NYE COUNTY

NYE COUNTY NUCLEAR WASTE REPOSITORY PROJECT OFFICE

WORK PLAN 6

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Early Warning Drilling Program Geophysical Logging Work Plan	Date: 5-31-01 Page: 1 of 11

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APPROVAL

Project Manager — Date: 07.27.01

CONCURRENCE

On-Site Geotechnical Representative — Date: 7/24/01

Principal Investigator — Date: 26 Jul '01

Project Quality Assurance Officer — Date: 17 July 2001

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1.0 INTRODUCTION

This work plan provides the purpose, background, scope of work, proposed schedule, and personnel and management responsibilities and requirements for the geophysical logging and other downhole logs of boreholes that will be drilled as part of the Nye County Nuclear Waste Repository Project Office's (NWRPO's) Independent Scientific Program Early Warning Drilling Program (EWDP). The user shall refer to the most current version of all referenced NWRPO technical procedures, work plans (WPs), and quality administrative procedures.

1.1 Purpose of the Work Plan

This work plan details the methods and procedures for the geophysical logging and other downhole logs of EWDP boreholes and other wells. The activities conducted under this work plan include the collection, analysis, and presentation of a suite of geophysical logs and other downhole logs. The purpose of the plan is to ensure that logging activities are completed in a manner that will support the planned investigations and the objectives of the NWRPO. Further, the plan is designed to provide the methods whereby the data collected and analyses performed will be accomplished in accordance with the NWRPO Quality Assurance Technical Program. This work plan has been prepared in accordance with the provisions the Nye County NWRPO QAP-5.2, *Preparation of Work Plans and Technical Procedures*.

1.2 Scope of the Work Plan

The scope of this work plan encompasses all activities associated with the geophysical logging and other downhole logging of 22 EWDP monitoring well and test well sets and other wells.

Geophysical Logs	**Other Logs**
Electric Logging	Caliper Logging
Nuclear Logging	Temperature, Fluid Temperature, Fluid Resistivity Logging
Sonic Logging	Spinner Logging
Density Logging	Deviation Survey
Magnetic Susceptibility	Video Logging
	Optical Televiewer and Image Logging
	Pressure, Fluid Conductivity, Salinity, O2 Saturation, pH, Redox

Items Included In the Scope of this Work Plan

This work plan addresses pre-logging activities, borehole logging operations, log specifications, and applicable documentation and reporting requirements.

Items Not Within the Scope of this Work Plan

In addition to this work plan, Nye County has prepared, or is preparing, work plans to cover other aspects of the EWDP:

1. WP-5, *Drilling and Well Construction Work Plan* - This plan addresses the drilling and construction of EWDP well sets and the collection of lithologic and fluid samples.

2. WP-8, *Sample Management Plan for EWDP* - This plan addresses the disposition of samples after they

are collected and includes the subsurface material samples collected under WP-5, *Drilling and Well Construction Work Plan* as well as gas and fluid samples collected under other plans.

3. Borehole and Testing Plan - This plan addresses the hydraulic tests and gas and water sampling and analyses for the wells constructed under WP-5, *Drilling and Well Construction Work Plan*.

1.3 Priorities

The logging activities and the analyses performed under this work plan will be used in a number of Nye County's activities:

- (W.B.S. 1.1.1.4) Reservoir Engineering and Other Data Analysis Support
- (W.B.S. 1.1.1.5) Water Supply and Demand, Other Land Use and EIS Issues Support
- (W.B.S. 1.1.1.6) Hydrogeochemistry, Geochemistry, Mineralogy-Petrology, and Other TSPA Issues Support
- (W.B.S. 1.1.2.1) Geologic Evaluation of YMP 3-D Geologic Model
- (W.B.S. 1.1.3.1) Technical Support to Develop Groundwater Database for Deep Carbonate Aquifer in the Amargosa - Death Valley Flow System
- (W.B.S. 1.1.3.1) Model the Regional Deep Aquifer and the Hydrogeochemistry Parameters of the Unit.

Copies of all logs and data recorded, and the results of the analyses performed, will be submitted to the NWRPO Quality Assurance Record Center immediately following data collection along with any supporting metadata and will subsequently be provided to YMP for use in their on-going activities. Access to boreholes will be provided to YMP in the event that other logging requirements are identified.

1.4 Plan Organization

The remainder of this work plan is organized into four parts. Section 2.0 provides information on the purpose of the EWDP, programmatic and activity objectives, and the purpose of each of the investigations that will be conducted. Section 3.0 provides background on the level of information available and reasons the activities in the scope of work are necessary as part of NWRPO's overall investigations. Section 4.0 presents the scope of work and details the types of activities that are planned, the locations, a schedule, the definition of NWRPO and contractor responsibilities, the requirements for equipment and calibration, and the numbers and types of samples to be collected.

1.5 NWRPO Work Description

The EWDP is included in W.B.S. 1.4, EWDP Cooperative Program.

2.0 PURPOSE

This section addresses the need for the downhole logging of EWDP well sets and the objectives of those logging activities.

2.1 Necessity

As noted in the *Nye County Comprehensive Plan*, it is the policy of Nye County to protect the health, welfare, and economic well being of the county and its residents. All water supplies in southern Nye County are derived from groundwater wells or groundwater discharging to the surface at springs. These water supplies must be protected to ensure public health and to ensure that all public water supplies are in compliance with the requirements of the United States Safe Drinking Water Act.

The results of models that have been developed to assess the long-term performance of a repository at Yucca Mountain indicate that releases from the repository may occur and that groundwater contamination may result. To protect the county's water supplies, a network of monitoring wells is needed along the potential pathways for contaminant transport down gradient of Yucca Mountain. The EWDP is designed to fulfill this necessity by drilling, constructing, testing, and monitoring a network of wells between the proposed repository site and the existing and reasonably foreseeable future water supply wells located down gradient of Yucca Mountain. Borehole geophysical logs and other logs are methods used for the collection of subsurface data. Data from logs are needed in the final design of monitoring wells and testing requirements.

2.2 Objectives

The objectives of the EWDP geophysical logging include:

- Provide measures and records of the physical properties of subsurface geologic media and fluids in EWDP boreholes

- Provide measures and video documentation of EWDP borehole conditions.

3.0 BACKGROUND

The EWDP is an adjunct to Nye County NWRPO's on-going oversight investigations related to the proposed construction and operation of a high-level radioactive waste repository at Yucca Mountain.

3.1 Summary

Basic geologic and hydrologic data are lacking for a large area in the vicinity of Yucca Mountain. Past studies conducted by the U.S. Department of Energy have concentrated on characterizing the conditions in the immediate vicinity of the proposed repository site. The data that have been collected to date indicate that there are significant contrasts in the hydraulic properties, water levels, temperatures, and water chemistry in the aquifers in the vicinity of, and down gradient of, Yucca Mountain.

3.2 Necessity

According to the information presented in the *Yucca Mountain Site Characterization Project Site Atlas 1997*, water level data, aquifer test data, and water chemistry data are not available for a large area in southern Jackass Flats,

southern Crater Flat, Oasis Valley, Rock Valley, and northern Amargosa Desert. Quantitative hydrologic data are

needed to define the conditions in these areas so the risk associated with long-term waste disposal at a repository at Yucca Mountain can be identified and evaluated. The EWDP is designed to meet the need for additional data in these areas and geophysical logging and other borehole logging techniques are standard methods for the collection of data from boreholes.

Logging techniques provide information on the specific geologic media and are of particular use in accurately defining formation tops in areas with thin layer beds or zones of poor sample recovery (electric and nuclear logs). Some logging techniques are needed to provide information of water transmitting zones, formation porosity, and borehole diameter to guide the placement of the sampling ports in the final monitoring well (temperature, electric, nuclear, spinner and caliper logs). Other logs are needed to confirm the locations and integrity of cement seals and borehole and well conditions (cement bond logs and video logs). A final set of logs includes techniques that have recently been developed for digital core reconstruction. The need for these types of logs will be evaluated as part of the EWDP to determine their suitability and cost-effectiveness for incorporation into the overall suite of logs that will be run in each borehole.

4.0 SCOPE OF WORK

The work to be done includes furnishing all material, labor, equipment, tools, transportation, power, water, and services for the downhole logging of single and multiple zone monitoring wells and test wells.

4.1 Type of Investigations and Activities

This section addresses four major areas: 1) prelogging activities, 2) borehole logging activities, 3) logging acceptance criteria, and 4) documentation requirements.

4.1.1 Predrilling Activities

4.1.1.1 Well Designations

Data collection and documentation for all downhole logs will use the NWRPO well designation for the name of the borehole. The naming convention of the EWDP wells is based upon two designations. For new monitoring wells that are to be drilled, the designation is:

- NC - 0XS for wells $\leq$ 1,500 ft in total depth, where X is the site number
- NC - 0XD for wells > 1,500 ft in total depth, where X is the site number.

For wells that are to be constructed as recompletions of existing boreholes or offsets from such boreholes, the name of the well as it appears in the published literature or State of Nevada files is the name assigned as an EWDP well. There are two wells that have this designation, the Washburn Well (designated NC-Washburn-1X) and the Felderhoff Federal 25-1 (designated as NC-Felderhoff Federal 25-1).

4.1.1.2 Permitting

It is the responsibility of the logging subcontractor to notify the Nevada Department of Health of the logging

operations and to obtain any permits that may be required. Proof of permits will be required by the NWRPO before a notification to mobilize will be made. In the event that YMP elects to have their own suite of logs run

by their own contractor, similar proof of permits will be required to NWRPO before access to the borehole is authorized.

4.1.1.3 Notification to Mobilize

The maintenance of borehole stability for logging and testing is an essential component of the EWDP. NWRPO will give notification for mobilization of the logging subcontractors to the well driller. The timing of this decision will be based upon the proximity to total depth, drilling rates and conditions, the time required to trip out of the borehole and prepare it for the logging operations, and the need for groundwater to stabilize within the borehole. Because of the concerns for borehole stability, the logging subcontractor must mobilize all equipment and personnel to the site and be prepared to commence logging operations within 24 hours of the notification.

4.1.1.4 Badging

During fiscal year 2000 and fiscal year 2001, seven well sets will be completed on the Nevada Test Site. All logging subcontractor personnel must be badged through NWRPO and the U.S. Department of Energy for access to drilling sites located on the Nevada Test Site. The badges may be obtained for an indefinite period or temporary badges may be issued. To obtain the appropriate badges, the logging subcontractor must submit a completed Visitor Badge Request Form to the NWRPO (Attention Danielle Fife) at least five working days prior to the need for access to the Nevada Test Site. One request form must be filled out for each member of the logging subcontractor that may be mobilized to the Nevada Test Site. A temporary badge will be issued, the person being issued the badge will be required to pick up their badge at the Nevada Test Site Badging Office, and the person will be required to surrender the badge to the same office on a daily basis. All persons who are badged must be made aware that the badges are the property of the United States of America and must be surrendered on completion of the badged person's activities on the NTS. *It is a Federal offense to fail to surrender a badge.*

4.1.2 Borehole Logging Activities

This section provides general specifications along with specifications for each of the downhole logging methods that will be used.

4.1.2.1 General Specifications

Logging Subcontractor Qualifications – The logging subcontractor will have a minimum of ten years of experience in providing well logging services. The on-site subcontractor personnel (the logger) will have a minimum of five years experience as a subcontractor employee and shall be fully trained in the proper calibration, maintenance, and operation of all logging tools and equipment and the standards for documentation.

Mobilization – In compliance with U.S. Bureau of Land Management (BLM) permit requirements, the logging subcontractor will take steps to control noxious weeds. The logging subcontractor will clean all vehicles and equipment prior their entry on BLM lands.

Utilities – No utilities will be available at any of the planned drilling locations. The well driller will provide portable power packs sufficient to meet all logging needs. The well driller will provide portable sanitary units. The well driller will provide any necessary water for logging operations.

4.1.2.2 Borehole Logging Specifications

This section specifies the requirements for borehole logging. All downhole logging will be conducted in accordance with ASTM D- 5753-95 *Standard Guide for Planning and Conducting Borehole Geophysical Logging* and with API (American Petroleum Institute) standards for Universal Log Heading and Electric Log Heading, chart and scale dimensions, and track designations.

Sequence of Logs

Geophysical logging operations will commence no sooner than eight hours after the removal of the drill string, or at the direction of the NWRPO. This period of time will allow the groundwater within the borehole to recover from the effects of tripping out of the borehole. As the introduction of downhole instruments will disturb the groundwater and may disturb the borehole, the logs must be run in sequence:

Sequence 1. Standard Downhole Log Suite

- Temperature Log
- Electric Log
- Spinner Log
- Deviation Survey
- Caliper log
- Nuclear logs
  - Spectral Gamma Ray Log
  - Neutron-Neutron Log
  - Gamma-Gamma Density Log
- Video Log

Sequence 2. Non-Standard Log Suite

- Optical Televiewer Log
- Pressure, Fluid Temperature, Fluid Resistivity Logs
- YMP logs (per sequence 1 except caliper last)
- Cement Bond Log (after well completion)
- Magnetic Susceptibility Log

Multiple logging tool equipment runs will be used as long as they do not adversely impact the other logs or threaten borehole stability and are approved by the NWRPO. For example, the electric logs can be combined with the temperature log and combination gamma ray neutron tools are acceptable. The Sequence 1 Log Suite is required to meet NWRPO program objectives and will be run in all EWDP wells prior to any other logging and prior to any packer tests. The need for Sequence 2 logs will be determined by the NWRPO based upon subsurface conditions, borehole integrity, and cost on a case-by-case basis and may be deferred until the completion of the packer testing. In the event that YMP desires to conduct borehole logging, access to the borehole will be granted after the NWRPO logging operations have been completed. If YMP elects to conduct logging, the last long run will be a caliper log per the NWRPO specifications outlined below to verify that the borehole is still suitable for completion as a monitoring well.

Log Specifications

This subsection provides the requirements for downhole logging.

General Requirements – The log heading will be filled out completely and accurately for all logs. Equipment types and serial numbers will be recorded on the heading. Elapsed time since borehole circulation stopped will be recorded on each log. All logs run in the well will be listed on the heading. The remarks column will be used to record any information that may aid in explaining the log responses including tool problems, drilling problems, unusual hole conditions, etc.

All changes in logging scales or parameters will be noted on the log. All logging depths will be measured from the top of the kelly bushing and all logging curves will be on depth with the resistivity log. A repeat section of at least 200 ft will be made at the beginning of each logging run. Repeat sections must agree with the main pass. Repeat sections will also be made of problem zones and at the direction of NWRPO.

The first reading of each curve, the log total depth, the fluid level in the borehole, and the casing point, will be marked on the log. Before survey and after survey calibrations must be carried out according to logging

subcontractor procedures and must be documented to be within prescribed limitations. All calibrations will be recorded on the log. Three paper copies of all logs will be provided to the NWRPO along with copies of the logs on electronic media.

Temperature, Fluid Resistivity, and Moisture Log – Temperature, fluid resistivity, and moisture logs will be run first in each EWDP log at a rate of 85 ft/min, or less. Sonic, VDL, and Delta Temperature logs must be run at a speed of 85 ft/min or less. The temperature tool must be calibrated prior to use in an EWDP borehole and the logging subcontractor will provide NWRPO with documentation of the calibration procedure used and the results of the calibration. The log will show both the gradient and differential curves.

Electric Log – Electric logs will be run in each EWDP borehole and will include Spontaneous Potential (SP) and Dual Induction Resistivity Log (DIL). *All welders, cathodic protectors, and unnecessary power sources must be turned off during electric logging operations.*

The SP scale must be sensitive enough to clearly show SP deflections from the shale baseline. The shale baseline must be one to three chart divisions to the left of the depth track. Shifts in the baseline must be done abruptly rather than gradually and any shifts must be noted on the log. If practical, the baseline will be shifted in shale. The SP curve must be normal with no noise, magnetism, or cyclic repetitiveness.

The DIL will be run at speeds of 85 ft/min, or less. If other tools are run in combination with the induction log, the run time limits for the additional logs will take precedence if they are lower than 85 ft/min. The DIL may be run in combination with the neutron log and a standoff is required when the DIL is not recorded in combination with a density or neutron log. The conductivity curve for the deep induction log must be recorded and must read greater than zero. Both the high and low deep induction values must reciprocate conductivity, the curves must not flat top, and all curves must be on depth with each other (i.e., the peaks must be at the same depth).

Spinner Log – Spinner logs will be run in each EWDP borehole at a rate of approximately 120 ft/min. Both down and up runs will be performed. Spinner logs will include line speed and counts per second and the results should match for nonproducing horizons.

Video Log – Video logging will be conducted for different purposes; as such, different requirements will be needed. The NWRPO may need to inspect existing water wells that are being considered as additional test or monitoring wells. When needed, these wells will be logged using "off the shelf" services to obtain conventional slim hole monochromatic video logs. The video logs for these will be annotated with the depth and time and three copies will be provided to the NWRPO. For the EWDP boreholes, more sophisticated video logging will be required. These boreholes will be logged with a 90^{o} viewing rotating mirror color camera, or equivalent. The logs will be annotated with the depth and time and three copies will be provided to the NWRPO.

Directional Survey – The monitoring well sampling ports must be positioned as accurately as possible and it may be necessary to make adjustments to account for borehole deviation. Deviation surveys will be conducted using a gyroscopic instrument and employing industry standard methods at a rate of 60 ft/min, or less. The results of the survey must be presented in the form of a Deviation Survey Data Sheet, a plan view that includes the depths and deviation, the total depth closure, and the method of calculation, and a vertical view that includes the plane of closure, total depth closure, the vertical section, and the method of calculation.

Caliper Log – Caliper logging will employ a six-arm caliper tool and will be run in each EWDP borehole at a rate of 85 ft/min, or less. All calipers must be calibrated and all calipers must be displayed on the log. The calipers selected must be appropriate for the drill bit size used. The caliper will be checked in 6-in ID casing at the start and finish of each logging run. Where conditions indicate, a second caliper log may be required in some

boreholes prior to completion as a monitoring or test well.

Nuclear Logs – Two types of nuclear logs will be run in each EWDP borehole, a spectral gamma ray log and a neutron-neutron log.

- Spectral Gamma Ray Log - The logging speed must be 45 ft/min, or less. The time constant must be appropriate for the logging speed. The scale must be in API units and the curve must have a normal sensitivity.

- Neutron-Neutron Log - The logging speed must be 85 ft/min, or less. Repeat sections will agree within 1 porosity unit. The porosity values will be reasonable for known lithologies and neutron porosity will be scale on the same matrix as the density porosity.

- Gamma-gamma Density Log - The compensated density logging techniques will be used. The logging speed must be 85 ft/min, or less. The correction curve must not consistently read negative and must stay near zero in intervals of smooth borehole. Both the bulk density and the correction curves must be on the log.

Pressure, Conductivity, Salinity, Oxygen, pH, and Redox Logs – The pressure, conductivity, salinity, oxygen, pH, and redox log must be run at a logging speed of 35 ft/min, or less.

Color Digital Optical Televiewer Log – This log must be run at a logging speed of 10 ft/min, or less. The NWRPO will review the logging results "realtime" and advise the Subcontractor as to whether or not the borehole conditions warrant the application of this logging method (fluid opacity).

YMP Logs – After access to an EWDP borehole has been requested and approved by the NWRPO, YMP may conduct whatever suite of logs needed to meet the objectives of their studies. The YMP Logs will be conducted under the YMP Quality Assurance Program and are not covered herein. As the last log, YMP will run a caliper log per the NWRPO specifications above to verify that the condition of the borehole will allow the plan monitoring well completion.

Deviation Survey, Fluid Temperature, Magnetic Susceptibility, Image Logging, Sonic Logging, Density Logging - Standard industry practices will be applied.

4.1.3 Logging Acceptance Criteria

Nye County will not accept poor quality logs. All logs must meet the specifications provided in Section 4.1.2 and all logs must be legible and complete.

4.1.4 Documentation Requirements

The logging subcontractor will provide the NWRPO QARC the results of all sonde and probe calibrations including the date and time of calibration, the calibration facility that was used, and the results of that calibration and the results of any field calibrations. The logging subcontractor will provide three copies of all logs at the time of logging to the NWRPO QARC and ten copies of all logs within 30 days after the completion of logging. NWRPO will own all logs.

4.2 Extent and Scale of EWDP Investigations

The EWDP is a three-year program of drilling and testing. A total of 22 wells sets are anticipated with six monitoring well sets and two well recompletions to be completed in fiscal year 1999, two test wells and six monitoring well sets to be completed in fiscal year 2000, and six well sets to be completed in fiscal year 2001.

4.3 Location of EWDP Wells

A map showing the locations of the EWDP well sites is included in WP-5, *Drilling and Well Construction Work Plan*. The wells will be drilled in the Crater Flat, Jackass Flats, and Amargosa Desert hydrographic basins.

4.4 Investigators and Responsibilities

The Principal Investigator (PI) for activities conducted under this work plan will be the Nye County NWRPO On-Site Geotechnical Representative. NWRPO staff and contractor assignments for the various activities undertaken will be at the discretion of the PI. The PI will ensure that personnel are knowledgeable on this Work Plan and the Nye County Quality Assurance Program's provisions and technical procedures that are applicable to assigned activities and will ensure that assignees have sufficient training to conduct assignments and tasks to guarantee quality records be submitted to the NWRPO QARC in a timely manner.

4.5 Equipment and Related Calibration Requirements

Standard borehole logging equipment and materials will be used. Equipment and methods used for logging activities during drilling will be in accordance with the procedures and methods outlined in Section 4.1 of this work plan. All equipment used will be in good operating conditions with recent quality assurance calibration data provided to NWRPO.

4.6 Numbers and Types of Samples and Analyses

No samples will be taken during logging operations.

5.0 MANAGEMENT

To ensure that the work involved will be quality controlled and accomplished in accordance with the scope and objectives of the EWDP, certain tasks must be performed. All individuals performing the investigations given in the above sections shall be trained in the procedures specifically applicable to the equipment and method used before conducting work and shall document that they have read and understand the applicable technical procedures. These individuals shall be referred to as NWRPO personnel. The project Quality Assurance Officer shall be responsible for the coordination of the internal review of this work plan and is responsible for assuring the proper training of NWRPO personnel and verifying the compliance with the requirements of this plan. The PI shall be responsible for the preparation and modification of this work plan, as well as the oversight of the performance of the plan.

Drilling and Well Construction Health and Safety Plan – The logging subcontractor will perform all work in accordance with the provisions of the Health and Safety Plan in WP-5, *Drilling and Well Construction Work Plan*.