/17/2015 JN ES14.0220

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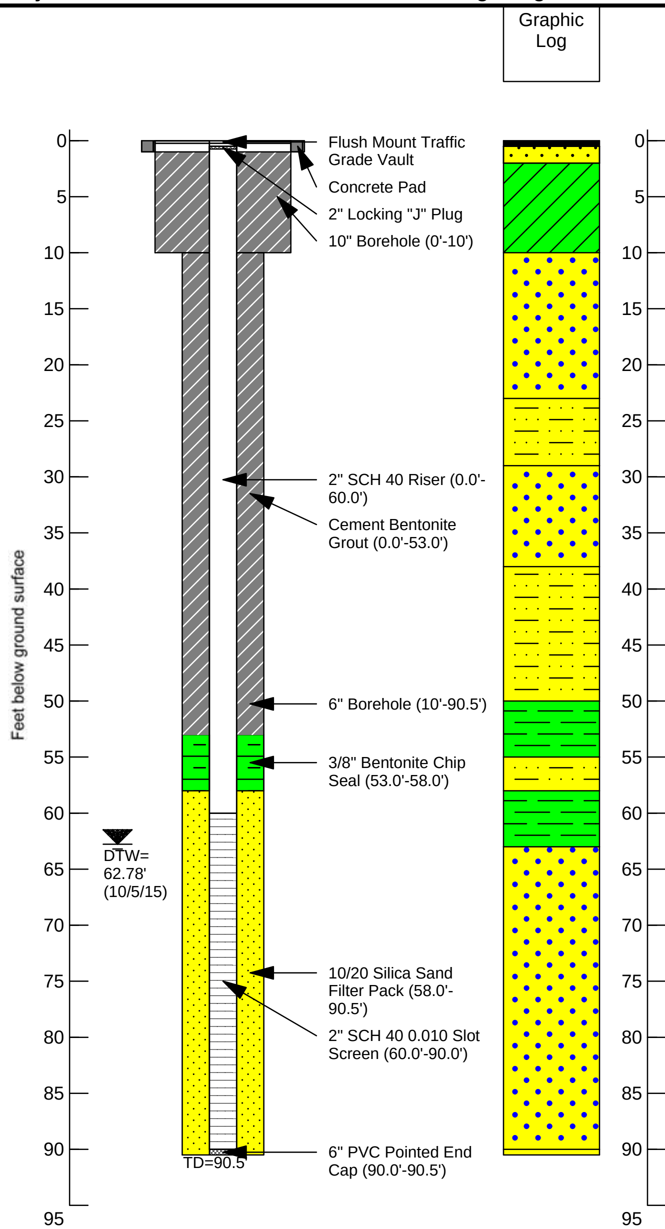

Sample Interval (ft bgs)	USCS Symbol	Lithology Interval	Comments and Lithology
0-0.5		0-0.5	Asphalt and fill material
0.5-2	SW-SC	0.5-2	Clayey sand - Yellowhish brown (10YR 5/4), fine to medium grained, subrounded, poorly sorted, moderate plasticity, moist.
2-5	CL	2-5	Sandy clay - grayish brown (10YR 5/2), fine grained, subrounded, moderate plasticity, stiff, dry, organic matter.
10-15		10-15	Sandstone - light yellowish brown (2.5Y 6/3), veryfine to med grained, poorly sorted, poorly cemented.
15-23		15-20	Sandstone - dark greenish gray (Gley 1 4/10Y)otherwise as above.
		20-23	
23-27		23-27	Siltstone - dark yellowish brown (10YR 4/6) with fine sand.
27-29		27-29	Siltstone - dark greenish gray (Fley 1 4/10Y)
29-38		29-30	Sandstone - dark greenish gray (Fley 1 4/10Y), fine grained, consolidated, minor clay.
		30-35	
		35-38	
38-39		38-39	Siltstone - black (10YR 2/1), with fine sand.
39-41		39-41	Siltstone - gray (2.5Y 5/1), with fine sand.
41-42		41-42	Siltstone - black (10YR 2/1), with fine sand.
42-45		42-45	Siltstone - dark grayish olive (10Y-5GY 4/2)
45-50		45-50	Siltstone - dark greenish gray (Gley 1 4/10Y), with fine sand.
50-55		50-55	Shale - gray (Gley 1 5/N)
55-58		55-58	Siltstone - black (Gley 1 2.5/N)
58-59		58-59	Shale - greenish black (Gley 1 2.5/10Y)
59-63		59-63	Shale - gray (Gley 1 5/N).
63-65		63-65	Sandstone - olive brown (2.5YR 4/4), fine to medium grained, rounded, cemented.
65-70		65-70	Sandstone - dark gray (Gley 1 4/N), fine grained, rounded, cemented.
70-72		70-72	Sandstone - dark gray (Gley 1 4/N) fine to medium grained, rounded, cemented.
72-73		72-73	Sandstone - dark yellowish brown (10YR 4/4), medium grained, subrounded to rounded, cemented.
73-85		73-75	Sandstone - dark gray (Gley 1 4/N), fine to medium grained, rounded, cemented.
		75-80	
		80-85	
85-90		85-90	Sandstone - dark yellowish brown (10YR 4/4), medium grained, subrounded to rounded, cemented.
90-90.5		90-90.5	Siltstone - dark bluish gray (Gley 1 4/10B).

Geologist: P. Barlow
Driller: EDI
Date completed: 9/9/2015

Drilling method: Hollow Stem Auger/Air Rotary

Bit diameter 10"/6"
Switch to air rotary drilling with a 6" bit at 10'
Sampling method: Cuttings

DTW= Depth to water (feet)
Depth to water measured below top of casing (feet)
Northing: 875354.449 Elevation: 7490.377'
Easting: 1815692.693

BELL GAS #1186
ALTO, NEW MEXICO

Well Completion Diagram and Geologic Log: MW-1S

Daniel B. Stephens & Associates, Inc.
11/23/2015 JN ES14.0220

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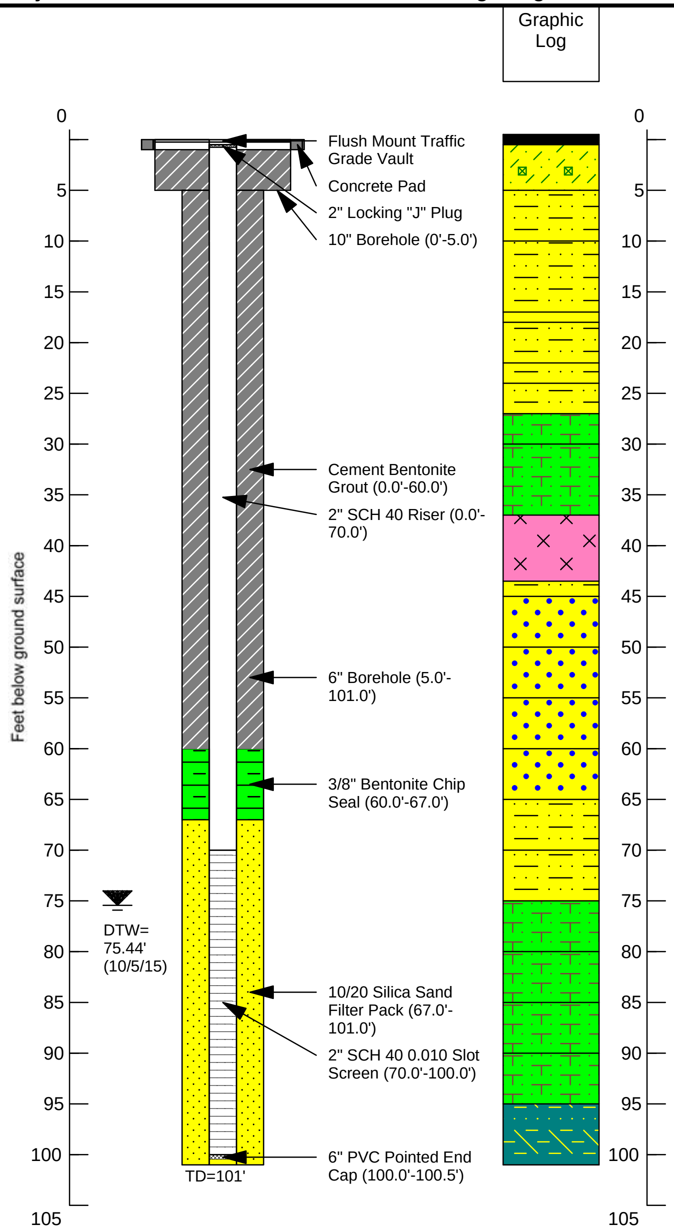

Sample Interval (ft bgs)	USCS Symbol	Lithology Interval	Comments and Lithology
0-5	GC	0-0.5	Asphalt
		0.5-5	Regolith: rounded cobbles of heavily weathered siltstone in a dark yellowish brown (10 YR 4/4) clayey matrix. Slightly moist, abundant organic material (plant roots)
5-10		5-10	Interbedded siltstone and v. fine grained sandstone, yellowish brown (10 YR 5/4). Sparse, dedritic oxidation mineralization on bedding planes. Moderately indurated, dry.
10-15		10-17	as above
		17-18	Brief color change to reddish brown, lithology similar to above.
15-20		18-22	Yellowish brown (10 YR 5/4) Interbedded siltstone and v. fine grained sandstone, similar to above. Some indication of secondary calcite in fractures, becoming darker in color.
		22-24	Color change to gray at 22'. No change in overall lithology or drilling character.
20-25		24-27	Siltstone, yellowish brown (10 YR 5/4), similar to above, micaceous, dry.
25-30		27-30	Claystone and clayey siltstone, gray (Gley 1 5N). Color somewhat variagated bluish to greenish gray, moderately to well indurated.
30-35		30-37	Gray claystone, as above, interbedded with micaceous siltstone, gray (2.5 Y 5/1-4/1). Laminated, fractures in thin flakes.
35-40		37-43.5	Mafic igneous rock. Dark bluish gray (10B 4/1) to black, with abundant reddish brown alteration. Porphyritic, with sparse lath-shaped feldspar up to 2 mm in a finely crystalline groundmass. Some secondary calcite mineralization in voids.
40-45		43.5-45	Siltstone, gray (Gley 1 5N). Clayey, similar to above but non-micaceous.
45-50		45-50	Sandstone, light olive brown (2.5 Y 5/4). Fine-grained to v. fine grained, well sorted, weakly to moderately indurated, non-calcareous, dry.
50-55		50-55	Sandstone, light yellowish brown (2.5 Y 6/4). Very fine grained, well sorted, weakly to moderatly indurated, non-calcareous, dry.
55-60		55-60	as above
60-65		60-65	Sandstone, light olive brown (2.5 Y 5/4). Fine- to medium-grained, moderately sorted, soft and friable with few rock chips in cuttings. Dry
65-70		65-70	Siltstone. Similar to above but finer grained. Strong hydrocarbon odors in discharge @ 68-72'
70-75		70-75	Siltstone and very fine-grained sandstone. Similar to above but becoming more grayish in color around 75'. No HC odor @75'
75-80		75-80	Claystone, very dark gray (Gley 1 3N). Finely laminated, moderately well indurated. Dry, no HC odor.
80-85		80-85	as above, v. slight HC odor
85-90		85-90	Claystone, gray (Gley 1 6N). Soft and friable with poor recovery of rock chips. Some darker claystone present in cuttings
90-95		90-95	as above, v. soft and friable
95-101		95-101	Claystone and sandstone, light gray to gray (Gley 1 6N to 7N). Sandstones are relatively sparse, fine- to medium-grained, moderately sorted and sub-round. Soft and friable with v. poor recovery of rock chips. Dry, no HC odor.

Geologist: J. Raucci
Driller: EDI
Date completed: 9/9/2015

Drilling method: Hollow Stem Auger/Air Rotary

Bit diameter 10"/6"
Switch to air rotary drilling with a 6" bit at 5'
Sampling method: Cuttings

DTW= Depth to water (feet)
Depth to water measured below top of casing (feet)
Northing: 875385.973 Elevation: 7488.46'
Easting: 1815741.934

BELL GAS #1186
ALTO, NEW MEXICO

Well Completion Diagram and Geologic Log: MW-7S

Daniel B. Stephens & Associates, Inc.
11/23/2015 JN ES14.0220

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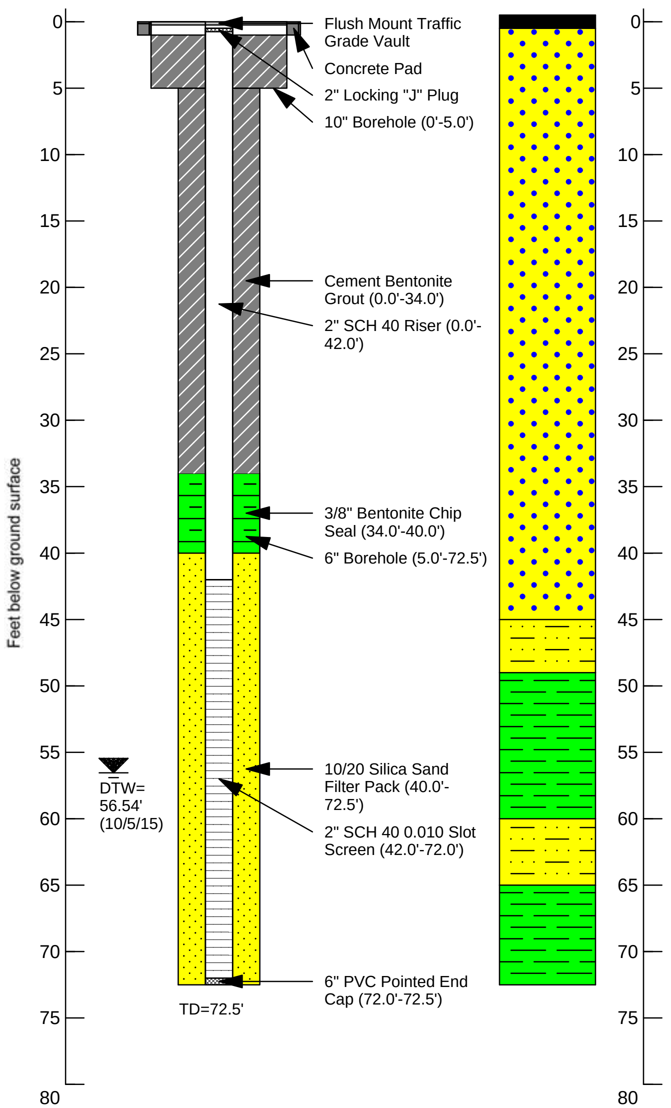

Sample Interval (ft bgs)	USCS Symbol	Lithology Interval	Comments and Lithology
0-0.5		0-0.5	Asphalt and fill material
0.5-5		0.5-10	Sandstone - dark yellowish brown (10YR 3/4), fine grained, subrounded, with silt and clay, cemented.
5-10			
10-15		10-18	Sandstone - very dark grayish brown (10YR 3/2), otherwise as above.
15-18			
18-20		18-23	Sandstone - olive brown (2.5Y 4/4), fine grained, subrounded, cemented, with calcite veins.
20-23			
23-27		23-27	Sandstone - dark gray (Gley 1 4/N), fine grained, subangular to subrounded, with clay and minor calcite.
27-30		27-45	Sandstone - olive brown (2.5Y 4/4), fine grained, subrounded, cemented, with calcite veins.
30-35			
35-40			
40-45			
45-49		45-49	Siltstone - dark brown (10YR 3/3), with sand fine grained, subrounded.
49-50		49-60	Shale - very dark gray (Gley 1 3/N), calcite veins, iron oxide on weathered surfaces, moist.
50-55			
55-60			
60-65		60-65	Sandy siltstone - dark brown (10YR 3/3), fine grained, subrounded, cemented.
65-70		65-72.5	Shale - gray (Gley 1 6/N).
70-72.5			

Geologist: P. Barlow
Driller: EDI
Date completed: 9/14/2015

Drilling method: Hollow Stem Auger/Air Rotary

Bit diameter 10"/6"
Switch to air rotary drilling with a 6" bit at 5'
Sampling method: Cuttings

DTW= Depth to water (feet)
Depth to water measured below top of casing (feet)
Northing: 875369.227 Elevation: 7475.983'
Easting: 1815861.794

BELL GAS #1186
ALTO, NEW MEXICO

Well Completion Diagram and Geologic Log: MW-14S

Daniel B. Stephens & Associates, Inc.
11/23/2015 JN ES14.0220

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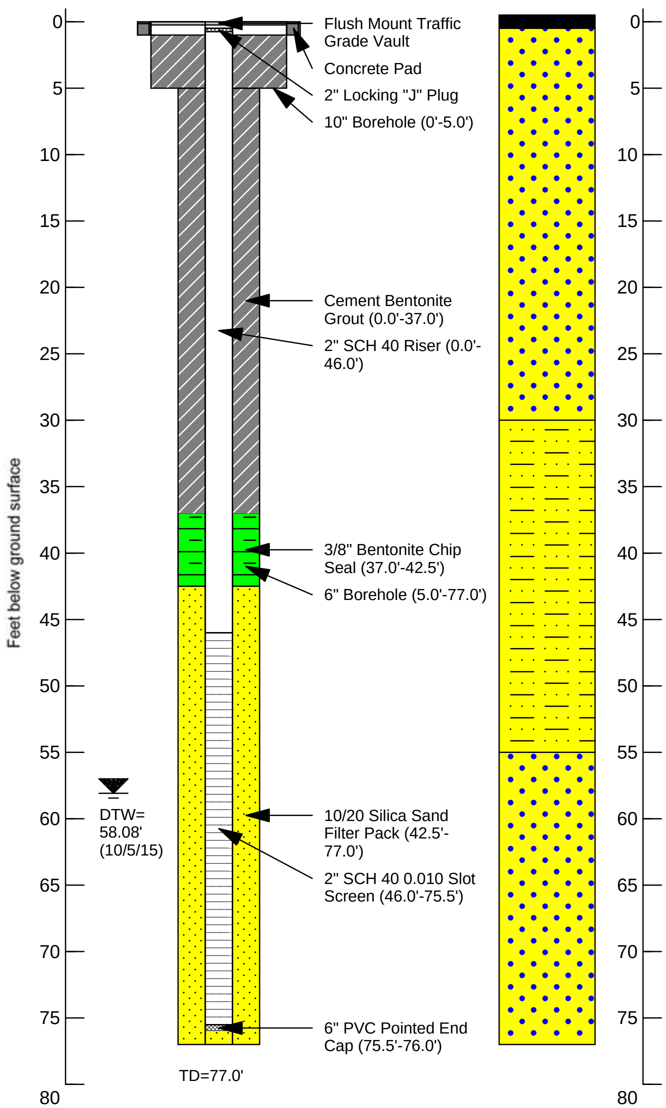


Sample Interval (ft bgs)	USCS Symbol	Lithology Interval	Comments and Lithology
0-0.5		0-0.5	Asphalt and fill material
0.5-5		0.5-30	Sandstone - brown (10YR 4/3) - fine to coarse grained, rounded to angular, cemented.
5-10			
10-15			
15-20			
20-25			
25-30			
30-35		30-38	Siltstone - black (10YR 2/1).
35-38			
38-40		38-40	Siltstone - very dark grayish brown (10YR 3/2).
40-42		40-42	Silitstone - dark gray (Gley 1 4/N).
42-45		42-55	Siltstone - gray (Gley 1 6/N).
45-50			
50-55			
55-60		55-65	Sandstone - gray (Gley 1 6/N), fine to medium grained, subrounded to angular, cemented.
60-65			
65-70		65--77	Sandstone - very dark gray (10YR 3/1), fine grained, rounded, cemented.
70-75			
75-77			

Geologist: P. Barlow
Driller: EDI
Date completed: 9/15/2015

Drilling method: Hollow Stem Auger/Air Rotary

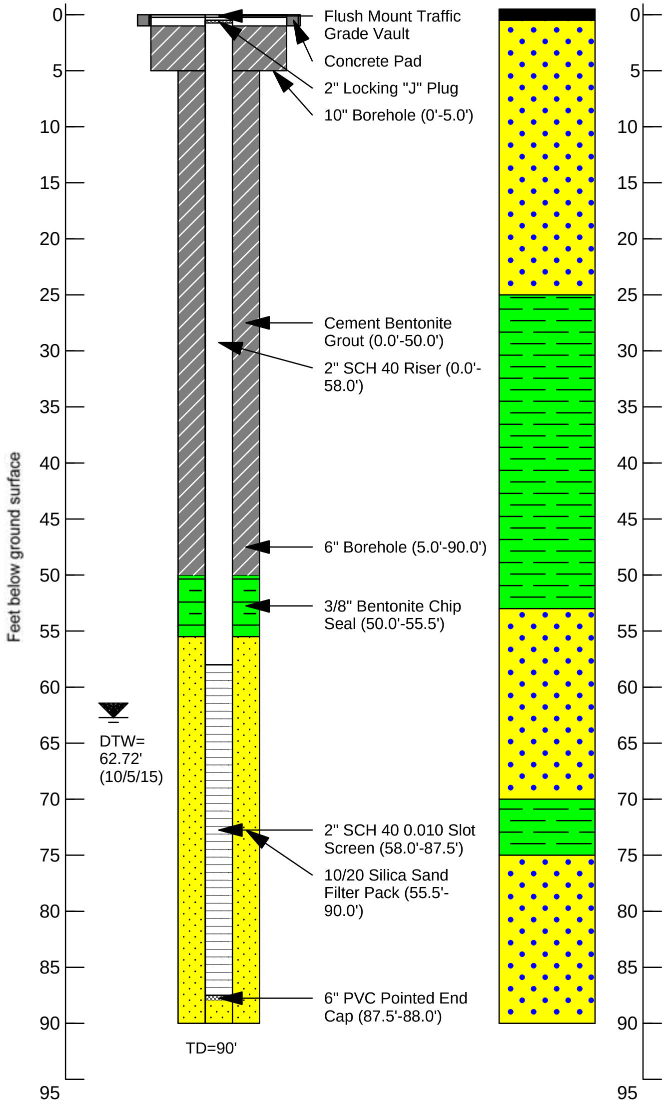
Bit diameter 10"/6"
Switch to air rotary drilling with a 6" bit at 5'
Sampling method: Cuttings

DTW= Depth to water (feet)
Depth to water measured below top of casing (feet)
Northing: 875218.908 Elevation: 7473.881'
Easting: 1815797.611

BELL GAS #1186
ALTO, NEW MEXICO

Well Completion Diagram and Geologic Log: MW-15S

Daniel B. Stephens & Associates, Inc.
11/23/2015 JN ES14.0220



Sample Interval (ft bgs)	USCS Symbol	Lithology Interval	Comments and Lithology
0-0.5		0-0.5	Asphalt and fill material
0.5-5		0.5-15	Sandstone - dark yellowish brown (10YR 4/4), fine grained, well sorted, rounded, cemented, clayey.
5-10			
10-15			
15-20		15-20	Sandstone - dark gray (Gley 1 4/N), fine grained, subrounded, cemented, silty.
20-25		20-25	Sandstone - dark olive brown (2.5Y 4/3), fine grained, rounded, cemented, with calcite veins.
25-30		25-40	Shale - black (10YR 2/1), iron oxide along weathered surfaces.
30-35			
35-38			
38-40			
40-42		40-53	Shale - gray (Gley 1 5/N).
42-45			
45-50			
50-53			
53-55		53-70	Sandstone - gray (Gley 1 5/N), fine to medium grained, rounded, cemented.
55-60			
60-65			
65-70			
70-75		70-75	Shale - black (10YR 2/1).
75-80		75-90	Sandstone - gray (Gley 1 5/N), fine grained, rounded, cemented.
80-85			
85-90			

Geologist: P. Barlow
Driller: EDI
Date completed: 9/16/2015

Drilling method: Hollow Stem Auger/Air Rotary

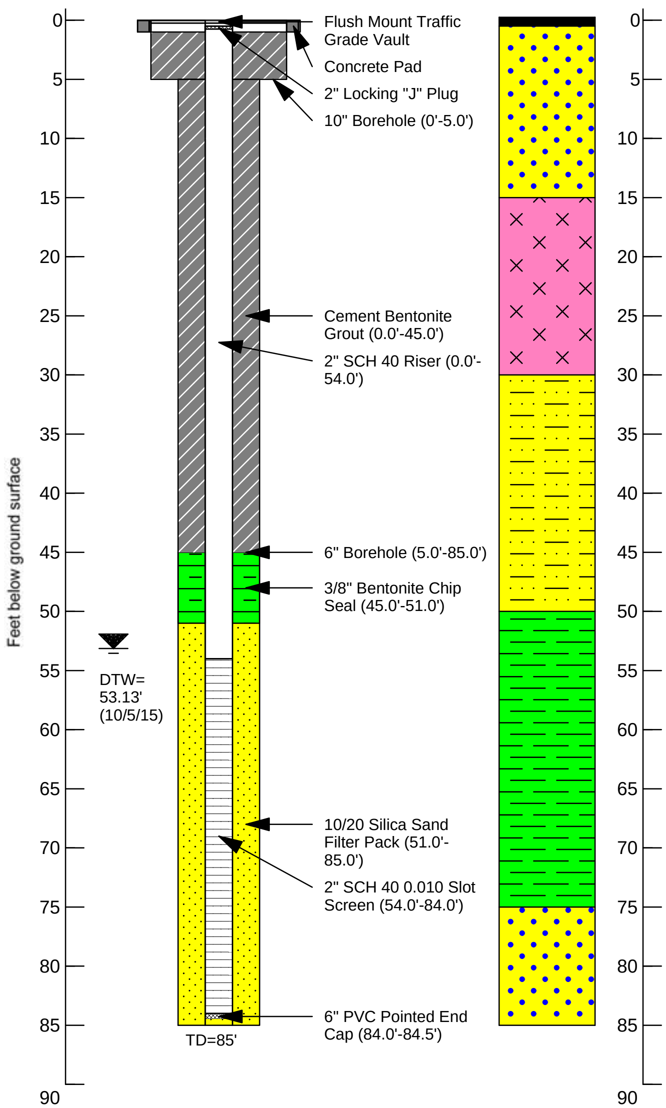
Bit diameter 10"/6"
Switch to air rotary drilling with a 6" bit at 5'
Sampling method: Cuttings

DTW= Depth to water (feet)
Depth to water measured below top of casing (feet)
Northing: 875429.296 Elevation: 7474.979'
Easting: 1815958.059

BELL GAS #1186
ALTO, NEW MEXICO

Well Completion Diagram and Geologic Log: MW-16S

Daniel B. Stephens & Associates, Inc.
11/23/2015 JN ES14.0220



Sample Interval (ft bgs)	USCS Symbol	Lithology Interval	Comments and Lithology
0-0.5		0-0.5	Asphalt and fill material
0.5-5		0.5-15	Sandstone - dark yellowish brown (10YR 4/4), fine grained, well sorted, rounded, cemented, with clay
5-10			
10-15			
15-20		15-30	Mafic igneous intrusive rock - dark yellowish brown (10YR 4/4), aphanitic matrix with plagioclase phenocrysts, iron oxide.
20-25			
25-30			
30-35		30-40	Siltstone - very dark graish brown (2.5Y 3/2).
35-40			
40-45		40-45	Siltstone - light olive brown (2.5Y 5/4).
45-50		45-50	Siltstone - grayish brown (2.5Y 5/2).
50-57		50-57	Shale - dark gray (Gley 1 4/N).
57-60		57-75	Shale - dark grayish brown (2.5Y 4/2) with fine sand.
60-65			
65-70			
70-75			
75-80		75-85	Sandstone - very dark gray (Gley 13/N), fine grained, rounded, poorly cemented, interbedded with shale - black (Gley 1 2.5/N).
85-80			

Geologist: P. Barlow
Driller: EDI
Date completed: 9/17/2015

Drilling method: Hollow Stem Auger/Air Rotary

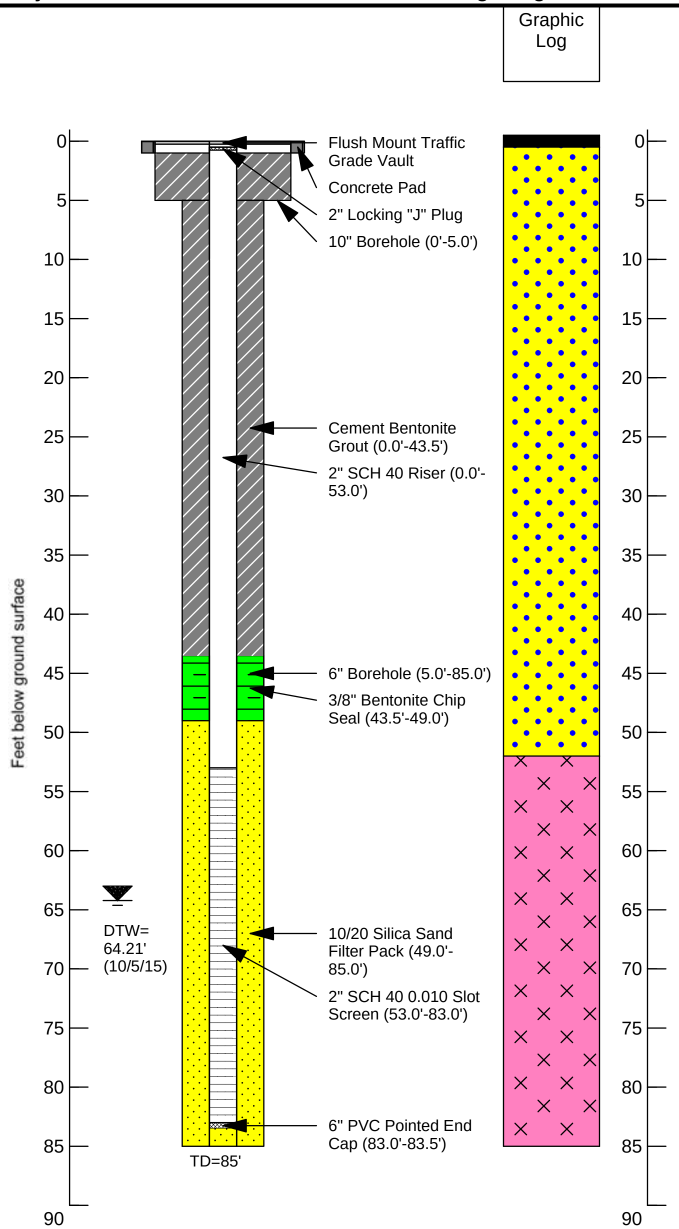
Bit diameter 10"/6"
Switch to air rotary drilling with a 6" bit at 5'
Sampling method: Cuttings

DTW= Depth to water (feet)
Depth to water measured below top of casing (feet)
Northing: 875356.603 Elevation: 7477.612'
Easting: 1815932.610

BELL GAS #1186
ALTO, NEW MEXICO

Well Completion Diagram and Geologic Log: MW-17S

Daniel B. Stephens & Associates, Inc.
11/23/2015 JN ES14.0220



Sample Interval (ft bgs)	USCS Symbol	Lithology Interval	Comments and Lithology
0-0.5		0-0.5	Asphalt and fill material
0.5-5		0.5-52	Sandstone - dark yellowish brown (10YR 3/4), fine grained, subrounded, with silt and clay, cemented.
5-10			
10-15			
15-20			
20-25			
25-30			
30-35			
35-40			
40-45			
45-50			
50-55			
		52-85	Mafic igneous intrusive rock - very dark gray (Gley 1 3/N), aphanitic matrix with plagioclase and pyroxene phenocrysts.
55-60			
60-65			
65-70			
70-75			
75-80			
80-85			

Geologist: P. Barlow
Driller: EDI
Date completed: 9/21/2015

Drilling method: Hollow Stem Auger/Air Rotary

Bit diameter 10"/6" O.D.
Switch to air rotary drilling with a 6" bit at 5'
Sampling method: Cuttings

DTW= Depth to water (feet)
Depth to water measured below top of casing (feet)
Northing: Elevation:
Easting:

BELL GAS #1186
ALTO, NEW MEXICO

Well Completion Diagram and Geologic Log: MW-18S

Daniel B. Stephens & Associates, Inc.
11/23/2015 JN ES14.0220

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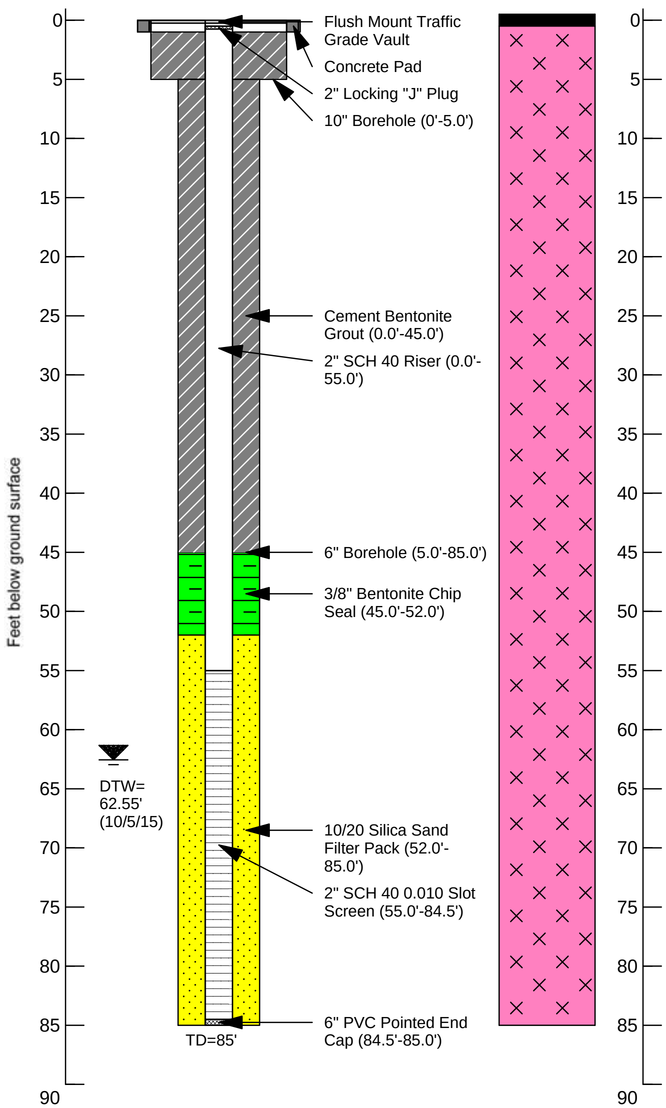


Sample Interval (ft bgs)	USCS Symbol	Lithology Interval	Comments and Lithology
0-0.5		0-0.5	Asphalt and fill material
0.5-2		0.5-2	Mafic igneous intrusive rock - very dark gray (Gley 1 3/N), aphanitic matrix with plagioclase and pyroxene phenocrysts with secondary calcite.
		2-3	
2-5		3-15	Mafic igneous intrusive rock - as above, weathered.
5-10			Mafic igneous intrusive rock - very dark gray (Gley 1 3/N), aphanitic matrix with plagioclase and pyroxene phenocrysts with secondary calcite.
10-25			
		15-52	Mafic igneous intrusive rock - weathered, with iron oxide, otherwise as above.
25-30			
30-35			
35-40			
40-45			
45-50			
50-52			
52-55		52-85	Mafic igneous intrusive rock - very dark gray (Gley 1 3/N), aphanitic matrix with glagioclase and pyroxene phenocrysts.
55-60			
60-65			
65-70			
70-75			
75-80			
80-85			

Geologist: P. Barlow
Driller: EDI
Date completed: 9/23/2015

Drilling method: Hollow Stem Auger/Air Rotary

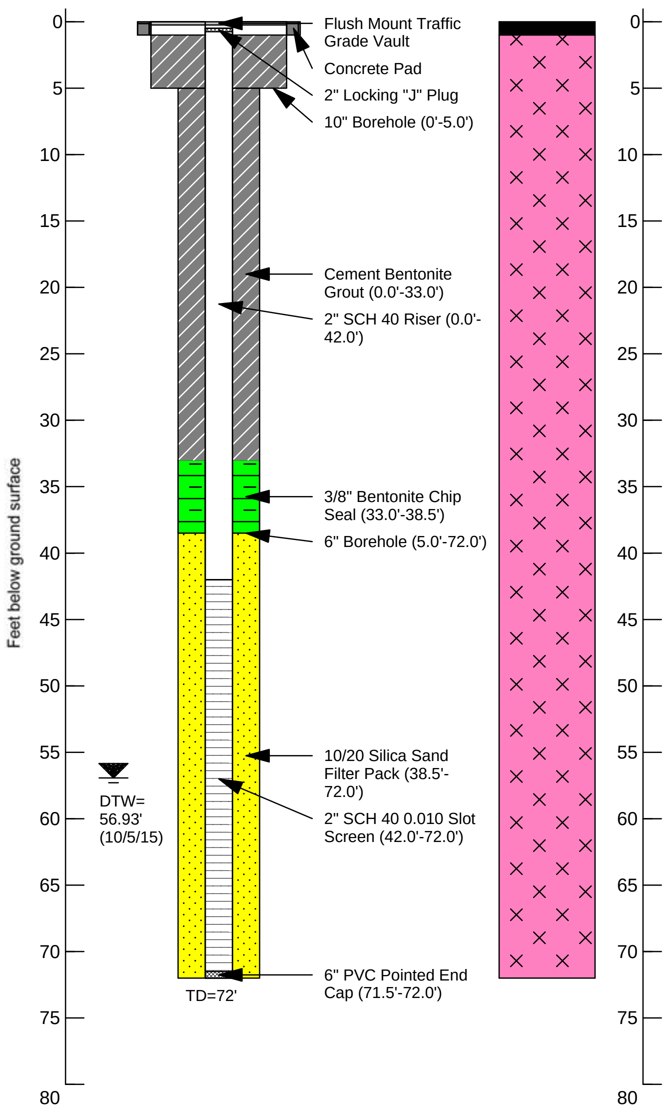
Bit diameter 10"/6"
Switch to air rotary drilling with a 6" bit at 5'
Sampling method: Cuttings

DTW= Depth to water (feet)
Depth to water measured below top of casing (feet)
Northing: 875168.284 Elevation: 7478.335'
Easting: 1815855.143

BELL GAS #1186
ALTO, NEW MEXICO

Well Completion Diagram and Geologic Log: MW-19S

Daniel B. Stephens & Associates, Inc.
11/23/2015 JN ES14.0220



Sample Interval (ft bgs)	USCS Symbol	Lithology Interval	Comments and Lithology
0-1		0-1	Asphalt and fill materiat
1-5		1-20	Mafic intrusive igneous rock - very dark grayish brown (10YR 3/2), aphanitic matrix with plagioclase and pyroxene phenocrysts, with secondary calcite, strongly weathered with iron oxide
5-10			
10-15			
15-20			
20-25		20-25	As above.Transition to less weathered rock of the same composition, no calcite.
25-30		25-72	Mafic intrusive igneous rock - (Gley 1 2.5/N), aphanitic matrix with plagioclase and pyroxene phenocrysts.
30-35			
35-40			
40-45			
45-50			
50-52			
52-55			
55-60			
60-65			
65-70			
70-72			

Geologist: P. Barlow
Driller: EDI
Date completed: 9/24/2015

Drilling method: Hollow Stem Auger/Air Rotary

Bit diameter 10"/6"
Switch to air rotary drilling with a 6" bit at 5'
Sampling method: Cuttings

DTW= Depth to water (feet)
Depth to water measured below top of casing (feet)
Northing: 875085.649 Elevation: 7476.795'
Easting: 1815806.614

BELL GAS #1186
ALTO, NEW MEXICO

Well Completion Diagram and Geologic Log: MW-20S

Daniel B. Stephens & Associates, Inc.
11/23/2015 JN ES14.0220

ATTACHMENT 4

BORING LOGS

SIERRA ENVIRONMENTAL INC.
3808 NORTH GARDEN AVE
ROSWELL, NM 88201

BORING LOG

Date:	1-26-09	Boring ID:	MW1
Drill Crew:	AEA	Boring Location:	NW of UST pit
Drill Method:	AR	Total Depth:	150'BH 104.31 Well
		Water Level:	92' on 1-27 82.50 on 1-29
		Static Water Level:	75.74

Name of Site: Bell Gas #1186

Phase of Work: MSA

Concrete Collar (Surf to 3'bgs), Bentonite Slurry (3' to 64.10'bgs), Top of Sand Pack (64.10'bgs, Top of Screen (74.31'bgs), Static Water Level (75.74'bgs), Total Depth Well (104.31'bgs), Sand Pack (104.31'bgs to 110'bgs), Bentonite Slurry (110'bgs to 150'bgs), TD (150'bgs)

Depth in Ft	USCS	Description	PID ppmv	Lab mg/kg		Notes
0-4	CH	Yellowish silty clay, high plasticity				
4-5	CH	Yellowish silty clay, high plasticity	4.0			Slight HC Odor
5-7	CH	Yellowish silty clay, high plasticity				Start AR @ 5'bgs
7-10	CL	Yellowish sandy clay, low plasticity	0.0			Hard formation @ 10'bgs
10-12		Yellowish sandstone, low plasticity				
12-15		Tan sandstone, consolidated	0.0			
15-18		Tan sandstone, consolidated				
18-20		Tan sandstone, unconsolidated	0.0			
20-23		Tan sandstone, unconsolidated				
23-24		Grey siltstone, soft, unconcolidated				
24-25		Tan sandstone, unconsolidated	0.0			
25-30		Tan sandstone, unconsolidated	0.0			
30-35		Grey shale, consolidated	0.0			
35-40		Grey shale, consolidated	0.0			
40-45		Grey shale, consolidated	0.0			
45-50		Grey shale, consolidated, brown silt	9.0			
50-55		Grey shale, consolidated	1.0			
55-57		Grey shale, consolidated				
57-60		Tan siltstone, unconsolidated	0.0			
60-62		Tan siltstone, unconsolidated				
62-65		Grey shale, consolidated	0.0			
65-70		Grey shale, consolidated	0.0			
70-75		Grey sandstone, consolidated	0.0			

SIERRA ENVIRONMENTAL INC.
3808 NORTH GARDEN AVE
ROSWELL, NM 88201

BORING LOG

Boring ID:	MW1
Boring Location:	NW of UST pit
Total Depth:	150'BH 104.31 Well
Water Level:	92' on 1-27 82.50 on 1-29
Static Water Level:	75.74

Name of Site:	Bell Gas #1186
Phase of Work:	MSA
Date:	1-26-09
Drill Crew:	AEA
Drill Method:	AR

Concrete Collar (Surf to 3'bgs), Bentonite Slurry (3' to 64.10'bgs), Top of Sand Pack (64.10'bgs, Top of Screen (74.31'bgs), Static Water Level (75.74'bgs), Total Depth Well (104.31'bgs), Sand Pack (104.31'bgs to 110'bgs), Bentonite Slurry (110'bgs to 150'bgs), TD (150'bgs)

Depth in Ft	USCS	Description	PID ppmv	Lab mg/kg		Notes
75-80		Grey sandstone, consolidated	0.0			
80-85		Grey shale, consolidated	0.0			WL 83' at 1205
						WL 82.81 at 1300
						WL 82.10 at 1345
						Not substantial accumulation H20
85-90		Grey shale, unconsolidated	0.0			
90-95		Black shale, unconsolidated	0.0			
95-100		Grey shale, unconsolidated	0.0			
100-105		Grey shale, unconsolidated	0.0			
105-110	CL	Grey silty clay, low plasticity	0.0			
110-115	CL	Grey silty clay, layers of unconsolidated grey shale,	0.0			Incr in moisture, not substantial
		low plasticity				accumulation H20
115-120	CL	Grey silty clay, layers of unconsolidated grey shale,	0.0			
		low plasticity				
120-125	CL	Grey silty clay, layers of unconsolidated grey shale,	0.0			
		low plasticity				
125-130	CL	Grey silty clay, layers of unconsolidated grey shale,	0.0			
		low plasticity				
130-135	CL	Grey silty clay, layers of unconsolidated grey shale,	0.0			
		medium plasticity				
135-140	CL	Grey shale, consolidated	0.0			Incr in moisture, WL 140 at 1640
140-145	CL	Grey silty clay, consolidated	0.0			
145-150	CL	Grey silty clay, layers of unconsolidated grey shale,	0.0			
		medium plasticity				

ATTACHMENT 4

BORING LOGS

SIERRA ENVIRONMENTAL INC. 3808 NORTH GARDEN AVE ROSWELL, NM 88201	**BORING LOG**	

Date:	7/12-13/11	Boring ID:	MW4
		Boring Location:	South of Southern Dispenser
		Total Depth:	85.88
Drill Crew:	AEA	Water Level:	71.10 (7-13), 73.19 (7-14)
Drill Method:	AR	Static Water Level:	69.65 (8-23)

Name of Site: Bell Gas #1186

Phase of Work: Ext MSA

Top of 0.010 Slot Screen (66.50), Top of 10/20 Sand Filter Pack (62.00), Top of Bentonite Seal Plug (60.00)

Bentonite Slurry (Surface to 60.00)

Depth In Ft	USCS	Description	PID ppmv	Lab mg/kg		Notes
0-2		Base coarse gravel and clay				
2-5	CL	Yellowish tan silty clay, small amt siltstone, low plasticity	0.0			
5-7		Yellowish tan silty clay, low plasticity				
7-10	CL	Yellowish sandy clay, med plasticity, fine to med gr sand	0.0			
10-12	CL	Yellowish sandy clay, med plasticity, fine to med gr sand				
12-15	CL	Greenish fine-grained sandy clay, med plasticity	0.0			
15-20	CL	Yellowish tan silty clay, consolidated, low plasticity	17.0			
20-22	CL	Yellowish tan silty clay, consolidated, low plasticity				
22-25		Grey siltstone, very consolidated	0.0			
25-30		Grey siltstone, consolidated				
30-35		Grey siltstone, consolidated, yellowish silty clay matrix	0.0			
35-38		Grey siltstone, consolidated, yellowish clay matrix	16.0			
38-40		Grey siltstone, consolidated				
40-45		Grey shale, consolidated	0.0			
45-48		Grey shale, consolidated				
48-50	CL	Grey and tan silt, low plasticity				
50-55	CL	Grey silt, low plasticity	0.0			
55-60	CL	Grey silt, low plasticity	20.0			
60-63	CL	Grey silt, low plasticity	36.0			
63-65		Grey igneous rock				
65-70		Grey igneous rock	4.0			
70-74		Grey igneous rock	5.6			
74-75		Grey sandy clay, fine grained, medium plasticity, small amt				Strong HC odor. WL 72.86 @ 1500
		pea gravel				Shut down 1530 to replace hyd line

SIERRA ENVIRONMENTAL INC.
3808 NORTH GARDEN AVE
ROSWELL, NM 88201

BORING LOG

Boring ID:	MW4
Boring Location:	South of Southern Dispenser
Total Depth:	
Water Level:	
Static Water Level:	

Date:	7/12-13/11
Drill Crew:	AEA
Drill Method:	AR

Name of Site: Bell Gas #1186

Phase of Work: Ext MSA

Depth In Ft	USCS	Description	PID ppmv	Lab mg/kg		Notes
75-80		Grey sandy clay, fine grained med plasticity, sm amt gravel	12.0	1038		
75-86		Grey sandy clay, fine grained, med plasticity, sm amt pea gravel				
80-87		Grey sandy clay, fine grained med plasticity, sm amt gravel				

SIERRA ENVIRONMENTAL INC.
3808 NORTH GARDEN AVE
ROSWELL, NM 88201

BORING LOG

Name of Site:	Bell Gas #1186	Date:	7/5-7/11
Phase of Work:	Ext MSA	Drill Crew:	AEA
		Drill Method:	AR

Boring ID:	MW5
Boring Location:	NE Corner of Bldg
Total Depth:	Borehole(130') Well (107.46')
Water Level:	130.00(7-6), 96.80 (7-7)
Static Water Level:	92.89 (8-23)

Top of 0.010 Slot Screen (87.46), Top of 10/20 Sand Filter Pack (83.25), Top of Bentonite Seal Plug (78.20), Bentonite Slurry (Surface to 78.20)

Depth In Ft	USCS	Description	PID ppmv	Lab mg/kg		Notes
0-2	CL	Dark brown clay, plant material, low plasticity				
2-4	CL	Tan clay, plant material, low plasticity				
4-6	CL	Dark brown clay, low plasticity	0.0			
6-7	CL	Dark brown clay, low plasticity				
7-10	CL	Yellowish tan clay, med plasticity	0.0			
10-11		Tan weathered sandstone, med grain size				
11-13	CL	Grey igneous gravel, very angular, yellowish clay matrix				50 blows/.5 ft
13-15		Yellowish tan weathered sandstone, yellowish clay lenses				
15-17		Yellowish tan sandstone, yellowish clay lenses	0.0			
17-20	CL	Grey igneous gravel, very angular, yellowish clay matrix				50 blows/.5 ft
20-22	CL	Yellowish clay	0.0			
22-25	CL	Grey igneous gravel, very angular, yellowish clay matrix				100 blows/.5 ft
25-27	CL	Grey igneous gravel, sub angular, yellowish clay matrix	1.0			
27-29	CL	Yellowish clay				
29-30	CL	Grey igneous gravel, yellowish clay				
30-31	CL	Grey igneous gravel, yellowish clay	5.8			
31-35		Tan sandstone, unconsolidated				Pulled out of hole for bit trip.
35-40		Grey shale, consolidated	0.0			Switched to air rotary.
40-45		Grey shale, consolidated	0.0			
45-50		Grey shale, consolidated	0.0			
50-55		Grey shale, consolidated	0.0			
55-60		Grey shale, consolidated				
60-65		Grey shale, consolidated	0.0			

SIERRA ENVIRONMENTAL INC. 3808 NORTH GARDEN AVE ROSWELL, NM 88201	**BORING LOG**	
Name of Site:	Bell Gas #1186	
Phase of Work:	Ext MSA	

Date:	7/5-7/11
Drill Crew:	AEA
Drill Method:	AR

Boring ID:	MW5
Boring Location:	NE Corner of Bldg
Total Depth:	
Water Level:	
Static Water Level:	

Depth In Ft	USCS	Description	PID ppmv	Lab mg/kg		Notes
65-67		Grey shale, consolidated	0.0			
67-70		Yellowish clay, unconsolidated				
70-75		Grey shale, consolidated				
75-80		Grey shale, consolidated	0.0			
80-85		Grey shale, consolidated	0.0			
85-90		Grey shale, consolidated	0.0			
90-95		Grey shale, consolidated	0.0			
95-97		Grey shale, consolidated	0.0			
97-100	CL	Yellowish clay, very plastic				
100-105		Grey shale, consolidated	0.0			
105-106		Grey shale, consolidated	0.0			
106-108	CL	Grey shale, clay lenses, consolidated to soft to consolidated				
108-110		Grey shale, consolidated				
110-115		Grey shale, unconsolidated	0.0			
115-120		Grey shale, unconsolidated	0.0			
120-125	CL	Grey silty clay, low plasticity	0.0			
125-130	CL	Grey silty clay, med plasticity	0.0			Water @ 130'. Pulled rods. Let well stabilize overnight to obtain static water level. WL 7-7-11 @ 96.80. Moved to MW6. Backfilled borehole from 130' to 107.60 with 10/20 sand.

SIERRA ENVIRONMENTAL INC.
3808 NORTH GARDEN AVE
ROSWELL, NM 88201

BORING LOG

Name of Site:	Bell Gas #1186	Date:	7/7-11/11
Phase of Work:	Ext MSA	Drill Crew:	AEA
		Drill Method:	AR

Boring ID:	MW6
Boring Location:	NE Property Line by Pipe Fence
Total Depth:	132.81'
Water Level:	107.45(7-11) 117.28(7-13)
Static Water Level:	126.16(8-23)

Top of 0.010 Slot Screen (112.81'), Top of 10/20 sand Filter Pack (72.00), Top of Bentonite Seal Plug (65.75), Bentonite Slurry (Surface to 65.75'bgs)

Depth in Ft	USCS	Description	PID ppmv	Lab mg/kg		Notes
0-2	CL	Dark brown clay, low plasticity				
2-4	CL	Tan clay, low plasticity				
4-5	CL	Yellowish tan clay, low plasticity	2.0			
5-7		Yellowish tan clay, low plasticity				
7-9		Yellowish tan clay, low plasticity, small amt pea gravel				
9-10	CL	Yellowish tan clay, low plasticity, pea gravel				
10-12		Yellowish tan clay, low plasticity	0.0			
12-14		Yellowish tan clay, low plasticity				
14-15	CL	Yellowish tan clay, low plasticity	0.0			
15-17		Yellowish weathered sandstone	0.0			
17-20	CL	Grey igneous gravel, very angular, yellowish clay matrix				
20-22		Grey igneous gravel, very angular, yellowish clay matrix	0.0			
22-25	CL	Grey igneous gravel, very angular, yellowish clay matrix				
25-27	CL	Grey igneous gravel, very angular, yellowish clay matrix	0.0			
27-30	CL	Grey igneous gravel, very angular, yellowish clay matrix				
30-35	CL	Grey igneous gravel, very angular, yellowish clay matrix	0.0			
35-37	CL	Grey igneous gravel, very angular, yellowish clay matrix	0.0			
37-40		Grey shale, consolidated	0.0			
40-45		Grey shale, consolidated	0.0			
45-50		Grey shale, consolidated	0.0			
50-55		Grey shale, consolidated	0.0			
55-60		Grey shale, consolidated	0			
60-65		Grey shale, consolidated	0.0			

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ROSWELL, NM 88201

BORING LOG

Boring ID:	MW6		
Boring Location:	NE Property Line by Pipe Fence		
Date:	7/7-11/11	Total Depth:	
Drill Crew:	AEA	Water Level:	
Drill Method:	AR	Static Water Level:	

Name of Site: Bell Gas #1186

Phase of Work: Ext MSA

Depth In Ft	USCS	Description	PID ppmv	Lab mg/kg		Notes
65-70		Grey granite	26.0			
70-75		Grey granite	16.0			
75-80		Grey granite	6.4			
80-85		Grey granite	12.0			
85-90		Grey granite				Broke driveshaft on rig power pack
90-95		Grey granite	0.0			at 88'bgs 1430
95-100		Grey granite	0.0			7-8-11 borehole at 88'TD moist
100-105		Grey granite	0.0			Had to make bit trip.
105-110		Grey granite				Reamed to 75'. Tight hole.
110-111		Grey granite		1840		Ran new bit to TD @ 105'.
111-115		Grey siltstone				Drill to 111.32
115-122		Grey siltstone				

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BORING LOG

Name of Site:	Bell Gas #1186	Boring ID:	MW7
Phase of Work:	Ext MSA	Boring Location:	65' North of MW3
Date:	7-11-11	Total Depth:	Borehole (132.00), Well (129.54)
Drill Crew:	AEA	Water Level:	127.86(7-12), 116.84(7-13)
Drill Method:	AR	Static Water Level:	126.58 (8-23)

Top of 0.010 Slot Screen (109.54), Top of 10.20 Sand Filter Pack (104.40), Top of Bentonite Seal Plug (96.00), Bentonite Slurry (Surface to 96.00)

Depth In Ft	USCS	Description	PID ppmv	Lab mg/kg		Notes
0-5	CL	Yellowish tan clay, consolidated, low plasticity	0.0			
5-10	CL	Yellowish tan clay, consolidated, low plasticity	17.0			
10-15	CL	Yellowish tan clay, consolidated, low plasticity	10.0			
15-16	CL	Yellowish tan clay, consolidated, low plasticity				
16-18	CL	Purple clay, low plasticity				
18-20		Yellowish weathered sandstone, consolidated	0.0			
20-25		Grey shale, consolidated	0.0			
25-30		Grey shale, consolidated	0.0			
30-35		Grey shale, consolidated	0.0			
35-40		Grey shale, consolidated	0.0			
40-43		Grey shale, consolidated				
43-45		Yellowish mudstone, consolidated				
45-49		Yellowish mudstone, consolidated	0.0			
49-50		Yellowish tan clay, low plasticity				
50-53		Yellowish tan clay, low plasticity	0.0			
53-55		Yellowish mudstone, consolidated				
55-60		Yellowish mudstone, consolidated	0.0			
60-65		Yellowish mudstone, consolidated	28.0			
65-70		Yellowish mudstone, grey shale, consolidated	0.0			
70-75		Grey shale, consolidated, dry	0.0			
75-80		Grey shale, consolidated, dry	0.0			
80-85		Grey shale, consolidated, dry	0.0			
85-90		Grey shale, consolidated, dry	0.0			

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ROSWELL, NM 88201

BORING LOG

Name of Site:	Bell Gas #1186
Phase of Work:	Ext MSA
Date:	7-11-11
Drill Crew:	AEA
Drill Method:	AR
Boring ID:	MW7
Boring Location:	65' North of MW3
Total Depth:	
Water Level:	
Static Water Level:	

Depth In Ft	USCS	Description	PID ppmv	Lab mg/kg		Notes
90-95		Grey shale, consolidated, dry	0.0			
95-100		Grey shale, consolidated, dry	0.0			
100-105		Grey shale, consolidated, dry	0.0			
105-110		Grey shale, consolidated, dry	0.0			
110-115		Grey shale, consolidated, dry	0.0			
115-120		Grey shale, consolidated, dry	0.0	1435		Secure for night at 119'bgs
120-125		Grey shale, consolidated, dry				TD 120.30' 7-11-11
125-130		Grey shale, consolidated, dry				TD 132'.00' 0915
130-132		Grey shale, consolidated, dry				
132		Grey shale, consolidated, dry				

SECTION 6

Soil Boring Logs

BORING LOG

Date:	2-6-13 and 2-7-13	Boring ID:	MW8
Site Name:	Bell Gas #1186 (TRs Market)	Boring Location:	Hi 48 West ROW, South Area
Site Address:	101 Sun Valley Drive, Alto, NM	Total Depth:	Borehole 84'bgs Well 81.15'bgs
Drilling Crew:	EnviroDrill	Water Level:	Approximately 68' on 2-7-13
Type:	Hollow Stem Auger / Air Rotary	Static Water Level:	54.76
Phase of Work:	Extended Hydro Investigation		

Completion Notes: Top of Screen (51.15'bgs), Top of 10/20 Sand Pack (44'bgs), Top of Chip Bentonite Seal Plug (37.0'bgs)
Cement Quik Grout Slurry (37'bgs to Surface)

Depth in Ft	USCS	Lithology Description	PID (ppmv)		Field Notes
0-5	CL	Yellowish tan silty clay, small gravel	0.00		Hollow Stem Auger
5-10	CL	Yellowish tan silty clay, small gravel	0.00		Swiitch Air Rotary
10-15	CL	Yellowish tan silty clay, consolidated gravel	0.00		
15-20		Grey shale, consolidated silty clay	0.00		
20-25		Grey shale, consolidated	0.00		
25-30		Grey shale, tan silty clay	0.00		
30-35		Grey shale, consolidated	2.00		
35-40		Grey shale, consolidated	0.00		
40-45		Grey shale, consolidated	40.00		Slight fuel odor
45-50		Blue grey shale, consolidated	0.00		
50-55		Blue grey shale, consolidated	0.00		
55-60		Grey shale, consolidated	0.00		
60-65		Grey shale, unconsolidated	0.00		
65-70		Grey shale, unconsolidated	0.00		
70-75		Grey shale, consolidated	0.00		WL = 68' 2-7-13
75-80		Grey shale, consolidated	0.00		Drill to 84'. Set Well w/ 81.15'TD
80-84		Grey shale, consolidated	0.00		

BORING LOG

Date:	10/16/2012 to 10/18/12	Boring ID:	MW9
Site Name:	Bell Gas #1186 (TRs Market)	Boring Location:	Corner of Mesa Heights and Sun Valley
Site Address:	101 Sun Valley Drive, Alto, NM	Total Depth:	Wellbore 182' Well 150.14'
Drilling Crew:	EnviroDrill	Water Level:	120' at time of drilling
Type:	Hollow Stem Auger / Air Rotary	Static Water Level:	115.09 10/19/2012
Phase of Work:	Extended Hydro Investigation		

Completion Notes: Top of Screen (110.14'), Top of 10/20 Sand Pack (105.0'), Top of Chip Bentonite Seal Plug (90'bgs), Cement Quik Grout Slurry (90' to Surface)

Depth in Ft	USCS	Lithology Description	PID (ppmv)		Field Notes
0-5	CL	Yellowish silty clay, gravel, low plasticity	0.00		
5-10	CL	Yellowish silty clay, gravel, low plasticity	0.00		
10-15	CL	Yellowish silty clay, gravel, low plasticity	0.00		
15-17	CL	Yellowish silty clay, gravel, low plasticity	0.00		
17-20	CL	Tan silty clay, gravel, low plasticity	0.00		
20-25	CL	Yellowish silty clay, gravel, low plasticity	0.00		
25-30	CL	Yellowish silty clay, gravel, low plasticity	0.00		
30-35	CL	Yellowish silty clay, gravel, low plasticity	0.00		
35-40	CL	Yellowish silty clay, gravel, low plasticity	0.00		
40-45	CL	Yellowish silty clay, gravel, low plasticity	0.00		
45-50	CL	Yellowish silty clay, low plasticity	0.00		
50-55	CL	Yellowish silty clay, low plasticity	0.00		
55-60	CL	Yellowish silty clay, low plasticity	0.00	1630	
60-65	CL	Yellowish silty clay, low plasticity	0.00		
65-70	CL	Yellowish silty clay, small amt gravel, low plasticity	0.00		
70-74	CL	Yellowish silty clay, gravel, low plasticity			No returns 75-80'. Switch to air rotary at 80'bgs
74-75	CL	Yellowish silty clay, gravel, low plasticity	0.00		

BORING LOG

Date:	10/16/2012 to 10/18/12	Boring ID:	MW9
Site Name:	Bell Gas #1186 (TRs Market)	Boring Location:	Corner of Mesa Heights and Sun Valley
Site Address:	101 Sun Valley Drive, Alto, NM	Total Depth:	Wellbore 182' Well 150.14'
Drilling Crew:	EnviroDrill	Water Level:	120' at time of drilling
Type:	Hollow Stem Auger / Air Rotary	Static Water Level:	115.09 10/19/2012
Phase of Work:	Extended Hydro Investigation		

Completion Notes: Top of Screen (110.14'), Top of 10/20 Sand Pack (105.0'), Top of Chip Bentonite Seal Plug (90'bgs), Cement Quik Grout Slurry (90' to Surface)

Depth in Ft	USCS	Lithology Description	PID (ppmv)		Field Notes
75-80	CL	No sample			
80-85		Grey shale, consolidated	0.00		Air rotary @ 80'bgs
85-90	CL	Grey shale, gravel, low plasticity	0.00		
90-95		Grey shale, consolidated	0.00		
95-100		Grey shale, consolidated	0.00		
100-105		Grey shale, consolidated	0.00		
105-110		Grey shale, consolidated	0.00		
110-115		Grey shale, consolidated	0.00		
115-120		Grey shale, consolidated	0.00		
120-125		Grey shale, consolidated	0.00		
125-130		Grey shale, consolidated	0.00		
130-135		Grey shale, consolidated	0.00		Incr in moisture noted in cuttings
135-140		Grey shale, consolidated	0.00	1030	
140-145		Grey shale, consolidated	0.00		
145-150		Grey shale, consolidated	0.00		
150-155		Grey shale, consolidated	0.00		Bit trip @ 155'bgs
155-160		Grey shale, consolidated	0.00		Left borehole open for 1 hr to
160-165		Grey shale, consolidated	0.00		ck for H2O. 1430 dry hole.

BORING LOG

Date:	10/16/2012 to 10/18/12	Boring ID:	MW9
Site Name:	Bell Gas #1186 (TRs Market)	Boring Location:	Corner of Mesa Heights and Sun Valley
Site Address:	101 Sun Valley Drive, Alto, NM	Total Depth:	Wellbore 182' Well 150.14'
Drilling Crew:	EnviroDrill	Water Level:	120' at time of drilling
Type:	Hollow Stem Auger / Air Rotary	Static Water Level:	115.09 10/19/2012
Phase of Work:	Extended Hydro Investigation		

Completion Notes: Top of Screen (110.14'), Top of 10/20 Sand Pack (105.0'), Top of Chip Bentonite Seal Plug (90'bgs), Cement Quik Grout Slurry (90' to Surface)

Depth in Ft	USCS	Lithology Description	PID (ppmv)		Field Notes
165-170		Grey shale, consolidated	0.00		
170-175		Grey shale, consolidated	0.00		
175-180		Grey shale, consolidated	0.00		
180-182		Grey shale, consolidated	0.00		10-18-12 ck for water WL 120'bgs

BORING LOG

Date:	10-15-12 to 1 to 10/18/12	Boring ID:	MW10
Site Name:	Bell Gas #1186 (TRs Market)	Boring Location:	Adj to Real Estate Sign
Site Address:	101 Sun Valley Drive, Alto, NM	Total Depth:	102.10'
Drilling Crew:	EnviroDrill	Water Level:	80' on 10-16-12
Type:	Hollow Stem Auger / Air Rotary	Static Water Level:	77.65' on 10-17-12
Phase of Work:	Extended Hydro Investigation		

Completion Notes: *Top of Screen (72.10'bgs), Top of Sand Pack (66'bgs), Top of Chip Bentonite Seal Plug (58'bgs), Cement Quik Grout Slurry (58' to Surface)*

Depth in Ft	USCS	Lithology Description	PID (ppmv)		Field Notes
0-5	CL	Dark brown silty clay top soil, small gravel, low plasticity	0.00		
5-7	CL	Dark brown silty clay top soil, small gravel			
7-10	CL	Tan silty clay top soil, gravel, dry, low plasticity	0.00		1300-1400 p/u Hyd Oil
10-13	CL	Tan silty clay top soil, gravel, dry, low plasticity			Auger refusal at 13'bgs
13-15		Black, angular, igneous gravel	0.00		Switch to air rotary @ 1430
15-20		Black, angular, igneous gravel	0.00		
20-24		Black, angular, igneous gravel			
24-25		Grey shale, consolidated	0.00		
25-28	CL	Grey angular igneous gravel, brown clay matrix			
28-30	CL	Grey angular igneous gravel, brown clay matrix	0.00		
30-33	CL	Grey angular igneous gravel, brown clay matrix			
33-34	CL	Brown clay, consolidated			
34-35	CL	Grey angular igneous gravel, grey clay matrix	0.00		
35-40	CL	Grey angular igneous gravel, grey clay matrix	0.00		
40-45		Grey angular igneous gravel	0.00		
45-50		Grey shale, consolidated	0.00		
50-55		Grey shale, consolidated	0.00		
55-60		Grey shale, consolidated	0.00		

BORING LOG

Date:	10-15-12 to 1 to 10/18/12	Boring ID:	MW10
Site Name:	Bell Gas #1186 (TRs Market)	Boring Location:	Adj to Real Estate Sign
Site Address:	101 Sun Valley Drive, Alto, NM	Total Depth:	102.10'
Drilling Crew:	EnviroDrill	Water Level:	80' on 10-16-12
Type:	Hollow Stem Auger / Air Rotary	Static Water Level:	77.65' on 10-17-12
Phase of Work:	Extended Hydro Investigation		

Completion Notes: *Top of Screen (72.10'bgs), Top of Sand Pack (66'bgs), Top of Chip Bentonite Seal Plug (58'bgs), Cement Quik Grout Slurry (58' to Surface)*

Depth in Ft	USCS	Lithology Description	PID (ppmv)		Field Notes
60-65		Yellowish shale, siltstone, consolidated	0.00		
65-70		Yellowish shale, siltstone, consolidated	1.00		
70-75		Yellowish shale, siltstone, consolidated	7.00		
75-77		Yellowish shale, consolidated	70.00	0940	
77-78		Yellowish shale, unconsolidated			
78-80		Grey shale, consolidated	54.00		Strong HC odor
80-85		Grey clay, small amt gravel	80.00		
85-88		Grey clay, gravel, unconsolidated			
88-90		Grey clay, gravel, unconsolidated	48.00	1000.0	Incr in Moisture
90-95		Grey clay, gravel, unconsolidated			
95-100		Grey clay, gravel, unconsolidated			
100-105		Grey clay, gravel, unconsolidated			
105-110		Grey clay, gravel, unconsolidated			
					WL 80' @ 1115
					WL 86' @ 1130
					PSH 76' @ 1130 10-16-12
					PSH 73.36' 10-17-12

BORING LOG

Date:	2-7-13 and 2-8-13	Boring ID:	MW11
Site Name:	Bell Gas #1186 (TRs Market)	Boring Location:	South Driveway
Site Address:	101 Sun Valley Drive, Alto, NM	Total Depth:	Borehole 104.4' Well 101.6
Drilling Crew:	EnviroDrill	Water Level:	90.40'
Type:	Hollow Stem Auger / Air Rotary	Static Water Level:	74.13'
Phase of Work:	Extended Hydro Investigation		

Completion Notes: Top of prepack 0.010Screen packed with 1/20 Sand (70'bgs), Top of 10/20 Sand Pack Around Pre Pack (65.00')
Top of Chip Bentonite Seal Pack (59.70'), Grout from 59.70' to Surface

Depth In Ft	USCS	Lithology Description	PID (ppmv)		Field Notes
0-4	CL	Reddish brown silty clay, low plasticity	0.00		Hollow Stem Auger
4-5	CL	Tan silty clay, low plasticity	0.00		Switch Air Rotary @ 5'bgs
5-6		Grey slmestone, grey shale, consolidated			
6-10		Grey shale, yellow silty clay, low plasticity	0.00		
10-15		Grey shale, yellow silty clay, low plasticity	0.00		
15-20		Grey shale, yellow silt, low plasticity	0.00		
20-25		Grey shale, yellow silt, low plasticity	0.00		
25-30		Grey shale, yellow silt, low plasticity	0.00		
30-35		Grey shale, yellow silt, dry	0.00		
35-40		Tan fine grained sandstone, consolidated	0.00		
40-45		Tan fine grained sandstone, consolidated	0.00		
45-50		Tan fine grained sandstone, consolidated	0.00		
50-55		Tan fine grained sandstone, consolidated	0.00		
55-60		Tan fine grained sandstone, consolidated	0.00		
60-65		Tan fine grained sandstone, consolidated	120.00	815	HC Odor
65-70		Tan fine grained sandstone, consolidated	40.00		
70-75		Grey shale, consolidated	11.00		
75-80		Grey shale, consolidated	0.00		

BORING LOG

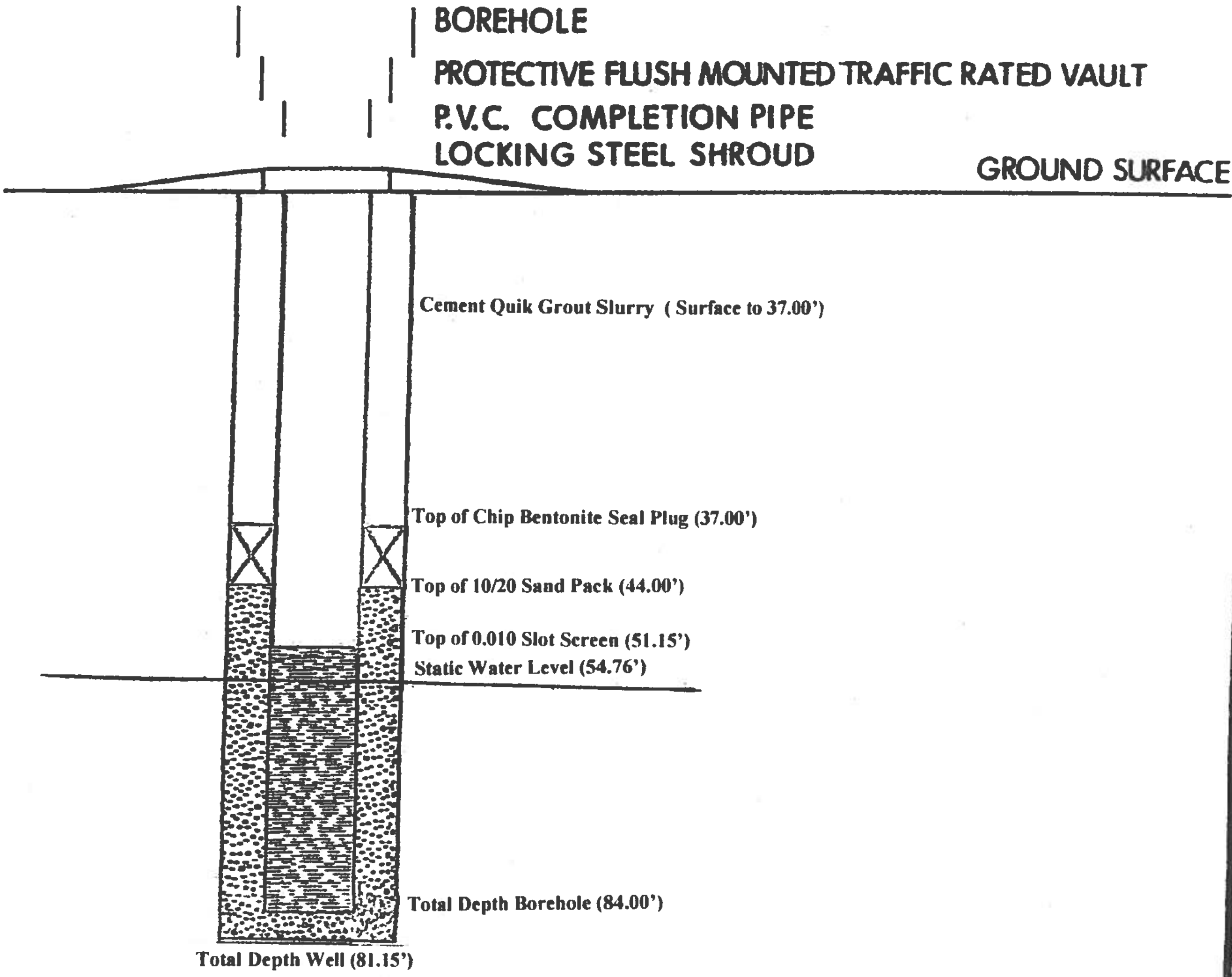
Date:	2-7-13 and 2-8-13	Boring ID:	MW11
Site Name:	Bell Gas #1186 (TRs Market)	Boring Location:	South Driveway
Site Address:	101 Sun Valley Drive, Alto, NM	Total Depth:	Borehole 104.4' Well 101.6
Drilling Crew:	EnviroDrill	Water Level:	90.40'
Type:	Hollow Stem Auger / Air Rotary	Static Water Level:	74.13'
Phase of Work:	Extended Hydro Investigation		

Completion Notes: Top of prepack 0.010Screen packed with 1/20 Sand (70'bgs), Top of 10/20 Sand Pack Around Pre Pack (65.00') Top of Chip Bentonite Seal Pack (59.70'), Grout from 59.70' to Surface

Depth in Ft	USCS	Lithology Description	PID (ppmv)		Field Notes
80-85		Grey shale, consolidated	0.00		
85-90		Grey shale, consolidated	0.00		
90-95		Grey shale, consolidated	0.00		
95-100		Grey shale, consolidated	0.00	950	
100-104		Grey shale, unconsolidated			

SECTION 7

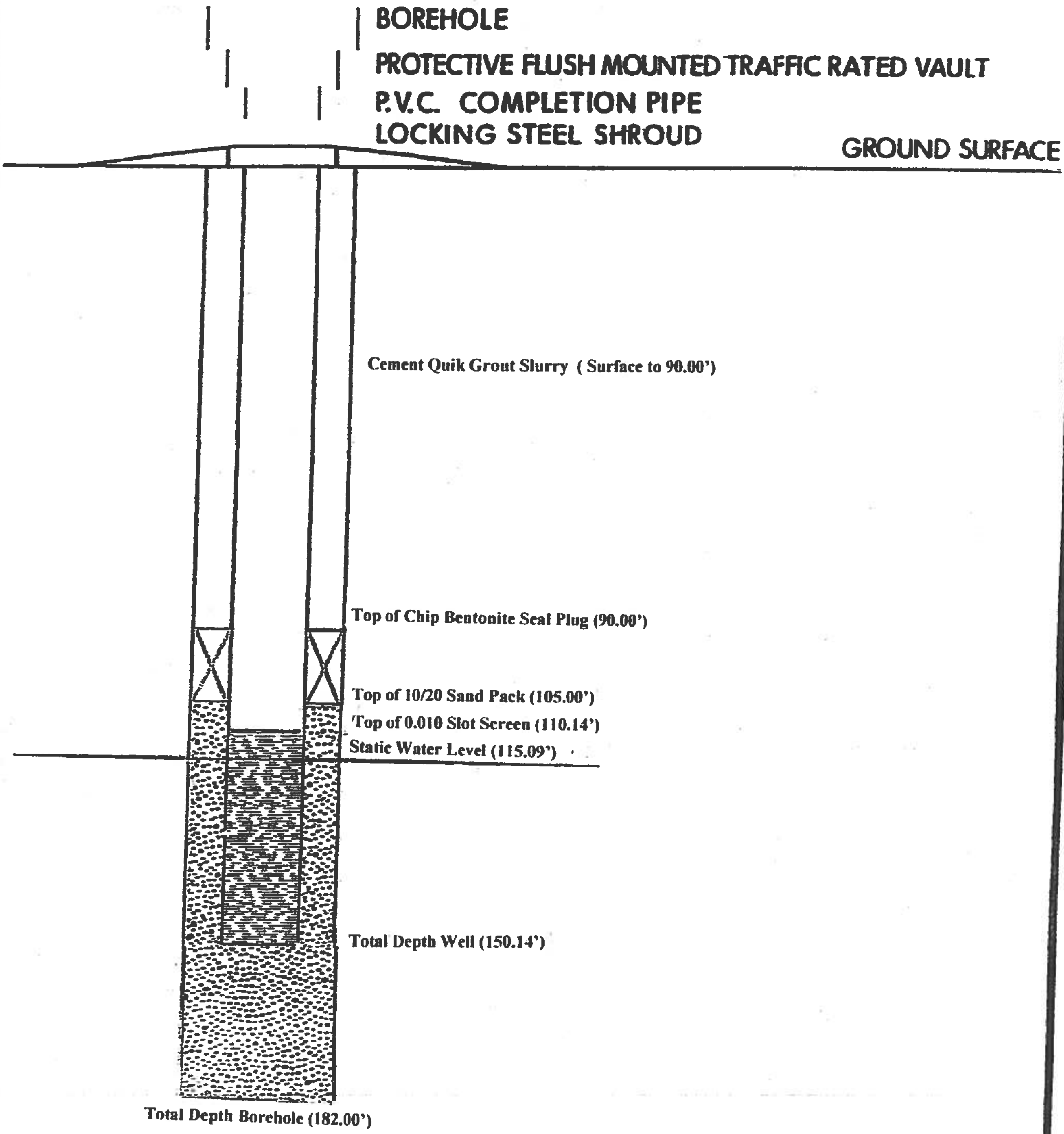
Monitoring Well Completion Diagrams



SIERRA ENVIRONMENTAL INC.
3808 NORTH GARDEN ROSWELL, NEW MEXICO
(505) 622-7700

Bell Gas #1186 (TRs Market)
101 Sun Valley Road
Alto, NM

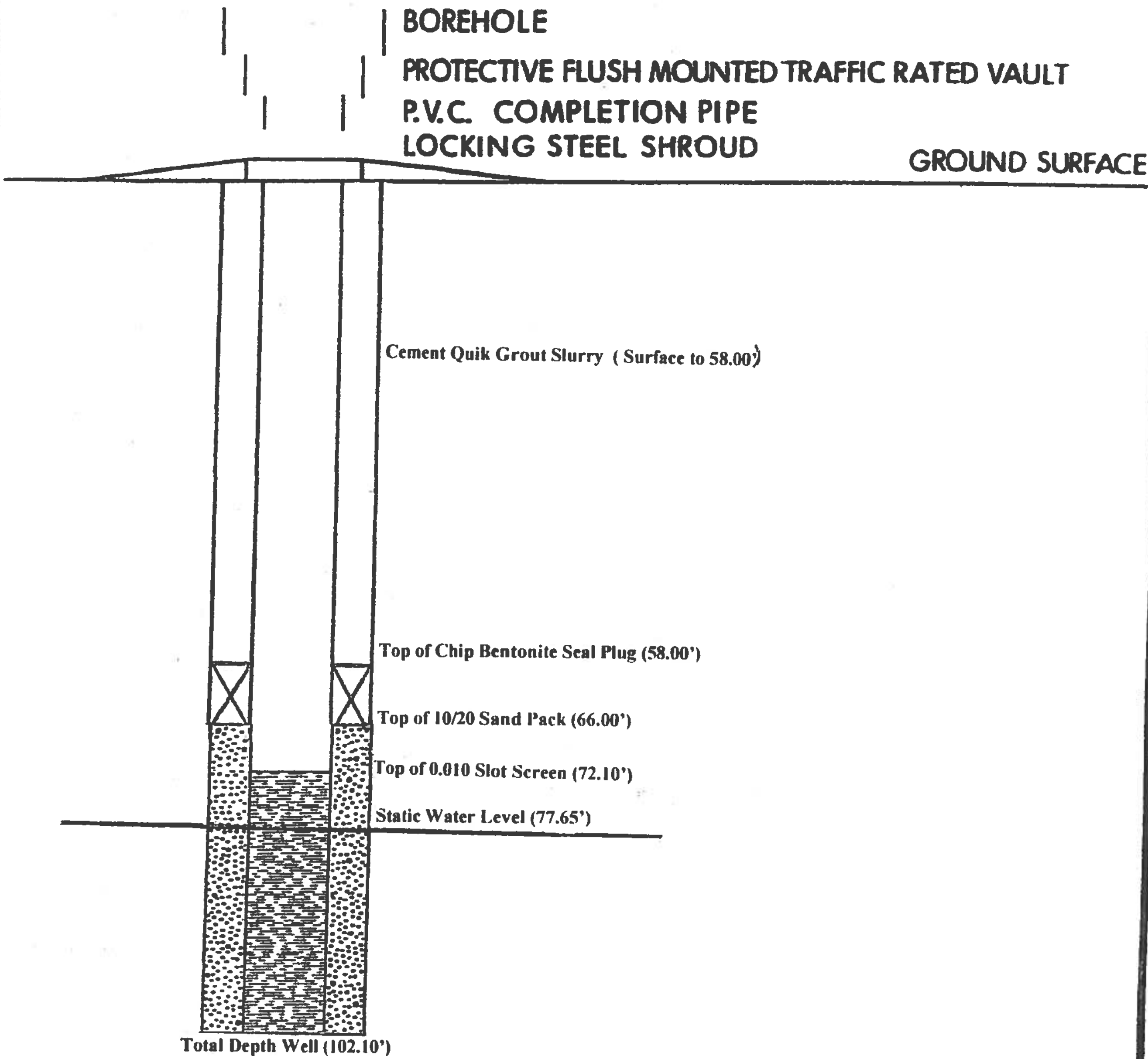
DESIGN:	SCALE:	FIG. NO:
DATE:	1" = 20'	MW8



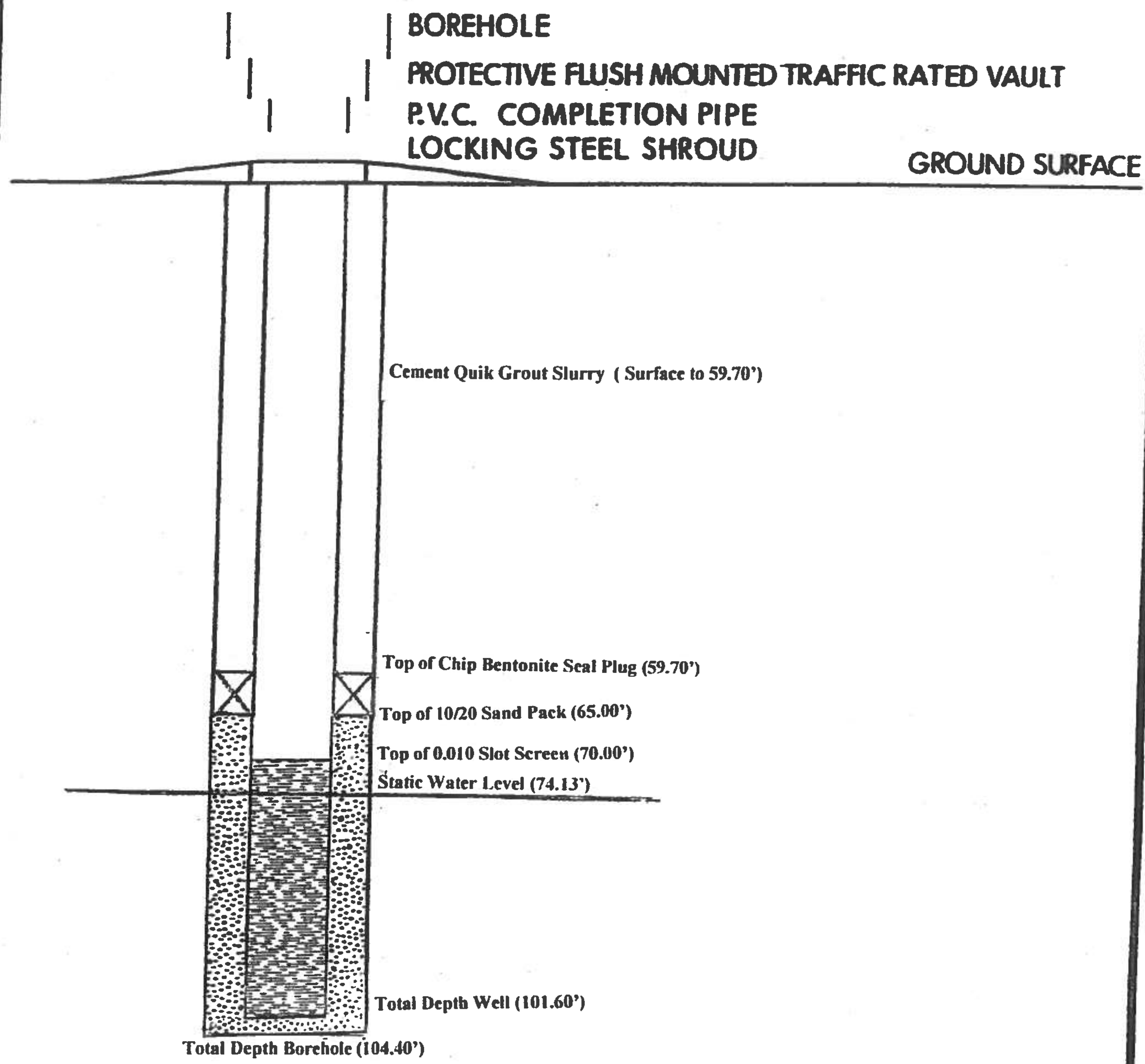
SIERRA ENVIRONMENTAL INC.
3308 NORTH GARDEN ROSWELL, NEW MEXICO
(505) 622-7700

Bell Gas #1186 (TRs Market)
101 Sun Valley Road
Alto, NM

DESIGN:	SCALE:	FIG. NO:
DATE:	1" = 30'	MW9



SIERRA ENVIRONMENTAL INC. 3808 NORTH GARDEN ROSWELL, NEW MEXICO (505) 622-7700		
Bell Gas #1186 (TRs Market) 101 Sun Valley Road Alto, NM		
DESIGN:	SCALE: 1" = 20'	FIG. NO: MW10
DATE:		



SIERRA ENVIRONMENTAL INC.
3808 NORTH GARDEN ROSWELL, NEW MEXICO
(505) 622-7700

Bell Gas #1186 (TRs Market)
101 Sun Valley Road
Alto, NM

DESIGN:	SCALE:	FIG. NO:
DATE:	1" = 20'	MW11

Attachment 5

Treatment Equipment Drawings and Technical Specifications

H2K Technologies, Inc.
7550 Commerce St.
Corcoran, MN 55340
Office: 763-746-9900
Fax: 763-746-9903
www.H2KTech.com

January 7, 2019

To: Thomas Golden, P.E.
Daniel B. Stephens & Associates, Inc.
6020 Academy Road NE, Suite 100 | Albuquerque, New Mexico 87109
T (505) 822-9400 | D (505) 353-9075 | M (505) 249-9402
Email: tgolden@geo-logic.com

Project Name: BELL GAS #1186
Project Location: Alto, NM
Quote Number: 5256

Dear Tom,
Below is a quote you requested for the above referenced project. Quote is per the specifications with exceptions as noted. We appreciate the opportunity to bid on this project, please call or email with any questions.

Description/Pricing

Dual Phase Extraction Equipment

(1) Inlet manfold, 6" main with (7) 2" takeoffs
- Sch 80 PVC pipe and fittings, dual phase configuration with over the top inlets to manifold
- (7) 2"PVC ball valves, manual operator, ss shaft, Teflon seat
- (7) Vacuum gages
- (7) Sample ports

DPE inlet manifold will terminate through the wall or the floor.

(1) Air dilution intake line
- 4" PVC butterfly valve
- 4" Filter/silencer, Solberg FS-365P-400

(1) Moisture separator, H2K model VLS-220
- Welded steel construction with external enamel finish
- Tangential inlet and demister for 99%+ moisture removal
- 30" Dia x 72" high vertical tank
- 220 gallon total capacity, 55 gallon liquid holding capacity
- Full vacuum design rating
- Epoxy lined, enamel exterior finish
- PVC site glass with ss low/high/high-high level switch assembly and union for easy removal
- Polypropylene demister element
- Acquiescence plate to isolate condensate water from turbulent airflow
- 1" Brass drain valve
- 6" plate flange inlet and outlet connections
- 6" Plate flanged cleanout port
- Sloped bottom for solids removal
- Vacuum gage on separator inlet & outlet, 0-100 "wc vacuum
- Sample port on separator intake

(1) Moisture Separator pump, Moyno 500 series model 344 progressive cavity pump
    3/4 hp, 460VAC, 3Ø, TEFC motor
    10 gpm at 40 psi differential pressure
    Cast iron housing, carbon steel rotor, NBR rubber stator
    Pump re-circulation loop with ball valve
    Flexible connectors on pump inlet and outlet
    Throttle valve, check valve, sample port & pressure gage on discharge

(1) Isolation and Purge/Bleed vapor control valves, mounted on vacuum side of blowers, controlled by oxidizer
    Supplied by others

(2) Inline vacuum filter on blower intake, Solberg CT-235P-400C with replaceable polyester element
    Differential pressure gage installed across filter

(2) Rotary claw compressor, Busch model MV1202A, to include:
    Cast iron housing, cast iron machined rotors
    30 HP, 460VAC, 3Ø, TEFC motor
    Capable of 600 ICFM at 18.5" Hg vacuum at 7500' elevation
    Factory mounted cooling shroud with integral fan
    Silencer on blower discharge
    Temperature gauge on discharge, 50-550 F
    Vacuum relief valve on blower inlet
    Sample port on blower discharge
    Pressure gage blower inlet and outlet
    4" CI butterfly valve on inlet
    4" check valve on blower inlet

Note: We have operated multiple liquid ring pumps at elevation before and they fail for various reasons within two years as the manufacturer requires higher maintenance under what they consider extreme operating conditions, shorter oil changes, more frequent filter changes. An oil sealed rotary vane pump is not recommended as the TPH may thin the oil causing a breakdown of the lubricating properties with constant operation. This may scour the compression chamber of break the vanes from hot spots, which will cause the unit to lose vacuum over time. With both the liquid ring and the oil lubricated vane the manufacturers will not stand behind it, so the risk is passed on and we are not willing to warranty. We have operated claw blowers up to 8,000' elevation without any issues, so those we do stand behind.

(1) Pressure transmitter on blower discharge, Foxboro IDP-10 transmitter, 4-20 mADC output, loop powered, local LCD display, NEMA 4X, ClassI, Div 2 rated

(1) Temperature transmitter on blower discharge, RTD with 4-20 mADC output

(1) Air flow transmitter on combined blower discharge, Dwyer DS-300-4 pitot tube with Foxboro IDP-10 transmitter, 4-20 mADC output, loop powered, local LCD display, NEMA 4X, ClassI, Div 2 rated

Water Treatment Equipment

(1) H2K Technologies model LLS8, oil/water separator
    304 stainless steel construction
    100% removal of 20 micron & larger droplets at 25 gpm w/ SG=0.75
    PVC slant rib coalescing media
    Adjustable skimming weir
    Gravity drain from skimmer into product holding tank
    Solids collection sump
    Clearwell for pumping directly from separator
    PVC site glass with ss low, high & high-high pump out level switch assembly, union mounted

Vapor tight gasketed cover, Buna-N Gasket
1” PVC vent line, plumbed to exterior
2” Brass ball valve, clearwell drain
Sample port on inlet
2” PVC ball valve on discharge

(1) Product storage tank, 300 gallon, UL 142 double wall tank (OUTSIDE OF ENCLOSURE)
Welded steel horizontal tank with enamel external finish
38.5” dia. x 68” long horizontal tank
High/high and high level switches
Normal vent with riser pipe
Emergency vent
Check valve and isolation valve on product inlet
120 VAC heat trace for class I, Div 1 hazardous location
1” polyurethane insulation, UV resistant, R-7 on tank

(1) H2K Technologies model DTA-2 Diffused Aeration Tank, each including:
304 Stainless steel welded construction
(2) Aeration chambers
(6) Non-fouling 304 Stainless Steel aeration diffusers
Quick connections for easy lateral removal
Counter current water and air flow to provide maximum flow path across each aeration chamber
Hinged 304 Stainless steel cover
Provides easy access to aeration chambers and diffusers
Off gas nozzle with polypropylene demister element
(1) Pump out clearwell
Site glass with ss high/high-high-low pump out level switches
Unit will be stand mounted to allow gravity drain from oil/water separator thru DTA into clarifier
Welded steel stand with enamel finish, walking platform for access into DTA for cleaning

(1) FPZ model K05-MS single stage regenerative blower
90 cfm @ 80” wc
4 hp, 230/460VAC 3 ph, TEFC motor
Aluminum wheel and housing
Interconnecting ducting to diffused air inlet
High & Low blower pressure switches

(1) H2K Technologies model IPC-40, inclined plate clarifier
304 stainless steel construction
90% removal of 20 micron & larger solids 7.5 gpm
PVC slant tube coalescing media
Adjustable skimming weir
Solids collection sump
Clearwell for pumping directly from clarifier
PVC site glass with ss low, high & high-high pump out level switch assembly, union mounted
Vapor tight gasketed cover, Buna-N Gasket
1” PVC vent line, plumbed to exterior
2” Brass ball valve, clearwell drain
Sample port on inlet
2” PVC ball valve on discharge

(1) Transfer pump, AMT model 489
10 gpm @ 82' TDH
Cast iron bronze fitted
3/4 HP, 208-230/460VAC, 3Ø, TEFC motor

2” PVC Isolation ball valve on inlet
1” Brass ball valve on discharge
1” Brass Check valve on pump discharge
Sample port on pump discharge
Pressure gage on pump discharge, ss, liquid filled

(2) Pentair L-88 Bag filter assembly piped in parallel, with the following:
304SS construction, 150 psi
Each unit houses (1) #2 size filer bag, swing bolt clamped lid
2” NPT inlet and outlet connections
(4) 2” PVC ball valves for isolation for inf. and eff. of each housing & bypass
(2) 1/2" drain valves, (2) Pressure gauges with bleed valve, air release valves

(1) DP transmitter across bag filters, Foxboro IDP-10 DP transmitter,
4-20 mADC output, loop powered, local LCD display, NEMA 4X, Class I, Div 2 rated

(1) Flow totalizer, total gallons, with pulse output

(1) Pressure switch on discharge, Barksdale model D1T

(2) H2K Tech model LC-005 liquid Phase Carbon vessels, each with:
Carbon steel construction, 60 psi design pressure
Epoxy resin lining, epoxy/urethane exterior finish
Forkliftable skid, lifting lugs
500 lbs. 8x30 mesh reactivated carbon in each
2” 150 lb. flanged inlet and outlet
PVC hub and lateral internals
3/4” Air bleed valve with galvanized piping
(2) 12”x16” manways
1” drain valve with galvanized piping
Pressure gage on inlet of each vessel
Sample port on inlet and outlet of each vessel
2” Camlock fititngs on inlet and outlet of each vessel
(3) 2” PVC reinforced hoses with camlock fittings for connection

Note: Modeling with DRO as Naphthalene at 150 ug/l at 10 gpm, the lead carbon adsorber will breakthrough beyond 1 ug/l in 5 years of constant flow. Modeling with BTEX as Benzene at 50 ppb at 10 gpm, the lead carbon adsorber will breakthrough beyond 1 ug/l in 2 years of constant flow. The BTEX loading does not affect the DRO removal substantially.

(1) Siphon break on discharge of vessels

(1) Vented Stand pipe on discharge of vessels with high/high level switch

(1) Pressure transmitter on discharge, Foxboro IDP-10 DP transmitter,
4-20 mADC output, loop powered, local LCD display, NEMA 4X, Class I, Div 2 rated

(1) High/High level switch for use in infiltration gallery

Controls

(1) Low Voltage Control Panel
For operation on 120 VAC, 1Ø,15 Amp incoming electrical service. To control (2) 30 HP DPE blower, (1) 5 HP air stripper blower, (2) pumps. To be mounted and wired on the enclosure exterior wall. To include:
<u>QTY</u> <u>DESCRIPTION</u>

1 Enclosure, NEMA 4, 36"h, 36"w, 12"d with inner door mounted switches and indicators
1 Enclosure vent fan with thermostat and inlet/outlet louvers
1 Allen Bradley Micrologix 1400 PLC, with input & output as required for system operation
1 8" Color operator interface terminal, with embedded web browser for local & remote viewing of system status & alarms
1 Ethernet switch
1 Industrial cell modem, to allow email/text alarm callout and remote system access
Cell carrier service to be direct paid by client
7 Switch; three position; Hand-Off-Auto
1 Light (red/LED); alarms, individual alarms called out on interface
1 Pushbutton (red/NO); alarm Reset
3 Motor run time meters
2 Emergency stop button on panel door and in treatment room
6 Intrinsically safe barrier, 2 Channel - for pressure and level switches
Relay logic and timers as required
Engraved laminated legends for all door mounted devices
Terminal blocks for external connections and fusing as required
Color-coded wiring with wire markers at all terminations
Fully documented, assembled, wired, programmed and pre-shipment test
1 UL 698A serialized label

(1) 480-120 VAC transformer NEMA 3R mounted under breaker panel
To power lights and controls

(1) Panel board 480VAC 3phase in NEMA 3R enclosure mounted next to control panel, includes:
1 Circuit breaker "Main Breaker"; 480V 3P200A 10K
4 Circuit breaker 480V 3P10A 15K; Pumps
2 Circuit breaker 480V 3P60A 15K; SVE blower
1 Circuit breaker 480V 3P20A 15K; AS blower
1 Circuit breaker 480V 3P50A 15K; Oxidizer
2 Circuit breaker 480V 2P20A 15K; Heaters

(1) Panel board 120VAC 1phase in NEMA 3R enclosure mounted next to control panel, includes:
1 Circuit breaker 120V 1P10A 15K; control power
3 Circuit breaker 120V 1P15A 15K; vent fans
1 Circuit breaker 120V 1P15A 15K; Lighting

(1) High Voltage Motor Control Panel
For operation on 480 VAC, 3Ø, 200 Amp incoming electrical service. To feed (2) 30 HP DPE blower, (1) 5 HP air stripper blower, (2) pumps, & (1) oxidizer. Furnished mounted and wired on the enclosure exterior wall. To include:

QTY	DESCRIPTION
1	Enclosure, NEMA 4, 48"h, 36"w, 8"d with outer door mounted switches and indicators
1	Power distribution terminal block (65-335A) 3 pole; L1, L2, L3
1	Power distribution terminal block, 1 pole; Neutral
2	Variable Frequency drive for DPE blowers, 30 hp 480 VAC, ABB or Yaskawa with panel mounted interface on inner door
1	Vent fan with thermostat and inlet/outlet louvers
1	Motor starter: Contactor 11A FLA/Overload relay 6-11A, 3Ø; AS Blower
2	Motor starter: Contactor 6A FLA/Overload relay 3-6A, 3Ø; pumps
3	Motor starter: Contactor 23A FLA3Ø; heaters
	Engraved laminated legends for all door mounted devices
	Terminal blocks for external connections and fusing as required
	Color-coded wiring with wire markers at all terminations
	Fully documented, assembled, wired, programmed and pre-shipment test
1	UL 508 serialized label

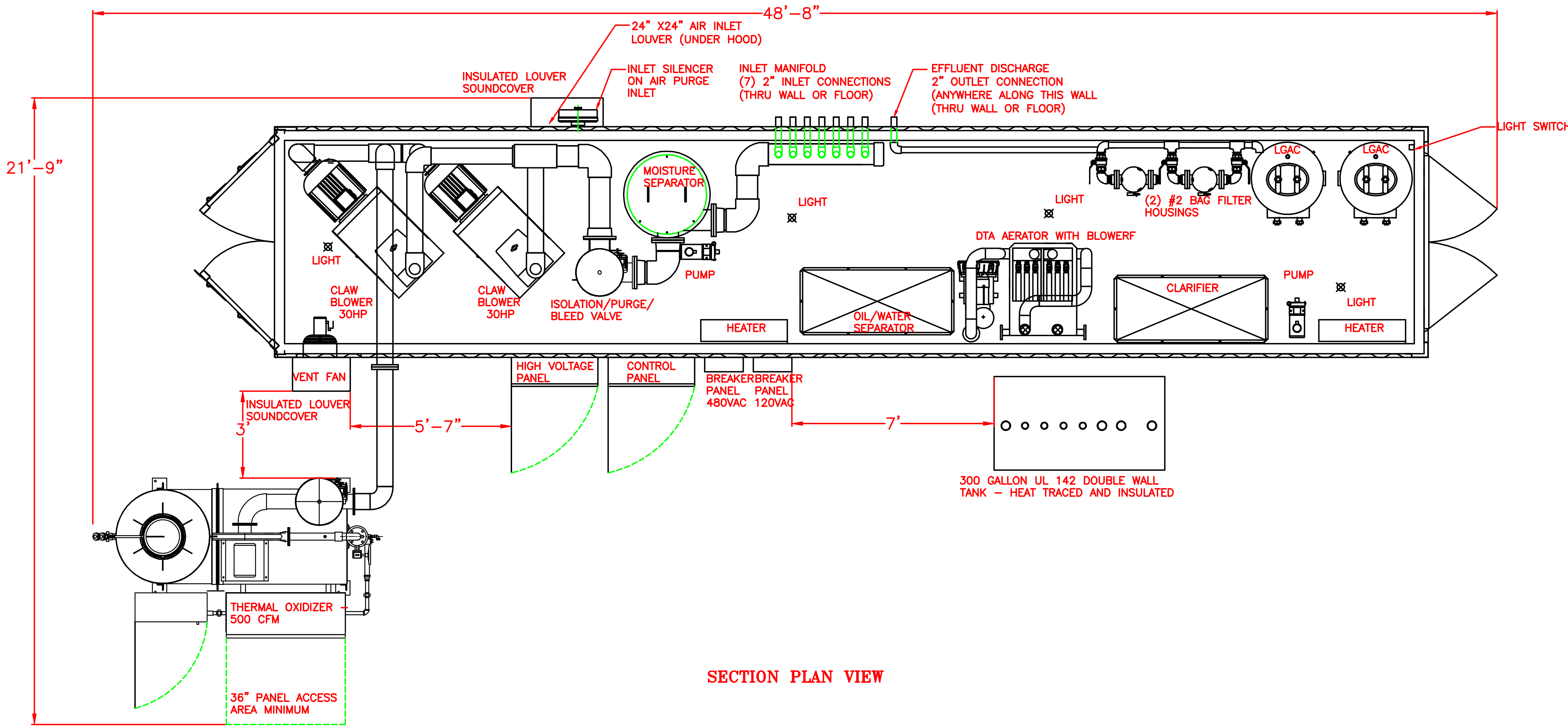
Enclosure

(1) Modified Cargo box enclosure system, 8’ wide x 40’ long x 8’6” high outside dimension

- Includes equipment installation and wiring
- **Welded steel Sea container with 2” fir decking**
- Floor sealed with non-skid bed liner
- Exterior painted as required to match existing color
- R-13 Insulation walls and ceiling with 2x4 furring and plywood interior
- Floor box or wall penetrations for incoming and outgoing lines as needed
- Anchor lugs and lifting eyes
- Double rear doors with cam lock
- (2) 36” x 6’-8” double insulated steel access door on other end
- Sound insulated louver covers for vent air intake and exhaust louvers
- Mounting of all equipment
- Spray urethane insulation under cargo box
- 2” Containment lip around interior of building (approx. 280 gallons totalvolume)
- (1) Floor sump w/ high level switch
- (2) Wall mounted explosion proof electric convection heater with thermostat, 3600 Watt
- (4) Ceiling mounted explosion proof lights with vapor globe and wall switch
- (1) Explosion proof 16” vent fan with inlet & outlet louvers, wall-mount cabinet, and thermostat

DPE and GWTS will be installed, piped and wired in enclosure, control panel will be mounted and wired on outside of enclosure. Piping will be schedule 40 black iron DPE discharge, Schedule 80 PVC for DPE inlet and water. Wiring will be per NEC for Class I, Div 2 Group D hazardous environment inside enclosure, outside enclosure shall be considered non-classified beyond 3’ from any opening.

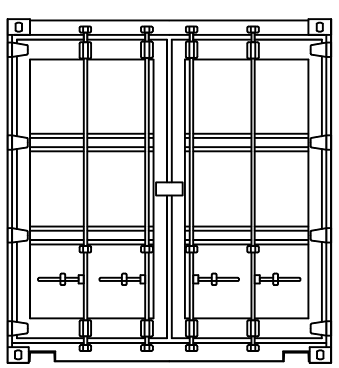
Spares
(1) Set of (6) diffusers for DTA, (1) case (25) 25 micron filter bags, (2) sets of oil for blowers, (2) sets of filter elements for all filters



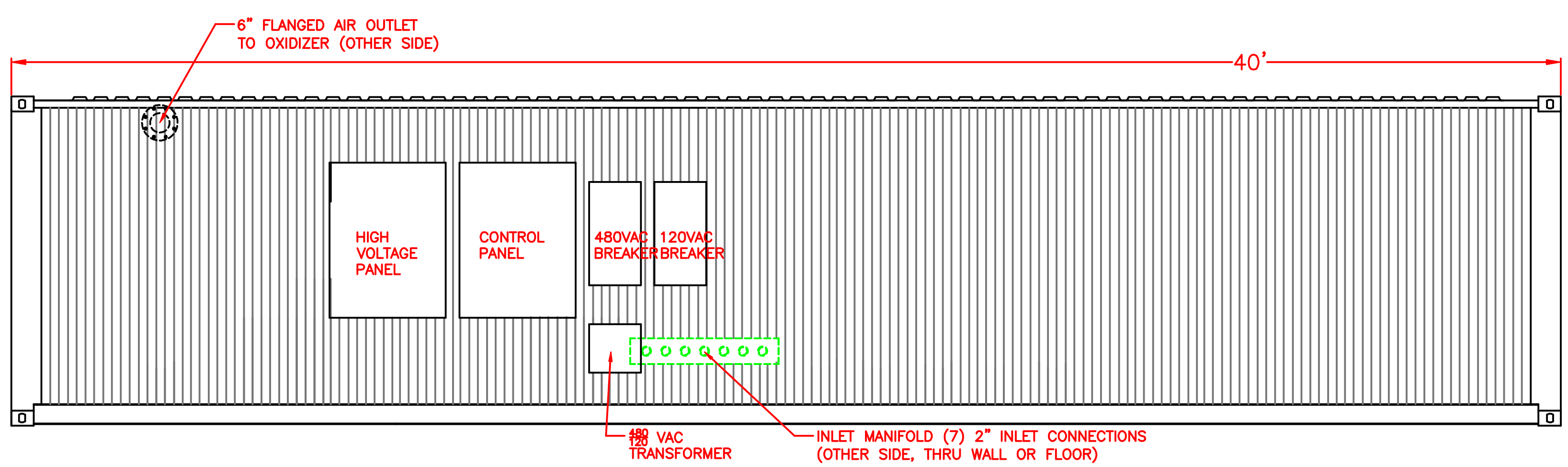
SECTION PLAN VIEW

NOTE:
1. DPE AND GWTS WILL BE MOUNTED, PIPED AND WIRED IN INSIDE ENCLOSURE, CONTROL PANEL WILL BE MOUNTED AND WIRED ON THE OUTSIDE OF THE ENCLOSURE.
2. WIRING WILL BE PER NEC FOR A CLASS I, DIV 2 AREA INSIDE THE ENCLOSURE AND NON-CLASSIFIED OUTSIDE THE ENCLOSURE BEYOND 3' FROM ANY OPENING.
3. PIPING WILL BE SCHEDULE 80 PVC FOR SVE INTAKE & WATER, SCHEDULE 40 BLACK IRON FOR SVE DISCHARGE.
4. CARGO BOX SYSTEM DRY WEIGHT INCLUDING PROCESS EQUIPMENT, MEDIA, VACUUM BLOWERS, KNOCKOUT, PIPING, CONTROLS, WIRING, INSULATION/WALL FRAMING & CARGO BOX, 32,000LBS. OPERATING WEIGHT: 38,000 LBS.

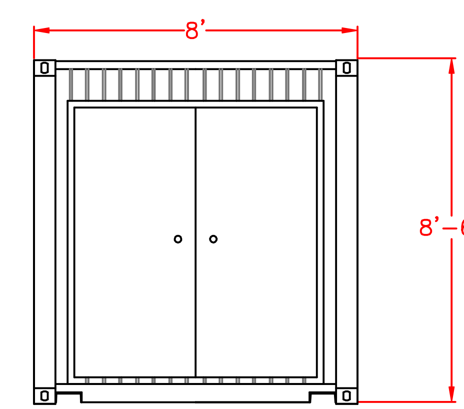
CONTAINER MODIFICAITONS
1. ADD DOUBLE DOORS TO END OF ENCLOSURE
2. ADD 14" X 14" OPENING FOR VENT FAN
3. ADD 24"X24" OPENING FOR INLET COOLING AIR
4. FRAME WALLS AND CEILING WITH 2X4 CONSTRUCTION R13 INSULATION.
5. INTERIOR FINISH WALLS AND CEILING TO BE 1/2" BCX PLYWOOD, PAINTED WHITE
6. FLOOR COATED WITH BEDLINER
7. SPRAY FOAM INSULATION UNDERSIDE OF CONTAINER
8. INTERIOR DIMENSIONS APPROX 7" WIDE X 38'-8"' LONG X 7'-6" HIGH



LEFT END VIEW



FRONT ELEVATION VIEW



RIGHT END VIEW

REVISIONS			
REV	DESCRIPTION	DATE	DWN

UNLESS SPECIFIED OTHERWISE
* DIMENSIONS ARE IN INCHES
* DO NOT SCALE DRAWING

DRAWN BY: TP
DESIGNED BY: GH
PROJECT MGR.: MK
DATE: 10/13/2016
PROJECT NO.: 4824

H2K Technologies, Inc.

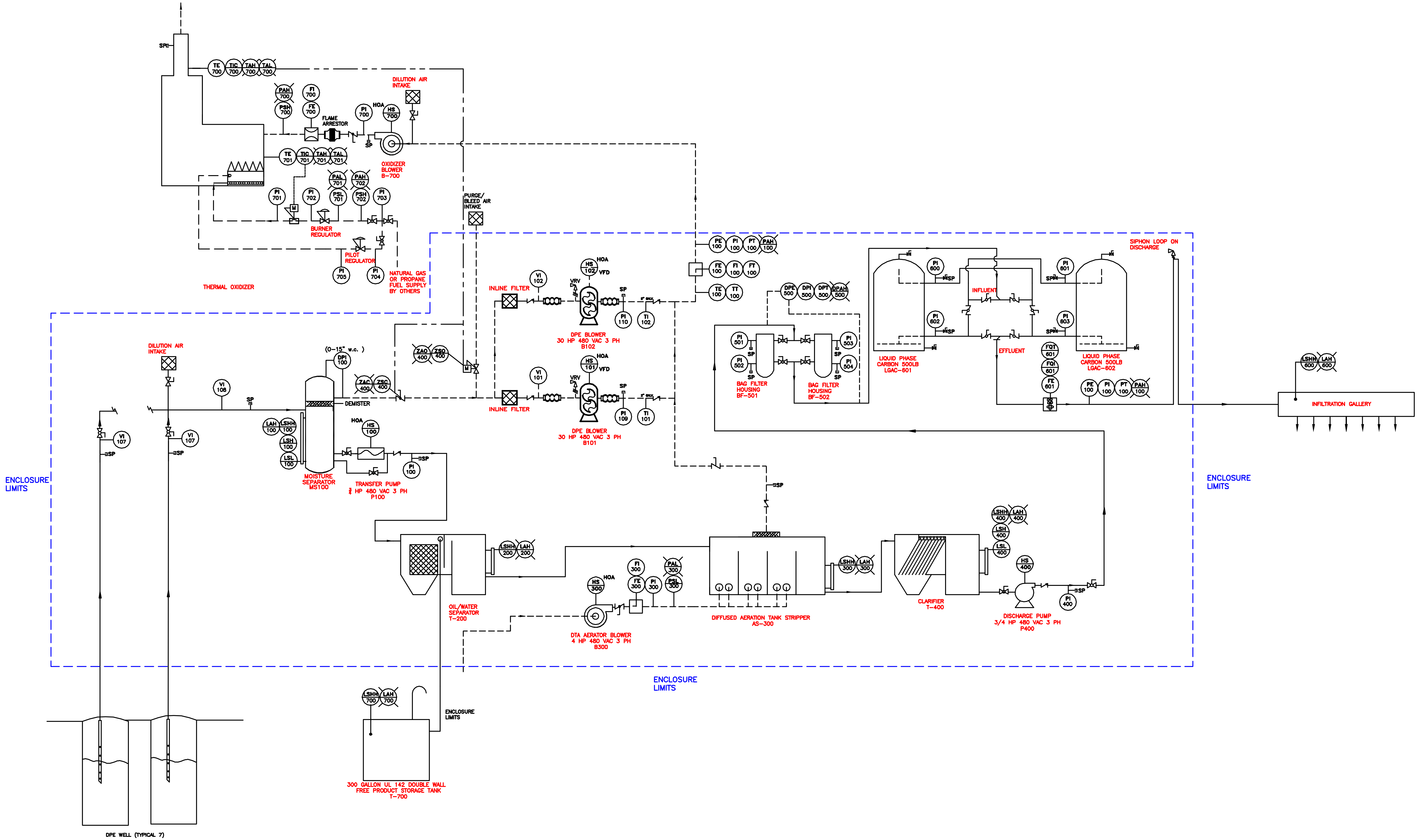
7550 COMMERCE ST, COROCORAN, MN 55340,Tel: 763-746-9900

PROJECT TITLE:
D.B. STEPHENS

DRAWING TITLE:
DPE/GWTS MODIFIED CARGO BOX ENCLOSURE LAYOUT
ALTA, NM

SHEET 1 OF 1

DRAWING NO.:
5256-01



REV	DESCRIPTION	DATE	DWN

REVISIONS

UNLESS SPECIFIED OTHERWISE
* DIMENSIONS ARE IN INCHES
* DO NOT SCALE DRAWING

DRAWN BY: GH
DESIGNED BY: GH
PROJECT MGR.: MK
DATE: 6/18/03
PROJECT NO.: STANDARD P&ID

H2K Technologies, Inc.
7550 COMMERCE ST, CORCORAN, MN 55340 Tel:763-746-9900

PROJECT TITLE:
D.B. STEPHENS

DRAWING TITLE:
DPE/GWTS P&ID
ALTA, NM

SHEET 1 OF 1
DRAWING NO.:
5256-02

Appendix H

Legal Notice Publication

NOTICE OF SUBMISSION OF
FINAL REMEDIATION PLAN

Date of Notice: December 16, 2020 and December 23, 2020

Notice is hereby given by Daniel B. Stephens & Associates, Inc. on behalf of the Petroleum Storage Tank Bureau of the New Mexico Environment Department (NMED) of the submission of a Final Remediation Plan on December 18, 2020, as follows:

1. The Final Remediation Plan proposes actions to remediate a release of petroleum or petroleum products into the environment.

2. The release occurred at the former Bell Gas #1186 (TR's Market) facility located at 101 Sun Valley Road, Alto, New Mexico. The property is currently occupied by a Chisum convenience store and gas station facility. Impacts associated with the release extend off-site to the northeast and southwest of the release location. The remediation equipment will be located adjacent to the current facility at the above address.

3. The Final Remediation Plan proposes to remove gasoline contamination through the use of multi-phase vapor and groundwater extraction technology. The vapors will be treated using thermal and/or catalytic oxidation technology and discharged to the atmosphere. Extracted groundwater will be treated on site and discharged to an infiltration gallery located immediately to the south of the gas station facility.

4. Copies of the Final Remediation Plan can be viewed by interested parties at the NMED PSTB offices at 1) 2905 Rodeo Park Drive East, Building 1, Santa Fe, New Mexico, 87505; and 2) 1914 W. Second Street, Roswell, New Mexico, 88201. Due to policies in place in response to the COVID-19 pandemic, arrangements must be made 48 hours in advance for an in-person viewing of the Plan. Please contact the NMED PSTB project manager, Ms. Renee Romero, by telephone at (575) 291-2109 or email at d.renee.romero@state.nm.us to arrange a viewing.

   In addition, the Final Remediation Plan and all applicable data may be viewed at the following website: http://dbsa-client-access.com/PSTB/file_access.htm. Services may be arranged for translation of documents, for interpreters, and for obtaining services for persons with disabilities by contacting the PSTB Project Manager. TDD or TTY users, please access phone numbers using the New Mexico Relay Network, 1-800-659-1779 (voice) and 1-800-659-8331 (TTY users).

5. Comments on the plan may be sent to the PSTB Project Manager: by mail at New Mexico Environment Department Petroleum Storage Tank Bureau, Attn: Renee Romero, 1914 W. Second Street, Roswell, New Mexico, 88201; by telephone at (575) 291-2109; or e-mailed to: d.renee.romero@state.nm.us. Comments sent to the project manager must also be mailed to the Secretary of the Environment Department at New Mexico Environment Department, Attn: Secretary Kenney, PO Box 5469, Santa Fe, NM 87502-5469. Comments must be delivered by January 14, 2021. Please include the name of the site "Bell Gas #1186 Site, 101 Sun Valley Road, Alto, New Mexico" to ensure comments are correctly assigned to the site.

AVISO DE PRESENTACIÓN DEL PLAN DE REMEDIACIÓN FINAL

Fecha de aviso: 16 de diciembre de 2020 y 23 de diciembre de 2020

Por el presente documento, Daniel B. Stephens & Associates, Inc. en nombre de la Oficina de Tanques de Almacenamiento de Petróleo (PSTB, por sus siglas en inglés) del Departamento de Medio Ambiente de Nuevo México (NMED, por sus siglas en inglés) da aviso de la presentación de un Plan de Remediación Final el 18 de diciembre de 2020, como sigue:

1. El Plan de Remediación Final propone medidas para remediar una liberación de petróleo o de productos derivados del petróleo al medio ambiente.

2. La liberación ocurrió en la antigua instalación de Bell Gas #1186 (TR's Market) ubicada en 101 Sun Valley Road, Alto, Nuevo México. La propiedad está actualmente ocupada por una tienda de Chisum y una gasolinera. Los impactos asociados con la liberación se extienden fuera del sitio al noreste y suroeste del lugar de liberación. El equipo de remediación estará localizado adyacente a la instalación actual en la dirección arriba mencionada.

3. El Plan de Remediación Final propone eliminar la contaminación por gasolina mediante el uso de tecnología multifásica de extracción de vapor y aguas subterráneas. Los vapores se tratarán utilizando tecnología de oxidación térmica y/o catalítica y se descargarán a la atmósfera. Las aguas subterráneas extraídas se tratarán in situ y se descargarán en una galería de infiltración situada inmediatamente al sur de la instalación de la gasolinera.

4. Las partes interesadas pueden ver una copia del Plan de Remediación Final en la oficina de PSTB del NMED en: 1) 2905 Rodeo Park Drive East, Building 1, Santa Fe, NM, 87505; y 2) 1914 W. Second Street, Roswell, NM, 88201. Debido a las políticas en vigor en respuesta a la pandemia de COVID-19, se deben hacer acomodaciones con 48 horas de antelación para poder ver el Plan en persona. Comuníquese con la gerente del proyecto de PSTB del NMED, la Sra. Renee Romero, por teléfono llamando al (575) 291-2109 o por correo electrónico a d.renee.romero@state.nm.us para concertar una visita en persona.

   Además, el Plan de Remediación Final y todos los datos aplicables se pueden ver en el siguiente sitio web: http://dbsa-client-access.com/PSTB/file_access.htm. Se pueden organizar servicios para obtener traducción de documentos, intérpretes y ayuda para personas con discapacidades comunicándose con la gerente del proyecto de PSTB. Los usuarios de TDD o TTY, pueden acceder a los números de teléfono usando la Red de Retransmisión de Nuevo México, 1-800-659-1779 (voz) y 1-800-659-8331 (usuarios de TTY).

5. Los comentarios sobre el plan pueden enviarse a la gerente del proyecto de PSTB: por correo postal a la Oficina de Tanques de Almacenamiento de Petróleo del Departamento de Medio Ambiente de Nuevo México, a la atención de Renee Romero, 1914 W. Second Street, Roswell, NM, 88201; por teléfono al (575) 291-2109; o por correo electrónico a d.renee.romero@state.nm.us. Los comentarios que se envíen a la gerente del proyecto también deben enviarse por correo postal al secretario del Departamento de Medio Ambiente al Departamento de Medio Ambiente de NM, a la atención del secretario Kenney, P.O. Box 5469, Santa Fe, NM 87502-5469. Los comentarios deben ser entregados a más tardar hasta el 14 de enero de 2021. Incluya el nombre del sitio “Bell Gas #1186 Site, 101 Sun Valley Road, Alto, NM” para asegurar que los comentarios sean asignados correctamente al Sitio.

1. View of public notice posted at the site

2. View of second public notice posted at the site

Parcel Ownership For Public Notice

Public Notice Parcel Map #	Owner Name	Owner Mailing Address from Assesor
1	CHAPPARAL INVESTMENTS, INC A TX CORP	4630 50TH ST #408 LUBBOCK TX 79414
2	PINNACLE REAL ESTATE & DEVELOP,INC A NEW MEXICO CORPORATION	931 STATE HWY 48 ALTO NM 88312
3	ROXY LAND & MINERALS, LLC	PO BOX 10158 MIDLAND TX 79702
4	MCBURNEY, JOHN O	249 FOURTH ST RUIDOSO NM 88345
5	DUKE, CARLA JO	249 FOURTH ST RUIDOSO NM 88345
6	GREAT WESTERN REALTY, INC	PO BOX 100 ALTO NM 88312
7	GREAT WESTERN REALTY, INC	PO BOX 100 ALTO NM 88312
8	GREAT WESTERN REALTY, INC	PO BOX 100 ALTO NM 88312
9	YOUNGER INVESTMENTS, LLC	105 BULL ELK CT ALTO NM 88312
10	ALTO LAKES GOLF & COUNTRY CLUB,INC	PO BOX 168 ALTO NM 88312
11	Not listed with Assessor's office	N/A
12	OTERO COUNTY ELECTRIC COOPERATIVE, INC.	PO BOX 227 CLOUDCROFT NM 88317
13	HILST/DERMIT, LLP AN OKLAHOMA LLP	4527 EAST 91ST ST TULSA OK 74137

S:\Projects\ES14.0220_Bell_Gas_1186\GIS\MXDs\Site_maps\Assessor Parcels 2020-09.mxd

Explanation

Parcels for Public Notice

BELL GAS #1186
ALTO, NEW MEXICO
Parcel Map

Figure #

Daniel B. Stephens & Associates, Inc.
12/03/2020
JN ES14.0220

Appendix I

Schedule for Implementation of Final Remediation Plan

Bell Gas #1186 FRP Implementation

Task	Calendar Days	Start Date	End Date
Final FRP Submittal			12/18/2020
Address PSTB and Public Comments	45	12/18/2020	2/1/2021
FRP Approval	7	2/1/2021	2/8/2021
Work Plan for FRP Implementation	30	2/8/2021	3/10/2021
Work Plan Approval	60	3/10/2021	5/9/2021
Equipment Procurement	84	5/9/2021	8/1/2021
Trenching/Piping	70	5/23/2021	8/1/2021
Equipment Installation	14	8/1/2021	8/15/2021
Startup	5	8/15/2021	8/20/2021
First Year System Operations	365	8/20/2021	8/20/2022