NYE COUNTY NUCLEAR WASTE REPOSITORY PROJECT OFFICE

TEST PLAN

TITLE: **Construction of Sonic Corehole NC-EWDP-22PC**	Revision: **1** Date: **10-13-04** Page: **1 of 34**
TEST PLAN NUMBER: **TPN-5.3**	SUPERSEDES: **None**
APPROVAL 10-13-04 Project Manager Date	CONCURRENCE 10/13/04 On-Site Geotechnical Representative Date 10/17/04 Principal Investigator Date 10/13/04 Quality Assurance Officer Date

1.0 INTRODUCTION

This test plan (TPN) provides general instructions for the construction of Nye County Nuclear Waste Repository Project Office (NWRPO) Early Warning Drilling Program (EWDP) sonic corehole NC-EWDP-22PC. These instructions include the following tasks:

- Drilling, sampling, and casing of 460 feet of the unsaturated zone.
- Continuous coring and geophysical logging of the upper 300 feet of the saturated zone.
- Geologic logging, sampling, and laboratory tests of alluvial textural layers within this core.
- Archival of the remaining continuous core samples from alluvial textural layers.
- Corehole completion with dual-string piezometers.

This TPN references applicable quality assurance (QA) technical procedures (TPs) that provide detailed instructions to NWRPO personnel for routine data collection activities. In addition, this TPN references the applicable portions of the NWRPO drilling contract that provide detailed drilling and well completion instructions and responsibilities for the drilling contractor.

This TPN applies solely to corehole NC-EWDP-22PC and includes information usually included in work plans developed for major phases of the EWDP to address the construction of a group of related wells.

2.0 PURPOSE AND JUSTIFICATION

The U.S. Department of Energy (DOE) has identified the saturated alluvium in Fortymile Wash as a potential groundwater flow pathway from Yucca Mountain to groundwater users in Amargosa Valley. Nye County believes that collecting continuous core from the upper portion of the alluvial aquifer is necessary in order to identify potential preferential flow pathways and provide small-scale estimates of flow and transport properties. These data will support and complement the interpretation of flow and transport data obtained on a much larger scale from single and cross-hole tracer tests and high rate/volume aquifer pump tests.

To date, only approximately 280 feet of continuous alluvium core have been collected in Fortymile Wash from one borehole location (NC-EWDP-19PB). To help fill the need for continuous alluvium core in Fortymile Wash, Nye County will construct a second corehole using conventional or dual-rotary drilling in the unsaturated zone and sonic coring methods in the saturated zone at the NC-EWDP-22 drill site. This site is also the location of proposed single- and multiple-well alluvium tracer tests. Approximately 300 feet of continuous sonic core will be collected from approximately 460 feet below ground surface (bgs) to a total depth of approximately 760 feet bgs. The corehole will be completed with dual-string piezometers, with screened intervals at depths corresponding to screened intervals in NC-EWDP-22PA. The piezometers will be used as injection and/or monitoring points in the planned tracer tests.

3.0 SCOPE OF WORK FOR DRILLING, CORING, 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 On-Site Geotechnical Representative will be the Principle Investigator (PI) 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 the 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, coring, and well construction specified in the NWRPO drilling contract documents (NWRPO, 2004). 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, in which the NDFR or designee is responsible for directing the work. The NDFR and CDFR will communicate regularly and review, approve, and sign daily drilling records that document contract billable items.

3.1.2 Site Location, Surveying, and Pad Preparation

NC-EWDP-22PC will be located in lower Fortymile Wash approximately 7 miles northwest of Lathrop Wells, Nevada, within approximately 60 feet east of existing well NC-EWDP-22S (Figure 1).

When the final location is determined by the NWRPO, a stake will be driven at the proposed wellhead location, the location surveyed using the global positioning system (GPS), and the latitude and longitude recorded to the nearest 0.01 second according to TP-9.8, *GPS Planning, Setup, Data Collection, and Post-Processing for the Trimble PRO/XRS*. All original GPS survey data collected will be transmitted to the NWRPO QA Records Center (QARC) along with associated metadata. Any additional processing of the data will also be transmitted to the QARC.

Since a large (i.e., approximately 100 by 200 feet) graded and fenced drilling pad is present at the site, no additional site preparation work will be required.

3.1.3 Permitting, License, and Reporting Requirements

The NWRPO, as the well owner, has completed all required federal and state permits. These permits were obtained for previous wells drilled at this site. Since NC-EWDP-22PC is located on an existing, fenced, and previously approved drill site, 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 mat 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 the drill site 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, Coring, and Well Completion

The alluvium of concern will include alternating thin layers (i.e., sometimes less than 2.5 feet thick) of relatively clean sand and gravel, sand and gravel with silt and/or clay, and silty sand with gravel. A summary lithologic log for NC-EWDP-22SA, which is approximately 60 feet west of NC-EWDP-22PC, is shown on Figure 2.

3.2.1 Summary of Drilling Contractor Scope of Work

The detailed scope of work for drilling, coring, and well completion is included in the drilling contract and included as Attachment 1. Negotiated modifications made to this scope of work following award of the drilling contract to Boart Longyear Co. are summarized in the Field Change Approval Form found in Attachment 2. In summary, this scope of work includes the following steps:

1. Using conventional rotary, dual-rotary, or another proven drilling method, drill a borehole and install a 10-inch diameter or larger conductor casing to approximately 460 feet bgs, approximately 10 feet above the water table. If directed by the NDFR, collect drill cuttings from 2.5 ft depth intervals

2. Collect nearly continuous sonic core from approximately 460 to 760 feet bgs using, to the extent possible, a 6-inch outside diameter (OD) steel core casing (i.e., core barrel) inside an 8-inch-diameter steel drill casing. Switch to a 4.5-inch OD core barrel inside a 5.5-inch drill casing when advancement of the larger sonic drilling/coring system is no longer feasible, as determined jointly by the NDFR and CDFR.

3. Install two 2-inch schedule 80 PVC piezometer strings with 70 and 90-foot screens and approximately 80 and 100-foot sand packs (i.e., 5 feet above and below screened interval); the first sand pack will extend from approximately 505 to 585 feet bgs and the second from approximately 660 to 760 feet bgs.

3.2.2 Well Completion

Figure 3 shows a detailed subsurface completion diagram for the dual-string piezometer with a 10-inch conductor casing grouted into place with concrete grout in a 14-inch-diameter borehole. If the casing is drilled to 460 feet bgs using a dual-rotary method, Figure 3 will be modified to show the casing in contact with the formation below 60 feet. All subsurface completion materials will be emplaced using tremmie pipe no more than 20 to 30 feet from the bottom of the hole. Figure 4 shows a dual-string piezometer surface completion diagram. Figures 3 and 4 may be modified before beginning completion activities to accommodate field conditions.

To minimize the potential for caving on the dual-string piezometer during the emplacement of stemming materials below 460 feet (i.e., the bottom of the conductor casing), the sonic drill casing should be pulled back in 10- to 30-foot stages. After each pull-back, the bottom of the well will be sounded to determine whether caving has occurred. Completion materials will then be emplaced (i.e., tremmied) in each pull-back interval to a depth of approximately 5 feet below the sonic drill casing.

Coarse-grained 8/12 silica sand will be used as sand pack from approximately 5 feet below to 5 feet above each well screen. A two to one by weight sand/granular bentonite mixture will be placed above the sand pack intervals to provide a seal between the sand packs and a solid surface for accurate depth measurements with a measuring tag line. A centrifugal pump will be used to emplace the sand pack as well as the sand/granular bentonite mixture.

A bentonite grout slurry will then be emplaced above the uppermost sand/granular bentonite interval to provide a seal in the annular space between the piezometer and conductor casings. This slurry will be emplaced upward by tremmie pipe and a standard grout pump to displace any fluid present in the interval being grouted. Finally, the upper approximate 50 feet of borehole will be filled with a fine-grained dry bentonite emplaced by the gravity free-fall method.

3.2.3 Drilling and Coring Specifications

3.2.3.1 Drilling Equipment Requirements

The upper 460 feet of unsaturated alluvium will be drilled by conventional or dual-rotary drilling methods. Sonic coring equipment will be used to core and advance the borehole from 460 to 760 feet in saturated alluvium. Equipment specifications for these drilling systems are detailed in the drilling contract (NWRPO, 2004).

3.2.3.2 Drilling Fluids

Permissible drilling fluids for the upper 460 feet of unsaturated alluvium are limited to compressed air, water, foam (e.g. QUIK-FOAM®), and untreated bentonite mud (e.g., Aqua Gel Gold Seal®). 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. No drilling fluids will be permitted when coring saturated alluvium from approximately 460 to 760 feet bgs.

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

3.2.3.3 Hole Deviation

The drilling contractor will use methods (e.g., drilling collars) to prevent, to the extent possible, borehole deviation from exceeding 1.5 degrees from vertical at 460 feet bgs, and must conduct a deviation survey at 460 feet bgs to demonstrate meeting this requirement. In addition, deviation exceeding 0.25 degrees per 100 feet (i.e., dogleg) will not be permitted in the upper 460 feet. If there appears to be a significant dogleg, the NWRPO will conduct a deviation survey to determine whether the dogleg requirement has been met.

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 and collars and their sizes before use. During drilling, the NWRPO will document the drilled interval by completing a Drilling/Coring Data Sheet and Tubing and Casing Record as detailed in TP-7.0, *Drill Site Management*.
- 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

Dust will be controlled on the gravel access road by limiting vehicle speed to 25 mph and by spraying water as necessary while digging mud pits. Neither other drilling fluids used to drill the unsaturated zone nor sonic coring methods required for the saturated zone produce dust.

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 EWDP Drilling and Well Construction Health and Safety Plan. A copy of this plan will be given to the drilling contractor upon the award of the contract and is included in this TPN as Attachment 3.

The well site will be within the boundaries of the Nevada Test Site; work thereon will require special training, badging, and/or security clearances for the drilling contractor and the

contractor's employees. The drilling contractor will be solely responsible for obtaining all such training, badging, and/or security clearances.

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 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

Based on data collected from boreholes and wells completed at the site, first water will be encountered between 470 and 475 feet bgs during sonic coring. A groundwater level measurement will be made with an electric well sounder, as detailed in TP-9.9, *Measurement of Groundwater Levels Using Electric Well Sounders*, when the sonic core barrel is removed from the borehole after reaching 475 feet bgs.

No first groundwater samples will be collected or field chemical parameters measured, due to the following:

1. Groundwater may be impacted from drilling fluids and grout material used while drilling and casing the overlying unsaturated zone.
2. The groundwater chemistry of the alluvium at this site has been sampled repeatedly in nearby wells. A first water sample would also likely be impacted from drilling activities and be of lesser quality than a sample obtained from the completed piezometer.

3.2.5.2 Saturated Zone Measurements/Sampling

The NWRPO will routinely measure and record the groundwater level before the start of drilling/coring activities each day. However, groundwater samples will not be collected for the reason stated in item 2 of section 3.2.5.1.

3.2.6 Sonic Coring Procedures

A single sonic core run will be 10 feet long, where possible; in no cases will a run exceed 10 feet. In cases where refusal is met before the target 10-foot depth interval is reached, one or more additional core runs will be conducted.

After a core run is brought to the ground surface, the drilling contractor will transfer the core in approximately 2-foot lengths from the core barrel to polyethylene tubing (plastic socks) with an inside diameter approximately equal to the outside diameter of the core barrel.

The corehole will be depth sounded between core runs to determine whether core has been left in the corehole (i.e., lost core) and/or caving has occurred. Disturbed material may be removed from the hole before the next run. NWRPO personnel will determine whether disturbed material is lost core or caved material.

After each 10-foot interval has been cored, the drill casing will be advanced to the bottom of the hole. The core barrel will then be used to clean out disturbed sediments to the bottom of the hole before initiating a new core run.

3.2.7 Geologic Sampling, Logging, and Processing

Unsaturated zone drill cuttings will be collected, logged, and processed from the upper 460 feet of unsaturated alluvium in NC-EWDP-22PC, if directed by NDFR. In general drill cuttings will be collected from depth intervals where compressed air is used as the drilling fluid and will not be collected if other drilling fluids are used.

Nearly continuous sonic core samples will be collected, logged, and processed from 460 to 760 feet bgs. Procedures for collecting, logging, and processing of both sonic core and drill cuttings are detailed in TP-8.0, *Field Collection, Logging, and Processing of Borehole Geologic Samples.* NWRPO logging of sonic core will include both geologic and digital photography logging. DOE contractors will be responsible for video logging of core.

3.2.8 Borehole Geophysical Logging

Two suites of borehole geophysical logs will be conducted in NC-EWDP-22PC by an NWRPO contractor after total depth is reached. A suite of drill string logs (i.e., density, deviation, fluid temperature, natural gamma, moisture, and spectral gamma) will be run inside the sonic drill casings. After the well is completed, a suite of well completion logs will be run in the deeper of the two piezometer strings. The completion suite will be the same as the drill string suite.

In addition, a second NWRPO contractor will run gamma-gamma density and epithermal-neutron porosity logs inside the sonic drill casings to total depth. The relatively large nuclear sources on the downhole tools used to produce these logs have the potential to see farther into the formation and be less affected by the sonic drill casings than density and moisture downhole tools.

Both logging companies will be required to meet the calibration, documentation, and deliverable requirements specified in TP-11.0, *Borehole Geophysical Logging Data Identification and Acceptance.*

4.0 SAMPLE MANAGEMENT AND TESTING

Drill cuttings and sonic core sample processing, addressed in TP-8.0, includes collecting representative samples for geologic logging and laboratory testing. The estimated total numbers of drill cuttings samples, sonic core segments, and sonic core grab samples are summarized in Table 1. Drill cuttings will be collected from each 2.5 ft depth interval if directed by the NDFR. Sonic core will be collected in approximately 2-foot-long plastic socks, referred to as segments in Table 1, and grab samples will be taken of the major textural layers observed in these segments. These textural layers will often extend across adjacent segments and may range in length from less than 0.25 feet to more than 10 feet. For Table 1, an average length of 1.5 feet is assumed.

The distribution of drill cuttings samples, sonic core segments, and sonic core grab samples among different users is shown in Table 2. Laboratory tests for different sample types are specified in Table 3, where possible. Distribution will be controlled and documented with the NWRPO Transfer of Custody Form. Geologic samples will be maintained under chain of custody at all times, either in view of the current holder or secured in locked storage.

After grab samples have been removed from the core segments and digital photographs and video have been taken of each sonic core segment, the DOE will assume custody of the core segments, transporting them to and storing them at the SMF.

All geologic sample data will be reviewed/checked by NWRPO personnel not directly involved in recording the data and submitted to the QARC with all supporting documentation and metadata.

The NFDR will use the numbers and types of samples in Tables 1 and 2 to ensure that all necessary containers and packing, marking, and preservation materials are available at the drill site.

5.0 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 and other applicable QA documents, (i.e., the most recent versions of TP-7.0, -8.0, -9.8, -9.9, and -11.0).

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 sampling and testing.

6.0 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), 2002. *EWDP Health and Safety Plan*, Nye County Department of Natural Resources and Federal Facilities, Pahrump, Nevada.

NWRPO (Nuclear Waste Repository Project Office), 2004. *Drilling, Sonic Coring, and Construction of One EWDP Phase V Monitoring Well on the Nevada Test Site - Bid Specifications and Request for Bids.* Nye County NV, Department of Natural Resources and Federal Facilities. Independent Scientific Investigations Program.

TP-7.0, *Drill Site Management.*

TP-8.0, *Field Collection, Logging, and Processing of Borehole Samples.*

TP-9.8, *GPS Planning, Setup, Data Collection, and Post-Processing for the Trimble PRO/XRS.*

TP-9.9, *Measurement of Groundwater Levels Using Electric Well Sounders.*

TP-11, *Borehole Geophysical Logging Data Identification and Acceptance.*

TABLES

Table 1
Geologic Sample Types and Numbers

Geologic Sample Type	Core Diameter (inches)	Estimated Total Footage (feet)	Estimated Average Core Run Length (feet)	Estimated Number of Core Runs	Core Segment Length (feet)	Number of Segments per Core Run	Total Number
Sonic Core	6	150	5[a]	30	2.0	2.5	75
	4.5	150	5[a]	30	2.0	2.5	75
Sonic Core Grab Sample	NA[b]	300	NA	NA	NA	NA	200[c]
Drill Cuttings	NA	460	NA	NA	NA	NA	184[d]

[a] Conservatively assuming an average 5-foot-long core run. Target core run is 10 feet.
[b] Not applicable.
[c] Assuming an average layer length of 1.5 feet.
[d] Assuming 2.5 foot sample intervals over 460 feet.

Table 2
Distribution of Geologic Samples

Geologic Sample Type	Segment Diameter	Total Number Of Segments/ Samples	Number of Segments/Samples Sent		
			NWRPO		DOE
			YMP SMF[a]	Laboratory	YMP SMF
Sonic Core	6-inch diameter	75	0	0	75
	4.5-inch diameter	75	0	0	75
Sonic Core Grab Sample	NA[b]	200	0	200	0
Drill Cuttings	NA	184[c]	184	184[d]	184

[a] Yucca Mountain Project Sample Management Facility.
[b] Not applicable.
[c] Assuming 2.5 foot interval samples are collected from 460 feet of borehole.
[d] Assuming the following two subsamples will be sent to the NWRPO laboratory from every other 2.5 foot sample interval: a moist sample for gravimetric water content and an air-dried sample for all other laboratory tests.

Table 3
Summary of Laboratory Tests on Geologic Samples

Geologic Sample Type	Number of Samples Tested								
	Hydraulic Conductivity	Volumetric Water Content	Gravimetric Water Content	Grain Density	Dry Bulk Density	Electrical Conductivity	Atterberg Limits	Particle Size Distribution	
								Wet Sieve	Hydrometer
Sonic Core[a]	TBD[b]	TBD	NA	TBD	TBD	NA	TBD	TBD	TBD
Sonic Core Grab Sample	NA[c]	NA	NA	50	NA	TBD	200	200	100
Drill Cuttings	NA	NA	92	46	NA	92	46	92	46

[a] Repacked to in situ densities.
[b] To be determined.
[c] Not applicable.

Table 4
Laboratory Test Methods for Geologic Samples

Laboratory Test	Method
Saturated Hydraulic Conductivity (Constant Head Method)	Klute, A., and C. Dirksen, 1986. Hydraulic Conductivity and Diffusivity: Laboratory Methods. In: Klute, A. (ed), Methods of Soil Analysis, Part 1, Physical and Mineralogical Methods (2nd ed.), American Society of Agronomy, Chapter 28, p. 694-700.
Volumetric Water Content	ASTM D2216-92. Method for laboratory determination of water (moisture content) of soil, rock, and soil-aggregate mixtures. In: 1996 Annual Book of ASTM Standards, Vol. 04.08, American Society for Testing and Materials.
Gravimetric Water Content	ASTM D-2216-98. Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass. In: 2003 *Annual Book of ASTM Standards,* Vol. 04.08, American Society for Testing and Materials.
Dry Bulk Density	Blake, G.R. and K.H. Hartge. 1986. Bulk Density. In: Klute, A. (ed), Methods of Soil Analysis, Part 1, Physical and Mineralogical Methods (2nd ed.), American Society of Agronomy, Chapter 13, p. 363-367.
Specific Gravity (Grain Density)	ASTM D854-92. Standard test method for specific gravity of soils. In: 1996 Annual Book of ASTM Standards, Vol. 04.08, American Society for Testing and Materials.
Soil Extract Electrical Conductivity	Rhoades, J.D. 1982. Soluble Salts—Extracts at Soil/Water Ratios of 1:1 and 1:5, Electrical conductivity of saturation extract. In: Page, A.L. (ed), *Methods of Soil Analysis,* Part 2, Chemical and Microbiological Properties (2nd ed.), American Society of Agronomy, Chapter 10, pp. 169-170 and 172-173.
Atterberg Limits	ASTM D-4318-00. Standard Test Methods for Liquid Limit, Plastic Limit, and plasticity Index of Soils. In: 2003 *Annual Book of ASTM Standards,* Vol. 04.08, American Society for Testing and Materials.
Hydrometer Analysis (Silt/Clay Break)	ASTM D422. Standard method for Particle Size Analysis of Soils. In: 1996 Annual Book of ASTM Standards, Vol. 04.08, American Society for Testing and Materials.
Wet Sieve Analysis	ASTM D1140 (97). Standard method for the amount of material in soils finer than the No. 200 (75um) sieve. In: 1998 Annual Book of ASTM Standards, Vol. 04.08, American Society for Testing and Materials.

FIGURES

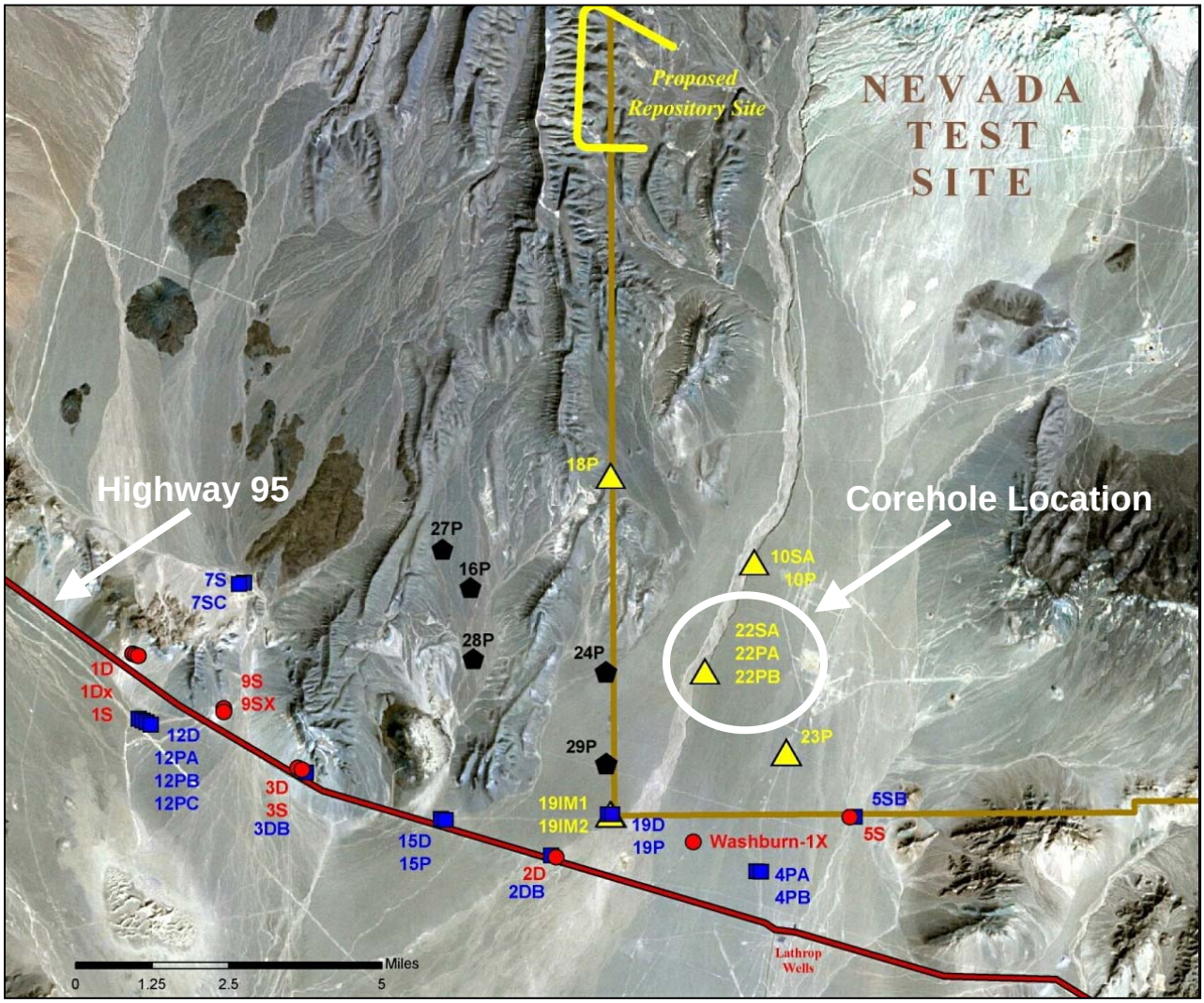
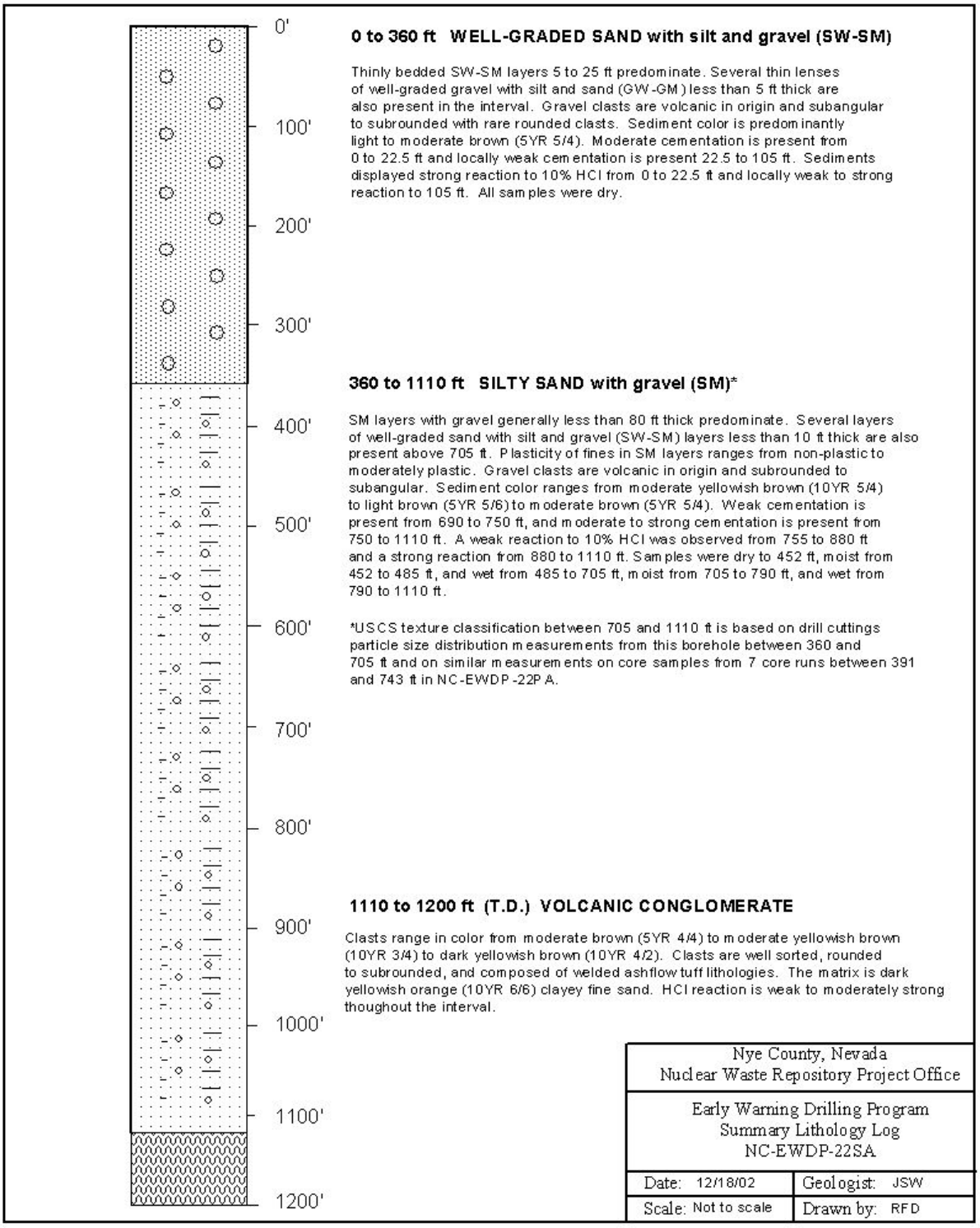


Figure 1
Location Map



NOTE: T.D. = total depth

Figure 2
Summary Lithologic Log for Well NC-EWDP-22SA

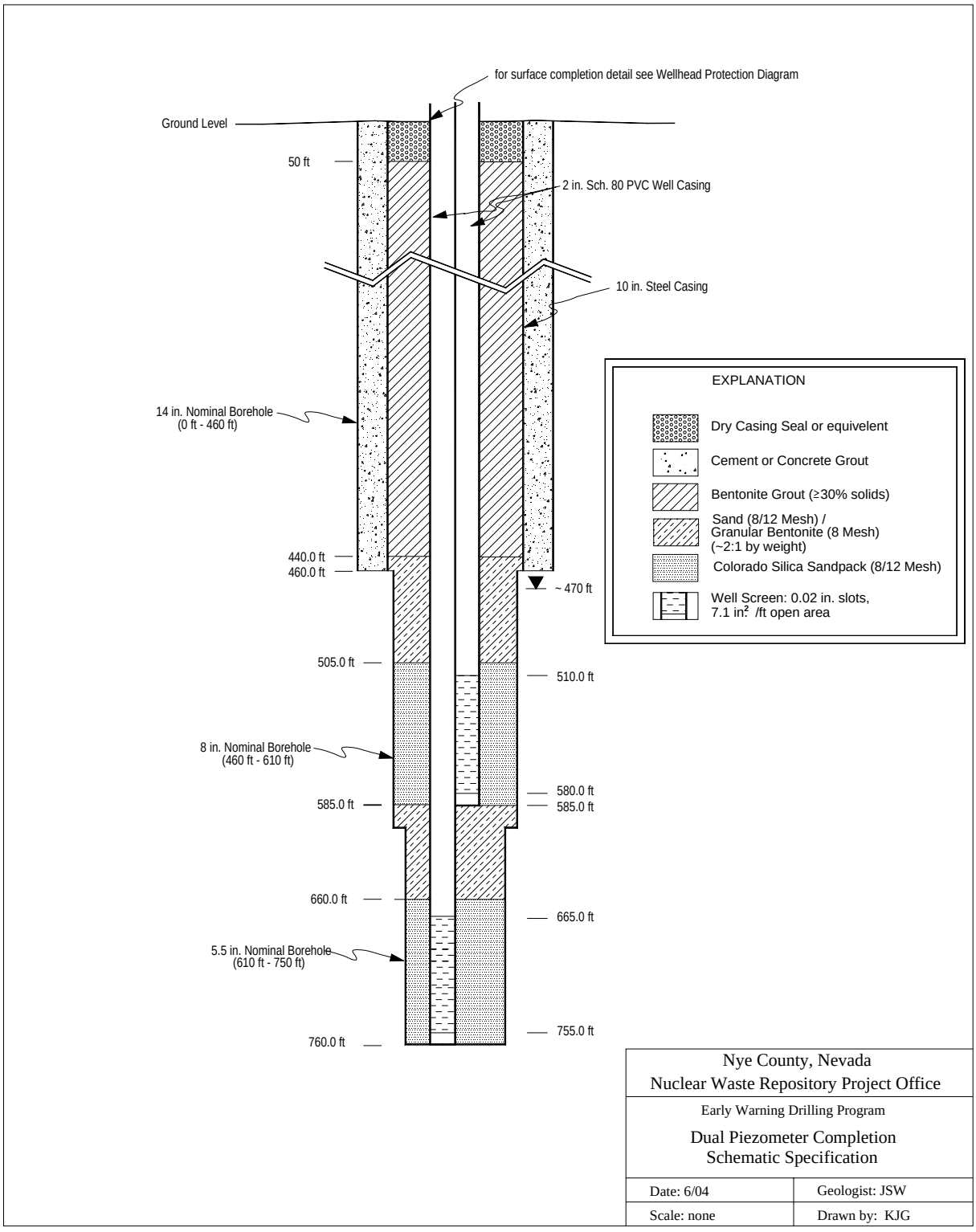
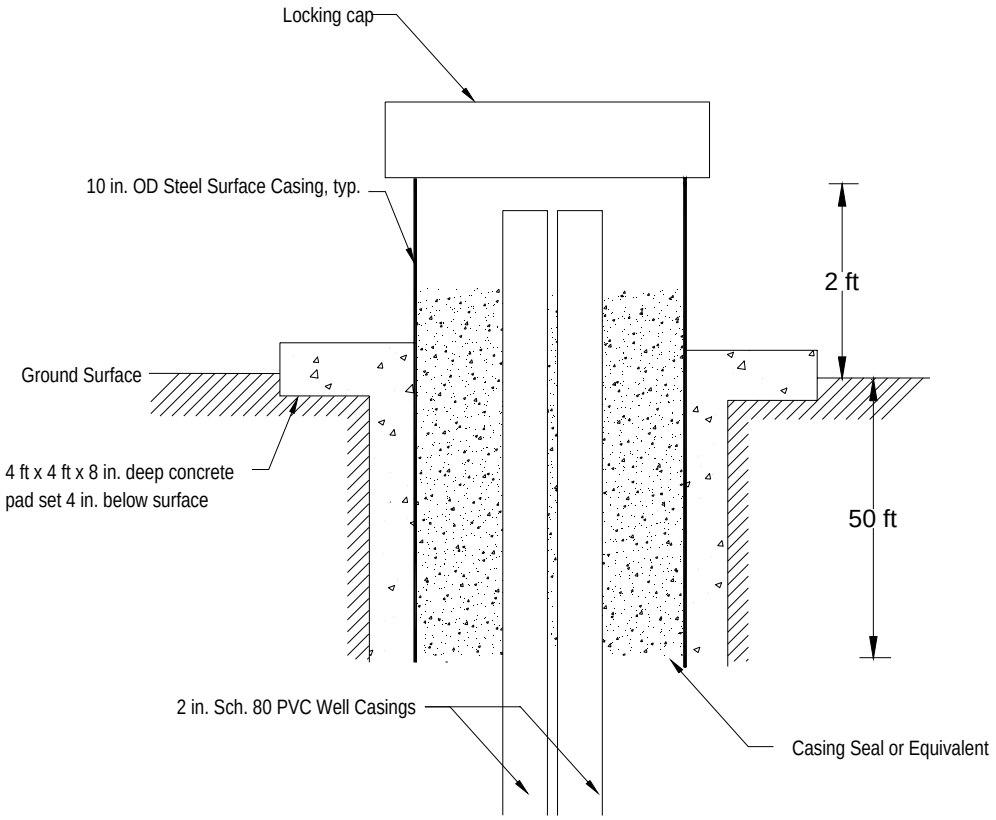


Figure 3
Typical Dual-Piezometer Subsurface Completion Diagram



Nye County, Nevada Nuclear Waste Repository Project Office	
Early Warning Drilling Program Dual Piezometer Surface Completion Detail	
Date: 6/04	
Scale: none	Drawn by: KJG

Figure 4
Typical Dual-Piezometer Surface Completion Diagram

ATTACHMENT 1

SCOPE OF WORK FOR DRILLING, SONIC CORING, AND CONSTRUCTION OF ONE EWDP PHASE V MONITORING WELL ON THE NEVADA TEST SITE

1.0 INTRODUCTION

The scope of work encompasses all activities associated with the drilling, sonic coring, and construction of a dual-string piezometer monitor well to a total depth of 760 feet below ground surface (bgs) in Fortymile Wash alluvial sediments at a location approximately 7 miles northwest of Lathrop Wells, NV on the Nevada Test Site. This well will be located within approximately 60 feet of existing well number 22S shown in Figure 1.

This single EWDP Phase V borehole will only penetrate relatively coarse grained alluvium. The alluvium will include alternating thin (sometimes less than 1 foot thick) layers of relatively clean sand and gravel, sand and gravel with silt and/or clay, and silty sand with gravel. A summary lithologic log for a well located within approximately 60 feet from the well proposed herein is presented in Figure 2. The water table is expected to be encountered at approximately 470 feet bgs.

A significant loss of bentonite drilling fluid (approximately 100,000 gallons) was observed while drilling the unsaturated zone (upper approximately 470 feet) in a previous 14.75-inch diameter borehole at this location using flooded mud reverse circulation methods. The Contractor should select a drilling method and drilling fluid to avoid similar excessive loss of liquid drilling fluid in the proposed well.

It is expected the Contractor will use two drill rigs, one for drilling and casing of the unsaturated alluvium, and one for the sonic coring and borehole advancement in saturated alluvium. However, if available, a multipurpose rig with all the required capabilities will be acceptable. Alternatively, the Contractor may propose to sonic core both the unsaturated alluvium and the underlying interval of saturated alluvium. The drill site has been graded and fenced by the Nye County Nuclear Waste Repository Project Office (NWRPO). The Contractor will be responsible for digging pits for liquid drilling fluids/cuttings.

The NWRPO and the Department of Energy contractors (DOE) will be responsible for maintaining depth control through pipe tally records. Pipe tally records will be kept for all drilling, coring, and completion activities. The Contractor will cooperate with the NWRPO and DOE in maintaining these records.

Contractor responsibilities regarding drilling permits required by the state of Nevada Department of Water Resources, waste disposal, health and safety, training, fire prevention, spill prevention and cleanup, good drilling/completion operation practices, supply of electricity and water, handling of nuisance water, water sampling, use of drilling fluids and lubricants, and other miscellaneous activities/requirements are

described in Part V, Sections A and B of this document (*Drilling, Sonic Coring, and Construction of One EWDP Phase V Monitoring Well on the Nevada Test Site – Bid Specifications and Request for Proposal*). In addition, communication and record keeping responsibilities for both the Contactor and the NWRPO are listed in Section B of Part V. Finally, equipment and material specifications are described in Part V Sections C and D.

Detailed specifications and requirements regarding mobilization/demobilization, drilling and casing of unsaturated alluvium, continuous Sonic coring of saturated alluvium, borehole geophysical logging, subsurface completion of a dual-piezometer monitor well, and the surface completion of this well are presented in the following.

2.0 MOBILIZATION/DEMOBILIZATION

2.1 The rig(s), auxiliary equipment, drillpipe and other downhole equipment and tools shall be mobilized in a clean condition, generally free of surface grease, soil, or other potential contaminants. Steam cleaning of grease, dirt, etc., from previous jobs not related to the subject work will not be allowed on the drill site.

2.2 Mobilization will be considered complete when all of the items listed in Part V, Section B, Item 2 have been accomplished.

2.3 Demobilization will be considered complete when:

- Tasks specified in the contract are completed or exempted from completion with approval of the NWRPO.
- All personnel, equipment, tools, unused materials, and drilling related debris are removed from the drill site location as well as the NWRPO laydown yard in Lathrop Wells. In addition, any pits and berms on the drill site must be graded to approximately the original elevation.

3.0 PROPOSED DRILLING AND CASING OF UNSATURATED ALLUVIUM

Using conventional rotary, casing-advance, or another proven drilling method, drill a suitable borehole and install an approximately 10-inch diameter (or larger) conductor casing to a depth of 460 feet bgs (approximately 10 feet above the water table) in accordance with specifications listed below. The Contractor may elect to drill a borehole significantly larger in diameter (e.g. approximately 14-inches) than the conductor casing and then grout the casing in place with concrete grout), or the Contractor may choose to drill the conductor casing to 460 feet bgs using a casing-advance drilling method such as dual-rotary or sonic methods.

3.1 Regardless of the drilling method employed, permissible drilling fluids are limited to water, untreated bentonite mud (e.g. AQUA GEL GOLD SEAL®), and compressed air. The Contractor must obtain NWRPO approval before using any other drilling fluid or additive.

3.2 The Contractor must employ methods (e.g. drilling collars) to keep the borehole deviation from exceeding 1.5 degrees from vertical at 460 feet bgs. In addition, no "dog legs" are permitted where deviation exceeds 0.25 degrees per 100 feet. The Contractor must conduct a deviation survey at 460 feet bgs to demonstrate the first requirement. If there appears to be a significant dog-leg, the NWRPO will conduct a survey to determine if the second requirement is met.

3.3 If the Contractor elects to use conventional rotary drilling methods and use concrete grout to seal the approximately 10-inch conductor casing in place, the borehole must be drilled to at least 14-inches in diameter to 460 feet bgs. The concrete grout must be pumped through a tremmie pipe using a "bottom-up" approach in stages to prevent casing collapse. In addition, the Contractor may also want to set a larger diameter surface casing (temporary or permanent) to prevent near surface caving of unconsolidated coarse-grained sediments.

3.4 If the Contractor chooses to drill the approximately 10-inch conductor casing down to 460 feet bgs using a drilling method such as dual-rotary or sonic, the contractor must first permanently install a larger diameter steel surface casing to at least 60 feet bgs. The diameter of the upper 60 feet of borehole and the diameter of the steel surface casing must be sufficient to permit grouting the surface casing with concrete and to support casing-advance drilling of the approximately 10-inch conductor casing to 460 feet bgs.

4.0 SONIC CORING OF SATURATED ALLUVIUM

The following describes the NWRPO preferred method of sonic coring. Slight field modifications to these methods may be required. All field modifications must be approved by NWRPO prior to implementation.

4.1 Run in approximately 8-inch diameter steel drill casing inside the approximately 10-inch conductor casing to 460 feet bgs.

4.2 Run in an approximately 20 foot length of approximately 6-inch steel core barrel attached to smaller diameter drill rods to 460 feet bgs.

4.3 Advance the approximately 6-inch core barrel using sonic methods a maximum of 10 feet. In some cases the core barrel will meet refusal before 10 feet is reached. When the target depth of 10 feet is reached or the when barrel meets refusal at a depth of less than 10 feet, return the core barrel to the ground surface and transfer the core sample to approximately 2 foot lengths of 4 to 6 mil polyethylene tubing. NWRPO and DOE will be responsible for determining and labeling the depth intervals of each approximately 2 foot length of core in polyethylene tubing.

4.4 Run the approximately 6-inch core barrel back into the borehole and continue advancing it a maximum of 10 feet per run and a maximum of 20 feet ahead of the approximately 8-inch drill casing provided no substantial caving in the open portion of the borehole is occurring. At this point, use Sonic methods to advance

the 8-inch drill casing down to the bottom of the borehole using the approximately 6-inch core barrel to clean out sediments from inside the drill casing. Remove the cleanout sediments from the borehole and core barrel prior to advancing the approximately 6-inch core barrel as described in section 4.3 above. Ideally, prior to each advance with the 6-inch core barrel, the bottom of the hole will be sounded with a tagging tool and the core barrel will be empty, thus simplifying the determination of the length of core sample vs. the length of cleanout material collected in the core barrel.

Continue collecting approximately 6-inch Sonic core and advancing the approximately 8-inch drill casing until (in the opinion of the Contractor) it is no longer feasible to do so. It is realistically expected that the maximum depth of advancement of this drilling/coring system will be between 610 and 660 feet bgs. For the purpose of the Cost Consideration Schedule (Table 1) in Part I, Section C of this document, it will be assumed that the 6-inch core barrel and 8-inch drill casing will be advanced from 460 to 610 feet bgs.

4.5 When advancement is no longer feasible with the above drilling/coring system, remove the approximately 6-inch Sonic core barrel and run in an approximately 5.5-inch drill casing and an approximately 4.5-inch core barrel. Continue collecting continuous Sonic core and advancing the borehole in a similar manner as sections 4.3 and 4.4 above using this smaller drilling/coring system to a maximum depth of 760 feet bgs.

For the purpose of the Cost Consideration Schedule (Table 1) in Part I, Section C of this document, it will be assumed that the approximately 5.5-inch drill casing and the approximately 4.5-inch core barrel will be advanced from 610 feet to 760 feet bgs.

5.0 BOREHOLE GEOPHYSICAL LOGGING AND SUBSURFACE COMPLETION

Figure 3 shows a typical completion diagram for the dual-string piezometer monitor well with approximately 10-inch conductor casing grouted in place with concrete grout in an approximately 14-inch diameter borehole. If the 10-inch conductor casing is drilled to 460 feet bgs using a casing-advance drilling method, Figure 3 would be modified to show the 10-inch conductor casing in contact with the formation below 60 feet, and to show the 60 feet of permanent larger diameter surface casing in the upper portion of the borehole.

In addition, Figure 3 may be modified by the NWRPO prior to initiating subsurface completion activities to accommodate field conditions. The target depths for all completion materials (including well casing/screen and stemming materials) must be achieved within several feet. Thus, the completion process must be conducted with extreme care including frequent tagging (i.e. measurement) of completion (stemming) material depths. The NWRPO will supply a tagging instrument

5.1 When the borehole total depth of 760 feet bgs is reached, remove the core barrel from the borehole and standby while borehole geophysical logging is conducted inside the drill casing(s) by other NWRPO contractors.

5.2 Upon completion of borehole geophysical logging, retract the 5.5-inch drill casing to a depth not exceeding 30 feet above the bottom of the borehole.

5.3 Run an approximately 1 ½-inch diameter steel tremmie to approximately 20 feet above the bottom of the borehole. Alternatively, an 1 ½-inch Schedule 80 PVC tremmie can be used.

5.4 Run in dual-string piezometer casing/screen (2-inch Schedule 80 PVC) strings with centralizers above and below the screens to approximately 760 feet as shown in Figure 3. The upper and lower piezometer strings will be strapped together. Suspend the tremmie line and piezometer strings on an appropriate line(s) to maintain tension at all times during completion.

5.5 Use an NWRPO approved centrifugal pump to emplace approximately 15 feet of the sandpack via the tremmie. Take care to terminate the emplacement of the sandpack at least 5 feet beneath the drill casing and tremmie. Pump water through the pump to carry the sand through the tremmie. Add the dry sand through an open “T” connection on the water intake side of the centrifugal pump.

5.6 Continuing to maintain tension on the piezometer strings, retract the tremmie and drill casing another approximately 20 feet and 30 feet, respectively above the top of the emplaced sandpack and repeat step 5.5.

5.7 Repeat step 5.6 until the sandpack has been emplaced around the lower piezometer string as shown in Figure 3.

5.8 Then emplace “bensand” grout seal (2:1 by weight mixture of 8/12 sand and 8 mesh bentonite [e.g. Benseal®]) between the upper and lower piezometer sandpacks (Figure 3) following the same methods for emplacing sand as described in steps 5.5, 5.6, and 5.7. Continue emplacing grout in this manner up to the bottom depth of the 8-inch drill casing (approximately 610 feet bgs as shown in Figure 3).

5.9 At this point, while maintaining tension on the piezometer strings and tremmie line, remove the 5.5-inch drill casing from the borehole.

5.10 Continue pulling up the tremmie and 8-inch drill casing (while maintaining tension on both the piezometer strings and tremmie) in stages and emplacing the grout in stages as described above until the grout seal between the screens has been completed.

5.11 Then emplace the sandpack around the upper piezometer screen and the bensand grout seal above this screen (Figure 3) as described the in steps 5.5 through 5.8.

5.12 When completion materials reach the bottom of the 10-inch casing at approximately 460 feet bgs, and while maintaining tension on the piezometer strings and tremmie, pull all the remaining 8-inch drill casing from the borehole and continue emplacing completion materials according to the specifications in Figure 3.

5.13 Emplace high solids bentonite grout interval above the uppermost bensand interval with a standard grout pump, and emplace the fine particle size dry bentonite seal in the upper 50 feet of borehole by gravity free-fall methods.

6.0 SURFACE COMPLETION

The required surface completion diagram for a borehole containing 10-inch conductor casing in an approximately 14-inch borehole is presented in Figure 4. If the 10-inch conductor casing is drilled in place, Figure 4 would also show a larger diameter steel surface casing terminating in the concrete pad.

6.1 Weld on an above ground extension to the approximately 10-inch diameter conductor casing. The steel conductor casing should extend approximately 2 ½ feet above the ground surface. The 2-inch PVC blank casing should extend slightly below the surface casing.

6.2 Install caps on the PVC casings and a locking cap on the surface casing.

6.3 Install an approximately 4 foot x 4 foot x 8-inch thick 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 foot away from the surface casing.

ATTACHMENT 2

Form TP-7.0-6 Rev. 2
8-19-03

Nye County Nuclear Waste Repository Project Office

Field Change Approval Form | Controlling Document: TP-7.0

Title(s) of Plan(s) proposed to be changed:
TPN-5.3 Construction of Sonic Corehole NC-EWDP-22PC
Attachment 1 - Scope of Work for Drilling, Sonic Coring, and Construction of One EWDP Phase V Monitoring Well on the NTS

NWRPO Field Personnel In Charge:
Walker

DESCRIPTION OF PROPOSED CHANGE - INCLUDE KNOWN EFFECTS OF CHANGE:
(Reference borehole IDs, Locations, Specific Tests, all necessary information to identify change)

Section 3.0 Add the following sentence: "If directed by the NWRPO, the Contractor shall collect drill cuttings in a cyclone separator from 2.5 ft. depth intervals".

Section 3.1 Include "foam (eq. QUIK-FOAM®)" in permissible drilling fluids and the statement that "compressed air shall be used to the extent reasonably possible".

Section 5.4 Change "Run in dual-string piezometer" to "Run in deep piezometer." Remove "The upper and lower piezometer strings will be strapped together." Change last sentence to "Maintain tension on piezometer string while emplacing completion materials into the borehole."

Section 5.6 Remove "Continuing to maintain tension on piezometer strings." Add sentence at end of paragraph that reads "Re-apply tension to piezometer string(s) prior to continuing to emplace completion materials."

Section 5.7 Add "Then run in shallow piezometer with centralizers to 585 ft. as shown in Figure 3."

Section 5.9, 5.10, and 5.12 Remove "while maintaining tension on piezometer strings and tremmie line" and replace where required with "Re-apply tension to piezometer string(s) prior to continuing to emplace completion materials."

Section 6.0 Remove "If the 10-inch . . . in the concrete pad."

APPROVAL: Dale Hammond — On-Site Geotechnical Representative — 10/7/04 Time/Date

APPROVAL: Dale Hammond — Principal Investigator — 10/7/04 Time/Date

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

ATTACHMENT 3

EWDP DRILLING AND WELL CONSTRUCTION HEALTH AND SAFETY PLAN

It is the responsibility of the drilling contractor (Contractor) to be aware of, and comply with, the conditions of this health and safety plan. The Contractor and any subcontractors will conduct all operations in accordance with all local, state, and federal regulations or requirements currently in effect concerning employee health and safety. In the event that any of these regulations or requirements requires variance from the provisions set forth in this work plan, the regulatory requirements shall take precedence.

1.0 TRAFFIC CONTROL

Because of the remote locations of the planned wells, traffic control will not be required as part of the EWDP. However, the Contractor is required to ensure that all drivers operate their vehicles and equipment in a safe manner. The Contractor will comply with all applicable state and local limits and restrictions and with any Nevada Department of Transportation and/or U.S. Department of Transportation requirements. The Nye County Sheriff's Office patrols the Nevada Test Site and all applicable county and state limits, and restrictions are enforced.

2.0 SAFETY SUPERVISOR

The Contractor will appoint a safety supervisor for each crew. This supervisor will be given the responsibility of providing a safe work environment and the authority to enforce safety as a first priority. The safety supervisor together with the NWRPO field safety officer will provide a tailgate review of work site hazards, including management of any potentially hazardous materials; trip, slip, and fall hazards; and discussion of desert environment related hazards (e.g., heat stroke and stress, dehydration, poisonous snakes and spiders) before the start of each work shift. The NWRPO field safety officer will document the tailgate safety meeting in the scientific notebook for the designated well. The safety supervisor will ensure that all equipment operators have adequate training and will inspect and test all safety equipment and devices are functioning properly including gauges, warning lights, and horns. On a daily basis, the safety supervisor will inspect the drilling equipment daily for damage, loose parts, missing guards, fluid leaks, damaged hoses, etc.

3.0 PERSONNEL PROTECTIVE EQUIPMENT

Clothing for all onsite personnel must be appropriate for drilling and sampling operations. Safety headgear and safety boots are required. Gloves are required for equipment handling and operation. All onsite personnel should wear safety glasses

4.0 GENERAL DRILL SITE OPERATIONS

Suitable storage locations will be provided for all tools, materials, and supplies so that these items can be retrieved safely and used without injury to drill crew members, other onsite personnel, and visitors. Tools, materials, and supplies are not to be stored on the mast. Pipe, drill rods, casings, augers, and similar materials are to be stacked orderly on racks or sills to prevent spreading, rolling, or sliding. Work areas, platforms, walkways, and other access ways will be kept clear of materials, debris, and obstructions. All warning lights and lenses, controls, control linkages, and operation lights will be kept clear of mud, oil, grease, and ice.

5.0 UTILITY HAZARDS

The NWRPO will obtain utility clearances for drill sites. In some instances, drill sites are located inside of rights-of-way for gas pipelines, telephone lines, and/or overhead electrical transmission lines. All transmission wires and underground cables are to be considered live. Drill rigs and other heavy equipment will maintain safe distances when used near transmission lines. The National Drilling Federation recommends a distance of at least 20 feet from any portion of the drill rig and mast to a transmission line. This minimum distance should take into account that both the transmission line and the rig mast may be affected by high winds.

6.0 FIRE PREVENTION

The Contractor will exercise due care at all times to ensure that fire danger is avoided. Flammable liquids, if present, will be stored in flammable-approved containers, and will be protected from ignition sources. Open ignition sources will be not be used in the presence of flammable liquids. Welding or cutting will not be performed near a storage tank or container. Gasoline or other volatile liquids will not be used as cleaning agents or around the drill rig.

7.0 SPILL PREVENTION AND CONTINGENCY PLAN

Minor quantities of hazardous products and fuels may be used during the drilling process and will be properly handled by the Contractor. All such products will be used and managed in accordance with their labeling instructions, and will be stored in a locked cabinet when not in use. The Contractor will inform the onsite crew of the potential hazards associated with the products that will be onsite, and spill kits will be maintained for any material kept onsite in excess of the reportable quantity. Well casings, specialized cements and grouts, foaming agents or other additives, and other routinely required drilling materials will be delivered to the site and prepared for use as needed. Cements, grouts, and drilling additives will be mixed in a portable tank and/or a mud pit. All excess materials will be disposed in accordance with applicable regulations. The Contractor will be equipped with either radio or cellular telephone communication. Spill notification information will be maintained onsite by the Contractor if reportable quantities of hazardous materials are present.

8.0 FIRST AID

The Contractor will have a first aid kit onsite at all times. The safety supervisor and all NWRPO personnel should be trained in first aid methods, including CPR.

9.0 NOTIFICATIONS AND EMERGENCY RESPONSE

In the event of any injury or medical need, the Contractor will notify the appropriate emergency response organization. For well sites located outside of the Nevada Test Site, the following organizations should be contacted**:**

Pahrump Emergency Services 911

Beatty Emergency Services 775-553-2345

Amargosa Emergency Services 775-372-5345

For well sites on the Nevada Test Site, the following organizations should be contacted:

NTS Emergency Services 911

Ranch Control 702-295-5915

After emergency services have been contacted, the Contractor will call the NWRPO as soon as it is safe and prudent to do so.