September 21, 2020

Mr. Tim Noger
New Mexico Environment Department
Petroleum Storage Tank Bureau
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505

Re: Final Remediation Plan
Lovington 66 State Lead UST Site, Lovington, New Mexico
Facility #1489, Release ID #1182, WPID #4123

Dear Mr. Noger:

Daniel B. Stephens & Associates, Inc. (DBS&A) is pleased to submit the enclosed Final Remediation Plan (FRP) for the above-referenced site. The plan has been prepared in accordance with your direction and applicable sections of the Petroleum Storage Tank Regulations and DBS&A standard operating procedures. The FRP was originally submitted on August 28, 2020. PSTB comments on the FRP were received through email on September 14, 2020.

With this submittal, DBS&A has provided a summary of comments and responses, in addition to a revised FRP document containing minor revisions to the applicable sections, as indicated in the summary document. Pending acceptance of the revised FRP, DBS&A intends to invoice the full amount budgeted for Deliverable ID 4123-4.

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

Jason J. Raucci, P.G.
Project Geologist

TG/ed
Enclosure
cc: Katherine MacNeil, NMED PSTB
Renee Romero, NMED PSTB

Responses to Petroleum Storage Tank Bureau Comments
Received September 14, 2020
Regarding Lovington 66 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 September 14, 2020, regarding the Final Remediation Plan (FRP) for the Lovington 66 site. DBS&A submitted the original FRP on August 28, 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

1. *Soil vapor extraction as the remedial approach does not directly address dissolved phase gw contamination at this site. In Section 3.2: "Remediation Goals and Performance Standards" it is mentioned that the dissolved phase gw contamination will be allowed to naturally attenuate, with the suggestion of additional remediation tools in the future to reduce the dissolved phase gw contamination levels to below NMWQCC standards. Utilizing SVE for source mass removal, clean-up of only two of the three contaminant phases (soil vapor, free product) will be accomplished with this approach. In the FRP in this same section 3.2, the nearby site, LCEC is mentioned. It reads that: "….concentrations decreased quickly following removal of source area contaminant mass", but at LCEC dissolved phase concentrations remain well above standards many years after remediation implementation. As per section 20.5.119.1923 D1 of PSTB regulations (attached), please provide a timeframe for when dissolved phase concentrations will be at or below NMWQCC standards notified.*

Paragraph D (1) from the regulations, cited in NMED comment, states in its entirety:

> *D. All final remediation plans shall, at a minimum, include all of the following:*
> *(1) goals of remediation and target concentrations to be achieved in each medium;*

The regulations do not specify that a timeframe for remediation be provided in the FRP; however, DBS&A typically provides this type of information when it can feasibly be estimated as it relates to the proposed remedial goals and target concentrations. Section 3.2 from the FRP text states that the primary remedial objective is removal of hydrocarbon source mass (i.e., soil vapor and free product). The performance standard is given as follows:

> "Within 2 years of system operation, document that measurable LNAPL is no longer present within the monitor well network and extracted soil vapor concentrations contain less than 100 parts per million by volume (ppmv) of volatile organic compounds (VOCs) as measured by a photoionization detector (PID)."

Absent an immediate threat to human health or the environment, source area mitigation prior to implementation of a groundwater remedy is an appropriate remedial strategy. The FRP explicitly provides for monitoring and assessment of groundwater conditions during and after the source area mitigation, and for implementation of contingency remedial actions should a change in site conditions produce an immediate threat to human health or the environment.

At other sites where SVE applications have been employed (e.g., Lea County Electric Co-op [LCEC], Santa Fe County Judicial Complex [SFCJC], Sandia Fina, and Moberg's Garage), actionable dissolved-phase hydrocarbon concentrations have been observed in groundwater following source removal, but the extent and magnitude of these concentrations have typically been reduced significantly from the pre-remediation condition. DBS&A cited LCEC as an example, because VOC concentrations in on-site wells decreased by several orders of magnitude (e.g., MW-3, MW-5, MW-6, and MW-9), after appropriately-sized remediation equipment was implemented in March 2011. Concentrations of contaminants of concern (COCs) in LCEC wells continue to naturally attenuate, and several wells are now below laboratory reporting limits or NMWQCC standards. Even off-site well MW-10 has seen an order of magnitude decrease in the methyl tertiary-butyl ether (MTBE) concentration since March 2011, and other COCs are below NMWQCC standards. DBS&A expects better performance at the Lovington 66 site due to favorable geology and high air flow rates through the horizontal wells (roughly three times the airflow as the LCEC site).

DBS&A expects that implementation of the SVE remedy and completion of source mass removal will last through the remainder of the current State Lead remediation contract. The dissolved-phase hydrocarbon plume in groundwater does not pose an immediate threat to the City of Lovington municipal water supply or other potential receptors, and DBS&A did not recommend that an active groundwater remedy be implemented for this reason. PSTB concurred with this approach with acceptance of the proposed remedial strategy. During the next State Lead contract, PSTB may wish to re-assess whether site conditions (or priorities) have changed and an active groundwater remedy should be implemented, or if a monitored natural attenuation (MNA) plan should be implemented in accordance with PSTB regulations (NMAC 20.5.119.1915 through 1921). Either course of action will be more appropriate after source mass has been removed. If MNA is selected, PSTB could require “the time necessary for achieving target concentrations” in accordance with paragraph C.8 of NMAC 20.5.119.1915, which can be more reliably estimated following source mass removal, based on reductions in both COC concentrations in groundwater and the residual hydrocarbon mass.

Section 3.2 has been revised to specify attainment of NMWQCC standards as the remedial objective for the groundwater medium.

2. *Calculation 1:*

a. *Pg. 6 of 6: Please clarify and indicate in narrative of calculation if this clean-up time estimate is for the entire plume (Lovington 66 site, Allsup’s 109 site, and NMDOT ROW). Table with interative reduction in mass of LNAPL suggest it is for the entire plume.*

The calculation objective (Section 1.0) has been revised to specifically mention it applies to the comingled LNAPL plume.

b. *Pg. 4 of 6: 90% of 22146.67 gallons of NAPL across entire plume (Lovington 66 site, Allsup’s 109 site, and NMDOT ROW) would be 19,932 gallons. Calculation narrative states 19,800 gallons.*

The total volume of LNAPL was rounded to 22,000 gallons for cleanup time estimation because of the number of assumptions that were used to derive the number, including an assumed formation thickness over half the LNAPL plume. Calculation of volume to two decimal places is not warranted; two significant figures were used instead. In addition, an extremely conservative value of 90 percent was used for the amount of recoverable LNAPL, which produces a conservative (longer) estimate for the time to remove the LNAPL plume (than if a more reasonable value of 60 percent was used).

c. *Pg. 6 of 6: Figure, "Contaminant Removal over Time" – Please provide rationale as to why 2-log removal (LNAPL mass 100 times less than 90% of initial LNAPL mass) is used in the estimation of clean up time rather than 3-log removal, for instance. Contaminant mass remaining is reduced from 123,874lbs to 401 lbs at 1.1 yrs after the commencement of SVE system operations.*

Based on DBS&A experience, 2-log removal is reasonable and cost-effective. Remediation is always a balancing act between time and level of effort. For example, achieving 3-log removal would result in removal of approximately 1,100 additional pounds of contaminant mass (~180 gallons), but it would require about 120 more days. As stated in the calculation, we want to reiterate that these numbers are all theoretical, and actual SVE removal could be more or less based on site specific considerations and equipment performance. However, note how this calculation was used in the context of the revised FRP text: we anticipate removing recoverable LNAPL within one year, but we will reduce soil vapor concentrations below an action level of 100 ppmv within 2 years.

d. *Pg. 6 of 6: 2nd last paragraph re: Estimate of total Clean-up time. It is mentioned that an initial recoverable mass is 19,800 lbs. Did you use the volume of 19,800 gallons using 90% of Total LNAPL Volume (90/100*22,146.67 gallons = 19,932 gallons) when it should have been 90% of Total LNAPL mass? If so, please revise the estimation of clean up time calculation. The paragraph states a goal of a LNAPL mass reduction of 99% (e.g. leaving 1.0% of initial LNAPL mass remaining). Therefore, using 123,874 lbs as the initial LNAPL mass; 1.0/100*123,874 lbs=1238.7 lbs or should it be 1% of initial recoverable LNAPL mass (e.g. 1/100* 90/100 * 123,874 lbs = 1114.9 lbs). In the calculation, narrative shows 1/100*19800 lbs = 198 lbs.*

The calculation has been revised to discuss reducing total recoverable mass of 123,874 pounds to 1,239 pounds, which will theoretically require approximately 295 days (0.8 year).

3. *Calculation 2:*

Review of the SVE head loss calculation yielded minor changes to fluid property values. However, changes did not significantly affect overall design of the system (calculated operating vacuum decreased from 93.6 to 93.5 inches water column, but the design vacuum of 100 inches is unchanged).

a. *Equation 1: denominator should be dynamic viscosity not kinematic viscosity. Please revise notes under equation.*

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

b. *Don't you have to convert the air density of 0.00217 slugs/cu ft to lb_f/cu ft, equating to 0.07 $_{lbf}$/cu ft to have units cancel (unitless)? Converting slugs/cu ft to lb_f/cu ft, would result in a $Re_{conveyance}$ = 3121236.44; similarly for Re $_{Manifold}$ = 4135513.46. If so, revise calculation and subsequently any equation that contain $Re_{Conveyance}$ and $Re_{Manifold}$.*

The source used for dynamic viscosity lists values in slugs/ft-sec. The calculation text on Page 3 has been revised to reflect the correct units; therefore, unit conversions are not needed.

c. *Please include formulas to correct/adjust the dynamic viscosity of air at standard atmospheric pressure, and at 60F for site conditions (elevation of 3910' ; atmospheric pressure of 12.735 psi, 60F). The calculation narrative provides the value ($3.92*10^{-7}$ lb_f*sec/ft^2) but not the formula to arrive at it.*

Dynamic viscosity is linearly-interpolated from a table in a published source, cited.

d. *Please include formula to adjust the density of air at standard atmospheric pressure, and at 60F to site elevation conditions (elevation of 3910'; atmospheric pressure of 12. 735 psi, 60F). Calculation narrative provides the air density at 3910' ($2.17*10^{-3}$ slugs/ft^3) but not the formula to arrive at it. Use of the engineering tool box (https://www.engineeringtoolbox.com/air-altitude[density-volume-d_195.html) yielded an air density at site elevation of 3910', 60F of $2.011*10^{-3}$ slugs/ft^3.*

Air density is linearly-interpolated from a table in a published source, cited. The air density value provided by PSTB would lower the design head loss by approximately 0.5 inch water column, so the DBS&A value is more conservative.

e. *Circuit lengths for SVEs 1 and 2 are stated to be 65' and 70', respectively for the conveyance piping from the entry point to the manifold at the equipment compound. Isn't the blank casing of the horizontal wells included in the pipe length when calculating the major pressure losses due to pipe friction? Revise calculation if appropriate.*

Based on pilot testing and experience at the LCEC site on the north side of Lovington, DBS&A has conservatively assumed that applied well vacuum will be 85 inches water column. This number already includes any losses in the well casing. The applied well vacuum is what you would measure at the wellhead vault at the surface. The SVE head loss calculation intentionally only includes pressure loss in the conveyance piping and SVE manifold.

Final Remediation Plan

Lovington 66 State Lead UST Site

424 South Main

Lovington, New Mexico

Prepared for **New Mexico Environment Department**

Petroleum Storage Tank Bureau

August 28, 2020

Daniel B. Stephens & Associates, Inc.

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

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1. Introduction

Daniel B. Stephens & Associates, Inc. (DBS&A) has prepared this final remediation plan (FRP) at the Lovington 66 Site (the site) in Lovington, New Mexico. The FRP was prepared in accordance with applicable sections of Part 119 of the New Mexico Petroleum Storage Tank Regulations (PSTR) and work plan identification (WPID) #4123 (DBS&A, 2020), which was approved by the New Mexico Environment Department (NMED) Petroleum Storage Tank Bureau (PSTB) on January 29, 2020 (NMED, 2020).

1.1 Site Summary

The site is located at 424 South Main, Lovington, New Mexico, and (Figure 1). The property is currently occupied by a McDonald’s franchise. A fuel release was discovered during an environmental site assessment and associated tank pull activities conducted at the site in 1991. Subsequent investigations in 1992 and 1993 revealed hydrocarbon impacts to soil and groundwater, specifically soil contamination to a depth of 40 feet below ground surface (bgs), a large light nonaqueous-phase (LNAPL) plume extending to the southeast under the intersection of Main Street and Avenue D, and a dissolved-phase plume migrating off-site to the southeast. Site investigation data suggests that contamination from the site is comingled with an LNAPL and dissolved-phase plume originating from the Allsup’s #109 (Allsup’s) site, located at the southeast corner of Avenue D and Main Street (Figure 2).

Investigation and monitoring activities were conducted between 2006 and 2015, including installation of additional monitor wells southeast of the Allsup’s site. The extent of the dissolved-phase 1, 2-dichloroethane (EDC) plume remains undefined to the southeast. No documented corrective action has been implemented at the site, except limited soil excavation during tank removal and LNAPL recovery by hand bailing. The site was designated a State Lead site on November 1, 2018.

1.2 Site History

In 1991, AEI Tank, Inc. (AEI) was contracted to perform a minimum site assessment (MSA) on the existing underground storage tank (UST) system at the Phillips 66 gasoline station as part of a proposed property transaction between Jack Walstad Oil Company, Inc. (Walstad) and Queen Oil and Gas Company. At that time, AEI discovered contamination in soil samples collected near the five USTs and associated conveyance and dispensers. Walstad then contracted AEI to remove the USTs and ancillary piping and to over-excavate the contaminated piping trenches and tank pits. AEI provided the results of shallow soil sampling to NMED in December 1991 (AEI, 1991). Per NMED’s request, AEI coordinated the installation of three monitor wells at the site in February and March 1992 (designated W-1 through W-3). NMED received this revised report April 3, 1992 (AEI did not change the date of the report).

During the MSA investigations conducted by AEI, hydrocarbon impacts to soil and groundwater contamination above New Mexico Water Quality Control Commission (NMWQCC) standards were discovered on-site and extending off-site downgradient to the southeast. Soil impacts were noted in association with the tank pit on the north side of the station building, the diesel dispenser on the west side of the station building, and the gasoline conveyance and dispensers to the southeast of the station building; these locations are presumed to be primary release sites (Figure 3). AEI reported removing approximately 90 percent of the impacted shallow soil from the vicinity of the identified release sites (AEI, 1991).

Soil and groundwater investigations completed by Billings & Associates, Inc. (BAI) in 1992 and 1993 identified soil contamination to a depth of at least 40 feet bgs, a large LNAPL plume, and a dissolved-phase plume migrating off-site to the southeast under the intersection of Main Street and Avenue D. BAI coordinated installation of monitor wells W-4 through W-18 during these initial characterization efforts (Figure 2).

Previous consultants coordinated investigation and monitoring activities from 2006 to 2018, including the installation of three additional monitor wells (W-19 through W-21) 400 to 600 feet southeast of the Allsup’s site. In 2015, a vertical multi-phase extraction well (MPE-1) was installed on-site and subsequently included in dual-phase extraction (DPE) pilot testing. In addition, DPE quick tests and LNAPL bail-down and recovery testing were completed on wells W-1, W-2, and W-3.

The site was included in a Responsible Party (RP)-Lead solicitation for remediation services, dated March 19, 2018. Although DBS&A was deemed the winner of that solicitation, the request for proposals (RFP) was revoked when the designated representative for the RP (Walstad) stated he no longer wished to participate in the cleanup process. The site was designated a State Lead site on November 1, 2018, and on April 22, 2019, the NMED PSTB issued a new RFP for State-Lead remediation services for the site. DBS&A responded to the RFP with a proposal submitted to the PSTB on May 28, 2019. DBS&A provided supplementary information to the proposal in a short list presentation to the PSTB on July 11, 2019. The DBS&A proposal was deemed to be the most responsive, and in a letter dated October 23, 2019, the PSTB requested preparation of an FRP to address the confirmed petroleum hydrocarbon release at the site.

The McDonald's restaurant on-site was torn down and rebuilt in October 2018, which resulted in destruction of all the on-site surface completions. The construction contractor hired Atkins Engineering, Inc. (AEA) of Roswell, New Mexico, to replace the surface completions. At that time, well W-4 (previously paved over) was recovered and repaired. In July 2020, AEA also recovered W-7, which had been paved over in the street adjacent to the curb. To date, 25 groundwater monitoring wells (W-1 through W-21, MPE-1, and MW-1 through MW-3) have been installed both on-site and in the vicinity of the site and the Allsup's site (Figure 2). Based on field reconnaissance conducted by PSTB and DBS&A in March 2019 and November 2019, respectively, and recent repair work, 21 of these wells remain in service. Wells MW-2, W-6, and W-10 appear to have been paved over, and well W-2 was found by NMED to be obstructed above the water table. Efforts will be made to clear the obstruction in well W-2 in a future groundwater monitoring event.

A baseline groundwater monitoring event was included in the current work plan (DBS&A, 2020); however, that work has been postponed due to ongoing access negotiations between the City of Lovington and NMED. This work will be completed prior to implementation of corrective action, but it is extremely unlikely (due to the extensive history of prior site investigation) to produce findings that alter the remedial approach or design presented in this FRP.

1.3 Site Hydrogeology

The site is located in the Llano Estacado section of the Great Plains physiographic province, at an elevation of approximately 3,910 feet above mean sea level (msl). The geology underlying the City of Lovington is comprised of layered sedimentary deposits of the Pliocene-age Ogallala Formation. The Ogallala Formation consists of fine-to-coarse-grained sand, silt, and clay; a weathering-resistant, carbonate-cemented “caprock” unit is present near the top of the formation. At the site, the caprock unit has been observed in borehole logs with a thickness of approximately 40 feet and is underlain by a thick sequence of fine-grained sands. Regionally, the Ogallala Formation is bounded below by the fine-grained red beds of the Triassic-age Dockum Group; this unit has not been encountered in borings at the site (Cronin, 1969).

Based on the groundwater monitoring event completed in February and March 2018, groundwater is present at a depth of approximately 60 feet bgs (Golder, 2018). This water level represents the regional groundwater level of the Ogallala aquifer, from which the City of Lovington obtains its water supply. Based on regional geologic data, the saturated thickness of the Ogallala Aquifer in the site vicinity is approximately 150 feet (Cronin, 1969; Tillery, 2008). The City of Lovington 40-Year Water Development Plan published in 2014 (JSAI) states that “groundwater is being pumped out at a faster rate than it is being recharged.” This has been observed at the site with typical decreases in groundwater elevation of 5 to 6 feet in all site wells since 2008. Groundwater flow beneath the site has consistently been to the southeast at an average gradient of approximately 0.004 foot per foot (ft/ft) (Figure 4).

Based on on-site slug testing performed in 1992, aquifer hydraulic conductivity (K) was estimated at 1 foot per day (BAI 1992). Assuming effective porosity of 15 percent and an average gradient of 0.004 ft/ft, lateral contaminant migration rates would be on the order of 10 feet per year (ft/yr). Based on NMED risk assessment guidance and reasonable assumptions of aquifer properties, a retardation coefficient of approximately 2.0 can be applied, yielding an overall migration rate of 5 ft/ yr. Considering the length and geometry of the plume, and published K values for the Ogallala Aquifer, this estimate appears unreasonably slow, and data gathered during remediation pilot testing in 2015 suggested considerably greater K values. Lacking a properly executed aquifer pumping test, DBS&A believes a more reasonable estimate of aquifer hydraulic conductivity to be on the order of 4 to 6 feet per day, yielding a retarded linear migration rate of approximately 20 to 30 ft/yr.

1.4 Distribution of Contaminants

1.4.1 Contaminants of Concern

The primary contaminants of concern (COCs) are gasoline fuel constituents, including benzene, toluene, ethylbenzene, and total xylenes (BTEX), EDC, 1,2-dibromoethane (EDB), and naphthalenes. Multiple investigations conducted since 1991 indicate that soil and groundwater contamination are present at the site. Groundwater in Lovington is used for potable domestic, public/municipal, and agricultural purposes. In the January 2008 *Secondary Investigation Report* (Golder Associates Inc. [Golder]), one municipal supply well was identified approximately 0.5 mile downgradient of the site; however, there are currently no active municipal supply wells located within the Lovington city limits. Based on the City of Lovington Comprehensive Plan, Lovington has a total of 20 active municipal supply wells, all of which are located in an industrial park wellfield 4 miles southeast of the site (Figure 1). No domestic wells were identified within 1,000 feet of the site.

1.4.2 Distribution of Contaminants in Soil

The lateral and vertical distribution of contaminants in the vadose zone has not been well defined due to the lack of discrete samples collected during air rotary drilling activities. Despite the limitations of the available soil characterization data, infiltration of hydrocarbons through sandy vadose zone materials is typically vertical, and the area of shallow vadose-zone contamination is expected to be limited to the immediate vicinity of the releases. The residual mass of hydrocarbon contamination in the shallow vadose zone is presumed to be minimal as the vast majority of the hydrocarbon-impacted soil above 15 feet bgs was removed by over-excavation during the tank pull (AEI, 1991), and there is limited available pore space in the underlying caprock. Soil samples collected during installation of monitor wells W-1, W-2, and W-3, during the MSA, show vadose zone contamination to be widespread in the smear zone above the current water table.

1.4.3 LNAPL Impacts

The current LNAPL plume encompasses more than 0.5 acre (Figure 5). Approximately 70 percent of the plume extends off-site, and more than half is located under state and federal highways (U.S. Highway 82 [US 82], New Mexico Highway 18 [NM 18], and New Mexico Highway 83 [NM 83]). LNAPL has been observed in on-site monitor wells W-1, W-2, W-3, and MPE-1, as well as off-site monitor well W-14 and Allsup's site well MW-3. Apparent LNAPL thickness has consistently exceeded 6 feet in on-site monitor wells since 2014. LNAPL was first documented in Allsup's well MW-3 in June 2016 (Golder, 2016); however, the first occurrence was likely in the monitoring data gap between 2009 and 2016. Groundwater elevation decreases during this time period likely mobilized LNAPL in the capillary fringe.

CMB Environmental (CMB) of Roswell, New Mexico, the previous consultant for the site, conducted LNAPL bail down and recovery testing in June 2015. Testing results showed that, despite the large apparent thickness, actual formation thickness of the LNAPL was less than 0.5 foot in all tested wells (Golder, 2015a). Average estimates of LNAPL transmissivity based on the bail down and recovery data varied from 0.24 to 0.66 square foot per day (ft^2/day) (Golder, 2015a), which is near the practical limit of 0.5 ft^2/day for active recovery systems, such as DPE.

DBS&A performed its own calculations to estimate the volume of LNAPL present in the subsurface based on a variety of U.S. Environmental Protection Agency (EPA) methods for estimating LNAPL formation thickness from measured thicknesses in wells. These thicknesses were higher than those estimated during bail down testing, and variations in off-site LNAPL thickness are difficult to quantify as the majority of the LNAPL plume is located within the highway right-of-way (ROW). However, combining a 9-inch (0.75-foot) thickness in those areas with on-site data, total volume of LNAPL would be approximately 22,000 gallons (Appendix A).

LNAPL samples from three on-site monitor wells (MPE-1, W-1, and W-3) were collected on June 15, 2020, and analyzed for total petroleum hydrocarbons (TPH) using EPA method 8015D. Results are summarized in Table 1, and the full laboratory report is provided in Appendix B. Approximately 20 percent of each sample fell within the diesel range; however, DBS&A contacted the laboratory to discuss these findings. The laboratory manager stated that this data was at the tail end of the gasoline peaks on the chromatograph, and that the samples looked like relatively fresh gasoline.

1.4.4 Distribution of Contaminants in Water

BTEX constituents, methyl tertiary-butyl ether (MTBE), naphthalenes, EDC, and EDB have been detected in groundwater at concentrations exceeding applicable water quality standards. Figure 5 shows the approximate extent of the dissolved-phase benzene plume based on the current monitoring well network last sampled in March 2018. Benzene is the constituent found at the highest concentrations. The plume extends for at least 600 feet downgradient to the south of the site. The dissolved-phase plume has been previously defined upgradient by monitor well W-7, cross-gradient by monitor wells W-13 and W-18 to the northeast and by monitor wells W-12, W-15, and W-16 to the southwest, and has been partially defined downgradient by monitor wells W-20 and W-21. DBS&A discussed the feasibility of installing additional downgradient monitor wells with the primary property owner, Haarmeyer Electric, but were denied access. No public ROW exists for a reasonable distance downgradient from the existing monitor well network.

Results from the most recent groundwater monitoring event in March 2018 showed EDC to be present above the NMWQCC standard across the greatest areal extent, including downgradient monitor well W-19 at 71 micrograms per liter (µg/L) (Golder, 2018; Figure 6). EDC concentrations in this well increased between monitoring events in 2009 and 2014, and show a stable trend since October 2014. EDC concentrations in wells W-8, W-9, and W-11 are decreasing over the same time period (Figure 7). The downgradient extent of actionable EDC remains undefined.

2. Contractor Qualifications

DBS&A is a licensed contractor in the state of New Mexico and holds a GS-29 license (License #89947).

DBS&A will use Ellingson-DTD of West Concord, Minnesota (DTD), for horizontal drilling and well installation. DTD has an established history of drilling horizontal remediation wells through caliche to underlying softer materials, including recent projects in Odessa and Knox City, Texas, and in Las Vegas, Nevada. Well screen lengths at the sites in Texas were 250 to 350 feet, which are similar to proposed lengths for this site. DTD also recently installed a 450-foot-long horizontal well in Las Vegas, New Mexico, while dealing with difficult drilling conditions through a competent shale formation, and has installed horizontal remediation wells for PSTB sites in New Mexico since 2009.

EnviroWorks of Edgewood, New Mexico, has been selected to serve as the general contractor at the site and will coordinate installation of the remediation system. The equipment manufacturer will be Intellishare Environmental (Intellishare) of Menomonie, Wisconsin. 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. AEI reportedly removed approximately 90 percent of the impacted shallow soil associated with the release locations (AEI, 1991), and the site is now 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 the smear zone above the water table, at a depth of 50 to 60 feet bgs. Based on current EPA guidance, petroleum hydrocarbons in soil at this depth are not considered a risk through the vapor intrusion pathway. However, concentrations of the halogenated organic compound EDC in groundwater exceeds the March 2017 New Mexico vapor intrusion screening level (VISL) for industrial land use of 109 µg/L. Halogenated organic compounds are comparatively stable in the vadose zone and may diffuse upward in the vapor phase from the water table to shallow soil. Based on the distribution of EDC in groundwater as shown on Figure 6, some occupied commercial structures may potentially overlay groundwater containing concentrations of EDC above the VISL.

Potential groundwater impacts to municipal production wells constitute an exposure pathway. Hydrocarbon concentrations above NMWQCC standards have been noted across a broad area, extending at least 600 feet downgradient of the site. However, the nearest active downgradient municipal production well is located more than 4 miles southeast of the site. Based on the distance to the municipal wellfield, the risk to water production wells is minimal under current conditions.

3.2 Remediation Goals and Performance Standards

The primary remedial objective is removing source area hydrocarbon mass to mitigate the potential for contaminant migration to regional groundwater. 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, such as the nearby Lea County Electric Co-op (LCEC) site, 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 NMWQCC standards. If site conditions or priorities change, PSTB could implement active groundwater treatment to accelerate reduction of dissolved-phase contaminants.

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

- Within 2 years of system operation, document that measurable LNAPL is no longer present within the monitor well network and extracted soil vapor concentrations contain less than 100 parts per million by volume (ppmv) of volatile organic compounds (VOCs) as measured by a photoionization detector (PID).

- Maintain minimum run-time of 90 percent for major remediation equipment. This 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 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.

DBS&A calculated the estimated time to cleanup following the method outlined by Kroopnick (1998), which indicates that recoverable LNAPL can be removed within one year (Appendix A).

4. Description of Proposed Remediation System

4.1 Overview

DBS&A will implement a site-specific soil vapor extraction (SVE) cleanup strategy that uses two horizontal wells to remove LNAPL and vadose zone soil contaminants from beneath the site and the Allsup's site, as well as beneath the highway ROW present within the NM 83 and US 82 intersection between the two sites (Figure 8).

Approximately 275 feet of well screen will be installed in each of the two wells at a depth of approximately 50 feet bgs to address the LNAPL plume. The wells will extend under the intersection of Main Street and Avenue D, from the site to the Allsup's site. The well screen in the horizontal wells will be located approximately 10 feet above the current water table to avoid upwelling that could otherwise decrease performance.

The horizontal wells will be completed at the surface at both ends of each well. This provides the ability to perform assessment of applied vacuum at both ends of the wells to ensure flow is being evenly distributed across the well screen. This also allows remediation equipment to be installed at either or both ends of the wells, to accelerate cleanup or address areas of well screen that are not operating at design conditions.

Remediation equipment will be located on vacant property off-site near the southern end of the horizontal wells as shown on Figure 8. Assuming SVE well flow of 1 standard cubic foot per minute (scfm) per foot of well screen, major remediation equipment would include a 550 scfm SVE blower, vapor/liquid-phase separator, condensate storage tank, and a natural gas-fired thermal oxidizer, as described in Section 4.2. The SVE blower will be equipped with a variable frequency drive (VFD) for operational flexibility based on projected flow rates, and to minimize stops and starts. In addition, instrumentation and controls will be included to alert DBS&A through email and/or text message when alarm conditions are triggered. The SVE blower, vapor-liquid separator, and associated equipment will be provided within a modified shipping container to reduce noise and mitigate theft and vandalism. The shipping container, thermal oxidizer, and intake manifold will be enclosed within an 8-foot-tall, gated chain-link fence forming a secure compound.

The remediation system is designed to achieve the goals outlined in Section 3 through the following primary processes:

- Recovery of contaminant mass from the release area and vicinity using SVE
- Reduction of hydrocarbon groundwater impacts by diffusing mass from a liquid to a vapor phase that can be removed through the SVE system

The proposed remediation system is detailed in the engineering drawings (Appendix C), supporting calculations (Appendix A), product cut sheets (Appendix D), and technical specifications (Appendix E).

4.2 Aboveground Treatment Equipment

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

- Inlet piping manifold: SVE wells will be piped to a common piping manifold using individual schedule (SCH) 40 polyvinyl chloride (PVC) conveyance lines. The conveyance piping will connect to the influent manifold, consisting of a 6-inch SCH 40 PVC header, with 4-inch SCH 40 PVC risers 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.
- Equipment enclosure: The SVE blower, vapor-liquid separator, and associated equipment and controls will be located within a modified shipping container. This enclosure will be used to reduce noise and mitigate vandalism and theft of remediation equipment. The enclosure will be provided with an insulated floor, walls, ceiling, and steel access doors; the floor will be sealed with a non-skid bed liner. Heating and cooling will be provided using a wall-mounted heater and vent fan with sound-insulated

inlet/outlet louvers and a thermostat. A floor sump and high-level sensor will be included in the event of a water leak from tanks or process piping. The noise level outside of the enclosure is estimated to be less than 70 A-weighted decibels (dBA) and closer to 55 dBA at the closest occupied structure 60 feet south of the site.

- Vapor-liquid separator: The piping manifold will connect to a 200-gallon vapor-liquid separator, including a 75-gallon liquid-holding capacity. 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 and 3-point level switch, vacuum relief valve, and bottom drain valve that will be connected, using a condensate transfer pump, to a 200-gallon, single-walled, polyethylene storage tank. The condensate storage tank bottom drain valve will provide access for disposal.
- SVE blower: The SVE blower will be a Sutorbuilt Legend 7M positive displacement blower, or equivalent, capable of maintaining an extraction flow rate of 550 scfm at 100 inches water column vacuum at an elevation of 3,910 feet msl. A 40-horsepower (hp), 480-volt, 3-phase completely enclosed fan-cooling variable speed motor will be provided, equipped with a VFD located at the main control panel. The blower will be mounted on a steel discharge silencer with adjustable motor base for belt tensioning. The blower inlet will include a particulate filter, and the discharge piping from the blower will be galvanized steel and will include a sample port, pressure gauge, and temperature gauge.
- Thermal oxidizer: The oxidizer used for treatment of extracted soil vapor will be the NMED-owned, Intellishare model TO-500 unit that has been used previously at the Santa Fe County Judicial Complex and Lil’s Food and Fuel sites in Santa Fe and Tatum, New Mexico, respectively. A brief visual inspection of the equipment was recently performed by a representative of Intellishare, who stated the unit appears to be in very good shape. The oxidizer is designed to operate at concentrations between 0 and 50 percent of the lower explosive limit (LEL) for gasoline and rated at a nominal flow of 500 scfm (the proposed flow of 550 scfm will not result in reduced performance). The base and reactor will be composed of A-36 carbon steel, with a 300-series stainless steel stack. The treatment unit will discharge through a stack that will vent at a height of

between 20 and 25 feet above the ground surface. An existing heat exchanger module in the discharge stack that was used with previous thermal injection applications will be removed prior to use at this site.

- Control panel: The control panel will consist of a NEMA 3R enclosure, or equivalent enclosure rated for outdoor use, 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. The PLC will be sized with two additional inputs and outputs beyond the number required to run the system and an uninterruptible power supply. The panel will include a control transformer, emergency stop switch, and ground fault interrupter outlet. The control panel will be labeled with an Underwriters Laboratory certification sticker.

4.3 Horizontal Wells, Piping, and Trenching

The layout of the remediation system and the extent of contamination are depicted on Figure 8. A cross-section depicting the subsurface geology and the path of the horizontal wells is provided in Figure 9. The remediation system will require the completion of two horizontal SVE wells and associated conveyance piping and trenching (Appendix C). The minimum area of influence anticipated to be affected by the system is shown on Figure 8. Based on the results of DPE pilot testing completed by AcuVac Remediation, LLC (AcuVac) of Houston, Texas, the radius of influence (ROI) is expected to be approximately 30 feet. Analysis in Golder’s 2015 DPE pilot test report suggested a smaller ROI (Golder, 2015b); however, that analysis failed to adjust for barometric pressure and is altogether questionable due to the suggestion that increased vacuum would lead to decreased ROI. The AcuVac analysis accounts for barometric pressure changes and falls more in line with work completed at the nearby LCEC PSTB site, which has similar subsurface lithology.

Installation of well materials will be accomplished using a pull-back method of placement. Wells will be drilled from southeast to their northwest termination points, and well materials will be pulled back through the hole, using a reaming bit if necessary. Investigation-derived waste (IDW) generated during horizontal well installation will be stored in lined mud (roll-off) boxes that are easily transported to the licensed disposal facility. Mud boxes will be located at each end of the wells.

Trenching, installation of conveyance lines and well vaults, and major remediation equipment installation will be performed by licensed contractors. Representatives of the remediation equipment manufacturer will also be on-site during shake-down operations to ensure that equipment is functioning safely and that operations team members are adequately trained on future operations and maintenance (O&M) of the remediation equipment.

4.3.1 Horizontal Extraction Wells

Horizontal wells will be installed using directional drilling technologies. An 8-inch nominal boring will be drilled for installation of the well casing and screen. A biodegradable drilling fluid will be used to cool the drill bit and keep the boring open during well installation. This fluid will make characterization of soil VOC concentrations infeasible, so no laboratory sampling will be performed during installation of the horizontal well.

The total length of each horizontal well will be nearly 800 feet. From the borehole entrance in the south, each well will be drilled at approximately a 5 to 1 slope until the boring passes through the caliche layer and reaches approximately 50 feet bgs (around 250 feet horizontally). The horizontal screened portion of the well will maintain a depth of approximately 50 feet bgs over its entire length, approximately 10 feet above the static water table. Under the McDonald's restaurant structure, the well will turn upward at a similar 5 to 1 slope and exit the subsurface at the southwest corner of the McDonalds employee parking lot, as shown on Figure 8 and Appendix C. Exact slopes will be influenced by the drilling conditions encountered. The exact bore path will be documented in an as-built report.

Installation of the horizontal well boring will require use of hand-carried, aboveground detection equipment above the bit. The aboveground equipment allows for precise location of the drilling head during horizontal drilling operations. The wells will traverse New Mexico Department of Transportation (NMDOT) ROW, so a traffic control plan (TCP) has been developed for submittal with an NMDOT utility permit application during implementation of the horizontal wells (Appendix F). Well installation will require temporary closure of certain lanes of traffic within the NM 83 and US 82 intersection as the wells are tracked across the intersection. A shadow truck will be used to expedite multiple lane closures for each well.

The horizontal well boring pit will be located on the vacant lot south of the Crosswinds Lovington Church parking lot. This area will also be the staging area for drilling equipment and well materials (Figure 8). The well exits will be located in the southwest corner of the McDonald's employee parking lot. HDPE well piping will be laid out and welded north of this location along the sidewalk before being pulled through the boreholes. DBS&A has already negotiated access with McDonald's for this work, and that agreement is currently being reviewed by NMED counsel.

Wells will be constructed of 4-inch-diameter high density polyethylene (HDPE) materials. Each well will be screened with machine-cut, longitudinally-slotted well screen with 0.02-inch slots and 0.25 percent open area. These SVE screen specifications had proven success at the Moberg's Garage site in Watrous, New Mexico. The target screen sections for the new wells have been selected to accomplish mass removal along the full length of the comingled LNAPL plume.

Following installation of the wells, surface completions will be installed at borehole entrance and exit points within a 2-foot by 2-foot flush-mounted, hinged, traffic-rated well vault, surrounded by a 6-inch-thick concrete pad. A sample port will be installed within each well vault to facilitate vapor and vacuum monitoring, and wye fittings will be used to provide a clean-out for each SVE well, if needed (Drawing C-2, Appendix C).

4.3.2 Conveyance Line Piping and Trenching

Details of conveyance piping trenches are shown on Drawing C-2 (Appendix C). The conveyance piping for horizontal extraction wells will be 4-inch-diameter SCH 40 PVC. The conveyance piping will be placed below ground in trenches; extraction well piping will be supported on top of plastic chairs. The piping circuits will be backfilled with native soil and compacted in accordance with the specifications (Appendix E). The non-paved surfaces will be brought to grade with native soil and any existing vegetative matter to match the existing land surface. Paved surfaces in the McDonald's employee parking lot will be machine-cut and replaced with similar material and thickness to the existing pavement.

Due to the shallow depth of the trenching and piping, it is not anticipated that contaminated media will be encountered during the installation of the remediation system.

When the system is completed, each piping circuit will have a shutoff valve, a sample port, a vacuum gauge, and access for a flow meter, as shown in the system schematic in Drawing M-1 (Appendix C). The sample port will be used for collecting air samples and as a port for connecting a redundant digital manometer.

4.4 Utility Requirements/Utility Clearances

Lea County Electric Cooperative is the electric service provider in Lovington. A new three-phase electric service will be required for the remediation system, which will be supplied through aboveground power lines and utility poles located within the alley west of the remediation system (Drawing C-1, Appendix C). The contractor will install a new pole and meter base to facilitate the electric service tie-in, similar to other recent remediation systems installations.

New Mexico Gas Company (NM Gas) is the natural gas provider in Lovington. NM Gas will install the new connection and gas meter after the service line is installed to the remediation equipment by a licensed plumber. This line will also be run to the alley west of the remediation system (Drawing C-1, Appendix C).

DBS&A will contact New Mexico One Call to mark utilities for proposed well installation activities. The approximate locations of known utilities in the installation area are shown on Drawing G-2 (Appendix C). At a boring depth of approximately 50 feet bgs, no utility conflicts are anticipated for the majority of proposed site activities.

DBS&A has already had lengthy discussions with property owners affected by proposed remediation activities and will continue to communicate with these properties as the work progresses. Property owners have expressed to DBS&A that they are pleased by the proposed low-impact design. Access agreements will be signed by these parties as needed, and DBS&A will coordinate with the PSTB to help resolve conflicts or other modifications to standard access documents. Notice will be provided to the PSTB with a minimum of 96 hours prior to initiating field activities.

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, water lines, and other relevant structures
- Any deviations from the drawings and specifications included in the FRP
- Tabulation of pertinent data including, but not limited to, flow rates, vacuums, temperatures, contaminant concentrations and groundwater elevations, at start up
- Boring logs and well completion diagrams
- Inventory of purchased remediation equipment
- Discussion of the data collection methods
- Laboratory results with chain-of-custody records and laboratory quality assurance/quality control (QA/QC)
- Photo documentation of critical construction junctures
- Characterization of wastes, including handling and disposal

- Elevation survey results
- Detailed description of remedial system and as-built drawings
- Discussion of system startup, including observed performance and operational adjustments made to optimize system performance
- Discussion of the remedial system's performance criteria
- Summary and recommendations

4.6 Operations

Operation of the remediation system will include initial startup activities and regular maintenance. O&M will be performed regularly to optimize mass removal and expedite site closure. 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 mass removal, maximizing treatment efficiency, and documenting compliance with permits issued for this project. Controls will also 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 air (from both the system as a whole and from individual SVE wells) and documenting system efficiency under different well operating configurations. The total mass of VOCs and chemical composition of extracted vapors will be quantified and tracked. To document hydrocarbon recovery efficiency, 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.

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 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. The current dissolved-phase plume is relatively stable and does not pose an immediate threat to the municipal water supply. Groundwater extraction will only be used as a contingency, after the source area mass is removed. If necessary, groundwater could be extracted, treated, and discharged to an infiltration gallery on one of the many vacant properties in the vicinity of the proposed extraction wells.

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 data on system operation
- Maximize the system's mechanical performance
- Optimize the SVE operating configurations
- Document groundwater quality in response to system operation
- Perform general equipment preventive maintenance

5.2 Off-Gas Vapor Monitoring

Off-gas emission concentrations will be measured to document system effectiveness, regulatory compliance, and hydrocarbon recovery rates. Total ionizable VOC concentrations will be measured during each O&M event using a PID. DBS&A will collect influent and effluent air samples from the system and have them analyzed for TPH and BTEX using EPA methods 8015D and 8021, respectively, on the following schedule:

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

To minimize the potential to emit regulated substances to the environment, the remediation system is designed and will be constructed and operated such that malfunction or failure of any integral component results in automatic shutdown of the entire system.

5.3 SVE System Operation and Maintenance

SVE system startup will require daily site visits for the first week of operation to document system performance and hydrocarbon recovery rates. During this initial startup period, the SVE system will be adjusted to obtain optimum performance. Well vacuum will be increased gradually to minimize submergence of LNAPL during startup. Startup testing will include training field technicians on system specifications, troubleshooting, and sampling. Applied vacuum and resultant flow rates and vapor concentrations in each SVE well will be recorded using a form similar to the example provided in Appendix G. Applied vacuum will be measured at both ends of each horizontal SVE well. Vacuum and fluid levels in surrounding wells will be observed to document the actual ROI for the horizontal treatment wells.

DBS&A will coordinate with the various stakeholders to ensure representatives of the manufacturer and PSTB can attend startup. In addition to monitoring applied wellhead vacuum, DBS&A will use nearby vertical wells not operating with the remediation system to assess residual vacuum during system startup, groundwater elevations (upwelling), and ongoing system operation.

After the startup period, the system will be operated and maintained for optimal efficiency. O&M and evaluation of the SVE system will be performed on a bi-weekly, monthly, quarterly, and annual basis. Actual remediation system performance will be documented in quarterly O&M reports.

DBS&A will perform the following biweekly (every two weeks) activities during regular system monitoring events:

- Record vapor flow rates, concentrations, and other pertinent operations data for individual wells and the overall system.
- Adjust and maintain applied well vacuums within design specifications.
- Adjust vapor flow rates to maximize mass removal rates.
- Monthly O&M updates documenting relevant field activities and mass removal will be provided electronically to the PSTB project manager.

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.

5.3.1 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.

5.3.2 Monthly Activities

DBS&A or its subcontractors will perform the following activities on a monthly basis:

- Measure SVE well flow rates and vacuum
- Adjust and maintain 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
- Evaluate the efficacy of filters and replace those materials that exhibit a significant decrease in performance
- Calculate system extraction and emission rates and destruction efficiency

5.4 One Year of Quarterly Monitoring and Reporting

Subsequent to system and monitoring well installation, DBS&A will initiate quarterly groundwater monitoring in accordance with DBS&A SOPs. Assuming access is granted for sampling at the Allsup’s site, a total of 21 groundwater monitor wells associated with the site will be gauged during each monitoring event. 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.

Fluid levels will be gauged 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 soap.

Prior to sampling, the wells will be purged using new 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. Groundwater field parameters (dissolved oxygen [DO], oxidation/reduction potential [ORP], electrical conductivity [EC], pH, and temperature) will be measured during purging using a YSI Professional or equivalent device.

After purging, each well will be sampled for laboratory analysis, provided it contains a sufficient amount of groundwater. To minimize volatilization and ensure sample integrity, new 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 Hall Environmental Analysis Laboratory (HEAL) in Albuquerque, New Mexico, for analysis.

During the first year of system operation, groundwater samples will be analyzed for VOCs using EPA method 8260B (full list) and EDB using EPA method 504.1. These methods may be adjusted with ongoing system operation. Groundwater samples will be accompanied by full chain-of-custody documentation at all times. LNAPL will be recovered by hand bailing from wells with a measurable thickness.

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 all underground utilities and other subsurface structures on or adjacent to the site’s property boundaries, buildings, monitor wells, storage tanks and lines, 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

5.5 Health and Safety Requirements

Safety of the public is the project’s top priority. All work will be completed in accordance with applicable Occupational Safety and Health Administration (OSHA) regulations, including preparing and implementing a site-specific health and safety plan (HASP), conducting daily health and safety meetings with subcontractors and on-site personnel during field activities, and monitoring ambient air quality, as necessary. Personnel who may be in direct contact with petroleum-contaminated soil will have a minimum of 24-hour OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER) training. Ambient air monitoring using a properly calibrated PID will be performed by the health and safety officer on a daily basis when appropriate based on site conditions and observations. Safety data sheets (SDSs) will be included in the HASP for the materials to be handled (e.g., cement, bentonite, etc.) and COCs (e.g., BTEX and naphthalenes). Standard safety operating procedures, emergency communication procedures, and routes to hospital(s) will also be included in the HASP.

All activities at the site will be completed with appropriate safety precautions, including fencing off working areas, barricading open trenches, and monitoring ambient air conditions. The majority of site work is expected to occur more than 100 feet from the highway, which will minimize impacts to vehicular and pedestrian traffic. The site TCP will only need to address surface monitoring of the horizontal bore path by DTD staff.

DBS&A has generated a 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 HASP is provided as Appendix H. A copy of the HASP will be kept on-site during all field activities.

6. Permits

The following permits will be required to complete the scope of work, (1) NMDOT ROW permit and (2) Construction Industries Division (CID) permits for utility services. As discussed in Section 4.3, a draft NMDOT utility permit has been provided in Appendix F.

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.

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 Hobbs News-Sun, on August 27 and September 3, 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 Lea County Assessor data and through additional contacts with property owners and occupants. Initial letters were sent to the owners and occupants of 15 parcels on August 26, 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 addresses, and a map indicating which residences and businesses received certified letters are provided in Appendix I. Additionally, DBS&A has conducted in-person meetings with the most directly affected property owners regarding business disruption, equipment footprint, noise, and other potential issues.

Notices of submission of the remediation plan are posted at the site, and at the proposed location of the remediation equipment, in a prominent location where they can be easily seen by the public. A set of signs were attached to T-posts near the proposed horizontal well entry and exit locations on property owned by McDonald’s and the Crosswinds Church. Signs were posted within 48-hours of the date of this FRP.

8. Implementation Schedule

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

- Approval of the FRP
- Installation of horizontal SVE wells, conveyance piping, and utility services
- Installation of remediation equipment
- System startup
- Submittal of the final as-built report
- Quarterly O&M reports

9. Evaluation of Remedial Actions

The 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 SVE system performance based on mass of fuel compounds removed
- Evaluation of the rate of natural attenuation
- 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 by DBS&A under contract number 20-667-3200-0002 for the Lovington 66 UST Site under the PSTB State Lead remediation program. 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).

August 28, 2020

Thomas Golden, P.E.
Project Engineer

Date

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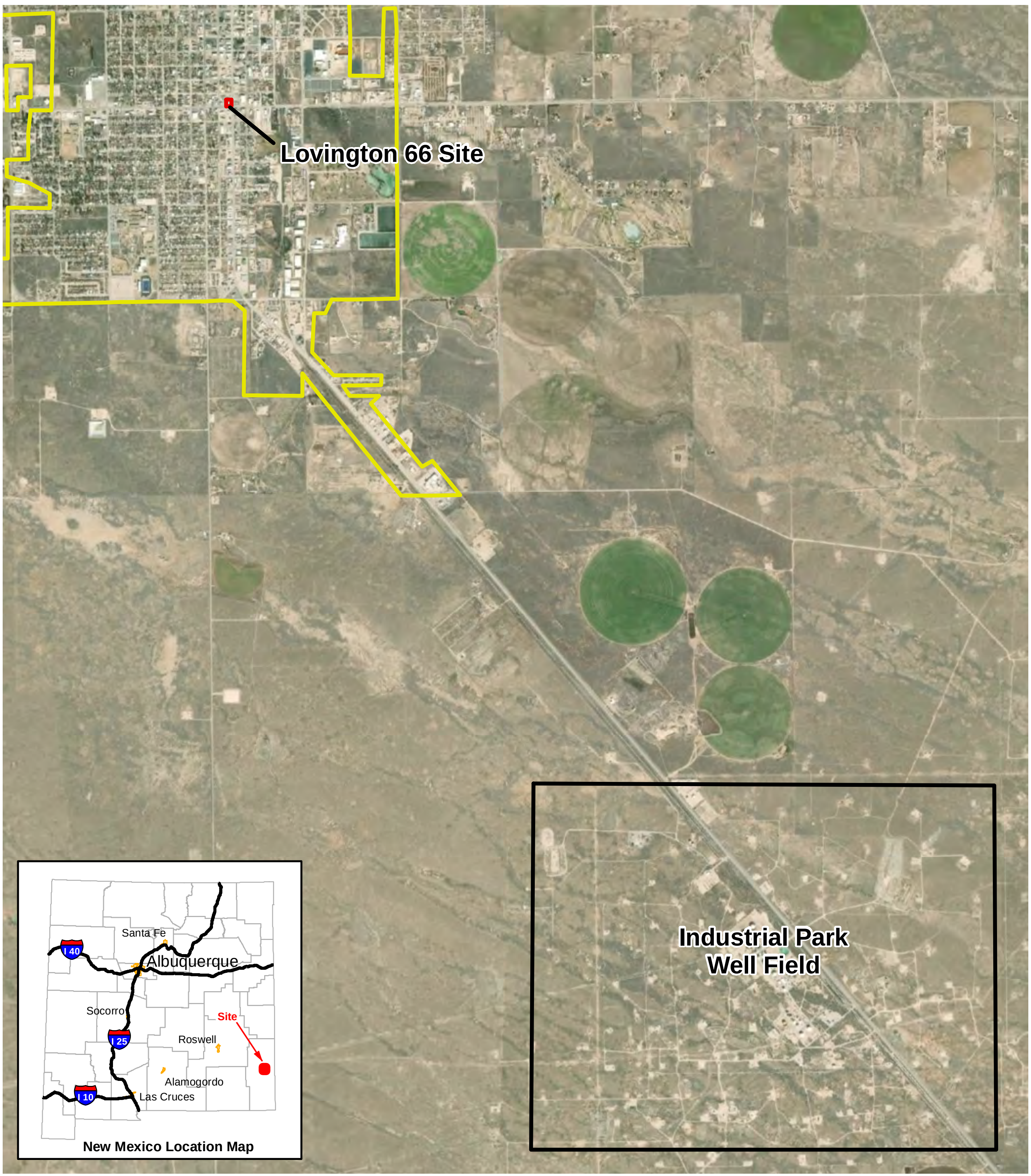
Figures



Source: ESRI, et al.

N

0 2000 4000
Feet

Explanation

🟨 Lovington city limits

LOVINGTON 66
424 SOUTH MAIN STREET
LOVINGTON, NEW MEXICO

Area Map

Daniel B. Stephens & Associates, Inc.
8/24/2020
JN DB19.1395

Figure 1

S:\PROJECTS\DB19.1395_LOVINGTON_66\GIS\MXDS\AREA_MAP.MXD

Explanation

◐ Monitor well

⊗ Monitor well - destroyed or inaccessible

⊙ Monitor well - plugged and abandoned

▭ Approximate parcel block boundaries

Source: AEA: 5/12/2020
Google Earth Pro: 11/2/2020

LOVINGTON 66
424 SOUTH MAIN STREET
LOVINGTON, NEW MEXICO

Site Map

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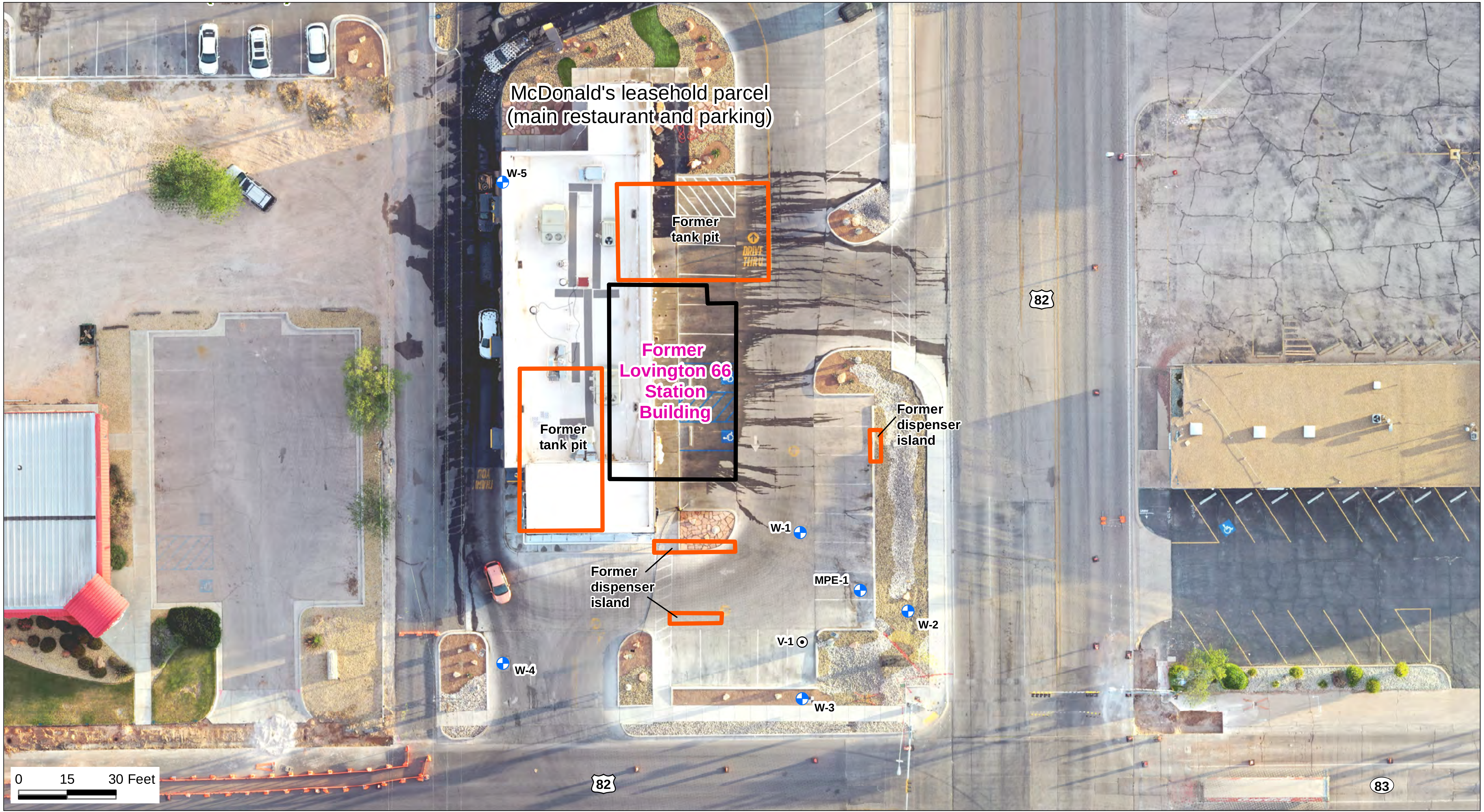
8/27/2020 JN DB19.1395

Figure 2

S:\PROJECTS\DB19.1395_LOVINGTON_66\GIS\MXDS\SITE_MAP.MXD



Source: AEA: 5/12/2020

N

Explanation

⊕ Monitor well

⊗ Monitor well - destroyed or inaccessible

⊙ Monitor well - plugged and abandoned

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LOVINGTON 66
424 SOUTH MAIN STREET
LOVINGTON, NEW MEXICO

Site Detail

Figure 3

S:\PROJECTS\DB19.1395_LOVINGTON_66\GIS\MXDS\ENGINEERING\SITE_DETAIL.MXD

Explanation

- ◐ Monitor well
- ⊗ Monitor well - destroyed or inaccessible
- ⊙ Monitor well - plugged and abandoned

N

- ― Potentiometric surface elevation contour (ft msl)
- W-8 Monitor well designation
- 3849.73 Potentiometric surface elevation (ft msl)

Source: Adapted from Golder, 2018
AEA: 5/12/2020, Google Earth Pro: 11/2/2020

LOVINGTON 66
424 SOUTH MAIN STREET
LOVINGTON, NEW MEXICO

Potentiometric Surface Elevations
February and March 2018

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8/24/2020 JN DB19.1395

Figure 4

S:\PROJECTS\DB19.1395_LOVINGTON_66\GIS\MXDS\FLUID LEVELS\POT_MAP.MXD

Source: Adapted from Golder, 2018
AEA: 5/12/2020, Google Earth Pro: 11/2/2020

Explanation

- 🔵 Monitor well
- ⊗ Monitor well - destroyed or inaccessible
- ⊙ Monitor well - plugged and abandoned

W-8	Monitor well designation
12,000	Benzene concentration in micrograms per liter (µg/L)
5.52'	LNAPL thickness (feet)
-·-	Approximate benzene isoconcentration contour (µg/L)
—	Approximate LNAPL thickness (feet)

LOVINGTON 66
424 SOUTH MAIN STREET
LOVINGTON, NEW MEXICO

LNAPL and Dissolved-Phase Benzene Isoconcentration Map
March 2018

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JN DB19.1395

S:\PROJECTS\DB19.1395_LOVINGTON_66\GIS\MXDS\CHEMISTRY\BZ\BENZENE_2018-03.MXD

Figure 5

N

Explanation

⊕ Monitor well

⊗ Monitor well - destroyed or inaccessible

⊙ Monitor well - plugged and abandoned

W-8 Monitor well designation

230 EDC concentration in micrograms per liter (µg/L)

— EDC isoconcentration contour (µg/L)
(dashed where inferred)

Source: Adapted from Golder, 2018
AEA: 5/12/2020, Google Earth Pro: 11/2/2020

LOVINGTON 66
424 SOUTH MAIN STREET
LOVINGTON, NEW MEXICO

Dissolved Phase EDC Isoconcentration Map
March 2018

Daniel B. Stephens & Associates, Inc.
8/21/2020 JN DB19.1395

Figure 6

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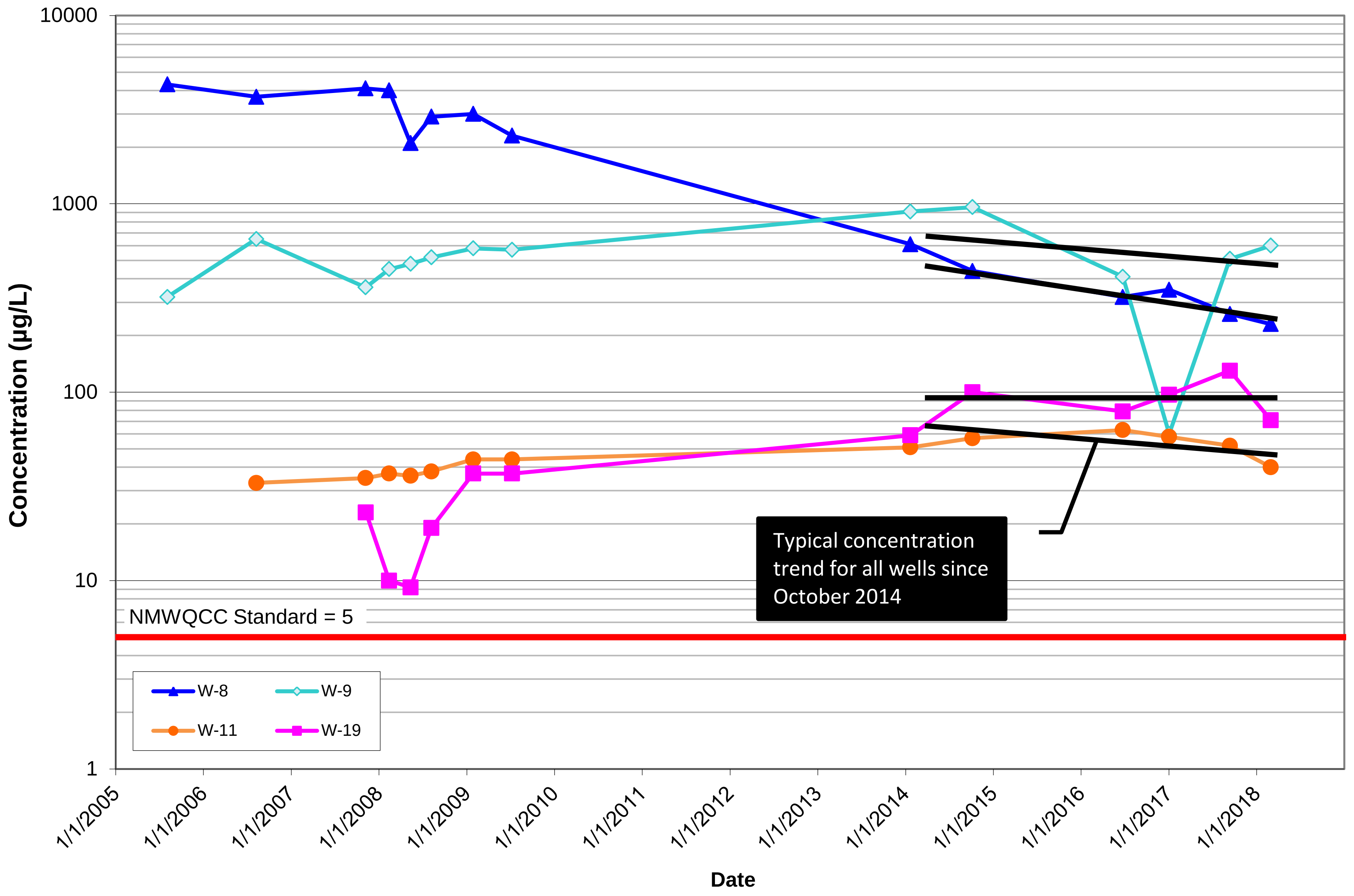

Typical concentration trend for all wells since October 2014

LOVINGTON 66
424 SOUTH MAIN STREET
LOVINGTON, NEW MEXICO

Time-Series Graph

Dissolved-Phase EDC Concentrations

Figure 7

Daniel B. Stephens & Associates, Inc.

8/28/20

Source: AEA: 5/12/2020
Google Earth Pro: 11/2/2020

N

Explanation

- ● Monitor well
- ⊗ Monitor well - destroyed or inaccessible
- ⊙ Monitor well - plugged and abandoned
- ◌ 30-foot SVE radius of influence
- ━ Proposed horizontal well (dashes indicate screen section)
- ─ Approximate LNAPL thickness (feet)

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8/21/2020
JN DB19.1395

LOVINGTON 66
424 SOUTH MAIN STREET
LOVINGTON, NEW MEXICO

Proposed Technical Approach

Figure 8

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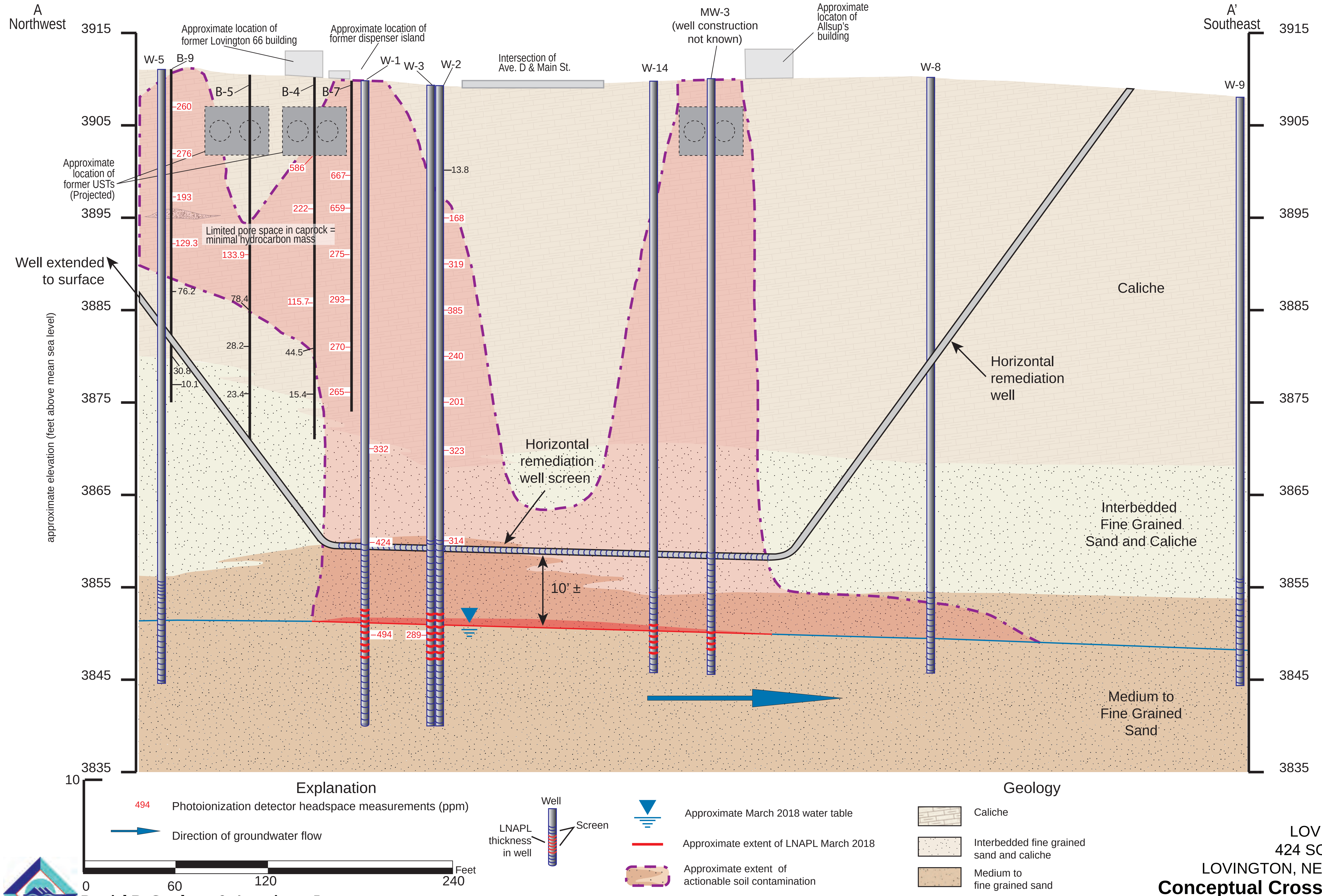

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Daniel B. Stephens & Associates, Inc.
05-23-19
JN DB18.1107

LOVINGTON 66
424 SOUTH MAIN
LOVINGTON, NEW MEXICO

Conceptual Cross Section

Figure 9

Table

Table 1. Summary of Product Type Analysis
Lovington 66, Lovington, New Mexico

Well Name	Date	Percent Composition [a]			
		DRO	MRO	GRO	TPH [b]
MPE-1	06/15/20	21	<3.9	110	131
W-1	06/15/20	22	<4.4	100	122
W-3	06/15/20	22	<4.4	85	107

[a] Samples analyzed in accordance with U.S. Environmental Protection Agency (EPA) method 8015D.
[b] Samples were analyzed separately for each hydrocarbon group, so total may not be 100%.

DRO = Diesel range organics
MRO = Motor oil range organics
GRO = Gasoline range organics
TPH = Total petroleum hydrocarbons

Appendix A

Calculations

Daniel B. Stephens & Associates, Inc.

Calculation Cover Sheet

Project Name Lovington 66 Project Number DB19.1395

Calculation Number DB19.1395-001 Discipline Engineering No. of Sheets 5

PROJECT: Lovington 66

THOMAS A. GOLDEN
22750
8|28|2020

SITE: Lovington 66, Lovington, New Mexico

SUBJECT: Determination of LNAPL volumes, effluent emission rates, and expected removal time of LNAPL with soil vapor extraction remediation

SOURCES OF DATA:

A. GIS map document FIG_Tech Approach.mxd
B. Golder Groundwater Monitoring Report, February 2018 Monitoring Event
C. AcuVac DPE Pilot Test Report, July 2015
D. Rotameter Flow Measurement, January 29, 2010

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. Remediation Technologies for Soils and Groundwater – Bahandari et al, March 2007
3. 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
4. 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	Final Remediation Plan	CES	4/30/2020	TG	8/18/2020	TG	8/26/2020
1	PSTB Comments					TG	9/15/2020

Daniel B. Stephens & Associates, Inc.

Calculation Sheet

Project No. DB19.1395

Date 4/30/20

Subject LNAPL volumes and removal time

Sheet 1 of 6

By CES

Checked By TG

Calculation No. DB19.1395-001

1.0 OBJECTIVES

1. Determine the volume of light non-aqueous phase liquid (LNAPL) present in the commingled plume that encompasses the Lovington 66 and Allsup's #109 sites.
2. Calculate the expected LNAPL removal time for the commingled plume.

2.0 GIVEN

Soil vapor concentrations and the extent and measured thickness of LNAPL from the March 2018 groundwater monitoring event completed by Golder[B]. Based on the horizontal well design, average air flow rate of 500 standard cubic feet per minute (scfm) from the two extraction wells along the length of the LNAPL plume.

3.0 METHOD

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 is used to generate Theissen polygons using the LNAPL plume boundary and approximate ROW boundary as the Theissen polygon boundary.

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". The equations and definitions for the methods are presented together in Appendix 1, as well as in the PSH_calcs spreadsheets. The thickness at each well is estimated with each method presented. For the area of the plume which falls under New Mexico Department of Transportation (NMDOT) right-of-way (ROW) a formation thickness shall be estimated based on the values at each of the wells. After the thickness is estimated, a volume of product for each polygon can be determined by multiplying the median or average product thickness by the areal extent of the corresponding Theissen polygon[A] and the soil porosity. For this analysis, it will be assumed that 60% of the available LNAPL volume is recoverable, which is slightly more aggressive than standard industry practice[2]. 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[3].

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[4] 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 W-1; results for all polygons are given in “Summary of NAPL volume.xlsx” attached at the end of this calculation.

Table 1: Summary of product thickness estimation methods for W-1

Method	Thickness (ft)
Method of de Pastrovich (1979)	2.01
Method of Hall, et. al. (1984)	5.63
Method of Blake and Hall (1984)	1.51
Method of Ballestero et. al. (1994)	1.51
Method of Schiegg (1985)	1.45
Method of Farr et. al. (1990)	0.82
Method of Lenhard and Parker (1990)	4.78

Only positive estimated values of LNAPL thickness will be considered valid. Compute the average LNAPL thickness for all reasonable values, excluding outliers:

$$H_{f,Avg} = \text{AVERAGE}(2.01,\cancel{5.63},1.51,1.51,1.45,0.82,\cancel{4.78}) = 1.46 \text{ feet}$$

Note that the large values estimated from Hall, et. al. (1984), and Lenhard and Parker (1990) are excluded as outliers when calculating average product thickness for each well. These methods rely on empirical coefficients and are assumed not to be representative of site conditions at Lovington 66.

Project No. DB19.1395 Date 4/30/20

Subject LNAPL volumes and removal time Sheet 3 of 6

By CES Checked By TG Calculation No. DB19.1395-001

Use GIS software to determine the areal extent of LNAPL[A]:

$$A_{Polygon} = 2{,}279 \text{ ft}^2$$

Well density for this site is not ideal, so measured well thicknesses do not likely account for decreases in plume thickness that would be observed at the edge of the LNAPL plume. Adjust the calculated formation thickness to account for these conditions:

$$H_{f,} = H_{f,Avg} * 0.70 = 1.46 * 0.70 = 1.02 \text{ feet}$$

Calculate the estimated volume of LNAPL within the polygon using the LNAPL thickness, polygon area, and assumed soil porosity, ϕ, of 15%.

$$V_{LNAPL} = H_f * A_{Polygon} * \phi = 1.02 \text{ ft} * 2{,}279 \text{ ft}^2 * 0.15 * 7.481 \text{ gal/ft}^3 \approx 2{,}615 \text{ gal}$$

Calculate the recoverable volume of LNAPL:

$$V_{rec} = V_{LNAPL} * 0.60 = 2{,}615 \text{ gal} * 0.60 = 1{,}569 \text{ gal}$$

Table 2: Summary of monitoring well LNAPL calculations

Well	Effective Formation Thickness (ft)	Calculated LNAPL Volume (gallons)	Recoverable LNAPL Volume (gallons)
Lovington 66 Monitoring Wells			
W-1	1.02	2,615	1,569
W-2	1.12	1,732	1,039
W-3	1.07	2,602	1,561
MPE-1	1.11	1,391	835
Allsups #109 Monitoring Wells			
W-14	0.88	2,219	1,331
MW-3	0.44	1,291	775
	Total	**11,850**	**7,110**

Table 3: Summary of LNAPL volumes for entire plume

Location	Area (ft^2)	Estimated NAPL Formation Thickness (ft)	Calculated LNAPL Volume (gallons)	Recoverable LNAPL Volume (gallons)
Lovington 66	6,951	see Table 2	8,340	5,004
Allsups #109	4,846	see Table 2	3,510	2,106
NMDOT ROW	12,234	0.75	10,296	6,178
Totals	**24,031**		**22,146**	**13,288**

The sample calculations given below are for the flow from horizontal wells SVE-1 and SVE-2, which will be located along the length of the LNAPL plume.

Project No. DB19.1395		Date 4/30/20	
Subject LNAPL volumes and removal time		Sheet 4 of 6	
By CES	Checked By TG	Calculation No. DB19.1395-001	

Assume the total standard well flow is 500 ft^3/min (scfm) based on the expected total length of open well screen. This is conservatively lower than the total design air flow of 550 scfm. Convert standard flow to actual flow assuming standard temperature is 520 R, standard pressure is 14.696 psia, and actual atmospheric pressure is 12.73 psia. An applied well vacuum of 100 inches water column (3.61 psi) is also factored into the actual pressure. Actual temperature is approximately 60 °F. Convert actual temperature to standard units:

$$° R = °F + 459.69 = 60 + 459.69 = 520 °R$$

Calculate actual well flow[D]:

$$ACFM = SCFM * \left(\frac{T_{act}°}{T_{std}°}\right)\left(\frac{P_{std}}{P_{act}}\right) = 500\, scfm * \left(\frac{520°R}{520°R}\right)\left(\frac{14.696\, psia}{12.73\, psia - 3.61}\right) \approx 800\, acfm$$

The following calculations utilize a well flow of 800 ft^3/min (acfm).

Compute the volume of air that passes through the system per day:

$$V_{air} = 800\ ft^3/min * 60\ min/hr * 24\ hr/day = 1,152,000\ ft^3/day$$

Compute the maximum mass of contaminant removed per day based on assumptions stated above:

$$R_{max} = (1,152,000\ ft^3/day) * (100\ L / 3.5336\ ft^3) * (1\ gr / 100\ L) = 326,016\ gr/day$$

$$R_{max} = (326,016\ gr/day) * (0.002205\ lb/gr) = \mathbf{R_{max} = 719\ lb/day}$$

Assume the initial soil vapor concentration, C_{ppmv}, is approximately 25,000 ppmv, which is a reasonable value between the DPE pilot test field screening[C] and laboratory data. Convert field measurements for TPH from ppmv to mass concentrations:

$$C_0 = C_{ppmv} * \rho_{air} * (MW_{fuel} / MW_{air})$$

$$C_0 = (25,000 / 1E6) * (1.184\ g/L) * (1E6\ \mu g/g) * (103\ g/mol / 29\ g/mol) = \mathbf{C_0 = 105,131\ \mu g/L}$$

Based on the method described by Kroopnick[4], model SVE system performance (see Cleanup time estimation.xls). Assuming approximately 19,800 gallons are recoverable, convert the volume into a mass assuming a specific gravity for LNAPL of 0.75:

$$M_{rec} = \gamma_{LNAPL} * V_{rec} = (62.4\ lb/ft^3 * 0.75) * (ft^3 / 7.4805\ gal) * (19,800\ gal) = 123,874\ lb$$

Assuming that 90 percent of the (rounded) total volume of LNAPL will be recoverable is extremely conservative with regard to cleanup time estimation.

Project No. DB19.1395

Date 4/30/20

Subject LNAPL volumes and removal time

Sheet 5 of 6

By CES

Checked By TG

Calculation No. DB19.1395-001

Two time steps are calculated below using computed values for the maximum vapor extraction flow rate, 800 ft^3/min (acfm), initial vapor concentration, 105,131 µg/L, and maximum daily removal based on the vapor extraction flow rate, 719 lb/day.

After one day, the total mass of LNAPL remaining will be reduced by the maximum daily removal:

$$M_{rem}(1\text{ day}) = M_{rec} - R_{max} = 123{,}874\text{ lb} - 719\text{ lb} = 123{,}155\text{ lb}$$

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):

$$C_1 = C_0\ e^{(-RF*1)} = (105{,}131\ \mu g/L) * e\ (-0.019513 * 1) = 103{,}100\ \mu g/L$$

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:

$$R_{200} = C_{200} * V_{air}$$
$$R_{200} = (2{,}123\ \mu g/L) * (28.3\ L/ft^3) * (800\ ft^3/min) * (lb / 453{,}592{,}370\ \mu g) * (1{,}440\ min/day)$$
$$R_{200} = 153\ lb/day$$

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):

$$M_{201} = M_{200} - R_{200} = 7{,}900\text{ lb} - 153\text{ lb} = 7{,}747\text{ lb}$$

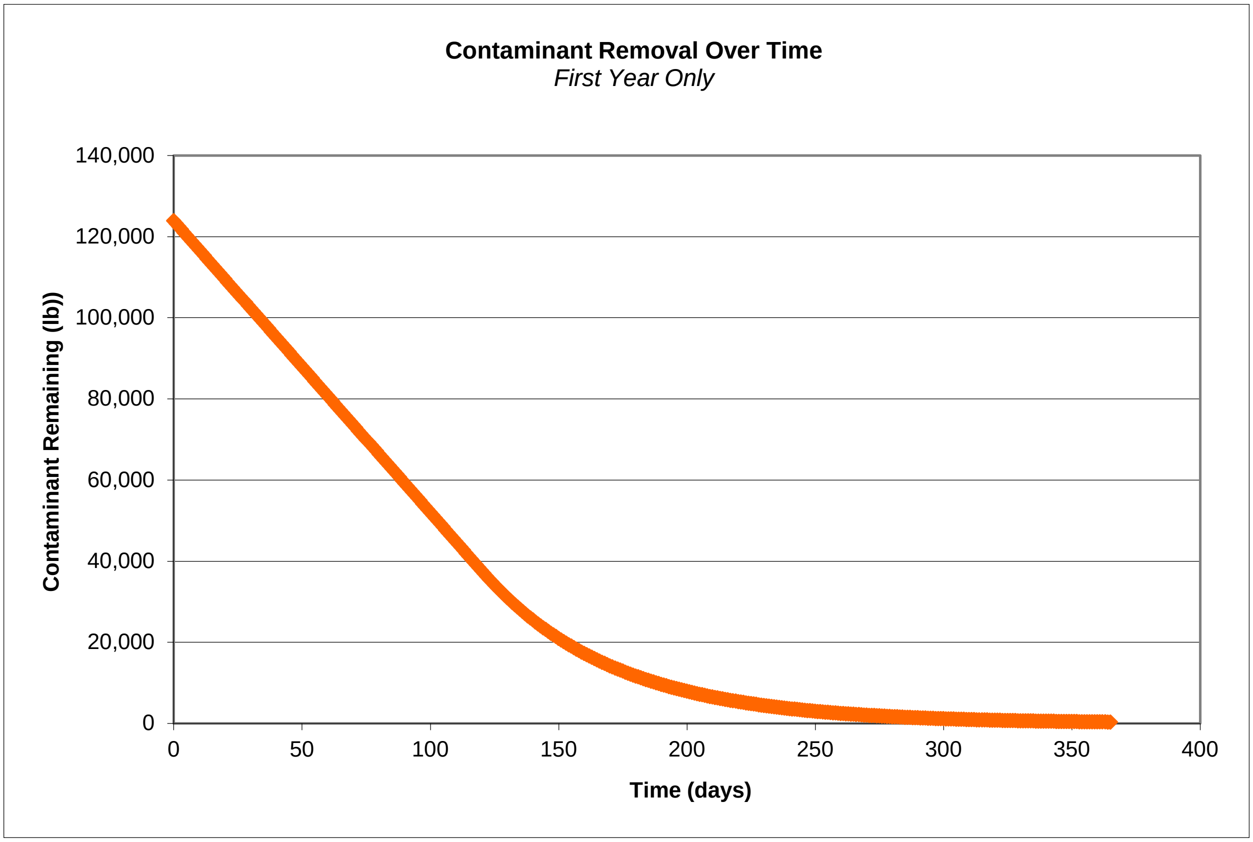
Using a spreadsheet (Cleanup time estimate.xls) these values can be calculated and the removal factor, RF, can be determined by adjusting the value until both the LNAPL mass remaining and the vapor concentration simultaneously approach zero. For this system, RF is determined to be 0.019513 using the SOLVER function.

Figure 1 estimates the modeled removal of the LNAPL contaminant with time:

Calculation Sheet

Daniel B. Stephens & Associates, Inc.

Project No. DB19.1395 Date 4/30/20
Subject LNAPL volumes and removal time Sheet 6 of 6
By CES Checked By TG Calculation No. DB19.1395-001



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 (123,874 lb * .01 = 1,239 lb) after 295 days or approximately **0.8 year**.

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), and that actual SVE removal is a non-linear process.

Variables for W-1

3.27		β_{ao}	air-oil scaling factor
1.44		β_{ow}	oil-water scaling factor
0.019		D	function of interfluid displacement pressure and hydrostatics
0.25	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
184.1	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
0.75	g/cm^3	ρ_o	density of hydrocarbon liquid
0.150		ϕ	soil porosity
72	dynes/cm	σ_{aw}	surface tension of water
22	dynes/cm	σ_{ao}	surface tension of hydrocarbon
50	dynes/cm	σ_{ow}	hydrocarbon-water interfacial tension
0.091		S_r	residual saturation
138.1	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:

🟨	Value from EPA 510-R-96-001 Appendix
🟪	Value from field approximations
🟦	Calculated value

THICKNESS CALCULATIONS FOR W-1

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.

1.46	Average of the 5 methods with reasonable values (ft)
1.51	Median of the 7 methods with positive thicknesses (ft)
0.82	Min of the 7 methods with positive thicknesses (ft)
5.63	Max of the 7 methods with positive thicknesses (ft)

Method of de Pastrovich (1979)

$$\boxed{H_f = \frac{H_0(\rho_w - \rho_o)}{\rho_o}}$$

H_f = 61.37 cm in formation
2.01 ft in formation

Method of Hall, et. al. (1984)

$$\boxed{H_f = H_0 - F}$$

H_f = 171.60 cm in formation
5.63 ft in formation

Method of Blake and Hall (1984)

$$\boxed{H_f = H_o - (x + h_a)}$$

H_f = 46.02 cm in formation
1.51 ft in formation

Method of Ballestero et. al. (1994)

$$\boxed{H_f = ((1 - \rho_o) \bullet H_0) - h_a}$$

H_f = 46.02 cm in formation
1.51 ft in formation

Method of Schiegg (1985)

$$\boxed{H_f = H_0 - 2(h_{c,dr})}$$

H_f = 44.1 cm in formation
1.45 ft in formation

Method of Farr et. al. (1990)

$$\boxed{H_f = \emptyset(1 - S_r)D\left[\frac{H_0}{D} - 1\right]}$$

$$\boxed{D = \frac{P_d^{ow}}{\Delta\rho g} - \frac{P_d^{ao}}{\rho_o g}}$$

D = 0.019
H_f = 25.10 cm in formation
0.82 ft in formation

Method of Lenhard and Parker (1990)

$$\boxed{H_f = \left[\frac{\rho_0\beta_{ao}H_0}{\rho_0\beta_{ao} - \beta_{ow}(1 - \rho_0}\right] - h_{c,dr}}$$

$$\boxed{\beta_{ao} = \frac{\sigma_{aw}}{\sigma_{ao}}} \qquad \boxed{\beta_{ow} = \frac{\sigma_{aw}}{\sigma_{ow}}}$$

β_{ao} = 3.272727
β_{ow} = 1.44
H_f = 145.74 cm in formation
4.78 ft in formation

Variables for W-2

3.27		β_{ao}	air-oil scaling factor
1.44		β_{ow}	oil-water scaling factor
0.019		D	function of interfluid displacement pressure and hydrostatics
0.25	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
194.77	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
0.75	g/cm^3	ρ_o	density of hydrocarbon liquid
0.150		ϕ	soil porosity
72	dynes/cm	σ_{aw}	surface tension of water
22	dynes/cm	σ_{ao}	surface tension of hydrocarbon
50	dynes/cm	σ_{ow}	hydrocarbon-water interfacial tension
0.091		S_r	residual saturation
146.1	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:

🟨	Value from EPA 510-R-96-001 Appendix
🟪	Value from field approximations
🟦	Calculated value

THICKNESS CALCULATIONS FOR W-2

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.

1.60	Average of the 5 methods with reasonable values (ft)
1.80	Median of the 7 methods with positive thicknesses (ft)
0.87	Min of the 7 methods with positive thicknesses (ft)
5.98	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 = 64.92 cm in formation
2.13 ft in formation

Method of Hall, et. al. (1984)

$$H_f = H_0 - F$$

H_f = 182.27 cm in formation
5.98 ft in formation

Method of Blake and Hall (1984)

$$H_f = H_o - (x + h_a)$$

H_f = 48.69 cm in formation
1.598 ft in formation

Method of Ballestero et. al. (1994)

$$H_f = ((1 - \rho_o) \bullet H_0) - h_a$$

H_f = 48.69 cm in formation
1.598 ft in formation

Method of Schiegg (1985)

$$H_f = H_0 - 2(h_{c,dr})$$

H_f = 54.77 cm in formation
1.80 ft in formation

Method of Farr et. al. (1990)

$$H_f = \emptyset(1 - S_r^{\square})D\left[\frac{H_0}{D} - 1\right]$$

$$D = \frac{P_d^{ow}}{\Delta\rho g} - \frac{P_d^{ao}}{\rho_o g}$$

D = 0.019
H_f = 26.55 cm in formation
0.87 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} = 3.272727
β_{ow} = 1.44
H_f = 158.24 cm in formation
5.19 ft in formation

Variables for W-3

	Value	Unit	Symbol	Description
🟦	3.27		β_{ao}	air-oil scaling factor
🟦	1.44		β_{ow}	oil-water scaling factor
🟦	0.019		D	function of interfluid displacement pressure and hydrostatics
🟦	0.25	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
🟪	188.98	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
🟨	0.75	g/cm^3	ρ_o	density of hydrocarbon liquid
🟪	0.150		ϕ	soil porosity
🟨	72	dynes/cm	σ_{aw}	surface tension of water
🟨	22	dynes/cm	σ_{ao}	surface tension of hydrocarbon
🟦	50	dynes/cm	σ_{ow}	hydrocarbon-water interfacial tension
🟨	0.091		S_r	residual saturation
🟦	141.7	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:

🟨	Value from EPA 510-R-96-001 Appendix
🟪	Value from field approximations
🟦	Calculated value

THICKNESS CALCULATIONS FOR W-3

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.

1.52	Average of the 5 methods with reasonable values (ft)
1.61	Median of the 7 methods with positive thicknesses (ft)
0.85	Min of the 7 methods with positive thicknesses (ft)
5.79	Max of the 7 methods with positive thicknesses (ft)

Method of de Pastrovich (1979)

$$\boxed{H_f = \frac{H_0(\rho_w - \rho_o)}{\rho_o}}$$

H_f = 62.99 cm in formation
2.07 ft in formation

Method of Hall, et. al. (1984)

$$\boxed{H_f = H_0 - F}$$

H_f = 176.48 cm in formation
5.79 ft in formation

Method of Blake and Hall (1984)

$$\boxed{H_f = H_o - (x + h_a)}$$

H_f = 47.24 cm in formation
1.55 ft in formation

Method of Ballestero et. al. (1994)

$$\boxed{H_f = ((1 - \rho_o) \bullet H_0) - h_a}$$

H_f = 47.24 cm in formation
1.55 ft in formation

Method of Schiegg (1985)

$$\boxed{H_f = H_0 - 2(h_{c,dr})}$$

H_f = 48.98 cm in formation
1.61 ft in formation

Method of Farr et. al. (1990)

$$\boxed{H_f = \emptyset(1 - S_r)D\left[\frac{H_0}{D} - 1\right]}$$

$$\boxed{D = \frac{P_d^{ow}}{\Delta\rho g} - \frac{P_d^{ao}}{\rho_o g}}$$

D = 0.019
H_f = 25.76 cm in formation
0.85 ft in formation

Method of Lenhard and Parker (1990)

$$\boxed{H_f = \left[\frac{\rho_0\beta_{ao}H_0}{\rho_0\beta_{ao} - \beta_{ow}(1 - \rho_0}\right] - h_{c,dr}}$$

$$\boxed{\beta_{ao} = \frac{\sigma_{aw}}{\sigma_{ao}}} \qquad \boxed{\beta_{ow} = \frac{\sigma_{aw}}{\sigma_{ow}}}$$

β_{ao} = 3.272727
β_{ow} = 1.44
H_f = 151.46 cm in formation
4.97 ft in formation

Variables for W-14

3.27		β_{ao}	air-oil scaling factor
1.44		β_{ow}	oil-water scaling factor
0.019		D	function of interfluid displacement pressure and hydrostatics
0.25	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
168.25	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
0.75	g/cm^3	ρ_o	density of hydrocarbon liquid
0.150		ϕ	soil porosity
72	dynes/cm	σ_{aw}	surface tension of water
22	dynes/cm	σ_{ao}	surface tension of hydrocarbon
50	dynes/cm	σ_{ow}	hydrocarbon-water interfacial tension
0.091		S_r	residual saturation
126.2	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:

🟨	Value from EPA 510-R-96-001 Appendix
🟥	Value from field approximations
🟦	Calculated value

THICKNESS CALCULATIONS FOR W-14

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.

1.26	Average of the 5 methods with reasonable values (ft)
1.38	Median of the 7 methods with positive thicknesses (ft)
0.75	Min of the 7 methods with positive thicknesses (ft)
5.11	Max of the 7 methods with positive thicknesses (ft)

Method of de Pastrovich (1979)

$$\boxed{H_f = \frac{H_0(\rho_w - \rho_o)}{\rho_o}}$$

H_f = 56.08 cm in formation
1.84 ft in formation

Method of Hall, et. al. (1984)

$$\boxed{H_f = H_0 - F}$$

H_f = 155.75 cm in formation
5.11 ft in formation

Method of Blake and Hall (1984)

$$\boxed{H_f = H_o - (x + h_a)}$$

H_f = 42.06 cm in formation
1.38 ft in formation

Method of Ballestero et. al. (1994)

$$\boxed{H_f = ((1 - \rho_o) \bullet H_0) - h_a}$$

H_f = 42.06 cm in formation
1.38 ft in formation

Method of Schiegg (1985)

$$\boxed{H_f = H_0 - 2(h_{c,dr})}$$

H_f = 28.25 cm in formation
0.93 ft in formation

Method of Farr et. al. (1990)

$$\boxed{H_f = \emptyset(1 - S_r)D\left[\frac{H_0}{D} - 1\right]}$$

$$\boxed{D = \frac{P_d^{ow}}{\Delta\rho g} - \frac{P_d^{ao}}{\rho_o g}}$$

D = 0.019
H_f = 22.94 cm in formation
0.75 ft in formation

Method of Lenhard and Parker (1990)

$$\boxed{H_f = \left[\frac{\rho_0\beta_{ao}H_0}{\rho_0\beta_{ao} - \beta_{ow}(1 - \rho_0}\right] - h_{c,dr}}$$

$$\boxed{\beta_{ao} = \frac{\sigma_{aw}}{\sigma_{ao}}} \qquad \boxed{\beta_{ow} = \frac{\sigma_{aw}}{\sigma_{ow}}}$$

β_{ao} = 3.272727
β_{ow} = 1.44
H_f = 127.17 cm in formation
4.17 ft in formation

Variables for MW-3

🟦 3.27		β_{ao}	air-oil scaling factor
🟦 1.44		β_{ow}	oil-water scaling factor
🟦 0.019		D	function of interfluid displacement pressure and hydrostatics
🟦 0.25	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
🟪 77.724	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
🟨 0.75	g/cm^3	ρ_o	density of hydrocarbon liquid
🟪 0.150		ϕ	soil porosity
🟨 72	dynes/cm	σ_{aw}	surface tension of water
🟨 22	dynes/cm	σ_{ao}	surface tension of hydrocarbon
🟦 50	dynes/cm	σ_{ow}	hydrocarbon-water interfacial tension
🟨 0.091		S_r	residual saturation
🟦 58.3	cm	x	distance from the water table to interface between free produc and groundwater in the well -- x is equal to the product of the thickness of the hydrocarbon and the hydrocarbon density

Explanation:

🟨	Value from EPA 510-R-96-001 Appendix
🟪	Value from field approximations
🟦	Calculated value

THICKNESS CALCULATIONS FOR MW-3

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.

0.63	Average of the 5 methods with reasonable values (ft)
0.66	Median of the 6 methods with positive thicknesses (ft)
0.35	Min of the 6 methods with positive thicknesses (ft)
2.14	Max of the 6 methods with positive thicknesses (ft)

Method of de Pastrovich (1979)

$$\boxed{H_f = \frac{H_0(\rho_w - \rho_o)}{\rho_o}}$$

H_f = 25.91 cm in formation
0.85 ft in formation

Method of Hall, et. al. (1984)

$$\boxed{H_f = H_0 - F}$$

H_f = 65.22 cm in formation
2.14 ft in formation

Method of Blake and Hall (1984)

$$\boxed{H_f = H_o - (x + h_a)}$$

H_f = 19.43 cm in formation
0.638 ft in formation

Method of Ballestero et. al. (1994)

$$\boxed{H_f = ((1 - \rho_o) \bullet H_0) - h_a}$$

H_f = 19.43 cm in formation
0.638 ft in formation

Method of Schiegg (1985)

$$\boxed{H_f = H_0 - 2(h_{c,dr})}$$

H_f = -62.28 cm in formation
-2.04 ft in formation

Method of Farr et. al. (1990)

$$\boxed{H_f = \emptyset(1 - S_r^{\square})D\left[\frac{H_0}{D} - 1\right]}$$

$$\boxed{D = \frac{P_d^{ow}}{\Delta\rho g} - \frac{P_d^{ao}}{\rho_o g}}$$

D = 0.019
H_f = 10.60 cm in formation
0.35 ft in formation

Method of Lenhard and Parker (1990)

$$\boxed{H_f = \left[\frac{\rho_0\beta_{ao}H_0}{\rho_0\beta_{ao} - \beta_{ow}(1 - \rho_0}\right] - h_{c,dr}}$$

$$\boxed{\beta_{ao} = \frac{\sigma_{aw}}{\sigma_{ao}}} \qquad \boxed{\beta_{ow} = \frac{\sigma_{aw}}{\sigma_{ow}}}$$

β_{ao} = 3.272727
β_{ow} = 1.44
H_f = 21.08 cm in formation
0.69 ft in formation

Variables for MPE-1

3.27		β_{ao}	air-oil scaling factor
1.44		β_{ow}	oil-water scaling factor
0.019		D	function of interfluid displacement pressure and hydrostatics
0.25	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
193.55	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
0.75	g/cm^3	ρ_o	density of hydrocarbon liquid
0.150		ϕ	soil porosity
72	dynes/cm	σ_{aw}	surface tension of water
22	dynes/cm	σ_{ao}	surface tension of hydrocarbon
50	dynes/cm	σ_{ow}	hydrocarbon-water interfacial tension
0.091		S_r	residual saturation
145.2	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:

🟨	Value from EPA 510-R-96-001 Appendix
🟪	Value from field approximations
🟦	Calculated value

THICKNESS CALCULATIONS FOR MPE-1

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.

1.58	Average of the 5 methods with reasonable values (ft)
1.76	Median of the 7 methods with positive thicknesses (ft)
0.87	Min of the 7 methods with positive thicknesses (ft)
5.94	Max of the 7 methods with positive thicknesses (ft)

Method of de Pastrovich (1979)

$$\boxed{H_f = \frac{H_0(\rho_w - \rho_o)}{\rho_o}}$$

H_f = 64.52 cm in formation
2.12 ft in formation

Method of Hall, et. al. (1984)

$$\boxed{H_f = H_0 - F}$$

H_f = 181.05 cm in formation
5.94 ft in formation

Method of Blake and Hall (1984)

$$\boxed{H_f = H_o - (x + h_a)}$$

H_f = 48.39 cm in formation
1.588 ft in formation

Method of Ballestero et. al. (1994)

$$\boxed{H_f = ((1 - \rho_o) \bullet H_0) - h_a}$$

H_f = 48.39 cm in formation
1.588 ft in formation

Method of Schiegg (1985)

$$\boxed{H_f = H_0 - 2(h_{c,dr})}$$

H_f = 53.55 cm in formation
1.76 ft in formation

Method of Farr et. al. (1990)

$$\boxed{H_f = \emptyset(1 - S_r)D\left[\frac{H_0}{D} - 1\right]}$$

$$\boxed{D = \frac{P_d^{ow}}{\Delta\rho g} - \frac{P_d^{ao}}{\rho_o g}}$$

D = 0.019
H_f = 26.39 cm in formation
0.87 ft in formation

Method of Lenhard and Parker (1990)

$$\boxed{H_f = \left[\frac{\rho_0\beta_{ao}H_0}{\rho_0\beta_{ao} - \beta_{ow}(1 - \rho_0}\right] - h_{c,dr}}$$

$$\boxed{\beta_{ao} = \frac{\sigma_{aw}}{\sigma_{ao}}} \qquad \boxed{\beta_{ow} = \frac{\sigma_{aw}}{\sigma_{ow}}}$$

β_{ao} = 3.272727
β_{ow} = 1.44
H_f = 156.81 cm in formation
5.14 ft in formation

Table 2. Summary of measured and calculated product thicknesses, LNAPL Volume, and recoverable LNAPL

			Calculated from EPA document			
Well	Area	Measured NAPL well thickness[A]	Avg. LNAPL formation thickness for well	LNAPL formation thickness for plume area	Calculated LNAPL volume	Recoverable LNAPL volume
	ft^2	ft	ft	ft	gal	gal
Lovington 66 Monitoring wells						
W-1	2,279	6.04	1.46	1.02	2,615	1,569
W-2	1,379	6.39	1.60	1.12	1,732	1,039
W-3	2,174	6.20	1.52	1.07	2,602	1,561
MPE-1	1,119	6.35	1.58	1.11	1,391	835
Allsups #109 Monitoring Wells						
W-14	2,249	5.52	1.26	0.88	2,219	1,331
MW-3	2,597	2.55	0.63	0.44	1,291	775
Totals	11,797				11,850	7,110

Values Used in Calculations	
Assumed porosity	15%
Well density adjustment factor	70%
Conversion from CF to gal	7.481
Assumed recoverable LNAPL	60%

Notes

A. Measured LNAPL = thickness in the well casing (2018)

Table 3.

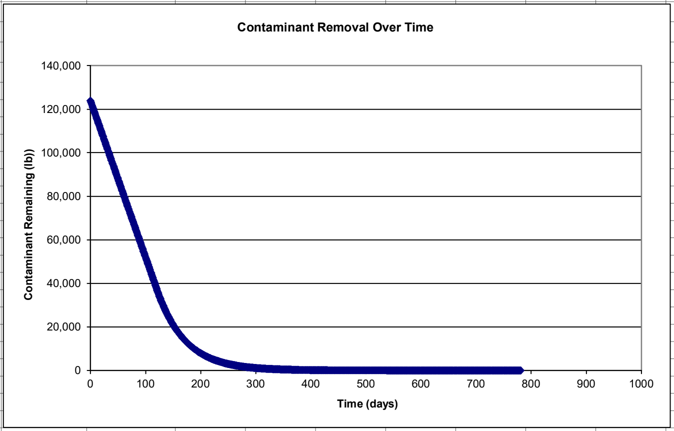
Location	Area	Estimated LNAPL formation thickness	Calculated LNAPL volume	Recoverable LNAPL volume
	ft^2	ft	gal	gal
Lovington 66	6,951	see Table 2	8,340	5,004
Allsups #109	4,846	see Table 2	3,510	2,106
NMDOT ROW	12,234	0.75	10,296	6,178
Totals	24,031		22,146	13,288

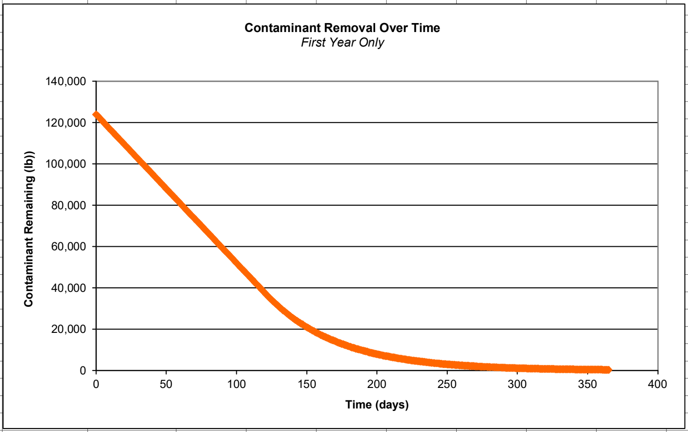
Time (days)	Contaminant Remaining (pounds)	Maximum SVE Flowrate (acfm)	SVE Vapor Concentration (µg/L)	Daily Removal (lbs/day)	Daily Emissions (lbs/day)
0	123,874	800	105,131	719	7
1	123,155	800	103,100	719	7
2	122,436	800	101,107	719	7
3	121,718	800	99,154	719	7
4	120,999	800	97,238	719	7
5	120,280	800	95,359	719	7
6	119,561	800	93,516	719	7
7	118,843	800	91,709	719	7
8	118,124	800	89,937	719	7
9	117,405	800	88,199	719	7
10	116,686	800	86,495	719	7
11	115,968	800	84,823	719	7
12	115,249	800	83,184	719	7
13	114,530	800	81,577	719	7
14	113,811	800	80,000	719	7
15	113,093	800	78,454	719	7
16	112,374	800	76,938	719	7
17	111,655	800	75,452	719	7
18	110,936	800	73,994	719	7
19	110,218	800	72,564	719	7
20	109,499	800	71,162	719	7
21	108,780	800	69,787	719	7
22	108,061	800	68,438	719	7
23	107,343	800	67,116	719	7
24	106,624	800	65,819	719	7
25	105,905	800	64,547	719	7
26	105,186	800	63,300	719	7
27	104,468	800	62,076	719	7
28	103,749	800	60,877	719	7
29	103,030	800	59,701	719	7
30	102,311	800	58,547	719	7
31	101,593	800	57,416	719	7
32	100,874	800	56,306	719	7
33	100,155	800	55,218	719	7
34	99,437	800	54,151	719	7
35	98,718	800	53,105	719	7
36	97,999	800	52,079	719	7
37	97,280	800	51,072	719	7
38	96,562	800	50,085	719	7
39	95,843	800	49,118	719	7
40	95,124	800	48,168	719	7
41	94,405	800	47,238	719	7
42	93,687	800	46,325	719	7
43	92,968	800	45,430	719	7
44	92,249	800	44,552	719	7
45	91,530	800	43,691	719	7
46	90,812	800	42,847	719	7
47	90,093	800	42,019	719	7
48	89,374	800	41,207	719	7
49	88,655	800	40,411	719	7
50	87,937	800	39,630	719	7
51	87,218	800	38,864	719	7
52	86,499	800	38,113	719	7
53	85,780	800	37,376	719	7
54	85,062	800	36,654	719	7
55	84,343	800	35,946	719	7
56	83,624	800	35,251	719	7
57	82,905	800	34,570	719	7
58	82,187	800	33,902	719	7
59	81,468	800	33,247	719	7
60	80,749	800	32,605	719	7
61	80,030	800	31,975	719	7
62	79,312	800	31,357	719	7
63	78,593	800	30,751	719	7
64	77,874	800	30,157	719	7
65	77,156	800	29,574	719	7
66	76,437	800	29,002	719	7
67	75,718	800	28,442	719	7
68	74,999	800	27,892	719	7
69	74,281	800	27,353	719	7
70	73,562	800	26,825	719	7
71	72,843	800	26,306	719	7
72	72,124	800	25,798	719	7
73	71,406	800	25,300	719	7
74	70,687	800	24,811	719	7
75	69,968	800	24,331	719	7
76	69,249	800	23,861	719	7
77	68,531	800	23,400	719	7
78	67,812	800	22,948	719	7
79	67,093	800	22,504	719	7
80	66,374	800	22,070	719	7
81	65,656	800	21,643	719	7
82	64,937	800	21,225	719	7
83	64,218	800	20,815	719	7
84	63,499	800	20,413	719	7
85	62,781	800	20,018	719	7
86	62,062	800	19,631	719	7
87	61,343	800	19,252	719	7
88	60,624	800	18,880	719	7
89	59,906	800	18,515	719	7
90	59,187	800	18,157	719	7
91	58,468	800	17,806	719	7
92	57,749	800	17,462	719	7
93	57,031	800	17,125	719	7
94	56,312	800	16,794	719	7
95	55,593	800	16,470	719	7
96	54,874	800	16,151	719	7
97	54,156	800	15,839	719	7
98	53,437	800	15,533	719	7
99	52,718	800	15,233	719	7
100	52,000	800	14,939	719	7
101	51,281	800	14,650	719	7
102	50,562	800	14,367	719	7
103	49,843	800	14,089	719	7
104	49,125	800	13,817	719	7
105	48,406	800	13,550	719	7
106	47,687	800	13,288	719	7
107	46,968	800	13,031	719	7

k=	0.0195126	
1 m^3 =	35.31	ft^3
1 lb =	453,592	mg
γ_w =	62.4	lb/ft^3
1 ft^3 =	7.48	gal
1 day =	1,440	min
1 ton =	2000	lb

Contaminant removed in first year =	123,558	lb		
Estimated first year removal rate =	61.8	ton/yr	14.1048	lb/hr
Contaminant removed in second year =	309	lb		
Estimated second year removal rate =	0.2	ton/yr	0.035323	lb/hr
Contaminant removed in life of project =	31.0	tons		

5982.4





Time (days)	Contaminant Remaining (pounds)	Maximum SVE Flowrate (acfm)	SVE Vapor Concentration (µg/L)	Daily Removal (lbs/day)	Daily Emissions (lbs/day)
108	46,250	800	12,780	719	7
109	45,531	800	12,533	719	7
110	44,812	800	12,290	719	7
111	44,093	800	12,053	719	7
112	43,375	800	11,820	719	7
113	42,656	800	11,592	719	7
114	41,937	800	11,368	719	7
115	41,218	800	11,148	719	7
116	40,500	800	10,933	719	7
117	39,781	800	10,721	719	7
118	39,062	800	10,514	719	7
119	38,343	800	10,311	719	7
120	37,625	800	10,112	719	7
121	36,906	800	9,916	713	7
122	36,193	800	9,725	699	7
123	35,493	800	9,537	686	7
124	34,808	800	9,353	673	7
125	34,135	800	9,172	660	7
126	33,475	800	8,995	647	6
127	32,828	800	8,821	634	6
128	32,194	800	8,650	622	6
129	31,572	800	8,483	610	6
130	30,962	800	8,319	598	6
131	30,364	800	8,158	587	6
132	29,777	800	8,001	575	6
133	29,202	800	7,846	564	6
134	28,637	800	7,695	553	6
135	28,084	800	7,546	543	5
136	27,541	800	7,400	532	5
137	27,009	800	7,257	522	5
138	26,487	800	7,117	512	5
139	25,975	800	6,979	502	5
140	25,473	800	6,844	492	5
141	24,981	800	6,712	483	5
142	24,498	800	6,583	473	5
143	24,025	800	6,455	464	5
144	23,561	800	6,331	455	5
145	23,105	800	6,208	446	4
146	22,659	800	6,088	438	4
147	22,221	800	5,971	429	4
148	21,792	800	5,855	421	4
149	21,371	800	5,742	413	4
150	20,958	800	5,631	405	4
151	20,553	800	5,522	397	4
152	20,156	800	5,416	389	4
153	19,766	800	5,311	382	4
154	19,384	800	5,208	375	4
155	19,010	800	5,108	367	4
156	18,642	800	5,009	360	4
157	18,282	800	4,912	353	4
158	17,929	800	4,817	346	3
159	17,582	800	4,724	340	3
160	17,243	800	4,633	333	3
161	16,909	800	4,543	327	3
162	16,583	800	4,456	320	3
163	16,262	800	4,370	314	3
164	15,948	800	4,285	308	3
165	15,640	800	4,202	302	3
166	15,338	800	4,121	296	3
167	15,041	800	4,041	291	3
168	14,750	800	3,963	285	3
169	14,465	800	3,887	280	3
170	14,186	800	3,812	274	3
171	13,912	800	3,738	269	3
172	13,643	800	3,666	264	3
173	13,379	800	3,595	259	3
174	13,121	800	3,525	254	3
175	12,867	800	3,457	249	2
176	12,619	800	3,391	244	2
177	12,375	800	3,325	239	2
178	12,136	800	3,261	235	2
179	11,901	800	3,198	230	2
180	11,671	800	3,136	226	2
181	11,446	800	3,075	221	2
182	11,224	800	3,016	217	2
183	11,008	800	2,958	213	2
184	10,795	800	2,901	209	2
185	10,586	800	2,844	205	2
186	10,382	800	2,790	201	2
187	10,181	800	2,736	197	2
188	9,984	800	2,683	193	2
189	9,791	800	2,631	189	2
190	9,602	800	2,580	186	2
191	9,417	800	2,530	182	2
192	9,235	800	2,481	178	2
193	9,056	800	2,433	175	2
194	8,881	800	2,386	172	2
195	8,710	800	2,340	168	2
196	8,541	800	2,295	165	2
197	8,376	800	2,251	162	2
198	8,214	800	2,207	159	2
199	8,056	800	2,165	156	2
200	7,900	800	2,123	153	2
201	7,747	800	2,082	150	1
202	7,598	800	2,041	147	1
203	7,451	800	2,002	144	1
204	7,307	800	1,963	141	1
205	7,166	800	1,925	138	1
206	7,027	800	1,888	136	1
207	6,891	800	1,852	133	1
208	6,758	800	1,816	131	1
209	6,628	800	1,781	128	1
210	6,500	800	1,746	126	1
211	6,374	800	1,713	123	1
212	6,251	800	1,680	121	1
213	6,130	800	1,647	118	1
214	6,012	800	1,615	116	1
215	5,895	800	1,584	114	1
216	5,781	800	1,553	112	1

Time (days)	Contaminant Remaining (pounds)	Maximum SVE Flowrate (acfm)	SVE Vapor Concentration (µg/L)	Daily Removal (lbs/day)	Daily Emissions (lbs/day)
217	5,670	800	1,523	110	1
218	5,560	800	1,494	107	1
219	5,453	800	1,465	105	1
220	5,347	800	1,437	103	1
221	5,244	800	1,409	101	1
222	5,143	800	1,382	99	1
223	5,043	800	1,355	97	1
224	4,946	800	1,329	96	1
225	4,850	800	1,303	94	1
226	4,757	800	1,278	92	1
227	4,665	800	1,253	90	1
228	4,575	800	1,229	88	1
229	4,486	800	1,205	87	1
230	4,399	800	1,182	85	1
231	4,314	800	1,159	83	1
232	4,231	800	1,137	82	1
233	4,149	800	1,115	80	1
234	4,069	800	1,093	79	1
235	3,990	800	1,072	77	1
236	3,913	800	1,052	76	1
237	3,838	800	1,031	74	1
238	3,764	800	1,011	73	1
239	3,691	800	992	71	1
240	3,620	800	973	70	1
241	3,550	800	954	69	1
242	3,481	800	935	67	1
243	3,414	800	917	66	1
244	3,348	800	900	65	1
245	3,283	800	882	63	1
246	3,220	800	865	62	1
247	3,157	800	848	61	1
248	3,096	800	832	60	1
249	3,037	800	816	59	1
250	2,978	800	800	58	1
251	2,920	800	785	56	1
252	2,864	800	770	55	1
253	2,809	800	755	54	1
254	2,754	800	740	53	1
255	2,701	800	726	52	1
256	2,649	800	712	51	1
257	2,598	800	698	50	1
258	2,547	800	685	49	0
259	2,498	800	671	48	0
260	2,450	800	658	47	0
261	2,403	800	646	46	0
262	2,356	800	633	46	0
263	2,311	800	621	45	0
264	2,266	800	609	44	0
265	2,222	800	597	43	0
266	2,179	800	586	42	0
267	2,137	800	574	41	0
268	2,096	800	563	41	0
269	2,055	800	552	40	0
270	2,016	800	542	39	0
271	1,977	800	531	38	0
272	1,939	800	521	37	0
273	1,901	800	511	37	0
274	1,864	800	501	36	0
275	1,828	800	491	35	0
276	1,793	800	482	35	0
277	1,758	800	472	34	0
278	1,724	800	463	33	0
279	1,691	800	454	33	0
280	1,658	800	446	32	0
281	1,626	800	437	31	0
282	1,595	800	429	31	0
283	1,564	800	420	30	0
284	1,534	800	412	30	0
285	1,504	800	404	29	0
286	1,475	800	396	29	0
287	1,447	800	389	28	0
288	1,419	800	381	27	0
289	1,391	800	374	27	0
290	1,364	800	367	26	0
291	1,338	800	360	26	0
292	1,312	800	353	25	0
293	1,287	800	346	25	0
294	1,262	800	339	24	0
295	1,238	800	333	24	0
296	1,214	800	326	23	0
297	1,190	800	320	23	0
298	1,167	800	314	23	0
299	1,145	800	308	22	0
300	1,122	800	302	22	0
301	1,101	800	296	21	0
302	1,080	800	290	21	0
303	1,059	800	284	20	0
304	1,038	800	279	20	0
305	1,018	800	274	20	0
306	998	800	268	19	0
307	979	800	263	19	0
308	960	800	258	19	0
309	942	800	253	18	0
310	923	800	248	18	0
311	906	800	243	18	0
312	888	800	239	17	0
313	871	800	234	17	0
314	854	800	230	17	0
315	838	800	225	16	0
316	821	800	221	16	0
317	806	800	216	16	0
318	790	800	212	15	0
319	775	800	208	15	0
320	760	800	204	15	0
321	745	800	200	14	0
322	731	800	196	14	0
323	717	800	193	14	0
324	703	800	189	14	0
325	689	800	185	13	0

Time (days)	Contaminant Remaining (pounds)	Maximum SVE Flowrate (acfm)	SVE Vapor Concentration (µg/L)	Daily Removal (lbs/day)	Daily Emissions (lbs/day)		
326	676	800	182	13	0		
327	663	800	178	13	0		
328	650	800	175	13	0		
329	637	800	171	12	0		
330	625	800	168	12	0		
331	613	800	165	12	0		
332	601	800	162	12	0		
333	590	800	158	11	0		
334	578	800	155	11	0		
335	567	800	152	11	0		
336	556	800	149	11	0		
337	545	800	147	11	0		
338	535	800	144	10	0		
339	524	800	141	10	0		
340	514	800	138	10	0		
341	504	800	136	10	0		
342	495	800	133	10	0		
343	485	800	130	9	0		
344	476	800	128	9	0		
345	466	800	125	9	0		
346	457	800	123	9	0		
347	449	800	121	9	0		
348	440	800	118	9	0		
349	431	800	116	8	0		
350	423	800	114	8	0		
351	415	800	112	8	0		
352	407	800	109	8	0		
353	399	800	107	8	0		
354	391	800	105	8	0		
355	384	800	103	7	0		
356	376	800	101	7	0		
357	369	800	99	7	0		
358	362	800	97	7	0		
359	355	800	95	7	0		
360	348	800	94	7	0		
361	341	800	92	7	0		
362	335	800	90	6	0		
363	328	800	88	6	0		
364	322	800	87	6	0		
365	316	800	85	6	0		Year 1
366	310	800	83	6	0		
367	304	800	82	6	0		
368	298	800	80	6	0		
369	292	800	78	6	0		
370	286	800	77	6	0		
371	281	800	75	5	0		
372	275	800	74	5	0		
373	270	800	73	5	0		
374	265	800	71	5	0		
375	260	800	70	5	0		
376	255	800	68	5	0		
377	250	800	67	5	0		
378	245	800	66	5	0		
379	240	800	65	5	0		
380	236	800	63	5	0		
381	231	800	62	4	0		
382	227	800	61	4	0		
383	222	800	60	4	0		
384	218	800	59	4	0		
385	214	800	57	4	0		
386	210	800	56	4	0		
387	205	800	55	4	0		
388	201	800	54	4	0		
389	198	800	53	4	0		
390	194	800	52	4	0		
391	190	800	51	4	0		
392	186	800	50	4	0		
393	183	800	49	4	0		
394	179	800	48	3	0		
395	176	800	47	3	0		
396	172	800	46	3	0		
397	169	800	45	3	0		
398	166	800	45	3	0		
399	163	800	44	3	0		
400	159	800	43	3	0		
401	156	800	42	3	0		
402	153	800	41	3	0		
403	150	800	40	3	0		
404	147	800	40	3	0		
405	145	800	39	3	0		
406	142	800	38	3	0		
407	139	800	37	3	0		
408	136	800	37	3	0		
409	134	800	36	3	0		
410	131	800	35	3	0		
411	129	800	35	2	0		
412	126	800	34	2	0		
413	124	800	33	2	0		
414	121	800	33	2	0		
415	119	800	32	2	0		
416	117	800	31	2	0		
417	114	800	31	2	0		
418	112	800	30	2	0		
419	110	800	30	2	0		
420	108	800	29	2	0		
421	106	800	28	2	0		
422	104	800	28	2	0		
423	102	800	27	2	0		
424	100	800	27	2	0		
425	98	800	26	2	0		
426	96	800	26	2	0		
427	94	800	25	2	0		
428	92	800	25	2	0		
429	90	800	24	2	0		
430	89	800	24	2	0		
431	87	800	23	2	0		
432	85	800	23	2	0		
433	84	800	23	2	0		
434	82	800	22	2	0		

Time (days)	Contaminant Remaining (pounds)	Maximum SVE Flowrate (acfm)	SVE Vapor Concentration (µg/L)	Daily Removal (lbs/day)	Daily Emissions (lbs/day)
435	80	800	22	2	0
436	79	800	21	2	0
437	77	800	21	1	0
438	76	800	20	1	0
439	74	800	20	1	0
440	73	800	20	1	0
441	72	800	19	1	0
442	70	800	19	1	0
443	69	800	19	1	0
444	67	800	18	1	0
445	66	800	18	1	0
446	65	800	17	1	0
447	64	800	17	1	0
448	62	800	17	1	0
449	61	800	16	1	0
450	60	800	16	1	0
451	59	800	16	1	0
452	58	800	16	1	0
453	57	800	15	1	0
454	56	800	15	1	0
455	54	800	15	1	0
456	53	800	14	1	0
457	52	800	14	1	0
458	51	800	14	1	0
459	50	800	14	1	0
460	49	800	13	1	0
461	48	800	13	1	0
462	47	800	13	1	0
463	47	800	13	1	0
464	46	800	12	1	0
465	45	800	12	1	0
466	44	800	12	1	0
467	43	800	12	1	0
468	42	800	11	1	0
469	41	800	11	1	0
470	41	800	11	1	0
471	40	800	11	1	0
472	39	800	11	1	0
473	38	800	10	1	0
474	38	800	10	1	0
475	37	800	10	1	0
476	36	800	10	1	0
477	35	800	10	1	0
478	35	800	9	1	0
479	34	800	9	1	0
480	33	800	9	1	0
481	33	800	9	1	0
482	32	800	9	1	0
483	31	800	8	1	0
484	31	800	8	1	0
485	30	800	8	1	0
486	30	800	8	1	0
487	29	800	8	1	0
488	29	800	8	1	0
489	28	800	8	1	0
490	27	800	7	1	0
491	27	800	7	1	0
492	26	800	7	1	0
493	26	800	7	1	0
494	25	800	7	0	0
495	25	800	7	0	0
496	24	800	7	0	0
497	24	800	6	0	0
498	23	800	6	0	0
499	23	800	6	0	0
500	23	800	6	0	0
501	22	800	6	0	0
502	22	800	6	0	0
503	21	800	6	0	0
504	21	800	6	0	0
505	20	800	6	0	0
506	20	800	5	0	0
507	20	800	5	0	0
508	19	800	5	0	0
509	19	800	5	0	0
510	19	800	5	0	0
511	18	800	5	0	0
512	18	800	5	0	0
513	17	800	5	0	0
514	17	800	5	0	0
515	17	800	5	0	0
516	16	800	4	0	0
517	16	800	4	0	0
518	16	800	4	0	0
519	16	800	4	0	0
520	15	800	4	0	0
521	15	800	4	0	0
522	15	800	4	0	0
523	14	800	4	0	0
524	14	800	4	0	0
525	14	800	4	0	0
526	14	800	4	0	0
527	13	800	4	0	0
528	13	800	4	0	0
529	13	800	3	0	0
530	13	800	3	0	0
531	12	800	3	0	0
532	12	800	3	0	0
533	12	800	3	0	0
534	12	800	3	0	0
535	11	800	3	0	0
536	11	800	3	0	0
537	11	800	3	0	0
538	11	800	3	0	0
539	10	800	3	0	0
540	10	800	3	0	0
541	10	800	3	0	0
542	10	800	3	0	0
543	10	800	3	0	0

Time (days)	Contaminant Remaining (pounds)	Maximum SVE Flowrate (acfm)	SVE Vapor Concentration (µg/L)	Daily Removal (lbs/day)	Daily Emissions (lbs/day)
544	10	800	3	0	0
545	9	800	3	0	0
546	9	800	2	0	0
547	9	800	2	0	0
548	9	800	2	0	0
549	9	800	2	0	0
550	8	800	2	0	0
551	8	800	2	0	0
552	8	800	2	0	0
553	8	800	2	0	0
554	8	800	2	0	0
555	8	800	2	0	0
556	7	800	2	0	0
557	7	800	2	0	0
558	7	800	2	0	0
559	7	800	2	0	0
560	7	800	2	0	0
561	7	800	2	0	0
562	7	800	2	0	0
563	7	800	2	0	0
564	6	800	2	0	0
565	6	800	2	0	0
566	6	800	2	0	0
567	6	800	2	0	0
568	6	800	2	0	0
569	6	800	2	0	0
570	6	800	2	0	0
571	6	800	2	0	0
572	5	800	1	0	0
573	5	800	1	0	0
574	5	800	1	0	0
575	5	800	1	0	0
576	5	800	1	0	0
577	5	800	1	0	0
578	5	800	1	0	0
579	5	800	1	0	0
580	5	800	1	0	0
581	5	800	1	0	0
582	4	800	1	0	0
583	4	800	1	0	0
584	4	800	1	0	0
585	4	800	1	0	0
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588	4	800	1	0	0
589	4	800	1	0	0
590	4	800	1	0	0
591	4	800	1	0	0
592	4	800	1	0	0
593	4	800	1	0	0
594	4	800	1	0	0
595	3	800	1	0	0
596	3	800	1	0	0
597	3	800	1	0	0
598	3	800	1	0	0
599	3	800	1	0	0
600	3	800	1	0	0
601	3	800	1	0	0
602	3	800	1	0	0
603	3	800	1	0	0
604	3	800	1	0	0
605	3	800	1	0	0
606	3	800	1	0	0
607	3	800	1	0	0
608	3	800	1	0	0
609	3	800	1	0	0
610	3	800	1	0	0
611	2	800	1	0	0
612	2	800	1	0	0
613	2	800	1	0	0
614	2	800	1	0	0
615	2	800	1	0	0
616	2	800	1	0	0
617	2	800	1	0	0
618	2	800	1	0	0
619	2	800	1	0	0
620	2	800	1	0	0
621	2	800	1	0	0
622	2	800	1	0	0
623	2	800	1	0	0
624	2	800	1	0	0
625	2	800	1	0	0
626	2	800	1	0	0
627	2	800	1	0	0
628	2	800	1	0	0
629	2	800	0	0	0
630	2	800	0	0	0
631	2	800	0	0	0
632	2	800	0	0	0
633	2	800	0	0	0
634	2	800	0	0	0
635	2	800	0	0	0
636	1	800	0	0	0
637	1	800	0	0	0
638	1	800	0	0	0
639	1	800	0	0	0
640	1	800	0	0	0
641	1	800	0	0	0
642	1	800	0	0	0
643	1	800	0	0	0
644	1	800	0	0	0
645	1	800	0	0	0
646	1	800	0	0	0
647	1	800	0	0	0
648	1	800	0	0	0
649	1	800	0	0	0
650	1	800	0	0	0
651	1	800	0	0	0
652	1	800	0	0	0

Time (days)	Contaminant Remaining (pounds)	Maximum SVE Flowrate (acfm)	SVE Vapor Concentration (µg/L)	Daily Removal (lbs/day)	Daily Emissions (lbs/day)		
653	1	800	0	0	0		
654	1	800	0	0	0		
655	1	800	0	0	0		
656	1	800	0	0	0		
657	1	800	0	0	0		
658	1	800	0	0	0		
659	1	800	0	0	0		
660	1	800	0	0	0		
661	1	800	0	0	0		
662	1	800	0	0	0		
663	1	800	0	0	0		
664	1	800	0	0	0		
665	1	800	0	0	0		
666	1	800	0	0	0		
667	1	800	0	0	0		
668	1	800	0	0	0		
669	1	800	0	0	0		
670	1	800	0	0	0		
671	1	800	0	0	0		
672	1	800	0	0	0		
673	1	800	0	0	0		
674	1	800	0	0	0		
675	1	800	0	0	0		
676	1	800	0	0	0		
677	1	800	0	0	0		
678	1	800	0	0	0		
679	1	800	0	0	0		
680	1	800	0	0	0		
681	1	800	0	0	0		
682	1	800	0	0	0		
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684	1	800	0	0	0		
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686	0	800	0	0	0		
687	0	800	0	0	0		
688	0	800	0	0	0		
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698	0	800	0	0	0		
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713	0	800	0	0	0		
714	0	800	0	0	0		
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716	0	800	0	0	0		
717	0	800	0	0	0		
718	0	800	0	0	0		
719	0	800	0	0	0		
720	0	800	0	0	0		
721	0	800	0	0	0		
722	0	800	0	0	0		
723	0	800	0	0	0		
724	0	800	0	0	0		
725	0	800	0	0	0		
726	0	800	0	0	0		
727	0	800	0	0	0		
728	0	800	0	0	0		
729	0	800	0	0	0		
730	0	800	0	0	0		Year 2
731	0	800	0	0	0		
732	0	800	0	0	0		
733	0	800	0	0	0		
734	0	800	0	0	0		
735	0	800	0	0	0		
736	0	800	0	0	0		
737	0	800	0	0	0		
738	0	800	0	0	0		
739	0	800	0	0	0		
740	0	800	0	0	0		
741	0	800	0	0	0		
742	0	800	0	0	0		
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744	0	800	0	0	0		
745	0	800	0	0	0		
746	0	800	0	0	0		
747	0	800	0	0	0		
748	0	800	0	0	0		
749	0	800	0	0	0		
750	0	800	0	0	0		
751	0	800	0	0	0		
752	0	800	0	0	0		
753	0	800	0	0	0		
754	0	800	0	0	0		
755	0	800	0	0	0		
756	0	800	0	0	0		
757	0	800	0	0	0		
758	0	800	0	0	0		
759	0	800	0	0	0		
760	0	800	0	0	0		
761	0	800	0	0	0		

Time (days)	Contaminant Remaining (pounds)	Maximum SVE Flowrate (acfm)	SVE Vapor Concentration (µg/L)	Daily Removal (lbs/day)	Daily Emissions (lbs/day)
762	0	800	0	0	0
763	0	800	0	0	0
764	0	800	0	0	0
765	0	800	0	0	0
766	0	800	0	0	0
767	0	800	0	0	0
768	0	800	0	0	0
769	0	800	0	0	0
770	0	800	0	0	0
771	0	800	0	0	0
772	0	800	0	0	0
773	0	800	0	0	0
774	0	800	0	0	0
775	0	800	0	0	0
776	0	800	0	0	0
777	0	800	0	0	0
778	0	800	0	0	0
779	0	800	0	0	0
780	0	800	0	0	0
781	0	800	0	0	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:

105,131	μg/L, estimated initial PSH vapor concentration
19,800	gallons, 90% of estimated initial PSH volume
0.75	estimated PSH specific gravity
123,874	pounds, estimated initial total PSH mass
719	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**	25,000	105,131
Benzene***	500	2,103

Assumptions	
*	Applies to all wells
**	Average measured TPH concentrations from July 2015 pilot test
***	Benzene assumed to be 2% of the TPH
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

VOLUME CALCULATIONS

Total = 22,000 gal

Using SCE to remove 90% of total volume = 19,800 gal

800 acfm removal in LNAPL area, daily volume removal is 1,152,000 ft^3/day

Per Johnson et. al. removal of 1 g of PSH needs 100L of air

100 liter = 3.5336 cubic foot

326,016 grams of contaminant per day
719 pounds per day

1 gram = 2.2046E-03 pound
1 gram = 1.1023E-06 ton

29.95 lbs/hr
0.359 tons per day
131.2 tons per year

Source: AEA: 5/12/2020
Google Earth Pro: 11/2/2020

N

Explanation

- ⊕ Monitor well
- ⊗ Monitor well - destroyed or inaccessible
- ⊙ Monitor well - plugged and abandoned
- ⬚ 30-foot SVE radius of influence
- — Proposed horizontal well (dashes indicate screen section)
- — Approximate LNAPL thickness (feet)

LOVINGTON 66
424 SOUTH MAIN STREET
LOVINGTON, NEW MEXICO

Proposed Technical Approach

Daniel B. Stephens & Associates, Inc.
8/21/2020
JN DB19.1395

S:\PROJECTS\DB19.1395_LOVINGTON_66\GIS\MXDS\ENGINEERING\TECHNICAL_APPROACH2.MXD

Figure 8

Golder Associates

RECEIVED
AUG 12 2015
NMED
PETROLEUM STORAGE TANK BUREAU

August 10, 2015 Project Number: 140-4221

Celestine Ngam
New Mexico Environment Department
Petroleum Storage Tank Bureau
2905 Rodeo Park Drive E., Bldg. 1
Santa Fe, NM 87505

RE: NOTICE OF COMPLETION OF DELIVERABLE ID 17138-3; COMPLETION OF DPE WELL PILOT TEST, LOVINGTON 66, LOVINGTON, NEW MEXICO

FACILITY #: 1489 RELEASE ID#: 1182 WPID#: 17138

Dear Mr. Ngam:

I am transmitting this letter to advise you that Golder has completed the task associated with Deliverable Identification number 17138-3, which included pilot testing a DPE well (DPE-1) at the above referenced site. Proposed equipment and tasks were set forth in our May 7, 2014 workplan.

The pilot well test was completed by AcuVac Remediation, LLC (AcuVac) out of Houston, Texas on July 12 and July 13, 2015. Figure 1 is a map showing the locations of the tested wells and summary results of testing. Attachment A includes photos detailing the specific equipment used and the overall layout of the test. Attachment B includes copies of the raw data and interpretations of the multiphase pilot testing prepared by AcuVac. The tests included an extended (8.6 hour) variable flow rate test of the MPE pilot test well (A-1), an extended constant flow rate test of Well A-1 (6 hours) and short-duration (1 hour) tests of wells W-1 and W-2. Gasoline recovered as LNAPL and vapor mass during the combined testing (16.6 hours, total combined test time) was approximately 229.5 gallons.

The NMED-PSTB agency workplan approval sets forth an approved budget of $26,069.48 for this task; we anticipate that we will issue a claim for the full amount upon receipt of your acceptance of deliverable for deliverable identification number 17138-3. If you have any questions regarding this transmittal, please do not hesitate to contact us.

Sincerely,

GOLDER ASSOCIATES INC.

Clay Kilmer Phil Car

Clay Kilmer
Senior Hydrogeologist

Phillip D. Carrillo
EIT, Civil Engineer

Attachments: Figure 1: Site map showing locations of tested wells and summary MPE test results
Attachment A: Photographic Log
Attachment B: AcuVac Remediation, LLC Report

CK/rj

p:\abq projects\2014 projects\140-4221 walstad pilot testing\deliverables\task 3 - completion and oversight of dpe pilot test and letter report\text\notice of completion - deliverable 17138-3_rev_1.docx

Golder Associates

RECEIVED
AUG 12 2015
NMED
PETROLEUM STORAGE TANK BUREAU

TRANSMITTAL

Date: August 11, 2015

Project No.: 140-4221.3

To: Mr. Celestine Ngam

Company: NMED-PSTB

From: Clay Kilmer, Sr Hydrogeologist

Address:
2905 Rodeo Park Drive E, Bldg. 1
Santa Fe, NM 87505

cc:
Mr. Robert C. Murrell
2317 Tuttington Circle,
Oklahoma, OK 73170
(one copy)

Email: CKilmer@golder.com

RE: **LOVINGTON 66 STATION, PSTB FACILITY #1489, DELIVERABLE ID 17138-3**

☒ Federal Express (priority, standard, **2-day**, 3-day)
☐ UPS
☐ DHL
☐ Email ____________________
☐ U.S. Mail
☐ Courier
☐ Hand Delivery
☐ Other ____________________

Quantity	Item	Description
1	Notice of Completion of DPE Well Pilot Test	Deliverable ID 17138-3, dated August 10, 2015

Notes:
Please call me if you have any questions or concerns at 505-821-3043.

Thank you,

Clay Kilmer

Please advise us if enclosures are not as described.

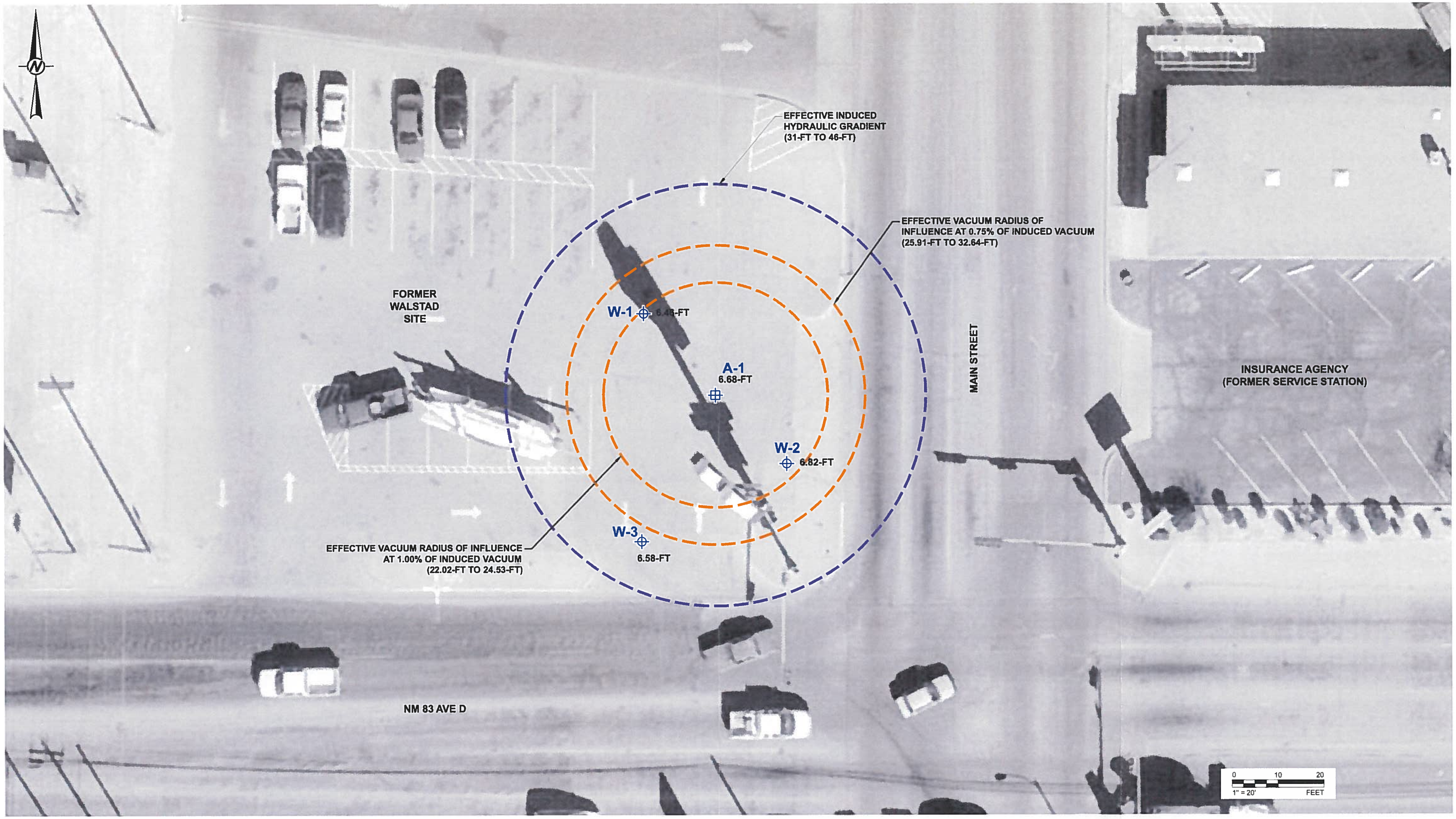
ACKNOWLEDGEMENT REQUIRED:

☐ Yes ☒ No

p:\abq projects\2014 projects\140-4221 walstad pilot testing\deliverables\task 3 - completion and oversight of dpe pilot test and letter report\submittal\transmittal letter nmed.docx

Golder Associates Inc.
5200 Pasadena Avenue N.E., Suite C
Albuquerque, NM 87113 USA
Tel: (505) 821-3043 Fax: (505) 821-5273 www.golder.com

FIGURE



LEGEND

⌖ W-2 6.82-FT	EXISTING MONITORING WELL WITH NAPL THICKNESS (FT)
⊞ A-1 6.68-FT	DUAL PHASE EXTRACTION WELL WITH NAPL THICKNESS (FT)
— — —	EFFECTIVE INDUCED HYDRAULIC GRADIENT
— — —	EFFECTIVE VACUUM RADIUS OF INFLUENCE

CLIENT
NEW MEXICO ENVIRONMENT DEPARTMENT
PETROLEUM STORAGE TANK BUREAU
SANTA FE, NEW MEXICO

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-07-22
DESIGNED	PDC
PREPARED	PDC
REVIEWED	CLK
APPROVED	BN

PROJECT
WALSTAD OIL COMPANY
LOVINGTON 66
LOVINGTON, NEW MEXICO

TITLE
DPE-1 PILOT TEST

PROJECT NO	TASK	REV	FIGURE
140-4221	4	0	1

Path: \\albuquerque\Cad\2014 Projects\1404221\PRODUCTION\ | File Name: 140-4221D001.dwg

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

Attachment A: Photographic Log

PHOTO 1

AcuVac Inc. arrives on set with their rig setup.

2015-07-12

PHOTO 2

The rig from AcuVac for producing the vacuum and oxidizing vapor contamination during the test.

2015-07-12

PHOTO 3

The pilot test was focused on DPE-1.

2015-07-13

PHOTO 4

W-1, W-2, & W-3 were used for monitoring during the test. Pictured is W-1.

2015-07-12

PHOTO 5

W-2 is shown.

2015-07-12

PHOTO 6

W-3 is shown.

2015-07-12

PHOTO 7

AcuVac Inc. installing the apparatus for testing.

2015-07-12

PHOTO 8

The testing setup is shown with the vacuum hose and flowmeter attached to DPE-1.

2015-07-12

PHOTO 9

The rig was used to create the vacuum for the test and oxidize vapor contamination.

2015-07-12

PHOTO 10

The pump test apparatus provided sight on water quality and a sampling port for collecting lab specimens.

2015-07-13

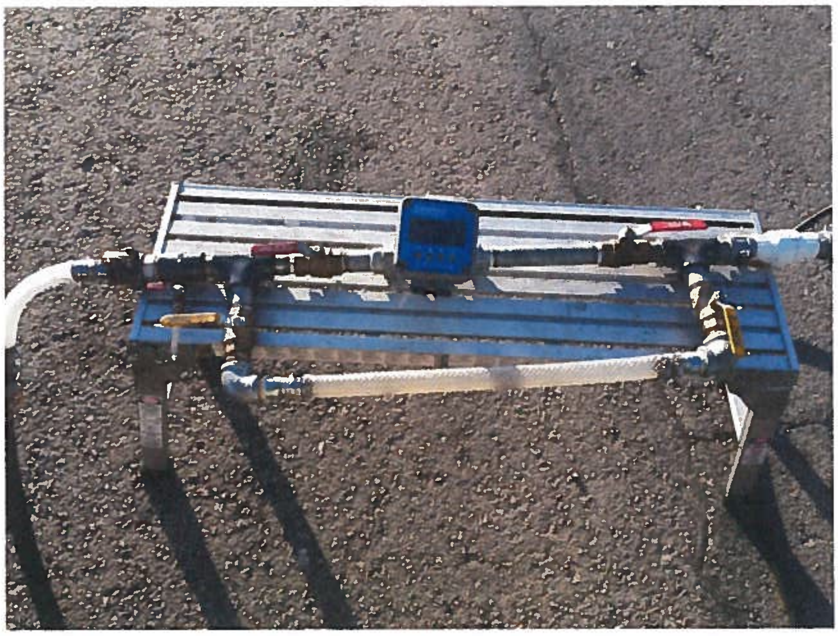


PHOTO 11 The flow meter read flow rate and total gallons pumped. 2015-07-13	
PHOTO 12 A clear portion of the outlet hose shows the condition of water being pumped. 2015-07-13	

PHOTO 13 AcuVac periodically collected water samples to gauge NAPL content. 2015-07-13	
PHOTO 14 Bio-fouling material was observed during the pilot test on day two. 2015-07-13	

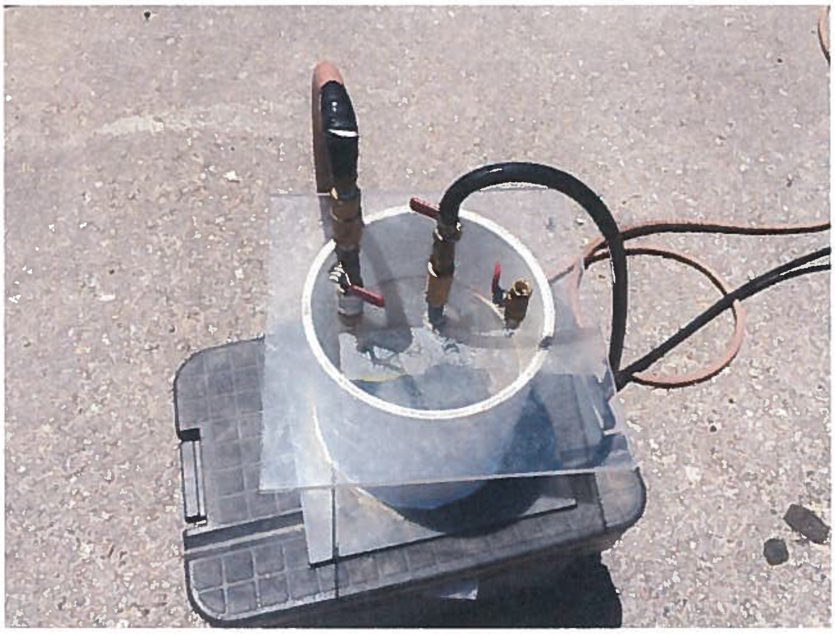
PHOTO 15 The testing apparatus for collecting air monitoring samples as well as the sample submitted for lab testing. 2015-07-12	
PHOTO 16 AcuVac checked the vacuum induced in the surrounding wells with a digital manometer. W-1 shown. 2015-07-12	

PHOTO 17 AcuVac checked the vacuum induced in the surrounding wells with a digital manometer. W-2 shown. 2015-07-12	
PHOTO 18 All produced water was containerized by Gandy in a tanker truck and sent off-site for proper disposal. 2015-07-12	

ATTACHMENT B

ACUVAC REMEDIATION, LLC REPORT

AcuVac Remediation, LLC

1656-H Townhurst, Houston, Texas 77043
713.468.6688 • www.acuvac.com

July 15, 2015

Mr. Clay Kilmer:
Senior Hydrogeologist
Golder Associates, Inc.
5200 Pasadena Avenue N.E. Suite C
Albuquerque, NM 87113

Dear Clay:

Re: Walstadd 66, Lovington, NM

At your request, we performed one Mobile Dual Phase (MDP) Pilot Test on July 12, 2015 at the above referenced sites. An Engineer and an Environmental Specialist, with over 14,500 hours of on-site testing, conducted the Pilot Test. The total MDP test time, including static data time, was 8.6 hours. The contaminant was weathered gasoline.

OBJECTIVES

The Objectives of an MDP Pilot Test are to:

- Evaluate the potential for removing liquid and vapor LNAPL and contaminated groundwater (GW) from soils in the subsurface formations.
- Expose the capillary fringe area and below to induced soil vacuum extraction (SVE) in the extraction well (EW).
- With induced vacuums, increase the GW specific yields. Stress the GW System and monitor its response.
- Maintain a near constant GW depression in the EW.
- Create an induced hydraulic gradient (IHG) to gain hydraulic control of the area.
- Record GW depression and pump rates to accomplish the above objectives.

The purpose of the EW induced vacuum variable rate test is to define the pressure/flow characteristics of sub-surface soils around the EW and to estimate potential conditions for an operational Dual Phase System. Starting a test with lower variable rates of vacuum and flow allows the EW and outer wells sufficient time to adjust and stabilize and minimizes the risk of developing preferential paths. This will also assist the development of newly installed extraction wells.

METHODS AND EQUIPMENT

The tests were conducted using AcuVac's I-6 System, with Roots RAI-33 and RAI-22 blowers, various instrumentation, including the HORIBA® Analyzer, Solinst Interface Probes, Lumidor O_2 Meter, vapor flow gauges, liquid volume/flow meter, a sensitive instrument to determine barometric pressure, V-1 vacuum box to capture non-diluted vapor samples, Redi-Flo 2 total fluids (TF) pump and other special equipment. The vacuum extraction portion of the AcuVac System consists of a vacuum pump driven by an internal combustion (IC) engine. The vacuum pump is connected to the extraction well and the vacuum created on the extraction well causes light hydrocarbons in the soil and on the GW to volatilize and flow through a moisture knockout tank, to the vacuum pump and the IC engine where they are burned as part of the normal combustion process. Propane is used as auxiliary fuel to help power the engine if the well vapors do not provide the required BTU.

The GW Extraction is provided by an in-well, Redi-Flo 2 total fluids pump that has the discharge line connected to a total volume meter. The discharge line from the volume meter is then connected to the stand-by tank truck. The electrical power for the GW pump was supplied from a 120v Honda generator. The GW flow rate can be adjusted to maintain a target level. Interface meters are used to measure Depth to Groundwater (DTGW)/Depth to Light Non-Aqueous Petroleum Liquids (DTLNAPL).

The AcuVac IC engine is fully loaded for maximum power that is necessary to achieve and maintain high induced vacuums and/or high well vapor flows required to maximize the vacuum SVE Radius of Influence (ROI) for Pilot Tests and short term Event remediation. The lower part of the IC engine is encased with a liquid collection pan designed to catch any oil drips or liquid leaks if it should occur.

Emissions from the engine are passed through three catalytic converters to ensure maximum destruction of removed hydrocarbon vapors. The engine's fuel to air ratio can be adjusted to maintain efficient combustion. Because the engine is the power source for all IC engine driven equipment, all systems stop when the engine stops. This eliminates any uncontrolled release of hydrocarbons. Since the AcuVac System is held entirely under vacuum, any leaks in the seals or connections are leaked into the System and not emitted into the atmosphere. The engine is automatically shut down by vacuum loss, low oil pressure or overheating.

The design of the AcuVac System enables complete independent control of both the Induced Well Vacuum and the GW pumping functions such that the AcuVac System operator can control the IHG to expose the maximum amount of the formation to SVE. The ability to separate the induced vacuum and liquid flows within the EW improves the LNAPL recovery rates, and enables the test data to be recorded independently. All the systems are properly grounded to eliminate any static electrical charge.

PROJECT SCOPE AND PROCEDURES

- Gauge the DTGW and DTLNAPL in the EW.
- Calculate the Hydro-equivalent in the EW.
- Determine the appropriate placement for the GW pump inlet.

- Calculate the GW depression necessary to gain hydraulic control of the area.
- Record the distances from the selected EW to the outer wells.
- Install the GW pump into the EW (A-1).
- Connect the ground wires for the AcuVac System and Honda generator.
- Set pump and data probe at the selected depth from TOC.
- Connect discharge hoses to liquid volume meter and then connect to the on-site tank truck.
- Connect the AcuVac System to the selected EW manifold and seal the selected outer observation wells with plugs designed to accept magnehelic gauges or digital manometers.
- Record the static well data, DTGW/DTLNAPL, well size, TD, screen intervals and then apply EW induced vacuum. Record the vacuum and well flow, all System data (including fuel flow of propane), temperature and barometric pressure.
- The test procedures are to provide variable rates of induced vacuum and GW pumping rates over the test period.
- Start the GW pump and set at proper flow rate to achieve the selected GW drawdown.
- Monitor the GW pump and adjust the flow to maintain the selected GW drawdown.
- Record pump flow rate and total liquid volume.
- Collect GW/LNAPL samples in a 2,000 ml beaker to determine the percentage of LNAPL in the recovered liquid volume.
- Install and observe the digital manometer on the outer observation wells to determine if the selected EW induced vacuum is in vacuum communication with the outer observation wells.
- Gauge the outer wells to determine the GW drawdown.
- Record the data at a selected interval of time.
- Operate the AcuVac System in such a manner that all well vapors are passed through the engine and catalytic converters, to destruct the contaminants and exhausted, to meet air emission standards. Comply with all security and safety regulations.
- Complete the tests by providing a report consisting of operating and analytical data, projection of SVE radius of influence (ROI), the IHG ROI and the collected volumes of GW and LNAPL.

CONDITIONS AFFECTING PILOT TESTS

- Generally, a decreasing barometric pressure results in increased well pressures (decreased vacuums) on those wells plugged and sealed at the TOC, while an increasing barometric pressure results in increased well vacuums. This is the function of GW levels increasing and decreasing. **There are many variables that can affect Pilot Test data, but barometric pressure fluctuations have the most immediate and profound effect.** This assumes that SVE short-circuiting is not a factor.
- To offset the induced vacuum/pressure as a result of GW depression or upwelling in the outer monitoring wells, the wells are vented periodically to atmosphere and then re-plugged prior to recording data at select intervals. The potential for increased vacuum or pressure as a result of in/decreasing GW levels will be minimized. GW depression surrounding an outer observation well will result in an induced vacuum not associated with the induced vacuum created in the EW. Likewise, GW mounding will create the opposite effect creating well pressures.

TEST #MDP-1
WALSTADD 66
LOVINGTON, NM
JULY 12, 2015

PRE-TEST FUNCTIONS - PILOT TEST #MDP-1

Prior to starting the MDP test with GW Extraction, all systems were checked for normal and safe operation. The DTGW/DTLNAPL, barometric and absolute pressure and ambient air temperature were recorded. The hydro equivalent (HE) was calculated. Based upon the HE, the GW pump inlet was set at 65 ft below the top of the well casing. The pump hose was then connected to the total volume meter. The discharge hose was connected to the on-site 3,000 gal liquid collection tank truck. Each magnehelic gauge was checked and calibrated to zero. The outer monitoring wells were plugged with expandable well plugs designed to accept a digital manometer. Static well data and the atmospheric effect on the outer wells were recorded prior to engaging the AcuVac System. The propane tank fuel level was recorded so that accurate fuel consumption could be estimated for the total test period. All safety checks were performed on the Systems. (See list of Attached Schedules and Figures, Page 11.)

DISCUSSION OF DATA - TEST #MDP-1

Test #MDP-1, with vacuum and GW/LNAPL extraction, was an 8.6 hour MDP test including static well data, conducted from well A-1 as the EW. Immediately prior to starting the test, the selected outer monitoring wells were recording zero vacuums. The general weather conditions were clear and cool. At the start of the MDP test, the EW induced vacuum was set at 40"H_2O, with an initial well vapor flow of 12.19 scfm. The data probe static reading was 7.5 ft, immediately decreasing to 2.0 ft when the GW pump was engaged. Based upon the data probe, it was determined that a constant drawdown creating a GW depression (GWD) of approximately 5.5 ft below HE static level would be appropriate for this test (see Table #1A). The initial GW pump rate was set at 3.5 gpm to achieve the selected GWD and then remained constant for 2.0 hours. The GWD and related GW pump rate are monitored constantly throughout the test and recorded every 30 minutes. Table #1A summarizes the GWD, GW pump rate and the drawdown in the EW and Table #1B summarizes the GWD in the outer observation wells.

During the first 2.0 hours of the test, the EW induced vacuum remained constant at 40"H_2O with a well vapor flow of 12.19 scfm. Outer well W-2, which is located 16.2 ft from the EW, immediately recorded a well vacuum increasing from 0 to 0.07"H_2O and continued on an increasing trend during the test period to 0.88"H_2O. Outer wells W-1 and W-3 which are located 25.8 and 38.3 ft from the EW, recorded a slight increasing vacuum level and then continued on a slight increasing vacuum trend to 0.36 and 0.17"H_2O. The ambient air temperature increased from 72.4 to 79.6°F and the barometric pressure was mostly steady at 30.10"Hg. The GW depression averaged 5.5 ft below static level. The total collected liquid volume was 420 gals and **38.9 gals of liquid LNAPL were observed on the collected GW.**

EXTRACTION WELL A-1
OPERATING DATA TEST #MDP-1
Table #1A

Location: Walstadd 66, Lovington, NM					
Project Date 07/12/2015	**A-1 DTGW ft**	**GWD ft**	**EW GWR gpm**	**Total Volume gal**	**EW Vacuum "H_2O**
Well Data					
TD	75.0	-	-	-	-
Screen	45.0-75.0	-	-	-	-
Well Size	4.0	-	-	-	-
DTGW 0715 hrs	64.08	-	-	-	-
DTGW Hydro Equivalent	59.14	-	-	-	-
DTLNAPL 0715 hrs	57.40	-	-	-	-
LNAPL 0715 hrs	6.68	-	-	-	-
Drawdown Data					
Data Probe 0730 hrs Start	7.50	-	-	-	-
Data Probe 0800 hrs	2.00	-5.50	3.50	105	40
Data Probe 0830 hrs	2.00	-5.50	3.50	210	40
Data Probe 0900 hrs	2.00	-5.50	3.50	315	40
Data Probe 0930 hrs	2.00	-5.50	3.50	420	40
Data Probe 1000 hrs	2.00	-5.50	4.30	549	60
Data Probe 1030 hrs	2.00	-5.50	4.30	678	60
Data Probe 1100 hrs	2.00	-5.50	4.30	807	60
Data Probe 1130 hrs	2.00	-5.50	4.30	936	60
Data Probe 1200 hrs	2.00	-5.50	4.30	1065	60
Data Probe 1230 hrs	2.00	-5.50	4.30	1194	60
Data Probe 1300 hrs	2.00	-5.50	4.30	1323	60
Data Probe 1330 hrs	2.00	-5.50	4.60	1460	75
Data Probe 1400 hrs	2.00	-5.50	4.60	1598	75
Data Probe 1430 hrs	2.00	-5.50	4.60	1736	75
Data Probe 1500 hrs	2.00	-5.50	5.20	1892	90
Data Probe 1530 hrs Stop	2.00	-5.50	5.20	2048	90
Data Probe 1600 hrs Static	7.46	-0.04	0.00	-	-
DTGW 1600 hrs	61.65	-	-	-	-
DTGW Hydro Equivalent	61.64	-	-	-	-
DTLNAPL 1600 hrs	61.61	-	-	-	-
LNAPL 1600 hrs	0.04	-	-	-	-
Average GW Depression	-	-5.50	-	-	-

OBSERVATION WELLS
INDUCED HYDRAULIC GRADIENT DATA
TEST #MDP-1
TABLE #1B

Location: Walstadd 66, Lovington, NM								
Project Date 07/12/2015		**W-2**		**W-1**		**W-3**		
Well Data								
TD	ft	75.0		80.0		75.0		
Screen	ft	50.0 - 70.0		50.0 - 70.0		50.0 - 70.0		
Well Size	in	4.0		4.0		4.0		
		DTGW ft	**Change in GWD ft**	**DTGW ft**	**Change in GWD ft**	**DTGW ft**	**Change in GWD ft**	**GW Pump Rate gpm**
Static/Start Data								
DTGW 0730 hrs	ft	63.92		64.62		63.81		3.50
DTGW Hydro Equivalent	ft	58.87	0	59.84	0	58.94	0	
DTLNAPL 0730 hrs	ft	57.10		58.16		57.23		
LNAPL 0730 hrs	ft	6.82		6.46		6.58		
Drawdown Data								
DTGW 1030 hrs	ft	64.13		64.82		63.87		4.30
DTGW Hydro Equivalent	ft	58.99	-0.11	59.91	-0.07	58.97	-0.03	
DTLNAPL 1030 hrs	ft	57.18		58.19		57.25		
LNAPL 1030 hrs	ft	6.95		6.63		6.62		
Drawdown Data								
DTGW 1330 hrs	ft	64.81		65.28		64.08		4.60
DTGW Hydro Equivalent	ft	59.46	-0.59	60.16	-0.32	59.14	-0.20	
DTLNAPL 1330 hrs	ft	57.58		58.36		57.41		
LNAPL 1330 hrs	ft	7.23		6.92		6.67		
Drawdown Data								
DTGW 1530 hrs	ft	64.91		65.38		64.21		5.20
DTGW Hydro Equivalent	ft	59.53	-0.66	60.21	-0.37	59.18	-0.24	
DTLNAPL 1530 hrs	ft	57.64		58.39		57.41		
LNAPL 1530 hrs	ft	7.27		6.99		6.80		
Maximum Drawdown	ft		-0.66		-0.37		-0.24	
Distance From EW		16.2		25.8		38.3		

Specific Gravity .74

HORIBA® analytical data indicated the two influent vapor samples taken from the EW had HC concentrations of 76,990 and 74,020 ppmv, with CO_2 at 4.72 and 5.12%, CO at 3.82 and 3.09%, O_2 at 6.8 and 6.1% and H_2S at 0 ppm. The propane flow to the IC engine averaged 0 cfh, with a well flow of 12.19 scfm. The influent vapors were supplying 100% of the IC engine required fuel. The HC levels were within the mid to high range normally found in soil gas samples collected from an area contaminated with weathered gasoline.

At test hour 2.0, the test continued with the induced vacuum increased to 60"H_2O and a well flow of 19.88 scfm. The test period was 3.5 hours with the EW induced vacuum and well flow remaining steady. Outer well W-2 continued on an increasing vacuum trend to 1.14"H_2O in response to the EW vacuum increase and then developed a slight decreasing trend when the barometric pressure decreased. Outer wells W-1 and W-3 recorded an increased vacuum trend to 0.43 and 0.15"H_2O and then decreased to 0.38 and 0.12"H_2O. The GW pump rate increased to 4.30 gpm and remained steady during this test period. The collected volume was 903 gals which brings the total to 1,323 gals, with a GW depression average of 5.5 ft. The ambient air temperature increased to 91.8°F and the barometric pressure decreased from 30.10 to 30.07"Hg. The influent vapor temperature increased to 71°F. **A total LNAPL volume of 14.4 gals was observed on the collected GW.**

Additional HORIBA® analytical data indicated the influent vapor samples recorded HC levels of 71,750, 68,490 and 61,890 ppmv, with CO_2 at 4.60, 5.24 and 5.12%, CO at 2.37, 2.55 and 1.88%, O_2 at 5.8, 6.4 and 8.3% and H_2S at 0 ppm. The influent vapors continued to supply 100% of the IC engine's fuel and the TPH levels continued to be within the range of weathered gasoline vapors.

At test hour 5.5, the test continued with the induced vacuum increased to 75"H_2O, and a vapor well flow of 21.34 scfm. The test period was 1.5 hours with the EW vacuum and well flow remaining steady. The outer observation wells, W-2, W-1 and W-3, immediately recorded increased vacuum levels for 1.0 hour, and then developed a decreasing trend as the barometric pressure continued to decrease. This is an excellent example of the effect of barometric pressure oscillations on the vacuum/pressures observed on the outer observation wells. The average GW drawdown in the EW was 5.5 ft. A drawdown of 0.59 ft was recorded in W-2, 0.32 ft in W-1 and 0.2 ft in W-3. The GW pump rate averaged 4.60 gpm with a collected volume 413 gals. The total collected volume increased to 1,736 gals and **7.6 gals of liquid LNAPL was observed on the GW.** The ambient air temperature increased from 91.8 to 93.3°F and the barometric pressure decreased from 30.07 to 30.04"Hg.

Additional HORIBA® analytical data indicated the influent vapor samples recorded a HC level of 61,720 ppmv, with CO_2 at 5.20%, CO at 1.75%, O_2 at 8.7% and H_2S at 0 ppmv. The influent vapors continued to supply 100% of the IC engine's fuel. Although the HORIBA® Analyzer has been proven to be reasonably accurate compared to laboratory analysis of influent vapors, projections should be based on analytical results from a Certified Testing Laboratory qualified to conduct tests on air emission samples.

At test hour 7.0, the test continued with the induced vacuum increased to 90"H_2O and a vapor well flow of 27.95 scfm. The test period was 1.0 hour with the EW vacuum and well flow remaining steady. Outer observation well W-2 recorded an increased vacuum level from 1.10 to 1.23"H_2O and continued to increase to 1.54"H_2O during the test period. Outer well W-1 recorded an increasing vacuum ranging from 0.37 to a maximum of 0.60"H_2O and well W-3 recorded an increase from 0.09 to 0.20"H_2O. The average GW drawdown in the EW was 5.5 ft. A maximum drawdown of 0.66 ft was recorded in W-2, 0.37 ft in W-1 and 0.24 ft in W-3. This was the maximum recorded drawdown before any required well vacuum adjustments resulting from the decreasing barometric pressure. The GW pump rate averaged 5.2 gpm with a collected volume of 312 gals. The total collected volume increased to 2,048 gals and **6.2 gals of liquid LNAPL was observed on the GW.** The ambient air temperature increased from 95.3 to 96.1°F and the barometric pressure decreased from 30.04 to 30.02"Hg.

Immediately before the conclusion of this test period, the outer observation wells were gauged. The gauging data is included on Table #1B.

RADIUS OF INFLUENCE & INDUCED HYDRAULIC GRADIENT

Figure #1A indicates that the effective vacuum radius of influence from Test #MDP-1 with groundwater extraction (GWE) would be from 25.91 to 32.64 ft, with extraction well flow of 22.0 to 24.0 scfm and extraction well vacuum in the 80 to 85"H_2O range. An approximation of the radius of influence may be obtained by determining the point at which the measured vacuum is **0.50 to 0.70"H_2O.** It is assumed that beyond the lower point, the pressure gradient (driving force) is negligible to effectively transport vaporized contaminants to the extraction well. **Under continuous operation, vacuum and radius of influence will most likely continue to increase horizontally and vertically.**

Figure #1B indicates that the effective vacuum radius of influence from Test #MDP-1 with groundwater extraction (GWE) would be from 22.02 to 24.53 ft, with extraction well flow of 22.0 to 24.0 scfm and extraction well vacuum in the 80 to 85"H_2O range. An approximation of the radius of influence may be obtained by determining the point at which the measured vacuum is **0.75 to 0.85"H_2O or approximately 1.0% of the EW induced vacuum.** It is assumed that beyond the lower point, the pressure gradient (driving force) is negligible to effectively transport vaporized contaminants to the extraction well. **Under continuous operation, vacuum and radius of influence will most likely continue to increase horizontally and vertically.**

Figure #2 indicates that the effective induced hydraulic gradient from Test #MDP-1 with vacuum and groundwater extraction would be greater than approximately 31.0 ft, with a pump rate of 4.0 to 4.3 gpm. An approximation of the radius of influence may be obtained by determining the point at which the measured GW level effect on the outer wells is greater than 0.30 ft. At the point at which the measured GW level effect on the outer wells is greater than 0.20 ft, **the effective induced hydraulic gradient with vacuum would be greater than approximately 46 ft. Under continuous operation, the gradient effect of the GW pump rate and depression may cover a larger area.**

The effective vacuum radius of influence is based on calculations and equations using a software program of which data was provided from an extensive database collected by AcuVac over a period of years. Each projection is based on the test data and site parameters, and takes into consideration such variables as barometric pressure oscillations and gauge error. Although we cannot provide total assurance of accuracy, past experience and results have proven these projections to be well within the acceptable range of accuracy.

PRODUCT RECOVERY

A total liquid volume of 2,048 gals were recovered during the test of which 3.11% or 63.64 gals was liquid gasoline. A calculated volume of 22.63 gals of gasoline contaminant were removed as part of the influent vapors and were burned as IC engine fuel bringing the total gasoline recovery to 86.27 gals or an average of 10.78 gals/hr.

GROUNDWATER RECOVERY

GW recovery was monitored in well A-1 for 30 minutes after the vacuum had ceased. The GW recovery was recorded with the interface meter. In 30 minutes, the recovery for A-1 was equal to 54.5% based on the hydro equivalent.

EMISSION DATA

During this Pilot Test, HORIBA® data indicated that the influent vapors had an average hydrocarbon level (TPH) of 69,142 ppmv. Laboratory analysis of influent vapor samples from previous pilot tests indicated that those vapor samples had a benzene level of approximately 2.0% of the 69,142 ppmv. Using an average well flow of 18.83 scfm from this extended test, **the calculated emissions from one extraction well without vapor treatment were as follows:**

HC	=	42.5 lbs/day	=	17.7 lbs/hr
Benzene	=	8.5 lbs/day	=	0.35 lbs/hr

ADDITIONAL INFORMATION

The HORIBA® analytical instrument is calibrated with Hexane and CO_2. One sample was collected for laboratory analysis.

The formula used to calculate the emission rate is:

$$\text{ER} = \text{HC (ppmv)} \times \text{MW (Hexane)} \times \text{Flow Rate (scfm)} \times 1.58\text{E}^{-7}\,\frac{(\text{min})(\text{lb mole})}{(\text{hr})(\text{ppmv})(\text{ft}^3)} = \text{lbs/hr}$$

To calculate MDP well placement, the equation we use is as follows:

L= 2 ROI Cos 30° (L = distance between wells; ROI = radius of influence)

All other data, including the groundwater depth, well placement, extraction well screened intervals, induced vacuum and vapor well flow and liquid recovery rate, must be considered in the final design for a Corrective Action Plan (CAP).

Static (baseline) data, recorded 0.5 hours after the conclusion of the test, indicates that W-1 was recording a pressure of 0.19"H_2O, W-1 was recording a well pressure of 0.15"H_2O and W-3 was recording a well pressure of 0.17"H_2O. The well pressure was the result of the decreasing barometric pressure.

The test provided excellent data to use in the calculation and projection of an SVE vacuum radius of influence and excellent data to project an induced hydraulic gradient.

CONCLUSION

Pilot Tests are conducted to provide information on short term tests that can be projected into long term remedial plans. These feasibility tests indicated that Mobile Dual Phase Extraction (MDP) with groundwater depression should provide an excellent method of remediation for this facility. Although the observed vacuum of the most distant outer monitoring well was moderately low, the duration of the pilot tests was short compared to continuous operation. **However, the tests results provided excellent data to project that wells W-2, W-1 and W-3 were in vacuum communication with the selected extraction well.** The vacuum radius of influence defines the region within which the vapor in the vadose zone flows to the extraction well under the influence of a vacuum. The radius of influence depends on the soil properties of the vented zone, properties of surrounding soil layers, the depth at which the well is screened, well installation and the presence of any impermeable boundaries such as the water table, clay layers, surface seal, building basements and the presence of such areas as tank pits with backfill and underground utilities. **The induced hydraulic gradient (IHG) defines the region within which a selected GW depression is recorded in the outer monitoring wells.** The IHG depends on the hydraulic properties of the underlying sub-surface, aquifer characteristics and the effect of the induced vacuum on specific yields.

SUMMARY AND OBSERVATIONS - TEST #MDP-1

- Based on the recorded test data, the sub-surface medium is most likely isotropic.
- Due to the age of the contaminant, the recovered gasoline may contain tetraethyl lead.
- An average induced vacuum of 60.3"H_2O was required to produce an average well vapor flow of 18.83 scfm. The ratio of the average EW induced vacuum to the EW well flow was 3.21:1.
- The average well flow per foot of EW well screen was 0.96 scfm with a maximum of 1.42 scfm.
- The GW pump rate was increased to provide a sufficient GW depression when the EW induced vacuum was increased. The average GW pump rate was 4.22 gpm with a maximum of 5.20 gpm.
- During each increase of the induced vacuum, outer observation wells W-2, W-1 and W-3 recorded increased vacuum levels. Additionally, GW drawdown in the observation wells continued to decrease during the test period.

- The average maximum percent of induced vacuum observed in outer observation wells W-2 at 16.2 ft was 1.74-2.30%, W-1 at 25.8 ft was 0.66-0.95% and W-3 was 0.25-0.50%.
- The HC levels recorded during the test period were **within** the range normally associated with soil gas samples taken from an area that is highly saturated with weathered gasoline.
- **The test provided excellent data for the calculation and projection of a vacuum radius of influence, excellent data for the projection of an induced hydraulic gradient and excellent data to support the collection and removal of liquid and vapor phase gasoline with Dual Phase Recovery.**
- **SVE without GW extraction would not be an effective remediation option at this site. The higher vacuums would result in GW upwelling in the EW which may cover the well screen and render the SVE ineffective.**

ATTACHED SCHEDULES AND FIGURES

Schedule A: Summary of Data
Schedule B: Graphic Summary of Data
Figure #1A: Plot of Observed Vacuum vs Distance at the Facility (ROI) at 0.75% of Induced Vacuum
Figure #1B: Plot of Observed Vacuum vs Distance at the Facility (ROI) at 1.00% of Induced Vacuum
Figure #2: Plot of Recorded GW Induced Hydraulic Gradient vs Distance at the Facility (ROI)

Additional Information (this should be read as part of the report):

- Field Operating Data and Notes – Test #MDP-1
- Site Photographs

Once you have reviewed the report, please call me if you have any questions.

Sincerely,
ACUVAC REMEDIATION, LLC

Sadler

James E. Sadler,
VP Engineering/Environmental

cc: Paul Faucher

Attachment A

Acronyms and Definitions

A	Annulus - the space between the pipes and lines in the extraction well and the outer casing
ACFM	Actual Cubic Feet Per Minute
AI (AS)	Air Injection (Sparging) the mass transfer of O_2 from air to groundwater
BGL	Below Ground Level
BGS	Below Ground Surface
BP	Barometric Pressure (Atmospheric Pressure)
BTOC	Below Top of Casing
CFH	Cubic Feet Per Hour
DNAPL	Dense Non-Aqueous Petroleum Liquid
DPVE	Dual Phase Vacuum Extraction
DTGW	Depth to Groundwater
DTPSH	Depth to Phase Separated Hydrocarbons/NAPL
DT	Drop Tube
EVR	Enhanced Vacuum Recovery, also referred to as SVE/GWD
EW	Extraction Well
GW	Groundwater
GWD	Groundwater Depression
GWE	Groundwater Extraction
GWUP	Groundwater Upwelling
HC	Hydrocarbon Concentration (Petroleum-TPH)
"H_2O	Inches of Water
"Hg	Inches of Mercury
IHG	Induced Hydraulic Gradient
IV	Induced Vacuum, normally from a vacuum pump connected to the extraction well or vapor recovery well
LNAPL	Light Non-Aqueous Petroleum Liquids
MDP	Mobile Dual Phase
NAPL	Non-Aqueous Petroleum Liquids
P	Pressure, the existence of above atmospheric pressure
ROI	Radius of Influence
RPM	Revolutions Per Minute
SCFM	Standard Cubic Feet Per Minute
SVE	Soil Vacuum Extraction
TD	Total Depth
QT	Quick Test, a short duration SVE Test
V	Vacuum, the existence of below atmospheric pressure
VEGE	Vacuum Enhanced Groundwater Extraction
VER	Vacuum Enhanced Recovery
VEW	Vapor Extraction Well
VWF	Vapor Well Flow
WVF	Well Vapor Flow

SCHEDULE A
Test # MDP-1

7/12/2015	DATA ELEMENT						
	Static 7:25	Start 7:30	8:00	8:30	9:00	9:30	10:00
Influent Vapor Data							
Horiba HC ppmv	ND	ND	76,990	ND	74,020	ND	71,750
Horiba CO_2%	ND	ND	4.72	ND	5.12	ND	4.60
Horiba CO%	ND	ND	3.82	ND	3.09	ND	2.37
Lumidor O_2%	ND	ND	6.8	ND	6.1	ND	5.8
Lumidor H_2S ppm	ND	ND	0	ND	0	ND	0
Influent Vapor Temp °F	OFF	69.0	69.0	69.0	69.0	70.0	70.0
Atmospheric Conditions							
Barometric Pressure "Hg	30.10	30.10	30.10	30.09	30.09	30.10	30.09
Absolute Pressure "Hg	26.09	26.09	26.09	26.08	26.08	26.09	26.08
Groundwater Data							
Groundwater Pump Rate (gpm)	OFF	3.50	3.50	3.50	3.50	3.50	4.30
Total Liquid Vol (gal)	0	0	105	210	315	420	549
Extraction Well Data - Well A-1							
Flow SCFM	OFF	12.19	12.19	12.19	12.19	12.19	19.88
Vacuum "H_2O	OFF	40.0	40.0	40.0	40.0	40.0	60.0
Well Vapor Flow SCFM / "H_2O	OFF	0.30	0.30	0.30	0.30	0.30	0.33
Well Vapor Flow SCFM / ft Well Screen	OFF	0.621	0.621	0.621	0.621	0.621	1.013
Observation Well Data - Vacuum "H_2O							
Well W-2 Dist. 16.2 ft	0.00	0.07	0.86	0.88	0.92	0.88	1.07
Well W-1 Dist. 25.8 ft	0.00	0.05	0.31	0.37	0.38	0.36	0.38
Well W-3 Dist. 38.3 ft	0.00	0.02	0.13	0.17	0.20	0.17	0.14

( ) Indicates Well Pressure
ND - No Recorded Data

SCHEDULE A
Test # MDP-1

7/12/2015	DATA ELEMENT						
	10:30	11:00	11:30	12:00	12:30	13:00	13:30
Influent Vapor Data							
Horiba HC ppmv	ND	68,490	ND	ND	ND	61,880	ND
Horiba CO_2%	ND	5.24	ND	ND	ND	5.12	ND
Horiba CO%	ND	2.55	ND	ND	ND	1.88	ND
Lumidor O_2%	ND	6.4	ND	ND	ND	8.3	ND
Lumidor H_2S ppm	ND	0	ND	ND	ND	0	ND
Influent Vapor Temp °F	70.0	70.0	71.0	71.0	71.0	71.0	71.0
Atmospheric Conditions							
Barometric Pressure "Hg	30.09	30.09	30.09	30.08	30.08	30.07	30.06
Absolute Pressure "Hg	26.08	26.08	26.08	26.07	26.08	26.07	26.06
Groundwater Data							
Groundwater Pump Rate (gpm)	4.30	4.30	4.30	4.30	4.30	4.30	4.60
Total Liquid Vol (gal)	678	807	936	1,065	1,194	1,323	1,460
Extraction Well Data - Well A-1							
Flow SCFM	19.88	19.88	19.88	19.88	19.88	19.88	21.34
Vacuum "H_2O	60.0	60.0	60.0	60.0	60.0	60.0	75.0
Well Vapor Flow SCFM / "H_2O	0.33	0.33	0.33	0.33	0.33	0.33	0.28
Well Vapor Flow SCFM / ft Well Screen	1.013	1.013	1.013	1.013	1.013	1.013	1.087
Observation Well Data - Vacuum "H_2O							
Well W-2 Dist. 16.2 ft	1.09	1.14	1.13	1.12	1.13	1.10	1.14
Well W-1 Dist. 25.8 ft	0.42	0.42	0.41	0.42	0.43	0.38	0.43
Well W-3 Dist. 38.3 ft	0.16	0.16	0.15	0.14	0.15	0.12	0.14

( ) Indicates Well Pressure
ND - No Recorded Data

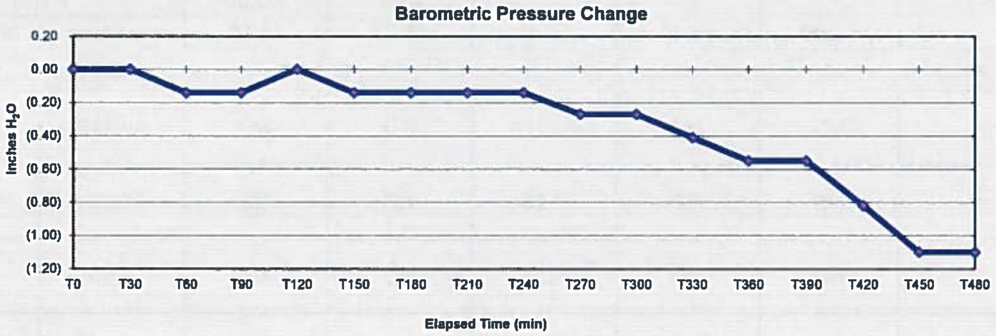
SCHEDULE A
Test # MDP-1

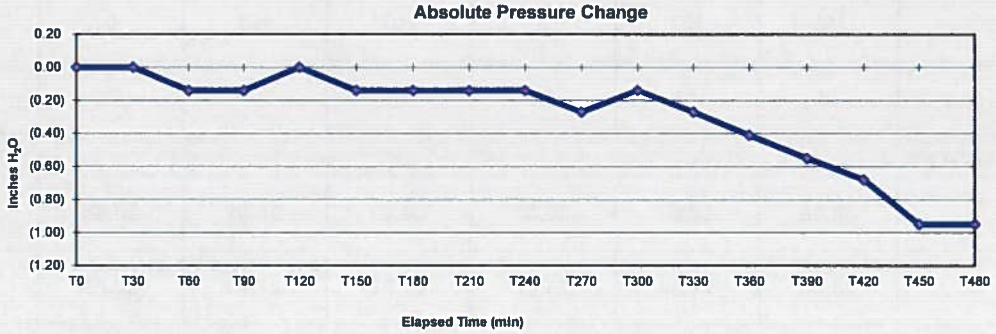
Walstadd 66
Lovington, NM
July 12, 2015

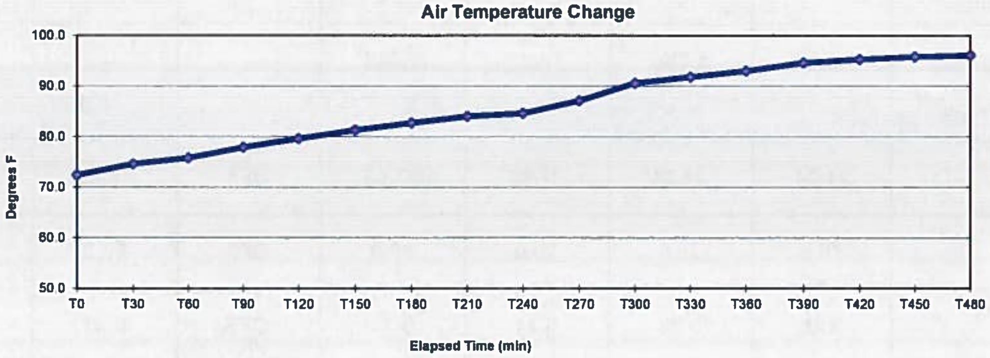
7/12/2015	DATA ELEMENT						
				End	Static	8 Hrs	
	14:00	14:30	15:00	15:30	16:00	Average	Maximum
Influent Vapor Data							
Horiba HC ppmv	ND	ND	61,720	ND	ND	69,142	76,990
Horiba CO_2%	ND	ND	5.20	ND	ND	5.00	5.24
Horiba CO%	ND	ND	1.75	ND	ND	2.58	3.82
Lumidor O_2%	ND	ND	8.7	ND	ND	7.0	8.7
Lumidor H_2S ppm	ND	ND	0	ND	ND	0	0
Influent Vapor Temp °F	71	71	71	72	OFF	70	72
Atmospheric Conditions							
Barometric Pressure "Hg	30.06	30.04	30.02	30.02	30.02	30.08	30.10
Absolute Pressure "Hg	26.05	26.04	26.02	26.02	26.02	26.07	26.09
Groundwater Data							
Groundwater Pump Rate (gpm)	4.60	4.60	5.20	5.20	OFF	4.22	5.20
Total Liquid Vol (gal)	1,598	1,736	1,892	2,048	-	-	-
Extraction Well Data - Well A-1							
Flow SCFM	21.34	21.34	27.95	27.95	OFF	18.83	27.95
Vacuum "H_2O	75.0	75.0	90.0	90.0	OFF	60.3	90.0
Well Vapor Flow SCFM / "H_2O	0.28	0.28	0.31	0.31	OFF	0.31	0.33
Well Vapor Flow SCFM / ft Well Screen	1.087	1.087	1.423	1.423	OFF	0.960	1.420
Observation Well Data - Vacuum "H_2O							
Well W-2 Dist. 16.2 ft	1.14	1.10	1.23	1.54	(0.19)	0.97	1.54
Well W-1 Dist. 25.8 ft	0.43	0.37	0.43	0.60	(0.15)	0.37	0.60
Well W-3 Dist. 38.3 ft	0.14	0.09	0.15	0.20	(0.17)	0.14	0.20

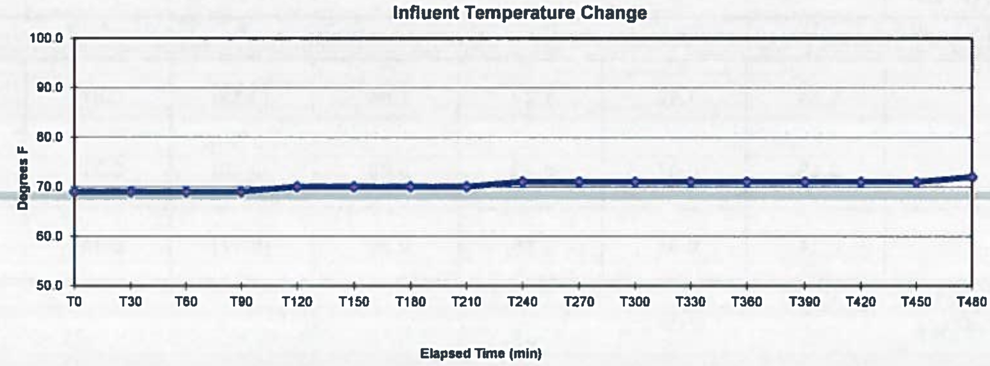
( ) Indicates Well Pressure
ND - No Recorded Data

SCHEDULE B
Summary of TEST # MDP-1
Atmospheric Conditions

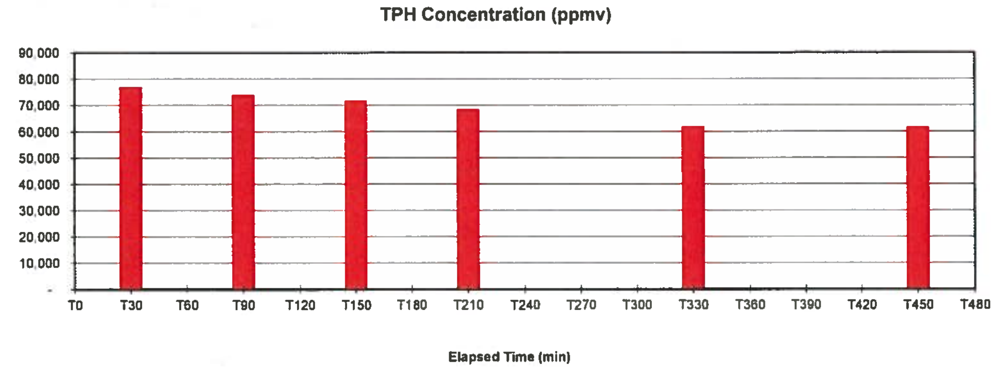

Barometric Pressure Change

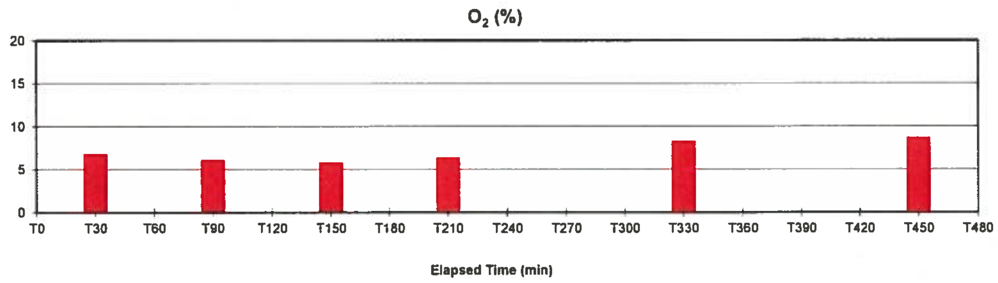

Absolute Pressure Change

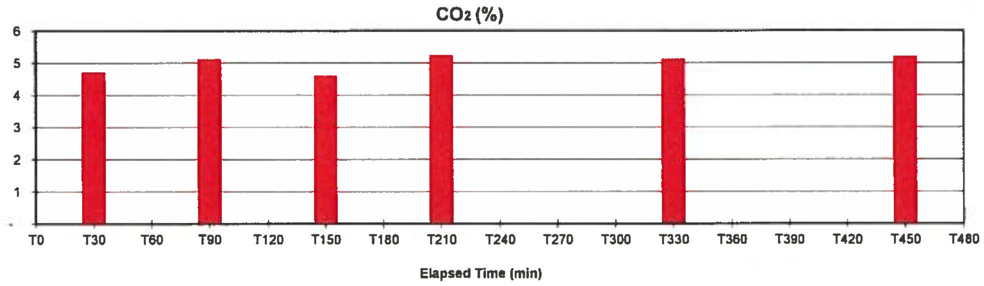

Air Temperature Change

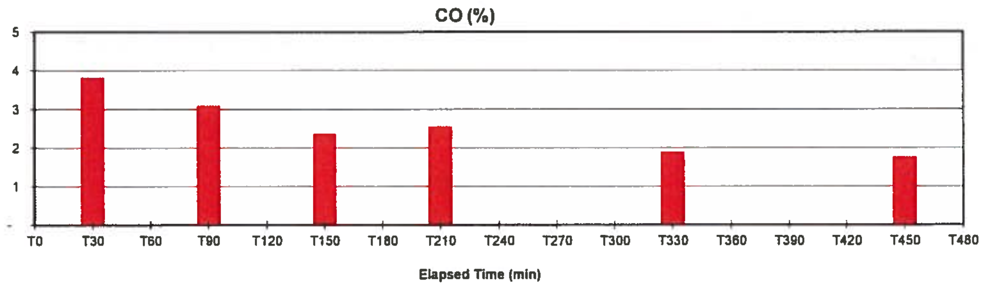

Influent Temperature Change

SCHEDULE B
Summary of TEST # MDP-1
Atmospheric Conditions



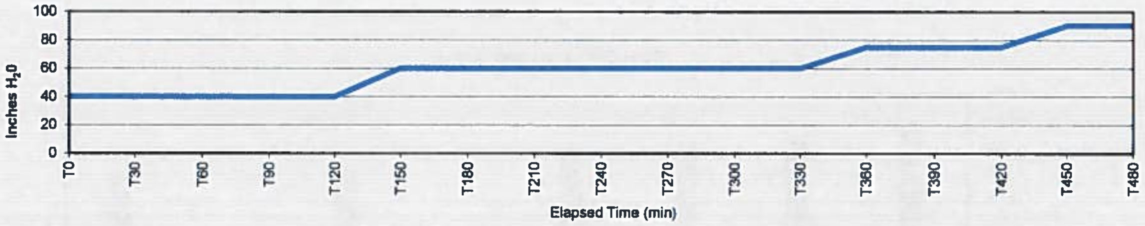


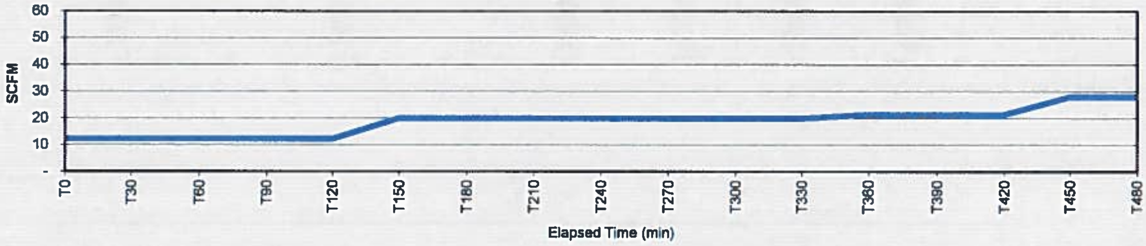


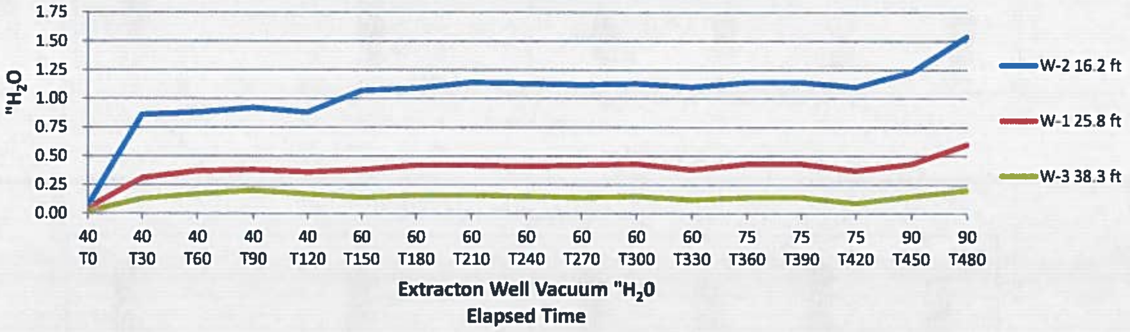


SCHEDULE B
Summary of ACUVAC TEST # MDP-1
Recorded Well Vacuums and/or (Pressures)

Walstadd 66
Lovington, NM
July 12, 2015


Induced Well Vacuum


Well Vapor Flow


Observation Well Induced Vacuums

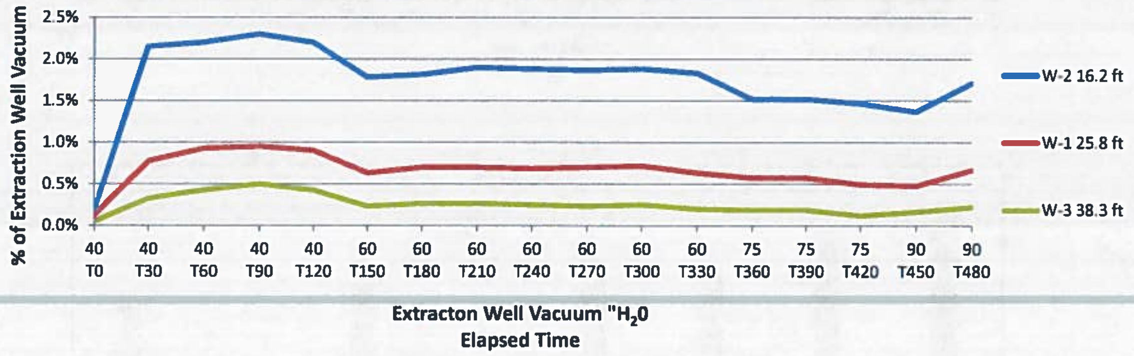

Observation Well Induced Vacuums

Figure #1A
Radius of Influence
Data from Pilot Test #MDP-1 at 0.75% of Induced Vacuum

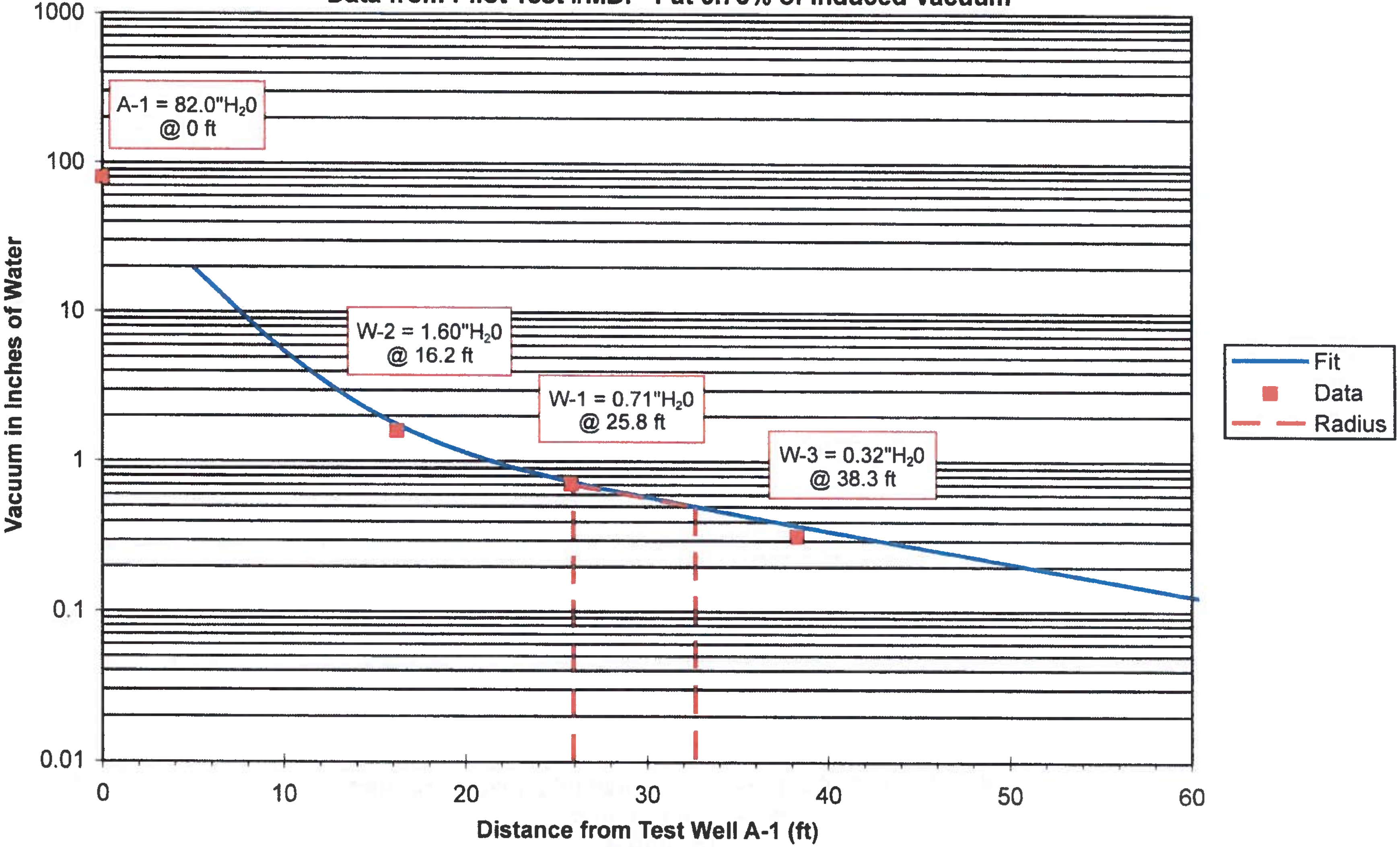


Figure #1B
Radius of Influence
Data from Pilot Test #MDP-1 at 1% of Induced Vacuum

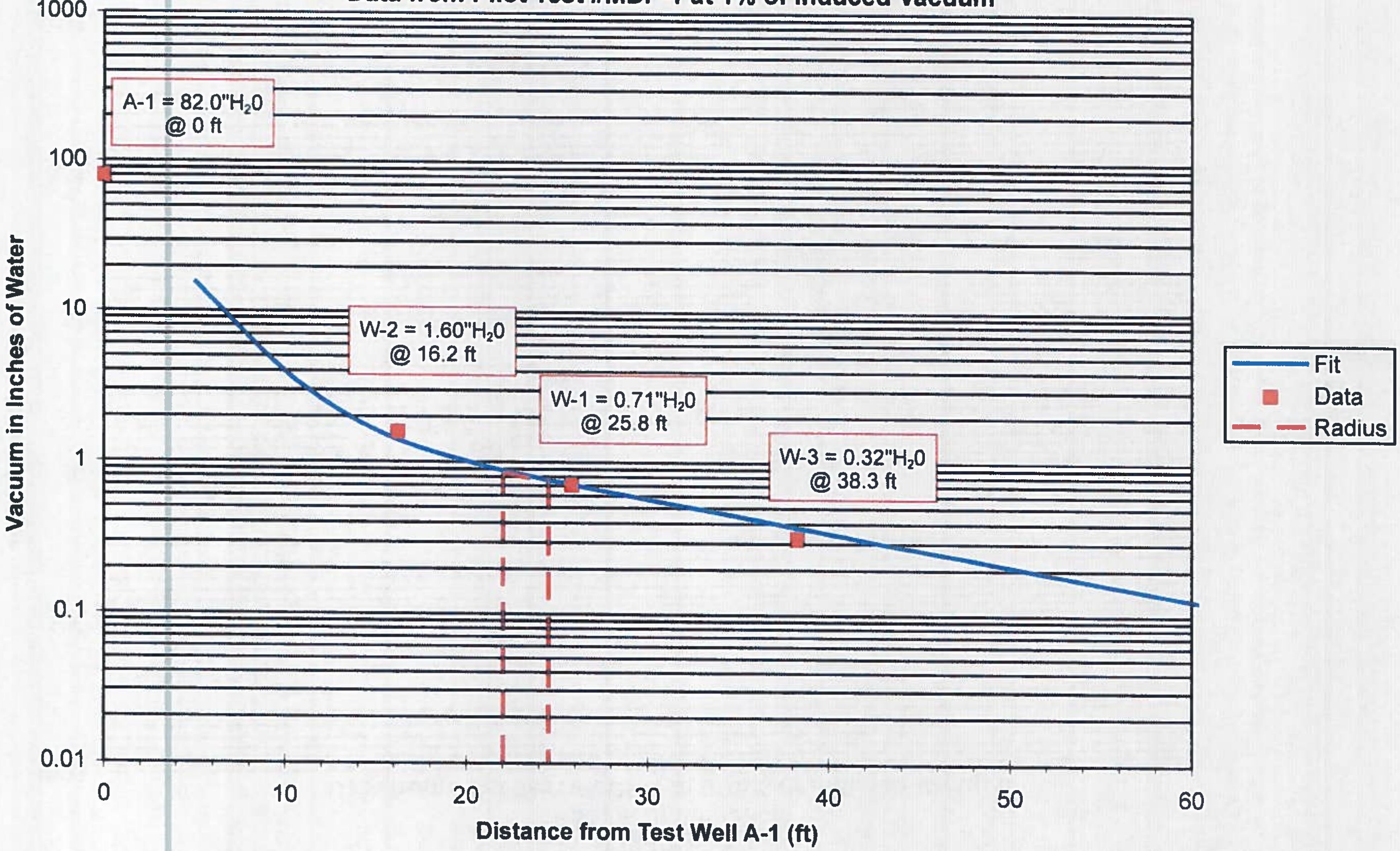
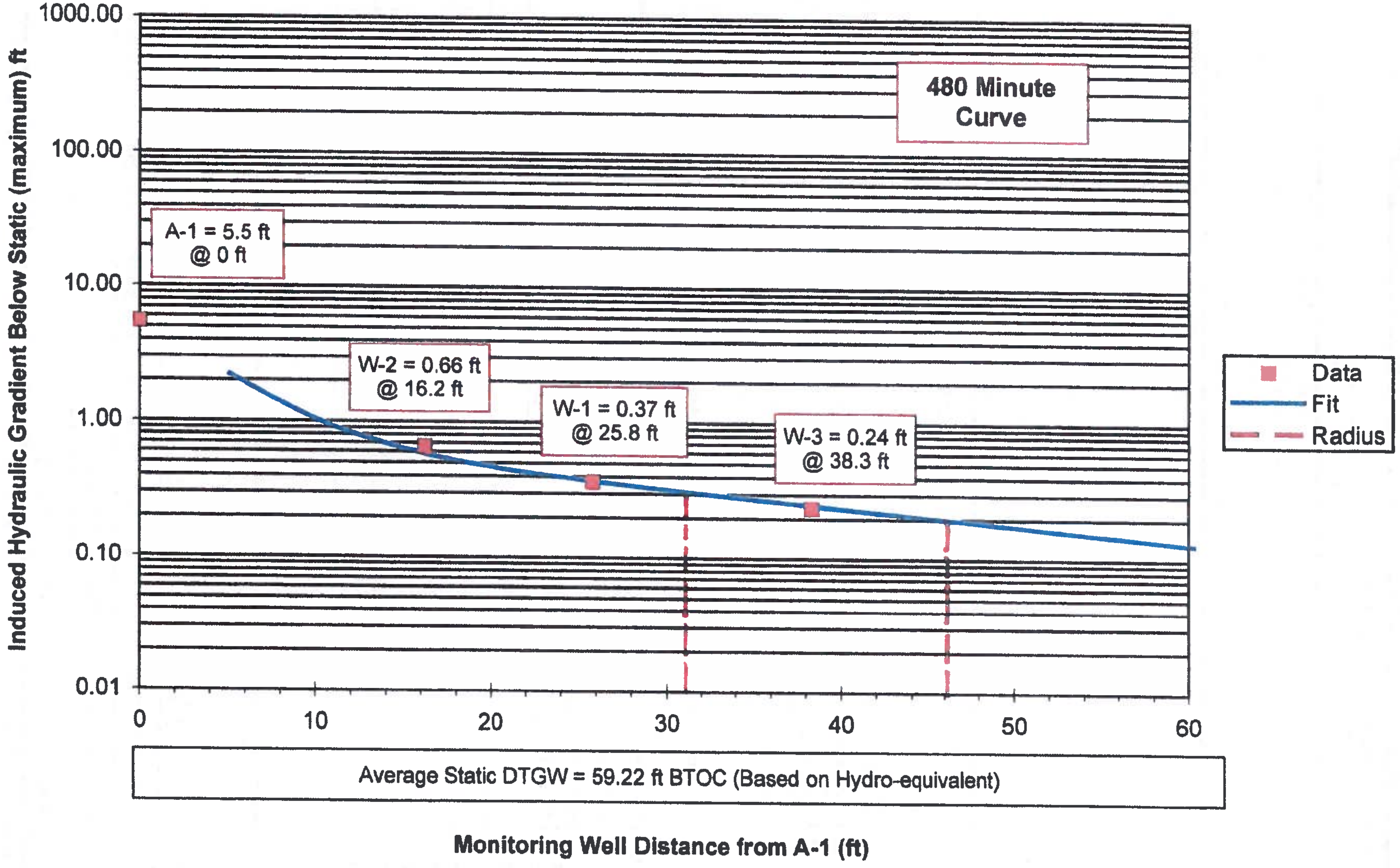


Figure #2
Drawdown at 480 Minutes vs Monitoring Well Distance



OPERATING DATA - PILOT TEST # 1 **PAGE #** 1

ACUVAC
MOBILE DUAL PHASE SYSTEM

Location: **Walstadd 66, Lovington, NM** **Project Managers: Sadler/Faucher**

		Date:	7-12-15	-	-	-	-	
Parameters			Time 0725	Time 0730	Time 0800	Time 0830	Time 0900	Time 0930
	Well # A-1		Hr Meter 7279.9	Hr Meter 7280.0	Hr Meter 7280.5	Hr Meter 7281.0	Hr Meter 7281.5	Hr Meter 7282.0
ENGINE/BLOWER	R.P.M.		1000	2200	2200	2200	2200	2200
	Oil Pressure	psi	50	50	50	50	50	50
	Water Temp	°F	155	160	160	160	160	160
	Volts		13.5	14.0	14.0	14.0	14.0	14.0
	Intake Vacuum	"Hg	19	18	18	18	18	18
	Gas Flow Fuel/Propane	cfh	100	0	0	0	0	0
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump	ON/OFF	OFF	ON	ON	ON	ON	ON
	Extraction Well Flow	scfm	OFF	12.19	12.19	12.19	12.19	12.19
	Extraction Well Vac.	"H₂O	OFF	40	40	40	40	40
	Pump Rate	gals/min	N/A	3.50	3.50	3.50	3.50	3.50
	Total Volume	gals	-	-	105	210	315	420
	Influent Vapor Temp.	°F	-	69	69	69	69	70
	Air Temp	°F	72.3	72.4	74.6	75.8	77.9	79.6
	Barometric Pressure	Hg	30.10	30.10	30.10	30.09	30.09	30.10
	Absolute Pressure	"Hg	26.09	26.09	26.09	26.08	26.08	26.09
MONITOR WELL VACUUM	(16.2) W-2	"H₂O	0	.07	.86	.88	.92	.88
	(25.8) W-1	"H₂O	0	.05	.31	.37	.38	.36
	(38.3) W-3	"H₂O	0	.02	.13	.17	.20	.17
		"H₂O						
		"H₂O						
		"H₂O	STATIC					
		"H₂O						
		"H₂O						
		"H₂O						
		"H₂O						
MANIFOLD	NAPL %	Vol Gals	—	—	180/189	9.5/10	5.5/5.8	4.0/4.2
	Data Logger / Probe	ft	7.5	2.0	2.0	2.0	2.0	2.0
	Depth of GW Depression	ft	0	-5.5	-5.5	-5.5	-5.5	-5.5
	Extraction Well	DTNAPL	57.40					
	Extraction Well	DTGW	64.08					

( ) Indicates Well Pressure 6.68

7FORMS/TestForms/1210010

SG=.74 HE: 59.14

OPERATING DATA - MDP PILOT TEST # 1 PAGE # 1

ACUVAC
MOBILE DUAL PHASE SYSTEM

Location: Walstadd 66 Lovington, NM **Project Managers: Sadler/Faucher**

	Date	7-12-15	-	-			
	Time	0800	0900				
TEST	Instrument	HORIBA	HORIBA	HORIBA	HORIBA	HORIBA	HORIBA
	Well No.	A-1	A-1				
VAPOR/INFLUENT	HC ppmv	76,490	74,020				
	CO_2 %	4.72	5.12				
	CO %	3.82	3.09				
	O_2 %	6.8	6.1				
	H_2S %	0	0				

0600	Arrived @ location - Positioned MDP System near well A-1 as
	the extraction well. Mobilized equipment · Opened selected wells - recorded
	distances & gauged wells - Install total fluid pump and probe in EW. Plugged outer
	observation wells - Connected LNAPL/GW discharge line to volume meter
	and standby tank truck - Safety checks · all ok - calibrated instruments
0725	Recorded static (baseline) data - all outer wells @ 0" H_2O - Pump inlet @ 65.0' BTOC
0730	START MDP-1 - Initial EW induced vacuum = 40' H_2O, WVF = 12.19 scfm
	GW pump rate: 3.5 gpm · All outer wells recorded slight increased vacuum levels
0800	Recorded data: BP - All outer wells on increasing vacuum trend · GWR
	= 3.5 gpm · GWD = -5.5 ft - (Heavy LNAPL recovery) Propane @ 0 cfh
	HORIBA DATA: TOH = HC = 76,490 ppmv, CO_2 = 4.72% · CO = 3.82% · O_2 = 6.8%
0830	Recorded data: BP ↓ Outer wells continue on a slight increasing trend
	GWR = 3.5 gpm LNAPL recovery (liquid) @ 5.5% = 5.8 gals
0900	HORIBA DATA: HC = 74,020 ppmv ↓ CO_2 = 5.12% ↑, CO = 3.09% ↓, O_2 = 6.1% ↓
	Recorded data BP - All outer wells continue on an increasing vacuum
	trend - GWR = 3.5 gpm · GWD = -5.5 ft - Liquid LNAPL @ 4%
0930	Recorded data: BP ↑ Outer wells recording a slight decreasing vacuum
	trend - LNAPL @ 3% · GWR = 3.5 gpm · Well vacuum and VWF steady
	INCREASED EW induced = 60" H_2O, WVF = 19.88 scfm. GWR:
	4.3 gpm - Pump rate increase necessary to maintain GWD @ 5.5 ft

OPERATING DATA - PILOT TEST # 1 **PAGE #** 2

ACUVAC
MOBILE DUAL PHASE SYSTEM

Location: **Walstadd 66, Lovington, NM** **Project Managers: Sadler/Faucher**

		Date:	7-12-15	-	-	-	-	-
Parameters			Time 1000	Time 1030	Time 1100	Time 1130	Time 1200	Time 1230
	Well # A-1		Hr Meter 7282.5	Hr Meter 7283.0	Hr Meter 7283.5	Hr Meter 7284.0	Hr Meter 7284.5	Hr Meter 7285.0
ENGINE/BLOWER	R.P.M.		2300	2300	2300	2300	2300	2300
	Oil Pressure	psi	50	50	50	50	50	50
	Water Temp	°F	165	165	170	170	170	170
	Volts		14.0	14.0	14.0	14.0	14.6	14.0
	Intake Vacuum	"Hg	17	17	17	17	17	17
	Gas Flow Fuel/Propane	cfh	0	0	0	0	0	0
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump	ON/OFF	ON	ON	ON	ON	ON	ON
	Extraction Well Flow	scfm	19.88	19.88	19.88	19.88	19.88	19.88
	Extraction Well Vac.	"H2O	60	60	60	60	60	60
	Pump Rate	gals/min	4.30	4.30	4.30	4.30	4.30	4.30
	Total Volume	gals	549	678	807	936	1065	1194
	Influent Vapor Temp.	°F	70	70	70	71	71	71
	Air Temp	°F	81.3	82.7	84.0	84.6	87.1	90.6
	Barometric Pressure	Hg	30.09	30.09	30.09	30.09	30.08	30.08
	Absolute Pressure	"Hg	26.08	26.08	26.08	26.08	26.07	26.08
MONITOR WELL VACUUM	W-2	"H2O	1.07	1.09	1.14	1.13	1.12	1.13
	W-1	"H2O	.38	.42	.42	.41	.42	.43
	W-3	"H2O	.14	.16	.16	.15	.14	.15
		"H2O						
		"H2O						
		"H2O						
		"H2O						
		"H2O						
		"H2O						
		"H2O						
MANIFOLD	NAPL %	Vol Gals	3.0/3.2	1.5/2.0	1.0/1.3	1.5/2.0	1.5/2.0	1.5/1.9
	Data Logger /Probe	ft	2.0	2.0	2.0	2.0	2.0	2.0
	Depth of GW Depression	ft	-5.5	-5.5	-5.5	-5.5	-5.5	-5.3
	Extraction Well	DTNAPL						
	Extraction Well	DTGW						

( ) Indicates Well Pressure

OPERATING DATA - MDP PILOT TEST # 1 PAGE # 2

ACUVAC
MOBILE DUAL PHASE SYSTEM

Location: Walstadd 66 Lovington, NM **Project Managers: Sadler/Faucher**

	Date	7-12-15	–	–			
	Time	1000	1100				
TEST	Instrument	HORIBA	HORIBA	HORIBA	HORIBA	HORIBA	HORIBA
	Well No.	A-1	A-1				
VAPOR/INFLUENT	HC ppmv	71,750	68,490				
	CO_2 %	4.60	5.24				
	CO %	2.37	2.55				
	O_2 %	5.8	6.4				
	H_2S %	0	0				

1000	HORIBA DATA HC = 71,750 ppmv ↓, CO_2 = 4.60% ↑, CO : 2.37% ↓ - O_2 : 5.8% ↓
	Recorded data: BP ↓ Outer well W-2, recording an increased vacuum
	level in response to the EW ↑, other wells, most steady - GWR = 4.3
	gpm - EW vacuum @ 60"H_2O, WVF = 19.88 scfm · LNAPL @ 1.5%
1030	Gauged all wells - ↓HC on slight decreasing trend
	Recorded data: BP — Outer wells continue on an increasing
	vacuum trend. GWR steady @ 4.3 gpm - LNAPL @ 1.0%
1100	Recorded data: BP – Outer well W-2, slight increase, the two
	wells, steady - NOTE - LNAPL @ 1.5% of volume
	HORIBA DATA: HC = 68,490 ppmv ↓, CO_2 = 5.24% ↑, CO : 2.55% ↑, O_2 = 6.48 ↑
1130	Recorded data: BP ∓ Outer wells mostly steady, but developing a
	slight decreasing vacuum trend · GWR · 4.3 gpm · LNAPL @ 1.5%
1200	Recorded data: BP ↓ · Outer wells mostly steady, slight increase/
	decreases · GWR steady @ 4.3 gpm · LNPL steady @ 1.5% - GWD = -5.5'
1230	Recorded data: BP — Outer wells mostly steady with slight
	increases - GWR = 4.3 gpm LNAPL = 1.5% GWD = 5.5 ft

AVR

OPERATING DATA - PILOT TEST # 1 **PAGE # 3**

ACUVAC
MOBILE DUAL PHASE SYSTEM

Location: Walstadd 66, Lovington, NM **Project Managers: Sadler/Faucher**

		Date:	7-12-15	-	-	-	-	-
	Parameters		Time 1300	Time 1330	Time 1400	Time 1430	Time 1500	Time 1530
	Well # A-1		Hr Meter 7285.5	Hr Meter 7286.0	Hr Meter 7286.5	Hr Meter 7287.0	Hr Meter 7287.5	Hr Meter 7288.0
ENGINE/BLOWER	R.P.M.		2300	2400	2400	2400	2400	2400
	Oil Pressure	psi	50	50	50	50	50	50
	Water Temp	°F	175	175	175	175	175	175
	Volts		14.0	14.0	14.0	14.0	14.0	14.0
	Intake Vacuum	"Hg	17	17	17	17	17	16
	Gas Flow Fuel/Propane	cfh	0	0	0	0	0	0
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump	ON/OFF	ON	ON	ON	ON	ON	ON
	Extraction Well Flow	scfm	19.88	21.34	21.34	21.34	27.95	27.95
	Extraction Well Vac.	"H2O	60	75	75	75	90	90
	Pump Rate	gals/min	4.30	4.60	4.60	4.60	5.20	5.20
	Total Volume	gals	1323	1460	1598	1736	1892	2048
	Influent Vapor Temp.	°F	71	71	71	71	71	72
	Air Temp	°F	91.8	93.0	94.6	95.3	95.8	96.1
	Barometric Pressure	Hg	30.07	30.06	30.06	30.04	30.02	30.02
	Absolute Pressure	"Hg	26.07	26.06	26.05	26.04	26.02	26.02
MONITOR WELL VACUUM	W-2	"H2O	1.10	1.14	1.14	1.10	1.23	1.54
	W-1	"H2O	.38	.43	.43	.37	.43	.60
	W-3	"H2O	.12	.14	.14	.09	.15	.20
		"H2O						
		"H2O						
		"H2O						
		"H2O						
		"H2O						
		"H2O						
		"H2O						
MANIFOLD	NAPL %	Vol Gals	1.5/2.0	1.5/2.1	2.0/2.7	20/2.8	2.0/3.1	20/3.1
	Data Logger	ft	2.0	2.0	2.0	2.0	2.0	2.0
	Depth of GW Depression	ft	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5
	Extraction Well	DTNAPL						61.61
	Extraction Well	DTGW						6165

( ) Indicates Well Pressure

7FORMS/TestForms/1210010

LNAPL = 0.04'
HE = 61.64'

OPERATING DATA - MDP PILOT TEST # 1 **PAGE #** 3

ACUVAC
MOBILE DUAL PHASE SYSTEM

Location: **Walstadd 66 Lovington, NM** **Project Managers: Sadler/Faucher**

	Date 7-12-15		-	-			
	Time		1300	1500			
TEST	Instrument		HORIBA	HORIBA	HORIBA	HORIBA	HORIBA	HORIBA
	Well No.		A-1	A-1				
VAPOR/INFLUENT	HC	ppmv	61,880	61,720				
	CO_2	%	5.12	5.20				
	CO	%	1.88	1.75				
	O_2	%	8.3	8.7				
	H_2S	%	0	0				

1300	HORIBA DATA: HC= 61,880 ppmv ↓, CO_2= 5.12% ↓ CO =1.88% ↓ O_2=8.3% ↑
	Recorded data: BP ↓ All outer wells recording a decreasing
	vacuum trend due to BP ↓ - LNAPL=1.5% - GWD = -5.5 ft
	INCREASED EW induced vacuum: 75" H_2O, WVF = 21.34 scfm
	GWR: 4.6gpm - LNAPL = 1.5%
1330	Recorded data: BP ↓ Outer well recording increased vacuum levels
	in response to the EW increase. GWR = 4.6gpm · LNAPL = 2%
	Gauged outer wells - Note increase in the IHC
1400	Recorded data: BP ↓ Outer well steady - No change
	GWR = 4.6 gpm · LNAPL steady @ 2% - GWD = 5.5 ft
1430	Recorded data: BP ↓↓ · Outer wells recording a decreasing
	vacuum trend due to BP ↓ - GWR = 4.6gpm - LNAPL=2%
1430	INCREASED EW induced vacuum = 90" H_2O, WVF = 27.95 scfm
	GWR = 5.2 gpm LNAPL = 2.0 %
1500	HORIBA DATA: HC = 61,720 ppmv ↓, CO_2: 5.20% ↑, CO = 1.75% ↓, O_2 = 8.7% ↑
1500	Recorded data: BP ↓↓ · Outer wells recorded increasing vacuum trend
	In response to EW vacuum increase - GWR = 5.2gpm - LNAPL = 2%
1530	Recorded data! BP — All wells recorded increased vacuum levels
	in response to A-1 @ 90" H_2O · GWR = 5.2gpm LNAPL = 2.0%
	Gauged wells -
1535	Discontinued GW pumping and induced vacuum to allow time
	for outer wells to adjust to atmospheric changes

AVR

OPERATING DATA - PILOT TEST # 1 **PAGE # 4**

ACUVAC
MOBILE DUAL PHASE SYSTEM

Location: Walstadd 66, Lovington, NM								**Project Managers: Sadler/Faucher**
		Date:	7-12-15					
Parameters			Time 1600	Time	Time	Time	Time	Time
	Well #		Hr Meter 7288.3	Hr Meter	Hr Meter	Hr Meter	Hr Meter	Hr Meter
ENGINE/BLOWER	R.P.M.		1000					
	Oil Pressure	psi	50					
	Water Temp	°F	165					
	Volts		14.0					
	Intake Vacuum	"Hg	19					
	Gas Flow Fuel/Propane	cfh	90					
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump	ON/OFF	OFF					
	Extraction Well Flow	scfm	OFF					
	Extraction Well Vac.	"H₂O	OFF					
	Pump Rate	gals/min	OFF					
	Total Volume	gals	2048					
	Influent Vapor Temp.	°F	N/A					
	Air Temp	°F	95.1					
	Barometric Pressure	Hg	30.02					
	Absolute Pressure	"Hg	26.02					
MONITOR WELL VACUUM	W-2	"H₂O	(.19)					
	W-1	"H₂O	(.15)					
	W-3	"H₂O	(.17)					
		"H₂O						
		"H₂O						
		"H₂O						
		"H₂O	STATIC					
		"H₂O						
		"H₂O						
		"H₂O						
MANIFOLD	NAPL %	Vol Gals	—					
	Data Logger	ft	—					
	Depth of GW Depression	ft	—					
	Extraction Well	DTNAPL	—					
	Extraction Well	DTGW	—					

( ) Indicates Well Pressure

OPERATING DATA - MDP PILOT TEST # 1 **PAGE #** 4

ACUVAC
MOBILE DUAL PHASE SYSTEM

Location: Walstadd 66 Lovington, NM

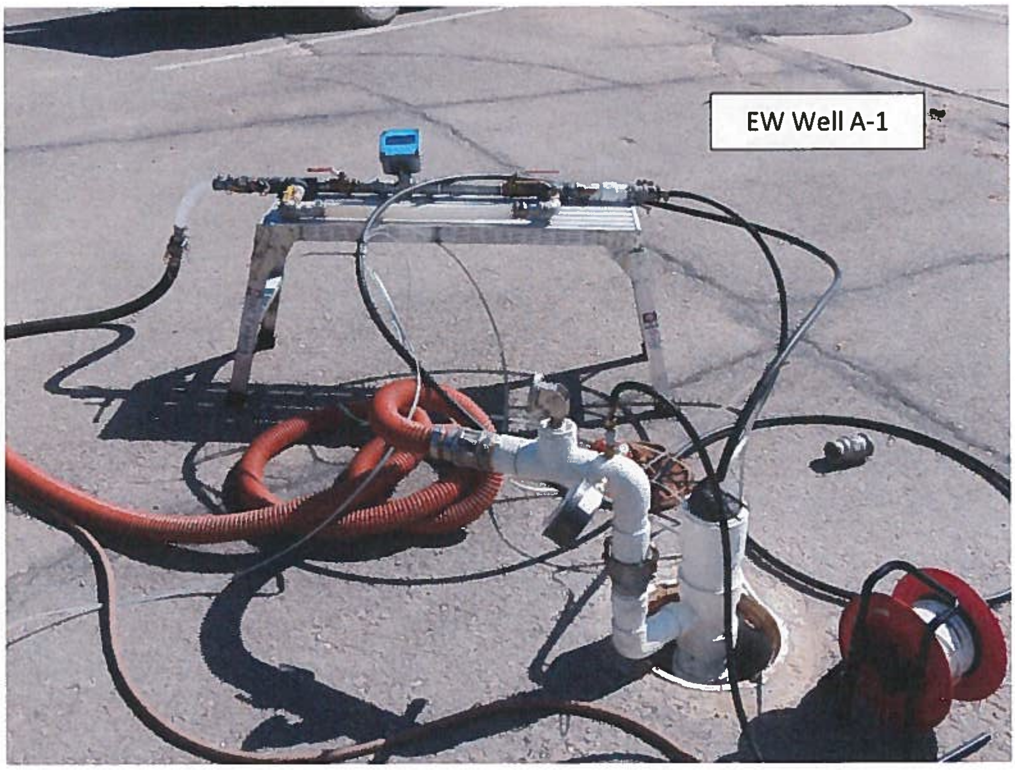
Project Managers: Sadler/Faucher

	Date	7-11-15					
	Time						
TEST	Instrument	HORIBA	HORIBA	HORIBA	HORIBA	HORIBA	HORIBA
	Well No.						
VAPOR/INFLUENT	HC ppmv						
	CO_2 %						
	CO %						
	O_2 %						
	H_2S %						

1600	Recorded static data: BP steady - All wells recording well
	pressure due to decreased barometric pressure on the GW
	TEST MDP-1 completed - NOTE - TOTAL Liquid Volume = 2048 gals
1635	Secured all wells - departed site

WALSTADD 66
LOVINGTON, NM

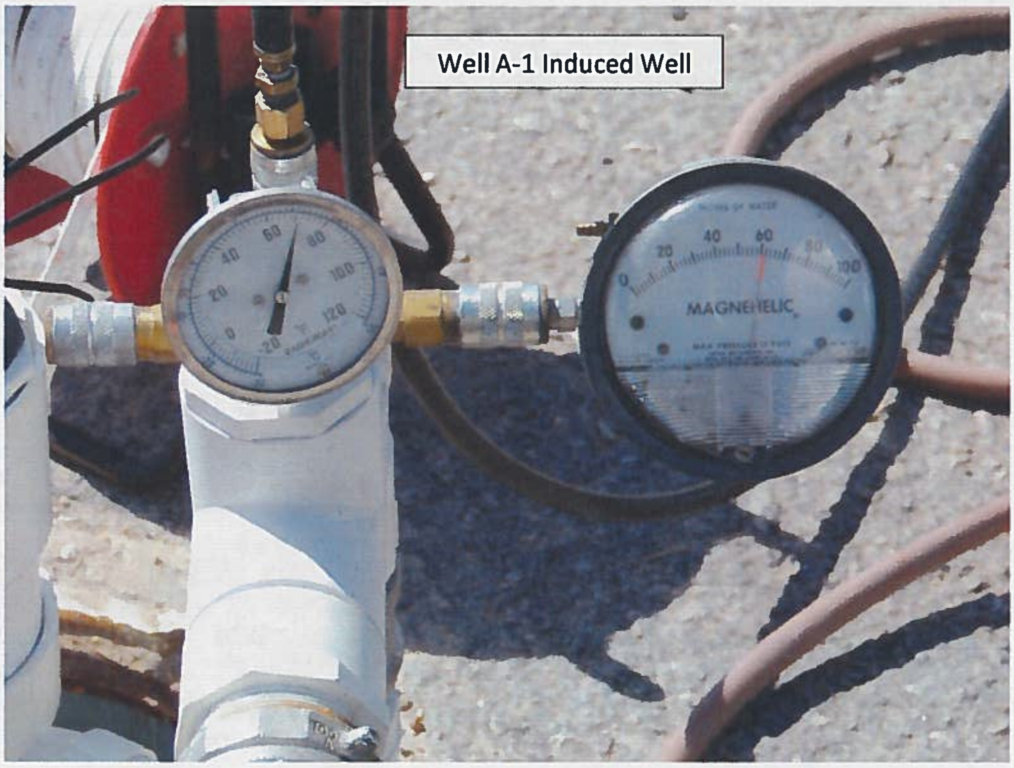
WALSTADD 66
LOVINGTON, NM



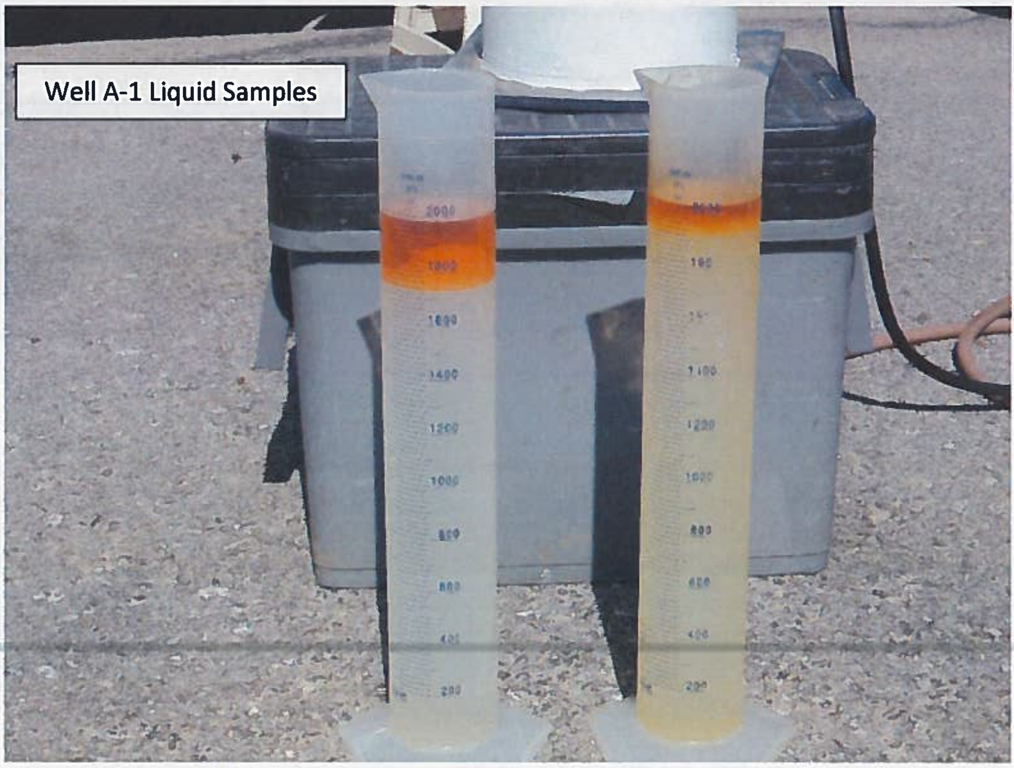
EW Well A-1

Standby Tank Truck

WALSTADD 66
LOVINGTON, NM



Well A-1 Induced Well



Well A-1 Liquid Samples

AcuVac Remediation, LLC

1656-H Townhurst • Houston, Texas 77043
713 468 6688 • acuvac.com

July 15, 2015

Mr. Clay Kilmer
Senior Hydrogeologist
Golder Associates, Inc.
5200 Pasadena Avenue, N.E. Suite C
Albuquerque, NM 87113

Dear Clay:

Re: Walstadd 66, Lovington, NM

At your request, we performed two 1-hour (Wells W-1 and W-2), and one 6.0-hour (Well A-1) Mobile Dual Phase (MDP) Events at the above referenced location on July 13, 2015. Following is the Report and a copy of the Operating Data collected during Event #1 at the above referenced location. Table #1A is the Well Summary Information and Table #1B is the Recovery Summary Information on wells W-2 (Event #1A), W-1 (Event #1B), and Well A-1 (Event #1C). PSH is referred to as LNAPL in this report. GW samples are taken in a 2,000 ml beaker to determine the average LNAPL percentage and volume.

OBJECTIVES

The Objectives of an MDP Event are to:

- Evaluate the potential for removing liquid and vapor phase LNAPL (PSH) from the groundwater (GW) and soils in the subsurface formations.
- Expose the capillary fringe area and below to the Extraction Well (EW) induced vacuums.
- Increase the GW and contaminant specific yields with high induced vacuums.
- Provide an induced hydraulic gradient (IHG) to gain hydraulic control of the area during the Event period.
- Select the GW depression and pump rates to accomplish the above objectives.

METHODS AND EQUIPMENT

The tests were conducted using AcuVac's I-6 System, with Roots RAI-33 and RAI-22 blowers, various instrumentation, including the HORIBA® Analyzer, Solinst Interface Probes, Lumidor O_2 Meter, flow gauges, a sensitive instrument to determine barometric pressure, V-1 vacuum box to capture non-diluted vapor samples, Redi-Flo 2 total fluids pump and other special equipment.

The vacuum extraction portion of the AcuVac System consists of a vacuum pump driven by an internal combustion (IC) engine. The vacuum pump is connected to the extraction well and the vacuum created on the extraction well causes light hydrocarbons in the soil and on the GW to volatilize and flow through a moisture knockout tank to the vacuum pump and the IC Engine where they are burned as part of the normal combustion process. Propane is used as auxiliary fuel to help power the engine if the well vapors do not provide the required BTU.

The AcuVac IC Engine is fully loaded for the maximum power necessary to achieve and maintain high induced vacuums and/or high well vapor flows required to maximize the vacuum Radius of Influence (ROI) for Pilot Tests and short term Event remediation.

Emissions from the engine are passed through three catalytic converters to ensure maximum destruction of removed hydrocarbon vapors. The engine's fuel to air ratio can be adjusted to maintain efficient combustion. Because the engine is the power source for all equipment, all systems stop when the engine stops. This eliminates any uncontrolled release of hydrocarbons. Since the AcuVac System is held entirely under vacuum, any leaks in the seals or connections are leaked into the System and not emitted into the atmosphere. The engine is automatically shut down by vacuum loss, low oil pressure or overheating.

The GW Extraction is provided by an in-well, Redi-Flo 2 total fluids pump that has the discharge line connected to a total volume meter. The discharge line from the volume meter is then connected to the stand-by tank truck. The electrical power for the GW pump was supplied from a 120v Honda generator. The GW flow rate can be adjusted to maintain a target level. Interface meters are used to measure all DTGW/DTLNAPL.

The design of the AcuVac System enables complete independent control of both the Induced Well Vacuum and the GW pumping functions such that the AcuVac team can control the IHG to expose the maximum amount of the formation to SVE. The ability to separate the vacuum and liquid flows within the Extraction Well improves the LNAPL recovery rates, and enables the AcuVac team to record data specific to each.

SUMMARY OF MDP EVENT #1A- WELL W-2

- The total Event time was 1.0 hour. The Event was conducted on July 13, 2015. There is no comparative data.
- The total liquid volume recovered was 192 gals, of which 13.50% or 25.92 gals were liquid LNAPL.
- Total vapor LNAPL burned as IC engine fuel was 1.97 gals, **for a total liquid and vapor LNAPL recovery of 27.89 gals.**
- Average HORIBA® Analytical Data from the influent vapor samples was: HC = 95,790 ppmv, CO_2 = 3.46%, CO = 7.46%, O_2 = 8.6% and H_2S = 0 ppm.
- The maximum HORIBA® Analytical Data from the influent vapor samples for TPH was 95,790 ppmv.
- The Average Induced Vacuum was 60"H_2O with a maximum vacuum of 60.00"H_2O.
- The average EW well vapor flow was 9.51 scfm with a maximum well vapor flow of 9.51 scfm.
- The GW pump inlet was set at 65.0 ft BTOC. The average GW pump rate was 3.20 gpm, and the maximum GW pump rate was 3.20 gpm.
- The average GW depression, based on the positioning of the GW pump, was 5.50 ft below static level.
- An LNAPL thickness of 6.54 ft was recorded prior to the start of Event #1A and no LNAPL thickness was recorded at the conclusion of the Event.

The total LNAPL removed, including liquid and vapor, during the 1.0 hour Event #1A, Well W-2, was 27.89 gals.

ADDITIONAL INFORMATION

- The higher percentage of the LNAPL volume, 25.92 gals or 92.94%, was recovered as liquid due to the high level of free phase LNAPL at the start of the Event.
- A minimal percentage of the LNAPL, 1.97 gals or 7.06%, was burned as IC engine fuel as a result of the short duration of the Event period.
- The high HC (TPH) levels indicate contaminant in the gasoline range.
- The relatively low O_2 levels in the influent vapors indicate SVE short circuiting from the ground surface most likely did not occur.
- Well W-2 was gauged at the conclusion of Event #1C (1445 hrs) and an LNAPL thickness of 4.40 ft was recorded indicating a rebound of 67.28%.

SUMMARY OF MDP EVENT #1B- WELL W-1

- The total Event time was 1.0 hour. The Event was conducted on July 13, 2015. There is no comparative data.
- The total liquid volume recovered was 201 gals, of which 23.69% or 47.61 gals were liquid LNAPL.
- Total vapor LNAPL burned as IC engine fuel was 1.84 gals, **for a total liquid and vapor LNAPL recovery of 49.45 gals.**
- Average HORIBA® Analytical Data from the influent vapor samples was: HC = 89,750 ppmv, CO_2 = 3.52%, CO = 5.74%, O_2 = 8.6% and H_2S = 0 ppm.
- The maximum HORIBA® Analytical Data from the influent vapor samples for TPH was 89,750 ppmv.
- The Average Induced Vacuum was 60"H_2O with a maximum vacuum of 60.00"H_2O.
- The average EW well vapor flow was 9.51 scfm with a maximum well vapor flow of 9.51 scfm.
- The GW pump inlet was set at 65.0 ft BTOC. The average GW pump rate was 3.47 gpm, and the maximum GW pump rate was 3.70 gpm.
- The average GW depression, based on the positioning of the GW pump, was 5.50 ft below static level.
- An LNAPL thickness of 6.84 ft was recorded prior to the start of Event #1B and an LNAPL thickness of 0.04 ft was recorded at the conclusion of the Event.

The total LNAPL removed, including liquid and vapor, during the 1.0 hour Event #1B, Well W-1, was 49.45 gals.

ADDITIONAL INFORMATION

- The higher percentage of the LNAPL volume of 47.61 gals or 96.27%, was recovered as liquid.
- A minimal amount of LNAPL, 1.84 gals or 3.73%, was burned as IC engine fuel as a result of the short duration of the Event period.

- The high HC (TPH) levels indicate contaminant in the gasoline range.
- The relatively low O_2 levels in the influent vapors indicate SVE short circuiting from the ground surface most likely did not occur.
- Well W-1 was gauged at the conclusion of Event #1C (1445 hrs) and an LNAPL thickness of 1.01 ft of was recorded indicating a rebound of 14.77%.
- A thickness of biomass was initially observed on the collected GW/LNAPL sample.

SUMMARY OF MDP EVENT #1C- WELL A-1

- The total Event time was 6.0 hours. The Event was conducted on July 13, 2015. The data is compared to Pilot Test #1 conducted on July 12, 2015 which had a total Test time of 8.0 hours.
- The total liquid volume recovered was 1,553 gals, of which 2.35% or 36.53 gals were liquid LNAPL.
- Total vapor LNAPL burned as IC engine fuel was 29.36 gals, **for a total liquid and vapor LNAPL recovery of 65.88 gals. This equates to an average of 10.98 gals/hr.**
- Average HORIBA® Analytical Data from the influent vapor samples was: HC = 59,027 ppmv, CO_2 = 5.61%, CO = 1.73%, O_2 = 7.1% and H_2S = 0 ppm.
- Compared with MDP Pilot Test #1 data, the average TPH levels decreased 10,115 ppmv, CO_2 increased 0.61%, CO decreased 0.85%, O_2 increased 0.1% and H_2S was steady at 0 ppm.
- The maximum HORIBA® Analytical Data from the influent vapor samples for TPH was 64,480 ppmv. Compared with MDP Pilot Test #1 data, the maximum TPH levels decreased 12,510 ppmv.
- The Average Induced Vacuum was 68.46"H_2O with a maximum vacuum of 70.00"H_2O. Compared with Pilot Test #1 data, the average induced vacuum increased 8.17"H_2O and the maximum induced vacuum decreased 20.00"H_2O.
- The average EW well vapor flow was 23.01 scfm with a maximum well vapor flow of 23.34 scfm. Compared with MDP Pilot Test #1 data, the average EW well vapor flow increased 4.18 scfm, and the maximum well flow decreased 4.61 scfm.
- The GW pump inlet was set at 65.0 ft BTOC. The average GW pump rate was 4.35 gpm, and the maximum GW pump rate was 4.50 gpm.
- The average GW depression, based on the positioning of the GW pump, was 5.50 ft below static level.
- An LNAPL thickness of 5.52 ft was recorded prior to the start of Event #1C and a LNAPL thickness of 0.13 ft was recorded at the conclusion of the Event.

The total LNAPL removed, including liquid and vapor, during the 6.0 hour Event #1C, Well A-1, was 65.88 gals.

ADDITIONAL INFORMATION

- The higher percentage of the LNAPL volume, 36.53 gals or 55.44%, was recovered as liquid.
- Of the total LNAPL volume recovered, 29.36 gals or 44.56%, was burned as IC engine fuel during the Event period as a result of the high TPH and Well Vapor Flow.
- The high HC (TPH) levels indicate contaminant in the gasoline range.
- The HC (TPH) recorded a decreasing trend throughout the Event period.
- The relatively low O_2 levels in the influent vapors indicate SVE short circuiting from the ground surface most likely did not occur.

TOTAL RECOVERY EVENT #1

The total LNAPL removed, including liquid and vapor, during the 8.0 hour Event #1, Wells W-1, W-2, and A-1, was 143.22 gals. This equates to 17.90 gal/hr.

RECOMMENDATION

The Events proved to be an extremely effective method of decreasing the liquid LNAPL thickness in these wells. An Event program should be considered to quickly reduce the LNAPL thickness before considering a CAP which includes an on-site recovery system. In many cases the Event program has initially been more cost effective.

METHOD OF CALIBRATION AND CALCULATIONS

The HORIBA® Analytical instrument is calibrated with Hexane, CO and CO_2.

The formula used to calculate the emission rate is:

$$ER = HC\ (ppmv) \times MW\ (Hexane) \times Flow\ Rate\ (scfm) \times 1.58E^{-7}\ \frac{(min)(lb\ mole)}{(hr)(ppmv)(ft^3)} = lbs/hr$$

INFORMATION INCLUDED WITH REPORT

- Table #1A Summary Well Data
- Table #1B Summary Recovery Data
- Recorded Data
- Photographs of the MDP System and Wells A-1, W-1 and W-2.

After you have reviewed the report and if you have any questions, please contact me. We appreciate you selecting AcuVac to provide this service.

Sincerely,
ACUVAC REMEDIATION, LLC

Paul D. Faucher
Vice President, Operations

Summary Well Data
Table #1A

Event		1A	1B	1C
WELL NO.		**W-2**	**W-1**	**A-1**
Total Event Hours		1.0	1.0	6.0
TD	ft	75.0	80.0	75.0
Well Screen	ft	45.0 to 75.0	50 to 70	50 to 70
Well Size	in	4.0	4.0	4.0
Well Data				
DTGW - Static - Start Event	ft	64.67	63.96	63.55
DTLNAPL - Static - Start Event	ft	58.13	57.12	58.03
LNAPL	ft	6.54	6.84	5.52
Hydro-Equivalent- Beginning	ft	59.83	58.90	59.47
DTGW - End Event	ft	57.76	59.21	60.01
DTLNAPL - End Event	ft	0	59.17	59.88
LNAPL	ft	0	0.04	0.13
Hydro-Equivalent - Ending	ft	57.76	59.18	59.91
Extraction Data				
Maximum Extraction Well Vacuum	"H_2O	60.00	60.00	70.00
Average Extraction Well Vacuum	"H_2O	60.00	60.00	68.46
Maximum Extraction Well Vapor Flow	scfm	9.51	9.51	23.34
Average Extraction Well Vapor Flow	scfm	9.51	9.51	23.01
Maximum GW/ LNAPL Pump Rate	gpm	3.20	3.70	4.50
Average GW/ LNAPL Pump Rate	gpm	3.20	3.47	4.35
Influent Data				
Maximum TPH	ppmv	95,790	89,750	64,480
Average TPH	ppmv	95,790	89,750	59,027
Average CO_2	%	3.46	3.52	5.61
Average CO	%	7.46	5.74	1.73
Average O_2	%	8.6	8.6	7.1
Average H_2S	ppm	0	0	0

Summary Recovery Data
Table #1B

Event		1A	1B	1C
WELL NO.		**W-2**	**W-1**	**A-1**
Recovery Data- Current Event				
Total Liquid Volume Recovered	gals	192	201	1,553
Total Liquid LNAPL Recovered	gals	25.92	47.61	36.53
Total Liquid LNAPL Recovered / Total Liquid	%	13.50	23.69	2.35
Total Liquid LNAPL Recovered / Total LNAPL	%	92.94	96.27	55.44
Total Vapor LNAPL Recovered	gals	1.97	1.84	29.36
Total Vapor LNAPL Recovered / Total LNAPL	%	7.06	3.73	44.56
Total Vapor and Liquid LNAPL Recovered	gals	27.89	49.45	65.88
Average LNAPL Recovery	gals/hr	27.89	49.45	10.98
Total LNAPL Recovered	lbs	195	346	461
Total Volume of Well Vapors	cu. ft	571	571	8,284
Recovery Data- Cumulative				
Total Liquid Volume Recovered	gals	192	201	3,601
Total Liquid LNAPL Recovered	gals	25.92	47.61	100.16
Total Vapor LNAPL Recovered	gals	1.97	1.84	51.87
Total Vapor and Liquid LNAPL Recovered	gals	27.89	49.45	152.03
Average LNAPL Recovery	gals/hr	27.89	49.45	10.86
Total LNAPL Recovered	lbs	195	346	1,064
Total Volume of Well Vapors	cu. ft	571	571	17,322

OPERATING DATA - EVENT #1 A **PAGE #** 1 **ACUVAC MOBILE DUAL PHASE SYSTEM**

Location:	Walstadd 66, Lovington, NM					**Project Managers: Sadler/Faucher**	
	Date:	7/13/15					
	Parameters	Time 0615	Time 0645	Time 0715	Time	Time	Time
	WELL # W-1	Hr Meter 7288.5	Hr Meter 7289.0	Hr Meter 7289.5	Hr Meter	Hr Meter	Hr Meter
ENGINE/BLOWER	R.P.M.	2206	2200	2200			
	Oil Pressure psi	50	50	50			
	Water Temp °F	130	140	150			
	Volts	14	14	14			
	Intake Vacuum "Hg	19	19	19			
	Gas Flow Fuel/Propane cfh	0	0	0			
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump ON/OFF	ON	ON	OFF			
	Extraction Well Flow scfm	9.51	9.51	9.51			
	Extraction Well Vacuum "H_2O	60	60	60			
	Pump Rate gals/min	3.2	3.2	3.2			
	Total Volume gals	—	96	192			
	Influent Vapor Temp. °F	68	68	68			
	Air Temperature °F	66.7	69.1	69.8			
	Barometric Pressure "Hg	30.03	30.02	30.01			
VAPOR /INFLUENT	HC ppmv	—	95790	—			
	CO_2 %	—	3.42	—			
	CO %	—	7.46	—			
	O_2 %	—	8.6	—			
	H_2S ppm	—	0	—			
NOTES	ARRIVED ON SITE AT 0545 HRS. POSITIONED THE ACUVAC SYSTEM NEAR WELL W-1. GAUGED THE WELL AND MOBILIZED ALL EQUIPMENT, PLACED THE IN WELLPUMP AT 67.0 FT BTOC. EVENT STARTED AT 0615 HRS, INITIAL WELL VAC SET AT 60"H_2O RESULTING IN WVF OF 9.50 SCFM. INFLUENT VAPOR SAMPLE INDICATES HIGH CONCENTRATION OF HYDROCARBONS IN THE 95,000 + PPMV RANGE. LIQUID SAMPLE TAKEN AT APPROX 0630 INDICATES 15 % OF LNAPL PRESENT IN THE LIQUID. INDUCED WELL VAC REDUCED AT 0705 HRS GW PUMPING STOPPED AT 0715. EVENT CONCLUDED AT 0715						
MANIFOLD	LNAPL % Vol Gals	– / –	15 / 14.40	12 / 11.52			
	Depth of GW Depression ft	-5.5	-5.5	-5.5	1445		
	Extraction Well DTLNAPL ft	58.13		—	59.00		
	Extraction Well DTGW ft	64.67		57.76	63.40		

( ) Indicates Well Pressure

LNAPL 6.54   0   4.40

HE 59.83   HE 60.14

OPERATING DATA - EVENT #1 B **PAGE # 1** **ACUVAC MOBILE DUAL PHASE SYSTEM**

Location: **Walstadd 66, Lovington, NM** **Project Managers: Sadler/Faucher**

		Date:	7/13/15				
	Parameters		Time 0730	Time 0800	Time 0830	Time	Time	Time
	WELL # W-2		Hr Meter 7289.5	Hr Meter 7290.0	Hr Meter 7290.5	Hr Meter	Hr Meter	Hr Meter
ENGINE/BLOWER	R.P.M.		2200	2200	2200			
	Oil Pressure	psi	50	50	50			
	Water Temp	°F	150	150	150			
	Volts		14	14	14			
	Intake Vacuum	"Hg	19	19	19			
	Gas Flow Fuel/Propane	cfh	0	0	0			
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump	ON/OFF	ON	ON	OFF			
	Extraction Well Flow	scfm	9.51	9.51	9.51			
	Extraction Well Vacuum	"H_2O	60	60	60			
	Pump Rate	gals/min	3.0	3.70	3.70			
	Total Volume	gals	-	90	201			
	Influent Vapor Temp.	°F	68	68	68			
	Air Temperature	°F	70.4	71.7	72.5			
	Barometric Pressure	"Hg	30.01	30.01	30.01			
VAPOR /INFLUENT	HC	ppmv	-	89,750	-			
	CO_2	%	-	3.52	-			
	CO	%	-	5.74	-			
	O_2	%	-	8.6	-			
	H_2S	ppm	-	0	-			

NOTES

RELOCATED THE ACUVAC SYSTEM NEAR WELL W-2. GAUGED THE WELL PLACED THE IN-WELL PUMP AT 67.0 FT BTOC. INITIAL WELL VAC SET AT 60"H_2O RESULTING IN A WVF OF 9.50 SCFM.

MANIFOLD	LNAPL %	Vol Gals	-/-	27/24.3	21/23.31			
	Depth of GW Depression	ft	-5.5	-5.5	-5.5		1445	
	Extraction Well DTLNAPL	ft	59.12		59.17		59.12	
	Extraction Well DTGW	ft	63.96		59.21		60.13	

( ) Indicates Well Pressure

LNAPL 6.84
HE 58.90

.04 HE 59.18

1.01 HE 59.38

AvR

OPERATING DATA - EVENT #1 C **PAGE # 1** **ACUVAC MOBILE DUAL PHASE SYSTEM**

Location: Walstadd 66, Lovington, NM **Project Managers: Sadler/Faucher**

	Date:	7/13/15					
	Parameters WELL # A-1	Time 0845 Hr Meter 7290.5	Time 0915 Hr Meter 7291.0	Time 0945 Hr Meter 7291.5	Time 1015 Hr Meter 7292.0	Time 1045 Hr Meter 7292.8	Time 1115 Hr Meter 7293.0
ENGINE/BLOWER	R.P.M.	2200	2200	2300	2300	2300	2300
	Oil Pressure psi	50	50	50	50	50	50
	Water Temp °F	150	150	150	150	155	160
	Volts	14	14	14	14	14	14
	Intake Vacuum "Hg	16	16	16	16	16	16
	Gas Flow Fuel/Propane cfh	0	0	50	50	50	50
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump ON/OFF	ON	ON	ON	ON	ON	ON
	Extraction Well Flow scfm	23.34	23.34	22.55	22.55	22.55	22.55
	Extraction Well Vacuum "H_2O	60	60	70	70	70	70
	Pump Rate gals/min	4.2	4.2	4.4	4.5	4.5	4.5
	Total Volume gals	–	126	252	384	519	654
	Influent Vapor Temp °F	71	71	71	72	72	72
	Air Temperature °F	74.3	77.8	84.3	86.7	88.5	89.4
	Barometric Pressure "Hg	30.01	30.01	30.00	30.00	30.00	29.99
VAPOR /INFLUENT	HC ppmv	–	–	64480	–	–	–
	CO_2 %	–	–	5.14	–	–	–
	CO %	–	–	2.09	–	–	–
	O_2 %	–	–	7.1	–	–	–
	H_2S ppm	–	–	0	–	–	–
NOTES	AT 0830 MOBILIZED THE ACUVAC EQUIPMENT ON WELL A-1. SET IN-WELL PUMP AT 67 FT BTOC. INITIAL WELL VAC SET AT 60"H_2O RESULTING IN A WVF OF 23.34 SCFM. INITIAL GW PUMP RATE SET AT 4.2 GPM. AT 0945 INCREASED WELL VAC TO 70"H_2O RESULTING IN A WVF OF 22.55 SCFM. GW PUMP RATE INCREASED TO 4.4 GPM AND INCREASED AGAIN AT 1015 HRS TO 4.5 GPM TO COMPENSATE FOR HIGHER VACUUM. TPH VAPORS REMAIN HIGH IN THE GASOLINE RANGE						
MANIFOLD	LNAPL % Vol Gals	–/–	8/10.08	4/5.04	2/2.64	2/2.7	1.5/2.03
	Depth of GW Depression ft	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5
	Extraction Well DTLNAPL ft	0820 58.03	0830 57.76				
	Extraction Well DTGW ft	63.55	63.87				

( ) Indicates Well Pressure

LNAPL	5.52	6.11
HE	59.47	59.35

OPERATING DATA - EVENT #1C **PAGE #2** **ACUVAC MOBILE DUAL PHASE SYSTEM**

Location: **Walstadd 66, Lovington, NM** **Project Managers: Sadler/Faucher**

		Date:	7/13/15				
	Parameters		Time 1145	Time 1215	Time 1245	Time 1315	Time 1345	Time 1445
	WELL # A-1		Hr Meter 7293.5	Hr Meter 7294.0	Hr Meter 7294.5	Hr Meter 7295.0	Hr Meter 7295.5	Hr Meter 7296.5
ENGINE/BLOWER	R.P.M.		2300	2300	2300	2300	2300	2300
	Oil Pressure	psi	50	50	50	50	50	50
	Water Temp	°F	160	160	165	165	165	165
	Volts		14	14	14	14	14	14
	Intake Vacuum	"Hg	16	16	16	16	16	16
	Gas Flow Fuel/Propane	cfh	50	50	50	50	50	50
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump	ON/OFF	ON	ON	ON	ON	ON	OFF
	Extraction Well Flow	scfm	22.55	22.55	22.55	22.55	22.55	22.55
	Extraction Well Vacuum	"H_2O	70	70	70	70	70	70
	Pump Rate	gals/min	4.5	4.5	4.5	4.4	4.4	3.5
	Total Volume	gals	789	924	1059	1194	1326	1553
	Influent Vapor Temp.	°F	71	71	71	71	71	71
	Air Temperature	°F	91.3	95.1	97.6	99.2	99.5	99.8
	Barometric Pressure	"Hg	29.98	29.97	29.96	29.94	29.92	29.92
VAPOR /INFLUENT	HC	ppmv	56,750	-	-	-	55850	-
	CO_2	%	5.74	-	-	-	5.96	-
	CO	%	1.57	-	-	-	1.52	-
	O_2	%	7.0	-	-	-	7.2	-
	H_2S	ppm	0	-	-	-	0	-

NOTES

WELL VAC AND WELL FLOW STEADY DURING PERIOD. TPH VAPORS MOSTLY STEADY DURING THE PERIOD.
AT 1445 EVENT CONCLUDED. ALL WELL GAUGED. WELL W-1 AND W-2 WERE GAUGED TO DETERMINE THE EXTENT OF ANY REBOUND.
ACUVAC EQUIPMENT AND SYSTEM DEMOBILIZED, SITE SECURED, DEPARTED SITE.

MANIFOLD	LNAPL %	Vol Gals	1.5/2.03	1.5/2.03	1.5/2.03	1.5/2.03	1.5/1.98	1.5/1.98
	Depth of GW Depression	ft	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5
	Extraction Well DTLNAPL	ft						59.98
	Extraction Well DTGW	ft						60.01

( ) Indicates Well Pressure

7FORMS/TestForms/1210017B

LNAPL .13

HE 59.91

OPERATING DATA - EVENT #1 A **PAGE #** 1 **ACUVAC MOBILE DUAL PHASE SYSTEM**

Location: Walstadd 66, Lovington, NM **Project Managers: Sadler/Faucher**

	Date:		7/13/15					
	Parameters		Time 0615	Time 0645	Time 0715	Time	Time	Time
	WELL # W-1		Hr Meter 7288.5	Hr Meter 7289.0	Hr Meter 7289.5	Hr Meter	Hr Meter	Hr Meter
ENGINE/BLOWER	R.P.M.		2206	2200	2200			
	Oil Pressure	psi	50	50	50			
	Water Temp	°F	130	140	150			
	Volts		14	14	14			
	Intake Vacuum	"Hg	19	19	19			
	Gas Flow Fuel/Propane	cfh	0	0	0			
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump	ON/OFF	ON	ON	OFF			
	Extraction Well Flow	scfm	9.51	9.51	9.51			
	Extraction Well Vacuum	"H_2O	60	60	60			
	Pump Rate	gals/min	3.2	3.2	3.2			
	Total Volume	gals	–	96	192			
	Influent Vapor Temp.	°F	68	68	68			
	Air Temperature	°F	66.7	69.1	69.8			
	Barometric Pressure	"Hg	30.03	30.02	30.01			
VAPOR /INFLUENT	HC	ppmv	–	95790	–			
	CO_2	%	–	3.42	–			
	CO	%	–	7.46	–			
	O_2	%	–	8.6	–			
	H_2S	ppm	–	0	–			

NOTES

ARRIVED ON SITE AT 0545 HRS. POSITIONED THE ACUVAC SYSTEM NEAR WELL W-1. GAUGED THE WELL AND MOBILIZED ALL EQUIPMENT. PLACED THE IN WELL PUMP AT 67.0 FT BTOC. EVENT STARTED AT 0615 HRS. INITIAL WELL VAC SET AT 60"H_2O RESULTING IN WVF OF 9.50 SCFM. INFLUENT VAPOR SAMPLE INDICATES HIGH CONCENTRATION OF HYDROCARBONS IN THE 95,000 + PPMV RANGE. LIQUID SAMPLE TAKEN AT APPROX 0630 INDICATES 15 % OF LNAPL PRESENT IN THE LIQUID. INDUCED WELL VAC REDUCED AT 0705 HRS GW PUMPING STOPPED AT 0715. EVENT CONCLUDED AT 0715

MANIFOLD	LNAPL	% Vol Gals	–/–	15/14.40	12/11.52			
	Depth of GW Depression	ft	−5.5	−5.5	−5.5	1445		
	Extraction Well DTLNAPL	ft	58.13		–	59.00		
	Extraction Well DTGW	ft	64.67		57.76	63.40		

( ) Indicates Well Pressure

LNAPL 6.54 0 4.40

HE 59.83 HE 60.14

7FORMS/TestForms/1210017B

AVR

OPERATING DATA - EVENT #1 B **PAGE #** 1 **ACUVAC MOBILE DUAL PHASE SYSTEM**

Location: Walstadd 66, Lovington, NM **Project Managers: Sadler/Faucher**

	Date:	7/13/15					
	Parameters	Time 0730	Time 0800	Time 0830	Time	Time	Time
	WELL # W-2	Hr Meter 7289.5	Hr Meter 7290.0	Hr Meter 7290.5	Hr Meter	Hr Meter	Hr Meter
ENGINE/BLOWER	R.P.M.	2200	2200	2200			
	Oil Pressure psi	50	50	50			
	Water Temp °F	150	150	150			
	Volts	14	14	14			
	Intake Vacuum "Hg	19	19	19			
	Gas Flow Fuel/Propane cfh	0	0	0			
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump **ON/OFF**	ON	ON	OFF			
	Extraction Well Flow scfm	9.51	9.51	9.51			
	Extraction Well Vacuum "H_2O	60	60	60			
	Pump Rate gals/min	3.0	3.70	3.70			
	Total Volume gals	-	90	201			
	Influent Vapor Temp °F	68	68	68			
	Air Temperature °F	70.4	71.7	72.5			
	Barometric Pressure "Hg	30.01	30.01	30.01			
VAPOR /INFLUENT	HC ppmv	-	89,750	-			
	CO_2 %	-	3.52	-			
	CO %	-	5.74	-			
	O_2 %	-	8.6	-			
	H_2S ppm	-	0	-			
NOTES	RELOCATED THE ACUVAC SYSTEM NEAR WELL W-2. GAUGED THE WELL PLACED THE ID WELL PUMP AT 67.0 FT BTOC. INITIAL WELL VAC SET AT 60 "H_2O RESULTING IN A WVF OF 9.50 SCFM.						
MANIFOLD	LNAPL % Vol Gals	-/-	27/24.3	21/23.31			
	Depth of GW Depression ft	-5.5	-5.5	-5.5		1445	
	Extraction Well DTLNAPL ft	57.12		59.17		59.12	
	Extraction Well DTGW ft	63.96		59.21		60.13	

( ) Indicates Well Pressure

7FORMS/TestForms/1210017B

LNAPL 6.84
HE 58.90

.04 HE 59.18

1.01 HE 59.38

OPERATING DATA - EVENT #1C PAGE # 1 **ACUVAC MOBILE DUAL PHASE SYSTEM**

Location: Walstadd 66, Lovington, NM

Project Managers: Sadler/Faucher

		Date:	7/13/15				
	Parameters WELL # A-1		Time 0845 Hr Meter 7290.5	Time 0915 Hr Meter 7291.0	Time 0945 Hr Meter 7291.5	Time 1015 Hr Meter 7292.0	Time 1045 Hr Meter 7292.8	Time 1115 Hr Meter 7293.0
ENGINE/BLOWER	R.P.M.		2200	2200	2300	2300	2300	2300
	Oil Pressure	psi	50	50	50	50	50	50
	Water Temp	°F	150	150	150	150	155	160
	Volts		14	14	14	14	14	14
	Intake Vacuum	"Hg	16	16	16	16	16	16
	Gas Flow Fuel/Propane	cfh	0	0	50	50	50	50
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump	ON/OFF	ON	ON	ON	ON	ON	ON
	Extraction Well Flow	scfm	23.34	23.34	22.55	22.55	22.55	22.55
	Extraction Well Vacuum	"H_2O	60	60	70	70	70	70
	Pump Rate	gals/min	4.2	4.2	4.4	4.5	4.5	4.5
	Total Volume	gals	-	126	252	384	519	654
	Influent Vapor Temp.	°F	71	71	71	72	72	72
	Air Temperature	°F	74.3	77.8	84.3	86.7	88.5	89.4
	Barometric Pressure	"Hg	30.01	30.01	30.00	30.00	30.00	29.99
VAPOR /INFLUENT	HC	ppmv	-	-	64480	-	-	-
	CO_2	%	-	-	5.14	-	-	-
	CO	%	-	-	2.09	-	-	-
	O_2	%	-	-	7.1	-	-	-
	H_2S	ppm	-	-	0	-	-	-
NOTES	AT 0830 MOBILIZED THE ACUVAC EQUIPMENT ON WELL A-1. SET IN-WELL PUMP AT 67 FT BTOC. INITIAL WELL VAC SET AT 60"H_2O RESULTING IN A WVF OF 23.34 SCFM. INITIAL GW PUMP RATE SET AS 4.2 GPM. AT 0945 INCREASED WELL VAC TO 70"H_2O RESULTING IN A WVF OF 22.55 SCFM. GW PUMP RATE INCREASED TO 4.4 GPM AND INCREASED AGAIN AT 1015 HRS TO 4.5 GPM TO COMPENSATE FOR HIGHER VACUUM. TPH VAPORS REMAIN HIGH IN THE GASOLINE RANGE							
MANIFOLD	LNAPL %	Vol Gals	-/-	8/10.08	4/5.04	2/2.64	2/2.7	1.5/2.03
	Depth of GW Depression	ft	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5
	Extraction Well DTLNAPL	ft	0820 58.03	0830 57.76				
	Extraction Well DTGW	ft	63.55	63.87				

( ) Indicates Well Pressure

LNAPL 5.52 6.11

HE 59.47 59.35

AvR

OPERATING DATA - EVENT #1C **PAGE #2** **ACUVAC MOBILE DUAL PHASE SYSTEM**

Location: **Walstadd 66, Lovington, NM** **Project Managers: Sadler/Faucher**

	Date:	7/13/15					
	Parameters	Time 11:45	Time 1215	Time 1245	Time 1315	Time 1345	Time 1445
	WELL # A-1	Hr Meter 7293.5	Hr Meter 7294.0	Hr Meter 7294.5	Hr Meter 7295.0	Hr Meter 7295.5	Hr Meter 7296.5
ENGINE/BLOWER	R.P.M.	2300	2300	2300	2300	2300	2300
	Oil Pressure psi	50	50	50	50	50	50
	Water Temp °F	160	160	165	165	165	165
	Volts	14	14	14	14	14	14
	Intake Vacuum "Hg	16	16	16	16	16	16
	Gas Flow Fuel/Propane cfh	50	50	50	50	50	50
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump ON/OFF	ON	ON	ON	ON	ON	OFF
	Extraction Well Flow scfm	22.95	22.95	22.95	22.95	22.95	22.95
	Extraction Well Vacuum "H_2O	70	70	70	70	70	70
	Pump Rate gals/min	4.5	4.5	4.5	4.4	4.4	3.5
	Total Volume gals	789	924	1059	1194	1326	1553
	Influent Vapor Temp. °F	71	71	71	71	71	71
	Air Temperature °F	91.3	95.1	97.6	99.2	99.5	99.8
	Barometric Pressure "Hg	29.98	29.97	29.96	29.94	29.92	29.92
VAPOR /INFLUENT	HC ppmv	56,750	-	-	-	55850	-
	CO_2 %	5.74	-	-	-	5.96	-
	CO %	1.57	-	-	-	1.52	-
	O_2 %	7.0	-	-	-	7.2	-
	H_2S ppm	0	-	-	-	0	-
NOTES	WELL VAC AND WELL FLOW STEADY DURING PERIOD. TPH VAPORS MOSTLY STEADY DURING THE PERIOD. AT 1445 EVENT CONCLUDED. ALL WELL GAUGED. WELL W-1 AND W-2 WERE GAUGED TO DETERMINE THE EXTENT OF ANY REBOUND. ACUVAC EQUIPMENT AND SYSTEM DEMOBILIZED, SITE SECURED, DEPARTED SITE.						
MANIFOLD	LNAPL % Vol Gals	1.5/2.03	1.5/2.03	1.5/2.03	1.5/2.03	1.5/1.98	1.5/1.98
	Depth of GW Depression ft	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5
	Extraction Well DTLNAPL ft						59.88
	Extraction Well DTGW ft						60.01

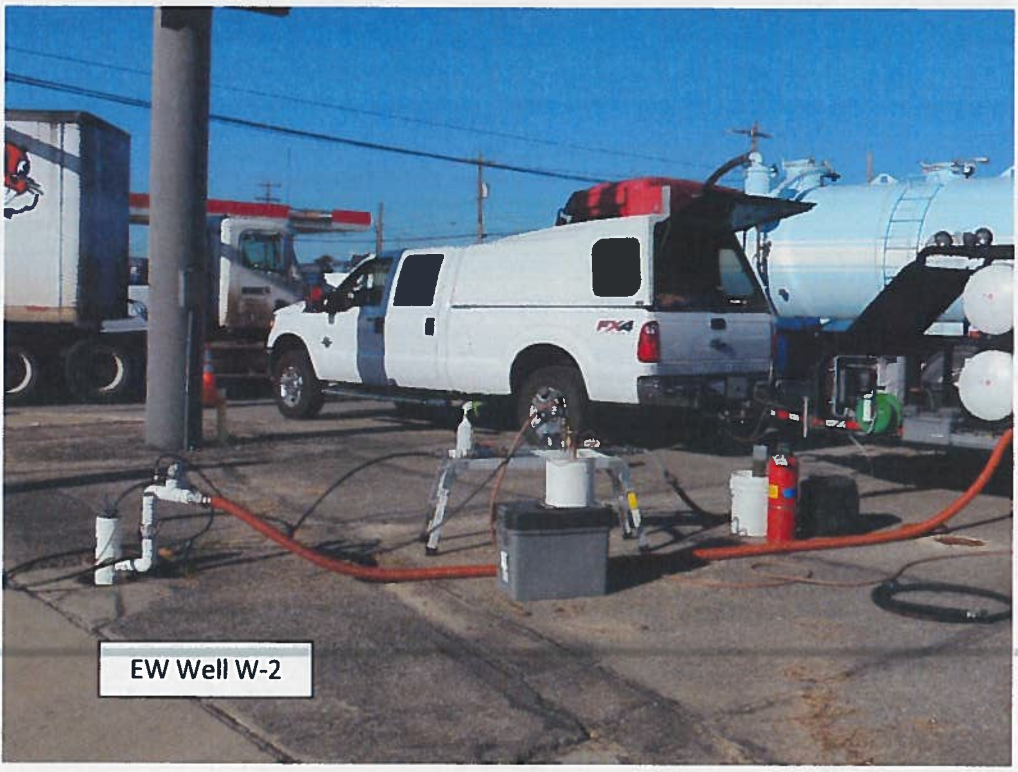
( ) Indicates Well Pressure

LNAPL .13

HE 59.91

WALSTADD 66
LOVINGTON, NM

AcuVac MDP System



EW Well W-2

WALSTADD 66
LOVINGTON, NM

Daniel B. Stephens & Associates, Inc.

MEMORANDUM

TO: Gundar Peterson, PE

FROM Tom Golden, Kelly Isaacson

DATE. January 29, 2010

SUBJECT Rotameter flow measurement

In response to Katherine MacNeil's email, we researched the apparent discrepancy between standard cubic feet per minute (SCFM) measurements given by a rotameter and the SCFM calculated by AcuVac in their soil vapor extraction (SVE) pilot test reports. The results of our research are summarized below

Definition of variables

ACFM actual cubic feet per minute (cfm) at a given temperature, pressure (elevation), and operating conditions

CFM_{meter}. cubic feet per minute (cfm) measured by a rotameter In the documentation provided, this is also called observed cfm and indicated scfm.

SCFM: equivalent flow in cubic feet per minute (cfm) at STP

STP· standard temperature and pressure, 70°F and 14 7 psi.

ρ density of a fluid, given in mass per unit volume

Problem statement

In the AMEC calculation provided regarding cfm measured with a rotameter, the author reports that the correct reporting unit from a rotameter calibrated for STP is SCFM. The AcuVac documentation refers to the flow rate measured with a rotameter as ACFM and converts this value to SCFM in the field. Does the value measured on the rotameter by AcuVac need to be converted to SCFM?

Solution

The need for the definition of three different types of CFM arises from the difference in calibration versus operation temperature and pressure conditions.

An analysis of the free body diagram of the float in a rotameter is given by Wellin[1], which shows that Q is dependent on the area of flow and density of air·

$$Q = K \cdot \frac{A}{\sqrt{\rho}} \tag{1}$$

When a rotameter is calibrated at STP, $\sqrt{\rho}$ is absorbed into the value of *K*, because ρ (air) is defined. When the density of the air is changed (i.e. elevation of the rotameter is changed), the calibrated rotameter no longer yields flow rate in SCFM, but instead what we will call CFM_{meter}.

The Dwyer technical documentation[2] for the VFC series rotameter used by AcuVac acknowledges this fact in the third paragraph under "Operation", which states,

"the flowmeter is calibrated to operate at a specific set of conditions, and deviation from those standard conditions will require correction for the calibration to be valid. In practice, the reading taken from the flowmeter scale must be corrected back to standard conditions to be used with the scale units. The correct location to measure the actual pressure and temperature is at the exit of the flowmeter, except under vacuum applications where they should be measured at the flowmeter inlet."

The conversion given to convert CFM_{meter} to SCFM[1,2] is a non linear relationship:

$$Q(SFCM) = CFM_{meter}\sqrt{\frac{P_{actual}}{P_{calibration}}\cdot\frac{T_{calibration}}{T_{actual}}} \qquad (2)$$

It can be noted that the calibration temperature and pressure are generally STP; however, calibration information should be provided by the flowmeter manufacturer

The relationship between SCFM and ACFM is linear:

$$ACFM = SCFM\ \frac{P_{standard}}{P_{actual}}\cdot\frac{T_{actual}}{T_{standard}} \qquad (3)$$

For completeness, the relationship between ACFM and CFM_{meter} is given by

$$ACFM = CFM_{meter}\sqrt{\frac{P_{standard}}{P_{actual}}\ \frac{T_{actual}}{T_{standard}}} \qquad (4)$$

Supporting documentation

Two Dwyer specification sheets for rotameters[2] (including the VFC Series Visi-Float used by AcuVac) are attached, which include the calculation of SCFM from the meter reading. This calculation is also discussed in Wellin[1]

The correct conversion from SCFM to ACFM is included in the documentation with the AMEC calculation (page 3 of 4 from King Correction Formulae & Sizing)[3], as well as in Wellin[1].

Implications

The primary problem here is one of terminology, although there are implications if formulas in either the AcuVac or AMEC documents were used to back-calculate ACFM/SCFM values. Although it may not be intuitive, ACFM is not the value read straight from the meter, rather the calculated actual volumetric flow rate through the meter.

Page 2 of the AMEC calculation gives an equation to calculate ACFM. This non-linear equation is the correct way to calculate ACFM from CFM_{meter}. It is not the correct way to calculate SCFM from ACFM or vice versa.

For most SVE applications in New Mexico (i.e. 3000-7000 feet elevation, air temperature of 50-70°F), the value of CFM_{meter} falls between the ACFM and SCFM, such that $ACFM > CFM_{meter} > SCFM$.

In the design equation given in the AMEC calculation

$$Q = kA(gh)^{0.5} \tag{5}$$

the fluid density, $\rho(air)$, is included in the calibration coefficient, *k*, a fact which is not acknowledged by the AMEC calculation. While the equation is valid for the calibration conditions, the flow rate read from the meter must be corrected as indicated above in equation 2 to reflect the correct SCFM.

Conclusions

In the problem statement of the AMEC calculation regarding CFM used in SVE systems, the correct answer to the question "What is the correct reporting unit directly read off the scale; SCFM, ACFM, or other?" is "other", and in this discussion is termed CFM_{meter}.

Additionally, AcuVac is correct in converting the CFM value read on the flowmeter to SCFM to adjust for changes in temperature and pressure, with the non-linear relationship given above, although what they call ACFM in their sample calculation is actually CFM_{meter}.

In summary, both the SCFM value in the AMEC calculation[4] and the ACFM value in the AcuVac report[5] refer to the value measured at the flowmeter, CFM_{meter}, therefore, both equations provided are true, but do not represent the actual relationship between true SCFM and ACFM.

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

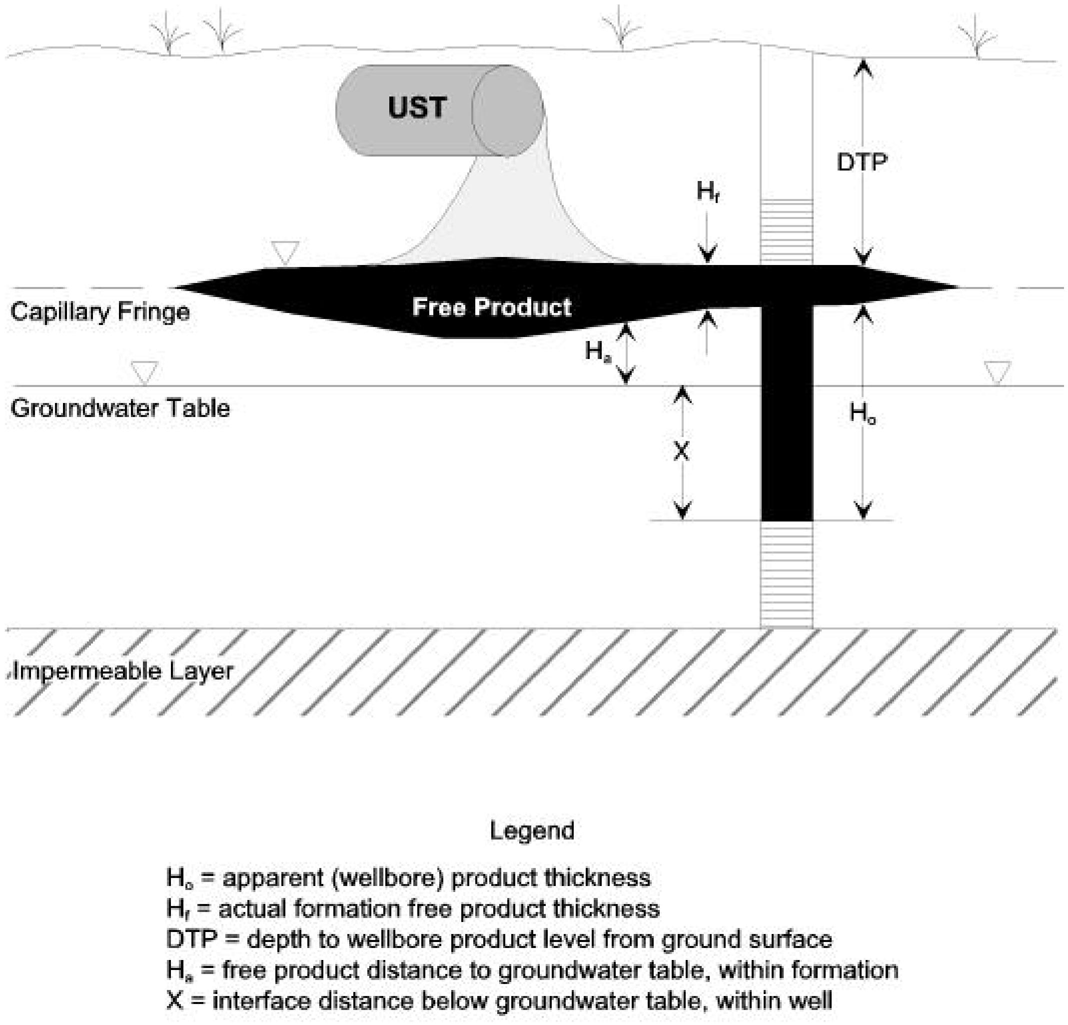
s_{ow} = hydrocarbon-water interfacial tension (= $s_{aw} - s_{ao}$)

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



Legend

H_o = apparent (wellbore) product thickness
H_f = actual formation free product thickness
DTP = depth to wellbore product level from ground surface
H_a = free product distance to groundwater table, within formation
X = interface distance below groundwater table, within 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)

$$H_f \quad = \quad H_o - \left(x + h_a \right)$$

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)

$$H_f \quad = \quad \left(\left(1 - r_o \right) \cdot H_o \right) - h_a$$

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.

From: Peterson, Gundar
Sent: Wednesday, September 03, 2008 3:28 PM
To: Golden, Tom
Subject: 50% recoverable hydrocarbons

Remediation Technologies for Soils and Groundwater (Paperback)
by Alok Bhandari (Editor), Rao Y. Surampalli (Editor), Pascale Champagne (Editor), Say Kee Ong (Editor), R. D. Tyagi (Editor)Paperback: 456 pages
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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 nonvolatile 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.

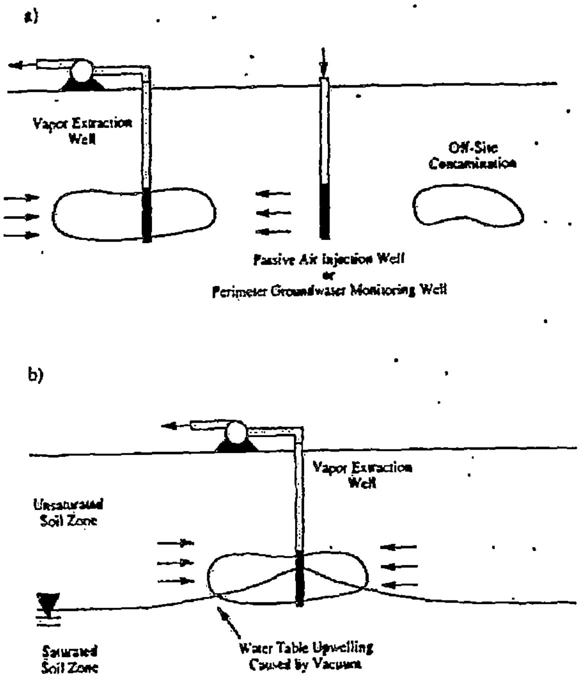


Figure 9. (a) Use of passive vapor wells to prevent migration of off-site contaminant vapors. (b) Water table rise caused by the applied vacuum.

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 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.

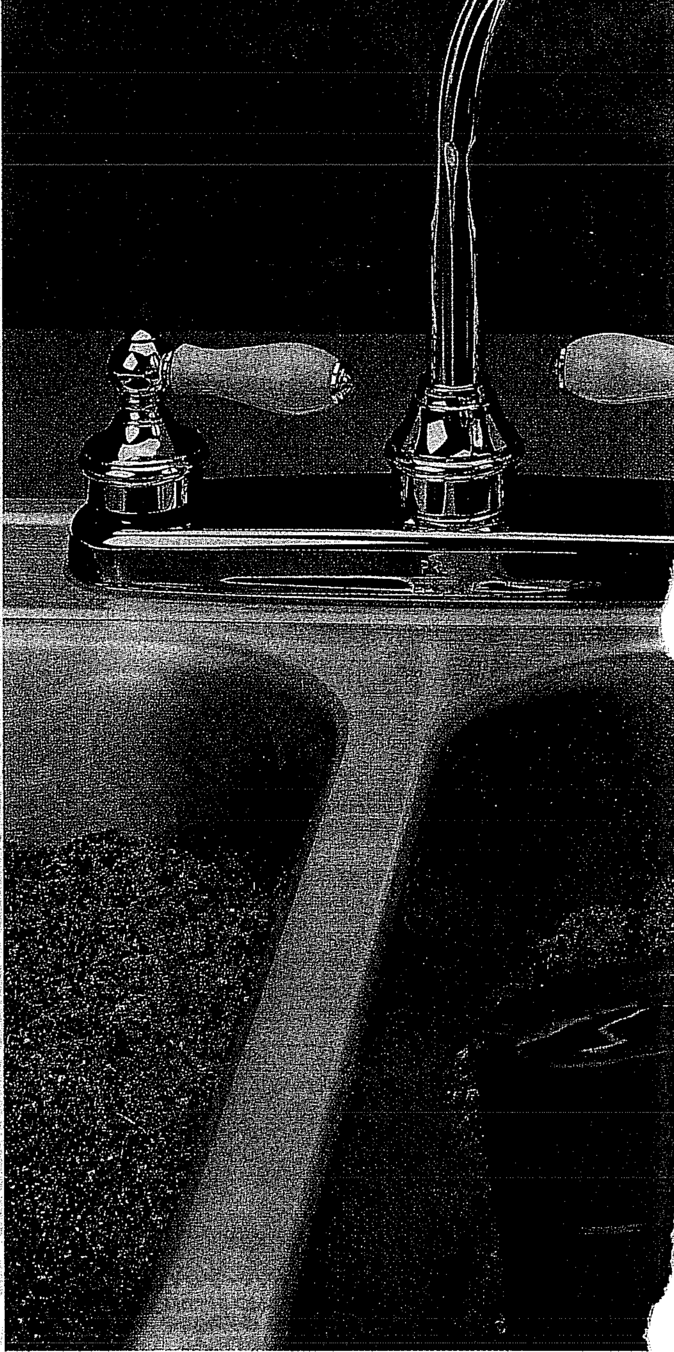
Air Permeability Tests

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

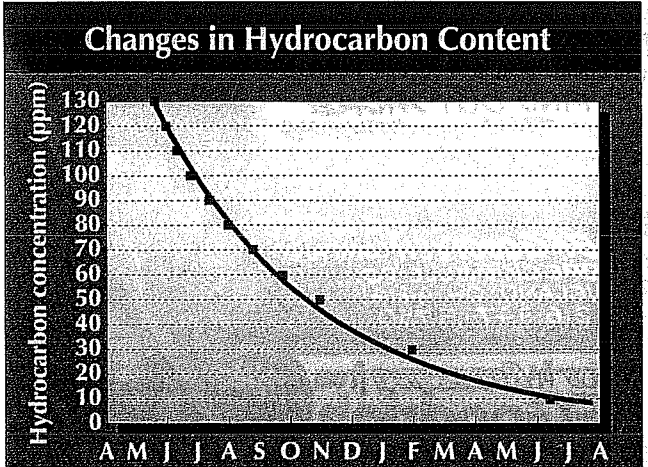
Estimating the life-cycle costs of treating hydrocarbon vapors extracted from soil.

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.



• *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.*

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-

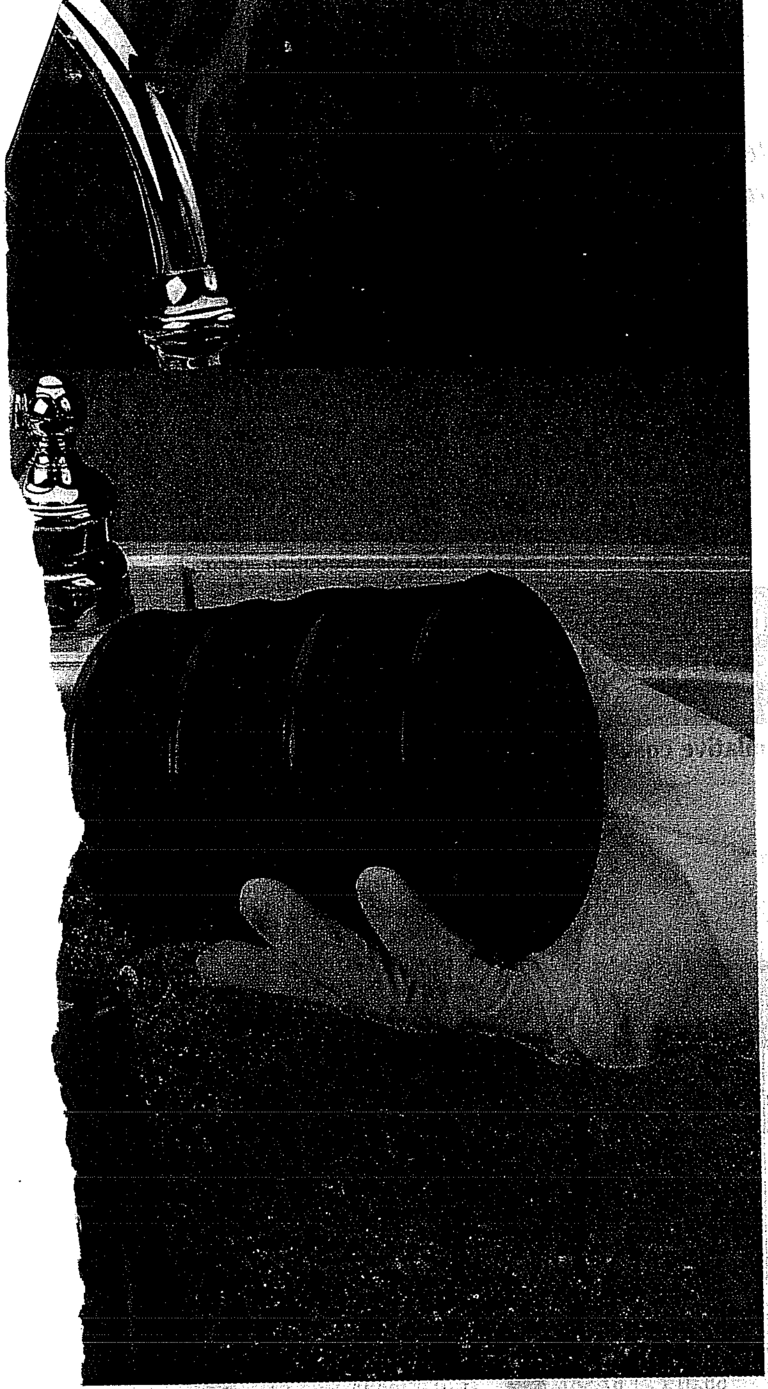


Table 1. Vapor Abatement Cost Analysis Program Input Data Worksheet

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).

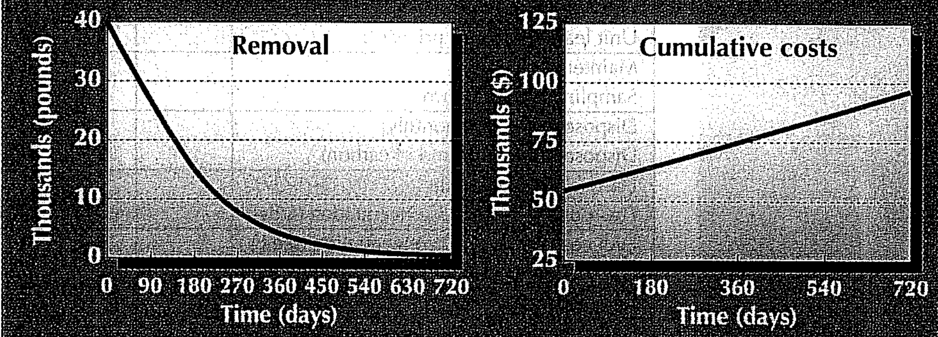
Simulating a remediation

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



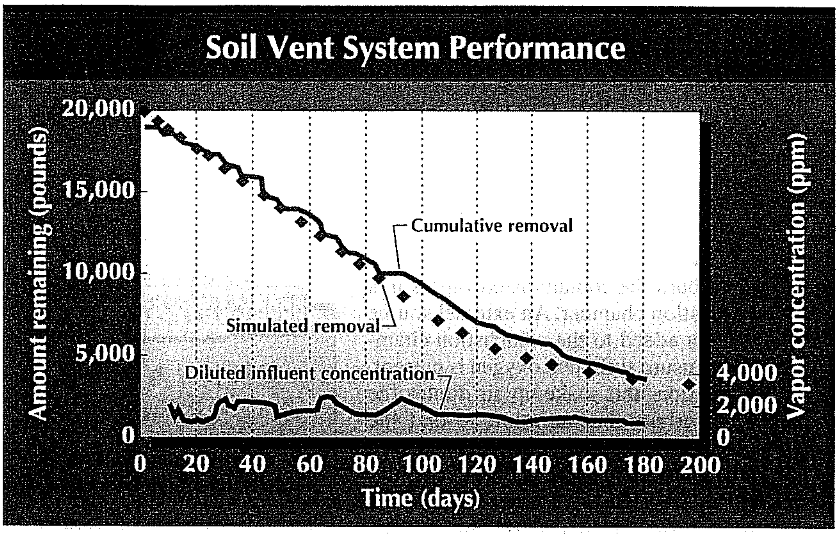
Time (days)	Contaminant left (pounds)	Daily removal (pounds/day)	Daily flow (cfm)	Vapor concentration (ppmv)	Daily cost ($)	Cumulative cost ($)	Cost NPV @10%
0	40,000	0.0	0	10,000	49	54,950	54,950
30	35,652	144.9	96	8090	52	56,495	56,488
60	31,303	144.9	118	6545	52	58,040	58,014
90	26,955	144.9	146	5295	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.***

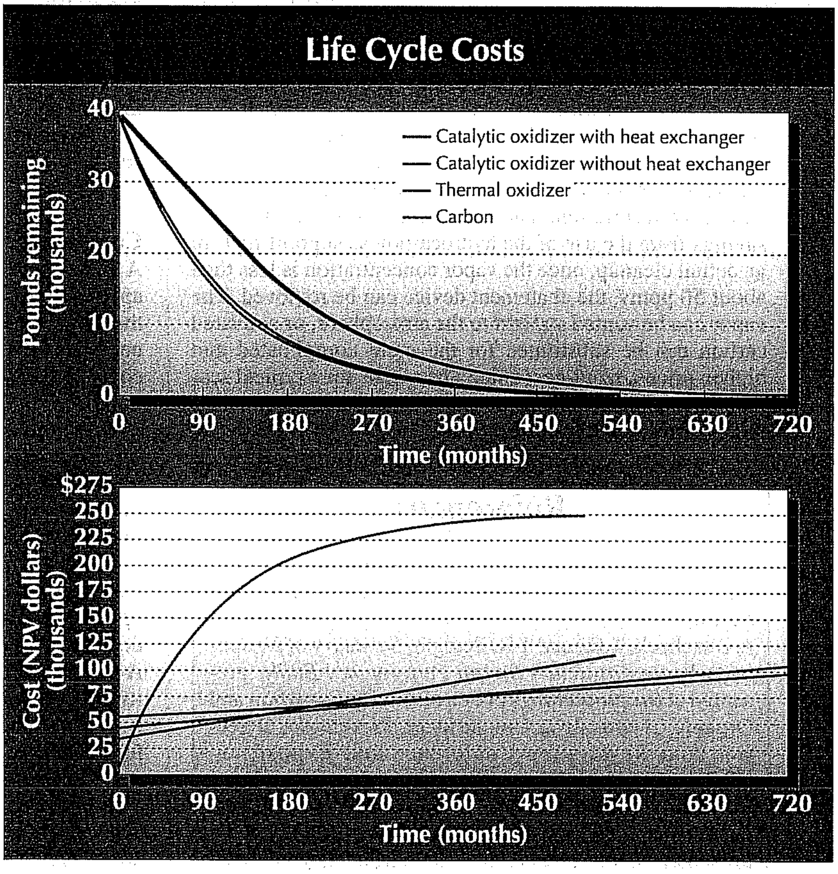
valve and is simulated as shown in Figure 2 by decreasing the total flow of air into the unit.

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.*



• ***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.***

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.

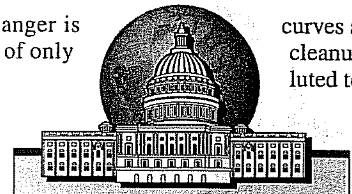
Vapor-phase activated carbon is used as the baseline abatement technology. In our experience, the adsorption efficiency of carbon is about 25 percent for most hydrocarbons. For the sake of comparison, the maximum flow rate through the carbon has been established to be 200 standard cubic feet per minute (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).

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.

Dr. Peter Kroopnick is a principal hydrogeologist and director of remediation technology at Fluor Daniel GTI, Renton, Wash., 425-228-9645, or e-mail, pkroopnick@gtionline.com.

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Reader Interest Review

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High **206** Medium **207** Low **208**

Calculation Cover Sheet

Daniel B. Stephens & Associates, Inc.

Project Name Lovington 66 Project Number DB19.1395.00

Calculation Number DB19.1395-02 Discipline Engineering No. of Sheets 6

PROJECT: Lovington 66

THOMAS A. GOLDEN
22750
8/28/2020

SITE: Lovington, New Mexico

SUBJECT: Determine pressure losses and size blowers for the 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. SCH 40 PVC pipe size and dimension data

D. Fundamentals of Momentum, Heat, and Mass Transfer, Welty and Rorrer

E. DPE Well Pilot Test Report for Lovington 66, Golder Associates, Inc, 2015

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	CES	6/16/2020	JES	6/18/2020	TG	8/18/2020
1	PSTB Comments					TG	9/15/2020

Calculation Sheet

Daniel B. Stephens & Associates, Inc.

Project No. DB19.1395.00 Date 06/16/2020

Subject Pressure losses and remediation system blower design Sheet 1 of 6

By CES Checked By JES/TG Calculation No. DB19.1395-02

1.0 OBJECTIVE

Calculate the amount of pressure loss within the soil vapor extraction (SVE) pipe network and use this information to size a system blower.

2.0 GIVEN

SVE conveyance pipe consisting of 4-inch schedule (SCH) 40 polyvinyl chloride (PVC), and equipment compound piping consisting of 6-inch SCH 40 PVC; minor loss coefficients, K, for fittings within the system; individual SVE well air flowrates; and Darcy Weisbach roughness coefficients of 0.000005 and 0.00015[A] for plastic and steel pipe, respectively. A vacuum of 85 inches of water applied at the wellhead.

3.0 METHOD

Use the Darcy-Weisbach equation[2] to determine the amount of major and minor pressure loss within a given pipe system. Energy lost due to the physical friction of the fluid against the pipe wall is categorized as major losses, whereas energy losses due to changes in flow direction or obstructions (e.g. valves) are categorized as minor losses. 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[2].

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 4,000 describe fully-developed turbulent flow[A]. In order to determine the Reynolds number, three variables are needed: the dynamic viscosity of the fluid, the characteristic length/diameter 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[1].

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

Where f = Darcy-Weisbach friction factor
k = Darcy-Weisbach roughness coefficient

Calculate major pressure losses within the system[2].

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

Where H_{maj} = Major headlosses
l = Pipe length
g = Gravitational acceleration

Minor pressure losses are dependent on the type of obstruction 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.

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

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

Use the major and minor pressure losses, together with the design extraction well vacuum of 85 in H_2O^D, to determine the expected blower operating vacuum.

4.0 SOLUTION

The Lovington 66 site will consist of a single SVE system connected to two 4-inch diameter horizontal wells each designed to convey up to 275 scfm[D]. The flow from each extraction well is conveyed to a 6-inch diameter SCH 40 PVC SVE manifold via 4-inch SCH 40 PVC pipe.

Example calculations are provided below for SVE-1 and manifold piping. Calculations for all lines are provided in the attached spreadsheet. The following equations display significant digits carried through in the spreadsheet.

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First, determine the linear flow velocity and Reynold's number for each conveyance line at the anticipated flow rate assuming full pipe flow. Average inside diameter is 3.998, and 6.031 inches for the 4- and 6-inch pipe materials[C]. Assume a dynamic viscosity and air density of 3.64 E-7 lbf*sec/ft^2 and 2.13 E-3 slug/ft^3, respectively, corresponding to a site elevation of 3,910 feet above mean sea level[D].

$V_{Conveyance}$ = Q / A = (275 ft^3/min) * (min / 60 sec) / (π / 4 * (3.998 in / 12 in/ft)^2) = 52.6 ft/sec

$V_{Manifold}$ = Q / A = (550 ft^3/min) * (min / 60 sec) / (π / 4 * (6.031 in / 12 in/ft)^2) = 46.2 ft/sec

$Re_{Conveyance}$ = ρ * V * D / μ = (2.13 E-3 slug/ft^3) * (52.6 ft/sec) * (3.998 in / 12 in/ft) / (3.64 E-7 slug/ft*sec) = 102,408

$Re_{Manifold}$ = ρ * V * D / μ = (2.13 E-3 slug/ft^3) * (46.2 ft/sec) * (6.031 in / 12 in/ft) / (3.64 E-7 slug/ft*sec) = 135,774

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:

$$f_{Conveyance} = \frac{1.325}{\left[\ln\left(\frac{0.000005}{3.7 * (3.998/12)} + \frac{5.74}{102{,}408^{0.9}}\right)\right]^2} = 0.0179$$

$$f_{Manifold} = \frac{1.325}{\left[\ln\left(\frac{0.000005}{3.7 * (6.031/12)} + \frac{5.74}{135{,}774^{0.9}}\right)\right]^2} = 0.0168$$

The schedule of pipe and fittings for the site is presented in Table 1 below. The length of each pipe circuit is calculated using AutoCAD software, with 25 percent added to each length to account for vertical changes in direction and piping alignment changes.

Table 1: Pipe and fitting schedule for the SVE system

Pipe Circuit	Circuit Length (ft)	90° Elbow		Butterfly Valve		Branched Tee Fitting		Entrance		Exit		Flowrate
		#	K	#	K	#	K	#	K	#	K	scfm
SVE-1	65	4	1.5	1	0.8	1	2	0	0.5	0	1	275
SVE-2	70	4	1.5	1	0.8	1	2	0	0.5	0	1	275
Manifold	10	1	1.5	0	0.7	0	2	1	0.5	1	1	550

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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 SVE-1 is provided with data summarized in Table 3 below:

$$H_{maj} = \frac{0.0179 * 65ft * \left(52.6\frac{ft}{sec}\right)^2}{\frac{3.998\,in}{12in/ft} * 2 * 32.2\frac{ft}{sec^2}} = 149.7\,ft\ air$$

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

$$149.7\ ft\ air * \frac{0.06846\frac{lbm}{ft^3}air}{62.37\frac{lbm}{ft^3}water} * \frac{12in}{ft} = 1.97\ in\ water$$

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 * 0.8) + (1 * 2) = 8.8

$$H_{min} = \frac{8.8 * \left(52.6\frac{ft}{sec}\right)^2}{2 * 32.2\frac{ft}{sec^2}} * \frac{0.06846\frac{lbm}{ft^3}air}{62.37\frac{lbm}{ft^3}water} * \frac{12in}{ft} = 4.96\ in\ water$$

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

$H_{H\text{-}1}$ = 1.97 + 4.96 = **6.93 in H_2O.**

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Table 3: 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**
SVE-1	65	275	1.97	4.96	6.93
SVE-2	70	275	2.12	4.96	7.08

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 SVE-2 as the SVE system design pressure loss, **ΔP = 7.08 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.

$$H_{maj(bldg)} = \frac{0.0168 * 10ft * \left(46.2\frac{ft}{sec}\right)^2}{\frac{6.031\ in}{12in/ft} * 2 * 32.2\frac{ft}{sec^2}} * \frac{0.06846\frac{lbm}{ft^3}air}{62.37\frac{lbm}{ft^3}water} * \frac{12in}{ft} = 0.15\ in\ water$$

Calculate minor pressure losses using equation 4 for fittings on the 6-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.

$K_m = (1 * 1.5) + 0.5 + 1.0 = 3.0$

$$H_{\min(bldg)} = \frac{3.0 * \left(46.2\frac{ft}{sec}\right)^2}{2 * 32.2\frac{ft}{sec^2}} * \frac{0.06846\frac{lbm}{ft^3}air}{62.37\frac{lbm}{ft^3}water} * \frac{12in}{ft} = 1.31\ in\ water$$

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

$\Delta H_{bldg} = 0.15 + 1.31 =$ **ΔH_{bldg} = 1.46 in H_2O.**

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By CES

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Calculation No. DB19.1395-02

Calculate the expected SVE blower total operating vacuum using the design pressure losses calculated above and the expected extraction well vacuum of 85 in H_2O^E:

$$H_{sys} = 7.08 \text{ in } H_2O + 1.46 \text{ in } H_2O + 85 \text{ in } H_2O = 93.5 \text{ in } H_2O$$

In order to provide an additional factor of safety, the blower will be sized for a vacuum of 100 inches of water. The blower will include a variable frequency drive (VFD), which can be adjusted down to match air flow operating requirements for the vapor treatment equipment.

Major Headloss Calculations

SVE COMPOUND PIPING

CONSTANTS

Pipe Roughness	smooth				
e/d	smooth		Altitude (ft)		3910
Dynamic Viscosity, u	3.64E-07	lbf-sec/ft^2			
k, Roughness Height, ft	5.00E-06				
Air Density	0.068464	lbm/ft^3 =		2.13E-03	slugs/ft^3
Water Density	62.37	lbm/ft^3			
Gravitational Acceleration,g	32.17	ft/s^2			

Major Headlosses

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

Horizontal well conveyance pipe, dia = 3.998 in (4" Sch 40 PVC)
Manifold conveyance pipe, dia = 6.031 in (6" Sch 40 PVC)

Table 1. Major Headlosses

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)
SVE-1	65	275	3.998	0.333	0.087	3154	52.6	102,408	0.0179	195.1	149.7	0.16	1.97
SVE-2	70	275	3.998	0.333	0.087	3154	52.6	102,408	0.0179	210.1	161.2	0.18	2.12
Manifold	10	550	6.031	0.503	0.198	2772	46.2	135,774	0.0168	19.9	11.1	0.01	0.15

Minor Headloss Calculations

SVE Compound Piping

		Minor Loss
Appurtenance		Coeff. (Kl)
90° elbow		1.5
45° elbow		0.4
Branch Flow (BF) Tees		2
Butterfly valves		0.8
Gate Valves (3/4 Closed)		17
Flow Meter		0.64
Entrance		0.5
Exit		1

Minor Headlosses

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

Table 2. Minor Headlosses

			Quantinty of Appurtenances										
Piping Run	90°	45°	Slip Tees (Branch Flow)	Butterfly Valve (Fully Open)	Gate Valve (3/4 Closed)	Flow Meter	Entrance	Exit	Kl Sum	Velocity,v (ft/S)	hL (ft air)	hL (ft water)	hL (in water)
SVE-1	4	0	1	1	0	0	0	0	8.8	52.6	376.2	0.41	4.96
SVE-2	4	0	1	1	0	0	0	0	8.8	52.6	376.2	0.41	4.96
Manifold	1	0	0	0	0	0	1	1	3.0	46.2	99.6	0.11	1.31

Total Design Headloss

SVE Compound Piping

CONSTANTS

Table 3. Total Headlosses

Piping Run	hL (ft air)	hL (ft water)	hL (in. water)	
SVE-1	525.9	0.58	6.93	
SVE-2	537.4	0.59	7.08	
Manifold	110.7	0.12	1.46	
Total Design Headloss	648.1	0.71	8.54	in H2O
			0.63	in Hg

Density of air

Altitude	=	3910	ft		
Rho	=	2.12E-03	slug/ft3		
mu	=	3.64E-07	slug/ft-sec		
Temp	=	45.3	F	504.996	R
Patm	=	1,843	lb/ft2		

Fundamentals of Momentum, Heat, and Mass Transfer
Wicks Welty, Wilson Rorrer

h(ft)	Temp (F)	Pressure (lb/ft2)	rho(slug/ft3)	mu(slug/ft-sec)
0	59	2116.2	0.002378	3.72E-07
1000	57.44	2040.9	0.00231	3.70E-07
2000	51.87	1967.7	0.002242	3.68E-07
3000	48.31	1896.7	0.002177	3.66E-07
4000	44.74	1827.7	0.002112	3.64E-07
5000	41.18	1760.8	0.002049	3.62E-07
6000	37.62	1696.0	0.001988	3.60E-07
7000	34.05	1633.0	0.001928	3.58E-07
8000	30.49	1571.9	0.001869	3.56E-07
9000	26.92	1512.8	0.001812	3.54E-07
10000	23.36	1455.4	0.001756	3.52E-07

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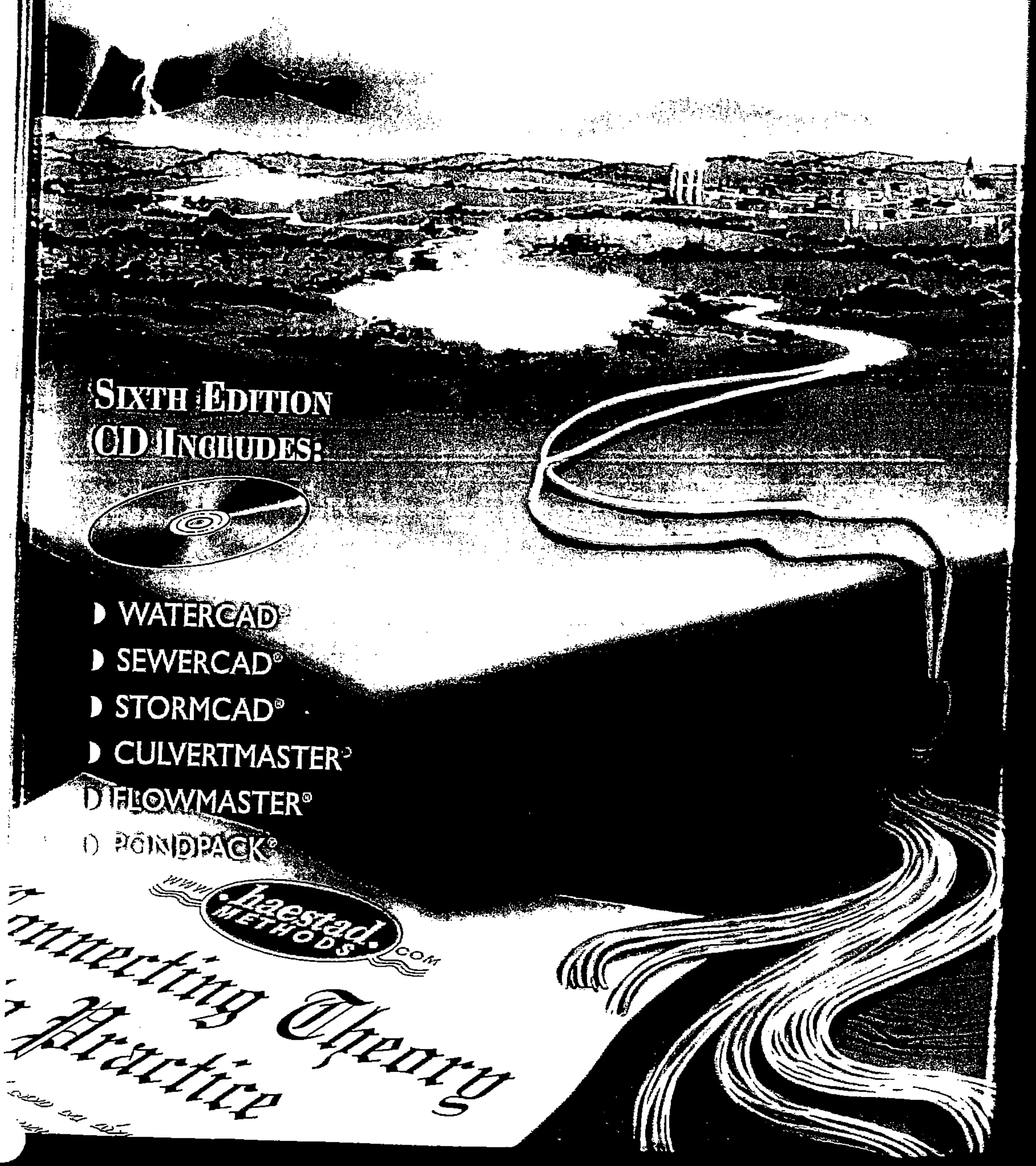

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given particle in the direction of flow, and at other times detract from it. The result is that velocity distributions captured at different times will be quite different from one another, and will be far more chaotic than the velocity distribution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

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

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

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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	$S_f = \frac{10.3(nQ)^2}{D^{5.33}}$	$S_f = \frac{4.66(nQ)^2}{D^{5.33}}$	$S_f = \frac{13.2(nQ)^2}{D^{5.33}}$

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■ TABLE B.3
Physical Properties of Air at Standard Atmospheric Pressure (BG Units)[a]

Temperature (°F)	Density, ρ (slugs/ft^3)	Specific Weight[b], γ (lb/ft^3)	Dynamic Viscosity, μ (lb·s/ft^2)	Kinematic Viscosity, ν (ft^2/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/s^2.

PVC FITTINGS ONLINE
a division of Commercial Industrial Supply

Schedule 40 PVC Pipe

Schedule 40 Pipe Dimensions

Nominal Pipe Size (inches)	Outside Diameter (O.D.)	Average Inside Diameter (I.D.)	Minimum Wall Thickness	Nominal Weight/Feet (Wt./Ft.)	Maximum Working Pressure (WP)
1/8"	0.405	0.249	0.068	0.051	810
1/4"	0.540	0.344	0.088	0.086	780
3/8"	0.675	0.473	0.091	0.115	620
1/2"	0.840	0.602	0.109	0.170	600
3/4"	1.050	0.804	0.113	0.226	480
1"	1.315	1.029	0.133	0.333	450
1-1/4"	1.660	1.360	0.140	0.450	370
1-1/2"	1.900	1.590	0.145	0.537	330
2"	2.375	2.047	0.154	0.720	280
2-1/2"	2.875	2.445	0.203	1.136	300
3"	3.500	3.042	0.216	1.488	260
3-1/2"	4.000	3.521	0.226	1.789	240
4"	4.500	3.998	0.237	2.118	220
5"	5.563	5.016	0.258	2.874	190
6"	6.625	6.031	0.280	3.733	180
8"	8.625	7.942	0.322	5.619	160
10"	10.750	9.976	0.365	7.966	140
12"	12.750	11.889	0.406	10.534	130
14"	14.000	13.073	0.437	12.462	130
16"	16.000	14.940	0.500	16.286	130
18"	18.000	16.809	0.562	20.587	130
20"	20.000	18.743	0.593	24.183	120
24"	24.000	22.544	0.687	33.652	120

Golder Associates

RECEIVED
AUG 12 2015
NMED
PETROLEUM STORAGE TANK BUREAU

August 10, 2015 Project Number: 140-4221

Celestine Ngam
New Mexico Environment Department
Petroleum Storage Tank Bureau
2905 Rodeo Park Drive E., Bldg. 1
Santa Fe, NM 87505

RE: NOTICE OF COMPLETION OF DELIVERABLE ID 17138-3; COMPLETION OF DPE WELL PILOT TEST, LOVINGTON 66, LOVINGTON, NEW MEXICO

FACILITY #: 1489 RELEASE ID#: 1182 WPID#: 17138

Dear Mr. Ngam:

I am transmitting this letter to advise you that Golder has completed the task associated with Deliverable Identification number 17138-3, which included pilot testing a DPE well (DPE-1) at the above referenced site. Proposed equipment and tasks were set forth in our May 7, 2014 workplan.

The pilot well test was completed by AcuVac Remediation, LLC (AcuVac) out of Houston, Texas on July 12 and July 13, 2015. Figure 1 is a map showing the locations of the tested wells and summary results of testing. Attachment A includes photos detailing the specific equipment used and the overall layout of the test. Attachment B includes copies of the raw data and interpretations of the multiphase pilot testing prepared by AcuVac. The tests included an extended (8.6 hour) variable flow rate test of the MPE pilot test well (A-1), an extended constant flow rate test of Well A-1 (6 hours) and short-duration (1 hour) tests of wells W-1 and W-2. Gasoline recovered as LNAPL and vapor mass during the combined testing (16.6 hours, total combined test time) was approximately 229.5 gallons.

The NMED-PSTB agency workplan approval sets forth an approved budget of $26,069.48 for this task; we anticipate that we will issue a claim for the full amount upon receipt of your acceptance of deliverable for deliverable identification number 17138-3. If you have any questions regarding this transmittal, please do not hesitate to contact us.

Sincerely,

GOLDER ASSOCIATES INC.

Clay Kilmer
Senior Hydrogeologist

Phillip D. Carrillo
EIT, Civil Engineer

Attachments: Figure 1: Site map showing locations of tested wells and summary MPE test results
Attachment A: Photographic Log
Attachment B: AcuVac Remediation, LLC Report

CK/rj

p:\abq projects\2014 projects\140-4221 walstad pilot testing\deliverables\task 3 - completion and oversight of dpe pilot test and letter report\text\notice of completion - deliverable 17138-3_rev_1.docx

Golder Associates

RECEIVED
AUG 12 2015
NMED
PETROLEUM STORAGE TANK BUREAU

TRANSMITTAL

Date: August 11, 2015

Project No.: 140-4221.3

To: Mr. Celestine Ngam

Company: NMED-PSTB

From: Clay Kilmer, Sr Hydrogeologist

Address:
2905 Rodeo Park Drive E, Bldg. 1
Santa Fe, NM 87505

cc:
Mr. Robert C. Murrell
2317 Tuttington Circle,
Oklahoma, OK 73170
(one copy)

Email: CKilmer@golder.com

RE: **LOVINGTON 66 STATION, PSTB FACILITY #1489, DELIVERABLE ID 17138-3**

☒ Federal Express (priority, standard, **2-day**, 3-day)
☐ UPS
☐ DHL
☐ Email ____________________
☐ U.S. Mail
☐ Courier
☐ Hand Delivery
☐ Other ____________________

Quantity	Item	Description
1	Notice of Completion of DPE Well Pilot Test	Deliverable ID 17138-3, dated August 10, 2015

Notes:
Please call me if you have any questions or concerns at 505-821-3043.

Thank you,

Clay Kilmer

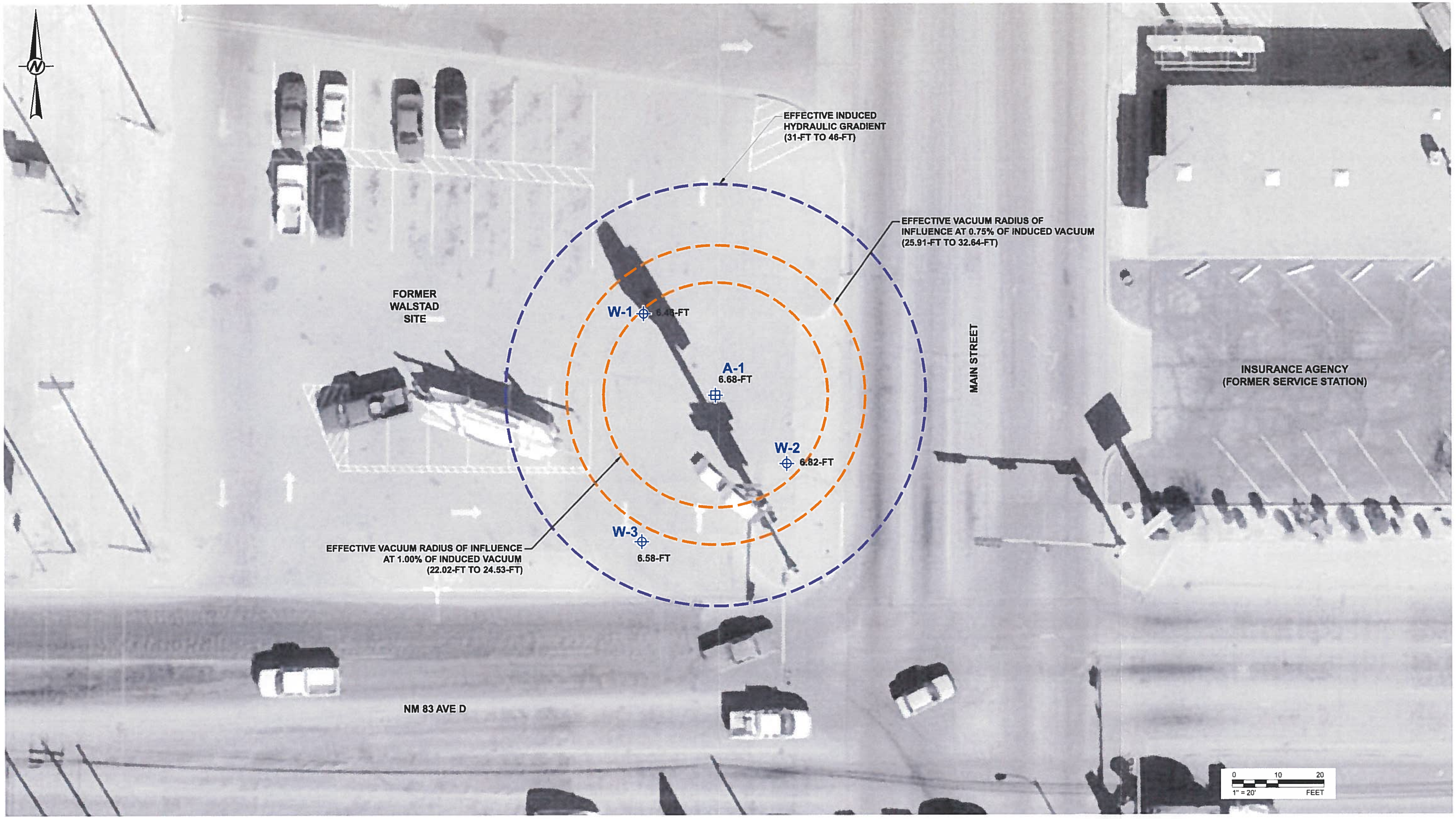
Please advise us if enclosures are not as described.

ACKNOWLEDGEMENT REQUIRED:

☐ Yes ☒ No

p:\abq projects\2014 projects\140-4221 walstad pilot testing\deliverables\task 3 - completion and oversight of dpe pilot test and letter report\submittal\transmittal letter nmed.docx

FIGURE



LEGEND

⊕ W-2 6.82-FT	EXISTING MONITORING WELL WITH NAPL THICKNESS (FT)
⊞ A-1 6.68-FT	DUAL PHASE EXTRACTION WELL WITH NAPL THICKNESS (FT)
— — —	EFFECTIVE INDUCED HYDRAULIC GRADIENT
— — —	EFFECTIVE VACUUM RADIUS OF INFLUENCE

CLIENT
NEW MEXICO ENVIRONMENT DEPARTMENT
PETROLEUM STORAGE TANK BUREAU
SANTA FE, NEW MEXICO

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-07-22
DESIGNED	PDC
PREPARED	PDC
REVIEWED	CLK
APPROVED	BN

PROJECT
WALSTAD OIL COMPANY
LOVINGTON 66
LOVINGTON, NEW MEXICO

TITLE
DPE-1 PILOT TEST

PROJECT NO	TASK	REV	FIGURE
140-4221	4	0	1

Path: \\albuquerque\Cad\2014 Projects\1404221\PRODUCTION\ | File Name: 140-4221D001.dwg

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

Attachment A: Photographic Log

PHOTO 1 AcuVac Inc. arrives on set with their rig setup. 2015-07-12	
PHOTO 2 The rig from AcuVac for producing the vacuum and oxidizing vapor contamination during the test. 2015-07-12	

PHOTO 3

The pilot test was focused on DPE-1.

2015-07-13

PHOTO 4

W-1, W-2, & W-3 were used for monitoring during the test. Pictured is W-1.

2015-07-12

PHOTO 5 W-2 is shown. 2015-07-12	
PHOTO 6 W-3 is shown. 2015-07-12	

PHOTO 7

AcuVac Inc. installing the apparatus for testing.

2015-07-12

PHOTO 8

The testing setup is shown with the vacuum hose and flowmeter attached to DPE-1.

2015-07-12

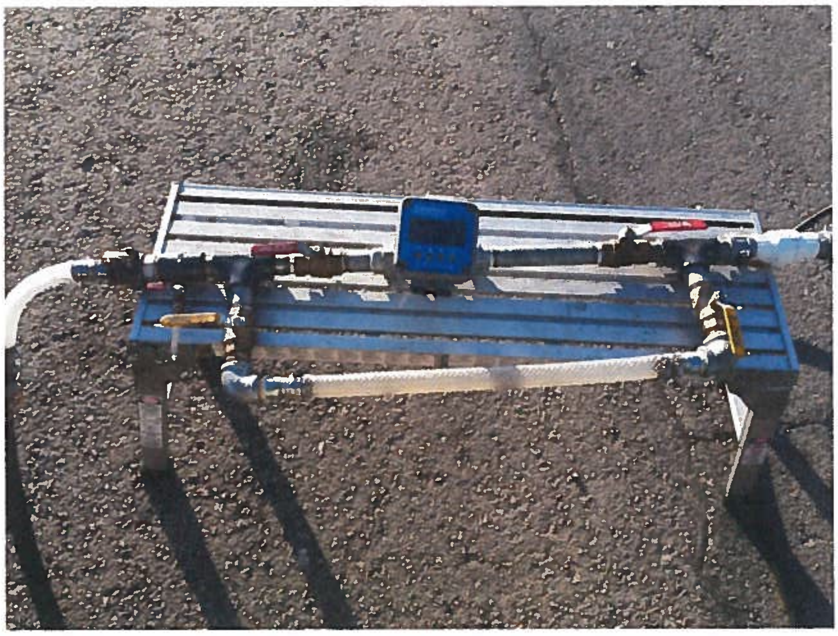
PHOTO 9 The rig was used to create the vacuum for the test and oxidize vapor contamination. 2015-07-12	
PHOTO 10 The pump test apparatus provided sight on water quality and a sampling port for collecting lab specimens. 2015-07-13	

PHOTO 11 The flow meter read flow rate and total gallons pumped. 2015-07-13	
PHOTO 12 A clear portion of the outlet hose shows the condition of water being pumped. 2015-07-13	

PHOTO 13

AcuVac periodically collected water samples to gauge NAPL content.

2015-07-13

PHOTO 14

Bio-fouling material was observed during the pilot test on day two.

2015-07-13

PHOTO 15

The testing apparatus for collecting air monitoring samples as well as the sample submitted for lab testing.

2015-07-12

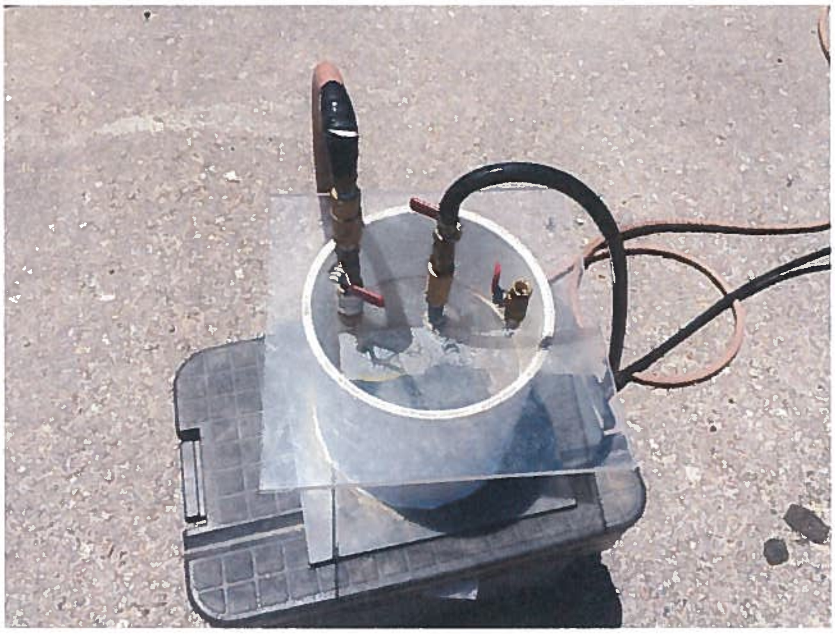


PHOTO 16

AcuVac checked the vacuum induced in the surrounding wells with a digital manometer. W-1 shown.

2015-07-12

PHOTO 17

AcuVac checked the vacuum induced in the surrounding wells with a digital manometer. W-2 shown.

2015-07-12

PHOTO 18

All produced water was containerized by Gandy in a tanker truck and sent off-site for proper disposal.

2015-07-12

ATTACHMENT B
ACUVAC REMEDIATION, LLC REPORT

AcuVac Remediation, LLC

1656-H Townhurst, Houston, Texas 77043
713.468.6688 • www.acuvac.com

July 15, 2015

Mr. Clay Kilmer:
Senior Hydrogeologist
Golder Associates, Inc.
5200 Pasadena Avenue N.E. Suite C
Albuquerque, NM 87113

Dear Clay:

Re: Walstadd 66, Lovington, NM

At your request, we performed one Mobile Dual Phase (MDP) Pilot Test on July 12, 2015 at the above referenced sites. An Engineer and an Environmental Specialist, with over 14,500 hours of on-site testing, conducted the Pilot Test. The total MDP test time, including static data time, was 8.6 hours. The contaminant was weathered gasoline.

OBJECTIVES

The Objectives of an MDP Pilot Test are to:

- Evaluate the potential for removing liquid and vapor LNAPL and contaminated groundwater (GW) from soils in the subsurface formations.
- Expose the capillary fringe area and below to induced soil vacuum extraction (SVE) in the extraction well (EW).
- With induced vacuums, increase the GW specific yields. Stress the GW System and monitor its response.
- Maintain a near constant GW depression in the EW.
- Create an induced hydraulic gradient (IHG) to gain hydraulic control of the area.
- Record GW depression and pump rates to accomplish the above objectives.

The purpose of the EW induced vacuum variable rate test is to define the pressure/flow characteristics of sub-surface soils around the EW and to estimate potential conditions for an operational Dual Phase System. Starting a test with lower variable rates of vacuum and flow allows the EW and outer wells sufficient time to adjust and stabilize and minimizes the risk of developing preferential paths. This will also assist the development of newly installed extraction wells.

METHODS AND EQUIPMENT

The tests were conducted using AcuVac's I-6 System, with Roots RAI-33 and RAI-22 blowers, various instrumentation, including the HORIBA® Analyzer, Solinst Interface Probes, Lumidor O_2 Meter, vapor flow gauges, liquid volume/flow meter, a sensitive instrument to determine barometric pressure, V-1 vacuum box to capture non-diluted vapor samples, Redi-Flo 2 total fluids (TF) pump and other special equipment. The vacuum extraction portion of the AcuVac System consists of a vacuum pump driven by an internal combustion (IC) engine. The vacuum pump is connected to the extraction well and the vacuum created on the extraction well causes light hydrocarbons in the soil and on the GW to volatilize and flow through a moisture knockout tank, to the vacuum pump and the IC engine where they are burned as part of the normal combustion process. Propane is used as auxiliary fuel to help power the engine if the well vapors do not provide the required BTU.

The GW Extraction is provided by an in-well, Redi-Flo 2 total fluids pump that has the discharge line connected to a total volume meter. The discharge line from the volume meter is then connected to the stand-by tank truck. The electrical power for the GW pump was supplied from a 120v Honda generator. The GW flow rate can be adjusted to maintain a target level. Interface meters are used to measure Depth to Groundwater (DTGW)/Depth to Light Non-Aqueous Petroleum Liquids (DTLNAPL).

The AcuVac IC engine is fully loaded for maximum power that is necessary to achieve and maintain high induced vacuums and/or high well vapor flows required to maximize the vacuum SVE Radius of Influence (ROI) for Pilot Tests and short term Event remediation. The lower part of the IC engine is encased with a liquid collection pan designed to catch any oil drips or liquid leaks if it should occur.

Emissions from the engine are passed through three catalytic converters to ensure maximum destruction of removed hydrocarbon vapors. The engine's fuel to air ratio can be adjusted to maintain efficient combustion. Because the engine is the power source for all IC engine driven equipment, all systems stop when the engine stops. This eliminates any uncontrolled release of hydrocarbons. Since the AcuVac System is held entirely under vacuum, any leaks in the seals or connections are leaked into the System and not emitted into the atmosphere. The engine is automatically shut down by vacuum loss, low oil pressure or overheating.

The design of the AcuVac System enables complete independent control of both the Induced Well Vacuum and the GW pumping functions such that the AcuVac System operator can control the IHG to expose the maximum amount of the formation to SVE. The ability to separate the induced vacuum and liquid flows within the EW improves the LNAPL recovery rates, and enables the test data to be recorded independently. All the systems are properly grounded to eliminate any static electrical charge.

PROJECT SCOPE AND PROCEDURES

- Gauge the DTGW and DTLNAPL in the EW.
- Calculate the Hydro-equivalent in the EW.
- Determine the appropriate placement for the GW pump inlet.

- Calculate the GW depression necessary to gain hydraulic control of the area.
- Record the distances from the selected EW to the outer wells.
- Install the GW pump into the EW (A-1).
- Connect the ground wires for the AcuVac System and Honda generator.
- Set pump and data probe at the selected depth from TOC.
- Connect discharge hoses to liquid volume meter and then connect to the on-site tank truck.
- Connect the AcuVac System to the selected EW manifold and seal the selected outer observation wells with plugs designed to accept magnehelic gauges or digital manometers.
- Record the static well data, DTGW/DTLNAPL, well size, TD, screen intervals and then apply EW induced vacuum. Record the vacuum and well flow, all System data (including fuel flow of propane), temperature and barometric pressure.
- The test procedures are to provide variable rates of induced vacuum and GW pumping rates over the test period.
- Start the GW pump and set at proper flow rate to achieve the selected GW drawdown.
- Monitor the GW pump and adjust the flow to maintain the selected GW drawdown.
- Record pump flow rate and total liquid volume.
- Collect GW/LNAPL samples in a 2,000 ml beaker to determine the percentage of LNAPL in the recovered liquid volume.
- Install and observe the digital manometer on the outer observation wells to determine if the selected EW induced vacuum is in vacuum communication with the outer observation wells.
- Gauge the outer wells to determine the GW drawdown.
- Record the data at a selected interval of time.
- Operate the AcuVac System in such a manner that all well vapors are passed through the engine and catalytic converters, to destruct the contaminants and exhausted, to meet air emission standards. Comply with all security and safety regulations.
- Complete the tests by providing a report consisting of operating and analytical data, projection of SVE radius of influence (ROI), the IHG ROI and the collected volumes of GW and LNAPL.

CONDITIONS AFFECTING PILOT TESTS

- Generally, a decreasing barometric pressure results in increased well pressures (decreased vacuums) on those wells plugged and sealed at the TOC, while an increasing barometric pressure results in increased well vacuums. This is the function of GW levels increasing and decreasing. **There are many variables that can affect Pilot Test data, but barometric pressure fluctuations have the most immediate and profound effect.** This assumes that SVE short-circuiting is not a factor.
- To offset the induced vacuum/pressure as a result of GW depression or upwelling in the outer monitoring wells, the wells are vented periodically to atmosphere and then re-plugged prior to recording data at select intervals. The potential for increased vacuum or pressure as a result of in/decreasing GW levels will be minimized. GW depression surrounding an outer observation well will result in an induced vacuum not associated with the induced vacuum created in the EW. Likewise, GW mounding will create the opposite effect creating well pressures.

TEST #MDP-1
WALSTADD 66
LOVINGTON, NM
JULY 12, 2015

PRE-TEST FUNCTIONS - PILOT TEST #MDP-1

Prior to starting the MDP test with GW Extraction, all systems were checked for normal and safe operation. The DTGW/DTLNAPL, barometric and absolute pressure and ambient air temperature were recorded. The hydro equivalent (HE) was calculated. Based upon the HE, the GW pump inlet was set at 65 ft below the top of the well casing. The pump hose was then connected to the total volume meter. The discharge hose was connected to the on-site 3,000 gal liquid collection tank truck. Each magnehelic gauge was checked and calibrated to zero. The outer monitoring wells were plugged with expandable well plugs designed to accept a digital manometer. Static well data and the atmospheric effect on the outer wells were recorded prior to engaging the AcuVac System. The propane tank fuel level was recorded so that accurate fuel consumption could be estimated for the total test period. All safety checks were performed on the Systems. (See list of Attached Schedules and Figures, Page 11.)

DISCUSSION OF DATA - TEST #MDP-1

Test #MDP-1, with vacuum and GW/LNAPL extraction, was an 8.6 hour MDP test including static well data, conducted from well A-1 as the EW. Immediately prior to starting the test, the selected outer monitoring wells were recording zero vacuums. The general weather conditions were clear and cool. At the start of the MDP test, the EW induced vacuum was set at 40"H_2O, with an initial well vapor flow of 12.19 scfm. The data probe static reading was 7.5 ft, immediately decreasing to 2.0 ft when the GW pump was engaged. Based upon the data probe, it was determined that a constant drawdown creating a GW depression (GWD) of approximately 5.5 ft below HE static level would be appropriate for this test (see Table #1A). The initial GW pump rate was set at 3.5 gpm to achieve the selected GWD and then remained constant for 2.0 hours. The GWD and related GW pump rate are monitored constantly throughout the test and recorded every 30 minutes. Table #1A summarizes the GWD, GW pump rate and the drawdown in the EW and Table #1B summarizes the GWD in the outer observation wells.

During the first 2.0 hours of the test, the EW induced vacuum remained constant at 40"H_2O with a well vapor flow of 12.19 scfm. Outer well W-2, which is located 16.2 ft from the EW, immediately recorded a well vacuum increasing from 0 to 0.07"H_2O and continued on an increasing trend during the test period to 0.88"H_2O. Outer wells W-1 and W-3 which are located 25.8 and 38.3 ft from the EW, recorded a slight increasing vacuum level and then continued on a slight increasing vacuum trend to 0.36 and 0.17"H_2O. The ambient air temperature increased from 72.4 to 79.6°F and the barometric pressure was mostly steady at 30.10"Hg. The GW depression averaged 5.5 ft below static level. The total collected liquid volume was 420 gals and **38.9 gals of liquid LNAPL were observed on the collected GW**.

EXTRACTION WELL A-1
OPERATING DATA TEST #MDP-1
Table #1A

Location: Walstadd 66, Lovington, NM					
Project Date 07/12/2015	A-1 DTGW ft	GWD ft	EW GWR gpm	Total Volume gal	EW Vacuum "H_2O
Well Data					
TD	75.0	-	-	-	-
Screen	45.0-75.0	-	-	-	-
Well Size	4.0	-	-	-	-
DTGW 0715 hrs	64.08	-	-	-	-
DTGW Hydro Equivalent	59.14	-	-	-	-
DTLNAPL 0715 hrs	57.40	-	-	-	-
LNAPL 0715 hrs	6.68	-	-	-	-
Drawdown Data					
Data Probe 0730 hrs Start	7.50	-	-	-	-
Data Probe 0800 hrs	2.00	-5.50	3.50	105	40
Data Probe 0830 hrs	2.00	-5.50	3.50	210	40
Data Probe 0900 hrs	2.00	-5.50	3.50	315	40
Data Probe 0930 hrs	2.00	-5.50	3.50	420	40
Data Probe 1000 hrs	2.00	-5.50	4.30	549	60
Data Probe 1030 hrs	2.00	-5.50	4.30	678	60
Data Probe 1100 hrs	2.00	-5.50	4.30	807	60
Data Probe 1130 hrs	2.00	-5.50	4.30	936	60
Data Probe 1200 hrs	2.00	-5.50	4.30	1065	60
Data Probe 1230 hrs	2.00	-5.50	4.30	1194	60
Data Probe 1300 hrs	2.00	-5.50	4.30	1323	60
Data Probe 1330 hrs	2.00	-5.50	4.60	1460	75
Data Probe 1400 hrs	2.00	-5.50	4.60	1598	75
Data Probe 1430 hrs	2.00	-5.50	4.60	1736	75
Data Probe 1500 hrs	2.00	-5.50	5.20	1892	90
Data Probe 1530 hrs Stop	2.00	-5.50	5.20	2048	90
Data Probe 1600 hrs Static	7.46	-0.04	0.00	-	-
DTGW 1600 hrs	61.65	-	-	-	-
DTGW Hydro Equivalent	61.64	-	-	-	-
DTLNAPL 1600 hrs	61.61	-	-	-	-
LNAPL 1600 hrs	0.04	-	-	-	-
Average GW Depression	-	-5.50	-	-	-

OBSERVATION WELLS
INDUCED HYDRAULIC GRADIENT DATA
TEST #MDP-1
TABLE #1B

Location: Walstadd 66, Lovington, NM								
Project Date 07/12/2015		**W-2**		**W-1**		**W-3**		
Well Data								
TD	ft	75.0		80.0		75.0		
Screen	ft	50.0 - 70.0		50.0 - 70.0		50.0 - 70.0		
Well Size	in	4.0		4.0		4.0		
		DTGW ft	**Change in GWD ft**	**DTGW ft**	**Change in GWD ft**	**DTGW ft**	**Change in GWD ft**	**GW Pump Rate gpm**
Static/Start Data								
DTGW 0730 hrs	ft	63.92		64.62		63.81		3.50
DTGW Hydro Equivalent	ft	58.87	0	59.84	0	58.94	0	
DTLNAPL 0730 hrs	ft	57.10		58.16		57.23		
LNAPL 0730 hrs	ft	6.82		6.46		6.58		
Drawdown Data								
DTGW 1030 hrs	ft	64.13		64.82		63.87		4.30
DTGW Hydro Equivalent	ft	58.99	-0.11	59.91	-0.07	58.97	-0.03	
DTLNAPL 1030 hrs	ft	57.18		58.19		57.25		
LNAPL 1030 hrs	ft	6.95		6.63		6.62		
Drawdown Data								
DTGW 1330 hrs	ft	64.81		65.28		64.08		4.60
DTGW Hydro Equivalent	ft	59.46	-0.59	60.16	-0.32	59.14	-0.20	
DTLNAPL 1330 hrs	ft	57.58		58.36		57.41		
LNAPL 1330 hrs	ft	7.23		6.92		6.67		
Drawdown Data								
DTGW 1530 hrs	ft	64.91		65.38		64.21		5.20
DTGW Hydro Equivalent	ft	59.53	-0.66	60.21	-0.37	59.18	-0.24	
DTLNAPL 1530 hrs	ft	57.64		58.39		57.41		
LNAPL 1530 hrs	ft	7.27		6.99		6.80		
Maximum Drawdown	ft		-0.66		-0.37		-0.24	
Distance From EW		16.2		25.8		38.3		

Specific Gravity .74

HORIBA® analytical data indicated the two influent vapor samples taken from the EW had HC concentrations of 76,990 and 74,020 ppmv, with CO_2 at 4.72 and 5.12%, CO at 3.82 and 3.09%, O_2 at 6.8 and 6.1% and H_2S at 0 ppm. The propane flow to the IC engine averaged 0 cfh, with a well flow of 12.19 scfm. The influent vapors were supplying 100% of the IC engine required fuel. The HC levels were within the mid to high range normally found in soil gas samples collected from an area contaminated with weathered gasoline.

At test hour 2.0, the test continued with the induced vacuum increased to 60"H_2O and a well flow of 19.88 scfm. The test period was 3.5 hours with the EW induced vacuum and well flow remaining steady. Outer well W-2 continued on an increasing vacuum trend to 1.14"H_2O in response to the EW vacuum increase and then developed a slight decreasing trend when the barometric pressure decreased. Outer wells W-1 and W-3 recorded an increased vacuum trend to 0.43 and 0.15"H_2O and then decreased to 0.38 and 0.12"H_2O. The GW pump rate increased to 4.30 gpm and remained steady during this test period. The collected volume was 903 gals which brings the total to 1,323 gals, with a GW depression average of 5.5 ft. The ambient air temperature increased to 91.8°F and the barometric pressure decreased from 30.10 to 30.07"Hg. The influent vapor temperature increased to 71°F. **A total LNAPL volume of 14.4 gals was observed on the collected GW.**

Additional HORIBA® analytical data indicated the influent vapor samples recorded HC levels of 71,750, 68,490 and 61,890 ppmv, with CO_2 at 4.60, 5.24 and 5.12%, CO at 2.37, 2.55 and 1.88%, O_2 at 5.8, 6.4 and 8.3% and H_2S at 0 ppm. The influent vapors continued to supply 100% of the IC engine's fuel and the TPH levels continued to be within the range of weathered gasoline vapors.

At test hour 5.5, the test continued with the induced vacuum increased to 75"H_2O, and a vapor well flow of 21.34 scfm. The test period was 1.5 hours with the EW vacuum and well flow remaining steady. The outer observation wells, W-2, W-1 and W-3, immediately recorded increased vacuum levels for 1.0 hour, and then developed a decreasing trend as the barometric pressure continued to decrease. This is an excellent example of the effect of barometric pressure oscillations on the vacuum/pressures observed on the outer observation wells. The average GW drawdown in the EW was 5.5 ft. A drawdown of 0.59 ft was recorded in W-2, 0.32 ft in W-1 and 0.2 ft in W-3. The GW pump rate averaged 4.60 gpm with a collected volume 413 gals. The total collected volume increased to 1,736 gals and **7.6 gals of liquid LNAPL was observed on the GW.** The ambient air temperature increased from 91.8 to 93.3°F and the barometric pressure decreased from 30.07 to 30.04"Hg.

Additional HORIBA® analytical data indicated the influent vapor samples recorded a HC level of 61,720 ppmv, with CO_2 at 5.20%, CO at 1.75%, O_2 at 8.7% and H_2S at 0 ppmv. The influent vapors continued to supply 100% of the IC engine's fuel. Although the HORIBA® Analyzer has been proven to be reasonably accurate compared to laboratory analysis of influent vapors, projections should be based on analytical results from a Certified Testing Laboratory qualified to conduct tests on air emission samples.

At test hour 7.0, the test continued with the induced vacuum increased to 90"H_2O and a vapor well flow of 27.95 scfm. The test period was 1.0 hour with the EW vacuum and well flow remaining steady. Outer observation well W-2 recorded an increased vacuum level from 1.10 to 1.23"H_2O and continued to increase to 1.54"H_2O during the test period. Outer well W-1 recorded an increasing vacuum ranging from 0.37 to a maximum of 0.60"H_2O and well W-3 recorded an increase from 0.09 to 0.20"H_2O. The average GW drawdown in the EW was 5.5 ft. A maximum drawdown of 0.66 ft was recorded in W-2, 0.37 ft in W-1 and 0.24 ft in W-3. This was the maximum recorded drawdown before any required well vacuum adjustments resulting from the decreasing barometric pressure. The GW pump rate averaged 5.2 gpm with a collected volume of 312 gals. The total collected volume increased to 2,048 gals and **6.2 gals of liquid LNAPL was observed on the GW.** The ambient air temperature increased from 95.3 to 96.1°F and the barometric pressure decreased from 30.04 to 30.02"Hg.

Immediately before the conclusion of this test period, the outer observation wells were gauged. The gauging data is included on Table #1B.

RADIUS OF INFLUENCE & INDUCED HYDRAULIC GRADIENT

Figure #1A indicates that the effective vacuum radius of influence from Test #MDP-1 with groundwater extraction (GWE) would be from 25.91 to 32.64 ft, with extraction well flow of 22.0 to 24.0 scfm and extraction well vacuum in the 80 to 85"H_2O range. An approximation of the radius of influence may be obtained by determining the point at which the measured vacuum is **0.50 to 0.70"H_2O.** It is assumed that beyond the lower point, the pressure gradient (driving force) is negligible to effectively transport vaporized contaminants to the extraction well. **Under continuous operation, vacuum and radius of influence will most likely continue to increase horizontally and vertically.**

Figure #1B indicates that the effective vacuum radius of influence from Test #MDP-1 with groundwater extraction (GWE) would be from 22.02 to 24.53 ft, with extraction well flow of 22.0 to 24.0 scfm and extraction well vacuum in the 80 to 85"H_2O range. An approximation of the radius of influence may be obtained by determining the point at which the measured vacuum is **0.75 to 0.85"H_2O or approximately 1.0% of the EW induced vacuum.** It is assumed that beyond the lower point, the pressure gradient (driving force) is negligible to effectively transport vaporized contaminants to the extraction well. **Under continuous operation, vacuum and radius of influence will most likely continue to increase horizontally and vertically.**

Figure #2 indicates that the effective induced hydraulic gradient from Test #MDP-1 with vacuum and groundwater extraction would be greater than approximately 31.0 ft, with a pump rate of 4.0 to 4.3 gpm. An approximation of the radius of influence may be obtained by determining the point at which the measured GW level effect on the outer wells is greater than 0.30 ft. At the point at which the measured GW level effect on the outer wells is greater than 0.20 ft, **the effective induced hydraulic gradient with vacuum would be greater than approximately 46 ft. Under continuous operation, the gradient effect of the GW pump rate and depression may cover a larger area.**

The effective vacuum radius of influence is based on calculations and equations using a software program of which data was provided from an extensive database collected by AcuVac over a period of years. Each projection is based on the test data and site parameters, and takes into consideration such variables as barometric pressure oscillations and gauge error. Although we cannot provide total assurance of accuracy, past experience and results have proven these projections to be well within the acceptable range of accuracy.

PRODUCT RECOVERY

A total liquid volume of 2,048 gals were recovered during the test of which 3.11% or 63.64 gals was liquid gasoline. A calculated volume of 22.63 gals of gasoline contaminant were removed as part of the influent vapors and were burned as IC engine fuel bringing the total gasoline recovery to 86.27 gals or an average of 10.78 gals/hr.

GROUNDWATER RECOVERY

GW recovery was monitored in well A-1 for 30 minutes after the vacuum had ceased. The GW recovery was recorded with the interface meter. In 30 minutes, the recovery for A-1 was equal to 54.5% based on the hydro equivalent.

EMISSION DATA

During this Pilot Test, HORIBA® data indicated that the influent vapors had an average hydrocarbon level (TPH) of 69,142 ppmv. Laboratory analysis of influent vapor samples from previous pilot tests indicated that those vapor samples had a benzene level of approximately 2.0% of the 69,142 ppmv. Using an average well flow of 18.83 scfm from this extended test, **the calculated emissions from one extraction well without vapor treatment were as follows:**

HC = 42.5 lbs/day = 17.7 lbs/hr
Benzene = 8.5 lbs/day = 0.35 lbs/hr

ADDITIONAL INFORMATION

The HORIBA® analytical instrument is calibrated with Hexane and CO_2. One sample was collected for laboratory analysis.

The formula used to calculate the emission rate is:

$$ER = HC\ (ppmv) \times MW\ (Hexane) \times Flow\ Rate\ (scfm) \times 1.58E^{-7}\ \frac{(min)(lb\ mole)}{(hr)(ppmv)(ft^3)} = lbs/hr$$

To calculate MDP well placement, the equation we use is as follows:

L= 2 ROI Cos 30° (L = distance between wells; ROI = radius of influence)

All other data, including the groundwater depth, well placement, extraction well screened intervals, induced vacuum and vapor well flow and liquid recovery rate, must be considered in the final design for a Corrective Action Plan (CAP).

Static (baseline) data, recorded 0.5 hours after the conclusion of the test, indicates that W-1 was recording a pressure of 0.19"H_2O, W-1 was recording a well pressure of 0.15"H_2O and W-3 was recording a well pressure of 0.17"H_2O. The well pressure was the result of the decreasing barometric pressure.

The test provided excellent data to use in the calculation and projection of an SVE vacuum radius of influence and excellent data to project an induced hydraulic gradient.

CONCLUSION

Pilot Tests are conducted to provide information on short term tests that can be projected into long term remedial plans. These feasibility tests indicated that Mobile Dual Phase Extraction (MDP) with groundwater depression should provide an excellent method of remediation for this facility. Although the observed vacuum of the most distant outer monitoring well was moderately low, the duration of the pilot tests was short compared to continuous operation. **However, the tests results provided excellent data to project that wells W-2, W-1 and W-3 were in vacuum communication with the selected extraction well.** The vacuum radius of influence defines the region within which the vapor in the vadose zone flows to the extraction well under the influence of a vacuum. The radius of influence depends on the soil properties of the vented zone, properties of surrounding soil layers, the depth at which the well is screened, well installation and the presence of any impermeable boundaries such as the water table, clay layers, surface seal, building basements and the presence of such areas as tank pits with backfill and underground utilities. **The induced hydraulic gradient (IHG) defines the region within which a selected GW depression is recorded in the outer monitoring wells.** The IHG depends on the hydraulic properties of the underlying sub-surface, aquifer characteristics and the effect of the induced vacuum on specific yields.

SUMMARY AND OBSERVATIONS - TEST #MDP-1

- Based on the recorded test data, the sub-surface medium is most likely isotropic.
- Due to the age of the contaminant, the recovered gasoline may contain tetraethyl lead.
- An average induced vacuum of 60.3"H_2O was required to produce an average well vapor flow of 18.83 scfm. The ratio of the average EW induced vacuum to the EW well flow was 3.21:1.
- The average well flow per foot of EW well screen was 0.96 scfm with a maximum of 1.42 scfm.
- The GW pump rate was increased to provide a sufficient GW depression when the EW induced vacuum was increased. The average GW pump rate was 4.22 gpm with a maximum of 5.20 gpm.
- During each increase of the induced vacuum, outer observation wells W-2, W-1 and W-3 recorded increased vacuum levels. Additionally, GW drawdown in the observation wells continued to decrease during the test period.

- The average maximum percent of induced vacuum observed in outer observation wells W-2 at 16.2 ft was 1.74-2.30%, W-1 at 25.8 ft was 0.66-0.95% and W-3 was 0.25-0.50%.
- The HC levels recorded during the test period were **within** the range normally associated with soil gas samples taken from an area that is highly saturated with weathered gasoline.
- **The test provided excellent data for the calculation and projection of a vacuum radius of influence, excellent data for the projection of an induced hydraulic gradient and excellent data to support the collection and removal of liquid and vapor phase gasoline with Dual Phase Recovery.**
- **SVE without GW extraction would not be an effective remediation option at this site. The higher vacuums would result in GW upwelling in the EW which may cover the well screen and render the SVE ineffective.**

ATTACHED SCHEDULES AND FIGURES

Schedule A: Summary of Data
Schedule B: Graphic Summary of Data
Figure #1A: Plot of Observed Vacuum vs Distance at the Facility (ROI) at 0.75% of Induced Vacuum
Figure #1B: Plot of Observed Vacuum vs Distance at the Facility (ROI) at 1.00% of Induced Vacuum
Figure #2: Plot of Recorded GW Induced Hydraulic Gradient vs Distance at the Facility (ROI)

Additional Information (this should be read as part of the report):

- Field Operating Data and Notes – Test #MDP-1
- Site Photographs

Once you have reviewed the report, please call me if you have any questions.

Sincerely,
ACUVAC REMEDIATION, LLC

Sadler

James E. Sadler,
VP Engineering/Environmental

cc: Paul Faucher

Attachment A

Acronyms and Definitions

A	Annulus - the space between the pipes and lines in the extraction well and the outer casing
ACFM	Actual Cubic Feet Per Minute
AI (AS)	Air Injection (Sparging) the mass transfer of O_2 from air to groundwater
BGL	Below Ground Level
BGS	Below Ground Surface
BP	Barometric Pressure (Atmospheric Pressure)
BTOC	Below Top of Casing
CFH	Cubic Feet Per Hour
DNAPL	Dense Non-Aqueous Petroleum Liquid
DPVE	Dual Phase Vacuum Extraction
DTGW	Depth to Groundwater
DTPSH	Depth to Phase Separated Hydrocarbons/NAPL
DT	Drop Tube
EVR	Enhanced Vacuum Recovery, also referred to as SVE/GWD
EW	Extraction Well
GW	Groundwater
GWD	Groundwater Depression
GWE	Groundwater Extraction
GWUP	Groundwater Upwelling
HC	Hydrocarbon Concentration (Petroleum-TPH)
"H_2O	Inches of Water
"Hg	Inches of Mercury
IHG	Induced Hydraulic Gradient
IV	Induced Vacuum, normally from a vacuum pump connected to the extraction well or vapor recovery well
LNAPL	Light Non-Aqueous Petroleum Liquids
MDP	Mobile Dual Phase
NAPL	Non-Aqueous Petroleum Liquids
P	Pressure, the existence of above atmospheric pressure
ROI	Radius of Influence
RPM	Revolutions Per Minute
SCFM	Standard Cubic Feet Per Minute
SVE	Soil Vacuum Extraction
TD	Total Depth
QT	Quick Test, a short duration SVE Test
V	Vacuum, the existence of below atmospheric pressure
VEGE	Vacuum Enhanced Groundwater Extraction
VER	Vacuum Enhanced Recovery
VEW	Vapor Extraction Well
VWF	Vapor Well Flow
WVF	Well Vapor Flow

SCHEDULE A
Test # MDP-1

Walstadd 66
Lovington, NM
July 12, 2015

7/12/2015	DATA ELEMENT						
	Static 7:25	Start 7:30	8:00	8:30	9:00	9:30	10:00
Influent Vapor Data							
Horiba HC ppmv	ND	ND	76,990	ND	74,020	ND	71,750
Horiba CO_2%	ND	ND	4.72	ND	5.12	ND	4.60
Horiba CO%	ND	ND	3.82	ND	3.09	ND	2.37
Lumidor O_2%	ND	ND	6.8	ND	6.1	ND	5.8
Lumidor H_2S ppm	ND	ND	0	ND	0	ND	0
Influent Vapor Temp °F	OFF	69.0	69.0	69.0	69.0	70.0	70.0
Atmospheric Conditions							
Barometric Pressure "Hg	30.10	30.10	30.10	30.09	30.09	30.10	30.09
Absolute Pressure "Hg	26.09	26.09	26.09	26.08	26.08	26.09	26.08
Groundwater Data							
Groundwater Pump Rate (gpm)	OFF	3.50	3.50	3.50	3.50	3.50	4.30
Total Liquid Vol (gal)	0	0	105	210	315	420	549
Extraction Well Data - Well A-1							
Flow SCFM	OFF	12.19	12.19	12.19	12.19	12.19	19.88
Vacuum "H_2O	OFF	40.0	40.0	40.0	40.0	40.0	60.0
Well Vapor Flow SCFM / "H_2O	OFF	0.30	0.30	0.30	0.30	0.30	0.33
Well Vapor Flow SCFM / ft Well Screen	OFF	0.621	0.621	0.621	0.621	0.621	1.013
Observation Well Data - Vacuum "H_2O							
Well W-2 Dist. 16.2 ft	0.00	0.07	0.86	0.88	0.92	0.88	1.07
Well W-1 Dist. 25.8 ft	0.00	0.05	0.31	0.37	0.38	0.36	0.38
Well W-3 Dist. 38.3 ft	0.00	0.02	0.13	0.17	0.20	0.17	0.14

( ) Indicates Well Pressure
ND - No Recorded Data

SCHEDULE A
Test # MDP-1

7/12/2015	DATA ELEMENT						
	10:30	11:00	11:30	12:00	12:30	13:00	13:30
Influent Vapor Data							
Horiba HC ppmv	ND	68,490	ND	ND	ND	61,880	ND
Horiba CO_2%	ND	5.24	ND	ND	ND	5.12	ND
Horiba CO%	ND	2.55	ND	ND	ND	1.88	ND
Lumidor O_2%	ND	6.4	ND	ND	ND	8.3	ND
Lumidor H_2S ppm	ND	0	ND	ND	ND	0	ND
Influent Vapor Temp °F	70.0	70.0	71.0	71.0	71.0	71.0	71.0
Atmospheric Conditions							
Barometric Pressure "Hg	30.09	30.09	30.09	30.08	30.08	30.07	30.06
Absolute Pressure "Hg	26.08	26.08	26.08	26.07	26.08	26.07	26.06
Groundwater Data							
Groundwater Pump Rate (gpm)	4.30	4.30	4.30	4.30	4.30	4.30	4.60
Total Liquid Vol (gal)	678	807	936	1,065	1,194	1,323	1,460
Extraction Well Data - Well A-1							
Flow SCFM	19.88	19.88	19.88	19.88	19.88	19.88	21.34
Vacuum "H_2O	60.0	60.0	60.0	60.0	60.0	60.0	75.0
Well Vapor Flow SCFM / "H_2O	0.33	0.33	0.33	0.33	0.33	0.33	0.28
Well Vapor Flow SCFM / ft Well Screen	1.013	1.013	1.013	1.013	1.013	1.013	1.087
Observation Well Data - Vacuum "H_2O							
Well W-2 Dist. 16.2 ft	1.09	1.14	1.13	1.12	1.13	1.10	1.14
Well W-1 Dist. 25.8 ft	0.42	0.42	0.41	0.42	0.43	0.38	0.43
Well W-3 Dist. 38.3 ft	0.16	0.16	0.15	0.14	0.15	0.12	0.14

( ) Indicates Well Pressure
ND - No Recorded Data

SCHEDULE A
Test # MDP-1

Walstadd 66
Lovington, NM
July 12, 2015

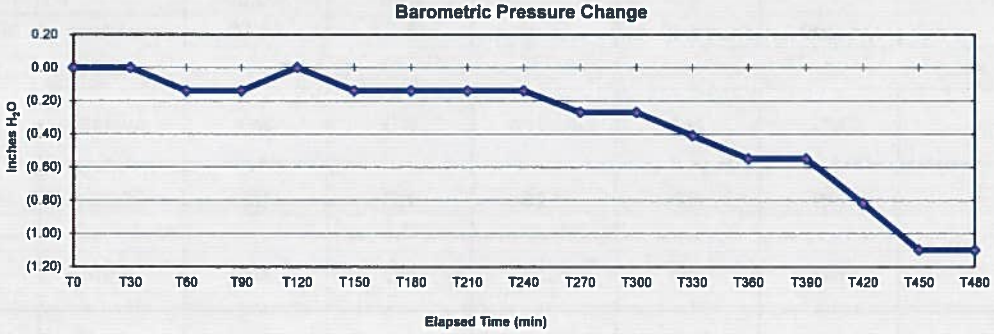
7/12/2015	DATA ELEMENT						
				End	Static	8 Hrs	
	14:00	14:30	15:00	15:30	16:00	Average	Maximum
Influent Vapor Data							
Horiba HC ppmv	ND	ND	61,720	ND	ND	69,142	76,990
Horiba CO_2%	ND	ND	5.20	ND	ND	5.00	5.24
Horiba CO%	ND	ND	1.75	ND	ND	2.58	3.82
Lumidor O_2%	ND	ND	8.7	ND	ND	7.0	8.7
Lumidor H_2S ppm	ND	ND	0	ND	ND	0	0
Influent Vapor Temp °F	71	71	71	72	OFF	70	72
Atmospheric Conditions							
Barometric Pressure "Hg	30.06	30.04	30.02	30.02	30.02	30.08	30.10
Absolute Pressure "Hg	26.05	26.04	26.02	26.02	26.02	26.07	26.09
Groundwater Data							
Groundwater Pump Rate (gpm)	4.60	4.60	5.20	5.20	OFF	4.22	5.20
Total Liquid Vol (gal)	1,598	1,736	1,892	2,048	-	-	-
Extraction Well Data - Well A-1							
Flow SCFM	21.34	21.34	27.95	27.95	OFF	18.83	27.95
Vacuum "H_2O	75.0	75.0	90.0	90.0	OFF	60.3	90.0
Well Vapor Flow SCFM / "H_2O	0.28	0.28	0.31	0.31	OFF	0.31	0.33
Well Vapor Flow SCFM / ft Well Screen	1.087	1.087	1.423	1.423	OFF	0.960	1.420
Observation Well Data - Vacuum "H_2O							
Well W-2 Dist. 16.2 ft	1.14	1.10	1.23	1.54	(0.19)	0.97	1.54
Well W-1 Dist. 25.8 ft	0.43	0.37	0.43	0.60	(0.15)	0.37	0.60
Well W-3 Dist. 38.3 ft	0.14	0.09	0.15	0.20	(0.17)	0.14	0.20

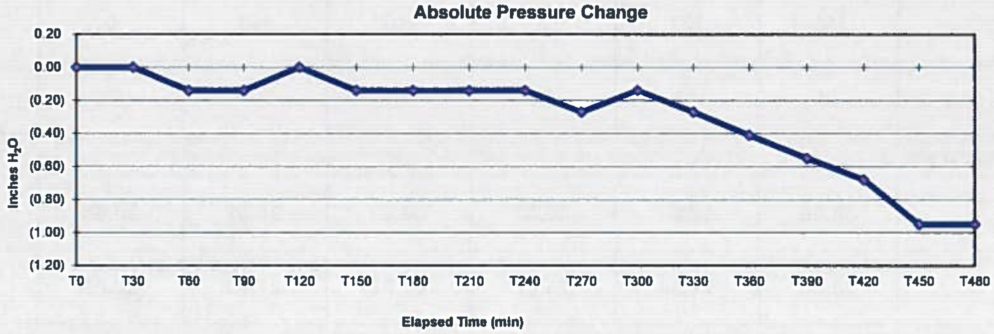
( ) Indicates Well Pressure
ND - No Recorded Data

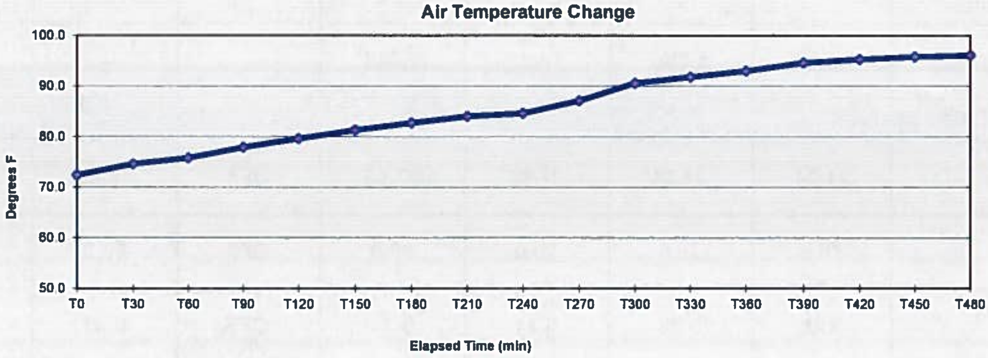
AcuVac Remediation, LLC
Page 1a

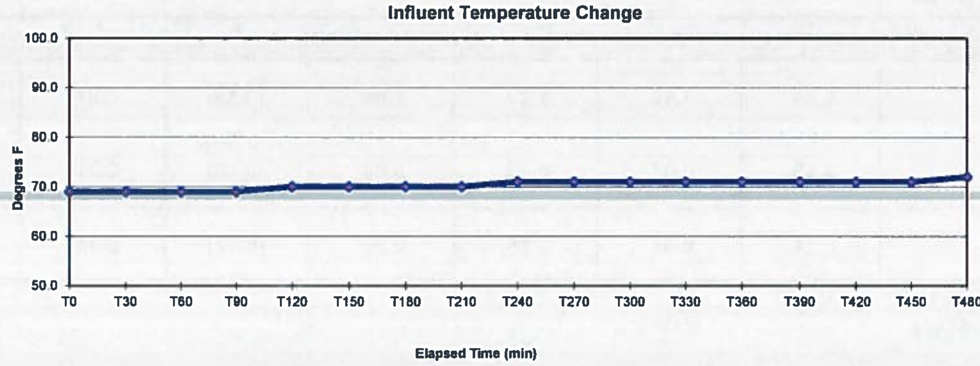
SCHEDULE B
Summary of TEST # MDP-1
Atmospheric Conditions

Walstadd 66
Lovington, NM
July 12, 2015

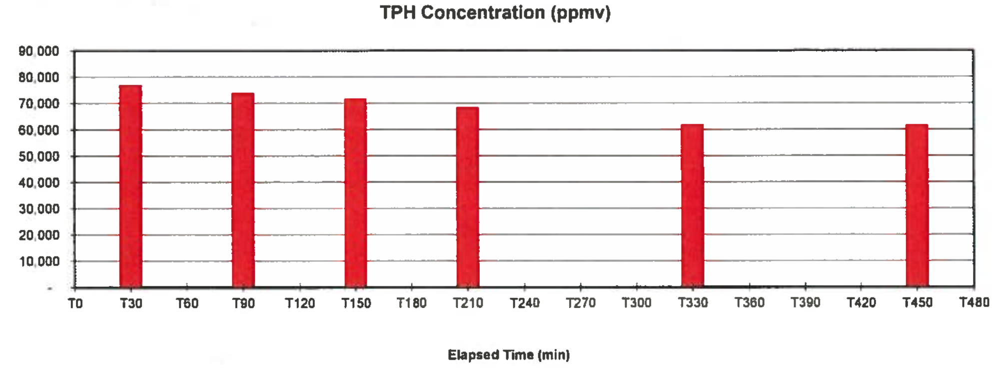

Barometric Pressure Change

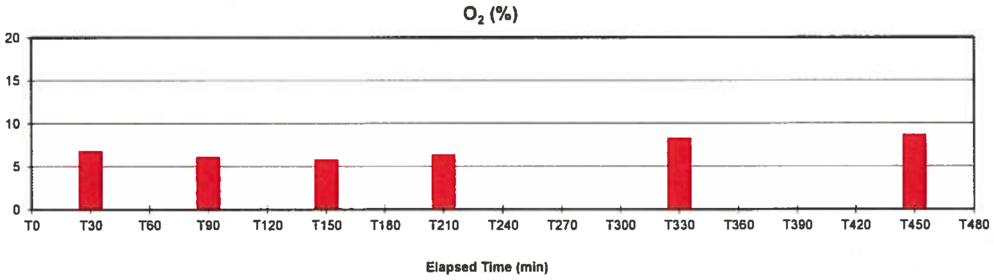

Absolute Pressure Change

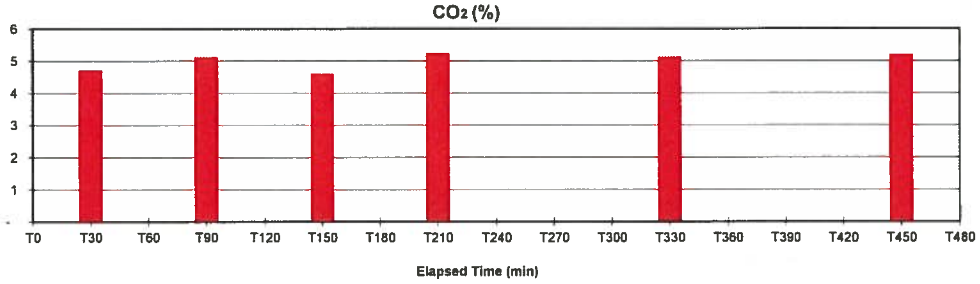

Air Temperature Change

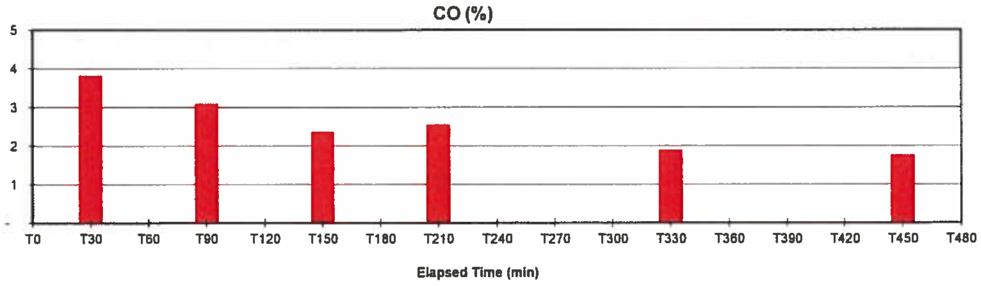

Influent Temperature Change

SCHEDULE B
Summary of TEST # MDP-1
Atmospheric Conditions



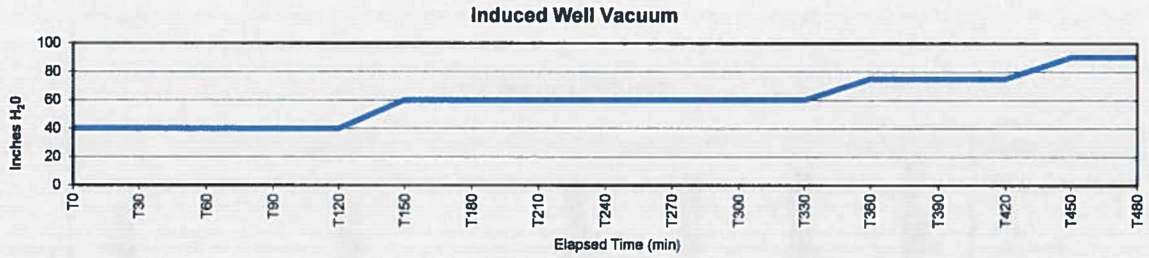


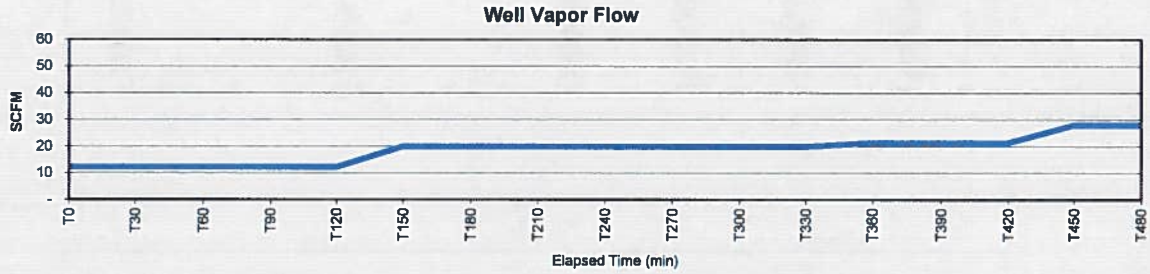


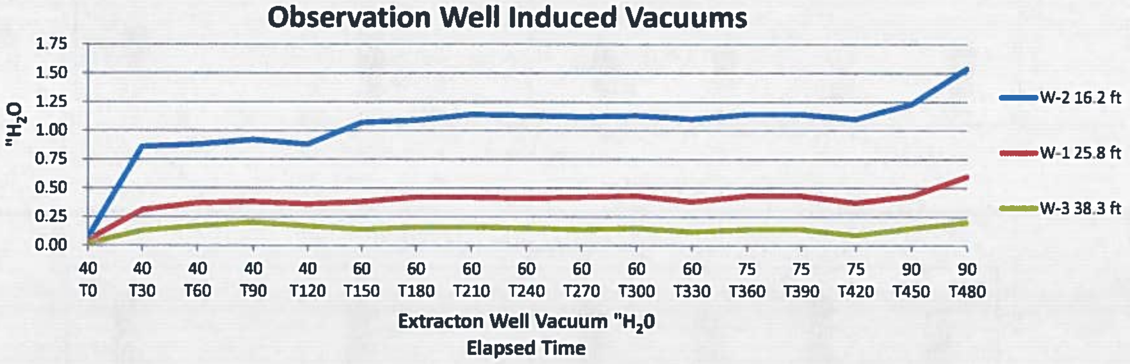


SCHEDULE B
Summary of ACUVAC TEST # MDP-1
Recorded Well Vacuums and/or (Pressures)

Walstadd 66
Lovington, NM
July 12, 2015


Induced Well Vacuum


Well Vapor Flow


Observation Well Induced Vacuums

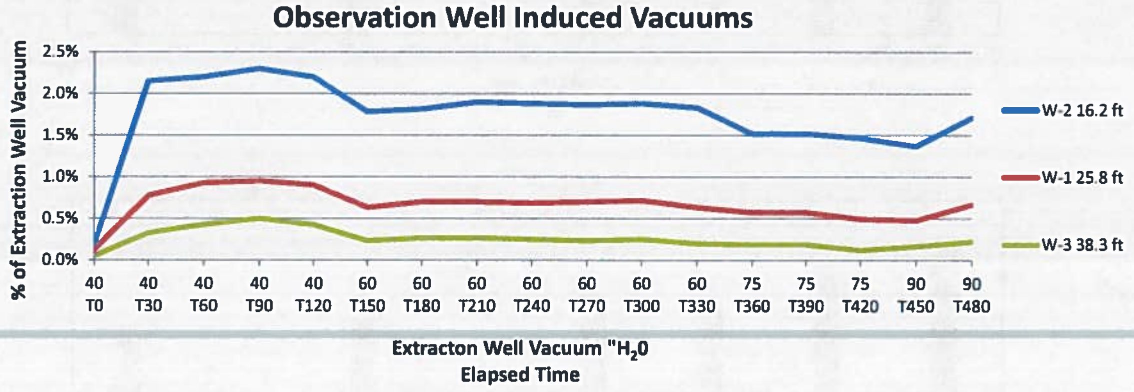

Observation Well Induced Vacuums

Figure #1A
Radius of Influence
Data from Pilot Test #MDP-1 at 0.75% of Induced Vacuum

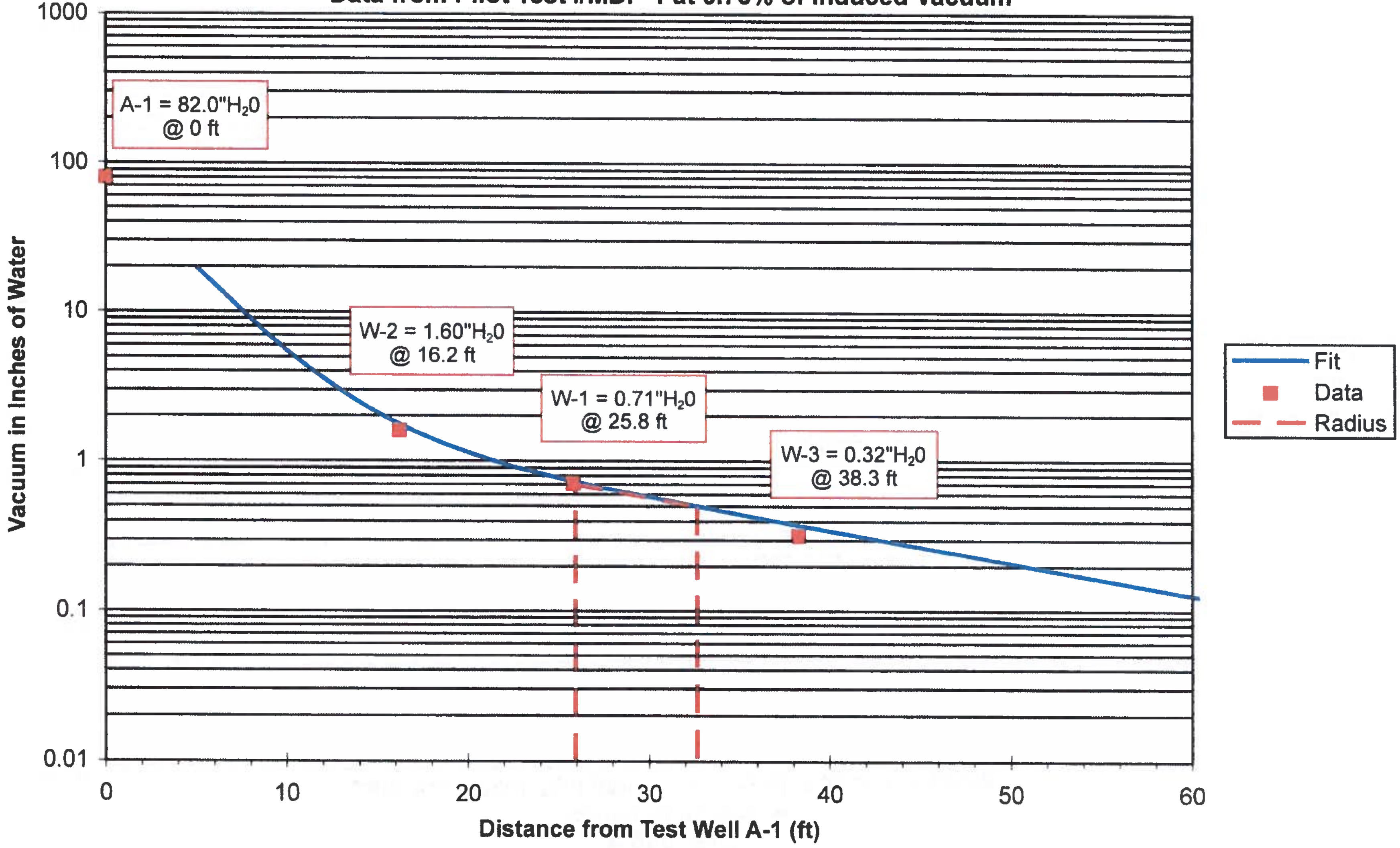


Figure #1B
Radius of Influence
Data from Pilot Test #MDP-1 at 1% of Induced Vacuum

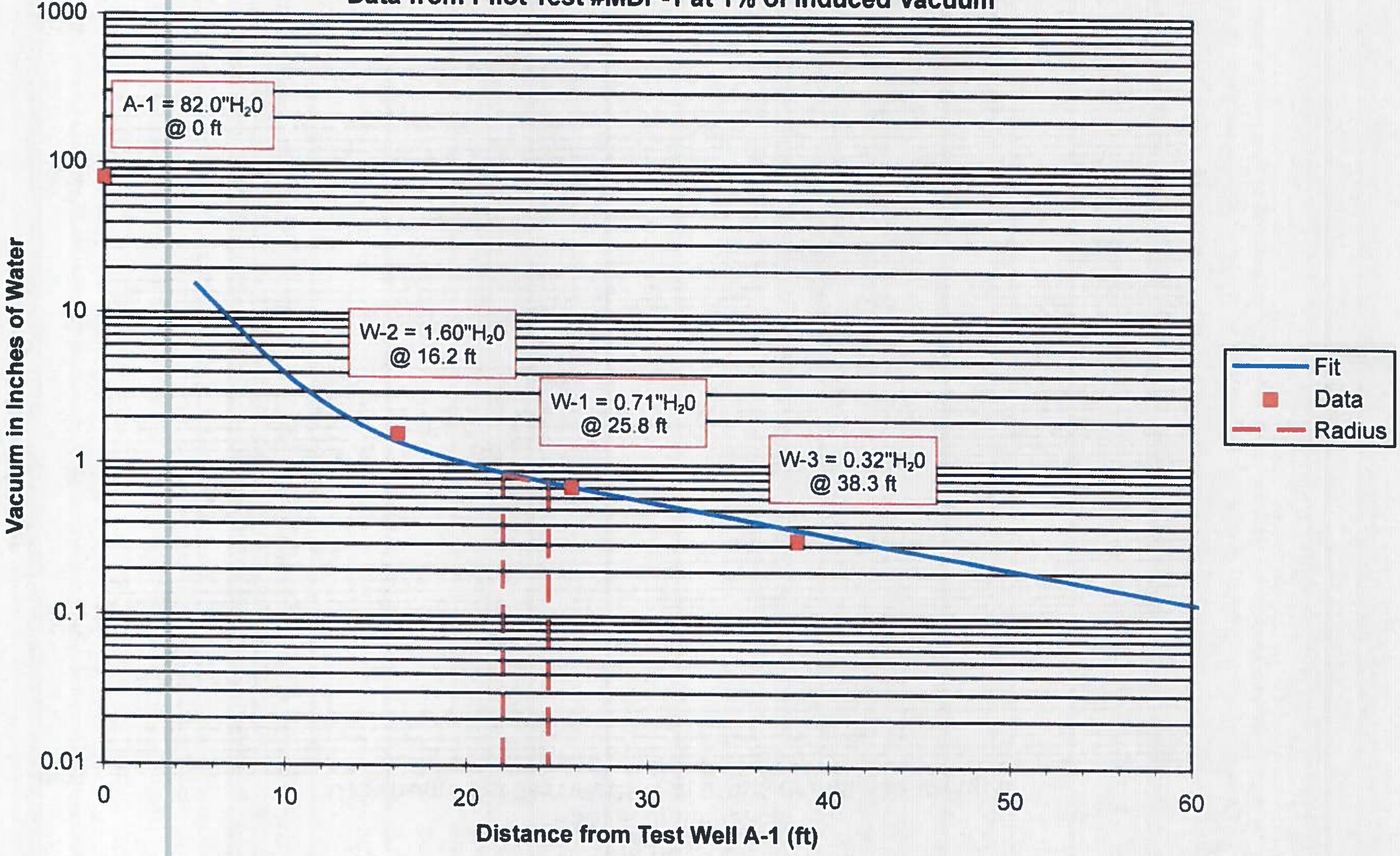
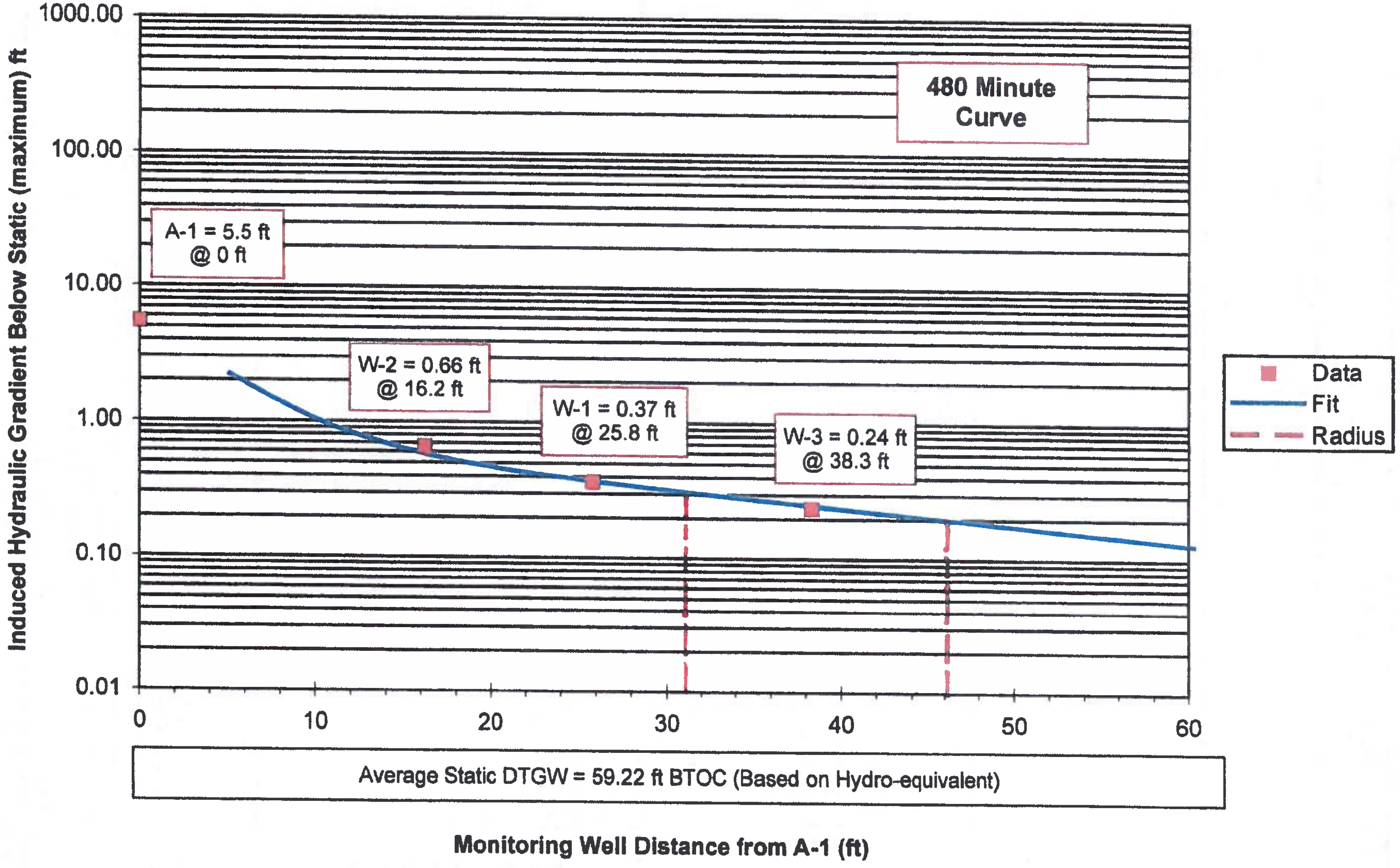


Figure #2
Drawdown at 480 Minutes vs Monitoring Well Distance



AvR

OPERATING DATA - PILOT TEST # 1 **PAGE #** 1

ACUVAC
MOBILE DUAL PHASE SYSTEM

Location: Walstadd 66, Lovington, NM								**Project Managers: Sadler/Faucher**
		Date:	7-12-15	-	-	-	-	
Parameters			Time 0725	Time 0730	Time 0800	Time 0830	Time 0900	Time 0930
	Well # A-1		Hr Meter 7279.9	Hr Meter 7280.0	Hr Meter 7280.5	Hr Meter 7281.0	Hr Meter 7281.5	Hr Meter 7282.0
ENGINE/BLOWER	R.P.M.		1000	2200	2200	2200	2200	2200
	Oil Pressure	psi	50	50	50	50	50	50
	Water Temp	°F	155	160	160	160	160	160
	Volts		13.5	140	14.0	14.0	14.0	140
	Intake Vacuum	"Hg	19	18	18	18	18	18
	Gas Flow Fuel/Propane	cfh	100	0	0	0	0	0
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump	ON/OFF	OFF	ON	ON	ON	ON	ON
	Extraction Well Flow	scfm	OFF	12.19	12.19	12.19	12.19	12.19
	Extraction Well Vac.	"H₂O	OFF	40	40	40	40	40
	Pump Rate	gals/min	N/A	3.50	3.50	3.50	3.50	3.50
	Total Volume	gals	-	-	105	210	315	420
	Influent Vapor Temp.	°F	-	69	69	69	69	70
	Air Temp	°F	72.3	72.4	74.6	75.8	77.9	79.6
	Barometric Pressure	Hg	30.10	30.10	30.10	30.09	30.09	30.10
	Absolute Pressure	"Hg	26.09	26.09	26.09	26.08	26.08	26.09
MONITOR WELL VACUUM	(16.2) W-2	"H₂O	0	.07	.86	.88	.92	.88
	(25.8) W-1	"H₂O	0	.05	.31	.37	.38	.36
	(38.3) W-3	"H₂O	0	.02	.13	.17	.20	.17
		"H₂O						
		"H₂O						
		"H₂O	STATIC					
		"H₂O						
		"H₂O						
		"H₂O						
		"H₂O						
MANIFOLD	NAPL %	Vol Gals	—	—	180/189	9.5/10	5.5/5.8	4.0/4.2
	Data Logger / Probe	ft	7.5	2.0	2.0	2.0	2.0	2.0
	Depth of GW Depression	ft	0	-5.5	-5.5	-5.5	-5.5	-5.5
	Extraction Well	DTNAPL	57.40					
	Extraction Well	DTGW	64.08					

( ) Indicates Well Pressure 6.68 7FORMS/TestForms/1210010

SG=.74 HE= 59.14

AvR **OPERATING DATA - MDP PILOT TEST # 1** **PAGE #** 1

ACUVAC
MOBILE DUAL PHASE SYSTEM

Location:	Walstadd 66 Lovington, NM				**Project Managers: Sadler/Faucher**		
	Date 7-12-15	-	-				
	Time	0800	0900				
TEST	Instrument	HORIBA	HORIBA	HORIBA	HORIBA	HORIBA	HORIBA
	Well No.	A-1	A-1				
VAPOR/INFLUENT	HC ppmv	76,990	74,020				
	CO_2 %	4.72	5.12				
	CO %	3.82	3.09				
	O_2 %	6.8	6.1				
	H_2S %	0	0				

0600	Arrived @ location - Positioned MDP System near well A-1 as
	the extraction well. Mobilized equipment - Opened selected wells - recorded
	distances & gauged wells - Install total fluid pump and probe in EW. Plugged outer
	observation wells - Connected LNAPL/GW discharge line to volume meter
	and standby tank truck - Safety checks - all ok - calibrated instruments
0725	Recorded static (baseline) data - all outer wells @ 0" H_2O - Pump inlet @ 65.0' BTOC
0730	START MDP-1 - Initial EW induced vacuum = 40" H_2O, WVF = 12.19 scfm
	GW pump rate: 3.5 gpm - All outer wells recorded slight increased vacuum levels.
0800	Recorded data: BP - All outer wells on increasing vacuum trend. GWR
	= 3.5 gpm. GWD = -5.5 ft - (Heavy LNAPL recovery) Propane @ 0 cfh
	HORIBA DATA: TOH = HC = 76,990 ppmv, CO_2: 4.72%. CO: 3.82%. O_2: 6.8%
0830	Recorded data: BP ↓ Outer wells continue on a slight increasing trend.
	GWR = 3.5 gpm LNAPL recovery (liquid) @ 5.5% = 5.8 gals
0900	HORIBA DATA: HC = 74,020 ppmv ↓ CO_2: 5.12% ↑, CO: 3.09% ↓, O_2: 6.1% ↓
	Recorded data BP - All outer wells continue on an increasing vacuum
	trend - GWR = 3.5 gpm. GWD = -5.5 ft - Liquid LNAPL @ 4%
0930	Recorded data: BP ↑ Outer wells recording a slight decreasing vacuum
	trend - LNAPL @ 3%. GWR = 3.5 gpm. Well vacuum and VWF steady
	INCREASED EW induced = 60" H_2O, WVF = 19.88 scfm. GWR:
	4.3 gpm - Pump rate increase necessary to maintain GWD @ 5.5 ft

OPERATING DATA - PILOT TEST # 1 **PAGE #** 2

ACUVAC
MOBILE DUAL PHASE SYSTEM

Location: Walstadd 66, Lovington, NM							**Project Managers: Sadler/Faucher**	
		Date:	7-12-15	-	-	-	-	-
Parameters			Time 1000	Time 1030	Time 1100	Time 1130	Time 1200	Time 1230
	Well # A-1		Hr Meter 7282.5	Hr Meter 7283.0	Hr Meter 7283.5	Hr Meter 7284.0	Hr Meter 7284.5	Hr Meter 7285.0
ENGINE/BLOWER	R.P.M.		2300	2300	2300	2300	2300	2300
	Oil Pressure	psi	50	50	50	50	50	50
	Water Temp	°F	165	165	170	170	170	170
	Volts		14.0	14.0	14.0	14.0	14.6	14.0
	Intake Vacuum	"Hg	17	17	17	17	17	17
	Gas Flow Fuel/Propane	cfh	0	0	0	0	0	0
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump	ON/OFF	ON	ON	ON	ON	ON	ON
	Extraction Well Flow	scfm	19.88	19.88	19.88	19.88	19.88	19.88
	Extraction Well Vac.	"H2O	60	60	60	60	60	60
	Pump Rate	gals/min	4.30	4.30	4.30	4.30	4.30	4.30
	Total Volume	gals	549	678	807	936	1065	1194
	Influent Vapor Temp.	°F	70	70	70	71	71	71
	Air Temp	°F	81.3	82.7	84.0	84.6	87.1	90.6
	Barometric Pressure	Hg	30.09	30.09	30.09	30.09	30.08	30.08
	Absolute Pressure	"Hg	26.08	26.08	26.08	26.08	26.07	26.08
MONITOR WELL VACUUM	W-2	"H2O	1.07	1.09	1.14	1.13	1.12	1.13
	W-1	"H2O	.38	.42	.42	.41	.42	.43
	W-3	"H2O	.14	.16	.16	.15	.14	.15
		"H2O						
		"H2O						
		"H2O						
		"H2O						
		"H2O						
		"H2O						
		"H2O						
MANIFOLD	NAPL %	Vol Gals	3.0/3.2	1.5/2.0	1.0/1.3	1.5/2.0	1.5/2.0	1.5/1.9
	Data Logger /Probe	ft	2.0	2.0	2.0	2.0	2.0	2.0
	Depth of GW Depression	ft	-5.5	-5.5	-5.5	-5.5	-5.5	-5.3
	Extraction Well	DTNAPL						
	Extraction Well	DTGW						

( ) Indicates Well Pressure

OPERATING DATA - MDP PILOT TEST # 1 PAGE # 2

ACUVAC
MOBILE DUAL PHASE SYSTEM

Location: Walstadd 66 Lovington, NM **Project Managers: Sadler/Faucher**

	Date	7-12-15	–	–				
	Time		1000	1100				
TEST	Instrument		HORIBA	HORIBA	HORIBA	HORIBA	HORIBA	HORIBA
	Well No.		A-1	A-1				
VAPOR/INFLUENT	HC	ppmv	71,750	68,490				
	CO_2	%	4.60	5.24				
	CO	%	2.37	2.55				
	O_2	%	5.8	6.4				
	H_2S	%	0	0				

1000	HORIBA DATA HC=71,750 ppmv↓, CO_2=4.60%↑, CO:2.37%↓ -O_2:5.8%↓
	Recorded data: BP↓ Outer well W-2, recording an increased vacuum
	level in response to the EW↑, other wells, most steady - GWR= 4.3
	gpm - EW vacuum @ 60"H_2O, WVF= 19.88 scfm· LNAPL @ 1.5%
1030	Gauged all wells - IHC on slight decreasing trend
	Recorded data: BP— Outer wells continue on an increasing
	vacuum trend. GWR steady @ 4.3gpm - LNAPL @ 1.0%
1100	Recorded data: BP – Outer well W-2, slight increase, the two
	wells, steady - NOTE - LNAPL @ 1.5% of volume
	HORIBA DATA: HC=68,490 ppmv↓, CO_2= 5.24%↑, CO:2.55%↑, O_2=6.48↑
1130	Recorded data: BP ∓ Outer wells mostly steady, but developing a
	slight decreasing vacuum trend· GWR·4.3 gpm· LNAPL @ 16%
1200	Recorded data: BP↓·Outer wells mostly steady, slight increase/
	decreases· GWR steady @ 4.3gpm· LNPL steady @ 1.5%-GWD=-5.5'
1230	Recorded data: BP— Outer wells mostly steady with slight
	increases -GWR = 4.3 gpm LNAPL=1.5% GWD= 5.5 ft

OPERATING DATA - PILOT TEST # 1 **PAGE # 3**

ACUVAC
MOBILE DUAL PHASE SYSTEM

Location: Walstadd 66, Lovington, NM **Project Managers: Sadler/Faucher**

		Date:	7-12-15	-	-	-	-	-
Parameters Well # A-1			Time 1300	Time 1330	Time 1400	Time 1430	Time 1500	Time 1530
			Hr Meter 7285.5	Hr Meter 7286.0	Hr Meter 7286.5	Hr Meter 7287.0	Hr Meter 7287.5	Hr Meter 7288.0
ENGINE/BLOWER	R.P.M.		2300	2400	2400	2400	2400	2400
	Oil Pressure	psi	50	50	50	50	50	50
	Water Temp	°F	175	175	175	175	175	175
	Volts		14.0	14.0	14.0	14.0	14.0	14.0
	Intake Vacuum	"Hg	17	17	17	17	17	16
	Gas Flow Fuel/Propane	cfh	0	0	0	0	0	0
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump	ON/OFF	ON	ON	ON	ON	ON	ON
	Extraction Well Flow	scfm	19.88	21.34	21.34	21.34	27.95	27.95
	Extraction Well Vac.	"H_2O	60	75	75	75	90	90
	Pump Rate	gals/min	4.30	4.60	4.60	4.60	5.20	5.20
	Total Volume	gals	1323	1460	1598	1736	1892	2048
	Influent Vapor Temp.	°F	71	71	71	71	71	72
	Air Temp	°F	91.8	93.0	94.6	95.3	95.8	96.1
	Barometric Pressure	Hg	30.07	30.06	30.06	30.04	30.02	30.02
	Absolute Pressure	"Hg	26.07	26.06	26.05	26.04	26.02	26.02
MONITOR WELL VACUUM	W-2	"H_2O	1.10	1.14	1.14	1.10	1.23	1.54
	W-1	"H_2O	.38	.43	.43	.37	.43	.60
	W-3	"H_2O	.12	.14	.14	.09	.15	.20
		"H_2O						
		"H_2O						
		"H_2O						
		"H_2O						
		"H_2O						
		"H_2O						
		"H_2O						
MANIFOLD	NAPL %	Vol Gals	1.5/2.0	1.5/2.1	2.0/2.7	2.0/2.8	2.0/3.1	2.0/3.1
	Data Logger	ft	2.0	2.0	2.0	2.0	2.0	2.0
	Depth of GW Depression	ft	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5
	Extraction Well	DTNAPL						61.61
	Extraction Well	DTGW						6165

( ) Indicates Well Pressure

7FORMS/TestForms/1210010

LNAPL = 0.04'
HE = 61.64'

AVR **OPERATING DATA - MDP PILOT TEST # 1** **PAGE #** 3

ACUVAC
MOBILE DUAL PHASE SYSTEM

Location:		**Walstadd 66 Lovington, NM**				**Project Managers: Sadler/Faucher**		
	Date	7-12-15	-	-				
	Time		1300	1500				
TEST	Instrument		HORIBA	HORIBA	HORIBA	HORIBA	HORIBA	HORIBA
	Well No.		A-1	A-1				
VAPOR/INFLUENT	HC	ppmv	61,880	61,720				
	CO_2	%	5.12	5.20				
	CO	%	1.88	1.75				
	O_2	%	8.3	8.7				
	H_2S	%	0	0				

1300	HORIBA DATA: HC = 61,890 ppmv ↓, CO_2 = 5.12% ↓ CO = 1.88% ↓ O_2 = 8.3% ↑
	Recorded data: BP ↓ All outer wells recording a decreasing
	vacuum trend due to BP ↓ - LNAPL = 1.5% - GWD = -5.5 ft
	INCREASED EW induced vacuum = 75" H_2O, WVF = 21.34 scfm
	GWR: 4.6 gpm - LNAPL = 1.5%
1330	Recorded data: BP ↓ Outer well recording increased vacuum levels
	in response to the EW increase. GWR = 4.6 gpm · LNAPL = 2%
	Gauged outer wells - Note increase in the IHC
1400	Recorded data: BP ↓ Outer well steady - No change
	GWR = 4.6 gpm · LNAPL steady @ 2% - GWD = 5.5 ft
1430	Recorded data: BP ↓↓ · Outer wells recording a decreasing
	vacuum trend due to BP ↓ - GWR = 4.6 gpm - LNAPL = 2%
1430	INCREASED EW induced vacuum = 90" H_2O, WVF = 27.95 scfm
	GWR = 5.2 gpm LNAPL = 2.0 %
1500	HORIBA DATA: HC = 61,720 ppmv ↓, CO_2 = 5.20% ↑, CO = 1.75% ↓, O_2 = 8.7% ↑
1500	Recorded data: BP ↓↓ · Outer wells recorded increasing vacuum trend
	In response to EW vacuum increase - GWR = 5.2 gpm - LNAPL = 2%
1530	Recorded data! BP - All wells recorded increased vacuum levels
	in response to A-1 @ 90" H_2O · GWR = 5.2 gpm LNAPL = 2.0%
	Gauged wells -
1535	Discontinued GW pumping and induced vacuum to allow time
	for outer wells to adjust to atmospheric changes

OPERATING DATA - PILOT TEST # 1 **PAGE #** 4

ACUVAC
MOBILE DUAL PHASE SYSTEM

Location: Walstadd 66, Lovington, NM

Project Managers: Sadler/Faucher

		Date:	7-12-15					
Parameters			Time 1600	Time	Time	Time	Time	Time
	Well #		Hr Meter 7288.3	Hr Meter	Hr Meter	Hr Meter	Hr Meter	Hr Meter
ENGINE/BLOWER	R.P.M.		1000					
	Oil Pressure	psi	50					
	Water Temp	°F	165					
	Volts		14.0					
	Intake Vacuum	"Hg	19					
	Gas Flow Fuel/Propane	cfh	90					
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump	ON/OFF	OFF					
	Extraction Well Flow	scfm	OFF					
	Extraction Well Vac.	"H_2O	OFF					
	Pump Rate	gals/min	OFF					
	Total Volume	gals	2048					
	Influent Vapor Temp.	°F	N/A					
	Air Temp	°F	95.1					
	Barometric Pressure	Hg	30.02					
	Absolute Pressure	"Hg	26.02					
MONITOR WELL VACUUM	W-2	"H_2O	(.19)					
	W-1	"H_2O	(.15)					
	W-3	"H_2O	(.17)					
		"H_2O						
		"H_2O						
		"H_2O						
		"H_2O	STATIC					
		"H_2O						
		"H_2O						
		"H_2O						
MANIFOLD	NAPL %	Vol Gals	—					
	Data Logger	ft	—					
	Depth of GW Depression	ft	—					
	Extraction Well	DTNAPL	—					
	Extraction Well	DTGW	—					

( ) Indicates Well Pressure

OPERATING DATA - MDP PILOT TEST # 1

PAGE # 4

ACUVAC
MOBILE DUAL PHASE SYSTEM

Location: Walstadd 66 Lovington, NM

Project Managers: Sadler/Faucher

	Date	7-11-15					
	Time						
TEST	Instrument	HORIBA	HORIBA	HORIBA	HORIBA	HORIBA	HORIBA
	Well No.						
VAPOR/INFLUENT	HC ppmv						
	CO_2 %						
	CO %						
	O_2 %						
	H_2S %						

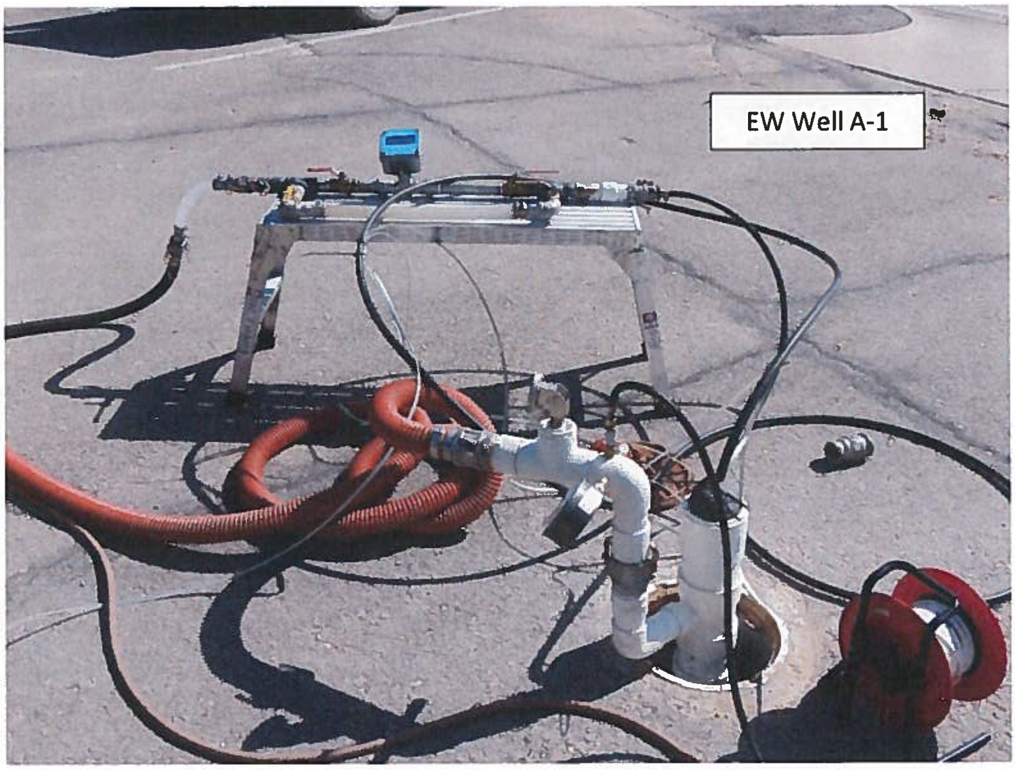
1600	Recorded static data: BP steady - All wells recording well
	pressure due to decreased barometric pressure on the GW
	TEST MDP-1 completed - NOTE - Total Liquid Volume = 2048 gals
1635	Secured all wells - departed site

WALSTADD 66
LOVINGTON, NM

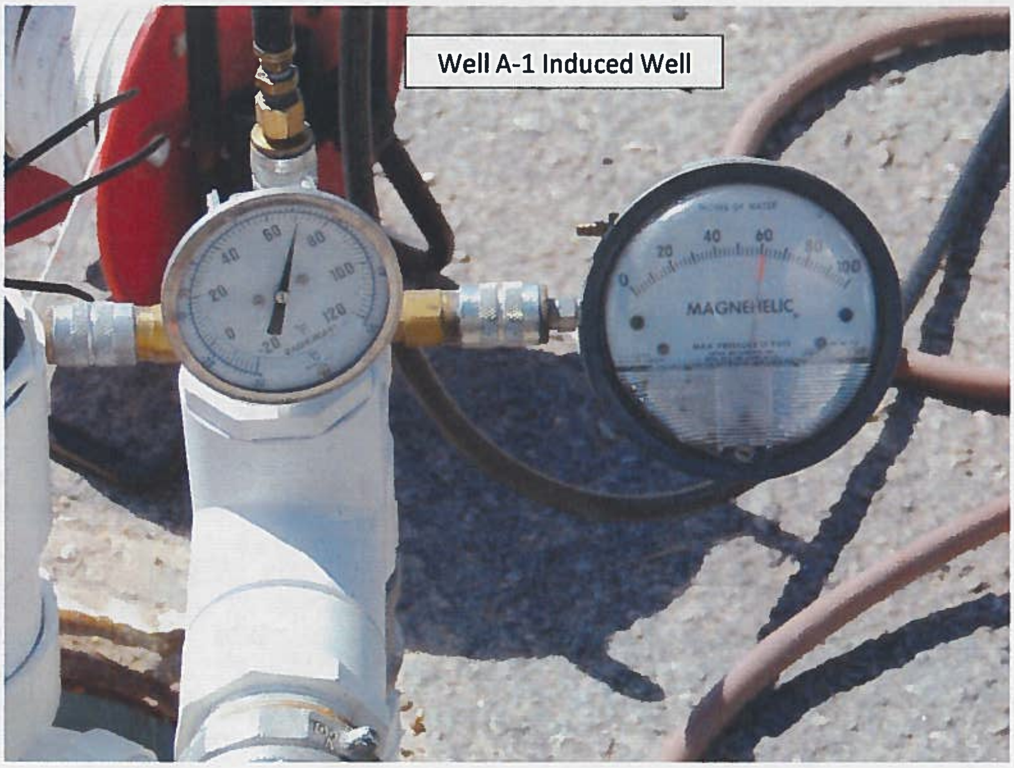
AcuVac MDP System

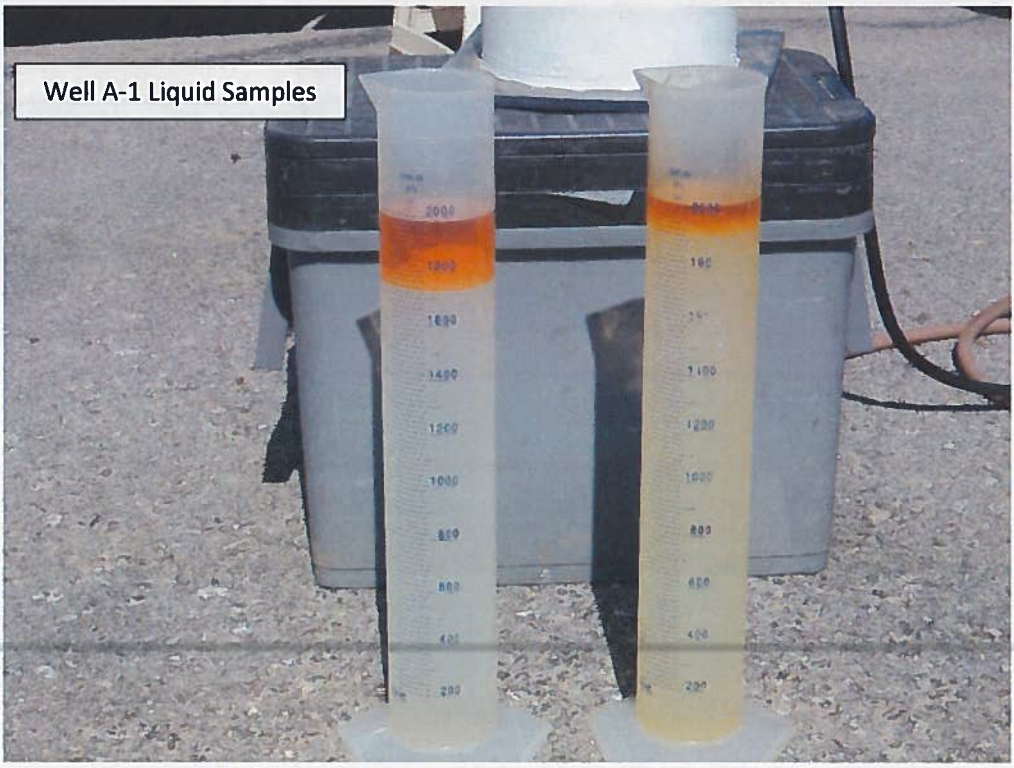
AcuVac MDP System

WALSTADD 66
LOVINGTON, NM



WALSTADD 66
LOVINGTON, NM





AcuVac Remediation, LLC

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July 15, 2015

Mr. Clay Kilmer
Senior Hydrogeologist
Golder Associates, Inc.
5200 Pasadena Avenue, N.E. Suite C
Albuquerque, NM 87113

Dear Clay:

Re: Walstadd 66, Lovington, NM

At your request, we performed two 1-hour (Wells W-1 and W-2), and one 6.0-hour (Well A-1) Mobile Dual Phase (MDP) Events at the above referenced location on July 13, 2015. Following is the Report and a copy of the Operating Data collected during Event #1 at the above referenced location. Table #1A is the Well Summary Information and Table #1B is the Recovery Summary Information on wells W-2 (Event #1A), W-1 (Event #1B), and Well A-1 (Event #1C). PSH is referred to as LNAPL in this report. GW samples are taken in a 2,000 ml beaker to determine the average LNAPL percentage and volume.

OBJECTIVES

The Objectives of an MDP Event are to:

- Evaluate the potential for removing liquid and vapor phase LNAPL (PSH) from the groundwater (GW) and soils in the subsurface formations.
- Expose the capillary fringe area and below to the Extraction Well (EW) induced vacuums.
- Increase the GW and contaminant specific yields with high induced vacuums.
- Provide an induced hydraulic gradient (IHG) to gain hydraulic control of the area during the Event period.
- Select the GW depression and pump rates to accomplish the above objectives.

METHODS AND EQUIPMENT

The tests were conducted using AcuVac's I-6 System, with Roots RAI-33 and RAI-22 blowers, various instrumentation, including the HORIBA® Analyzer, Solinst Interface Probes, Lumidor O_2 Meter, flow gauges, a sensitive instrument to determine barometric pressure, V-1 vacuum box to capture non-diluted vapor samples, Redi-Flo 2 total fluids pump and other special equipment.

The vacuum extraction portion of the AcuVac System consists of a vacuum pump driven by an internal combustion (IC) engine. The vacuum pump is connected to the extraction well and the vacuum created on the extraction well causes light hydrocarbons in the soil and on the GW to volatilize and flow through a moisture knockout tank to the vacuum pump and the IC Engine where they are burned as part of the normal combustion process. Propane is used as auxiliary fuel to help power the engine if the well vapors do not provide the required BTU.

The AcuVac IC Engine is fully loaded for the maximum power necessary to achieve and maintain high induced vacuums and/or high well vapor flows required to maximize the vacuum Radius of Influence (ROI) for Pilot Tests and short term Event remediation.

Emissions from the engine are passed through three catalytic converters to ensure maximum destruction of removed hydrocarbon vapors. The engine's fuel to air ratio can be adjusted to maintain efficient combustion. Because the engine is the power source for all equipment, all systems stop when the engine stops. This eliminates any uncontrolled release of hydrocarbons. Since the AcuVac System is held entirely under vacuum, any leaks in the seals or connections are leaked into the System and not emitted into the atmosphere. The engine is automatically shut down by vacuum loss, low oil pressure or overheating.

The GW Extraction is provided by an in-well, Redi-Flo 2 total fluids pump that has the discharge line connected to a total volume meter. The discharge line from the volume meter is then connected to the stand-by tank truck. The electrical power for the GW pump was supplied from a 120v Honda generator. The GW flow rate can be adjusted to maintain a target level. Interface meters are used to measure all DTGW/DTLNAPL.

The design of the AcuVac System enables complete independent control of both the Induced Well Vacuum and the GW pumping functions such that the AcuVac team can control the IHG to expose the maximum amount of the formation to SVE. The ability to separate the vacuum and liquid flows within the Extraction Well improves the LNAPL recovery rates, and enables the AcuVac team to record data specific to each.

SUMMARY OF MDP EVENT #1A- WELL W-2

- The total Event time was 1.0 hour. The Event was conducted on July 13, 2015. There is no comparative data.
- The total liquid volume recovered was 192 gals, of which 13.50% or 25.92 gals were liquid LNAPL.
- Total vapor LNAPL burned as IC engine fuel was 1.97 gals, **for a total liquid and vapor LNAPL recovery of 27.89 gals.**
- Average HORIBA® Analytical Data from the influent vapor samples was: HC = 95,790 ppmv, CO_2 = 3.46%, CO = 7.46%, O_2 = 8.6% and H_2S = 0 ppm.
- The maximum HORIBA® Analytical Data from the influent vapor samples for TPH was 95,790 ppmv.
- The Average Induced Vacuum was 60"H_2O with a maximum vacuum of 60.00"H_2O.
- The average EW well vapor flow was 9.51 scfm with a maximum well vapor flow of 9.51 scfm.
- The GW pump inlet was set at 65.0 ft BTOC. The average GW pump rate was 3.20 gpm, and the maximum GW pump rate was 3.20 gpm.
- The average GW depression, based on the positioning of the GW pump, was 5.50 ft below static level.
- An LNAPL thickness of 6.54 ft was recorded prior to the start of Event #1A and no LNAPL thickness was recorded at the conclusion of the Event.

The total LNAPL removed, including liquid and vapor, during the 1.0 hour Event #1A, Well W-2, was 27.89 gals.

ADDITIONAL INFORMATION

- The higher percentage of the LNAPL volume, 25.92 gals or 92.94%, was recovered as liquid due to the high level of free phase LNAPL at the start of the Event.
- A minimal percentage of the LNAPL, 1.97 gals or 7.06%, was burned as IC engine fuel as a result of the short duration of the Event period.
- The high HC (TPH) levels indicate contaminant in the gasoline range.
- The relatively low O_2 levels in the influent vapors indicate SVE short circuiting from the ground surface most likely did not occur.
- Well W-2 was gauged at the conclusion of Event #1C (1445 hrs) and an LNAPL thickness of 4.40 ft was recorded indicating a rebound of 67.28%.

SUMMARY OF MDP EVENT #1B- WELL W-1

- The total Event time was 1.0 hour. The Event was conducted on July 13, 2015. There is no comparative data.
- The total liquid volume recovered was 201 gals, of which 23.69% or 47.61 gals were liquid LNAPL.
- Total vapor LNAPL burned as IC engine fuel was 1.84 gals, **for a total liquid and vapor LNAPL recovery of 49.45 gals.**
- Average HORIBA® Analytical Data from the influent vapor samples was: HC = 89,750 ppmv, CO_2 = 3.52%, CO = 5.74%, O_2 = 8.6% and H_2S = 0 ppm.
- The maximum HORIBA® Analytical Data from the influent vapor samples for TPH was 89,750 ppmv.
- The Average Induced Vacuum was 60"H_2O with a maximum vacuum of 60.00"H_2O.
- The average EW well vapor flow was 9.51 scfm with a maximum well vapor flow of 9.51 scfm.
- The GW pump inlet was set at 65.0 ft BTOC. The average GW pump rate was 3.47 gpm, and the maximum GW pump rate was 3.70 gpm.
- The average GW depression, based on the positioning of the GW pump, was 5.50 ft below static level.
- An LNAPL thickness of 6.84 ft was recorded prior to the start of Event #1B and an LNAPL thickness of 0.04 ft was recorded at the conclusion of the Event.

The total LNAPL removed, including liquid and vapor, during the 1.0 hour Event #1B, Well W-1, was 49.45 gals.

ADDITIONAL INFORMATION

- The higher percentage of the LNAPL volume of 47.61 gals or 96.27%, was recovered as liquid.
- A minimal amount of LNAPL, 1.84 gals or 3.73%, was burned as IC engine fuel as a result of the short duration of the Event period.

- The high HC (TPH) levels indicate contaminant in the gasoline range.
- The relatively low O_2 levels in the influent vapors indicate SVE short circuiting from the ground surface most likely did not occur.
- Well W-1 was gauged at the conclusion of Event #1C (1445 hrs) and an LNAPL thickness of 1.01 ft of was recorded indicating a rebound of 14.77%.
- A thickness of biomass was initially observed on the collected GW/LNAPL sample.

SUMMARY OF MDP EVENT #1C- WELL A-1

- The total Event time was 6.0 hours. The Event was conducted on July 13, 2015. The data is compared to Pilot Test #1 conducted on July 12, 2015 which had a total Test time of 8.0 hours.
- The total liquid volume recovered was 1,553 gals, of which 2.35% or 36.53 gals were liquid LNAPL.
- Total vapor LNAPL burned as IC engine fuel was 29.36 gals, **for a total liquid and vapor LNAPL recovery of 65.88 gals. This equates to an average of 10.98 gals/hr.**
- Average HORIBA® Analytical Data from the influent vapor samples was: HC = 59,027 ppmv, CO_2 = 5.61%, CO = 1.73%, O_2 = 7.1% and H_2S = 0 ppm.
- Compared with MDP Pilot Test #1 data, the average TPH levels decreased 10,115 ppmv, CO_2 increased 0.61%, CO decreased 0.85%, O_2 increased 0.1% and H_2S was steady at 0 ppm.
- The maximum HORIBA® Analytical Data from the influent vapor samples for TPH was 64,480 ppmv. Compared with MDP Pilot Test #1 data, the maximum TPH levels decreased 12,510 ppmv.
- The Average Induced Vacuum was 68.46"H_2O with a maximum vacuum of 70.00"H_2O. Compared with Pilot Test #1 data, the average induced vacuum increased 8.17"H_2O and the maximum induced vacuum decreased 20.00"H_2O.
- The average EW well vapor flow was 23.01 scfm with a maximum well vapor flow of 23.34 scfm. Compared with MDP Pilot Test #1 data, the average EW well vapor flow increased 4.18 scfm, and the maximum well flow decreased 4.61 scfm.
- The GW pump inlet was set at 65.0 ft BTOC. The average GW pump rate was 4.35 gpm, and the maximum GW pump rate was 4.50 gpm.
- The average GW depression, based on the positioning of the GW pump, was 5.50 ft below static level.
- An LNAPL thickness of 5.52 ft was recorded prior to the start of Event #1C and a LNAPL thickness of 0.13 ft was recorded at the conclusion of the Event.

The total LNAPL removed, including liquid and vapor, during the 6.0 hour Event #1C, Well A-1, was 65.88 gals.

ADDITIONAL INFORMATION

- The higher percentage of the LNAPL volume, 36.53 gals or 55.44%, was recovered as liquid.
- Of the total LNAPL volume recovered, 29.36 gals or 44.56%, was burned as IC engine fuel during the Event period as a result of the high TPH and Well Vapor Flow.
- The high HC (TPH) levels indicate contaminant in the gasoline range.
- The HC (TPH) recorded a decreasing trend throughout the Event period.
- The relatively low O_2 levels in the influent vapors indicate SVE short circuiting from the ground surface most likely did not occur.

TOTAL RECOVERY EVENT #1

The total LNAPL removed, including liquid and vapor, during the 8.0 hour Event #1, Wells W-1, W-2, and A-1, was 143.22 gals. This equates to 17.90 gal/hr.

RECOMMENDATION

The Events proved to be an extremely effective method of decreasing the liquid LNAPL thickness in these wells. An Event program should be considered to quickly reduce the LNAPL thickness before considering a CAP which includes an on-site recovery system. In many cases the Event program has initially been more cost effective.

METHOD OF CALIBRATION AND CALCULATIONS

The HORIBA® Analytical instrument is calibrated with Hexane, CO and CO_2.

The formula used to calculate the emission rate is:

$$\text{ER} = \text{HC (ppmv)} \times \text{MW (Hexane)} \times \text{Flow Rate (scfm)} \times 1.58\text{E}^{-7} \frac{\text{(min)(lb mole)}}{\text{(hr)(ppmv)(ft}^3\text{)}} = \text{lbs/hr}$$

INFORMATION INCLUDED WITH REPORT

- Table #1A Summary Well Data
- Table #1B Summary Recovery Data
- Recorded Data
- Photographs of the MDP System and Wells A-1, W-1 and W-2.

After you have reviewed the report and if you have any questions, please contact me. We appreciate you selecting AcuVac to provide this service.

Sincerely,
ACUVAC REMEDIATION, LLC

Paul D. Faucher
Vice President, Operations

Summary Well Data
Table #1A

Event		1A	1B	1C
WELL NO.		W-2	W-1	A-1
Total Event Hours		1.0	1.0	6.0
TD	ft	75.0	80.0	75.0
Well Screen	ft	45.0 to 75.0	50 to 70	50 to 70
Well Size	in	4.0	4.0	4.0
Well Data				
DTGW - Static - Start Event	ft	64.67	63.96	63.55
DTLNAPL - Static - Start Event	ft	58.13	57.12	58.03
LNAPL	ft	6.54	6.84	5.52
Hydro-Equivalent- Beginning	ft	59.83	58.90	59.47
DTGW - End Event	ft	57.76	59.21	60.01
DTLNAPL - End Event	ft	0	59.17	59.88
LNAPL	ft	0	0.04	0.13
Hydro-Equivalent - Ending	ft	57.76	59.18	59.91
Extraction Data				
Maximum Extraction Well Vacuum	"H_2O	60.00	60.00	70.00
Average Extraction Well Vacuum	"H_2O	60.00	60.00	68.46
Maximum Extraction Well Vapor Flow	scfm	9.51	9.51	23.34
Average Extraction Well Vapor Flow	scfm	9.51	9.51	23.01
Maximum GW/ LNAPL Pump Rate	gpm	3.20	3.70	4.50
Average GW/ LNAPL Pump Rate	gpm	3.20	3.47	4.35
Influent Data				
Maximum TPH	ppmv	95,790	89,750	64,480
Average TPH	ppmv	95,790	89,750	59,027
Average CO_2	%	3.46	3.52	5.61
Average CO	%	7.46	5.74	1.73
Average O_2	%	8.6	8.6	7.1
Average H_2S	ppm	0	0	0

Summary Recovery Data

Table #1B

Event		1A	1B	1C
WELL NO.		W-2	W-1	A-1
Recovery Data- Current Event				
Total Liquid Volume Recovered	gals	192	201	1,553
Total Liquid LNAPL Recovered	gals	25.92	47.61	36.53
Total Liquid LNAPL Recovered / Total Liquid	%	13.50	23.69	2.35
Total Liquid LNAPL Recovered / Total LNAPL	%	92.94	96.27	55.44
Total Vapor LNAPL Recovered	gals	1.97	1.84	29.36
Total Vapor LNAPL Recovered / Total LNAPL	%	7.06	3.73	44.56
Total Vapor and Liquid LNAPL Recovered	gals	27.89	49.45	65.88
Average LNAPL Recovery	gals/hr	27.89	49.45	10.98
Total LNAPL Recovered	lbs	195	346	461
Total Volume of Well Vapors	cu. ft	571	571	8,284
Recovery Data- Cumulative				
Total Liquid Volume Recovered	gals	192	201	3,601
Total Liquid LNAPL Recovered	gals	25.92	47.61	100.16
Total Vapor LNAPL Recovered	gals	1.97	1.84	51.87
Total Vapor and Liquid LNAPL Recovered	gals	27.89	49.45	152.03
Average LNAPL Recovery	gals/hr	27.89	49.45	10.86
Total LNAPL Recovered	lbs	195	346	1,064
Total Volume of Well Vapors	cu. ft	571	571	17,322

OPERATING DATA - EVENT #1 A

PAGE # 1

ACUVAC MOBILE DUAL PHASE SYSTEM

Location: **Walstadd 66, Lovington, NM**

Project Managers: Sadler/Faucher

	Date:		7/13/15					
	Parameters		Time 0615	Time 0645	Time 0715	Time	Time	Time
	WELL # W-1		Hr Meter 7288.5	Hr Meter 7289.0	Hr Meter 7289.5	Hr Meter	Hr Meter	Hr Meter
ENGINE/BLOWER	R.P.M.		2206	2200	2200			
	Oil Pressure	psi	50	50	50			
	Water Temp	°F	130	140	150			
	Volts		14	14	14			
	Intake Vacuum	"Hg	19	19	19			
	Gas Flow Fuel/Propane	cfh	0	0	0			
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump	ON/OFF	ON	ON	OFF			
	Extraction Well Flow	scfm	9.51	9.51	9.51			
	Extraction Well Vacuum	"H_2O	60	60	60			
	Pump Rate	gals/min	3.2	3.2	3.2			
	Total Volume	gals	—	96	192			
	Influent Vapor Temp.	°F	68	68	68			
	Air Temperature	°F	66.7	69.1	69.8			
	Barometric Pressure	"Hg	30.03	30.02	30.01			
VAPOR /INFLUENT	HC	ppmv	—	95790	—			
	CO_2	%	—	3.42	—			
	CO	%	—	7.46	—			
	O_2	%	—	8.6	—			
	H_2S	ppm	—	0	—			
NOTES	ARRIVED ON SITE AT 0545 HRS. POSITIONED THE ACUVAC SYSTEM NEAR WELL W-1. GAUGED THE WELL AND MOBILIZED ALL EQUIPMENT, PLACED THE IN WELL PUMP AT 67.0 FT BTOC. EVENT STARTED AT 0615 HRS, INITIAL WELL VAC SET AT 60"H_2O RESULTING IN WVF OF 9.50 SCFM. INFLUENT VAPOR SAMPLE INDICATES HIGH CONCENTRATION OF HYDROCARBONS IN THE 95,000 + PPMV RANGE. LIQUID SAMPLE TAKEN AT APPROX 0630 INDICATES 15 % OF LNAPL PRESENT IN THE LIQUID. INDUCED WELL VAC REDUCED AT 0705 HRS GW PUMPING STOPPED AT 0715. EVENT CONCLUDED AT 0715							
MANIFOLD	LNAPL % Vol Gals		-/-	15/14.40	12/11.52			
	Depth of GW Depression	ft	-5.5	-5.5	-5.5	1445		
	Extraction Well DTLNAPL	ft	58.13		—	59.00		
	Extraction Well DTGW	ft	64.67		57.76	63.40		

( ) Indicates Well Pressure

LNAPL 6.54

Ø

4.40

HE 59.83

HE 60.14

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OPERATING DATA - EVENT #1 B PAGE # 1 ACUVAC MOBILE DUAL PHASE SYSTEM

Location: Walstadd 66, Lovington, NM **Project Managers: Sadler/Faucher**

	Date:	7/13/15					
	Parameters	Time 0730	Time 0800	Time 0830	Time	Time	Time
	WELL # W-2	Hr Meter 7289.5	Hr Meter 7290.0	Hr Meter 7290.5	Hr Meter	Hr Meter	Hr Meter
ENGINE/BLOWER	R.P.M.	2200	2200	2200			
	Oil Pressure psi	50	50	50			
	Water Temp °F	150	150	150			
	Volts	14	14	14			
	Intake Vacuum "Hg	19	19	19			
	Gas Flow Fuel/Propane cfh	0	0	0			
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump ON/OFF	ON	ON	OFF			
	Extraction Well Flow scfm	9.51	9.51	9.51			
	Extraction Well Vacuum "H_2O	60	60	60			
	Pump Rate gals/min	3.0	3.70	3.70			
	Total Volume gals	-	90	201			
	Influent Vapor Temp. °F	68	68	68			
	Air Temperature °F	70.4	71.7	72.5			
	Barometric Pressure "Hg	30.01	30.01	30.01			
VAPOR /INFLUENT	HC ppmv	-	89,750	-			
	CO_2 %	-	3.52	-			
	CO %	-	5.74	-			
	O_2 %	-	8.6	-			
	H_2S ppm	-	0	-			

NOTES

RELOCATED THE ACUVAC SYSTEM NEAR WELL W-2. GAUGED THE WELL PLACED THE IN-WELL PUMP AT 67.0 FT BTOC. INITIAL WELL VAC SET AT 60 "H_2O RESULTING IN A WVF OF 9.50 SCFM.

MANIFOLD	LNAPL % Vol Gals	-/-	27/24.3	21/23.31			
	Depth of GW Depression ft	-5.5	-5.5	-5.5		1445	
	Extraction Well DTLNAPL ft	59.12		59.17		59.12	
	Extraction Well DTGW ft	63.96		59.21		60.13	

( ) Indicates Well Pressure

LNAPL 6.84
HE 58.90

.04 HE 59.18

7FORMS/TestForms/1210017B

1.01 HE 59.38

AvR

OPERATING DATA - EVENT #1 C **PAGE # 1** **ACUVAC MOBILE DUAL PHASE SYSTEM**

Location: Walstadd 66, Lovington, NM **Project Managers: Sadler/Faucher**

	Date:	7/13/15					
	Parameters	Time 0845	Time 0915	Time 0945	Time 1015	Time 1045	Time 1115
	WELL # A-1	Hr Meter 7290.5	Hr Meter 7291.0	Hr Meter 7291.5	Hr Meter 7292.0	Hr Meter 7292.8	Hr Meter 7293.0
ENGINE/BLOWER	R.P.M.	2200	2200	2300	2300	2300	2300
	Oil Pressure psi	50	50	50	50	50	50
	Water Temp °F	150	150	150	150	155	160
	Volts	14	14	14	14	14	14
	Intake Vacuum "Hg	16	16	16	16	16	16
	Gas Flow Fuel/Propane cfh	0	0	50	50	50	50
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump ON/OFF	ON	ON	ON	ON	ON	ON
	Extraction Well Flow scfm	23.34	23.34	22.55	22.55	22.55	22.55
	Extraction Well Vacuum "H_2O	60	60	70	70	70	70
	Pump Rate gals/min	4.2	4.2	4.4	4.5	4.5	4.5
	Total Volume gals	–	126	252	384	519	654
	Influent Vapor Temp °F	71	71	71	72	72	72
	Air Temperature °F	74.3	77.8	84.3	86.7	88.5	89.4
	Barometric Pressure "Hg	30.01	30.01	30.00	30.00	30.00	29.99
VAPOR /INFLUENT	HC ppmv	–	–	64480	–	–	–
	CO_2 %	–	–	5.14	–	–	–
	CO %	–	–	2.09	–	–	–
	O_2 %	–	–	7.1	–	–	–
	H_2S ppm	–	–	0	–	–	–

NOTES

AT 0830 MOBILIZED THE ACUVAC EQUIPMENT ON WELL A-1. SET IN-WELL PUMP AT 67 FT BTOC. INITIAL WELL VAC SET AT 60"H_2O RESULTING IN A WVF OF 23.34 SCFM. INITIAL GW PUMP RATE SET AT 4.2 GPM.

AT 0945 INCREASED WELL VAC TO 70"H_2O RESULTING IN A WVF OF 22.55 SCFM. GW PUMP RATE INCREASED TO 4.4 GPM AND INCREASED AGAIN AT 1015 HRS TO 4.5 GPM TO COMPENSATE FOR HIGHER VACUUM. TPH VAPORS REMAIN HIGH IN THE GASOLINE RANGE

MANIFOLD	LNAPL % Vol Gals	–/–	8/10.08	4/5.04	2/2.64	2/2.7	1.5/2.03
	Depth of GW Depression ft	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5
	Extraction Well DTLNAPL ft	0820 58.03	0830 57.76				
	Extraction Well DTGW ft	63.55	63.87				

( ) Indicates Well Pressure

LNAPL 5.52 6.11

HE 59.47 59.35

OPERATING DATA - EVENT #1C **PAGE #2** **ACUVAC MOBILE DUAL PHASE SYSTEM**

Location: **Walstadd 66, Lovington, NM** **Project Managers: Sadler/Faucher**

	Date:	7/13/15					
	Parameters	Time 1145	Time 1215	Time 1245	Time 1315	Time 1345	Time 1445
	WELL # A-1	Hr Meter 7293.5	Hr Meter 7294.0	Hr Meter 7294.5	Hr Meter 7295.0	Hr Meter 7295.5	Hr Meter 7296.5
ENGINE/BLOWER	R.P.M.	2300	2300	2300	2300	2300	2300
	Oil Pressure psi	50	50	50	50	50	50
	Water Temp °F	160	160	165	165	165	165
	Volts	14	14	14	14	14	14
	Intake Vacuum "Hg	16	16	16	16	16	16
	Gas Flow Fuel/Propane cfh	50	50	50	50	50	50
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump ON/OFF	ON	ON	ON	ON	ON	OFF
	Extraction Well Flow scfm	2255	22.55	22.55	22.55	22.55	2255
	Extraction Well Vacuum "H_2O	70	70	70	70	70	70
	Pump Rate gals/min	4.5	4.5	4.5	4.4	4.4	3.5
	Total Volume gals	789	924	1059	1194	1326	1553
	Influent Vapor Temp. °F	71	71	71	71	71	71
	Air Temperature °F	91.3	95.1	97.6	99.2	99.5	99.8
	Barometric Pressure "Hg	29.98	29.97	29.96	29.94	29.92	2992
VAPOR /INFLUENT	HC ppmv	56,750	-	-	-	55850	-
	CO_2 %	5.74	-	-	-	5.96	-
	CO %	1.57	-	-	-	1.52	-
	O_2 %	7.0	-	-	-	7.2	-
	H_2S ppm	0	-	-	-	0	-
MANIFOLD	LNAPL % Vol Gals	1.5/2.03	1.5/2.03	1.5/2.03	1.5/2.03	1.5/1.98	1.5/1.98
	Depth of GW Depression ft	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5
	Extraction Well DTLNAPL ft						59.88
	Extraction Well DTGW ft						60.01

NOTES

WELL VAC AND WELL FLOW STEADY DURING PERIOD. TPH VAPORS MOSTLY STEADY DURING THE PERIOD.
AT 1445 EVENT CONCLUDED. ALL WELL GAUGED. WELL W-1 AND W-2 WERE GAUGED TO DETERMINE THE EXTENT OF ANY REBOUND.
ACUVAC EQUIPMENT AND SYSTEM DEMOBILIZED, SITE SECURED, DEPARTED SITE.

( ) Indicates Well Pressure

LNAPL .13
HE 59.91

AvR

OPERATING DATA - EVENT #1 A **PAGE #** 1 **ACUVAC MOBILE DUAL PHASE SYSTEM**

Location: Walstadd 66, Lovington, NM **Project Managers: Sadler/Faucher**

		Date:	7/13/15					
	Parameters		Time 0615	Time 0645	Time 0715	Time	Time	Time
	WELL # W-1		Hr Meter 7288.5	Hr Meter 7289.0	Hr Meter 7289.5	Hr Meter	Hr Meter	Hr Meter
ENGINE/BLOWER	R.P.M.		2200	2200	2200			
	Oil Pressure	psi	50	50	50			
	Water Temp	°F	130	140	150			
	Volts		14	14	14			
	Intake Vacuum	"Hg	19	19	19			
	Gas Flow Fuel/Propane	cfh	0	0	0			
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump	ON/OFF	ON	ON	OFF			
	Extraction Well Flow	scfm	9.51	9.51	9.51			
	Extraction Well Vacuum	"H_2O	60	60	60			
	Pump Rate	gals/min	3.2	3.2	3.2			
	Total Volume	gals	–	96	192			
	Influent Vapor Temp.	°F	68	68	68			
	Air Temperature	°F	66.7	69.1	69.8			
	Barometric Pressure	"Hg	30.03	30.02	30.01			
VAPOR /INFLUENT	HC	ppmv	–	95790	–			
	CO_2	%	–	3.42	–			
	CO	%	–	7.46	–			
	O_2	%	–	8.6	–			
	H_2S	ppm	–	0	–			

NOTES

ARRIVED ON SITE AT 0545 HRS. POSITIONED THE ACUVAC SYSTEM NEAR WELL W-1. GAUGED THE WELL AND MOBILIZED ALL EQUIPMENT. PLACED THE IN WELL PUMP AT 67.0 FT BTOC. EVENT STARTED AT 0615 HRS. INITIAL WELL VAC SET AT 60"H_2O RESULTING IN WVF OF 9.50 SCFM. INFLUENT VAPOR SAMPLE INDICATES HIGH CONCENTRATION OF HYDROCARBONS IN THE 95,000 + PPMV RANGE. LIQUID SAMPLE TAKEN AT APPROX 0630 INDICATES 15 % OF LNAPL PRESENT IN THE LIQUID. INDUCED WELL VAC REDUCED AT 0705 HRS GW PUMPING STOPPED AT 0715. EVENT CONCLUDED AT 0715

MANIFOLD	LNAPL % Vol Gals		–/–	15/14.40	12/11.52			
	Depth of GW Depression	ft	-5.5	-5.5	-5.5	1445		
	Extraction Well DTLNAPL	ft	58.13		–	59.00		
	Extraction Well DTGW	ft	64.67		57.76	63.40		

( ) Indicates Well Pressure

LNAPL 6.54 0 4.40

HE 59.83 HE 60.14

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OPERATING DATA - EVENT #1 B **PAGE #** 1 **ACUVAC MOBILE DUAL PHASE SYSTEM**

Location: Walstadd 66, Lovington, NM **Project Managers: Sadler/Faucher**

		Date:	7/13/15				
	Parameters WELL # W-2		Time 0730 Hr Meter 7289.5	Time 0800 Hr Meter 7290.0	Time 0830 Hr Meter 7290.5	Time Hr Meter	Time Hr Meter	Time Hr Meter
ENGINE/BLOWER	R.P.M.		2200	2200	2200			
	Oil Pressure	psi	50	50	50			
	Water Temp	°F	150	150	150			
	Volts		14	14	14			
	Intake Vacuum	"Hg	19	19	19			
	Gas Flow Fuel/Propane	cfh	0	0	0			
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump	ON/OFF	ON	ON	OFF			
	Extraction Well Flow	scfm	9.51	9.51	9.51			
	Extraction Well Vacuum	"H_2O	60	60	60			
	Pump Rate	gals/min	3.0	3.70	3.70			
	Total Volume	gals	-	90	201			
	Influent Vapor Temp	°F	68	68	68			
	Air Temperature	°F	70.4	71.7	72.5			
	Barometric Pressure	"Hg	30.01	30.01	30.01			
VAPOR /INFLUENT	HC	ppmv	-	89,750	-			
	CO_2	%	-	3.52	-			
	CO	%	-	5.74	-			
	O_2	%	-	8.6	-			
	H_2S	ppm	-	0	-			
NOTES	RELOCATED THE ACUVAC SYSTEM NEAR WELL W-2. GAUGED THE WELL PLACED THE ID WELL PUMP AT 67.0 FT BTOC. INITIAL WELL VAC SET AT 60 "H_2O RESULTING IN A WVF OF 9.50 SCFM.							
MANIFOLD	LNAPL %	Vol Gals	-/-	27/24.3	21/23.31			
	Depth of GW Depression	ft	-5.5	-5.5	-5.5		1445	
	Extraction Well DTLNAPL	ft	57.12		59.17		59.12	
	Extraction Well DTGW	ft	63.96		59.21		60.13	

( ) Indicates Well Pressure

LNAPL 6.84
HE 58.90

.04 HE 59.18

1.01 HE 59.38

7FORMS/TestForms/1210017B

OPERATING DATA - EVENT #1 C **PAGE # 1** **ACUVAC MOBILE DUAL PHASE SYSTEM**

Location: **Walstadd 66, Lovington, NM** **Project Managers: Sadler/Faucher**

		Date:	7/13/15				
	Parameters		Time 0845	Time 0915	Time 0945	Time 1015	Time 1045	Time 1115
	WELL # A-1		Hr Meter 7290.5	Hr Meter 7291.0	Hr Meter 7291.5	Hr Meter 7292.0	Hr Meter 7292.5	Hr Meter 7293.0
ENGINE/BLOWER	R.P.M.		2200	2200	2300	2300	2300	2300
	Oil Pressure	psi	50	50	50	50	50	50
	Water Temp	°F	150	150	150	150	155	160
	Volts		14	14	14	14	14	14
	Intake Vacuum	"Hg	16	16	16	16	16	16
	Gas Flow Fuel/Propane	cfh	0	0	50	50	50	50
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump	ON/OFF	ON	ON	ON	ON	ON	ON
	Extraction Well Flow	scfm	23.34	23.34	22.95	22.95	22.95	22.95
	Extraction Well Vacuum	"H_2O	60	60	70	70	70	70
	Pump Rate	gals/min	4.2	4.2	4.4	4.5	4.5	4.5
	Total Volume	gals	-	126	252	384	519	654
	Influent Vapor Temp.	°F	71	71	71	72	72	72
	Air Temperature	°F	74.3	77.8	84.3	86.7	88.5	89.4
	Barometric Pressure	"Hg	30.01	30.01	30.00	30.00	30.00	29.99
VAPOR /INFLUENT	HC	ppmv	-	-	64480	-	-	-
	CO_2	%	-	-	5.14	-	-	-
	CO	%	-	-	2.09	-	-	-
	O_2	%	-	-	7.1	-	-	-
	H_2S	ppm	-	-	0	-	-	-
MANIFOLD	LNAPL %	Vol / Gals	-/-	8/10.08	4/5.04	2/2.64	2/2.7	1.5/2.03
	Depth of GW Depression	ft	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5
	Extraction Well DTLNAPL	ft	0820 58.03	0830 57.76				
	Extraction Well DTGW	ft	63.55	63.87				

NOTES

AT 0830 MOBILIZED THE ACUVAC EQUIPMENT ON WELL A-1. SET IN-WELL PUMP AT 67 FT BTOC. INITIAL WELL VAC SET AT 60"H_2O RESULTING IN A WVF OF 23.34 SCFM. INITIAL GW PUMP RATE SET AS 4.2 GPM.

AT 0945 INCREASED WELL VAC TO 70"H_2O RESULTING IN A WVF OF 22.95 SCFM. GW PUMP RATE INCREASED TO 4.4 GPM AND INCREASED AGAIN AT 1015 HRS TO 4.5 GPM TO COMPENSATE FOR HIGHER VACUUM. TPH VAPORS REMAIN HIGH IN THE GASOLINE RANGE

( ) Indicates Well Pressure

LNAPL 5.52 6.11

HE 59.47 59.35

AvR

OPERATING DATA - EVENT #1C **PAGE #2** **ACUVAC MOBILE DUAL PHASE SYSTEM**

Location: **Walstadd 66, Lovington, NM** **Project Managers: Sadler/Faucher**

	Date:	7/13/15					
	Parameters	Time 11:45	Time 1215	Time 1245	Time 1315	Time 1345	Time 1445
	WELL # A-1	Hr Meter 7293.5	Hr Meter 7294.0	Hr Meter 7294.5	Hr Meter 7295.0	Hr Meter 7295.5	Hr Meter 7296.5
ENGINE/BLOWER	R.P.M.	2300	2300	2300	2300	2300	2300
	Oil Pressure psi	50	50	50	50	50	50
	Water Temp °F	160	160	165	165	165	165
	Volts	14	14	14	14	14	14
	Intake Vacuum "Hg	16	16	16	16	16	16
	Gas Flow Fuel/Propane cfh	50	50	50	50	50	50
ATMOSPHERE/VACUUM/AIR PUMP/VOLUME	GW Pump ON/OFF	ON	ON	ON	ON	ON	OFF
	Extraction Well Flow scfm	22.95	22.95	22.95	22.95	22.95	2295
	Extraction Well Vacuum "H_2O	70	70	70	70	70	70
	Pump Rate gals/min	4.5	4.5	4.5	4.4	4.4	3.5
	Total Volume gals	789	924	1059	1194	1326	1553
	Influent Vapor Temp. °F	71	71	71	71	71	71
	Air Temperature °F	91.3	95.1	97.6	99.2	99.5	99.8
	Barometric Pressure "Hg	29.98	29.97	29.96	29.94	29.92	2992
VAPOR /INFLUENT	HC ppmv	56,750	-	-	-	55850	-
	CO_2 %	5.74	-	-	-	5.96	-
	CO %	1.57	-	-	-	1.52	-
	O_2 %	7.0	-	-	-	7.2	-
	H_2S ppm	0	-	-	-	0	-
NOTES	WELL VAC AND WELL FLOW STEADY DURING PERIOD. TPH VAPORS MOSTLY STEADY DURING THE PERIOD. AT 1445 EVENT CONCLUDED. ALL WELL GAUGED. WELL W-1 AND W-2 WERE GAUGED TO DETERMINE THE EXTENT OF ANY REBOUND. ACUVAC EQUIPMENT AND SYSTEM DEMOBILIZED, SITE SECURED, DEPARTED SITE.						
MANIFOLD	LNAPL % Vol Gals	1.5/2.03	1.5/2.03	1.5/2.03	1.5/2.03	1.5/1.98	1.5/1.98
	Depth of GW Depression ft	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5
	Extraction Well DTLNAPL ft						59.98
	Extraction Well DTGW ft						60.01

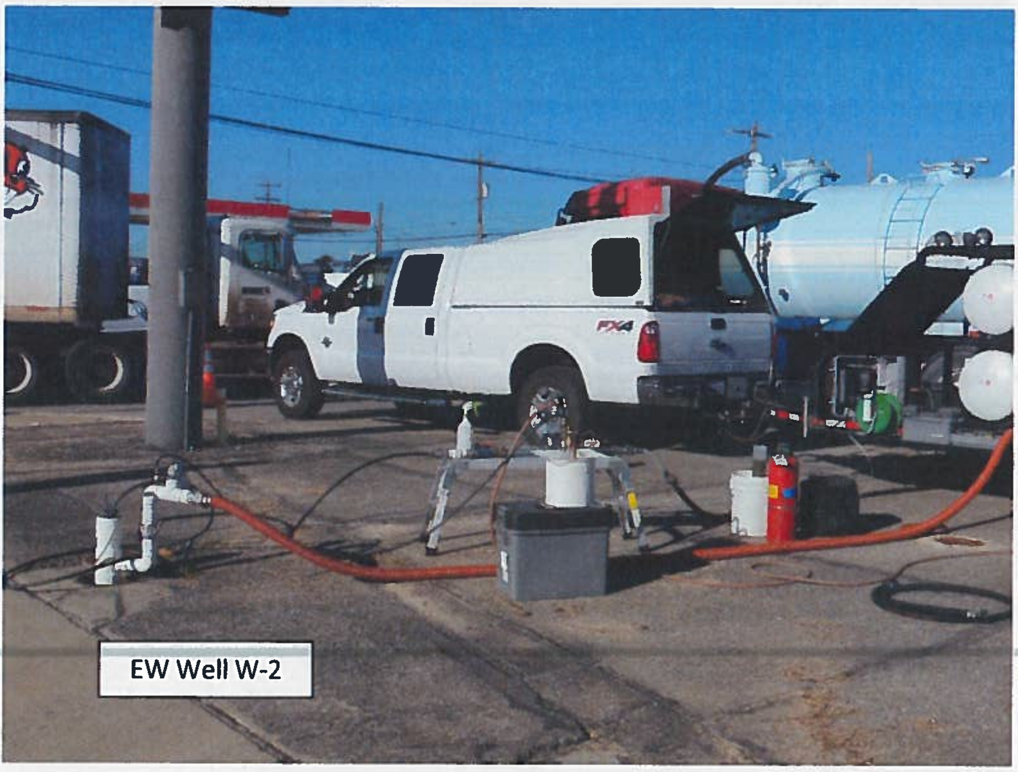
( ) Indicates Well Pressure

7FORMS/TestForms/1210017B

LNAPL .13

HE 59.91

WALSTADD 66
LOVINGTON, NM



WALSTADD 66
LOVINGTON, NM

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.

(2)

WATER RESOURCES ENGINEERING

Ralph A. Wurbs ▪ Wesley P. James

②

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Replacing the dependent variable with the nonrepeating independent variable μ gives

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

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

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

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

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

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

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

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

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

$$F{:}\quad 0 = c \qquad c = 0$$

$$T{:}\quad 0 = -a \qquad a = 0$$

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

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

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.

Appendix B

Laboratory Report

HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: clients.hallenvironmental.com

June 24, 2020

Jason Raucci
Daniel B. Stephens & Assoc.
6020 Academy NE Suite 100
Albuquerque, NM 87109
TEL: (505) 822-9400
FAX: (505) 822-8877

RE: Lovington 66 OrderNo.: 2006969

Dear Jason Raucci:

Hall Environmental Analysis Laboratory received 4 sample(s) on 6/17/2020 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. In order to properly interpret your results, it is imperative that you review this report in its entirety. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. When necessary, data qualifiers are provided on both the sample analysis report and the QC summary report, both sections should be reviewed. All samples are reported, as received, unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

ADHS Cert #AZ0682 -- NMED-DWB Cert #NM9425 -- NMED-Micro Cert #NM0901

Sincerely,

Andy

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Daniel B. Stephens & Assoc.
Project: Lovington 66
Lab ID: 2006969-001
Matrix: PRODUCT
Client Sample ID: W-1
Collection Date: 6/15/2020 1:25:00 PM
Received Date: 6/17/2020 12:00:00 PM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
DRO BY 8015D						Analyst:	**BRM**
Diesel Range Organics (DRO)	22	0.88		wt%	20	6/20/2020 9:01:44 PM	53191
Motor Oil Range Organics (MRO)	ND	4.4	D	wt%	20	6/20/2020 9:01:44 PM	53191
Surr: DNOP	0	70-130	S	%Rec	20	6/20/2020 9:01:44 PM	53191
GRO BY 8015D						Analyst:	**NSB**
Gasoline Range Organics (GRO)	100	2.5		wt%	1	6/20/2020 10:21:05 PM	53174
Surr: BFB	121	58.9-156		%Rec	1	6/20/2020 10:21:05 PM	53174

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Daniel B. Stephens & Assoc.
Project: Lovington 66
Lab ID: 2006969-002
Matrix: PRODUCT
Client Sample ID: W-3
Collection Date: 6/15/2020 2:20:00 PM
Received Date: 6/17/2020 12:00:00 PM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
DRO BY 8015D						Analyst:	**BRM**
Diesel Range Organics (DRO)	22	0.89		wt%	20	6/20/2020 9:25:57 PM	53191
Motor Oil Range Organics (MRO)	ND	4.4	D	wt%	20	6/20/2020 9:25:57 PM	53191
Surr: DNOP	0	70-130	S	%Rec	20	6/20/2020 9:25:57 PM	53191
GRO BY 8015D						Analyst:	**NSB**
Gasoline Range Organics (GRO)	85	2.5		wt%	1	6/20/2020 11:08:14 PM	53174
Surr: BFB	120	58.9-156		%Rec	1	6/20/2020 11:08:14 PM	53174

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

CLIENT: Daniel B. Stephens & Assoc. **Client Sample ID:** MPE-1
Project: Lovington 66 **Collection Date:** 6/15/2020 1:50:00 PM
Lab ID: 2006969-003 **Matrix:** PRODUCT **Received Date:** 6/17/2020 12:00:00 PM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
DRO BY 8015D							Analyst: **BRM**
Diesel Range Organics (DRO)	21	0.79		wt%	20	6/20/2020 9:50:17 PM	53191
Motor Oil Range Organics (MRO)	ND	3.9	D	wt%	20	6/20/2020 9:50:17 PM	53191
Surr: DNOP	0	70-130	S	%Rec	20	6/20/2020 9:50:17 PM	53191
GRO BY 8015D							Analyst: **NSB**
Gasoline Range Organics (GRO)	110	2.5		wt%	1	6/20/2020 11:55:06 PM	53174
Surr: BFB	127	58.9-156		%Rec	1	6/20/2020 11:55:06 PM	53174

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

CLIENT: Daniel B. Stephens & Assoc.
Project: Lovington 66
Lab ID: 2006969-004

Matrix: AQUEOUS

Client Sample ID: Field Blank
Collection Date: 6/16/2020 9:10:00 AM
Received Date: 6/17/2020 12:00:00 PM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: GASOLINE RANGE							Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	6/22/2020 1:29:27 PM	G69815
Surr: BFB	82.9	67.5-110		%Rec	1	6/22/2020 1:29:27 PM	G69815

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.
D	Sample Diluted Due to Matrix
H	Holding times for preparation or analysis exceeded
ND	Not Detected at the Reporting Limit
PQL	Practical Quanitative Limit
S	% Recovery outside of range due to dilution or matrix
B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
P	Sample pH Not In Range
RL	Reporting Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **2006969**

24-Jun-20

Client: Daniel B. Stephens & Assoc.

Project: Lovington 66

Sample ID:	**LCS-53191**	SampType:	**LCS**	TestCode:	**DRO by 8015D**		
Client ID:	**LCSW**	Batch ID:	**53191**	RunNo:	**69775**		
Prep Date:	**6/20/2020**	Analysis Date:	**6/20/2020**	SeqNo:	**2422483**	Units:	**wt%**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	0.50	0.10	0.5000	0	99.8	70	130			
Surr: DNOP	0.051		0.05000		103	70	130			

Sample ID:	**LCSD-53191**	SampType:	**LCSD**	TestCode:	**DRO by 8015D**		
Client ID:	**LCSS02**	Batch ID:	**53191**	RunNo:	**69775**		
Prep Date:	**6/20/2020**	Analysis Date:	**6/20/2020**	SeqNo:	**2422484**	Units:	**wt%**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	0.51	0.10	0.5000	0	101	70	130	1.55	20	
Surr: DNOP	0.052		0.05000		104	70	130	0	0	

Sample ID:	**MB-53191**	SampType:	**MBLK**	TestCode:	**DRO by 8015D**		
Client ID:	**PBW**	Batch ID:	**53191**	RunNo:	**69775**		
Prep Date:	**6/20/2020**	Analysis Date:	**6/20/2020**	SeqNo:	**2422485**	Units:	**wt%**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.10								
Motor Oil Range Organics (MRO)	ND	0.50								
Surr: DNOP	0.10		0.1000		103	70	130			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

QC SUMMARY REPORT

WO#: **2006969**

Hall Environmental Analysis Laboratory, Inc.

24-Jun-20

Client: Daniel B. Stephens & Assoc.

Project: Lovington 66

Sample ID: **mb-53174** SampType: **MBLK** TestCode: **GRO by 8015D**

Client ID: **PBW** Batch ID: **53174** RunNo: **69786**

Prep Date: **6/19/2020** Analysis Date: **6/20/2020** SeqNo: **2422999** Units: **wt%**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	2.5								
Surr: BFB	810		1000		80.7	58.9	156			

Sample ID: **lcs-53174** SampType: **LCS** TestCode: **GRO by 8015D**

Client ID: **LCSW** Batch ID: **53174** RunNo: **69786**

Prep Date: **6/19/2020** Analysis Date: **6/20/2020** SeqNo: **2423000** Units: **wt%**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	22	2.5	25.00	0	89.6	75.2	120			
Surr: BFB	940		1000		93.6	58.9	156			

Sample ID: **lcsd-53174** SampType: **LCSD** TestCode: **GRO by 8015D**

Client ID: **LCSS02** Batch ID: **53174** RunNo: **69786**

Prep Date: **6/19/2020** Analysis Date: **6/20/2020** SeqNo: **2423001** Units: **wt%**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	22	2.5	25.00	0	88.5	75.2	120	1.26	20	
Surr: BFB	940		1000		94.0	58.9	156	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

Sample ID: **mb1**	SampType: **MBLK**			TestCode: **EPA Method 8015D: Gasoline Range**						
Client ID: **PBW**	Batch ID: **G69815**			RunNo: **69815**						
Prep Date:	Analysis Date: **6/22/2020**			SeqNo: **2424124**	Units: **mg/L**					
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	16		20.00		79.3	67.5	110			

Sample ID: **2.5ug gro lcs**	SampType: **LCS**			TestCode: **EPA Method 8015D: Gasoline Range**						
Client ID: **LCSW**	Batch ID: **G69815**			RunNo: **69815**						
Prep Date:	Analysis Date: **6/22/2020**			SeqNo: **2424125**	Units: **mg/L**					
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	0.40	0.050	0.5000	0	80.9	70.8	121			
Surr: BFB	18		20.00		91.3	67.5	110			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

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HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: **Daniel B. Stephens & Assoc.**

Work Order Number: **2006969**

RcptNo: **1**

Received By: **Isaiah Ortiz** **6/17/2020 12:00:00 PM** I-Ox

Completed By: **Emily Mocho** **6/18/2020 11:35:41 AM**

Reviewed By: SPA 6.18.20

Chain of Custody

1. Is Chain of Custody complete?	Yes ☑	No ☐	Not Present ☐
2. How was the sample delivered?	UPS		

Log In

3. Was an attempt made to cool the samples?	Yes ☑	No ☐	NA ☐
4. Were all samples received at a temperature of >0° C to 6.0°C	Yes ☑	No ☐	NA ☐
5. Sample(s) in proper container(s)?	Yes ☑	No ☐	
6. Sufficient sample volume for indicated test(s)?	Yes ☑	No ☐	
7. Are samples (except VOA and ONG) properly preserved?	Yes ☑	No ☐	
8. Was preservative added to bottles?	Yes ☐	No ☑	NA ☐
9. Received at least 1 vial with headspace <1/4" for AQ VOA?	Yes ☑	No ☐	NA ☐
10. Were any sample containers received broken?	Yes ☐	No ☑	
11. Does paperwork match bottle labels? (Note discrepancies on chain of custody)	Yes ☑	No ☐	
12. Are matrices correctly identified on Chain of Custody?	Yes ☑	No ☐	
13. Is it clear what analyses were requested?	Yes ☑	No ☐	
14. Were all holding times able to be met? (If no, notify customer for authorization.)	Yes ☑	No ☐	

# of preserved bottles checked for pH:
(<2 or >12 unless noted)
Adjusted?
Checked by: My 06/18/20

Special Handling (if applicable)

15. Was client notified of all discrepancies with this order?	Yes ☐	No ☐	NA ☑

Person Notified:
Date:
By Whom:
Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding:
Client Instructions:

16. Additional remarks:

17. **Cooler Information**

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	5.0	Good	Not Present			

Chain-of-Custody Record

Client: Daniel B. Stephens & Associates, Inc.
ATTN: Jason Raucci, P.G.
Mailing Address: 6020 Academy NE, Suite 100
Albuquerque, NM 87109
Phone #: 505. 822. 9400
email or Fax#: jraucci@geo-logic.com
QA/QC Package:
☒ Standard ☐ Level 4 (Full Validation)
Accreditation: ☐ Az Compliance
☐ NELAC ☐ Other
☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush
Project Name: DBS&A Lovington 66
Project #: DB. 19. 1935 NAPL Sampling
Project Manager: Jason Raucci, P.G.
Sampler: CmBarnhill, PG
On Ice: ☒ Yes ☐ No
# of Coolers: 1
Cooler Temp(including CF): 5.0-0 cf= 5.0 (°C)

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Name	Container Type and #	Preservative Type	HEAL No. 2006969	BTEX / MTBE / TMB's (8021)	TPH:8015D([✓ GRO] / [✓ DRO] / MRO)	8081 Pesticides/8082 PCB's	EDB (Method 504.1)	PAHs by 8310 or 8270SIMS	RCRA 8 Metals	Cl, F, Br, NO_3, NO_2, PO_4, SO_4	8260 (VOA)	8270 (Semi-VOA)	Total Coliform (Present/Absent)
05/15/2020	13:25	H2O	W-1	3x40mL VOAs 1x1Liter AG	HgCl2 None	-001		X								
05/15/2020	14:20	H2O	W-3	↓	↓	-002		X								
05/15/2020	13:30	H2O	MPE-1	↓	↓	-003		X								
05/16/2020	0910	H2O	Field Blank	2x40mL VOAs	HgCl2	-004										

Samples were collected in June per Jason Raucci 6/17/20 LB

Date:	Time:	Relinquished by:	Received by:	Via:	Date	Time
05/16/2020	0930	PG	J.O	UPS	6/17/20	1200
Date:	Time:	Relinquished by:	Received by:	Via:	Date	Time

Remarks: Any Questions? Please Call Jason Raucci, Project Manager @ 505. 353. 9068

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

Appendix C

Engineering Drawings

VICINITY MAP
NTS

SITE MAP
NTS

STATE LEAD REMEDIATION
LOVINGTON 66

LOVINGTON, NEW MEXICO

PREPARED FOR NEW MEXICO ENVIRONMENT DEPARTMENT
PETROLEUM STORAGE TANK BUREAU

INDEX OF DRAWINGS

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4	C-1	REMEDIATION SYSTEM SITE PLAN	0
5	C-2	CIVIL DETAILS	0
		MECHANICAL	
6	M-1	PROCESS AND INSTRUMENTATION DIAGRAM	0
7	M-2	MECHANICAL SITE PLAN	0
8	M-3	MECHANICAL DETAILS	0

S:\PROJECTS\DB19.1395_LOVINGTON_66\CAD\PRODUCTION\G-0 TITLE SHEET 1.DWG August 21, 2020 - 2:14 PM BY: CHRISTOPHER KING

REV. NO.	DATE	DESCRIPTION	APPROVED BY

DATE OF ISSUE: AUGUST 28, 2020
DESIGNED BY: T. GOLDEN
DRAWN BY: JA/RT/CK
CHECKED BY: C. STEARNES
APPROVED BY: T. GOLDEN

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8/28/2020

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STATE LEAD REMEDIATION
LOVINGTON 66
LOVINGTON, NEW MEXICO

COVER SHEET AND INDEX

SHT. 1 OF 8
DWG NO. G-0

JOB NO.
DB19.1395.00

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 PLANS, 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 DAMAGE 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 PERFORMED MAY 2020 BY ATKINS ENGINEERING ASSOCIATES, INC. (AEA) USING DRONE TECHNOLOGY. ANY DISCREPANCIES BETWEEN THE ENGINEER'S DESIGN AND SITE SURFACE CONDITIONS SHALL BE BROUGHT TO THE ENGINEER'S ATTENTION IMMEDIATELY.

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 LEA 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 CITY OF LOVINGTON, 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 LEA 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 UNDERGROUND 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

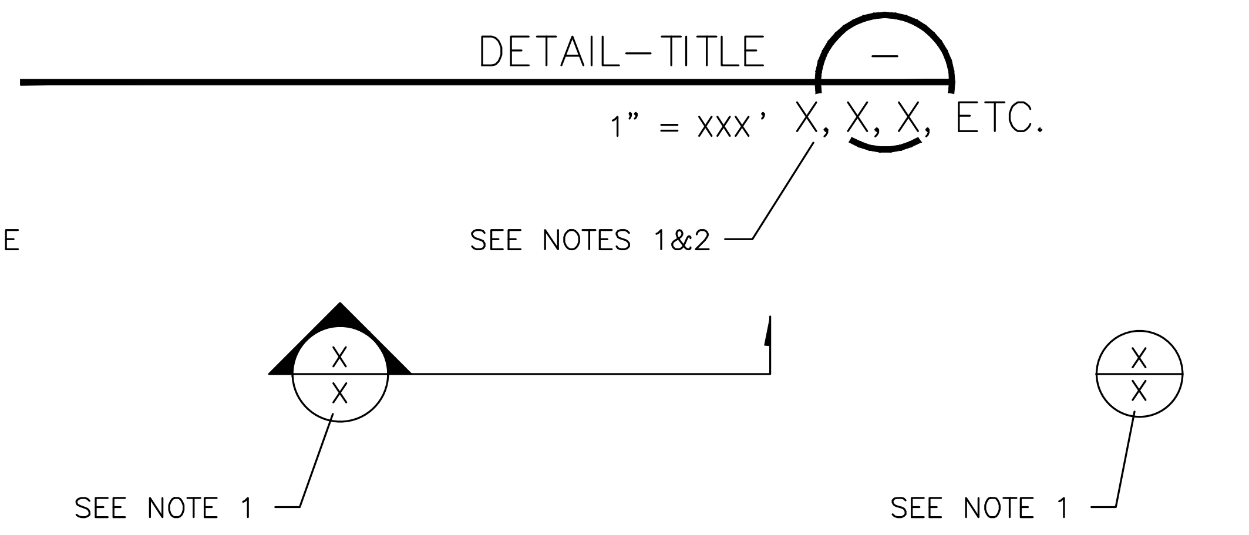
AG. THE CONTRACTOR SHALL PROVIDE ALL REQUIRED TRAFFIC CONTROL PLANS AND TRAFFIC CONTROL EQUIPMENT. ALL SIGNS, BARRICADES, CHANNELIZATION DEVICES, SIGN FRAMES AND ERECTION OF SUCH DEVICES SHALL CONFORM TO THE REQUIREMENTS OF "MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES FOR STREETS AND HIGHWAYS" LATEST EDITION. 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.

——— – ———	CENTERLINE
—— 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
△	SURVEY MONUMENT (PREVIOUS PROJECT)
▨	EXISTING STRUCTURE
3910	DEPRESSION CONTOUR
– –3910– – –	EXISTING CONTOUR LINE AND ELEVATION DESIGNATION
– –3909– – –	
× 3910	SPOT ELEVATION (FT MSL)
▣	EXISTING STORM DRAIN MANHOLE
E	EXISTING ELECTRICAL BOX
◑	EXISTING LIGHT POLE
○	EXISTING POWER POLE
Ⓢ	EXISTING SEWER MANHOLE
▯	EXISTING COMMUNICATION MANHOLE
○ T/P	EXISTING TELEPHONE POLE
⊠	EXISTING TRAFFIC SIGNAL
?	EXISTING UNKNOWN OBJECT
●	EXISTING HYDRANT
⋈	EXISTING WATER VALVE
⊢	EXISTING GUY WIRE
○ S	EXISTING SIGN
◕	EXISTING MONITOR WELL
⊗	EXISTING MONITOR WELL–DESTROYED OR INACCESSIBLE
◉	EXISTING MONITOR WELL–PLUGGED OR ABANDONED
━━━━━	PROPOSED HORIZONTAL WELL
━ ━━ ━	SCREEN SECTION OF HORIZONTAL WELL
——○——○—	PROPOSED CHAIN LINK FENCE
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:

AI	AIR INJECTION
ARV	AIR RELIEF VALVE
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
BMP	BEST MANAGEMENT PRACTICE
CMP	CORRUGATED METAL PIPE
CMU	CONCRETE MASONRY UNIT
CS	CARBON STEEL
DI	DUCTILE IRON
DIA	DIAMETER
EOP	EDGE OF PAVEMENT
EXIST	EXISTING
FH	FLUSH HYDRANT
FT	FEET
FT MSL	FEET ABOVE MEAN SEA LEVEL
H	HEIGHT
HDPE	HIGH DENSITY POLYETHYLENE
HOR	HORIZONTAL
INV	INVERT ELEVATION
LB	POUND
LF	LINEAR FEET
MDWCA	MUTUAL DOMESTIC WATER CONSUMER ASSOCIATION
MIN	MINIMUM
MSL	MEAN SEA LEVEL
N/A	NOT APPLICABLE
NMDOT	NEW MEXICO DEPARTMENT OF TRANSPORTATION
NMED	NEW MEXICO ENVIRONMENT DEPARTMENT
NTS	NOT TO SCALE
OC	ON CENTER
P/L	PROPERTY LINE
POT	POTABLE WATER
PSI	POUNDS PER SQUARE INCH
PVC	POLY VINYL CHLORIDE
RED	REDUCER
ROW	RIGHT OF WAY
SCH	SCHEDULE
STA	STATION
STD	STANDARD
SVE	SOIL VAPOR EXTRACTION
TBD	TO BE DETERMINED
THR	THREADED
VERT	VERTICAL
W	WIDTH
W/	WITH
WL	WATER LINE

REV. NO.	DATE	DESCRIPTION	APPROVED BY

DATE OF ISSUE: AUGUST 28, 2020
DESIGNED BY: T. GOLDEN
DRAWN BY: JA/RT/CK
CHECKED BY: C. STEARNES
APPROVED BY: T. GOLDEN

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8/28/2020

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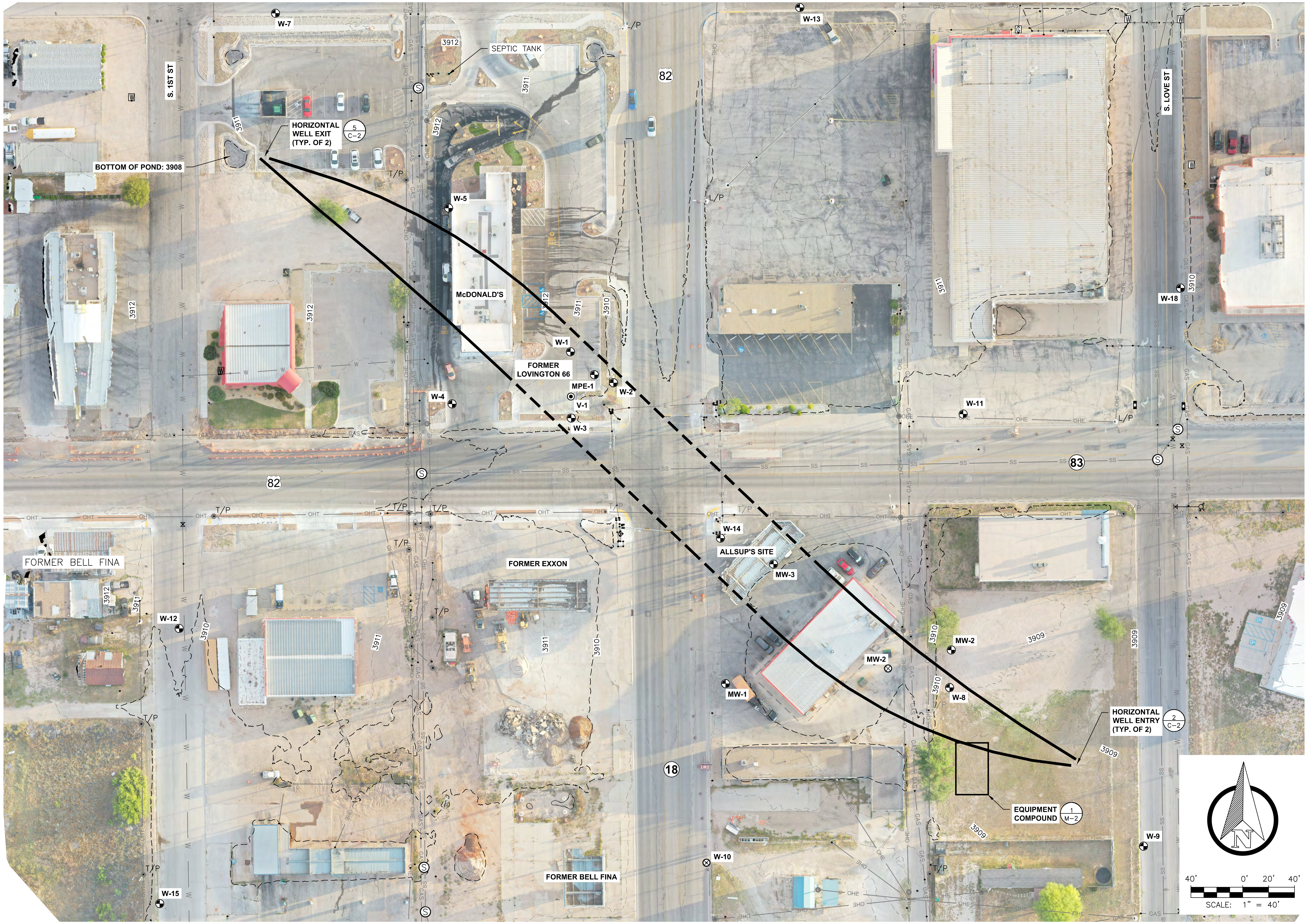
STATE LEAD REMEDIATION
LOVINGTON 66
LOVINGTON, NEW MEXICO

GENERAL NOTES AND LEGEND

SHT. 2 OF 8
DWG NO. G-1

JOB NO.
DB19.1395.00



GENERAL NOTES:

1. DESIGN SURVEY AND AERIAL PHOTOGRAPHY PROVIDED BY AEA.
2. HORIZONTAL WELL RUN-IN AND RUN-OUT SHOWN AT SLOPE OF 5:1 (H:V). SLOPE MAY BE ADJUSTED IN THE FIELD DEPENDING ON DRILLING CONDITIONS.

LEGEND:

⊕	MONITOR WELL
⊗	MONITOR WELL–DESTROYED OR INACCESSIBLE
⊙	MONITOR WELL–PLUGGED OR ABANDONED
———	PROPOSED HORIZONTAL WELL
— — —	SCREEN SECTION OF HORIZONTAL WELL

REFERENCE: AERIAL PHOTO AND TOPOGRAPHY BASED ON MAY, 2020 AERIAL DRONE SURVEY PERFORMED BY AEA

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PROFESSIONAL ENGINEER

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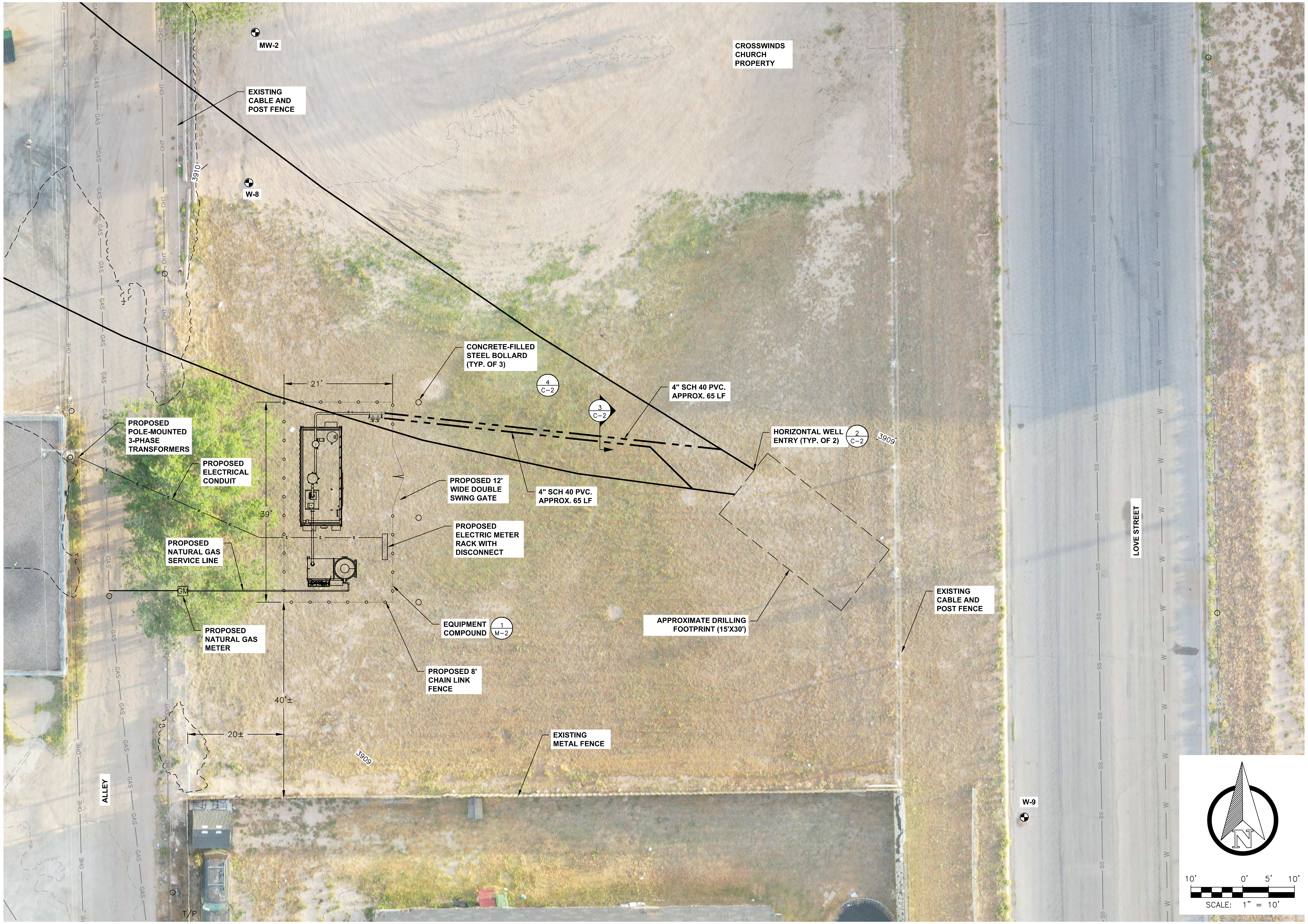
STATE LEAD REMEDIATION
LOVINGTON 66
LOVINGTON, NEW MEXICO

GENERAL SITE PLAN

SHT. 3 OF 8
DWG NO. G-2

JOB NO.
DB19.1395.00

S:\PROJECTS\DB19.1395_LOVINGTON_66\CAD\PRODUCTION\SITE PLAN.DWG August 27, 2020 - 2:14 PM BY: CHRISTOPHER KING



GENERAL NOTES:

1. HORIZONTAL EXTRACTION WELL CONVEYANCE PIPING FROM WELL TO EQUIPMENT COMPOUND 4" SCH 40 PVC.
2. CONTRACTOR RESPONSIBLE FOR MAINTAINING THE INTEGRITY OF PIPE CIRCUITS FROM THE WELL HEAD TO THE EQUIPMENT COMPOUND.
3. EXTRACTION WELL CONVEYANCE PIPING SLOPED TOWARD THE WELL HEAD AT A MINIMUM SLOPE OF 1% TO ENCOURAGE ANY CONDENSATE GENERATED IN THE CONVEYANCE LINE TO DRAIN TOWARD THE WELL.
4. USE LONG RADIUS ELBOWS AS NEEDED FOR ANY CHANGES IN BURIED PIPE DIRECTION.
5. EQUIPMENT TO BE SURROUNDED BY 8-FOOT TALL CHAIN LINK FENCE WITH A 12-FOOT WIDE DOUBLE-SWING GATE.
6. EQUIPMENT TO BE PLACED ON LEVEL COMPACTED PAD MADE FROM BASE COURSE, CALICHE, OR OTHER SIMILAR MATERIAL APPROVED BY THE ENGINEER.

LEGEND:

◓	MONITOR WELL
▬▬▬	PROPOSED HORIZONTAL WELL
━ ━ ━	SCREEN SECTION OF HORIZONTAL WELL
── E ──	PROPOSED ELECTRICAL LINE
── - - ──	SVE CONVEYANCE LINE

S:\PROJECTS\DB19.1395_LOVINGTON_66\CAD\PRODUCTION\C-1 REMEDIATION SITE PLAN.DWG August 21, 2020 - 2:14 PM BY: CHRISTOPHER KING

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8/28/2020

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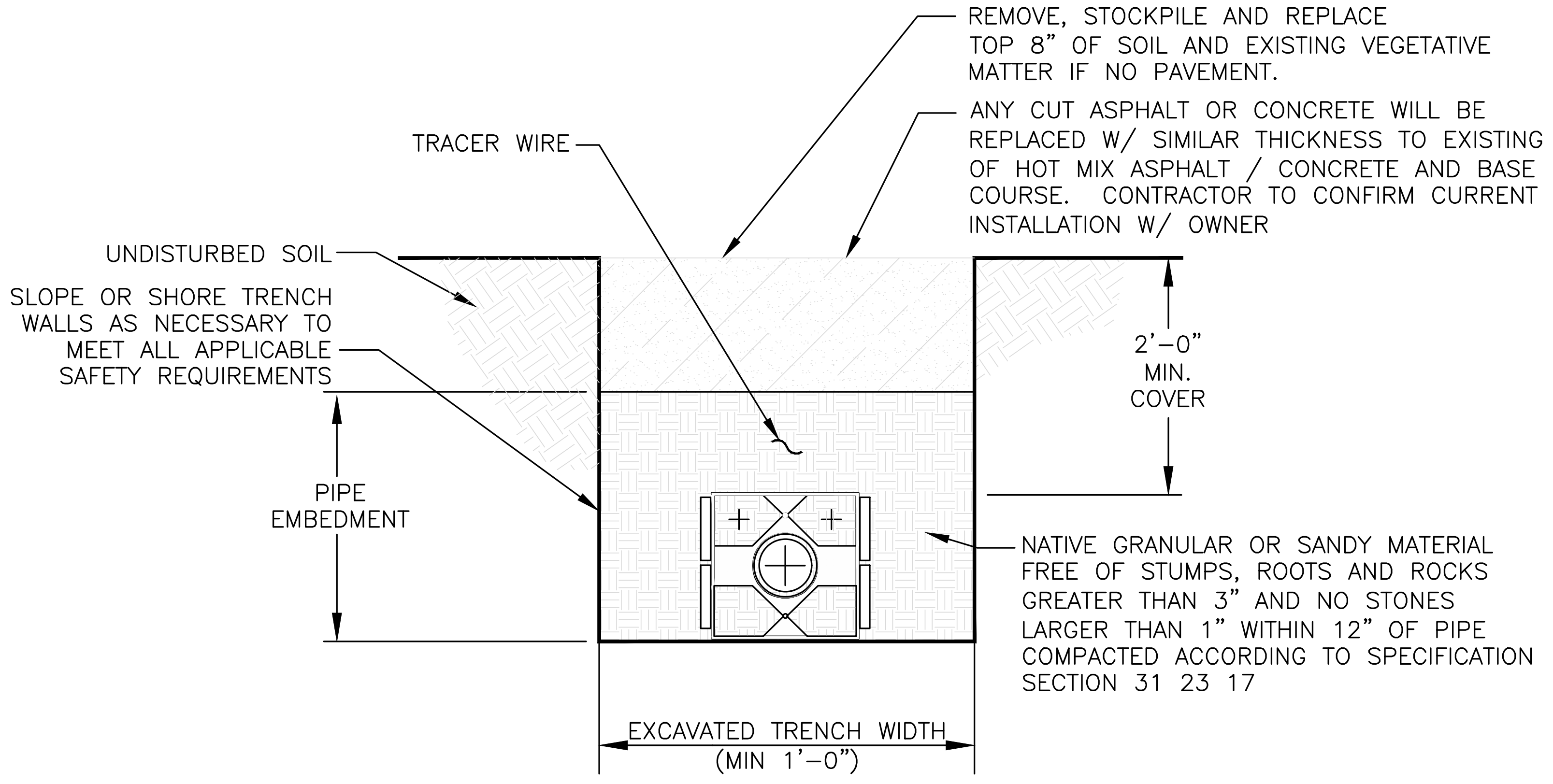
STATE LEAD REMEDIATION
LOVINGTON 66
LOVINGTON, NEW MEXICO

REMEDIATION SYSTEM SITE PLAN

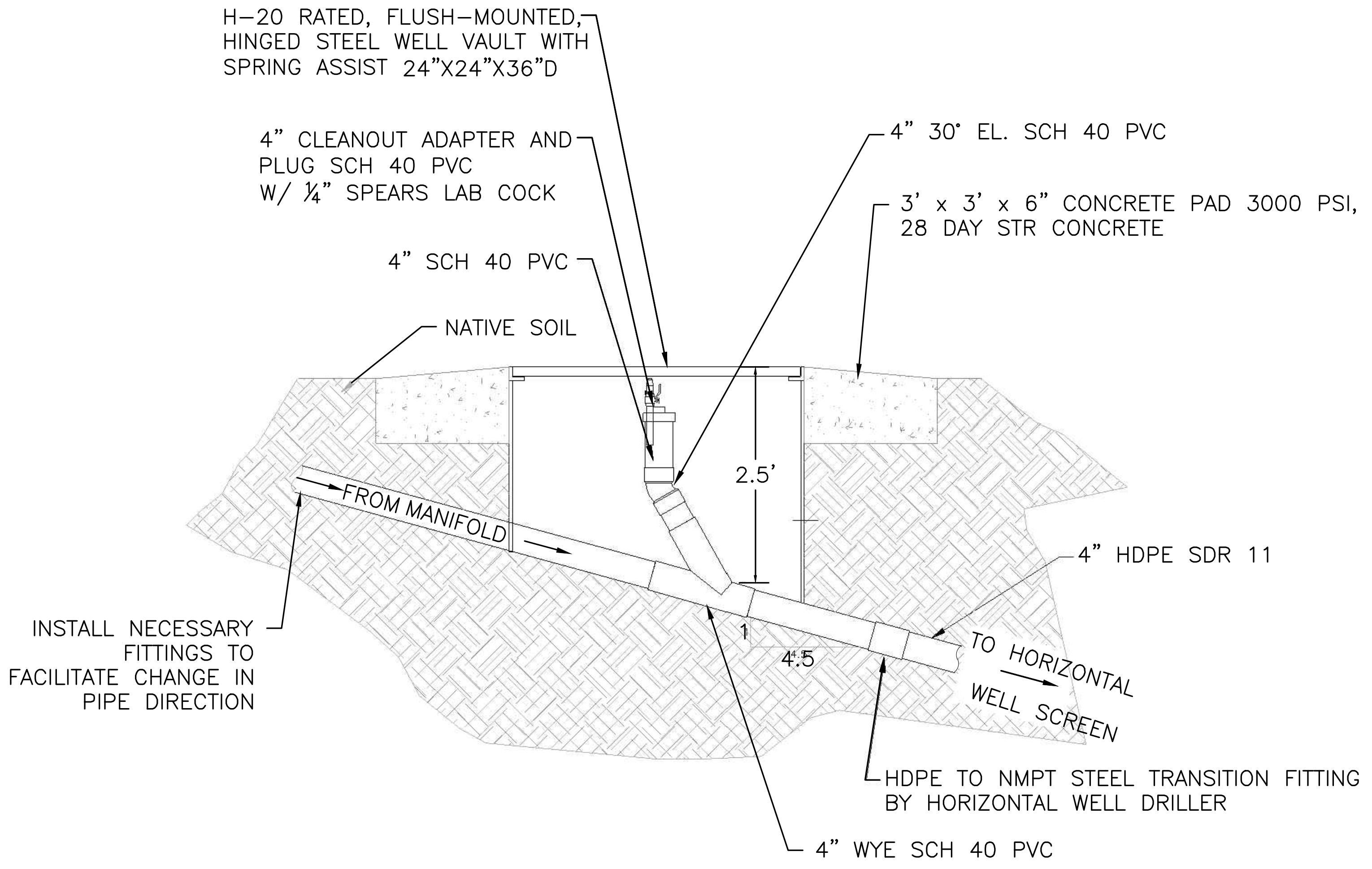
SHT. 4 OF 8
DWG NO. C-1

JOB NO.
DB19.1395.00



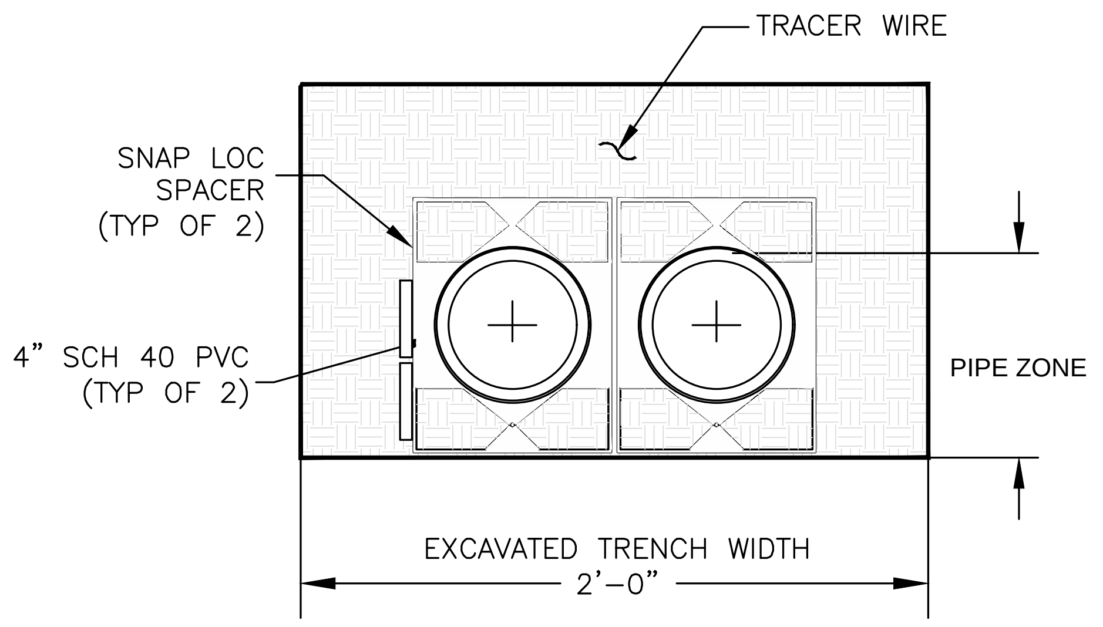
TYPICALCONVEYANCE PIPING TRENCH SECTION 1 / -

NTS



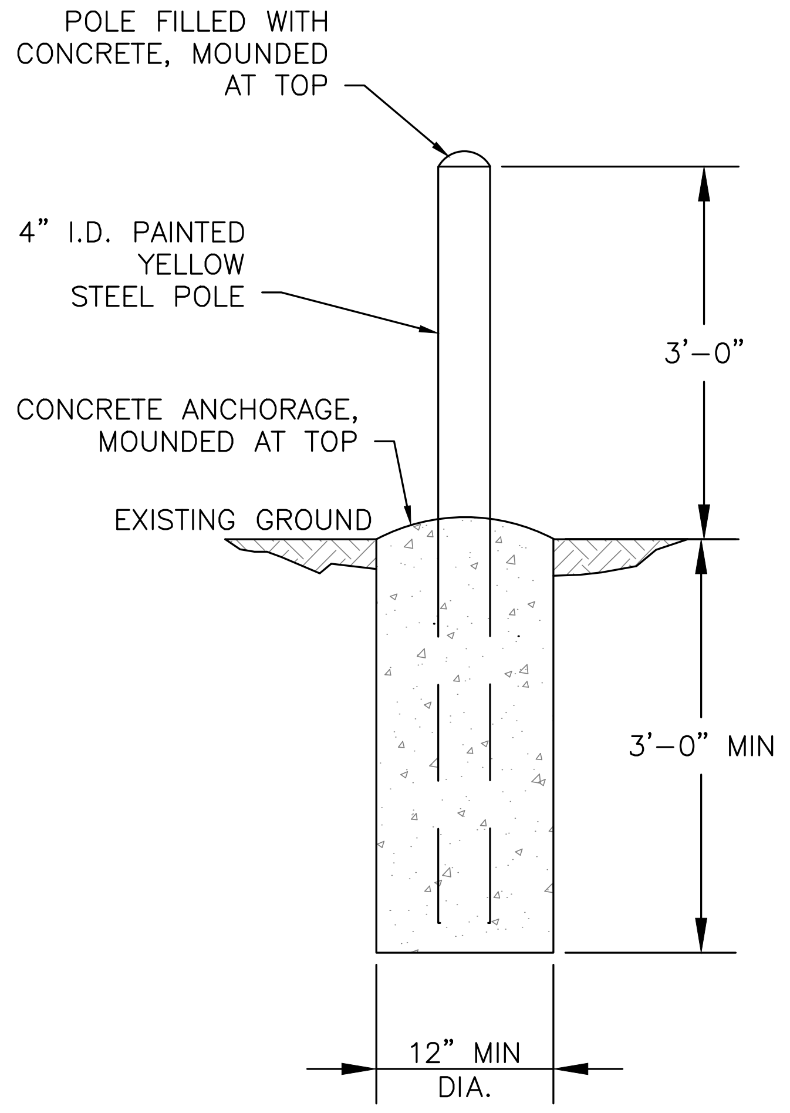
HORIZONTAL WELL ENTRY DETAILS 2 / C-1

NTS



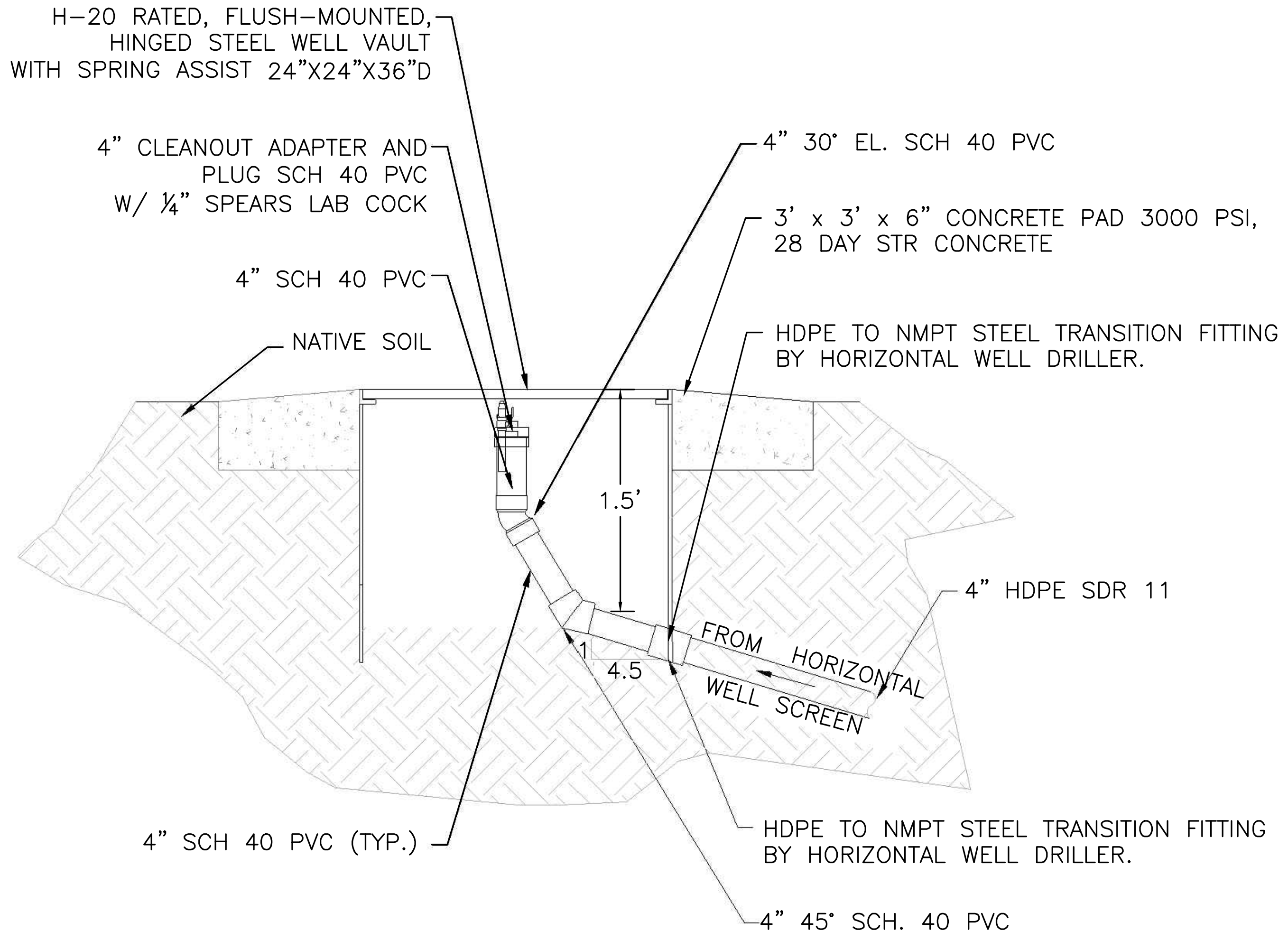
CONVEYANCE PIPING CONFIGURATION 3 / -

NTS



TYPICAL BOLLARD DETAIL 4 / -

NTS



HORIZONTAL WELL EXIT DETAILS 5 / -

NTS

GENERAL NOTES:

1. EXTRACTION WELL CONVEYANCE PIPING SCH 40 PVC.

TRENCH GENERAL NOTES:

A. FOR ALL TRENCH BACKFILL AND SAFETY REQUIREMENTS, SEE SPECIFICATION SECTION 31 23 17.
B. TRENCH WIDTH MAY VARY DUE TO NUMBER OF PIPES IN THE TRENCH.
C. PVC PIPE PER SPECIFICATION SECTION 22 05 03.02. STEEL PIPE PER SPECIFICATION SECTION 22 05 03.03.
D. PIPES SUPPORTED EVERY 10' LENGTH WITH CHAIRS.
E. SECURE PIPES TO PIPE SUPPORT EVERY 20' LENGTH WITH TIE WIRE.

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DATE OF ISSUE: AUGUST 28, 2020
DESIGNED BY: T. GOLDEN
DRAWN BY: JA/RT/CK
CHECKED BY: C. STEARNES
APPROVED BY: T. GOLDEN

DBS&A
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Albuquerque, NM 87109-3315

THOMAS A. GOLDEN
22750
8/28/2020

424 SOUTH MAIN STREET
LOVINGTON, NM 88260

STATE LEAD REMEDIATION
LOVINGTON 66
LOVINGTON, NEW MEXICO

CIVIL DETAILS

SHT. 5 OF 8
DWG NO. C-2

JOB NO.
DB19.1395.00

S:\PROJECTS\DB19.1395_LOVINGTON_66\CAD\PRODUCTION\C-2 CIVIL DETAILS.DWG August 21, 2020 - 2:14 PM BY: CHRISTOPHER KING

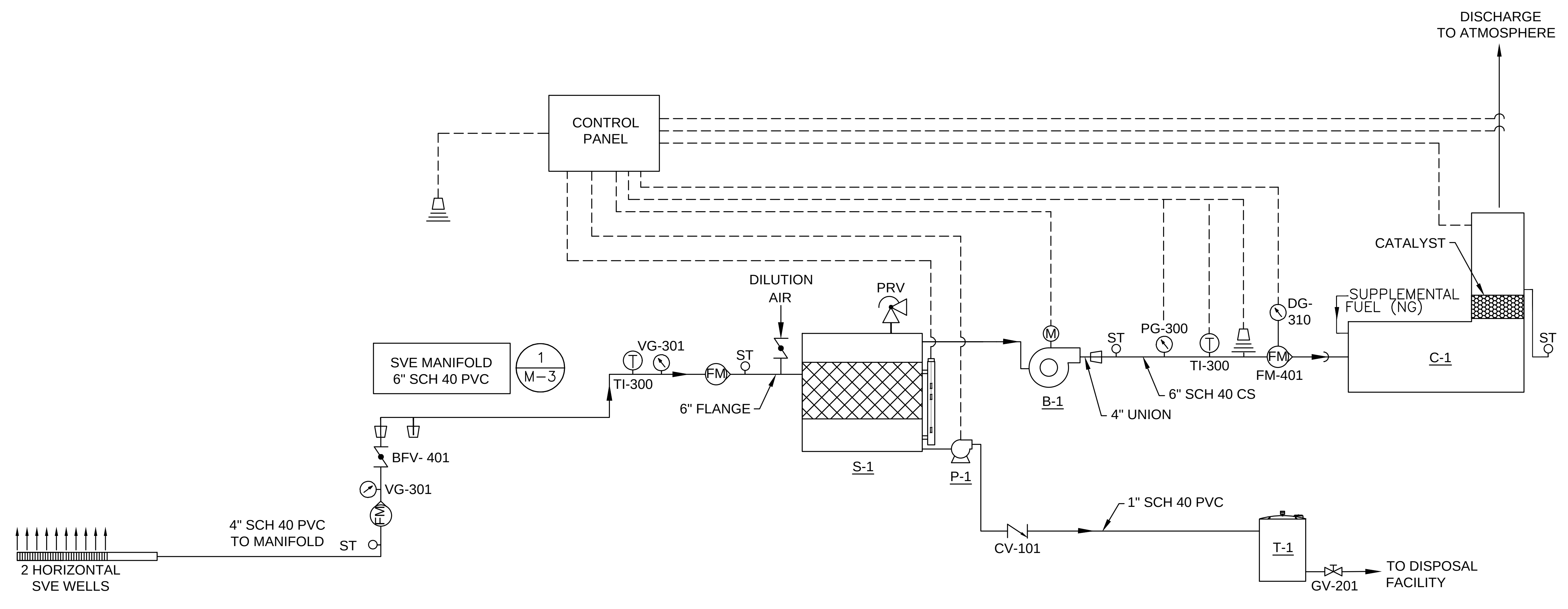
B-1
SVE BLOWER
PROVIDED BY INTELLISHARE
SUTORBILT LEGEND 7M
POSITIVE DISPLACEMENT BLOWER
550 SCFM @ 100" H2O VACUUM
SEALED BEARINGS, VARIABLE
FREQUENCY DRIVE
40 HP 480 VAC/3 PH/60 HZ

C-1
THERMAL OXIDIZER
PROVIDED BY NMED
500 SCFM
1400-1600 DEGREES F
MAX 50% LEL
OPTIONAL CATALYST

P-1
CONDENSATE TRANSFER PUMP
PROVIDED BY INTELLISHARE
GOULDS MODEL NPE
10 GPM, 80 TDH
1/2 HP 230 VAC/3 PH/60 HZ
4¾" IMPELLER DIAMETER

S-1
VAPOR/LIQUID SEPARATOR
PROVIDED BY INTELLISHARE
200 GALLON NOMINAL,
75 GALLON LIQUID HOLDING
CAPACITY

T-1
CONDENSATE STORAGE TANK
200 GALLON POLYETHYLENE
PROVIDED BY INTELLISHARE
30" DIA, 70" HIGH



PROCESS AND INSTRUMENTATION DIAGRAM 2
NTS -

ABBREVIATION KEY

BFV	BUTTERFLY VALVE
CS	CARBON STEEL
CV	CHECK VALVE
DG	DIFFERENTIAL PRESSURE GAUGE
DIA	DIAMETER
F	FARENHEIT
FM	FLOW METER
GV	GATE VALVE
M	MOTOR
NG	NATURAL GAS
PG	PRESSURE GAUGE
PRV	PRESSURE RELIEF VALVE
PVC	POLYVINYL CHLORIDE
SCH	SCHEDULE
SVE	SOIL VAPOR EXTRACTION
ST	SAMPLE TAP
TI	TEMPERATURE INDICATOR
VG	VACUUM GAUGE

SYMBOL LEGEND

⋈	BUTTERFLY VALVE
⋊	CHECK VALVE
—	ELECTRICAL
FM	FLOW METER
⋈	GATE VALVE
⏏	LEL SENSOR
Ⓜ	MOTOR
⚠	PRESSURE RELIEF VALVE
⊘	PRESSURE/VACUUM GAUGE
⏢	REDUCING FITTING
⚲	SAMPLE TAP
►	SYSTEM FLOW DIRECTION
Ⓣ	TEMPERATURE GAUGE

GENERAL NOTES:

1. VALVE AND GAUGE IDENTIFIER REFERS TO SCHEDULE IN ASSOCIATED TECHNICAL SPECIFICATION.
2. GREY SHADING INDICATES EQUIPMENT PROVIDED BY VENDOR AS INDICATED IN THE EQUIPMENT SCHEDULE.
3. CONTRACTOR TO INSTALL AND MAKE ALL CONNECTIONS FOR A FULLY FUNCTIONING SYSTEM.
4. CATALYST MODULE THAT WAS PURCHASED ORIGINALLY WITH THE PROPOSED THERMAL OXIDIZER MAY NEED TO BE TESTED AND/OR REPLACED PRIOR TO USE.

S:\PROJECTS\DB19.1395_LOVINGTON_66\CAD\PRODUCTION\M-1 PID.DWG August 21, 2020 - 2:14 PM BY: CHRISTOPHER KING

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LOVINGTON, NEW MEXICO

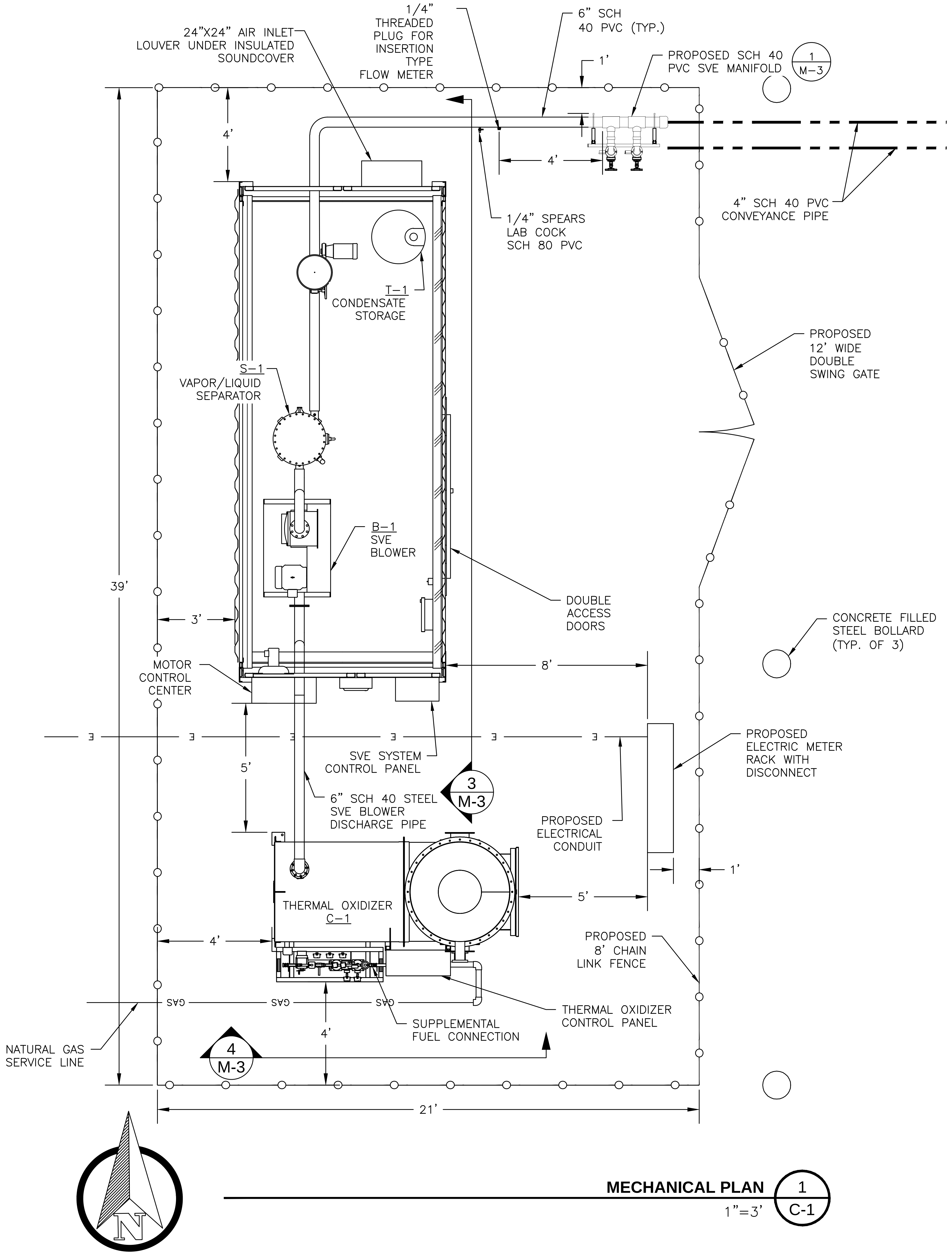
PROCESS AND INSTRUMENTATION DIAGRAM

SHT. 6 OF 8
DWG NO. M-1

JOB NO.
DB19.1395.00

GENERAL NOTES:

1. CONTRACTOR TO REMOVE AND RECYCLE HEAT EXCHANGER MODULE IN THERMAL OXIDIZER STACK.
2. DETAILED EQUIPMENT LAYOUT INSIDE MODIFIED SHIPPING CONTAINER WILL BE SHOWN ON INTELLISHARE AS-BUILT DRAWINGS.



MECHANICAL PLAN 1 C-1
1"=3'

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8 28 2020

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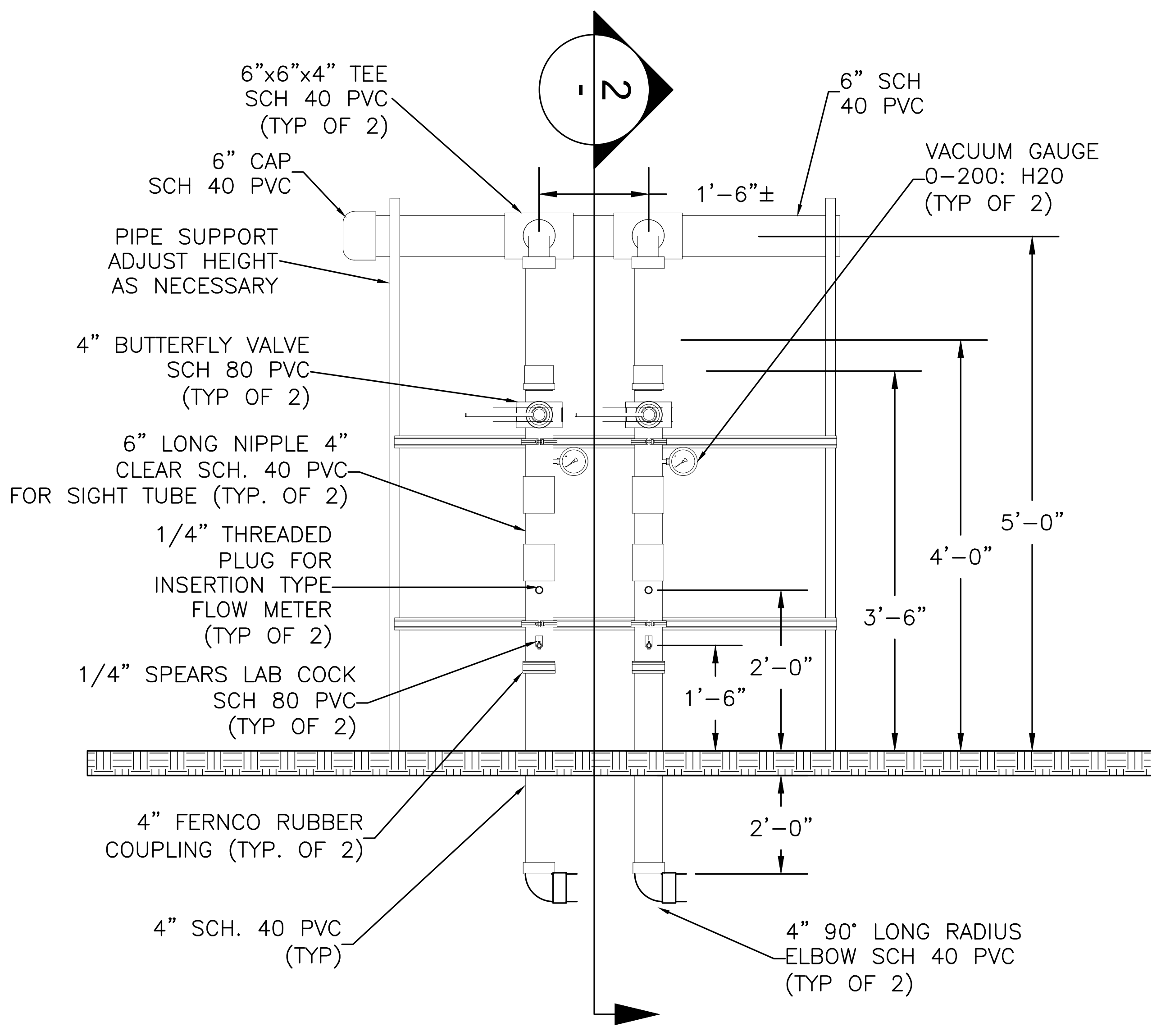
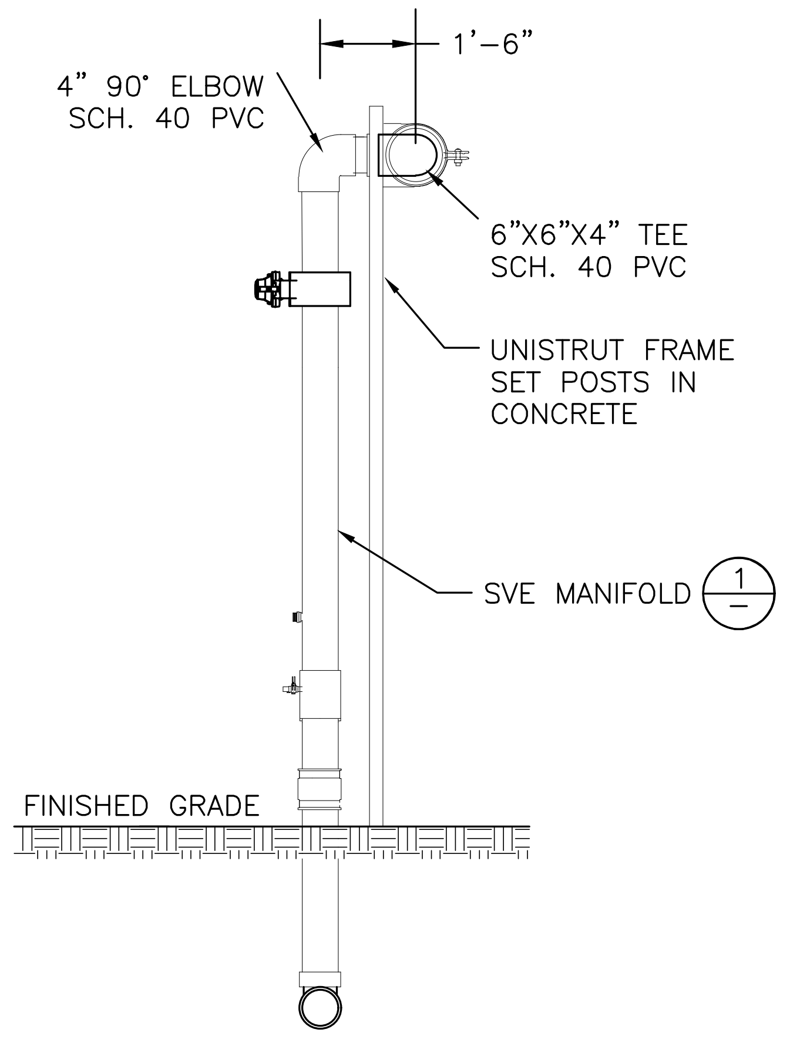
MECHANICAL SITE PLAN

SHT. 7 OF 8
DWG NO. M-2

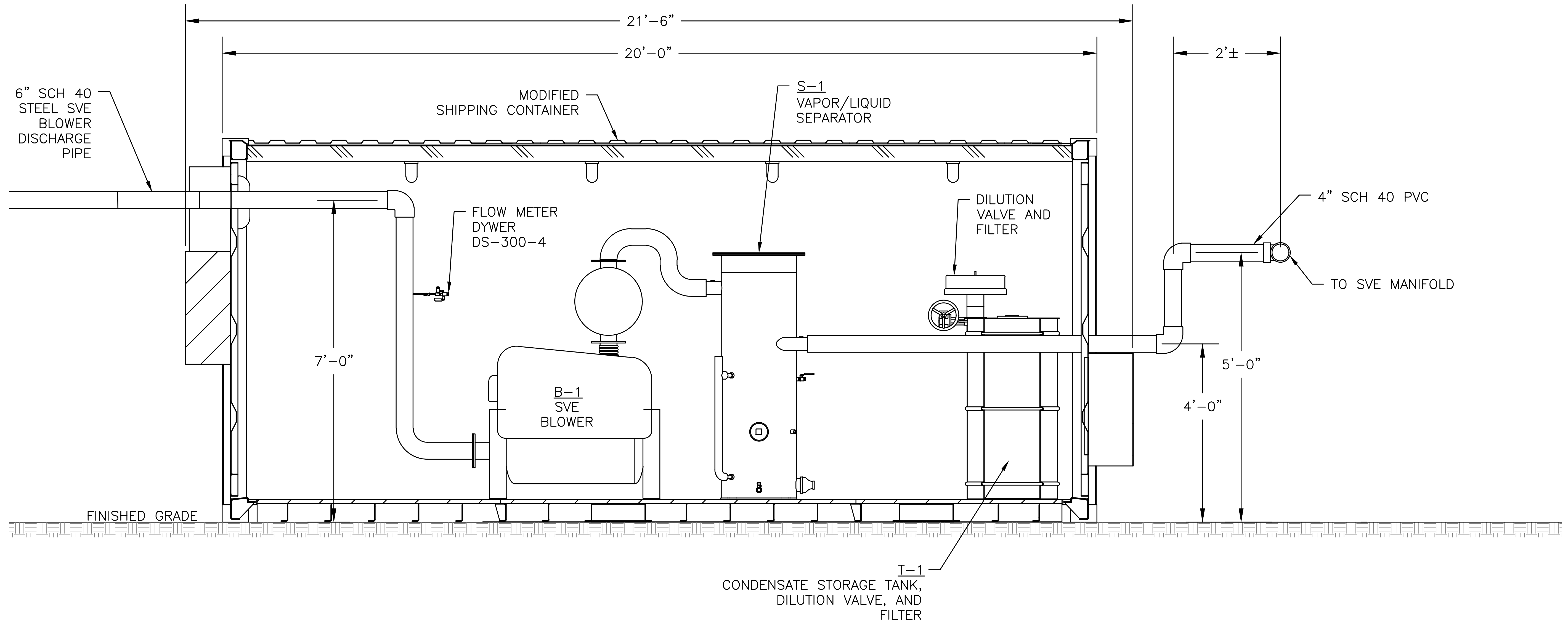
JOB NO.
DB19.1395.00



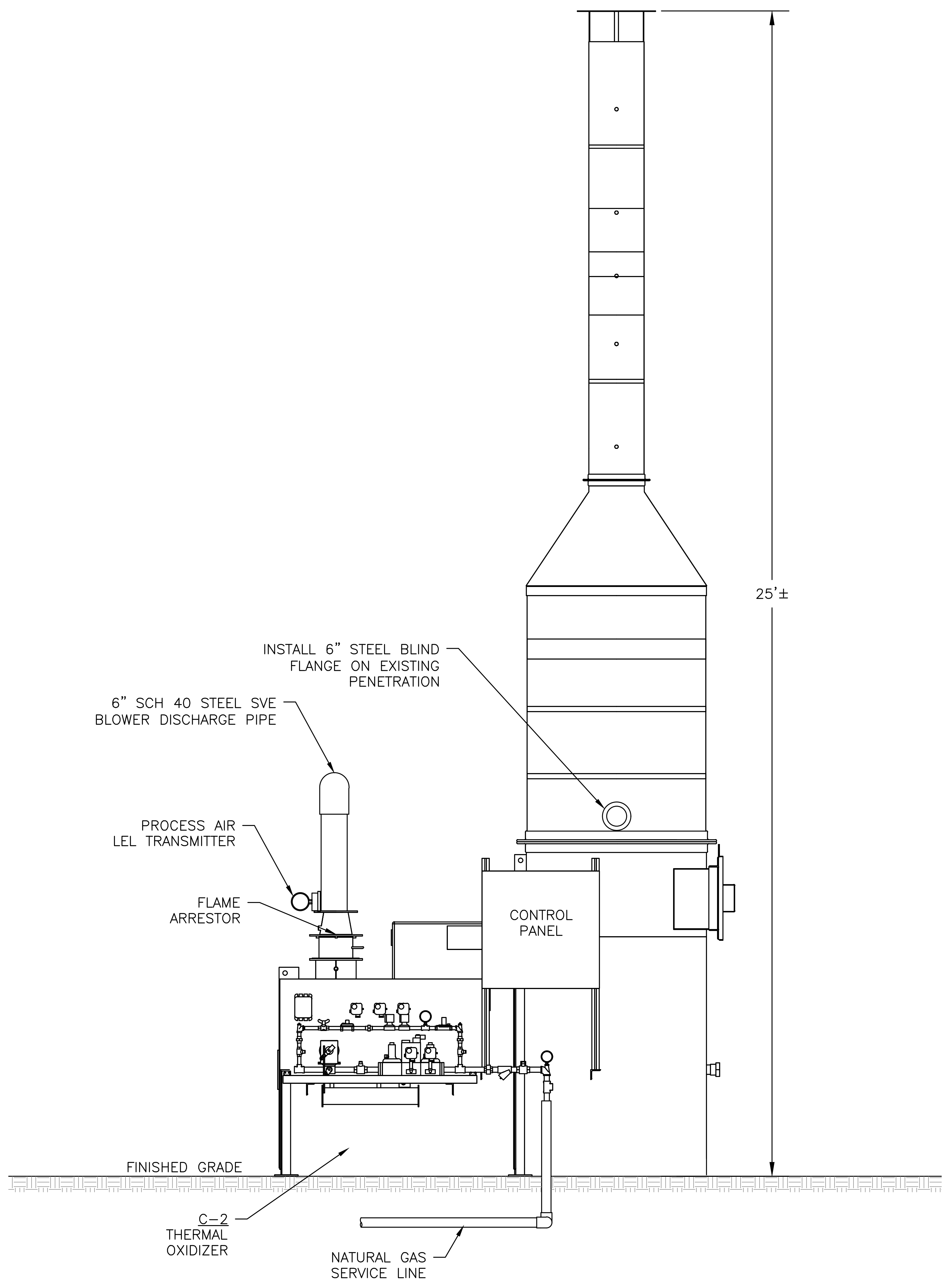
SVE MANIFOLD 1/M-2
NTS



PIPE SUPPORT DETAIL 2/-
NTS



SVE EQUIPMENT ELEVATION 3/M-2
NTS



THERMAL OXIDIZER DETAIL 4/M-2
NTS

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MECHANICAL DETAILS

SHT. 8 OF 8
DWG NO. M-3

JOB NO.
DB19.1395.00

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Appendix D

Product Cut Sheets

INTELLISHARE
ENVIRONMENTAL
CLEAN AIR SOLUTIONS

E4803 395th Avenue
Menomonie, WI 54751 USA
Phone: 715-233-6115
Fax: 715-232-0669
E-Mail: jstrey@intellishare-env.com
Website: www.intellishare-env.com

Date:	2/26/10
ISE Proposal No:	N-10-0988
Client Project ID:	Sante Fe New Mexico
Proposal For:	Tom Golden DB Stephens
Phone:	503-353-9075
Fax:	
E-Mail:	tgolden@dbstephens.com
Application:	Remediation
Proposed Solution:	North & South Systems

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

South System Oxidizer Process Data

SVE Discharge:	400 SCFM
Maximum Oxidizer Capacity:	500 SCFM
Minimum Gas Pre-Heater Input:	50,000 BTUH
Max Gas Pre-Heater Input:	1,500,000 BTUH
Average Thermal Operating Temperature:	1400 degrees F.
Maximum Thermal Operating Temperature:	1600 degrees F.
Minimum Catalyst Inlet Temperature:	550 degrees F.
Average Catalyst Operating Temperature:	600 degrees F.
Maximum Catalyst Operating Temperature:	1200 degrees F.
Catalyst Volume:	.764 cubic feet
Catalyst Gas Hourly Space Velocity:	39,000 GHSV^{-1}
Destruction Efficiency:	➢ 99% (thermal) ➢ 98% (catalytic)
Maximum LEL Throughput:	50% with LEL Sensor
Time to Reach Operating Temperature:	15-20 minutes from cold start
Inlet Connection:	4” Flange
Stack Height:	To Be Determined
Foot Print:	W=6’, L=12’, H=8’
Weight:	4000 lbs

Equipment Specification (South Thermal Oxidizer)

Oxidizer Reactor: The reactor housing will be constructed of 7 gauge rolled steel. The Inlet and outlet connections are flanged. The oxidizer is painted with a two component paint.

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 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.

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.

Main Control Panel: The main control panel shall be Nema 4 construction and shall be pre-wired to all components. The control is via Allen Bradley Micro Logix PLC with ethernet capability. The control panel features alarm detection and an hour meter to record run time. Temperature control will be provided with approved temperature control devices and 4-20ma temperature retransmit and limit switches. The control panel shall be UL labeled and listed as an assembly.

Automatic Dilution Control: A dilution control assembly will be installed on the inlet of the SVE blower to allow a fresh air purge of the oxidizer. 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.

Optional Catalyst Module: The oxidizer may be furnished with a monolith catalyst, specifically designed for the destruction of petroleum hydrocarbons. The catalyst module is easily field inserted with minimal requirements and typically takes 2-4 hours for complete conversion. The catalyst module will be crated and shipped loose.

INTELLISHARE
ENVIRONMENTAL
CLEAN AIR SOLUTIONS

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Menomonie, WI 54751 USA
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Fax: 715-232-0669
E-Mail: jstrey@intellishare-env.com
Website: www.intellishare-env.com

Date: 8/21/20

ISE Proposal No: N-20-2331
Client Project ID: Lovington 66, NM

Proposal For: Tom Golden
DB Stephens/Geo Logic
6020 Academy Road NE, Suite 100
Albuquerque, NM 87109
Phone: 505-353-9071
Fax:
E-Mail: tgolden@geologic.com

Application: Remediation

Proposed Solution: 550 CFM SVE Building System

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

SVE Process Information

- Design Air Flow Capacity: 550 SCFM
- Inlet Air Flow at Vacuum: 945 ICFM
- SVE Design Vacuum: 100” W.C.
- SVE Design pressure: 12” W.C.
- Site Elevation: 3910’ msl
- Estimated Noise Level Outside of Building: < 70 dBA at a distance of 10’
- Horsepower at Design Condition: 27.4hp
- Horespower Installed: 40hp
- Inlet Connection: 6”
- Outlet Connection: 6”
- VLS Liquid Capacity: 75 Gallon
- Liquid Pump Out: 10 GPM
- Power Input: 480/3/60
- Estimated Blower dbA: 88
- Estimated Blowr dbA 50’ from enclosure: 75

SVE Equipment Specification

SVE Blower: 550 SCFM @ 100" W.C. vacuum at 3910' msl. Sutorbuilt Legend 7M Positive Displacement (PD) Blower with 40 HP TEFC motor, belt drive. Discharge Silencer, belt tensioner, vacuum relief valve. A blower inlet filter will be provided.

Moisture Separator: The vapor liquid separator (VLS) is welded steel construction with external enamel finish. The separator is 200 gallon total capacity with 75 gallon liquid holding capacity. Internal to the separator is a moisture/filter demister. The separator is equipped with PVC site glass and three point liquid level control. The separator will be equipped with 1.5" drain valve.

Condensate Removal Pump: Centrifugal pump to provide 10 GPM at 80' TDH, stainless steel impeller and volute. 1/2hp TEFC motor. Check valve, throttle valve, pressure gauge on pump discharge.

Condensate Tank: A poly tank with 200 gallon capacity will be installed inside the building. A two point level sensor (warning and high level shutdown) will be installed in the tank. A vent will be plumbed outside the enclosure.

Automatic Purge/Dilution Control: An automatic valve will be installed on the inlet of the SVE blower. Once the fresh air purge of the oxidizer is complete, the valve is automatically switched to dilution control and works on a PID loop with the catalyst exit temperature thermocouple.

Automatic Inlet Isolation Valve: An automatic valve with modulating actuator will be installed on the inlet of the SVE system.

SVE Control Panel: The NEMA 3R control panel will be completely assembled, wired and mounted at eye level. Control panel includes power disconnect The control panel is PLC based with operator touch screen terminal. An hour meter is provided to record system run time. HOA function for blower and transfer pump will be through the operator touchscreen. Oxidizer interlocks will be provided. The control panel will be UL 508 approved as an assembly. All wiring will be consistent with standards set forth in the NEC.

Telemetry: A telemetry system consists of a modem to allow remote access to the system controls. The operator can view data and will also receive an email for any alarm events. The telemetry system is real time and also allows Intellishare the ability to log in and make any PLC program changes or modifications and remote support over the course of the project duration. The telemetry system will consist of a cellular modem with Verizon data plan by others.
Remote display will include the below:

1. Oxidizer inlet temperature
2. Oxidizer outlet temperature
3. SVE discharge pressure
4. SVE discharge flow
5. SVE inlet & discharge temperature
6. SVE wellfield vacuum and soil gas LEL

SVE Instrumentation: Pitot tube flow sensor with DP transmitter w/display installed on SVE blower outlet (flow to oxidizer). Vacuum transmitter w/display on blower inlet. Pressure transmitter w/display on SVE discharge. A thermocouple will be installed on the SVE inlet & discharge. LEL sensor piped around the SVE blower to indicate LEL.

Spare Parts (estimate for 1st year of operation):
(2) SVE blower belts
(12) Synthetic blower oil
(4) SVE inlet filter elements
(1) SVE inlet dilution filter element
(1) LEL Sensor Module

SVE Equipment Specification

Modified Cargo Box enclosure;
-8’ wide x 20’ long x 8’6” high outside dimension
-Welded sea container
-Used container with be like new condition
-Container will be repainted after modifications to match existing beige color
-Floor sealed with non-skid bed liner
-R-13 Insulation walls and ceiling with 2 x 4 furring and painted plywood interior
-(2) 36” x 6’-8” insulated steel access doors on side
-Sound insulated louver covers for vent air intake and exhaust louvers
-1800 W wall mounted electric fan forced heater with thermostat
-(3) Ceiling mounted incandescent lights with vapor globe and wall switch
-(1) 14” vent fan with inlet and outlet louvers and thermostat
-Spray foam urethane insulation under floor for sound and heat retention
-Floor sump and high level sensor

Equipment Mounted and Wired:
-The container will have;
-Wall penetrations for the inlet and outlet SVE/VLS pump piping and tank vent
-(2) LEL meters to detect explosive environment
-SVE, VLS and Pump mounted and wired
-SVE control panel and breaker box mounted to exterior

Sutorbilt Legend - 7M

Product Information

CORRECTED VALUES	ORIGINAL UNITS	ENGLISH UNITS	METRIC UNITS
Ambient Pressure	3910 ALTI-FT	12.716 PSIA	0.877 bar a
Elevation	3910 ALTI-FT	3910 ALTI-FT	1192 alti-m
Inlet Pressure	100 InH2O V	-3.613 PSIG	-0.249 bar g
Inlet Pressure Loss	0.5 PSIG	0.500 PSIG	0.034 bar g
Inlet Temp	68 F	68 °F	20 °C
Inlet Flow	550 SCFM	945 ICFM	1606 m^3/h
Discharge Pressure	12.716 PSIA	0.000 PSIG	0 bar g
Discharge Pressure Loss	1 PSIG	1.000 PSIG	0.069 bar g
MEASURED VALUES	**ORIGINAL UNITS**	**ENGLISH UNITS**	**METRIC UNITS**
Speed	1541 RPM	1541 RPM	1541 RPM
RPM % Of Max	75	75	75
Power	27.4 HP	27.4 HP	20.432 kW
Discharge Temp	164 °F	164 °F	73 °C
Temp % of Max	50	50	50
Noise	88 dBa	88 dBa	88 dBa
Pressure % of Max	65	65	65
Adiabatic Efficiency	64.46%	64.46%	64.46%

RELIEF VALVES	VACUUM
Pressure	110 InH2O V
Pressure % of Max	70
Discharge Temp	176 °F
Temp % of Max	54

PHYSICAL	
Weight	600 lbs.
Gear Diameter / Center Distance	7 in.
Connection Size	6i/6d in.
Case Length	11 in.
WR^2	12.49 lb-ft^2
Orientation	horizontal
PERFORMANCE	
Max Delta P	10 PSI
Max Temp	325 °F
Max Speed	2050 RPM
Min Speed	546 RPM
Max Case Pressure	25 PSIG
Max Delta T	225 °F

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QuickPik™

AMBIENT GAS PARAMETERS	ENGLISH UNITS	METRIC UNITS
Molecular Weight	28.852 lbm/lbmol	28.852 kg/kgmol
R Value	53.549 ft.lbf/lbm.R	0.288 kJ/kg.K
Density	0.065 lbm/ft ^{3}	1.038 kg/m^3

GAS MIX:	VOL
Air	100%

Performance Curves

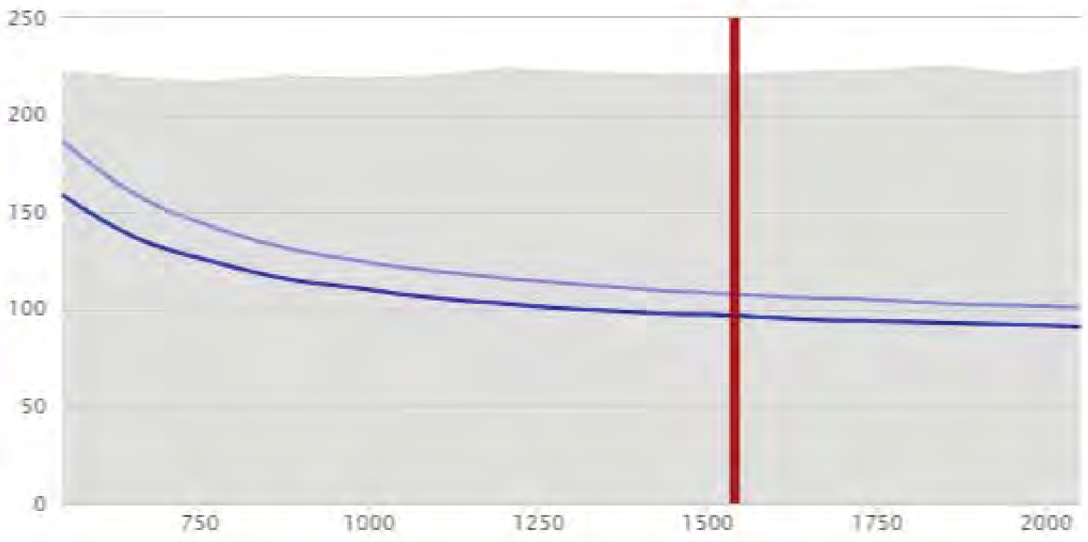
Temperature Rise

DEFINED CONDITIONS
96 F

RELIEF VALVE
108 F

RPM
1541

▨ Published Data
— Defined Conditions



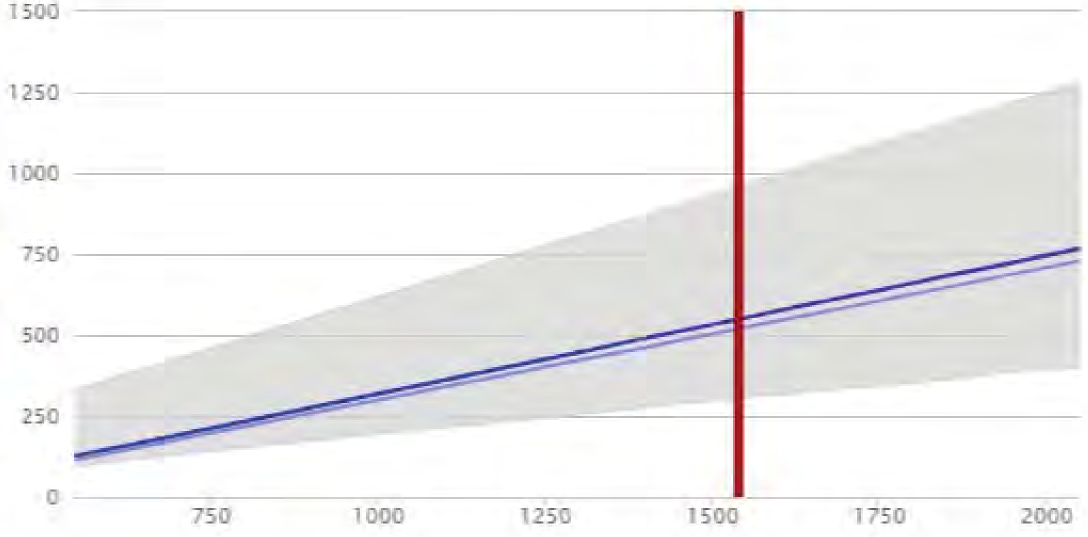
Flow

DEFINED CONDITIONS
550 SCFM

RELIEF VALVE
520 SCFM

RPM
1541

▨ Published Data
— Defined Conditions



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QuickPik™

Performance Curves

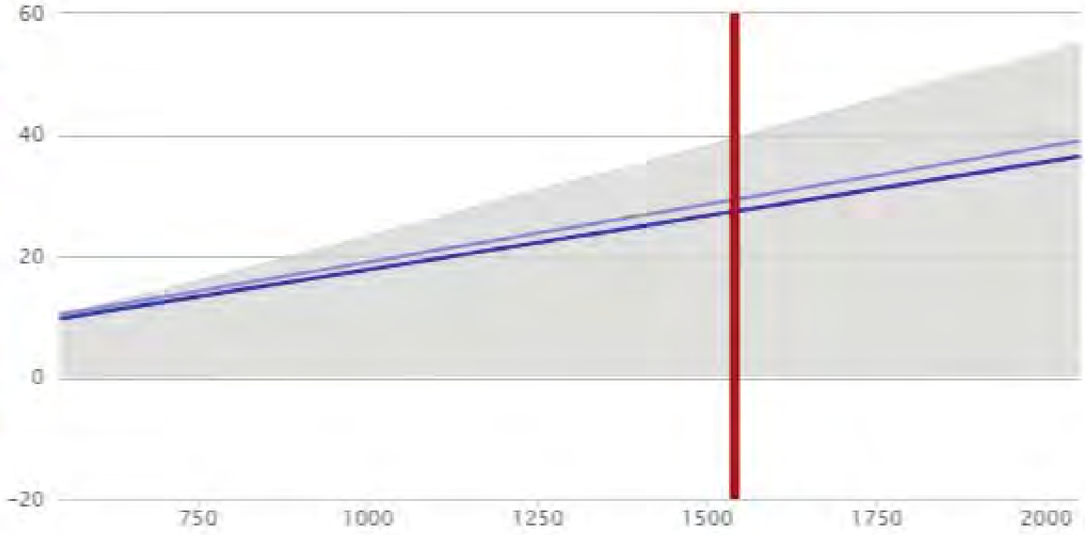
Power

DEFINED CONDITIONS
27.4 HP

RELIEF VALVE
29.3 HP

RPM
1541

▨ Published Data
— Defined Conditions



Torque

DEFINED CONDITIONS
93.4 ft-lb

RELIEF VALVE
99.9 ft-lb

RPM
1541

▨ Published Data
— Defined Conditions

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Intellishare Environmental, Inc.

Gas Fired Thermal Oxidizer

About Our Gas Fired Thermal Oxidizer

The Intellishare thermal oxidizer was developed on a modular platform allowing for maximum flexibility in system selection. Each system can be configured multiple ways to fit nearly any space requirement. All units are designed to incorporate our heat recovery and catalyst modules and are built for long term reliability and performance.

Intellishare Environmental specializes in the engineering and manufacturing of oxidation technology for soil and groundwater remediation, VOCs , HAPs and odor abatement.

Features & Benefits

Modular Construction: We can help you spend your project dollars wisely! Our units are built to allow catalyst modules, heat exchangers and LEL monitors to be easily field inserted at any time.

High Temperature Combustion Chamber: Low outer skin temperature and greater than 99% destruction efficiency.

Intellishare One Touch Controls: Reduces operator error and increases uptime by taking the guesswork out of operation. Walks the operator through basic system tasks such as start-up, shut-down and troubleshooting.

PLC: PLC offers unlimited programming flexibility without control panel modification.

Honeywell Flame Control: Provides exceptional reliability in display of burner system status and flame strength.

Automatic Dilution Control: Reduces operator site time by automatically adjusting to varying hydrocarbon concentrations preventing temperature overshoots and system shut-downs.

UL Listed Controls: Certified UL compliant.

Options

Catalyst: Metal monolith

Electrical Rating: Class 1 Division 1/2, Group D

Safety Rating: SIL—Safety Integrity Level

LEL Monitor: Catalytic or IR type with 4-20 mA output

Air Flow: Sensor or transmitter with 4-20 mA output

Recording: Up to four 4-20 mA input, paper or paperless

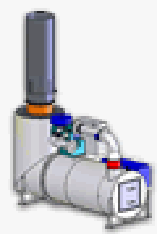
Process Blower: Centrifugal Fan

SVE Blower: Multiple SVE blowers or vacuums

Additional Sizes: 250-3000 SCFM

System Specification

Model:	500 CFM
Air Flow:	200-500 SCFM
Pressure Drop:	Maximum 12” WC
Concentrations:	0-50% LEL
Input Voltage:	230V/1Ph/60Hz or 208-230V/460V/3Ph/50-60Hz
Overall Size:	12’ L, 6’ W, 8’ H
Overall Weight:	4000 lb
Reactor:	A-36 Carbon Steel
Heat Exchanger:	300 Series Stainless Steel
Main Control Panel:	Nema 4
Disconnect:	600 VAC
Control Type:	Allen Bradley PLC
Operator Interface:	Allen Bradley Touch Screen
Flame Arrestor:	Spiral crimped element
Stack:	300 Series Stainless Steel
Insulation:	8”-8lb density soft ceramic
Exterior:	Painted
Base:	A-36 Carbon Steel
Optional Catalyst:	400 CPSI Precious Metal Monolith
Inlet & Outlet:	Flanged
Lifting:	Forklift or Crane
Purge/Dilution:	Automatic
Gas Pre-Heater:	1.5 MMBTUH
Temp Range:	1400-1600° F
Max Temp:	1800° F
Thermocouples:	Type J C1, D1, GD
Temp Control:	Honeywell
Optional Heat Exch	Nominal 50%



Visit us on the web to view a 3-D animation!

INTELLISHARE ENVIRONMENTAL
CLEAN AIR SOLUTIONS

Special Points of Interest:

- Multi mode operation
- Primary or secondary air burners
- Highest uptime percentage of any oxidizer
- Horizontal or vertical orientation

Other Products & Services:

Electric Catalytic Oxidizer

Gas Fired Catalytic Oxidizer

Electric Thermal Oxidizer

Thermal Accelerator

Chlorinated/ Fluorinated Oxidizer

Regenerative Thermal Oxidizer

Complete Soil Remediation Oxidizer Packages

Used and Rentals Available

Field Repairs

Training

Emergency Response

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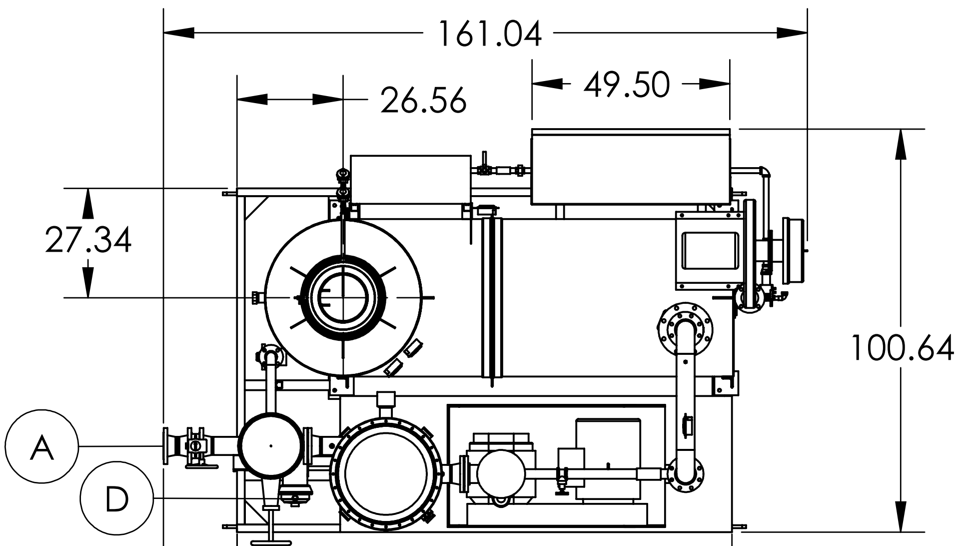
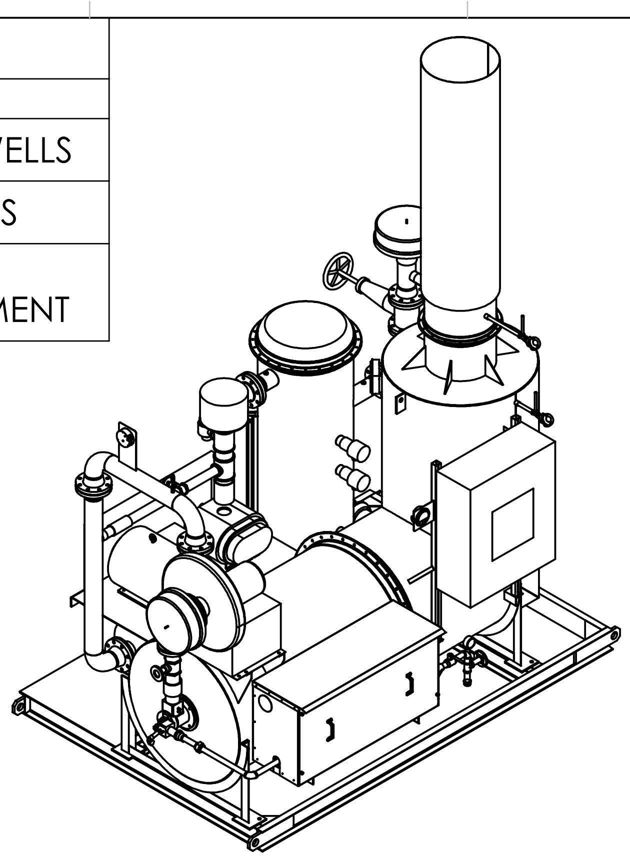
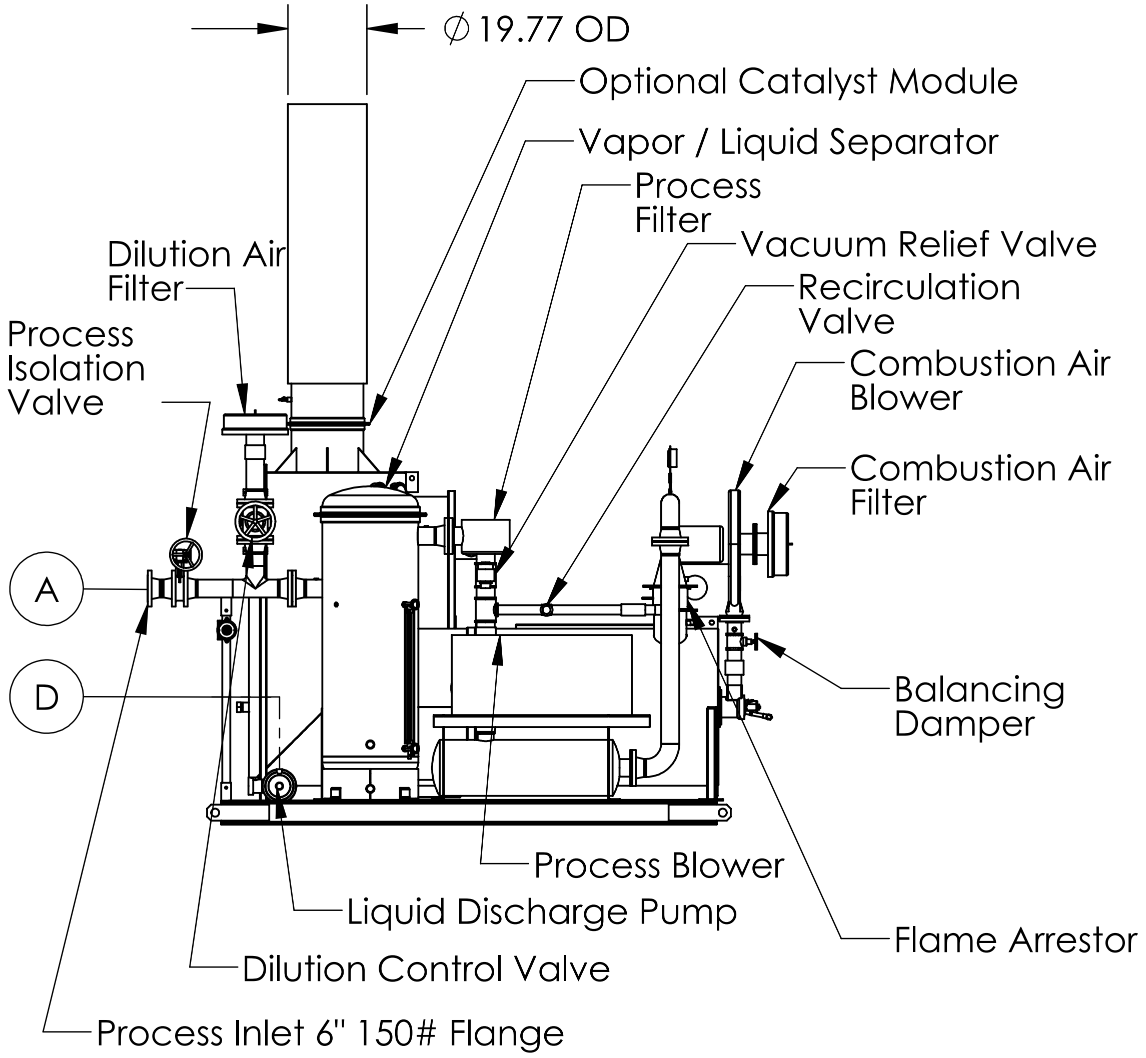


Top View

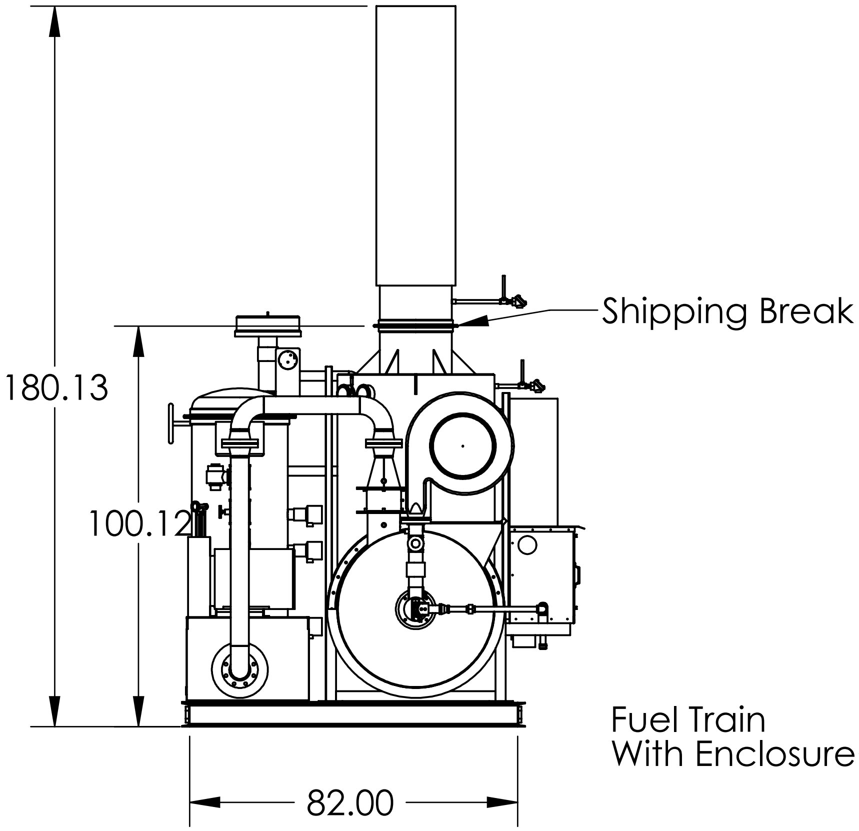
CONNECTION SCHEDULE		
MK	SIZE	DESCRIPTION
A	6" 150#	INLET FROM VAPOR WELLS
B	1" FNPT	INLET NATURAL GAS
C	1" FNPT	DISCHARGE TO WASTE WATER TREATMENT



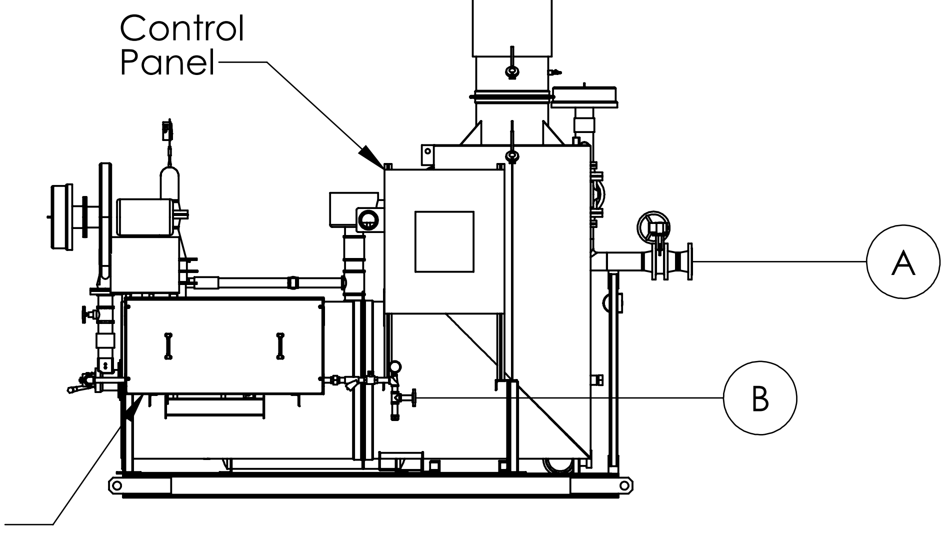


Left Side View

Approximate Weight: 7500 lbs



Front View



Right Side View

Note: Dimensions given in Inches unless otherwise indicated.

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INTELLISHARE ENVIRONMENTAL
CLEAN AIR SOLUTIONS

TO500 w-RPDSVE Sales Drawing

TITLE
TO500 W/RPDSVE
SALES DRAWING

DRAWING NO.
TO500 w-RPDSVE Sales Drawing

SCALE
NTS

DRAWN Henry A DATE 8/2/2006
CHECKED DATE
APPROVED DATE
LAST DRAWN BY Henry A DATE 6/30/2008

CONTACT:
Intellishare Environmental, Inc.
E4803 395th Ave. - Menomonie, WI 54751
www.intellishare-env.com

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PAGE 1 OF 1

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- > Fittings
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Coming through.

Version 2.2 2007

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

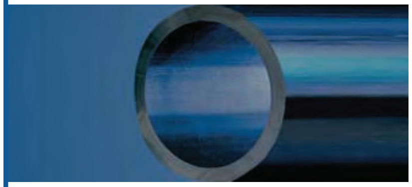
ASTM D 2657 – Standard Practice of Heat Fusion Joining of Polyolefin Pipe and Fittings

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

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.

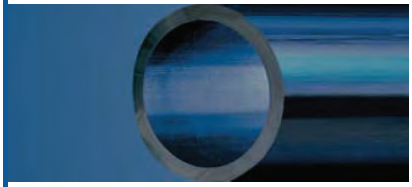
Types of Polyethylene Pipe

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.

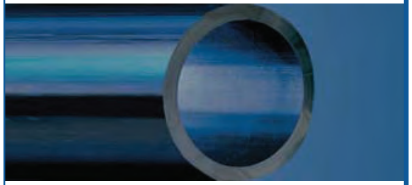
Traditional PE 3408/3608 resins have PENT test values of about 100 hours. New bimodal resins used to make PE 3710 and PE 4710 pipes have values ranging from 600 hours to several thousand hours.

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

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)

1-800-345-ISCO

www.isco-pipe.com

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.

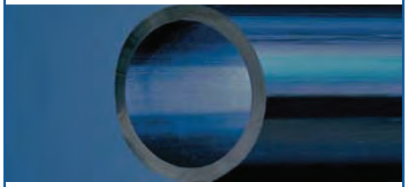
Derating factors for fittings are provided in Table 1, Derating Factors for HDPE Fittings. This table can assist in the selection of the correct fitting for a given application based on pressure rating requirements. Derating factor is the percentage that the pressure rating is lowered.

Table 1: Derating Factors For HDPE Fittings

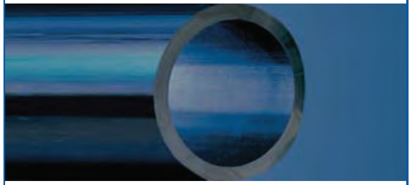
Description	**Industry Practice**	**Derating ASME B31.3**
Fabricated 90 degree Ell - Five Segment	25%	25%
Fabricated 90 degree Ell Three	25%	38%
Fabricated 45 degree Ell Three	25%	25%
Fabricated 45 degree Ell Two	25%	38%
Fabricated 22.5 degree Ell Two	25%	25%
Fabricated Tees, Three Piece	25%	25%
Fabricated 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



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

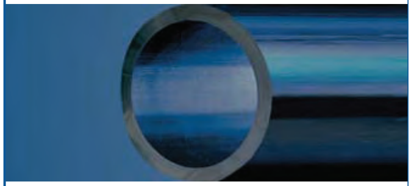
Stainless Steel Transition Fittings

Features:

Compression design effectively resists creep and pullout
Stainless Steel 304 Body (316 Available)
O-Ring design for added protection
Meets ASTM 2513

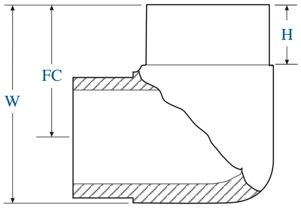
No Weld Design
Size range 3/4” through 2”
No shear points
Available with AWWA pipe

Threads per ANSI B1.20.1



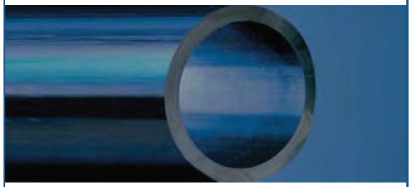
IPS
HDPE
Fittings

IPS Fittings Molded 90° Ell



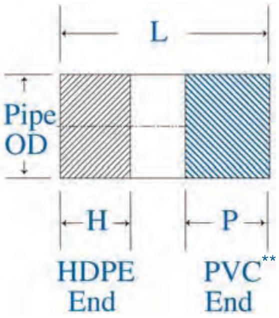
IPS Fittings Molded 90° Ell

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			Weight Lbs.	Shipping Method
				H (in)	L (in)	P (in)		
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.**

FLEXIBILITY The flexibility of polyethylene pipe allows it to be curved over, under, and around obstacles as well as make elevation and directional changes. In some instances, the pipe's flexibility can eliminate the need for fittings and reduce installation costs.

Driscopipe HDPE pipe can be bent to a minimum radius between 20 to 40 times the pipe diameter.

TABLE 2: MINIMUM ALLOWABLE BEND RADIUS @ 73.4°F

SDR	Minimum Allowable Bend Radius, R_a
32.5	> 40 times outside diameter
26	> 35 times outside diameter
21	> 28 times outside diameter
19	> 27 times outside diameter
17	> 27 times outside diameter
15.5	> 27 times outside diameter
13.5	> 25 times outside diameter
11	> 25 times outside diameter
9	> 20 times outside diameter
7	> 20 times outside diameter

Example: Assume a 24" diameter DR 21 pipe was to be bent. The minimum bend radius can be calculated as follows:

$$R_a > 28 \times D \qquad R_a > 28 \times 24" \qquad R_a > 672"$$

Where:

R_a is the radius of curvature of the bend in the pipe, in.

D is the outside diameter of the pipe, in.

The radius of the circular sector (bend) must be greater than 672" (56 ft).

FLOW FACTORS Driscopipe polyethylene pipe has a smooth inside surface. A "C" factor of 150 is recommended in the Hazen-Williams Formula. Polyethylene pipe has a recommended Manning's "n" value of 0.009. The smoothness factor, ε, is equal to 7×10^{-5} ft. Smooth walls and the non-wetting characteristic of polyethylene allow higher flow capacity and reduced friction loss with polyethylene pipe.

LIFE EXPECTANCY The hydrostatic design basis for Driscopipe pipe is based on extensive hydrostatic testing data evaluated by standardized industry methods. Based on ASTM D2837, regression curves project a life expectancy of approximately 50 years when transporting water at 73.4°F. Internal and external environmental conditions may alter the expected life or change the recommended design basis for a given application.

LIGHTWEIGHT Polyethylene pipe is much lighter than concrete, cast iron, or steel pipe. It is easier to handle and install. Reduced manpower and equipment requirements may result in installation savings.

PRESSURE RATINGS Phillips Driscopipe manufactures polyethylene pipe for gravity flow and pressure service through 267 psi at 73.4° F. Some applications or design codes require that the pipe be derated, resulting in lower design pressure ratings. The formulas used to design polyethylene piping systems include a 2:1 safety factor in hydrostatic stress and a greater than 2:1 safety factor in surge fatigue.

Air Intake Filter and Filter Silencer

The Series F72 Air Intake Filter and Filter Silencer is designed to mount directly on the inlet of an engine, blower or compressor. It will provide 16dB to 20dB noise reduction. The Polyurethane filter media has an efficiency of 98% on 10 micron particles and a stainless steel center core.

SERVICE LIFE & CLEANING: The service life of the element is dependent upon the surrounding environment and cannot be predicted.

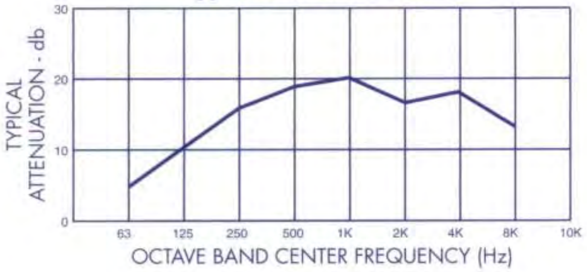
To prevent COLLAPSING of the filter element, STODDARD SILENCERS recommends the differential pressure across the filter element NOT exceed 15 inches of water column. Positive indication that the element requires cleaning or replacement can be provided with STODDARD SILENCERS model A40-108 Pressure Drop Indicator, at an extra charge.

Wash in sink or large pan using either water and any good washday type detergent and rinse clean. Squeeze out filter by pressing it against metal grid. Let stand and allow to dry completely.

F72 shown with optional A40-108 Pressure Drop Indicator.

Pre-Filter wrap available at added cost
Consult Factory
(90% on 75 micron particles and larger)

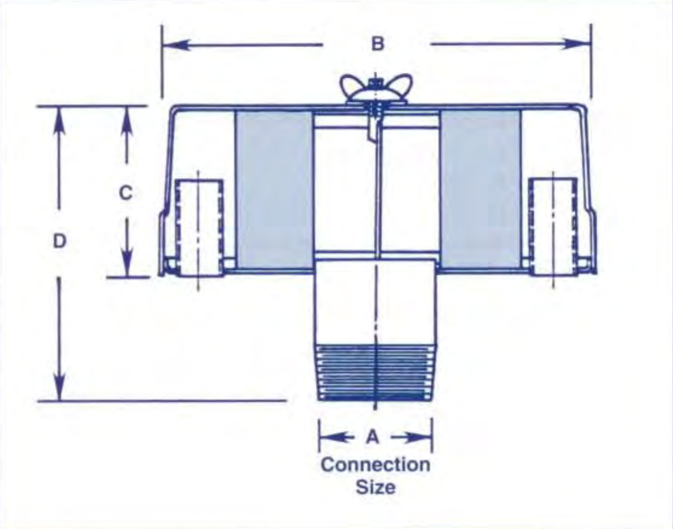
Typical Attenuation Curve



F72 Series

Model	A Connection Size	B	C	D	Rated CFM	Wt.	Replacement Element Number
F72-1	1" NPT	10	4	7	35	9	F8-119
F72-1½	1½" NPT	10	4	7	80	9	F8-119
F72-2	2" NPT	10	4	7	135	10	F8-119
F72-2½	2½" NPT	10	4	7	180	10	F8-119
F72-3	3" NPT	16	5	8	285	20	F8-120
F72-4	4" NPT	16	5	8	520	20	F8-120
F72-5	5" NPT/FLG	16	5	8	750	23	F8-120
F72-6	6" Flange	20	5	8	1235	40	F8-121
F72-8	8" Flange	20	10	13	2125	50	F8-122
F72-10	10" Flange	26	15½	20	3335	95	F8-123
F72-12	12" Flange	26	15½	20	4675	100	F8-123
F72-14	14" Flange	26	15½	20	5655	115	F8-123

Sizes 10", 12" and 14" are FILTERS only



Standard Filter Elements

F64 Intake Filter Silencer

Paper Elements (Replaceable)
Efficiency: 99% on 1 micron particles and larger

Element #	Housing Size
F8-108	1" to 2½"
F8-109	3" to 5"
F8-110	6"
F8-111	8"
F8-137	10" to 14"

F72 Intake Filter Silencer

Polyurethane Elements (Washable)
Efficiency: 98% on 10 micron particles and larger

Element #	Housing Size
F8-119	1" to 2½"
F8-120	3" to 5"
F8-121	6"
F8-122	8"
F8-123	10" to 14"

Alternate Elements for F64

Polyester Felt Elements (Washable)
Efficiency: 99% on 3 micron particles and larger

Element #	Housing Size
F8-151	1" to 2½"
F8-135	3" to 5"
F8-134	6"
F8-139	8"
F8-148	10" to 14"

Epoxy Coated Wire Mesh Elements (Washable)
Efficiency: 90% on 20 micron particles and larger

Element #	Housing Size
F8-129	1" to 2½"
F8-130	3" to 5"
F8-131	6"
F8-132	8"
F8-142	10" to 14"

Stoddard Silencers

Specialists in Industrial Silencing

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Web page - www.stoddardsilencersinc.com

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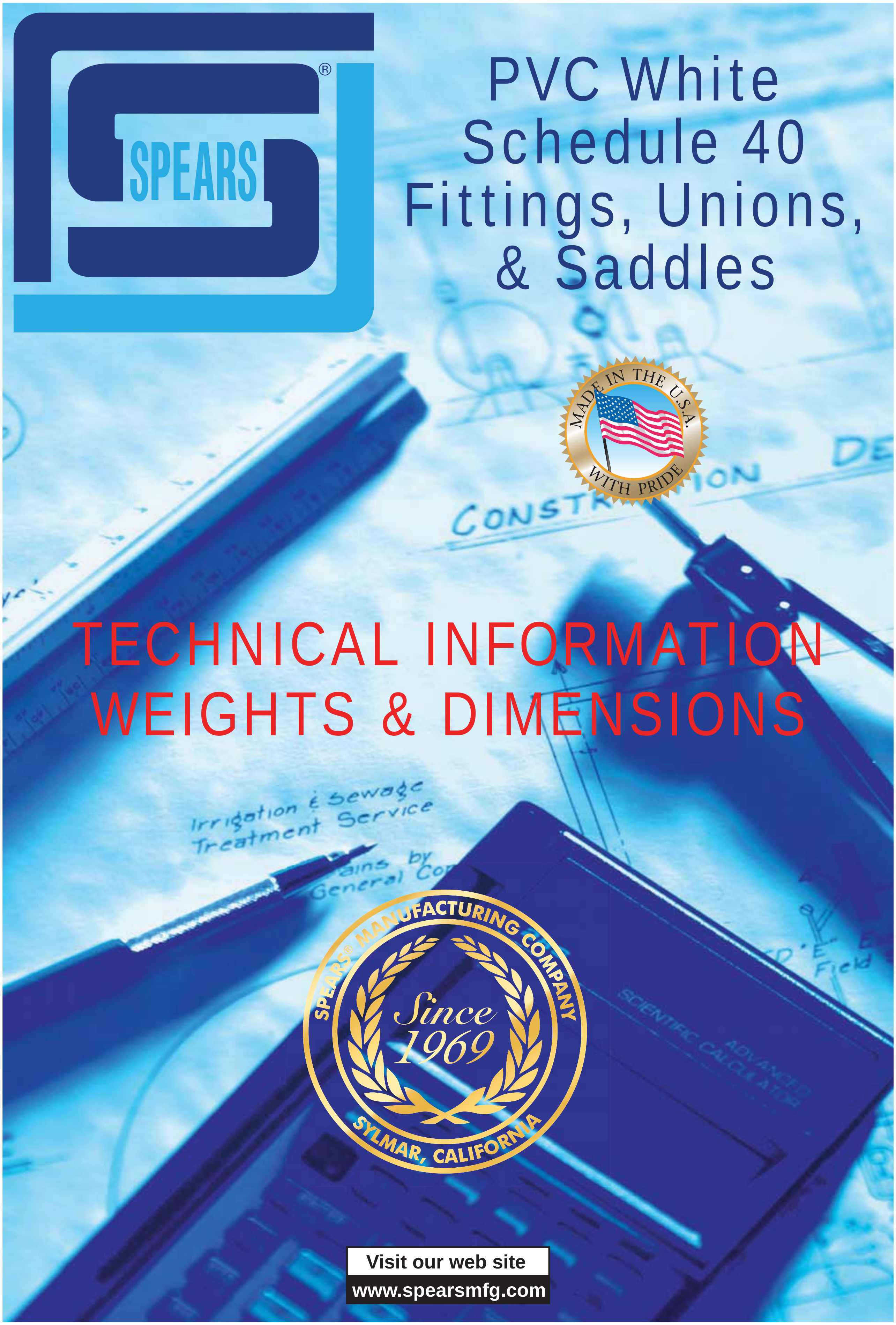
SPEARS®

PVC White Schedule 40 Fittings, Unions, & Saddles

MADE IN THE U.S.A. WITH PRIDE



TECHNICAL INFORMATION WEIGHTS & DIMENSIONS

SPEARS® MANUFACTURING COMPANY
Since 1969
SYLMAR, CALIFORNIA

Visit our web site
www.spearsmfg.com

Performance Engineered & Tested

SPEARS® Schedule 40 PVC fitting designs combine years of proven experience with computer generated stress analysis to yield the optimum physical structure and performance for each fitting. Material reinforcement is uniformly placed in stress concentration areas for substantially improved pressure handling capability. Resulting products are subjected to numerous verification tests to assure the very best PVC fittings available.

Full 1/4" Through 12" Availability

Spears® comprehensive line of PVC fittings offers a variety of injection molded configurations in Schedule 40 sizes 1/4" through 12" conforming to ASTM D 2466.

Exceptional Chemical & Corrosion Resistance

Unlike metal, PVC fittings never rust, scale, or pit, and will provide many years of maintenance-free service and extended system life.

High Temperature Ratings

PVC thermoplastic can handle fluids at service temperatures up to 140°F (60°C), allowing a wide range of process applications, including corrosive fluids.

Lower Installation Costs

Substantially lower material costs than steel alloys or lined steel, combined with lighter weight and ease of installation, can reduce installation costs by as much as 60% over conventional metal systems.

Higher Flow Capacity

Smooth interior walls result in lower pressure loss and higher volume than conventional metal fittings.

Additional Fabricated Configurations through 36"

Extra large, hard-to-find, and custom configurations are fabricated from NSF® Certified pipe. Fittings are engineered and tested to provide full pressure handling capabilities according to Spears® specifications.

PVC Valves

SPEARS® PVC Valve products are available for total system compatibility and uniformity.

Advanced Design Specialty Fittings

Spears® wide range of innovative, improved products include numerous metal-to-plastic transition fittings and unions with Spears® patented special reinforced (SR) plastic threads.

1/2" Through 16" Industrial Pipe Availability

Spears® premium quality Industrial CPVC pipe is offered in Schedule 40 White sizes 1/2" through 16".

Sample Engineering Specifications

All PVC Schedule 40 fittings shall be produced by Spears® Manufacturing Company from PVC Type I cell classification 12454, conforming to ASTM D 1784. All injection molded PVC Schedule 40 fittings shall be Certified for potable water service by NSF International and manufactured in strict compliance to ASTM D 2466. All fabricated fittings shall be produced in accordance with Spears® General Specifications for Fabricated Fittings.

General Information

Recommendations For Installers And Users

Plastic piping systems should be ENGINEERED, INSTALLED and OPERATED in accordance with ESTABLISHED DESIGN AND ENGINEERING STANDARDS AND PROCEDURES for plastic piping systems. Suitability for the intended service application should be determined by the installer and/or user prior to installation of a plastic piping system. PRIOR TO ASSEMBLY, all piping system components should be inspected for damage or irregularities. Mating components should be checked to assure that tolerances and engagements are compatible. Do not use any components that appear irregular or do not fit properly. Contact the appropriate manufacturer of the component product in question to determine usability. Consult all applicable codes and regulations for compliance prior to installation.

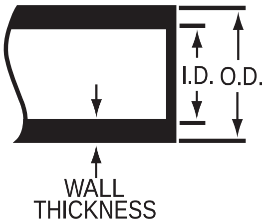
Solvent Weld Connections — Use quality solvent cements and primers formulated for the intended service application, pipe size and type of joint. While the pipe and fitting materials may be compatible with the intended medium, the solvent cement may not be. Consult the manufacturers for suitability of use. Read and follow the cement and primer manufacturers' applications and cure time instructions thoroughly. Be sure to use the correct size applicator.

Threaded Connections — Use a quality grade thread sealant. WARNING: SOME PIPE JOINT COMPOUNDS OR PTFE PASTES MAY CONTAIN SUBSTANCES THAT COULD CAUSE STRESS CRACKING TO PLASTIC. Spears® Manufacturing Company recommends the use of Spears® BLUE 75™ Thread Sealant which has been tested for compatibility with Spears® products. Please follow the sealant manufacturers' application / installation instructions. Choice of an appropriate thread sealant other than those listed above is at the discretion of the installer. 1 to 2 turns beyond FINGER TIGHT is generally all that is required to make a sound plastic threaded connection. Unnecessary OVERTIGHTENING will cause DAMAGE TO BOTH PIPE AND FITTING.

"Lead Free" low lead certification – unless otherwise specified, all Spears® Schedule 40 fittings specified here-in are certified by NSF International to ANSI/NSF® Standard 61, Annex G and is in compliance with California's Health & Safety Code Section 116825 (commonly known as AB1953) and Vermont Act 193. Weighted average lead content <=0.25%.

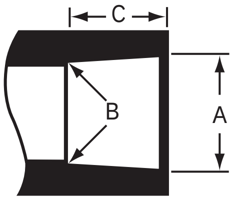
ASTM STANDARD DIMENSIONS

SCHEDULE 40 PIPE DIMENSIONS ASTM D 1785



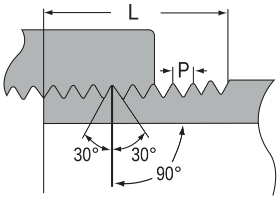
Nominal Pipe Size In.	Mean Outside Diameter In.	O. D. Tolerance In.	Minimum Wall Thickness In.
1/8	.405	± .004	.068
1/4	.540	± .004	.088
3/8	.675	± .004	.091
1/2	.840	± .004	.109
3/4	1.050	± .004	.113
1	1.315	± .005	.133
1-1/4	1.660	± .005	.140
1-1/2	1.900	± .006	.145
2	2.375	± .006	.154
2-1/2	2.875	± .007	.203
3	3.500	± .008	.216
4	4.500	± .009	.237
5	5.563	± .010	.258
6	6.625	± .011	.280
8	8.625	± .015	.322
10	10.750	± .015	.365
12	12.750	± .015	.408

SCHEDULE 40 SOCKET DIMENSIONS ASTM D 2466



Nominal Size In.	Diameter			Socket Length Minimum C
	Entrance A	Bottom B	Tolerance A	
1/8	.417	.401	± .004	.500
1/4	.552	.536	± .004	.500
3/8	.687	.671	± .004	.594
1/2	.848	.836	± .004	.688
3/4	1.058	1.046	± .004	.719
1	1.325	1.310	± .005	.875
1-1/4	1.670	1.655	± .005	.938
1-1/2	1.912	1.894	± .006	1.094
2	2.387	2.369	± .006	1.156
2-1/2	2.889	2.868	± .007	1.750
3	3.516	3.492	± .008	1.875
4	4.518	4.491	± .009	2.000
5	5.583	5.553	± .010	3.000
6	6.647	6.614	± .011	3.000
8	8.655	8.610	± .015	4.000
10	10.780	10.735	± .015	5.000
12	12.780	12.735	± .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	.2639	.03704
1/4	18	.4018	.05556
3/8	18	.4078	.05556
1/2	14	.5337	.07143
3/4	14	.5457	.07143
1	11-1/2	.6828	.08696
1-1/4	11-1/2	.7068	.08696
1-1/2	11-1/2	.7235	.08696
2	11-1/2	.7565	.08696
2-1/2	8	1.1375	.12500
3	8	1.2000	.12500
4	8	1.3000	.12500
5	8	1.4063	.12500
6	8	1.5125	.12500
8	8	1.7125	.12500

Molded Schedule 40 products are manufactured to ASTM D 2466 for use with pipe manufactured to ASTM D 1785. 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 D 1785. 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.

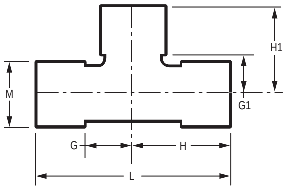
Injection Molded Dimension References:

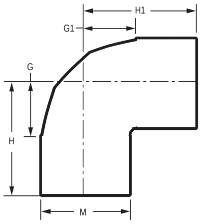
G = (LAYING LENGTH) intersection of center lines to bottom of socket/thread; 90° elbows, tees, crosses; ± 1/32 inch.
H = Intersection of center lines to face of fitting; 90° elbows tees, crosses; ± 1/32 inch.
J = Intersection of center lines to bottom of socket/thread; 45° elbows; ± 1/32 inch
L = Overall length of fittings; ± 1/16 inch.
M = Outside diameter of socket/thread hub; ± 1/16 inch.
N = Socket bottom to socket bottom; couplings; ± 1/16 inch.
W = Height of cap; ± 1/16 inch.

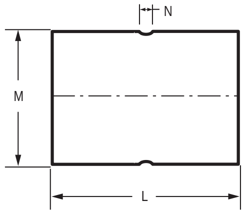
Fabricated Dimension References:

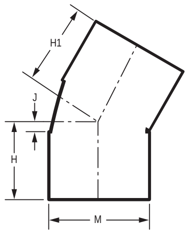
G = (LAYING LENGTH) intersection of center lines to bottom of socket/thread; 90° elbows, tees, crosses; ± 1/4 inch; 14" & larger ± 1/2 inch.
H = Intersection of center lines to face of fitting; 90° elbows, tees, crosses; ± 1/4 inch.; wyes ± 1/2 inch; 14" & larger ± 1/2 inch.
J = Intersection of center lines to bottom of socket/thread; 45° elbows; ± 1/4 inch; 14" & larger ± 1/2 inch.
L = Overall length of fittings; ± 1/2 inch.; wyes ± 1 inch; 14" & larger ± 1 inch.
M = Outside diameter of socket/thread hub; ± 1/4 inch.
N = Socket bottom to socket bottom; couplings; ± 1/2 inch.
W = Height of cap; ± 1/4 inch.

Typical Fabricated Dimension References



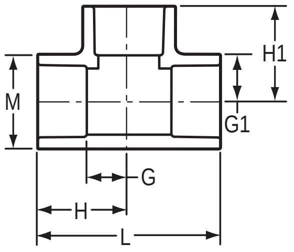






TEE

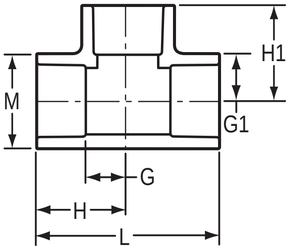
Socket x Socket x Socket



Part Number	Size	G	G1	H	H1	L	M	Approx. Wt. (Lbs.)
401-003	3/8	3/8	3/8	1-1/8	1-1/8	2-1/4	31/32	.04
401-005	1/2	1/2	1/2	1-1/4	1-1/4	2-1/2	1-3/32	.06
401-007	3/4	9/16	9/16	1-9/16	1-9/16	3-1/8	1-5/16	.10
401-010	1	11/16	11/16	1-3/4	1-3/4	3-1/2	1-5/8	.16
401-012	1-1/4	7/8	7/8	2-1/8	2-1/8	4-1/4	2	.25
401-015	1-1/2	1-3/32	1-3/32	2-11/32	2-11/32	4-11/16	2-1/4	.36
401-020	2	1-3/8	1-3/8	2-3/4	2-3/4	5-1/2	2-3/4	.51
401-025	2-1/2	1-21/32	1-21/32	3-13/32	3-13/32	6-13/16	3-11/32	1.03

TEE **(continued)**

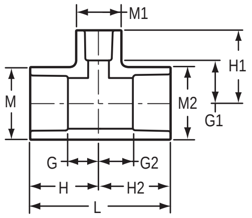
Socket x Socket x Socket



Part Number	Size	G	G1	H	H1	L	M	Approx. Wt. (Lbs.)
401-030	3	1-15/16	1-15/16	3-27/32	3-27/32	7-11/16	4	1.43
401-040	4	2-13/32	2-13/32	4-7/16	4-7/16	8-7/8	5-1/32	2.22
401-050	5	3	3	6	6	12	6-5/32	4.59
401-060	6	3-5/8	3-5/8	6-21/32	6-21/32	13-5/16	7-9/32	6.00
401-080	8	4-1/2	4-1/2	8-17/32	8-17/32	17-1/16	9-3/8	11.81
401-100	10	5-13/16	5-13/16	10-27/32	10-27/32	21-11/16	11-21/32	24.25
401-100F	10	9-7/8	9-3/8	15-1/8	14-5/8	30-1/4	11-1/2	36.21
401-120	12	6-27/32	6-27/32	12-27/32	12-27/32	25-11/16	13-3/4	37.94
401-120F	12	10-3/4	10-3/16	17	16-7/16	34	13-9/16	56.32
401-140F	14	11-3/8	11	18-3/8	18	36-3/4	14-7/8	75.11
401-160F	16	15	12-7/8	23	20-7/8	46	17	111.00
401-180F	18	15-7/8	13-3/8	24-7/8	22-3/8	49-3/4	19-1/8	151.26
401-200F	20	18-1/4	15-1/2	28-1/4	25-1/2	56-1/2	21-3/16	206.74
401-240F	24	21-1/8	17-1/2	33-1/8	29-1/2	66-1/4	25-3/8	337.03

REDUCING TEE

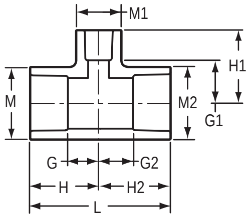
Socket x Socket x Socket



Part Number	Size	G	G1	G2	H	H1	H2	L	M	M1	M2	Approx. Wt. (Lbs.)
401-053	3/8x3/8x1/2	17/32	21/32	17/32	2-1/32	1-3/4	2-1/32	4-1/16	7/8	1-3/32	7/8	.08
401-074	1/2x1/2x3/4	9/16	9/16	9/16	1-5/16	1-9/16	1-5/16	2-5/8	1-1/16	1-9/32	1-1/16	.07
401-075	1/2x1/2x1	25/32	17/32	25/32	1-17/32	1-11/16	1-17/32	3-1/16	1-1/16	1-5/8	1-1/16	.11
401-094	3/4x1/2x1/2	17/32	21/32	17/32	1-17/32	1-13/32	1-7/32	2-13/16	1-5/16	1-3/32	1-3/32	.08
401-095	3/4x1/2x3/4	13/16	11/16	5/8	1-13/16	1-15/32	1-3/8	3-3/16	1-5/16	1-5/16	1-1/16	.10
401-101	3/4x3/4x1/2	17/32	5/8	17/32	1-7/16	1-3/8	1-7/16	2-29/32	1-5/16	1-1/8	1-5/16	.08
D401-101	3/4x3/4x1/2	9/16	19/32	17/32	1-17/32	1-27/32	1-17/32	3-1/16	1-5/16	1-3/32	1-5/16	.11
401-102	3/4x3/4x1	23/32	5/8	23/32	1-21/32	1-21/32	1-21/32	3-5/16	1-5/16	1-5/8	1-5/16	.11
401-122	1x1/2x1	23/32	23/32	27/32	1-25/32	1-25/32	1-19/32	3-7/16	1-5/8	1-5/8	1-3/32	.14

REDUCING TEE (continued)

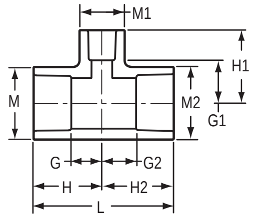
Socket x Socket x Socket



Part Number	Size	G	G1	G2	H	H1	H2	L	M	M1	M2	Approx. Wt. (Lbs.)
401-124	1x3/4x1/2	5/8	23/32	19/32	1-21/32	1-15/32	1-1/2	3-5/32	1-5/8	1-3/32	1-5/16	.12
401-125	1x3/4x3/4	21/32	25/32	5/8	1-25/32	1-25/32	1-5/8	3-7/16	1-19/32	1-5/16	1-5/16	.14
401-126	1x3/4x1	3/4	13/16	13/16	1-29/32	1-15/16	1-13/16	3-3/4	1-5/8	1-5/8	1-5/16	.17
401-130	1x1x1/2	9/16	13/16	9/16	1-5/8	1-9/16	1-5/8	3-3/16	1-5/8	1-1/16	1-5/8	.13
D401-130	1x1x1/2	11/16	25/32	11/16	1-23/32	2-1/32	1-23/32	3-15/32	1-5/8	1-1/8	1-5/8	.15
401-131	1x1x3/4	19/32	3/4	19/32	1-5/8	1-21/32	1-5/8	3-9/32	1-5/8	1-5/16	1-5/8	.14
401-132	1x1x1-1/4	31/32	27/32	31/32	2-3/32	2-3/32	2-3/32	4-3/16	1-5/8	1-31/32	1-5/8	.22
401-133	1x1x1-1/2	1-1/8	13/16	1-1/8	2-1/4	2-1/8	2-1/4	4-1/2	1-5/8	2-9/32	1-5/8	.24
401-134	1x1x2	1-7/16	27/32	1-7/16	2-1/2	2-1/4	2-1/2	5	1-5/8	2-3/4	1-5/8	.31
401-156	1-1/4x1x1/2	21/32	1	17/32	1-25/32	1-3/4	1-21/32	3-7/16	2	1-1/16	1-5/8	.18
401-157	1-1/4x1x3/4	5/8	1	21/32	1-29/32	2	1-25/32	3-11/16	1-31/32	1-5/16	1-5/8	.20
401-158	1-1/4x1x1	13/16	1	7/8	2-1/16	2-3/32	2	4	1-31/32	1-21/32	1-5/8	.22
401-166	1-1/4x1-1/4x1/2	17/32	29/32	17/32	1-25/32	1-21/32	1-25/32	3-9/16	1-31/32	1-3/32	1-31/32	.18
D401-166	1-1/4x1-1/4x1/2	23/32	31/32	23/32	1-31/32	2-3/16	1-31/32	3-29/32	2	1-1/8	2	.22
401-167	1-1/4x1-1/4x3/4	21/32	31/32	21/32	1-29/32	1-31/32	1-29/32	3-13/16	2	1-11/32	2	.22
401-168	1-1/4x1-1/4x1	13/16	31/32	13/16	1-15/16	2-1/32	1-15/16	3-27/32	2	1-5/8	2	.22
401-169	1-1/4x1-1/4x1-1/2	1-3/32	1	1-3/32	2-11/32	2-5/16	2-11/32	4-11/16	1-31/32	2-7/32	1-31/32	.30
401-170	1-1/4x1-1/4x2	1-11/32	1	1-11/32	2-19/32	2-3/8	2-19/32	5-3/16	2	2-3/4	2	.38
401-199	1-1/2x1-1/4x1/2	17/32	1-1/8	17/32	1-27/32	1-7/8	1-25/32	3-5/8	2-7/32	1-1/16	1-31/32	.22
401-201	1-1/2x1-1/4x3/4	21/32	1-5/32	21/32	1-15/16	2-3/16	1-15/16	3-7/8	2-1/4	1-11/32	2	.26
401-202	1-1/2x1-1/4x1	13/16	1-3/16	13/16	2-1/8	2-9/32	2-1/16	4-3/16	2-1/4	1-5/8	2	.30
401-209	1-1/2x1-1/2x1/2	17/32	1-1/32	17/32	1-27/32	1-25/32	1-27/32	3-11/16	2-3/16	1-1/16	2-3/16	.21
D401-209	1-1/2x1-1/2x1/2	17/32	1-1/16	17/32	1-27/32	2-5/16	1-27/32	3-11/16	2-7/32	1-1/16	2-7/32	.23
401-210	1-1/2x1-1/2x3/4	21/32	1-3/32	21/32	1-31/32	2-3/32	1-31/32	3-29/32	2-7/32	1-5/16	2-7/32	.24
401-211	1-1/2x1-1/2x1	25/32	27/32	25/32	2-3/32	1-31/32	2-3/32	4-3/16	2-7/32	1-5/8	2-7/32	.28
401-212	1-1/2x1-1/2x1-1/4	1	1-3/16	1	2-9/32	2-7/16	2-9/32	4-19/32	2-1/4	2	2-1/4	.31
401-213	1-1/2x1-1/2x2	1-5/16	1-3/16	1-5/16	2-5/8	2-9/16	2-5/8	5-7/32	2-1/4	2-3/4	2-1/4	.39
401-214	1-1/2x1-1/2x2-1/2	1-21/32	1-3/16	1-21/32	2-31/32	2-15/16	2-31/32	5-15/16	2-1/4	3-11/32	2-1/4	.58
401-233	2x1x2	1-1/4	1-1/4	1-7/32	2-19/32	2-19/32	2-11/32	5	2-3/4	2-3/4	1-5/8	.40
401-238	2x1-1/2x3/4	21/32	1-13/32	21/32	2-1/32	2-13/32	1-31/32	4	2-23/32	1-5/16	2-1/4	.31
401-239	2x1-1/2x1	13/16	1-1/2	13/16	2-1/8	2-5/8	2-1/8	4-9/32	2-3/4	1-5/8	2-1/4	.38
401-241	2x1-1/2x1-1/2	1	1-9/32	1-1/32	2-3/8	2-9/16	2-5/16	4-11/16	2-23/32	2-7/32	2-7/32	.37
401-247	2x2x1/2	17/32	1-11/32	17/32	1-29/32	2-3/32	1-29/32	3-27/32	2-23/32	1-3/32	2-23/32	.30
D401-247	2x2x1/2	9/16	1-7/32	9/16	1-15/16	2-1/2	1-15/16	3-7/8	2-23/32	1-1/16	2-23/32	.31

REDUCING TEE (continued)

Socket x Socket x Socket

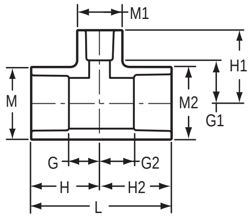


Part Number	Size	G	G1	G2	H	H1	H2	L	M	M1	M2	Approx. Wt. (Lbs.)
401-248	2x2x3/4	21/32	1-1/2	21/32	2-1/32	2-1/16	2-1/32	4-1/16	2-3/4	1-11/32	2-3/4	.32
401-249	2x2x1	13/16	1-3/8	13/16	2-3/16	2-1/2	2-3/16	4-3/8	2-23/32	1-5/8	2-23/32	.36
401-250	2x2x1-1/4	1	1-3/8	1	2-3/8	2-5/8	2-3/8	4-23/32	2-23/32	1-31/32	2-23/32	.39
401-251	2x2x1-1/2	1-1/16	1-5/16	1-1/16	2-3/8	2-9/16	2-3/8	4-3/4	2-23/32	2-1/4	2-23/32	.42
401-253[1]	2x2x3	2-7/8	1-13/16	2-7/8	4-1/4	3-13/16	4-1/4	8-1/2	4	4	3-15/16	2.64
401-254[1]	2x2x4	3-13/32	2-3/8	3-13/32	4-25/32	4-3/8	4-25/32	9-9/16	5-1/16	5-1/16	5-1/16	3.89
401-287	2-1/2x2-1/2x1/2	25/32	1-15/32	25/32	2-17/32	2-7/32	2-17/32	5-1/16	3-5/16	1-1/16	3-5/16	.56
401-288	2-1/2x2-1/2x3/4	7/8	1-9/16	7/8	2-5/8	2-1/2	2-5/8	5-9/32	3-5/16	1-5/16	3-5/16	.60
401-289	2-1/2x2-1/2x1	13/16	1-17/32	13/16	2-13/16	2-21/32	2-13/16	5-5/8	3-5/16	1-5/8	3-5/16	.67
401-290	2-1/2x2-1/2x1-1/4	1-7/32	1-21/32	1-7/32	2-31/32	2-29/32	2-31/32	5-31/32	3-11/32	2-1/32	3-11/32	.77
401-291	2-1/2x2-1/2x1-1/2	1-3/16	1-5/8	1-3/16	2-31/32	2-15/16	2-31/32	5-15/16	3-11/32	2-1/4	3-11/32	.76
401-292	2-1/2x2-1/2x2	1-13/32	1-21/32	1-13/32	3-3/16	3-1/32	3-3/16	6-3/8	3-5/16	2-3/4	3-5/16	.78
401-293[1]	2-1/2x2-1/2x3	2-1/4	1-31/32	2-1/4	4-1/4	3-13/16	4-1/4	8-15/32	4	4	4	2.37
401-294[1]	2-1/2x2-1/2x4	2-3/4	2-3/8	2-3/4	4-3/4	4-3/8	4-3/4	9-1/2	5-1/16	5	5-1/16	4.03
401-333	3x3x1/2	11/16	1-13/16	11/16	2-9/16	2-17/32	2-9/16	5-1/32	3-31/32	1-3/32	3-31/32	.76
401-334	3x3x3/4	3/4	2	3/4	2-21/32	3	2-21/32	5-9/32	4	1-11/32	4	.84
401-335	3x3x1	29/32	1-25/32	29/32	2-51/64	2-29/32	2-51/64	5-19/32	3-31/32	1-19/32	3-31/32	.85
401-336	3x3x1-1/4	1-7/32	1-31/32	1-7/32	2-31/32	3-7/32	2-31/32	5-15/16	4	2	4	.92
401-337	3x3x1-1/2	1-7/32	1-13/16	1-7/32	3-3/32	3-1/8	3-3/32	6-3/16	4-1/16	2-7/32	4-1/16	1.00
401-338	3x3x2-1/2	1-7/16	1-13/16	1-7/16	3-11/32	3-3/16	3-11/32	6-11/16	3-31/32	2-23/32	3-31/32	1.05
401-342	3x3x4	2-1/2	2-1/16	2-1/2	4-1/2	4-1/16	4-1/2	9	3-31/32	5	3-31/32	1.87
401-344[1]	3x3x6	5-1/2	4	5-1/2	7-1/2	7	7-1/2	15	7-1/4	7-1/4	7-1/4	11.75
401-416	4x4x3/4	25/32	2-9/32	25/32	2-13/16	3-9/32	2-13/16	5-5/8	5-3/32	1-5/16	5-3/32	1.24
401-417	4x4x1	13/16	2-9/16	13/16	2-13/16	3-5/8	2-13/16	5-19/32	5-1/32	1-19/32	5-1/32	1.19
401-418	4x4x1-1/4	1-1/16	2-9/32	1-1/16	3-3/32	3-17/32	3-3/32	6-3/16	5	1-31/32	5	1.33
401-419	4x4x1-1/2	1-3/16	2-17/32	1-3/16	3-3/16	3-27/32	3-3/16	6-13/32	5-1/16	2-1/4	5-1/16	1.40
401-420	4x4x2	1-13/32	2-3/4	1-13/32	3-7/16	4-5/32	3-7/16	6-7/8	5-1/32	2-3/4	5-1/32	1.49
401-421[1]	4x4x2-1/2	1-31/32	3-3/32	2-1/32	4-3/32	4-27/32	4-3/32	8-5/32	5-5/32	4-1/16	5-5/32	2.67
401-422	4x4x3	2-1/32	2-5/8	2-1/32	4-3/32	4-1/2	4-3/32	8-5/32	5-5/32	4-1/16	5-5/32	2.31
401-426[1]	4x4x6	5-1/2	3-1/2	5-1/2	7-1/2	7	7-1/2	14-15/16	6-7/8	7-1/2	6-7/8	10.38
401-428[1]	4x4x8	6-3/4	4-1/2	6-3/4	8-3/4	8-1/2	8-3/4	17-1/2	9-1/4	9-5/8	9-5/8	18.30
401-486	5x5x2	1-11/32	3-1/32	1-11/32	4-23/64	4-13/32	4-23/64	8-23/32	6-1/8	2-23/32	6-1/8	2.39
401-487[1]	5x5x2-1/2	2	3-5/8	2	5-1/32	5-3/8	5-1/32	10-1/16	6-5/32	4-1/32	6-5/32	3.63
401-488	5x5x3	2	3-3/16	2	5-1/32	5-1/16	5-1/32	10-1/16	6-5/32	4-1/32	6-5/32	3.23
401-490	5x5x4	2-1/2	3-5/32	2-1/2	5-9/16	5-3/16	5-9/16	11-1/8	6-5/32	5-1/32	6-5/32	3.61
401-526[1]	6x6x1-1/4	1-3/8	4-1/16	1-3/8	4-27/32	5-5/16	4-27/32	9-11/16	7-1/4	2-3/4	7-1/4	3.61

[1] Outlet sized with bushing

REDUCING TEE (continued)

Socket x Socket x Socket

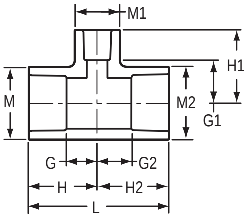


Part Number	Size	G	G1	G2	H	H1	H2	L	M	M1	M2	Approx. Wt. (Lbs.)
401-527[1]	6x6x1-1/2	1-3/8	3-7/8	1-3/8	4-27/32	5-3/16	4-27/32	9-11/16	7-1/4	2-11/16	7-1/4	3.60
401-528	6x6x2	1-13/32	3-5/8	1-13/32	4-13/32	4-31/32	4-13/32	8-27/32	7-1/4	2-3/4	7-1/4	3.28
401-529	6x6x2-1/2	2	3-15/16	2	5-1/2	5-15/16	5-1/2	10-15/16	7-3/16	3-15/16	7-3/16	4.29
401-530	6x6x3	1-31/32	3-5/8	1-31/32	4-31/32	5-1/2	4-31/32	10	7-1/4	4	7-1/4	3.90
401-532	6x6x4	2-3/32	3-5/8	2-3/32	5-9/16	5-5/8	5-9/16	11-1/8	7-7/32	5	7-7/32	4.35
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
401-622F	10x10x2-1/2	5-5/8	7-3/4	5-5/8	10-7/8	9-3/4	10-7/8	21-3/4	11-1/2	3-1/4	11-1/2	20.26
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
401-626F	10x10x6	6-7/8	8-3/8	6-7/8	12-1/8	11-5/8	12-1/8	24-1/4	11-1/2	7-3/16	11-1/2	26.48
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	13-9/16	2-11/16	13-1/2	25.00
401-662F	12x12x2-1/2	5-3/4	8-3/4	5-3/4	12	10-3/4	12	24	13-9/16	3-1/4	13-9/16	28.61
401-663F	12x12x3	5-3/4	9	5-3/4	12	11-1/4	12	24	13-9/16	3-15/16	13-9/16	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	5-7/8	8-13/16	5-7/8	12-7/8	10-9/16	12-7/8	25-3/4	14-7/8	2-11/16	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	7-3/8	9-7/8	7-3/8	14-3/8	12-1/8	14-3/8	28-3/4	14-7/8	5	14-7/8	38.58
401-696F	14x14x6	7-7/8	9-15/16	7-7/8	14-7/8	13-3/16	14-7/8	29-3/4	14-7/8	7-3/16	14-7/8	45.70
401-698F	14x14x8	8-7/8	9-7/8	8-7/8	15-7/8	14-1/8	15-7/8	31-3/4	14-7/8	9-1/4	14-7/8	51.99

[1] Outlet sized with bushing

REDUCING TEE **(continued)**

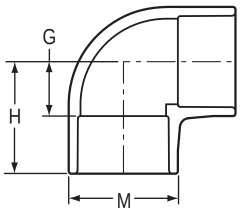
Socket x Socket x Socket



Part Number	Size	G	G1	G2	H	H1	H2	L	M	M1	M2	Approx. Wt. (Lbs.)
401-700F	14x14x10	10-3/8	10-15/16	10-3/8	17-3/8	16-3/16	17-3/8	34-3/4	14-7/8	11-1/2	14-7/8	61.56
401-702F	14x14x12	11-3/8	10-3/4	11-3/8	18-3/8	17	18-3/8	36-3/4	14-7/8	13-9/16	14-7/8	62.78
401-751F	16x16x2	6-3/8	9-3/4	6-3/8	14-3/8	11-1/2	14-3/8	28-3/4	17	2-11/16	17	51.76
401-753F	16x16x3	6-1/2	10-1/2	6-1/2	14-1/2	12-3/4	14-1/2	29	17	3-15/16	17	57.67
401-754F	16x16x4	8	10-13/16	8	16	13-1/16	16	32	17	5	17	58.90
401-756F	16x16x6	9	10-7/8	9	17	14-1/8	17	34	17	7-3/16	17	66.52
401-758F	16x16x8	10	10-13/16	10	18	15-1/16	18	36	17	9-1/4	17	73.17
401-760F	16x16x10	11	11-7/8	11	19	17-1/8	19	38	17	11-1/2	17	73.88
401-762F	16x16x12	12	11-11/6	12	20	17-15/16	20	40	17	13-9/16	17	85.48
401-764F	16x16x14	13	11-15/16	13	21	18-15/16	21	42	17	14-7/8	17	95.95
401-781F	18x18x2	6-1/4	10-11/16	6-1/4	15-1/4	12-7/16	15-1/4	30-1/2	19-1/8	2-11/16	19-1/8	65.63
401-783F	18x18x3	7-1/4	11-7/16	7-1/4	16-1/4	13-11/16	16-1/4	32-1/2	19-1/8	3-15/16	19-1/8	---
401-784F	18x18x4	7-3/4	11-3/4	7-3/4	16-3/4	14	16-3/4	33-1/2	19-1/8	5	19-1/8	82.00
401-786F	18x18x6	8-3/4	11-13/16	8-3/4	17-3/4	15-1/16	17-3/4	35-1/2	19-1/8	7-3/16	19-1/8	88.04
401-788F	18x18x8	9-3/4	11-3/4	9-3/4	18-3/4	16	18-3/4	37-1/2	19-1/8	9-1/4	19-1/8	107.00
401-790F	18x18x10	10-3/4	12-13/16	10-3/4	19-3/4	18-1/16	19-3/4	39-1/2	19-1/8	11-1/2	19-1/8	105.41
401-792F	18x18x12	11-3/4	12-5/8	11-3/4	20-3/4	18-7/8	20-3/4	41-1/2	19-1/8	13-9/16	19-1/8	113.48
401-794F	18x18x14	12-7/8	12-7/8	12-7/8	21-7/8	19-7/8	21-7/8	43-3/4	19-1/8	14-7/8	19-1/8	116.67
401-796F	18x18x16	13-7/8	13-13/16	13-7/8	22-7/8	21-13/16	22-7/8	45-3/4	19-1/8	17	19-1/8	134.41
401-811F	20x20x2	6-3/4	12-7/16	6-3/4	16-3/4	14-3/16	16-3/4	33-1/2	21-3/16	21-11/16	21-3/16	81.39
401-813F	20x20x3	7-1/4	12-7/16	7-1/4	17-1/4	14-11/16	17-1/4	34-1/2	21-3/16	3-15/16	21-3/16	91.14
401-814F	20x20x4	8-1/4	12-3/4	8-1/4	18-1/4	15	18-1/4	36-1/2	21-3/16	5	21-3/16	72.10
401-816F	20x20x6	9-1/4	12-13/16	9-1/4	19-1/4	16-1/16	19-1/4	38-1/2	21-3/16	7-3/16	21-3/16	106.19
401-818F	20x20x8	10-1/4	12-3/4	10-1/4	20-1/4	17	20-1/4	40-1/2	21-3/16	9-1/4	21-3/16	115.35
401-820F	20x20x10	11-1/4	13-13/16	11-1/4	21-1/4	19-1/16	21-1/4	42-1/2	21-3/16	11-1/2	21-3/16	125.44
401-822F	20x20x12	12-1/4	13-5/8	12-1/4	22-1/4	19-7/8	22-1/4	44-1/2	21-3/16	13-9/16	21-3/16	129.36
401-824F	20x20x14	13-1/4	13-7/8	13-1/4	23-1/4	20-7/8	23-1/4	46-1/2	21-3/16	14-7/8	21-3/16	123.55
401-826F	20x20x16	14-1/4	14-13/16	14-1/4	24-1/4	22-13/16	24-1/4	48-1/2	21-3/16	17	21-3/16	154.48
401-828F	20x20x18	15-1/4	14-3/8	15-1/4	25-1/4	23-3/8	25-1/4	50-1/2	21-3/16	19-1/8	21-3/16	176.98
401-901F	24x24x2	8-1/8	14-5/16	8-1/8	20-1/8	16-1/16	20-1/8	40-1/4	25-3/8	2-11/16	25-3/8	156.00
401-903F	24x24x3	8-5/8	14-5/16	8-5/8	20-5/8	16-9/16	20-5/8	41-1/4	25-3/8	3-15/16	25-3/8	161.00
401-904F	24x24x4	9-1/8	14-5/8	9-1/8	21-1/8	16-7/8	21-1/8	42-1/4	25-3/8	5	25-3/8	148.46
401-906F	24x24x6	10-1/8	14-11/16	10-1/8	22-1/8	17-15/16	22-1/8	44-1/4	25-3/8	7-3/16	25-3/8	159.56
401-908F	24x24x8	11-1/8	14-5/8	11-1/8	23-1/8	18-7/8	23-1/8	46-1/4	25-3/8	9-1/4	25-3/8	171.52
401-910F	24x24x10	12-1/8	15-11/16	12-1/8	24-1/8	20-15/16	24-1/8	48-1/4	25-3/8	11-1/2	25-3/8	213.94
401-912F	24x24x12	13-1/8	15-1/2	13-1/8	25-1/8	21-3/4	25-1/8	50-1/4	25-3/8	13-9/16	25-3/8	199.98

90° ELBOW

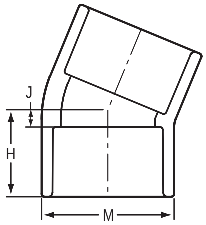
Socket x Socket



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	1-1/8	.05
406-007	3/4	9/16	1-1/2	1-11/32	.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	2-11/32	2-1/4	.25
406-020	2	1-15/32	2-27/32	2-3/4	.42
406-025	2-1/2	1-1/2	3-1/4	3-11/32	.73
406-030	3	1-27/32	3-23/32	4	1.03
406-040	4	2-13/32	4-13/32	5-1/32	1.73
406-045F	4-1/2	8-5/8	6-1/8	5-7/16	3.13
406-050	5	3-1/16	6-1/8	6-5/32	3.58
406-060	6	3-17/32	6-9/16	7-9/32	4.52
406-080	8	4-7/16	8-15/32	9-11/32	8.70
406-100	10	5-13/16	10-27/32	11-19/32	15.75
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

22-1/2° ELBOW

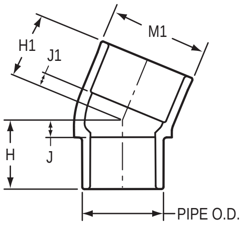
Socket x Socket



Part Number	Size	H	J	M	Approx. Wt. (Lbs.)
416-005	1/2	1-1/16	3/16	1-5/32	.06
416-007	3/4	1-3/16	3/16	1-7/16	.09
416-010	1	1-3/8	9/32	1-23/32	.13
416-012	1-1/4	1-1/2	11/32	2-3/32	.21
416-015	1-1/2	1-11/32	11/32	2-11/32	.26
416-020	2	1-23/32	3/8	2-25/32	.24
416-025	2-1/2	2-1/4	1/2	3-1/2	.69
416-025F	2-1/2	2-13/16	13/16	3-1/4	.63
416-030	3	2-13/32	9/16	4-5/32	.83
416-040	4	2-27/32	19/32	5-3/16	1.69
416-045F	4-1/2	3-9/16	1-1/16	5-7/16	1.59
416-050F	5	4-1/8	1-1/8	6-1/16	2.27
416-060	6	4-9/16	1-9/32	7-3/16	4.39
416-060F	6	4-5/8	1-3/8	7-3/16	3.25
416-080	8	5-7/8	1-3/4	9-3/4	8.38
416-080F	8	5-13/16	1-9/16	9-1/4	5.73
416-100F	10	7-7/16	2-3/16	11-1/2	10.04
416-120F	12	8-1/2	2-1/4	13-9/16	15.74
416-140F	14	9-1/2	2-1/2	15	19.69
416-160F	16	11-1/4	3-1/4	17	30.98
416-180F	18	13-1/2	4-1/2	19-3/16	45.38
416-200F	20	14-1/2	4-1/2	21-3/16	59.07
416-240F	24	16-1/8	5-1/8	25-1/2	98.64

22-1/2° STREET ELBOW

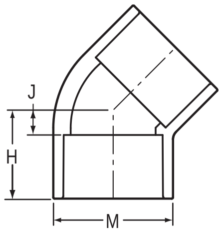
Spigot x Socket



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	1-21/32	1-7/8	9/32	1/2	2-3/8	.26
442-020	2	2	1-29/32	15/32	13/32	2-7/8	.40
442-025F	2-1/2	4-9/16	1-13/16	13/16	3/16	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

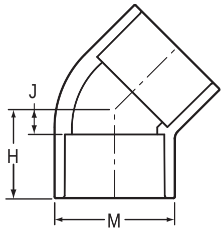
Socket x Socket



Part Number	Size	H	J	M	Approx. Wt. (Lbs.)
417-005	1/2	1-1/8	11/32	1-3/32	.04
417-007	3/4	1-3/8	7/16	1-5/16	.07
417-010	1	1-1/2	15/32	1-21/32	.11
417-012	1-1/4	1-19/32	3/8	1-31/32	.15
417-015	1-1/2	1-29/32	19/32	2-1/4	.22
417-020	2	2-1/16	11/16	2-3/4	.31
417-025	2-1/2	2-7/16	21/32	3-11/32	.56
417-030	3	2-27/32	27/32	4	.84
417-040	4	3-3/32	1-3/32	5-1/32	1.22
417-045F	4-1/2	4-3/16	1-11/16	5-7/16	1.59
417-050	5	4-3/8	1-3/8	6-1/16	2.41
417-060	6	4-3/4	1-11/16	7-9/32	3.47
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

45° ELBOW **(continued)**

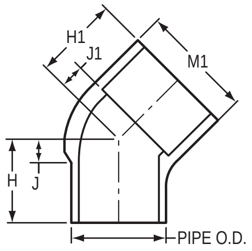
Socket x Socket



Part Number	Size	H	J	M	Approx. Wt. (Lbs.)
417-120	12	9-19/32	3-3/32	14-5/16	34.15
417-120F	12	9-19/32	3-11/32	13-9/16	17.39
417-140F	14	10-7/8	3-7/8	14-7/8	24.61
417-160F	16	12-1/2	4-1/2	17	34.85
417-180F	18	14-7/8	5-7/8	19-1/8	52.10
417-200F	20	16-1/2	6-1/2	21-3/16	68.92
417-240F	24	19-7/8	7-7/8	25-1/2	112.34

45° STREET ELBOW

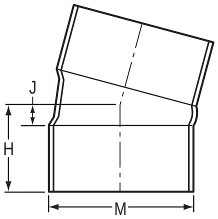
Spigot x Socket



Part Number	Size	H	H1	J	J1	M1	Approx. Wt. (Lbs.)
427-005	1/2	1-9/32	1-9/32	11/32	13/32	1-3/16	.06
427-007	3/4	1-1/2	1-17/32	7/16	17/32	1-13/32	.09
427-010	1	1-19/32	1-21/32	13/32	17/32	1-23/32	.10
427-012	1-1/4	1-25/32	1-29/32	1/2	21/32	2-3/32	.22
427-015	1-1/2	2-1/32	2-3/32	19/32	23/32	2-11/32	.19
427-020	2	2	2	5/8	15/32	2-23/32	.30
427-025	2-1/2	2-5/8	2-5/8	3/4	7/8	3-11/32	.59
427-030	3	2-31/32	3-1/32	1	1-7/32	4-5/32	1.19
427-040	4	3-21/32	3-13/16	1-9/32	1-9/16	5-3/16	2.07
427-050	5	6-1/8	4-3/8	2-7/8	1-3/8	6-1/16	3.49
427-060	6	5-1/4	6-1/4	1-3/4	3	7-5/8	6.16
427-080	8	6-5/8	5-31/32	2-19/32	1-3/4	9-3/4	10.60

15° ELBOW

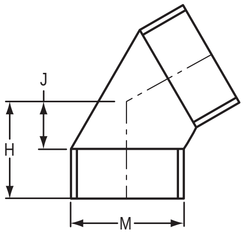
Socket x Socket



Part Number	Size	H	J	M	Approx. Wt. (Lbs.)
418-005F	1/2	1-5/16	5/16	1-1/16	.05
418-007F	3/4	1-5/16	5/16	1-1/4	.07
418-010F	1	1-5/8	3/8	1-9/16	.11
418-012F	1-1/4	2	1/2	1-15/16	.14
418-015F	1-1/2	2	1/2	2-3/16	.20
418-020F	2	2-5/16	9/16	2-11/16	.34
418-025F	2-1/2	2-3/4	3/4	3-1/4	.57
418-030F	3	3	3/4	3-15/16	.82
418-040F	4	3	13/16	5	1.39
418-045F	4-1/2	3-3/8	7/8	5-7/16	1.36
418-050F	5	3-7/8	7/8	6-1/16	1.88
418-060F	6	4-3/8	1-1/8	7-3/16	2.95
418-080F	8	5-1/2	1-1/4	9-1/4	5.29
418-100F	10	6-31/32	1-19/32	11-1/2	9.42
418-120F	12	8-1/4	2	13-9/16	14.91
418-140F	14	9-1/8	2-1/8	15	19.69
418-160F	16	10-5/8	2-5/8	17	29.69
418-180F	18	12-1/4	3-1/4	19-1/8	43.70
418-200F	20	13-5/8	3-5/8	21-1/4	57.11
418-240F	24	14-7/8	3-7/8	25-1/2	90.42

60° ELBOW

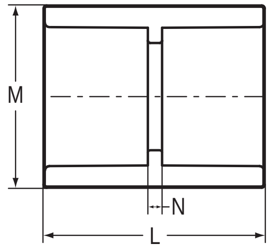
Socket x Socket



Part Number	Size	H	J	M	Approx. Wt. (Lbs.)
424-005F	1/2	1-5/8	5/8	1-1/16	.13
424-007F	3/4	1-11/16	11/16	1-1/4	.07
424-010F	1	2	3/4	1-9/16	.17
424-012F	1-1/4	2-1/2	1	1-15/16	.38
424-015F	1-1/2	2-9/16	1-1/16	2-3/16	.27
424-020F	2	2-15/16	1-3/16	2-11/16	.59
424-025F	2-1/2	3-1/2	1-1/2	3-1/4	1.38
424-030F	3	3-5/8	1-3/8	3-15/16	1.70
424-040F	4	4-1/4	2	5	1.52
424-045F	4-1/2	4-5/8	2-1/8	5-7/16	2.96
424-050F	5	5-5/16	2-5/16	6-1/16	2.42
424-060F	6	6-1/16	2-13/16	7-3/16	6.20
424-080F	8	7-5/8	3-3/8	9-1/4	11.89
424-100F	10	9-1/4	4	11-1/2	20.09
424-120F	12	11	4-3/4	13-9/16	31.47
424-140F	14	17-1/2	10-1/2	15	42.32
424-160F	16	20-1/4	12-1/4	17	36.39
424-180F	18	22-7/8	13-7/8	19-3/16	94.11
424-200F	20	26-1/4	16-1/4	21-1/4	122.09
424-240F	24	31	20	25-1/2	199.58

COUPLING **(continued)**

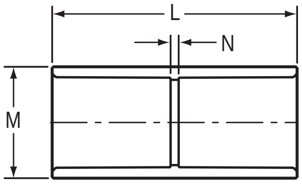
Socket x Socket



Part Number	Size	L	M	N	Approx. Wt. (Lbs.)
429-007	3/4	2-3/32	1-5/16	3/32	.05
429-007N	3/4	2-3/32	1-5/16	3/32	.05
429-010	1	2-1/8	1-19/32	1/8	.07
429-010N	1	2-11/32	1-21/32	3/32	.10
429-012	1-1/4	2-11/32	1-31/32	3/32	.11
429-015	1-1/2	2-5/8	2-7/32	1/16	.13
429-020	2	2-7/8	2-3/4	3/32	.21
429-025	2-1/2	3-3/4	3-5/16	3/16	.41
429-030	3	3-31/32	4	3/16	.57
429-040	4	4-1/4	5-1/32	3/16	.85
429-045F	4-1/2	6-7/8	5-7/16	1-7/8	1.43
429-050	5	6-3/16	6-1/8	3/16	1.67
429-060	6	6-5/16	7-1/4	1/4	2.11
429-080	8	8-11/32	9-11/32	1/4	4.22
429-100	10	10-3/8	11-9/16	15/32	7.24
429-100F	10	12-3/8	11-1/2	1-7/8	8.16
429-120	12	12-3/8	13-21/32	3/8	11.68
429-120F	12	14-3/4	13-9/16	2-1/4	13.25
429-140	14	14-13/32	15-5/8	7/16	27.27
429-140F	14	16-1/4	14-7/8	2-1/4	18.22
429-160F	16	18-5/8	17	2-5/8	23.23
429-180F	18	21-3/4	19-1/8	3-3/4	38.65
429-200F	20	24	21-3/16	4	48.63
429-240F	24	29-1/4	25-3/8	5-1/4	82.20

DEEP SOCKET COUPLING

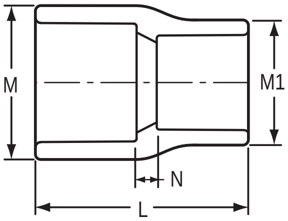
Socket x Socket



Part Number	Size	L	M	N	Approx. Wt. (Lbs.)
479-005N	1/2	2-1/2	1-1/16	3/16	.04
479-007	3/4	2-7/8	1-5/16	3/32	.07
479-010	1	3-5/8	1-5/8	3/32	.13
479-015	1-1/2	4-5/8	2-1/4	1/8	.24
479-020	2	5-3/32	2-3/4	3/32	.36
479-025	2-1/2	7-1/2	3-5/16	1/4	.79
479-030	3	8	4	1/4	1.06
479-040	4	8-3/16	5	5/16	1.53
479-045F	4-1/2	9-1/2	5-7/16	1-1/2	1.92
479-060F	6	12	7-3/16	1-1/2	3.72

REDUCER COUPLING

Socket x Socket

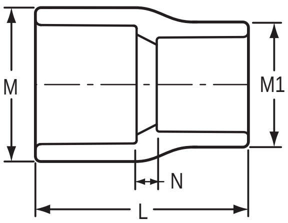


Part Number	Size	L	M	M1	N	Approx. Wt. (Lbs.)
429-101	3/4x1/2	1-25/32	1-5/16	1-3/32	1/8	.04
429-130	1x1/2	2-7/32	1-5/8	1-3/32	13/32	.07
429-131	1x3/4	2-1/8	1-5/8	1-5/16	1/8	.07
429-166	1-1/4x1/2	2-9/16	2-3/32	1-5/32	7/16	.13
429-168	1-1/4x1	2-11/16	2-1/8	1-3/4	5/16	.17
429-210	1-1/2x3/4	2-13/16	2-11/32	1-13/32	7/16	.19
429-211	1-1/2x1	2-23/32	2-7/32	1-5/8	3/8	.13
429-212	1-1/2x1-1/4	2-13/16	2-13/32	2-1/8	5/32	.22
429-247	2x1/2	3-3/32	2-7/8	1-5/32	11/16	.30
429-248	2x3/4	3-7/32	2-7/8	1-13/32	23/32	.30
429-249	2x1	3-1/2	2-13/16	2-5/16	3/4	.41
429-250[1]	2x1-1/4	3-1/16	2-23/32	2-1/4	13/32	.25
429-251	2x1-1/2	2-13/16	2-27/32	2-1/4	1/8	.19
429-291	2-1/2x1-1/2	3-3/4	3-1/2	2-3/8	19/32	.52
429-292	2-1/2x2	3-5/8	3-15/32	2-7/8	7/16	.48
429-335[1]	3x1	4-3/16	4-5/32	2-7/8	1-1/4	.91
429-337[1]	3x1-1/2	4-3/16	4-5/32	2-29/32	1	.87

[1] Outlet sized with bushing

REDUCER COUPLING **(continued)**

Socket x Socket



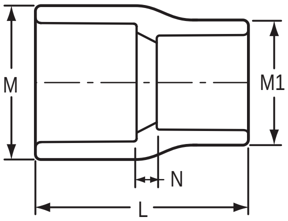
Part Number	Size	L	M	M1	N	Approx. Wt. (Lbs.)
429-338	3x2	4	4-3/16	2-7/8	21/32	.73
429-339[1]	3x2-1/2	4-5/16	4	4	21/32	.95
429-340F	3x2-1/2	5-5/8	3-7/8	3-1/4	1-3/8	.68
429-416[1]	4x3/4	5-7/32	5-1/32	2-25/32	2-3/16	1.04
429-417	4x1	5-1/4	5-1/32	2-25/32	2-5/32	1.04
429-420	4x2	5	5-1/32	2-23/32	1-9/16	.83
429-421	4x2-1/2	5	5-1/4	4-1/8	3/4	1.63
429-422	4x3	4-5/8	5-1/4	4-5/32	15/32	1.25
429-422F	4x3	6-1/2	4-15/16	3-15/16	2	1.04
429-460F	4-1/2x4	6-11/16	5-7/16	5	1-15/16	1.39
429-488F	5x3	8	6-1/16	5-1/4	3-1/8	2.29
429-490F	5x4	7-11/16	6-1/16	5	2-7/16	1.60
429-491F	5x4-1/2	7-7/16	6-1/16	5-7/16	1-15/16	1.59
429-528F	6x2	9-1/4	7-1/8	5-1/16	4-5/8	2.75
429-530F	6x3	9-3/16	7-1/8	5-1/4	4-1/16	2.89
429-532	6x4	6-15/32	7-1/4	5-1/32	1-11/32	2.05
429-532F	6x4	8-7/8	7-1/8	5	3-3/8	1.80
429-533F	6x5	8-5/8	7-1/8	6-1/16	2-3/8	2.50
429-534F	6x4-1/2	8-11/16	7-1/8	5-7/16	2-15/16	2.05
429-578F	8x2	14-7/8	9-3/16	5	9-1/4	5.75
429-580F	8x3	14-13/16	9-3/16	5	8-11/16	5.71
429-582	8x4	8-7/16	9-11/32	5-1/16	2-11/32	4.02
429-582F	8x4	14-1/2	9-3/16	5	8	5.11
429-583F	8x5	14-1/4	9-3/16	6-1/16	7	5.07
429-585	8x6	8-13/32	9-11/32	7-9/32	1-11/32	4.07
429-585F	8x6	11	9-3/16	7-3/16	3-1/2	4.63
429-621F	10x2	17-5/8	11-3/8	5	11	8.15
429-623F	10x3	17-9/16	11-3/8	5	10-7/16	7.97
429-624	10x4	10-7/16	11-17/32	5-1/16	3-11/32	7.40
429-624F	10x4	17-1/4	11-3/8	5	9-3/4	7.18
429-625F	10x5	17	11-3/8	6-1/16	8-3/4	7.31
429-626	10x6	10-7/16	11-9/16	7-9/32	2-1/4	7.11
429-626F	10x6	13-7/8	11-3/8	7-1/4	5-3/8	6.61
429-628	10x8	10-7/16	11-5/8	9-3/8	1-3/8	7.07
429-628F	10x8	13-1/4	11-9/16	9-7/16	3-3/4	8.95
429-661F	12x2	24-3/8	13-9/16	5	16-3/4	19.16
429-663F	12x3	24-5/16	13-9/16	5	16-3/16	14.92
429-664F	12x4	24	13-9/16	5	15-1/2	15.20
429-665F	12x5	23-3/4	13-9/16	6-1/16	14-1/2	21.03

[1] Outlet sized with bushing

NOT FOR DISTRIBUTION OF COMPRESSED AIR OR GAS

REDUCER COUPLING **(continued)**

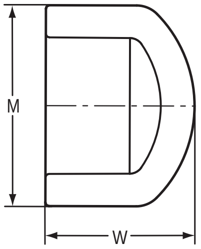
Socket x Socket



Part Number	Size	L	M	M1	N	Approx. Wt. (Lbs.)
429-666	12x6	12-13/32	13-21/32	7-9/32	3-9/32	10.73
429-666F	12x6	20-1/2	13-9/16	7-1/4	11	14.23
429-668	12x8	12-13/32	13-21/32	9-3/8	2-1/4	10.58
429-668F	12x8	15-3/4	13-9/16	9-7/16	5-1/4	12.31
429-670	12x10	12-3/8	13-21/32	11-19/32	1-9/32	10.84
429-670F	12x10	15-1/8	13-9/16	11-9/16	3-5/8	13.16
429-693F	14x3	26-3/16	14-13/16	5	17-5/16	39.67
429-694F	14x4	25-7/8	14-13/16	5	16-5/8	20.57
429-696F	14x6	22-3/8	14-13/16	7-1/4	12-1/8	20.57
429-698F	14x8	21-13/16	14-3/4	9-1/4	10-9/16	18.37
429-700F	14x10	17	14-13/16	11-9/16	4-3/4	15.36
429-702F	14x12	16-1/2	15	13-3/4	3-1/4	19.59
429-751F	16x2	32-7/8	17	5	23-1/2	33.96
429-754F	16x4	32-1/2	17	5	22-1/4	33.96
429-756F	16x6	29	17	7-3/16	17-3/4	33.53
429-758F	16x8	24-3/4	17	9-7/16	12-1/2	33.90
429-760F	16x10	24	17	11-9/16	10-3/4	35.66
429-762F	16x12	18-7/8	17	13-3/4	4-5/8	22.40
429-764F	16x14	18-1/2	16-7/8	14-7/8	3-1/2	21.66
429-786F	18x6	38	19	7-3/16	25-3/4	60.39
429-788F	18x8	33-3/4	19	9-7/16	20-1/2	43.61
429-790F	18x10	33	19	11-9/16	18-3/4	46.43
429-792F	18x12	27-7/8	19	13-5/8	12-5/8	44.78
429-794F	18x14	27-1/2	19	14-7/8	11-1/2	43.23
429-796F	18x16	21-5/8	19	17	4-5/8	30.98
429-814F	20x4	50-1/2	21-1/8	5	38-1/4	---
429-816F	20x6	47	21-1/8	7-3/16	33-3/4	74.45
429-818F	20x8	42-3/4	21-1/8	9-7/16	28-1/2	97.93
429-820F	20x10	42	21-1/8	11-9/16	26-3/4	82.76
429-822F	20x12	36-7/8	21-1/8	13-3/4	20-5/8	74.24
429-824F	20x14	36-1/2	21-3/8	14-7/8	19-1/2	71.00
429-826F	20x16	30-5/8	21-1/8	17	12-5/8	58.53
429-828F	20x18	23-1/4	21-1/8	19-1/8	4-1/4	45.38
429-906F	24x6	59-1/4	25-3/16	7-3/16	44	120.00
429-908F	24x8	55	25-3/16	9-7/16	38-3/4	124.96
429-910F	24x10	54-1/4	25-3/16	11-9/16	37	126.88
429-912F	24x12	49-1/8	25-3/16	13-3/4	30-7/8	120.00
429-914F	24x14	48-3/4	25-3/16	14-7/8	29-3/4	111.51
429-916F	24x16	42-7/8	25-3/16	17	22-7/8	107.16

CAP

Socket

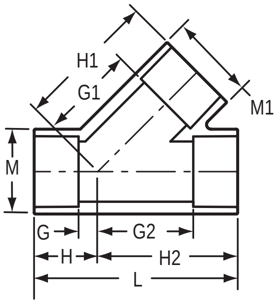


Part Number	Size	M	W	Approx. Wt. (Lbs.)
447-003	3/8	7/8	1	.01
447-005	1/2	1-3/32	1-1/16	.02
447-007	3/4	1-5/16	1-5/16	.04
447-010	1	1-9/16	1-9/16	.06
447-012	1-1/4	1-31/32	1-3/4	.09
447-015	1-1/2	2-1/4	1-29/32	.12
447-020	2	2-23/32	2-1/32	.17
447-025	2-1/2	3-5/16	2-9/16	.33
447-030	3	4	2-29/32	.49
447-040	4	5-1/16	3-1/8	.79
447-045F	4-1/2	5-7/16	3-5/8	.31
447-050	5	6-1/8	4-13/32	1.43
447-060	6	7-1/4	5	2.34
447-080	8	9-9/16	6-3/8	4.26
447-100F	10	11-13/16	5-1/4	5.22
447-120F	12	13-7/8	6-7/8	8.22
447-140F	14	15	7-3/8	8.75
447-160F	16	17-1/16	8-1/2	12.15
447-180F	18	19-1/8	9	17.58
447-200F	20	21-3/16	12-1/4	26.48
447-240F	24	25-5/16	14-1/8	40.26

WYE

Socket x Socket x Socket

Pressure Rating
1/2" -2" 235 psi @ 73°F
2-1/2" -6" 150 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	5/16	1-3/8	1-3/8	1-5/16	2-3/8	2-3/8	3-23/32	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[1]	2-1/2	1-3/16	5-1/8	4-23/32	2-15/16	6-7/8	6-15/32	9-13/32	4-3/16	4-3/16	3.77
475-030	3	11/16	4-23/32	4-1/4	2-9/16	6-5/8	6-1/8	8-23/32	4-3/16	4-3/16	2.63
475-040	4	1-7/32	5-23/32	5	3-1/2	7-31/32	7-1/4	10-3/4	5-1/4	5-1/4	4.87
475-050F	5	3-3/4	9-3/8	9-3/8	6-3/4	12-3/8	12-3/8	19-1/8	6-1/16	6-1/16	13.26
475-060	6	1-5/32	8-25/32	8-3/16	4-3/16	11-25/32	11-3/16	15-3/8	7-9/16	7-9/16	12.01
475-080	8	1-15/16	11-11/32	11-11/32	5-31/32	15-11/32	15-11/32	21-5/16	9-3/4	9-3/4	25.44
475-080F	8	5-5/8	14-5/16	14-5/16	9-7/8	18-9/16	18-9/16	28-7/16	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	6-9/16	17-1/4	17-1/4	11-13/16	22-1/2	22-1/2	34-5/16	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	7-5/16	20-1/16	20-1/16	13-9/16	26-5/16	26-5/16	39-7/8	13-9/16	13-9/16	63.02
475-140F	14	7-3/16	21-3/16	21-3/16	14-3/16	28-3/16	28-3/16	42-3/8	14-7/8	14-7/8	90.24
475-160F	16	8-3/4	24-3/4	24-3/4	16-3/4	32-3/4	32-3/4	49-1/2	17	17	93.06
475-180F	18	9-7/16	27-7/16	27-7/16	18-7/16	36-7/16	36-7/16	54-7/8	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	35	35	23	47	47	70	25-3/8	25-3/8	420.00

[1] Outlet sized with bushing

NOT FOR DISTRIBUTION OF COMPRESSED AIR OR GAS

SPEARS®

THERMOPLASTIC FLANGES
MOLDED & FABRICATED

MADE IN THE U.S.A. WITH PRIDE

TECHNICAL INFORMATION
WEIGHTS & DIMENSIONS

SPEARS® MANUFACTURING COMPANY
Since 1969
SYLMAR, CALIFORNIA

Visit our web site
www.spearsmfg.com

GENERAL INFORMATION

Recommendations For Installers And Users

Plastic piping systems should be ENGINEERED, INSTALLED, and OPERATED in accordance with ESTABLISHED DESIGN AND ENGINEERING STANDARDS AND PROCEDURES for plastic piping systems. Suitability for the intended service application should be determined by the installer and /or user prior to installation of a plastic piping system. PRIOR TO ASSEMBLY, **all piping system components should be inspected for damage or irregularities. Mating components should be checked to assure that tolerances and engagements are compatible. Do not use any components that appear irregular or do not fit properly. Contact the appropriate manufacturer of the component product in question to determine usability.**

Solvent Weld Connections — Use quality solvent cements and primers formulated for the intended service application, pipe size and type of joint. While the pipe and fitting materials may be compatible with the intended medium, the solvent cement may not be. Consult the manufacturer for suitability of use. Read and follow the cement and primer manufacturers' applications and cure time instructions thoroughly. Be sure to use the correct size applicator.

Threaded Connections — Use a quality grade thread sealant. **WARNING:** SOME PIPE JOINT COMPOUNDS OR PTFE PASTES MAY CONTAIN SUBSTANCES THAT COULD CAUSE STRESS CRACKING TO PLASTIC. Spears® Manufacturing Company recommends the use of Spears® Blue 75™ thread sealant which has been tested for compatibility with Spears® products. Please follow the sealant manufacturer's application/installation instructions. Choice of an appropriate thread sealant other than those listed above is at the discretion of the installer. 1 to 2 turns beyond FINGER TIGHT is generally all that is required to make a sound plastic thread connection. Unnecessary OVERTIGHTENING will cause DAMAGE TO BOTH PIPE AND FITTING.

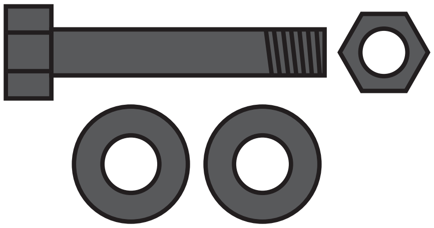
"Lead Free" low lead certification – unless otherwise specified, all Spears® Thermoplastic Flanges specified here-in are certified by NSF International to ANSI/NSF® Standard 61, Annex G and is in compliance with California's Health & Safety Code Section 116825 (commonly known as AB1953) and Vermont Act 193. Weighted average lead content <=0.25%.

Bolt Kit Selection Guide

Bolt Hardware Kits Available
For Connection of 2-Spears® Flanges
Includes Bolts, Nuts & Flat Washers for Specified Flange Size

Order Gaskets & Bolt Kits Separately

- Pre-coated, Anti-seize Lubricated Bolts
- Available in Zinc Coated Steel, Type 316 Stainless Steel or Type 304 Stainless Steel



Flange Size	Bolts* Per Kit	Diameter (in.-TPI)	Length (in.)	Kit Part Number		
				Zinc	316 SS	304 SS
1/2 & 3/4	4	1/2 - 13	2	HK-005	HK1-005	HK2-005
1 & 1-1/4	4	1/2 - 13	2-1/4	HK-010	HK1-010	HK2-010
1-1/2	4	1/2 - 13	2-1/2	HK-015	HK1-015	HK2-015
2	4	5/8 - 11	3	HK-020	HK1-020	HK2-020
2-1/2	4	5/8 - 11	3-1/4	HK-025	HK1-025	HK2-025
3	4	5/8 - 11	3-1/2	HK-030	HK1-030	HK2-030
4	8	5/8 - 11	3-1/2	HK-040	HK1-040	HK2-040
5 & 6	8	3/4 - 10	4	HK-060	HK1-060	HK2-060
8	8	3/4 - 10	4-1/2	HK-080	HK1-080	HK2-080
10 & 12	12	7/8 - 9	5	HK-120	HK1-120	HK2-120

* Each Bolt Includes Nut & Two (2) Flat Washers

Bolt Torque

Recommended Bolt Torque is shown in **Table 1**. Threads should be clean and well lubricated. Actual field conditions may require variations in these recommendations. **CAUTION: UNNECESSARY OVER TORQUING WILL DAMAGE THE FLANGE.**

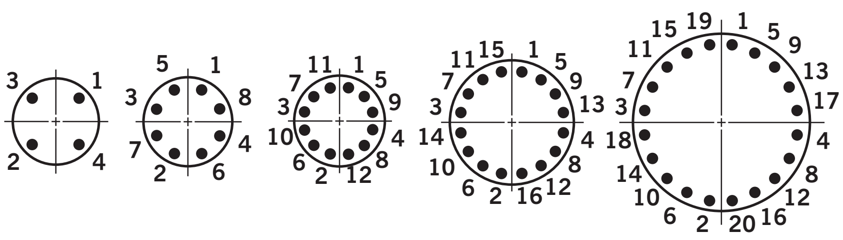
Table 1

Flange Size (in.)	Recommended Torque (ft. lbs.)
1/2 - 1-1/2	12
2 - 4	25
5	30
6 - 8	40
10	64
12	95
14 - 24	110

Torque Sequence

Bolt Torque sequence is shown Below in **Table 2**.

Table 2



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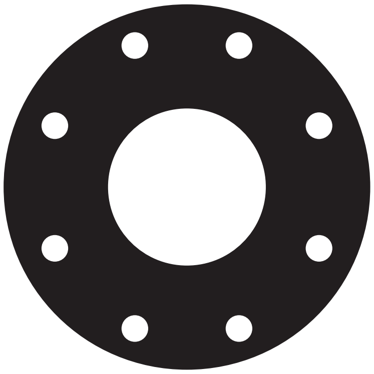
Gaskets

Full faced, 1/8" thick elastomer gaskets with a Shore "A" Durometer of approximately 70 is recommended.

Gasket Selection Guide

Following Gasket Numbers Available from Spears®

Order Gaskets & Bolt Kits Separately
- 1/8" Full-Face design with ANSI Class 150 Bolt Patterns
- Pressure rated to 150 psi @ 73°F
- Available in Buna-N, EPDM, or FKM



Flange Size	Bolts Per Kit	Gasket Part Number Buna-N	EPDM	FKM
1/2	4	GK1-005	GK2-005	GK3-005
3/4	4	GK1-007	GK2-007	GK3-007
1	4	GK1-010	GK2-010	GK3-010
1-1/4	4	GK1-012	GK2-012	GK3-012
1-1/2	4	GK1-015	GK2-015	GK3-015
2	4	GK1-020	GK2-020	GK3-020
2-1/2	4	GK1-025	GK2-025	GK3-025
3	4	GK1-030	GK2-030	GK3-030
4	8	GK1-040	GK2-040	GK3-040
5	8	GK1-050	GK2-050	GK3-050
6	8	GK1-060	GK2-060	GK3-060
8	8	GK1-080	GK2-080	GK3-080
10	12	GK1-100	GK2-100	GK3-100
12	12	GK1-120	GK2-120	GK3-120

Flange Make-up

Once a flange is joined to pipe, the method for joining two flanges is as follows:

1. Piping runs joined to the flanges must be installed in a straight line position to the flange to avoid stress at the flange due to misalignment. Piping must also be secured and supported to prevent lateral movement which can create stress and damage the flange.
2. With gasket in place, align the bolt holes of the mating flanges by rotating the ring into position.
3. Insert all bolts, washers (two standard flat washers per bolt), and nuts.
4. Make sure the faces of the mating surfaces are flush against gasket prior to bolting down the flanges.
5. Tighten the nuts by hand until they are snug. Establish uniform pressure over the flange face by tightening the bolts in 5 ft.-lbs. increments according to the sequence shown in Table 2 following a 180° opposing sequence.
6. Care must be taken to avoid "bending" the flange when joining a Spears® flange to a "raised face" flange, or a wafer-style valve. Do not use bolts to bring together improperly mated flanges.

Configuration Terminology

Multi-Bolt Pattern Ring — Bolt hole drilling accepts ANSI and Metric Flanges
Socket — Slip socket connection for solvent cement welding
Spigot — Pipe O.D. connection for solvent welding
Fipt — Female Iron Pipe Thread
SR Fipt — Spears® patented Special Reinforced (SR) plastic thread
IPS — Iron Pipe Size
PIP — Plastic Irrigation Pipe

Type-57 Butterfly Valve

Standard Features (Sizes 1-1/2" – 14")

- Standard model (1-1/2" – 14") has PVC body and PP disc for superior chemical resistance and elevated temperature capabilities
- 316 stainless steel shaft has full engagement over the entire length of the disc and is a non-wetted part
- Only solid and abrasion resistant plastic disc and elastomeric liner are wetted parts
- ISO bolt circle on top flange – No body or stem modifications required for accessories
- Stem retainer – PP retainer to prevent stem removal
- Seat overtightening protection – Molded body stops and seat stress relief area
- Spherical disc design offers increased Cv, ultimate sealing and high cycle life
- 21-position throttle plate for lever handle style

Options

- Pneumatically and electrically actuated with accessories
- Alternate discs:
  - (I): PVC : 1-1/2" – 14"
  - (II) PVDF : 1-1/2" – 14"
  - (III) CPVC : 3", 4", 6" & 8"
- Lug style (stainless steel 304 or 316) for blocking and end-of-line applications
- Stems in titanium or Hastelloy C®
- 2" square nut on stem (1-1/2" - 8" only)
- 2" square nut on gear operator (all sizes)
- Stem extensions (single stem and two-piece stem)
- Locking devices (gear type – standard on lever)
- Chain operators
- Manual limit switch - Asahi P-Series
- Tandem arrangements (Patented by A/A, Inc.)

Specifications

Sizes: Lever: 1-1/2" – 8"
Gear: 1-1/4" – 14"
Models: Wafer Style
Operators: Lever and Gear
Bodies: PVC, PP and PVDF
Discs: PVC, PP, PVDF and CPVC
Seats: EPDM, FKM, and Nitrile
Seals: Same as seating material
Stems: 316 stainless steel,
Titanium, Hastelloy C® ‡

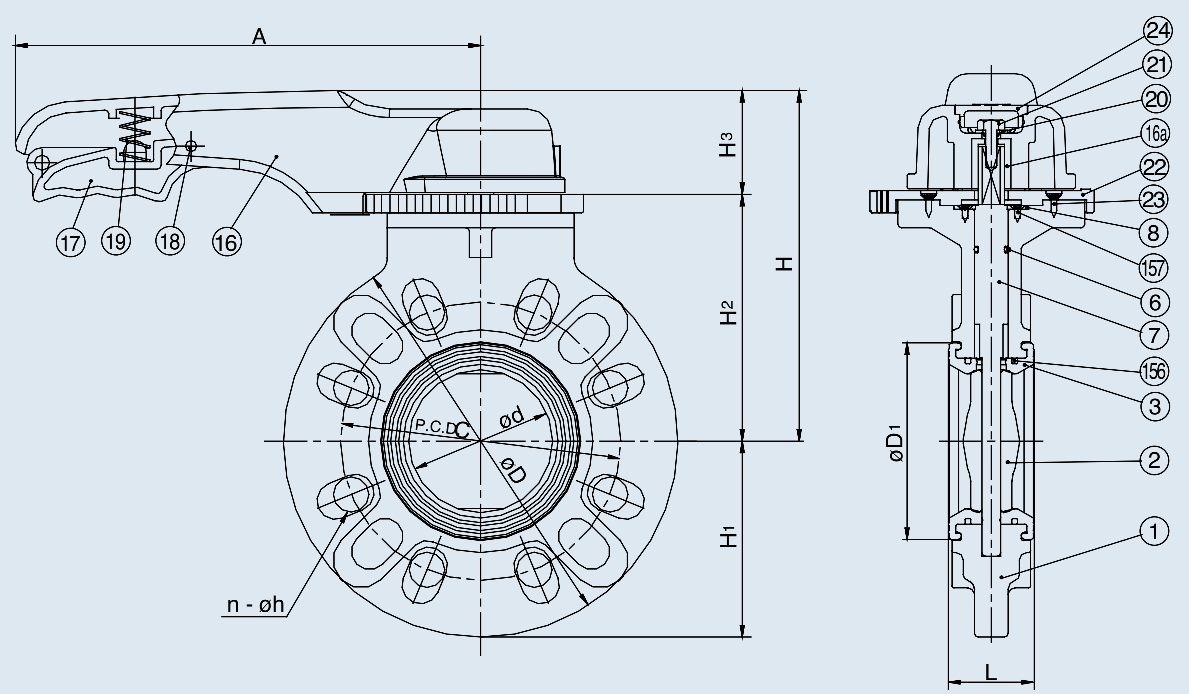
PVC/PP/EPDM Models
NSF-61 Certified

‡ Trademark of Cabot Corporation

Parts List (Lever: Sizes 1-1/2" – 8")

PARTS			
NO.	**DESCRIPTION**	**PCS.**	**MATERIAL**
1	Body	1	PVC, PP, PVDF
2	Disc	1	PVC, CPVC, PP, PVDF
3	Seat	1	EPDM, FKM, NBR
6	O-Ring (C)	1	EPDM, FKM, NBR
7	Stem	1	Stainless Steel 316
8	Stem Retainer	1	PP
16	Handle	1	PP
16A	Metal Insert in Handle	1	Stainless Steel 316L
17	Handle Lever	1	PPG
18	Pin	1	PPG
19	Spring	1	Stainless Steel 304
20	Washer (A)	1	Stainless Steel 304
21	Bolt (B)	1	Stainless Steel 304
22	Locking Plate	1	PPG
23	Screw (B)	4	Stainless Steel 304
24	Cap (A)	1	PP
156	Liner Stabilization Ring	2	Stainless Steel (SCS13)
157	Screw (F)	4	Stainless Steal 304

Type-57 – Lever Operated Butterfly Valves



Dimensions (Lever: Sizes 1-1/2" – 8") (in.)

NOMINAL SIZE			ANSI CLASS 150										
INCHES	mm	d	C	n	h	D	D1	L	H	H1	H2	H3	A
1-1/2	40	1.77	3.88	4	0.62	5.91	2.83	1.54	6.14	2.95	3.94	2.20	8.66
2	50	2.20	4.75	4	0.75	6.50	3.23	1.65	6.54	3.25	4.33	2.20	8.66
2-1/2	65	2.72	5.50	4	0.75	7.28	3.78	1.81	6.93	3.64	4.72	2.20	8.66
3	80	3.03	6.00	4	0.75	8.31	4.17	1.81	7.52	4.15	5.31	2.20	9.84
4	100	4.02	7.50	8	0.75	9.37	5.31	2.20	8.11	4.69	5.91	2.20	9.84
5	125	5.08	8.50	8	0.88	10.39	6.69	2.60	9.33	5.20	6.61	2.72	12.60
6	150	5.91	9.50	8	0.88	11.22	7.52	2.80	9.92	5.61	7.20	2.72	12.60
8	200	7.68	11.75	8	0.88	13.39	9.53	3.43	11.14	6.69	8.43	2.72	15.75

Cv Values

NOMINAL SIZE		Cv (at various opening degrees)		
INCHES	mm	30°	60°	90°
1-1/2	40	4	43	71
2	50	7	73	120
2-1/2	65	15	153	250
3	80	18	183	300
4	100	28	287	470
5	125	49	506	830
6	150	66	671	1100
8	200	150	1525	2500

Pressure vs. Temperature (psi, water, non-shock)*

BODY		PVC			PP		PVDF			
DISC		PP			PP		PVDF			
NOMINAL SIZE		30° F 120° F	121° F 140° F	141° F 175° F	- 5° F 140° F	141° F 175° F	- 5° F 140° F	141° F 175° F	176° F 210° F	211° F 250° F
INCHES	mm									
1-1/2	40	150	70	30	150	100	150	100	85	75
2	50	150	70	30	150	100	150	100	85	75
2-1/2	65	150	70	30	150	100	150	100	85	75
3	80	150	70	30	150	100	150	100	85	75
4	100	150	45	30	150	100	150	100	85	75
5	125	150	45	30	150	100	150	100	85	75
6	150	150	45	30	150	100	150	100	85	75
8	200	150	40	20	150	85	150	85	75	60

Wt. (lbs.) / Vacuum Service

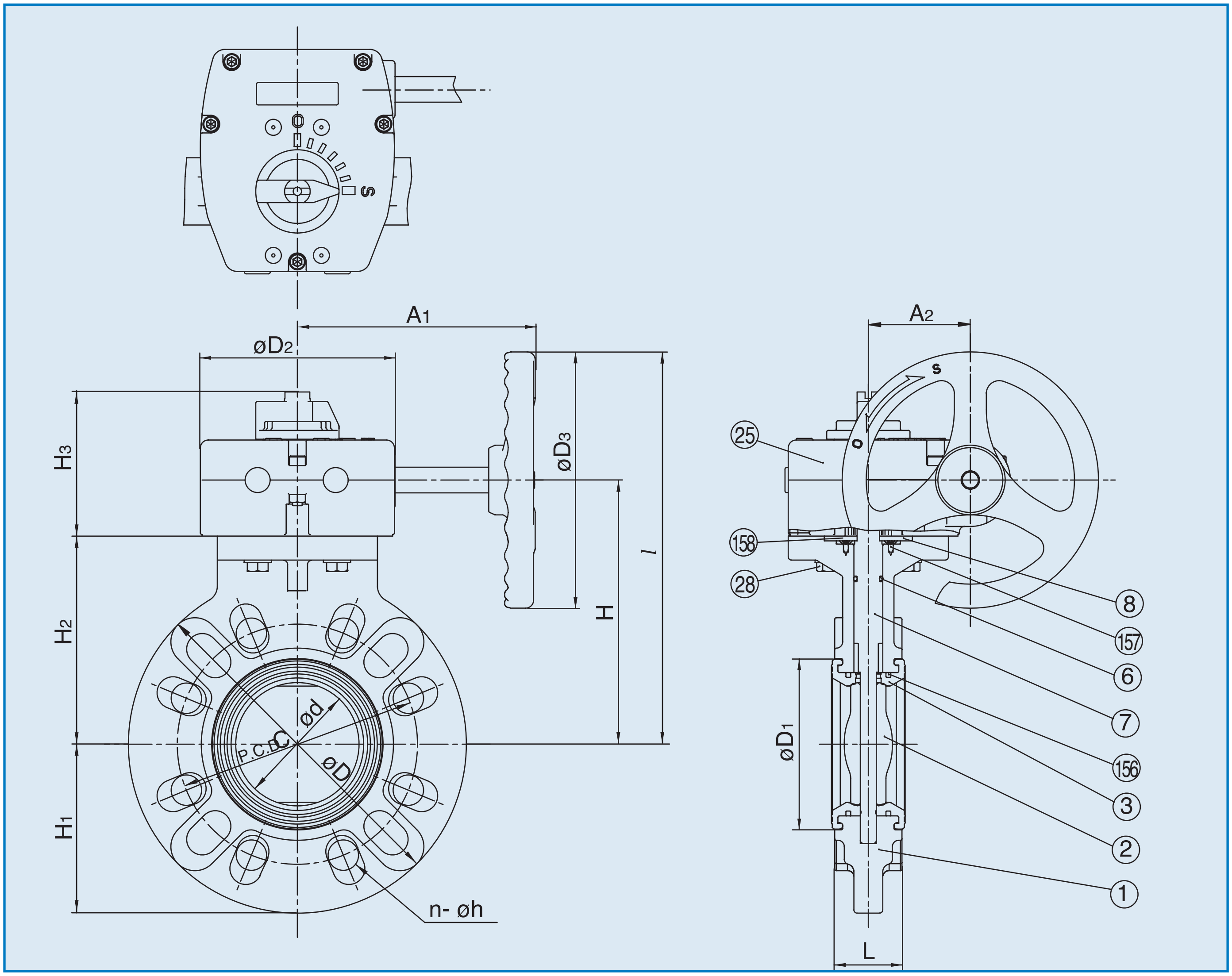
NOMINAL SIZE		PVC	PP	PVDF
INCHES	mm			
1-1/2	40	3	3	3
2	50	4	3	4
2-1/2	65	4	3	4
3	80	5	4	5
4	100	6	5	7
5	125	11	9	13
6	150	13	10	15
8	200	21	16	25

NOMINAL SIZE		VACUUM SERVICE (INCHES OF MERCURY)
INCHES	mm	
1-1/2	40	-29.92
2	50	-29.92
2-1/2	65	-29.92
3	80	-29.92
4	100	-29.92
5	125	-29.92
6	150	-29.92
8	200	-29.92

* For lug style data consult factory.

* FKM seat butterfly valves have a lower temperature limit of 23° F

Type-57 – Gear Operated Butterfly Valves



Dimensions (Sizes 1-1/2" – 14") (in.)

NOMINAL SIZE			ANSI CLASS 150																Wheel Cycles	Gear Box Model No.
INCHES	mm	d	C	n	h	D	D1	D2	D3	L	H	H1	H2	H3	l	A1	A2			
1-1/2	40	1.77	3.88	4	0.62	5.91	2.83	4.8	6.30	1.54	5.12	2.95	3.74	3.54	8.27	6.57	2.52		9.5	241
2	50	2.20	4.75	4	0.75	6.50	3.23	4.8	6.30	1.65	5.51	3.25	4.13	3.54	8.66	6.57	2.52		9.5	
2-1/2	65	2.72	5.50	4	0.75	7.28	3.78	4.8	6.30	1.81	5.91	3.64	4.53	3.54	9.06	6.57	2.52		9.5	
3	80	3.03	6.00	4	0.75	8.31	4.17	4.8	6.30	1.81	6.50	4.15	5.12	3.54	9.65	6.57	2.52		9.5	
4	100	4.02	7.50	8	0.75	9.37	5.31	4.8	6.30	2.20	7.09	4.69	5.71	3.54	10.24	6.57	2.52		9.5	
5	125	5.08	8.50	8	0.88	10.39	6.69	4.8	6.30	2.60	7.68	5.20	6.30	3.54	10.83	6.57	2.52		9.5	
6	150	5.91	9.50	8	0.88	11.22	7.52	4.8	6.30	2.80	8.27	5.61	6.89	3.54	11.42	6.57	2.52		9.5	
8	200	7.68	11.75	8	0.88	13.39	9.53	4.8	6.30	3.43	9.49	6.69	8.11	3.54	12.64	6.57	2.52		9.5	
10	250	9.84	14.25	12	1.00	16.57	11.89	4.8	6.30	4.33	10.87	8.31	9.49	3.62	14.02	6.57	2.52		9.5	
12	300	11.93	17.00	12	1.00	19.21	14.17	7.4	11.81	5.08	13.39	9.61	11.73	4.25	19.29	10.71	3.90		9.5	243
14	350	13.82	18.75	12	1.12	21.22	15.47	7.4	11.81	5.08	14.45	10.63	12.80	4.25	20.35	10.71	3.90		9.5	

Type-57 – Gear Operated Butterfly Valves

Parts List (Gear: Sizes 1-1/2" – 14")

PARTS			
NO.	**DESCRIPTION**	**PCS.**	**MATERIAL**
1	Body	1	PVC, PP, PVDF
2	Disc	1	PVC, CPVC, PP, PVDF
3	Seat	1	EPDM, FKM, NBR
6	O-Ring (C)	1	EPDM, FKM, NBR
7	Stem	1	Stainless Steel 316
8	Stem Retainer	1	PP
25	Gear Box	1	Plasgear™
28	Bolt (C)	4	Stainless Steel 304
156	Liner Stabilization Ring	2	Stainless Steel (SCS13)
157	Screw (F)	4	Stainless Steel 304
158	Gasket	1	EPDM

Troubleshooting

What if fluid still flows when the valve is closed?

1. Make sure lever or gear is in a fully closed position (gear type may require travel stop adjustment).
2. Liner is damaged or worn. Replace liner.
3. Disc is damaged or abraded. Change disc.
4. Foreign material is caught between seat and disc. Remove the substance.
5. Mating flange bolts either overtightened or unevenly tightened. Retighten properly.

What if fluid leaks outside between seat and mating flange?

1. Seat damage. Change seat.
2. Mating flange bolts not tightened with proper torque or unevenly tightened. Retighten to the appropriate torque.

What if valve does not operate smoothly?

1. Foreign material is caught between disc and seat. Remove the material and clean.
2. Lever or gearbox is damaged. Replace.
3. Mating flange bolts overtightened. Retighten.

Sample Specification

All solid thermoplastic butterfly valves sizes 1-1/2" through 14" shall be of the Type-57 lined body design and bubble-tight seal (meeting or exceeding Class VI as defined by American National Standard Institute) with only the liner and disc as wetted parts. The lever handle (sizes 1-1/2" thru 8") shall have a molded provision for a padlock. Gear operators shall be worm gear design, self-locking Plasgear™. The spherical disc design for higher Cv values shall be of solid, abrasion resistant plastic. Liner shall be molded and formed around the body, functioning as gasket seals with convex ring design on each side of the valve for lower bolt tightening torque and valve body shall have molded body stops and seat relief area to prevent over tightening of mating flanges. Stem shall be of 316 stainless steel, non-wetted, have engagement over the full length of the disc and be locked into valve body by PP stem retainer. Valves shall have a molded ISO bolt pattern on top flange for actuator mount. PVC shall conform to ASTM D1784 Cell Classification 12454A, PP conforming to ASTM D4101 Cell Classification PP0210B67272, and PVDF conforming to ASTM D 3222 Cell Classification Type II. All PVC, PP and PVDF body valves shall be rated to 150psi at 70º F, sizes 1-1/2" through 10" and 100psi for sizes 12" and 14". Butterfly valves shall be wafer style, as manufactured by Asahi/America, Inc.

Caution

- Never remove valve from pipeline under pressure.
- Always wear protective gloves and goggles.

Cv Values

NOMINAL SIZE		30°	60°	90°
INCHES	mm			
8	200	150	1525	2500
10	250	232	2355	3860
12	300	342	3477	5700
14	350	386	3928	6440

Pressure vs. Temperature (psi, water, non-shock)* Wt. (lbs.) /Vacuum Service

BODY		PVC			PP		PVDF			
DISC		PP			PP		PVDF			
NOMINAL SIZE		30° F 120° F	121° F 140° F	141° F 175° F	- 5° F 140° F	141° F 175°F	- 5° F 140° F	141° F 175° F	176° F 210° F	211° F 250° F
INCHES	mm									
8	200	150	40	20	150	85	150	85	75	60
10	250	150	40	20	150	85	150	85	75	60
12	300	100	30	15	100	60	100	60	45	30
14	350	100	30	7	100	45	100	45	30	15

NOMINAL SIZE		PVC	PP	PVDF
INCHES	mm			
8	200	24	20	28
10	250	33	27	41
12	300	62	53	76
14	350	67	58	81

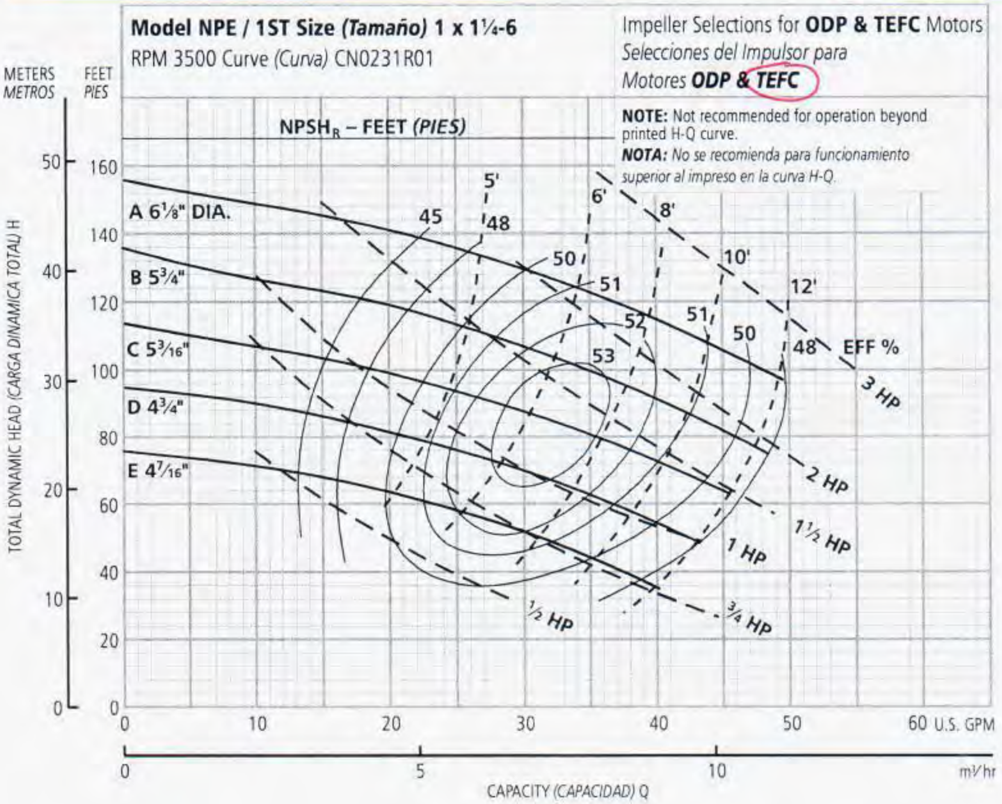
NOMINAL SIZE		VACUUM SERVICE (INCHES OF MERCURY)
INCHES	mm	
8	200	-29.92
10	250	-29.92
12	300	-23.62
14	350	-23.62

* For lug style data consult factory.

* FKM seat butterfly valves have a lower temperature limit of 23° F

CONDENSATE PUMP

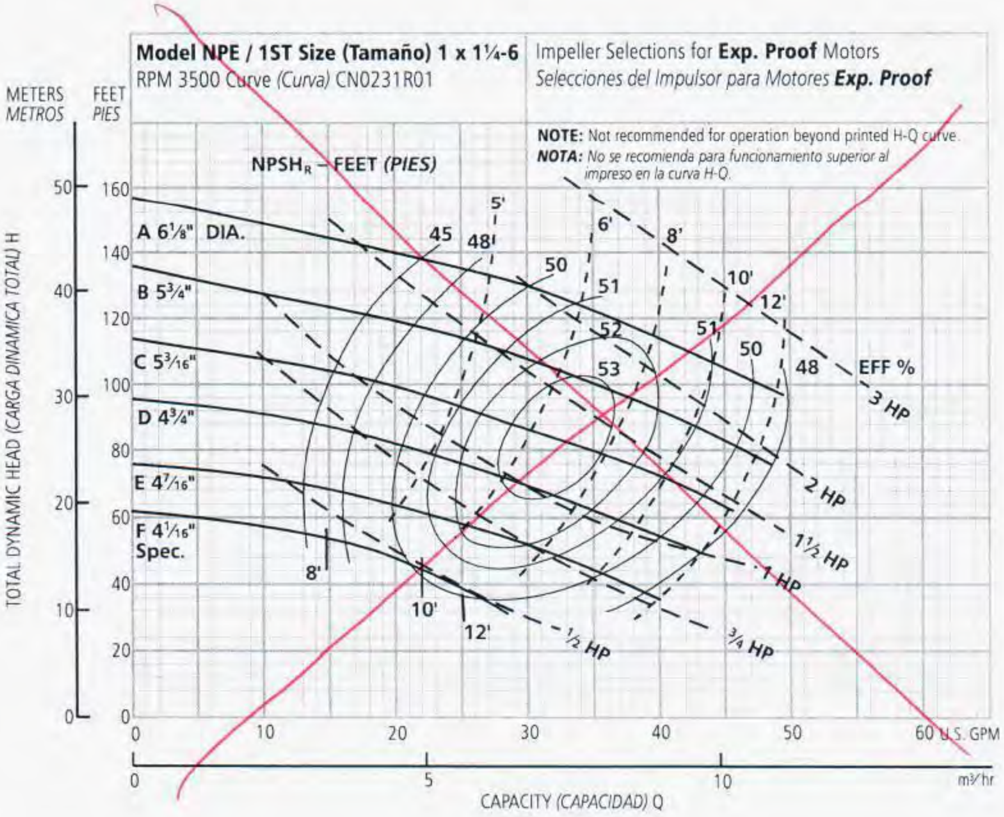
Performance Curves – 60 Hz, 3500 RPM
Curvas de Funcionamiento – 60 Hz, 3500 RPM



Ordering Code, *Código de Pedido*	Standard HP Rating, *Estándar HP Potencia*	Imp. Dia.
E	½	4$\frac{7}{16}$"
D	¾	4¾
C	1	5$\frac{3}{16}$
B	1½	5¾
A	2	6⅛

NOTE: Although not recommended, the pump may pass a $\frac{1}{16}$" sphere.

NOTA: *Si bien no se recomienda, la bomba puede pasar una esfera de $\frac{1}{16}$".*



Ordering Code, *Código de Pedido*	Standard HP Rating, *Estándar HP Potencia*	Imp. Dia.
F	½	4$\frac{1}{16}$" spec.
E	¾	4$\frac{7}{16}$
D	1	4¾
C	1½	5$\frac{3}{16}$
B	2	5¾
A	3	6⅛

NOTE: Although not recommended, the pump may pass a $\frac{1}{16}$" sphere.

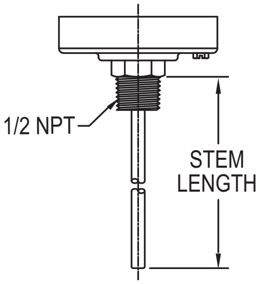
NOTA: *Si bien no se recomienda, la bomba puede pasar una esfera de $\frac{1}{16}$".*

Dwyer

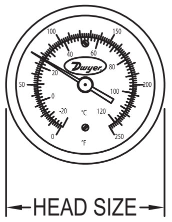
SERIES BT

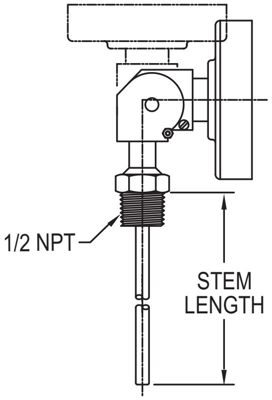
BIMETAL THERMOMETER

2˝, 3˝ or 5˝ Dial, Dual Scale, ±1% FS Accuracy, External Reset



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 s.
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)	Price	Model	Dial Size	Stem Length	Connection	Range °F (°C)	Degree Div °F (°C)	Price
BTB22551*	2˝	2-1/2˝	Back	0 to 250	2	**$36.25**	**BTB3605D**	3˝	6˝	Back	0 to 250 (-20 to 120)	2 (2)	**$36.25**
BTB2405D	2˝	4˝	Back	0 to 250 (-20 to 120)	2 (2)	**36.25**	**BTA54010D**	5˝	4˝	Adjustable	0 to 200 (-20 to 100)	2 (2)	**109.00**
BTB2409D	2˝	4˝	Back	200 to 1000 (100 to 550)	10 (5)	**36.25**	**BTA5405D**	5˝	4˝	Adjustable	0 to 250 (-20 to 120)	2 (2)	**109.00**
BTB32510D	3˝	2-1/2˝	Back	0 to 200 (-20 to 100)	2 (2)	**36.25**	**BTA5407D**	5˝	4˝	Adjustable	50 to 550 (10 to 290)	5 (5)	**109.00**
BTB3255D	3˝	2-1/2˝	Back	0 to 250 (-20 to 120)	2 (2)	**36.25**	**BTA56010D**	5˝	6˝	Adjustable	0 to 200 (-20 to 100)	2 (2)	**109.00**
BTB3257D	3˝	2-1/2˝	Back	50 to 550 (10 to 290)	5 (5)	**36.25**	**BTA5605D**	5˝	6˝	Adjustable	0 to 250 (-20 to 120)	2 (2)	**109.00**
BTB34010D	3˝	4˝	Back	0 to 200 (-20 to100)	2 (2)	**36.25**	**BTA5607D**	5˝	6˝	Adjustable	50 to 550 (10 to 290)	5 (5)	**109.00**
BTB3405D	3˝	4˝	Back	0 to 250 (-20 to 120)	2 (2)	**36.25**	**BTC3255D**	3˝	2-1/2˝	Lower	0 to 250 (-20 to 120)	2 (2)	**109.00**
BTB3407D	3˝	4˝	Back	50 to 550 (10 to 290)	5 (5)	**36.25**							

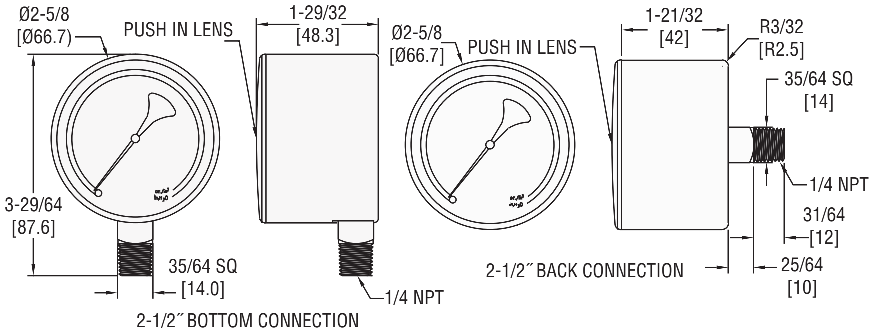
*Model offered in Fahrenheit scale only.

Dwyer

SERIES LPG3 | DWYER

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 1A 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.

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).

MODEL CHART			
Model Bottom	**Range in w.c./oz/in^2**	**Model Back**	**Range in w.c./oz/in^2**
LPG3-D8122N	0 to 15 (0 to 8.6 oz/in^2)	**LPG3-D8142N**	0 to 15 (0 to 8.6 oz/in^2)
LPG3-D8222N	0 to 32 (0 to 18.5 oz/in^2)	**LPG3-D8242N**	0 to 32 (0 to 18.5 oz/in^2)
LPG3-D8422N	0 to 55 (0 to 32.0 oz/in^2)	**LPG3-D8442N**	0 to 55 (0 to 32.0 oz/in^2)
LPG3-D8622N	0 to 100 (0 to 58.0 oz/in^2)	**LPG3-D8642N**	0 to 100 (0 to 58.0 oz/in^2)
LPG3-D8822N	0 to 200 (0 to 116 oz/in^2)	**LPG3-D8842N**	0 to 200 (0 to 116 oz/in^2)
Model Bottom	**Range psi/kPa**	**Model Back**	**Range psi/kPa**
LPG3-D9922N	0 to 5 (0 to 35 kPa)	**LPG3-D9942N**	0 to 5 (0 to 35 kPa)
LPG3-D0022N	0 to 10 (0 to 70 kPa)	**LPG3-D0042N**	0 to 10 (0 to 70 kPa)

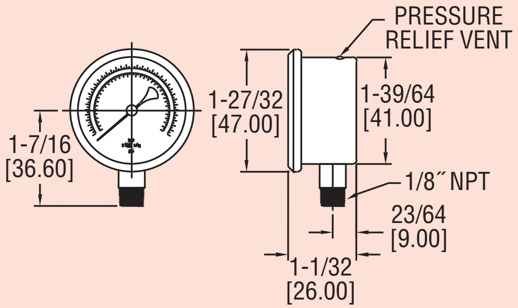
Series
SG1

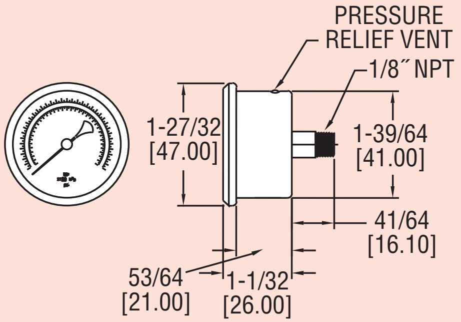
1.5″ Stainless Steel Industrial Pressure Gage

2.5% FS Accuracy, Brass Wetted Parts, Dual PSI/Bar x100 kPa Scales

SG1 Bottom

SG1 Back





The Series SG1 Gages are perfect for applications where resistance to corrosion is necessary. The stainless steel case and ring offer excellent protection from harsh processes. The SG1 gages are an economical choice where ambient corrosion and vibration are a concern. Gages are suitable for all fluids that are compatible with brass and bronze, and are available with bottom or back connections.

Model	Range
SG1-B10121N	0 to 30″ Hg
SG1-B10321N	0 to 30 psi
SG1-B10421N	0 to 60 psi
SG1-B10521N	0 to 100 psi
SG1-B10621N	0 to 160 psi
SG1-B10721N	0 to 200 psi
SG1-B11021N	0 to 300 psi

Note: Change ending 21N to 41N for back connection

SPECIFICATIONS

Service: Compatible gases and liquids.
Wetted Materials: Brass connector, bronze tube.
Housing: 304 SS.
Lens: Polycarbonate.
Accuracy: ±2.5% FS.
Pressure Limit: FS range.
Temperature Limits: -4 to 140°F (-20 to 60°C).
Size: 1.5″ (40 mm).
Process Connections: 1/8″ NPT.
Weight: 2.2 oz (63 g) bottom, 2.3 oz (65 g) back.

OPTION

For NIST traceable calibration certificate, use order code NISTCAL-PG1.

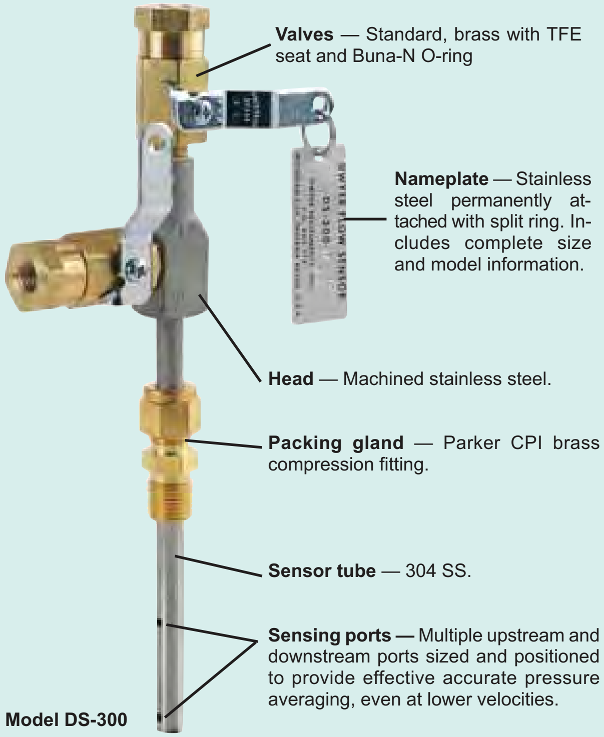
ACCESSORY

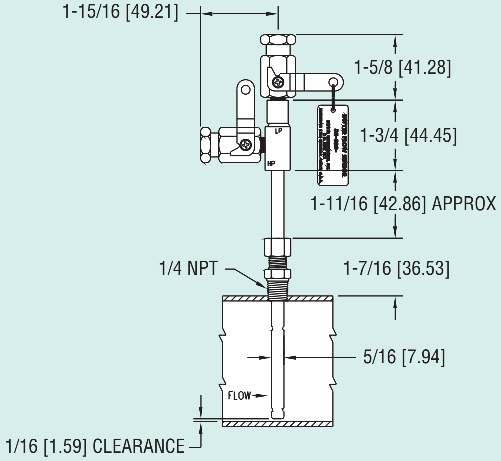
A-445B, U-Bracket Mounting Kit for 1.5″ Gage

Series DS

In-Line Flow Sensors

Use with the Dwyer® Differential Pressure Gages or Transmitters





In-Line Flow Sensors are averaging Pitot tubes that provide accurate and convenient flow rate sensing for schedule 40 pipe. When purchased with a Dwyer® Capsuhelic® differential pressure gage of appropriate range, the result is a flow indicating system delivered off the shelf at an economical price.

Pitot tubes have been used in flow measurement for years. Conventional pitot tubes sense velocity pressure at only one point in the flowing stream. Therefore, a series of measurements must be taken across the stream to obtain a meaningful average flow rate. The Dwyer® flow sensor eliminates the need for "traversing" the flowing stream because of its multiple sensing points and built-in averaging capability.

The Series DS-300 flow sensors are designed to be inserted in the pipeline through a compression fitting. They 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® gage kit. Standard valves are rated at 200 psig (13.7 bar) and 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˝.

DS-400 Averaging Flow Sensors are quality constructed from extra strong 3/4˝ dia. stainless steel to resist increased forces encountered at higher flow rates with both air and water. This extra strength also allows them to be made in longer insertion lengths up to 24 inches (61 cm). All models include convenient and quick-acting quarter-turn ball valves to isolate the sensor for zeroing. Process connections to the valve assembly are 1/8˝ female NPT. A pair of 1/8˝ NPT X 1/4˝ SAE 45° flared adapters are included, compatible with hoses used in the Model A-471 Portable Capsuhelic® Gage Kit. Supplied solid brass mounting adapter has a 3/4˝ dia. compression fitting to lock in required insertion length and a 3/4˝ male NPT thread for mounting in a Threaded Branch Connection.

Prices — Select model with suffix which matches pipe size

Model DS-300-1˝	**$130.00**
Model DS-300-1-1/4˝	**130.00**
Model DS-300-1-1/2˝	**130.00**
Model DS-300-2˝	**130.00**
Model DS-300-2-1/2˝	**130.00**
Model DS-300-3˝	**150.00**
Model DS-300-4˝	**178.00**
Model DS-300-6˝	**226.00**
Model DS-300-8˝	**286.00**
Model DS-300-10˝	**338.00**
Model DS-400-6˝	**$266.00**
Model DS-400-8˝	**326.00**
Model DS-400-10˝	**381.00**
Model DS-400-12˝	**401.00**
Model DS-400-14˝	**473.00**
Model DS-400-16˝	**517.00**
Model DS-400-18˝	**556.00**
Model DS-400-20˝	**597.00**
Model DS-400-24˝	**678.00**

OPTIONS & ACCESSORIES

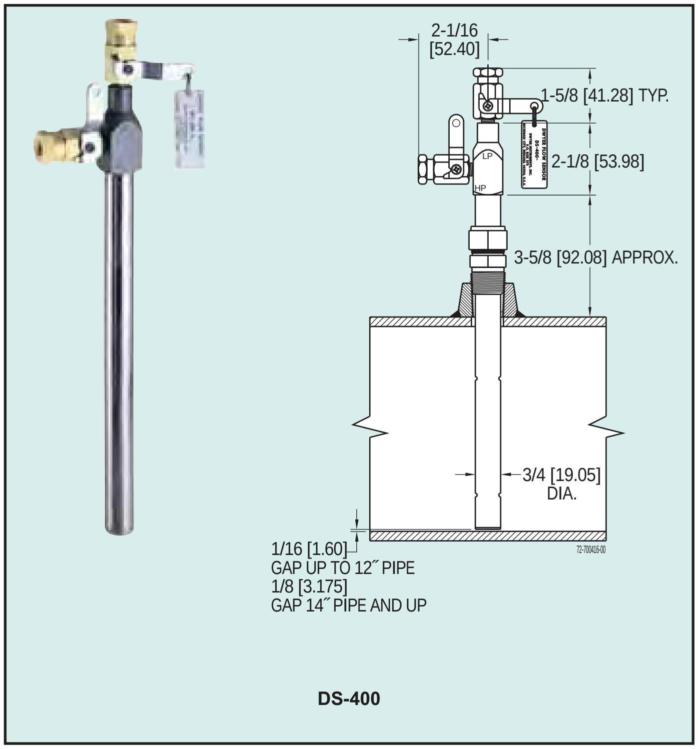
A-160, Threaded Branch Connection, 3/8˝ NPT, forged steel, 3000 psi	**$14.25**
A-161, Brass Bushing, 1/4˝ x 3/8˝	**3.50**
DS-300 or DS-400 Less Valves. To order, add suffix **-LV**	**deduct 13.50**

How To Order

Merely determine the pipe size into which the flow sensor will be mounted and designate the size as a suffix to Model DS-300. For example, a flow sensor to be mounted in a 2″ pipe would be a Model No. DS-300-2″. For non-critical water and air flow monitoring applications, the chart below can be utilized for ordering a stock Capsuhelic® differential pressure gage for use with the DS-300 flow sensor. Simply locate the maximum flow rate for the media being measured under the appropriate pipe size and read the Capsuhelic® gage range in inches of water column to the left. The DS-300 sensor is supplied with installation and operating instructions, Bulletin F-50. It also includes complete flow conversion information for the three media conditions shown in the chart below. This information enables the user to create a complete differential pressure to flow rate conversion table for the sensor and differential pressure gage employed. Both the Dwyer® Capsuhelic® gage and flow sensor feature excellent repeatability so, once the desired flow rate is determined, deviation from that flow in quantitative measure can be easily determined. You may wish to order the adjustable signal flag option for the Capsuhelic® gage to provide an easily identified reference point for the proper flow.

Capsuhelic® gages with special ranges and/or direct reading scales in appropriate flow units are available on special order for more critical applications. Customer supplied data for the full scale flow (quantity and units) is required along with the differential pressure reading at that full flow figure. Prior to ordering a special Capsuhelic® differential pressure gage for flow read-out, we recommend you request Bulletin F-50 to obtain complete data on converting flow rates of various media to the sensor differential pressure output. With this bulletin and after making a few simple calculations, the exact range gage required can easily be determined.

Large Inch Diameter for Extra Strength in Lengths to Inches



DS-400

Gage Range (in w.c.)	Media @ 70°F	Full Range Flows by Pipe Size (Approximate)									
		1″	1-1/4″	1-1/2″	2″	2-1/2″	3″	4″	6″	8″	10″
2	Water (GPM)	4.8	8.3	11.5	20.5	30	49	86	205	350	560
	Air @ 14.7 PSIA (SCFM)	19.0	33.0	42.0	65.0	113	183	330	760	1340	2130
	Air @ 100 PSIG (SCFM)	50.0	90.5	120.0	210.0	325	510	920	2050	3600	6000
5	Water (GPM)	7.7	14.0	18.0	34.0	47	78	138	320	560	890
	Air @ 14.7 PSIA (SCFM)	30.0	51.0	66.0	118.0	178	289	510	1200	2150	3400
	Air @ 100 PSIG (SCFM)	83.0	142.0	190.0	340.0	610	820	1600	3300	5700	10000
10	Water (GPM)	11.0	19.0	25.5	45.5	67	110	195	450	800	1260
	Air @ 14.7 PSIA (SCFM)	41.0	72.0	93.0	163.0	250	410	725	1690	3040	4860
	Air @ 100 PSIG (SCFM)	120.0	205.0	275.0	470.0	740	1100	2000	4600	8100	15000
25	Water (GPM)	18.0	32.0	40.5	72.0	108	173	310	720	1250	2000
	Air @ 14.7 PSIA (SCFM)	63.0	112.0	155.0	255.0	390	640	1130	2630	4860	7700
	Air @ 100 PSIG (SCFM)	185.0	325.0	430.0	760.0	1200	1800	3300	7200	13000	22000
50	Water (GPM)	25.0	44.0	57.5	100.0	152	247	435	1000	1800	
	Air @ 14.7 PSIA (SCFM)	90.0	161.0	205.0	360.0	560	900	1600	3700	6400	
	Air @ 100 PSIG (SCFM)	260.0	460.0	620.0	1050.0	1700	2600	4600	10000	18500	
100	Water (GPM)	36.5	62.0	82.0	142.0	220	350	620	1500		
	Air @ 14.7 PSIA (SCFM)	135.0	230.0	300.0	505.0	800	1290	2290	5000		
	Air @ 100 PSIG (SCFM)	370.0	660.0	870.0	1500.0	2300	3600	6500	15000		

Model - Portable Kit

The Dwyer® Series 4000 Capsuhelic® differential pressure gage is ideally suited for use as a read-out device with the DS-300 Flow Sensors. The gage may be used on system pressures of up to 500 psig even when the flow sensor differential pressure to be read is less than 0.5″ w.c. With accuracy of ±3% of full scale, the Capsuhelic® gage can be used in ambient temperatures from 32 to 200°F (0 to 93.3°C). Zero and range adjustments are made from outside the gage. The standard gage with a die cast aluminum housing can be used with the flow sensor for air or oil applications. For water flow measurements, the optional forged brass housing should be specified. The Capsuhelic® gage may be panel or surface mounted and permanently plumbed to the flow sensor if desired. The optional A-610 pipe mounting bracket allows the gage to be easily attached to any 1-1/4″ - 2″ horizontal or vertical pipe.

For portable operation, the A-471 Capsuhelic® Portable Gage Kit is available complete with tough polypropylene carrying case, mounting bracket, 3-way manifold valve, two 10' high pressure hoses, and all necessary fittings.

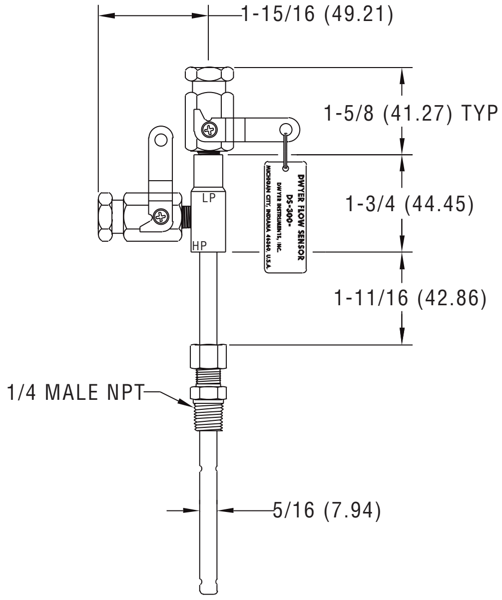
See pages 8 and 9 for complete information on the Capsuhelic® gage **$477.00**

Capsuhelic® Gage Shown Instaled In A-471 Portable Kit

Bulletin F-50

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.**

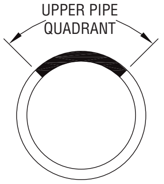
POSITION

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

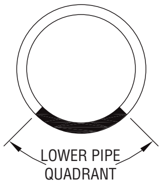
Install in upper quadrant of pipe



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

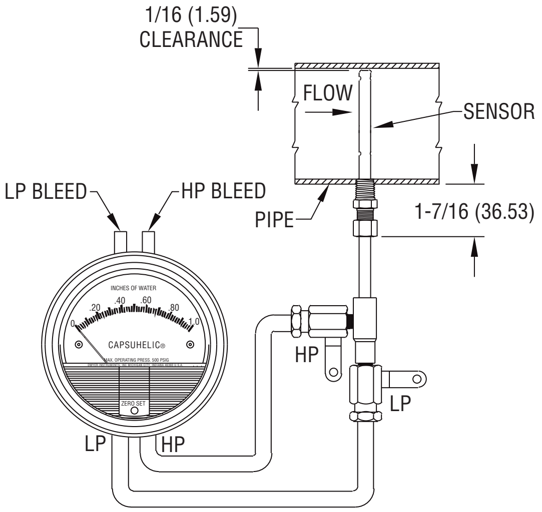
Connect the slide pressure tap to the high pressure port of the Magnehelic® (air only) or Capsuhelic® gage or transmitting instrument and the top connection to the low pressure port.

See the connection schematics below.

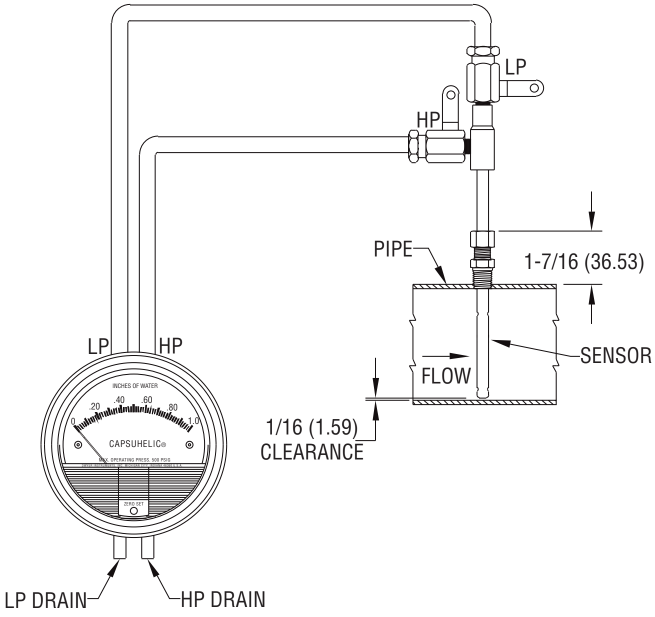
Bleed air from instrument piping on liquid flows. Drain any condensate from the instrument piping on air and gas flows.

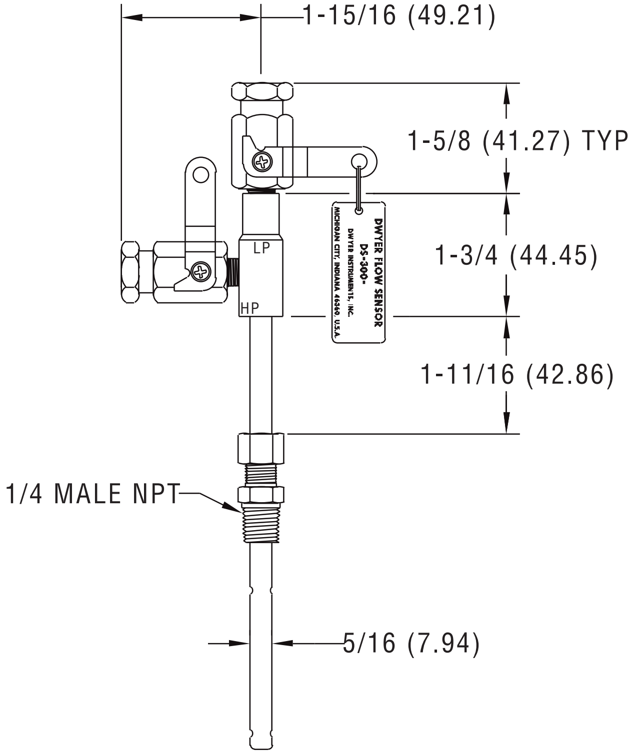
Open valves to instrument to place flow meter into service. For permanent installations, a 3-valve manifold is recommended to allow the gage to be zero checked without interrupting the flow. The Dwyer A-471 Portable Test Kit includes such a device.

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

$$Q\ (\text{GPM}) = 5.668 \times K \times D^2 \times \sqrt{\Delta P / S_f}$$

2. Steam or Any Gas

$$Q\ (\text{lb/Hr}) = 359.1 \times K \times D^2 \times \sqrt{p \times \Delta P}$$

3. Any Gas

$$Q\ (\text{SCFM}) = 128.8 \times K \times D^2 \times \sqrt{\frac{P \times \Delta P}{(T + 460) \times S_s}}$$

DIFFERENTIAL PRESSURE EQUATIONS

1. Any Liquid

$$\Delta P\ (\text{in. WC}) = \frac{Q^2 \times S_f}{K^2 \times D^4 \times 32.14}$$

2. Steam or Any Gas

$$\Delta P\ (\text{in. WC}) = \frac{Q^2}{K^2 \times D^4 \times p \times 128{,}900}$$

3. Any Gas

$$\Delta P\ (\text{in. WC}) = \frac{Q^2 \times S_s \times (T + 460)}{K^2 \times D^4 \times P \times 16{,}590}$$

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: $D = \sqrt{\dfrac{4 \times \text{Height} \times \text{Width}}{\pi}}$

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

$$\text{SCFM} = \text{ACFM} \times \left(\frac{14.7 + \text{PSIG}}{14.7}\right)\left(\frac{520^*}{460 + {}^\circ\text{F}}\right)$$

$$\text{ACFM} = \text{SCFM} \times \left(\frac{14.7}{14.7 + \text{PSIG}}\right)\left(\frac{460 + {}^\circ\text{F}}{520}\right)$$

$$\begin{matrix}\text{POUNDS PER}\\ \text{CUBIC FOOT}\end{matrix}\ \text{STD.} = \begin{matrix}\text{POUNDS PER}\\ \text{CUBIC FOOT}\end{matrix}\ \text{ACT.} \times \left(\frac{14.7}{14.7 + \text{PSIG}}\right)\left(\frac{460 + {}^\circ\text{F}}{520^*}\right)$$

$$\begin{matrix}\text{POUNDS PER}\\ \text{CUBIC FOOT}\end{matrix}\ \text{ACT.} = \begin{matrix}\text{POUNDS PER}\\ \text{CUBIC FOOT}\end{matrix}\ \text{STD.} \times \left(\frac{14.7 + \text{PSIG}}{14.7}\right)\left(\frac{520^*}{460 + {}^\circ\text{F}}\right)$$

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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DWYER INSTRUMENTS, INC.
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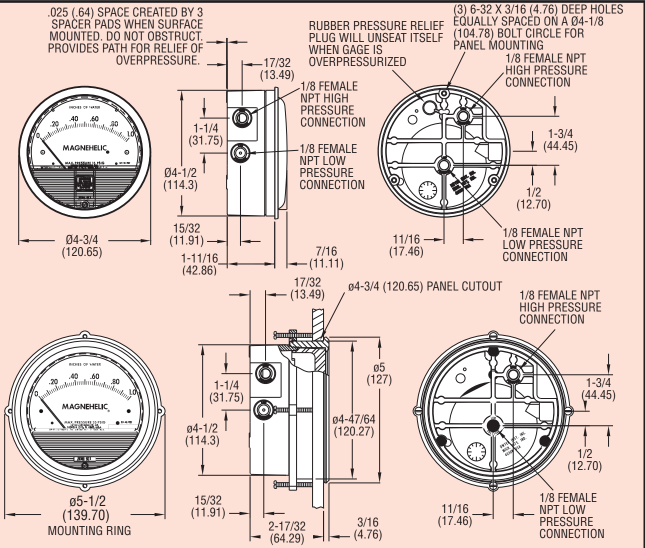
Series 2000

Magnehelic® Differential Pressure Gages

Indicate Positive, Negative or Differential, Accurate within 2%



Select the Dwyer® Magnehelic® gage for high accuracy – guaranteed within 2% of full scale – and for the wide choice of 81 models available to suit your needs precisely. Using Dwyer's simple, frictionless Magnehelic® gage movement, it quickly indicates low air or non-corrosive gas pressures – either positive, negative (vacuum) or differential. The design resists shock, vibration and over-pressures. No manometer fluid to evaporate, freeze or cause toxic or leveling problems. It's inexpensive, too.

The Magnehelic® gage is the industry standard to measure fan and blower pressures, filter resistance, air velocity, furnace draft, pressure drop across orifice plates, liquid levels with bubbler systems and pressures in fluid amplifier or fluidic systems. It also checks gas-air ratio controls and automatic valves, and monitors blood and respiratory pressures in medical care equipment.

Note: May be used with hydrogen. Order a Buna-N diaphragm. Pressures must be less than 35 psi.

Flush, Surface or Pipe Mounted

Mounting

A single case size is used for most models of Magnehelic® gages. They can be flush or surface mounted with standard hardware supplied. With the optional **A-610** Pipe Mounting Kit they may be conveniently installed on horizontal or vertical 1-1/4˝ - 2˝ pipe. Although calibrated for vertical position, many ranges above 1˝ may be used at any angle by simply re-zeroing. However, for maximum accuracy, they must be calibrated in the same position in which they are used. These characteristics make Magnehelic® gages ideal for both stationary and portable applications. A 4-9/16˝ hole is required for flush panel mounting. Complete mounting and connection fittings plus instructions are furnished with each instrument.

Vent Valves

In applications where pressure is continuous and the Magnehelic® gage is connected by metal or plastic tubing which cannot be easily removed, we suggest using Dwyer A-310A vent valves to connect gage. Pressure can then be removed to check or re-zero the gage.

High and Medium Pressure Models

Installation is similar to standard gages except that a 4-13/16˝ hole is needed for flush mounting. The medium pressure construction is rated for internal pressures up to 35 psig and the high pressure up to 80 psig. Available for all models. Because of larger case, the medium pressure and high pressure models will not fit in a portable case size. Installation of the A-321 safety relief valve on standard Magnehelic® gages often provides adequate protection against infrequent overpressure.

ⓘ See Note.

SPECIFICATIONS

Service: Air and non-combustible, compatible gases (natural gas option available).
Wetted Materials: Consult factory.
Housing: Die cast aluminum case and bezel, with acrylic cover. Exterior finish is coated gray to withstand 168 hour salt spray corrosion test.
Accuracy: ±2% of full scale (±3% on - 0, -100 Pa, -125 Pa, 10MM and ±4% on - 00, -60 Pa, -6MM ranges), throughout range at 70°F (21.1°C).
Pressure Limits: -20˝ Hg to 15 psig† (-0.677 to 1.034 bar); MP option: 35 psig (2.41 bar); HP option: 80 psig (5.52 bar).
Overpressure: Relief plug opens at approximately 25 psig (1.72 bar), standard gages only. See Overpressure Protection Note on next page.
Temperature Limits: 20 to 140°F* (-6.67 to 60°C).
Size: 4˝ (101.6 mm) diameter dial face.
Mounting Orientation: Diaphragm in vertical position. Consult factory for other position orientations.
Process Connections: 1/8˝ female NPT duplicate high and low pressure taps - one pair side and one pair back.
Weight: 1 lb 2 oz (510 g), MP & HP 2 lb 2 oz (963 g).
Standard Accessories: Two 1/8˝ NPT plugs for duplicate pressure taps, two 1/8˝ pipe thread to rubber tubing adapter and three flush mounting adapters with screws. (Mounting and snap ring retainer substituted for 3 adapters in MP & HP gage accessories.)

*Low temperature models available as special option.

†For applications with high cycle rate within gage total pressure rating, next higher rating is recommended. See Medium and High pressure options at lower left.

OPTIONS AND ACCESSORIES

Transparent Overlays

Furnished in red and green to highlight and emphasize critical pressures.

Adjustable Signal Flag

Integral with plastic gage cover. Available for most models except those with medium or high pressure construction. Can be ordered with gage or separate.

Add suffix **-ASF** to end of gage model number

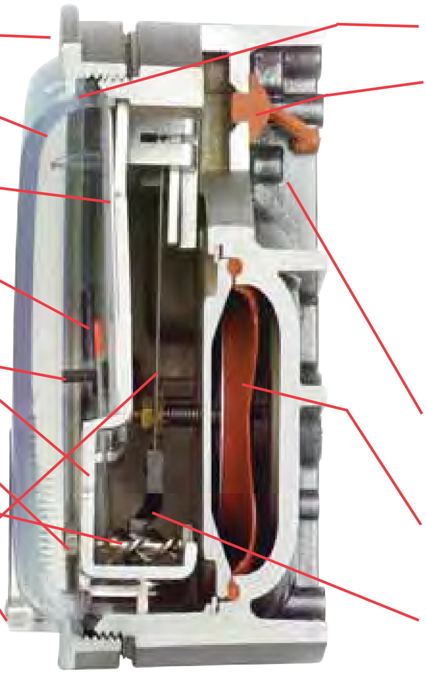
LED Setpoint Indicator

Bright red LED on right of scale shows when setpoint is reached. Field adjustable from gage face, unit operates on 12-24 VDC. Requires MP or HP style cover and bezel.

ⓘ See Note.

Add suffix **-SP** to end of gage model number

ualit design and construction features



Bezel provides flange for flush mounting in panel.

Clear plastic face is highly resistant to breakage. Provides undistorted viewing of pointer and scale.

Precision litho-printed scale is accurate and easy to read.

Red tipped pointer of heat treated aluminum tubing is easy to see. It is rigidly mounted on the helix shaft.

Pointer stops of molded rubber prevent pointer over-travel without damage.

"Wishbone" assembly provides mounting for helix, helix bearings and pointer shaft.

Jeweled bearings are shock-resistant mounted; provide virtually friction-free motion for helix. Motion damped with high viscosity silicone fluid.

Zero adjustment screw is conveniently located in the plastic cover, and is accessible without removing cover. O-ring seal provides pressure tightness.

Helix is precision made from an alloy of high magnetic permeability. Mounted in jeweled bearings, it turns freely, following the magnetic field to move the pointer across the scale.

Calibrated range spring is flat spring steel. Small amplitude of motion assures consistency and long life. It reacts to pressure on diaphragm. Live length adjustable for calibration.

O-ring seal for cover assures pressure integrity of case.

OVERPRESSURE PROTECTION

Blowout plug is comprised of a rubber plug on the rear which functions as a relief valve by unseating and venting the gage interior when over pressure reaches approximately 25 psig (1.7 bar). To provide a free path for pressure relief, there are four spacer pads which maintain 0.023 inch clearance when gage is surface mounted. Do not obstruct the gap created by these pads.

The blowout plug is not used on models above 180 inches of water pressure, medium or high pressure models, or on gages which require an elastomer other than silicone for the diaphragm.

The blowout plug should not be used as a system overpressure control. High supply pressures may still cause the gage to fail due to over pressurization, resulting in property damage or serious injury. Good engineering practices should be utilized to prevent your system from exceeding the ratings or any component.

Die cast aluminum case is precision made and iridite-dipped to withstand 168 hour salt spray corrosion test. Exterior finished in baked dark gray hammerloid. One case size is used for all standard pressure options, and for both surface and flush mounting.

Silicone rubber diaphragm with integrally molded O-ring is supported by front and rear plates. It is locked and sealed in position with a sealing plate and retaining ring. Diaphragm motion is restricted to prevent damage due to overpressures.

Samarium Cobalt magnet mounted at one end of range spring rotates helix without mechanical linkages.

Series 2000 Magnehelic® Gage — Models and Ranges

Page VI shows examples of special models built for OEM customers. For special scales furnished in ounces per square inch, inches of mercury, metric units, square root scales for volumetric flow, etc., contact the factory.

Model	Range Inches of Water
2000-00N†••	.05-0-.2
2000-00†••	0-.25
2000-0†•	0-.50
2001	0-1.0
2002	0-2.0
2003	0-3.0
2004	0-4.0
2005	0-5.0
2006	0-6.0
2008	0-8.0
2010	0-10
2012	0-12
2015	0-15
2020	0-20
2025	0-25
2030	0-30
2040	0-40
2050	0-50
2060	0-60
2080	0-80
2100	0-100
2120	0-120
2150	0-150
2160	0-160
2180*	0-180
2250*	0-250
Zero Center Ranges	
2300-00†••	0.125-0-0.125
2300-0†•	.25-0-.25
2301	.5-0-.5
2302	1-0-1
2304	2-0-2
2310	5-0-5
2320	10-0-10
2330	15-0-15

Model	Range PSI
2201	0-1
2202	0-2
2203	0-3
2204	0-4
2205	0-5
2210*	0-10
2215*	0-15
2220*	0-20
2230**	0-30

Model	Range, CM of Water
2000-15CM	0-15
2000-20CM	0-20
2000-25CM	0-25
2000-50CM	0-50
2000-80CM	0-80
2000-100CM	0-100
2000-150CM	0-150
2000-200CM	0-200
2000-250CM	0-250
2000-300CM	0-300
Zero Center Ranges	
2300-4CM	2-0-2
2300-10CM	5-0-5
2300-30CM	15-0-15

†These ranges calibrated for vertical scale position.
• Accuracy +/-3%
• • Accuracy +/-4%
*MP option standard
**HP option standard

Model	Range MM of Water
2000-6MM†••	0-6
2000-10MM†•	0-10
2000-15MM	0-15
2000-25MM	0-25
2000-30MM	0-30
2000-50MM	0-50
2000-80MM	0-80
2000-100MM	0-100
2000-125MM	0-125
2000-150MM	0-150
2000-200MM	0-200
2000-250MM	0-250
2000-300MM	0-300
Zero Center Ranges	
2300-6MM†••	3-0-3
2300-10MM†•	5-0-5
2300-20MM†•	10-0-10

Model	Range, Pa
2000-60NPA†••	10-0-50
2000-60PA†••	0-60
2000-100PA†•	0-100
2000-125PA†•	0-125
2000-250PA	0-250
2000-300PA	0-300
2000-500PA	0-500
2000-750PA	0-750
2000-1000PA	0-100 x 10
Zero Center Ranges	
Model	**Range, Pa**
2300-60PA†••	30-0-30
2300-100PA†•	50-0-50
2300-120PA	60-0-60
2300-200PA	100-0-100
2300-250PA	125-0-125
2300-300PA	150-0-150
2300-500PA	250-0-250
2300-1000PA	500-0-500

Model	Range, kPa
2000-0.5KPA	0-0.5
2000-1KPA	0-1
2000-1.5KPA	0-1.5
2000-2KPA	0-2
2000-2.5KPA	0-2.5
2000-3KPA	0-3
2000-4KPA	0-4
2000-5KPA	0-5
2000-8KPA	0-8
2000-10KPA	0-10
2000-15KPA	0-15
2000-20KPA	0-20
2000-25KPA	0-25
2000-30KPA	0-30
Zero Center Ranges	
2300-1KPA	.5-0-.5
2300-2KPA	1-0-1
2300-2.5KPA	1.25-0-1.25
2300-3KPA	1.5-0-1.5

Dual Scale Air Velocity Units
For use with pitot tube

Model	Range in W.C./ Velocity F.P.M.
2000-00AV†••	0-.25/300-2000
2000-0AV†•	0-.50/500-2800
2001AV	0-1.0/500-4000
2002AV	0-2.0/1000-5600
2005AV	0-5.0/2000-8800
2010AV	0-10/2000-12500

Dual Scale English/Metric Models

Model	Range, In. W.C.	Range, Pa or kPa
2000-OOD†••	0-.25	0-62 Pa
2000-OD†•	0-0.5	0-125 Pa
2001D	0-1.0	0-250 Pa
2002D	0-2.0	0-500 Pa
2003D	0-3.0	0-750 Pa
2004D	0-4.0	0-1.0 kPa
2005D	0-5.0	0-1.25 kPa
2006D	0-6.0	0-1.5 kPa
2008D	0-8.0	0-2.0 kPa
2010D	0-10	0-2.5 kPa
2015D	0-15	0-3.7 kPa
2020D	0-20	0-5 kPa
2025D	0-25	0-6.2 kPa
2050D	0-50	0-12.4 kPa
2060D	0-60	0-15 kPa

ACCESSORIES
A-299, Surface Mounting Bracket
A-300, Flat Flush Mounting Bracket
A-310A, 3-Way Vent Valve
A-321, Safety Relief Valve
A-432, Portable Kit
A-448, 3-piece magnet kit for mounting Magnehelic® gage directly to magnetic surface
A-605, Air Filter Kit
A-610, Pipe Mount Kit

OPTIONS — To order, add suffix: I.E. 2001-ASF
ASF, Adjustable Signal Flag
HP, High Pressure Option
LT, Low Temperatures to -20°F
MP, Med. Pressure Option
SP, Setpoint Indicator
Scale Overlays, Red, Green, Mirrored or Combination, Specify Locations

VELOCICALC®
AIR VELOCITY METERS
MODELS 9515, 9535, 9535-A, 9545 AND 9545-A

The dependable TSI VelociCalc® Air Velocity Meters measure air velocity and temperature. Models are available to calculate flow rate, perform statistical calculations, and measure humidity with dew point and wet bulb temperature conversions.

Model 9545

The Model 9515 is an economical choice for a digital air velocity meter, without compromising accuracy or precision. Professionals find them to be the ideal tool for face velocity measurements in fume hoods, spray booths, or ventilation system checks.

The Models 9535 and 9545 Air Velocity 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.

Applications
+ HVAC system performance
+ Commissioning
+ Plant maintenance
+ Critical environment certification
+ Duct traverses

Features and Benefits
+ Accurate air velocity measurement
+ Easy to read display
+ Simple to operate
+ Calibration certificate included

Models 9535, 9535-A, 9545 and 9545-A
+ Simultaneously measure temperature and velocity
+ Displays up to three measurements simultaneously
+ 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)
+ Measures humidity (Model 9545 and 9545-A)

TSI®

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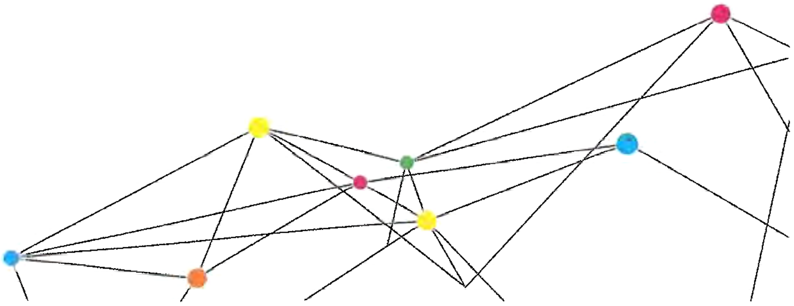

SPECIFICATIONS

VELOCICALC® AIR VELOCITY METERS
MODELS 9515, 9535, 9535-A, 9545 AND 9545-A

Velocity

Range (9515)	0 to 4,000 ft/min (0 to 20 m/s)
Range (9535 and 9545)	0 to 6,000 ft/min (0 to 30 m/s)
Accuracy (9515)[1&2]	±5% of reading or ±5 ft/min (±0.025 m/s), whichever is greater
Accuracy (9535 and 9545)[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 (9535 and 9545)

Dimensions	1 to 250 inches in increments of 0.1 in. (1 to 635 cm in increments of 0.1 cm)

Volumetric Flow Rate (9535 and 9545)

Range	Actual range is a function of velocity and duct size

Temperature

Range (9515, 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	5 to 95% RH
Accuracy[4]	±3% RH
Range	0.1% RH

Instrument Temperature Range

Operating (Electronics)	40 to 113°F (5 to 45°C)
Models 9515 and 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 (9535 and 9545)

Range	12,700+ samples and 100 test IDs

Logging Interval (9535 and 9545)

1 second to 1 hour

Time Constant (9535 and 9545)

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

	9515	9535, 9535-A	9545, 9545-A
Velocity range 0 to 4000 ft/min (0 to 20.00 m/s)	+		
Velocity range 0 to 6000 ft/min (0 to 30.00 m/s)		+	+
Temperature	+	+	+
Flow		+	+
Humidity, wet bulb, dew point			+
Probe	Straight	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 4000 ft/min. (0.15 m/s through 20 m/s) for the Model 9515, and 30 ft/min through 6,000 ft/min (0.15 m/s through 30 m/s) for Models 9535 and 9545.

[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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TSI Incorporated - Visit our website **www.tsi.com** for more information.

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Germany	**Tel:** +49 241 523030		

P/N 2980569 Rev D

Printed in U.S.A.

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

H2K Technologies, Inc.
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Corcoran, MN 55340
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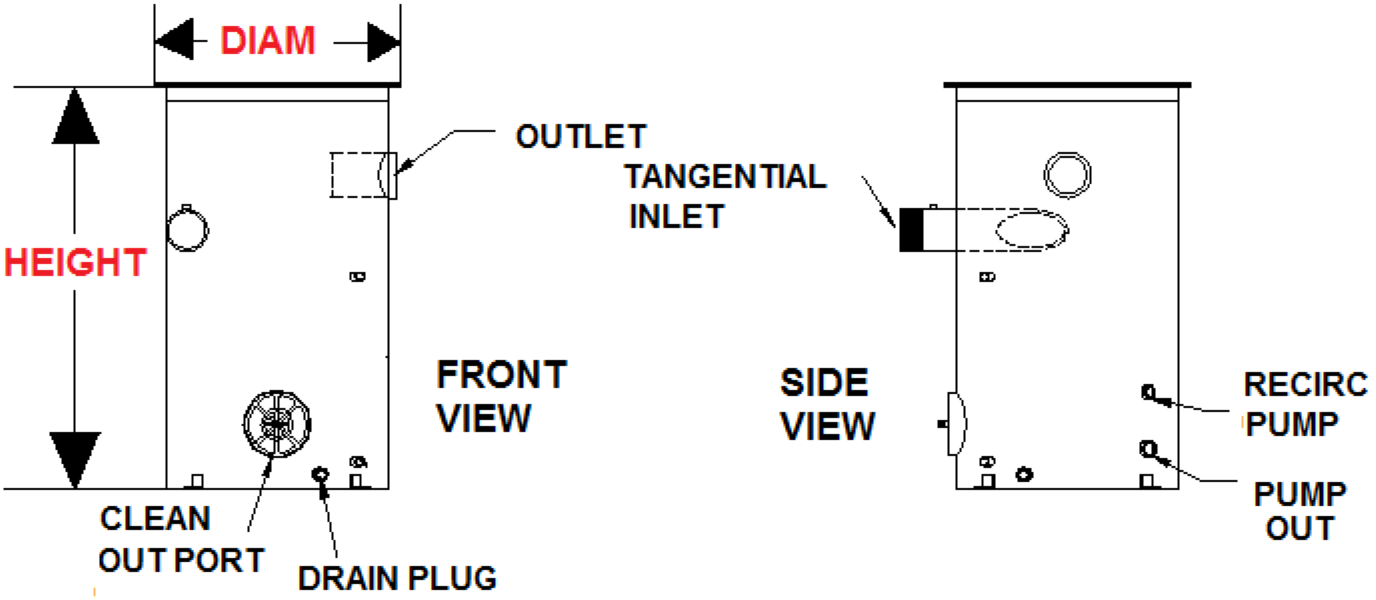
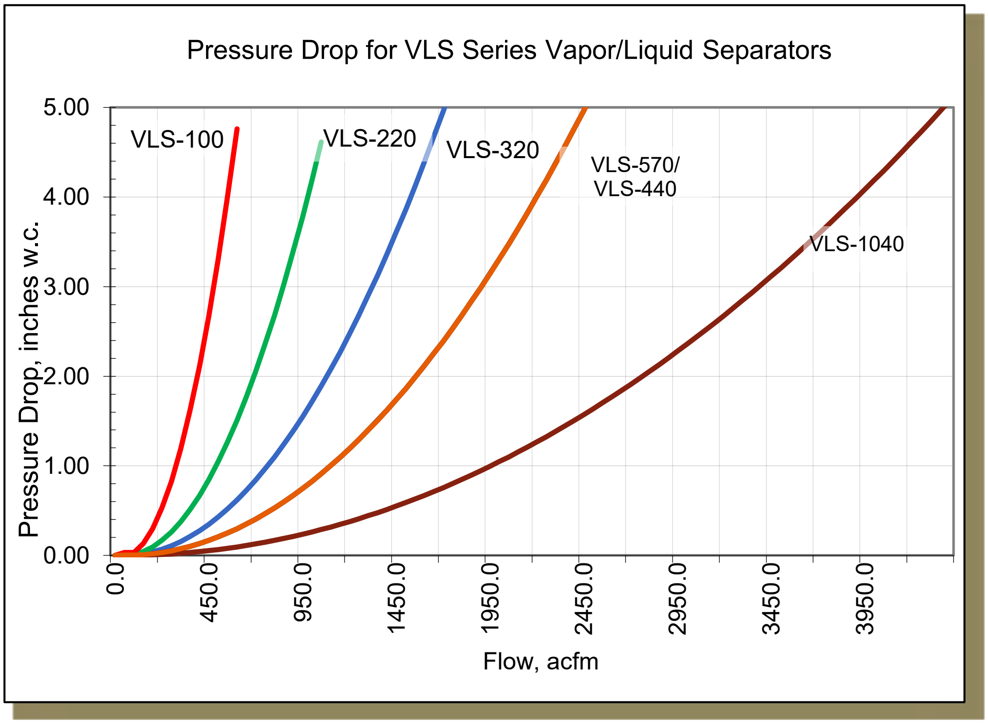
www.H2KTECH.com
Sales@H2KTech.com

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

Appendix E

Technical Specifications

Lovington 66
Final Remediation Plan
Table of Contents

Specification Number **Description**

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Division 22: Plumbing

22 05 03.01 High Density Polyethylene Pipe
22 05 03.02 PVC Piping
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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, shall be rated for the pressure service at least equal to that of the system pipe, and shall have outlets manufactured to the same DR as that of system pipe.
6. Molded fittings shall be manufactured in accordance with ASTM D3261.
7. Socket fittings shall be manufactured in accordance with ASTM D2683.

2.2 UNDERGROUND PIPE MARKERS

A. Underground pipe marker shall be metallic detectable brightly colored plastic tape.

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 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 systems:
   1. SVE conveyance 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 D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
   4. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
   5. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.

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.

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 elevation as indicated on Drawings.

D. Install pipe on prepared bedding.

E. Install valves at locations indicated on Drawings in accordance with this Section.

F. Install plastic ribbon tape continuously buried 12 inches above pipe line; coordinate with Section 31 23 17.

G. 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 gradient. Route parallel and perpendicular to walls.

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 installation of insulation and access to valves and fittings. Provide access where valves and fittings are not accessible.

F. Install non-conducting dielectric connections wherever jointing dissimilar metals.

G. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

H. Install piping penetrating roofed areas to maintain integrity of roof assembly.

I. Install valves in accordance with the manufacturer's instructions.

J. Insulate piping as shown in the Drawings.

END OF SECTION

SECTION 22 05 03.03

STEEL PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Pipe and pipe fittings for the air sparge system.

B. Related Sections:
  1. Section 22 05 19.01 - Pressure Gauges
  2. Section 22 05 19.02 - Flow Meters
  3. Section 22 05 19.03 - Heat Dissipation Sensors
  4. Section 31 23 17 - Trenching and Backfill
  5. Section 44 11 36 - Soil Vapor Extraction System

1.2 REFERENCES

A. American Society of Mechanical Engineers:
  1. ASME B16.3 - Malleable Iron Threaded Fittings.
  2. ASME B16.4 - Gray Iron Threaded Fittings.
  3. ASME B31.1 - Power Piping.
  4. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.
  5. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. ASTM International:
  1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

C. American Welding Society:
  1. AWS D1.1 - Structural Welding Code - Steel.

1.3 SUBMITTALS

A. Product Data: Submit data on pipe materials and fittings. Submit manufacturers catalog information.

B. Welders’ Certificate: Include welders’ certification of compliance with AWS D1.1.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.1 code for installation of piping systems and ASME Section IX for welding materials and procedures.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing work of this section with minimum five years experience.

1.6 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.

1.7 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 AIR SPARGE PIPING

A. Steel Pipe: ASTM A53/A53M, Schedule 40.
  1. Fittings: ASTM A234/A234M, forged steel welding type or threaded couplings.
  2. Joints: Welded or threaded couplings.

2.2 PIPE INSULATION

A. Manufacturers:
  1. Owens Corning, SoftR Duct Wrap.
  2. Substitutions: Permitted with the Engineer's approval.

2.3 UNDERGROUND PIPE MARKERS

A. Plastic Ribbon Tape: Bright colored, continuously printed, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.4 BEDDING AND COVER MATERIALS

A. Pipe Cover and Backfilling:
  1. Backfill trench in accordance with Sections 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. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

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. Excavate pipe trench in accordance with Section 31 23 17.

C. Install pipe to elevation as indicated on Drawings.

D. Wrap each length pipe continuously in insulation in the locations indicated on the Drawings.

E. Install pipe on prepared bedding with supports and tie-downs as indicated on the Drawings.

F. Install pipe to allow for expansion and contraction without stressing pipe or joints.

G. Install expansion compensators a minimum of every 18 feet and as indicated on the Drawings.

H. Install expansion compensators at each elbow, tee or appurtenance.

I. Install valves at locations indicated on Drawings in accordance with this Section.

J. Install plastic ribbon tape continuously buried 12 inches, above pipe line; coordinate with Section 31 23 17.

K. Pipe Cover and Backfilling:
  1. Backfill trench in accordance with Section 31 23 17 and as indicated on the Drawings.
  2. Do not bond flowable fill concrete insulation to piping or expansion compensators.

3.4 INSTALLATION - ABOVE GROUND PIPING

A. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

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. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Provide access where valves and fittings are not accessible.

G. Install non-conducting dielectric connections wherever jointing dissimilar metals.

H. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

I. Install piping penetrating roofed areas to maintain integrity of roof assembly.

J. Install valves in accordance with the manufacturer's instructions.

K. Insulate piping as shown in the Drawings.

END OF SECTION

SECTION 22 05 19

GAUGES AND SENSORS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
  1. Analog dial-type vacuum gauges.
  2. Analog dial-type pressure gauges.
  3. Analog differential pressure gauges.
  4. Flow sensors.
  5. Temperature sensors.

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 LPG3 Low Pressure Gauge.
  2. Substitutions: Permitted with the Engineer's approval.

2.2 GAUGE AND SENSOR CONSTRUCTION:

A. Dwyer Series LPG3
  1. Unless otherwise specified, gauges shall be indicating dial type with:
    a. 304 stainless steel housing.
    b. Shatter-proof safety glass lens.

2.3 OPERATION

A. The dial shall be 3 inches diameter or less 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.

END OF SECTION

SECTION 22 05 23

GENERAL DUTY VALVES

PART 1 GENERAL

1.1 SUMMARY

A. Furnish all labor, materials, equipment, and incidentals required to install all valves necessary for the soil vapor extraction, treatment, and hot air injection systems including but not limited to wells, piping, and equipment.

B. Section Includes:
   1. Gate valves.
   2. Butterfly valves.
   3. Check 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.
   2. ASTM D4101 - Standard Specification for Polypropylene Injection and Extrusion Materials

B. Manufacturers Standardization Society of the Valve and Fittings Industry:
   1. MSS SP 67 - Butterfly Valves.
   2. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
   3. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

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.

1.9 EXTRA MATERIALS

A. Furnish two packing kits for each size valve.

PART 2 PRODUCTS

2.1 GATE VALVES

A. Manufacturers:
   1. King Brothers Industries, Model GVP.
   2. Substitutions: Permitted with the Engineer's approval.

B. 2-inch (GV-201): Schedule 40, 150 psi at 73 degrees F water temperature, maximum service temperature: 140 degrees F, ASTM D1785 PVC body and gate, hand-wheel, EPDM seals, regular port, glue socket ends.

2.2 BUTTERFLY VALVES

A. Manufacturers:
   1. Asahi/America, Inc, Model Type 57.
   2. Substitutions: Permitted with the Engineer's approval.

B. 4-inch (BFV-401): 150 psi at 73 degrees F water temperature, maximum service temperature: 140 degrees F, one piece body, ASTM D1785 PVC, lug type flange facing, disc encapsulated with EPDM, stainless steel shaft, locking lever handle.

2.3 CHECK VALVES

A. Ball Check Valves:
   1. Manufacturers:

    a. Spears, True Union 2000 Industrial Ball Check Valve.
    b. Substitutions: Permitted with the Engineer's approval.
  2. 1-inch (CV-101): 235 psi at 73 degrees F water temperature, maximum service temperature: 140 degrees F, ASTM D1785 PVC, spigot end.

B. Spring Loaded Wafer Check Valves:
  1. Manufacturers:
    a. Cameron Valves and Measurements, Model 4.0-DPW-CI-36-T
    b. Substitutions: Permitted with the Engineer's approval.
  2. 2- to 4-inch (CV-201 & CV-301): Pressure class 125 ASME, flange, cast iron body, 316 stainless steel internals and female threaded ends. Rated for a maximum temperature of 450 degrees F.

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.

3.4 SCHEDULES

Valve ID	**Valve Type**	**Material**	**Size, inches**	**Number of Valves**
GV-201	Gate	PVC	2	1
BFV-401	Butterfly	PVC	4	2
CV-101	Check	PVC	1	1

END OF SECTION

SECTION 22 30 10

HIGH DENSITY POLYETHYLENE TANKS

PART 1 GENERAL

1.1 SUMMARY

A. This specification covers upright, single-walled, flat bottom SVE condensate storage tank assemblies. The tanks are designed for aboveground, vertical installation, and are capable of containing fluids at atmospheric pressure. Tank capacity shall be 200 gallons.

1.2 MATERIALS

A. The material used shall be virgin polyethylene resin.

1.3 DIMENSIONS AND TOLERANCES

A. All dimensions will be taken with the tank in the vertical 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. Snyder Industries, Inc
   2. Substitutions: Permitted with approval of Engineer.

B. Product Description:
   1. Polyethylene tanks shall be 200 gallon single-walled tanks.

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. The bulkhead fittings shall be constructed of polyvinyl chloride (PVC), polypropylene (PP), or other specified material. Gaskets shall be a minimum of ¼ in. thickness and constructed of EPDM.

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 SVE condensate storage tanks as indicated on 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 FIELD QUALITY CONTROL

A. Field Testing:
   1. Hydrostatically test each storage tank by filling with water to the overflow pipe level.
   2. Conduct test minimum of 24 hours.
   3. No leakage is permitted.

4. Adjust, repair, modify, or replace components of system failing to perform as specified and rerun tests.

3.5 Schedules

A. Storage Tank Schedule:

Stored Material	**Tank Type & Number**	**Tank Dimensions (Nominal)**	**Tank Size (Capacity)**
SVE condensate water	T-1	30 in. D x 70 in. H	200 gal

END OF SECTION

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. Three

copies of such permission shall be furnished to the ENGINEER before removal operations commence.

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 structural backfill.

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. Super silt fence shall be installed prior to earth-moving activities.

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 31 10 00 - Site Clearing.

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 in unpaved areas.

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 for the particular type of pipe installed.

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 require written approval of the property owner and confirmation from the Engineer.

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. Native Earth Backfill: Native earth backfill, acceptable for use, shall be fine-grained material free from roots, debris, and rocks with a maximum dimension not larger than 3 inches.

B. Imported Backfill Material: Whenever the excavated material is not suitable for backfill, the Contractor shall arrange for and furnish suitable imported backfill material that is capable of attaining the required relative density.

C. The Contractor shall dispose of the excess trench excavation material as specified in the preceding section. Backfilling with imported material shall be done in accordance with the methods described herein.

PART 3 EXECUTION

3.1 COMPACTION REQUIREMENTS

A. Determine the density of soil in place by the use of a nuclear testing gauge or similar.

B. Determine laboratory moisture-density relations of existing soils by ASTM D698.

C. Determine the relative density of cohesionless soils by ASTM D2049.

D. Sample backfill materials by ASTM D75.

E. Express "relative compaction" as the ratio, expressed as a percentage; of the in place dry density to the laboratory maximum dry density.

F. Compaction shall be deemed to comply with the specifications when no test falls below the specified relative compaction.

G. The Contractor will secure the services of a soils tester and pay the costs of all compaction testing. The Contractor will be responsible for the cost of all retests in failed areas. Test results will be furnished to the Engineer immediately upon conclusion of the test.

H. If the backfill fails to meet the specified relative compaction requirements, the Contractor shall rework the backfill until the requirements are met. The Contractor shall make all necessary excavations for density tests as directed by the Engineer. The Contractor will be responsible for the cost of all additional compaction tests in the reworked areas.

I. Compaction tests shall be performed at 2 foot depths and at 200-foot intervals or as per section A-1 of Standard Specification 701.

J. Unless otherwise shown on the drawings or otherwise described in the specifications for the particular type of pipe installed, relative compaction in pipe trenches shall be as described below:
   1. Pipe zone and pipe bed: 90% relative compaction.

2. Trench zone not beneath paving: 90% relative compaction.
3. Trench zone beneath paving outside of work performed in roadways: 95% relative compaction.
4. Work performed in roadways shall be done in accordance with section A-1 of Standard Specification 701 and approval of the roadway Owner.

3.2 MATERIAL REPLACEMENT

A. Removal and replacement of any trench and backfill material which does not meet the specifications shall be the Contractor's responsibility.

3.3 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.

3.4 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.

3.5 TRENCH WIDTHS

A. Excavation and trenching shall be true to line with a minimum width of the largest outside diameter of the pipe + 12 inches and a maximum width of the largest outside diameter of the pipe + 24 inches. Width of trenches for multiple pipes shall be according to the Drawings.

3.6 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.

3.7 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.

3.8 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.

3.9 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, (see Section 3.10 C) it shall be removed to a depth at least 6 inches below grade and the trench shall be backfilled with 3/4-inch crushed rock 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..

3.10 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.

3.11 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. Grade the top of the pipe bedding ahead of the pipe to provide firm, uniform support along the full length of pipe.

3.12 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.

3.13 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.

3.14 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 44 11 36

SOIL VAPOR EXTRACTION SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the containerized treatment equipment and installation of a Soil Vapor Extraction (SVE) System.

B. Related Sections:

1. Section 22 05 23 - General Duty Valves
2. Section 22 05 03.02 - PVC Piping
3. Section 22 30 10 - High Density Polyethylene Tanks

1.2 Acronym Definitions

A. scfm - standard cubic feet per minute

B. ppmv - parts per million by volume

C. VOC - volatile organic compound

D. TPH - total petroleum hydrocarbons

E. in. - inch

F. HP - horsepower

G. SVE - soil vapor extraction

H. VFD - variable frequency drive

1.3 PERFORMANCE REQUIREMENTS

A. The system shall remove 550 scfm of soil vapor using a conventional thermal oxidizer for vapor treatment. The thermal oxidizer, owned by the State of New Mexico, shall be transferred from an existing PSTB site in Tatum, New Mexico, and is expected to have a minimum of 99% destruction efficiency of incoming 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.

1.4 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.

1.5 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.

1.6 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 110°F.

B. The equipment should be designed to operate at an elevation of 3,910 feet without adverse effect to performance and operation.

1.7 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.

1.8 COORDINATION

A. Coordinate work with the Engineer and other Contractors as required.

PART 2 PRODUCTS

2.1 VAPOR EXTRACTION EQUIPMENT

A. Suppliers:

1. Intellishare Environmental, Inc.
   E4803 395th Avenue
   Menomonie, WI 54751 USA
   Contact: John Strey
   Phone: 1.715.233.6115
   Fax: 1.715.232.0669
   Email: jstrey@intellishare-env.com

2.2 COMPONENTS

A. Remediation equipment:

1. SVE blower and vapor liquid separator
2. Thermal oxidizer with option to run in catalytic mode
   a. NMED-owned equipment: mobilized from Tatum, New Mexico
3. Control panels and local instrumentation and controls with the ability to be remotely accessed
4. Interconnected process piping
5. Electrical power connections
6. Natural gas feed connections

B. Equipment Enclosure

1. SVE blower, vapor-liquid separator, and associated equipment and controls will be located within a modified shipping container. This enclosure will be used to reduce noise and mitigate vandalism and theft of remediation equipment.
2. Noise restriction: noise level outside of the building shall be less than 70 dBA at a distance of 10 feet, and less than 60 dBA at a distance of 50 feet, with intake and exhaust louvers directed away from local residences.
3. Interior
   a. Floor sealed with non-skid bed liner
   b. Insulated floor, walls, ceiling, and steel access door
   c. Overhead lighting
   d. Wall-mounted electric heater
   e. Vent fan, sound-insulated inlet/outlet louvers, and thermostat

C. SVE Blowers

1. Blowers:
   a. The SVE blower shall be a Sutorbilt Legend 7M positive displacement blower with 40-hp TEFC variable speed motor and a VFD located at the main control panel. The blower will be rated for 550 scfm at an applied vacuum of 100 inches water column, and shall have an automatic belt tensioner.
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.

3. Vapor Liquid Separator: A vapor liquid separator shall be located on the inlet of the system and provide sufficient storage for 75 gallons of accumulated condensate. The vapor liquid separator shall include a liquid coalescing media internal to the separator and external devices will include three point liquid level switches mounted inside a clear PVC site glass. The separator shall have a condensate pump and bottom drain.

D. 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 13’ AGL and is supplied with sampling ports.

E. Control System
   1. Main Control System: 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 3R and constructed of steel.

F. Telemetry
   1. A cellular modem will be provided to allow remote access to system controls. The telemetry system will provide data access and the ability to be notified of alarm conditions via text or email.

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 vapor extraction and treatment equipment.

B. Start-up training to include up to 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 F

Draft NMDOT Utility Permit

A-0063
Revised:07/2019
Right-of-Way

NEW MEXICO DEPARTMENT OF TRANSPORTATION
APPLICATION FOR PERMIT TO INSTALL UTILITY FACILITIES WITHIN PUBLIC RIGHT OF WAY

Permit No. ____________

____ Renewal Permit
____ Relocation
____ Remain in Place
X New Installation
____ Out of Service

TO: NEW MEXICO DEPARTMENT OF TRANSPORTATION
P.O. Box 1149
SANTA FE, NEW MEXICO 87504-1149

1. Pursuant to New Mexico Statutes Annotated, 1978 Compilation, Sections 67-8-13 and 55-2-7, and 17.4.2 NMAC the undersigned

Daniel B. Stephens & Associates, Inc.

Address: 6020 Academy Rd. NE, Suite 100, Albuquerque, NM 87109

herein makes application to use highway rights of way to install:

Size and Type of Facility Two horizontal remediation wells underneath right of way. Approximately 170 ft in length for each well.

in the following location: N.M. Project No. See attached map Route No. ____________

Highway MP/GPS NM18: 72.13 and to Highway MP/GPS NM83: 0.07 and US82: 171.36 to 171.39

Lea County, Section 10 and 3 , Township 16S , Range 36E

2. For the purpose of this application “within” shall be construed as meaning “on, upon, over, under, across or along.”
   a. “Engineer” shall be construed as meaning the District Engineer of the New Mexico Department of Transportation of the District Engineer’s Representative.
   b. “Applicant shall be construed as meaning the individual, firm, corporation, association, governmental subdivision, or other organization making application, or the successors of any of the above.
   c. “Facility” shall be construed as meaning, but not limited to any publicly, privately, cooperatively, municipally or governmentally owned facility used for carriage, distribution or transmission or water, gas or electricity, oil and products derived therefrom, sewage, stream or other projects carried by means of pipelines, conduits, wires, culverts, ditches, conveyors or other methods.
   d. If application is for a parallel installation, justification as to why private right may be utilized must be furnished.

3. Applicant proposes to ☐ relocate ☒ install ☐ leave facility varies, see map feet within the NM18/NM83/US82 right of way line. The Proposed installation shall be:

crossing	subsurface	boring
(Crossing or Parallel)	(Subsurface or Overhead)	(Boring, Jacking, or Pavemet Cuts)

   a. If applicant requests installation by pavement cut, complete justification therefore shall be submitted by attachment.
   b. Where application for pavement cut us justified, the application may be held in abeyance pending receipt of cash bond in an amount to be fixed by the Engineer.

4. There is attached hereto a diagrammatic dimensioned drawing showing the location of existing and/or proposed installation referenced to roadway and right of way, right of way lines, any access control lines, distance of proposed installation above, or below grade, highway stationing, identification of materials to be used an any other pertinent data. If application is for parallel installation, nature of adjacent land use must be shown. Proposed installations on or in bridges or other structures, or for the installation of any structures, shall require detailed structural drawings.

5. Applicant desired this permit to be in affect for 25 years. Permit shall not be issued for a period longer than 25 years, and must be renewed upon expiration. The burden of timely renewal is on the Applicant. The Applicant shall formally notify the engineer of actual commencement and completion of construction of the installation. The Applicant shall also formally notify the Engineer of removal or abandonment of the facility, or relinquishment of the permit.

NEW MEXICO DEPARTMENT OF TRANSPORTATION

APPLICATION FOR PERMIT TO INSTALL UTILITY FACILITIES WITHIN PUBLIC RIGHT OF WAY

6. This application shall be validated as a permit upon the signing of the application by the Engineer and returned it to the Applicant. The granting if this permit shall not be construed as granting any easement of property right.

7. Servicing of facilities shall not be permitted within the access control lines on any controlled access project. Should an emergency occur, the Applicant shall notify the Engineer and shall provide such flagmen, flashers, warning or other safely devices as required by the Engineer. All routine maintenance shall be performed from outside any access control lines.

8. The relocation or installation of facilities within public right of way shall be in strict conformance with all **application provisions of regulations of the New Mexico Department of Transportation 17.4.2 NMAC,** all provisions of this application, drawing and the Instructions for Utility Permits, as they may be modified by the Engineer, and no departure therefrom may be made without the written consent of the Engineer. All facilities shall be so placed that they will not interfere with or endanger any roadway features or other existing facilities. All construction of facilities shall be subject to the inspection and approval of the Engineer. All such work shall be performed so that danger, inconvenience and delay to the traveling public will be held to a minimum. Protection and handling of traffic during the installation are the responsibility of the Applicant and must be approved by the Engineer.

9. The Applicant shall, except as otherwise ordered by the Engineer, restore the right of way, and all bridges or other structures thereon or adjacent thereto which have been altered or affected by facility installation performed hereunder, in accordance with sound construction practices and the Engineer's specifications, and shall cause the work to be done in a workmanlike manner, if any damage is caused to the highway right of way or to any bridge, structure or improvement thereon or adjacent thereto by reason of the design installation, maintenance alteration or removal of such facilities or other appurtenances, the Applicant shall reimburse the Engineer the full amount thereof promptly upon demand by the Engineer provided, however, that the obligation imposed under this paragraph shall not apply in the event the damage resulted from causes beyond the control of the Applicant or its contractors or its consultants. All such facilities located with the right of way shall at all times be kept in such repair so as not to damage the highway, inconvenience or endanger the traveling public and shall be kept free advertisement, posters and the like.

10. Should the Applicant at the time fail to promptly and fully perform any of the obligations imposed hereby and after thirty (30) days written notice thereof, the Engineer may, at his option (a) cause the obligations to be fully carried out and performed, and the Applicant shall promptly reimburse the Engineer for all costs and expenses incident thereto, or (b) summarily order the removal of such facility and if the Applicant fails to comply with that removal order within a reasonable time, the Engineer may direct the removal of the facility with all costs and expenses thereto to be borne by Applicant.

11. If by reason of any change in the location, construction, grade or by any other matter affecting the highway upon which any facility is located because of changing traffic conditions or otherwise, it shall become advisable in the opinion of the engineer that said facility be removed, relocated or otherwise modified, the utility, upon written notice from the engineer, shall provide all horizontal and vertical data including pothole information, size and type of material, and condition of material. If necessary the utility shall remove, relocate or modify such facility without undue delay in such manner as the engineer may direct or approve, at the utility's expense and at no cost to the engineer. All facilities located on public right-of-way under the dual jurisdiction of the state and a subordinate governmental entity shall comply with all applicable rules and regulations of such entity properly and lawfully in force and including but not limited to provisions of local franchises not in conflict with the rules and regulations of the engineer. The engineer makes no warranty, either express or implied, as to the continued existence of any highway in any particular location and expressly assumes no obligation with regard to the facility upon change, vacation or abandonment of any highway or portions thereof.

12. Neither the making of this application nor anything herein contained shall constitute a waiver on the part of the Applicant of any rights or claims had or made by some with respect to the occupancy of the streets and highways under the Constitution and Laws of the State of New Mexico, nor shall anything herein contained in any prejudice or impair any rights or claims existing independent of this application with respect to the construction, operation, and maintenance of the Applicant's facilities in the State of New Mexico.

13. The utility owner must indemnity and hold harmless the New Mexico Department of Transportation from loss due to any negligent act of the utility, the utility's employees, any agent acting on the utility's behalf, and anyone else engaged by the utility to work on the utility installations, maintenance or relocations of their facilities. Any contractor or subcontractor engaged by the utility to perform utility installations or relocations in conjunction with or prior to highway construction must also indemnify and hold harmless the New Mexico Department of Transportation from loss due to any negligent act of the utility's contractor or subcontractor.

14. Each copy of the application shall be signed by the Applicant as an individual owner or by any official designated to execute such Documents.

NEW MEXICO DEPARTMENT OF TRANSPORTATION

APPLICATION FOR PERMIT TO INSTALL UTILITY FACILITIES WITHIN PUBLIC RIGHT OF WAY

15. Utility owners shall carry insurance in amounts not less than those below specified and as outlined in 17.4.2 NMAC and the Standard Specifications for Highway and Bridge Construction, 2019 Edition, (hereinafter, "Specifications"), as may be updated from time to time. In the event of conflict between the specification, and the regulations, owner shall carry the largest amount of insurance. If a utility is self-insured, the utility shall provide an Owner's Protective Liability Insurance Policy, in favor of the Department, in the amounts below specified. **Department as additional named insured:** The utility, is contractor or subcontractor shall have the New Mexico Department of Transportation added as an additional named insured on the Comprehensive General Liability Form or Commercial General Liability Form furnished by the Utility.

    This application is hereby granted subject to all provisions herein and including the following special provisions, changes or amendments:

    The utility shall provide "as-built" horizontal and vertical location information in hard copy and electronic file (AutoCAD) DWG (3D). The standard horizontal datum shall be North American Datum 1983 (NAD83) and the standard projections shall be the New Mexico State Plane Coordinate System 1983 (NMSPCS83). The standard vertical datum shall be North American Vertical Datum 1988 (NAVD 1988). The utility location information shall be tied to Department monuments and referenced to highway mileposts and/or GIS coordinates and certified by a New Mexico Registered Land Surveyor. Metadata or "data about the data" shall be submitted with each utility's as-built electronic file, preferably as a separate text file on the electronic submittal media, and shall include: **1.** District Utility Permit Number. **2.** Name, address and phone number of the responsible land surveyor. **3.** Date of completion of survey. **4.** Equipment used to conduct the Survey. **5.** Horizontal and vertical control marks used to tie the survey to the NMSPC83 and NAVD88. **6.** Ground to Grid combined scale factor used. **7.** Elevations shall be provided every 500 feet and at all survey break points, including all high and low points.

Note: Highway projects are time sensitive therefore, permit information requested from Authorization to Engineer Letters must be returned by the date indicated within the Authorization to Engineer letter.

16. Any utility qualifying for reimbursement shall relocate in accordance with and pursuant to MAP-21; http://www.fhwa.dot.gov/construction/contreacts/buyam-qa.cfm and (23U.S.C313)

Applicant/Utility Owner certifies we are in compliance with Buy America for said facility and agrees and understands nonadhereence will void said permit.

Applicant: Daniel B. Stephens & Associates, Inc.

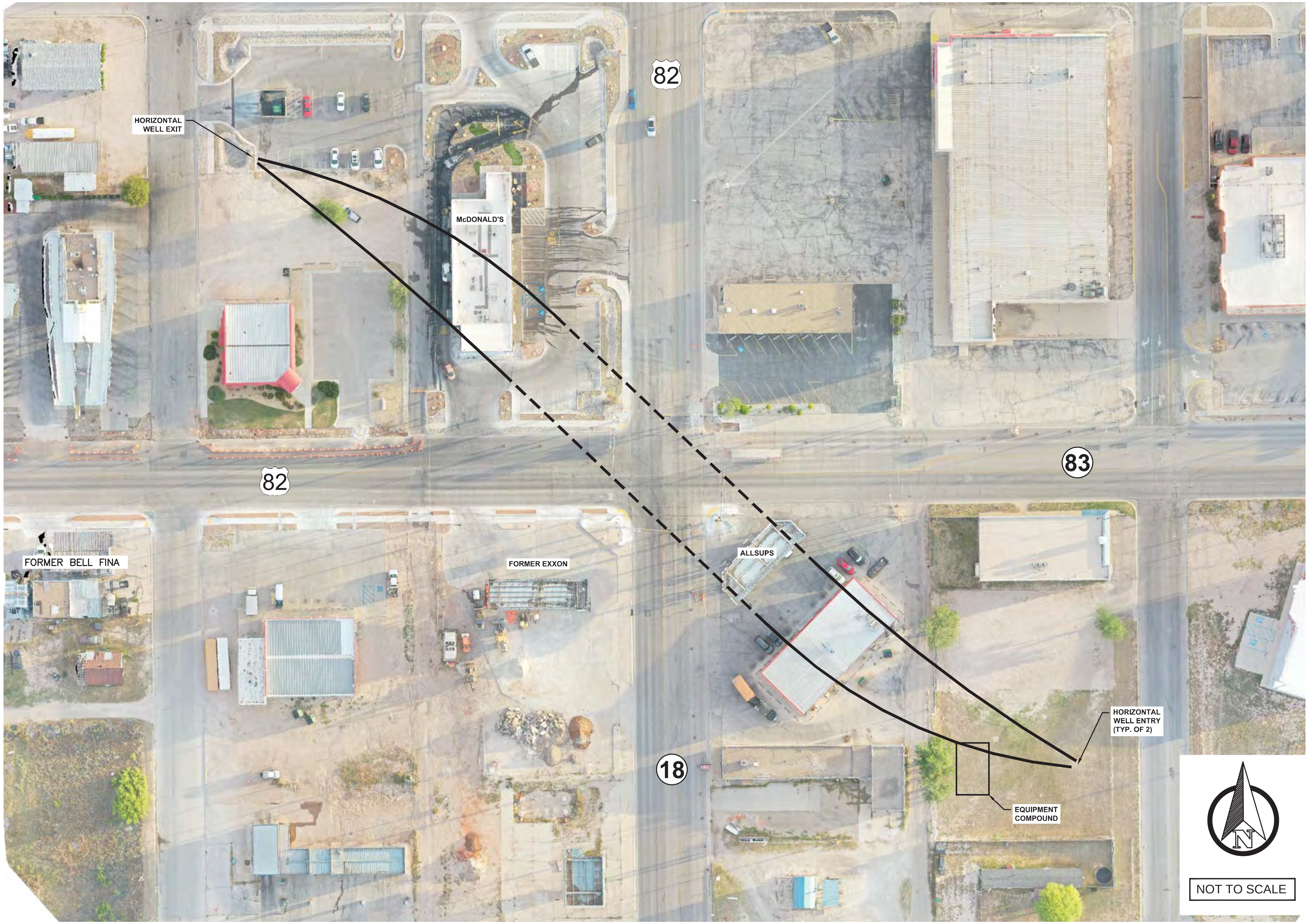
By: Thomas Golden, P.E.

Signature: ______________________ Date: __________

Approval of this permit is hereby given this __________ day of ____________________ , 20 ______

NEW MEXICO DEPARTMENT OF TRANSPORTATION

By: ______________________



GENERAL NOTES:

1. DESIGN SURVEY AND AERIAL PHOTOGRAPHY PROVIDED BY AEA.
2. HORIZONTAL WELL RUN–IN AND RUN–OUT SHOWN AT SLOPE OF 5:1 (H:V). SLOPE MAY BE ADJUSTED IN THE FIELD DEPENDING ON DRILLING CONDITIONS.

LEGEND:

▬▬	PROPOSED HORIZONTAL WELL
– – –	SCREEN SECTION OF HORIZONTAL WELL

NOT FOR CONSTRUCTION

DRAFT ISSUED FOR REVIEW

S:\PROJECTS\DB19.1395_LOVINGTON_66\CAD\PRODUCTION\JIC\VICINITY MAP.DWG August 6, 2020 – 2:14 PM BY: CHRISTOPHER KING

REV. NO.	DATE	DESCRIPTION	APPROVED BY

DATE OF ISSUE: AUGUST 28, 2020
DESIGNED BY: T. GOLDEN
DRAWN BY: JA/RT/CK
CHECKED BY: G. PETERSON
APPROVED BY: T. GOLDEN

DBS&A
Daniel B. Stephens & Associates, Inc.
6020 Academy Rd. NE, Suite 100
Albuquerque, NM 87109-3315

424 SOUTH MAIN STREET
LOVINGTON, NM 88260

STATE LEAD REMEDIATION
LOVINGTON 66
LOVINGTON, NEW MEXICO

GENERAL SITE PLAN

SHT. 1 OF 1
DWG NO. -
JOB NO. DB19.1395.00

New Mexico DEPARTMENT OF
TRANSPORTATION
MOBILITY FOR EVERYONE

Environmental Clearance for Undertakings within NMDOT Rights-of-way

In order to receive environmental clearance for permitted projects in highway rights-of-way the following information will need to be submitted to the NMDOT Environmental Development Section. Submittals (usually) are reviewed Tuesday of each week. Submittals received on Tuesday will not be reviewed until the following Tuesday. Emergency requests are handled on a case-by-case basis.

1. **Purpose** and **Nature** of undertaking. Describe the undertaking along with width, length and depth of ground disturbance. <u>Include the methods and machinery to be used.</u>

Two horizontal remediation wells will be drilled underneath the US82/NM18/NM83 right-of-way (Figure 1). Approximately 170 ft in length for each well. The well will be constructed using directional drilling technology. Both the entrances and exits will be on private land. The well depths will be ~50 feet bgs.

2. **Is your project resulting from a NMDOT project?** If so, provide the control and/or project number.

No.

3. **Funding source.** Is the funding private, state, or federal? If state and/or federal, list agency(s).

New Mexico Environment Department Petroleum Storage Tank Bureau

4. **Land status.** Is the project on right of way owned by BLM, Forest Service, Tribal land, or State Trust land? (NMDOT does not own all highway rights of way!)

No

5. **Permitting agencies.** List other permitting agencies involved besides NMDOT.

New Mexico Office of the State Engineer

6. **County**. List the county or counties in which the project is located.

Lea County

7. **Highway number.** Indicate the highway the project will cross or parallel.

NM18, NM83, and US82

8. **BOP and EOP.** Provide the milepost locations for the beginning of the project area (BOP) and the end of the project area (EOP). If highway crossing only, list the milepost location. Indicate BOP and EOP on quadrangle maps as well.

BOP: US82: 171.36 and 171.39, EOP: NM18: 72.13 and NM83: 0.07

9. **Side(s)** of the road. Indicate on which side of the road the project will be located using cardinal directions (north, south, east, west). List all project crossings of the highway by milepost.

The wells will enter the ROW on the North and West sides of US82, continue under the intersection and cross to the East side of NM18 and South side of NM83. See Figure 1.

10. **Length** of the project. Indicate the length of the project within NMDOT right of way in terms of feet and/or miles.

243 ft of US82 ROW, 85 ft of NM18 ROW, and 85 ft of NM83 ROW.

11. **Provide the legal description** of the project area: Township, Range, and Section(s).

T16S, R36E, S10 and 3

12. **USGS 1:24,000 (7.5') Quadrangle map.** List the name(s) of the USGS quadrangle map(s) on which the project is located.

See attached (Figure 2).

13. Include the appropriate portion of the **USGS 1:24,000 (7.5') Quadrangle map(s)** with the project area indicated by an **X** if a crossing, or **BOP** and **EOP** if linear**.** Quad map images can be printed at no charge from the map locator/downloader page at the USGS store at: http://store.usgs.gov/

Google Maps of the project location are also acceptable **if** the background image is the satellite photo and **if** you are sending your request electronically: http://maps.google.com/

14. **Include you**r:

Name: Patrice Feltman

Company (if applicable): Daniel B. Stephens & Associates,

Inc. **Phone** #: (505) 822-9400

Fax #: (505) 822-8877

Email address (if you use one): pfeltman@geo-logic.com

15. **Do not** send photos (including aerial photos or photo maps) unless they are scanned or sent via US Mail. Faxed photos come out entirely black.

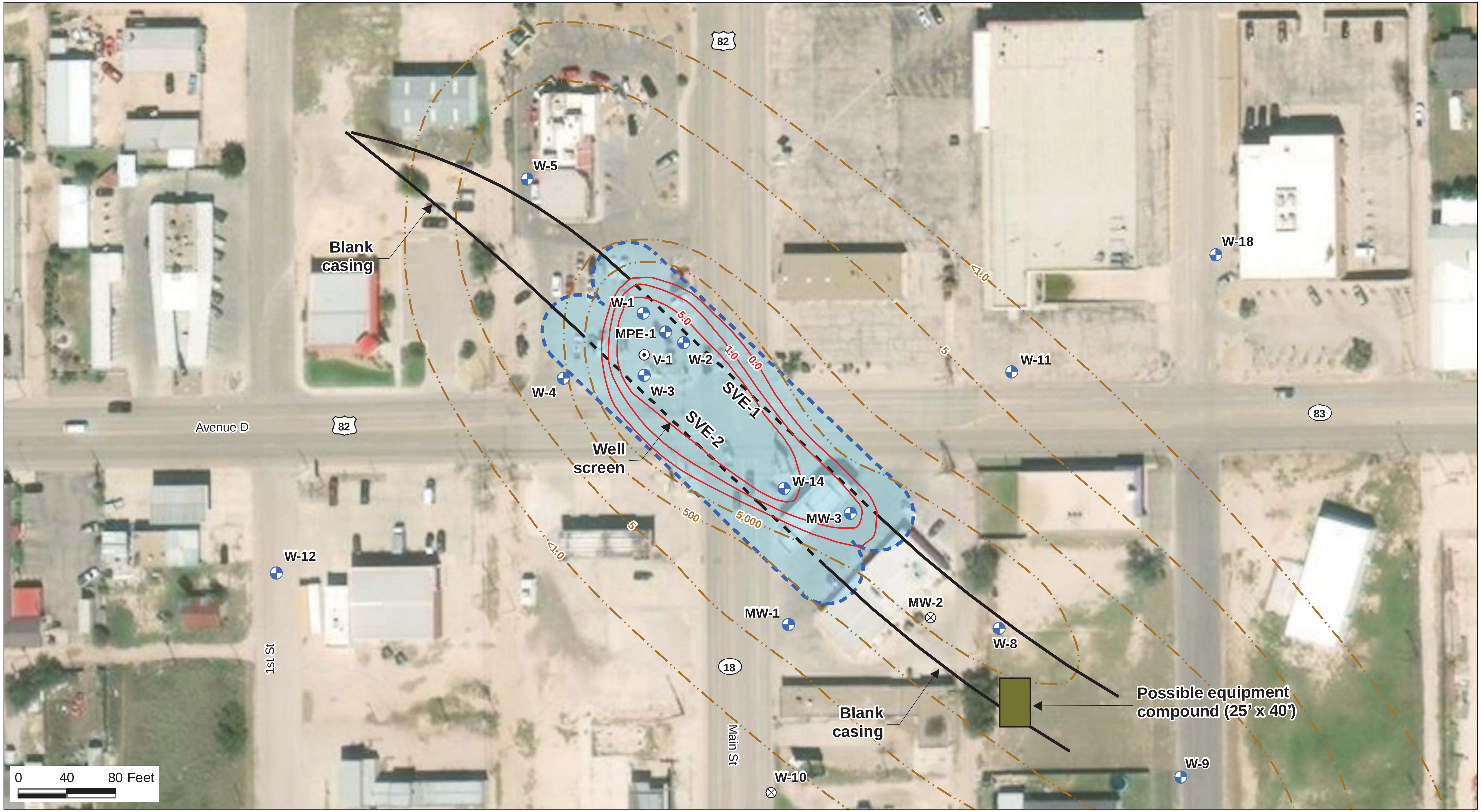
16. Submit your requests by email, by fax, **OR** by mail.
Send in one format only – Please **do not** send in multiple formats.

Send clearance requests to:

Gary Funkhouser, NMDOT - Environmental Development
P.O. Box 1149
Santa Fe, NM 87504-1149

Physical address:
1120 Cerrillos Road, Room 206
Santa Fe, NM 87505-1842
(for FedEx or UPS the ZIP code is 87505)

Fax: 505-827-3243; **Phone**: 505-570-7291; **Email**: gary.funkhouser@state.nm.us



Source: USDA NAIP 5/10/2014

N

Explanation

⊕ Monitor well

⊗ Monitor well - destroyed or inaccessible

⊙ Monitor well - plugged and abandoned

Proposed horizontal well (dashes indicate screen section)

Approximate benzene isocontour (µg/L)

30-foot SVE radius of influence

Approximate LNAPL thickness (feet)

LOVINGTON 66
424 SOUTH MAIN STREET
LOVINGTON, NEW MEXICO

Proposed Technical Approach

Daniel B. Stephens & Associates, Inc.
11/20/2019
JN DB19.1395

Figure 1

S:\PROJECTS\DB19.1395_LOVINGTON_66\GIS\MXDS\TECHNICAL_APPROACH.MXD

Source: USGS Lovington Quadrangle, New Mexico - Lea County

Explanation

☐ Site location

N

0 500 1000 Feet

Daniel B. Stephens & Associates, Inc.
8/17/2020
JN DB18.1107

LOVINGTON 66
424 SOUTH MAIN STREET
LOVINGTON, NEW MEXICO

Topographic Map

Figure 2

S:\PROJECTS\DB19.1395_LOVINGTON_66\GIS\MXDS\TOPO MAP.MXD

ACORD®

CERTIFICATE OF LIABILITY INSURANCE

DATE(MM/DD/YYYY)
12/05/2019

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must have ADDITIONAL INSURED provisions or be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

Holder Identifier : A

PRODUCER
Aon Risk Insurance Services West, Inc.
Los Angeles CA Office
707 Wilshire Boulevard
Suite 2600
Los Angeles CA 90017-0460 USA

CONTACT NAME:
PHONE (A/C. No. Ext): (866) 283-7122
FAX (A/C. No.): (800) 363-0105
E-MAIL ADDRESS:

INSURED
Daniel B. Stephens & Associates, Inc.
6020 Academy NE, Ste 100
Albuquerque NM 87109 USA

INSURER(S) AFFORDING COVERAGE		NAIC #
INSURER A:	Steadfast Insurance Company	26387
INSURER B:	Zurich American Ins Co	16535
INSURER C:		
INSURER D:		
INSURER E:		
INSURER F:		

COVERAGES **CERTIFICATE NUMBER:** 570079445815 **REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

Limits shown are as requested

INSR LTR	TYPE OF INSURANCE	ADDL INSD	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
A	☒ **COMMERCIAL GENERAL LIABILITY**			GPL016606903	12/31/2019	12/31/2020	EACH OCCURRENCE	$2,000,000
	☐ ☐ CLAIMS-MADE ☒ OCCUR						DAMAGE TO RENTED PREMISES (Ea occurrence)	$1,000,000
	☐						MED EXP (Any one person)	$25,000
	☐						PERSONAL & ADV INJURY	$1,000,000
	GEN'L AGGREGATE LIMIT APPLIES PER:						GENERAL AGGREGATE	$6,000,000
	☒ POLICY ☐ PRO-JECT ☐ LOC						PRODUCTS - COMP/OP AGG	$4,000,000
	OTHER:							
B	**AUTOMOBILE LIABILITY**			BAP 0166068-03	12/31/2019	12/31/2020	COMBINED SINGLE LIMIT (Ea accident)	$1,000,000
	☒ ANY AUTO						BODILY INJURY (Per person)	
	☐ OWNED AUTOS ONLY ☐ SCHEDULED AUTOS						BODILY INJURY (Per accident)	
	☐ HIRED AUTOS ONLY ☐ NON-OWNED AUTOS ONLY						PROPERTY DAMAGE (Per accident)	
A	☐ **UMBRELLA LIAB** ☒ OCCUR			SXS016607603	12/31/2019	12/31/2020	EACH OCCURRENCE	$10,000,000
	☒ **EXCESS LIAB** ☐ CLAIMS-MADE						AGGREGATE	$10,000,000
	☐ DED ☐ RETENTION							
B	**WORKERS COMPENSATION AND EMPLOYERS' LIABILITY** Y / N	N / A		WC016606603	12/31/2019	12/31/2020	☒ PER STATUTE ☐ OTH-ER	
	ANY PROPRIETOR / PARTNER / EXECUTIVE OFFICER/MEMBER EXCLUDED? **(Mandatory in NH)** Y						E.L. EACH ACCIDENT	$1,000,000
	If yes, describe under DESCRIPTION OF OPERATIONS below						E.L. DISEASE-EA EMPLOYEE	$1,000,000
							E.L. DISEASE-POLICY LIMIT	$1,000,000
A	E&O-PL-Primary			GPL016606903 Prof Liab - Claims Made	12/31/2019	12/31/2020	Each Claim Policy Aggregate	$2,000,000 $6,000,000

Certificate No : 570079445815

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (ACORD 101, Additional Remarks Schedule, may be attached if more space is required)

RE: Project No. ES11.0174.02. New Mexico Department of Transportation (NMDOT), District 2 is included as Additional Insured in accordance with the policy provisions of the General Liability policy.

CERTIFICATE HOLDER

New Mexico Department of
Transportation (NMDOT) District 2
Attn: Contracts Administrator
PO Box 1457, 4505 West Second St.
Roswell NM 88202 USA

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE

Aon Risk Insurance Services West, Inc.

Additional Insured-Automatic-Owners, Lessees Or Contractors

Coverage Part One-Commercial General Liability
Coverage Part Two-Contractor's Pollution Liability

Policy No.	Eff. Date of Pol.	Exp. Date of Pol.	Eff. Date of End.	Producer	Add'l Prem.	Return Prem.
GPL 0166069-03	12/31/2019	12/31/2020	12/31/2019	75272000		

Named Insured and Mailing Address:

Producer: Aon Risk Insurance Services West, Inc.
707 Wilshire Blvd Ste. 2600
Los Angeles, CA 90017-3533

THIS ENDORSEMENT CHANGES THE POLICY. PLEASE READ IT CAREFULLY.

This endorsement modifies insurance provided under the following:

Environmental Services Package Policy

[X] COVERAGE PART ONE-COMMERCIAL GENERAL LIABILITY

[X] COVERAGE PART TWO-CONTRACTOR'S POLLUTION LIABILITY

1. Who is an Insured (Section I.) in the COMMON COVERAGE PROVISIONS is amended to include as an additional insured any person(s) or organization(s) whom you are required to add as an additional insured on this policy under a written contract or written agreement.
2. The insurance provided to the additional insured person(s) or organization(s) applies only to:
   a. "Bodily injury", "property damage" or "personal and advertising injury" under COVERAGE PART ONE-COMMERCIAL GENERAL LIABILITY, COVERAGE A - BODILY INJURY AND PROPERTY DAMAGE LIABILITY and COVERAGE B - PERSONAL AND ADVERTISING INJURY LIABILITY caused, in whole or in part, by:
      (1) Your acts or omissions; or
      (2) The acts or omissions of those acting on your behalf;
      and resulting directly from:
         (a) Your ongoing operations performed for the additional insured, which is the subject of the written contract or written agreement; or
         (b) "Your work" completed as included in the "products-completed operations hazard", performed for the additional insured, which is the subject of the written contract or written agreement; and/or
   b. "Claims" arising out of a "pollution event" under COVERAGE PART TWO - CONTRACTOR'S POLLUTION LIABILITY, caused, in whole or in part, by:
      (1) Your acts or omissions; or
      (2) The acts or omissions of those acting on your behalf**,**
      and resulting directly from:
         (a) "Covered operations" performed for the additional insured, which is the subject of the written contract or written agreement; or

(b) "Completed operations" of the "covered operations" performed for the additional insured, which is the subject of the written contract or written agreement.

3. However, regardless of the provisions of paragraphs 1. and 2. above, the insurance afforded to such additional insured:

   a. Only applies to the extent permitted by law; and

   b. Will not be broader than that which you are required by the written contract or written agreement to provide to such additional insured.

4. With respect to the insurance afforded to the additional insured under this endorsement, the following is added to **Section III – Limits Of Insurance and Deductible**:

   The most we will pay on behalf of the additional insured is the amount of insurance:

   a. Required by the written contract or written agreement you have entered into with the additional insured; or

   b. Available under the applicable Limits of Insurance shown in the Declarations,

   whichever is less.

   This endorsement shall not increase the applicable Limits of Insurance shown in the Declarations

5. The insurance provided to the additional insured person or organization does not apply to:

   "Bodily injury", "property damage" or "personal and advertising injury" arising out of the rendering or failure to render any professional architectural, engineering or surveying services including:

   (1) The preparing, approving or failing to prepare or approve maps, shop drawings, opinions, reports, surveys, field orders, change orders or drawings and specifications; and

   (2) Supervisory, inspection, architectural or engineering activities.

   This exclusion applies even if the claims against any insured allege negligence or other wrongdoing in the supervision, hiring, employment, training or monitoring of others by that insured, if the "occurrence" which caused the "bodily injury" or "property damage", or the offense which caused the "personal and advertising injury", involved the rendering of or the failure to render any architectural, engineering or surveying services.

6. The additional insured must see to it that:

   a. We are notified as soon as practicable of an "occurrence", offense or “pollution event”, as applicable, that may result in a claim;

   b. We receive written notice of a claim or "suit" as soon as practicable; and

   c. A request for defense and indemnity of the claim or "suit" will promptly be brought against any policy issued by another insurer under which the additional insured may be an insured in any capacity. This provision does not apply to insurance on which the additional insured is a Named Insured, if the written contract or written agreement requires that this coverage be primary and non-contributory.

7. For the coverage provided by this endorsement:

   a. The following paragraph is added to Paragraph 8.a. Other Insurance, Conditions (Section V.) in the COMMON COVERAGE PROVISIONS:

      Primary and Noncontributory Insurance

      This Insurance is primary to and will not seek contribution from any other insurance available to an additional insured under this endorsement provided that:

      (1) The additional insured is a Named Insured under such other insurance; and

      (2) You have agreed in a written contract or written agreement that this insurance would be primary and would not seek contribution from any other insurance available to the additional insured.

   b. The following paragraph is added to Paragraph 8.b. Other Insurance, Conditions (Section V.) in the COMMON COVERAGE PROVISIONS:

      This insurance is excess over:

Any of the other insurance, whether primary, excess, contingent or on any other basis, available to an additional insured, in which the additional insured on our policy is also covered as an additional insured on another policy providing coverage for the same "occurrence", offense, claim or "suit". This provision does not apply to any policy in which the additional insured is a Named Insured on such other policy and where our policy is required by written contract or written agreement to provide coverage to the additional insured on a primary and non-contributory basis.

8. This endorsement does not apply to an additional insured which has been added to this policy by an endorsement showing the additional insured in a Schedule of additional insureds, and which endorsement applies specifically to that identified additional insured.

ALL OTHER TERMS AND CONDITIONS OF THE POLICY SHALL APPLY AND REMAIN UNCHANGED.

ACORD®

CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY)
4/3/2020

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must have ADDITIONAL INSURED provisions or be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER
CSDZ, LLC
225 South Sixth Street, Suite 1900
Minneapolis MN 55401

CONTACT NAME: Wendy Kurtz
PHONE (A/C, No, Ext): 612-322-6014
FAX (A/C, No):
E-MAIL ADDRESS: wkurtz@csdz.com

INSURED ELLICOMI
Ellingson Drainage Inc
Ellingson Trenchless LLC
56113 State Hwy 56
West Concord MN 55985

INSURER(S) AFFORDING COVERAGE	NAIC #
INSURER A : Nautilus Insurance Company	17370
INSURER B : Zurich American Insurance Company	16535
INSURER C : American Guarantee & Liab Ins Co	26247
INSURER D :	
INSURER E :	
INSURER F :	

COVERAGES **CERTIFICATE NUMBER:** 744763256 **REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSD	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
B	☒ **COMMERCIAL GENERAL LIABILITY** ☐ CLAIMS-MADE ☒ OCCUR ☒ Contr Liab Per ☒ Policy Form/XCU GEN'L AGGREGATE LIMIT APPLIES PER: ☐ POLICY ☒ PRO-JECT ☐ LOC ☐ OTHER:	Y		300097501	4/1/2020	4/1/2021	EACH OCCURRENCE DAMAGE TO RENTED PREMISES (Ea occurrence) MED EXP (Any one person) PERSONAL & ADV INJURY GENERAL AGGREGATE PRODUCTS - COMP/OP AGG	$ 2,000,000 $ 1,000,000 $ 10,000 $ 2,000,000 $ 4,000,000 $ 4,000,000 $
B	**AUTOMOBILE LIABILITY** ☒ ANY AUTO ☐ OWNED AUTOS ONLY ☐ SCHEDULED AUTOS ☐ HIRED AUTOS ONLY ☐ NON-OWNED AUTOS ONLY ☒ Comp: $1,000 ☒ Coll: $1,000			30009761	4/1/2020	4/1/2021	COMBINED SINGLE LIMIT (Ea accident) BODILY INJURY (Per person) BODILY INJURY (Per accident) PROPERTY DAMAGE (Per accident) Hired Car Phys Damage	$ 2,000,000 $ $ $ $ ACV of Vehicle
C	☒ **UMBRELLA LIAB** ☒ OCCUR ☐ **EXCESS LIAB** ☐ CLAIMS-MADE ☐ DED ☐ RETENTION $			AUC302078601	4/1/2020	4/1/2021	EACH OCCURRENCE AGGREGATE	$ 10,000,000 $ 10,000,000 $
B A	**WORKERS COMPENSATION AND EMPLOYERS' LIABILITY** **Y / N** ANYPROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? **(Mandatory in NH)** ☐ N If yes, describe under DESCRIPTION OF OPERATIONS below	**N / A**		30009751 Stop Gap: ND OH WA WY	4/1/2020 4/1/2020	4/1/2021 4/1/2021	☒ PER STATUTE ☐ OTH-ER E.L. EACH ACCIDENT E.L. DISEASE - EA EMPLOYEE E.L. DISEASE - POLICY LIMIT	 $ 2,000,000 $ 2,000,000 $ 2,000,000
A	Contractors Professional Liab Including Pollution Liab	N	N	CPP201775314	4/1/2020	4/1/2021	Each Claim $5,000,000 Deductible: $50,000	Ann Agg $5,000,000 Claims Made

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (ACORD 101, Additional Remarks Schedule, may be attached if more space is required)

Project No. ES11.0174.02.

Additional Insured only if required by written contract with respect to General Liability: New Mexico Department of Transportation (NMDOT) District 2 and Others as required by written contract.

CERTIFICATE HOLDER

New Mexico Department of Transportation (NMDOT)
District 2
P.O. Box 1457
4505 West Second St.
Roswell NM 88202

CANCELLATION

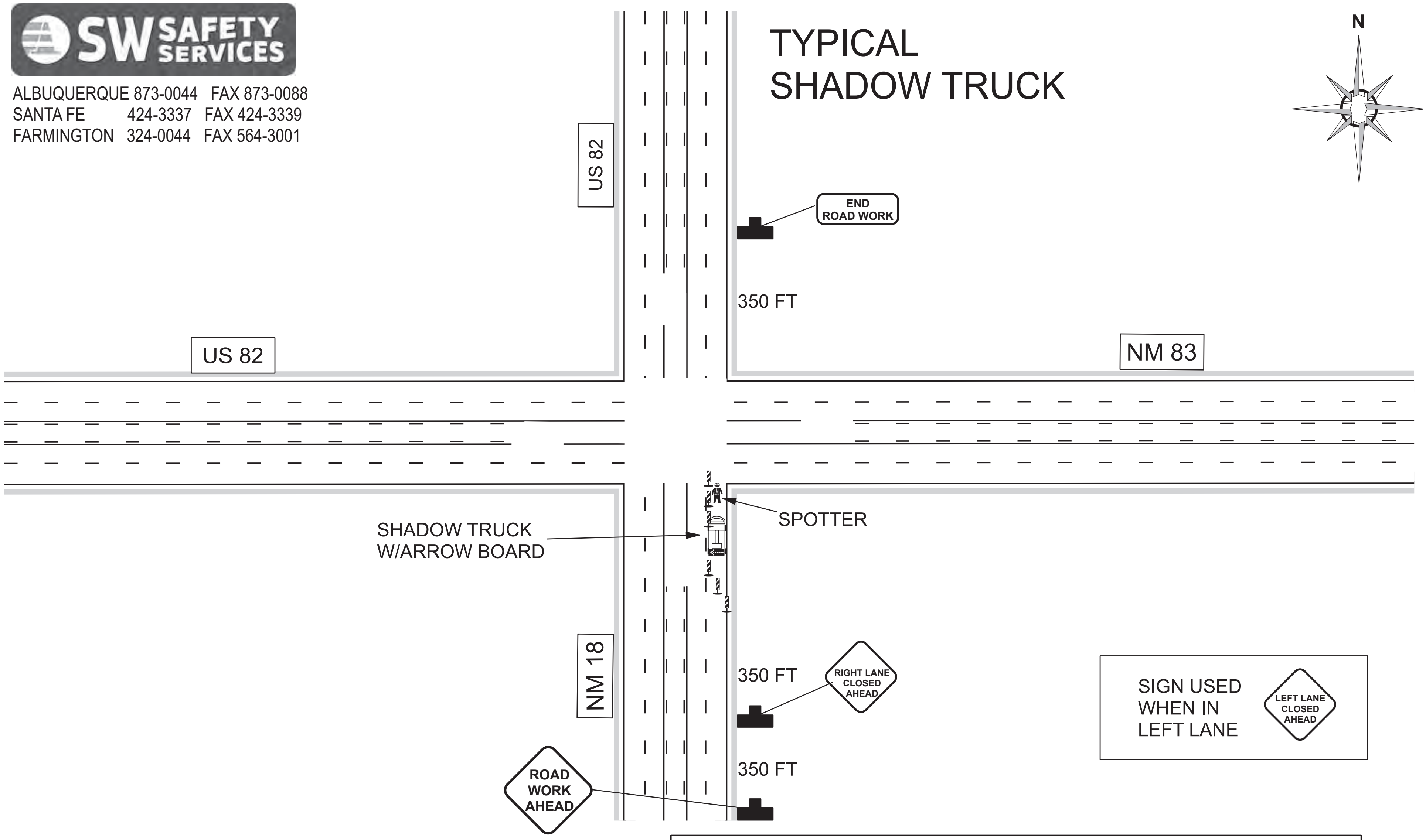
SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE

SW SAFETY SERVICES

ALBUQUERQUE 873-0044 FAX 873-0088
SANTA FE 424-3337 FAX 424-3339
FARMINGTON 324-0044 FAX 564-3001

TYPICAL SHADOW TRUCK



Legend

- Density Technician
- Vertical Face Panel

Date: 08/17/2020 **Author:** DARRELL ASHLEY **Project:** DANIEL B STEPHENS
OWNER: CITY OF LOVINGTON/ NMDOT DISTRICT 2

Comments:

1) DRAWING NOT TO SCALE
2) POSTED SPEED LIMIT 35 MPH
3) 36" SIGNS USED WITH FLAGS & SANDBAGS
4) VERTICAL PANELS USED AT 35 FT SPACING
5) WORK HOURS 0700-1900
6) SWITCH LANES AS NEEDED TO CROSS INTERSECTION

Appendix G

O&M Data Collection Form

Site: Lovington 66 **Project No:** DB19.1395.00

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:

OX OUTLET TEMP (°F):

OX INLET TEMP (°F):

Gas Valve (%)

Dilution Air (%) TCV1

LEL (%)

Statistics Menu

SVE HOURS: CYCLES:

Transfer Pump HOURS: CYCLES:

This Site HOURS:

System Control Panel Main Menu

Sample point	Vacuum (in H_2O)	Pressure (in H_2O/psi)	Temp. (°F)	Flow (scfm)	Motor (amps)
SVE combined influent	PIT 1	NA	TE 1	NA	NA
SVE blower effluent	NA	PIT 2	TE 2	FIT 1	

KNOCKOUT TANK: inches

Raw Water Storage Tank: gallons

SVE Wells *Measure @ wall

Well	Vacuum (in H2O)	HC Conc (ppm-v)	VelociCalc (cfm)	Velocity (ft/min)	Remarks
Ox Effluent	NA		NA	NA	
SVE-1					
SVE-2					
SVE combined					

LABORATORY SAMPLES COLLECTED:

LOVINGTON 66 EFF LOVINGTON 66 INF OTHER (LIST BELOW)

NOTES:

Appendix H

Health and Safety Plan

HEALTH AND SAFETY PLAN

Lovington 66
Lovington, New Mexico

8/12/2020
PROJECT NO. DB19.1395.00

PREPARED BY:

Geo-Logic Associates
6155 Indian School Rd.
Scottsdale, AZ 85251
(480) 659-7131

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Site Health and Safety Plan Summary

THIS SUMMARY IS PROVIDED AS A QUICK REFERENCE/OVERVIEW ONLY. THE REMAINDER OF THE SITE-SPECIFIC HEALTH AND SAFETY PLAN (HASP) IS INTERGRAL TO THE SAFE CONDUCT OF SITE OPERATIONS AND MUST BE APPLIED IN ITS ENTIRETY.

Emergency Numbers:

Location of Nearest Telephone: GLA Vehicles

Site Emergency Numbers (If Applicable):

Site Security: NA

Site HAZMAT Team: NA

Emergency Numbers:

Fire, Police, Ambulance: 911

Hospital: Nor-Lea Hospital (575) 396-6611

Poison Control Center: (800) 222-1222

CHEMTREC (24-hour): (800) 424-9300

National Response Center, Oil & Toxic Chemical Spills: (800) 424-8802

GLA and Other Contacts

GLA Project Manager: Jason Raucci, (505) 353-9068

GLA H&S Committee Member: Chad Johannesen, (505) 353-9072

GLA Corporate Program Administrator: Russell Granfors (cell) (602) 659-7131

Human Resources Manager: Maria Robles, Ontario: (909) 626-2281

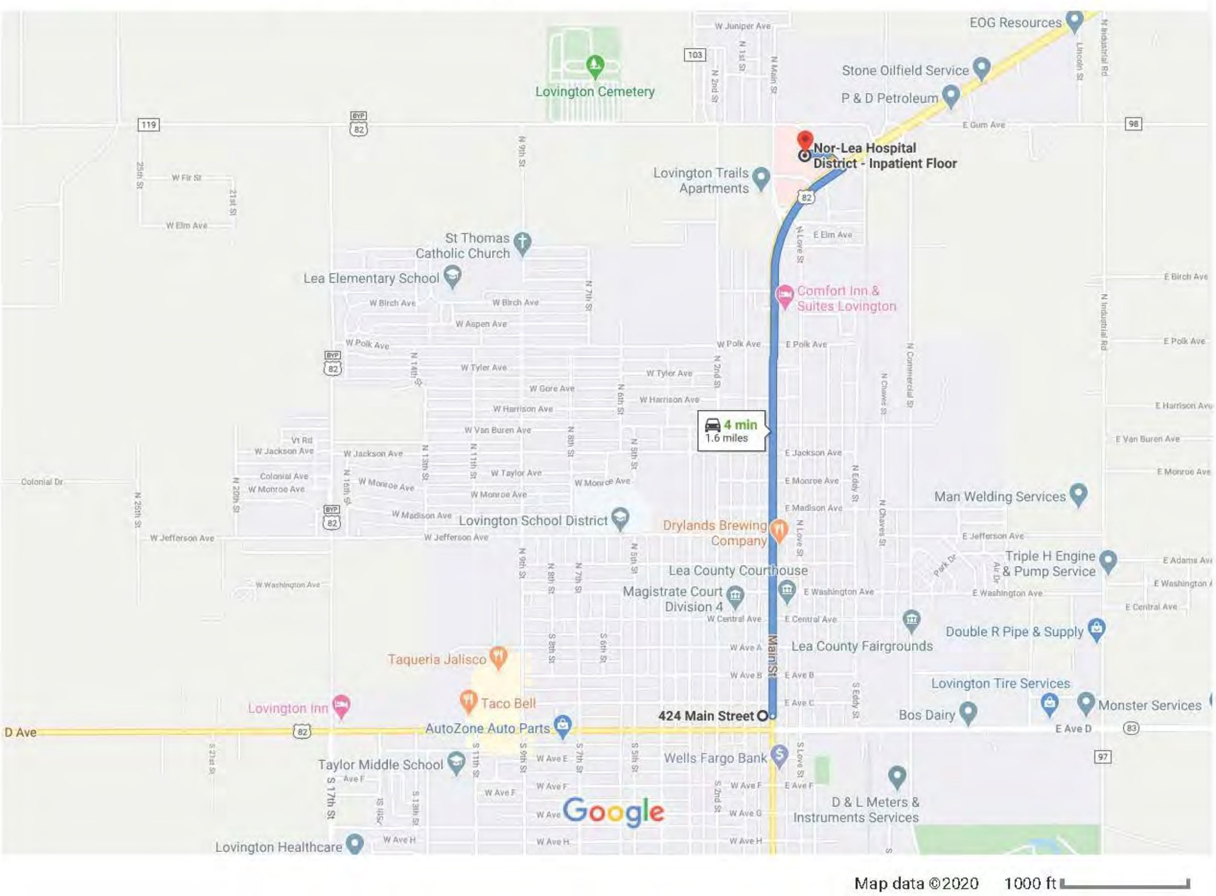
Client Contact: Tim Noger, (505) 372-8150

Regulatory Contact (if appropriate): Tim Noger, (505) 372-8150

Other Contacts:

Figure 1. Hospital Route

Google Maps 424 Main St, Lovington, NM 88260 to Nor-Lea Hospital District - Inpatient Floor Drive 1.6 miles, 4 min



424 Main St
Lovington, NM 88260

1. Head north on US-82 E/Main St toward E Ave C
   Continue to follow US-82 E
   1.5 mi
2. Turn left onto Deardurff Dr
   358 ft
3. Turn left
   Destination will be on the left
   256 ft

APPROVAL OF THE SITE SAFETY AND HEALTH PLAN

Plan Prepared By:

	Patrice Feltman	Geologist
	Name	Title
	Signature	Date

Plan Approved By:

	Name	Title
	Signature	Date
	Name	Title
	Signature	Date

Plan Revised By:

	Name	Title
	Signature	Date

Site-Specific Health and Safety Plan

Project Name: Lovington 66
Project Location: Lovington, NM
GLA Project Manager: Jason Raucci

1. INTRODUCTION

This Health and Safety Plan (HASP) establishes the responsibilities, requirements, and procedures for Geo-Logic Associates (GLA) personnel while performing work 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) and CAL/OSHA in 8 CCR 5192(b)(4) (Site Specific Safety Plan). This HASP is designed to augment the health and safety policies and procedures established in the GLA Injury and Illness Prevention Plan (IIPP).

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.

1.1 Scope of Work and General Site Description

DBS&A will implement a site-specific SVE cleanup strategy that utilizes two horizontal wells to remove LNAPL and vadose zone soil contaminants (petroleum hydrocarbons) associated with the Lovington 66 PSTB site, including highway right-of-way under the intersection of Avenue D and Main Street. Primary activities will include remediation system construction, operation, and maintenance, together with regular groundwater monitoring activities and LANPL recovery. Remediation equipment consists of a thermal oxidizer and an SVE system in a modified shipping container, with an SVE blower, vapor-liquid separator, condensate storage tank, and associated electrical, controls, and telemetry. Staff will be collecting air and water samples, from the equipment and associated compliance wells, recording system operations data, and performing maintenance on the equipment. Horizontal well vaults will be located in parking lots, and many of the monitor wells are in either the parking lot of a busy fast-food restaurant or right-of-way for local residential streets.

1.1.1 Site Status

__X__ Active/Open __ Inactive/Open ____ Inactive/Closed ____ Unknown

1.1.2 Surroundings

The site is an active McDonald's restaurant, and the area around the site is generally commercial property. The site is at the northwest corner of the busiest intersection in Lovington, New Mexico. Many off-site monitor wells are located on residential streets.

1.1.3 Climate

Average Wind Speed and Direction: Westerly @ 18 mph (average)
Humidity: ___ Arid _X__ Semiarid ___ Humid ___ Tropical
Expected High Temperature (°F) 105
Expected Low Temperature (°F) 30

1.1.4 Locations of Resources Available to Onsite Personnel

Nearest telephone:	GLA personnel
Nearest water:	Potable water will be supplied
Nearest bathroom facilities:	McDonald's and Allsup's Gas Station
Nearest fire extinguisher:	GLA vehicles
Nearest first aid kit:	GLA vehicles
Warning/method signal for site evacuation:	Verbal

1.2 Chemicals in Onsite Media

Petroleum hydrocarbons (BTEX, MTBE, EDB, EDC, and naphthalenes).

A SDS for each chemical of concern is included in Appendix D.

1.3 Site Work Zones

Based on the nature of certain field work, site work zones will be designated during specific field tasks. For example, horizontal well construction will require work zones at each end of the well, and another work zone where the drill bit is being tracked at the surface. Groundwater monitoring will have work zones at each individual well, and the work zone for remediation system O&M will primarily be in the equipment compound.

2. ORGANIZATION AND SAFETY RESPONSIBILITIES

To meet its safety and health objectives, GLA has developed a line of reporting and tasked individuals with safety and health responsibilities. This information is presented below.

PROJECT MANAGER: *Jason Raucci*
Acquaint field personnel with potential hazards and procedures to minimize the negative impact of those hazards. Make available proper PPE, adequate time and budget, and trained personnel to perform site work in a safe manner. Arrange for preparation of a Health and Safety Plan (HASP). Investigate and report to the Designated Health and Safety Officer (DSHO) each work-related illness or injury, near-misses, accidents, and damage to physical property.

DESIGNATED HEALTH AND SAFETY OFFICER: *(TBD based on task)*
Write or review and approve the HASP. Implement safety and health procedures that are stated in the HASP. Conduct periodic audits to confirm that the HASP is being followed.

SITE SUPERVISOR: *(TBD based on task)*
Ensure that site personnel have read and signed the master copy of this document (Appendix A). Coordinate with the Site Safety and Health Officer (SSHO) regarding accident investigations, as necessary. (See Accident Investigation Form in Appendix A)

SITE SAFETY AND HEALTH OFFICER: *(TBD based on task)*
Ensure that the guidelines, rules, and procedures in this document are followed for site work. Check that site personnel meet requirements regarding training, medical examinations, and fit testing. Be familiar with local emergency services. Conduct a tailgate safety and health meeting before work startup each day and when activities change. Additional meetings may be required for specific job tasks or site activities. Maintain and inspect PPE, monitor onsite hazards, and monitor the physical condition of site personnel. Perform daily inspections of work site activities. Maintain safety and health files, which will include training and medical certifications, tailgate meeting notes and rosters, inspection reports, or other safety and health documentation, as applicable. Shut down operations that pose a potential threat to site personnel.

EMPLOYEES
Obey safety and health work practices issued by law and by GLA. Wear PPE as directed by this HASP. PPE requirements are found in Section 7. Use safety equipment as directed by this HASP.

VISITORS
Follow the direction of the Site Supervisor or the SSHO. Read, understand, and sign the HASP. Do not enter the work zones unless the appropriate training has been obtained. Use PPE, as appropriate.

SUBCONTRACTORS
Follow the guidelines, rules, and procedures in this document. Attend tailgate meetings and sign the meeting log included in Appendix A of this HASP following each meeting. Report recognized unsafe conditions and actions to the SSHO and/or the Project Manager. Provide Safety Data Sheets (SDSs) for subcontractor-provided materials at the job site. Provide their own safety and health procedures addressing hazard recognition, evaluation and control practices/procedures for general and specific site hazards and activities unique to their operations.

3. 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 1 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 Table 2.

Table 1. Proposed Tasks and Hazard Assessment

	Proposed Tasks				
Potential Hazards	Drilling, Well Installation, and Development	Soil Sampling	Groundwater Sampling	GW Treatment System Installation and Operation	Trenching and Excavations
Heavy equipment	X			X	X
Excavation	X			X	X
Hand Tools	X	X	X	X	X
Unstable ground					X
Noise hazards	X	X		X	X
Eye hazards	X	X	X	X	X
Head hazards	X			X	X
Dermal contact	X	X	X	X	X
Slips, trips, and/or falls	X	X	X	X	X
Heavy lifting	X	X	X	X	X
Vehicle traffic	X	X	X	X	X
Unauthorized site entry	X	X	X	X	X
Buried utilities	X	X		X	X
Overhead utilities	X			X	X
Respiratory Concerns	X			X	X
Contaminated soil or liquids	X	X	X	X	X
Explosive atmospheres					
Heat/cold stress	X	X	X	X	X
Sunburn	X	X	X	X	X
Electrical hazards	X			X	X
Compressed air or gases	X	X		X	
Fire hazards (hot work)					
Chemical hazards (other than COCs)	X		X	X	X
Insects and vermin	X	X	X	X	X
Confined spaces					
Ionizing Radiation					

Unexploded Ordnance/Munitions					
Other					
COVID-19	X	X	X	X	X
HAZARD RANKING (Low, Medium, High)	Medium	Medium	Medium	Medium	High

COCs = Contaminants of concern

Table 2. Controls for Potential Hazards

Potential Hazards	*Controls to Eliminate or Manage Hazards*
Heavy equipment	Wear reflective vest, keep eye contact with operator
Excavation	Stay back a safe distance, competent person should inspect excavation
Hand Tools	Wear work gloves, Use the tool for its intended purpose
Unstable ground	Be aware of your surroundings, wear slip resistant shoes
Noise hazards	Wear appropriate noise cancellation PPE
Eye hazards	Wear appropriate safety glasses, goggles or face shield
Head hazards	Wear appropriate hard hat
Dermal contact	Wear long sleeve shirts, use caution handling contaminated liquids and soils
Slips, trips, and/or falls	Be aware of your surroundings, wear slip resistant shoes
Heavy lifting	Use proper lifting techniques, use dollies or other equipment to move heavy loads
Vehicle traffic	Wear reflective vests, be aware of traffic
Unauthorized site entry	Use barricades to restrict site access
Buried utilities	Call local commercial underground locating service, and or private underground locating service
Overhead utilities	Use caution around overhead utilities, have utilities guarded if necessary
Respiratory Concerns	Wear appropriate respiratory protection for the hazard, move up wind of dust creating work
Contaminated soil or liquids	Be cautious handling soils or liquids, wear appropriate gloves for the hazard
Explosive atmospheres	Do not smoke or use spark devices near locations, use gas monitoring equipment for testing
Heat/cold stress	Wear proper clothing, drink plenty of liquids, take breaks
Sunburn	Wear sunblock, wear large brim hats and proper clothing
Electrical hazards	Always inspect electrical equipment before use, never use electrical devises without training
Compressed air or gases	Stay clear of gas cylinders unless properly trained on their use and storage
Fire hazards (hot work)	Keep a fire extinguisher in work truck, obtain a hot work permit if it is a site requirement
Chemical hazards (other than COCs)	Wear appropriate PPE, Stay upwind of construction activities
Insects and vermin	Never approach a wild animal, be aware of insect when moving objects
Confined spaces	Never enter a confined space unless properly trained and with a trained attendant
Ionizing Radiation	Use proper PPE and storage containers when coming in contact with items that have radiation
Unexploded Ordnance/Munitions	Be aware of your surroundings
Other	
COVID-19	Use precautions listed in Appendix E – Field guidance for COVID-19

3.1 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 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. A comprehensive Heat Illness Prevention Plan is included in Appendix C, in accordance with CAL/OSHA.

During cold weather, GLA personnel should wear multilayer, wind-resistant outfits and drink warm fluids. Warm shelter will be available during breaks.

3.2 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 SSHO will shut down operations. Additional safety measures for weather-related hazards are described in the IIPP.

If lightning is visible and the sound of thunder is heard less than 60 seconds after lightning is observed (10 miles), stop field operations and move to a sturdy, completely enclosed building. There are many apps for cell phones that will show immediate radar and tell you how many miles away lightning is from your location (e.g., Weather Bug). 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.

3.3 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. In the event of a bite or sting, 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 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.

The most common adverse reactions to plants from occupational exposures are skin injuries. These can result from simple mechanical trauma, photochemical response to psoralens, or sensitization to plant allergens. In the western United States, there are many plants that contain thorns, spines, and/or needles capable of injury.

Secondary to needle pricks from thorns and cactus needles, the most common trauma results from contact with plants in the poison ivy family (Anacardiaceae), including poison oak and poison sumac. The sensitizers in these plants are various unsaturated, long-chained substituted catechols. In healthy undisturbed plants, the sensitizer is contained in special channels. Contact with the intact plant does not produce sensitization or dermatitis. Even slight damage can release the sensitizer, however, and the best prevention is avoiding contact with the plants.

If skin contact occurs, the dermatitis may be avoided by prompt removal of the allergen. About 10 minutes are required for the cutaneous penetration of the allergen. Wash with running water, but avoid soap. Soap removes protective skin oils and may cause or hasten penetration of the allergen. Avoid nonpolar solvents, such as alcohol, which may spread the allergen over a wider area. Early application of topical steroids minimizes the severity of the dermatitis. If the face or genitalia are involved, seek professional medical assistance immediately.

Important Note: Any individual with a known allergy to wasps and bees must notify the SSHO 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.

3.4 Emergency Response

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.

4. CODE OF SAFE PRACTICES

GLA's code of safe practices advocates exercising every reasonable precaution when performing work to prevent injuries and accidents, and to protect the safety and health of employees, the public, and the environment.

Employees have certain responsibilities for their own safety, as follows:

- Report to work rested, and physically and mentally fit to perform the job assignment.
- Working while under the influence of intoxicants, narcotics, or controlled substances is prohibited.
- Wear suitable clothing for the weather and the work.
- Wear PPE and follow established procedures for a particular job. Do not wear jewelry or loose-fitting clothing when operating or near equipment.
- Call to the supervisor's attention any behavior or condition that may cause injury or illness to others or damage to property.
- Labels on tools, materials and chemical containers must be read before use, and the instructions for proper use, handling and personal protective equipment required must be followed.
- Discontinue any operation that could lead to injury, illness, or property damage.
- Keep horseplay and other disruptive behavior away from the job.
- Promptly report to the Site Supervisor or Site Safety and Health Officer any occupational injury, illness, or exposure to toxic material. If injured, get first aid. Small injuries can become serious if neglected.

- Promptly inform the Site Supervisor or Site Safety and Health Officer whenever new substances, processes, procedures, or equipment that could present new safety and health hazards are brought into work areas or onto projects.
- Do not eat, smoke, chew tobacco, or chew gum in the work area.
- Do not allow visitors without adequate safety training or personal protective equipment into the work area.
- Work upwind of invasive field activities when it is possible to do so.
- Perform work in a manner that will minimize dust from becoming airborne (i.e., use water spray or wet technique when feasible).
- Avoid contact with objects or water unless the contact is necessary to the field operation.
- Be alert to any abnormal behavior of other personnel that may indicate distress, disorientation, or other ill effects.
- Be aware of the potential for biological hazards at the field site (e.g., poison oak, loose dogs, snakes, rodent droppings).
- Verify that vehicles have an ABC-rated fire extinguisher, a first-aid kit, and 16 ounces of eyewash fluid.
- Employees must not attempt to cross the path of a truck or a piece of heavy equipment unless eye contact is made with the operator and the “go ahead” signal is given. Employees must stay alert and keep clear of moving equipment.
- Monitor weather conditions; particularly wind direction, because they could affect potential exposure.
- Excavations and trenches have additional hazards that require special precautions prior to entering. Supervisors shall be competent in the identification of hazards and determination in protective systems.
- Operate a vehicle only if you are a licensed driver. Seatbelts must be worn when operating a company vehicle, or when driving a private vehicle on company business.
- Drive company vehicles safely and professionally and care for them as you would other company property. Drive only vehicles that are safe and within maintenance specifications. Obey traffic regulations.
- Do not exceed speed limits for conditions.
- Practice defensive driving.
- Park in legal spaces; do not obstruct traffic.
- Lock vehicle when unattended.

- Contact the Site Safety and Health Officer if contact with human blood occurs during the administration of first aid.

These general safety responsibilities also apply to subcontractors and visitors.

5. 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.

5.1 Air Monitoring

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 1 identifies each of the tasks to be performed at the site. These tasks may include monitoring of organic vapors, particulates, combustible gases, and oxygen. Section 1.2 lists each of the contaminants of concern for the site. Table 3 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 3. 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	Use Level C respiratory protection; evaluate specific

Hazard	Equipment	Action Levels in BZ	Action Response
		minutes	compounds.
		MUC for respiratory protection in use.	Stop work; upgrade to Level B
	Colorimetric (Drager) Tubes	Chemical specific:	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

5.1.1 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. Section 1.2 lists each of the volatile contaminants of concern for the site.

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.

5.1.2 Combustible and Oxygen-Deficient Atmospheres

An instrument or instruments capable of detecting combustible gases and oxygen levels will be used during activities where these atmospheres may be encountered. The instrument(s) shall be placed as close to work activity as possible. The lower explosive limit (LEL) and the upper explosive limit (UEL) for chemicals are published in the NIOSH Pocket Guide. Work activities 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. Work activities will be suspended when readings indicate oxygen levels at or below 19.5 percent and at or above 22 percent.

5.1.3 Particulates

When respirable dust is considered a potential hazard (e.g., drilling or 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.

5.2 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 drill rig). However, impact noise, such as the tripping of a pneumatic or hydraulic hammer on a direct-push rig or driving casing on a dual-tube drill rig, can be considerably higher. 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.

6. TRAINING AND MEDICAL SURVEILLANCE REQUIREMENTS

Section 6 refers to field personnel who work on or may work on hazardous waste sites regulated by OSHA. All field personnel must have successfully completed training and field experience requirements for hazardous waste site operations in accordance with the requirements of 29 CFR section 1910.120(e) and 8 CCR 5192(e).

6.1 Regular Site Personnel Exposed to Hazardous Substances

Site personnel whose job responsibilities cause them to be exposed to or to have the potential to be exposed to hazardous substances or health hazards are required to comply with 29 Code of Federal Regulations (CFR) Section 1910.120(e)(3)(I) or applicable state regulations. This regulation requires site personnel exposed to hazardous substances to complete 40 hours of offsite instruction and three days of field experience supervised by a trained supervisor.

6.2 Regular Site Personnel Potentially Exposed to Hazardous Substances Below Permissible Exposure Limits

Regular site personnel whose job responsibilities cause them to be potentially exposed to hazardous substances below permissible exposure limits (PELs) or health hazards are required to comply with 29 CFR Section 1910.120(e)(3)(iii) or applicable state regulations. This regulation requires that these personnel receive a minimum of 40 hours of offsite instruction and one day of field experience supervised by a trained supervisor. The project SSHO or designated representative must ensure that these personnel will not be exposed above PELs. This decision will be made on the basis of review of previous monitoring in these work areas and possibly historical site background information.

6.3 Occasional Site Personnel Potentially Exposed to Hazardous Substances Below Permissible Exposure Limits

Occasional site personnel who visit the site for a specific limited task and whose exposure is designated by the SSHO to be under PELs are required to comply with 29 CFR Section 1910.120(e)(3)(ii) or applicable state regulations. This regulation requires that these personnel receive a minimum of 40 hours of offsite instruction and one day of field experience supervised by a trained supervisor.

In accordance with 29 CFR Section 1910.120(e)(3)(iv) or applicable state regulations, regular (as defined in Section 4.1.2 above) and occasional site personnel having completed an initial 24-hour classroom instruction must complete an additional 16 hours of offsite instruction and two days of field experience supervised by a trained supervisor before they are qualified to engage in activities that may expose them to hazardous substances above PELs.

6.4 Management and Supervisory Training

In accordance with 29 CFR Section 1910.120(e)(4) or applicable state regulations, individuals who manage or supervise personnel engaged in hazardous waste operations at the site must receive 40 hours of offsite instruction and three days of field experience supervised by a trained supervisor. In addition, management and supervisory personnel shall receive an additional 8 hours of specialized training that addresses the safety and health program, training requirements, personal protective and respiratory equipment program, health hazard monitoring procedures.

6.5 Refresher Training

Annual refresher training in accordance with 29CFR Section 1910.120(e)(8) or applicable state regulations shall be completed at least annually following the completion of the individual's 40-hour or 24-hour training course. Personnel will be required to attend the annual refresher training to maintain their qualifications for hazardous waste operation.

6.6 Documentation

Training must be properly documented and filed onsite for reference by the DSHO or designated representative. Personnel required to meet the training requirements must present evidence of this training for applicable projects. The Site Supervisor is responsible for checking before each activity to verify complete and current documentation. A copy of the training records documentation will be kept for a duration of no less than 3 years, and will be readily available or onsite, as applicable.

6.7 Site-Specific Training

In addition to the training requirements specified above, field personnel must participate in site-specific training. The training, conducted by the Project Manager (PM) or Site Safety & Health Officer, will include a review of the H&S procedures specific to each individual's job responsibilities and tasks. The field team should review the HASP to ensure that each individual is familiar with the site and fully understands the H&S procedures and guidelines they are required to implement for each assigned task. Specific attention should be given to the following items:

- Facility/site description and characterization.
- Chemical and physical hazards.
- Safety rules.
- Emergency response/contingency plan and emergency contacts.
- Protective measures and controls, including PPE, safety equipment, restrictions, and site communication.
- Decontamination procedures.
- Site control, work zones, security, access and exit points, and site communication plan.

Project personnel will be required to adhere to safe work practices as defined by the SSHO.

6.8 Medical Surveillance Requirements

Field personnel are required to participate in the Medical Surveillance Program). All field personnel must have completed either a baseline or annual medical monitoring examination within 12 months of their assignment to the site. Only medically qualified personnel will be permitted to conduct field activities.

As part of the medical surveillance program, all personnel working at hazardous waste sites are required to undergo an annual physical examination. The content of the annual surveillance physical includes most of the baseline physical, laboratory, and diagnostic tests, but may also include additional tests in instances of actual or potential chemical exposure. It will be up to the attending physician to determine the need for additional tests. The physician shall summarize pertinent findings and submit copies of the summary to the employee.

6.9 Site-Specific Medical Monitoring

The risk of exposure to the types of chemical and physical hazards anticipated during field activities at the work site will not require field personnel to undergo specific tests prior to beginning field activities. Physical, diagnostic, and laboratory tests conducted as part of the baseline or periodic medical monitoring are expected to be adequate for the types and levels of potential chemical exposure. Follow-up testing will be conducted in the event of any exposures to airborne contaminants exceeding permissible exposure levels (PELs).

Field personnel will be informed of the results of any personal monitoring/sampling conducted during field activities and any other information related to possible exposure. Any data or other documentation indicating possible employee exposure to chemical hazards exceeding PELs will be forwarded to the employee, and upon the employee's request, to his/her personal physician.

6.10 Exposure/Injury/Medical Support

Any employee who suffers an illness, injury, or chemical exposure during the course of field activities is required to see a physician. Depending upon the extent and type of exposure, illness, or injury, it may be critical to perform follow-up testing within 24 to 48 hours of initial medical examination. The physician responsible for conducting the employee medical surveillance examinations shall be notified and consulted to determine the type(s) of tests required to accurately monitor the employee. Workers may return to work only with the written approval of the attending physician.

6.11 Record Keeping

In addition to OSHA and Cal/OSHA record keeping requirements, the SSHO will maintain a file of any H&S-related events occurring at a site. Any exposure or potential exposure episodes are to be recorded, as well as those accidents or incidents that require the filing of an Illness, Injury and Unusual Occurrence Report (e.g., injuries, illnesses, accidental damage to property, or “near miss” occurrences that could have resulted in personal injury). A copy of the Illness, Injury and Unusual Occurrence Report form is included as Appendix 1-4 of the Injury and Illness Prevention Plan.

7. PROTECTIVE EQUIPMENT

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 pre-filters. 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 6.1. 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 IIPP.

7.1 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.

7.2 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 SSHO 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 SSHO 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.

8. SITE CONTROL

Barricades, caution tape, or other necessary means shall be used when necessary to prevent unauthorized access into the work area. The SSHO 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.

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.

9. CONFINED SPACE ENTRY

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 SSHO will contact the PM and this site-specific HASP will be amended accordingly. The SSHO will ensure that entries are performed in accordance with the GLA Confined Space Entry Program Plan. If necessary, the SSHO will contact the local fire department to coordinate the entry and rescue requirements.

10. SPILL PREVENTION

Minor spills of potentially contaminated soil, residual free product, or groundwater may occur during site work. The area beneath drill rig may be lined with plastic sheeting to control fluid leaks from the equipment. 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.

11. SAFETY MEETINGS

A site safety or “tailgate” safety meeting will be held every day 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).

Appendix A

Health and Safety Forms

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 Lovington 66

Job No. DB19.1395.00

Location Lovington, New Mexico

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

Tailgate Safety Meeting

Project ID: DB19.1395.00 ____________ Day: ____________

Location: Lovington, New Mexico ____________ Date: ____________

Project Manager: Jason Raucci ____________ 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
- ___ Drill Rig "KILL" Switches
- ___ 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

Name: ____________________________

Address: ____________________________

Tel. No.: ____________________________

Safety Meeting Attendees:

Name	Signature	Name	Signature

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:

Health and Safety Inspection Checklist - Field Environment

SAFE WORK CONDITION/PRACTICE	CHECKED BY (INITIALS)	COMMENTS
1. GLA field activities:		**( ) No field work being performed at this time.**
If yes, please describe briefly or attach scope:		**( ) Yes/Approximate days per month: ________**
		( ) Yes/Hazardous field work (Attach Scope)
2. Does GLA have sub-contractors on site?		**( ) No ( ) Yes**
If you answered "No" to questions 1 and 2 do not complete the rest of this form. Submit only this form.		
3. Does GLA Corporate IIPP address field activities?		**( ) Yes ( ) No ( ) Don't Know?**
4. GLA Site Safety Plan (SSP) developed and on site?		**( ) Yes ( ) No ( ) Don't Know?**
5. Client SSP on site.		**( ) Yes ( ) No**
6. Are GLA activities addressed in the Client's SSP?		**( ) Yes ( ) No**
7. Sub-Contractor SSP on site.		**( ) Yes ( ) No**
8. Have all GLA team personnel reviewed the site IIPP/SSP and signed the acknowledgement form?		**( ) Yes ( ) No ( ) Don't Know?**
9. GLA safety training records on site?		**( ) Yes ( ) No**
10. GLA sub-contractor safety training records on site?		**( ) Yes ( ) No**
11. Records of Tailgate Safety Meetings on site?		**( ) Yes ( ) No**
12. Minimum PPE requirements met.		**( ) Yes ( ) No**
13. PPE provided, properly stored and used.		**( ) Yes ( ) No**
14. Cal/OSHA, Fed/OSHA posters posted?		**( ) Yes ( ) No Location:**
15. Emergency medical information displayed.		**( ) Yes ( ) No Location:**
16. Evacuation routes clearly marked.		**( ) Yes ( ) No Location:**
17. Evacuation route maps posted.		**( ) Yes ( ) No Location:**
18. Adequate employee CPR/First Aid Training.		**( ) Yes ( ) No**
19. MSDS available?		**( ) Yes ( ) No Location:**
20. Sanitation adequate.		**( ) Yes ( ) No**
21. Are any special hazard procedures being used? (Confined Space, Lock Out/Tag Out, etc.)		**( ) Yes ( ) No** **Describe:**
22. Eyewash stations identified/tested.		**( ) Yes ( ) No Location:**
23. Fire extinguishers charged, identified, inspected.		**( ) Yes ( ) No Last Inspection Date: _________**

Person responsible for correction:____ Copy provided: ________________________

Corrective action (specify in detail): ____

____

Signature of person responsible for correction: ____ Date: __________________

Copy reviewed by management official: ____ Date: __________________

____

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 and Health Officer (SSHO) 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 SSHO, the subcontractor Health and Safety representative, and the Project Manager (PM).

The SSHO and other on-site personnel are responsible for conducting the emergency response in an efficient, rapid, and safe manner. The SSHO 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 SSHO, 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 SSHO 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 SSHO 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 SSHO 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 SSHO.

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 SSHO 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.

- **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 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 Gatorade™ or Quick Kick™, 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 SSHO, 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

Heat Illness Prevention Plan

MODULE 6:

HEAT ILLNESS PREVENTION PROGRAM

GEO-LOGIC ASSOCIATES INJURY AND ILLNESS PREVENTION PROGRAM
MODULE 6 – HEAT ILLNESS PREVENTION PROGRAM

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MODULE 6. HEAT ILLNESS PREVENTION PROGRAM

This procedure has been created to assist in the avoidance and reduction of the risk of work related heat illnesses. Geo-Logic Associates' employees are commonly required to work outdoors in areas that often reach temperatures greater than 85 degrees Fahrenheit. Prolonged exposure to elevated temperatures can increase the risk of developing a heat illness if preventative measures to seek shade, increase rest periods, and maintain adequate hydration are not followed.

This module of the Geo-Logic Associates IIPP is intended to promote awareness of conditions that can lead to heat illnesses, provide a list of signs and symptoms associated with heat illness, provide guidelines for preventing heat illness, and outline heat illness training requirements for supervisory and non-supervisory employees.

6.1 Purpose

Heat related illness is a common work-related risk that Geo-Logic Associates' employees may encounter. Heat related illness may be brought on by performing moderate to heavy work in elevated temperatures, or when performing relatively low-intensity work in a hot environment. Geo-Logic Associates is required to provide its employees with sufficient shade, water, and rest periods to minimize the risk of heat related illness.

Employers with outdoor places of employment must consider the effects of elevated ambient temperatures and direct exposure to the sun as a workplace hazard. The procedures laid out in this Module of the IIPP are intended to reduce the risk of work related heat illnesses among Geo-Logic Associates' employees. These procedures provide the minimal steps applicable to most outdoor work settings and are essential to reducing the incidence of heat related illnesses. In working environments with a higher risk for heat illness (e.g., during a heat wave, or other severe working or environmental conditions), Geo-Logic Associates may need to exercise greater caution and take additional protective measures beyond what is listed in this document, as needed to protect their employees.

The elements reflected within this Module, and that should be incorporated into a Site Specific Health and Safety Plan, include the following:

- Preventing Heat Illness
- Identification of Heat Illness
- Communication procedures
- Response to Heat Illness
- Training

6.2 Preventing Heat Illness

6.2.1 Provision of Water

Water is a key preventive measure to minimize the risk of heat related illnesses. Geo-Logic Associates shall provide its employees with access to potable and suitably cool drinking water. Where the supply of water is not plumbed or otherwise continuously supplied, water shall be provided in sufficient quantity at the beginning of the work shift to provide one quart per employee per hour for drinking for the entire shift. Employees may begin the shift with smaller quantities of water if they have effective procedures for replenishment during the shift as needed to allow employees to drink one quart or more per hour. Geo-Logic Associates encourages its employees to drink water frequently throughout the day.

For all field projects, the following water supply procedures shall be adhered to by all Geo-Logic Associates' employees:

- Field employees will check their daily water supply at the daily tailgate safety meeting or at the start of the work day. If an employee's water supply is less than 2 gallons at the start of the day, water will be exchanged among field employees or will be purchased from local vendors before commencing field work, so that each employee has a minimum of 2 gallons of water at the start of the day. Work shifts that extend beyond eight hours require the availability of an additional quart per hour.
- At the start of each working day, field employees will determine their work areas and identify the nearest drinking water source. If potable water is not available the employee shall purchase or otherwise obtain a full day supply of water before commencing field work.
- The Project Manager will routinely remind field employees of the importance of maintaining their drinking water supply.
- Geo-Logic Associates will provide field employees with funding to purchase bottled water as needed throughout the project.
- The Project Manager will routinely remind field employees to keep cool water in their field vehicles at all times during the project.
- The Project Manager will periodically remind field employees to check their water supply, and to replenish it whenever an individual's supply is less than two gallons.

To encourage frequent drinking of potable water, the following steps will be taken:

- The Project Manager will periodically contact the field employees to discuss water consumption and remind them to take breaks.
- Water consumption will be discussed at tailgate safety meetings.

6.2.2 Access to Shade and Rest Periods

Access to rest and shade or other cooling measures are important preventive steps to minimize the risk of heat related illnesses. Employees feeling the effects of heat illness or believing a preventative recovery period is needed, shall be provided access to an area with shade that is either open to the air or provided with ventilation or cooling for a period of no less than five minutes. Such access to shade shall be permitted at all times.

To ensure access to shade at all times, the following steps will be taken:

- When working in the field, Geo-Logic Associates encourages its employees to take a 5-minute rest break in an area sheltered from the sun as often as needed or at least once every two hours. A 10-minute rest break will be necessary when the temperature equals or exceeds 95 degrees Fahrenheit.
- Employees are encouraged to use their local field offices or trailers, or shade trees to provide shade. Air conditioned buildings, trailers, or vehicles are also acceptable locations for a cool-down break.
- In periods of extreme heat and sun exposure, employees are encouraged to limit their field time and exertion and increase the frequency and duration of break periods.

To ensure that employees have access to a preventative recovery period, the following steps will be taken:

- Project Managers will be aware of daily weather conditions within the project work area, and will advise site workers of standard work-break procedures, and whether or not additional breaks are warranted.
- Tailgate safety meetings will discuss weather, work conditions, and cool-down rest
- Employees will be instructed to take a minimum 5-minute break for every two hours of work. Employees are encouraged to park their vehicles near live shade trees or use the vehicle ventilation system to achieve a comfortable temperature.
- While driving between work properties, employees will be encouraged to use their vehicle air conditioning or ventilation systems to create a comfortable recovery temperature.

6.2.3 High-Heat Procedures

When the temperature equals or exceeds 95°F high-heat procedures must be implemented.

- Effective communication between supervisors and workers must be present either by voice, observation, radio or cell phone. This communication is to be used to check on the well-being of workers or for workers to report signs or symptoms of heat illness.
- Supervisors must frequently observe workers with special attention to their alertness or presentation of signs or symptoms of heat illness.
- Supervisors must remind employees throughout the work shift to drink plenty of water and not to wait until they are thirsty.
- Supervisors must ensure that employees actually take 10-minute preventative cool-down rest period every 2 hours.
- Close supervision of new workers is required for the first 14 days of their assignment working under high heat conditions. This requirement may be waived if, at the time of hire, the worker indicates that he or she has been doing similar outdoor work for at least 10 of the past 30 days for 4 or more hours per day.

6.3 Types and Symptoms of Heat Illness

Heat illness and/or heat stress may result from the use of personal protective equipment, over-exertion, high ambient temperatures, or a combination of all three. Heat-related illness usually comes in stages: heat cramps, heat exhaustion, and heat stroke.

Heat cramps: Heat cramps are muscular pains and spasms due to heavy exertion. They usually involve the abdominal muscles or the legs. It is generally thought that the loss of water and salt from heavy sweating causes the cramps. Signs of Heat Cramps include: muscle cramping, spasms, or muscular pain.

Heat exhaustion: Heat exhaustion typically occurs when people exercise heavily or work in a warm, humid place where body fluids are lost through heavy sweating. Fluid loss causes blood flow to decrease in the vital organs, resulting in a form of shock. With heat exhaustion, sweat does not evaporate as it should, possibly because of high humidity or too many layers of clothing. As a result, the body is not cooled properly. Signs of Heat Exhaustion include:

- Cool, moist, pale skin (the skin may be red right after physical activity).
- Heavy sweating.
- Headache.
- Dizziness and weakness or exhaustion.
- Nausea or vomiting.
- The skin may or may not feel hot.

Heat stroke: Also known as sunstroke, heat stroke is life-threatening. The victim's temperature control system, which produces sweating to cool the body, stops working.

The body temperature can rise so high that brain damage and death may result if the body is not cooled quickly.

The signals of the late stage of a heat-related illness (often called heat stroke) include:

- Skin may still be moist or the victim may stop sweating and the skin may be red, hot and dry. Rapid, weak pulse.
- Vomiting.
- Decreased alertness level or complete loss of consciousness.
- High body temperature (sometimes as high as 105oF).

This late stage of a heat-related illness is life threatening. Call 9-1-1 or the local emergency number.

6.4 Response to Heat Illness

Response to heat illness includes three steps:

1. Contact Emergency Services

2. Provide General Care

3. Contact Geo-Logic Associates' Project Manager or Corporate Program Administrator.

Contact emergency services: Geo-Logic Associates provides its employees with cellular telephones that are to be used to contact emergency services in the event of accident, illness, or injury on the job site, including heat illness. The site-specific Health and Safety Plan is required to contain a map to the nearest hospital and directions from the project site to the nearest hospital. When contacting emergency services, the employee shall use this information to provide the directions to the site.

Provide general care: When working at remote locations, the response time of emergency responders may be lengthy, and as a result, employees should be prepared to provide general care for heat illness.

The American Red Cross provides the following general care for heat illness:

- Cool the body.
- Give fluids but not to an unconscious victim.
- Minimize shock by placing individual in a line position, in the shade with the legs slightly elevated.

In addition, the following American Red Cross care guidelines are provided specific heat illnesses:

For heat cramps or heat exhaustion: Move the person to a cooler place and have him or her rest in a comfortable position. If the person is fully awake and alert, give a half glass of cool water every 15 minutes. Do not let him or her drink too quickly. Do not give liquids with alcohol or caffeine in them, as they can make conditions worse. Remove or loosen tight clothing and apply cool, wet cloths such as towels or wet sheets. Call 911 or the local emergency number if the person refuses water, vomits or loses consciousness.

For heat stroke: Heat stroke is a life-threatening situation! Help is needed fast. Call 911 or your local EMS number. Move the person to a cooler place. Quickly cool the body. Wrap wet sheets around the body and fan it. If you have ice packs or cold packs, wrap them in a cloth and place them on each of the victim's wrists and ankles, in the armpits and on the neck to cool the large blood vessels. (Do not use rubbing alcohol because it closes the skin's pores and prevents heat loss.) Watch for signals of breathing problems and make sure the airway is clear. Keep the person lying down.

Contact Geo-Logic Associates managers: After emergency services are contacted and general care is administered, the employee shall contact his or her Project Manager or the Corporate Program Administrator to notify him or her of the situation.

6.5 Training

Training is critical to help reduce the risk of heat related illnesses and to assist with obtaining emergency assistance without delay.

6.6 General Training

Training in the following topics shall be provided to all supervisors (Project Managers) and non-supervisory employees:

1. The personal risk factors for heat illness;
    - Age
    - Degree of acclimatization
    - General health
    - Lack of water consumption
    - Alcohol consumption
    - Caffeine consumption
    - Use of prescription medications that affect the body's water retention
    - Other medical conditions that can affect physiological responses to heat

2. The environmental risk factors for heat illness;
    - Air temperature
    - Relative humidity
    - Radiant heat from the sun and other sources
    - Conductive heat sources such as the ground
    - Air movement
    - Workload severity and duration
    - Protective clothing and personal protective equipment worn by employees

3. Geo-Logic Associates' procedures for working in hot and high heat conditions.

4. The importance of frequent consumption of small quantities of water, up to 4 cups per hour, when the work environment is hot and employees are likely to be sweating more than usual in the performance of their duties;

5. The importance of acclimatization, especially during heat waves or with new employees

6. The different types of heat illness and the common signs and symptoms of heat illness;

7. The importance to employees of immediately reporting to the employer, directly or through the employee's Project Manager, symptoms or signs of heat illness in themselves, or in co-workers;

8. Geo-Logic Associates' procedures for responding to symptoms of possible heat illness, including how emergency medical services will be provided should they become necessary;

9. Geo-Logic Associates' procedures for contacting emergency medical services, and if necessary, for transporting employees to a point where they can be reached by an emergency medical service provider;

10. Geo-Logic Associates' procedures for ensuring that, in the event of an emergency, clear and precise directions to the work site can and will be provided as needed to emergency responders.

6.6.1 Supervisor/Project Manager Training

Prior to assignment to supervision of employees working in the heat, training on the following topics shall be provided:

- The information contained in this procedure

- Their responsibility to follow and implement the applicable provisions in this procedure.
- The procedures the Project Manager is to follow when an employee exhibits symptoms consistent with possible heat illness, including emergency response procedures.
- Initial and annual first-aid training by the American Red Cross or other accredited organization.
- How to monitor weather reports and how to respond to hot weather advisories.
- How to prepare a Site-Specific Health and Safety Plan to tailor this Heat Illness Prevention Plan to the specific concerns at his or her project site.
- How to review and sign the Site-Specific Health and Safety Plan to acknowledge that he or she understand its contents.
- How to brief the field employees on the contents of this document and Site-Specific Health and Safety Plan requirements for Heat Illness identification, prevention, and response.
- How to maintain records of the training.

6.6.2 Employee Training

To ensure employees are trained to understand heat related illness and injuries and the appropriate response, the following steps will be taken:

- All employees will receive heat illness prevention training prior to working outdoors, especially all newly-hired employees or employees who are new to the project.
- On hot days (≥80°F), and during a heat wave, the Project Manager or designee will hold short tailgate meetings to review this important information with all workers.
- All newly hired workers will be assigned a buddy or experienced coworker to ensure that they understood the training and follow the company procedures.
- The Project Manager or Site Supervisor will be trained prior to being assigned to supervise outdoor workers.
- Primary and secondary employers will ensure that all employee’s (including temporary) working outdoors are trained in heat illness prevention and will keep records of the training

Appendix D

Safety Data Sheets

SIGMA-ALDRICH

sigma-aldrich.com

SAFETY DATA SHEET

Version 5.8
Revision Date 12/28/2015
Print Date 05/13/2016

1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name : BTEX/MTBE in Soil

Product Number : SQC025
Brand : Sigma-Aldrich

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses : Laboratory chemicals, Synthesis of substances

1.3 Details of the supplier of the safety data sheet

Company : Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO 63103
USA

Telephone : +1 800-325-5832
Fax : +1 800-325-5052

1.4 Emergency telephone number

Emergency Phone # : (314) 776-6555

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)
Acute toxicity, Oral (Category 4), H302
Carcinogenicity (Category 1A), H350
Specific target organ toxicity - single exposure (Category 1), H370
Specific target organ toxicity - repeated exposure, Inhalation (Category 2), H373

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram

Signal word Danger

Hazard statement(s)

H302	Harmful if swallowed.
H350	May cause cancer.
H370	Causes damage to organs.
H373	May cause damage to organs through prolonged or repeated exposure if inhaled.

Precautionary statement(s)

P201	Obtain special instructions before use.
P202	Do not handle until all safety precautions have been read and understood.
P260	Do not breathe dust/ fume/ gas/ mist/ vapours/ spray.
P264	Wash skin thoroughly after handling.

P270	Do not eat, drink or smoke when using this product.
P280	Wear protective gloves/ protective clothing/ eye protection/ face protection.
P301 + P312 + P330	IF SWALLOWED: Call a POISON CENTER or doctor/ physician if you feel unwell. Rinse mouth.
P307 + P311	IF exposed: Call a POISON CENTER or doctor/ physician.
P405	Store locked up.
P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.2 Mixtures

Hazardous components

Component		Classification	Concentration
Quartz			
CAS-No. EC-No.	14808-60-7 238-878-4	Carc. 2; STOT RE 2; H351, H373	>= 90 - <= 100 %
Methanol			
CAS-No. EC-No. Index-No. Registration number	67-56-1 200-659-6 603-001-00-X 01-2119433307-44-XXXX	Flam. Liq. 2; Acute Tox. 3; STOT SE 1; H225, H301 + H311 + H331, H370	>= 10 - < 20 %

For the full text of the H-Statements mentioned in this Section, see Section 16.

4. FIRST AID MEASURES

4.1 Description of first aid measures

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Take victim immediately to hospital. Consult a physician.

In case of eye contact
Flush eyes with water as a precaution.

If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

No data available

5. FIREFIGHTING MEASURES

5.1 Extinguishing media

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture

Carbon oxides, silicon oxides

5.3 Advice for firefighters

Wear self-contained breathing apparatus for firefighting if necessary.

5.4 Further information
No data available

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Use personal protective equipment. Avoid dust formation. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas. Avoid breathing dust.
For personal protection see section 8.

6.2 Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

6.3 Methods and materials for containment and cleaning up
Pick up and arrange disposal without creating dust. Sweep up and shovel. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections
For disposal see section 13.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Further processing of solid materials may result in the formation of combustible dusts. The potential for combustible dust formation should be taken into consideration before additional processing occurs.Avoid contact with skin and eyes. Avoid formation of dust and aerosols.
Provide appropriate exhaust ventilation at places where dust is formed.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities
Keep container tightly closed in a dry and well-ventilated place.

Recommended storage temperature 4 °C
Storage class (TRGS 510): Non-combustible, acute toxic Cat.3 / toxic hazardous materials or hazardous materials causing chronic effects

7.3 Specific end use(s)
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

Components with workplace control parameters

Component	CAS-No.	Value	Control parameters	Basis
Quartz	14808-60-7	TWA	0.025 mg/m3	USA. ACGIH Threshold Limit Values (TLV)
	Remarks	Suspected human carcinogen		
		TWA	0.025 mg/m3	USA. ACGIH Threshold Limit Values (TLV)
		Lung cancer Pulmonary fibrosis Suspected human carcinogen		
Methanol	67-56-1	TWA	200.000000 ppm	USA. ACGIH Threshold Limit Values (TLV)
		Headache Nausea Dizziness Eye damage Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Danger of cutaneous absorption		

		STEL	250.000000 ppm	USA. ACGIH Threshold Limit Values (TLV)
		Headache Nausea Dizziness Eye damage Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Danger of cutaneous absorption		
		TWA	200.000000 ppm 260.000000 mg/m3	USA. NIOSH Recommended Exposure Limits
		Potential for dermal absorption		
		ST	250.000000 ppm 325.000000 mg/m3	USA. NIOSH Recommended Exposure Limits
		Potential for dermal absorption		
		TWA	200.000000 ppm 260.000000 mg/m3	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
		The value in mg/m3 is approximate.		
		TWA	200 ppm	USA. ACGIH Threshold Limit Values (TLV)
		Headache Nausea Dizziness Eye damage Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Danger of cutaneous absorption		
		STEL	250 ppm	USA. ACGIH Threshold Limit Values (TLV)
		Headache Nausea Dizziness Eye damage Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Danger of cutaneous absorption		
		TWA	200 ppm 260 mg/m3	USA. NIOSH Recommended Exposure Limits
		Potential for dermal absorption		
		ST	250 ppm 325 mg/m3	USA. NIOSH Recommended Exposure Limits
		Potential for dermal absorption		
		TWA	200 ppm 260 mg/m3	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
		The value in mg/m3 is approximate.		
		STEL	250 ppm 325 mg/m3	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
		Skin notation		
		TWA	200 ppm 260 mg/m3	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
		Skin notation		

Biological occupational exposure limits

Component	CAS-No.	Parameters	Value	Biological specimen	Basis
Methanol	67-56-1	Methanol	15.0000 mg/l	Urine	ACGIH - Biological Exposure Indices (BEI)
	Remarks	End of shift (As soon as possible after exposure ceases)			
		Methanol	15 mg/l	Urine	ACGIH - Biological Exposure Indices (BEI)
		End of shift (As soon as possible after exposure ceases)			

8.2 Exposure controls

Appropriate engineering controls

Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection

Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Body Protection

Complete suit protecting against chemicals, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection

Where risk assessment shows air-purifying respirators are appropriate use a full-face particle respirator type N99 (US) or type P2 (EN 143) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure

Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: solid
b)	Odour	No data available
c)	Odour Threshold	No data available
d)	pH	No data available
e)	Melting point/freezing point	No data available
f)	Initial boiling point and boiling range	No data available
g)	Flash point	No data available
h)	Evaporation rate	No data available
i)	Flammability (solid, gas)	No data available
j)	Upper/lower flammability or explosive limits	No data available

k)	Vapour pressure	No data available
l)	Vapour density	No data available
m)	Relative density	No data available
n)	Water solubility	No data available
o)	Partition coefficient: n-octanol/water	No data available
p)	Auto-ignition temperature	No data available
q)	Decomposition temperature	No data available
r)	Viscosity	No data available
s)	Explosive properties	No data available
t)	Oxidizing properties	No data available

9.2 Other safety information

No data available

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10. STABILITY AND REACTIVITY

10.1 Reactivity

No data available

10.2 Chemical stability

Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions

No data available

10.4 Conditions to avoid

No data available

10.5 Incompatible materials

Strong oxidizing agents

10.6 Hazardous decomposition products

Other decomposition products - No data available
In the event of fire: see section 5

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11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity
No data available

Inhalation: No data available

Dermal: No data available

No data available

Skin corrosion/irritation
No data available

Serious eye damage/eye irritation
No data available

Respiratory or skin sensitisation
No data available

Germ cell mutagenicity
No data available

Carcinogenicity

IARC:	1 - Group 1: Carcinogenic to humans (Quartz)
ACGIH:	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.
NTP:	Known to be human carcinogen (Quartz)
OSHA:	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity
No data available
No data available

Specific target organ toxicity - single exposure
No data available

Specific target organ toxicity - repeated exposure
No data available

Aspiration hazard
No data available

Additional Information
RTECS: Not available

To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

Liver - Irregularities - Based on Human Evidence
Stomach - Irregularities - Based on Human Evidence
Stomach - Irregularities - Based on Human Evidence (Methanol)
Stomach - Irregularities - Based on Human Evidence (Xylene)
Stomach - Irregularities - Based on Human Evidence (Toluene)
Stomach - Irregularities - Based on Human Evidence (Benzene)
Stomach - Irregularities - Based on Human Evidence (Ethylbenzene)
Heart - (Naphthalene)
Stomach - Irregularities - Based on Human Evidence (1,2-Dichlorobenzene)
Stomach - Irregularities - Based on Human Evidence (Mesitylene)
Central nervous system - (1,2,4-Trimethylbenzene)
Central nervous system - (tert-Butyl methyl ether)

12. ECOLOGICAL INFORMATION

12.1 Toxicity
No data available

12.2 Persistence and degradability
No data available

12.3 Bioaccumulative potential
No data available

12.4 Mobility in soil
No data available

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects
No data available

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Product
Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
Not dangerous goods

IMDG
Not dangerous goods

IATA
Not dangerous goods

15. REGULATORY INFORMATION

SARA 302 Components
No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
The following components are subject to reporting levels established by SARA Title III, Section 313:

	CAS-No.	Revision Date
Methanol	67-56-1	2007-07-01

SARA 311/312 Hazards
Acute Health Hazard, Chronic Health Hazard

Massachusetts Right To Know Components

	CAS-No.	Revision Date
Quartz	14808-60-7	1994-04-01
Methanol	67-56-1	2007-07-01
Benzene	71-43-2	2007-07-01
1,4-Dichlorobenzene	106-46-7	2007-07-01

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Quartz	14808-60-7	1994-04-01
Methanol	67-56-1	2007-07-01

New Jersey Right To Know Components

	CAS-No.	Revision Date
Quartz	14808-60-7	1994-04-01
Methanol	67-56-1	2007-07-01

California Prop. 65 Components

WARNING! This product contains a chemical known to the State of California to cause cancer.	CAS-No.	Revision Date
Benzene	71-43-2	2009-02-01
Ethylbenzene	100-41-4	2007-09-28
Naphthalene	91-20-3	1990-01-01
1,4-Dichlorobenzene	106-46-7	2007-09-28
Quartz	14808-60-7	2007-09-28

WARNING: This product contains a chemical known to the	CAS-No.	Revision Date
State of California to cause birth defects or other reproductive	67-56-1	2012-03-16

harm.
Methanol

Toluene	108-88-3	2009-02-01
Benzene	71-43-2	2009-02-01

16. OTHER INFORMATION

Full text of H-Statements referred to under sections 2 and 3.

Acute Tox.	Acute toxicity
Carc.	Carcinogenicity
Flam. Liq.	Flammable liquids
H225	Highly flammable liquid and vapour.
H301 + H311 + H331	Toxic if swallowed, in contact with skin or if inhaled
H302	Harmful if swallowed.
H350	May cause cancer.
H351	Suspected of causing cancer.
H370	Causes damage to organs.
H373	May cause damage to organs through prolonged or repeated exposure if inhaled.
STOT RE	Specific target organ toxicity - repeated exposure
STOT SE	Specific target organ toxicity - single exposure

HMIS Rating

Health hazard:	2
Chronic Health Hazard:	*
Flammability:	0
Physical Hazard	0

NFPA Rating

Health hazard:	2
Fire Hazard:	0
Reactivity Hazard:	0

Further information

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Preparation Information

Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956

Version: 5.8 Revision Date: 12/28/2015 Print Date: 05/13/2016

SIGMA-ALDRICH

sigma-aldrich.com

SAFETY DATA SHEET

Version 5.9
Revision Date 12/28/2015
Print Date 05/13/2016

1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name : BTEX/MTBE in Water

Product Number : QC1642
Brand : Sigma-Aldrich

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses : Laboratory chemicals, Synthesis of substances

1.3 Details of the supplier of the safety data sheet

Company : Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO 63103
USA

Telephone : +1 800-325-5832
Fax : +1 800-325-5052

1.4 Emergency telephone number

Emergency Phone # : (314) 776-6555

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)
Flammable liquids (Category 2), H225
Acute toxicity, Oral (Category 3), H301
Acute toxicity, Inhalation (Category 3), H331
Acute toxicity, Dermal (Category 3), H311
Specific target organ toxicity - single exposure (Category 1), H370

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram

Signal word Danger

Hazard statement(s)

H225	Highly flammable liquid and vapour.
H301 + H311 + H331	Toxic if swallowed, in contact with skin or if inhaled
H370	Causes damage to organs.

Precautionary statement(s)

P210	Keep away from heat/sparks/open flames/hot surfaces. No smoking.
P233	Keep container tightly closed.
P240	Ground/bond container and receiving equipment.
P241	Use explosion-proof electrical/ ventilating/ lighting/ equipment.
P242	Use only non-sparking tools.
P243	Take precautionary measures against static discharge.

P260	Do not breathe dust/ fume/ gas/ mist/ vapours/ spray.
P264	Wash skin thoroughly after handling.
P270	Do not eat, drink or smoke when using this product.
P271	Use only outdoors or in a well-ventilated area.
P280	Wear protective gloves/ protective clothing/ eye protection/ face protection.
P301 + P310 + P330	IF SWALLOWED: Immediately call a POISON CENTER or doctor/ physician. Rinse mouth.
P303 + P361 + P353	IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304 + P340 + P311	IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER or doctor/ physician.
P307 + P311	IF exposed: Call a POISON CENTER or doctor/ physician.
P362	Take off contaminated clothing and wash before reuse.
P370 + P378	In case of fire: Use dry sand, dry chemical or alcohol-resistant foam to extinguish.
P403 + P233	Store in a well-ventilated place. Keep container tightly closed.
P403 + P235	Store in a well-ventilated place. Keep cool.
P405	Store locked up.
P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

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3. COMPOSITION/INFORMATION ON INGREDIENTS

3.2 Mixtures

Hazardous components

Component		Classification	Concentration
Methanol			
CAS-No. EC-No. Index-No. Registration number	67-56-1 200-659-6 603-001-00-X 01-2119433307-44-XXXX	Flam. Liq. 2; Acute Tox. 3; STOT SE 1; H225, H301 + H311 + H331, H370	>= 90 - <= 100 %

For the full text of the H-Statements mentioned in this Section, see Section 16.

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4. FIRST AID MEASURES

4.1 Description of first aid measures

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Take victim immediately to hospital. Consult a physician.

In case of eye contact
Flush eyes with water as a precaution.

If swallowed
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

No data available

5. FIREFIGHTING MEASURES

5.1 Extinguishing media

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture
Carbon oxides

5.3 Advice for firefighters
Wear self-contained breathing apparatus for firefighting if necessary.

5.4 Further information
Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Wear respiratory protection. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.
For personal protection see section 8.

6.2 Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

6.3 Methods and materials for containment and cleaning up
Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13).

6.4 Reference to other sections
For disposal see section 13.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Avoid contact with skin and eyes. Avoid inhalation of vapour or mist.
Use explosion-proof equipment.Keep away from sources of ignition - No smoking.Take measures to prevent the build up of electrostatic charge.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities
Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.

Recommended storage temperature 4 °C
Storage class (TRGS 510): Flammable liquids

7.3 Specific end use(s)
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

Components with workplace control parameters

Component	CAS-No.	Value	Control parameters	Basis
Methanol	67-56-1	TWA	200.000000 ppm	USA. ACGIH Threshold Limit Values (TLV)
	Remarks	Headache Nausea Dizziness Eye damage		

		Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Danger of cutaneous absorption		
		STEL	250.000000 ppm	USA. ACGIH Threshold Limit Values (TLV)
		Headache Nausea Dizziness Eye damage Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Danger of cutaneous absorption		
		TWA	200.000000 ppm 260.000000 mg/m3	USA. NIOSH Recommended Exposure Limits
		Potential for dermal absorption		
		ST	250.000000 ppm 325.000000 mg/m3	USA. NIOSH Recommended Exposure Limits
		Potential for dermal absorption		
		TWA	200.000000 ppm 260.000000 mg/m3	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
		The value in mg/m3 is approximate.		
		TWA	200 ppm	USA. ACGIH Threshold Limit Values (TLV)
		Headache Nausea Dizziness Eye damage Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Danger of cutaneous absorption		
		STEL	250 ppm	USA. ACGIH Threshold Limit Values (TLV)
		Headache Nausea Dizziness Eye damage Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Danger of cutaneous absorption		
		TWA	200 ppm 260 mg/m3	USA. NIOSH Recommended Exposure Limits
		Potential for dermal absorption		
		ST	250 ppm 325 mg/m3	USA. NIOSH Recommended Exposure Limits
		Potential for dermal absorption		
		TWA	200 ppm 260 mg/m3	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
		The value in mg/m3 is approximate.		
		STEL	250 ppm 325 mg/m3	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
		Skin notation		

		TWA	200 ppm 260 mg/m3	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
		Skin notation		

Biological occupational exposure limits

Component	CAS-No.	Parameters	Value	Biological specimen	Basis
Methanol	67-56-1	Methanol	15.0000 mg/l	Urine	ACGIH - Biological Exposure Indices (BEI)
	Remarks	End of shift (As soon as possible after exposure ceases)			
		Methanol	15 mg/l	Urine	ACGIH - Biological Exposure Indices (BEI)
		End of shift (As soon as possible after exposure ceases)			

8.2 Exposure controls

Appropriate engineering controls
Avoid contact with skin, eyes and clothing. Wash hands before breaks and immediately after handling the product.

Personal protective equipment

Eye/face protection
Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Body Protection
Complete suit protecting against chemicals, Flame retardant antistatic protective clothing., The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type AXBEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure
Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: liquid
b)	Odour	No data available
c)	Odour Threshold	No data available
d)	pH	No data available
e)	Melting point/freezing point	No data available
f)	Initial boiling point and boiling range	64 - 65 °C (147 - 149 °F) at 1,013 hPa (760 mmHg)
g)	Flash point	11 °C (52 °F) - closed cup - Solvent
h)	Evaporation rate	No data available

i)	Flammability (solid, gas)	No data available
j)	Upper/lower flammability or explosive limits	Upper explosion limit: 36 %(V) Lower explosion limit: 6 %(V)
k)	Vapour pressure	No data available
l)	Vapour density	No data available
m)	Relative density	No data available
n)	Water solubility	No data available
o)	Partition coefficient: n-octanol/water	No data available
p)	Auto-ignition temperature	No data available
q)	Decomposition temperature	No data available
r)	Viscosity	No data available
s)	Explosive properties	No data available
t)	Oxidizing properties	No data available

9.2 Other safety information

No data available

10. STABILITY AND REACTIVITY

10.1 Reactivity

No data available

10.2 Chemical stability

Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions

Vapours may form explosive mixture with air.

10.4 Conditions to avoid

Heat, flames and sparks.

10.5 Incompatible materials

Strong oxidizing agents

10.6 Hazardous decomposition products

Other decomposition products - No data available
In the event of fire: see section 5

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity
No data available

Inhalation: No data available

Dermal: No data available

No data available

Skin corrosion/irritation
No data available

Serious eye damage/eye irritation
No data available

Respiratory or skin sensitisation
No data available

Germ cell mutagenicity
No data available

Carcinogenicity

IARC:	No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
ACGIH:	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.
NTP:	No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
OSHA:	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity
No data available
No data available

Specific target organ toxicity - single exposure
No data available

Specific target organ toxicity - repeated exposure
No data available

Aspiration hazard
No data available

Additional Information
RTECS: Not available

To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

Stomach - Irregularities - Based on Human Evidence
Stomach - Irregularities - Based on Human Evidence
Stomach - Irregularities - Based on Human Evidence (Toluene)
Stomach - Irregularities - Based on Human Evidence (Benzene)
Kidney - (m-Xylene)
Nerves. - (o-Xylene)
Stomach - Irregularities - Based on Human Evidence (Ethylbenzene)
Central nervous system - (tert-Butyl methyl ether)
Stomach - Irregularities - Based on Human Evidence (p-Xylene)

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12. ECOLOGICAL INFORMATION

12.1 Toxicity
No data available

12.2 Persistence and degradability
No data available

12.3 Bioaccumulative potential
No data available

12.4 Mobility in soil
No data available

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects
No data available

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Product
Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
UN number: 1230 Class: 3 Packing group: II
Proper shipping name: Methanol, solution
Reportable Quantity (RQ):

Poison Inhalation Hazard: No

IMDG
UN number: 1230 Class: 3 (6.1) Packing group: II EMS-No: F-E, S-D
Proper shipping name: METHANOL, SOLUTION

IATA
UN number: 1230 Class: 3 (6.1) Packing group: II
Proper shipping name: Methanol, solution

15. REGULATORY INFORMATION

SARA 302 Components
No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
The following components are subject to reporting levels established by SARA Title III, Section 313:

	CAS-No.	Revision Date
Methanol	67-56-1	2007-07-01

Massachusetts Right To Know Components

	CAS-No.	Revision Date
Methanol	67-56-1	2007-07-01
Benzene	71-43-2	2007-07-01

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Methanol	67-56-1	2007-07-01
Toluene	108-88-3	2007-07-01
Benzene	71-43-2	2007-07-01
m-Xylene	108-38-3	2007-07-01
o-Xylene	95-47-6	2007-07-01
Ethylbenzene	100-41-4	2007-07-01
tert-Butyl methyl ether	1634-04-4	2007-07-01
p-Xylene	106-42-3	2007-07-01

New Jersey Right To Know Components

	CAS-No.	Revision Date
Methanol	67-56-1	2007-07-01

California Prop. 65 Components

WARNING! This product contains a chemical known to the State of California to cause cancer.	CAS-No.	Revision Date
Benzene	71-43-2	2009-02-01
Ethylbenzene	100-41-4	2007-09-28

WARNING: This product contains a chemical known to the State of California to cause birth defects or other reproductive harm.	CAS-No.	Revision Date
Methanol	67-56-1	2012-03-16
Toluene	108-88-3	2009-02-01
Benzene	71-43-2	2009-02-01

16. OTHER INFORMATION

Full text of H-Statements referred to under sections 2 and 3.

Acute Tox.	Acute toxicity
Flam. Liq.	Flammable liquids
H225	Highly flammable liquid and vapour.
H301	Toxic if swallowed.
H301 + H311 + H331	Toxic if swallowed, in contact with skin or if inhaled
H311	Toxic in contact with skin.
H331	Toxic if inhaled.
H370	Causes damage to organs.
STOT SE	Specific target organ toxicity - single exposure

HMIS Rating

Health hazard:	2
Chronic Health Hazard:	*
Flammability:	3
Physical Hazard	0

NFPA Rating

Health hazard:	2
Fire Hazard:	3
Reactivity Hazard:	0

Further information

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Preparation Information

Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956

Version: 5.9 Revision Date: 12/28/2015 Print Date: 05/13/2016

Appendix E

Guidance for Field Personnel Related to the Covid-19 Pandemic

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 in the United States.

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, ensure to wear gloves when refueling and sanitize hands once complete.
- 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.
- Make as few stops as possible during travels to limit exposure to public spaces.
- Avoid close contact with anyone experiencing flu-like symptoms.
- If you feel unwell or develop flu-like symptoms, contact your supervisor immediately and your Project Manager.
- If a subcontractor, client or client contractor exhibits flu-like symptoms, confirmed or presumptive to be COVID-19, remove yourself from the area. Notify your project manager/supervisor immediately of the potential exposure.
- 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, surfaces in and on portable bathrooms and other equipment that they come in contact with.
- GLA employees will wear gloves while on site and wash and or/sanitize their hands upon removing them.
- Tools and equipment shall be disinfected often and at the end of use.
- Bring water, meals and snacks with you to avoid stopping at stores or restaurants. Dine in your vehicle or outside alone. Avoid using the project trailer or site facilities for eating.
- Meals shall be eaten alone or at a minimum distance of approximately 6 ft. and not in groups.
- Practice social distancing when conducting Daily Tailgate Safety Meetings/Pre-Work Assessments.

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- GLA staff shall avoid independent hotels, alternative accommodations and 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.).
- Do not circulate sign in sheets but have one person document those in attendance on the sheet.
- Since access to running water for hand washing may be impracticable, obtain alcohol-based hand sanitizers and/or wipes prior to the 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.
- Several local and State governmental agencies are recommending face covering or facemasks to reduce the spread and exposure to COVID-19. Field employees should carry disposable or reusable face masks that can be used for this purpose. If facemasks are not available, a scarf, bandana, or other cloth 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 and if available.
- Any trash collected from the jobsite must be changed frequently by someone wearing nitrile, latex, or vinyl gloves.
- Any portable jobsite toilets should be cleaned by the leasing company at least twice per week and disinfected on the inside. 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 also require disinfecting.
- GLA staff should carry the essentials services letter explaining why they are considered an essential employee.

Appendix I

Legal Notice Publication

NOTICE OF SUBMISSION OF FINAL REMEDIATION PLAN

Date of Notice: August 27, 2020 and September 3, 2020

Notice is hereby given by the Petroleum Storage Tank Bureau (PSTB) of the New Mexico Environment Department (NMED) of the submission of a Final Remediation Plan (Plan) on August 28, 2020, as follows:

1. The Plan proposes actions to remediate a release of petroleum or petroleum products into the environment.

2. The release occurred at the Lovington 66 site, located at the northwest corner of Main Street and Avenue D in Lovington, New Mexico. Impacts associated with the release extend under the intersection and adjacent property to the southeast. With permission, remediation equipment will be located on property south of the Crosswinds Lovington church at 502 S. Love Street, between Love Street and the alley to the west.

3. The Plan proposes to remove gasoline contamination through the use of soil vapor extraction technology using horizontal wells extending under the site and the intersection of Main Street and Avenue D to the remediation equipment location. The extracted hydrocarbon vapors will be treated using thermal and/or catalytic oxidation technology and discharged to the atmosphere.

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, Mr. Tim Noger, by telephone at 505-372-8150 or email at tim.noger@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: Tim Noger, 2905 Rodeo Park Drive East, Building 1, Santa Fe, New Mexico, 87505; by telephone at 505-372-8150; or e-mailed to: tim.noger@state.nm.us. Comments sent to the PSTB Project Manager must also be mailed to the NMED Secretary at New Mexico Environment Department, Attn: Secretary Kenney, PO Box 5469, Santa Fe, NM 87502-5469. Comments must be delivered by September 24, 2020. Please include the name of the site “Lovington 66, 424 South Main, Lovington, New Mexico” to ensure comments are correctly assigned to the site.

AVISO DE LA PRESENTACIÓN DE UN PLAN DE REMEDIACIÓN FINAL

Fechas del aviso: 27 de agosto de 2020 y 3 de septiembre de 2020

Por el presente documento, la Oficina de Tanques para Almacenamiento de Petróleo (PSTB, por sus siglas en inglés) del Departamento del Medio Ambiente de Nuevo México (NMED, por sus siglas en inglés) da aviso de la presentación de un Plan de Remediación Final (Plan) el 28 de agosto de 2020 como se indica a continuación:

1. El Plan propone acciones para remediar una liberación de petróleo o productos del petróleo en el medio ambiente.

2. La liberación ocurrió en el sitio Lovington 66, ubicado en la esquina noroeste de Main Street y Avenue D en Lovington, Nuevo México. El impacto asociado con la liberación se extiende por debajo de la intersección y la propiedad adyacente hacia el sureste. Se colocará, con autorización, el equipo de remediación en la propiedad ubicada al sur de la iglesia Crosswinds Lovington, en 502 S. Love Street, entre Love Street y el pasaje situado al oeste.

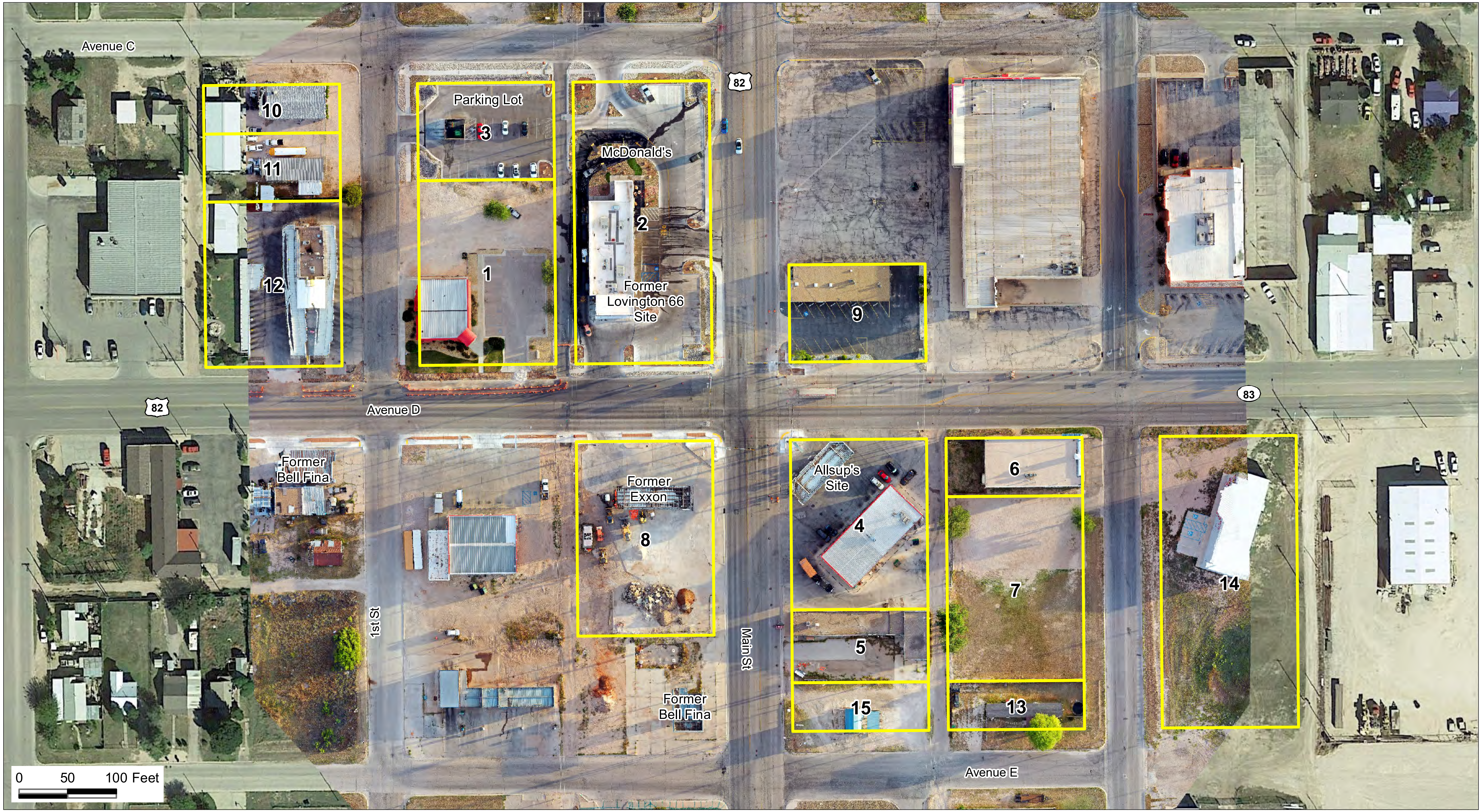
3. El Plan propone eliminar la contaminación de gasolina mediante la aplicación de tecnología de extracción de vapores del suelo, la cual usa pozos horizontales que se extienden por debajo del sitio y de la intersección de Main Street y Avenue D hasta el lugar de emplazamiento del equipo de remediación. Los vapores de hidrocarburos extraídos serán tratados usando tecnología de oxidación térmica y/o catalítica para luego ser descargados en la atmósfera.

4. Las partes interesadas podrán ver copias del Plan de Remediación Final en las oficinas de la PSTB del NMED ubicadas en 1) 2905 Rodeo Park Drive East, Edificio 1, Santa Fe, Nuevo México, 87505 y 2) 1914 W. Second Street, Roswell, Nuevo México, 88201. Debido a las reglas establecidas en respuesta a la pandemia del COVID-19, para ver el Plan en persona se deben hacer los arreglos necesarios con 48 horas de anticipación. Para hacer estos arreglos, se debe comunicar con el gerente de proyectos de la PSTB del NMED, el señor Tim Noger, por teléfono al 505-372-8150 o por correo electrónico a la dirección tim.noger@state.nm.us.

   Asimismo, el Plan de Remediación Final y todos los datos correspondientes podrán examinarse en el sitio web http://dbsa-client-access.com/PSTB/file_access.htm. Podrán hacerse arreglos para servicios de traducción de documentos, de interpretación y de ayuda para personas con discapacidades por medio del gerente de proyectos de la PSTB. Los usuarios de TDD o TTY pueden acceder a su número de teléfono a través de la Red de Retransmisión de Nuevo México, llamando al 1-800-659-1779 (voz) y al 1-800-659-8331 (usuarios de TTY).

5. Los comentarios sobre el Plan podrán enviarse al gerente de proyectos de la PSTB ya sea por correo postal a New Mexico Environment Department Petroleum Storage Tank Bureau, Attn: Tim Noger, 2905 Rodeo Park Drive East, Building 1, Santa Fe, New Mexico, 87505; por teléfono llamando al 505-372-8150, o por correo electrónico enviando un mensaje a tim.noger@state.nm.us. Los comentarios enviados al gerente de proyectos de la PSTB también deben enviarse por correo postal al secretario del NMED a New Mexico Environment

Department, Attn: Secretary Kenney, PO Box 5469, Santa Fe, NM 87502-5469. Los comentarios deberán ser entregados a más tardar el 24 de septiembre de 2020. Incluya el nombre del sitio “Lovington 66, 424 South Main, Lovington, New Mexico” para que los comentarios sean correctamente asignados al sitio.



Source: AEA: 5/12/2020
Google Earth Pro: 11/2/2020

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Explanation

▭ Parcel

S:\PROJECTS\DB19.1395_LOVINGTON_66\GIS\MXDS\PUBLIC_NOTICE_PARCEL_MAP.MXD

Daniel B. Stephens & Associates, Inc.
8/27/2020
JN DB19.1395

LOVINGTON 66
424 SOUTH MAIN STREET
LOVINGTON, NEW MEXICO

Public Notice Parcel Map

Figure 1

Property number (from map)	Parcel Number	Physical Address (if available)	Legal Owner 1 (assessor records)	Owner Mailing address (assessor records)	Owner 2 or Alternate Contact Name	Owner 2/ Alternate mailing address	Notes or Comments
1	4000229010001	22 West Avenue D Lovington NM 88260	LeaCo Rural Telephone Coop	220 W. Broadway Hobbs, NM 88240	c/o Lisa Franklin Sales & Marketing Manager		
2	4000203790001	410 Main Street Lovington NM 88260	Pearson Oil Company	PO Box 5037 Granbury TX 76049	Kenny Fadke McDonald's Manager PO Box 5528 Hobbs NM 88241	Pearson Oil Company 717 W Sanger St. Hobbs, NM 88240	This property is the site. Land is owned by Pearson Oil, and occupied by a McDonald's under lease agreement. Send notice to all three addresses (two for Pearson, one to McDonalds manager).
3	4000208010001	19 West Avenue C Lovington NM 88260	McDonald's Real Estate Company	PO Box 5528 Hobbs NM 88241	Kim Pavlin Real Estate Portfolio Manager McDonald's U.S. Restaurant Development Long Beach Field Office	McDonald’s Real Estate Company Attn: US Legal – Site 30-0087 110 N Carpenter Street Chicago, IL 60607	This the McDonald's employee parking lot. Notice must go to McDonald's Real Estate Company. Email electronic copy of the notice to Kimberly Pavlin
4	4000256400001	503 Main St, Lovington, NM 88260	Allsup's #109	BOX 1907, Clovis, NM 88102	c/o Jeff Scarbrough		Allsups gas station
5	4000232120001	511 Main St, Lovington, NM 88260	Diana Hernandez	1911 N. Grayson St, Hobbs, NM 88240			Also mail to physical address
6	4000226460001	502 Love St, Lovington, NM 88260	Baptist Church Inc Love Street	PO Box 506 Lovington, NM 88260	c/o Matt Cunningham, Pastor Crosswinds Church		Also mail to physical address & electronic copy to church pastor
7	4000226620001	None listed	Baptist Church Inc Love Street (assessor lists church in Hobbs, see note)	PO Box 506 Lovington, NM 88260	c/o Matt Cunningham, Pastor Crosswinds Church		08/18/2020: Melissa Medina with Crosswinds in Hobbs advised that two weeks ago they signed over ownership of the property to the Lovington Church. Same ownership as Property#7
8	4000210910001	500 Main St, Lovington, NM 88260	Pearson Oil Company	PO Box 1288, Hobbs, NM 88241			
9	4000205350001	423 Main St, Lovington, NM 88260	Jace Reid	PO Box 1852 Lovington, NM 88260			Also mail to physical address
10	4000210530001	402 1st St, Lovington, NM 88260	Jerry Fuentes	705 S. Love St, Lovington, NM 88260			Also mail to physical address
11	4000208020001	None listed	Gerardo Fuentez	705 S. Love St, Lovington, NM 88260			
12	4000220530001	102 Ave D, Lovington, NM 88260	M & D Industries Corp	102 W Avenue D, Lovington, NM 88260			Also mail to physical address
13	4000253850001	115 Ave E, Lovington, NM 88260	Elsa Holguin	115 E Ave E, Lovington, NM 88260			Also mail to physical address
14	4000226670001	507 S. Love St, Lovington, NM 88260	Mr W Fireworks Inc	PO Box 114 Somerset TX, 78069			
15	4000261690001	515 Main St, Lovington, NM 88260	Lizardo Rudolfo	3705 Plains Hwy, Lovington, NM 88260			Also mail to physical address

Appendix J

Schedule for FRP Implementation

Lovington 66 Remedial Action Schedule

Task	Calendar Days	Start Date	End Date
Final FRP Submittal			8/28/2020
Address PSTB and Public Comments	60 days	8/28/2020	10/27/2020
FRP Approval	14 days	10/27/2020	11/10/2020
Work Plan for FRP Implementation	28 days	11/10/2020	11/17/2020
Work Plan Approval	90 days	11/17/2020	2/15/2021
Equipment Procurement	84 days	2/15/2021	5/10/2021
Horizontal Well Installation	21 days	4/5/2021	4/26/2021
Trenching/Piping	14 days	4/26/2021	5/10/2021
Equipment Installation	14 days	5/10/2021	5/24/2021
Startup	5 days	5/24/2021	5/29/2021
First Year System Operations	365 days	5/29/2021	5/29/2022