DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 377TH AIR BASE WING (AFMC)

Colonel Tom D. Miller
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Mr. Tom Blaine, Manager
Environmental Health Division Director
Environmental Health Division
New Mexico Environment Department (NMED)
1190 St. Francis Drive
Santa Fe, New Mexico 87502

Dear Mr. Blaine

Attached is the Soil-Vapor Extraction System Expansion Work Plan Part I: Candidate Well Identification and Pilot Testing for Bulk Fuels Facility Spill, Solid Waste Management Units ST-106 and SS111. This work plan details the requirements for pilot testing of candidate wells to collect the required data to inform the expansion of the Soil-Vapor Extraction Systems related to the Bulk Fuels Facility spill site.

If you have any questions or concerns about this letter or its attachment, please contact Mr. L. Wayne Bitner at (505) 853-3484 (Ludie@bitner@kirtland.af.mil) or Ms. Victoria R. Martinez at (505) 846-6362 (Victoria.martinez@kirtland.af.mil).

Sincerely

TOM D. MILLER, Colonel USAF
Commander

Attachment: Soil-Vapor Extraction System Expansion Work Plan Part I: Candidate Well Identification and Pilot Testing

cc:
NMED-HWB (Kieling, Cobrain, Moats, McDonald, Brandwein) w/attch
NMED-PSTB (Reuter) w/attch
EPA Region 6 (King) w/o attch
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OCTOBER 2013

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TOM D. MILLER, Colonel, USAF
Commander, 377th Air Base Wing

This document has been approved for public release.

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ALBUQUERQUE, NEW MEXICO

Soil Vapor Extraction System
Expansion Work Plan Part I:
Candidate Well Identification and Pilot Testing

Bulk Fuels Facility Spill
Solid Waste Management Units ST-106 and SS-111

October 2013

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KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO

SOIL-VAPOR EXTRACTION SYSTEM EXPANSION WORK PLAN
PART I:
CANDIDATE WELL IDENTIFICATION AND PILOT TESTING

BULK FUELS FACILITY SPILL
SOLID WASTE MANAGEMENT UNITS ST-106 AND SS-111
KIRTLAND AIR FORCE BASE, NEW MEXICO

October 2013

Prepared for
U.S. Army Corps of Engineers
Albuquerque District
Albuquerque, New Mexico 87109

USACE Contract No. W912DY-10-D-0014
Delivery Order 0002

Prepared by
Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)
6380 South Fiddler's Green Circle, Suite 300
Greenwood Village, Colorado 80111

NOTICE

This report was prepared for the U.S. Army Corps of Engineers by Shaw Environmental & Infrastructure, Inc. (a CB&I company) for the purpose of aiding in the implementation of a final remedial action plan under the U.S. Air Force Environmental Restoration Program. As the report relates to actual or possible releases of potentially hazardous substances, its release prior to a final decision on remedial action may be in the public's interest. The limited objectives of this report and the ongoing nature of the Environmental Restoration Program, along with the evolving knowledge of site conditions and chemical effects on the environment and health, must be considered when evaluating this report, since subsequent facts may become known which may make this report premature or inaccurate.

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13. ABSTRACT (Maximum 200 words)

This work plan details requirements for pilot testing of candidate to inform the future expansion of the SVE System at Solid Waste Management Units ST-106 and SS-111, Bulk Fuels Facility (BFF) Spill site, Kirtland Air Force Base (AFB), New Mexico. Two groups of wells will be evaluated during pilot testing. Thirteen wells outside of the zone of influence of the existing SVE wells will be evaluated to determine if they are suitable for expansion of the SVE zone of influence. The pilot test data will be evaluated to determine if these thirteen wells should be immediately tied in to the existing system or considered for inclusion in the design for additional SVE capacity. The second set of wells tested will include the two existing SVE wells (KAFB-106160 and KAFB-106161) and the three Pneulog® wells within the zone of influence of the existing SVE system. Pilot test data from these five wells will be evaluated to optimize the removal of benzene and ethylene dibromide (EDB) in soil-vapor within the zone of influence of the existing SVE system.

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I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

TOM D. MILLER, Colonel, USAF
Commander, 377th Air Base Wing

This document has been approved for public release.

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377th Air Base Wing Public Affairs

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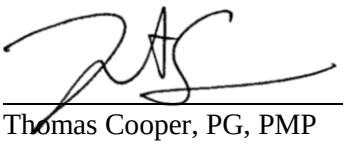
PREFACE

This Soil-Vapor Extraction System Expansion Work Plan Part I: Candidate Well Identification and Pilot Testing has been prepared by Shaw Environmental & Infrastructure, Inc. (Shaw), a CB&I company, for the U.S. Army Corps of Engineers (USACE), under Contract W912DY-10-D-0014, Delivery Order 0002. It pertains to the Kirtland Air Force Base Bulk Fuels Facility Spill, Solid Waste Management Units ST-106 and SS-111, located in Albuquerque, New Mexico. This report was prepared in accordance with all applicable federal, state, and local laws and regulations, including the New Mexico Hazardous Waste Act, New Mexico Statutes Annotated 1978, New Mexico Hazardous Waste Management Regulations, Resource Conservation and Recovery Act, and regulatory correspondence between the New Mexico Environment Department Hazardous Waste Bureau and the U.S. Air Force, dated April 2, June 4, August 6, and December 10, 2010.

This work will be performed under the authority of USACE Contract No. W912DY-10-D-0014, Delivery Order 0002. Mr. Walter Migdal is the USACE Albuquerque District Project Manager; Mr. Wayne Bitner, Jr. is the Kirtland Air Force Base Restoration Section Chief; and Mr. Thomas Cooper is the Shaw Project Manager. This report was prepared by Diane Agnew.



Thomas Cooper, PG, PMP
Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)
Project Manager

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ACRONYMS AND ABBREVIATIONS

%	percent
µg/L	microgram(s) per liter
AFB	Air Force Base
BFF	Bulk Fuels Facility
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
CATOX	catalytic oxidizer
CO	carbon monoxide
CO_2	carbon dioxide
CY	calendar year
EDB	ethylene dibromide
EPA	U.S. Environmental Protection Agency
ft	feet/foot
H_2S	hydrogen sulfide
HDPE	high-density polyethylene
L	liter(s)
LEL	lower explosive limit
O_2	oxygen
ppmv	parts per million by volume
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
SCFM	standard cubic feet per minute
Shaw	Shaw Environmental & Infrastructure, Inc., a CB&I company
SVE	soil-vapor extraction
SVM	soil-vapor monitoring
THC	total hydrocarbons
USACE	U.S. Army Corps of Engineers
VFD	variable frequency drive
VOC	volatile organic compound

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EXECUTIVE SUMMARY

Shaw Environmental & Infrastructure, Inc. (Shaw), a CB&I company, prepared this work plan detailing requirements for pilot testing of candidate wells to collect the required data to design the expansion of the Soil-Vapor Extraction (SVE) System at Solid Waste Management Units ST-106 and SS-111, Bulk Fuels Facility Spill site, Kirtland Air Force Base, New Mexico. Two groups of wells will be evaluated during pilot testing. Thirteen wells outside of the zone of influence of the existing SVE wells will be evaluated to determine if they are suitable for expansion of the SVE zone of influence when additional SVE equipment is installed at the BFF Site. The pilot test data will be evaluated to determine if these thirteen wells should be immediately tied in to the existing system or considered for inclusion in the design for additional SVE capacity. The second set of wells tested will include the two existing SVE wells (KAFB-106160 and KAFB-106161) and the three Pneulog® wells within the zone of influence of the existing SVE system. Pilot test data from these five wells will be evaluated to optimize the removal of benzene and ethylene dibromide (EDB) in soil-vapor within the zone of influence of the existing SVE system.

Additionally this work plan outlines requirements for both one-hour quick tests, and longer duration tests. For the majority of the wells, testing will be conducted using a mobile pilot testing unit; however, two Pneulog® wells KAFB-106149 and KAFB-106154 will be connected directly to the existing SVE pipeline. Although not candidates for pilot testing, SVE wells SVEW-01, SVEW-02, SVEW-03, SVEW-04, SVEW-05, SVEW-06, SVEW-07, SVEW-08, and SVEW-09 will also be connected directly to the existing SVE pipeline.

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1. INTRODUCTION

The Bulk Fuels Facility (BFF) Spill site is located within the western portion of Kirtland Air Force Base (KAFB), New Mexico and is comprised of two Solid Waste Management Units, designated as ST-106 and SS-111. The component of the BFF Spill project related to investigation and remediation of the vadose zone near the Former Fuel Off-Loading Rack is designated as ST-106. The phase-separated, hydrocarbon-impacted groundwater component of the project is designated as SS-111.

This work plan outlines Part I of the planned expansion to the existing soil-vapor extraction (SVE) system in place as an interim measure at Solid Waste Management Units ST-106 and SS-111, BFF Spill site, Kirtland AFB, New Mexico (U.S. Environmental Protection Agency [EPA] Identification Number NM9570024423/ HWB-KAFB-10-004). This initial Part I work plan outlines pilot testing of thirteen identified candidate wells to determine the optimal conditions for adding them to the system.

1.1 Current SVE System Overview

A full description of the existing SVE system, including an operations and maintenance manual, can be found in the Phase II Remediation Interim Measures Plan (USACE, 2013). The SVE system includes two SVE wells (KAFB-106160 and KAFB-106161), an aboveground piping manifold that transports the vapors to a blower skid, and a catalytic oxidation unit to destroy the hydrocarbon vapors in the extracted well gas. The SVE system is designed to extract up to 1,600 standard cubic feet (ft) per minute (SCFM) of air, containing up to 3,450 parts per million by volume (ppmv) total hydrocarbons (THC) from the two SVE wells (KAFB-106160 and KAFB-106161), which results in removal of over 2,200 pounds of hydrocarbons per day. In addition to the 1,600 SCFM of well gas and dilution air from the well field, the unit also draws in another 900 SCFM of dilution air at the inlet of the catalytic oxidizer (CATOX), for a total of up to 2,500 SCFM of air flow through the unit.

The SVE blower skid includes a knock-out pot for removing and collecting entrained non-aqueous phase liquid, condensate, and a positive displacement blower fitted with silencers and inlet filters. The blower is enclosed in noise-reduction housing and fitted with a variable frequency drive (VFD) that can be used to adjust blower speed. The blower is designed to operate at a wide range of inlet vacuum and air flow rates. The blower motor horsepower and VFD drive speed allow the blower to operate at start-up conditions (approximately 1,600 SCFM and 40 inches of water vacuum) and later in the remediation when it may be necessary to apply high vacuum to the wells (1,000 SCFM and 11 inches of mercury vacuum).

The CATOX is a natural gas-fired unit designed for 98 percent destruction of hydrocarbons. The catalyst block is a Johnson Mathey volatile organic compound (VOC) oxidation catalyst, CONCAT #91447, which is a platinum group metal catalyst. The CATOX includes an inlet system fan burner and burner control systems, a catalyst bed, a heat-recovery exchanger, and an exhaust stack.

Construction of the new SVE treatment system was started in October 2012 and was completed on January 21, 2013. SVE system startup and radius of influence testing were completed and full operation started on March 15, 2013. Beginning on May 6, 2013, flow rate, vacuum pressure, and THC were measured at the two SVE wells two to three times per week while the SVE system was running. Beginning on April 2, 2013, flow rate, vacuum pressure, and THC were measured at the CATOX unit at least four times per week while the SVE system was running. Figure 1-1 shows the flow rate and vacuum pressure measurements at all locations, and Figure 1-2 shows the THC at all locations, along with concentrations of oxygen (O_2) and carbon dioxide (CO_2).

1.2 Existing SVE Well Construction

The existing SVE system configuration operates on the two previously installed wells, KAFB-106160 and KAFB-106161, as shown in Figure 1-3, which also illustrates all soil vapor wells used for quarterly soil vapor monitoring sampling. Well Construction Diagrams for the two wells are presented in Appendix A.

The well casing is 6-inch, stainless steel with stainless steel centralizers. The well screen is 6-inch, 0.050-slot wire-wrapped stainless steel set in a 50-ft section and a 40-ft section separated by 10 ft of casing. From the bottom of the 40-ft section of the 6-inch, 0.050-slot screen, a 6-inch, 0.030-slot wire-wrapped stainless steel screen is continued to 525 ft below ground surface (bgs). The bottom of the sump is set at 530 ft bgs and is 5 ft in length. The soil vapor extraction well design was constructed for multi-purpose applications and, as such, was screened across the water table to provide an option to adapt the well for future groundwater extraction, if required.

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2. CANDIDATE WELL IDENTIFICATION AND TESTING

2.1 Candidate Well Description

Two groups of wells will be evaluated during pilot testing. Thirteen wells outside of the zone of influence of the existing SVE wells will be evaluated to determine if they are suitable for expansion of the SVE system, when new SVE treatment equipment is installed. In addition, five additional wells will be evaluated to optimize SVE within the zone of influence of the current system.

The initial thirteen wells will be pilot tested to determine if they should be immediately tied in to the existing system, or considered for inclusion in the design for additional SVE capacity. One hour quick-tests will be performed at these thirteen wells. Based on the results of the quick tests, at least two wells will undergo long duration testing. The locations of these thirteen wells in relation to the zone of influence of the current SVE system, and the benzene, toluene, ethylbenzene, and xylene (BTEX) vapor plumes at 250, 350, and 450 ft bgs respectively, are illustrated in Figures 2-1, 2-2, and 2-3.

The second set of wells tested will include the two existing SVE wells (KAFB-106160 and KAFB-106161) and the three Pneulog® wells within the zone of influence of the existing SVE system. Quick tests and long duration tests both will be performed at the three Pneulog® wells. Separate optimization tests will be performed at KAFB-106160 and KAFB-106161. Pilot test data from these five wells will be evaluated to optimize the removal of benzene and ethylene dibromide (EDB) in soil-vapor within the zone of influence of the existing SVE system.

2.1.1 Selected Candidate Wells for Expansion of the SVE Zone of Influence

This work plan offers a final list of thirteen candidate wells for quick testing and further long duration testing, which includes seven SVE monitoring wells (KAFB-10628, KAFB-106113, KAFB-106119, KAFB-106129, KAFB-106130, KAFB-106131, and KAFB-106142) a single SVE well (SVEW-11),

and five Pneulog® wells (KAFB-106148, KAFB-106152, KAFB-106153, KAFB-106155, and KAFB-106156), as shown in Figure 1-1. The locations of these wells in relation to the zone of influence of KAFB-106160 and KAFB-106161, and BTEX vapor plume at 250, 350, and 450 ft bgs respectively, are shown in Figures 2-1 through 2-3. Rationale for this revised list is explained in the following paragraphs.

The SVE monitoring wells identified as pilot testing candidates include five monitoring well clusters: KAFB-106113, KAFB-106119, KAFB-106129, KAFB-106130, and KAFB-106131. These well clusters each consist of six separate wells at approximate depths of 450, 350, 250, 150, 50 and 25 ft bgs in a single borehole. The 450 ft well is constructed using 3-inch, schedule 80 polyvinyl chloride (PVC) with a 10-ft, 0.050 slot screen. The remaining five wells in each borehole are constructed using ¾-inch, schedule 80 PVC with a 10-ft, 0.050 slot screen (construction diagrams of all candidate wells can be found in Appendix B). Only the 3-inch diameter wells will be used for pilot testing, as the wells constructed with ¾-inch diameter PVC are too small in diameter to provide adequate airflow for pilot testing.

Wells KAFB-106142 and KAFB-10628, located in Bullhead Memorial Park, will also be included in pilot testing. These wells will be quick tested. The results of the quick tests will determine whether long duration testing will be performed at these wells. Analysis of the soil-vapor data from these two wells shows significant levels of benzene (19,000 micrograms per liter [µg/L] at 450 ft bgs at KAFB-10628, and 18,000 µg/L at 450 ft bgs at KAFB-106142 during First Quarter Calendar Year [CY] 2013). Additionally, groundwater samples collected near these wells demonstrate elevated EDB concentrations at a maximum of 71 µg/L at KAFB-10628-510 during First Quarter CY 2013. Pilot testing at KAFB-106142 and KAFB-10628 will evaluate the efficacy of possible future passive soil venting systems, or small dedicated SVE systems at these wells.

Although SVE monitoring well KAFB-106111 was originally considered for pilot testing, it will not be included in pilot test testing. KAFB-106111 is in close proximity to Pneulog® well KAFB-106156 which will be a much better candidate for inclusion in the extraction system because it has a total of over 300 ft of screen that is comprised of three wells with over 100 ft of screen, the lowest of which is located in the most contaminated zone of 350-450 ft and.

The Pneulog® wells proposed for pilot testing include wells KAFB-106148, KAFB-106152, KAFB-106153, KAFB-106155, and KAFB-106156. Each Pneulog® well consists of three nested wells screened roughly between 25 to 195 ft, 200 ft to 350 ft, and 350 ft to 485 ft bgs (Appendix B). Prior to pilot testing, the results of the Second Quarter 2013 soil-vapor sampling will be reviewed at each of the selected Pneulog® locations. Based on this data, the screen interval with the highest benzene and total VOC concentrations will be selected for pilot testing.

2.1.2 Selected Candidate Wells for Optimization of the Current Zone of Influence

In addition to performing pilot testing to expand the zone of influence (quick tests followed by long duration tests in a few selected wells), pilot testing will also be performed to optimize the SVE design within the zone of influence of current operations (quick tests, followed by long duration tests at three of the five wells, and long duration tests at KAFB-106160 and KAFB-106161). In addition to the two existing SVE wells, KAFB-106160 and KAFB-106161, three Pneulog® wells will be pilot tested for optimization of benzene and EDB removal in the zone of influence of the existing SVE system.

Soil-vapor data from First Quarter CY 2013 show that KAFB-106160 has higher concentrations of both benzene and EDB than KAFB-106161. First Quarter CY 2013 soil-vapor data show benzene concentrations in the SVE wells have decreased in comparison to surrounding monitoring wells. This indicates that the operation of the SVE system at wells KAFB-106160 and KAFB-106161 has resulted in depletion of benzene from soil in the surrounding vadose zone. As contaminant concentrations shift in

these wells due to successful operation of the SVE system, additional pilot testing will ensure SVE operations remain optimal. Testing conducted at KAFB-106160 and KAFB-106161 will determine the effect of increased vacuum at each well on soil-vapor flow rates. Sampling during the testing will show the effect of increased extraction rate on the concentration of benzene and EDB in the extracted soil gas. This testing will be done as part of the long duration testing (Section 2.2.2) and will provide data not only for optimization of the current system, but design data for expanded systems that may include installation of additional SVE wells.

Additionally, Pneulog® wells KAFB-106149, KAFB-106150, and KAFB-106154 will be included in pilot testing to determine which wells can consistently yield the highest concentrations of benzene and EDB. This determination will further optimize existing SVE operations.

2.2 Pilot Testing Requirements

For the majority of the wells, testing will be conducted using a mobile pilot testing unit rated for flow rates between 100 and 150 SCFM, capable of pulling vacuums up to 200 inches of water. The pilot testing unit will be equipped with an air/moisture separator, flow meters, vacuum/pressure gauges, in situ data logger, and will include a thermal oxidizer to treat soil-vapor to ensure compliance with the Albuquerque Environmental Health Department air quality standards. This unit will be used for both the quick tests and the long duration runs.

Pneulog® wells KAFB-106149, and KAFB-106154 are in close proximity to the existing SVE pipeline. These wells will be connected directly to the existing system and will be tested using the existing system. These two wells will be pilot tested with initial quick tests followed by long duration tests. These Pneulog® wells will be tested at the screened interval where benzene concentrations are expected to be the highest.

2.2.1 One Hour Quick Tests

Quick tests will be conducted to select the wells used for long duration tests, and to estimate the flow rates used in the long duration tests. Quick tests will be conducted at the thirteen wells KAFB-10628, KAFB-106113, KAFB-106119, KAFB-106129, KAFB-106130, KAFB-106131, and KAFB-106142, SVEW-11, KAFB-106148, KAFB-106152, KAFB-106153, KAFB-106155, and KAFB-106156 , and the three additional wells KAFB-106149, KAFB-106150, and KAFB-106154. Prior to beginning the quick tests, the SVE system will be shut down for one week to allow the vadose zone to equilibrate.

Quick test wells will be connected to either the mobile SVE unit or the existing SVE pipeline. The quick tests will be conducted as a step test with three levels of applied vacuum. Applied vacuum will start low and be increased to the highest practicable vacuum and extraction rate. This maximum vacuum will be dependent upon the flow rate versus vacuum capacity curve for the selected portable SVE system and the local permeability of the formation. For the Pnuelog® wells and other wells with substantial screen length, maximum vacuum is expected to be around 40 to 60 inches of water. The SVE monitoring wells with 10 ft of screen will probably have maximum vacuum exceeding 100 inches of water. This vacuum step testing will provide data on extraction rate versus applied vacuum on all wells. The following parameters will be measured on the test well every 10 minutes for the duration of the test:

- Flow Rate
- Vacuum
- Soil-vapor temperature and humidity
- THCs, fixed gases (CO_2, carbon monoxide [CO], O_2, hydrogen sulfide [H_2S]), and lower explosive limit (LEL)

Vapor samples will be collected as described in Section 2.2.3. None of the candidate wells are screened below the water table, consequently water and product levels will not be taken.

Two observation wells will be selected for each short-duration test. These will be the nearest soil-vapor monitoring (SVM) well to the extraction well, and one well at least 500 ft from the extraction well to be used as a background monitoring well (Section 2.2.4). Vacuum pressure at the observation wells will be measured prior to the start of the quick tests, 30 minutes into the test, and immediately before the test ends.

Measurements collected taken at the test well and at the observation wells will be recorded on the field forms located in Appendix C. Barometric pressure is recorded hourly at the Albuquerque Sunport, and will be downloaded for the time period over which quick tests are conducted. The Albuquerque Sunport is adjacent to Kirtland AFB.

2.2.2 Long Duration Tests

Of the thirteen candidate wells on which quick tests are performed, at least two will be selected for long duration (8-10 hour) tests. Additionally, long duration tests will be conducted at the five wells KAFB-106149, KAFB-106150,KAFB-106154 KAFB-106160, and KAFB-106161,. The following criteria will be used in selecting long duration test wells:

- Wells should be screened in areas of high concentrations of benzene or EDB.
- Wells should be capable of producing a high flow rate, at least 100 SCFM, as determined by the quick tests.

Long duration tests will last for 8 to 10 hours. The vacuum applied to each test well will remain constant for the duration of the test, and will be determined using the data obtained during the quick tests. The following parameters will be measured every 30 minutes for the duration of the test:

- Test well flow rate
- Test well vacuum
- Test well soil-vapor temperature and humidity

- Test well THCs, fixed gases (CO_2, CO, O_2, H_2S), and LEL
- Observation well vacuum

Vapor samples will be collected as described in Section 2.2.3. Barometric pressure is recorded hourly at the Albuquerque Sunport, and will be downloaded for the time period over which the long duration tests are conducted. The Albuquerque Sunport is adjacent to Kirtland AFB.

Section 2.2.4 describes the criteria for the selection of observation wells for the long duration tests. Table 2-1 identifies the wells for long duration testing, and their associated observation wells. Table 2-1 does not include the wells that will be selected for long duration testing based on the results of the quick tests. Measurements collected taken at the test well and at the observation wells will be recorded on the field forms located in Appendix C.

Results of the long duration tests will be used to determine if the test wells should be included in the SVE system expansion.

2.2.3 Analytical Sampling Methodology

During the Fourth Quarter CY 2013 vapor sampling event, 35 soil-vapor well locations will be sampled for EDB in conjunction with quarterly soil vapor sampling. The well locations of these samples are identified in Table 2-2. Soil-vapor hydrocarbon concentration (ppmv), O_2 percent (%), CO%, CO_2%, and pressure will be measured in the field at time of collection using a Horiba Model MEXA 584 L portable auto emissions analyzer, which can measure from 0 to 10,000 parts per million of THC. The 35 soil-vapor locations will then be collected using 1 liter (L) or 6L Summa canisters through sampling ports installed at the top of each individual well casing. All soil-vapor samples will be collected in accordance with the Vadose Zone Investigation Work Plan procedures (USACE, 2011a) and Kirtland AFB BFF Spill Quality Assurance Project Plan (QAPP) requirements (USACE, 2011b).

No samples for laboratory analysis will be collected during the one hour quick tests as the short time-span makes collection of samples a logistical impossibility. Additionally, the equilibrium of the soil-vapor will not be altered enough to be visible over the time-span of a quick test. Shaw will use the available quarterly vapor monitoring data to help determine the wells chosen for the long duration tests.

The five to six candidate wells that are chosen for long duration tests and the two existing extraction wells (KAFB-106160 and KAFB-106161) will be sampled 30 minutes into each test and at the end of each test for VOCs, BTEX, and EDB. The samples will be collected using 1L or 6L Summa canisters through sampling ports installed at the top of each individual well casing. Soil-vapor samples will be shipped to ALS Laboratories in Simi Valley, California, for the following list of analytical parameters:

- VOCs by EPA Method TO-15 (EPA, 1999)
- EDB by California Air Resources Board Method 422 (California Air Resources Board, 1987)

Field QC samples will be collected in accordance with the BFF Spill QAPP (USACE, 2011b) and include field duplicate samples for VOCs. Soil-vapor analytical data will be validated for precision, accuracy, representativeness, comparability, and completeness in accordance with the BFF Spill QAPP (USACE, 2011b), and appropriate data qualifiers are appended to the analytical data in the project database.

Data will be initially reported in a preliminary technical memorandum, which will summarize the data and propose a plan for SVE expansion at the site. A comprehensive report of laboratory analytical data will be reported in the Fourth Quarter CY 2013 quarterly report and the pilot test report. Both reports will include field data sheets, laboratory reports, and the following graphs:

- Field data sheets
- Laboratory reports
- Barometric pressure versus time
- Absolute pressure (barometric pressure adjusted for site elevation) versus time
- Influent soil-vapor temperature versus time

- Ambient air temperature versus time
- Test well flow rates versus time
- Test wellhead vacuum versus time
- Observed vacuum versus distance from the SVE well for estimating the radius of influence
- Hydrocarbon vapor concentrations versus time
- CO_2 versus time
- CO versus time
- O_2 versus time
- Summary data tables corresponding to each graph

2.2.4 Identification of Observation Wells

Observation wells will be used during pilot testing. Barometric pressure changes at the site have a strong impact on vacuum pressure at observation wells, which can drown out the effect of SVE on a single well. It is therefore necessary to have a sufficient network of observation wells. During long duration tests, vacuum pressures will be monitored in the observation wells prior to the start of the test, thirty minutes into the test, and just prior to the end of the test. Table 2-1 identifies observation wells chosen for the long duration tests. The following criteria will be used when selecting observation wells:

- All observation well clusters will have screens at the same intervals. SVM wells with 10-ft screened intervals at 450, 350, 250, 150, 50, and 25 ft bgs are pervasive at the site; therefore, these are well-suited for use as observation wells.
- At least five observation wells will be selected for each long duration test. These will be the five wells nearest to the test well with screened intervals as described above.
- One observation well will be selected for each quick test. This will be the nearest well to the test well with the screened intervals as described above.
- One background monitoring well should be selected for each test. This well will have the same screened intervals as described above, and be at least 500 ft away from the test well. Vacuums observed in the five observation wells will be compared to vacuums observed in the background monitoring well.

2.3 Identification of Candidate Wells for Immediate Addition to the System

As shown on Figure 2-5, benzene concentrations at soil-vapor monitoring wells in the zone of influence of the existing SVE wells have decreased significantly from Fourth Quarter CY 2012 to First Quarter CY 2013. Benzene concentrations in many of the soil-vapor wells have decreased to the point where it is

likely that total benzene removal may be increased by shutting down the existing SVE wells to allow concentrations in the current zone of influence to rebound while connecting new wells to the SVE system. Several existing SVE and Pneulog® wells, which are close to the existing SVE pipeline, will be included in the pilot testing.

These data on air flow and soil vapor concentrations of benzene and EDB from testing these wells, along with operating data from the current system, will be used to develop an optimized SVE scenario. Any wells added to the system would be selected to pull air from soil where benzene and EDB concentrations are expected to be high compared to other wells. Extracting soil vapor from the additional wells will mean that flow from the operational SVE wells KAFB-106160 and KAFB-106161 will have to be reduced so that the total air flow and hydrocarbon load match the capacity of the existing CATOX unit. The ability to switch extraction between multiple wells will enable a cyclic removal of contaminants from a larger aerial extent of the vadose zone than what is currently possible with the established SVE configuration, and will allow for optimized extraction of contaminants until such time as additional treatment capacity is added. Once additional treatment capacity has been installed in the form of an additional treatment system, the sustained subsurface zone of influence will be expanded.

Based on the results of the June soil vapor sampling, as shown of Figures 2-2, 2-3, and 2-4, it is very likely that the middle screened intervals of Pneulog® wells KAFB-106149, and KAFB-106154 will be connected directly to the existing SVE pipeline. For the pilot testing KAFB-106149 and KAFB-106154 will be connected directly to the pipeline. Connecting these two wells can be accomplished with no road crossings, and within the proposed schedule. KAFB-106150 will be tested using the portable SVE system.

Although not candidates for pilot testing, nine SVE wells (SVEW-01, SVEW-02, SVEW-03, SVEW-04, SVEW-05, SVEW-06, SVEW-07, SVEW-08, and SVEW-09) are in areas of high benzene concentrations and will also be connected directly to the existing SVE pipeline. These wells were selected based on their

proximity to areas where Second Quarter CY 2012 benzene plume footprints show higher concentrations. Additionally, these wells also have sufficient screened interval to produce substantial soil-vapor flow. Moreover, five wells (SVEW-01, SVEW-02, SVEW-03, SVEW-06, and SVEW-07) are suitably positioned to address perched soil vapor contamination because they are shallow wells.

2.3.1 Pipeline Design and Construction

The SVE well vapor collection piping system includes temporary high-density polyethylene (HDPE) well piping that will connect the existing extraction and treatment equipment to the selected Pneulog® wells (KAFB-106149, and KAFB-106154) and from the existing piping manifold that links the SVE wells in near the former loading rack (SVEW-01 to -09). Following pilot testing, if it its determined that permanent piping is necessary, Shaw will submit engineering drawings that have been stamped by a professional engineer certified in the State of New Mexico. All piping and fittings will be constructed of HDPE with the exception of the well-head assembly, which is PVC. The newly selected wells and SVE manifold will be connected to the SVE treatment system through 6-inch HDPE pipes to each well and the manifold with the collection header being 8- to 10-inch HDPE. Calculations will confirm the pressure drop and pipe sizes based on the anticipated maximum recovery rates from each well. Pressure drop calculations and a description are located in Appendix D. Wells located relatively close to the SVE treatment system will be piped directly to the system while wells located some distance away will utilize existing piping where possible to avoid additional road crossings. For example, KAFB-106149 may be plumbed into the existing piping to KAFB-106160. All other wells and the SVE manifold will be plumbed directly back to SVE treatment system with "home runs," which are dedicated lines that run directly from the pilot test wells to the SVE treatment system. This will allow for maximum flexibility when a future system is installed adjacent to the existing system. Each "homerun" can be plumbed with a block valve to each system. Well vapors can then be directed to a selected system based on vapor concentration, vacuum and flow rates.

The pipelines are installed aboveground with the exception of road crossings. The pipe is supported above grade by 4-inch by 4-inch by 24-inch pressure treated posts and will be held in place with a galvanized pipe strap. Supports are placed every 8 ft for 6-inch piping and every 10 ft for 8-inch piping. Expansion loops will be provided as needed, and the pipe will be anchored at select locations to control expansion and contraction of the HDPE pipe.

At road crossings the pipe drops into a trenched culvert where the pipe is transported under the roadway. The culvert is slightly sloped in the direction of the SVE system. After crossing the road and reaching the end of the culvert, the pipe is connected to a series of tees to bring the pipe above ground level and continue to the SVE system. The tee connections are designed with a sump to capture any condensate that may condense out of the vapor stream. One new road crossing is anticipated in the line that runs west from the SVE treatment system to the SVE manifold, where it will cross under Fuel Drive SE.

2.3.2 Wellhead Design and Construction

The well-head assembly is constructed of PVC, including the well-head fitting, well-head shut-off valve, well-head air dilution air intake and air dilution shut off valve, and the flex-tubing that connects the well head assembly to the HDPE. The well-head set-up also includes a sample port to collect vapor samples and measure flow rate, a gauge to measure the vacuum pressure at the well-head, and a filter/silencer to reduce noise and prevent sand and dust from entering the piping.

3. INTERPRETATION OF DATA TO INFORM SYSTEM EXPANSION

3.1 Reporting Requirements

Reporting must include descriptions of equipment, methods, and instruments used to conduct the tests, tables summarizing all data collected by category, all laboratory reports, and at a minimum, the following:

- Field data sheets
- Laboratory Reports
- Graphs of:
  - Barometric pressure versus time.
  - Absolute pressure (barometric pressure adjusted for site elevation) versus time.
  - Influent soil-vapor temperature versus time.
  - Ambient air temperature versus time.
  - Test well flow rates versus time.
  - Test wellhead vacuum versus time.
  - Hydrocarbon vapor concentrations versus time.
  - CO_2 versus time.
  - CO versus time.
  - O_2 versus time.
  - Groundwater upwelling versus time.
  - Observed well vacuums at each observation wells versus time for each pilot test.
  - Vacuum in inches of water versus distance from the test well plotted on semi-log paper to estimate the vacuum radius of influence on the long duration pilot tests.
  - Cumulative mass of hydrocarbons removed versus time for long duration pilot tests.
  - Mass removal rate of total petroleum hydrocarbons calculation.

In addition to reporting in the 4th Quarter CY 2013 report as stated in section, the initial data from the results of the pilot testing and the tying in of wells will be reported in a preliminary technical memorandum within 45 days of completion of the final test. This preliminary memo will outline the findings of the test analysis and propose a plan for expansion of SVE remediation at the site.

4. SCHEDULE

Appendix E contains the project schedule for pilot testing and system design. The project schedule is specific to this phase of work and does not include contract milestones.

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REFERENCES

California Air Resources Board. 1987. Method 422, Determination of Volatile Organic Compounds in Emissions from Stationary Sources. January.

EPA. 1999. Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition. Compendium Method TO-15. Determination of Volatile Organic Compounds (VOCs) In Air Collected In Specially-Prepared Canisters and Analyzed By Gas Chromatography/ Mass Spectrometry (GC/MS). January.

USACE. 2013. *Phase II Remediation Interim Measures Work Plan, Bulk Fuels Facility (BFF) Spill, Solid Waste Management Units ST-106 and SS-111, Kirtland Air Force Base, Albuquerque, New Mexico.* Prepared by Shaw Environmental & Infrastructure, Inc. for the USACE Albuquerque District under USACE Contract No. W912DY-10-D-0014, Delivery Order 0002. August.

USACE. 2011a. *Vadose Zone Investigation Work Plan, Bulk Fuels Facility (BFF) Spill, Solid Waste Management Units ST-106 and SS-111, Kirtland Air Force Base, Albuquerque, New Mexico.* Prepared by Shaw Environmental & Infrastructure, Inc. for the USACE Albuquerque District under USACE Contract No. W912DY-10-D-0014, Delivery Order 0002. March.

USACE. 2011b. *Quality Assurance Project Plan, Bulk Fuels Facility (BFF) Spill, Solid Waste Management Units ST-106 and SS-111, Kirtland Air Force Base, Albuquerque, New Mexico.* Prepared by Shaw Environmental & Infrastructure, Inc. for the USACE Albuquerque District under USACE Contract No. W912DY-10-D-0014, Delivery Order 0002. April.

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FIGURES

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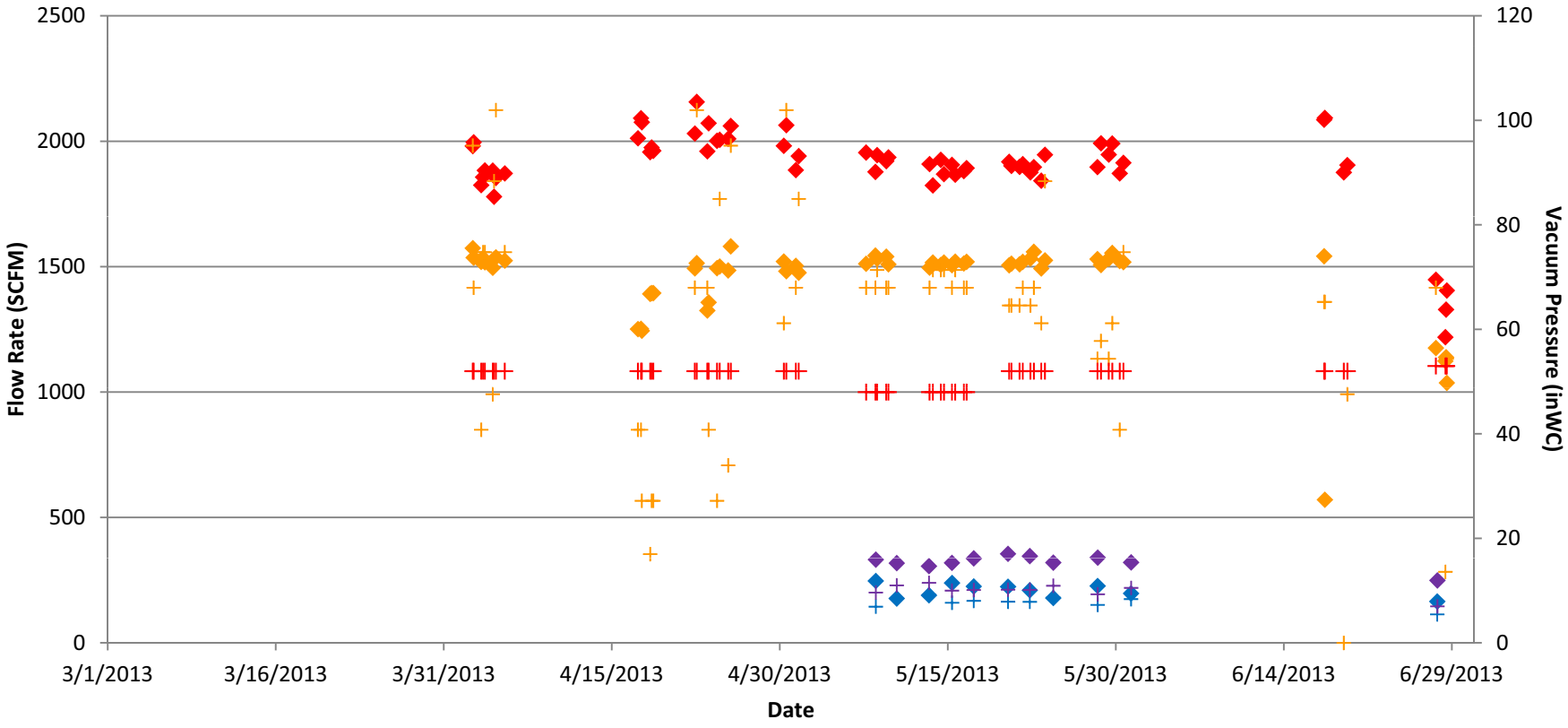
Figure 1-1. Vacuum Pressure and Flow Rates at the SVE Wellheads and CATOX Unit
Second Quarter CY 2013



- Flow Rate from KAFB-106160
- Flow Rate from KAFB-106161
- Flow Rate through the CATOX Unit
- Flow Rate at the SVE System, Prior to the Knock-Out Tank
- Vacuum Pressure at KAFB-106160
- Vacuum Pressure at KAFB-106161
- Vacuum Pressure at the SVE System, Prior to the Knock-Out Tank
- Vacuum Pressure at the CATOX Unit

CATOX = catalytic oxidation
CY = calendar year
inWC = inches of water column
KAFB = Kirtland Air Force Base
SVE = soil vapor extraction
SCFM = standard cubic feet per minute

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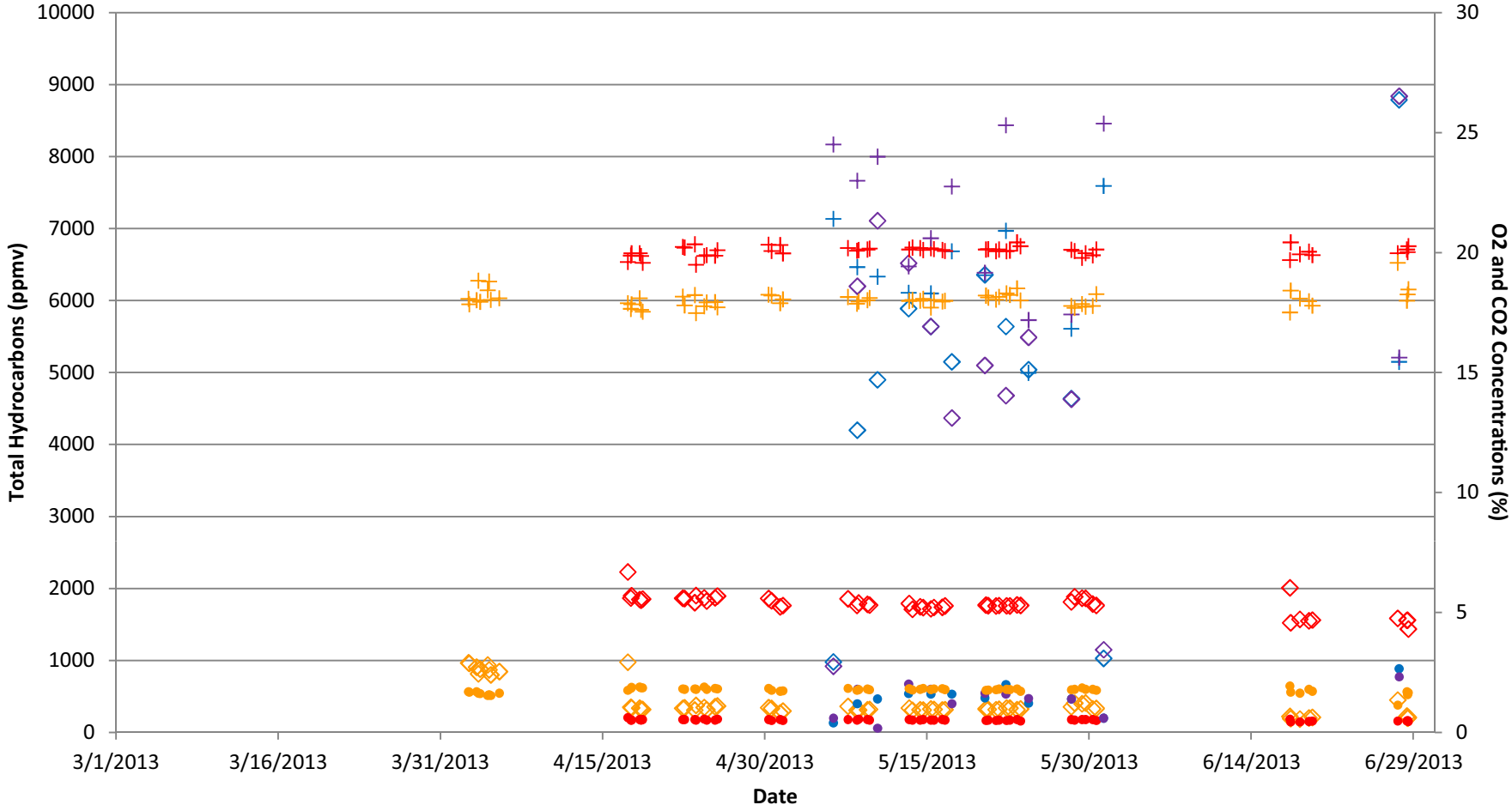
Figure 1-2. Vapor Concentrations Measured at the SVE Wellheads and CATOX Unit
Second Quarter CY 2013



- Total Hydrocarbons at KAFB-106160
- Total Hydrocarbons at KAFB-106161
- O2 Concentration at KAFB-106160
- O2 Concentration at KAFB-106161
- CO2 Concentration at KAFB-106160
- CO2 Concentration at KAFB-106161
- Total Hydrocarbons at the SVE system, prior to the CATOX unit
- Total Hydrocarbons at the SVE system, after the CATOX unit
- O2 Concentration at the SVE system, prior to the CATOX unit
- O2 Concentration at the SVE system, after the CATOX unit
- CO2 Concentration at the SVE system, prior to the CATOX unit
- CO2 Concentration at the SVE system, after the CATOX unit

SVE = Soil Vapor Extraction
CY = calendar year
CATOX = catalytic oxidation
KAFB = Kirtland Air Force Base
ppmv = parts per million by volume
% = percent

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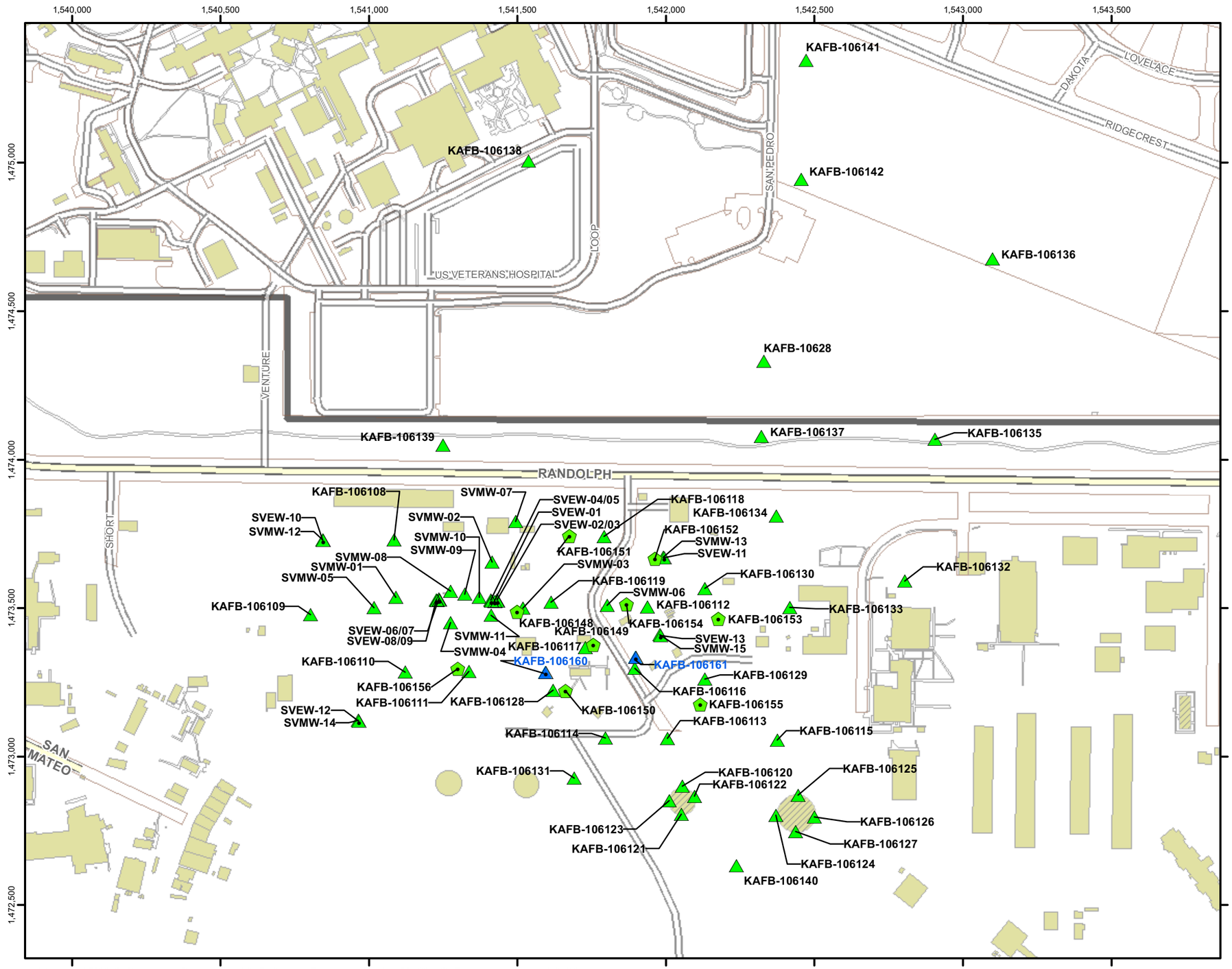
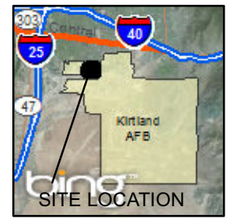


Legend

- Currently Operational SVE Extraction Well
- Pneulog Cluster
- SVE Extraction Well
- SVM Cluster
- Previously Existing Structure
- Existing Structure
- Installation Boundary
- Major Road
- Road



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Revision Date: 10/07/13

N

0 175 350 700

Feet

1 inch = 350 feet

Projection : NAD83 State Plane New Mexico Central FIPS3002 Feet

SVE SYSTEM EXPANSION PLAN
PART I: CANDIDATE WELL IDENTIFICATION AND PILOT TESTING
BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 1-3

SVE, SVM, AND PNEULOG WELL LOCATIONS

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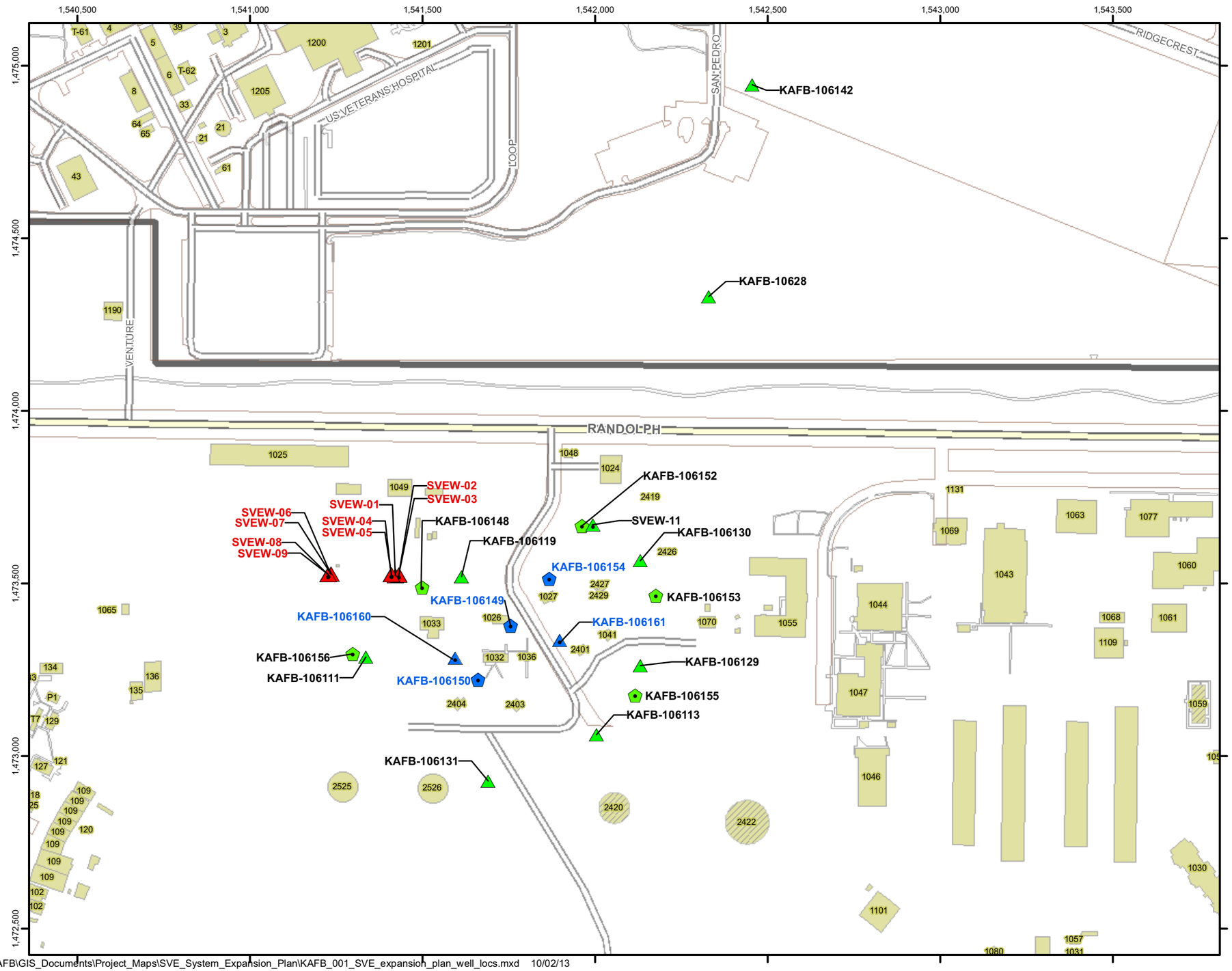
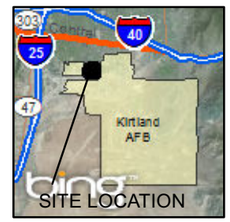


Legend

Candidate Wells for Optimization of SVE in Current Zone of Influence
- Pneulog Cluster
- SVE Extraction Well

Candidate Wells for Expansion of SVE Zone of Influence
- SVE Extraction Well
- SVM Cluster
- Pneulog Cluster

Additional Wells to be Connected Directly to the Existing System
- SVE Extraction Well
- Installation Boundary
- Existing Structure
- Previously Existing Structure
- Major Road
- Road



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Revision Date: 10/02/13

N

0 150 300 600

Feet

1 inch = 300 feet

Projection : NAD83 State Plane New Mexico Central FIPS3002 Feet

SVE SYSTEM EXPANSION PLAN
PART I: CANDIDATE WELL IDENTIFICATION AND PILOT TESTING
BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 2-1

CANDIDATE WELL LOCATIONS

H:\Kirtland_AFB\GIS_Documents\Project_Maps\SVE_System_Expansion_Plan\KAFB_001_SVE_expansion_plan_well_locs.mxd 10/02/13

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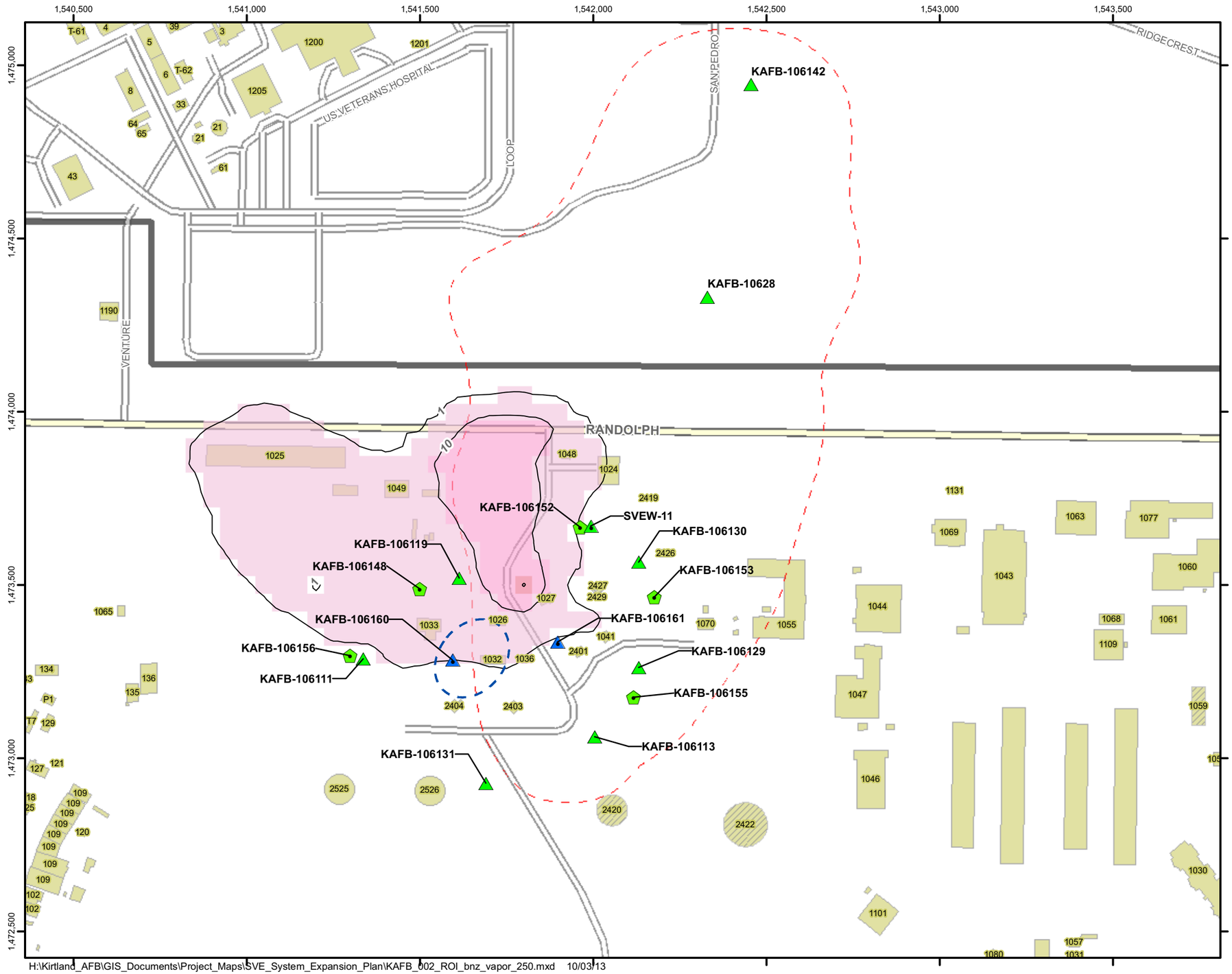


H:\Kirtland_AFB\GIS_Documents\Project_Maps\SVE_System_Expansion_Plan\KAFB_002_ROI_bnz_vapor_250.mxd 10/03/13

Legend

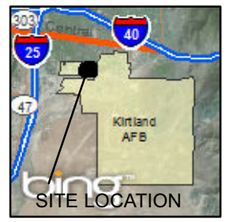
- SVE Extraction Well

Candidate Wells for Expansion of SVE Zone of Influence

- SVE Extraction Well
- SVM Cluster
- Pneulog Cluster
- Corrected Observed Vacuum (inWC) at Approximately 250' bgs
- (dashed where estimated)
- June 2013 Benzene Vapor Concentration Contours (ppmv) at Approximately 250' bgs

June 2013 Benzene Concentration (ppmv) at Approximately 250' bgs

- 0 - 1
- 2 - 10
- 11 - 100
- 101 -220
- Historical Area of Observed NAPL (July 2009)
- Major Road
- Road
- Previously Existing Structure
- Existing Structure
- Installation Boundary



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Revision Date: 10/03/13

N

0 150 300 600

Feet

1 inch = 300 feet

Projection : NAD83 State Plane New Mexico Central FIPS3002 Feet

SVE SYSTEM EXPANSION PLAN
PART I: CANDIDATE WELL IDENTIFICATION AND PILOT TESTING
BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 2-2

MEASURED RADIUS OF INFLUENCE OF KAFB-106160 AND KAFB-106161 AND BENZENE VAPOR PLUME AT 250 FT BGS

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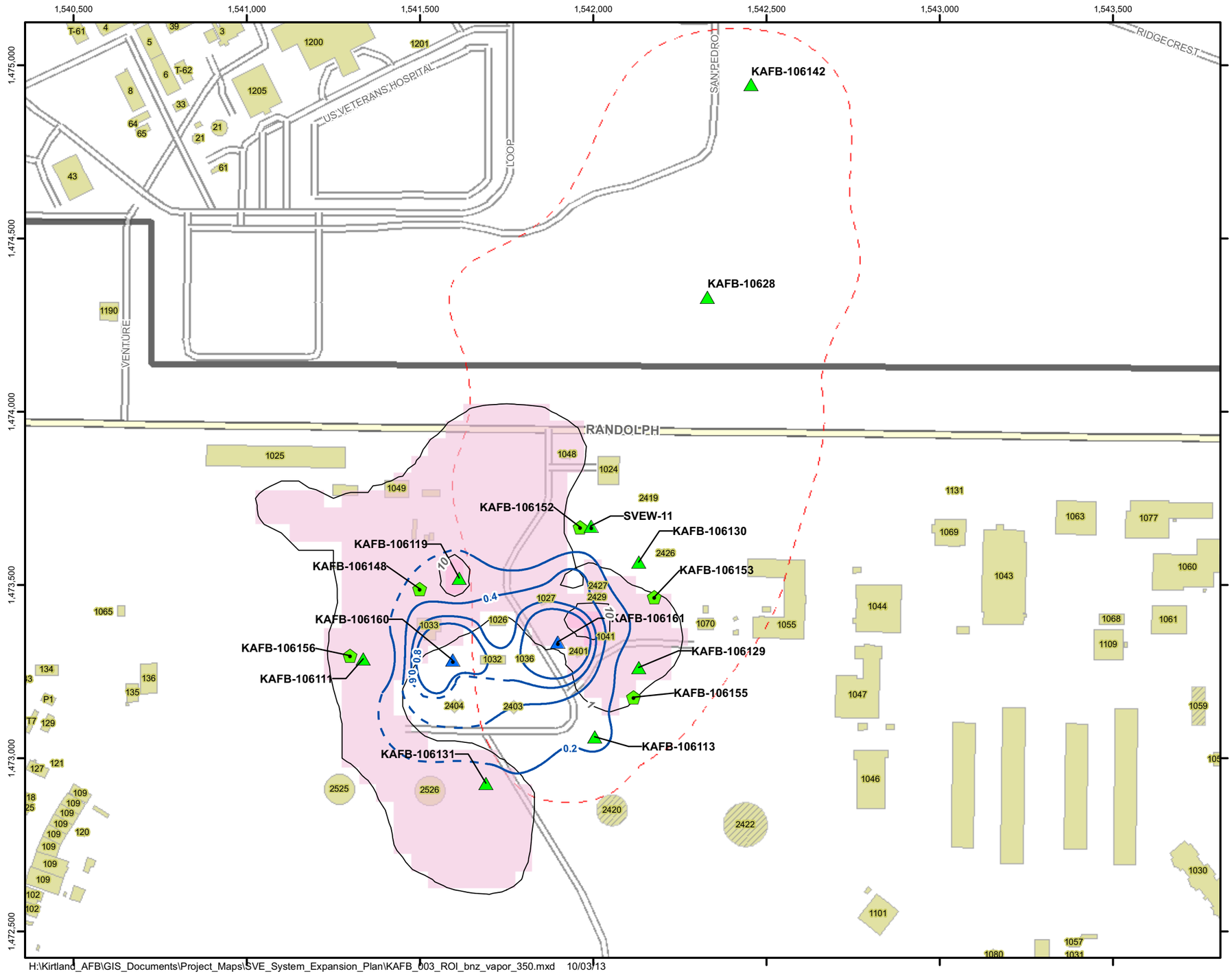

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Legend

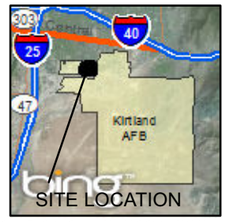
- SVE Extraction Well

Candidate Wells for Expansion of SVE Zone of Influence

- SVE Extraction Well
- SVM Cluster
- Pneulog Cluster
- Corrected Observed Vacuum (inWC) at Approximately 350' bgs
- (dashed where estimated)
- June 2013 Benzene Vapor Concentration Contours (ppmv) at Approximately 350' bgs

June 2013 Benzene Concentration (ppmv) at Approximately 350' bgs

- 0 - 1
- 2 - 10
- 11 - 100
- 101 -180
- Historical Area of Observed NAPL (July 2009)
- Major Road
- Road
- Previously Existing Structure
- Existing Structure
- Installation Boundary



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Revision Date: 10/03/13

N

0 150 300 600

Feet

1 inch = 300 feet

Projection : NAD83 State Plane New Mexico Central FIPS3002 Feet

SVE SYSTEM EXPANSION PLAN
PART I: CANDIDATE WELL IDENTIFICATION AND PILOT TESTING
BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 2-3

MEASURED RADIUS OF INFLUENCE OF KAFB-106160 AND KAFB-106161 AND BENZENE VAPOR PLUME AT 350 FT BGS

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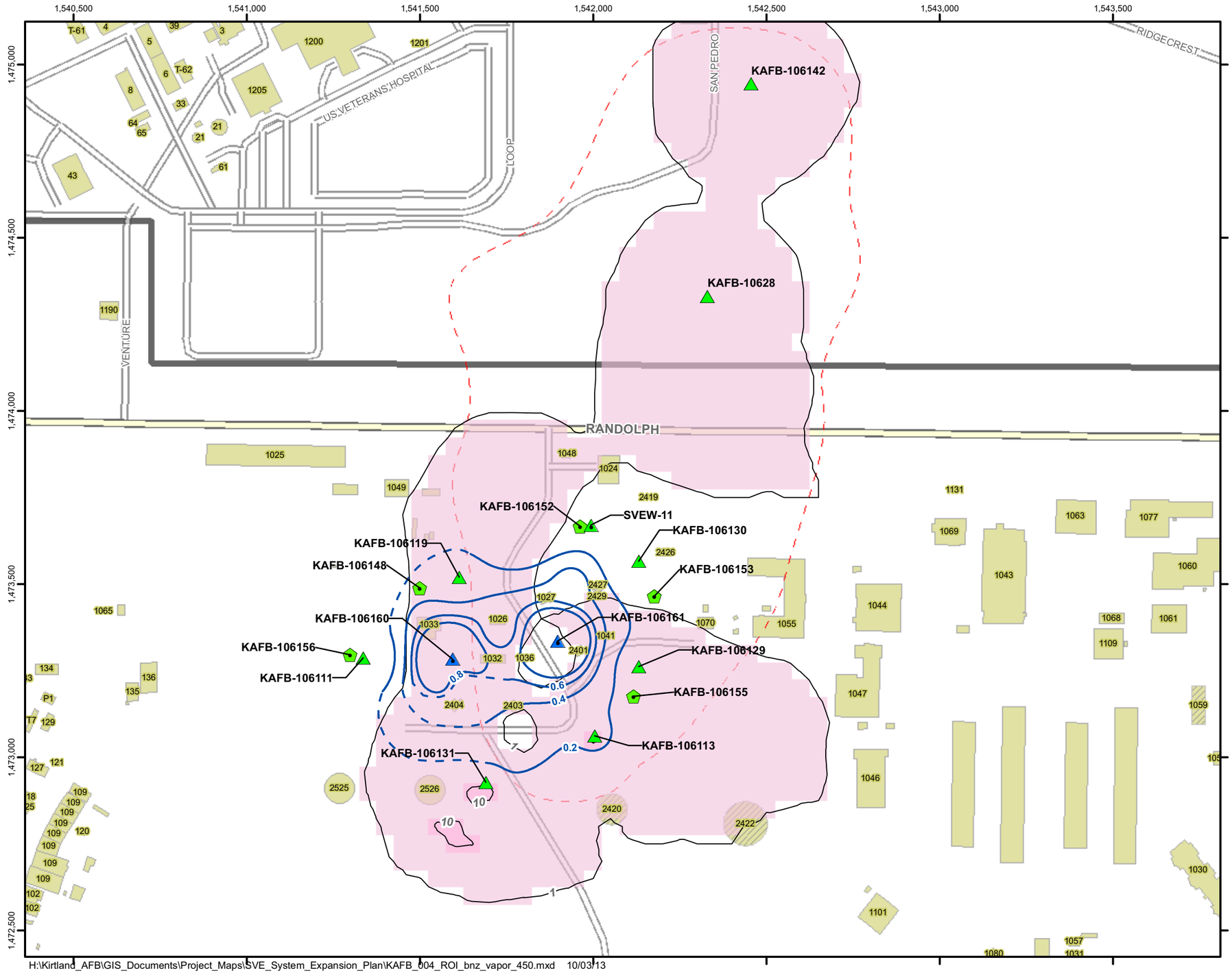

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Legend

- SVE Extraction Well

Candidate Wells for Expansion of SVE Zone of Influence

- SVE Extraction Well
- SVM Cluster
- Pneulog Cluster
- Corrected Observed Vacuum (inWC) at Approximately 450' bgs
- (dashed where estimated)
- June 2013 Benzene Vapor Concentration Contours (ppmv) at Approximately 350' bgs

June 2013 Benzene Concentration (ppmv) at Approximately 450' bgs

- 0 - 1
- 2 - 10
- 11 - 100
- 101 -290
- Historical Area of Observed NAPL (July 2009)
- Major Road
- Road
- Previously Existing Structure
- Existing Structure
- Installation Boundary

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Revision Date: 10/03/13

N

0 150 300 600

Feet

1 inch = 300 feet

Projection : NAD83 State Plane New Mexico Central FIPS3002 Feet

SVE SYSTEM EXPANSION PLAN
PART I: CANDIDATE WELL IDENTIFICATION AND PILOT TESTING
BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 2-4

MEASURED RADIUS OF INFLUENCE OF KAFB-106160 AND KAFB-106161 AND BENZENE VAPOR PLUME AT 450 FT BGS

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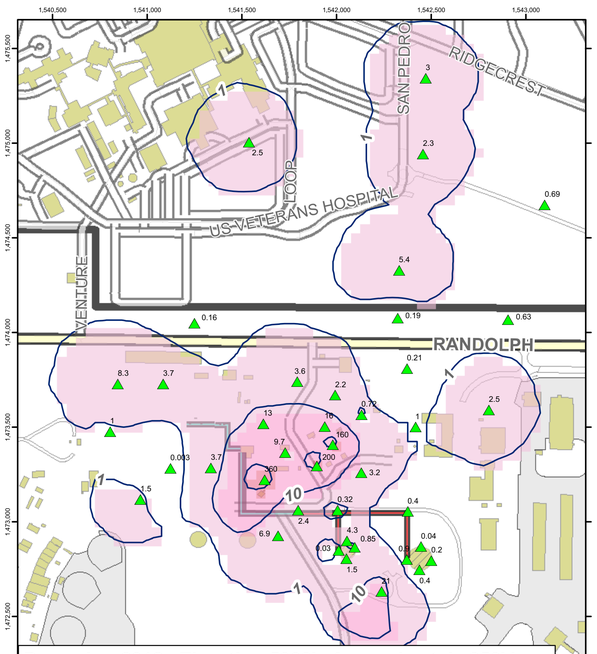
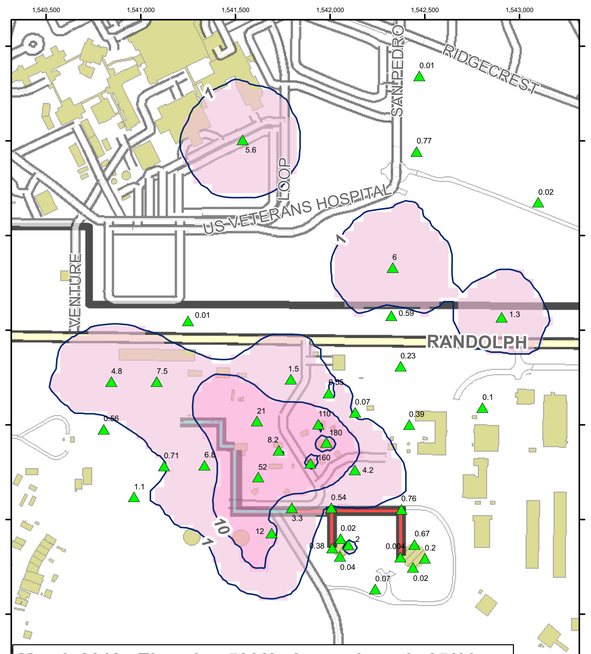
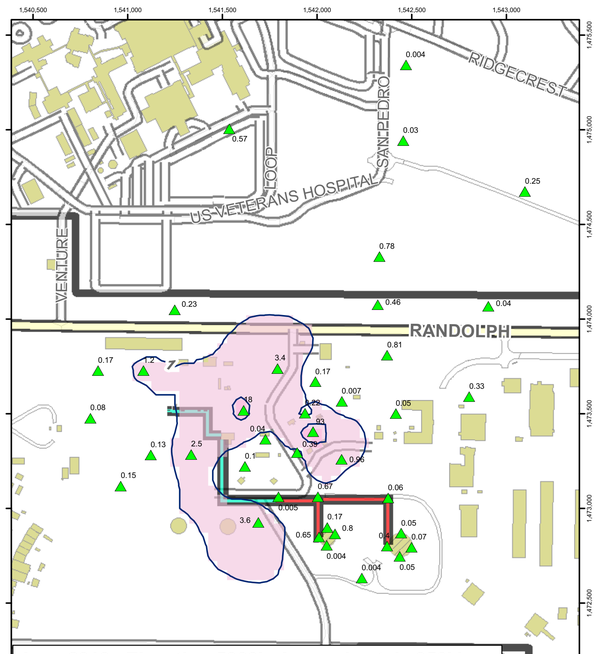


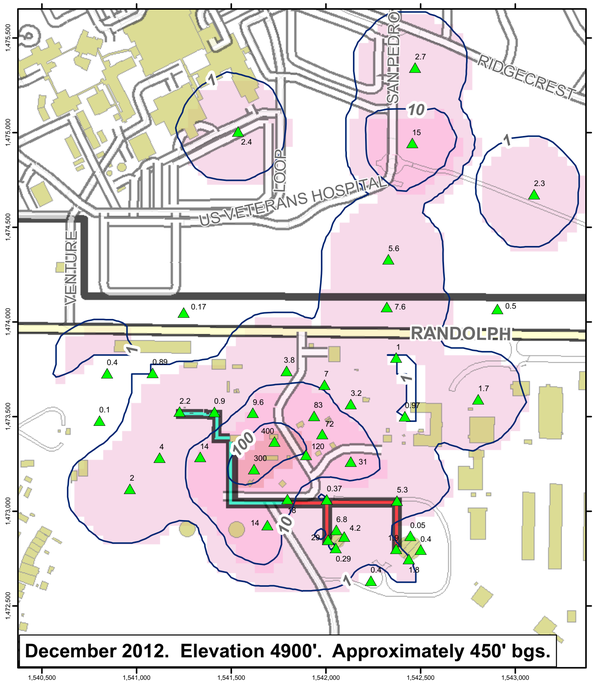
December 2012. Elevation 5000'. Approximately 350' bgs.



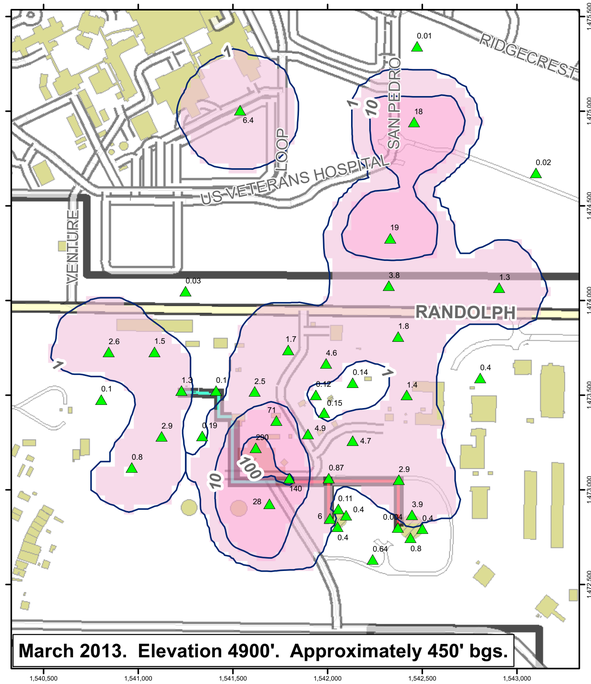
March 2013. Elevation 5000'. Approximately 350' bgs.



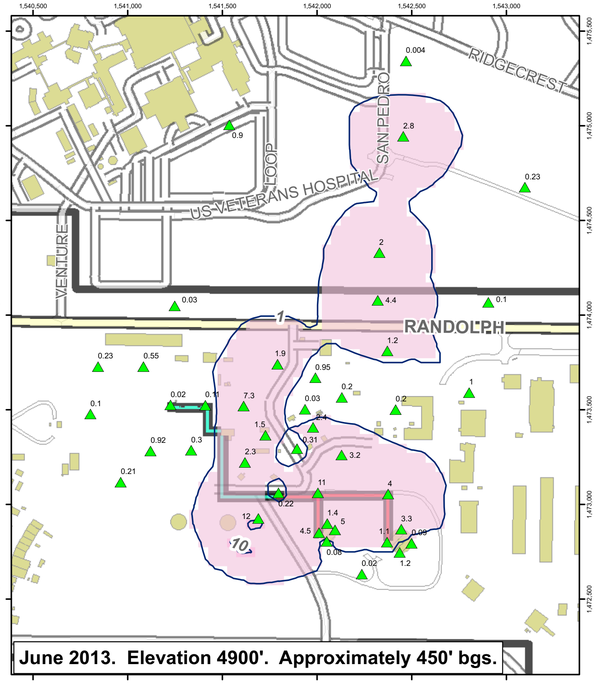
June 2013. Elevation 5000'. Approximately 350' bgs.



December 2012. Elevation 4900'. Approximately 450' bgs.



March 2013. Elevation 4900'. Approximately 450' bgs.



June 2013. Elevation 4900'. Approximately 450' bgs.

Legend

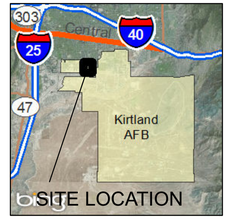
- SVE Well with Benzene Vapor Concentration (ppmv)
- Benzene Vapor Concentration Contours (ppmv)

Benzene Concentration (ppmv)

- 0 - 1
- 2 - 10
- 11 - 100
- 101 -400
- Aboveground Fuel Transfer Lines
- Underground Fuel Transfer Lines
- Existing Structure
- Previously Existing Structure
- Installation Boundary
- Major Road
- Road

Note:
The vadose zone benzene plume was gridded in three dimensions using inverse distance weighting in RockWorks and then concentration plan-view maps were "cut" at respective elevations. Ground elevations range from 5314 to 5364 ft above mean sea level across the ST-106/SS-111 investigation area.

SVE well locations are presented with the benzene concentration in ppmv for each elevation. Sample results within 25 ft of the elevation are posted. For example, elevation 5000 includes sample results within the 5025 to 4075 ft interval. Locations are not shown at elevations where there is no sample result for the elevation interval.



N

Revision Date: 10/03/13

0 400 800 1,600

Feet

1 inch = 400 feet

Projection : NAD83 State Plane New Mexico Central FIPS3002 Feet

SVE SYSTEM EXPANSION PLAN
PART I: CANDIDATE WELL IDENTIFICATION AND PILOT TESTING
BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 2-5

BENZENE VAPOR PLUME FOOTPRINTS DECEMBER 2012 TO JUNE 2013 350 AND 450 FT BELOW GROUND SURFACE

H:\Kirtland_AFB\GIS_Documents\Project_Maps\SVE_System_Expansion_Plan\KAFB_006_BZ_vapor_plan_Dsize.mxd 10/03/13

TABLES

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Table 2-1
Observation Wells for Long Duration Pilot Testing

Long Duration Pilot Test Well	Observation Wells	Horizontal Distance between Observation Well and Test Well (ft)	Available Screened Intervals for Observation Well[a] (ft bgs)
KAFB-106160	KAFB-106128	60	240-250, 340-350, 440-450
	KAFB-106117	150	240-250, 340-350, 440-450
	KAFB-106119	250	340-350, 440-450
	KAFB-106116	300	340-350, 440-450
	KAFB-106114	300	340-350, 440-450
	KAFB-106121	675	240-250, 340-350, 430-440
KAFB-106161	KAFB-106116	25	240-250, 340-350, 440-450
	KAFB-106117	175	240-250, 340-350, 440-450
	KAFB-106112	175	339-349, 439-449
	KAFB-106129	250	338-348, 440-450
	KAFB-106114	300	340-350, 440-450
	KAFB-106121	550	240-250, 340-350, 430-440
KAFB-106149	KAFB-106117	25	15-25, 40-50, 140-150, 240-250, 340-350, 440-450
	KAFB-106116	150	10-20, 40-50, 140-150, 240-250, 340-350, 440-450
	KAFB-106128	200	15-25, 40-50, 140-150, 240-250, 340-350, 440-450
	KAFB-106119	200	15-25, 40-50, 140-150, 240-250, 340-350, 440-450
	KAFB-106112	225	15-25, 40-50, 140-150, 240-250, 339-349, 439-449
	KAFB-106121	650	15-25, 40-50, 135-145, 240-250, 340-350, 430-440
KAFB-106150	KAFB-106128	40	15-25, 40-50, 140-150, 240-250, 340-350, 440-450
	KAFB-106117	150	15-25, 40-50, 140-150, 240-250, 340-350, 440-450
	KAFB-106114	200	15-25, 40-50, 140-150, 235-245, 340-350, 440-450
	KAFB-106116	250	10-20, 40-50, 140-150, 240-250, 340-350, 440-450
	KAFB-106119	300	15-25, 40-50, 140-150, 240-250, 340-350, 440-450
	KAFB-106115	750	15-25, 40-50, 145-155, 240-250, 340-350, 440-450
KAFB-106154	KAFB-106112	50	15-25, 40-50, 140-150, 240-250, 339-349, 439-449
	KAFB-106117	200	15-25, 40-50, 140-150, 240-250, 340-350, 440-450
	KAFB-106116	225	10-20, 40-50, 140-150, 240-250, 340-350, 440-450
	KAFB-106130	250	15-25, 40-50, 150-160, 240-250, 340-350, 440-450
	KAFB-106119	250	15-25, 40-50, 140-150, 240-250, 340-350, 440-450
	KAFB-106121	750	15-25, 40-50, 145-155, 240-250, 340-350, 440-450

[a]Observation well screened intervals used during the testing of PneuLog® wells KAFB-106149, KAFB-106150, and KAFB-106154 will be a subset of the available screened intervals. The monitoring points chosen will be determined based on the screened interval in the PneuLog® well which is used as the extraction well (Section 2.1.1).

bgs below ground surface
ft feet
KAFB Kirtland Air Force Base

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Table 2-2
Sample Locations of EDB Samples to be
Collected During Fourth Quarter CY 2013 Soil Vapor Sampling Event

Well Number	Sample Depth (ft bgs)
KAFB-106108	250
	350
KAFB-106113	350
	450
KAFB-106114	350
	450
KAFB-106116	350
	450
KAFB-106117	250
	350
	450
KAFB-106118	250
	350
	450
KAFB-106119	250
	350
	450
KAFB-106123	450
KAFB-106128	350
	450
KAFB-106131	350
	450
KAFB-106134	350
	450
KAFB-106137	350
	450
KAFB-106142	350
	450
SVEW-2	60
SVEW-3	160
SVEW-4	313
SVEW-6	60
SVEW-7	160
SVEW-8	260
SVEW-9	460

bgs below ground surface
CY calendar year
EDB ethylene dibromide
ft feet
KAFB Kirtland Air Force Base
SVEW soil vapor extraction well

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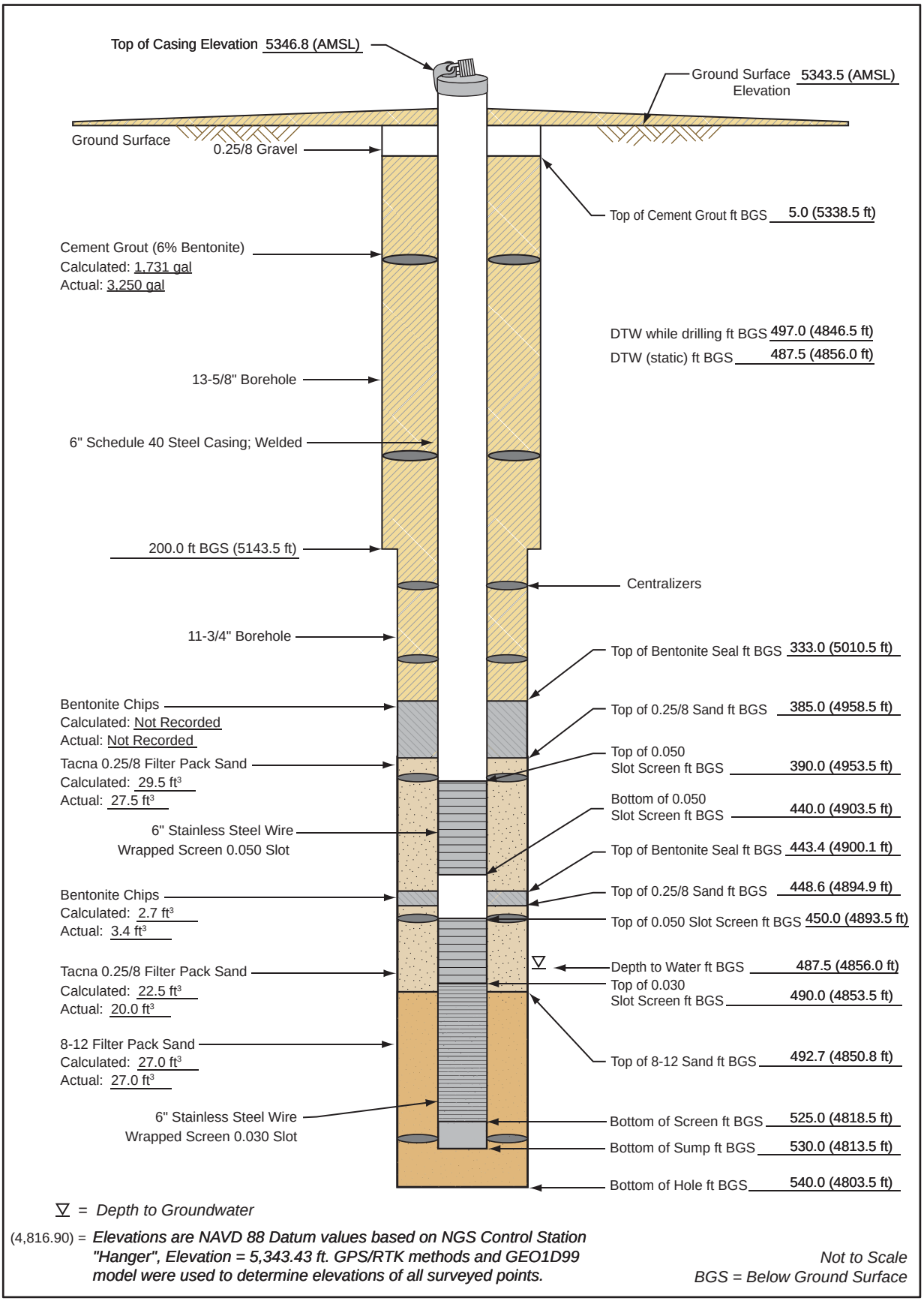
APPENDIX A

Well Construction Diagrams of Existing SVE Wells

Soil Vapor Extraction Well KAFB-106160

Installation Start Date/Time: 2/29/2012 @ 0930
Installation End Date/Time: 3/5/2012 @ 1700



▽ = *Depth to Groundwater*

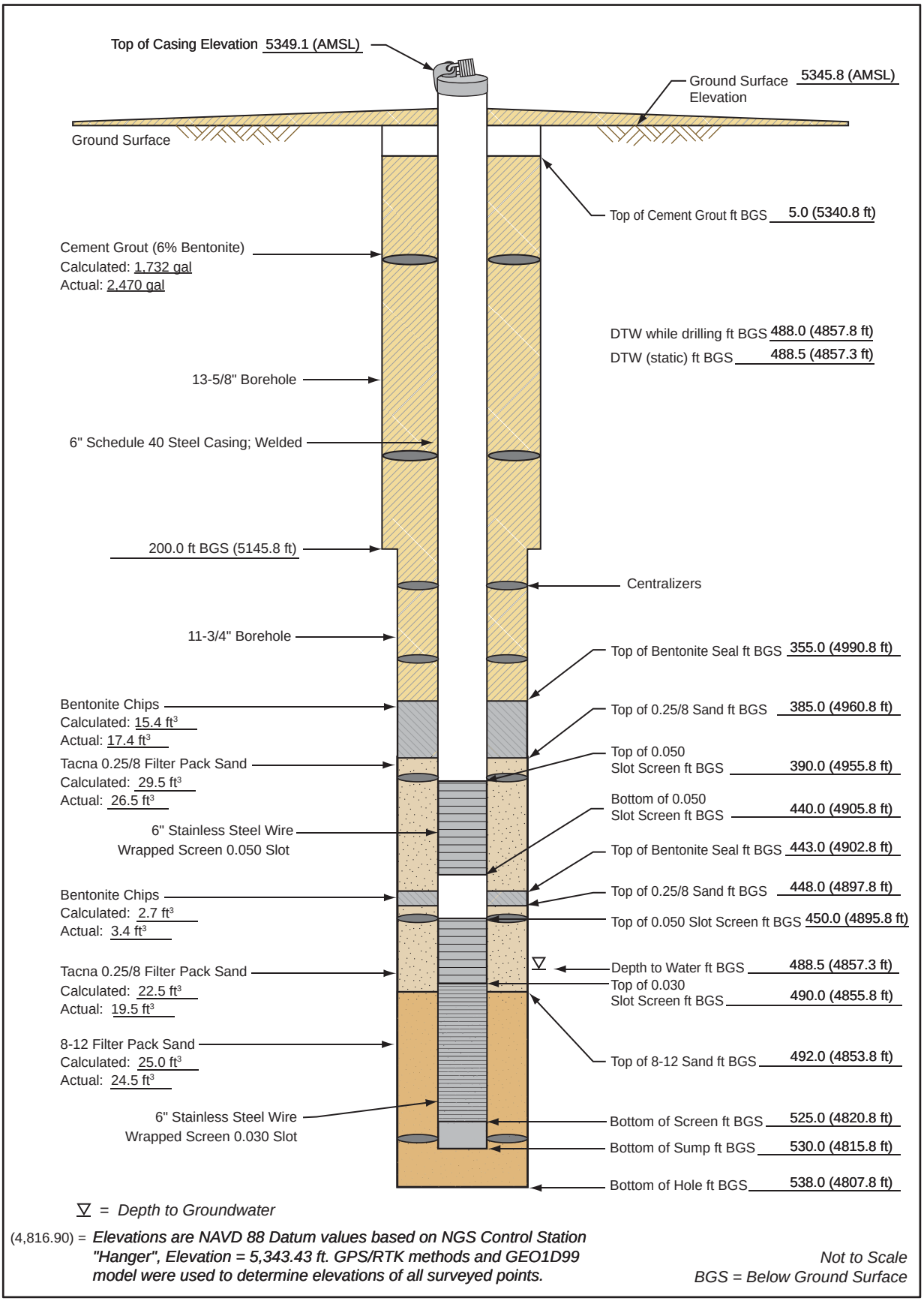
(4,816.90) = *Elevations are NAVD 88 Datum values based on NGS Control Station "Hanger", Elevation = 5,343.43 ft. GPS/RTK methods and GEO1D99 model were used to determine elevations of all surveyed points.*

Not to Scale
BGS = Below Ground Surface

140705.FB010010_SVE_KAFB_106160

Soil Vapor Extraction Well KAFB-106161

Installation Start Date/Time: 2/13/2012 @ 0915
Installation End Date/Time: 2/23/2012 @ 1720



▽ = *Depth to Groundwater*

(4,816.90) = *Elevations are NAVD 88 Datum values based on NGS Control Station "Hanger", Elevation = 5,343.43 ft. GPS/RTK methods and GEO1D99 model were used to determine elevations of all surveyed points.*

Not to Scale
BGS = Below Ground Surface

140705.FB010010_SVE_KAFB_106161

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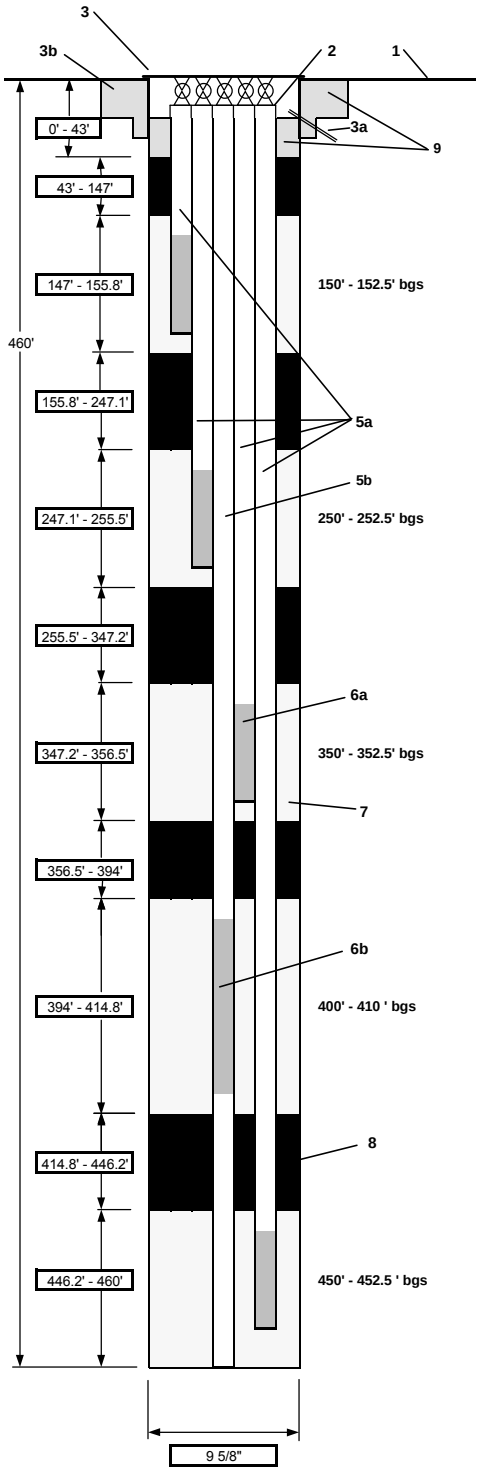
APPENDIX B

Candidate Well Construction Diagrams

PROJECT NUMBER	WELL NUMBER
185906.02.FI	SVMW-13/SVEW-11 SHEET 1 OF 1

SOIL VAPOR WELL COMPLETION DIAGRAM

PROJECT : Distal Vapor Monitoring Points
LOCATION : Bulk Fuels Facility - KAFB
ELEVATION: 5344.98
DRILLING CONTRACTOR : Water Development Corporation / Mark Green
DRILLING METHOD AND EQUIPMENT USED: SpeedStar 30K ARCH w/18" split spoon
WATER LEVELS: NA
START : 01/27/2004 END : 01/30/2004 LOGGER : D. Boss-Walker



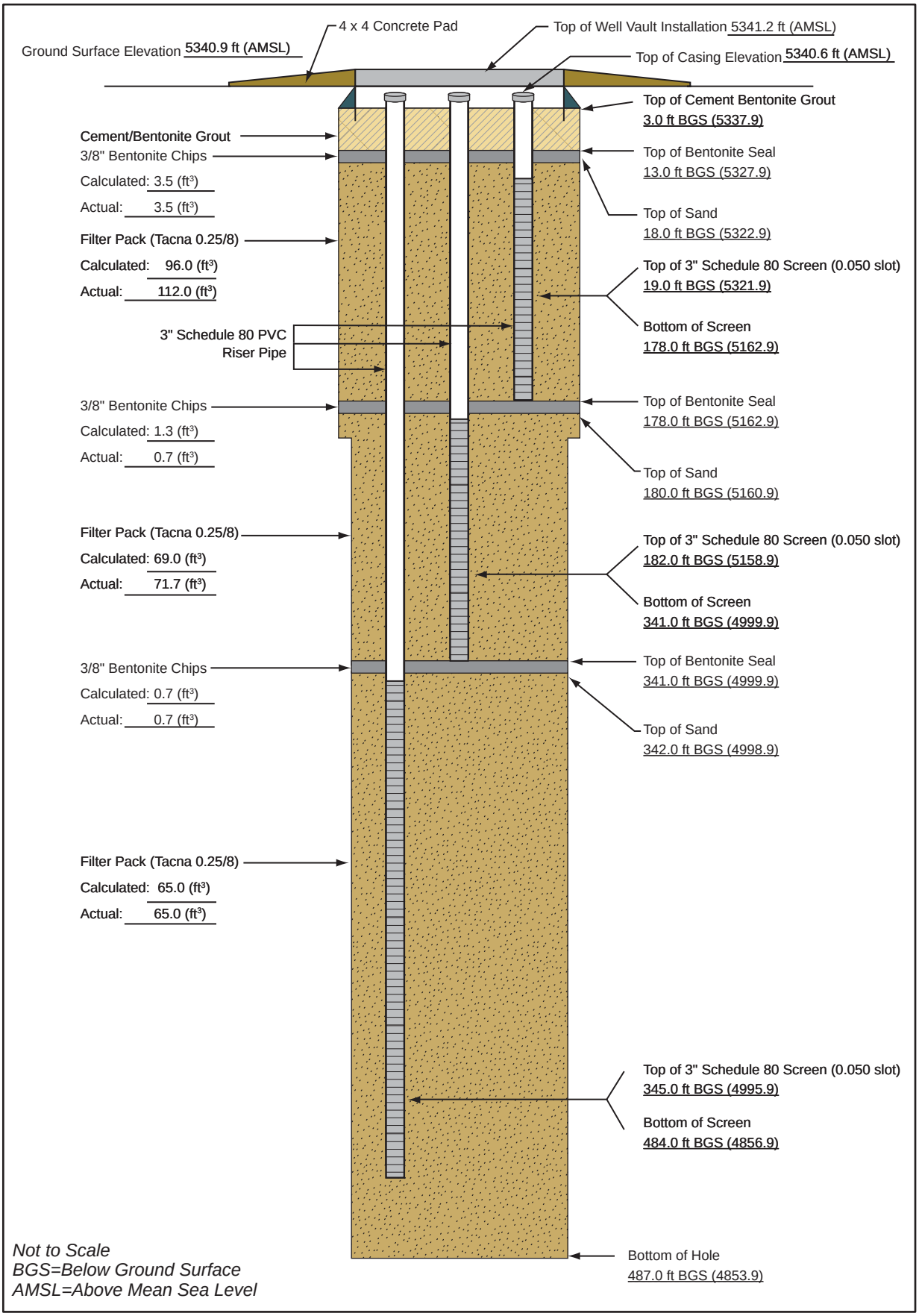
1-	Ground elevation at well	approximately 5339'
2-	Top of casing elevation	NA
3-	Wellhead protection cover type	12" flush mount, locking caps
	a) drain tube?	None
	b) concrete pad dimensions	4' square flush mount
4-	Dia./type surface casing	None
5-	a) Dia./type of well casing	1/2" OD Sch. 80 PVC w/ball valve
	b) Dia./type of well casing	2" OD Sch. 80 PVC w/slip cap
6-	a) Type/slot/size of screen	1/2" OD Sch. 80 PVC, 0.050 slot, 2.5' length
	b) Type/slot/size of screen	2" OD Sch. 80 PVC, 0.050 slot, 10' length
7-	Type screen filter	8 - 12 Oglebay Colorado Silica
	quantity used	56 x 50 lb sacks
8-	Type of seals	Hydrated Enviroplug 3/8" (medium)
	quantity used	Bentonite chips - 290 x 50 lb sacks
9-	Grout	
	a) Grout mix used	Portland Cement
	b) Method of placement	Pump
	c) Vol.of surface casing grout	NA
	d) Vol. of well casing grout	Portland cement - 38 x 100 lb sacks Bentonite Gel - 2 x 50 lb sacks
	Development method	NA - Vapor well
	Development time	NA - Vapor well
	Estimated purge volume	NA - Vapor well

Comments
Each of the four 1/2" wells is fitted with a PVC slip cap with a brass ball valve threaded into the cap. The 2" well is fitted with a PVC slip cap.

Illustration not to scale.

PneuLog Well Completion Diagram KAFB-106156

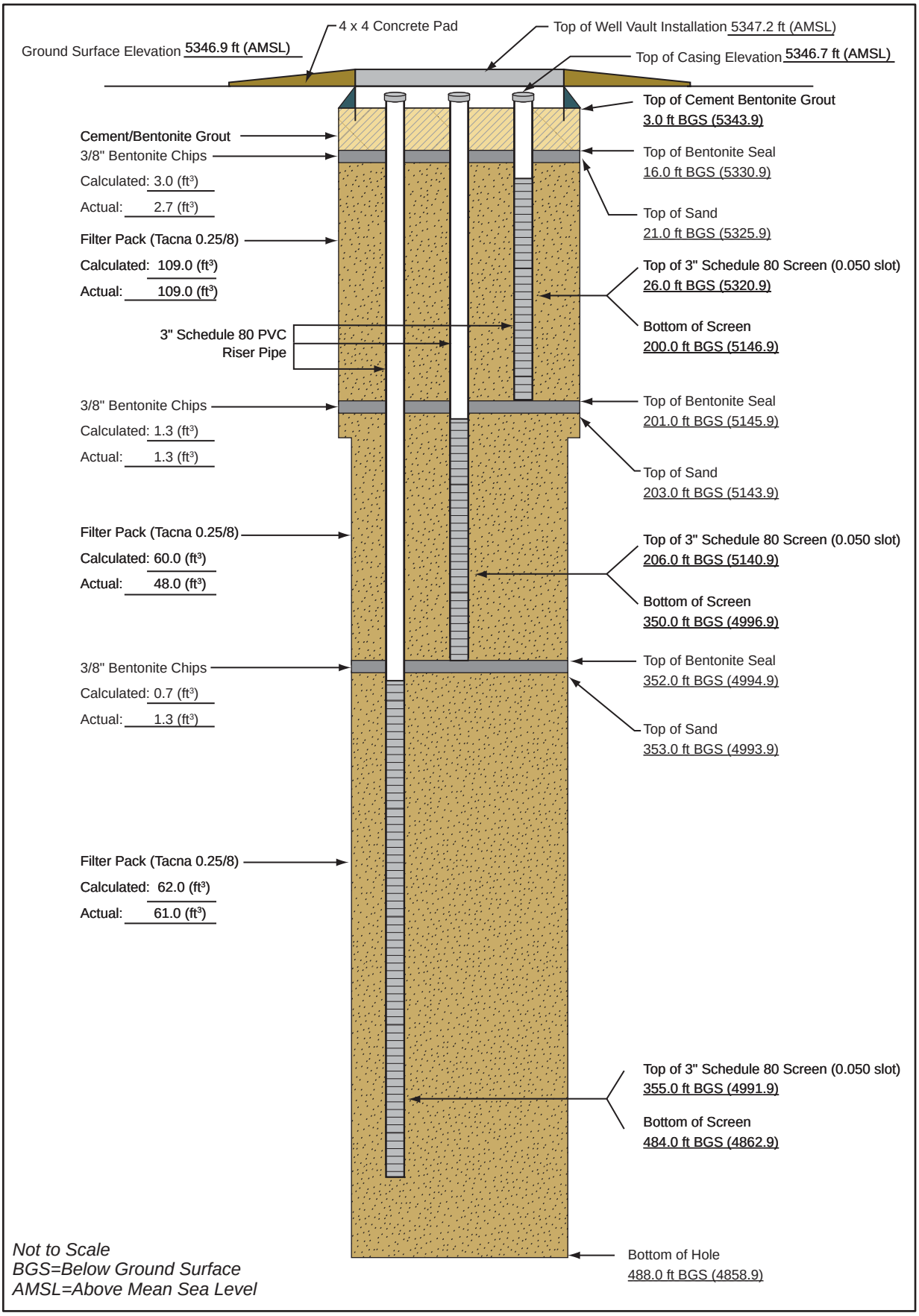
Installation Start Date/Time: 11/04/2011@ 08:00
Installation End Date/Time: 11/09/2011@ 12:00



140705.EA010020_106156

PneuLog Well Completion Diagram KAFB-106155

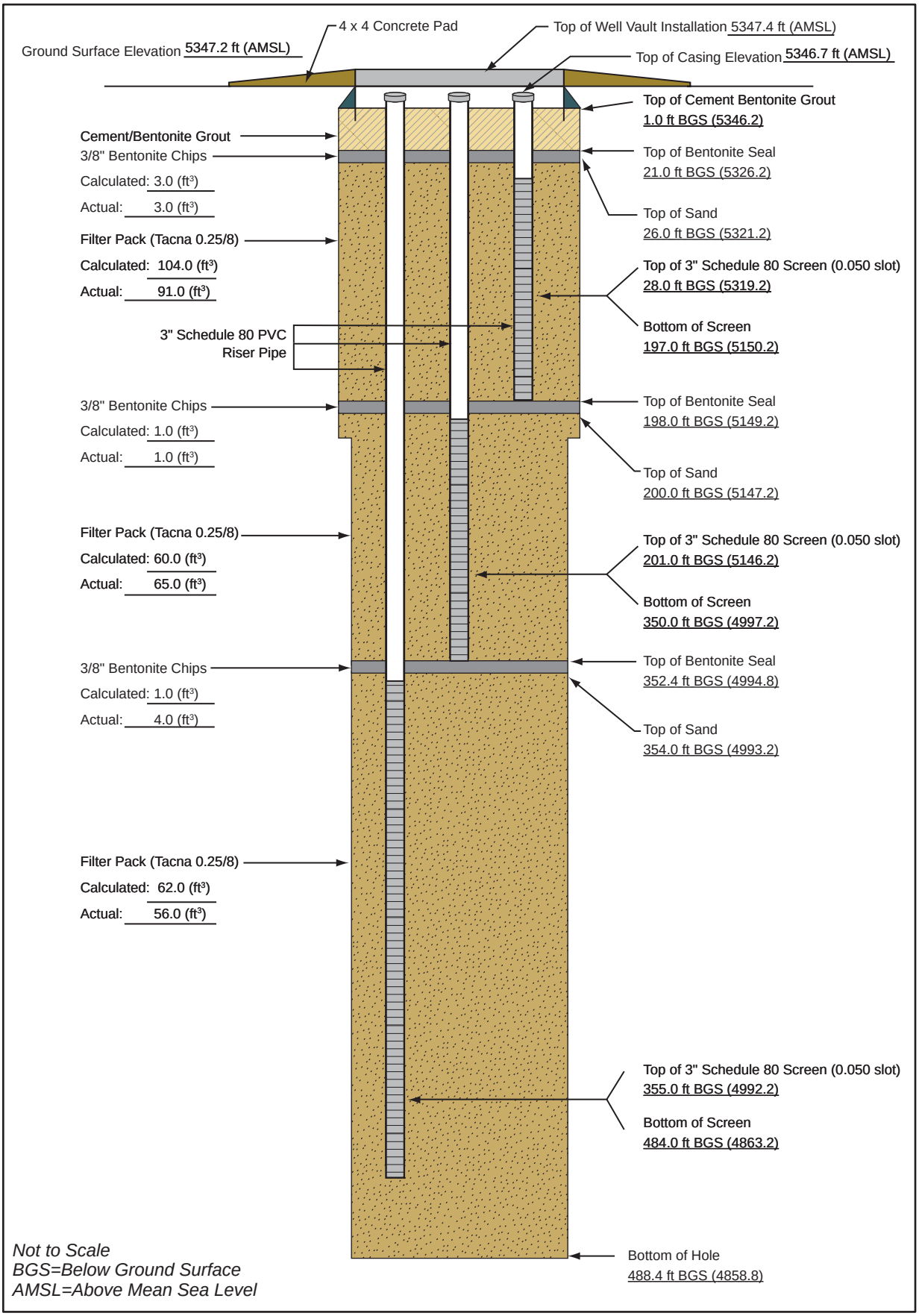
Installation Start Date/Time: 10/28/2011@ 08:00
Installation End Date/Time: 11/01/2011@ 12:00



140705.EA010020_106155

PneuLog Well Completion Diagram KAFB-106154

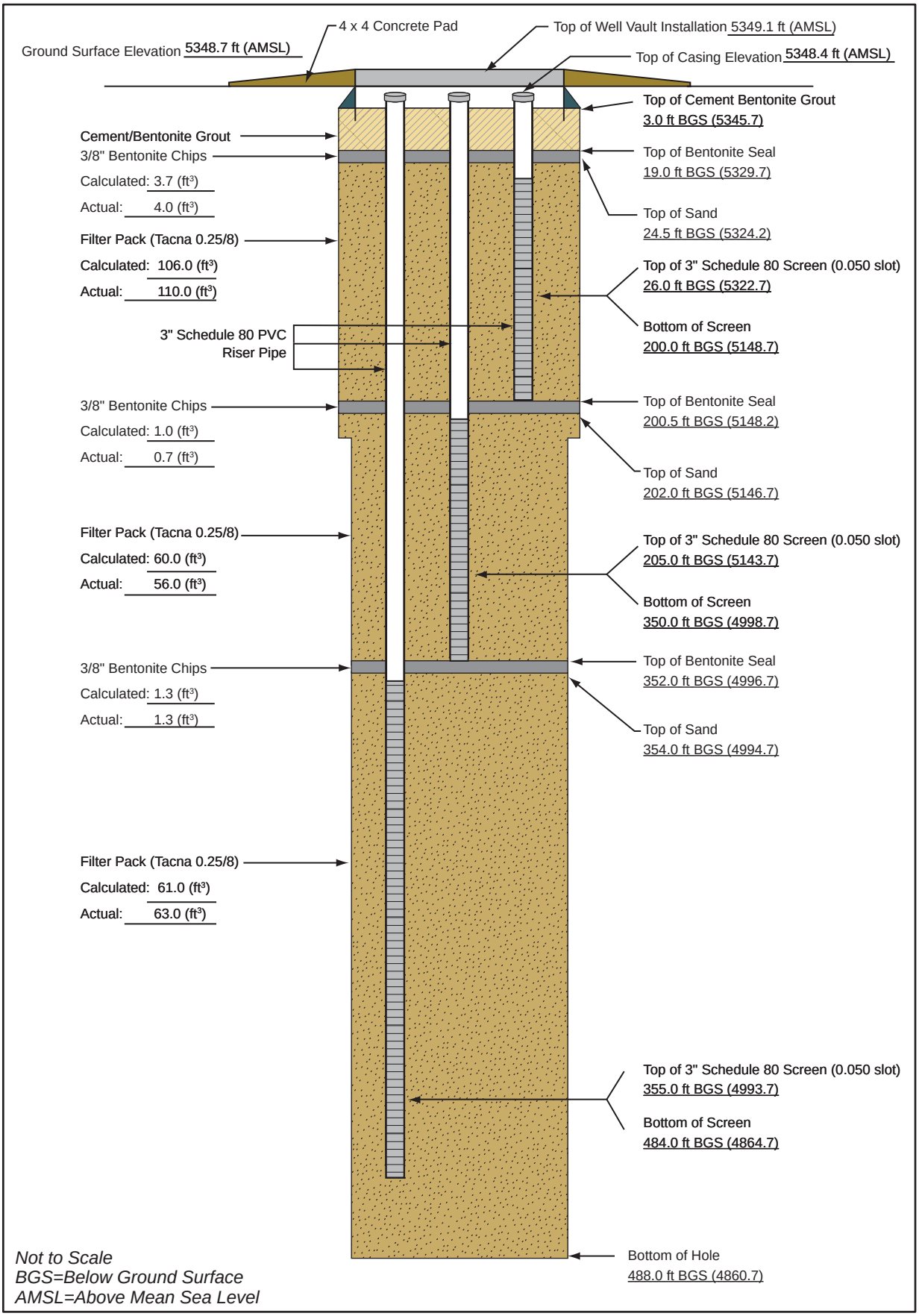
Installation Start Date/Time: 10/18/2011@08:00
Installation End Date/Time: 10/20/2011@12:00



140705.EA010020_106154

PneuLog Well Completion Diagram KAFB-106153

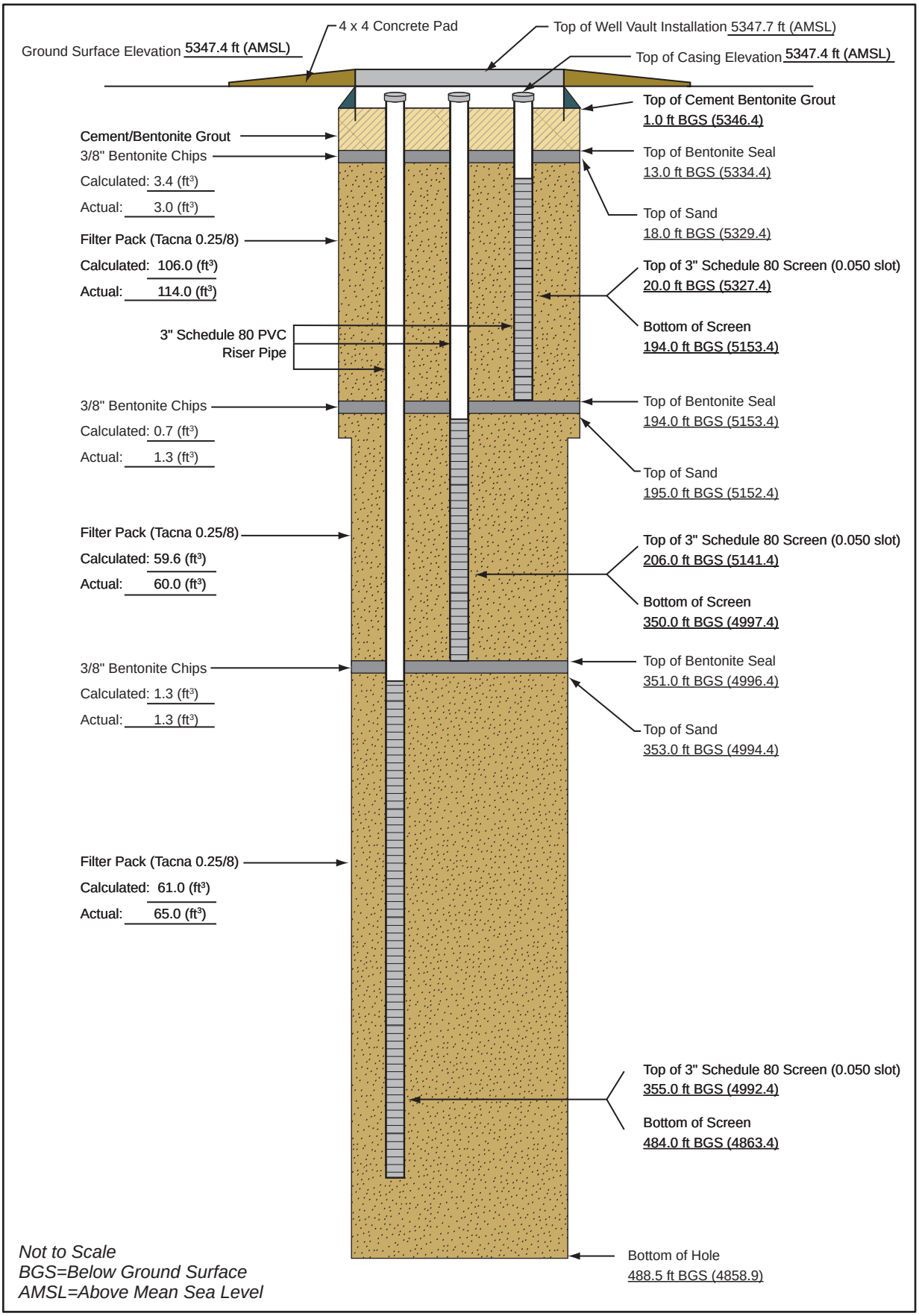
Installation Start Date/Time: 10/21/2011@11:00
Installation End Date/Time: 10/25/2011@12:00



140705.EA010020_106153

PneuLog Well Completion Diagram KAFB-106152

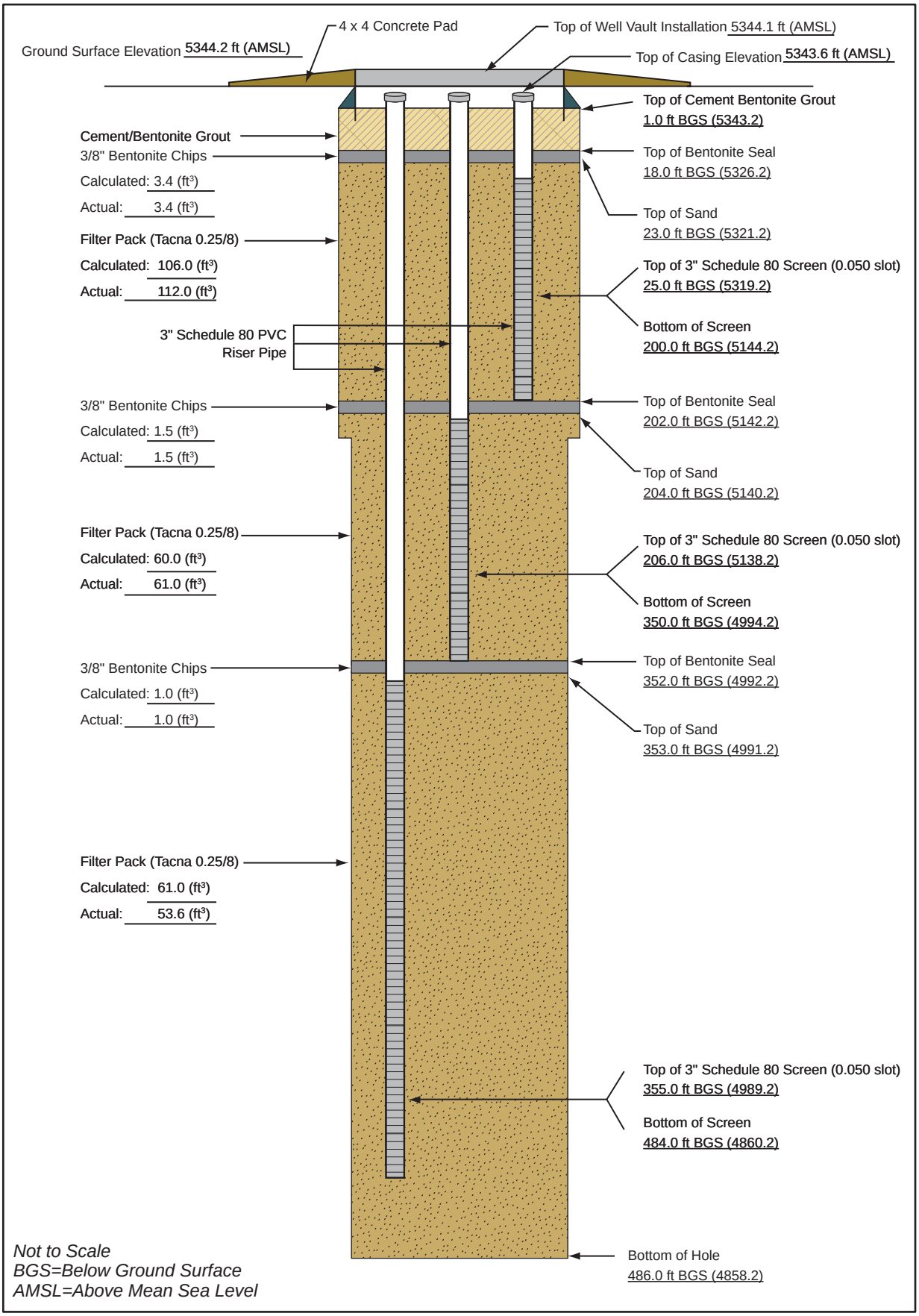
Installation Start Date/Time: 10/05/2011@12:00
Installation End Date/Time: 10/07/2011@12:20



140705.EA010020_106152

PneuLog Well Completion Diagram KAFB-106150

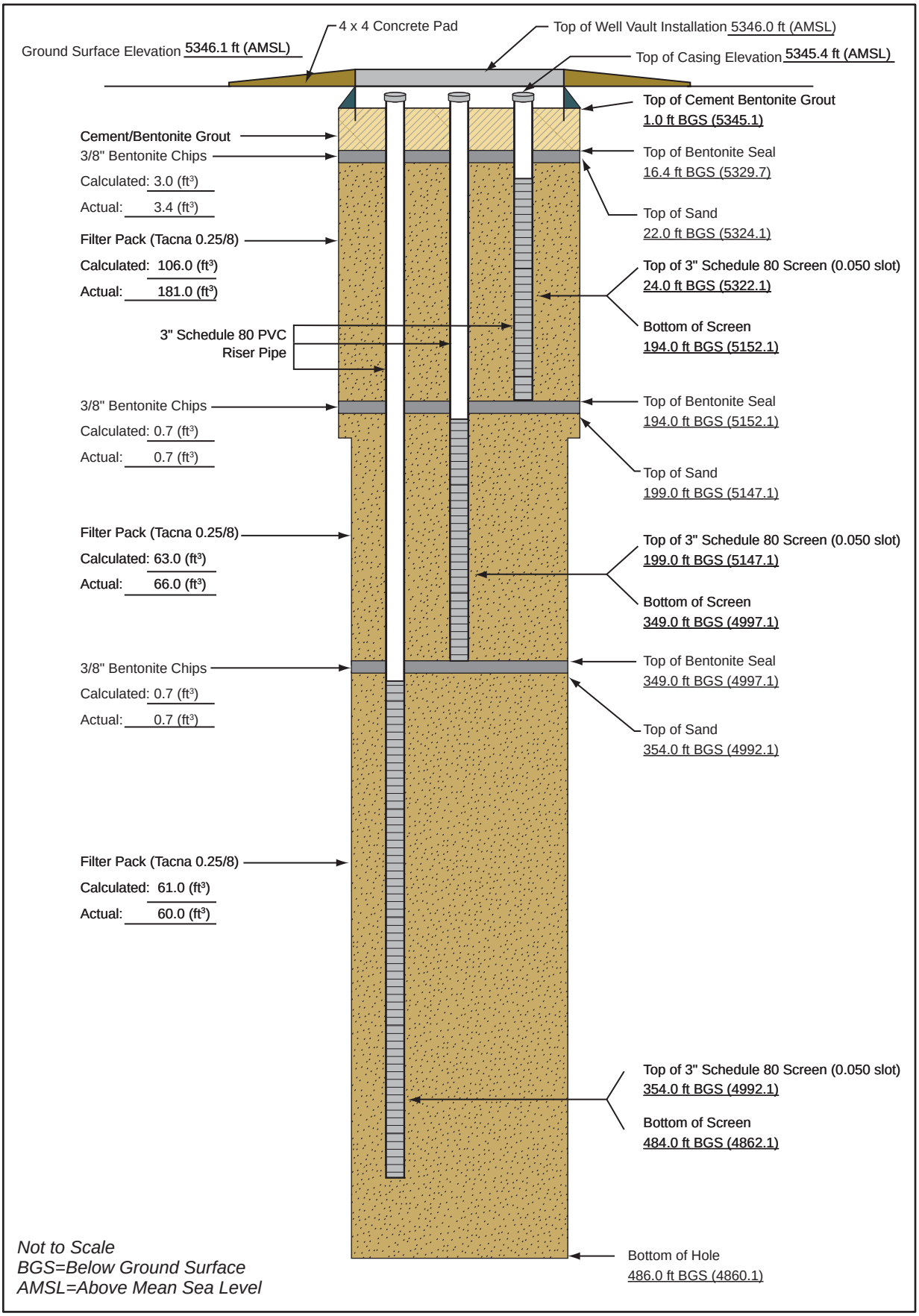
Installation Start Date/Time: 9/21/2011@12:00
Installation End Date/Time: 9/23/2011@12:00



140705.EA010020_106150

PneuLog Well Completion Diagram KAFB-106149

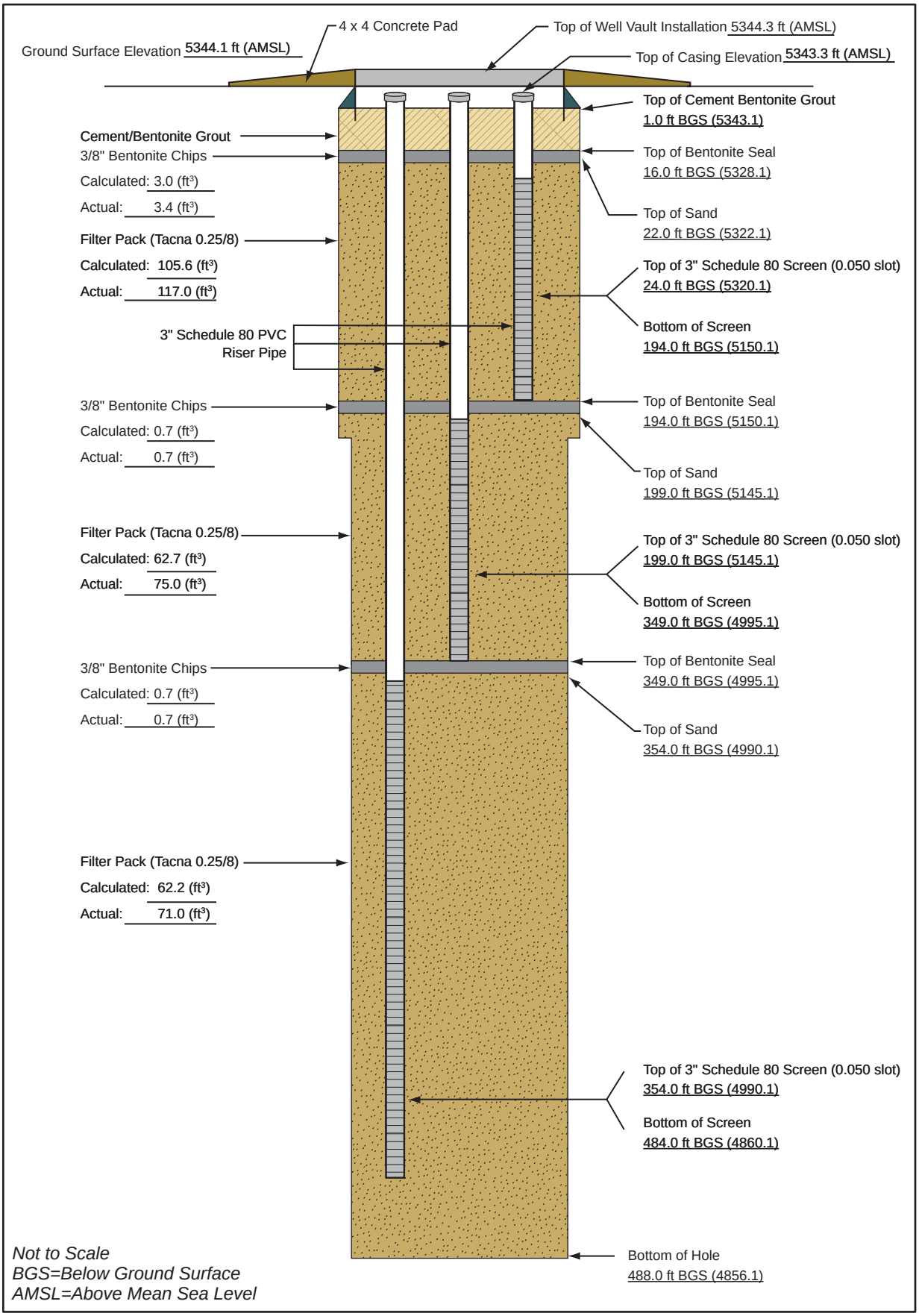
Installation Start Date/Time: 9/15/2011@08:40
Installation End Date/Time: 9/16/2011@13:15



140705.EA010020_106149

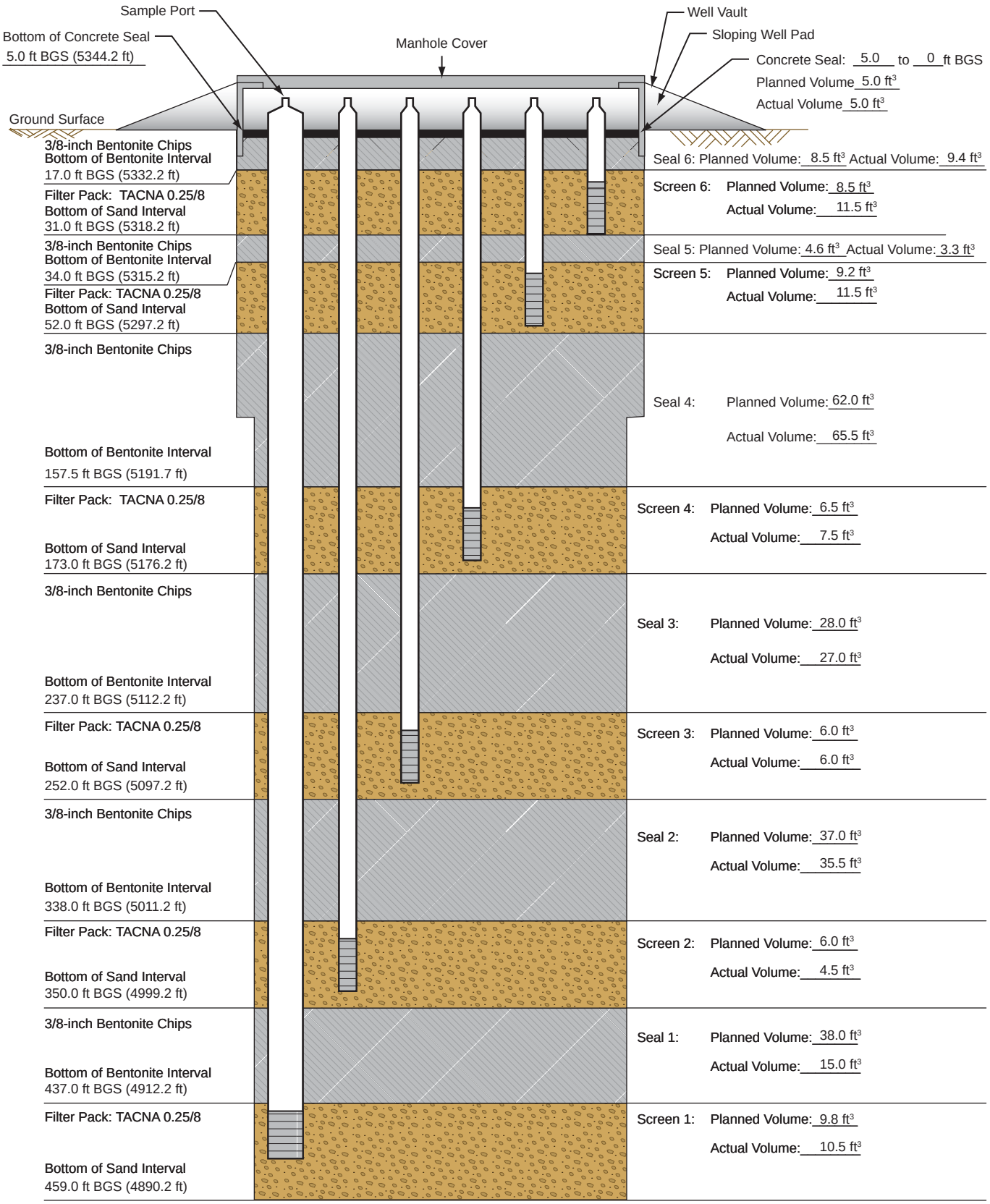
PneuLog Well Completion Diagram KAFB-106148

Installation Start Date/Time: 9/08/2011@10:00
Installation End Date/Time: 9/12/2011@10:20



140705.EA010020_106148

Nested Soil Vapor Well Completion Diagram for KAFB-106142

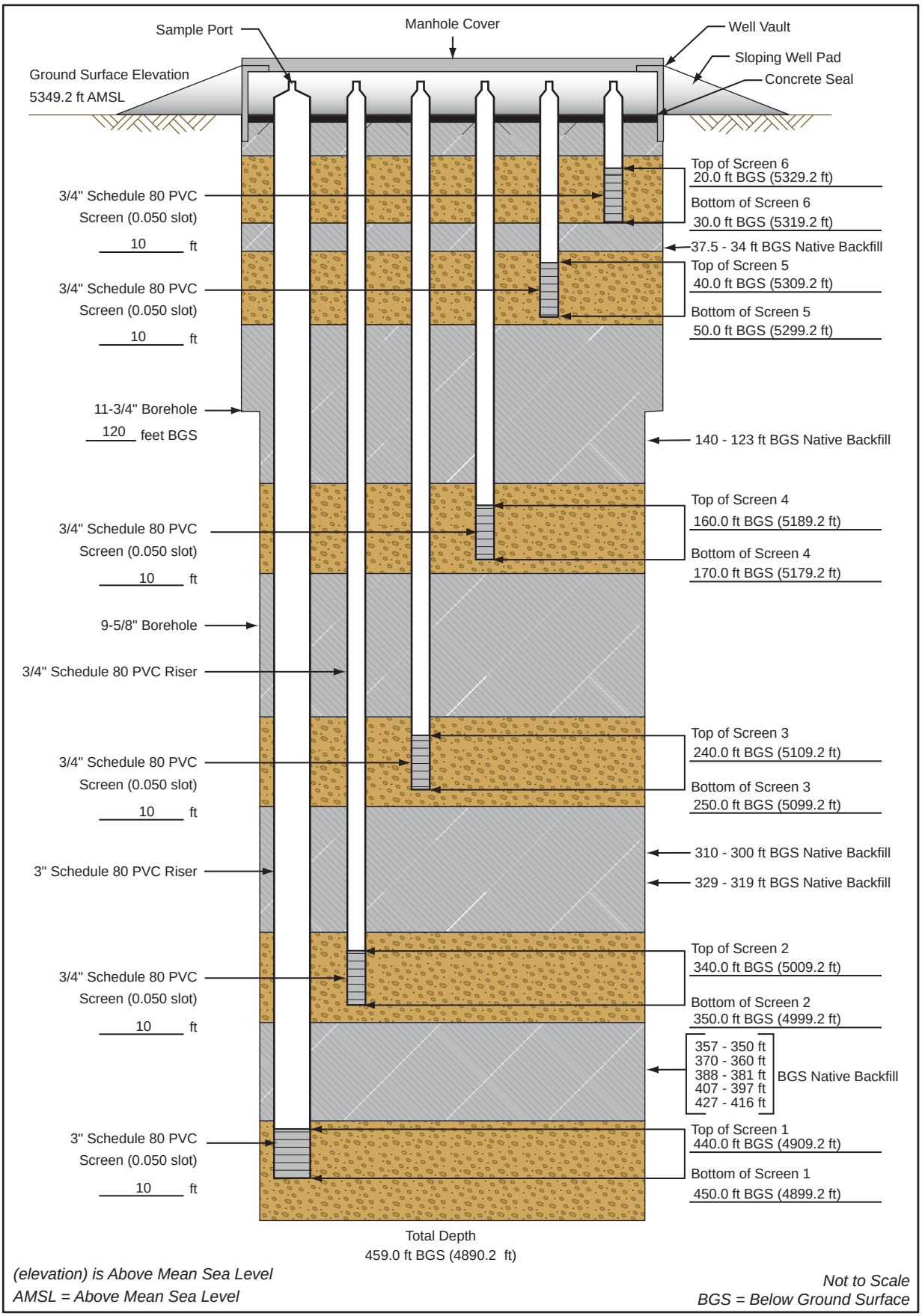


(elevation) is Above Mean Sea Level
All Materials Placed with Tremie Pipe

Not to Scale
BGS = Below Ground Surface

Nested Soil Vapor Well Completion Diagram for KAFB-106142

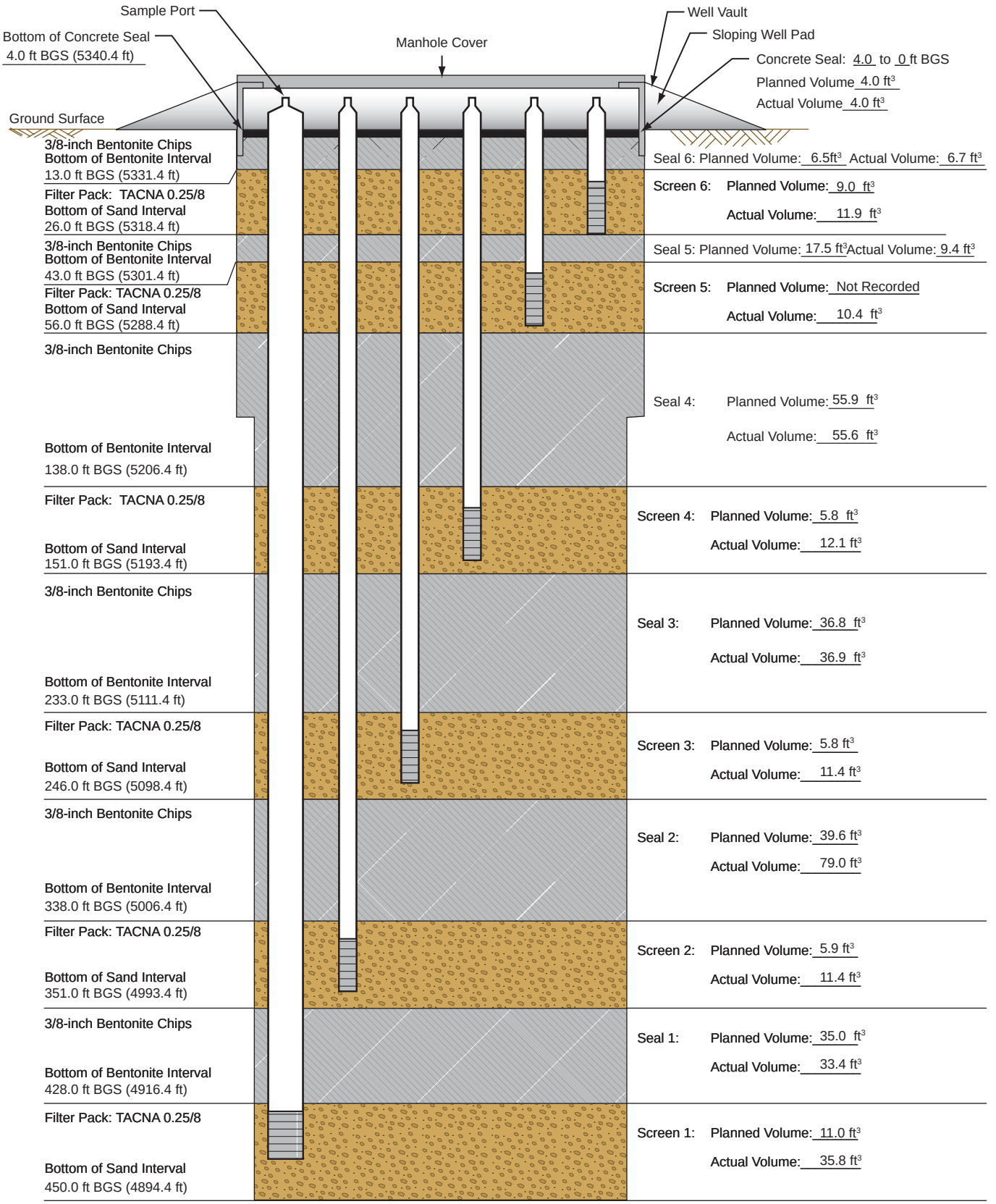
Installation Start Date/Time: 4/18/2011 @ 09:20
Installation End Date/Time: 4/21/2011 @ 14:30



(elevation) is Above Mean Sea Level
AMSL = Above Mean Sea Level

Not to Scale
BGS = Below Ground Surface

Nested Soil Vapor Well Completion Diagram for KAFB-106131

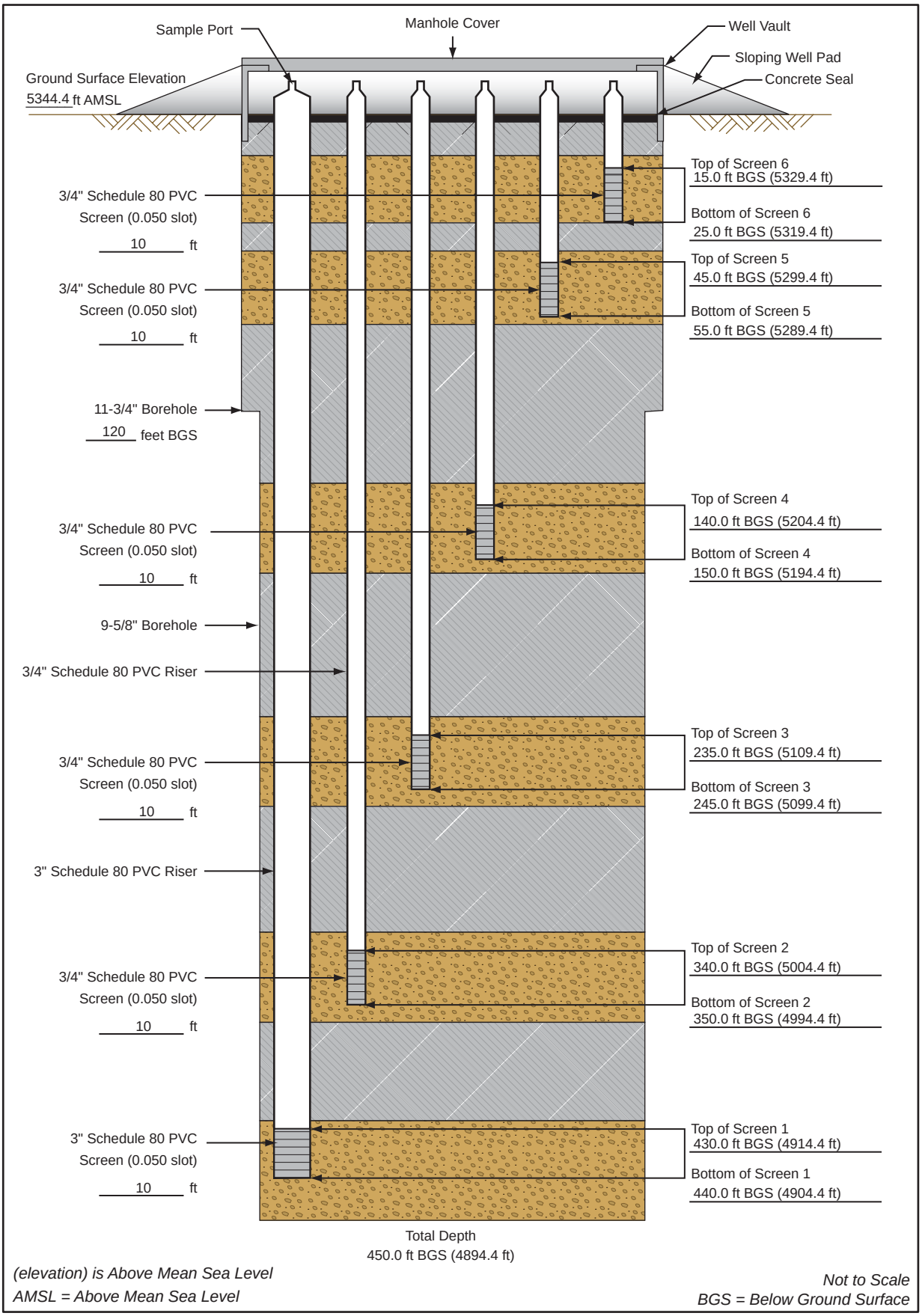


(elevation) is Above Mean Sea Level
All Materials Placed with Tremie Pipe

Not to Scale
BGS = Below Ground Surface

Nested Soil Vapor Well Completion Diagram for KAFB-106131

Installation Start Date/Time: 3/6/2011 @ 07:40
Installation End Date/Time: 3/7/2011 @ 16:00

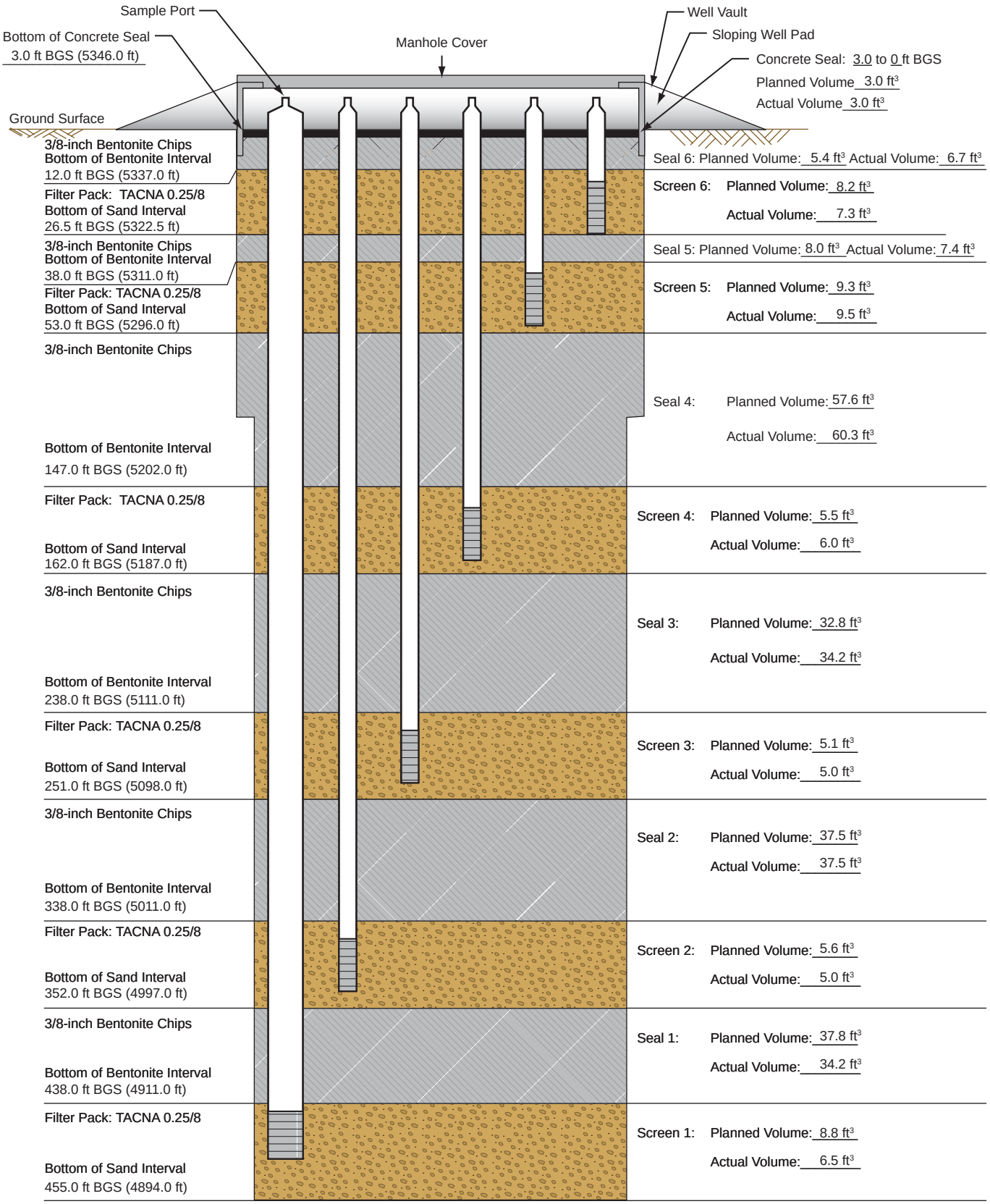


(elevation) is Above Mean Sea Level
AMSL = Above Mean Sea Level

Not to Scale
BGS = Below Ground Surface

140705_CA010020_SV_KAFB.106131 (a)

Nested Soil Vapor Well Completion Diagram for KAFB-106130

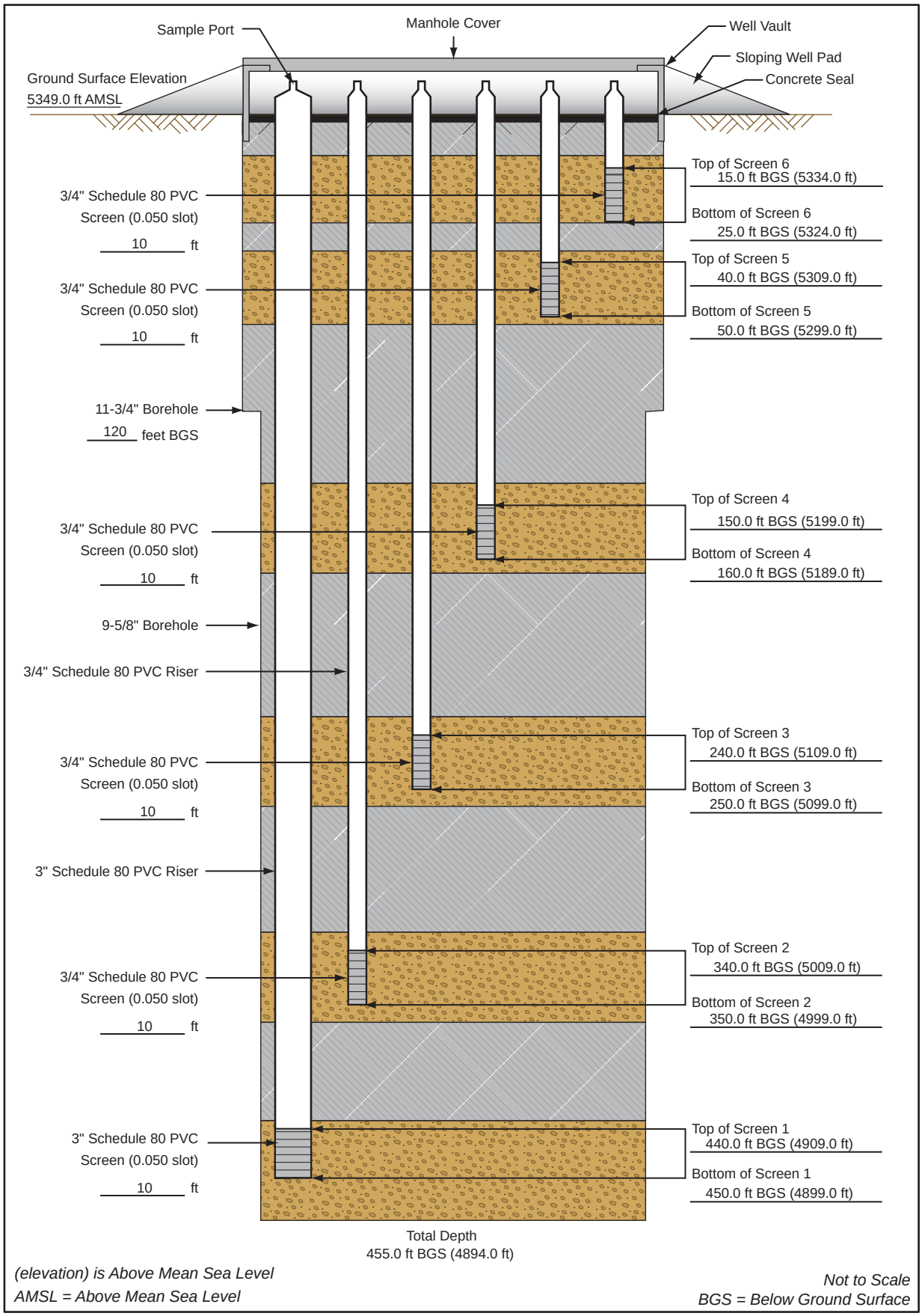


(elevation) is Above Mean Sea Level
All Materials Placed with Tremie Pipe

Not to Scale
BGS = Below Ground Surface

Nested Soil Vapor Well Completion Diagram for KAFB-106130

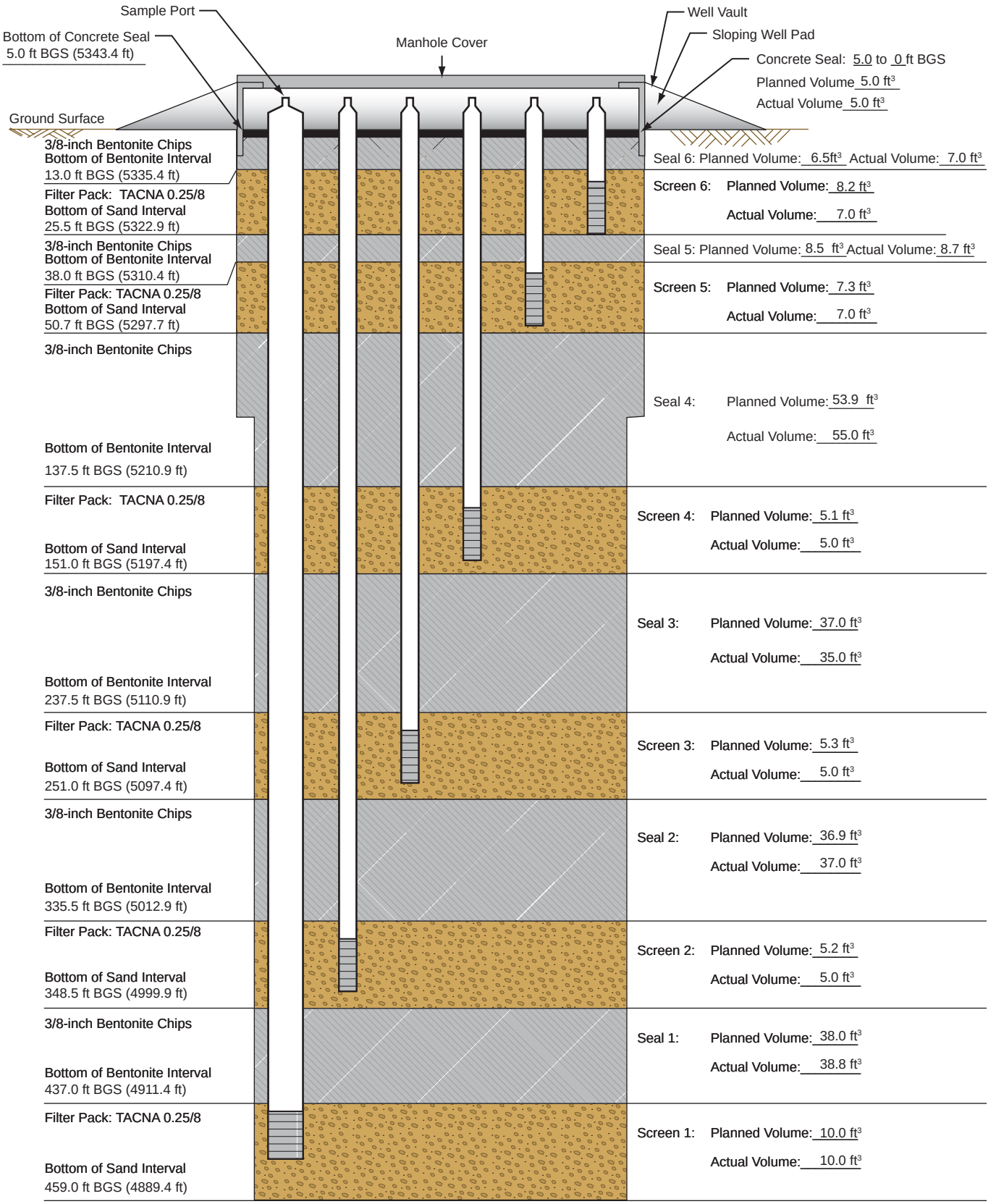
Installation Start Date/Time: 2/20/2011 @ 09:22
Installation End Date/Time: 2/21/2011 @ 16:45



(elevation) is Above Mean Sea Level
AMSL = Above Mean Sea Level

Not to Scale
BGS = Below Ground Surface

Nested Soil Vapor Well Completion Diagram for KAFB-106129

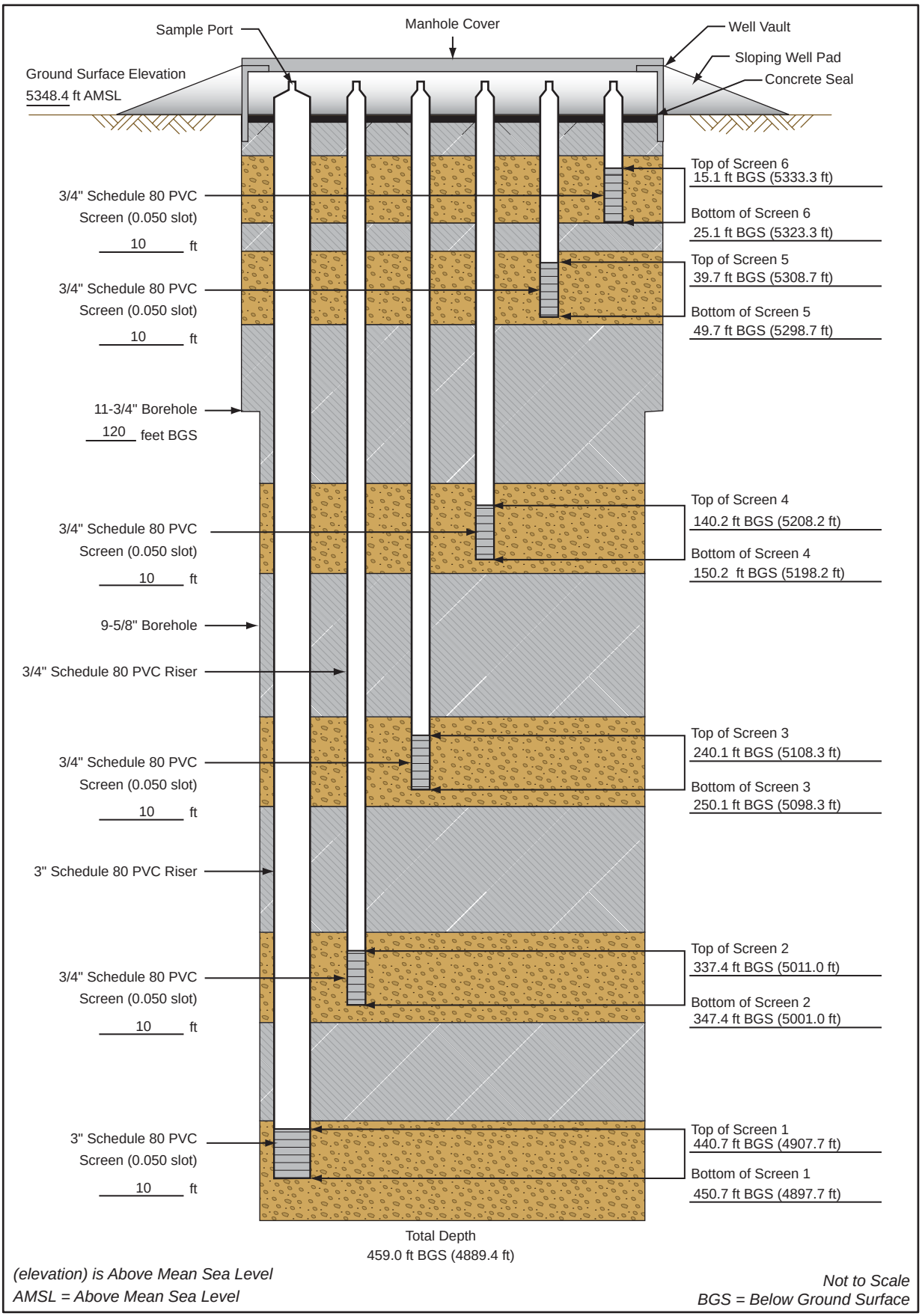


(elevation) is Above Mean Sea Level
All Materials Placed with Tremie Pipe

Not to Scale
BGS = Below Ground Surface

Nested Soil Vapor Well Completion Diagram for KAFB-106129

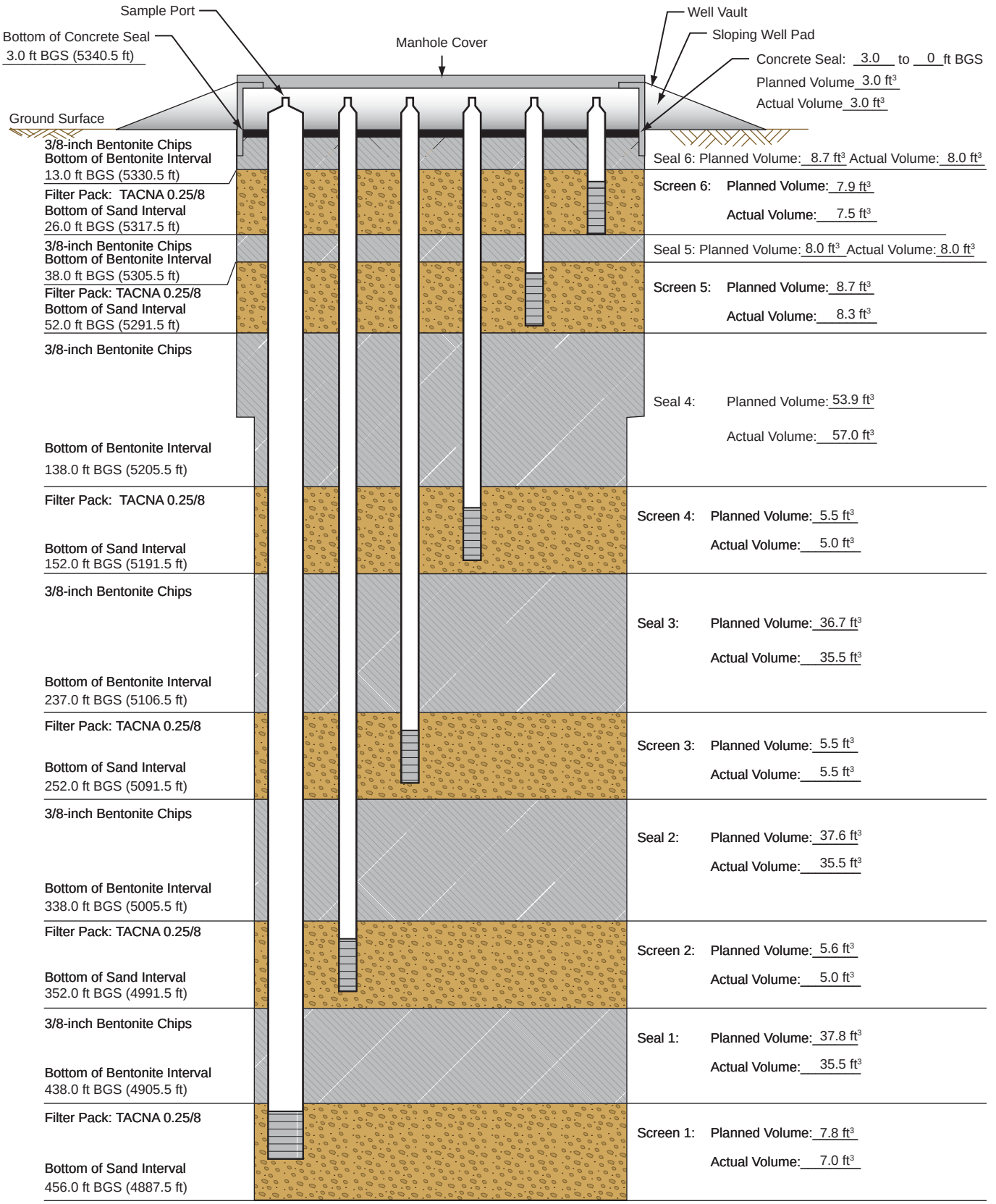
Installation Start Date/Time: 3/3/2011 @ 16:40
Installation End Date/Time: 3/6/2011 @ 14:30



(elevation) is Above Mean Sea Level
AMSL = Above Mean Sea Level

Not to Scale
BGS = Below Ground Surface

Nested Soil Vapor Well Completion Diagram for KAFB-106119

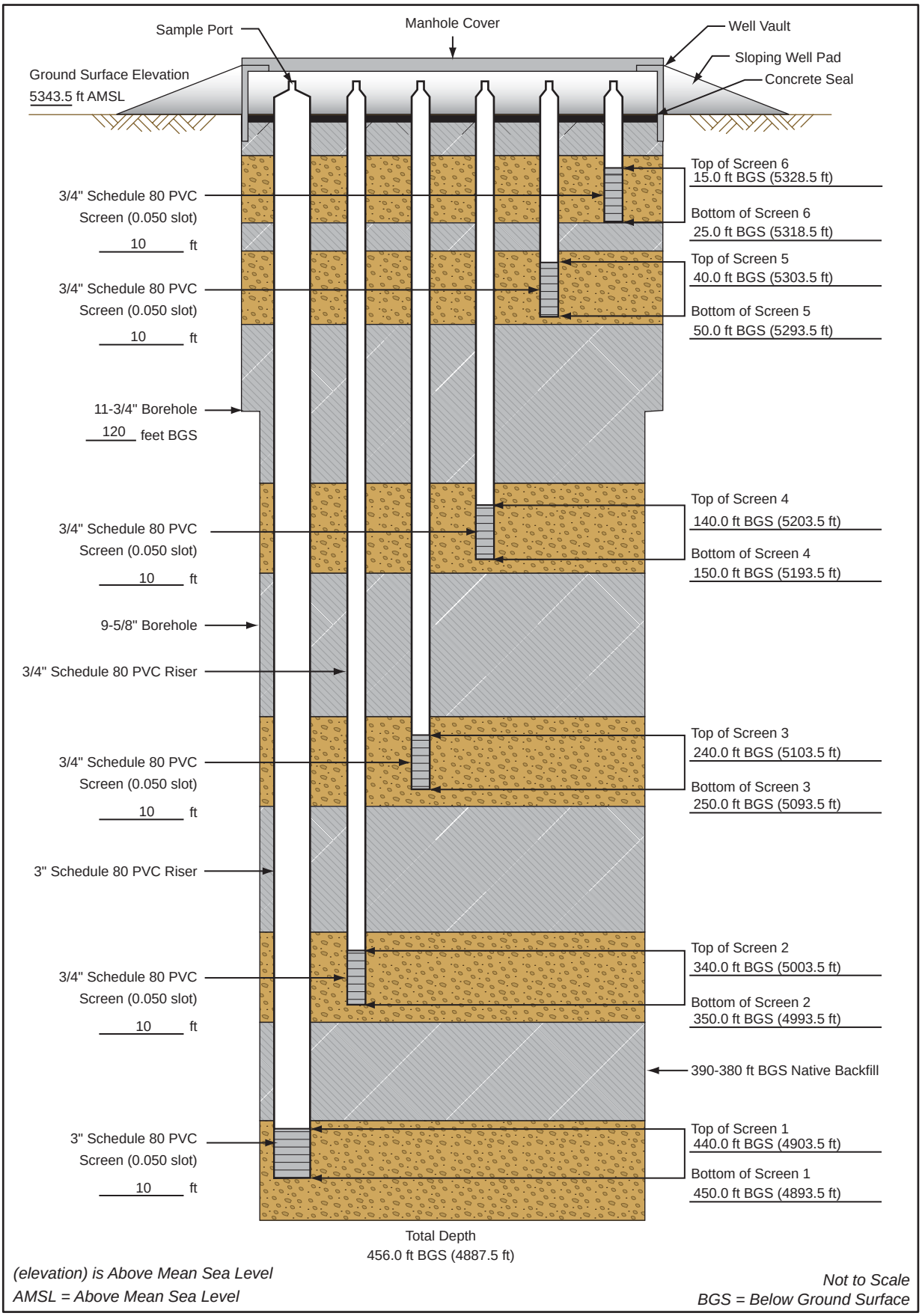


(elevation) is Above Mean Sea Level
All Materials Placed with Tremie Pipe

Not to Scale
BGS = Below Ground Surface

Nested Soil Vapor Well Completion Diagram for KAFB-106119

Installation Start Date/Time: 3/5/2011 @ 8:00
Installation End Date/Time: 3/6/2011 @ 15:00

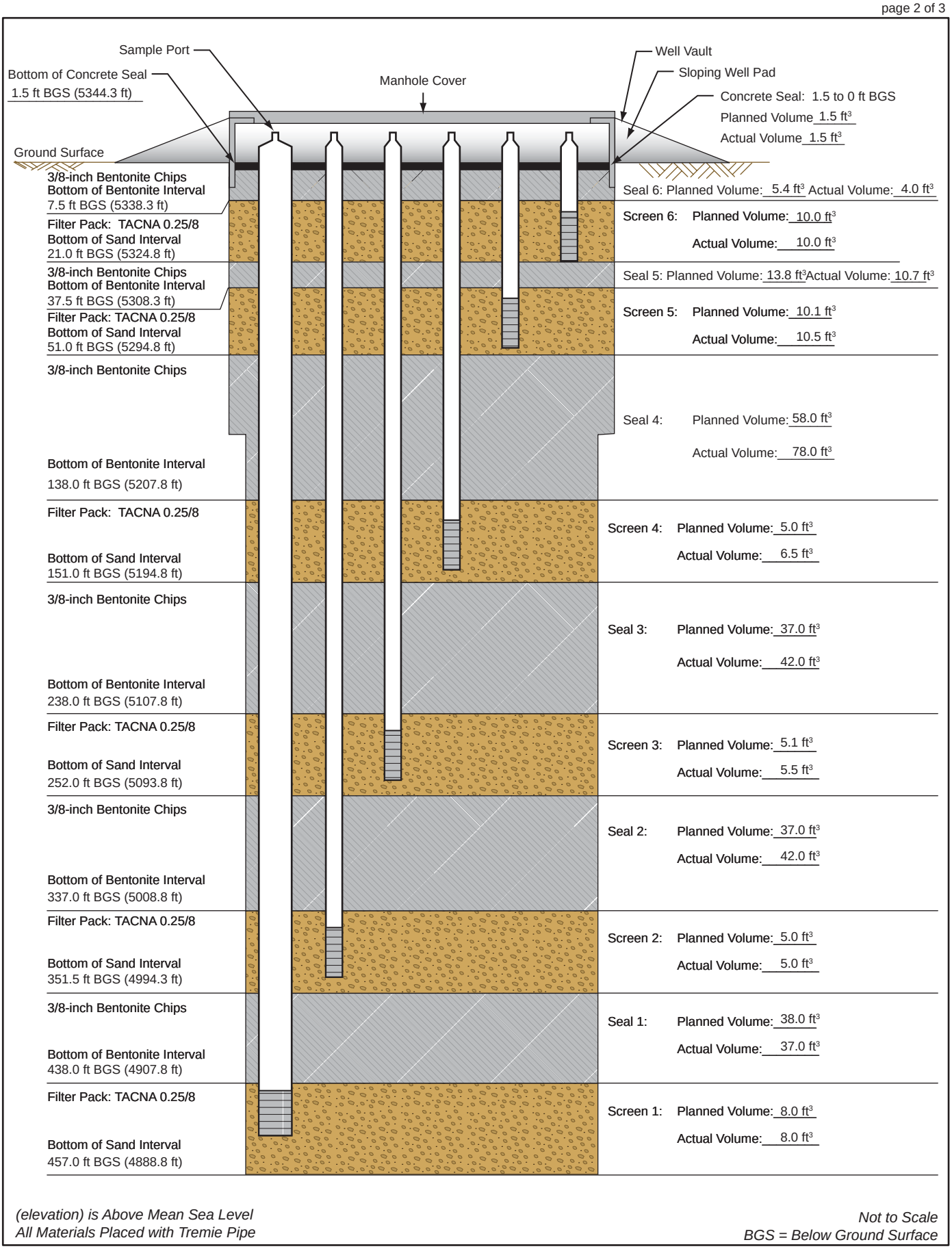


(elevation) is Above Mean Sea Level
AMSL = Above Mean Sea Level

Not to Scale
BGS = Below Ground Surface

140705_CA010020_SV_KAFB.106119 (a)

Nested Soil Vapor Well Completion Diagram for KAFB-106113

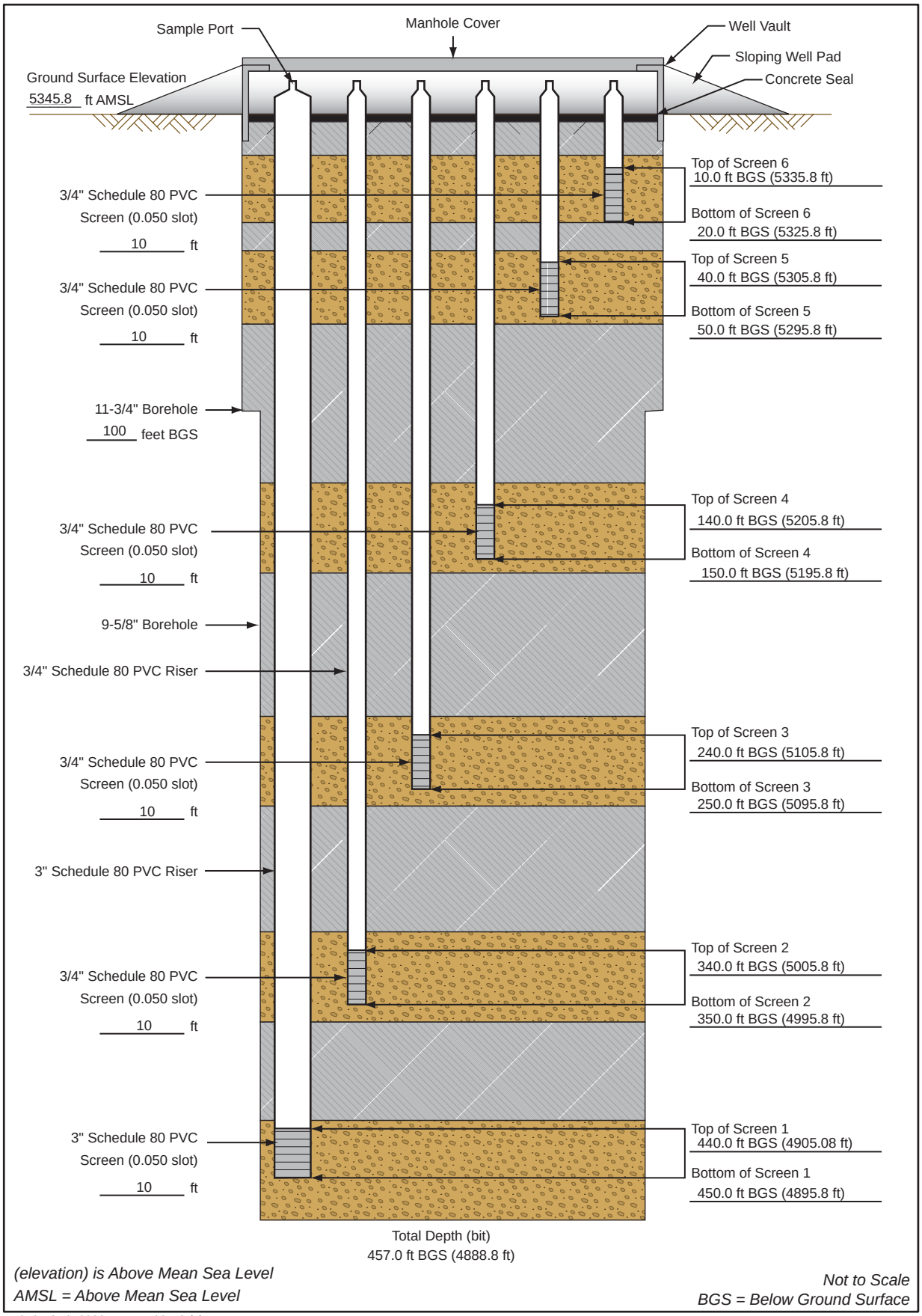


(elevation) is Above Mean Sea Level
All Materials Placed with Tremie Pipe

Not to Scale
BGS = Below Ground Surface

Nested Soil Vapor Well Completion Diagram for KAFB-106113

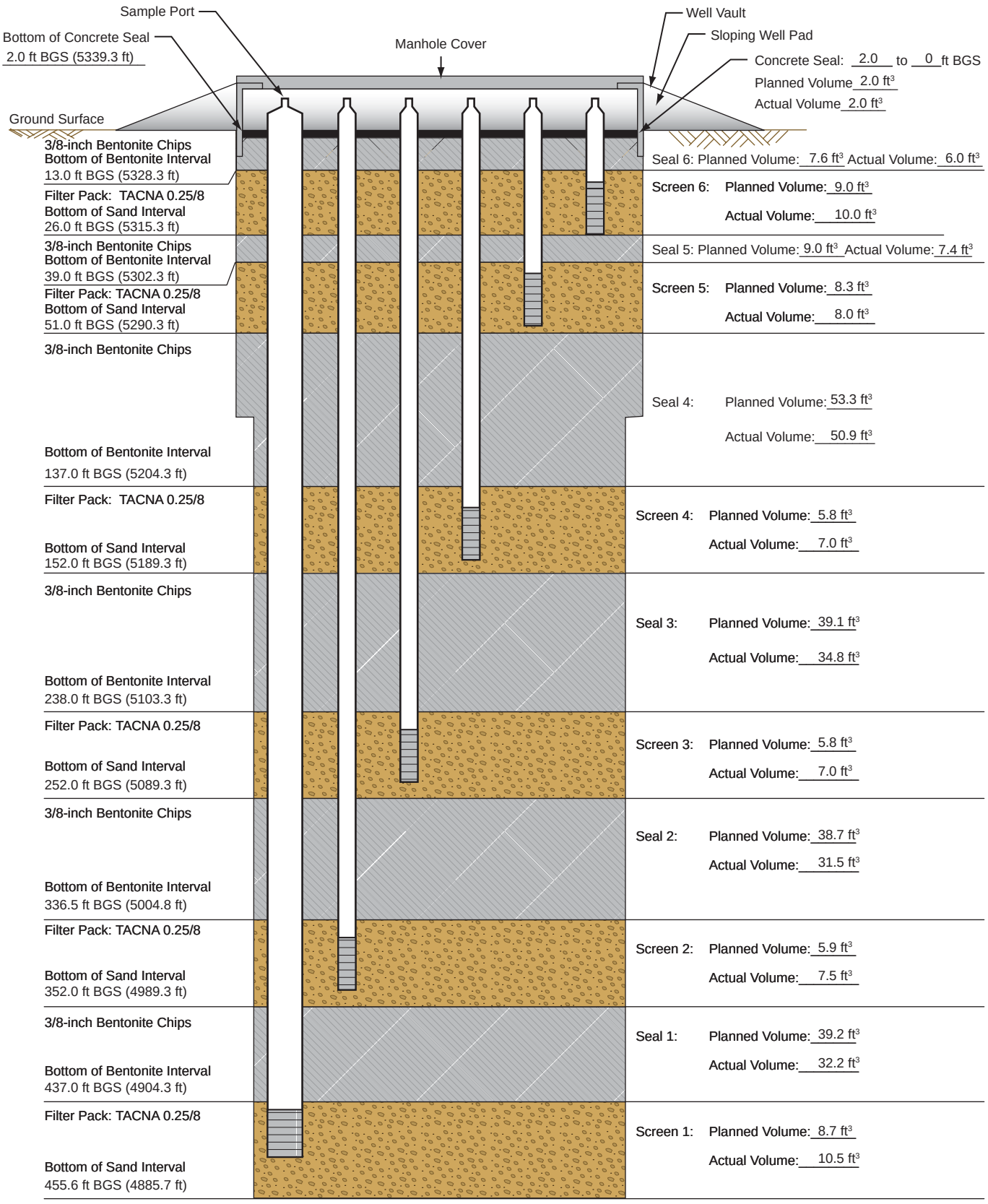
Installation Start Date/Time: 2/5/2011 @ 08:08
Installation End Date/Time: 2/8/2011 @ 10:51



(elevation) is Above Mean Sea Level
AMSL = Above Mean Sea Level

Not to Scale
BGS = Below Ground Surface

Nested Soil Vapor Well Completion Diagram for KAFB-106111

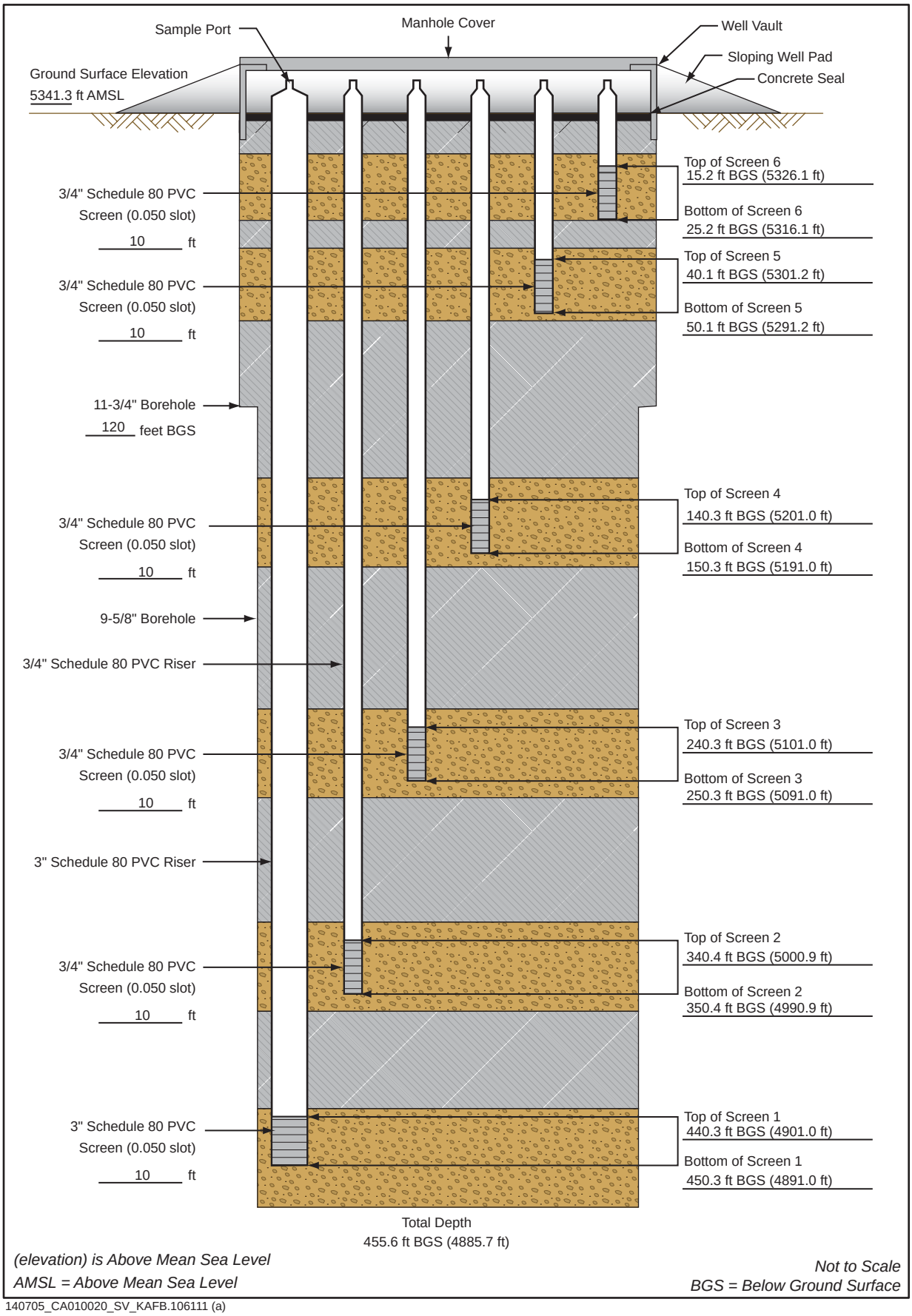


(elevation) is Above Mean Sea Level
All Materials Placed with Tremie Pipe

Not to Scale
BGS = Below Ground Surface

Nested Soil Vapor Well Completion Diagram for KAFB-106111

Installation Start Date/Time: 3/3/2011 @ 10:35
Installation End Date/Time: 3/4/2011 @ 16:25



(elevation) is Above Mean Sea Level
AMSL = Above Mean Sea Level

Not to Scale
BGS = Below Ground Surface

140705_CA010020_SV_KAFB.106111 (a)

Borehole ID: KAFB-106111

Client: US Army Corps of Engineers
Project Location: KAFB, Albuquerque, NM
Project Name: KAFB BFF SWMU ST-106 and SS-111
Project Number: 140705

Date Started: 3/1/2011
Date TD Reached: 3/3/2011
Date Completed: 3/4/2011

Ground Elevation AMSL (ft): 5341.3
Y Coordinate: 1473288.69
X Coordinate: 1541336.23

Hole Diameter Upper (in.): 11-3/4
Hole Diameter Lower (in.): 9-5/8
Surface Completion Type: Flush mount

Groundwater Levels BGS (ft):
At Time of Drilling: N/A
At End of Drilling: N/A
After Drilling: N/A

Drillling Contractor: WDC Drilling
Drilling Method: Air Rotary Casing Hammer
Logged By: Patrick Ostrye

Depth (ft)	Sample Type	Number	Headspace PID	Lithologic Log	Material Description	U.S.C.S.	Well Diagram	Remarks
0					No description recorded; disturbed.		Concrete Seal	Hand augered.
5					Silty SAND (SM); light reddish brown (2.5YR 6/4); dry; loose; 55% very fine to fine sand; 5% very coarse sand; 10% gravel to 4mm; subrounded; 30% silt.			Began drilling @ 1220 on 3/1/11.
		SB0043	0.0				Bentonite Seal	Blow counts (7-8.5'): 75/Not Recorded. Blow counts (8.5-10'): 100/Not Recorded. Blow counts (10-11.5'): Not Recorded.
10		SB0044	0.0		Silty SAND (SM); reddish brown (2.5YR 4/4); dry; very dense; 55% very fine to fine sand; 5% gravel to 4mm; subrounded to rounded; 40% silt; mottling throughout. Note: small piece of wood (10mm) in split spoon sample.			
		SB0044					Top of Filter Pack	
15					Silty SAND (SM); reddish brown (2.5YR 4/4); dry; medium dense; 50% very fine to fine sand; 5% coarse sand; 45% silt.		Top of 3/4" Schedule 80 PVC 0.050 Slot Screen	
		SB0045	0.0			SM		Blow counts (17-18.5'): 100/Not Recorded. Blow counts (18.5-20'): 100/Not Recorded. Petroleum odor @ 18'.
20		SB0045			Silty SAND (SM); light reddish brown (2.5YR 7/3); dry; very dense; 55% very fine to fine sand; 5% very coarse sand; 40% silt; very mottled throughout.			
25					Silty SAND (SM); reddish brown (2.5YR 4/3); moist; medium dense; 55% very fine to fine sand; 45% silt.		Bottom of Screen	
		SB0046 SB0046-MS	0.0				Bentonite Seal	Blow counts (27-28.5'): 50/35/20. Blow counts (28.5-30'): 50/25/15.
30		SB0046-MSD	0.0					

Borehole ID: KAFB-106111

Client: US Army Corps of Engineers
Project Location: KAFB, Albuquerque, NM
Project Name: KAFB BFF SWMU ST-106 and SS-111
Project Number: 140705

Date Started: 3/1/2011
Date TD Reached: 3/3/2011
Date Completed: 3/4/2011

Ground Elevation AMSL (ft): 5341.3
Y Coordinate: 1473288.69
X Coordinate: 1541336.23

Hole Diameter Upper (in.): 11-3/4
Hole Diameter Lower (in.): 9-5/8
Surface Completion Type: Flush mount

Groundwater Levels BGS (ft):
At Time of Drilling: N/A
At End of Drilling: N/A
After Drilling: N/A

Drillling Contractor: WDC Drilling
Drilling Method: Air Rotary Casing Hammer
Logged By: Patrick Ostrye

Depth (ft)	Sample Type	Number	Headspace PID	Lithologic Log	Material Description	U.S.C.S.	Well Diagram	Remarks
30					Silty SAND (SM); reddish brown (2.5YR 4/3); moist; medium dense; 55% very fine to fine sand; 45% silt.			New 10' connection @ 1440. Resumed drilling @ 1448.
35					Silty SAND (SM); reddish brown (2.5YR 5/4); moist; medium dense; 55% very fine to fine sand; trace gravel; 35% silt; 10% clay; nonplastic; some mottling.		- Bentonite Seal	
		SB0047	0.0					Blow counts (37-38.5'): 20/30/50.
40					Silty SAND (SM); reddish brown (2.5YR 5/4); dry; medium dense; 60% very fine to fine sand; trace gravel to 4mm; rounded; 40% silt; mottling throughout.		- Top of Filter Pack - Top of 3/4" Schedule 80 PVC 0.050 Slot Screen	New 10' connection @ 1505. Resumed drilling @ 1515.
45					Silty SAND (SM); reddish brown (2.5YR 4/4); moist; medium dense; 65% very fine to fine and coarse sand; 5% gravel to 3mm; rounded; 30% silt; mica flakes throughout.	SM		
		SB0048	0.0					Blow counts (47-48.5'): 20/30/50.
50					Silty SAND (SM); reddish brown (2.5YR 4/4); moist; medium dense; 70% very fine to fine sand; trace gravel; 30% silt.		- Bottom of Screen	New 10' connection @ 1530. Resumed drilling @ 1540.
55					Silty SAND with Gravel (SM); reddish brown (2.5YR 4/3); moist; loose; 60% very fine to fine sand; 15% gravel to 15mm; subangular to subrounded; 25% silt.		- Bentonite Seal	
60								

Borehole ID: KAFB-106111

Client: US Army Corps of Engineers
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Project Name: KAFB BFF SWMU ST-106 and SS-111
Project Number: 140705

Date Started: 3/1/2011
Date TD Reached: 3/3/2011
Date Completed: 3/4/2011

Ground Elevation AMSL (ft): 5341.3
Y Coordinate: 1473288.69
X Coordinate: 1541336.23

Hole Diameter Upper (in.): 11-3/4
Hole Diameter Lower (in.): 9-5/8
Surface Completion Type: Flush mount

Groundwater Levels BGS (ft):
At Time of Drilling: N/A
At End of Drilling: N/A
After Drilling: N/A

Drillling Contractor: WDC Drilling
Drilling Method: Air Rotary Casing Hammer
Logged By: Patrick Ostrye

Depth (ft)	Sample Type	Number	Headspace PID	Lithologic Log	Material Description	U.S.C.S.	Well Diagram	Remarks
60					Silty SAND (SM); reddish brown (2.5YR 4/3); moist; loose; 60% very fine to fine sand; 40% silt.			New 20' connection @ 1545. Resumed drilling @ 1550.
65					Same as above (60 ft).			
70					Same as above (60 ft).			
75					Silty SAND (SM); reddish brown (2.5YR 5/4); moist; loose; 85% fine sand; 15% silt.	SM	Bentonite Seal	
80					Silty SAND (SM); yellowish red (5YR 5/6); moist; loose; 85% very fine to fine sand; 15% silt.			New 20' connection @ 1605.
85					Silty SAND (SM); yellowish red (5YR 5/6); moist; loose; 80% fine sand; 3% gravel to 20mm; subrounded to rounded; 17% silt.			
90								

Borehole ID: KAFB-106111

Client: US Army Corps of Engineers
Project Location: KAFB, Albuquerque, NM
Project Name: KAFB BFF SWMU ST-106 and SS-111
Project Number: 140705

Date Started: 3/1/2011
Date TD Reached: 3/3/2011
Date Completed: 3/4/2011

Ground Elevation AMSL (ft): 5341.3
Y Coordinate: 1473288.69
X Coordinate: 1541336.23

Hole Diameter Upper (in.): 11-3/4
Hole Diameter Lower (in.): 9-5/8
Surface Completion Type: Flush mount

Groundwater Levels BGS (ft):
At Time of Drilling: N/A
At End of Drilling: N/A
After Drilling: N/A

Drillling Contractor: WDC Drilling
Drilling Method: Air Rotary Casing Hammer
Logged By: Patrick Ostrye

Depth (ft)	Sample Type	Number	Headspace PID	Lithologic Log	Material Description	U.S.C.S.	Well Diagram	Remarks
90					Poorly graded SAND (SP); reddish brown (5YR 5/4); moist; loose; 97% fine to medium sand; 3% gravel to 15mm; subrounded to rounded.			
95					Poorly graded SAND (SP); pinkish gray (5YR 7/2); dry; loose; 100% very fine to medium sand.			
		SB0049	0.9					Blow counts (97-98.5'): 30/50.
100					Poorly graded SAND (SP); pinkish gray (5YR 7/2); dry; dense; 100% very fine to medium sand. Note: split spoon contained 2" section of cemented sand.			Resumed drilling @ 1645.
105					Poorly graded SAND (SP); pinkish gray (5YR 7/2); dry; loose; 100% very fine to medium sand. Note: fragments of cemented very fine sand and silt.	SP	Bentonite Seal	
110					Poorly graded SAND with Gravel (SP); moist; loose; 60% fine and coarse to very coarse sand; 40% gravel to 20mm; angular to subrounded.			
115					Poorly graded SAND (SP); moist; loose; 100% very fine to fine sand.			
120								

Borehole ID: KAFB-106111

Client: US Army Corps of Engineers
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Project Name: KAFB BFF SWMU ST-106 and SS-111
Project Number: 140705

Date Started: 3/1/2011
Date TD Reached: 3/3/2011
Date Completed: 3/4/2011

Ground Elevation AMSL (ft): 5341.3
Y Coordinate: 1473288.69
X Coordinate: 1541336.23

Hole Diameter Upper (in.): 11-3/4
Hole Diameter Lower (in.): 9-5/8
Surface Completion Type: Flush mount

Groundwater Levels BGS (ft):
At Time of Drilling: N/A
At End of Drilling: N/A
After Drilling: N/A

Drillling Contractor: WDC Drilling
Drilling Method: Air Rotary Casing Hammer
Logged By: Patrick Ostrye

Depth (ft)	Sample Type	Number	Headspace PID	Lithologic Log	Material Description	U.S.C.S.	Well Diagram	Remarks
120					Silty SAND (SM); reddish brown (2.5YR 4/3); moist; loose; 60% very fine to fine sand; 40% silt.	SM		End of 3/1/11 @ 1645. Resumed drilling @ 1010 on 3/2/11, advancing with 9-5/8" casing.
125					Silty SAND (SM); reddish brown (5YR 5/3); moist; loose; 55% very fine to fine sand; 35% silt; 10% clay; nonplastic.			
130					Poorly graded SAND (SP); reddish brown (5YR 5/4); moist; very loose; 100% medium to coarse sand.	SP	- Bentonite Seal	
135					Poorly graded SAND (SP); light reddish brown (5YR 6/4); moist; very loose; 100% medium to very coarse sand.		- Top of Filter Pack	
140					Poorly graded SAND with Gravel (SP); light reddish brown (5YR 6/4); moist; very loose; 85% fine to coarse sand; 15% gravel to 4mm; subrounded.		- Top of 3/4" Schedule 80 PVC 0.050 Slot Screen	New 10' connection @ 1020.
145					Poorly graded SAND (SP); light reddish brown (5YR 6/4); moist; very loose; 100% fine to coarse sand.			
		SB0050	0.0					Blow counts (147-148.5'): 50/30/20. Blow counts (148.5-150'): Not Recorded.
150		SB0050			Poorly graded SAND with Gravel (SP); pinkish gray (5YR 6/2); moist; dense; 85% medium to very coarse sand; 15%			

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Project Number: 140705

Date Started: 3/1/2011
Date TD Reached: 3/3/2011
Date Completed: 3/4/2011

Ground Elevation AMSL (ft): 5341.3
Y Coordinate: 1473288.69
X Coordinate: 1541336.23

Hole Diameter Upper (in.): 11-3/4
Hole Diameter Lower (in.): 9-5/8
Surface Completion Type: Flush mount

Groundwater Levels BGS (ft):
At Time of Drilling: N/A
At End of Drilling: N/A
After Drilling: N/A

Drillling Contractor: WDC Drilling
Drilling Method: Air Rotary Casing Hammer
Logged By: Patrick Ostrye

Depth (ft)	Sample Type	Number	Headspace PID	Lithologic Log	Material Description	U.S.C.S.	Well Diagram	Remarks
150					gravel to 10mm; angular to rounded. Note: split spoon contained cemented fragments to 45mm.	SP	Bottom of Screen	
					Poorly graded GRAVEL with Sand (GP); moist; very loose; 70% gravel to 35mm; subrounded to rounded; 30% medium to very coarse sand.	GP		
155								
					Poorly graded SAND (SP); pinkish gray (5YR 7/2); moist; very loose; 90% medium to very coarse sand; 10% gravel to 10mm; subrounded to rounded.			
160					Same as above (156 ft).			New 20' connection @ 1105.
165					Poorly graded SAND (SP); light reddish brown (5YR 6/3); moist; very loose; 95% fine to medium sand; 5% gravel to 4mm; subangular to subrounded.	SP	Bentonite Seal	
170					Poorly graded SAND (SP); reddish brown (5YR 5/4); moist; very loose; 90% fine to coarse sand; 10% gravel to 4mm; subrounded.			
175					Poorly graded SAND (SP); reddish brown (5YR 5/4); moist; very loose; 90% fine to medium sand; 10% gravel to 4mm; subrounded.			
180								

Borehole ID: KAFB-106111

Client: US Army Corps of Engineers
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Project Name: KAFB BFF SWMU ST-106 and SS-111
Project Number: 140705

Date Started: 3/1/2011
Date TD Reached: 3/3/2011
Date Completed: 3/4/2011

Ground Elevation AMSL (ft): 5341.3
Y Coordinate: 1473288.69
X Coordinate: 1541336.23

Hole Diameter Upper (in.): 11-3/4
Hole Diameter Lower (in.): 9-5/8
Surface Completion Type: Flush mount

Groundwater Levels BGS (ft):
At Time of Drilling: N/A
At End of Drilling: N/A
After Drilling: N/A

Drillling Contractor: WDC Drilling
Drilling Method: Air Rotary Casing Hammer
Logged By: Patrick Ostrye

Depth (ft)	Sample Type	Number	Headspace PID	Lithologic Log	Material Description	U.S.C.S.	Well Diagram	Remarks
180					Poorly graded SAND with Gravel (SP); reddish brown (5YR 5/4); moist; very loose; 85% fine to medium sand; 15% gravel to 10mm; subangular to subrounded.			New 20' connection @ 1120. Resumed drilling @ 1125.
185					Poorly graded SAND with Gravel (SP); reddish brown (5YR 5/4); moist; very loose; 80% medium to very coarse sand; 20% gravel to 10mm; subangular to rounded.	SP		
190					No cuttings returned; casing fell too fast to collect sample.			
195					Poorly graded SAND with Gravel (SP); reddish brown (5YR 5/4); moist; very loose; 60% medium to very coarse sand; 40% gravel to 7mm; subangular to rounded.	SP	Bentonite Seal	
		SB0051	0.0					Blow counts (197-198.5'): 50/50.
200					Poorly graded GRAVEL with Sand (GP); moist; very dense; 60% gravel to 30mm; subrounded to rounded; 40% medium to coarse sand.	GP		New 20' connection @ 1140. Resumed drilling @ 1220.
205					Clayey SAND (SC); light yellowish brown (2.5YR 6/3); moist; medium dense; 80% fine to medium sand; 15% clay; 5% silt.	SC		
210								

Borehole ID: KAFB-106111

Client: US Army Corps of Engineers
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Project Name: KAFB BFF SWMU ST-106 and SS-111
Project Number: 140705

Date Started: 3/1/2011
Date TD Reached: 3/3/2011
Date Completed: 3/4/2011

Ground Elevation AMSL (ft): 5341.3
Y Coordinate: 1473288.69
X Coordinate: 1541336.23

Hole Diameter Upper (in.): 11-3/4
Hole Diameter Lower (in.): 9-5/8
Surface Completion Type: Flush mount

Groundwater Levels BGS (ft):
At Time of Drilling: N/A
At End of Drilling: N/A
After Drilling: N/A

Drillling Contractor: WDC Drilling
Drilling Method: Air Rotary Casing Hammer
Logged By: Patrick Ostrye

Depth (ft)	Sample Type	Number	Headspace PID	Lithologic Log	Material Description	U.S.C.S.	Well Diagram	Remarks
210					Poorly graded SAND with Gravel (SP); yellowish brown (10YR 5/4); moist; very loose; 85% fine to coarse sand; 15% gravel to 20mm; subrounded to rounded.			
215					Poorly graded SAND with Gravel (SP); light brownish gray (10YR 6/2); moist; very loose; 70% sand; 30% gravel to 15mm; subangular.			
220					Poorly graded SAND with Gravel (SP); light brownish gray (10YR 6/2); moist; very loose; 85% fine to coarse sand; 15% gravel to 4mm; subangular to rounded; gravel is pumice.	SP	- Bentonite Seal	New 20' connection @ 1225. Resumed drilling @ 1235.
225					Poorly graded SAND with Gravel (SP); light brownish gray (10YR 6/2); moist; very loose; 85% fine to coarse sand; 15% gravel to 15mm; angular to subrounded; gravel is pumice.			
230					Well graded SAND with Gravel (SW); light gray (7.5YR 7/1); moist; very loose; 60% sand; 40% gravel to 20mm; subangular to subrounded.			
235					Well graded SAND with Gravel (SW); light brownish gray (10YR 6/2); moist; very loose; 60% sand; 40% gravel to 20mm; subangular to rounded.	SW	- Top of Filter Pack	
240								

Borehole ID: KAFB-106111

Client: US Army Corps of Engineers
Project Location: KAFB, Albuquerque, NM
Project Name: KAFB BFF SWMU ST-106 and SS-111
Project Number: 140705

Date Started: 3/1/2011
Date TD Reached: 3/3/2011
Date Completed: 3/4/2011

Ground Elevation AMSL (ft): 5341.3
Y Coordinate: 1473288.69
X Coordinate: 1541336.23

Hole Diameter Upper (in.): 11-3/4
Hole Diameter Lower (in.): 9-5/8
Surface Completion Type: Flush mount

Groundwater Levels BGS (ft):
At Time of Drilling: N/A
At End of Drilling: N/A
After Drilling: N/A

Drillling Contractor: WDC Drilling
Drilling Method: Air Rotary Casing Hammer
Logged By: Patrick Ostrye

Depth (ft)	Sample Type	Number	Headspace PID	Lithologic Log	Material Description	U.S.C.S.	Well Diagram	Remarks
240					Well graded SAND with Gravel (SW); light brownish gray (10YR 6/2); dry; very loose; 75% sand; 25% gravel to 15mm; subangular to rounded.	SW	Top of 3/4" Schedule 80 PVC 0.050 Slot Screen	New 10' connection @ 1240. Resumed drilling @ 1250.
245					Well graded SAND with Gravel (SW); pinkish gray (7.5YR 6/2); dry; very loose; 80% sand; 20% gravel to 7mm; subangular to rounded; pumice present.			
		SB0052	0.7					Blow counts (247-248.5'): 50/Not Recorded. Blow counts (248.5-250'): 60/Not Recorded.
250		SB0052			Poorly graded SAND (SP); pinkish gray (5YR 6/2); moist; very dense; 100% very fine to medium sand; trace gravel.	SP	Bottom of Screen	New 10' connection @ 1315.
255					Poorly graded SAND (SP); pinkish gray (7.5YR 6/2); moist; very loose; 100% fine to medium sand; coarse pumice fragments.			
260					Silty SAND (SM); reddish brown (5YR 5/4); moist; medium dense; 60% very fine to medium sand; 40% silt.	SM	Bentonite Seal	New 20' connection @ 1335. Resumed drilling @ 1340.
265					Same as above (258 ft).			
270								

Borehole ID: KAFB-106111

Client: US Army Corps of Engineers
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Project Number: 140705

Date Started: 3/1/2011
Date TD Reached: 3/3/2011
Date Completed: 3/4/2011

Ground Elevation AMSL (ft): 5341.3
Y Coordinate: 1473288.69
X Coordinate: 1541336.23

Hole Diameter Upper (in.): 11-3/4
Hole Diameter Lower (in.): 9-5/8
Surface Completion Type: Flush mount

Groundwater Levels BGS (ft):
At Time of Drilling: N/A
At End of Drilling: N/A
After Drilling: N/A

Drillling Contractor: WDC Drilling
Drilling Method: Air Rotary Casing Hammer
Logged By: Patrick Ostrye

Depth (ft)	Sample Type	Number	Headspace PID	Lithologic Log	Material Description	U.S.C.S.	Well Diagram	Remarks
270					Clayey SAND (SC); brown (7.5YR 4/4); moist; medium dense; 60% fine to medium sand; 20% clay; 20% silt; nonplastic.	SC		
275					Poorly graded SAND (SP); pale brown (10YR 6/3); moist; loose; 100% medium to very coarse sand.	SP		
280					Well graded SAND (SW); dry; loose; 95% sand; 5% gravel to 5mm; subangular to rounded.	SW		New 20' connection @ 1350. Resumed drilling @ 1400.
285					Poorly graded GRAVEL with Sand (GP); dry; medium dense; 60% gravel to 15mm; subangular to subrounded; 40% medium to very coarse sand.	GP	Bentonite Seal	
290					Poorly graded GRAVEL with Sand (GP); dry; medium dense; 50% gravel to 15mm; subangular to subrounded; 45% fine to very coarse sand; 5% silt.			
295					Well graded SAND with Gravel (SW); moist; medium dense; 60% sand; 40% gravel to 35mm; subrounded to rounded.	SW		
		SB0053	0.0					Blow counts (297-298.5'): 60/Not Recorded. Blow counts (298.5-300'): 67/Not Recorded.
300		SB0053			Poorly graded GRAVEL (GP); dry; very dense; 90% gravel to 25mm; angular to rounded; 10% medium to very coarse	GP		

Borehole ID: KAFB-106111

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Project Number: 140705

Date Started: 3/1/2011
Date TD Reached: 3/3/2011
Date Completed: 3/4/2011

Ground Elevation AMSL (ft): 5341.3
Y Coordinate: 1473288.69
X Coordinate: 1541336.23

Hole Diameter Upper (in.): 11-3/4
Hole Diameter Lower (in.): 9-5/8
Surface Completion Type: Flush mount

Groundwater Levels BGS (ft):
At Time of Drilling: N/A
At End of Drilling: N/A
After Drilling: N/A

Drillling Contractor: WDC Drilling
Drilling Method: Air Rotary Casing Hammer
Logged By: Patrick Ostrye

Depth (ft)	Sample Type	Number	Headspace PID	Lithologic Log	Material Description	U.S.C.S.	Well Diagram	Remarks
300					sand.			New 20' connection @ 1430. Resumed drilling @ 1435.
305					Poorly graded GRAVEL with Sand (GP); dry; medium dense; 55% gravel to 25mm; subangular to rounded; 45% coarse to very coarse sand.	GP		
310					Well graded SAND with Gravel (SW); light reddish brown (5YR 6/4); moist; medium dense; 60% sand; 40% gravel to 12mm; subrounded to rounded.	SW		
315					Poorly graded GRAVEL with Sand (GP); pale brown (10YR 6/3); moist; medium dense; 70% gravel to 30mm; subrounded to rounded; 30% medium to coarse sand.	GP	Bentonite Seal	
320					Well graded SAND with Gravel (SW); pale brown (10YR 6/3); moist; medium dense; 80% sand; 20% gravel to 10mm; subangular to subrounded.	SW		New 20' connection @ 1445. Resumed drilling @ 1450.
325					Poorly graded SAND (SP); pinkish gray (5YR 6/2); dry; loose; 95% medium to coarse sand; 5% gravel to 4mm; subangular to subrounded.	SP		
330								

Borehole ID: KAFB-106111

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Date TD Reached: 3/3/2011
Date Completed: 3/4/2011

Ground Elevation AMSL (ft): 5341.3
Y Coordinate: 1473288.69
X Coordinate: 1541336.23

Hole Diameter Upper (in.): 11-3/4
Hole Diameter Lower (in.): 9-5/8
Surface Completion Type: Flush mount

Groundwater Levels BGS (ft):
At Time of Drilling: N/A
At End of Drilling: N/A
After Drilling: N/A

Drillling Contractor: WDC Drilling
Drilling Method: Air Rotary Casing Hammer
Logged By: Patrick Ostrye

Depth (ft)	Sample Type	Number	Headspace PID	Lithologic Log	Material Description	U.S.C.S.	Well Diagram	Remarks
330					Well graded SAND with Gravel (SW); light brown (7.5YR 6/3); moist; loose; 80% sand; 20% gravel to 4mm; angular to subrounded.	SW	Bentonite Seal	
335					Well graded SAND with Clay and Gravel (SW-SC); brown (7.5YR 5/3); moist; loose; 70% sand; 20% gravel to 35mm; angular to rounded; 10% clay.	SW-SC	Top of Filter Pack	
340					Poorly graded SAND (SP); brown (7.5YR 5/3); moist; loose; 95% fine to medium sand; 5% gravel to 10mm; subangular to rounded.	SP	Top of 3/4" Schedule 80 PVC 0.050 Slot Screen	New 10' connection @ 1455. Resumed drilling @ 1505.
345					Well graded SAND with Gravel (SW); light brown (7.5YR 6/3); moist; medium dense; 60% sand; 40% gravel to 20mm; angular to rounded.	SW		
		SB0054	0.0					Blow counts (347-348.5'): 50/Not Recorded.
350					Poorly graded SAND with Gravel (SP); dry; dense; 85% medium to coarse sand; 15% gravel to 20mm; angular to rounded.	SP	Bottom of Screen	New 10' connection @ 1525.
355					Well graded SAND with Gravel (SW); pinkish gray (7.5YR 6/2); moist; loose; 85% sand; 15% gravel to 30mm; angular to rounded.	SW	Bentonite Seal	
360								

Borehole ID: KAFB-106111

Client: US Army Corps of Engineers
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Project Number: 140705

Date Started: 3/1/2011
Date TD Reached: 3/3/2011
Date Completed: 3/4/2011

Ground Elevation AMSL (ft): 5341.3
Y Coordinate: 1473288.69
X Coordinate: 1541336.23

Hole Diameter Upper (in.): 11-3/4
Hole Diameter Lower (in.): 9-5/8
Surface Completion Type: Flush mount

Groundwater Levels BGS (ft):
At Time of Drilling: N/A
At End of Drilling: N/A
After Drilling: N/A

Drillling Contractor: WDC Drilling
Drilling Method: Air Rotary Casing Hammer
Logged By: Patrick Ostrye

Depth (ft)	Sample Type	Number	Headspace PID	Lithologic Log	Material Description	U.S.C.S.	Well Diagram	Remarks
360					Poorly graded SAND with Gravel (SP); light brown (7.5YR 6/3); moist; loose; 85% fine to very coarse sand; 15% gravel to 25mm; angular to rounded.	SP		New 20' connection @ 1525. Resumed drilling @ 1545.
365					Well graded SAND (SW); pinkish gray (5YR 6/2); dry; loose; 95% sand; 5% gravel to 15mm; subangular to rounded.			
370					Well graded SAND with Gravel (SW); pinkish gray (5YR 6/2); moist; loose; 85% sand; 15% gravel to 50mm; subangular to rounded.			
375					Well graded SAND (SW); pinkish gray (5YR 6/2); moist; loose; 95% sand; 5% gravel to 15mm; subangular to rounded.	SW	Bentonite Seal	
380					Well graded SAND with Gravel (SW); pinkish gray (7.5YR 6/2); moist; loose; 70% sand; 30% gravel to 20mm; subangular to rounded.			New 20' connection @ 1550. Resumed drilling @ 1600.
385					Well graded SAND with Gravel (SW); dry; dense; 85% sand; 15% gravel to 10mm; angular to rounded.			
390								

Borehole ID: KAFB-106111

Client: US Army Corps of Engineers
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Project Name: KAFB BFF SWMU ST-106 and SS-111
Project Number: 140705

Date Started: 3/1/2011
Date TD Reached: 3/3/2011
Date Completed: 3/4/2011

Ground Elevation AMSL (ft): 5341.3
Y Coordinate: 1473288.69
X Coordinate: 1541336.23

Hole Diameter Upper (in.): 11-3/4
Hole Diameter Lower (in.): 9-5/8
Surface Completion Type: Flush mount

Groundwater Levels BGS (ft):
At Time of Drilling: N/A
At End of Drilling: N/A
After Drilling: N/A

Drillling Contractor: WDC Drilling
Drilling Method: Air Rotary Casing Hammer
Logged By: Patrick Ostrye

Depth (ft)	Sample Type	Number	Headspace PID	Lithologic Log	Material Description	U.S.C.S.	Well Diagram	Remarks
390					Poorly graded SAND (SP); light brown (7.5YR 6/4); moist; dense; 100% medium sand.	SP		
395					Silty SAND (SM); light brown (7.5YR 6/4); dry; dense; 50% very fine to medium sand; 5% gravel to 5mm; subrounded to rounded; 35% silt; 10% clay; nonplastic.	SM		
					Clayey SAND (SC); light gray (10YR 7/1); moist; dense; 55% very fine to fine sand; 35% clay; 10% silt; low plasticity.	SC		
		SB0055	0.0					Blow counts (397-398.5'): 50/40. Blow counts (398.5-400'): 50/40.
400		SB0056	0.0		Poorly graded SAND (SP); light reddish brown (5YR 6/4); dry; dense; 100% fine to coarse sand.			Resumed drilling @ 1650.
405					Same as above (398 ft).		Bentonite Seal	
410					Same as above (398 ft).	SP		
415					Same as above (398 ft).			
420								

Borehole ID: KAFB-106111

Client: US Army Corps of Engineers
Project Location: KAFB, Albuquerque, NM
Project Name: KAFB BFF SWMU ST-106 and SS-111
Project Number: 140705

Date Started: 3/1/2011
Date TD Reached: 3/3/2011
Date Completed: 3/4/2011

Ground Elevation AMSL (ft): 5341.3
Y Coordinate: 1473288.69
X Coordinate: 1541336.23

Hole Diameter Upper (in.): 11-3/4
Hole Diameter Lower (in.): 9-5/8
Surface Completion Type: Flush mount

Groundwater Levels BGS (ft):
At Time of Drilling: N/A
At End of Drilling: N/A
After Drilling: N/A

Drillling Contractor: WDC Drilling
Drilling Method: Air Rotary Casing Hammer
Logged By: Patrick Ostrye

Depth (ft)	Sample Type	Number	Headspace PID	Lithologic Log	Material Description	U.S.C.S.	Well Diagram	Remarks
420					Silty SAND (SM); brown (7.5YR 5/4); moist; medium dense; 60% very fine to medium sand; 40% silt.			New 20' connection @ 1655.
425					Silty SAND (SM); brown (7.5YR 5/4); moist; loose; 60% very fine to medium sand; 40% silt.	SM	- Bentonite Seal	
430					Silty SAND (SM); brown (7.5YR 5/4); moist; loose; 60% very fine to medium sand; trace gravel to 40mm; 25% silt; 15% clay; nonplastic.			
435					Poorly graded SAND (SP); light reddish brown (5YR 6/3); moist; loose; 95% very fine to medium sand; trace gravel to 30mm; 5% silt.		- Top of Filter Pack	
440					Same as above (435 ft).	SP	- Top of 3" Schedule 80 PVC 0.050 Slot Screen	
445					Poorly graded SAND (SP); light reddish brown (5YR 6/3); moist; loose; 100% very fine to medium sand.			End of 3/2/11. Resumed drilling @ 0755 on 3/3/11.
		SB0057	0.0					Blow count (447-448.5'): 50/45.
450					Poorly graded SAND (SP); pinkish gray (7.5YR 6/2); moist; dense; 100% fine to medium sand.			

Borehole ID: KAFB-106111

Client: US Army Corps of Engineers
Project Location: KAFB, Albuquerque, NM
Project Name: KAFB BFF SWMU ST-106 and SS-111
Project Number: 140705

Date Started: 3/1/2011
Date TD Reached: 3/3/2011
Date Completed: 3/4/2011

Ground Elevation AMSL (ft): 5341.3
Y Coordinate: 1473288.69
X Coordinate: 1541336.23

Hole Diameter Upper (in.): 11-3/4
Hole Diameter Lower (in.): 9-5/8
Surface Completion Type: Flush mount

Groundwater Levels BGS (ft):
At Time of Drilling: N/A
At End of Drilling: N/A
After Drilling: N/A

Drillling Contractor: WDC Drilling
Drilling Method: Air Rotary Casing Hammer
Logged By: Patrick Ostrye

Depth (ft)	Sample Type	Number	Headspace PID	Lithologic Log	Material Description	U.S.C.S.	Well Diagram	Remarks
450					Poorly graded SAND (SP); pinkish gray (7.5YR 6/2); moist; dense; 100% fine to medium sand.	SP	Bottom of Screen	New 10' connection @ 0810. Resumed drilling @ 0815.
455					Same as above (450 ft).		Bottom of Filter Pack	
460					Well graded SAND (SW); brown (7.5YR 4/3); moist; medium dense; 100% sand.	SW	Native Backfill	Total depth = 460 ft. Reached @ 0820 on 3/3/11.
465								Water added during drilling (gallons) = 0
470								Water added during construction (gallons) = 320
475								
480								

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
	KAFB-10628	SHEET 1 OF 1

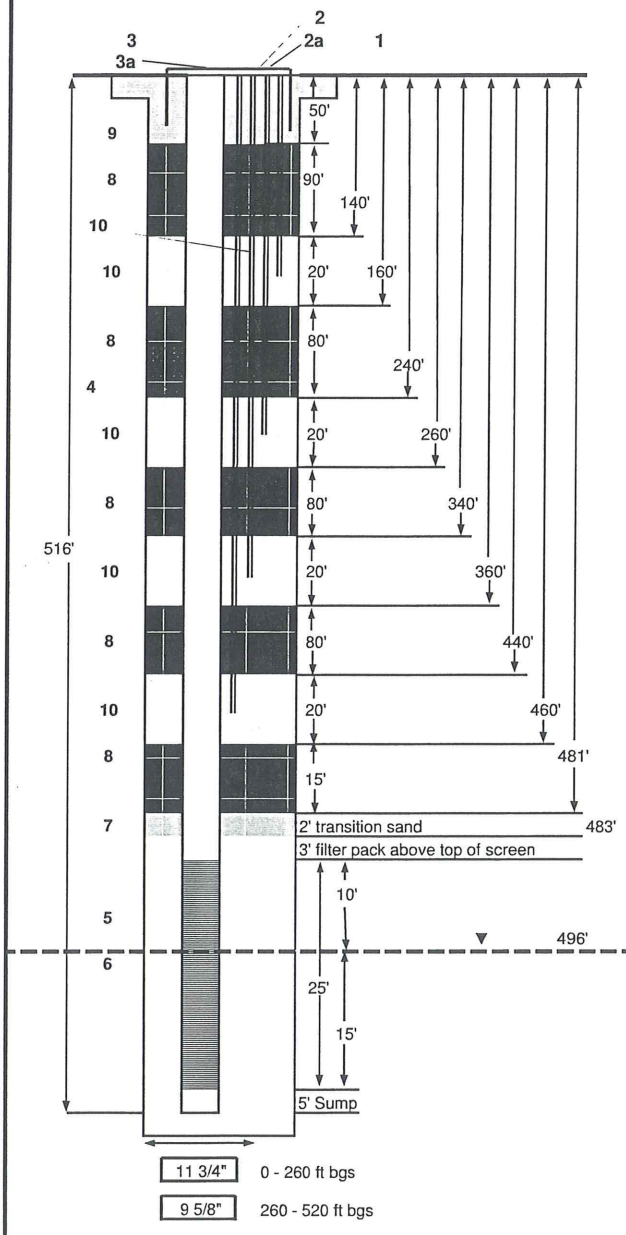
WELL COMPLETION DIAGRAM

PROJECT : KAFB Bulk Fuels Facility, LOCATION : USS Bullhead Park

DRILLING CONTRACTOR : WDC Exploration & Wells COORDINATES : TBD

DRILLING METHOD AND EQUIPMENT USED : Air Rotary Casing Hammer, Speedstar 30K DRILLER: Lee Alymer

WATER LEVEL : 496' START : 5/4/2010 END : 5/16/2010 LOGGER : W.Conway and M.Brislen



Not to scale

1- Ground elevation at well	TBD
2- Top of casing elevation	Surface elevation
a) vent hole?	no
3- Wellhead protection cover type	Surface completion
a) weep hole?	no
b) concrete pad dimensions	4' x 4'
4- Dia./type of well casing	4" schedule 80 PVC
5- Type/slot size of screen	Stainless Steel 0.010" slot
6- Type screen filter	10-20 Colorado Silica Sand
a) thickness installed	
7- Transition sand	20-40 Colorado Silica Sand
a) thickness installed	
8- Type of seal	Hydrated bentonite chips
a) thickness installed	
9- Cement	
a) Cement mix used	portland cement grout
b) thickness installed	50' (from ground surface to 50' bgs)
10- Dia./type of vapor wells	3/4" PVC vapor wells to be installed with 2.5' of 0.050" slot PVC screen and 8-16 Colorado Silica Sand filter pack. Installed at 450' bgs, 350' bgs, 250' bgs, and 150' bgs. Vapor wells will be spaced in well vault at ground surface with at least 1" of clearance between vapor well groundwater monitoring well. WDC indicated building a metal plate to aid well spacing in the vault.
Development method	None expected
Estimated purge volume	
Development time	

Comments: Borehole drilled to 520' bgs.
All depths below ground surface.

Well vault will need to be of suffiecient size for access to all wells

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APPENDIX C

Field Forms

SVE Pilot Testing
Observation Wells

Project Name: KAFB BFF

Project Number: 140705

Staff: ____________________

Date: ____________________

Well ID	Depth	Time	Vacuum (inWC)	Comments

SVE Pilot Testing
Test Well

Project Name: KAFB BFF
Project Number: 140705

Staff: _____
Date: _____

Well ID	Screened Interval (ft bgs)	Time	Vacuum (inWC)	Differential Pressure (inWC)	Flow Rate (scfm)	Temp. (°F)	Relative Humidity (%)	Total HC (ppm)	CO_2 (%)	CO (%)	O_2 (%)	H_2S (%)	LEL (%)	Comments

ft bgs = feet below ground surface inWC = inches of water column scfm = standard cubic feet per minute °F = degrees Fahrenheit % = percent
ppm = parts per million HC = hydrocarbons LEL = lower explosive limit

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APPENDIX D

Pressure Drop Calculations

Shaw® Shaw E & I

Calculation Title:	SVE Expansion Vacuum Pipe Friction Loss
Calculation Number:	140705-M-0002-00
Project Name/Number:	Bulk Fuel Facility (BFF) Kirtland AFB, Albuquerque, New Mexico

Table of Contents Page Number

1. Problem Statement

The objective of this calculation is to determine the frictional losses for the quick and long-term tests to the soil-vapor extraction (SVE) system at the Bulk Fuel Facilities (BFF), Kirtland AFB, Albuquerque, New Mexico. Pneulog wells KAFB-106149 and KAFB-106154 will be combined to the existing vacuum pipeline which feeds the downstream treatment system.

2. References

2.1 Design Flow Solutions Software. Version 4, ABZ, Incorporated

3. Calculation Methodology

Design Flow Solutions (DFS), a pipeline modeling software program is used to calculate the velocities and pressures within the vacuum pipeline. The piping system is built by creating individual branches or pipelines. The model is created to show temporary pipelines from well KAFB-106149 and well KAFB-106154 to the main treatment system. Additionally, wells KAFB-106160 and KAFB-106161 are shown in the model, but are closed to prevent flow during the test. The temporary and existing piping was evaluated at 150 Standard Cubic Feet per Minute (SCFM) from each well to determine the pressure loss across the connection.

3.1 Pipeline

Each extraction well KAFB-106149 and KAFB-160154 contains a well head with drop pipe to the well and a dilution air entry port at the well head. Flows are input for the well vapor and ambient dilution air. Individual pipelines are modeled from each well with pipe components from the well heads to a common header. The common header is modeled to the inlet of the vacuum blower system. A pressure from the vacuum blower curve is input at the end of the pipeline closest to the blower system.

With given fluid conditions, piping materials, piping lengths, preliminary pipe diameters are input. An output of velocity and pressure are calculated. Pipe diameters are adjusted for each pipeline to produce a minimal friction loss within the piping.

4. Input and Assumptions

4.1 Well Head Piping

Each well head for extraction wells KAFB-160149 and KAFB-160154 is identically modeled. Properties and components of each modeled pipeline are shown below. The components of all piping within the wellhead are estimated for the temporary setup. All data output is detailed within the calculation outputs (Attachment A).

4.1.1 Material

Piping material within the well head piping is Polyvinylchloride (PVC), schedule 80 with a rubberized hose to connect to the outgoing pipeline to the treatment system.

4.1.2 Valves & Fittings

The well head is modeled with the following components:

- 3-inch pipe to each of the 3 screened casings at each Pneulog well
- 6-inch ball valve (from well)
- 6-inch ball valve (from dilution air)
- Enlarger/Reducer for pipe schedule and pipe size change

4.1.3 Lengths and Elevations

Piping at the well head includes 5 feet of 6-inch PVC pipe. A 100 foot section of 4-inch diameter rubberized hose connects the well head at KAFB-106149 piping and a 40 foot section from KAFB-106154 to the HDPE pipeline leaving the wellhead.

The pipeline contains mostly air from the well with little water vapor. Elevation changes do not significantly affect frictional losses within air pipelines, so no elevation changes were entered in the model.

4.2 Existing Vacuum Pipeline

The branch lines from each well head to the common header were modeled. A common header was then modeled to the treatment system.

4.2.1 Material

Piping material within the vacuum pipeline header is High Density Polyethylene (HDPE), SDR-17

4.2.2 Valves & Fittings

The existing vacuum pipeline from the temporary connections to the SVE system is modeled with the following components:

- Five (8) 90-degree elbows (from KAFB-160149 well head to common header)
- Two (2) Branch Tees, at road crossings (from KAFB-160149 well head to common header)
- Enlargers/Reducers for pipe schedule and pipe size change

4.2.3 Lengths and Elevations

Piping from well KAFB-160149 temporary connection to the common header includes 200 feet of 6-inch pipe. Piping from well KAFB-106154 to the common header includes 25 feet of 6-inch pipe. When the two separate lines join to the common header an 8-inch section of pipe, 100 feet long, extends to the treatment system.

Elevation changes do not significantly affect frictional losses within air pipelines, so no elevation changes were entered in the model.

4.3 Fluid Conditions

Fluid references are to air, and entering the piping at the wellhead at 50 degrees Fahrenheit. Atmospheric conditions of 12.04 psia and 50 degrees Fahrenheit are modeled at the treatment system.

Flow conditions are 150 SCFM at each well head, 75 SCFM from two of the three well casings.
A vacuum of 11 in Hg at from the blower or 183 inches water column (in WC) vacuum at elevation is input at the treatment system.

5. Calculations

5.1 Frictional Head Loss

Design Flow Solutions (DFS) is a computerized software tool implementing macroscopic fluid flow calculations to solve networks of branches and pipelines. Using the inputs from section 4, velocities and pressures are determined through a compressible flow calculation. Consecutive iterations are conducted changing the pipe diameter until ideal velocities and pressures are reached.

6. Results and Conclusions

The frictional head loss within the vacuum pipeline is detailed in the table below.

Pipeline	Piping Vacuum Loss [in WC]
	150 SCFM per Well
KAFB-160149	183.0 (SVE) – 186.7 (wellhead) = 3.7 in WC vacuum loss
KAFB-160154	183.0 (SVE) – 185.0 (wellhead) = 2 in WC vacuum loss

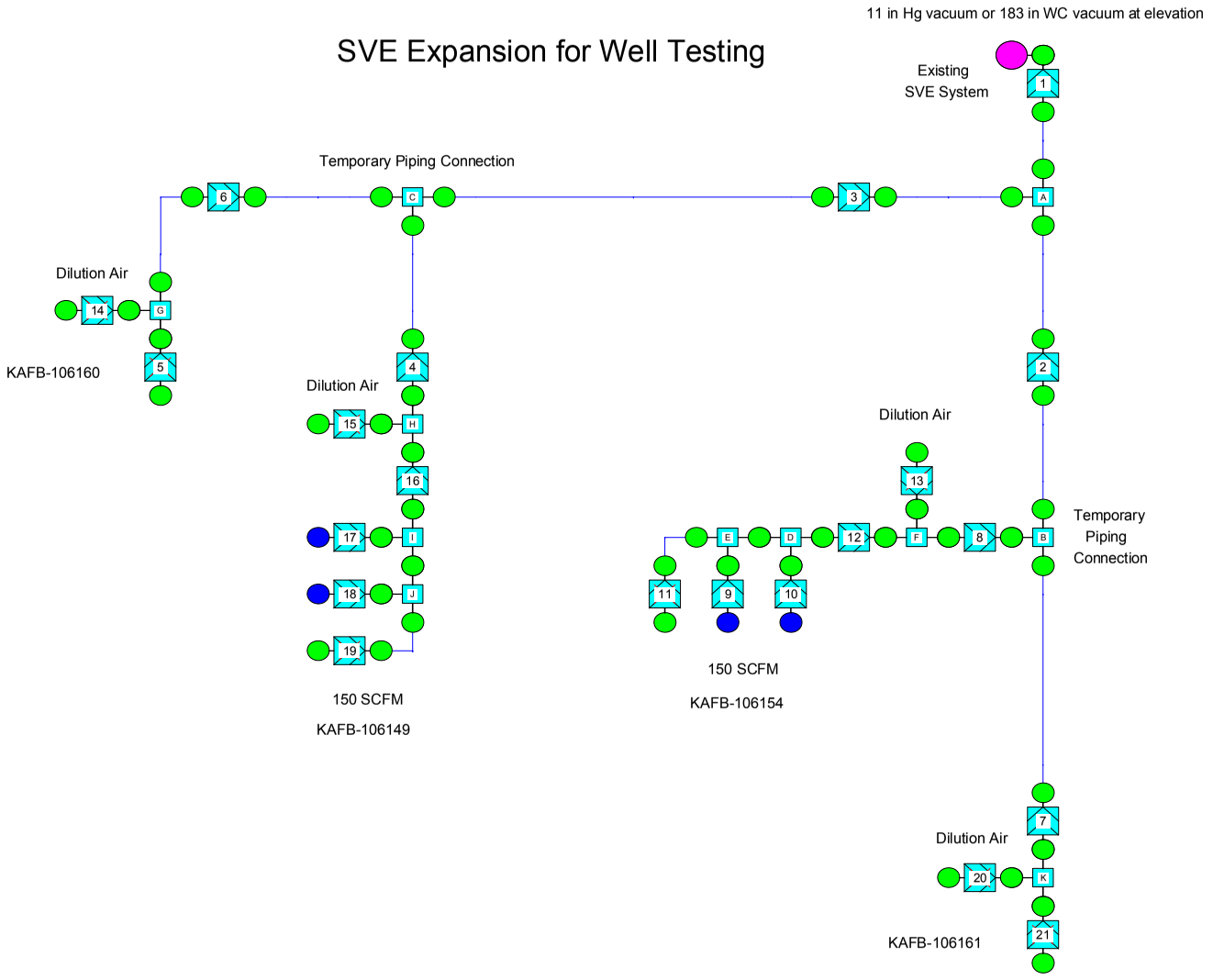
The vacuum loss in each pipeline and temporary connection is a maximum of 3.7 in WC and is acceptable for losses throughout the piping for the tests.

7. Attachments

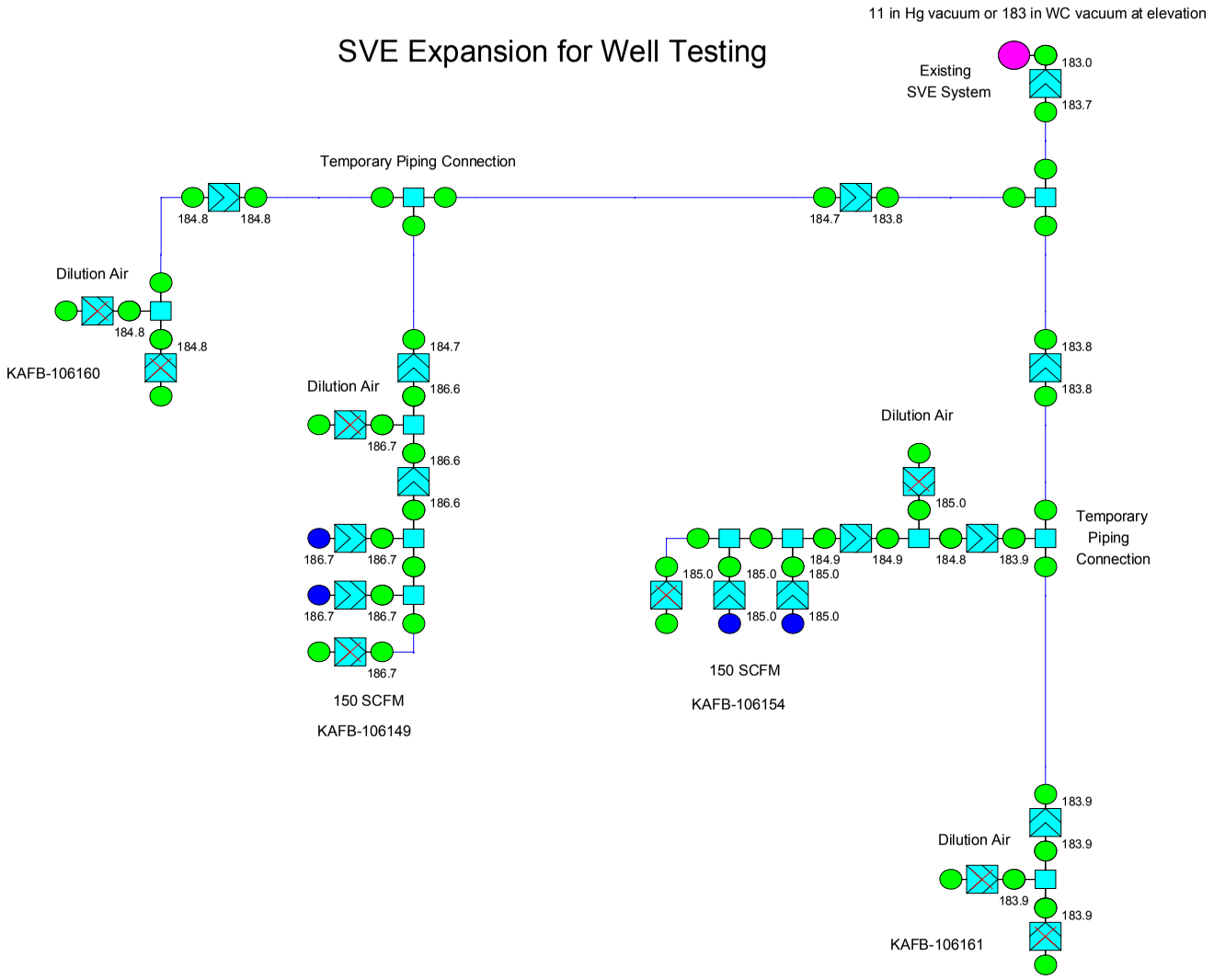
Attachment A includes the following information for each case:

- Branch Numbers
- Pressure
- Volumetric Flow Rate
- Velocity
- Pipe Inside Diameter
- Branch Summaries

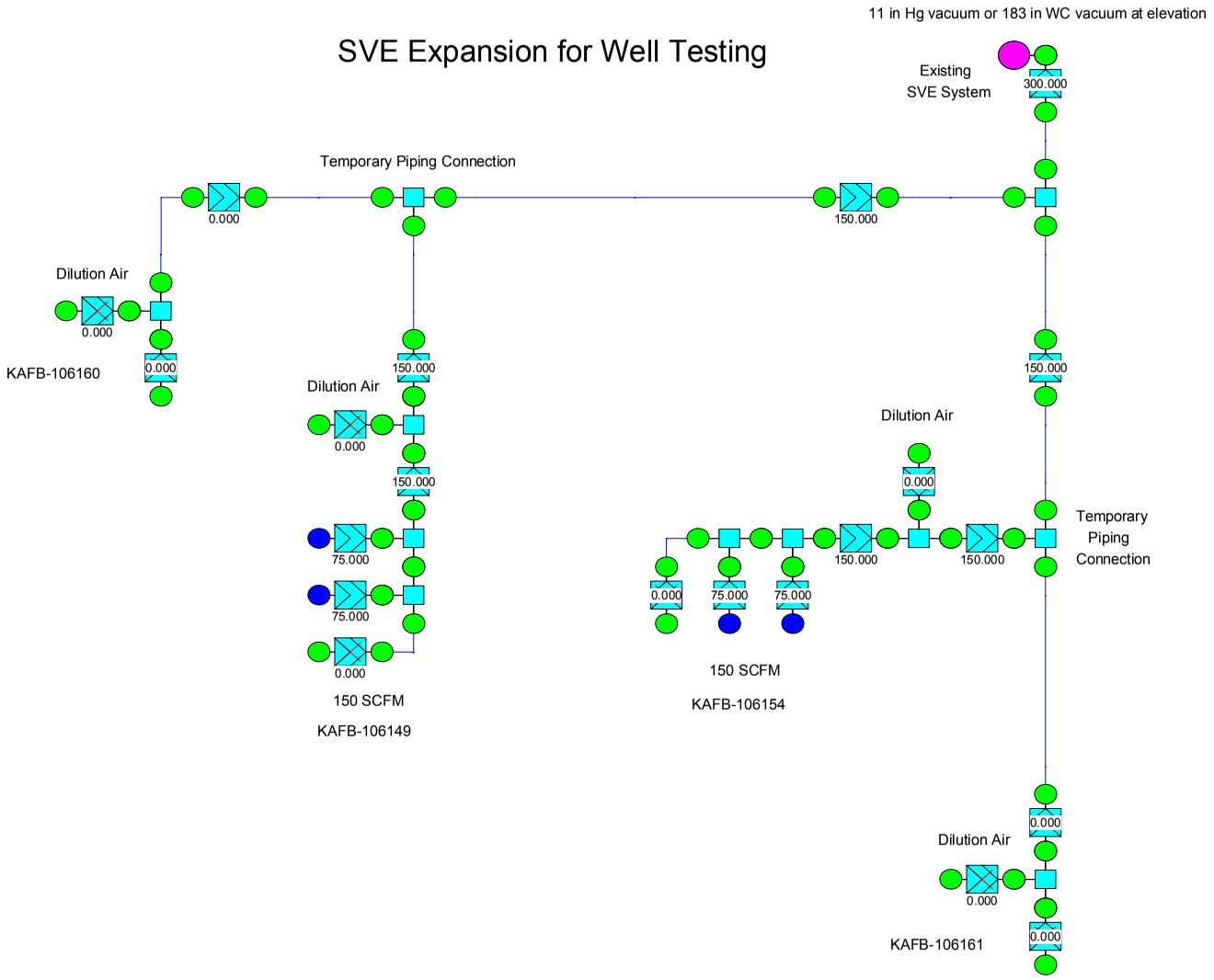
Attachment A
Design Flow Solutions Software Output


SVE Expansion for Well Testing
11 in Hg vacuum or 183 in WC vacuum at elevation
Existing
SVE System
1
A
3
Temporary Piping Connection
C
6
Dilution Air
14
G
5
KAFB-106160
2
4
Dilution Air
15
H
16
17
I
18
J
19
150 SCFM
KAFB-106149
Dilution Air
13
E
D
12
F
8
B
11
9
10
150 SCFM
KAFB-106154
Temporary
Piping
Connection
7
Dilution Air
20
K
21
KAFB-106161

Pressure in in water (68F) abs

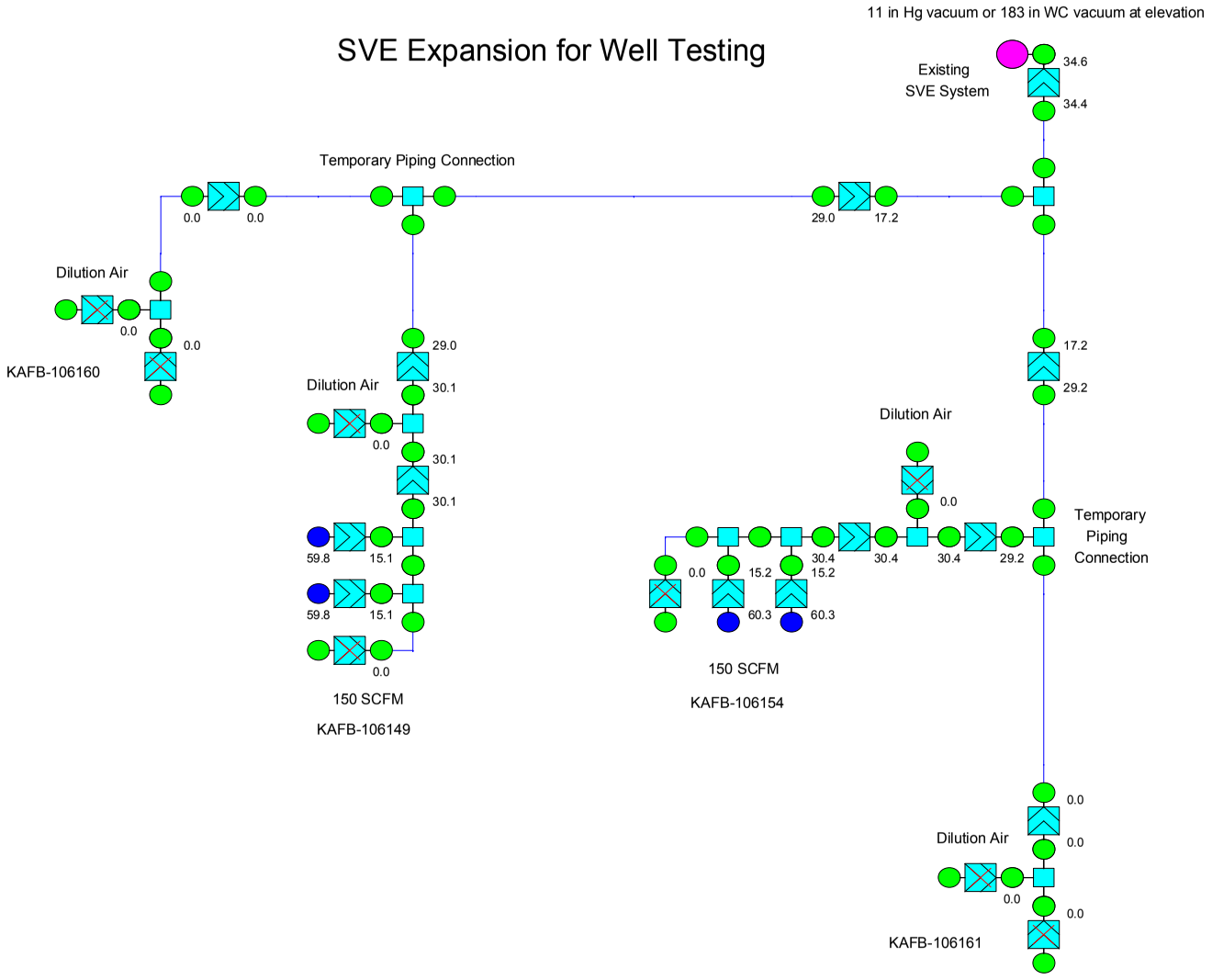


Standard Flow Rate in SCFM

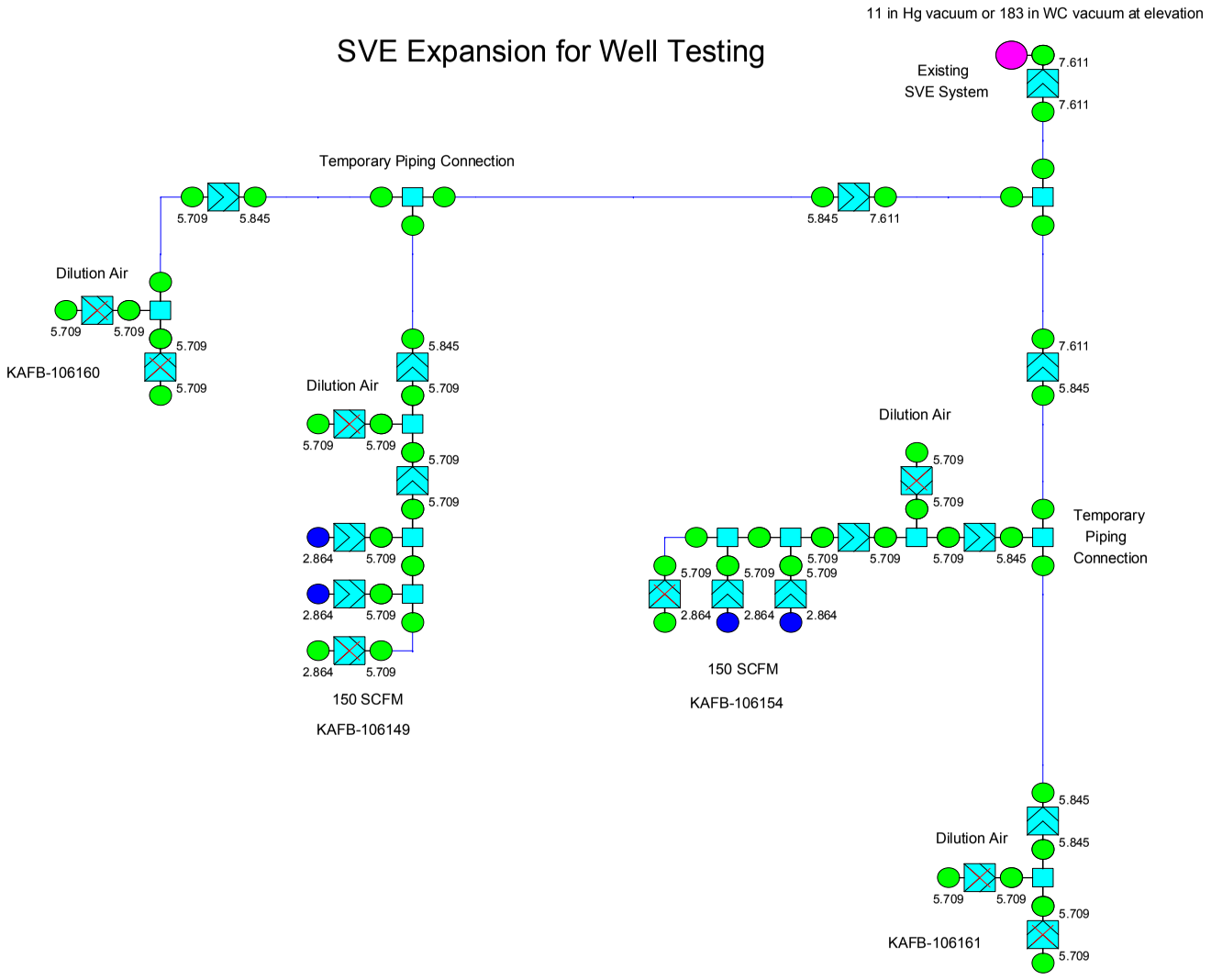


DF DesigNet, Version 4 ...EM\VACUUM PIPE\CALCULATION\SVE EXPANSION.NET Mon Oct 07 17:59:50 2013

Velocity in ft/sec (FPS)



Diameter in inches



ONE-PAGE SUMMARY

Branch Number: 1

FLUID DESCRIPTION

Outlet Fluid Conditions

Spec. Heat Ratio (Cp/Cv):	1.400	
Molecular Weight:	28.96	
Specific Gravity:	1.000	
Temperature:	50.00	Fahrenheit
Pressure:	183.02	in water (68F) abs = 6.60 PSIA
Density:	0.03	lb/cu ft
Specific Volume:	28.608	cu ft/lb
Abs. Viscosity:	0.017	centipoise
Kin. Viscosity:	31.063	centistokes

HARDWARE DESCRIPTION

Number of Components:	7	
Branch Inlet Diameter:	7.611	inches
Branch Outlet Diameter:	7.611	inches
Branch Elevational Change:	0.0	feet
Branch K Factor:	5.18	

FLOW DESCRIPTION

Mass Flow Rate:	1,374.2	lb/hr
Std Vol. Flow Rate:	300.000	SCFM
Inlet Vol. Flow Rate:	4,884.3	US gal/min
Inlet Velocity:	34.4	ft/sec (FPS)
Inlet Mach No.:	0.031	
Outlet Vol. Flow Rate:	4,901.5	US gal/min
Outlet Velocity:	34.6	ft/sec (FPS)
Outlet Mach No.:	0.031	
Differential Pressure:	0.02	PSID

HARDWARE DESCRIPTION - TABLE 1

Symbols and Units:
- Din - Inlet Diameter - inches
- Dout - Outlet Diameter - inches
- A - Inlet Area - sq inches
- dZ - Elevational Change - feet
- Re - Reynolds Number
- EL - Equivalent Length - Diameters
- K - K Factor relative to Inlet Diameter
- Pin - Inlet Pressure - in water (68F) abs
- Pout - Outlet Pressure - in water (68F) abs
- DP - Differential Pressure - PSID
- HL - Frictional Head Loss - feet
- D - Inlet Density - lb/cu ft
- mu - Inlet Absolute Viscosity - centipoise
- W - Mass Flow Rate - lb/hr
- Q - Actual Volumetric Flow Rate - US gal/min
- Vin - Inlet Velocity - ft/sec (FPS)
- Vout - Outlet Velocity - ft/sec (FPS)

Component Name: [2] Tee, 8" Thru Branch

Din:	7.611	Dout:	7.611	Area:	45.496	dZ:	0.00
Re:	65506	f:	0.014210	EL:	60.00	K:	0.85
Pin:	183.67	Pout:	183.45	DP:	0.01	HL:	
D:	0.035	mu:	0.017				
W:	1374.23	Q:	4884.26	Vin:	34.44	Vout:	34.48

Component Name: Pipe, NPS 8, sched 17.0, 100.00 feet

Din:	7.611	Dout:	7.611	Area:	45.496	dZ:	0.00
Re:	65506	f:	0.011237	EL:	157.67	K:	1.77
Pin:	183.45	Pout:	183.23	DP:	0.01	HL:	
D:	0.035	mu:	0.017				
W:	1374.23	Q:	4889.92	Vin:	34.48	Vout:	34.52

Component Name: [4] Elbow, 8" 90 Thr/SW

Din:	7.611	Dout:	7.611	Area:	45.496	dZ:	0.00
Re:	65506	f:	0.014210	EL:	30.00	K:	0.43
Pin:	183.23	Pout:	183.02	DP:	0.01	HL:	
D:	0.035	mu:	0.017				
W:	1374.23	Q:	4895.82	Vin:	34.52	Vout:	34.56

ONE-PAGE SUMMARY

Branch Number: 2

FLUID DESCRIPTION

Compressible - Location Not Specified
Spec. Heat Ratio (Cp/Cv): 1.400
Molecular Weight: 28.96
Specific Gravity: 1.000

HARDWARE DESCRIPTION

Number of Components: 2
Branch Inlet Diameter: 5.845 inches
Branch Outlet Diameter: 7.611 inches

Branch Elevational Change: 0.0 feet
Branch K Factor: 0.77

FLOW DESCRIPTION

Mass Flow Rate: 687.1 lb/hr
Std Vol. Flow Rate: 150.000 SCFM
Inlet Vol. Flow Rate: 2,440.7 US gal/min
Inlet Velocity: 29.2 ft/sec (FPS)
Inlet Mach No.: 0.026
Outlet Vol. Flow Rate: 2,440.9 US gal/min
Outlet Velocity: 17.2 ft/sec (FPS)
Outlet Mach No.: 0.016

Differential Pressure: 4.024E-05 PSID

HARDWARE DESCRIPTION - TABLE 1

Symbols and Units:
- Din - Inlet Diameter - inches
- Dout - Outlet Diameter - inches
- A - Inlet Area - sq inches
- dZ - Elevational Change - feet
- Re - Reynolds Number
- EL - Equivalent Length - Diameters
- K - K Factor relative to Inlet Diameter
- Pin - Inlet Pressure - in water (68F) abs
- Pout - Outlet Pressure - in water (68F) abs
- DP - Differential Pressure - PSID
- HL - Frictional Head Loss - feet
- D - Inlet Density - lb/cu ft
- mu - Inlet Absolute Viscosity - centipoise
- W - Mass Flow Rate - lb/hr
- Q - Actual Volumetric Flow Rate - US gal/min
- Vin - Inlet Velocity - ft/sec (FPS)
- Vout - Outlet Velocity - ft/sec (FPS)

Component Name: Pipe, NPS 6, sched 17.0, 25.00 feet

Din:	5.845	Dout:	5.845	Area:	26.832	dZ:	0.00
Re:	42647	f:	0.011803	EL:	51.33	K:	0.61
Pin:	183.78	Pout:	183.73	DP:	0.00	HL:	
D:	0.035	mu:	0.017				
W:	687.12	Q:	2440.71	Vin:	29.18	Vout:	29.19

Component Name: Enlarger, 6 X 8" sud

Din:	5.845	Dout:	7.611	Area:	26.832	dZ:	0.00
Re:	32749	f:	0.015020	EL:	11.20	K:	0.17
Pin:	183.73	Pout:	183.78	DP:	0.00	HL:	
D:	0.035	mu:	0.017				
W:	687.12	Q:	2441.43	Vin:	29.19	Vout:	17.21

ONE-PAGE SUMMARY

Branch Number: 5

FLUID DESCRIPTION

Compressible - Location Not Specified
Spec. Heat Ratio (Cp/Cv): 1.400
Molecular Weight: 28.96
Specific Gravity: 1.000

HARDWARE DESCRIPTION

Number of Components: 2
Branch Inlet Diameter: 5.709 inches
Branch Outlet Diameter: 5.709 inches

Branch Elevational Change: 0.0 feet

FLOW DESCRIPTION

Mass Flow Rate: 0.0 lb/hr
Std Vol. Flow Rate: 0.000 SCFM
Outlet Vol. Flow Rate: 0.0 US gal/min
Outlet Velocity: 0.0 ft/sec (FPS)
Outlet Mach No.: 0.000

HARDWARE DESCRIPTION - TABLE 1

Symbols and Units:
- Din - Inlet Diameter - inches
- Dout - Outlet Diameter - inches
- A - Inlet Area - sq inches
- dZ - Elevational Change - feet
- Re - Reynolds Number
- EL - Equivalent Length - Diameters
- K - K Factor relative to Inlet Diameter
- Pin - Inlet Pressure - in water (68F) abs
- Pout - Outlet Pressure - in water (68F) abs
- DP - Differential Pressure - PSID
- HL - Frictional Head Loss - feet
- D - Inlet Density - lb/cu ft
- mu - Inlet Absolute Viscosity - centipoise
- W - Mass Flow Rate - lb/hr
- Q - Actual Volumetric Flow Rate - US gal/min
- Vin - Inlet Velocity - ft/sec (FPS)
- Vout - Outlet Velocity - ft/sec (FPS)

Component Name: Pipe, NPS 6, sched 80, 5.00 feet

Din:	5.709	Dout:	5.709	Area:	25.598	dZ:	0.00
Re:		f:		EL:		K:	
Pin:		Pout:		DP:		HL:	
D:		mu:					
W:	0.00	Q:		Vin:		Vout:	

Component Name: Ball valve

Din:	5.709	Dout:	5.709	Area:	25.598	dZ:	0.00
Re:		f:	0.015096	EL:	3.00	K:	1.0E+24
Pin:		Pout:	184.76	DP:		HL:	
D:		mu:					
W:	0.00	Q:		Vin:		Vout:	0.00

ONE-PAGE SUMMARY

Branch Number: 3

FLUID DESCRIPTION

Compressible - Location Not Specified
Spec. Heat Ratio (Cp/Cv): 1.400
Molecular Weight: 28.96
Specific Gravity: 1.000

HARDWARE DESCRIPTION

Number of Components:	12	
Branch Inlet Diameter:	5.845	inches
Branch Outlet Diameter:	7.611	inches
Branch Elevational Change:	0.0	feet
Branch K Factor:	10.42	

FLOW DESCRIPTION

Mass Flow Rate:	687.1	lb/hr
Std Vol. Flow Rate:	150.000	SCFM
Inlet Vol. Flow Rate:	2,429.1	US gal/min
Inlet Velocity:	29.0	ft/sec (FPS)
Inlet Mach No.:	0.026	
Outlet Vol. Flow Rate:	2,440.7	US gal/min
Outlet Velocity:	17.2	ft/sec (FPS)
Outlet Mach No.:	0.016	
Differential Pressure:	0.03	PSID

HARDWARE DESCRIPTION - TABLE 1

Symbols and Units:
- Din - Inlet Diameter - inches
- Dout - Outlet Diameter - inches
- A - Inlet Area - sq inches
- dZ - Elevational Change - feet
- Re - Reynolds Number
- EL - Equivalent Length - Diameters
- K - K Factor relative to Inlet Diameter
- Pin - Inlet Pressure - in water (68F) abs
- Pout - Outlet Pressure - in water (68F) abs
- DP - Differential Pressure - PSID
- HL - Frictional Head Loss - feet
- D - Inlet Density - lb/cu ft
- mu - Inlet Absolute Viscosity - centipoise
- W - Mass Flow Rate - lb/hr
- Q - Actual Volumetric Flow Rate - US gal/min
- Vin - Inlet Velocity - ft/sec (FPS)
- Vout - Outlet Velocity - ft/sec (FPS)

Component Name: Pipe, NPS 6, sched 17.0, 200.00 feet

Din:	5.845	Dout:	5.845	Area:	26.832	dZ:	0.00
Re:	42647	f:	0.011803	EL:	410.61	K:	4.85
Pin:	184.66	Pout:	184.23	DP:	0.02	HL:	
D:	0.035	mu:	0.017				
W:	687.12	Q:	2429.09	Vin:	29.04	Vout:	29.11

Component Name: [8] Elbow, 6" 90 Thr/SW

Din:	5.845	Dout:	5.845	Area:	26.832	dZ:	0.00
Re:	42647	f:	0.015020	EL:	30.00	K:	0.45
Pin:	184.23	Pout:	183.91	DP:	0.01	HL:	
D:	0.035	mu:	0.017				
W:	687.12	Q:	2434.79	Vin:	29.11	Vout:	29.16

Component Name: [2] Tee, 6" Thru Branch

Din:	5.845	Dout:	5.845	Area:	26.832	dZ:	0.00
Re:	42647	f:	0.015020	EL:	60.00	K:	0.90
Pin:	183.91	Pout:	183.75	DP:	0.01	HL:	
D:	0.035	mu:	0.017				
W:	687.12	Q:	2439.06	Vin:	29.16	Vout:	29.19

Component Name: Enlarger, 6 X 8" sud

Din:	5.845	Dout:	7.611	Area:	26.832	dZ:	0.00
Re:	32749	f:	0.015020	EL:	11.20	K:	0.17
Pin:	183.75	Pout:	183.80	DP:	0.00	HL:	
D:	0.035	mu:	0.017				
W:	687.12	Q:	2441.20	Vin:	29.19	Vout:	17.21

ONE-PAGE SUMMARY

Branch Number: 6

FLUID DESCRIPTION

Compressible - Location Not Specified
Spec. Heat Ratio (Cp/Cv): 1.400
Molecular Weight: 28.96
Specific Gravity: 1.000

HARDWARE DESCRIPTION

Number of Components: 12
Branch Inlet Diameter: 5.709 inches
Branch Outlet Diameter: 5.845 inches

Branch Elevational Change: 0.0 feet
Branch K Factor: 12.41

FLOW DESCRIPTION

Mass Flow Rate: 0.0 lb/hr
Std Vol. Flow Rate: 0.000 SCFM
Inlet Vol. Flow Rate: 0.0 US gal/min
Inlet Velocity: 0.0 ft/sec (FPS)
Inlet Mach No.: 0.000
Outlet Vol. Flow Rate: 0.0 US gal/min
Outlet Velocity: 0.0 ft/sec (FPS)
Outlet Mach No.: 0.000

Differential Pressure: 0.00 PSID

HARDWARE DESCRIPTION - TABLE 1

Symbols and Units:
- Din - Inlet Diameter - inches
- Dout - Outlet Diameter - inches
- A - Inlet Area - sq inches
- dZ - Elevational Change - feet
- Re - Reynolds Number
- EL - Equivalent Length - Diameters
- K - K Factor relative to Inlet Diameter
- Pin - Inlet Pressure - in water (68F) abs
- Pout - Outlet Pressure - in water (68F) abs
- DP - Differential Pressure - PSID
- HL - Frictional Head Loss - feet
- D - Inlet Density - lb/cu ft
- mu - Inlet Absolute Viscosity - centipoise
- W - Mass Flow Rate - lb/hr
- Q - Actual Volumetric Flow Rate - US gal/min
- Vin - Inlet Velocity - ft/sec (FPS)
- Vout - Outlet Velocity - ft/sec (FPS)

Component Name: Reducer, 6 X 4" sud

Din:	5.709	Dout:	4.000	Area:	25.598	dZ:	0.00
Re:	0	f:	0.015096	EL:	69.98	K:	1.06
Pin:	184.76	Pout:	184.76	DP:	0.00	HL:	
D:	0.035	mu:	0.017				
W:	0.00	Q:	0.00	Vin:	0.00	Vout:	0.00

Component Name: Pipe, NPS 4, 5.00 feet

Din:	4.000	Dout:	4.000	Area:	12.566	dZ:	0.00
Re:	0	f:	0.012695	EL:	15.00	K:	0.19
Pin:	184.76	Pout:	184.76	DP:	0.00	HL:	
D:	0.035	mu:	0.017				
W:	0.00	Q:	0.00	Vin:	0.00	Vout:	0.00

Component Name: Enlarger, 4 X 6" sud

Din:	4.000	Dout:	5.845	Area:	12.566	dZ:	0.00
Re:	0	f:	0.016311	EL:	17.33	K:	0.28
Pin:	184.76	Pout:	184.76	DP:	0.00	HL:	
D:	0.035	mu:	0.017				
W:	0.00	Q:	0.00	Vin:	0.00	Vout:	0.00

Component Name: Pipe, NPS 6, sched 17.0, 240.00 feet

Din:	5.845	Dout:	5.845	Area:	26.832	dZ:	0.00
Re:	0	f:	0.011803	EL:	492.73	K:	5.82
Pin:	184.76	Pout:	184.76	DP:	0.00	HL:	
D:	0.035	mu:	0.017				
W:	0.00	Q:	0.00	Vin:	0.00	Vout:	0.00

Component Name: [6] Elbow, 6" 90 Thr/SW

Din:	5.845	Dout:	5.845	Area:	26.832	dZ:	0.00
Re:	0	f:	0.015020	EL:	30.00	K:	0.45
Pin:	184.76	Pout:	184.76	DP:	0.00	HL:	
D:	0.035	mu:	0.017				
W:	0.00	Q:	0.00	Vin:	0.00	Vout:	0.00

Component Name: [2] Tee, 6" Thru Branch

Din:	5.845	Dout:	5.845	Area:	26.832	dZ:	0.00
Re:	0	f:	0.015020	EL:	60.00	K:	0.90
Pin:	184.76	Pout:	184.76	DP:	0.00	HL:	
D:	0.035	mu:	0.017				
W:	0.00	Q:	0.00	Vin:	0.00	Vout:	0.00

ONE-PAGE SUMMARY

Branch Number: 7

FLUID DESCRIPTION

Compressible - Location Not Specified
Spec. Heat Ratio (Cp/Cv): 1.400
Molecular Weight: 28.96
Specific Gravity: 1.000

HARDWARE DESCRIPTION

Number of Components: 1
Branch Inlet Diameter: 5.845 inches
Branch Outlet Diameter: 5.845 inches

Branch Elevational Change: 0.0 feet
Branch K Factor: 4.85

FLOW DESCRIPTION

Mass Flow Rate: 0.0 lb/hr
Std Vol. Flow Rate: 0.000 SCFM
Inlet Vol. Flow Rate: 0.0 US gal/min
Inlet Velocity: 0.0 ft/sec (FPS)
Inlet Mach No.: 0.000
Outlet Vol. Flow Rate: 0.0 US gal/min
Outlet Velocity: 0.0 ft/sec (FPS)
Outlet Mach No.: 0.000

Differential Pressure: 0.00 PSID

HARDWARE DESCRIPTION - TABLE 1

Symbols and Units:
- Din - Inlet Diameter - inches
- Dout - Outlet Diameter - inches
- A - Inlet Area - sq inches
- dZ - Elevational Change - feet
- Re - Reynolds Number
- EL - Equivalent Length - Diameters
- K - K Factor relative to Inlet Diameter
- Pin - Inlet Pressure - in water (68F) abs
- Pout - Outlet Pressure - in water (68F) abs
- DP - Differential Pressure - PSID
- HL - Frictional Head Loss - feet
- D - Inlet Density - lb/cu ft
- mu - Inlet Absolute Viscosity - centipoise
- W - Mass Flow Rate - lb/hr
- Q - Actual Volumetric Flow Rate - US gal/min
- Vin - Inlet Velocity - ft/sec (FPS)
- Vout - Outlet Velocity - ft/sec (FPS)

Component Name: Pipe, NPS 6, sched 17.0, 200.00 feet

Din:	5.845	Dout:	5.845	Area:	26.832	dZ:	0.00
Re:	0	f:	0.011803	EL:	410.61	K:	4.85
Pin:	183.88	Pout:	183.88	DP:	0.00	HL:	
D:	0.035	mu:	0.017				
W:	0.00	Q:	0.00	Vin:	0.00	Vout:	0.00

ONE-PAGE SUMMARY

Branch Number: 8

FLUID DESCRIPTION

Compressible - Location Not Specified
Spec. Heat Ratio (Cp/Cv): 1.400
Molecular Weight: 28.96
Specific Gravity: 1.000

HARDWARE DESCRIPTION

Number of Components: 3
Branch Inlet Diameter: 5.709 inches
Branch Outlet Diameter: 5.845 inches

Branch Elevational Change: 0.0 feet
Branch K Factor: 11.10

FLOW DESCRIPTION

Mass Flow Rate: 687.1 lb/hr
Std Vol. Flow Rate: 150.000 SCFM
Inlet Vol. Flow Rate: 2,426.6 US gal/min
Inlet Velocity: 30.4 ft/sec (FPS)
Inlet Mach No.: 0.027
Outlet Vol. Flow Rate: 2,439.6 US gal/min
Outlet Velocity: 29.2 ft/sec (FPS)
Outlet Mach No.: 0.026

Differential Pressure: 0.04 PSID

HARDWARE DESCRIPTION - TABLE 1

Symbols and Units:
- Din - Inlet Diameter - inches
- Dout - Outlet Diameter - inches
- A - Inlet Area - sq inches
- dZ - Elevational Change - feet
- Re - Reynolds Number
- EL - Equivalent Length - Diameters
- K - K Factor relative to Inlet Diameter
- Pin - Inlet Pressure - in water (68F) abs
- Pout - Outlet Pressure - in water (68F) abs
- DP - Differential Pressure - PSID
- HL - Frictional Head Loss - feet
- D - Inlet Density - lb/cu ft
- mu - Inlet Absolute Viscosity - centipoise
- W - Mass Flow Rate - lb/hr
- Q - Actual Volumetric Flow Rate - US gal/min
- Vin - Inlet Velocity - ft/sec (FPS)
- Vout - Outlet Velocity - ft/sec (FPS)

Component Name: Reducer, 5.709 X 4" sud

Din:	5.709	Dout:	3.970	Area:	25.598	dZ:	0.00
Re:	43663	f:	0.015096	EL:	73.15	K:	1.10
Pin:	184.85	Pout:	184.42	DP:	0.02	HL:	
D:	0.035	mu:	0.017				
W:	687.12	Q:	2426.58	Vin:	30.41	Vout:	63.01

Component Name: Pipe, NPS 4, 50.00 feet

Din:	4.000	Dout:	4.000	Area:	12.566	dZ:	0.00
Re:	62345	f:	0.014066	EL:	150.00	K:	2.11
Pin:	184.42	Pout:	183.56	DP:	0.03	HL:	
D:	0.035	mu:	0.017				
W:	687.12	Q:	2431.02	Vin:	62.07	Vout:	62.36

Component Name: Enlarger, 4 X 6" sud

Din:	3.970	Dout:	5.845	Area:	12.379	dZ:	0.00
Re:	42647	f:	0.016338	EL:	17.76	K:	0.29
Pin:	183.56	Pout:	183.86	DP:	-0.01	HL:	
D:	0.035	mu:	0.017				
W:	687.12	Q:	2442.44	Vin:	63.30	Vout:	29.17

ONE-PAGE SUMMARY

Branch Number: 9
File Name: 3 inch well head

FLUID DESCRIPTION

Compressible - Location Not Specified
Spec. Heat Ratio (Cp/Cv): 1.400
Molecular Weight: 28.96
Specific Gravity: 1.000

HARDWARE DESCRIPTION

Number of Components: 3
Branch Inlet Diameter: 2.864 inches
Branch Outlet Diameter: 5.709 inches

Branch Elevational Change: 0.0 feet
Branch K Factor: 1.47

FLOW DESCRIPTION

Mass Flow Rate: 343.6 lb/hr
Std Vol. Flow Rate: 75.000 SCFM
Inlet Vol. Flow Rate: 1,211.7 US gal/min
Inlet Velocity: 60.3 ft/sec (FPS)
Inlet Mach No.: 0.055
Outlet Vol. Flow Rate: 1,212.4 US gal/min
Outlet Velocity: 15.2 ft/sec (FPS)
Outlet Mach No.: 0.014

Differential Pressure: 8.821E-05 PSID

HARDWARE DESCRIPTION - TABLE 1

Symbols and Units:
- Din - Inlet Diameter - inches
- Dout - Outlet Diameter - inches
- A - Inlet Area - sq inches
- dZ - Elevational Change - feet
- Re - Reynolds Number
- EL - Equivalent Length - Diameters
- K - K Factor relative to Inlet Diameter
- Pin - Inlet Pressure - in water (68F) abs
- Pout - Outlet Pressure - in water (68F) abs
- DP - Differential Pressure - PSID
- HL - Frictional Head Loss - feet
- D - Inlet Density - lb/cu ft
- mu - Inlet Absolute Viscosity - centipoise
- W - Mass Flow Rate - lb/hr
- Q - Actual Volumetric Flow Rate - US gal/min
- Vin - Inlet Velocity - ft/sec (FPS)
- Vout - Outlet Velocity - ft/sec (FPS)

Component Name: Pipe, NPS 3, sched 80, 15.00 feet

Din:	2.864	Dout:	2.864	Area:	6.442	dZ:	0.00
Re:	43534	f:	0.013567	EL:	62.85	K:	0.85
Pin:	185.01	Pout:	184.68	DP:	0.01	HL:	
D:	0.035	mu:	0.017				
W:	343.56	Q:	1211.69	Vin:	60.34	Vout:	60.45

Component Name: Ball valve

Din:	2.864	Dout:	2.864	Area:	6.442	dZ:	0.00
Re:	43534	f:	0.017591	EL:	3.00	K:	0.05
Pin:	184.68	Pout:	184.66	DP:	0.00	HL:	
D:	0.035	mu:	0.017				
W:	343.56	Q:	1213.85	Vin:	60.45	Vout:	60.46

Component Name: Enlarger, 3 X 6" sud

Din:	2.864	Dout:	5.709	Area:	6.442	dZ:	0.00
Re:	21830	f:	0.017591	EL:	31.84	K:	0.56
Pin:	184.66	Pout:	185.01	DP:	-0.01	HL:	
D:	0.035	mu:	0.017				
W:	343.56	Q:	1213.99	Vin:	60.46	Vout:	15.20

ONE-PAGE SUMMARY

Branch Number: 10
File Name: 3 inch well head

FLUID DESCRIPTION

Compressible - Location Not Specified
Spec. Heat Ratio (Cp/Cv): 1.400
Molecular Weight: 28.96
Specific Gravity: 1.000

HARDWARE DESCRIPTION

Number of Components: 3
Branch Inlet Diameter: 2.864 inches
Branch Outlet Diameter: 5.709 inches

Branch Elevational Change: 0.0 feet
Branch K Factor: 1.47

FLOW DESCRIPTION

Mass Flow Rate: 343.6 lb/hr
Std Vol. Flow Rate: 75.000 SCFM
Inlet Vol. Flow Rate: 1,211.7 US gal/min
Inlet Velocity: 60.3 ft/sec (FPS)
Inlet Mach No.: 0.055
Outlet Vol. Flow Rate: 1,212.4 US gal/min
Outlet Velocity: 15.2 ft/sec (FPS)
Outlet Mach No.: 0.014

Differential Pressure: 8.822E-05 PSID

HARDWARE DESCRIPTION - TABLE 1

Symbols and Units:
- Din - Inlet Diameter - inches
- Dout - Outlet Diameter - inches
- A - Inlet Area - sq inches
- dZ - Elevational Change - feet
- Re - Reynolds Number
- EL - Equivalent Length - Diameters
- K - K Factor relative to Inlet Diameter
- Pin - Inlet Pressure - in water (68F) abs
- Pout - Outlet Pressure - in water (68F) abs
- DP - Differential Pressure - PSID
- HL - Frictional Head Loss - feet
- D - Inlet Density - lb/cu ft
- mu - Inlet Absolute Viscosity - centipoise
- W - Mass Flow Rate - lb/hr
- Q - Actual Volumetric Flow Rate - US gal/min
- Vin - Inlet Velocity - ft/sec (FPS)
- Vout - Outlet Velocity - ft/sec (FPS)

Component Name: Pipe, NPS 3, sched 80, 15.00 feet

Din:	2.864	Dout:	2.864	Area:	6.442	dZ:	0.00
Re:	43534	f:	0.013567	EL:	62.85	K:	0.85
Pin:	185.00	Pout:	184.67	DP:	0.01	HL:	
D:	0.035	mu:	0.017				
W:	343.56	Q:	1211.74	Vin:	60.35	Vout:	60.45

Component Name: Ball valve

Din:	2.864	Dout:	2.864	Area:	6.442	dZ:	0.00
Re:	43534	f:	0.017591	EL:	3.00	K:	0.05
Pin:	184.67	Pout:	184.65	DP:	0.00	HL:	
D:	0.035	mu:	0.017				
W:	343.56	Q:	1213.90	Vin:	60.45	Vout:	60.46

Component Name: Enlarger, 3 X 6" sud

Din:	2.864	Dout:	5.709	Area:	6.442	dZ:	0.00
Re:	21830	f:	0.017591	EL:	31.84	K:	0.56
Pin:	184.65	Pout:	185.00	DP:	-0.01	HL:	
D:	0.035	mu:	0.017				
W:	343.56	Q:	1214.04	Vin:	60.46	Vout:	15.20

ONE-PAGE SUMMARY

Branch Number: 11
File Name: 3 inch well head

FLUID DESCRIPTION

Compressible - Location Not Specified
Spec. Heat Ratio (Cp/Cv): 1.400
Molecular Weight: 28.96
Specific Gravity: 1.000

HARDWARE DESCRIPTION

Number of Components: 3
Branch Inlet Diameter: 2.864 inches
Branch Outlet Diameter: 5.709 inches

Branch Elevational Change: 0.0 feet

FLOW DESCRIPTION

Mass Flow Rate: 0.0 lb/hr
Std Vol. Flow Rate: 0.000 SCFM
Outlet Vol. Flow Rate: 0.0 US gal/min
Outlet Velocity: 0.0 ft/sec (FPS)
Outlet Mach No.: 0.000

HARDWARE DESCRIPTION - TABLE 1

Symbols and Units:
- Din - Inlet Diameter - inches
- Dout - Outlet Diameter - inches
- A - Inlet Area - sq inches
- dZ - Elevational Change - feet
- Re - Reynolds Number
- EL - Equivalent Length - Diameters
- K - K Factor relative to Inlet Diameter
- Pin - Inlet Pressure - in water (68F) abs
- Pout - Outlet Pressure - in water (68F) abs
- DP - Differential Pressure - PSID
- HL - Frictional Head Loss - feet
- D - Inlet Density - lb/cu ft
- mu - Inlet Absolute Viscosity - centipoise
- W - Mass Flow Rate - lb/hr
- Q - Actual Volumetric Flow Rate - US gal/min
- Vin - Inlet Velocity - ft/sec (FPS)
- Vout - Outlet Velocity - ft/sec (FPS)

Component Name: Pipe, NPS 3, sched 80, 15.00 feet

Din:	2.864	Dout:	2.864	Area:	6.442	dZ:	0.00
Re:		f:		EL:		K:	
Pin:		Pout:		DP:		HL:	
D:		mu:					
W:	0.00	Q:		Vin:		Vout:	

Component Name: Ball valve

Din:	2.864	Dout:	2.864	Area:	6.442	dZ:	0.00
Re:		f:	0.017591	EL:	3.00	K:	1.0E+24
Pin:		Pout:	185.01	DP:		HL:	
D:		mu:					
W:	0.00	Q:		Vin:		Vout:	

Component Name: Enlarger, 3 X 6" sud

Din:	2.864	Dout:	5.709	Area:	6.442	dZ:	0.00
Re:	0	f:	0.017591	EL:	31.84	K:	0.56
Pin:	185.01	Pout:	185.01	DP:	0.00	HL:	
D:		mu:					
W:	0.00	Q:		Vin:		Vout:	0.00

ONE-PAGE SUMMARY

Branch Number: 12
File Name: Well Head

FLUID DESCRIPTION

Compressible - Location Not Specified
Spec. Heat Ratio (Cp/Cv): 1.400
Molecular Weight: 28.96
Specific Gravity: 1.000

HARDWARE DESCRIPTION

Number of Components: 2
Branch Inlet Diameter: 5.709 inches
Branch Outlet Diameter: 5.709 inches

Branch Elevational Change: 0.0 feet
Branch K Factor: 0.17

FLOW DESCRIPTION

Mass Flow Rate: 687.1 lb/hr
Std Vol. Flow Rate: 150.000 SCFM
Inlet Vol. Flow Rate: 2,426.0 US gal/min
Inlet Velocity: 30.4 ft/sec (FPS)
Inlet Mach No.: 0.027
Outlet Vol. Flow Rate: 2,426.2 US gal/min
Outlet Velocity: 30.4 ft/sec (FPS)
Outlet Mach No.: 0.027

Differential Pressure: 0.0005992 PSID

HARDWARE DESCRIPTION - TABLE 1

Symbols and Units:
- Din - Inlet Diameter - inches
- Dout - Outlet Diameter - inches
- A - Inlet Area - sq inches
- dZ - Elevational Change - feet
- Re - Reynolds Number
- EL - Equivalent Length - Diameters
- K - K Factor relative to Inlet Diameter
- Pin - Inlet Pressure - in water (68F) abs
- Pout - Outlet Pressure - in water (68F) abs
- DP - Differential Pressure - PSID
- HL - Frictional Head Loss - feet
- D - Inlet Density - lb/cu ft
- mu - Inlet Absolute Viscosity - centipoise
- W - Mass Flow Rate - lb/hr
- Q - Actual Volumetric Flow Rate - US gal/min
- Vin - Inlet Velocity - ft/sec (FPS)
- Vout - Outlet Velocity - ft/sec (FPS)

Component Name: Pipe, NPS 6, sched 80, 5.00 feet

Din:	5.709	Dout:	5.709	Area:	25.598	dZ:	0.00
Re:	43663	f:	0.011856	EL:	10.51	K:	0.12
Pin:	184.90	Pout:	184.88	DP:	0.00	HL:	
D:	0.035	mu:	0.017				
W:	687.12	Q:	2425.98	Vin:	30.41	Vout:	30.41

Component Name: Ball valve

Din:	5.709	Dout:	5.709	Area:	25.598	dZ:	0.00
Re:	43663	f:	0.015096	EL:	3.00	K:	0.05
Pin:	184.88	Pout:	184.88	DP:	0.00	HL:	
D:	0.035	mu:	0.017				
W:	687.12	Q:	2426.14	Vin:	30.41	Vout:	30.41

ONE-PAGE SUMMARY

Branch Number: 13
File Name: Dilution Air

FLUID DESCRIPTION

Compressible - Location Not Specified
Spec. Heat Ratio (Cp/Cv): 1.400
Molecular Weight: 28.96
Specific Gravity: 1.000

HARDWARE DESCRIPTION

Number of Components: 4
Branch Inlet Diameter: 5.709 inches
Branch Outlet Diameter: 5.709 inches

Branch Elevational Change: 0.0 feet

FLOW DESCRIPTION

Mass Flow Rate: 0.0 lb/hr
Std Vol. Flow Rate: 0.000 SCFM
Outlet Vol. Flow Rate: 0.0 US gal/min
Outlet Velocity: 0.0 ft/sec (FPS)
Outlet Mach No.: 0.000

HARDWARE DESCRIPTION - TABLE 1

Symbols and Units:
- Din - Inlet Diameter - inches
- Dout - Outlet Diameter - inches
- A - Inlet Area - sq inches
- dZ - Elevational Change - feet
- Re - Reynolds Number
- EL - Equivalent Length - Diameters
- K - K Factor relative to Inlet Diameter
- Pin - Inlet Pressure - in water (68F) abs
- Pout - Outlet Pressure - in water (68F) abs
- DP - Differential Pressure - PSID
- HL - Frictional Head Loss - feet
- D - Inlet Density - lb/cu ft
- mu - Inlet Absolute Viscosity - centipoise
- W - Mass Flow Rate - lb/hr
- Q - Actual Volumetric Flow Rate - US gal/min
- Vin - Inlet Velocity - ft/sec (FPS)
- Vout - Outlet Velocity - ft/sec (FPS)

Component Name:	Pipe, NPS 6, sched 80, 3.00 feet						
Din:	5.709	Dout:	5.709	Area:	25.598	dZ:	0.00
Re:		f:		EL:		K:	
Pin:		Pout:		DP:		HL:	
D:		mu:					
W:	0.00	Q:		Vin:		Vout:	

Component Name:	[2] Elbow, 6" 90 Thr/SW						
Din:	5.709	Dout:	5.709	Area:	25.598	dZ:	0.00
Re:		f:	0.015096	EL:	30.00	K:	0.45
Pin:		Pout:		DP:		HL:	
D:		mu:					
W:	0.00	Q:		Vin:		Vout:	

Component Name:	Ball valve						
Din:	5.709	Dout:	5.709	Area:	25.598	dZ:	0.00
Re:		f:	0.015096	EL:	3.00	K:	1.0E+24
Pin:		Pout:	184.96	DP:		HL:	
D:		mu:					
W:	0.00	Q:		Vin:		Vout:	0.00

ONE-PAGE SUMMARY

Branch Number: 14
File Name: Dilution Air

FLUID DESCRIPTION

Compressible - Location Not Specified
Spec. Heat Ratio (Cp/Cv): 1.400
Molecular Weight: 28.96
Specific Gravity: 1.000

HARDWARE DESCRIPTION

Number of Components: 4
Branch Inlet Diameter: 5.709 inches
Branch Outlet Diameter: 5.709 inches

Branch Elevational Change: 0.0 feet

FLOW DESCRIPTION

Mass Flow Rate: 0.0 lb/hr
Std Vol. Flow Rate: 0.000 SCFM
Outlet Vol. Flow Rate: 0.0 US gal/min
Outlet Velocity: 0.0 ft/sec (FPS)
Outlet Mach No.: 0.000

HARDWARE DESCRIPTION - TABLE 1

Symbols and Units:
- Din - Inlet Diameter - inches
- Dout - Outlet Diameter - inches
- A - Inlet Area - sq inches
- dZ - Elevational Change - feet
- Re - Reynolds Number
- EL - Equivalent Length - Diameters
- K - K Factor relative to Inlet Diameter
- Pin - Inlet Pressure - in water (68F) abs
- Pout - Outlet Pressure - in water (68F) abs
- DP - Differential Pressure - PSID
- HL - Frictional Head Loss - feet
- D - Inlet Density - lb/cu ft
- mu - Inlet Absolute Viscosity - centipoise
- W - Mass Flow Rate - lb/hr
- Q - Actual Volumetric Flow Rate - US gal/min
- Vin - Inlet Velocity - ft/sec (FPS)
- Vout - Outlet Velocity - ft/sec (FPS)

Component Name:	Pipe, NPS 6, sched 80, 3.00 feet						
Din:	5.709	Dout:	5.709	Area:	25.598	dZ:	0.00
Re:		f:		EL:		K:	
Pin:		Pout:		DP:		HL:	
D:		mu:					
W:	0.00	Q:		Vin:		Vout:	

Component Name:	[2] Elbow, 6" 90 Thr/SW						
Din:	5.709	Dout:	5.709	Area:	25.598	dZ:	0.00
Re:		f:	0.015096	EL:	30.00	K:	0.45
Pin:		Pout:		DP:		HL:	
D:		mu:					
W:	0.00	Q:		Vin:		Vout:	

Component Name:	Ball valve						
Din:	5.709	Dout:	5.709	Area:	25.598	dZ:	0.00
Re:		f:	0.015096	EL:	3.00	K:	1.0E+24
Pin:		Pout:	184.76	DP:		HL:	
D:		mu:					
W:	0.00	Q:		Vin:		Vout:	0.00

ONE-PAGE SUMMARY

Branch Number: 15
File Name: Dilution Air

FLUID DESCRIPTION

Compressible - Location Not Specified
Spec. Heat Ratio (Cp/Cv): 1.400
Molecular Weight: 28.96
Specific Gravity: 1.000

HARDWARE DESCRIPTION

Number of Components: 4
Branch Inlet Diameter: 5.709 inches
Branch Outlet Diameter: 5.709 inches

Branch Elevational Change: 0.0 feet

FLOW DESCRIPTION

Mass Flow Rate: 0.0 lb/hr
Std Vol. Flow Rate: 0.000 SCFM
Outlet Vol. Flow Rate: 0.0 US gal/min
Outlet Velocity: 0.0 ft/sec (FPS)
Outlet Mach No.: 0.000

HARDWARE DESCRIPTION - TABLE 1

Symbols and Units:
- Din - Inlet Diameter - inches
- Dout - Outlet Diameter - inches
- A - Inlet Area - sq inches
- dZ - Elevational Change - feet
- Re - Reynolds Number
- EL - Equivalent Length - Diameters
- K - K Factor relative to Inlet Diameter
- Pin - Inlet Pressure - in water (68F) abs
- Pout - Outlet Pressure - in water (68F) abs
- DP - Differential Pressure - PSID
- HL - Frictional Head Loss - feet
- D - Inlet Density - lb/cu ft
- mu - Inlet Absolute Viscosity - centipoise
- W - Mass Flow Rate - lb/hr
- Q - Actual Volumetric Flow Rate - US gal/min
- Vin - Inlet Velocity - ft/sec (FPS)
- Vout - Outlet Velocity - ft/sec (FPS)

Component Name: Pipe, NPS 6, sched 80, 3.00 feet

Din:	5.709	Dout:	5.709	Area:	25.598	dZ:	0.00
Re:		f:		EL:		K:	
Pin:		Pout:		DP:		HL:	
D:		mu:					
W:	0.00	Q:		Vin:		Vout:	

Component Name: [2] Elbow, 6" 90 Thr/SW

Din:	5.709	Dout:	5.709	Area:	25.598	dZ:	0.00
Re:		f:	0.015096	EL:	30.00	K:	0.45
Pin:		Pout:		DP:		HL:	
D:		mu:					
W:	0.00	Q:		Vin:		Vout:	

Component Name: Ball valve

Din:	5.709	Dout:	5.709	Area:	25.598	dZ:	0.00
Re:		f:	0.015096	EL:	3.00	K:	1.0E+24
Pin:		Pout:	186.68	DP:		HL:	
D:		mu:					
W:	0.00	Q:		Vin:		Vout:	0.00

ONE-PAGE SUMMARY

Branch Number: 16
File Name: Well Head

FLUID DESCRIPTION

Compressible - Location Not Specified
Spec. Heat Ratio (Cp/Cv): 1.400
Molecular Weight: 28.96
Specific Gravity: 1.000

HARDWARE DESCRIPTION

Number of Components: 2
Branch Inlet Diameter: 5.709 inches
Branch Outlet Diameter: 5.709 inches

Branch Elevational Change: 0.0 feet
Branch K Factor: 0.17

FLOW DESCRIPTION

Mass Flow Rate: 687.1 lb/hr
Std Vol. Flow Rate: 150.000 SCFM
Inlet Vol. Flow Rate: 2,403.6 US gal/min
Inlet Velocity: 30.1 ft/sec (FPS)
Inlet Mach No.: 0.027
Outlet Vol. Flow Rate: 2,403.8 US gal/min
Outlet Velocity: 30.1 ft/sec (FPS)
Outlet Mach No.: 0.027

Differential Pressure: 0.0005936 PSID

HARDWARE DESCRIPTION - TABLE 1

Symbols and Units:
- Din - Inlet Diameter - inches
- Dout - Outlet Diameter - inches
- A - Inlet Area - sq inches
- dZ - Elevational Change - feet
- Re - Reynolds Number
- EL - Equivalent Length - Diameters
- K - K Factor relative to Inlet Diameter
- Pin - Inlet Pressure - in water (68F) abs
- Pout - Outlet Pressure - in water (68F) abs
- DP - Differential Pressure - PSID
- HL - Frictional Head Loss - feet
- D - Inlet Density - lb/cu ft
- mu - Inlet Absolute Viscosity - centipoise
- W - Mass Flow Rate - lb/hr
- Q - Actual Volumetric Flow Rate - US gal/min
- Vin - Inlet Velocity - ft/sec (FPS)
- Vout - Outlet Velocity - ft/sec (FPS)

Component Name: Pipe, NPS 6, sched 80, 5.00 feet

Din:	5.709	Dout:	5.709	Area:	25.598	dZ:	0.00
Re:	43663	f:	0.011856	EL:	10.51	K:	0.12
Pin:	186.62	Pout:	186.60	DP:	0.00	HL:	
D:	0.036	mu:	0.017				
W:	687.12	Q:	2403.61	Vin:	30.13	Vout:	30.13

Component Name: Ball valve

Din:	5.709	Dout:	5.709	Area:	25.598	dZ:	0.00
Re:	43663	f:	0.015096	EL:	3.00	K:	0.05
Pin:	186.60	Pout:	186.60	DP:	0.00	HL:	
D:	0.036	mu:	0.017				
W:	687.12	Q:	2403.76	Vin:	30.13	Vout:	30.13

ONE-PAGE SUMMARY

Branch Number: 17
File Name: 3 inch well head

FLUID DESCRIPTION

Compressible - Location Not Specified
Spec. Heat Ratio (Cp/Cv): 1.400
Molecular Weight: 28.96
Specific Gravity: 1.000

HARDWARE DESCRIPTION

Number of Components: 3
Branch Inlet Diameter: 2.864 inches
Branch Outlet Diameter: 5.709 inches

Branch Elevational Change: 0.0 feet
Branch K Factor: 1.47

FLOW DESCRIPTION

Mass Flow Rate: 343.6 lb/hr
Std Vol. Flow Rate: 75.000 SCFM
Inlet Vol. Flow Rate: 1,200.6 US gal/min
Inlet Velocity: 59.8 ft/sec (FPS)
Inlet Mach No.: 0.054
Outlet Vol. Flow Rate: 1,201.3 US gal/min
Outlet Velocity: 15.1 ft/sec (FPS)
Outlet Mach No.: 0.014

Differential Pressure: 8.688E-05 PSID

HARDWARE DESCRIPTION - TABLE 1

Symbols and Units:
- Din - Inlet Diameter - inches
- Dout - Outlet Diameter - inches
- A - Inlet Area - sq inches
- dZ - Elevational Change - feet
- Re - Reynolds Number
- EL - Equivalent Length - Diameters
- K - K Factor relative to Inlet Diameter
- Pin - Inlet Pressure - in water (68F) abs
- Pout - Outlet Pressure - in water (68F) abs
- DP - Differential Pressure - PSID
- HL - Frictional Head Loss - feet
- D - Inlet Density - lb/cu ft
- mu - Inlet Absolute Viscosity - centipoise
- W - Mass Flow Rate - lb/hr
- Q - Actual Volumetric Flow Rate - US gal/min
- Vin - Inlet Velocity - ft/sec (FPS)
- Vout - Outlet Velocity - ft/sec (FPS)

Component Name: Pipe, NPS 3, sched 80, 15.00 feet

Din:	2.864	Dout:	2.864	Area:	6.442	dZ:	0.00
Re:	43533	f:	0.013567	EL:	62.85	K:	0.85
Pin:	186.72	Pout:	186.40	DP:	0.01	HL:	
D:	0.036	mu:	0.017				
W:	343.56	Q:	1200.59	Vin:	59.79	Vout:	59.90

Component Name: Ball valve

Din:	2.864	Dout:	2.864	Area:	6.442	dZ:	0.00
Re:	43534	f:	0.017591	EL:	3.00	K:	0.05
Pin:	186.40	Pout:	186.38	DP:	0.00	HL:	
D:	0.036	mu:	0.017				
W:	343.56	Q:	1202.69	Vin:	59.90	Vout:	59.90

Component Name: Enlarger, 3 X 6" sud

Din:	2.864	Dout:	5.709	Area:	6.442	dZ:	0.00
Re:	21830	f:	0.017591	EL:	31.84	K:	0.56
Pin:	186.38	Pout:	186.72	DP:	-0.01	HL:	
D:	0.036	mu:	0.017				
W:	343.56	Q:	1202.82	Vin:	59.90	Vout:	15.06

ONE-PAGE SUMMARY

Branch Number: 18
File Name: 3 inch well head

FLUID DESCRIPTION

Compressible - Location Not Specified
Spec. Heat Ratio (Cp/Cv): 1.400
Molecular Weight: 28.96
Specific Gravity: 1.000

HARDWARE DESCRIPTION

Number of Components: 3
Branch Inlet Diameter: 2.864 inches
Branch Outlet Diameter: 5.709 inches

Branch Elevational Change: 0.0 feet
Branch K Factor: 1.47

FLOW DESCRIPTION

Mass Flow Rate: 343.6 lb/hr
Std Vol. Flow Rate: 75.000 SCFM
Inlet Vol. Flow Rate: 1,200.5 US gal/min
Inlet Velocity: 59.8 ft/sec (FPS)
Inlet Mach No.: 0.054
Outlet Vol. Flow Rate: 1,201.2 US gal/min
Outlet Velocity: 15.1 ft/sec (FPS)
Outlet Mach No.: 0.014

Differential Pressure: 8.687E-05 PSID

HARDWARE DESCRIPTION - TABLE 1

Symbols and Units:
- Din - Inlet Diameter - inches
- Dout - Outlet Diameter - inches
- A - Inlet Area - sq inches
- dZ - Elevational Change - feet
- Re - Reynolds Number
- EL - Equivalent Length - Diameters
- K - K Factor relative to Inlet Diameter
- Pin - Inlet Pressure - in water (68F) abs
- Pout - Outlet Pressure - in water (68F) abs
- DP - Differential Pressure - PSID
- HL - Frictional Head Loss - feet
- D - Inlet Density - lb/cu ft
- mu - Inlet Absolute Viscosity - centipoise
- W - Mass Flow Rate - lb/hr
- Q - Actual Volumetric Flow Rate - US gal/min
- Vin - Inlet Velocity - ft/sec (FPS)
- Vout - Outlet Velocity - ft/sec (FPS)

Component Name: Pipe, NPS 3, sched 80, 15.00 feet

Din:	2.864	Dout:	2.864	Area:	6.442	dZ:	0.00
Re:	43533	f:	0.013567	EL:	62.85	K:	0.85
Pin:	186.73	Pout:	186.40	DP:	0.01	HL:	
D:	0.036	mu:	0.017				
W:	343.56	Q:	1200.54	Vin:	59.79	Vout:	59.89

Component Name: Ball valve

Din:	2.864	Dout:	2.864	Area:	6.442	dZ:	0.00
Re:	43534	f:	0.017591	EL:	3.00	K:	0.05
Pin:	186.40	Pout:	186.38	DP:	0.00	HL:	
D:	0.036	mu:	0.017				
W:	343.56	Q:	1202.65	Vin:	59.89	Vout:	59.90

Component Name: Enlarger, 3 X 6" sud

Din:	2.864	Dout:	5.709	Area:	6.442	dZ:	0.00
Re:	21830	f:	0.017591	EL:	31.84	K:	0.56
Pin:	186.38	Pout:	186.73	DP:	-0.01	HL:	
D:	0.036	mu:	0.017				
W:	343.56	Q:	1202.78	Vin:	59.90	Vout:	15.06

ONE-PAGE SUMMARY

Branch Number: 19
File Name: 3 inch well head

FLUID DESCRIPTION

Compressible - Location Not Specified
Spec. Heat Ratio (Cp/Cv): 1.400
Molecular Weight: 28.96
Specific Gravity: 1.000

HARDWARE DESCRIPTION

Number of Components: 3
Branch Inlet Diameter: 2.864 inches
Branch Outlet Diameter: 5.709 inches

Branch Elevational Change: 0.0 feet

FLOW DESCRIPTION

Mass Flow Rate: 0.0 lb/hr
Std Vol. Flow Rate: 0.000 SCFM
Outlet Vol. Flow Rate: 0.0 US gal/min
Outlet Velocity: 0.0 ft/sec (FPS)
Outlet Mach No.: 0.000

HARDWARE DESCRIPTION - TABLE 1

Symbols and Units:
- Din - Inlet Diameter - inches
- Dout - Outlet Diameter - inches
- A - Inlet Area - sq inches
- dZ - Elevational Change - feet
- Re - Reynolds Number
- EL - Equivalent Length - Diameters
- K - K Factor relative to Inlet Diameter
- Pin - Inlet Pressure - in water (68F) abs
- Pout - Outlet Pressure - in water (68F) abs
- DP - Differential Pressure - PSID
- HL - Frictional Head Loss - feet
- D - Inlet Density - lb/cu ft
- mu - Inlet Absolute Viscosity - centipoise
- W - Mass Flow Rate - lb/hr
- Q - Actual Volumetric Flow Rate - US gal/min
- Vin - Inlet Velocity - ft/sec (FPS)
- Vout - Outlet Velocity - ft/sec (FPS)

Component Name: Pipe, NPS 3, sched 80, 15.00 feet

Din:	2.864	Dout:	2.864	Area:	6.442	dZ:	0.00
Re:		f:		EL:		K:	
Pin:		Pout:		DP:		HL:	
D:		mu:					
W:	0.00	Q:		Vin:		Vout:	

Component Name: Ball valve

Din:	2.864	Dout:	2.864	Area:	6.442	dZ:	0.00
Re:		f:	0.017591	EL:	3.00	K:	1.0E+24
Pin:		Pout:	186.73	DP:		HL:	
D:		mu:					
W:	0.00	Q:		Vin:		Vout:	

Component Name: Enlarger, 3 X 6" sud

Din:	2.864	Dout:	5.709	Area:	6.442	dZ:	0.00
Re:	0	f:	0.017591	EL:	31.84	K:	0.56
Pin:	186.73	Pout:	186.73	DP:	0.00	HL:	
D:		mu:					
W:	0.00	Q:		Vin:		Vout:	0.00

ONE-PAGE SUMMARY

Branch Number: 20
File Name: Dilution Air

FLUID DESCRIPTION

Compressible - Location Not Specified
Spec. Heat Ratio (Cp/Cv): 1.400
Molecular Weight: 28.96
Specific Gravity: 1.000

HARDWARE DESCRIPTION

Number of Components: 4
Branch Inlet Diameter: 5.709 inches
Branch Outlet Diameter: 5.709 inches

Branch Elevational Change: 0.0 feet

FLOW DESCRIPTION

Mass Flow Rate: 0.0 lb/hr
Std Vol. Flow Rate: 0.000 SCFM
Outlet Vol. Flow Rate: 0.0 US gal/min
Outlet Velocity: 0.0 ft/sec (FPS)
Outlet Mach No.: 0.000

HARDWARE DESCRIPTION - TABLE 1

Symbols and Units:
- Din - Inlet Diameter - inches
- Dout - Outlet Diameter - inches
- A - Inlet Area - sq inches
- dZ - Elevational Change - feet
- Re - Reynolds Number
- EL - Equivalent Length - Diameters
- K - K Factor relative to Inlet Diameter
- Pin - Inlet Pressure - in water (68F) abs
- Pout - Outlet Pressure - in water (68F) abs
- DP - Differential Pressure - PSID
- HL - Frictional Head Loss - feet
- D - Inlet Density - lb/cu ft
- mu - Inlet Absolute Viscosity - centipoise
- W - Mass Flow Rate - lb/hr
- Q - Actual Volumetric Flow Rate - US gal/min
- Vin - Inlet Velocity - ft/sec (FPS)
- Vout - Outlet Velocity - ft/sec (FPS)

Component Name: Pipe, NPS 6, sched 80, 3.00 feet

Din:	5.709	Dout:	5.709	Area:	25.598	dZ:	0.00
Re:		f:		EL:		K:	
Pin:		Pout:		DP:		HL:	
D:		mu:					
W:	0.00	Q:		Vin:		Vout:	

Component Name: [2] Elbow, 6" 90 Thr/SW

Din:	5.709	Dout:	5.709	Area:	25.598	dZ:	0.00
Re:		f:	0.015096	EL:	30.00	K:	0.45
Pin:		Pout:		DP:		HL:	
D:		mu:					
W:	0.00	Q:		Vin:		Vout:	

Component Name: Ball valve

Din:	5.709	Dout:	5.709	Area:	25.598	dZ:	0.00
Re:		f:	0.015096	EL:	3.00	K:	1.0E+24
Pin:		Pout:	183.88	DP:		HL:	
D:		mu:					
W:	0.00	Q:		Vin:		Vout:	0.00

ONE-PAGE SUMMARY

Branch Number: 21
File Name: Well Head

FLUID DESCRIPTION

Compressible - Location Not Specified
Spec. Heat Ratio (Cp/Cv): 1.400
Molecular Weight: 28.96
Specific Gravity: 1.000

HARDWARE DESCRIPTION

Number of Components: 2
Branch Inlet Diameter: 5.709 inches
Branch Outlet Diameter: 5.709 inches

Branch Elevational Change: 0.0 feet

FLOW DESCRIPTION

Mass Flow Rate: 0.0 lb/hr
Std Vol. Flow Rate: 0.000 SCFM
Outlet Vol. Flow Rate: 0.0 US gal/min
Outlet Velocity: 0.0 ft/sec (FPS)
Outlet Mach No.: 0.000

HARDWARE DESCRIPTION - TABLE 1

Symbols and Units:
- Din - Inlet Diameter - inches
- Dout - Outlet Diameter - inches
- A - Inlet Area - sq inches
- dZ - Elevational Change - feet
- Re - Reynolds Number
- EL - Equivalent Length - Diameters
- K - K Factor relative to Inlet Diameter
- Pin - Inlet Pressure - in water (68F) abs
- Pout - Outlet Pressure - in water (68F) abs
- DP - Differential Pressure - PSID
- HL - Frictional Head Loss - feet
- D - Inlet Density - lb/cu ft
- mu - Inlet Absolute Viscosity - centipoise
- W - Mass Flow Rate - lb/hr
- Q - Actual Volumetric Flow Rate - US gal/min
- Vin - Inlet Velocity - ft/sec (FPS)
- Vout - Outlet Velocity - ft/sec (FPS)

Component Name: Pipe, NPS 6, sched 80, 5.00 feet

Din:	5.709	Dout:	5.709	Area:	25.598	dZ:	0.00
Re:		f:		EL:		K:	
Pin:		Pout:		DP:		HL:	
D:		mu:					
W:	0.00	Q:		Vin:		Vout:	

Component Name: Ball valve

Din:	5.709	Dout:	5.709	Area:	25.598	dZ:	0.00
Re:		f:	0.015096	EL:	3.00	K:	1.0E+24
Pin:		Pout:	183.88	DP:		HL:	
D:		mu:					
W:	0.00	Q:		Vin:		Vout:	0.00

ONE-PAGE SUMMARY

Branch Number: 4

FLUID DESCRIPTION

Compressible - Location Not Specified

Spec. Heat Ratio (Cp/Cv):	1.400
Molecular Weight:	28.96
Specific Gravity:	1.000

HARDWARE DESCRIPTION

Number of Components:	3	
Branch Inlet Diameter:	5.709	inches
Branch Outlet Diameter:	5.845	inches
Branch Elevational Change:	0.0	feet
Branch K Factor:	19.74	

FLOW DESCRIPTION

Mass Flow Rate:	687.1	lb/hr
Std Vol. Flow Rate:	150.000	SCFM
Inlet Vol. Flow Rate:	2,404.2	US gal/min
Inlet Velocity:	30.1	ft/sec (FPS)
Inlet Mach No.:	0.027	
Outlet Vol. Flow Rate:	2,428.0	US gal/min
Outlet Velocity:	29.0	ft/sec (FPS)
Outlet Mach No.:	0.026	
Differential Pressure:	0.07	PSID

HARDWARE DESCRIPTION - TABLE 1

Symbols and Units:
- Din - Inlet Diameter - inches
- Dout - Outlet Diameter - inches
- A - Inlet Area - sq inches
- dZ - Elevational Change - feet
- Re - Reynolds Number
- EL - Equivalent Length - Diameters
- K - K Factor relative to Inlet Diameter
- Pin - Inlet Pressure - in water (68F) abs
- Pout - Outlet Pressure - in water (68F) abs
- DP - Differential Pressure - PSID
- HL - Frictional Head Loss - feet
- D - Inlet Density - lb/cu ft
- mu - Inlet Absolute Viscosity - centipoise
- W - Mass Flow Rate - lb/hr
- Q - Actual Volumetric Flow Rate - US gal/min
- Vin - Inlet Velocity - ft/sec (FPS)
- Vout - Outlet Velocity - ft/sec (FPS)

Component Name: Reducer, 6 X 4" sud

Din:	5.709	Dout:	4.000	Area:	25.598	dZ:	0.00
Re:	43663	f:	0.015096	EL:	69.98	K:	1.06
Pin:	186.57	Pout:	186.16	DP:	0.01	HL:	
D:	0.036	mu:	0.017				
W:	687.12	Q:	2404.20	Vin:	30.13	Vout:	61.49

Component Name: Pipe, NPS 4, 100.00 feet

Din:	4.000	Dout:	4.000	Area:	12.566	dZ:	0.00
Re:	62343	f:	0.014066	EL:	300.01	K:	4.22
Pin:	186.16	Pout:	184.45	DP:	0.06	HL:	
D:	0.036	mu:	0.017				
W:	687.12	Q:	2408.34	Vin:	61.49	Vout:	62.06

Component Name: Enlarger, 4 X 6" sud

Din:	4.000	Dout:	5.845	Area:	12.566	dZ:	0.00
Re:	42647	f:	0.016311	EL:	17.33	K:	0.28
Pin:	184.45	Pout:	184.74	DP:	-0.01	HL:	
D:	0.035	mu:	0.017				
W:	687.12	Q:	2430.69	Vin:	62.06	Vout:	29.03

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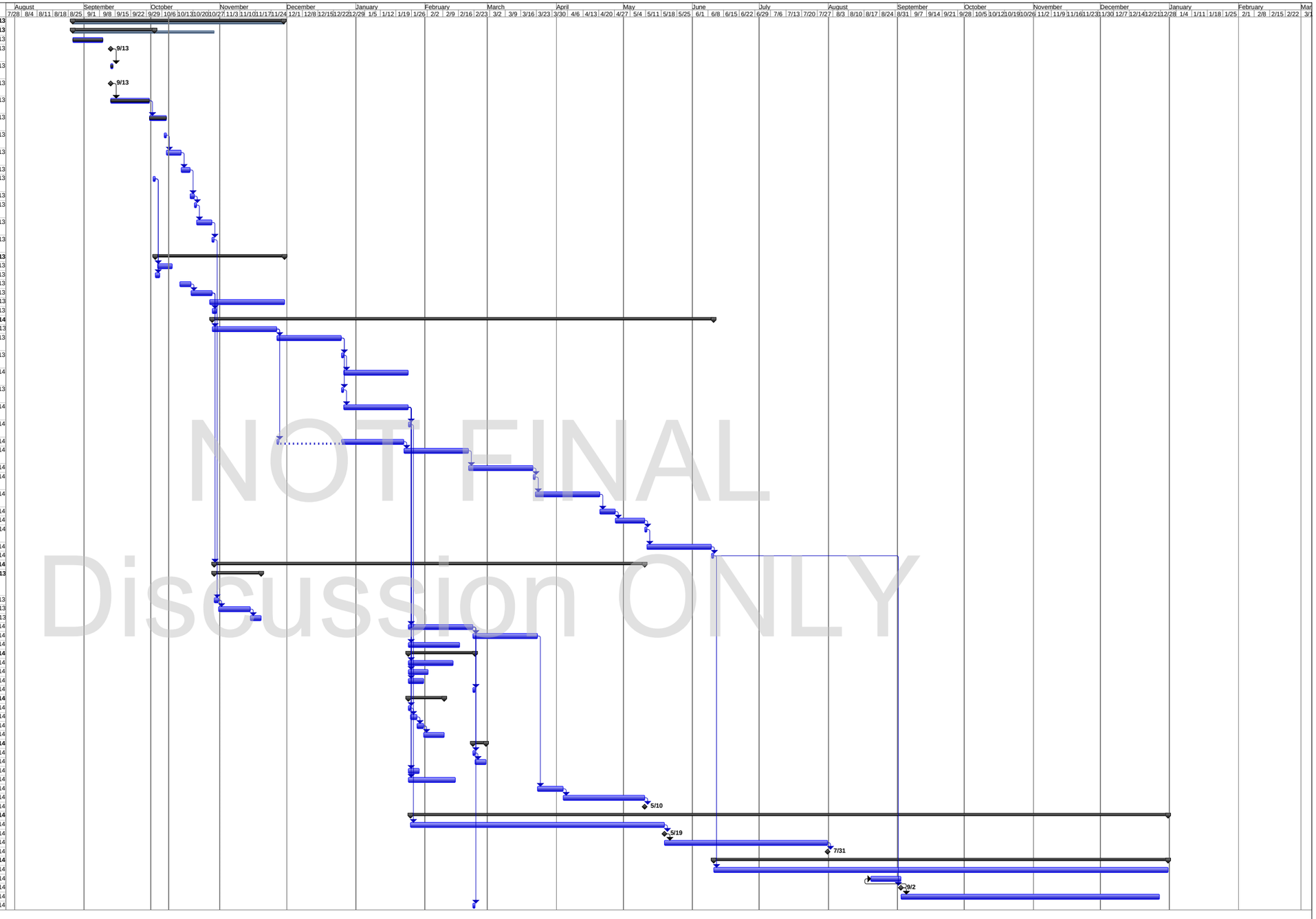
APPENDIX E

Project Schedule

ID	Task Name	Duration	Start	Finish
1	**SVE Expansion Pilot Testing**	**98 days**	**Tue 8/27/13**	**Fri 11/29/13**
2	**SVE Expansion Pilot Test Work Plan**	**38 days**	**Tue 8/27/13**	**Wed 10/2/13**
3	Prepare Draft SVE Expansion Pilot Test Work Plan	14 days	Tue 8/27/13	Mon 9/9/13
4	Submit Draft SVE Expansion Pilot Test Work Plan to USACE and KAFB for review	0 days	Fri 9/13/13	Fri 9/13/13
5	USACE and KAFB review of SVE Expansion Pilot Test Work Plan	1 day	Fri 9/13/13	Fri 9/13/13
6	Submit "Look Ahead" SVE Expansion Pilot Test Work Plan to NMED for unofficial review	0 days	Fri 9/13/13	Fri 9/13/13
7	NMED Review of "Look Ahead" SVE Expansion Pilot Test Work Plan	18 days	Fri 9/13/13	Mon 9/30/13
8	Prepare Revised "Look Ahead" SVE Expansion Pilot Test Work Plan for NMED unofficial review	8 days	Mon 9/30/13	Mon 10/7/13
9	USACE and KAFB review of Revised "Look Ahead" SVE Expansion Pilot Test Work Plan	1 day	Mon 10/7/13	Mon 10/7/13
10	NMED Review of Revised "Look Ahead" SVE Expansion Pilot Test Work Plan	7 days	Tue 10/8/13	Mon 10/14/13
11	Prepare Final SVE Expansion Pilot Test Work Plan	4 days	Mon 10/14/13	Fri 10/18/13
12	NMED Verbal Approval of SVE Expansion Pilot Test Work Plan	1 day	Wed 10/2/13	Wed 10/2/13
13	Commander Signature for official submittal	2 days	Fri 10/18/13	Sun 10/20/13
14	Submit Final SVE Expansion Pilot Test Work Plan to NMED for review and approval	1 day	Sun 10/20/13	Mon 10/21/13
15	NMED Review of Final SVE Expansion Pilot Test Work Plan	7 days	Mon 10/21/13	Mon 10/28/13
16	NMED Approval of Final SVE Expansion Pilot Test Work Plan	1 day	Mon 10/28/13	Tue 10/29/13
17	**SVE Expansion Pilot Testing**	**60 days**	**Thu 10/3/13**	**Fri 11/29/13**
18	SVE System Shutdown (equilibration)	7 days	Fri 10/4/13	Thu 10/10/13
19	Mobilization	2 days	Thu 10/3/13	Fri 10/4/13
20	Pilot Testing Quick Tests	5 days	Mon 10/14/13	Fri 10/18/13
21	Pilot Testing Long Duration Tests	10 days	Sat 10/19/13	Mon 10/28/13
22	Soil Vapor Sampling of 35 Wells	35 days	Sun 10/27/13	Fri 11/29/13
23	Demobilization	2 days	Mon 10/28/13	Wed 10/30/13
24	**SVE Expansion Design Plan**	**233 days**	**Mon 10/28/13**	**Tue 6/10/14**
25	Data Evaluation	30 days	Mon 10/28/13	Tue 11/26/13
26	Prepare Draft Engineering Design Drawings for Expanded SVE System	30 days	Tue 11/26/13	Wed 12/25/13
27	Submit Draft Engineering Design Drawings for Expanded SVE System to USACE and KAFB for Review	1 day	Wed 12/25/13	Thu 12/26/13
28	USACE and KAFB Review of Draft Engineering Design Drawings for Expanded SVE System	30 days	Thu 12/26/13	Fri 1/24/14
29	Submit Draft Engineering Design Drawings for Expanded SVE System to NMED for unofficial Review	1 day	Wed 12/25/13	Thu 12/26/13
30	NMED Review of Draft Engineering Design Drawings for Expanded SVE System	30 days	Thu 12/26/13	Fri 1/24/14
31	NMED Approval of Engineering Design Drawings for Expanded SVE System	1 day	Fri 1/24/14	Sat 1/25/14
32	Prepare Draft SVE Expansion Design Plan	30 days	Tue 11/26/13	Wed 1/22/14
33	Submit Draft SVE Expansion Design Plan for USACE and KAFB review	30 days	Wed 1/22/14	Thu 2/20/14
34	USACE and KAFB review of SVE Expansion Design Plan	30 days	Thu 2/20/14	Fri 3/21/14
35	Submit Look Ahead SVE Expansion Design Plan to NMED for unofficial review	1 day	Fri 3/21/14	Sat 3/22/14
36	NMED review of Look Ahead SVE Expansion Design Plan	30 days	Sat 3/22/14	Sun 4/20/14
37	Prepare Final SVE Expansion Design Work Plan	7 days	Sun 4/20/14	Sun 4/27/14
38	Commander Signature for official submittal	14 days	Sun 4/27/14	Sat 5/10/14
39	Submit Final SVE Expansion Design Plan to NMED for review and approval	1 day	Sat 5/10/14	Sun 5/11/14
40	NMED Review of Final SVE Expansion Design Plan	30 days	Sun 5/11/14	Mon 6/9/14
41	NMED Approval of Final SVE Expansion Design Plan	1 day	Mon 6/9/14	Tue 6/10/14
42	**Construction of Expanded SVE System**	**200.25 days**	**Tue 10/29/13**	**Sat 5/10/14**
43	**Piping of SVEW-01 thru SVEW-09 and three pneulog wells into existing SVE treatment system**	**22 days**	**Tue 10/29/13**	**Tue 11/19/13**
44	Mobilization	2 days	Tue 10/29/13	Thu 10/31/13
45	Construction of piping	15 days	Thu 10/31/13	Thu 11/14/13
46	System Optimization Testing	5 days	Thu 11/14/13	Tue 11/19/13
47	Procurement of new SVE equipment	30 days	Fri 1/24/14	Sat 2/22/14
48	Shipment of SVE equipment	30 days	Sat 2/22/14	Sun 3/23/14
49	Concrete pad construction	24 days	Fri 1/24/14	Sun 2/16/14
50	**Eletrical**	**31 days**	**Fri 1/24/14**	**Sun 2/23/14**
51	Ground loop, trenching, and piping	21 days	Fri 1/24/14	Thu 2/13/14
52	Eletrical pull, terminations, and test	9 days	Fri 1/24/14	Sun 2/2/14
53	Panel for heat trace	7 days	Fri 1/24/14	Fri 1/31/14
54	Compressor	1 day	Sat 2/22/14	Sun 2/23/14
55	**Natural Gas**	**17 days**	**Fri 1/24/14**	**Sun 2/9/14**
56	Pot holing for utilities	1 day	Fri 1/24/14	Sat 1/25/14
57	Trenching and pipe installation	3 days	Sat 1/25/14	Tue 1/28/14
58	Main line tie-in/shutdown	3 days	Tue 1/28/14	Fri 1/31/14
59	Connections and line testing	10 days	Fri 1/31/14	Sun 2/9/14
60	**Condensate Tank**	**6 days**	**Sat 2/22/14**	**Fri 2/28/14**
61	Tank Delivery	1 day	Sat 2/22/14	Sun 2/23/14
62	Connections and testing	5 days	Sun 2/23/14	Fri 2/28/14
63	Fencing installation	5 days	Fri 1/24/14	Wed 1/29/14
64	HDPE piping and system connections	22 days	Fri 1/24/14	Fri 2/14/14
65	HPLC programming and system testing	12 days	Sun 3/23/14	Thu 4/3/14
66	System Shakedown and ROI Testing	38 days	Fri 4/4/14	Sat 5/10/14
67	System Operation Begins	0 days	Sat 5/10/14	Sat 5/10/14
68	**Air Permit**	**352 days**	**Sat 1/25/14**	**Wed 12/31/14**
69	Prepare Emergency Air Permit	118 days	Sat 1/25/14	Mon 5/19/14
70	Submit Emergency Air Permit to AEHD	0 days	Mon 5/19/14	Mon 5/19/14
71	AEHD review of Emergency Air Permit	76 days	Mon 5/19/14	Thu 7/31/14
72	AEHD approval of Emergency Air Permit	0 days	Thu 7/31/14	Thu 7/31/14
73	**Prepare Air Permit Modification**	**211 days**	**Tue 6/10/14**	**Wed 12/31/14**
74	KAFB Review of Air Permit Modification	211 days	Tue 6/10/14	Wed 12/31/14
75	Staffing for Commander Signature	14 days	Wed 8/20/14	Tue 9/2/14
76	Submit Air Permit Mod to AEHD	0 days	Tue 9/2/14	Tue 9/2/14
77	AEHD review of Air Permit Modification	120 days	Tue 9/2/14	Sat 12/27/14
78	AEHD Approval of Air Permit Modification	1 day	Sat 2/22/14	Sun 2/23/14



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Split | Summary | External Tasks | Inactive Task | Inactive Summary | Duration-only | Manual Summary | Finish-only | Deadline

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