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CIVILIAN RADIOACTIVE WASTE MANAGEMENT SYSTEM

Management and Operating Contractor

Contract #: DE-AC01-91-RW00134
Document #: B00000000-01717-2200-00088 Rev. 01

WASTE ISOLATION EVALUATION
BOW RIDGE FAULT TRENCHING NEAR DRILLHOLE UE-25 NRG#2A

by

James E. Houseworth

February 14, 1994

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This waste isolation evaluation was prepared as a Category III evaluation in accordance with M&O NLP-3-17 "Development of Waste Isolation Evaluations" and the M&O "Waste Isolation Evaluation Preparation Plan #1."

The Bow Ridge Fault trenches and associated components have not been assigned QA classifications in accordance with M&O QAP-2-3.

Waste Isolation Evaluation
Bow Ridge Fault Trenching near Drillhole NRG-2A

1. INTRODUCTION

1.1 Purpose of Evaluation and Revision

Science Applications International Corporation (SAIC), acting on behalf of the Yucca Mountain Site Characterization Project Office (YMPO) Regulatory and Site Evaluation Division (RSED) and in accordance with AP-5.21Q, Revision 3, requested Waste Isolation and Test-to-Test Interference Evaluations from the Civilian Radioactive Waste Management Systems Management and Operating Contractor (CRWMS M&O) for excavation of two trenches along the Bow Ridge Fault in the vicinity of drillhole UE-25 NRG#2A [Weaver, 1993].

The current revision was requested [Jones, 1994] due to changes in the permeability testing program for trench NRT-1 and to clarify recommendations concerning ponding of water in the trench.

1.2 Planned Activities

Two trenches are planned to be excavated along the Bow Ridge Fault in the vicinity of existing drillhole UE-25 NRG#2A [Shephard, 1993; Weaver, 1993]. The purpose of the exploration and testing activities to be conducted in the trenches are to uncover and define the extent and character of the expected unlithified tuff materials; this information will support design of the Exploratory Studies Facility (ESF) north ramp through the interval of the unlithified Rainier Mesa tuff immediately adjacent to the Bow Ridge fault [Shephard, 1993].

The planned trench sites are located on the eastern flank of Exile Hill; their locations are shown in Figures 1 and 2 and are designated NRT-1 and NRT-2 [Weaver, 1993]. At present, trench NRT-1 is approximately 7.3 m (24 ft) wide at the bottom, 6.1 m (20 ft) deep, and 69.2 m (227 ft) long [Gibson, 1994]. An additional slot excavated along the bottom of the trench is approximately 0.9 m (3 ft) wide, 3.0 m (10 ft) deep, and 15.2 m (50 ft) long. If needed, trench, NRT-2 is planned to be 1.5 m (5 ft) wide, 4.5 m (15 ft) deep, and 6 m (20 ft) long.

Additional details pertaining to the trenches are as follows [Weaver, 1993]:

1. Wood or metal shoring will be used, if determined necessary by a soils engineer.
2. The trenches will be open less than six months.
3. A lightly graded access road is required for trench NRT-2; existing access to trench NRT-1 is adequate for the proposed activity.
4. Several tests will be conducted in the trenches including percolation using minor amounts of water, less than 680 liters (180 gal) for trench NRT-1, and soil auger

of 10 to 15 cm (4 to 6 in) diameter holes 31 to 46 cm (12 to 18 in) deep using dry drilling techniques only [Shephard, 1994].

5. Other tests include taking split spoon samples, standard penetration tests, cone penetration tests, and plate bearing tests.

6. The excavated topsoil and rock will be stored near the trenches [Savino, 1993].

This evaluation does not address potential effects of grouting experiments, if any.

1.3 Quality Assurance

This report was prepared as a quality-affecting activity according to CRWMS M&O Implementing Line Procedure NLP-3-17 "Development of Waste Isolation Evaluations." Format and content guidance was provided by the M&O "Waste Isolation Evaluation Preparation Plan #1," including its associated checklist, to assure that no activities and potential waste isolation impacts were overlooked [Houseworth, 1993].

No computer code calculations were specifically performed for this evaluation. Data used in this evaluation are marked with an asterisk (*) or addressed in a footnote if they are listed in the Yucca Mountain Site Characterization Project (YMP) Technical Data Catalog [YMP, 1993c][1] as having been acquired or developed in accordance with a Nuclear Regulatory Commission (NRC) accepted quality assurance program or qualified in accordance with appropriate YMP procedures. Some of the data and referenced analyses used in this evaluation may not have been approved for quality-affecting work. The extent and possible effect of non-qualified data, analyses, and computer codes on the evaluations, conclusions and recommendations of this report were not specifically determined. However, the conservative assumptions, estimates and methods used in this evaluation address any reasonable scenario and are therefore expected to bound potential impacts on waste isolation.

2. BACKGROUND INFORMATION

2.1 Evaluation Approach

This is a qualitative evaluation of the potential impacts of the planned activity on waste isolation. The following previous waste isolation evaluations provided background information:

Drilling of UE-25 NRG#2 and UE-25 NRG#2A [Foust, 1993a]
Drilling of UE-25 NRG#2B [Foust, 1993b]
Solitario Canyon Trenching [Foust, 1993c]
Alice Ridge Trenching [Foust, 1993d]

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1 Currently, this catalog does not contain design data for surface-based-testing facilities and the Exploratory Studies Facility.

2.2 Relative Locations and Elevations

The planned trench locations are shown in Figure 1 relative to the conceptual perimeter drift boundary (CPDB) and conceptual controlled area boundary (CCAB). The excavations are about 1 km (0.6 mi) outside and east of the nearest point of the CPDB; approximately on top of the eastern boundary of potential expansion area 6; and about 2 km (1.5 mi) inside and southwest of the nearest point on the CCAB [EG&G, 1992a].

The planned trenching and related activities are located along the Bow Ridge Fault in the vicinity of existing drillhole UE-25 NRG#2A (Figure 2), in a side arm of Pagany Wash between the eastern flanks of Yucca Mountain and the western flank of Exile Hill [EG&G, 1992b]. Trench NRT-1 is about 45 m (150 ft) south and trench NRT-2 is about 15 m (50 ft) north of the ESF north ramp alignment west of Exile Hill; existing trenches 14 and 14A are near the two planned trenches (Figure 2).

Relevant elevations are listed in Table 1.

Table 1. Relevant Elevations

Location	Elevation above m.s.l.		Reference
	m	ft	
Trench NRT-1, surface	~1150	~3780	Weaver, 1993
Trench NRT-2, surface	~1150	~3780	Weaver, 1993
Drillhole NRG-2A, surface	1154	3785	Foust, 1993a
Ground-water table in vicinity of trenches	730.25-730.50	2396-2397	Ervin et al., 1993[2]
ESF north ramp invert at portal entrance	1124	3687	YMP, 1991a
ESF north ramp invert nearest NRG-2A	1108	3635	Dyer, 1993
ESF north ramp invert at Topopah Spring main drift junction	988	3240	YMP, 1991a

[2] Some of the ground-water table elevations used in this reference were acquired under an approved quality assurance program.

2.3 Relevant Hydrogeology

The expected major near-surface lithologic units in the vicinity of the planned trenches are alluvium and colluvium, the Rainier Mesa Member of the Timber Mountain Tuff, and the Tiva Canyon Member of the Paintbrush Tuff [Scott and Bonk, 1984]. All materials to be excavated are expected to be unlithified [Shephard, 1993]. The top of the Tiva Canyon Member is at a depth of about 50.5 m (165.9 ft) below the ground surface based on the NRG-2A borehole log [T&MSS, 1993]; therefore, the trenches and boreholes in the trenches are not expected to intersect the Tiva Canyon Member. In this vicinity, these and the underlying lithologic units in the unsaturated zone are expected to dip downward in an easterly direction, away from the conceptual repository area and potential eastern repository expansion area [Scott and Bonk, 1984, cross-section B-B'].

The ground-water table in this vicinity dips slightly downward in a southeasterly direction, ranging in elevation above mean sea level (m.s.l.) from 730.50 (2397 ft) west to 730.25 m (2396 ft) east of the planned trench locations [Ervin et al., 1993][3]; this puts the water table about 420 m (1380 ft) below the ground surface.

The planned trench locations lie outside any identified maximum probable flood zones [EG&G, 1992b].

2.4 Affected Natural Barriers and Engineered Items

The alluvium is the only natural barrier on the current Q-List [YMP, 1993a] which will be penetrated by the planned trenching and associated activities. The Rainier Mesa Member of the Timber Mountain Tuff is not listed. The Tiva Canyon Welded Hydrogeologic Unit and underlying units are on the current Q-List; they could be affected if recommended controls are not implemented. No natural barriers are in the current MC-List [YMP, 1993b].

The recommended Q-List revisions [Voegele, 1993] would remove the alluvium and place it on the MC-List as part of the Unconsolidated Surficial Materials (USMs). The USMs include alluvial, colluvial, eolian, debris-flow, and other detrital deposits overlying the Paintbrush Tuff, including locally indurated materials within the Timber Mountain Tuff, where present; the latter includes the Rainier Mesa Member.

The planned trenching and associated activities do not use engineered items on the current Q-List [YMP, 1993a] and MC-List [YMP, 1993b]. They could affect the characteristics of natural barriers in the vicinity of the ESF north ramp and potential ramp sealing locations; the Waste Ramp, Tuff Ramp, and Seals are on the current Q-List as items important to safety and as items important to waste isolation.

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[3] Some of the ground-water table elevations used in this reference were acquired under an approved quality assurance program.

SPECIFIC EVALUATIONS AND INTERPRETATIONS

3.1 Hydrology

The main concern regarding the planned activities is the potential for increased surface-water infiltration due to ponding of water in the trenches, which could be enhanced because of the location of the planned trenches along the Bow Ridge Fault.

About 680 liters (180 gal) of water is planned to be used in percolation testing in 6 shallow auger holes at NRT-1, 10 to 15 cm (4 to 6 in) in diameter and 31 to 46 cm (12 to 18 in) deep from the bottom of the trench [Shephard, 1994]. This water will slightly increase the water content of the surrounding near-surface rocks, but it is not expected to reach the CPDB due to the small quantity of water, the long distance to the CPDB, and the depth to potential repository horizons. Movement to potential expansion areas may be possible if the percolating water is able to move downward through continuous fracture paths that may exist in the Bow Ridge Fault Zone. Trench NRT-1 overlies the eastern boundary of potential expansion area 6 and the Bow Ridge Fault Zone (see Section 2.2). Any waste emplacement in this expansion area is assumed to be in the TSw2 thermal/mechanical stratigraphic unit, the potential waste emplacement zone within the CPDB [McKenzie, 1993]. The TSw2 is estimated to have a porosity of about 0.12 and water saturation of about 0.65 [YMP, 1993d]. The conceptual repository and potential expansion areas occupy about 3843 hectares (9496 acres) and may be conservatively bounded by a thickness of at least 100 m (330 ft) [DOE, 1986; USGS, 1993]. Therefore the total volume of TSw2 within the CPDB and potential expansion areas is about 3.8×10^9 m^3 (1.4×10^{11} ft^3). If all of the applied water migrated to the TSw2, the maximum volume of host rock affected by a 0.001 increase in water saturation would be about 6800 m^3 (2.4×10^5 ft^3), roughly 1.8×10^{-4} % of the total potential TSw2 waste emplacement volume.

Thus, the planned excavation and associated activities are not expected to influence the ground-water flux and saturation at the potential repository horizons and below at the conceptual repository and potential repository expansion area 6, provided existing controls on construction and operational water use are observed [YMP, 1992a], and berms or other measures are provided to prevent surface water from flowing into and ponding in the trenches. Enhanced infiltration is not expected to affect waste isolation provided that water (rainfall, dust control water, etc.) introduced over the time period that the trench remains open does not exceed a total of 9 mm/day (2 gal/yd^2/day) averaged over any six-month period [YMP, 1992a].

No effects on the saturated ground-water zone are expected, provided the control measures mentioned above are implemented (i.e., limits on dust control water and avoidance of surface-water ponding in the trenches), due to the small quantities of water needed for the planned activities and the 420-m (1380-ft) depth to the water table.

3.2 Geochemistry

Other than water used in the percolation tests and inadvertent construction equipment fluid spills, no tracers, fluids and materials are expected to remain at the site from the planned activities, provided existing controls on TFM use and spills are observed [YMP, 1992a]. As before, due to the distances and depths involved, no geochemical effects are expected at potential repository horizons and the water table, and no significant geochemical effects are expected in the surrounding natural barriers, including along potential gaseous and aqueous radionuclide pathways.

The storage of the excavated soils and rocks near the planned trenches, including leachates caused by precipitation, are not expected to impact waste isolation due to the similar nature of the excavated materials to the materials underlying the storage locations.

This evaluation does not address potential effects of grouting experiments, if any.

3.3 Thermal/Mechanical Characteristics

The excavation of the trenches and drilling of boreholes in the trenches will disturb the mechanical characteristics of the excavated and drilled materials, but effects on nearby materials are expected to be insignificant. The planned activities are not expected to have any permanent effects on the thermal characteristics of the surrounding rocks. As before, due to the distances and depths involved, no thermal/mechanical effects are expected at potential repository horizons, the water table, and along potential gaseous and aqueous radionuclide pathways. Blasting is not expected to be needed, due to the expected unlithified nature of the rocks to be excavated. If blasting is needed, the depth of penetration of the disturbance is expected to be 10 m (30 ft) or less [Tsai, 1993].

3.4 Interpretations

The planned activities do not lie along any potential pathways for aqueous radionuclides. A conservative limit that has been used for water saturation change at potential emplacement areas is 0.001 [Fewell, et al. 1992]. The performance impact of a 0.001 change in saturation has not been quantified, but measured saturations in the TSw1, TSw2, and TSw3 units have a reported standard deviation of 0.19 [YMP, 1993d]. The quantity of water planned for percolation tests could, as an upper bound, increase water saturation 0.001 for less than 2 parts in 10^6 of the total available potential emplacement volume. Therefore, this activity is believed to be an acceptable risk. Due to the lack or insignificance of hydrologic, geochemical, and thermal/mechanical impacts of the planned activities, the planned activities will not affect aqueous radionuclide transport from potential repository locations to the water table and accessible environment.

The rocks below the planned activities could provide pathways for gaseous radionuclides from a waste emplacement horizon in the potential repository expansion area 6. Because of the total volume of rock available for gaseous radionuclide transport in relation to the small volume and shallow depth involved in the planned activities, any impacts on gaseous radionuclides are expected to be insignificant.

4. SUMMARY

4.1 Recommendations and Conclusions

The proposed excavations and activities for the planned trenches NRT-1 and NRT-2 are not expected to impact waste isolation, provided existing controls for water use, spill control, spill cleanup, spoils storage, land reclamation, and recording actual use of tracers, fluids, and materials are implemented [YMP, 1991b; YMP, 1992a; YMP, 1992b].

Enhanced infiltration from surface water flowing into the planned trenches during and following precipitation and runoff, including snowmelt events, may have an adverse effect on waste isolation. In order to prevent surface water inflow and ponding of water, the trenches shall be constructed with berms or provide other means to deflect surface drainage away from them and shall be backfilled as soon as possible. The dimensions and characteristics of the berms or other measures shall be determined on the basis of calculations of maximum probable surface runoff from the drainage areas upstream of each trench. If the cumulative water introduced (including rainfall) exceeds 9 mm/day (2 gal/yd^2/day) averaged over any six-month period during the time when the trench is open, then the trench should be filled and graded to prevent any additional excess infiltration in the trench.

With respect to sealing the planned boreholes at the bottom of the planned trenches, backfilling with sufficiently small-grained materials is considered adequate due to the shallow depth of the boreholes; the backfilling should alternate with compacting to achieve a density similar to that of the original materials.

4.2 Critical Assumptions and Data

No critical assumptions and data were required for this waste isolation evaluation; the most important aspect related to the data and assumptions used is the location of the planned activities above the Bow Ridge Fault and a potential repository expansion area.

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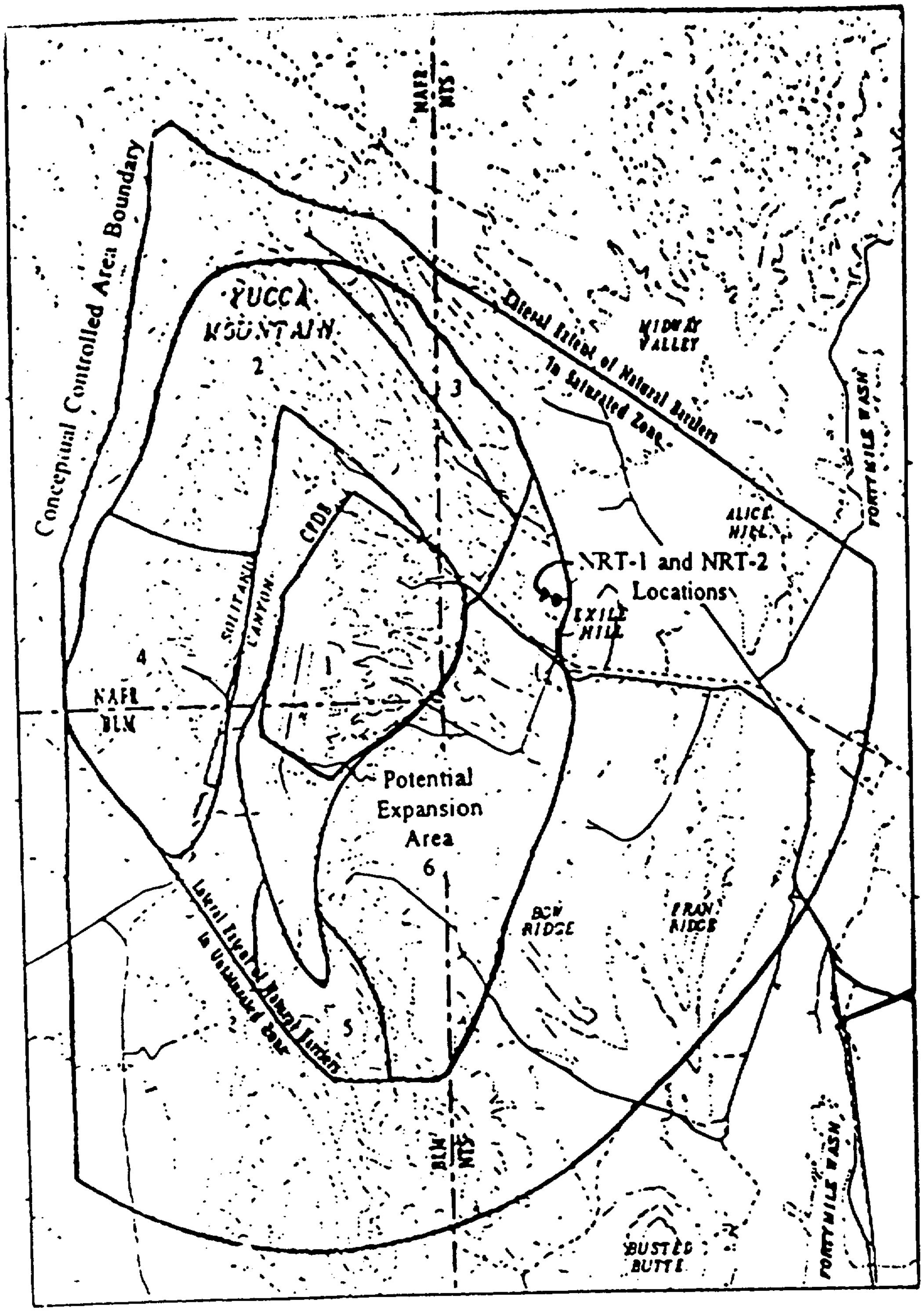

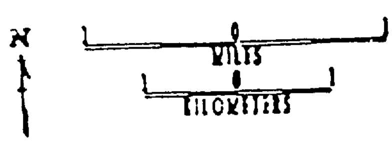

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Figure 1
Yucca Mountain Site Map with Bow Ridge
NRT-1 and NRT-2 Trench Locations

Source: map YMP-93-204.1 [EG&G, 1993]
modified by adding NRT-1 and NRT-2 locations

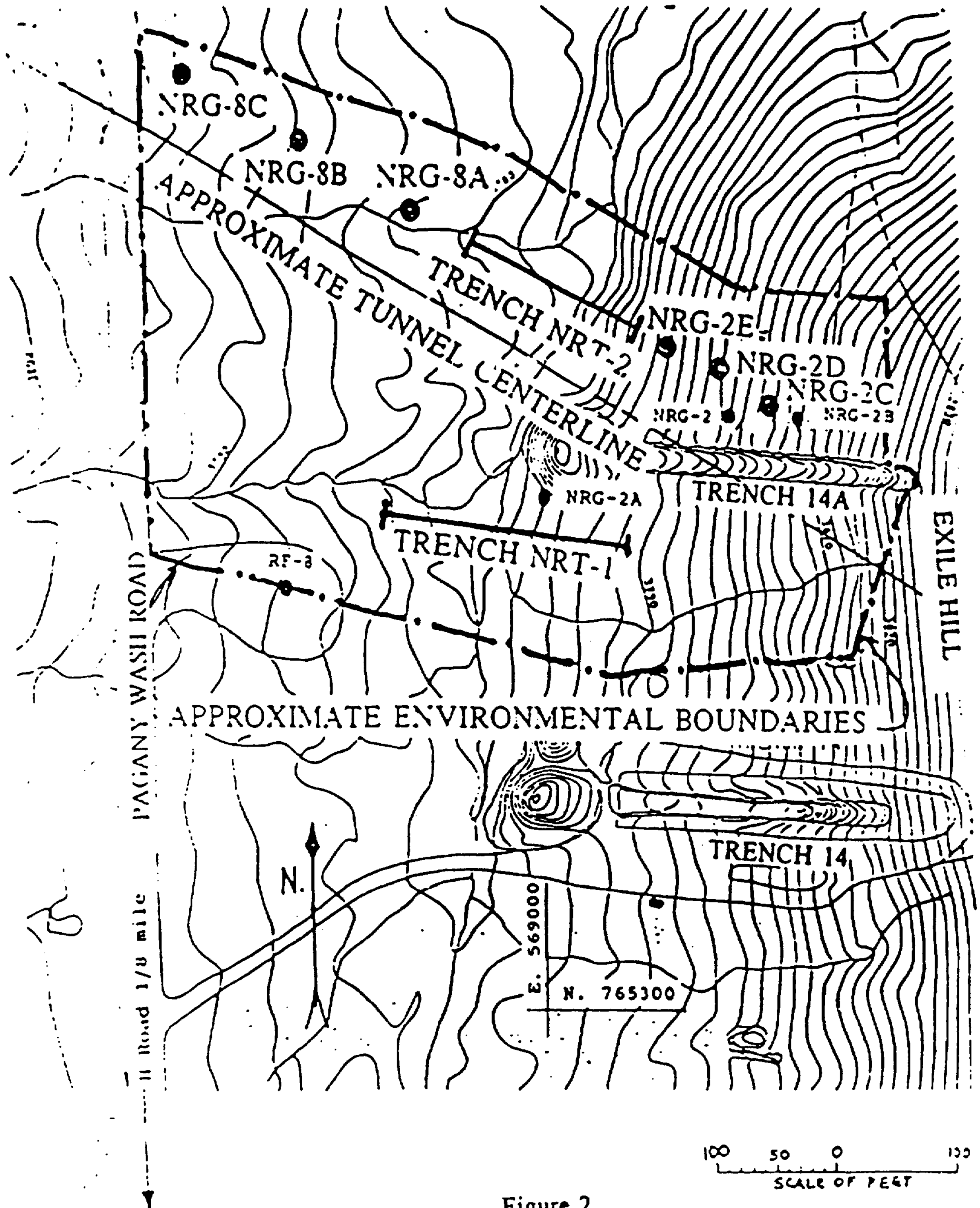

Figure 2
Vicinity Map of Bow Ridge NRT-1 and NRT-2 Trenches

Source: Weaver, 1993.

CHECKLIST OF ACTIVITIES AND TFMs FOR WASTE ISOLATION EVALUATIONS	
ACTIVITY / TFM	**COMMENTS**
I Water	
A Surface Sources	
1 Road watering for dust control	Sections 3 1, 4.1
2 Drill pad dust control	NA
3. Equipment washdown	Section 4.1
4 Natural surface runoff	Sections 3.1, 4.1
5 Accidental water spillage	Section 4 1
6 Used in testing	Sections 1 2, 3.1, 4.1
B Underground	
1. Water loss during drilling	
a) Fishing	NA
b) Other	NA
2. Recovered or produced during drilling	
a) Perched water	NA
b) Water table	NA
3 Used in construction	
a) Drilling	NA
b) Construction materials	NA
c) Dust control	NA
d) Equipment washdown	NA
4. Used in testing	NA

CHECKLIST OF ACTIVITIES AND TFMs FOR WASTE ISOLATION EVALUATIONS	
II Materials (other than water)	
A Used in surface and subsurface construction	
1. Building materials	Section 1.2, 3.2, 4.1
2. Leachates from rock & muck piles	Section 3.2, 4.1
3. Fuels, lubricants & coolants	Section 3.2, 4.1
B Used in borehole construction and/or sealing	
1. Grout for surface casings	NA
2 Drilling fluids	Section 1.2
3 Other materials left in boreholes	Section 4.1
C Used in testing	Section 1.2, 3.2, 4.1
III Other considerations	
A. Physical and chemical characteristics of seals	NA
B Cut-and-fill for roads, pads, trenches & pits	Section 1.2, 3.2, 4.1
C. Blasting	Section 3.3
D Underground excavation	NA