

WM-9
PDR

Return to
wm
623-55

201.6/RDS/82/07/1

- 1 -

JUL 1 1982

Distribution:

- NMSS r/f
- WM r/f
- WMLL r/f
- WMLL s/f
- RDSmith
- EFHawkins
- DLsiefken
- GCPangburn
- REBrowning
- JBMartin
- DNussbaumer, SP

MEMORANDUM FOR: John B. Martin, Director
Division of Waste Management

FROM: R. Dale Smith, Chief
Low-Level Waste Licensing Branch

SUBJECT: TRIP REPORT - COLORADO HEALTH DEPARTMENT,
DENVER, COLORADO

Enclosed is a trip report for a visit to the Colorado Health Department,
Denver, Colorado, on June 15, 1982 to discuss the status of the
announced low-level waste disposal facility for western Colorado.

Original Signed by
R. DALE SMITH

R. Dale Smith, Chief
Low-Level Waste Licensing Branch

Enclosure:
As stated

OFFC	:	WMLL	:	:	:	:	:	:
NAME	:	RDSmith:ajf	:	:	:	:	:	:
DATE	:	:82/07/01	:	:	:	:	:	:

TRIP REPORT, DENVER, COLORADO

Date of Meeting: June 15, 1982

Place of Meeting: Colorado Health Department, Denver, Colorado

Purpose of Meeting: To informally discuss status of the announced low-level waste disposal facility for western Colorado

Attendees: Jake Jacoby, Colorado Health Department
R. Dale Smith, NRC

On June 15, 1982, I met with Jake Jacoby of the Colorado Health Department to informally discuss the status of the announced low-level waste disposal facility for western Colorado.

Mr. Jacoby gave me copies of several documents pertinent to the LLW site (see attached). These documents outline the site investigations carried out to date by F. M. Fox and Associates for Chem-Nuclear Systems, Inc., (CNSI). Also included is a site development schedule prepared by CNSI.

There are several points of interest to note on the schedule. According to the schedule, CNSI will begin preparation of an application in July 1982, with completion set for May 1983. According to Jacoby, CNSI will be providing information to the state as it is generated during this period. The State of Colorado, according to CNSI is allowed six months for their licensing review. Colorado law provides for a 90-day advance notice of decision by the Health Department for public input; thus, the technical review must be done in three months. Construction of the facility is scheduled to begin four months into the review time.

Mr. Jacoby and I explored various ways by which NRC could provide technical assistance to Colorado. No conclusions were reached or commitments made in this regard. As a result of these discussions, I sent them information on the various analytical models we have operational, along with the LLW Program Plan to show what technical studies we have underway and the branch positions and regulatory guides that we are developing. I also furnished Mr. Jacoby the most recent version of Part 61 to aid them in preparing state regulations. There are

a number of factors that appear to be at work that will make the Colorado Health Department's job difficult.

1. The proposed site is located in an area of high unemployment and there not only is local acceptance, but local pressures to get the facility.
2. Governor Lamm has publicly expressed support of the project and has essentially promised that the facility will be built.
3. Chem-Nuclear is insisting that their schedule must be met if they are going to develop the site.
4. Further, CNSI has made it clear that the facility must receive both LLW and mill tailings to be economically viable. (It is not clear where these tailings will come from, since some mill operators and DOE are reported to have indicated an unwillingness to ship tailings to the site.)

No plans were set for further discussions, but we agreed that they would be worthwhile. Further arrangements will be made through Office of State Programs and Region IV.

Site Investigation Plan for
Montrose-West Uranium
Mill-Tailings and Low-Level
Waste Disposal Facility

Prepared by Chem-Nuclear Systems, Inc.
and F.M. Fox and Associates
April 23, 1982

Chem-Nuclear Systems, Inc. has completed a search for potential sites for a below-grade uranium mill-tailings and low-level radioactive waste disposal site in western Montrose County, Colorado. This led to selection of an area two (2) miles southwest of the town of Naturita (see map at Figure 1). An option is being negotiated for the privately-owned, 160-acre area; application for temporary use of the 760-acre area held by the Bureau of Land Management has been made and approval is expected within forty-five (45) days.

We now plan to conduct a two-phase field and laboratory characterization of the geology, hydrology, meteorology, air quality, ecology, land uses, cultural resources and socioeconomics of the site and surrounding area. This effort will collect the data necessary to evaluate the capability of this site to contain the wastes for the period of time they may present a significant hazard to public health and safety, to predict the long-term stability of the site and to evaluate the potential environmental impacts of the proposed facility. The first phase will be a preliminary evaluation of the geology and hydrology of the proposed site. This will enable us to determine the likelihood that the site will be found to be technically suitable and economically feasible before proceeding with the lengthy and costly investigations of Phase II.

The studies in Phase I will be conducted by F. M. Fox and Associates, under contract to Chem-Nuclear. In Phase II we will complement that firm's expertise in geohydrology and geotechnical engineering with a second contractor that will have responsibility for investigating the meteorology, air quality, ecology,

and human values traits of the site and area. Chem-Nuclear will coordinate their results into the environmental report for the facility. The sections below outline the data to be collected during each phase of the site investigation.

Phase I - Preliminary Evaluation

This activity will focus on characterizing the geology and hydrology of the site to determine:

- a) possible impacts of the geologic and hydrologic conditions on the proposed facility, and
- b) possible impacts of the facility on the present and future geological processes and environmental conditions of the area.

Surficial Geology and Hydrology

Geohydrological features of the site surface will be mapped on a scale consistent with the topographic maps to be completed in Phase II (i.e., 1 inch equals 200 feet). This mapping will identify surface water bodies and the site drainage configuration, including:

- * size of drainage areas
- * drainage divides
- * closed drainage areas
- * surface gradients
- * flash flood areas
- * scour or sedimentation areas

Land forms such as landslides and sharply-incised valleys will be identified. Potential geologic and tectonic hazards in the region will be evaluated, using published sources and field reconnaissance.

Geotechnical Characteristics

The field engineering properties of the soil and subsoil materials present at the site will be evaluated. Thirteen (13) holes that are six (6) inches in diameter will be drilled to sixty (60) feet below the surface using continuous flight hollow augers. 5 of these will be drilled on the private land and 8 on the BLM land. At approximately 5-foot intervals, California barrel drive samples will be collected. Packer permeability tests will be conducted in each of these holes to determine in-situ horizontal hydraulic conductivities. Adjacent to each of these holes, a second set of 10-inch diameter holes will be drilled to 20 feet below the surface with continuous flight hollow augers. Six-inch diameter schedule 40 PVC will be set in these and standpipe permeability tests will be performed to determine in-situ vertical hydraulic conductivities.

Soil samples collected during the drilling will be tested in the laboratory to determine geomechanical suitability. Tests to be performed include:

- * 20 Atterberg limits
- * 20 Sieve analyses
- * 20 Natural moisture contents
- * 4 Modified Type A Proctor Tests
- * 8 Constant head permeability tests on samples remolded and compacted at optimum moisture content, as determined by the Proctor Tests.

Subsurface Geology and Hydrology

To define the deep geohydrologic conditions of the site, 4 holes that are a minimum diameter of 6 inches will be rotary-drilled. Two of these will be to a depth of 500 feet and two to 300 feet. One of each hole will be drilled on each of the two properties. All drill cuttings will be logged.

Each of the holes will be logged, using a ^{full} suite of borehole geophysical techniques, including high resolution density, caliper, neutron-neutron, specific potential, and resistivity. *natural γ (Pomeroy)*

Schedule 40 PVC (4-inch diameter) casing will be set in each borehole. It will be perforated below the surface casing and sealed, per Colorado State Engineers Water Well Construction regulations. Groundwater monitoring will be conducted to measure head and moisture content on a monthly basis. Samples will be collected for water chemistry testing.

For all water wells within a 2-mile radius, available logs and permit applications at the State Engineer's office will be reviewed. *or greater if necessary* (11)

Preliminary Report on Site Geohydrology

A report will be prepared on the preliminary investigation of the site. This will include:

- * a geologic map and geologic cross-section, indicating the lithology, thickness, lateral extent, continuity and inclination for the significant hydrogeologic units.
- * a description of borehole locations
- * test-hole logs and sample locations
- * results of field tests
- * results of laboratory tests

Phase II - Full Investigation

A detailed investigation of the site will be performed to provide:

- a) a complete analysis of the geologic, geotechnical, hydrologic, and environmental conditions of the site;
- b) an evaluation of the possible interactions between the site and the proposed facility;
- c) an evaluation of the site's ability to isolate the wastes;
- d) data to determine the design of the facility;
- e) a baseline for the environmental monitoring program to be conducted during construction, operation, closure, and post-closure care of the site;
- f) an evaluation of potential environmental impacts of the facility.

Geology and Tectonics

The surface and subsurface geological conditions of the site will be completely defined. The regional stratigraphy, tectonics, structure, physiography, and seismicity will be developed from published sources and field reconnaissance. The site-specific geology will be defined by the following:

- * aerial photography of the site;
- * topographic mapping of the site and upstream drainage area at a scale of 1 inch = 200 feet with a 5-foot contour interval. USGS topographic maps (7½ or 15-minute) will be obtained for downstream drainage areas.
- * surface mapping of the geologic features of the site, on a scale consistent with the topographic maps. This map will show the extent of the geologic units and existing geologic structures.
- * Geologic cross-sections, depicting the stratigraphy and structure of the subsurface geology;
- * evaluation of the geologic hazards in and around the site;
- * surficial geophysical surveys, using seismic refraction and earth resistivity, to define the shallow subsurface conditions and identify buried stream channels, sand lenses, and other heterogeneities;
- * laboratory tests of soil samples collected during the drilling described below; tests will include soil chemistry and radiology (lime equivalent, cation exchange capacity, exchangeable cations, sodium absorption ratio, etc.) consolidation, compaction, constant head permeability, sieve analyses, hydrometer analyses on the -200 fraction, Atterberg limits, moisture content;

- * visual observation of core samples for primary structures, depositional features and weathering profiles;
- * evaluation of geomorphic conditions of the site, including erosion rates and slope instability.

Geotechnical Characteristics

Based on the findings of the preliminary investigation, approximately 36 borings (6-inch diameter) will be drilled with a continuous flight hollow auger to depths ranging from 40 to 100 feet on 700-foot centers. California barrel samples will be collected at approximately 5-foot intervals. Various bulk samples of drill cuttings will also be collected. Laboratory tests outlined in the previous section will be performed on these samples.

Packer permeability tests will be performed in each of the boreholes to determine horizontal hydraulic conductivities beneath the site.

Adjacent to these holes, another set of 10-inch diameters will be bored with a continuous flight hollow auger to the 20-foot depth. Schedule 40 PVC (6-inch diameter) will be set in these. Standpipe permeability tests will be performed to define the vertical hydraulic conductivities beneath the site.

Groundwater

Groundwater conditions of the site and surrounding area will be defined. This will include definition of:

- * the configuration of all aquifers and confining beds;
- * depth to water
- * baseline groundwater use
- * hydraulic characteristics of aquifers and confining beds, if appropriate.

The groundwater monitoring program begun in Phase I will be continued, with quarterly sampling to provide a full 12 months of data on head and moisture content. Samples will be tested for water chemistry and radiologic characteristics.

-/-
A moisture content profile beneath the site will be developed, based on data collected during borehole drilling and from the groundwater monitoring wells.

The hydraulic conductivity data generated from tests described in the previous section will be supplemented with a multiphase seepage analysis to determine the potential for offsite migration of any leachate which could develop within the disposal cells.

The data collected in this program will form the basis for a detailed description of the occurrence, direction, and velocity of soil moisture movement and groundwater flow.

Surface Water

Surface-water users and municipal supplies within 5 miles downstream will be inventoried and information will be collected on the amount of use and water quality.

The aerial photographs and topographic maps will be used to characterize drainage locations. Runoff coefficients, infiltration rates and channel characteristics will be measured to determine flow rates, depths, volumes and durations.

Sediment yields will be measured to determine erosion rates for site soils. Quarterly samples of sediment will be collected for radiologic analyses.

Continuous proportional flow samplers will be placed on the surface water stream, one upstream and one downstream, to establish the water balance of the site. Monthly samples will be collected for water chemistry and radiologic analysis.

Meteorology

A 10-meter meteorology tower will be installed to continuously measure temperature, wind speed, and wind direction for one year. Data will also be collected on surface humidity, dew point and atmospheric pressure.

Precipitation, frost penetration, and snow cover will be measured through a 12-month period.

Site-specific data will be compared to historical records for the area so that regional data can be used for projecting long-term traits.

Air Quality

Low-volume continuous samplers will be installed at several locations around the site for collection of air particulates. Filters will be collected for chemical and radiochemical analysis. Twelve months of data will be compiled.

Ecology

An inventory of flora and fauna within a 3-mile radius will be compiled. Sampling of terrestrial and aquatic species will be conducted quarterly for one year. The number, extent, and distribution of livestock and crops will also be determined.

Grab samples of vegetation, fish and wildlife will be analyzed for radiologic characteristics.

Direct Radiation

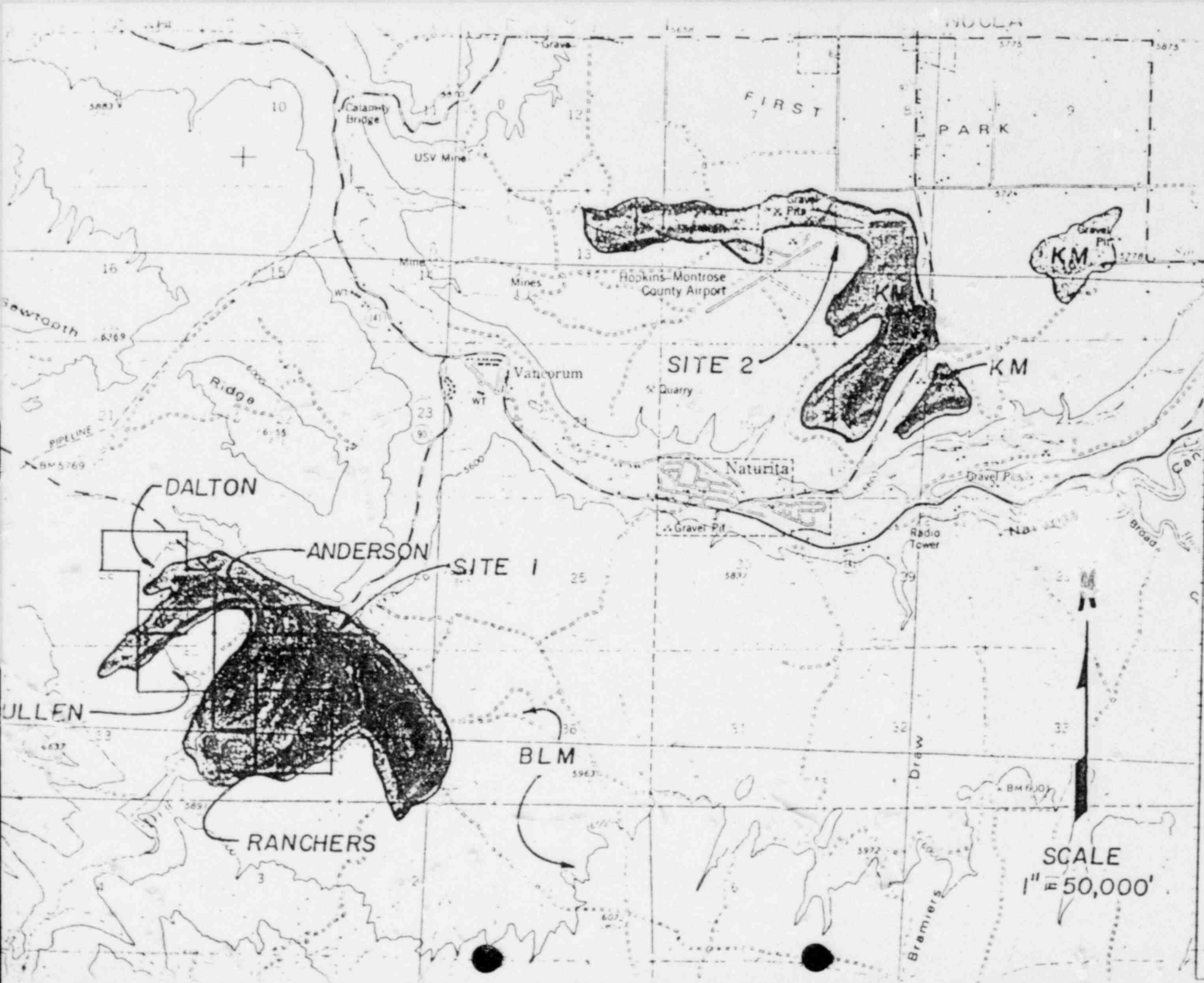
In addition to measurements of direct radiation from soil, water and vegetation samples, TLD's will be placed at various locations around the site. These will be measured monthly.

Land Use, Cultural Resources and Socioeconomics

A history of the region and local area will be collected. The demography of the area will be defined, including population, labor availability, and labor skills. Transportation networks will be described. The housing stock will be surveyed and data will be collected on the school systems, health care, fire and police protection, and utilities. The tax and economic base of the area will be determined.

A land use survey will be conducted to define the classes of land use within 5-10 miles and identify trends. An inventory of residences within that area will be compiled.

Cultural resources within 5-10 miles will be identified. The potential for inclusion of any of these in a State or Federal registry of historic places or natural landmarks will be evaluated.



Job No: 020043

Date: 3-23-82

LOCATION PLAN

Consulting Engineers and Geologists





CHEM-NUCLEAR SYSTEMS INC.

P.O. Box 1866 • Bellevue, Washington 98009 • (206) 827-0711

June 4, 1982

Mr. Ken L. K. Weaver
Senior Health Physicist
Uranium Recovery Unit
Colorado Department of Health
4210 East 11th. Avenue,
Denver, CO 80220

Dear Mr. Weaver:

As you requested on May 14, enclosed is a copy of the siting criteria Chem-Nuclear Systems, Inc., provided to our geohydrologic contractor, F. M. Fox and Associates. These criteria were used in selecting the site in Montrose County proposed for disposal of uranium mill tailings and low-level radioactive wastes. The list was developed from (1) the requirements of the draft 10CFR Part 61, (2) our past siting experiences, and (3) recommendations of other geologic consultants.

F. M. Fox also evaluated the area with respect to the guidelines of the Colorado Health Department and Geological Survey. These added the following additional limitations on the site search:

1. Identify outcrops of Mancos or Lewis Shale
2. Eliminate the following areas:
 - (a) floodplains
 - (b) within 1 mile of perennial streams or lakes
 - (c) aquifers within 150 feet
 - (d) low evaporation/precipitation ratio
 - (e) within 1 mile of major fault
 - (f) within 1 mile of igneous
 - (g) on buttes or escarpments

If I can provide further information, please contact me.

Sincerely,

CHEM-NUCLEAR SYSTEMS, INC.

A. Louise Dressen
A. Louise Dressen
Manager Site Development

ALD:km1

Encl. Appendix A-Scope of Work

cc: Paul Rosasco, Fox & Assoc.

APPENDIX A
SCOPE OF WORK

The contractor shall utilize its in-house expertise and existing data to conduct reconnaissance-level screening for candidate sites for disposal of low-level radioactive wastes and uranium mill tailings in western Montrose County, Colorado. These sites shall have a combination of natural conditions and land uses that will enhance long-term site stability and predictability, radio-nuclide retention and protection of public health and safety.

The contractor shall collect existing reconnaissance-level information on the geology, hydrology, topography, demography and resources of the region of interest. The contractor shall utilize (1) its in-house geologic and environmental literature, (2) existing maps of topography, geology, water resources and demography, (3) other readily available data bases, and (4) consultation, where appropriate, with state geological survey agencies. The data shall be analyzed against the following criteria to identify at least one suitable location (NOTE: Some of these are obviously not in the area of interest, but are included for completeness):

GEOLOGY

1. Avoid areas where faulting, folding, high seismic activity or vulcanism may adversely affect site performance.
2. Avoid areas subject to excessive wind and/or water erosion, slumping, landsliding, mass wasting, or weathering.
3. Avoid areas with a complex lithology and geometry which may preclude characterization, defensible modelling, analysis, and monitoring.
4. Give preference to areas with relatively impermeable (10⁻⁶ centimeters per second or less) surficial and subsurface deposits to a depth of several hundred feet or more.
5. Give preference to areas of clays, silts, shales and dirty sands.
6. Give preference to areas with loose or weakly indurated surficial materials to a depth of 25 feet or more that can be trenched with a D-7 or D-8 bulldozer or dragline.

HYDROLOGY

1. Avoid wetlands.
2. Avoid areas within 100-year floodplains.
3. Avoid recharge zones for sole-source aquifers.
4. Avoid areas with high stream densities.

1. Avoid areas with a high seasonal groundwater table closer than about 40 feet to the surface.
2. Avoid areas with undesirable surface water features such as significant upstream surface water drainage from which the isolation of the location is not practical, hydrologic depressions, swampy conditions, etc.
3. Give preference to areas with long groundwater travel times to discharge locations and with soils that have high cation exchange capacities.
4. Avoid areas with major surface water supplies used for human consumption.
5. Avoid locations where groundwater originating from within the selected site discharges into a surface water body within the selected location.
6. Give preference to areas where groundwater aquifers are infrequently utilized for human consumption due to high concentrations of dissolved solids (greater than 1000 ppm).

TOPOGRAPHY

1. Avoid low-lying areas or those with significant topographic relief which may lead to slope failure, erosion, mass wasting, slumping, weathering, etc.
2. Give preference to large flat areas to expedite disposal design without significant alteration of the natural topography.

ENVIRONMENT

1. Avoid critical and/or unique wildlife habitats.
2. Avoid high-hazard areas, e.g., coastal areas subject to hurricanes, tsunamis, inland areas subject to severe tornadoes, etc.

SOCIO-ECONOMICS

1. Avoid high-population density areas.
2. Avoid areas with incompatible land uses or potentially valuable mineral and energy resources.
3. Avoid areas with high recreational potential.
4. Avoid historic areas.
5. Give preference to areas that are well connected by all-weather roads fully suited to truck traffic.

FOX

Consulting Engineers and Geologists

1138 NORTH TOWNSEND AVENUE
MONTROSE, COLORADO 81401
(303) 249-5579

PRELIMINARY GEOLOGICAL INVESTIGATION
for SITE SELECTION
LOW LEVEL RADIOACTIVE WASTE DISPOSAL
WESTERN MONTROSE COUNTY, COLORADO

Prepared for:
CHEM-NUCLEAR SYSTEMS
Attention: A. LOUISE DRESSEN

Project No. 020043
March 23, 1982

TABLE OF CONTENTS

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS	Page 1
PURPOSE OF SCOPE	1
HISTORY AND DEMOGRAPHICS	2
REGIONAL GEOLOGY	3
CANDIDATE SITES	3
SITE #1 - DRY CREEK	4
SITE #2 - HOPKINS - MONTROSE COUNTY AIRPORT	6
SITE #3 - UPPER MAILBOX PARK	6
SITE #4 - EDMONDSON SPRING	7
RECOMMENDATIONS	8
SITE LOCATION - SITES 1 and 2	Figure 1
SITE LOCATION - SITE 3	2
SITE LOCATION - SITE 4	3
BIBLIOGRAPHY	
SCOPE OF WORK	Appendix A

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

1. One and possibly two viable sites for low level radioactive waste disposal have been identified as follows:

Site #1 - Dry Creek - This site appears to meet all pertinent criteria.

Site #3 - Upper Mailbox Park - This site appears to meet most pertinent criteria but may be too close to perennial streams and lack proper access.

2. Two other sites were considered and eliminated. These are identified as Site #2 - Hopkins-Montrose County Airport and Site #4 - Edmondson Springs.
3. A detailed investigation of Site #1 should be conducted to assure it meets all criteria. Also, this site will require purchase, trade or cooperation with the Bureau of Land Management.
4. Other data and specific discussions are made elsewhere in this report.

PURPOSE OF SCOPE

The purpose of this preliminary investigation is to review existing literature and data to select candidate sites for a low-level radioactive waste disposal facility in Western Montrose County. For the purpose of this report, Western Montrose County is identified as that portion of Montrose County that lies west of the crest of the Uncompahgre Plateau. Or more simply, it can be considered that portion of Montrose County within the Dolores River drainage basin.

The criteria for this investigation are outlined in the Scope of Work which is attached as Appendix A. Additionally, we have evaluated the area

with respect to the guidelines of the Colorado State Health Department and the Colorado Geological Survey. This adds further limitations on the project as follows:

1. Identify outcrops of Mancos or Lewis Shale
2. Eliminate the following areas:
 - a) floodplains
 - b) within 1 mile of perennial streams or lakes
 - c) aquifers within 150 feet
 - d) low evaporation/precipitation ratio
 - e) within 1 mile of major fault
 - f) within 1 mile of igneous or geothermal activity
 - g) on buttes or escarpments

It should be cautioned that this study was conducted solely by review of existing literature and data. No on-site work has been performed during the course of this study. Detailed investigations will be required to corroborate the opinions and conclusions reach in this preliminary investigation.

HISTORY AND DEMOGRAPHICS

The base industries for Western Montrose County was ranching and timber for many years. In the early 1950's, uranium exploration and development became the prominent industry in the area. Since that time, the economic viability of the area has been closely tied to that industry.

Because of this close association, it is believed that the proposed facility would be well received; particularly in view of the jobs that it would create. Much of the labor force is familiar with or trained in the handling of radioactive materials.

The 1980 preliminary census lists 3952 people in Western Montrose County with 1027 in Nucla and 819 in Naturita. It is believed, however, that this number is much lower now owing to the closing of most of the uranium mines and mills in the area.

REGIONAL GEOLOGY

The area covered in this report lies on the Northeastern flank of the Colorado Plateau and on the west edge of the San Juan Mountain Range. By definition, the area lies west of the Uncompahgre Plateau. The complex geology of the west end of the San Juan Mountains will not be discussed in this report as none of the candidate sites are involved in that geology. It should be mentioned for reference, however, that the San Juan Mountains represent extensive igneous activity resulting in significant mineralization. Some geothermal activity is still found in that area.

Of the candidate sites that will be discussed later, all are in the vicinity of either the Sagers-Nucla Syncline (Dolores River Syncline) or the Paradox Valley Anticline (1). The Paradox Basin has been eliminated from consideration because of the extensive faulting in the area.

In general, the geology of the area under consideration consists almost entirely of sedimentary or alluvial deposits. Most of these units are flat-lying or have very shallow dips except for areas of faulting and folding.

CANDIDATE SITES

Four sites have been selected which meet some or all of the criteria listed above and in Appendix A. All of these sites are within outcrops of Mancos Shale. This shale has been selected for several reasons.

1. It is uniform throughout the area.
2. It has been approved for radioactive waste disposal by the Colorado State Health Department and the Colorado Geological Survey (2).
3. The coefficient of permeability is commonly less than 10^{-6} centimeters per second.
4. This material is usually rippable or easily excavated with standard earthmoving equipment.
5. It is not considered an aquifer or source of potable water.
6. It's absorption and adsorption characteristics are generally conducive to radioactive waste disposal.

The four candidate sites are discussed individually below.

SITE #1 - DRY CREEK

Site Number One lies astraddle of Dry Creek approximately 2 miles southwest of the town of Naturita. Refer to Figure 1 for location and other data. This site lies in parts of Sections 26, 27, 28, 33, 34, 35, and 36, Township 46N, R16W. Most of the site lies south of Colorado Highway 90. Dry Creek is an intermittent stream that drains to the San Miguel River approximately two miles north of the site. The site has relatively gentle relief but is encompassed by steep hillsides to the north, west and south. This area is not in a general floodplain (local hydrology must be considered); is not in an active seismic area; contains no significant geologic structures such as faults or folds; has no history of igneous or geothermal activity; has no shallow groundwater problems, and no history of uranium mining in the immediate area.

Portions of the site have been used in the past for uranium mill tailings reprocessing and disposal by Ranchers Exploration and Development. This

project, which was completed approximately 5 years ago, took mill tailings from various sites in the area and reprocessed them by leaching in earthen tanks. The soluble uranium and accessory minerals were then extracted from the pregnant solution. This site is complete with 3 earthen tanks as well as several evaporation ponds. Process water was pumped up from the San Miguel River as attempts to drill a water well on the site proved unsuccessful (8). This site is now dormant and may be available for reopening or alteration.

Consideration was given to groundwater supplies within a 2 miles radius of Site Number 1. The Colorado State Division of Water Resources show only 5 permitted wells in this area. Of these 5 wells, three are in the shallow river gravels adjacent to the San Miguel River in the northwest quarter of Section 24. One well in the northeast quarter of Section 23 is reportedly 216 feet deep and yields 3 gallons per minute. The last well is reportedly in the southwest quarter of the southeast quarter of Section 27. This well was reported as 250 feet deep and yielding 30 gallons per minute. This well was reportedly drilled in 1967. Based on our knowledge of the area, we cannot verify the existence of this well. Its location may have been mis-reported. One of the reasons that we question the existence and/or yield of this well is the experience that was reported on the Ranchers Exploration site (8). From personal knowledge and as confirmed by conversation with others, Ranchers Exploration attempted to drill a water well on this site to 200 to 300 feet. This well reportedly yielded less than 5 gallons per minute. It is not known if this well was ever used in the project; however, the lack of record of it in the State files indicates that the well was never completed and was probably plugged and abandoned.

There are some possible disadvantages of this site for the purpose

expressed. The erosion rates may be unacceptably high; however, this problem can probably be solved with proper engineering and design. The thickness of the Mancos shale at this site is not known. It may be too thin to meet necessary criteria. There is a possibility of some uranium mining potential on the site.

Based on the data available to us so far, Site Number 1 appears to meet all or most of the site selection criteria.

SITE #2 - HOPKINS - MONTROSE COUNTY AIRPORT

A small band of Mancos shale surrounds the airport in parts of Section 13, T46N, R16W, and Sections 17, 18, 19, and 20, T46N, R15W, (see Figure 1). This site lies equidistant between the towns of Nucla and Naturita. Aside from its advantages such as accessibility, topography, and the features inherent in the Mancos Shale, this site has numerous disadvantages.

- . It is too near population centers (approximately 1-1½ miles).
- . It is close to perennial streams and/or irrigation.
- . Numerous sand and gravel deposits are in the area.
- . The site is adjacent to and may overlie mines or mineral resources.
- . The Mancos is a narrow band and likely to be quite thin.
- . Ten permitted water wells are known to exist within 2 miles of the site including four identified under Site #1, and other wells that range in depth from 80 to 345 feet and yield from 7 to 50 gallons per minute.

SITE #3 - UPPER MAILBOX PARK

Site #3 is located on an elongated bench between Maverick Draw and the San Miguel River in parts of Sections 31 and 32, T46N, R13W, and Sections

3, 4, 5, 9, 10, and 11 in T45N, R13W, (see Figure 2). This site lies approximately 4 to 6 miles northwest of Norwood. It is not served by state highways, although there are a number of county and ranch roads through the area. It has the advantage of being a relatively large mass of Mancos shale away from any population centers, however, it does not meet criteria for distances to perennial streams. Also, it could be considered to be on a butte and is adjacent to the very steep south wall of the San Miguel Canyon. No specific water well data was obtained, but groundwater is expected to be deep owing to the sites elevation above the river (approximately 800 feet). There is not significant faulting in the area except for the extreme east end of the outcrop where a fault crosses the San Miguel River and comes up onto the ridge.

The Mancos is likely quite thin in the area and erosion rates may be high. This site may have potential if sufficient area can be obtained which meets all distance requirements and if site access can be solved.

SITE #4 - EDMONDSON SPRING

The Edmonson Spring area is a site of a rather large Mancos shale deposit. This site is near the Montrose-Ouray County line in Townships 45 and 46 North, Range 10 and 11 West (see Figure 3). Edmondson Spring is the most identifiable feature in the area.

There are numerous springs in the area and Horsefly Creek runs through the center of the outcrop. There are some distinct disadvantages with this site that preclude it from further consideration:

- . The site is at a relatively high altitude (average elevation 8600 feet MSL) and receives considerable snowfall in winter.
- . There are no year-round paved roads to the site.

- . Shallow groundwater can be expected in meadows.
- . It will be difficult to stay at least 1 mile away from all perennial streams.
- . This area may be a critical wildlife habitat as it is a probable winter range for elk.

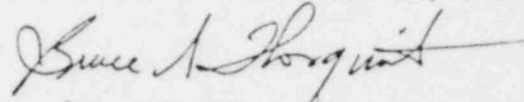
RECOMMENDATIONS

Based on the analysis of the four sites considered in this report, it is our opinion that Sites #2 and #4 are unusable because of many factors. Site #3 may be a viable site if certain conditions can be met. Site #1 is considered the primary objective and it is recommended that emphasis be put on further work on this site. Such work would include:

1. A detailed on-site geologic and soils testing program to define areas of shallow groundwater, thickness of Mancos Shale, permeability of shale and depth to potable groundwater (if any).
2. Negotiations with the Bureau of Land Management for land purchase or trade to obtain a sufficiently large block of land to justify the facility.
3. Investigation of groundwater or purchase of water rights to assure sufficient water for plant and facilities operation.
4. Contact with pertinent State and Federal agencies to obtain input and conditions for approval.

We will be happy to assist in all or part of the above services for which we are qualified. Thank you for this opportunity to serve you, if you have any questions, please contact me.

F. M. FOX & ASSOCIATES, INC.



Bruce A. Florquist, P.E.
Principal Geological Engineer

BAF/dkw





LOCATION PLAN

BIBLIOGRAPHY

- (1) Bush, A. L., Bromfield, C. S., and Pierson, C. T., 1959, Areal Geology of the Placerville Quadrangle, San Miguel County, Colorado, U. S. Geological Survey Bull. 1072-E.
- (2) Colorado State Department of Health and Colorado Geological Survey, 1980, A Report to the Legislature Concerning Hazardous Waste Generation and Disposal in the State of Colorado.
- (3) Cross, W. and Larsen, E. S., 1935, A Brief Review of the Geology of the San Juan Region of Southwestern Colorado, U. S. Geologic Survey Bull. 843.
- (4) New Mexico Geological Survey, 1981, Western Slope of Colorado.
- (5) Rocky Mountain Association of Geologists, Guidebook to the Geology of Colorado.
- (6) Rocky Mountain Association of Geologists, 1981, Geology of the Paradox Basin, Colorado.
- (7) Williams, Paul L., 1964, Geology, Structure and Uranium Deposits of the Moab Quadrangle, Colorado and Utah, U. S. Geological Survey Map I-360.
- (8) Zambrana, Bernard, 1982, Personal Communication.

APPENDIX A
SCOPE OF WORK

The contractor shall utilize its in-house expertise and existing data to conduct reconnaissance-level screening for candidate sites for disposal of low-level radioactive wastes and uranium mill tailings in western Montrose County, Colorado. These sites shall have a combination of natural conditions and land uses that will enhance long-term site stability and predictability, radio-nuclide retention and protection of public health and safety.

The contractor shall collect existing reconnaissance-level information on the geology, hydrology, topography, demography and resources of the region of interest. The contractor shall utilize (1) its in-house geologic and environmental literature, (2) existing maps of topography, geology, water resources and demography, (3) other readily available data bases, and (4) consultation, where appropriate, with state geological survey agencies. The data shall be analyzed against the following criteria to identify at least one suitable location (NOTE: Some of these are obvious; not in the area of interest, but are included for completeness):

GEOLOGY

1. Avoid areas where faulting, folding, high seismic activity or vulcanism may adversely affect site performance.
2. Avoid areas subject to excessive wind and/or water erosion, slumping, landsliding, mass wasting, or weathering.
3. Avoid areas with a complex lithology and geometry which may preclude characterization, defensible modelling, analysis, and monitoring.
4. Give preference to areas with relatively impermeable (10-6 centimeters per second or less) surficial and subsurface deposits to a depth of several hundred feet or more.
5. Give preference to areas of clays, silts, shales and dirty sands.
6. Give preference to areas with loose or weakly indurated surficial materials to a depth of 25 feet or more that can be trenched with a D-7 or D-8 bulldozer or dragline.

HYDROLOGY

1. Avoid wetlands.
2. Avoid areas within 100-year floodplains.
3. Avoid recharge zones for sole-source aquifers.
4. Avoid areas with high stream densities.

1. Avoid areas with a high seasonal groundwater table closer than about 40 feet to the surface.
2. Avoid areas with undesirable surface water features such as significant upstream surface water drainage from which the isolation of the location is not practical, hydrologic depressions, swampy conditions, etc.
3. Give preference to areas with long groundwater travel times to discharge locations and with soils that have high cation exchange capacities.
4. Avoid areas with major surface water supplies used for human consumption.
5. Avoid locations where groundwater originating from within the selected site discharges into a surface water body within the selected location.
6. Give preference to areas where groundwater aquifers are infrequently utilized for human consumption due to high concentrations of dissolved solids (greater than 1000 ppm).

TOPOGRAPHY

1. Avoid low-lying areas or those with significant topographic relief which may lead to slope failure, erosion, mass wasting, slumping, weathering, etc.
2. Give preference to large flat areas to expedite disposal design without significant alteration of the natural topography.

ENVIRONMENT

1. Avoid critical and/or unique wildlife habitats.
2. Avoid high-hazard areas, e.g., coastal areas subject to hurricanes, tsunamis, inland areas subject to severe tornadoes, etc.

SOCIO-ECONOMICS

1. Avoid high-population density areas.
2. Avoid areas with incompatible land uses or potentially valuable mineral and energy resources.
3. Avoid areas with high recreational potential.
4. Avoid historic areas.
5. Give preference to areas that are well connected by all-weather roads fully suited to truck traffic.