
**NYE COUNTY NUCLEAR WASTE REPOSITORY
PROJECT OFFICE INDEPENDENT SCIENTIFIC
INVESTIGATIONS PROGRAM
ANNUAL REPORT
MAY 1997 – APRIL 1998**

Prepared by:

***NYE COUNTY DEPARTMENT OF NATURAL RESOURCES AND
FEDERAL FACILITIES***

NUCLEAR WASTE REPOSITORY PROJECT OFFICE

GRANT DE-FG08-96NV12027

JULY 1998

DISCLAIMER

The investigations and research reported here have been conducted according to Nye County's Quality Assurance Program Plan manual, which is compliant with NQA-1 standards. However, the results reported here have not been thoroughly checked and compared against the sources of information. Some of the results are preliminary, and the quality assurance for some of the activities has not been completed as of the date of this printing. Therefore, some of the results presented in this report are subject to change and verification.

TABLE OF CONTENTS

DISCLAIMER.....	ii
TABLE OF CONTENTS.....	iii
LIST OF FIGURES AND PHOTOGRAPHS.....	vii
LIST OF TABLES	xi
CONVERSION FACTORS.....	xii
CONTENTS OF THE ACCOMPANYING MEDIA	xiii
Database	xiii
<i>Pres_Temp</i>	xiii
<i>Springs Pumpage and Discharge (NQA)</i>	xiii
<i>Tunnel</i>	xiii
<i>WaterLevel (NQA)</i>	xiii
Document	xiii
Figures.....	xiv
<i>Figures in Text</i>	xiv
<i>Nrg4</i>	xiv
<i>Onc1</i>	xiv
<i>GasSampling</i>	xiv
<i>Tunnel</i>	xiv
<i>Ecrb</i>	xiv
<i>Esf</i>	xv
<i>WaterUsage</i>	xv
Tables and Graphs.....	xv
EXECUTIVE SUMMARY.....	xvi
1.0 INTRODUCTION.....	1
1.1 SCOPE.....	2
1.2 NYE COUNTY'S BOREHOLE AND TUNNEL MONITORING STUDIES.....	3
1.3 OTHER ACTIVITIES	4
1.4 PROPOSED FUTURE INVESTIGATIONS.....	5

2.0	PETROGRAPHIC STUDIES OF UE-25 ONC#1	6
2.1	INTRODUCTION	6
2.2	PURPOSE OF ACTIVITY	6
2.3	METHODOLOGY	7
2.4	SUMMARY OF FINDINGS	7
3.0	REGIONAL HYDROGEOLOGY	13
3.1	EVALUATION OF YUCCA MOUNTAIN WATER SUPPLY AND DEMAND ISSUES	14
3.1.1	<i>Definition and Evaluation of Nye County's Water Supply and Demand Issues</i>	15
3.1.1.1	Protection of Drinking Water Supplies and Wildlife Habitats	15
3.1.1.2	Water Use Trends and Future Water Availability	16
3.1.1.2.1	Managed Overdraft	17
3.1.1.2.2	Carbonate Aquifer Development	19
3.1.1.2.3	Interbasin Transfers of Water	20
3.1.1.2.4	Methods	22
3.2	REGIONAL GROUNDWATER MODELING	24
3.2.1	<i>Data Limitations</i>	26
3.2.2	<i>Death Valley Regional Flow System Boundaries</i>	28
3.2.3	<i>Model Boundaries</i>	30
3.2.4	<i>Boundary Conditions</i>	31
3.2.5	<i>Recharge</i>	33
3.2.6	<i>Discharge</i>	35
3.2.7	<i>Recharge Over Discharge Areas</i>	38
3.2.8	<i>Steady State Versus Transient Conditions</i>	39
3.2.9	<i>Calibration</i>	40
3.2.10	<i>Methods Used</i>	40
3.3	MODELING EFFORT BY NYE COUNTY	40
3.4	SUMMARY	44
4.0	SITE HYDROGEOLOGY	45
5.0	SITE HYDROCHEMISTRY	49
5.1	CHLORINE-36 GEOCHEMISTRY OF CUTTINGS SAMPLES FROM UE-25 ONC#1	49
5.1.1	<i>Introduction</i>	49
5.1.2	<i>Methodology</i>	49
5.1.3	<i>Results</i>	50
5.1.4	<i>Conclusions</i>	50
5.2	GAS SAMPLING FROM UE-25 ONC#1	51

5.2.1	June 1997 Gas Sampling.....	52
5.2.1.1	Apparatus and Sampling Procedures.....	53
5.2.1.2	Chemical Sampling Zones	55
5.2.1.3	Results of June 1997 Gas Sampling.....	55
5.2.2	April 1998 Gas Sampling.....	60
5.2.2.1	Apparatus and Sampling Procedures.....	60
5.2.2.2	Chemical Sampling Zones	61
5.3	CONCLUSIONS AND RECOMMENDATIONS.....	62
6.0	WELL TEST ANALYSIS RESULTS.....	65
6.1	BACKGROUND	65
6.2	UE-25 ONC#1 RESPONSE TO ATMOSPHERIC PRESSURE PULSES	65
6.2.1	Investigative Activities.....	65
6.2.2	Methodology.....	65
6.2.2.1	Conventional Pulse Test Analysis.....	66
6.2.2.2	Regression Analysis	68
6.2.2.3	Fourier Series Analysis	71
6.2.2.4	Lomb Spectral Analysis	73
6.2.3	Results of Investigations.....	74
6.3	UE-25 ONC#1 VACUUM TESTS.....	76
6.3.1	Investigative Activities.....	76
6.3.2	Methodology.....	76
6.3.3	Results of Investigations.....	79
6.4	Conclusions.....	80
7.0	TUNNEL INSTRUMENTATION AND DATA.....	82
7.1	INTRODUCTION	82
7.2	ATMOSPHERIC MONITORING.....	82
7.3	EVALUATION OF THE USE OF WATER IN THE TUNNEL	83
8.0	ALTERNATIVE REPOSITORY DESIGN.....	86
8.1	INTRODUCTION	86
8.2	OBSERVATIONS IN THE YUCCA MOUNTAIN ESF TUNNEL	89
8.3	PRELIMINARY SIMULATIONS	89
8.4	SIMULATIONS USING THE SITE-SCALE UZ MODEL	90
8.5	RESULTS OF SIMULATION	90
8.6	REPOSITORY DESIGN	91
9.0	DATABASE MANAGEMENT	93

10.0	GIS	95
11.0	QUALITY ASSURANCE.....	96
11.1	NWRPO INTRODUCTION	96
11.2	NYE COUNTY NUCLEAR WASTE REPOSITORY PROJECT OFFICE.....	96
11.3	QUALITY ASSURANCE PROGRAM.....	97
11.4	QA ACTIVITES - SUMMARY APRIL 1997 to APRIL 1998.....	98
11.5	QA ISSUES	99
12.0	SUMMARY AND CONCLUSIONS	101
13.0	REFERENCES.....	105

LIST OF FIGURES AND PHOTOGRAPHS

<u>Figure 1-1</u>	Location of Yucca Mountain site in Nye County, Nevada
<u>Figure 1-2</u>	Topography, location of selected boreholes, ESF centerline and ECRB at Yucca Mountain Site
<u>Figure 3-1</u>	The “data gap” located down gradient of, and near to Yucca Mountain
<u>Figure 3-2</u>	The Death Valley flow system as defined by Harrill et al (1988)
<u>Figure 3-3</u>	Comparison of extent of model domains for the three regional models
<u>Figure 3-4</u>	Attempted mesh for the regional saturated-zone model
<u>Figures 3-5a-i</u>	Water level contour maps, ten year intervals
<u>Figures 3-6a-j</u>	Water level contour maps, entire data collection period
<u>Figures 3-6k-m</u>	Water level contour maps, entire data collection period, all wells
<u>Figure 3-7a</u>	Water table elevations of selected wells in Pahrump Valley
<u>Figure 3-7b</u>	Water table elevations of selected wells in Amargosa Valley
<u>Figure 3-7c</u>	Water table elevations of selected wells in Inyo County
<u>Figure 4-1</u>	Schematic profile of instrumentation setup in UE-25 ONC# 1 and USW NRG4
<u>Figure 4-2</u>	Temperature variation with time in UE-25 ONC#1 corrected with interpolation calibration, June 1997
<u>Figure 4-3</u>	Temperature variation with time in UE-25 ONC#1 corrected with interpolation calibration, October 1997
<u>Figure 4-4</u>	Temperature variation with time in UE-25 ONC#1 corrected with interpolation calibration, March 1998
<u>Figure 4-5</u>	Absolute pressure for UE-25 ONC#1 corrected with interpolation calibration, June 1997
<u>Figure 4-6</u>	Absolute pressure for UE-25 ONC#1 corrected with interpolation calibration, October 1997

<u>Figure 4-7</u>	Absolute pressure for UE-25 ONC#1 corrected with interpolation calibration, March 1998
<u>Figure 4-8</u>	Temperature variation with time in USW NRG4 corrected with interpolation calibration, June 1997
<u>Figure 4-9</u>	Temperature variations with time in USW NRG4, October 1997
<u>Figure 4-10</u>	Temperature variations with time in USW NRG4, March 1998
<u>Figure 4-11</u>	Absolute pressure for USW NRG4 corrected with interpolation calibration, June 1997
<u>Figure 4-12</u>	Absolute pressure for USW NRG4 corrected with interpolation calibration, October 1997
<u>Figure 4-13</u>	Absolute pressure for USW NRG4 corrected with interpolation calibration, March 1998
<u>Figure 5-1</u>	Composite cuttings sample, borehole UE-25 ONC#1
<u>Figure 5-2</u>	Schematic diagram of the surface attachments for gas sampling in UE-25 ONC#1, June 1997
<u>Figure 5-3</u>	UE-25 ONC#1 stratigraphy and instrumentation profile, June 1997 gas sampling
<u>Figure 5-4</u>	Plot of all chemical analyses except for isotopic analyses, UE-25 ONC#1, June 1997
<u>Figure 5-5</u>	Concentration of methane and carbon oxides, UE-25 ONC#1, June 1997
<u>Figure 5-6</u>	Concentration of chlorinated hydrocarbons with depth, UE-25 ONC#1, June 1997
<u>Figure 5-7</u>	Concentration of chlorinated fluorocarbon compounds with depth, UE-25 ONC#1, June 1997.
<u>Figure 5-8</u>	Concentration of nitrous oxide with depth, UE-25 ONC#1, June 1997
<u>Figure 5-9</u>	Concentration of Deuterium and O-18 ratios with depth, UE-25 ONC#1, June 1997
<u>Figure 5-10</u>	O-18 versus Deuterium plot, UE-25 ONC#1, June 1997

<u>Figure 5-11</u>	Carbon-14 apparent age with depth, UE-25 ONC#1, June 1997
<u>Figure 5-12</u>	Comparison of 1996 and 1997 sampling with UZ-1, UZ-14 and UZ#16 values for Carbon-14
<u>Figure 5-13</u>	Comparison of 1996 and 1997 sampling with UZ-1, UZ-14 and UZ#16 values for ¹³ C
<u>Figure 5-14</u>	Schematic diagram of the surface attachments for gas sampling in UE-25 ONC#1, April 1998
<u>Figure 5-15</u>	UE-25 ONC#1 stratigraphy and instrumentation profile, April 1998 gas sampling
<u>Figure 6-1</u>	Correlation between probes 0 and 3 showing response to ESF breakthrough (UE-25 ONC#1 pressure response)
<u>Figure 6-2</u>	Comparison between probes 2 and 3, UE-25 ONC#1
<u>Figure 6-3</u>	Combined frequency response at UE-25 ONC#1
<u>Figure 6-4</u>	Combined frequency response at UE-25 ONC#1 around 1 day period
<u>Figure 6-5</u>	Combined frequency response at UE-25 ONC#1 around half day period
<u>Figure 6-6</u>	Probe 0 response from March 28, 1996 to March 24, 1997 (spectral analysis of UE-25 ONC#1 pressure)
<u>Figure 6-7</u>	Probe 3 response from March 28, 1996 to March 24, 1997 (spectral analysis of UE-25 ONC#1 pressure)
<u>Figure 6-8</u>	Comparison between atmospheric response and probe 1 response from March 28, 1996 to March 24, 1997
<u>Figure 6-9</u>	UE-25 ONC#1 vacuum test #5, spherical flow analysis
<u>Figure 6-10</u>	UE-25 ONC#1 well schematic and flow inferences
<u>Figure 7-1</u>	Configuration of instrumentation frame for 25' diameter ESF, August 1995 through May 1997
<u>Figure 7-2</u>	Configuration of instrumentation frame for 17' diameter ECRB
<u>Figure 8-1</u>	Temperature anomaly caused by a flood lamp near Nye County's instrumentation

<u>Figure 8-2</u>	Three-dimensional simulated tunnel model and cross-sectional view
<u>Figure 8-3</u>	Oblique view of the modified unsaturated zone mesh
<u>Figure 8-4</u>	Saturation level around ESF after 1000 years
<u>Figure 8-5</u>	Temperature versus time for $D_{atm} = 0.01$ with decayed heat load
<u>Figure 8-6</u>	Conceptualization of natural ventilation
Photograph 5-1	View at the UE-25 ONC#1 sampling and testing setup
Photograph 7-1	View of the climatological monitoring station setup in the ECRB

LIST OF TABLES

<u>Table 5-1</u>	Chlorine-36 analyses of leachates from rock cuttings samples
<u>Table 5-2</u>	UE-25 ONC#1 testing and sampling, June 2 to June 13, 1997
<u>Table 5-3</u>	Results of gas sampling in UE-25 ONC#1 and ESF tunnel
<u>Table 5-4</u>	Results of carbon isotope sampling in UE-25 ONC#1, June 1997
<u>Table 5-5</u>	Results of carbon isotope sampling in UE-25 ONC#1, April 1998
<u>Table 5-6</u>	Results of gas sampling in UE-25 ONC#1, April 1998
<u>Table 6-1</u>	Summary of regression results (page 70 of the report)
<u>Table 6-2</u>	UE-25 ONC#1 vacuum test preliminary results (page 79 of the report)

CONVERSION FACTORS

Multiply	By	To obtain
acre-foot (acre-ft)	0.001233	cubic hectometer
acre-foot per year (acre-ft/yr.)	0.001233	cubic hectometer per year
cubic foot per second (ft ³ /s)	.02832	cubic meter per second
foot (ft)	.3048	meter
inch (in.)	25.40	millimeter
mile (mi.)	1.609	kilometer
square mile	2.590	square kilometer

Temperature: Degrees Fahrenheit (F) may be converted to degrees Celsius (C) by using the formula $C = 0.5556 (F - 32)$

CONTENTS OF THE ACCOMPANYING MEDIA

DATABASE

PRES_TEMP

Nycoun97.mdb

Pressure and temperature data collected at ONC#1 and NRG4 boreholes and atmospheric monitoring data collected in the ESF tunnel and the ECRB drift

Stor97.mdb

Pressure and temperature data collected at ONC#1 and NRG4 boreholes and atmospheric monitoring data collected in the ESF tunnel and the ECRB drift

SPRINGS PUMPAGE AND DISCHARGE (NQA)

Discharge.xls

Estimated evapotranspiration and spring discharge rates by discharge area

Pumpage.xls

Total pumpage rates per year for the Death Valley Regional Watershed

Springs.xls

Spring discharge rates for the Death Valley Regional Watershed

TUNNEL

tunldata.mdb

Atmospheric monitoring data collected in the ESF tunnel and the ECRB drift

WATERLEVEL (NQA)

modelUTM.mdb

Water Level data for monitoring and agricultural wells located in the Death Valley Regional Watershed

DOCUMENT

AnnualRpt97_98.doc

NWRPO Annual Report May 1997 – April 1998

FIGURES

FIGURES IN TEXT

<u>RegionAllWells.ppt</u>	Water level contour maps for all hydrographic areas combined
<u>10yr_maps.ppt</u>	Water level contour maps presented in 10-year intervals
<u>AllYr_maps.ppt</u>	Water level contour maps of the entire data collection period
<u>Nrg4Text.ppt</u>	NRG-4 graphs referenced in the text section of the Report
<u>Onc1Text.ppt</u>	ONC#1 graphs referenced in the text section of the Report
<u>TextFiguresA.ppt</u>	Additional figures located within the text section of the Report
<u>TextFiguresB.ppt</u>	Additional figures located within the text section of the Report

NRG4

<u>Nrg4Press&Temp.ppt</u>	Pressure and Temperature data collected at the NRG-4 borehole
-------------------------------	---

ONC1

<u>Onc1Press&Temp.ppt</u>	Pressure and Temperature data collected at the ONC#1 borehole
-------------------------------	---

GASSAMPLING

<u>Onc1GasChem97.ppt</u>	Gas Chemistry Results from ONC#1 - 1997
<u>Onc1GasChem98.ppt</u>	Gas Chemistry Results from ONC#1 - 1998

TUNNEL

ECRB

<u>ecrbMay20_June25.ppt</u>	Atmospheric monitoring data from the ECRB drift - 1998
-----------------------------	--

ecrbJune98.ppt

Atmospheric monitoring data from the ECRB drift - 1998

ESFESFInstall.ppt

Atmospheric monitoring data from the one-time installation in the ESF tunnel

ESF_TBM.ppt

Atmospheric monitoring data from the TBM installation in the ESF tunnel

WATERUSAGETunnelWaterUse.ppt

Water usage data from the ESF tunnel and ECRB drift

TABLES AND GRAPHSCl36RockCuttings.xls

Chlorine-36 analyses of leachates from rock cuttings samples

Onc1GasChem.xls

Gas chemistry results in table form from ONC#1, 1997 and 1998

WaterLevelData.xls

Precipitation graphs, hydrographs and water level data for the Death Valley region

ecrb.xls

Site activity and water usage data from ECRB tunnel

esf.xls

Site activity and water usage data from ESF tunnel

EXECUTIVE SUMMARY

This annual summary report, prepared by the Nye County Nuclear Waste Repository Project Office (NWRPO), summarizes the activities that were performed during the period from May 1, 1997 to April 30, 1998. These activities were conducted in support of the Independent Scientific Investigation Program (ISIP) of Nye County at the Yucca Mountain Site (YMS).

The Nye County NWRPO is responsible for protecting the health and safety of the Nye County residents. NWRPO's on-site representative is responsible for designing and implementing the Independent Scientific Investigation Program (ISIP). Major objectives of the ISIP include:

- Investigating key issues related to conceptual design and performance of the repository that can have major impact on human health, safety, and the environment
- Identifying areas not being addressed adequately by the Department of Energy (DOE)

Nye County has identified several key scientific issues of concern that may affect repository design and performance which were not being adequately addressed by DOE. Nye County has been conducting its own independent study to evaluate the significance of these issues.

The reader is referred to previous reports (NWRPO, 1995; Multimedia Environmental Technology, Inc. (MET), 1995; 1996, and 1997) for a detailed explanation of these specific concerns.

This report summarizes the results of monitoring from two boreholes and the Exploratory Studies Facility (ESF) tunnel that have been instrumented by Nye County since March and April of 1995. The preliminary data and interpretations

presented in this report do not constitute and should not be considered as the official position of Nye County.

The ISIP presently includes borehole and tunnel instrumentation, monitoring, data analysis, and numerical modeling activities to address the concerns of Nye County.

Figure 1-1 shows the regional setting of the Yucca Mountain. Nye County has installed and is currently monitoring pressure and temperature instruments in boreholes UE-25 ONC#1 and USW NRG4 (Figure 1-2) to evaluate the long-term pneumatic conditions at strategic depths in the subsurface both in response to fluctuations in atmospheric conditions and in response to other possible disturbances resulting from site characterization activities such as the ESF tunnel construction. UE-25 ONC#1 was drilled by Nye County as part of its oversight program. Nye County has also installed instruments to measure temperature, pressure, humidity and wind speed within the ESF tunnel and the Enhanced Characterization of the Repository Block (ECRB) drift to characterize the air being used to ventilate the tunnel that could potentially impact the performance of the repository. Additionally, Nye County collected gas samples from the vadose zone in UE-25 ONC#1 at three different times to establish background conditions and to evaluate changes in the chemical composition of the gases. Changes in the chemical compositions of the gases in the vadose zone with time may be used to evaluate the impact of the ESF construction and obtain transport properties of the rock mass at the site. Finally, Nye County is conducting numerical simulations to evaluate factors (including tunnel ventilation) that might potentially affect both short-term and long-term pneumatic and moisture conditions in the repository host rock.

Nye County has also been evaluating new critical data and information as it becomes available from the DOE's Yucca Mountain Project studies. In the past year, Nye County has observed water usage in the tunnel and its potential impact on the repository horizon and the scientific investigation results. The

interpretation of the results of the ^{36}Cl and other environmental and geological isotope studies such as ^{14}C , ^{13}C , and ^3H have been the focus of many meetings attended by Nye County which has resulted in several letter reports to DOE during the past year. Some of these communications have resulted in DOE's more focused attention to some of the issues raised by Nye County. Specifically, these issues related to the need for more detailed studies in the ESF tunnel and ECRB drift, limiting the use of construction water, enhanced ventilation studies, and enhanced interpretation of the results of the isotope sampling.

Nye County evaluated procedures and methods used by DOE to conduct air-permeability tests in the unsaturated zone of YMS. As a result of several interactions between Nye County and DOE, satisfactory procedures were developed and used by DOE in more recent testing efforts. The results of these tests were analyzed and reported (Advance Resources International, 1995 and Multimedia Environmental Technology, Inc., 1995, 1996 and 1997).

Water resources of the county are one of its most important assets. Nye County has been conducting research as to the potential impact of the construction and operation of the Yucca Mountain Repository on its water resources. As part of this task, a regional model of the Death Valley Hydrologic Basin was developed and is undergoing refinement. Preliminary results have revealed inadequacies in current models of the Yucca Mountain hydrologic system. As a result of several meetings, DOE has developed plans to alleviate and address these concerns.

Nye County is planning to perform several investigations in the near future to clear some of the issues that were outlined above by installing new wells in both the saturated and unsaturated zones, testing and sampling these wells, and performing data analysis and modeling. These issues are related to the steep gradients in the saturated zone north and west of the site, the potential for dilution in the saturated zone as unsaturated zone moisture enters the saturated zone, the atmospheric and pneumatic boundaries in the Solitario Canyon that might impact the repository performance, and the large-scale transport properties of the

fractured formations in both saturated and unsaturated zones. Nye County has identified future monitoring well locations and plans to begin installation of these wells in late 1998.