NYE COUNTY NUCLEAR WASTE REPOSITORY PROJECT OFFICE

TEST PLAN

TITLE:	Revision: 1
Drilling, Well Construction and Testing of Groundwater Evaluation Piezometer Wells, Southern Nye County	Date: **04/22/2013** Page: **1 of 48**

TEST PLAN NUMBER:	SUPERSEDES:
TPN-5.6	**Rev. 0, 05-10-10**

APPROVAL	CONCURRENCE
Project Manager — Date: 5/1/13	Geoscience Manager — Date: 6 MAY 2013 Principal Investigator — Date: 5/6/13 Quality Assurance Officer — Date: 5/1/13

1.0 INTRODUCTION

This test plan (TPN) provides general instructions for the drilling, construction and preliminary testing of Nye County Nuclear Waste Repository Project Office (NWRPO) Groundwater Evaluation (GWE) wells. These instructions include the following tasks:

- Drilling, sampling, and casing of boreholes;
- Geologic logging and chip sample archiving;
- Geophysical logging of boreholes;
- Completion of two boreholes: One as a piezometer/observation/monitoring well and the second as a test/monitoring well; and
- Well test pumping

This TPN references the applicable portions of the NWRPO drilling contract that provides detailed drilling and well completion instructions and responsibilities for the drilling contractor.

2.0 PURPOSE AND JUSTIFICATION

The Nye County NWRPO is conducting groundwater evaluation (GWE) studies in southern Nye County under a Department of Energy (DOE) grant. As part of this work, the county has installed a network of groundwater piezometer wells to supplement the existing groundwater monitoring network. Nye County proposes to drill a new test/monitoring well and piezometer well at an existing testing complex to characterize the hydrologic properties of the Gravity Fault.

The Gravity Fault in Amargosa Valley is a prominent hydrologic feature that controls head relationships between the Lower Carbonate Aquifer (LCA) to the east, and Valley Fill Aquifer (VFA) to the west. The fault and overlying sediments probably also control discharge from the LCA to the VFA. Although this feature was identified in the 1970's and the feature has been incorporated into several hydrologic flow models, no direct hydrologic testing has been conducted to evaluate the hydrologic significance of the fault. The proposed wells provide the opportunity to conduct a series of aquifer pump tests to better determine the hydrologic characteristics of the Gravity Fault.

3.0 SCOPE OF WORK FOR DRILLING, LOGGING, AND WELL COMPLETION

3.1 Responsibilities and Pre- and Post-Drilling Requirements

3.1.1 Responsibilities, Chain of Command, and Communication

The Nye County NWRPO Geoscience Manager (GSM) will be responsible for supervising all technical data collection described in this plan. The NWRPO-designated field representative (NDFR), in most cases the Contract Managing Geologist, will supervise other contract geologists and technicians, collectively referred to as NWRPO field personnel herein. NWRPO field personnel are responsible for conducting the activities described in this TPN.

The drilling contractor is responsible for the drilling and well construction specified in the NWRPO drilling contract documents (NWRPO, 2013a; and Scope of Work: Attachment A). A drilling contractor-designated field representative (CDFR) will direct all drilling contractor activities, with the exception of the NWRPO-directed activities specified in the drilling contract, which the NDFR or designee is responsible for directing. The NDFR and CDFR will communicate on a daily basis and review, approve, and sign daily drilling records that document contract billable items.

3.1.2 Site Locations, Collar Locations and Pad Preparation

Sites for GWE Gravity Fault wells are located in Amargosa Valley in southern Nye County, Nevada. All sites have gravel access roads (Figure 1).

Final well locations at each well site will be determined by the NWRPO, a stake will be driven at the proposed wellhead location, and a preliminary location acquired using a hand-held global positioning system (GPS). An 8-inch spike will be driven into the ground near the well collar to provide an original ground level datum for depth control during drilling and completion activities. Preliminary GPS data collected for each drill site will be transmitted to the NWRPO Quality Assurance (QA) Records Center (QARC) along with associated metadata. Any additional processed data will also be transmitted to the QARC.

Drill pads and access roads will be constructed and maintained as necessary by the NWRPO.

3.1.3 Permitting, License, and Reporting Requirements

The NWRPO, as the well owner, has completed all required federal and state permits. No additional permits are required from the U.S. Department of the Interior, U.S. Bureau of Land Management (BLM), Nevada Division of Water Resources (NDWR), or Nevada Division of Water Pollution Control.

The drilling contractor will be required to notify the NDWR before drilling operations by submitting a Notice of Intent to Drill at least 3 working days before the rig is set up, according to the requirements of Nevada Administrative Code (NAC) 534.320. The Notice of Intent to Drill will list any permits or waivers issued previously by the NDWR; the NWRPO will supply the drilling contractor with this list.

The drilling contractor will provide the NWRPO with copies of each driller's license before drilling operations begin. Per NAC 534.330, each driller will carry his license when he is present at the drilling site and produce the license upon request by an NDWR representative. At least one driller with a Nevada license will be present at the site when the drill rig is operating.

The drilling contractor is also required to meet the reporting requirements of Nevada Revised Statute (NRS) 534.170 and NAC 534.340 by submitting a completed Driller's Report and Record of Work to the NDWR within 30 days of completion for each well. Copies of the documents will also be transmitted to the NWRPO.

3.1.4 Mobilization and Demobilization

Mobilization will be considered complete when the following steps have been taken:

1. The rig and associated equipment have been inspected and approved by the NDFR as being in clean condition and good working order.
2. A containment mat has been installed under the rig. The drilling contractor will use an appropriately heavy-gauge, single-piece plastic mat under the rig and other equipment, as appropriate, to contain all leaks of hydraulic oil, lubricants, or other liquids. The containment area should be constructed at least 4 inches deep with a border of wooden skids or other material.
3. The format of the daily drilling record (i.e., field ticket) has been reviewed and approved by the CDFR.
4. Material safety data sheets (MSDSs) for all applicable materials on site have been submitted to the NDFR.
5. All proofs of insurance, personnel training, and other certifications specified in the contract have been submitted to the NWRPO.
6. All State of Nevada requirements for the drilling contractor (e.g., Notice of Intent to Drill) have been met and applicable documents submitted to the NDWR, with copies to the NWRPO.
7. The rig and its associated equipment (e.g., drilling fluid handling and sampling systems) have been set up at the proposed location and are ready to conduct linear footage drilling or other activities as directed by the NDFR.

8. All personnel, equipment, tools, and material required under the contract are on the site, except those not needed immediately. The drilling contractor may use the NWRPO lay-down yard in Lathrop Wells for equipment storage; however, rig time incurred while waiting for such equipment to be retrieved will be at the drilling contractor's expense.

Demobilization will be considered complete when the following steps have been taken.

1. Tasks specified in the contract are complete or exempt from completion by approval from the NWRPO.

2. Any pits and berms on all the drill sites have been graded to approximately the original elevation.

3. All personnel, equipment, tools, unused materials, and drilling-related debris have been removed from the site, as well as from the NWRPO lay-down yard.

3.2 Drilling and Well Completion

3.2.1 Summary of Drilling Contractor Scope of Work

The detailed scope of work for drilling and well completion is included in the drilling contract and included as Attachment A. In summary, this scope of work includes the following steps:

1. Drill and sample approximately 8-inch and 15-inch boreholes using conventional air circulation with injection of a water and foam mixture. The boreholes will be drilled to a maximum depth of 500 ft. The drilling of the larger test well will be conducted in two passes: an approximately 8-inch air/foam pilot bore for sampling, followed by borehole reaming pass using conventional mud rotary methods. Collect geologic samples (drill cutting samples) at 5-ft intervals from the discharge using a cyclone air/cuttings separator or similar system. A 20-foot deep 10-inch steel surface casing for the piezometer well and a 20-foot deep 16-inch steel surface casing for the monitoring/test well will be installed prior to main advance of the boreholes.

2. Run in flush joint tremmie line, followed by 4-inch flush-threaded Schedule 80 PVC well casing with screens and blanks for the piezometer well and 8-inch ¼-inch wall steel casing with louvered screens and blanks for the test well. Pump in sand or gravel (as water and sand slurry) through the tremmie line in stages to approximately 5 feet above the well screens. Set a 2-foot lift of 60-mesh sandpack. Seal well with 30% by weight bentonite grout in bottom-up approach through the tremmie line. Extend surface casing to approximately 2 ft above ground level and cut down well casing to slightly below surface casing. Install locking cap and 4-ft x 4-ft x 8-inch thick concrete well pad apron. Air lift well to remove drilling fluids from screen/sandpack interval.

3.2.2 Well Completion

A schematic well completion diagram for a typical piezometer well showing borehole diameter requirements and well completion requirements is shown in Figure 2. A schematic surface completion for a 4-inch piezometer well is shown in Figure 3. A schematic well completion diagram for a typical 8-inch test well showing borehole diameter requirements and well

completion requirements is shown in Figure 4. A schematic surface completion for an 8-inch test well is shown in Figure 5.

All subsurface completion materials will be emplaced using tremmie pipe no more than 20 to 30 feet from the bottom of the hole. Tremmie pipe must be run-in the borehole prior to running in the well casing. 8/12 silica sand will be emplaced around the slotted well screen of the piezometer and ¼-inch rounded pea gravel in the test well to approximately 5 feet above each well screen. A 2-foot lift of 60-mesh sand will be emplaced above the sand/gravel pack. A centrifugal pump or gravity feed with chase water will be used to emplace the sand/gravel pack.

A bentonite grout slurry (30% bentonite by weight) will then be emplaced above the sandpack in the well to provide a seal in the annular space. This slurry will be emplaced upward by tremmie pipe using a positive displacement grout pump or diaphragm pump to displace any fluid present in the interval being grouted. The grout level will be raised to approximately 2 feet below ground surface. The well casing will be cut down to slightly less than 2 ft above ground level. The wellhead casing will be constructed by extending (welding on) an approximate 2-foot locking wellhead casing to the existing surface casing. Finally, an 8-inch thick concrete well pad will be constructed using a 4 ft by 4 ft form centered on the wellhead casing and extending approximately 4 inches above original ground level. The well name and pad height above the original ground level will be scribed into the well pad concrete.

The well will be air-lifted using an approximate 2-inch airline with a maximum submergence of 80 feet for the 4-inch PVC well and 120 feet for the 8-inch steel well from static water level. This step can be completed prior to constructing the wellhead casing. Approximate production rates will be recorded in the Scientific Notebook, as well as observations of water clarity and degree of well development.

Prior to rig demobilization from a well site, the site will be cleaned of any trash and construction materials, and cutting pits or berms restored to original grade.

Following well completion and preliminary air-lift development, NWRPO contractors will test pump each well using a submersible pump. The pump will have a pressure transducer attached to monitor well performance during test pumping.

3.2.3 Drilling Specifications

3.2.3.1 Drilling Equipment Requirements

In each borehole, up to 500 feet of unsaturated and saturated valley-fill, volcaniclastic sediments and Paleozoic carbonate rocks will be drilled by conventional air and mud rotary methods. Equipment specifications for these drilling systems are detailed in the drilling contract (NWRPO, 2013a).

3.2.3.2 Drilling Fluids

Permissible drilling fluids are limited to compressed air, water, bentonite mud and foam (e.g. QUIK-FOAM®). Compressed air shall be used to the extent reasonably possible. The drilling contractor will obtain NWRPO approval before using any drilling fluid other than compressed air, water and foam.

All discharged drilling fluids will be initially collected in a cuttings pit or berm for onsite storage and cuttings settling. No water containing excessive cuttings, drilling additives, batch water, wastewater, cement, or any fluids other than clear water may be discharged offsite. Discharge rates will be estimated or determined by timed volume measurements as appropriate and will be documented in accordance with the requirements of the temporary discharge permit (date, times and discharge rates). The NWRPO will photograph erosion controls for any offsite discharges.

3.2.3.3 Borehole Deviation

The drilling contractor will use methods (e.g., drilling collars or stabilizers) to prevent, to the extent possible, borehole deviation. If there appears to be a significant borehole deviation, the NWRPO may conduct a deviation survey to determine the extent.

3.2.3.4 Nuisance Water

It is anticipated that nuisance water, such as rainfall or surface runoff, may be encountered during well drilling and construction. The drilling contractor will protect the work at all times from damage by such water and take all due measures to prevent delays in progress of the work caused by such water. The drilling contractor will dispose of nuisance water, without adverse effects, onto adjacent property.

3.2.3.5 Utilities

No utilities will be available at the drilling location. The drilling contractor will provide portable power packs sufficient to meet all drilling and well construction needs. The drilling contractor will purchase all necessary water for drilling operations from well owners. Construction and makeup water will be fresh water only and the source of the supply will be approved by the NWRPO. To the extent possible, the NWRPO will facilitate the identification of well owners interested in selling water supplies to the drilling contractor.

3.2.3.6 Depth Control

Depth control will be maintained by the following methods:

- Direct monitoring: the NWRPO will inventory drill pipe, collars and bottom hole assemblies and their sizes before use. During drilling, the NWRPO will document the drilled interval by completing a Drilling/Coring Data Sheet (Attachment B) and Tubing and Casing Record (Attachment C).
- Depth sounding: well depths may be periodically sounded with an NWRPO-approved “tag line”.
- The total borehole depth and depth of formation tops determined by the above pipe tally and depth sounding methods will be verified against depths of the same features determined independently by geophysical logging.

3.2.3.7 Dust Control

Best Management Practices will be utilized to control dust on gravel access roads, including limiting vehicle speed to 25 mph and watering roads as necessary. Water will also be used to

control dust while digging mud pits. Drilling fluids used to drill the unsaturated zone will minimize dust production.

3.2.4 Other Drilling Contractor Responsibilities

It is the responsibility of the drilling contractor to be aware of, and comply with, the conditions of the *NWRPO Site Specific Health and Safety Plan for the Drilling, Well Construction and Testing of Groundwater Evaluation Piezometer Wells, Southern Nye County* (NWRPO, 2013b). A copy of this plan will be given to the drilling contractor at the preconstruction meeting. As part of every shift, a tailgate safety meeting will be conducted and documented on the Tailgate Safety Briefing Worksheet.

The well sites are located on private lands, and will not require special training, badging, and/or security clearances for the drilling contractor or the contractor's employees.

All solid waste, trash, and construction debris will be removed from the site and managed in accordance with applicable regulations. No wastes will be disposed onsite. Hazardous wastes are not expected to be generated during the drilling and monitoring processes. Drilling returns are not hazardous wastes.

In compliance with BLM permit requirements, the drilling contractor will take steps to control noxious weeds. The drilling contractor will steam-clean the undercarriage of all drilling and heavy equipment before entering public lands.

The drilling contractor will excavate one or more shallow pits to manage cuttings and fluids resulting from drilling. Any pits, trenches, or berms constructed during drilling will be back-filled by the drilling contractor prior to demobilization. Drill cuttings (i.e., small rock chips and fragments) will be used as fill material. No borrow materials will be used for fill or grading. No unsuitable excavated materials are expected to be generated.

3.2.5 Groundwater Measurements and Sampling During Drilling

3.2.5.1 First Groundwater Measurements/Sampling

The time and depth that first water is encountered during drilling will be recorded by the Contractor and the NDFR will be notified for entry in the geologic log and scientific notebook. The drill string will be broken at the first joint near ground level, and the water level will be measured with an electric well sounder.

No first groundwater samples will be collected or field chemical parameters measured, due to the influence of injection water and drilling additives.

3.2.5.2 Saturated Zone Measurements/Sampling

The NWRPO will routinely measure and record the groundwater level before the start of drilling activities each day. However, groundwater samples will not be collected during drilling and completion activities for the reason stated in section 3.2.5.1.

3.2.6 Rotary Drilling Procedures

After setting up the drill rig, all down hole tools will be measured and recorded on tubing and casing records, and the drilling head and mast will be marked at even 5-foot depth intervals to

mark sample end points. Alternatively, each drill pipe can be marked with sample points at even 5-foot depths. Rotary drill cuttings samples will be collected at 5-foot intervals through the entire drilled interval. Cuttings samples will be collected in 20 gallon galvanized steel tubs. An empty tub will be inserted in the return stream prior to advancing each 5 foot sample interval. The drilling contractor will provide the sample to NWRPO personnel for geologic logging. Depth control will be maintained through the use of Drilling Coring Data Sheets (Attachment B) and Tubing and Casing Records (Attachment C). A 20-foot surface casing will be installed and grouted prior to main advance of the borehole. Once in place, a diverter head and discharge hose will be installed on the surface casing. Re-check sample points on drill head or mast prior to main advance of the borehole.

3.2.7 Geologic Logging and Processing

Drill cuttings samples will be collected, logged, and processed for the entire drilled interval from each borehole. The general procedure will include:

Geologic logging will be recorded on the Cuttings Sample Log (Attachment D). Geologic logging of unconsolidated formation (alluvium and sediments) will include descriptions of the following parameters: color, field estimates of particle size distribution and Unified Soil Classification System (USCS) classification, degree of rounding, grading, cementation, plasticity, clast composition and reaction to 10% hydrochloric acid in a descriptive sentence format. Contacts within unconsolidated formations will be based on changes in USCS group symbols.

Consolidated formation (rock) will be logged similarly, and include description of following parameters: color, grain size (if applicable), lithology (rock type or composition), sedimentary structure (bedding, laminations if applicable), foliation (if applicable), alteration and weathering; for volcanic rocks, include percentage of phenocrysts and size (if applicable), welding features, and matrix type (dense non-porous or open porous). If Paleozoic carbonate rocks are encountered, descriptions should include depositional textures, carbonate type (micrite, oolitic etc.), fossils, dolomite content and any other observable carbonate-related parameters. Contacts in consolidated formation will be based on changes in lithology.

The Cuttings Sample Log includes a column to record drilling rates on a sample by sample basis. The notes column is to be used to clarify any data not described above, such as depth to water, water production and changes in water production, as well as drilling information including bit changes, lost circulation zones and drilling problems. The Cuttings Sample Log is a free form log and should include any pertinent geologic and drilling information, comments and data relative to the borehole in a descriptive manner using sentence format.

No archive samples will be collected from the drilling, except a small representative chip sample stored in 40 dram clear plastic vials for future reference. For unconsolidated samples, the chip samples should be unwashed and include all of the particle sizes represented in the interval sample. Additionally, washed unconsolidated formation samples will also be collected and stored in 40 dram clear plastic vials for future reference. For consolidated (rock) samples, chips should be washed and include mostly the coarse chips from the formation. Chip vials will be labeled with borehole ID and depth interval and placed in labeled plastic core boxes for archival by NWRPO personnel. No transfer of custody will be required for the chip samples. Chip samples will be transported to and stored at an NWRPO storage facility after the completion of each borehole or well.

3.2.8 Borehole Geophysical Logging

Open-hole geophysical logs will be conducted in each borehole prior to well completion. At borehole total depth, the driller will remove the drill string and diverter head to provide access to the borehole for a NWRPO contractor to conduct geophysical logging. In general, four logging tools will be run in the open boreholes. The tools are: caliper, polyprobe (including gamma log, self potential, single point resistivity and normal resistivity), temperature and fluid resistivity tool and deviation. After the well is completed, developed and test pumped, a suite of well completion logs will be run inside the well casings. The completion suite will include: gamma, temperature, fluid resistivity and sonic logs.

3.2.9 Well Completion of Piezometer Well NC-GWE-GF-4PB

3.2.9.1 Subsurface Completion

Subsequent to open-hole geophysical logging, NC-GWE-GF-4PB will be completed as a 4-inch PVC piezometer well (Figure 2). Depth control for the well casing, tremmie line and air-lift lines will be maintained on Tubing and Casing Records (Attachment C) and the well construction will be documented in the Scientific Notebook. Depths of well casing, screens, completion materials and casing stick up will be documented on the Well Completion Diagrams (Figures 2 and 3). Placement of the screened interval will be based on the geologic and geophysical logs. The drilling contractor will conduct the well construction with input from NWRPO personnel. The general sequence for well completions is:

1) Run in tremmie line to approximately 20 feet from bottom.
2) Run in 4-inch schedule 80 flush threaded PVC well casing with 10 foot blank casing and end cap on bottom followed by up to 80 feet of 0.020-inch slotted well casing and blank casing to surface.
3) Pump in or gravity feed 8/12 sand through the tremmie line in lifts with frequent tagging of fill level. Compare fill volume with caliper log to ensure that sand is not bridging in annular space. Sand pack well screens to approximately 5 feet above the top of screens. Sand will be pumped with gas powered centrifugal pumps, using an open “T” fitting on the suction side of the pump, or gravity fed with chase water. Maintain the tremmie line between 10 to 30 feet above the fill level.
4) Add another approximate 2-foot lift of 60-mesh sand above the well screen sandpack.
5) With tremmie line approximately 20 feet above the fill level, begin pumping high-solids bentonite grout (>30% solids by weight)in batches using a bottom-up approach to displace water in the completion interval. Grout should be mixed following the manufacturers specification to produce >30% solids by weight grout. If possible, avoid flushing tremmie line with clear water in to the completion interval.
6) Raise grout level to slightly below surface. Remove tremmie line.
7) Air-lift well development (described below) will be conducted either at this stage or after surface completion.

3.2.9.2 Surface Completion

1) Cut down 4-inch PVC well casing to slightly less than 2-feet above ground level. Casing should be cut with a clean level cut without plastic shavings entering the well.

2) Weld on a 2-foot extension with locking cap to the 10-inch surface casing, using a welding shield to protect the 4-inch PVC well casing.
3) Using a wooden form, pour an 8-inch thick by 4 foot square concrete well pad centered on the well. The pad should extend approximately 4-inches below and above the original ground level. Write the well ID and height of the well pad above the original ground level in the curing concrete pad.

3.2.9.3 Well Development

1) Sound depth to water level in 4-inch piezometer well using an electric well sounder.
2) Run in approximately 2-inch diameter air-lift line to approximately 40 ft below static water level.
3) Install a 4-inch diverter head on top of the 4-inch well casing.
4) Turn on air pressure to lift water. Record approximate discharge rate and duration. If well continues to produce once unloaded, and the rate is above approximately 10 gpm, continue air-lifting until discharge water is clear.
5) If well discharge is sporadic or below approximately 10 gpm, add 20 feet of air-lift line and repeat step 4). Air-lift submergence should not exceed 80 feet or well damage may occur.
6) Air-lift well at maximum rate while monitoring water clarity and electrical conductivity of discharge water. Air-lift well until discharge water is clear, electrical conductivity has stabilized, or two hours of continuous air lifting has occurred. Document observations in the scientific notebook.
7) Open the air lift line and sound the water level as soon as possible. After removal of the airline, sound the water level again. Water level measurements must be recorded in the scientific notebook.

3.2.9.4 Well Test Pumping

After preliminary air-lift well development, the piezometer will be test pumped using a submersible pump and generator. The pump may be reel mounted (i.e., the AMS trailer) or set by a pump contractor. The test pumping will include drawdown measurements from a pressure transducer deployed with the well pump. Discharge measurements will be made using a combination of a 1-inch totalizing flow meter and timed bucket tests to confirm flow meter readings. Data collected during test pumping will be documented on a GWE Piezometer Well Pump Testing Form (Attachment E). Data files from the transducer will be transmitted to the QARC with the form. The general sequence for test pumping a piezometer is:

1) Mobilize pump, generator, and pump contractor (if applicable) to the well site, conduct safety briefing.
2) Sound depth to water using an electric well sounder and record on the GWE Piezometer Well Test Pumping Form.
3) Attach transducer probe to pump bundle, approximately 1 foot above the top of the pump. Measure distance between transducer port and intake screen on pump. Start logger recording at 2 second interval.
4) Run in 3-inch pump and transducer to approximately 60 feet below water level. Record depth of transducer (submergence in feet below water) from data logger.
5) Install discharge head including flow meter and flow control valve.

3.2.9.4.1 Step Test Procedure

1) Start pump at approximately 5 gpm and wait for drawdown to stabilize (at least 10 minutes); then observe water quality. Record pumping rate, submergence and time [Step Test 1].
2) If drawdown is less than 10% of available drawdown (i.e., less than 6 ft), increase pump rate to 15 gpm [Step Test 2];
   If drawdown is between 10 and 25% of available drawdown (i.e., between 6 and 15 ft), increase rate to 8 gpm [Step Test 2];
   If drawdown is between 25 and 100% of available drawdown (i.e., between 15 and 60 ft), decrease rate to 2 gpm; see procedure in 6) below
3) Wait for drawdown to stabilize (at least 10 minutes, observe water quality). Record pumping rate, submergence and time.
   If drawdown is still less than 20% of available drawdown (i.e., less than 12 ft), increase pump rate to 25 gpm [Step Test 3];
   If drawdown is between 20 and 50% of available drawdown increase rate to 12 gpm [Step Test 3];
4) Wait for drawdown to stabilize (at least 10 minutes, observe water quality). Record pumping rate, submergence and time.
   If drawdown is still less than 50% of available drawdown (i.e., less than 30 ft), increase pump rate to 40 gpm or the maximum pump rate [Step Test 4];
   If drawdown is between 50 and 75% of available drawdown increase rate to 15 gpm [Step Test 4];
5) Wait for drawdown to stabilize (at least 10 minutes, observe water quality). Record pumping rate, submergence and time. Determine an ideal test yield based on the performance of the well during step testing. The ideal test yield should drawdown the well approximately 30 to 40 feet.
6) For low yield wells identified in step 2) above, conduct test at step rates of 2, 4, 6, 8 gpm or at similar lower increments based on the well performance (i.e., 1, 2, 3, 4 gpm), such that the highest step (step 4) does not draw down the well to below the pump intake.
7) Determine an ideal test yield based on the performance of the well during step testing. The ideal test yield should draw the well down approximately 30 to 40 feet.
8) Shut in pump and allow well to recover.

3.2.9.4.2 Constant Discharge Test Procedure

1) Allow well to recover to at least 95% of the drawdown from the step test (i.e., within 2 feet of static water level recorded for the fourth step for a drawdown of 40 feet during step testing or 0.5 foot for 20 feet of drawdown). Record pre-test static water level.
2) Start pump and adjust pump rate to predetermined rate based on step test above. Record rate and initial drawdown. If drawdown is greater than 40 feet, decrease rate slightly. Record the adjusted rate.
3) Pump well continuously for a minimum of 6 hours and ideally for 10 hours. Record pump rate and drawdown every 10 minutes for the first 100 minutes and every 100 minutes until the end of the test. If timed barrel tests are within 10% of the flow meter readings, flow meter readings are considered accurate and no further timed barrel tests are needed, except a final reading prior to pump shut-in. Drawdown can

exceed 40 feet provided the total drawdown does not reach the pump and transducer. Should the drawdown begin to approach 60 feet, adjust the discharge rate down in 10% increments. Record the times that these pump rate changes are made.

4) Take photos of discharge area for compliance with discharge permits.
5) Record pump rate and maximum drawdown prior to shutting in pump. Shut in pump.
6) Allow well to recover within 95% of the drawdown recorded in step 4) above.
7) Remove pump and transducer from well; secure wellhead.
8) Download data from the transducer and transmit data and forms to NWRPO as soon as possible.

3.2.10 Well Completion of Test Well NC-GWE-GF-3T

3.2.10.1 Subsurface Completion

Subsequent to open-hole geophysical logging, NC-GWE-GT-3T will be completed as a 8-inch test well (Figure 4). Depth control for the well casing, tremmie line and air-lift lines will be maintained on Tubing and Casing Records (Attachment C) and the well construction will be documented in the Scientific Notebook. Depths of well casing, screens, completion materials and casing stick up will be documented on the Well Completion Diagrams (Figures 4 and 5). Placement of the screened interval will be based on the geologic and geophysical logs. The drilling contractor will conduct the well construction with input from NWRPO personnel. The general sequence for well completions is:

1) Run in tremmie line to approximately 20 feet from bottom.
2) Follow this by running the 8-inch butt welded and/or weld-collar coupled ¼-inch wall steel well casing, well screens with louvered 0.050-inch openings, centralizers and welded end cap to a maximum depth of 480 ft. The well string must be maintained under tension during the remaining completion activities.
3) Emplace the ¼-inch rounded “pea” gravel through the tremmie into the borehole in stages to a depth of approximately 5 ft above the well screen section. The addition of the gravel pack can be accomplished using gravity feed methods or with a gravel pump system using clean water only. Care should be taken to avoid bridging of the gravel pack. Frequent tagging of the fill level will be conducted and compared with calculated caliper log volumes to assure correct gravel pack emplacement.
4) Following the emplacement of the gravel pack, pump another approximately 2 foot lift of fine mesh (60-mesh) silica sand above the existing gravel pack.
5) Then pump high solids (>30%) bentonite grout in a “bottom-up” method to a depth of approximately 5 ft below the next screened section.
6) Continue gravel pack and bentonite seal installation as described in steps 3 through 5. Above the uppermost screened and gravel pack section, install high-solids bentonite grout to surface.
7) Air-lift well development (described below) can be conducted at this stage or after surface completion.

3.2.10.2 Surface Completion

1) Cut down 8-inch well casing to slightly less than 2-feet above ground level. Casing should be cut with a clean level cut without metal shavings or slag entering the well.
2) Weld on tabs to install a locking cap to the 8-inch well casing.
3) Using a wooden form, pour an 8-inch thick by 4 foot square concrete well pad centered on the well. Incorporate 16-inch surface casing in pad, cutting down to original ground level if needed. The pad should extend approximately 4-inches below and above the original ground level. Write the well ID and height of the well pad above the original ground level in the curing concrete pad.

3.2.10.3 Well Development

1) Sound depth to water level in 8-inch test well using an electric well sounder.
2) Run in approximately 2-inch diameter air-lift line to approximately 80 ft below static water level.
3) Install an 8-inch diverter head on top of the 8-inch well casing.
4) Turn on air pressure to lift water. Record approximate discharge rate and duration. If well continues to produce once unloaded, and the rate is above approximately 100 gpm, continue air-lifting until discharge water is clear.
5) If well discharge is sporadic or below approximately 100 gpm, add 40 feet of air-lift line and repeat step 4). Air-lift line submergence should not exceed 200 feet.
6) Air-lift well at maximum rate while monitoring water clarity and electrical conductivity of discharge water. Air-lift well until discharge water is clear, electrical conductivity has stabilized, or eight hours of continuous air lifting has occurred. Document observations in the scientific notebook. If substantial bentonite mud was used to stabilize well borehole, slug well with diluted AquaClear PFD dispersant prior to airlifting. Ideally, dispersant should be left for several hours or overnight to disperse drilling fluids in the well completion.
7) Open the air lift line and sound the water level as soon as possible. After removal of the airline, sound the water level again. Water level measurements must be recorded in the scientific notebook.

3.2.10.4 Well Test Pumping

After preliminary air-lift well development, the test well will be test pumped using a submersible pump and generator. The pump will set by a pump contractor. The test pumping will include drawdown measurements from a pressure transducer deployed with the well pump and observation wells at wells sites 3 and 4. Discharge measurements will be made using a combination of a 3-inch totalizing flow meter and timed barrel tests to confirm flow meter readings. Data collected during test pumping will be documented on a GWE Piezometer Well Pump Testing Form (Attachment E) and the scientific notebook. Data files from the transducers will be transmitted to the QARC with the form. The general sequence for pump testing the test well is:

1) Mobilize pump contractor with pump, pump string and discharge head and generator to the well site, conduct safety briefing.
2) Sound depth to water in test well using an electric well sounder and record on the GWE Piezometer Well Test Pumping Form.

3) Attach Level Troll transducer probe to pump bundle, approximately 1 foot above the top of the pump. Measure distance between transducer port and intake screen on pump.
4) Run in 5-inch pump and transducer to approximately 200 feet below static water level. Set discharge line with flow meter, including minimum 4-foot "straight" run before and after flow meter. Record depth of transducer (submergence in feet) from data logger. Start logging transducer data at 2 second interval.
5) At each observation well within the Gravity Fault test area (GF-3, GF-4 and GF-4PA), sound static water level (depth to water) using an electric well sounder, install Level Troll transducer with approximately 20 ft of submergence, record initial submergence, and start logging transducer information at 5 minute interval. Record all information for each observation well on a separate page in the scientific notebook. Ideally, the observation wells would be instrumented with transducers several days prior to test pumping.

3.2.10.4.1 Step Test Procedure

1) Start pump at approximately 40 gpm and wait for drawdown to stabilize (at least 10 minutes); then observe water quality. Record pumping rate, submergence and time [Step Test 1].
2) If drawdown is less than 10% of available drawdown (i.e., less than 20 ft), increase pump rate to 60 gpm [Step Test 2];
   If drawdown is between 10 and 25% of available drawdown (i.e., between 20 and 50 ft), increase rate to 80 gpm [Step Test 2];
   If drawdown is between 25 and 100% of available drawdown (i.e., between 50 and 200 ft), decrease rate to 20 gpm; see procedure in 6) below
3) Wait for drawdown to stabilize (at least 10 minutes, observe water quality). Record pumping rate, submergence and time.
   If drawdown is still less than 20% of available drawdown (i.e., less than 20 ft), increase pump rate to 120 gpm [Step Test 3];
   If drawdown is between 20 and 50% of available drawdown increase rate to 80 gpm [Step Test 3];
4) Wait for drawdown to stabilize (at least 10 minutes, observe water quality). Record pumping rate, submergence and time.
   If drawdown is still less than 50% of available drawdown (i.e., less than 30 ft), increase pump rate to 240 gpm or the maximum pump rate [Step Test 4];
   If drawdown is between 50 and 75% of available drawdown increase rate to 160 gpm [Step Test 4];
5) Wait for drawdown to stabilize (at least 10 minutes, observe water quality). Record pumping rate, submergence and time. Determine an ideal test yield based on the performance of the well during step testing. The ideal test yield should drawdown the well approximately 120 to 160 feet.
6) For low yield wells identified in step 2) above, conduct test at step rates of 20, 40, 60, 80 gpm or at similar lower increments based on the well performance (i.e., 10, 20, 30, 40 gpm), such that the highest step (step 4) does not draw down the well to below the pump intake.
7) Determine an ideal test yield based on the performance of the well during step testing. The ideal test yield should draw the well down approximately 120 to 160 feet.
8) Shut in pump and allow well to recover (ideally overnight).

3.2.9.4.2 Constant Discharge Test Procedure

1) Check that all transducers in all wells are operating correctly. Start pump and adjust pump rate to pre-determined rate based on step test above. Record rate and initial drawdown. If drawdown is greater than 160 feet, decrease rate slightly. Record the adjusted rate.
2) Pump well continuously for a minimum of 48 hours. Record pump rate and transducer submergence every 10 minutes for the first 100 minutes and every 100 minutes until the end of the test. If timed buckets tests are within 10% of the flow meter readings, flow meter readings are considered accurate and no further timed barrel tests are needed, except a final barrel test prior to pump shut-in. Drawdown can exceed 160 feet provided the total drawdown does not reach the pump and transducer. Should the drawdown begin to approach 200 feet, adjust the discharge rate down in 10% increments. Record the times that these pump rate changes are made.
3) Record pump rate and transducer submergence prior to shutting in pump. Shut in pump.
4) Allow well to recover within 95% of the drawdown recorded in step 4) above.
5) Remove pump and transducer from well; secure wellhead.
6) Download data from the transducer and transmit data, copies of the scientific notebook and forms to NWRPO as soon as possible.

4.0 SAMPLE MANAGEMENT

Drill cuttings samples will be collected, logged and an archive chip sample will be collected for future reference. No samples for testing or archive (except chip samples) will be collected. The estimated total numbers of drill cuttings samples used for logging are summarized in Table 1. Drill cuttings samples for geologic logging will be collected from each 5 ft depth interval. No samples will be required to be controlled and documented with the NWRPO Chain-of-Custody Form.

The NFDR will use the numbers and types of samples in Table 1 to ensure that all necessary containers for archive chip samples are available at the drill site.

5.0 DRILL SITE MANAGEMENT

5.1 Preparation

1. Review the drilling package for specific information for drill site activities and verify that all equipment meets specifications outlined in the relevant plans.

2. Ensure that all required health and safety training has been completed by NWRPO field personnel.

3. Ensure that appropriate field support areas have been prepared (e.g., sample logging areas, rest areas, etc.). Ensure that adequate physical space for the planned operations is reserved on site.

4. Ensure that the work site is cleared of all brush and minor obstructions and have the location of utilities (if applicable) properly staked and identified.

5. Ensure that proposed drilling locations are not traversed by utility transmission lines.

6. Ensure that all necessary equipment and supplies are in place and in working order.

7. Ensure that all site environmental permitting requirements are followed.

5.2 Field Changes to Drilling Package

It is the responsibility of the NWRPO person in charge in the field to execute fieldwork in accordance with the controls of the approved drilling package.

However, unanticipated conditions may require deviation from the approved drilling package. It is the intent of this test plan to ensure prior approval for field changes that may have *significant impact* on the planned purpose of a borehole. This will include significant impact to drilling, sampling, testing, completion, or cost. Insignificant field deviations to the controls of the approved drilling package need not be approved in advance.

The following process shall be followed if significant changes to the drilling package are required:

1. The NWRPO person in charge in the field will contact the GSM and the Principal Investigator (PI) for the drilling package by telephone (a three-way conference call is preferable) or in person to discuss the proposed departure from the approved drilling package prior to carrying out a change. Verbal agreement from the GSM and PI will signal approval for the NWRPO person in charge in the field to execute the change. The NWRPO Person in Charge in the field will document the approval in the scientific (field) notebook for the subject borehole.

2. If verbal approval is given by the GSM and the PI, then the person proposing the change will transmit a summary of the changes on the Field Change Approval Form (Attachment F) to the GSM within 24 hours. The GSM will sign and date the form and pass it on to the PI. The PI will then sign and date the form, route a copy to the QARC, and give the completed Field Change Approval Form to the NWRPO person in charge in the field.

3. The NWRPO person in charge in the field will document known effects of the field change in the scientific (field) notebook for the subject borehole.

5.3 Field Operations Documentation

The NWRPO person in charge in the field will ensure that drill site operations are documented as specified in the following:

1. Drilling, completion, and abandonment operations will be documented by NWRPO field personnel in drilling operation records. GWE drilling operation records are listed in Section 8.0 and included as attachments in Section 11.0. Depth control operations during drilling, reaming, and cleanout are documented on the Tubing and Casing Record (Attachment C) and the Drilling/Coring Data Sheet (Attachment B). Depth control while running casing during well completion is documented in the Tubing and Casing Record. Both a running time record of drilling operations and a record of materials used are

documented in the Daily Drilling Activities Record (Attachment G and H). Those personnel entering the data in drilling operations records shall sign forms as preparers.

2. All information entered into these forms will be checked for accuracy in the field by NWRPO field personnel different from those originally entering information into the forms. These forms will be transmitted to the QARC generally once per week.

3. Important drilling operations-related information that is not documented in drilling operations records should be recorded in the scientific notebook for the project.

4. Borehole geophysical logging activities should be documented on the Geophysical Log Header Check Sheet (Attachment I), in the scientific notebook, and the geophysical logs produced should be labeled and transmitted to the QARC as soon as possible.

5. Aquifer testing activities should be documented in the scientific notebook and on the GWE Piezometer Well Pump Testing Form and all hard copy and electronic data generated shall be transmitted to the QARC as soon as possible after testing has been completed.

6.0 MANAGEMENT

All NWRPO field personnel performing the tasks described in this TPN will be trained in the procedures specifically applicable to the equipment and methods used before conducting work. Personnel will document that they have read and understand this TPN.

The QA Officer is responsible for ensuring that this plan meets QA requirements and that NWRPO field personnel are trained to and comply with the requirements of this TPN. The PI is responsible for the preparation, technical review, and revision of this TPN, as well as oversight of its performance. NWRPO field personnel are responsible for conducting field logging, depth control, drill site management and well testing.

7.0 REFERENCES

NAC (Nevada Administrative Code) 534.320. “Notice of Intent to Drill: Contents, Submission.”

NAC (Nevada Administrative Code) 534.330. “Responsibilities of Licensed Well Drillers at Drilling Site.”

NAC (Nevada Administrative Code) 534.340. “Log and Record of Work: Form; Contents.”

NRS (Nevada Revised Statutes) 534.170. “Underground Water and Wells, Well Driller to Keep Log and Records; Contents; Information to be Furnished to State Engineer; Report of Test.”

NWRPO (Nuclear Waste Repository Project Office), 2013a. Well Drilling and Completion of Groundwater Evaluation Wells in Southern Nye County - Bid Specifications and Request for Bids, Nye County, NV, NWRPO.

NWRPO (Nuclear Waste Repository Project Office), 2013b. Groundwater Evaluation, Site Specific Health and Safety Plan, Nye County NWRPO, Pahrump, Nevada.

8.0 RECORDS

Drilling/Coring Data Sheet

Tubing and Casing Record

Cuttings Sample Log and Continuation Form

GWE Piezometer Well Pump Testing Form

Field Change Approval Form

Daily Drilling Activities Record

Geophysical Log Header Check Sheet

9.0 TABLES

Table 1 Geologic Sample Types and Numbers

10.0 FIGURES

Figure 1 Location Map

Figure 2 Typical Piezometer Subsurface Completion Diagram

Figure 3 Typical Piezometer Surface Completion Diagram

Figure 4 Typical Monitor/Test Well Subsurface Completion Diagram

Figure 5 Typical Monitor/Test Well Surface Completion Diagram

11.0 ATTACHMENTS

A Scope of Work from Well Drilling and Completion of Groundwater Evaluation Wells in Southern Nye County - Bid Specifications and Request for Bids, Nye County, NV, NWRPO

B Drilling/Coring Data Sheet

C Tubing and Casing Record

D Cuttings Sample Log and Cuttings Sample Log Continuation

E GWE Piezometer Well Pump Testing Form and GWE Piezometer Well Pump Testing Form Continuation

F Field Change Approval Form

G Daily Drilling Activities Record – GF-4PB

H Daily Drilling Activities Record - GF-3T

I Geophysical Log Header Check Sheet

TABLES

Table 1
Geologic Sample Types and Numbers

Geologic Sample Type	Borehole Diameter (inches)	Estimated Total Footage (feet)	Sample Length or Interval (feet)	Estimated Number of Samples	Total Number
Drill Cuttings – Chip Samples	8.75	500	5	100	100
Drill Cuttings – Chip Samples	15	500	5	100	100

FIGURES

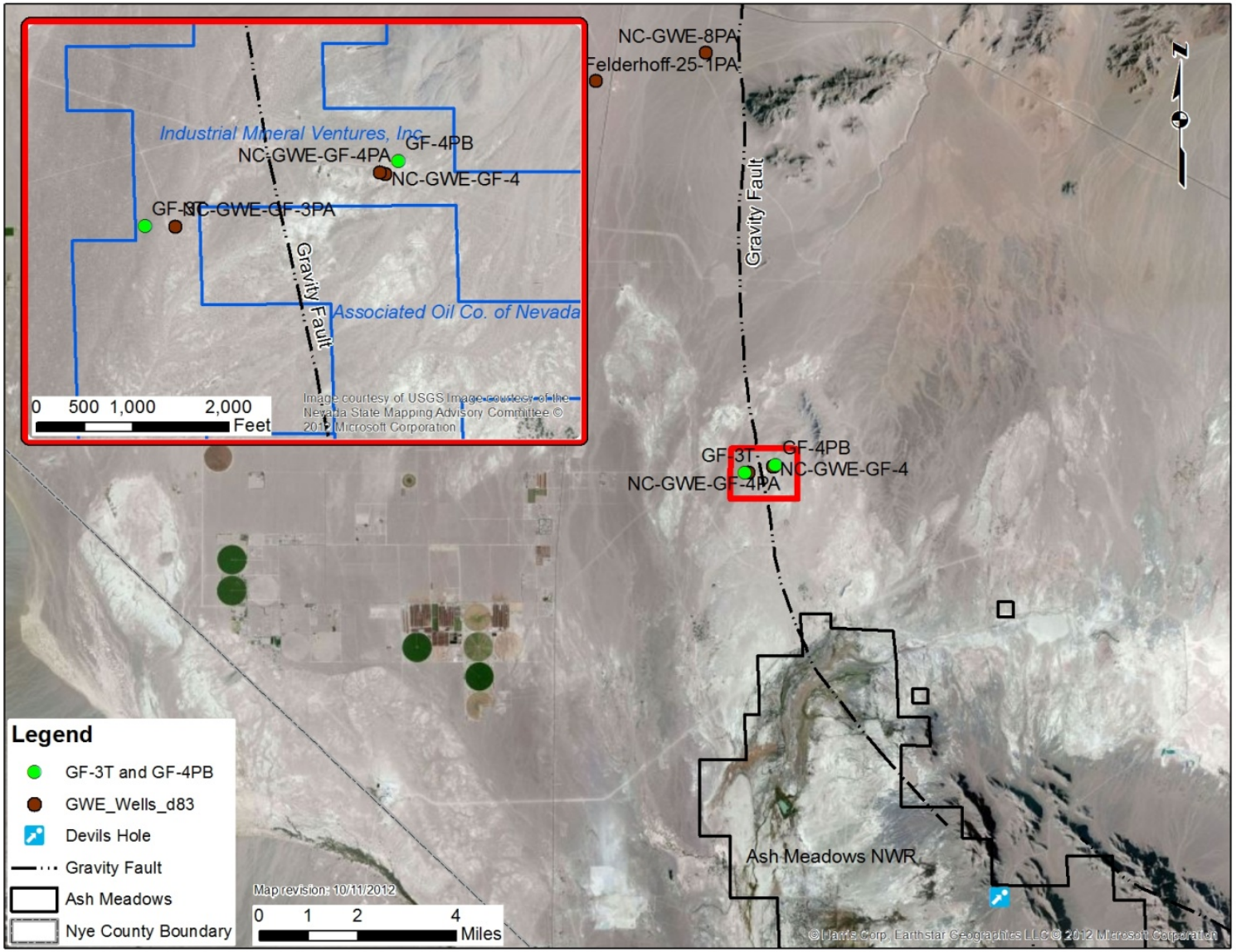


Figure 1
Location Map

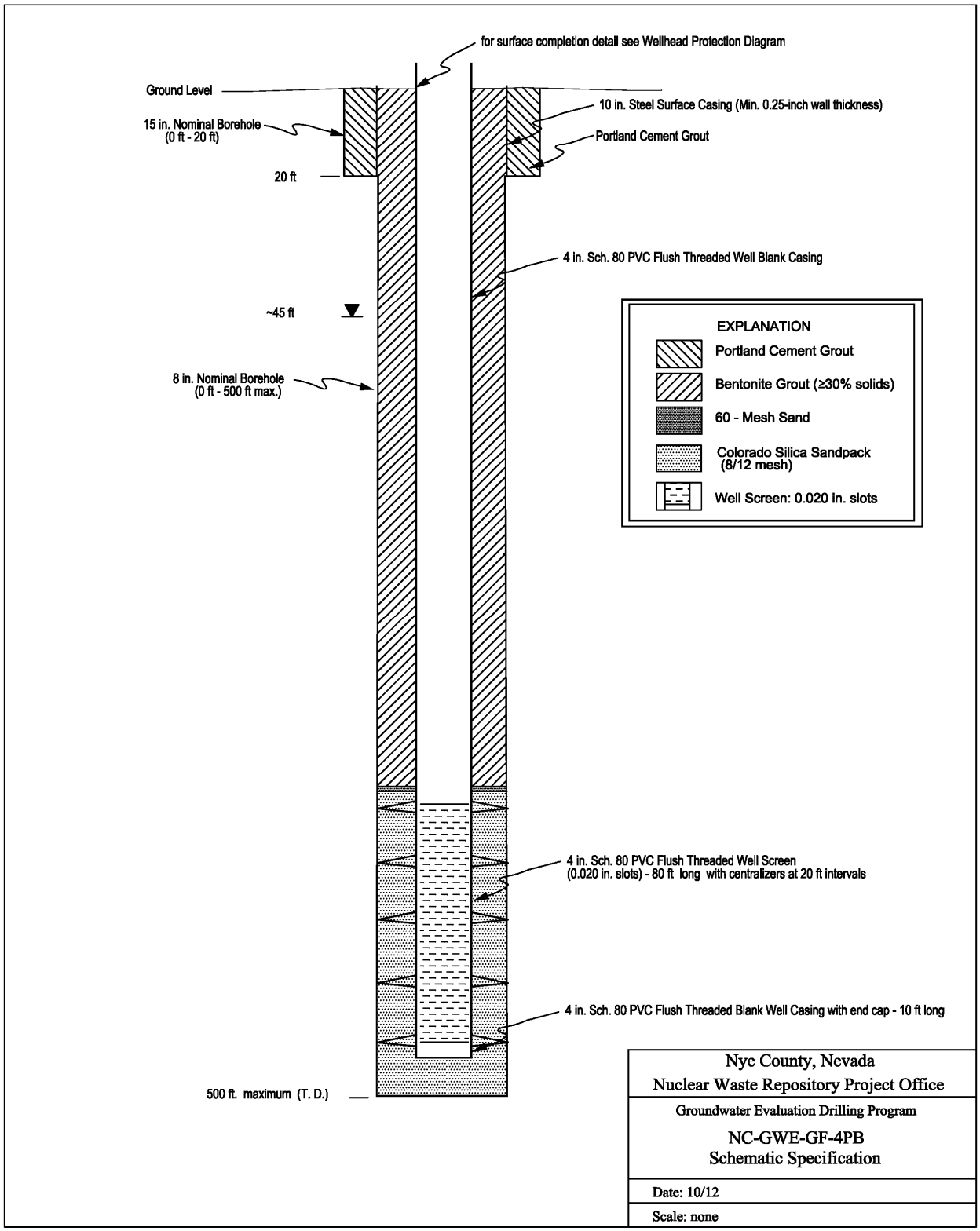


Figure 2
Typical Piezometer Subsurface Completion Diagram

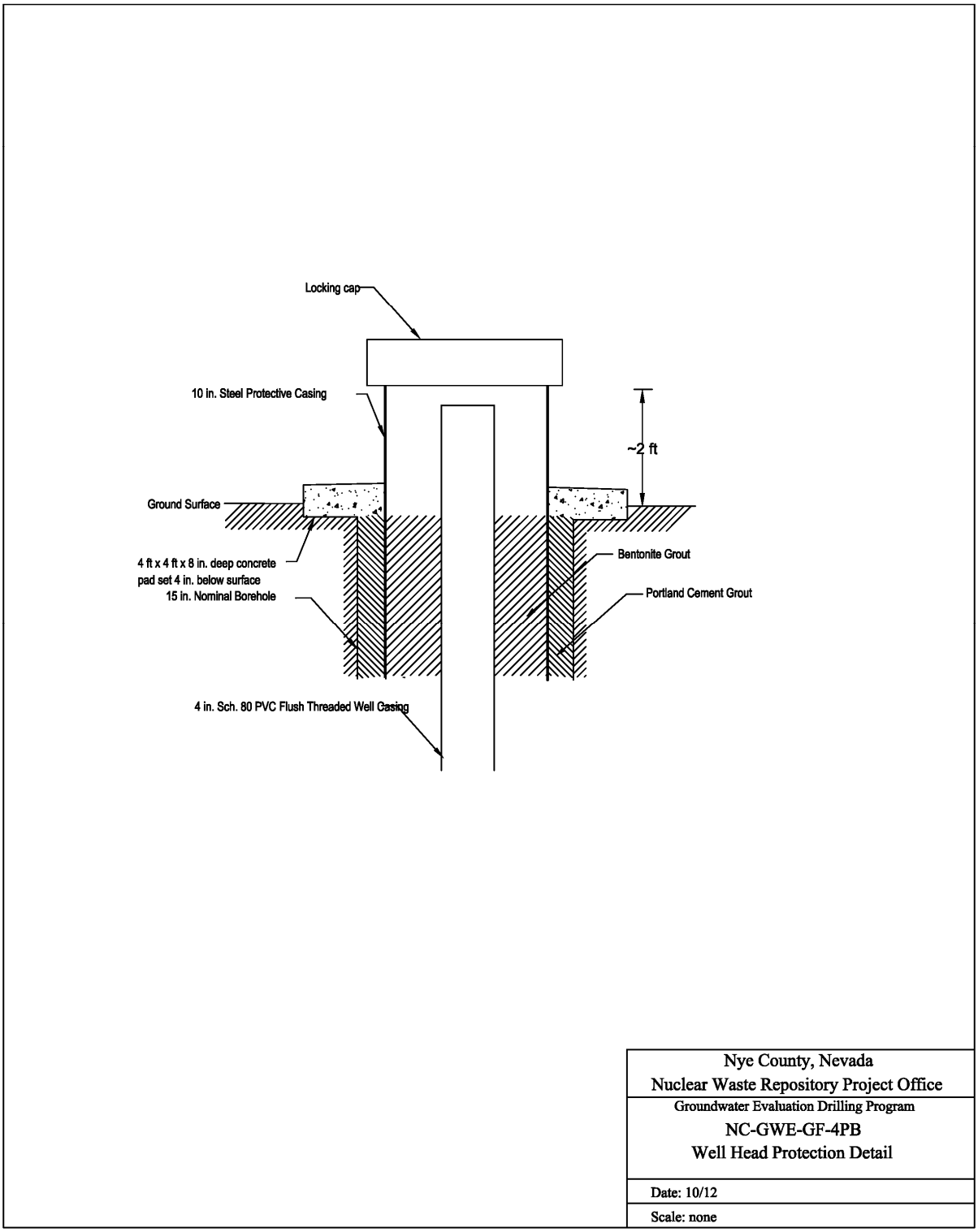


Figure 3
Typical Piezometer Surface Completion Diagram

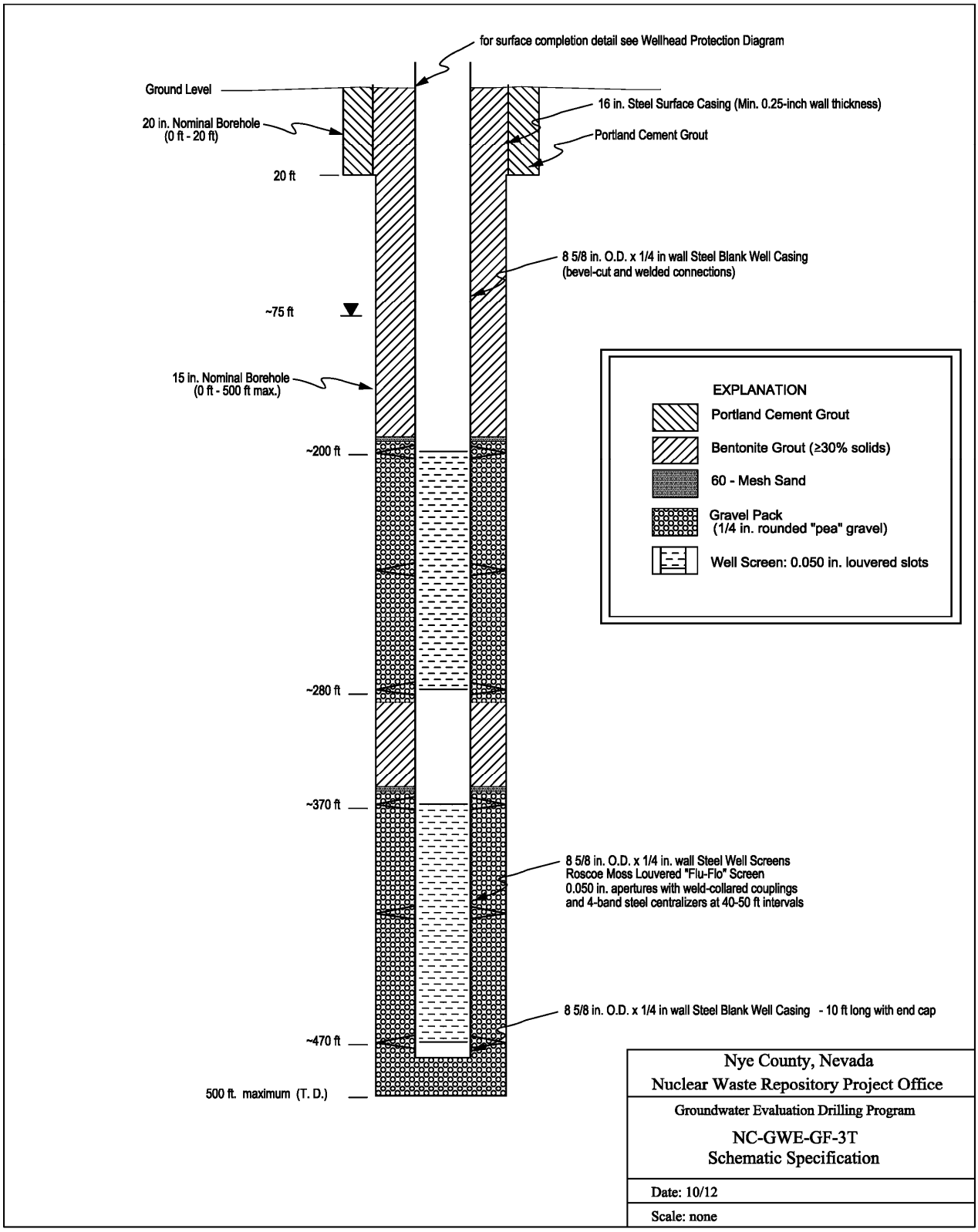
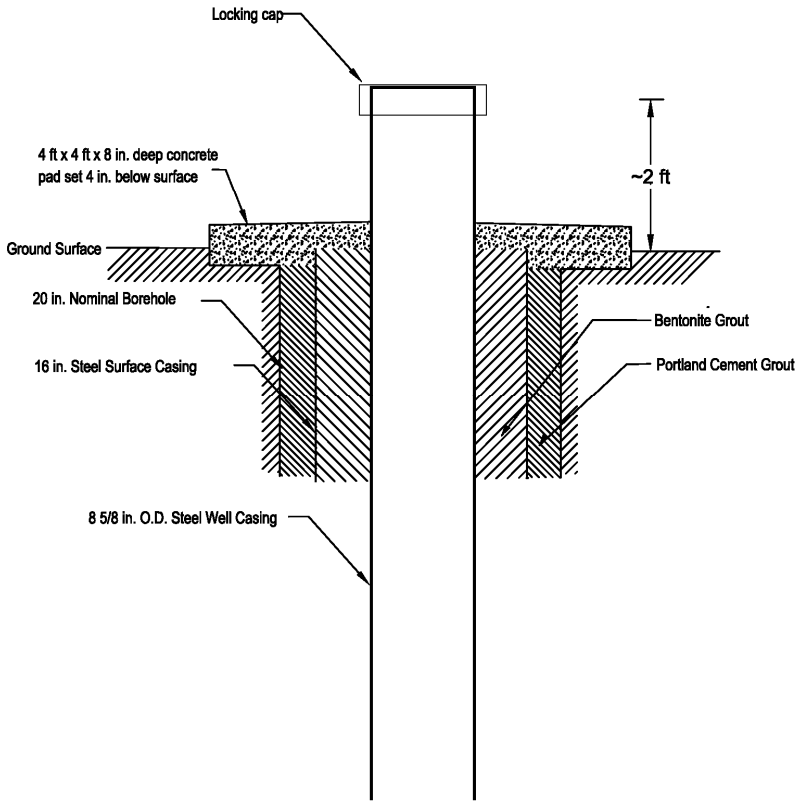


Figure 4
Typical Monitor/Test Well Subsurface Completion Diagram



Nye County, Nevada Nuclear Waste Repository Project Office
Groundwater Evaluation Drilling Program NC-GWE-GF-3T Well Head Protection Detail
Date: 10/12
Scale: none

Figure 5
Typical Monitor/Test Well Surface Completion Diagram

ATTACHMENTS

ATTACHMENT A

SCOPE OF WORK FOR GROUNDWATER EVALUATION WELL DRILLING AND CONSTRUCTION IN AMARGOSA VALLEY, NYE COUNTY

Introduction

The NWRPO is drilling two 500 ft deep boreholes in Amargosa Valley. Two wells will be completed, one in limestones and quartzites of the Lower Carbonate Aquifer (LCA) and the other in unconsolidated sediments of Valley Fill Aquifer (VFA). Drill pads and access roads will be constructed and maintained by the NWRPO.

1.0 Drilling and Completing of Piezometer and Test Wells (Not to Exceed 500 feet)

Two not to-exceed 500-ft deep boreholes will be drilled at two sites on private lands in Amargosa Valley. The boreholes will be drilled with open-hole conventional air rotary (air-foam) methods. At one site, the well will be completed as a 480 ft 8-inch steel test/monitoring well and at the other site, the well will be completed as a 480 ft 4-inch PVC piezometer monitoring well. The drilling of the larger test well will be conducted in two passes: an approximately 8-inch air/foam pilot bore for sampling, followed by borehole reaming pass using conventional mud rotary methods. The well locations are shown in Figure 1. The boreholes will be drilled to a maximum depth of 500 ft. Upon reaching total depth these boreholes will be geophysically logged by another Nye County contractor. The piezometer well will be completed as a single 4-inch PVC piezometer well with well screens based on geologic and geophysical logs. The test well will be completed with 8-inch steel well casing with louvered screens. The screened intervals (up to 200 ft total) will be based on geologic and geophysical logs with individual sand/gravel packs and bentonite seals. Table 1 summarizes the approximate alluvium thickness, depth to water, maximum borehole depths, and the approximate screen depth interval.

A schematic well completion diagram for a typical piezometer well showing borehole diameter requirements and well completion requirements is shown in Figure 2. A schematic surface completion for a 4-inch piezometer well is shown in Figure 3. A schematic well completion diagram for a typical 8-inch test well showing borehole diameter and well completion requirements is shown in Figure 4. A schematic surface completion for an 8-inch test well is shown in Figure 5.

1.1 Background Information

Nye County is conducting groundwater evaluation (GWE) studies in southern Nye County under a Department of Energy (DOE) grant. As part of the grant work, the county has installed a network of groundwater piezometer wells to supplement the existing groundwater monitoring network. Additionally at site GF-3 and GF-4, a testing complex will be developed to characterize the hydrologic properties of the Gravity Fault. This testing complex will require the drilling of a test well near well GF-3 and the drilling of a deeper piezometer near GF-4PA.

Since 1998, the Nye County Nuclear Waste Repository Project Office has been involved in installing a network of deep wells in northern Amargosa Valley as part of the county's oversight of the Yucca Mountain project. The well boreholes have used a variety of drilling methods including: dual wall air rotary, conventional mud rotary, reverse mud rotary, several casing advance methods and sonic coring. At site GF-3, under the GWE drilling program, conventional

air (foam) rotary methods were used to drill a nominal 8-inch test hole to 609 ft. Based on the information from this relatively shallow exploratory pilot hole, a shallower test well will be installed to 480 ft.

1.2 Drilling and Sampling of Piezometer Well NC-GWE-GF-4PB

1.2.1 Drill and sample (at 5-foot interval) an approximately 15-inch diameter borehole to a depth of approximately 20 ft using conventional air rotary (with injection water/foam) methods. Install a 10-inch steel surface casing to approximately 20 feet with diverter head. Back-fill the annular space with Portland grout.

1.2.2 After sufficient casing seal setting time, advance borehole beyond the 20 ft surface casing with approximate 8-inch rotary bit using conventional air circulation with injection of a water and foam (Baroid QUIK FOAM or equivalent) mixture. The borehole will be drilled to a maximum depth of 500 ft. Collect geologic samples (drill cutting samples) at 5-ft intervals using a cyclone air/cuttings separator with wet-splitter capability or similar system. It is expected that the drilling will encounter dolomitic limestone and quartzite units at a depth of 250-300 ft. Should rotary drilling slow significantly, a down-hole air hammer can be used to complete the hole to total depth.

1.2.3 Condition/stabilize (with NWRPO approval) intervals of borehole wall that are unstable and/or are responsible for lost circulation by injecting bentonite mud or bentonite mud and polymer into the annular space between the drill pipe and the formation wall using conventional circulation methods. Excess conditioning fluids that have been added during borehole conditioning will be removed from the borehole by conventional air circulation prior to advancing the borehole deeper into undrilled formation. Lost circulation zones in the open borehole can be addressed with bentonite mud and/or lost circulation materials only with prior NWRPO written approval. NWRPO reserves the right to terminate drilling at any depth. Upon reaching total depth, remove the drill string from the borehole to permit open borehole geophysical logging by another Nye County contractor.

1.3 Subsurface Completion

A typical single string piezometer subsurface well completion diagram is presented in Figure 2. Depths for the well screens and sandpacks will be determined from geologic and geophysical logging data. Typically, an 80 foot screen interval above 10 ft blank casing with cap on bottom will be installed. The depths of the 4-inch schedule 80 PVC casings will not exceed 480 ft. Note that target depths for all completion materials (including well casing/screen, sand pack and grout seals) must be achieved within several feet. Thus, the completion process must be conducted with extreme care including frequent tagging (i.e., measurement) of completion material depths. All materials will be emplaced with pump/tremmie line methods and at no time should the open end of the tremmie be more than 30 ft above the completion material level of the well. The tagging instrument will be supplied by the NWRPO and will include a small diameter (light weight) wire, a comparatively heavy tagging bar, and an accurate depth counting meter. Top of gravel/sand pack will be tagged at a minimum of 20 ft fill intervals. Subsurface completion procedures are briefly described below.

1.3.1 Run a steel tremmie pipe (e.g., 1.5-inch ID) to near the bottom of the borehole.

1.3.2 Follow this by running the 4-inch flush threaded Schedule 80 PVC piezometer blank casings, well screens with mill-slotted 0.020-inch slot opening, and 5 centralizers at 20 ft intervals to a maximum depth of 480 ft. The piezometer string must be maintained under tension during the remaining completion activities.

1.3.3 Emplace the Colorado silica sand pack (8/12-mesh) through the tremmie into the borehole in stages to a depth of approximately 10 ft above the piezometer screen. The addition of the sand is accomplished by pumping clean water down the tremmie and adding the dry sand to the water stream on the suction side of the pump. Care should be taken to avoid bridging of the sand pack. Top of gravel/sand pack will be tagged at a minimum of 20 ft fill intervals.

1.3.4 Following the emplacement of the sand pack, pump another approximate 2 foot lift of fine mesh (60-mesh) silica sand above the existing sand pack.

1.3.5 Then pump high solids (30%) bentonite grout in a "bottom-up" method to a depth of approximately 5 ft below ground surface.

1.4 Surface Completion

A typical piezometer surface completion diagram is presented in Figure 3. Surface completion procedures are briefly described below.

1.4.1 Release tension from the piezometer well string. Cut down 4-inch PVC well casing to approximately 2 ft above ground surface. Install (weld on) a 2-foot extension to the 10-inch surface casing (with prefabricated locking cap) to form a lockable wellhead casing. Protect PVC well casing with a welding shield. The surface casing should extend approximately 2 ft above the ground surface. The 4-inch PVC blank casing should extend slightly below the surface casing. Fill annular space with bentonite grout to ground level. Add sufficient grout to complete surface seal between the 10-inch surface casing and the native soils.

1.4.2 Airlift develop the well using approximately 2-inch steel air-lift line and a maximum of 80 feet of submergence for approximately 2 hours or until well discharge is clear of drilling fluids and suspended sediments.

1.4.3 Install a locking cap on the surface casing.

1.4.4 Install an approximately 8-inch thick by 4-ft square concrete pad that extends approximately 4 inches below and 4 inches above ground surface. Slope the top of the concrete pad approximately 0.25 inches per horizontal ft away from the surface casing.

1.5 Drilling and Sampling of Test Well NC-GWE-GF-3T

1.5.1 Drill and sample (at 5-foot interval) an approximately 20-inch diameter borehole to a depth of approximately 20 ft using conventional air rotary (with injection water/foam) methods. Install a 16-inch steel surface casing to approximately 20 feet with diverter head. Back-fill the annular space with Portland grout. The casing borehole can be drilled in two passes, but must provide a plumb borehole to "hang" a 16-inch diameter casing plumb during the casing seal operation.

1.5.2 After sufficient casing seal setting time, advance borehole beyond the 20 ft surface casing with approximate 8-inch rotary bit using conventional air circulation with injection of a water and foam (Baroid QUIK FOAM or equivalent) mixture. The borehole will be drilled to a maximum depth of 500 ft. Collect geologic samples (drill cutting samples) at 5-ft intervals using a cyclone air/cuttings separator with wet-splitter capability or similar system. It is expected that the drilling will encounter a sequence of primarily clay-rich sediments with interbeds of cleaner sands and gravels, locally with significant water production. Should water production during drilling exceed the capacity of the conventional air/foam method or borehole stability issues are encountered, the borehole can be deepened by switching to mud rotary methods to complete the approximate 8-inch borehole to 500 ft. Following geophysical logging, the borehole will be re-entered with approximately 15-inch rotary bit and "opened-up" with conventional mud rotary techniques to 500 ft. The approximate 15-inch borehole must not deviate from vertical more than ½ degree per 100-foot advance and dog-leg severity beyond 0.5 degrees/100 ft. A deviation survey will be conducted subsequent to drilling.

1.5.3 Condition/stabilize (with NWRPO approval) intervals of borehole wall that are unstable and/or are responsible for lost circulation by injecting bentonite mud or bentonite mud and polymer into the annular space between the drill pipe and the formation wall using conventional circulation methods. Excess conditioning fluids that have been added during borehole conditioning will be removed from the borehole by conventional air circulation prior to advancing the borehole deeper into undrilled formation. Lost circulation zones in the open borehole can be addressed with bentonite mud and/or lost circulation materials only with prior NWRPO written approval. NWRPO reserves the right to terminate drilling at any depth. Upon reaching total depth, remove the drill string from the borehole to permit open borehole geophysical logging by another Nye County contractor.

1.6 Subsurface Completion

A typical single 8-inch test subsurface well completion diagram is presented in Figure 4. Depths for the well screens and gravel packs will be determined from geologic and geophysical logging data. Typically, two screened intervals will be installed, separated by blank casing with a 10 ft blank casing with end cap on bottom. The depths of the 8-inch well casing will not exceed 480 ft. Note that target depths for all completion materials (including well casing/screen, sandpack and grout seals) must be achieved within several feet. All materials will be emplaced with pump/tremmie line methods and at no time should the open end of the tremmie be more than 30 ft above the completion material level of the well. Top of gravel pack will be tagged at 20 ft fill intervals. A tagging instrument will be supplied by the Nuclear Waste Repository Project Office. Subsurface completion procedures are briefly described below.

1.6.1 Run a steel tremmie pipe (e.g., 2-inch ID) to near the bottom of the borehole.

1.6.2 Follow this by running the 8-inch butt welded or weld collar ¼-inch wall steel well casing with louvered well screens (0.050-inch opening Roscoe Moss Louvered "Full-Flo" Screen or equivalent), and 6 centralizers at 40 ft intervals to

a maximum depth of 480 ft. The well string must be maintained under tension during the remaining completion activities.

1.6.3 Emplace the rounded ¼-inch washed "pea" gravel through the tremmie line into the borehole in stages to a depth of approximately 10 ft above the well screen section. The addition of the gravel pack can be accomplished using gravity feed methods or with a gravel pump system using clean water only. Top of gravel/sand pack will be tagged at a minimum of 20 ft fill intervals.

1.6.4 Following the emplacement of the gravel pack, pump another approximate 2 foot lift of fine mesh (60-mesh) silica sand above the existing sand pack.

1.6.5 Then pump high solids (30%) bentonite grout in a "bottom-up" method to a depth of approximately 10 ft below the next screened section.

1.6.6 Continue gravel pack and bentonite seal installation as 1.6.3 to 1.6.5. Above the uppermost screened and gravel pack section, install high-solids bentonite grout to surface.

1.7 Surface Completion

A typical Test Well surface completion diagram is presented in Figure 4. Surface completion procedures are briefly described below.

1.7.1 Release tension from the well string. Cut down 8-inch steel well casing to approximately 2 ft above ground surface. Install (weld on) tabs to 8-inch casing for a locking steel well cover to form a lockable wellhead casing. Fill annular space with bentonite grout to ground level. Add sufficient grout to complete surface seal between the 16-inch surface casing and the native soils.

1.7.2 Airlift develop well using approximately 2-inch steel air-lift line with swab attachment above air discharge and sufficient submergence and air compressor capacity for approximately 8 hours or until well discharge is clear of drilling fluids and suspended sediments. If significant bentonite and/or polymers were used to condition the borehole during drilling, the injection of dispersant (Baroid PFD or equivalent) into the well, allowing sufficient time (overnight) will be required prior to air-lifting.

1.7.3 Install a locking cap on the 8-inch casing.

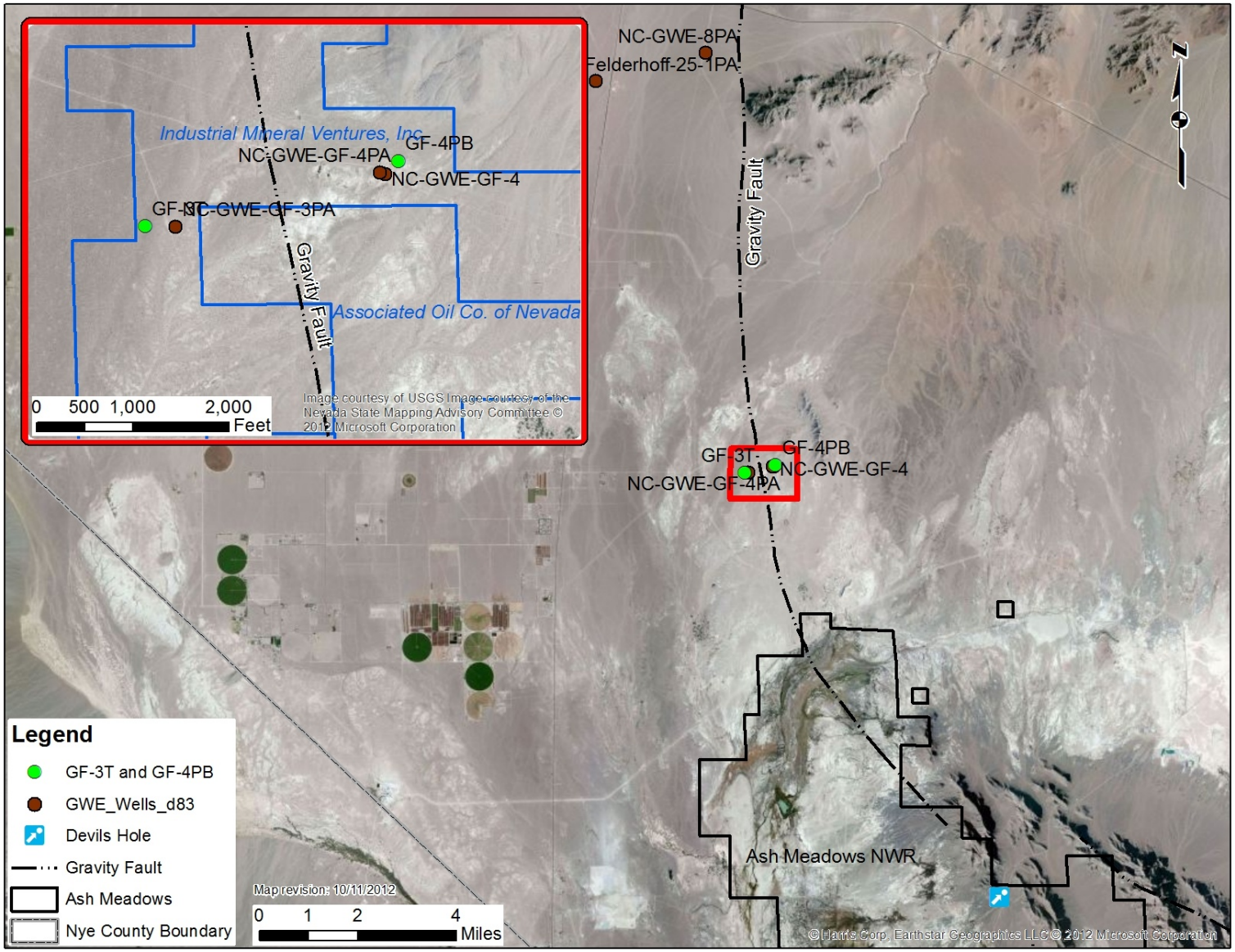
1.7.4 Install an approximately 8-inch thick by 4-ft square concrete pad that extends approximately 4 inches below and 4 inches above ground surface. Slope the top of the concrete pad approximately 0.25 inches per horizontal ft away from the well casing. Incorporate the 16-inch surface casing (cut to ground level if needed) into the concrete pad.

Attachment Table 1

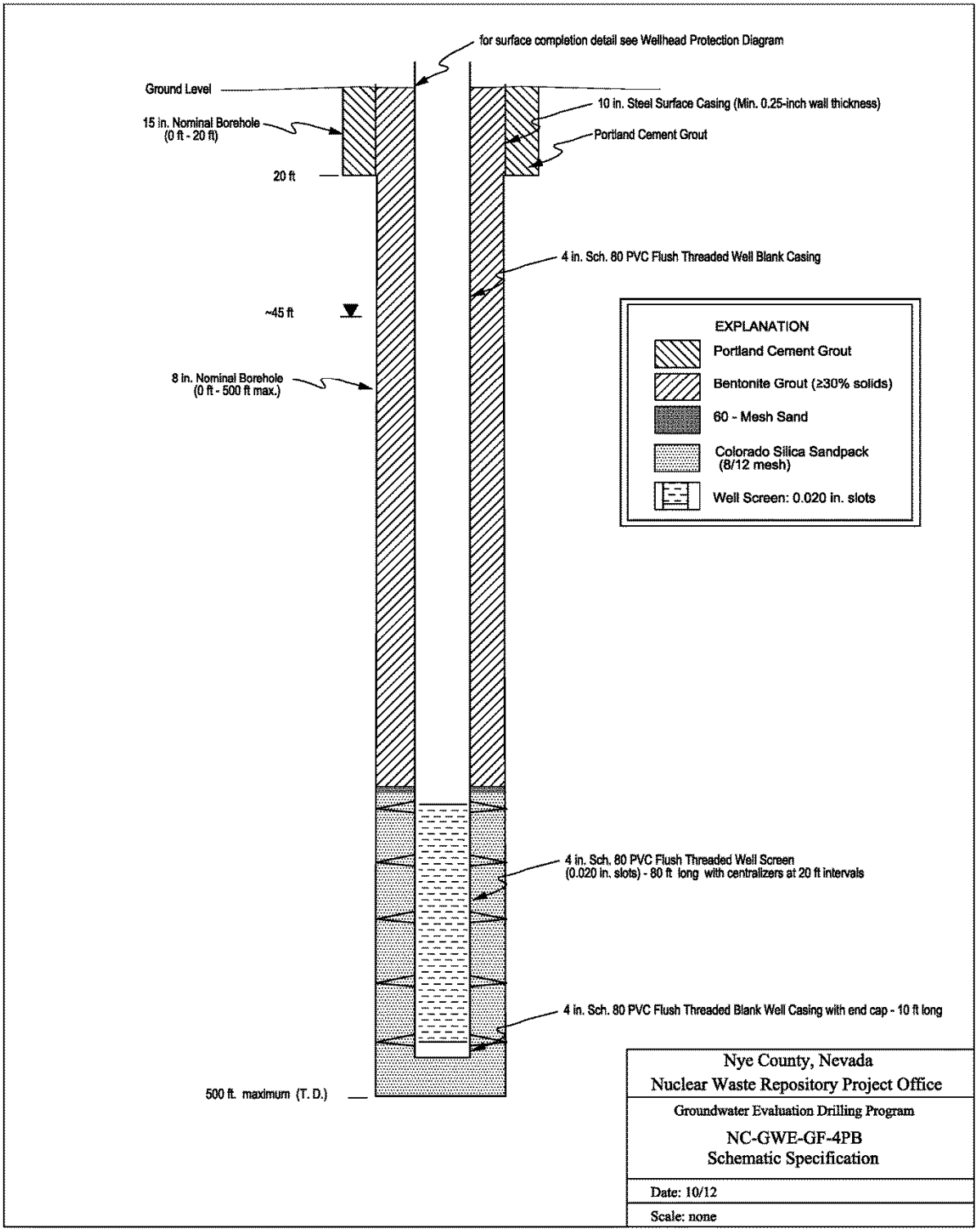
Groundwater Evaluation Well Drilling

Well No. (NC-GWE-)[a]	Drilling Method[b]	Maximum Total Depth (ft)	Completion Type	Approximate Screen or Sandpack Depths (ft, bgs)[c]	Approximate Depth to Water (ft, bgs)	Approximate Unconsolidated Thickness (ft)
GF-3T	CAR[b]	500	8 5/8-inch O.D. ¼" wall steel with louvered screen	200-280 370-470	75	1000
GF-4PB	CAR[b]	500	4-inch flush threaded Sch. 80 PVC piezometer casing	390-470	45	250

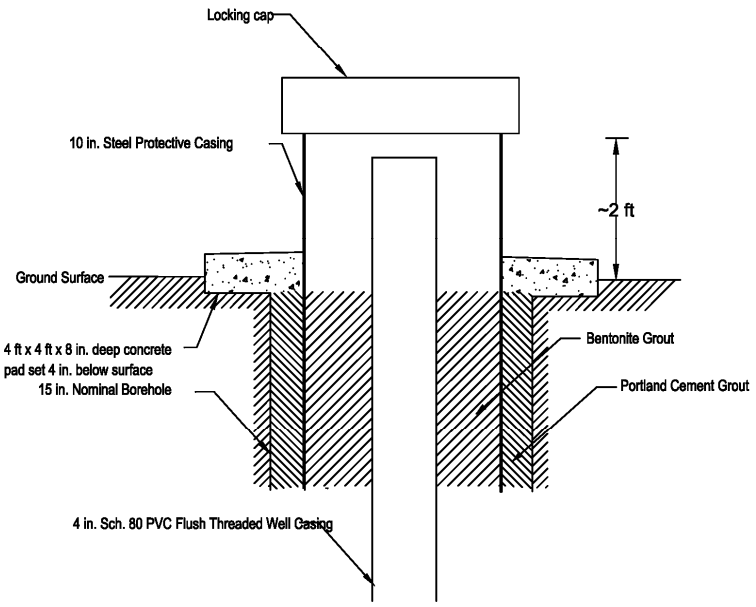
[a] Suffix for all GWE wells
[b] Conventional Air Rotary (Air-Foam)
[c] Estimated Value



Attachment Figure 1
Location Map

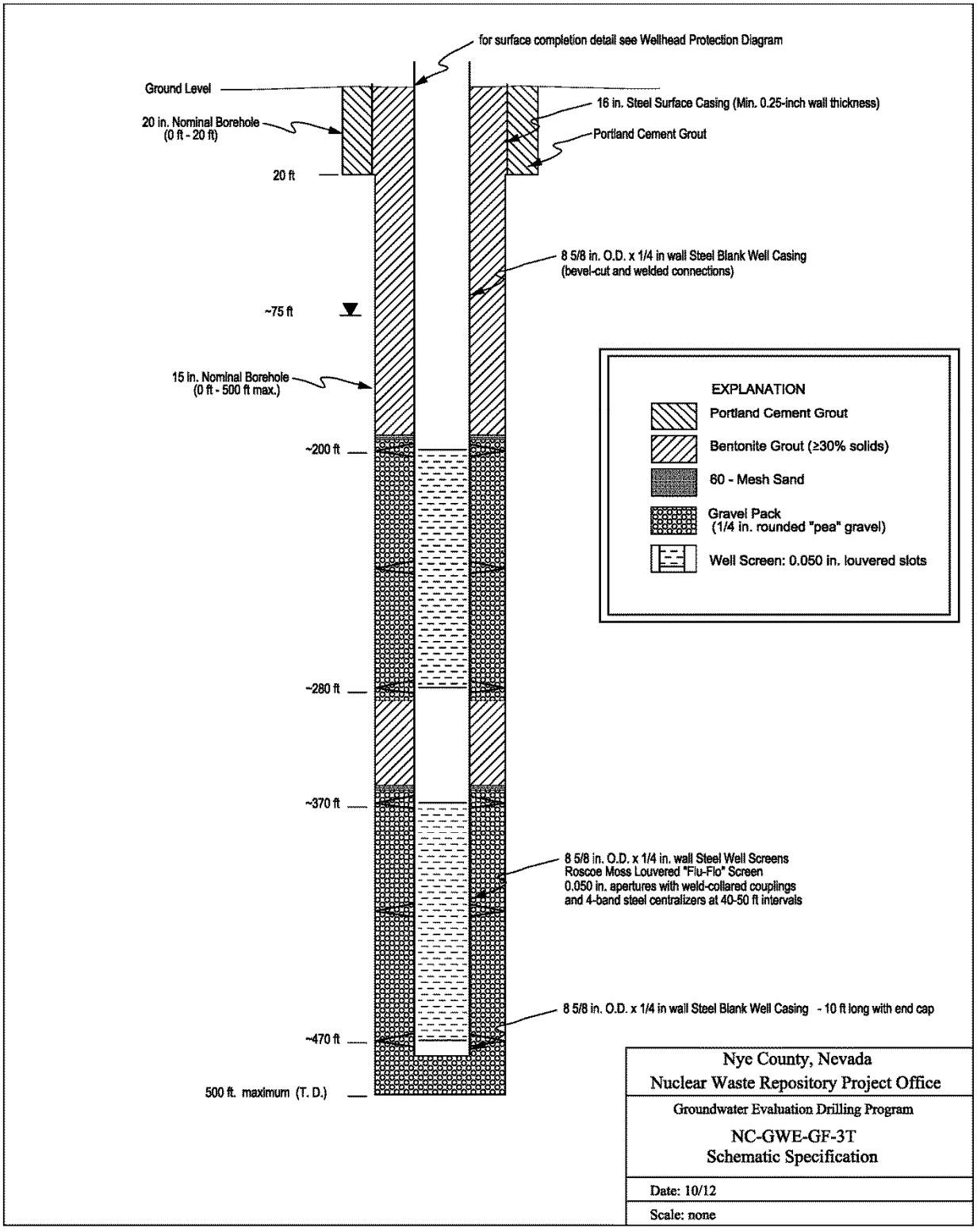


Attachment Figure 2
Schematic Well Completion Diagram for GWE-GF-4PB

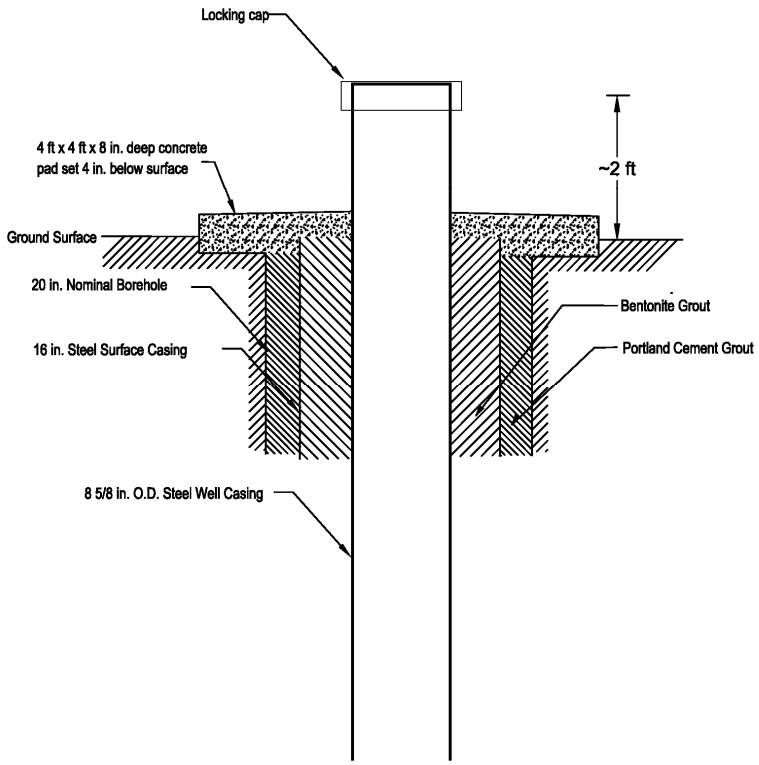


Nye County, Nevada Nuclear Waste Repository Project Office
Groundwater Evaluation Drilling Program NC-GWE-GF-4PB Well Head Protection Detail
Date: 10/12
Scale: none

Attachment Figure 3
Schematic Well Head Protection detail for GWE-GF-4PB



Attachment Figure 4
Schematic Well Completion Diagram for GWE GF-3T Well



Nye County, Nevada Nuclear Waste Repository Project Office
Groundwater Evaluation Drilling Program NC-GWE-GF-3T Well Head Protection Detail
Date: 10/12
Scale: none

Attachment Figure 5
Schematic Well Head Protection detail for GWE GF-3T Well

Attachment B
Drilling/Coring Data Sheet

Nye County Nuclear Waste Repository Project Office — Sheet _____ of _____ — TPN-5.6, Rev. 0

Drilling/Coring Data Sheet — 05-10-2010

Borehole Name/ID: NC-GWE-

Date:

Bit Manufacture/ Type:

Bit Size/Serial Number:

Drill Rig:

Shift:

Circle Activity: Coring Drilling Ream Clean Out

Drilling Method:

Coring Method:

Core/Drill String Data
(Measurement to 0.01 of a foot)

Item No.	Item Description	Item Length	Cumulative Length	Stickup	Hole Depth
BHA	Bottom Hole Assembly				

Core Run/Drill Data
(Measurement to 0.1 of a foot)

Run No.	Time Start/End	From	To	Cut	Preliminary Recovery

Geologic Info:

Comments:

GL - Slips =

Prepared By:

Date:

Checked By:

Date:

Attachment C
Tubing and Casing Record

Nye County
Nuclear Waste Repository Project Office
TUBING AND CASING RECORD

TPN-5.6, Rev. 0
05-10-2010

Page 1 of ____

ONLY APPLICABLE BLOCKS ARE TO BE COMPLETED

Borehole Name/ID:	Date/Time Started:	Date/Time Completed:
Borehole Depth:	Borehole Size:	Drill Rig Used:

Description Tubing or Casing:

Tubing or Casing Tally (Measurements to nearest 1/100 of a foot):

Item No.	Item Length	Cum. Length	Item No.	Item Length	Cum. Length	Item No.	Item Length	Cum. Length	Item No.	Item Length	Cum. Length	Item No.	Item Length	Cum. Length
1			21			41			61			81		
2			22			42			62			82		
3			23			43			63			83		
4			24			44			64			84		
5			25			45			65			85		
6			26			46			66			86		
7			27			47			67			87		
8			28			48			68			88		
9			29			49			69			89		
10			30			50			70			90		
11			31			51			71			91		
12			32			52			72			92		
13			33			53			73			93		
14			34			54			74			94		
15			35			55			75			95		
16			36			56			76			96		
17			37			57			77			97		
18			38			58			78			98		
19			39			59			79			99		
20			40			60			80			100		
Total			Total			Total			Total			Total		

Bottom Hole Assembly (BHA) Description/Information:

Tubing or Casing Depth Info:		Remarks/Notes:
BHA Length	Ft.	
Total Ft. This Page	Ft.	
Total From Page 2	Ft.	
Total Feet	Ft.	
Stick Up on Last Joint	Ft.	
String Set at G. L.	Ft.	

Prepared by: _____ Date: _____

Checked by: _____ Date: _____

Attachment D
Cuttings Sample Log

NYE COUNTY NUCLEAR WASTE REPOSITORY PROJECT OFFICE TPN-5.6, Rev. 0

CUTTINGS SAMPLE LOG 05-10-2010

Borehole ID_____ Drill Depth From _____To_____ Page_____ of_____

Driller_____ Start Date/Time_____End Date/Time_____

Drilling Equip./Method_____Sampling Equip. Method_____

DEPTH (FEET)	Drilling Time (min/5 ft)	DESCRIPTION OF LITHOLOGY-PETROLOGY	GRAPHIC LOG	LITHOLOGIC UNIT	NOTES
10					
20					
30					
40					
50					
60					
70					
80					
90					

PREPARED BY_____DATE_____CHECKED BY_____DATE_____

Attachment D (continued)
Cuttings Sample Log Continuation

NYE COUNTY NUCLEAR WASTE REPOSITORY PROJECT OFFICE

CUTTINGS SAMPLE LOG | **CONTINUATION**

Borehole ID_____ Drill Depth From _____To_____ Page_____ of_____

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05-10-2010

DEPTH (FEET)	Drilling Time (min/5 ft)	DESCRIPTION OF LITHOLOGY-PETROLOGY	GRAPHIC LOG	LITHOLOGIC UNIT	NOTES
0					
0					
0					
0					
0					
0					
0					
0					
0					
0					

PREPARED BY_____DATE_____CHECKED BY_____DATE_____

Attachment E
GWE Piezometer Well Pump Testing Form

Nye County NWRPO
GWE Piezometer Well Pump Testing Form
TPN-5.6, Rev. 0
05-10-2010

Preliminary Information

Well Name: _____ Personnel On-Site: _____
Static Water Level: _____ Sounder #: _____ Initials: _____

Part 1: Step Testing

Date: _____
Pump and Transducer Detail _____
Pump Type and Model: _____ Transducer Serial Number: _____
Distance Between Pump Intake and Transducer Port (0.00 ft): _____ ft
Time Tranducer Start Recording: _____
Depth of Pump Setting (approx.): _____
Initial Transducer Depth (submergance in ft)

Time	Rate (GPM)	Submergance (ft)	Rate Change (GPM) From	Rate Change (GPM) To	Step # and Comments

Final Ideal Rate for Constant Discharge Test (GPM): _____
Approximate Submergance for Constant Discharge Test (ft): _____

Part 2: Constant Discharge Test

Date: _____ Personnel On-Site: _____
Initial Transducer Depth (submergance in ft) _____ Recovery from Step Test %: _____
Time Pump On: _____ Ideal Test Rate (GPM): _____

Time	Rate (GPM)	Submergance	Rate Change (GPM) From	Rate Change (GPM) To	Comments

(Use Continuation Sheet for more Readings)

Pump Removal

Submergance _____ Percentage Recovery from Step Test: _____
Time for Transducer Off: _____

Prepared by: _____ Date: _____
Checked by: _____ Date: _____

Attachment E (continued)
GWE Piezometer Well Pump Testing Form Continuation

Nye County NWRPO
GWE Piezometer Well Pump Testing Form (continuation)
TPN-5.6, Rev. 0
05-10-2010

Preliminary Information

Well Name: _____

Part 2: Constant Discharge Test (continuation)

Date: _____ Personnel On-Site: _____

Initial Transducer Depth (submergance in ft) _____

Time Pump On: _____ Ideal Test Rate (GPM): _____

Time	Rate (GPM)	Submergance	Rate Change (GPM) (if applicable) From	To	Comments

Prepared by: _____ Date: _____

Checked by: _____ Date: _____

Attachment F

Field Change Approval Form

Nye County Nuclear Waste Repository Project Office	TPN-5.6, Rev. 0 05-10-2010
Field Change Approval Form	
Title(s) of Plan(s) proposed to be changed:	NWRPO Field Personnel In Charge: Name Date
DESCRIPTION OF PROPOSED CHANGE - INCLUDE KNOWN EFFECTS OF CHANGE: (Reference borehole IDs, Locations, Specific Tests, all necessary information to identify change)	

APPROVAL: _____ _____
Geoscience Manager Time/Date

APPROVAL: _____ _____
Principal Investigator Time/Date

Copy to: Nye County Nuclear Waste Repository Project Office, Quality Assurance Records Center (QARC)

Attachment G
Daily Drilling Activities Record GF-4PB

Daily Drilling Activities Record - GWE Gravity Fault Drilling - Nye County Nuclear Waste Repository Project Office

TPN-5.6 Rev 1
04/19/2013

Date:	Time Drilling Co. Arrive / Depart Site: /	Prepared By: (Nye County Contract Geologist)	**Form TPN-5.6**
Borehole ID. NC-GWE-GF-4PB	Time Nye County Arrive / Depart Site: /	Checked By: (Nye County Designated Field Rep.)	
Drilling Co.		Approved By: (Drilling Co. Designated Field Rep.)	PAGE OF

Time		Elapsed Time	Depth Interval (ft, bgs)		Footage	Billable Line Items														Non-Billable Items				Description of Other and Comments
						Footage Items		Material Items					Hourly Items				Task Items								
						Drill approx. 8-inch Hole (Includes Eqpt., Labor, and Materials)	**Construct** Monitoring Well (Materials Billed Separately)	**High Solids Bentonite Grout** (50 lb bags)	**Colorado Silica Sand** (8/12 Mesh) (50 lb bags)	**Fine Sand** (60-mesh sand) (50 lb bags)	**Blank Casing** (4-inch Sch. 80 PVC, Flush Joint)	**Well Screen** (4-inch Sch. 80 PVC, 0.020 slots)	**NWRPO Directed** Rig Operating Time	**Standby Time with Crew**	**Standby Time without Crew**	**Airlift Develop Well**	**Mobe - Demobe**	**Move to Well**	**Install 20 ft of 10-inch Surface Casing** (Includes Eqpt., Labor, Materials)	**Construct Surface Pad** (Includes Locking Casing Extension, Eqpt., Labor, Materials)	**Tailgate Safety Meeting**	**Equipment Warm-up/Servicing**	**Equipment Repair**	**Other**	
Start	End	hr	From	To	ft	ft	ft	bags	bags	bags	ft	ft	hrs	hrs	hrs	hrs	Job	Job	Job	Job					
					TOTALS																				

Attachment H
Daily Drilling Activities Record GF-3T

Daily Drilling Activities Record - GWE Gravity Fault Drilling - Nye County Nuclear Waste Repository Project Office

TPN-5.6 Rev 1
04/19/2013

Date:	Time Drilling Co. Arrive / Depart Site: /	Prepared By: (Nye County Contract Geologist)	Form TPN-5.6
Borehole ID. NC-GWE-GF-3T	Time Nye County Arrive / Depart Site: /	Checked By: (Nye County Designated Field Rep.)	
Drilling Co.		Approved By: (Drilling Co. Designated Field Rep.)	PAGE OF

Time		Elapsed Time	Depth Interval (ft, bgs)		Footage	Billable Line Items																		Non-Billable Items				Description of Other and Comments
						Footage Items			Material Items							Hourly Items				Task Items								
						Drill approx. 8-inch Hole (Includes Eqpt., Labor, and Materials)	**Ream** approx. 8-inch to 15-inch Hole (Includes Eqpt., Labor, and Materials)	**Construct** 8-inch Test/Monitoring Well (Materials Billed Separately)	**High Solids Bentonite Grout** (50 lb bags)	**Gravel Pack** (1/4-inch rounded "pea" gravel)	**Fine Sand** (60-mesh sand) (50 lb bags)	**Blank Casing** (8 5/8-inch OD x 1/4-inch wall, bevel cut weld or flush-threaded)	**Louvered Well Screen** (8 5/8-inch x 1/4-inch wall, 0.050-inch apertures, weld-collared couplings)	**Baroid AquaClear PFD** (5-gallon liquid)	**Casing Centralizers** (4 or 5 band type)	**NWRPO Directed** Rig Operating Time	**Standby Time with Crew**	**Standby Time without Crew**	**Airlift Develop Well**	**Mobe - Demobe**	**Move to Well**	**Install 20 ft of 10-inch Surface Casing** (Includes Eqpt., Labor, Materials)	**Construct Surface Pad** (Includes Locking Casing Cap, Eqpt., Labor, Materials)	**Tailgate Safety Meeting**	**Equipment Warm-up/Servicing**	**Equipment Repair**	**Other**	
Start	End	hr	From	To	ft	ft	ft	ft	bags	bags	bags	ft	ft	5-gal bucket		hrs	hrs	hrs	hrs	Job	Job	Job	Job					
					TOTALS																							

Attachment I
Geophysical Log Header Check Sheet

TPN-5.6, Rev. 0
05-10-2010

Nye County Nuclear Waste Repository Project Office	
	Geophysical Log Header Check Sheet

Client: _____

Well Id: _____

Project: _____ Logging Suite: _____

County: _____ _____

Date: _____ Type of Fluid in Hole: _____

Logging Job No: _____ Res Drilling Fluid: _____

Well Type: _____ Res Filtrate: _____

Total Depth-Driller: _____ Res Wall Cake: _____

Max Depth-Logger: _____ Max Rec Temp: _____

Additives: _____ Depth to Water: _____

Bit Type: _____

Drilling Method: _____

Recorded By: _____

Witnessed By: _____

Run No. Tool; S/N _____ From: _____ To: _____

Run No. Tool; S/N _____ From: _____ To: _____

Run No. Tool; S/N _____ From: _____ To: _____

Run No. Tool; S/N _____ From: _____ To: _____

Run No. Tool; S/N _____ From: _____ To: _____

Run No. Tool; S/N _____ From: _____ To: _____

Prepared By:	Date:
Checked By:	Date: