Colorado Department of Public Health and Environment
Radioactive Materials License 1102-01
Renewal Application

Volume 2 of 7

Contents:

Clean Harbors Environmental Services. 2005. *Radioactive Materials License Application, Clean Harbors Deer Trail, LLC, Hazardous Waste Treatment, Storage, Disposal Facility*

May 2010

Clean Harbors Deer Trail, LLC
108555 East Highway 36
Deer Trail, CO 80105-9611

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ACRONYMS AND ABBREVIATIONS

ALARA	as low as reasonably achievable
ASTM	American Society for Testing and Materials
BFI	Browning-Ferris Industries, Inc.
CAPCD	Colorado Air Pollution Control Division
CCR	Code of Colorado Regulations
CDOW	Colorado Division of Wildlife
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Liability, and Recovery Act
CFR	Code of Federal Regulations
CGS	Colorado Geologic Survey
CHDT	Clean Harbors Deer Trail
CQA	Construction Quality Assurance
CQC	Construction Quality Control
cm	centimeter
DIA	Denver International Airport
EPA	U.S. Environmental Protection Agency
ft^2	square foot
FWS	U.S. Fish and Wildlife Service
g	gram
GCL	geosynthetic clay liner
GMU	Game Management Unit
gpm	gallons per minute
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDPE	high-density polyethylene
HELP	Hydrologic Evaluation Landfill Performance (model)
km	kilometer
KPI	Key Performance Indicator
L	liter
lb	pound
LCRS	leachate collection and removal system
LDCRS	leak detection, collection, and removal system
LDR	Land Disposal Restriction
LLC	Limited Liability Company
µg	microgram
µR	microroentgen
m^3	cubic meter

MARSSIM	Multiagency Radiation Survey and Site Investigation Manual
mg	milligram
mrem	millirem
NAAQS	National Ambient Air Quality Standard
NCRP	National Council on Radiation Protection and Measurements
NORM	Naturally Occurring Radioactive Material
NRC	U.S. Nuclear Regulatory Commission
OJT	on-the-job training
pCi	picocuries
PM	particulate matter
QA	quality assurance
RCRA	Resource Conservation and Recovery Act
RSO	Radiation Safety Officer
sec	second
SIC	Standard Industrial Classification
SOP	Standard Operating Procedure
SSRB	Segregated Storm Water Retention Basin
TDS	total dissolved solids
TENORM	Technologically Enhanced Naturally Occurring Radioactive Material
TLD	thermoluminescent dosimeter
TSDF	treatment, storage, and disposal facility
TSP	total suspended particulates
UCDP	Uncontaminated Storm Water Detention Pond
USGS	U.S. Geological Survey
WAP	Waste Analysis Plan
WMU	Waste Management Unit
yd^3	cubic yard
yr	year

1.0 GENERAL INFORMATION

In 1980, the Highway 36 Land Development Company purchased property in Adams County, Colorado, and began a process to permit a portion of the property (the Deer Trail facility) for a hazardous waste treatment, storage, and/or disposal facility (TSDF). On November 12, 1987, Adams County issued a Certificate of Designation for the Deer Trail facility, currently owned by Clean Harbors Deer Trail (CHDT), to operate as a Resource Conservation and Recovery Act (RCRA) Subtitle C hazardous waste disposal facility. To receive the Certificate of Designation, CHDT conducted lengthy studies of the site, its geology and hydrogeology, environmental setting, potential environmental impacts, and engineering design. The State of Colorado evaluated and ultimately approved these studies before Adams County issued the Certificate of Designation.

This radioactive waste disposal license application allows for transfer of a specific and limited type of licensed radioactive material to CHDT for disposal. This application applies only to radioactive material consistent with the radionuclides found in Naturally Occurring Radioactive Material (NORM) and Technologically Enhanced Naturally Occurring Radioactive Material (TENORM), with concentrations that are less than the Colorado statutory definition of radioactive waste (C.R.S. § 25-11-201). However, because of waste-specific regulatory determinations, some of this waste could be licensed at the generating source and require disposal in a licensed disposal facility. The limited concentrations considered in this application comprise a total activity of less than 2,000 picocuries per gram (pCi/g) (natural uranium and thorium decay chain products only), with a maximum ^{226}Ra concentration less than 400 pCi/g. These materials will have external dose rates that are generally less than 100 microroentgens per hour (μR/hr), exclusive of background. This license application does not include radioactive waste in the broader definition of low-level radioactive waste, including other licensed forms of manmade radioactive materials.

The strategy of this license application is to limit the concentrations of NORM/TENORM waste to low levels so workers will be considered members of the public and radiation exposures will be limited to no more than 100 millirem per year (mrem/yr), with a goal of 25 mrem/yr or less. The ALARA (As Low As Reasonably Achievable) philosophy/process will be applied to limit potential doses. If worker dosimetry results indicate that selected worker doses could exceed

25 mrem/yr, an assessment will determine the potential for other manmade exposures for these workers to ensure that maximum individual doses from manmade sources will not exceed 100 mrem/yr. Rather than hypothetical members of the public, this assessment will consider real individuals working at Deer Trail because they will have the highest potential for exposure.

In support of the May 2001 rulemaking, "Storage, Treatment, Transportation, and Disposal of Mixed Wastes" (FR 66, pp. 27218 – 27266), the U.S. Environmental Protection Agency (EPA) contracted with the Research Triangle Institute to prepare a report on the containment effectiveness of low-level radioactive waste disposal facilities regulated under 10 CFR 61 in comparison to Subtitle C RCRA facilities regulated under 40 CFR 260-299 (EPA 2001). In summary, the report concluded that Subtitle C RCRA disposal facilities provide ground-water protection similar to U.S. Nuclear Regulatory Commission (NRC)-regulated low-level radioactive waste disposal facilities and would be protective of long-term human health and the environment. The EPA report also concluded that NRC-regulated low-level radioactive waste disposal facilities would be protective of human health and the environment for the disposal of RCRA hazardous wastes following the prescribed Land Disposal Restrictions (LDR) treatment for containerized waste. Although there might be some issues regarding bulk waste disposal and closure conditions, the report based its general conclusions on the similarities of the overall facility designs and estimates of long-term performance regarding ground-water protection.

CHDT has streamlined this radioactive materials disposal license application to include by reference much of the existing information developed during the technical evaluations and approval process for the Certificate of Designation for the Deer Trail RCRA Subtitle C hazardous waste landfill. This is appropriate because much of this information is the same and CHDT proposes to accept for disposal only NORM/TENORM wastes at relatively low concentrations and dose rates. Because CHDT is proposing to accept only limited concentrations of NORM/TENORM waste for treatment, storage, and/or disposal, and no other forms of low-level radioactive waste, CHDT proposes to provide financial assurance pursuant to State of Colorado and Federal environmental regulations consistent with its status as a RCRA Subtitle C landfill, rather than the financial assurance information requested in 10 CFR 61.61 and 61.62. In addition, CHDT will conduct closure consistent with the technical and financial conditions specified in the regulations for a RCRA Subtitle C facility. For ease of review, Volumes 2

through 6 of this application contain key documents developed as part of the RCRA Permit process. This application cites references to the reports in Volumes 2 through 6 in **bold (including the supporting volume number)**; references not in Volumes 2 through 6 are not in bold. Reference lists at the end of each major section contain both types of references.

1.1 INTRODUCTION/BACKGROUND

Extensive site selection studies supported the RCRA approval process for the Deer Trail facility as a hazardous waste TSDF. These studies are outlined in a report from the Colorado Department of Health, Waste Management Division titled *Technical Guidelines on Siting of Hazardous Waste Disposal Facilities* (CDH 1982a). The studies include a site description report, an engineering geological data report, a hydrologic report, and a meteorologic/climate data report. The results of these studies were summarized in an initial two-volume report developed by the (then) owners, Browning-Ferris Industries, Inc. (BFI), titled *Chemical Waste Treatment/Solidification & Disposal Facility Plan* **(BFI 1981 – see Volume 2 of this application).**[1] According to the BFI report, the site was selected from among several candidate sites based on a number of favorable factors consistent with existing and anticipated environmental protection regulations. Although the geologic strength of the Adams County site was of prime importance, important site selection considerations and requirements included:

- Suitable geologic conditions,
- Convenient location near waste sources,
- Sparsely populated area,
- Good transportation access,
- No anticipated adverse environmental impacts,
- Availability of utilities,
- Land availability and site size requirements,
- No nearby airports,
- Favorable topography,
- Soils suitable for liner material,
- Not within a corridor of growth (i.e., remote location),

[1] For ease of review, references in **bold** are in Volumes 2 through 6 of this application.

- Not within a fault zone,
- Not within a 100-year floodplain,
- Not within a wetland area,
- No impact on endangered or threatened species and critical habitats,
- Extensive buffer zone,
- Not within an aquifer recharge zone, and
- Favorable evaporation rates with minimal rainfall (BFI 1981).

BFI submitted the 1981 plan and reports to Adams County and the State of Colorado for review and evaluation pursuant to the regulations of the Colorado Solid Waste Act (30-20 C.R.S. 1973, as amended). In response to the request for review, the Colorado Department of Health established a technical review group consisting of nine State agencies, with an emphasis on intensive public input. The lead agency was the Colorado Department of Health, Waste Management Division. Representatives of this division conducted or attended 11 public meetings across Eastern Colorado, and collected 231 questions that were submitted to BFI for response. The original submittal and comment responses from BFI completed the application package, which was sent to the Department of Health for a Finding of Fact from the State. In a letter dated March 19, 1982, the Waste Management Division determined that (CDH 1982b):

> *the site proposed by Browning-Ferris Industries would be able to comply with the regulations adopted by the Board of Health pursuant to Section 25-15-208 of the Hazardous Waste Act C.R.S. 1973 as amended, if it was constructed and operated in accordance with the designs and procedures contained in the application documents...*

Following this Finding of Fact from the State, BFI revised, updated, and resubmitted the 1981 plans and reports in final form to Adams County and the State of Colorado **(BFI 1982 – see Volume 3 of this application)**. The Adams County Community Development Department then requested that the Waste Management Division provide a final Finding of Fact regarding the proposed BFI Chemical Waste Treatment/Solidification and Disposal facility to determine if the facility design and operation would be in compliance with the regulations adopted by the Board of Health pursuant to the Hazardous Waste Act (25-15-208 C.R.S. 1973, as amended). Again,

the Waste Management Division led a technical review group consisting of nine State agencies, with an emphasis on public input. Throughout the technical review, the Division conducted or attended 14 public meetings across Eastern Colorado. In a letter dated January 17, 1983, the Waste Management Division again issued a Finding of Fact from the State that determined that the site would be able to comply with the regulations adopted pursuant to the Hazardous Waste Act. Further, the Division stated that its Finding of Fact *is buttressed by the evaluations of independent consultants retained by the Environmental Protection Agency, Adams County, and the City of Aurora.*

On August 15, 1983, at a regular meeting of the Adams Board of County Commissioners, the Board unanimously adopted a resolution granting the application for a Certificate of Designation and Conditional Use Permit to operate the Adams County hazardous waste treatment and disposal facility, subject to a set of conditions. The conditions included obtaining all necessary State and Federal permits, providing detailed engineering and construction drawings, and installing and operating all required monitoring facilities.

After issuance of these Findings of Fact, the EPA received and reviewed extensive hydrogeologic information for the Adams County site, and met with the State of Colorado and the owner/operator. Based on the additional information, Marcia Williams, Director of the EPA Office of Solid Waste, wrote a Memorandum on November 14, 1986 to Robert L. Duprey, Director of EPA Region VIII, indicating:

> *Based on this additional information, we now believe that the site has been adequately characterized in terms of its geology and hydrogeology for purposes of permit issuance. Since the hydrogeological characterization is now complete, it does not represent an impediment to final permit issuance.*

On November 23, 1986, Robert L. Duprey, EPA Region VIII, sent final EPA comments to the Colorado Waste Management Division, stating:

> *In general, our review has shown that your Division, while faced with writing a very complex and precedent setting permit, was able to meet the challenge*

and has drafted a permit which is well designed and protective of human health and the environment.

At the conclusion of litigation regarding the permit process, on November 12, 1987, Adams County, Colorado, officially issued a Certificate of Designation for the Hazardous Waste Disposal Site.

In parallel with the permit approval process for the Deer Trail facility, the Colorado Geologic Survey (CGS), Department of Natural Resources, conducted an evaluation to find suitable low-level radioactive waste disposal sites in Colorado **(CGS 1986 – see Volume 3 of this application)**. This evaluation was the initial step in a site selection process conducted by the Rocky Mountain Low-Level Radioactive Waste Compact. For its evaluation, the CGS used a comprehensive process to identify and select candidate areas and representative sites based on a detailed technical analysis of geologic, geohydrologic, and geotechnical parameters important to radioactive waste disposal. The evaluation gave primary emphasis to natural mechanisms that would promote long-term isolation of the waste from man and the environment. It identified areas of Colorado that had stable geology, with thick layers of relatively impermeable shale containing little, if any, useable ground water. The CGS established a Geotechnical Rating Matrix system that considered various important geologic factors, assigned a ranking for each factor, and translated the ranking into a numeric score to provide a comparison among candidate sites. The matrix scores could range from a perfect score of 120 down to zero (a highly unsuitable site). The Adams County site is in the Central Plains Candidate Area identified by the CGS, underlain with the Pierre Shale formation. The Adams County site ranked with the highest scoring sites and the CGS indicated that it *should be considered as having a very high potential for safe, long-term disposal of radioactive wastes* **(CGS 1986 – see Volume 3 of this application)**.

The process used to site and permit the Deer Trail facility under RCRA was thorough and complete, and largely based on the process outlined for disposal of uranium mill tailings, which is quite similar to the process for licensing low-level radioactive waste disposal facilities. This means that the technical evaluation of the Deer Trail site was as thorough and complete as the process used to site and license radioactive waste disposal facilities under 6 CCR 1007-1,

Radiation Control, Part 14, *Licensing Requirements for Land Disposal of Low-Level Radioactive Waste*. Therefore, the strategy used in this license application relies on referencing the technical information originally developed for obtaining the Certificate of Designation, wherever possible, and providing supplemental information regarding the slightly radioactive properties of the identified NORM/TENORM waste.

1.2 GENERAL FACILITY DESCRIPTION

The Clean Harbors Deer Trail, LLC facility (commonly referred to as the Deer Trail facility) is an existing hazardous waste management facility that provides treatment, storage, transfer, and disposal services for a variety of hazardous and nonhazardous waste from a variety of industries. The EPA identification number for the Deer Trail facility is COD 991300484. The Colorado Department of Public Health and Environment (CDPHE) has issued Hazardous Waste Part B Permit No. CO-98-02-26-01. The services provided by the facility are best described under Standard Industrial Classification (SIC) Code 4953 – Refuse System Waste Disposal.

Figure 1.1[2] is an aerial photograph of the Deer Trail Facility, which consists of the following major features:

- Landfills
- Waste Treatment and Container Storage Building
- Bulk Waste Container Storage Areas
- Contaminated Water Tanks
- Wastewater Treatment Plant
- Facility Maintenance Building
- Operations Building
- Administrative Office Building

Figure 1.2 shows a general layout of the Deer Trail facility. Because the Deer Trail facility is an existing hazardous waste treatment storage and disposal facility, CHDT does not anticipate construction of any new infrastructure to manage NORM/TENORM waste materials.

[2] Note, figures appear after the references at the end of this section.

Additional pertinent information is as follows:

Facility Address: Clean Harbors Deer Trail, LLC
108555 East U.S. Highway 36
Deer Trail, Colorado 80105

Facility Contact: Jack Kehoe
General Manager
Telephone Number: (970) 386-2293

1.2.1 Land Use/Property/Buffer Zone Description

The Deer Trail facility is on the north side of Highway 36, approximately 70 miles east of Denver, in Adams County, Colorado. Figure 1.3 is a map showing the general location of the facility. Clean Harbors owns approximately 5,760 acres, of which approximately 325 acres comprise the Deer Trail facility. Section 2 of this application contains a complete description of the property.

The site is relatively flat and is characterized by broadly rolling topography. The site is on the Pierre shale, which is an estimated 4,300 feet thick. The Pierre shale is a gray to black, silty, fossiliferous, marine shale. Elevations at the site range from 4,800 feet to 4,910 feet above mean sea level. Figure 1.4 is a topographic map of the facility and the surrounding location. The climate of the eastern plains is characterized by cold winters, hot summer days and cool nights, abundant sunshine, and low but variable precipitation.

The Deer Trail facility is on former unirrigated farmland. The surrounding property is used for unirrigated production of dry land wheat, sunflowers, and grasslands for grazing cattle. There are no residential areas, industrial areas, schools, colleges, hospitals, convalescent homes, or day care centers within a 1-mile radius of the facility. The property is zoned as A-3. Figure 1.5 is the Adams County zoning map.

Within the context of this license application the terms "property" and "facility" have different meanings. The property consists of the disposal facility plus the buffer zone and the additional 5,760 acres owned by Clean Harbors Deer Trail, LLC. The disposal facility is on 325 acres

currently permitted by the State of Colorado for the treatment, storage, and disposal of hazardous waste.

The buffer zone has been established in accordance with 10 CFR 61.52 and 6 CCR 1007-1-14.2 under the disposal unit and between the disposal units and the property boundary. The size of the currently designated buffer zone area far exceeds the Colorado guideline of 30 meters discussed in *License Application Guidelines for Land Disposal of Low-Level Radioactive Waste in Colorado* (SC 1985). The purpose of the buffer zone is to provide an area to perform environmental monitoring and enable implementation of corrective actions.

1.2.2 Principal Features

The principal features at the Deer Trail RCRA Subtitle C hazardous waste disposal facility include landfills, a waste treatment building, contaminated water tanks, a wastewater treatment plant, a facility maintenance building, a laboratory/office building, and an administrative office building. Figure 1.2 shows the facility layout and general relationship between these major features. The following section briefly describes these features, which will apply to both hazardous and NORM/TENORM waste.

1.2.2.1 Landfill Units

The Deer Trail facility is permitted for seven secure disposal cells. The approximate volume of each cell is:

- Cell 1: 173,000 cubic yards
- Cell 2: 220,600 cubic yards
- Cell 3: 480,240 cubic yards
- Cell 4: 491,840 cubic yards
- Cell 5: 472,120 cubic yards
- Cell 6: 433,840 cubic yards
- Cell 7: 466,320 cubic yards

The total maximum permitted capacity is 2,737,960 cubic yards. At present, Cell 1 is full to capacity, capped, and closed. Cell 2 is operational and has a remaining capacity of

approximately 30,200 cubic yards. Cell 3 is partially excavated in preparation for liner system construction. All the cells will be excavated to have the entire floor set on unweathered Pierre shale.

Landfill Cells 1 and 2 and all future cells have been or will be constructed with the following liner system from bottom to top:

- A 3-foot-thick compacted clay liner with a maximum permeability of 1×10^{-7} centimeter per second (cm/sec);
- An 80-mil, high-density, polyethylene (HDPE) geomembrane liner;
- A geocomposite (geonet and geotextile fabric) leak detection, collection, and removal system (LDCRS);
- A 3-foot-thick compacted clay cap with a maximum permeability of 1×10^{-7} cm/sec;
- An 80-mil HDPE geomembrane cap liner;
- One foot of sand over the geomembrane cap liner acting as a leachate (precipitation infiltration) collection and removal system (LCRS); and
- A 2-foot-thick compacted protective soil layer to cover the cap.

The side-slope liner system consists or will consist of the following from bottom to top:

- A 4.5-foot-thick compacted clay liner with a maximum permeability of 1×10^{-7} cm/sec;
- An 80-mil HDPE geomembrane liner;
- A geocomposite LDCRS;
- A 3-foot-thick compacted clay liner with a maximum permeability of 1×10^{-7} cm/sec;
- An 80-mil HDPE geomembrane cap liner;

- A geocomposite cap LCRS; and
- A 1.5-foot-thick protective soil cover layer to cover the cap.

Figure 1.6 shows a cross-section of the typical existing landfill liner systems.

The purpose of the LCRS and LDCRS is to intercept, collect, and remove leachate in the landfill. The LCRS for Cell 1 is on the base of the cell and consists of 10 lateral pipes and 1 header pipe. Nine of the lateral pipes are connected to the header pipe and the remaining lateral pipe drains into a 36-inch-diameter reinforced concrete riser pipe that rises vertically out of the sump. As the secure cell was filled, the concrete riser pipe was extended vertically. The LDCRS sump for Cell 1 is accessed by 14-inch-diameter HDPE side-slope riser pipes placed near the corner of the cell on a 2:1 slope.

The LCRS in Cell 2 consists of two leachate collection pipes that drain to the leachate collection sump and a layer of geonet that extends across the base of the secure cell beneath the geotextile layer, covered with gravel; the geotextile cushion is wrapped around the gravel. There are three leachate collection system clean-out pipes, and a geonet flush pipe is in the corner of the cell near the access ramp and along the toe of the access ramp slope. The leachate collection system drains and is accessed by a 24-inch HDPE riser pipe at the corner of the slope. Leachate enters the pipe through a 19-foot-long, perforated pipe at the bottom of the sump. The HDPE pipes used for access to the LCRS, the LDCRS, and the permanent sump have a 1-foot perforated section with a perforated HDPE end cap at the bottom of the pipe. Access to the LCRS sump on Cell 2 is through the 18-inch-diameter HDPE side-slope riser pipes that were trenched into the corner of the cell. The liquid in the sump enters the pipe along the bottom of the sump through a perforated section of the pipe.

An onsite wastewater treatment system treats the leachate collected from Secure Cell 1 and Secure Cell 2 before discharge. The brine water that contains high concentrations of dissolved solids during wastewater treatment is disposed of off the site. The Deer Trail facility generates approximately 600,000 gallons of leachate per year.

The final cover for each Deer Trail landfill will provide long-term minimization of migration of liquids into the underlying waste, function with minimum maintenance, promote drainage and

minimize erosion, accommodate settlement and subsidence, and have a permeability less than or equal to 1×10^{-7} cm/s.

Each disposal cell cover will consist of the following layers, from top to bottom. These layers are shown on Drawing 25 of the Conceptual Site Development Drawings in the *Permit Renewal Report for Incorporation of a Geosynthetic Clay Liner (GCL) in the Liner Section for Secure Cells 3 Through 7 and in the Cover Section for Secure Cells 1 Through 7,* hereinafter referred to as the *Permit Renewal Report* **(CHDT 2004 –see Volumes 4 and 5 of this application).**

- An 8-inch vegetative cover (with topsoil);
- A 3-foot general fill soil cover to protect the underlying geomembrane from frost and erosion;
- A geocomposite drainage layer consisting of geonet with nonwoven geotextile thermally bonded to both sides;
- An 80-mil textured HDPE geomembrane;
- A GCL; and
- A 0.5-foot (minimum) interim soil cover.

The covers will be sized to close each disposal cell adequately. Cells 1 and 2 are approximately 600 feet long by 300 feet wide; Cells 3 through 7 will range in length from 700 to 900 feet and have widths of approximately 500 feet. Section 3.0 of this application contains further information on the design and construction of the disposal unit covers.

1.2.2.2 Waste Treatment Building

The Waste Treatment Building is permitted to store and treat a wide variety of hazardous wastes that cannot be disposed of directly in a landfill. The treatment process uses pozzolonic and/or other reagents to solidify and/or treat waste to meet EPA LDR standards. The process modifies the chemical and/or physical characteristics of the waste to enable subsequent placement in a

landfill. This system will be used only for selected NORM/TENORM wastes that contain liquids or sludge that would not be acceptable for direct bulk disposal.

The Waste Treatment Building is a fully enclosed metal fabricated building with an air purification (e.g., particulate removal) system. This system consists of ductwork and fans that move air through a baghouse outside the building. Hazardous waste treatment occurs in nine treatment mixing basins, designated A-1, A-2, A-3, A-4, D-1, D-2, D-3, and Basins B and C. The treatment mixing basins and the process equipment containing basins are constructed of reinforced concrete with a protective, sacrificial steel liner installed inside the basins. Basins A-1, A-2, A-3, D-1, and D-2 have an approximate capacity of 150 yd^3 each. Basin D-3 has an approximate capacity of 300 yd^3. Basins B and C have an approximate capacity of 600 yd^3 each. The maximum treatment capacity of the unit is approximately 2,400 yd^3 per day.

The entire foundation of the Waste Treatment Building is underlain by a liner system. The liner system consists of the following from bottom to top:

- Three feet of compacted clay;
- A 40-mil HDPE geomembrane;
- A geocomposite leachate collection/leak detection system;
- Three feet of compacted clay; and
- An 80-mil HDPE geomembrane.

The size of a designated waste storage and staging area in the western portion of the treatment building is approximately 120 feet by 60 feet. The maximum storage/staging capacity in mixing tanks is approximately 600 cubic yards. Waste materials, reagents, and/or water are together in the mixing tanks with an excavator. After a determination that the waste meets applicable LDR standards, the waste is removed from the mixing tanks, placed into offroad dump trucks, and transported to the landfill for disposal.

1.2.2.3 Container Management Building

The Container Management Building is a fully enclosed metal building with a concrete floor designed to receive, store, and manage containerized (drums, supersacks, tri-wall boxes, totes, etc.) waste. It is connected to and located in the southeast section of the Waste Treatment

Building, but is separated from the Waste Treatment Building by a common wall, where a container (e.g., drum) shredder is located. The Container Management Building is underlain with the same liner system as the Waste Treatment Building, which is described in the previous section.

Hazardous, nonhazardous, and NORM/TENORM wastes in liquid, sludge, or solid form are or will be stored in containers in this building prior to treatment, storage, disposal, or transfer to another facility. The building's curbed concrete floor was designed and constructed to be sufficiently impervious to leaks, spills, and accumulated precipitation until such occurrences can be detected and removed. In addition, the concrete is coated with a chemical-resistant impervious material. The Container Management Building is separated into two sections. The floor design provides separate storage areas to allow segregation of incompatible wastes. Each storage area in the Container Management Buildings is sloped with a minimum 3% grade to a collection trench. Each collection trench has a capacity of 220 gallons. The combined capacity of the collection trench and sloped area of each segregated storage area is more than 440 gallons. The combined capacity of the collection trench and the sloped area of the drum unloading area is more than 2,200 gallons.

The maximum capacity of the container management building is 33,000 gallons (11,000 gallons for Class I/II hazardous wastes and 22,000 gallons for Class III hazardous wastes).

1.2.2.4 Bulk Container (Roll-Off Bin) Storage Areas

The Deer Trail facility has two concrete areas for storing bulk solid waste for treatment, storage, disposal, or transfer. These areas are known as Container Storage Areas A and B. Container Storage Area A is east of the Maintenance Building in the southeast corner of the process area. The maximum capacity of Container Storage Area A is 2,000 cubic yards. Container Storage Area B is west of the Waste Treatment Building; its maximum capacity is 1,000 cubic yards. See Figure 1.2 for a general facility layout map.

1.2.2.5 Contaminated Water Tanks

The Contaminated Water Tanks are two above-ground, dish-bottomed, steel tanks. The purpose of the tank system is to store leachate containing hazardous materials from the landfill prior to treatment in the Waste Water Treatment Plant. The tanks are lined with Tenemac Series 104.

1.2.2.6 Wastewater Treatment Plant

The Deer Trail facility has a 5,000-square-foot Wastewater Treatment Plant, which can treat 360,000 gallons a day. The wastewater to be treated includes landfill leachate, truck/equipment washwater, laboratory-derived wastewater, contaminated storm water, drained free liquids, and wastewater recovered from pumping wells. The wastewater is stored in the Contaminated Water Tanks and treated before discharge. The wastewater treatment system employs a metal removal technology that is based on alkaline coprecipitation with ferric hydroxide via ferric sulfate and lime addition, followed by filtration, carbon absorption, and reverse osmosis.

1.2.2.7 Facility Maintenance Building

The Deer Trail facility has a fully enclosed 12,000-square-foot metal Facility Maintenance Building. The purpose of this building is repair and maintenance of facility equipment, which includes earthmoving equipment (bulldozers, compactors, excavators, etc.), trucks, company vehicles, and other process equipment. The maintenance building includes office space for maintenance personnel, eight service bays, a storage area for part and supplies, and tanks for fuels and lubricants.

A truck wash on the east side of the building has a recycling system to reuse washwater. This system consists of two above-ground, elevated, conical-bottom, fiberglass tanks with a minimum shell thickness of 0.18 inch. An additional corrosion allowance has been added to the minimum thickness of each surface. The maximum capacity of each tank is 1,650 gallons, for a total maximum capacity of 3,300 gallons. Water from the truck wash system is sent to the Contaminated Water Tanks and treated, as described in Section 1.2.2.5.

1.2.2.8 Operations Building

The Operations Building is a 7,200-square-foot building divided into three basic areas. The east side of the building contains laboratories. The west side contains the first aid, training, and

decontamination areas. The south end contains the office area. The main laboratory area, with an area of 500 square feet, is directly adjacent to the Sample Station (outside the building), so waste samples can be brought directly into the laboratory. A small lounge and rest room for use by truck drivers while they wait for analysis of their loads is just south of the main laboratory. Directly north of the main laboratory are three smaller laboratories and offices for use by laboratory technicians. At the northwest corner is the employee training and first aid room, with the Safety Director's office at the rear.

The main central portion of the west half of the Operations Building is the decontamination area for hazardous and NORM/TENORM waste. This consists of men's and women's shower rooms, locker rooms, and the boot wash. The employee lunchroom is directly south of the decontamination area. Across the south end of the building are four offices used by the General Manager and the Senior Facility Compliance Manager, among others.

1.2.2.9 Administration Building

The Administration Building is a one-story structure near the entrance to the Deer Trail facility near Highway 36. In addition to records storage, this building is used for public meetings with local residents. The building area is 3,674 square feet, with more than 2,300 square feet of office space. An electrical adapter mounted to an exterior wall enables the hookup of a generator for emergency power.

1.2.3 Restricted Areas

The limited concentrations considered in this application comprise a total activity of less than 2,000 pCi/g (natural uranium and thorium decay chain products only), with a maximum ^{226}Ra concentration less than 400 pCi/g. These materials will have external dose rates that are generally less than 100 μR/h, exclusive of background. This application does not include radioactive waste in the broader definition of low-level radioactive waste, including other licensed forms of manmade radioactive materials. Because of the low dose rates that would occur, all areas of the facility are considered to be unrestricted in terms of potential radiation dose. However, the Deer Trail facility will have designated areas with access restricted as defined in 6 CCR 1007-1-1.4. These will include the immediate areas surrounding the disposal cells and areas of the Treatment Building and laboratory. The primary reasons for these

restrictions are to protect workers who might be in proximity to hazardous materials (including NORM/TENORM waste), and to restrict public access to the facility and surrounding property.

1.2.4 Ground-Water Users

A survey of registered wells within a 6.2-mile radius of the permit area was conducted in conjunction with the preparation of this application using records of the Colorado State Engineer. Figure 5.4.13 of the technical report submitted to Adams County in support of the Certificate of Designation Application includes records for the 369 wells on the site and within a 6.2-mile radius **(BFI 1981 – see Volume 2 of this application).**

More than half of these wells are on the site and within a one-half-mile buffer zone. The facility operator uses most of these wells for ground-water monitoring. Of the wells used for water supply, most are within the Pierre Shale bedrock, capturing small, discontinuous lenses of ground water in this otherwise relatively impermeable formation. A few of the shallower wells might capture limited alluvial ground water in the valleys of the larger intermittent streams in the area such as Beaver and Wetzel Creeks. Water supply wells range in depths from 20 to 480 feet with a mean depth of 52 feet and a median depth of 40 feet.

Yields of the water supply wells range from 3 to 175 gallons per minute (gpm) with a mean of 15.6 gpm and a median of 10 gpm. Table 2-6 in Section 2.4.2.10 lists uses for the water supply wells.

Water in the Pierre Shale is generally of poor quality (high in total dissolved solids and suspended sediments). For more detailed information on water quality, refer to Section 2.4 of this application.

1.2.5 Utilities

Key utilities for the Deer Trail RCRA Subtitle C landfill include telephone communications, electric power, propane and other fuel services, drinking water, and sanitary waste disposal. None of these utilities has been identified as a critical component in nuclear safety accident situations because the landfill handles bulk waste and relies on passive performance of safety features. This means that redundant features, such as backup power supplied by diesel generators, are not needed. For routine and emergency use, the Deer Trail facility is serviced by telephone communications via surface lines and by cellular phone service to the General

Manager and key staff members. In addition to the site telephone system, the facility has site-wide intercom paging and alarm warning systems. In addition, two-way mobile radio systems are used for communicating with personnel in operational areas. Electrical service is supplied to the site by overhead transmission lines from a county substation. There are no natural gas lines supplying the facility. For indoor heating, the Deer Trail facility has three large tanks that store propane for gas furnaces. Additional gasoline and diesel storage is provided for onsite vehicles. Sanitary waste disposal is provided through septic tanks for human sewage and the county garbage collection services for other solid waste. Because of the local scarcity of potable water, drinking water is provided through a bottled water service. Other service water is supplied by tanker truck with onsite storage.

1.2.6 Surface-Water Control Features

Surface-water drainage will be controlled to minimize its potential to contact waste and cause erosion at the Deer Trail facility. The Conceptual Site Development Drawings in Volume I of the *Permit Renewal Report* **(CHDT 2004 – see Volumes 4 and 5 of this application)** show the surface-water drainage patterns to be established during the different phases of disposal cell activities. The surface-water drainage pattern at the end of disposal activities at the Deer Trail facility will generally reflect the drainage pattern present at the facility prior to construction of the disposal cells. The facility's central location on a knoll enables the natural drainage of surface water away from the disposal cells in all directions.

Site drainage features include storm water drainage channels, drop structures (as required to reduce channel slopes and consequential erosion), culverts, and erosion control structures such as temporary ridges, swales, or straw bales. All of the site's drainage features included as a design criterion of 8.2 inches in 24 hours. Section 3.0 of this application contains further information on the design and construction of the surface-water control features.

1.2.7 Intruder Barriers

The remote location of the Deer Trail facility provides primary intruder protection. In addition, the thickness of the covers lessens the potential that future human activity would breach the multiple layers of the covers to the extent that waste would become exposed. Intrusion of the

disposal cells in this manner would require more than the normal excavation effort expected for the area. Section 6.2 of this application contains a detailed discussion of intruder protection.

1.2.8 Boundaries and Markers

A land surveyor registered in the State of Colorado found or established boundaries at the Deer Trail facility in accordance with the survey controls described in Section 4.3 of this application. A registered land surveyor lays out the boundaries and grades for the landfills, using the benchmarks as a reference. Following initial excavation and periodically during operation, a registered land surveyor surveys the open cell for as-built drawings. At closure, as-built drawings are filed with the facility permanent records. As-built drawings show the coordinate system and the coordinates and upper elevations of the waste placed in the cells. Permanent markers will be placed to locate the closed cells.

1.2.9 Survey Control Program

The initial construction phase of the Deer Trail facility began on November 4, 1980, after the facility received "interim status" under the EPA's hazardous waste management program. Full site characterization, including legal surveys of the property, aerial reconnaissance, and field reconnaissance, were completed and reported in the BFI *Technical Report* **(BFI 1982 – see Volume 3 of this application)**. Section 5.3 of the BFI *Technical Report* contains a full legal description of the property and a certified copy of the boundary survey.

1.2.10 Site Utilization Plan

The disposal units and their configurations, land features, roadways, buildings, and equipment are described in other portions of this Section and are discussed throughout this license application. Determination of the sequence for development of the disposal cells is orderly and considered minimizing surface disturbance, promoting worker safety, and facilitating closure and long-term stability. Engineering drawings and specifications are referenced in appropriate sections of this license application. Aside from the information presented in the current Deer Trail RCRA Part B Permit and this license application, no future land use is anticipated or planned. The BFI *Technical Report* **(BFI 1982 – see Volume 3 of this application)** contains additional information about the technical basis of the Deer Trail facility.

1.2.11 Storage and Waste Handling

When waste arrives at the Deer Trail facility, inspections occur at the weigh station just inside the perimeter fence. These inspections ensure compliance with RCRA Permit requirements. Section 4.1 of this license application describes waste acceptance procedures. Once accepted for disposal, the shipment is moved to the Bulk Container (Roll-Off Bin) Storage Area or to the Waste Treatment Building if treatment is required. Sections 4.2 and 4.3 of this application contain further details of waste handling. In some instances, it might be necessary to store waste temporarily prior to final disposal. Waste could be stored in the transport vehicle or in a designated storage area in the Controlled Area. The length of time the waste will be stored in such a manner depends on the reason for storage, such as conformance to waste acceptance parameters, equipment availability, site conditions, or construction. In no case will waste be permanently stored in this manner.

1.2.12 Decontamination Areas

The Deer Trail facility has two primary decontamination areas for hazardous and NORM/ TENORM waste; a truck/equipment wash station and a personnel decontamination area for control of potentially contaminated protective clothing. The wastewater truck/equipment washwater is stored in the Contaminated Water Tanks and treated before discharge. The purpose of the truck/equipment wash station, which is on the east side of the Facility Maintenance Building, is to recycle the washwater, thereby minimizing potential liquid effluents. The main central portion of the west half of the Operations Building contains the personnel decontamination area, including men's and women's showers and a boot wash station.

1.2.13 Physical Security

The Deer Trail facility prevents unknowing entry and minimizes the possibility for unauthorized entry of persons or livestock in accordance with 6 CCR 1007-1-14.20. CHDT controls entry at all times through fences, gates, doors, and other entrances to the site; an 8-foot, chain-link fence topped with barbed wire surrounds the facility. The fence includes additional gates at the south, east, and west sides of the facility. In addition, CHDT has posted warning signs at the entry gate and at a maximum of 200-foot intervals along the perimeter fence. The signs read "Danger - Unauthorized Personnel Keep Out."

1.2.14 Equipment and Equipment Storage

Facility equipment for disposal of NORM/TENORM waste is the same as the equipment currently in use for hazardous waste disposal operations at the facility. Disposal cells are excavated using normal earthmoving and construction equipment such as scrapers, bulldozers, and graders. Equipment maintenance occurs routinely at the Maintenance Building. Some minor repairs might occur in other areas of the facility if practicable. Equipment not in use could be stored south of the Maintenance Building area.

1.2.15 Excavated Materials

Prior to the start of excavation of a cell, a written excavation plan is prepared. The plan indicates the areas and sequence of excavation, and the anticipated classification of the excavated material (e.g., structural or general fill, clay liner material). CHDT reviews and approves the plan. The excavation contractor takes into account that the stockpiling portion of the excavation plan could be modified during construction based on the results of any conformance testing of the excavated material required by the Quality Assurance Plan (see Section 9.0 of this application).

Excavated materials classified as fill are stockpiled in designated areas free of incompatible soil, clearing debris, or other objectionable materials. Stockpile areas are shown on the Construction Drawings or as designated by CHDT. Excavated material classified as spoil is segregated from fill and stockpiled or disposed of in the manner shown on the Construction Drawings or as specified by the Owner. The CHDT General Manager assists in the determination of what excavation material is select fill or spoil material. Stockpiles of fill or spoil material are no steeper than 3:1 (horizontal:vertical) or other slope approved by CHDT, graded to drain, sealed by tracking parallel to the slope with a bulldozer or other means approved by CHDT, and dressed daily during periods of active placement of fill from the stockpile. The excavation contractor can cover fill stockpiles with plastic sheeting or other material approved by CHDT to preserve the moisture content of the fill. Stockpiles that remain out of active use for a period longer than 7 months are either covered or stabilized by revegetation in accordance with RCRA Permit requirements. The excavation contractor cannot remove fill material from the project site without the prior written approval of CHDT.

1.3 SCHEDULES

As stated above, the Deer Trail facility is an existing hazardous waste TSDF and, as such, does not anticipate construction of any new infrastructure to manage NORM/TENORM waste materials. The facility will be ready to accept NORM and TENORM waste for disposal as soon as the State issues a Radioactive Materials License. CHDT does not anticipate closure of the facility for at least 30 years.

1.4 INSTITUTIONAL INFORMATION

Under 6 CCR 1007-1, Part 11: *Special Land Ownership Requirements* (1998), through this application CHDT is applying for an exemption from the land ownership requirements of §25-11-103 (7). The basis for this request is that the Control Requirements defined in Part 11 are consistent with the control requirements already in place under the RCRA Permit for the Deer Trail facility. This applies specifically to the demonstration of control, including financial assurances, the institutional control program, restrictive covenants, deed annotations, easements, as-built drawings, and transfer of records. Closure of the facility will be consistent with the requirements provided under RCRA.

1.5 CONFORMANCE TO REGULATORY GUIDES

As stated in Section 1.1, the strategy used in this license application relies, where possible, on referencing the technical information originally developed for obtaining the Certificate of Designation and providing supplemental information on the radioactive properties of the NORM/TENORM waste. This means that the application gives preference to the historical requirements enforced under RCRA in developing, reviewing, and approving the supporting environmental analyses. Because this application is only for disposal of a specific and limited type of radioactive material consistent with NORM/TENORM radionuclides at relatively low concentrations (not the broader categories of low-level radioactive waste defined by regulation), disposal operations and facility management and closure will be consistent with RCRA Permit requirements. Further, because the facility currently operates under the terms and conditions in its RCRA Permit, there is little conformance with the applicable NRC regulatory guides. However, this application addresses the requirements under 6 CCR 1007-1, Radiation Control, Part 14: *Licensing Requirements for Land Disposal of Low-Level Radioactive Waste*, and covers

the major areas identified in *License Application Guidelines for Land Disposal of Low-Level Radioactive Waste in Colorado* (SC 1985). For ease of review, this license application follows the format recommended by the NRC in NUREG-1199 (NRC 1991).

1.6 SUMMARY OF PRINCIPAL REVIEW MATTERS

The radiological safety analysis supporting this low-level radioactive waste disposal license application identified no major technical licensing issues, apart from the overall strategy that relies on referencing the technical information originally developed for obtaining the Certificate of Designation wherever possible to streamline the process. This application provides supplemental information on the radioactive properties of the identified NORM/TENORM waste, the determination of waste acceptance criteria, and the relevant occupational and public health and safety concerns.

Under 6 CCR 1007-1, Part 11: *Special Land Ownership Requirements* (1998), through this application CHDT is applying for an exemption from the land ownership requirements of §25-11-103 (7). The basis for this request is that the Control Requirements defined in Part 11 are consistent with the control requirements already in place under the RCRA Permit for the Deer Trail facility. This specifically applies to the demonstration of control, including all financial assurances, the institutional control program, restrictive covenants, deed annotations, easements, as-built drawings, and transfer of records.

To facilitate the licensing process, CHDT has met with representatives of the CDPHE on NORM/TENORM waste disposal issues. In addition, NORM/TENORM issues were discussed in a public meeting on September 29, 2004, at the Deer Trail facility. The purpose of the meeting was to provide an overview of the RCRA Class III Permit Modification and to receive public comments. The permit modifications included allowing receipt of NORM/TENORM waste with a total activity of less than 2,000 pCi/g (natural uranium and thorium decay chain products only), and with a maximum ^{226}Ra concentration less than 400 pCi/g, consistent with the radionuclides and concentrations requested in this license application.

1.7 REFERENCES CITED

6 CCR 1007-1, Radiation Control, Part 11: *Special Land Ownership Requirements* (Effective March 1998).

6 CCR 1007-1, Radiation Control, Part 14: Licensing Requirements for Land Disposal of Low-Level Radioactive Waste.

10 CFR 61. 1990. *Licensing Requirements for Land Disposal of Radioactive Waste.*

10 CFR 61.61. 2002. *Subpart E – Financial Assurances: Applicant Qualifications and Assurances.*

10 CFR 61.62. 2002. *Subpart E – Funding for Disposal Site Closure and Stabilization.*

Adams County, State of Colorado. 1983. Resolution Containing Findings of Fact, Conclusions of Law, and Orders Granting the Applications of Highway 36 Land Development Company for a Certificate of Designation and a Conditional Use Permit to Operate a Hazardous Waste Disposal Facility in Adams County. Case No. 147-82-C-CD (August 15, 1983).

Adams County, State of Colorado. 1987. Certificate of Designation for the Deer Trail Hazardous Waste Disposal Site. November 12, 1987.

Browning-Ferris Industries, Inc. (BFI). 1981. *Chemical Waste Treatment/Solidification & Disposal Facility Plan.* Volume I - Technical Report. Highway 36 Land Development Company, Adams County, Colorado, Draft for Review and Comment (provided in Volume 2 of this application).

Browning-Ferris Industries, Inc. (BFI). 1982. *Chemical Waste Treatment/Solidification & Disposal Facility Plan.* Volume I - Technical Report. Highway 36 Land Development Company, Adams County, Colorado, Revised October 1982 (provided in Volume 3 of this application).

Clean Harbors Deer Trail (CHDT). 2004. Permit Renewal Report for Incorporation of a Geosynthetic Clay Liner (GCL) in the Liner Section for Secure Cells 3 Through 7

and in the Cover Section for Secure Cells 1 Through 7 (the Permit Renewal Report – provided in Volumes 4 and 5 of this application).

Colorado Department of Health (CDH). 1982a. *Technical Guidelines on Siting of Hazardous Waste Disposal Sites*. Submitted by Kenneth L. Waesche, Acting Director, Waste Management Division.

Colorado Department of Health (CDH). 1982b. March 19, 1982. Letter to the Adams County Commissioners from Kenneth L. Waesche, Acting Director, Waste Management Division: Finding of Fact for Site Designation.

Colorado Department of Health. 1983. January 17, 1983. Letter to the Adams County Commissioners from Kenneth L. Waesche, Acting Director, Waste Management Division: Finding of Fact for Site Designation.

Colorado Geological Survey (CGS). 1986. *Candidate Area Evaluation Report, Low-Level Radioactive Waste Disposal, Colorado*. Open File 86-7 (provided in Volume 3 of this application).

C.R.S. Title 25, Article 11, *Radiation Control*, Part 2, *Radioactive Waste Disposal,* § 201, *Definitions.*

C.R.S. Title 30-20, Article 101. 1973. *Solid Waste Disposal Sites and Facilities Act.*

State of Colorado. 1985. License Application Guidelines for Land Disposal of Low-Level Radioactive Waste in Colorado. Denver, Colorado.

U.S. Nuclear Regulatory Commission (NRC). 1991. Standard Format and Content of a License Application for a Low-Level Radioactive Waste Disposal Facility. NUREG 1199, Rev. 2. Washington, D.C.

U.S. Environmental Protection Agency (EPA). November 14, 1986. Memorandum to Robert L. Duprey, Director Waste Management Division, Region VIII from Marcia Williams, Director, Office of Solid Waste: Adequacy of Site Characterization.

U.S. Environmental Protection Agency (EPA). November 23, 1986. Letter to Kenneth L. Waesche, Director Waste Management Division from Robert L. Duprey, Director Waste Management Division, Region VIII: Final EPA Comments – Permit Protective of Human Health and the Environment.

Figure 1.1. Aerial Photograph of the Deer Trail Facility.

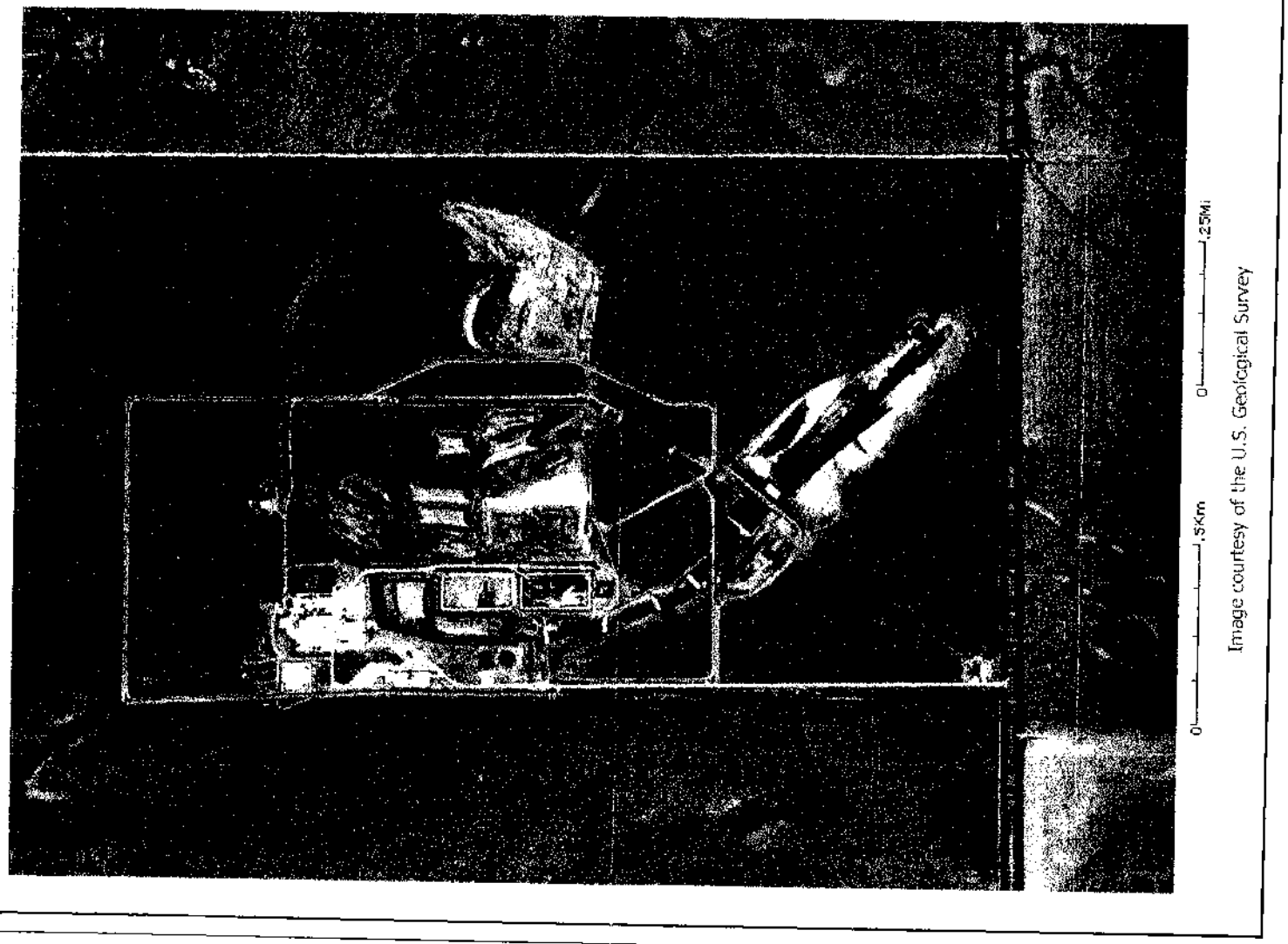


Figure 1.2. General Layout of the Deer Trail Facility.

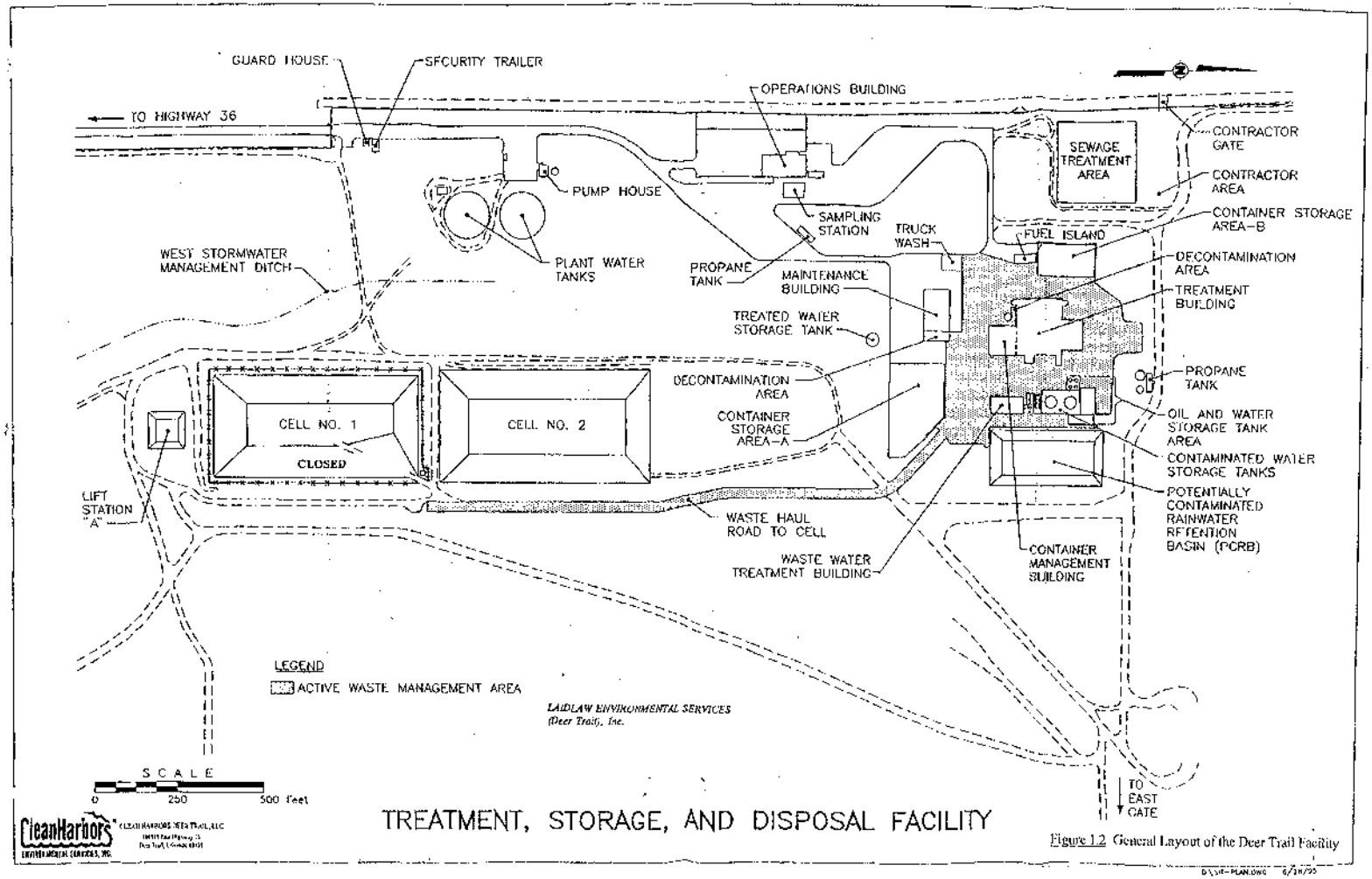
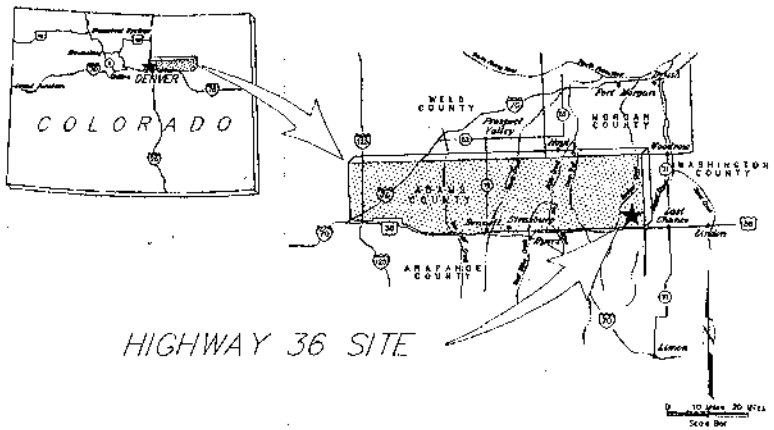
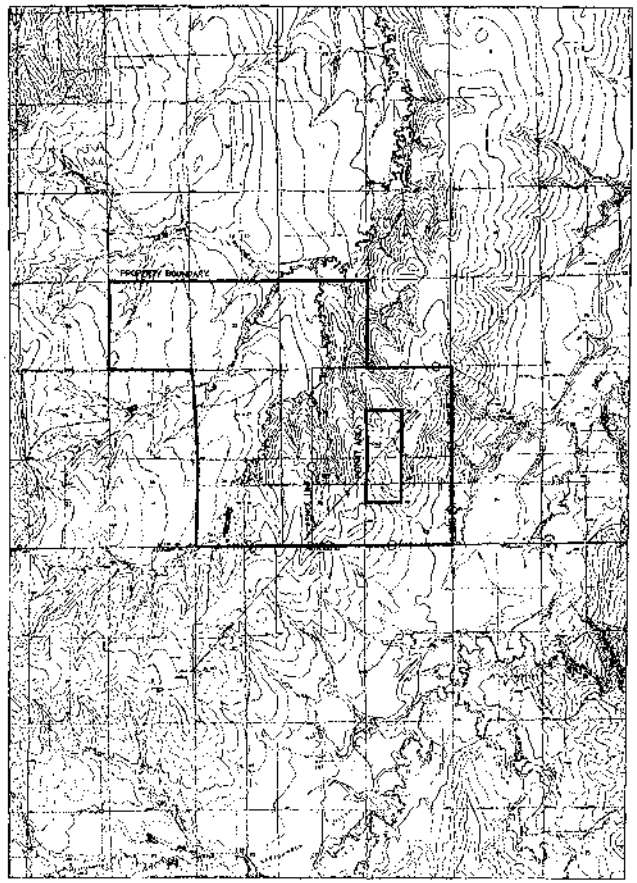


Figure 1.2 General Layout of the Deer Trail Facility

Figure 1.3. Regional Map with the General Location of the Deer Trail Facility.





GENERAL NOTES

Figure 1.3 Regional Map With the General Location of the Deer Trail Facility

Figure 1.4. Topographic Map of the Deer Trail Facility and Surrounding Area.

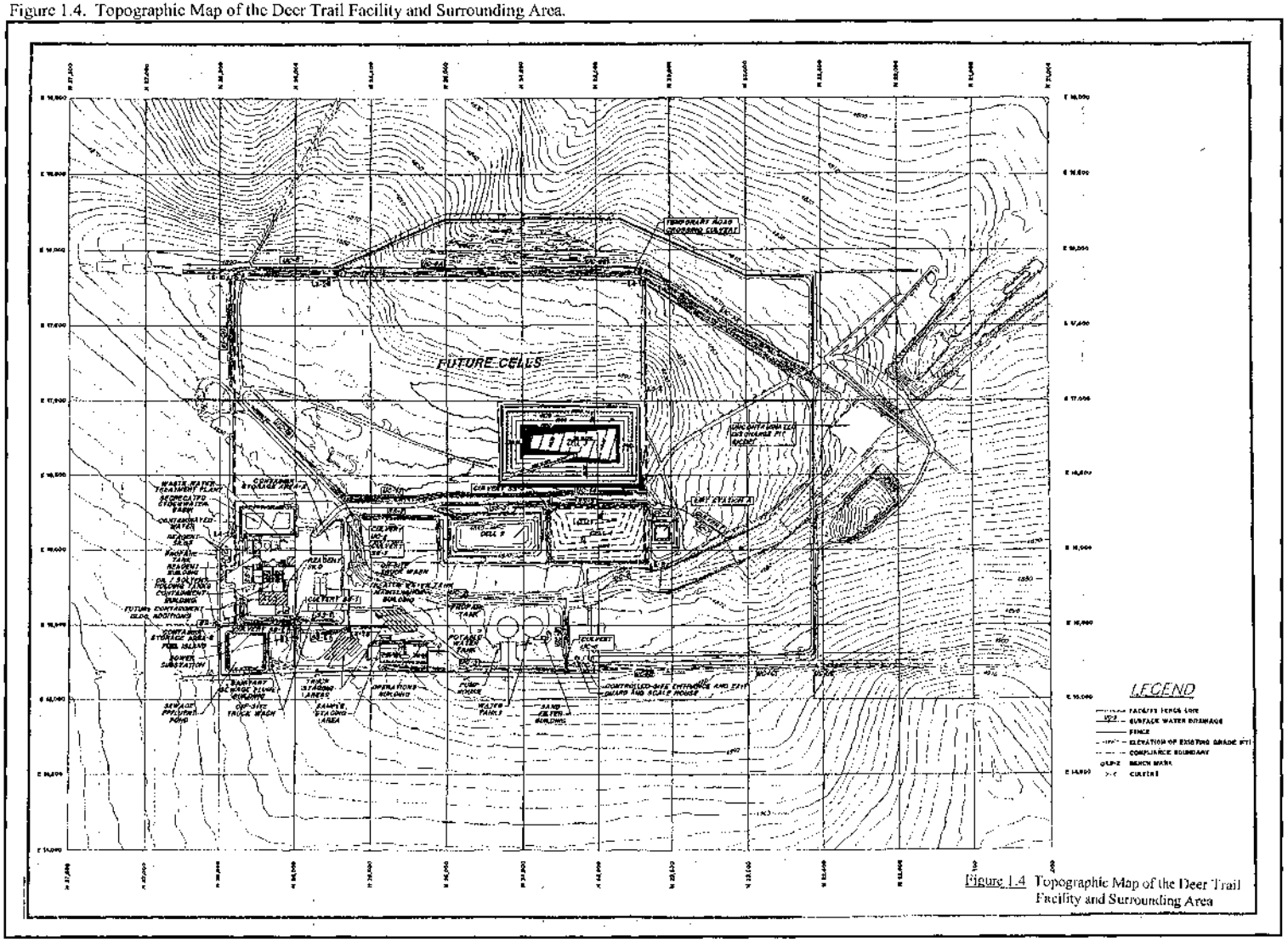
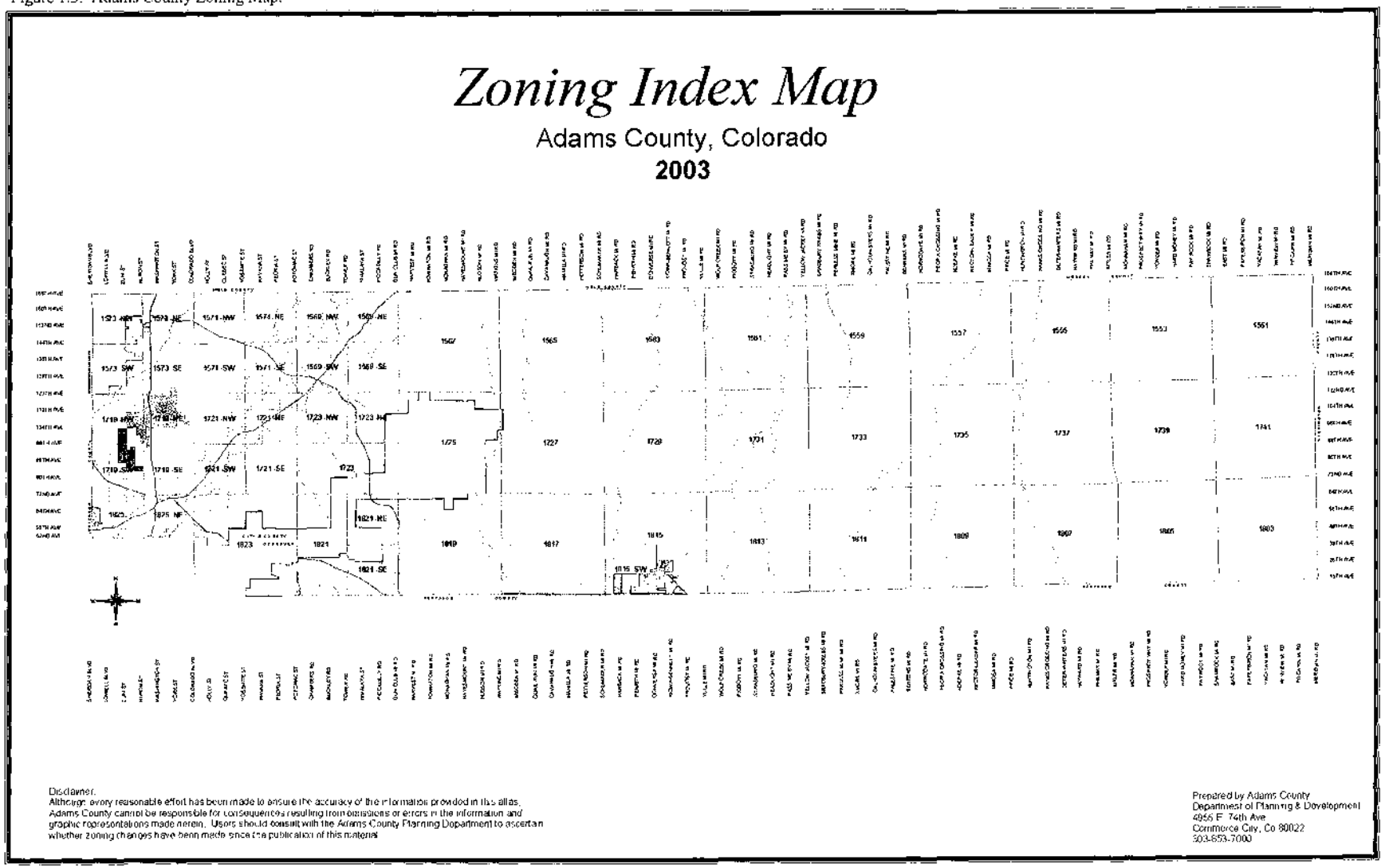


Figure 1.5. Adams County Zoning Map.



2.0 SITE CHARACTERISTICS

Since 1980, there have been numerous field investigations, studies, and reports related to the Deer Creek facility. In general, these consist of three different groups:

- Investigations, studies, and reports conducted in the early 1980s that were part of the site selection process and the application for a Certificate of Designation from Adams County. A two-volume draft and final report developed by the initial owners, Browning-Ferris Industries, Inc. (BFI), *Chemical Waste Treatment/Solidification & Disposal Facility Plan*, summarizes or references these reports **(BFI 1981 and 1982 – see Volumes 2 and 3, respectively, of this application)**.[3]

- Investigations, studies, and reports that pertained to the development of the Resource Conservation and Recovery Act (RCRA) Part B Permit Application for a hazardous waste treatment, storage, and/or disposal facility (TSDF). These reports, developed in the mid to late 1980s, provided baseline data for ground water, surface water, soils, and air as part of the RCRA Part B Permit Application process. Examples include an evaluation by the Colorado Geologic Survey **(CGS 1986 – see Volume 3 of this application)** and an analysis of pertinent weather factors for the site **(Crow 1987 – see Volume 6 of this application).** The current *Permit Renewal Report* summarizes additional information from this group of investigations, studies, and reports **(CHDT 2004 – see Volumes 4 and 5 of this application)**.

- Routine and nonroutine monitoring reports developed to demonstrate compliance with applicable Hazardous Waste Facility Permit condition(s). Examples include the ground-water protection program **(McCulley, Frick, and Gilman 1997 – see Volume 6 of this application)**, and the 2003 Annual Ground Water Monitoring Report **(Cameron-Cole 2004 – see Volume 6 of this application)**.

The following information is based on information from these three groups of reports. The full reports in Volumes 2 through 6 of this application contain more information.

[3] For ease of review, references in **bold** are in Volumes 2 through 6 of this application.

2.1 GEOGRAPHY, DEMOGRAPHY, AND FUTURE DEVELOPMENTS

The following sections describe the geographical location of the Deer Trail facility, information on the population of Adams County and near the Deer Trail facility, and future developments.

2.1.1 Site Location and Description

The Clean Harbors Deer Trail hazardous waste TSDF is approximately 70 miles east of Denver and 7 miles west of Last Chance, Colorado, off U.S. Highway 36. The facility is in Adams County, Colorado, as shown in Figure 1.3. It is in Sections 25 and 36, Township 3 South, Range 57 West. The legal description of these two sections is as follows:

> *All of Sections 25 and 36, Township 3 South, Range 57 West of the sixth prime meridian, Adams County, Colorado; except an apparent utility easement across Sections 25 and 36 and except an easement and right-of-way for the purpose of constructing, reconstructing, operating, and maintaining a 6 inch oil pipeline, granted to Arapahoe Pipeline Company by the State of Colorado, acting by and through the State Board of Land Commissioners, affecting Sections 25 and 36, excepting right-of-way for ditches or canals, reserved in United States patents recorded in Book 106, page 201, affecting the north half of Section 25; also Book 99, page 201, affecting the south half of Section 25; and excepting the east 30.00 feet of Section 25; also excepting the east 30.00 feet of Section 36 to be dedicated to Adams County, and except the south 100.00 feet of Section 36.*

This document uses the following terms to define specific areas of the 5,760 acres owned by Clean Harbors:

- **Facility:** The approximately 325 acres that the State of Colorado currently permits for treatment, storage, and disposal of hazardous waste. This area is described as the southwest quarter of Section 25 and the northwest quarter of Section 36.

- **Property:** The 5,435 additional acres that surround the facility. This land serves as a buffer zone and isolates the facility from potential development.

2.1.2 Topography and Surface-Water Drainage

As described in the Browning-Ferris Industries, Inc. (BFI; the previous owners) *Technical Report* **(BFI 1982 – see Volume 3 of this application)**, the Deer Trail facility area is characterized by broadly rolling topography. Nearby small creeks are in relatively wide flat areas. The facility is drained by a tributary to Beaver Creek to the east and Wetzel Creek to the west. Beaver and Wetzel Creeks, which are ephemeral in nature, are composed of highly erodable clay-loam soils. In the undeveloped portions of the drainage basins, the ground cover is predominantly native grassland. Figure 1.4 is a United States Geological Survey (USGS) 7.5-minute topographical map of the area around the facility. The facility is well drained with little rainfall run-on. The surface slope of the facility ranges from flat to about 6%.

2.1.3 Nearby Facilities

As described in the BFI *Technical Report* **(BFI 1982 –see Volume 3 of this application)**, the Deer Trail facility is in an area of eastern Colorado that is characterized by agricultural activities. There are no nearby industrial facilities that would affect baseline environmental conditions in relation to the disposal of Naturally Occurring Radioactive Material (NORM)/Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) waste in accordance with the site suitability requirements of 10 CFR 61.50, Disposal Site Suitability Requirements for Land Disposal, and NUREG-0902. Section 2.9 discusses the preoperational monitoring plan in detail.

CHDT believes that future industrial growth potential in the area around the facility is minimal. Since 1987, the operation of the facility has not spurred industrial growth in the area. The original developer chose the facility site because of its favorable geologic conditions, low population density, good access, and general remote location. These features, which make the area attractive for hazardous and radioactive waste disposal, make the area unlikely to attract industrial, manufacturing, or wholesale activities.

2.1.4 Population Distribution

As described in the BFI *Technical Report* **(BFI 1982 – see Volume 3 of this application)**, a 1981 house-to-house survey identified 95 residential structures within 10 miles of the facility property boundary. In 1997, the number of housing units within 10 miles of the boundary was identified from aerial photographs taken in 1993. There appeared to be no significant change in

the number of housing units between 1981 and 1993. Residential units within 10 miles of the facility are primarily farmhouses. The residential unit nearest to the facility is about 0.5 mile east of the southeast corner of the property boundary in the south half of Section 31, Township 3 South, Range 56 West.

There are no towns or cities with a population greater than 10,000 persons within a radius of 31 miles of the facility. The only community within a 10-mile radius is Last Chance, which is an unincorporated town with a population of approximately 15 people. Transient populations in the region are generally associated with agricultural activities. However, no transient populations have been identified within 6 miles of the facility. The BFI *Technical Report* **(BFI 1982 – see Volume 3 of this application)** contains additional details.

2.2 METEOROLOGY AND CLIMATOLOGY

This section summarizes and updates climate and meteorological information presented in earlier reports and applications for the Deer Trail facility. Data have been extracted from BFI Technical Reports **(BFI 1981 and 1982 – see Volumes 2 and 3, respectively, of this application),** and an analysis of pertinent weather factors for the site **(Crow 1987 – see Volume 6 of this application).** The current *Permit Renewal Report* **(CHDT 2004 – see Volumes 4 and 5 of this application)** summarizes additional information from site investigations, studies, and reports. This section presents updated data on precipitation and wind near the facility area. It presents wind climatology data for the closest long-term reporting location, Denver Stapleton Airport, in a format that can be used for air dispersion modeling.

2.2.1 Climate

The climate of the eastern plains of Colorado is classified as continental steppe, characterized by cold winters, hot summer days and cool nights, abundant sunshine, and low but variable precipitation. On average, the spatial distribution of temperature on the eastern plains tends to be fairly consistent with little annual variation between locations within 50 miles of each other. However, because more than 60% of the annual precipitation occurs during late spring and summer as thunderstorms, spatial variations in precipitation exist between neighboring locations. The precipitation regime is influenced by two major features. Air masses moving across Colorado from the southwest and the northwest lose a large portion of their moisture over the

Rocky Mountains. Conversely, air masses entering Colorado from the south or southeast can transport moisture from the Gulf of Mexico. The influence of moisture from the Gulf region produces the largest amounts of spring and summer precipitation with thunderstorms.

2.2.1.1 Climatological Data

Earlier documents on the Deer Trail facility presented data for Byers, Colorado, as representative of conditions at the facility **(BFI 1981 and 1982 – see Volumes 2 and 3, respectively, of this application)**. However, because less moisture is available for precipitation as air masses move west, Byers (approximately 27 miles west-southwest of the facility) could be drier than the facility. A comparison of annual precipitation data collected since 1989 at Byers and at Lindon, Colorado (approximately 16 miles east of the facility), confirms that Byers is drier (Table 2-1). A similar comparison of annual precipitation data from Akron, Colorado (approximately 39 miles northeast of the facility), and Lindon suggests that Akron is probably more representative of the facility than Byers.

Table 2-1. Comparison of Akron, Byers and Lindon Annual Precipitation.

Year	Akron	Lindon	Byers
1989	13.55	12.74	12.14
1990	20.88	17.41	13.84
1991	14.89	15.29	17.83
1992	14.02 [1]	15.11	15.22
1993	17.71	17.03	16.97
1994	12.76	12.18	11.12
1995	20.65	21.54	18.17

Notes: 1. No data for July

Because of the similarity between Lindon and Akron precipitation data, Akron data were used in support of the RCRA Permit process rather than data on onsite precipitation, temperature, humidity, evapotranspiration, and significant meteorological event.

Table 2-2 lists long-term climatology data from Akron for 1950 to 1995. These data were obtained from the Natural Resources Conservation Service, Centralized Forecasting System Computer, Western National Technical Center, Portland, Oregon. Comprehensive long-term wind data are not available from the facility or other nearby locations, including Akron. Therefore, wind data from Denver Stapleton Airport and Denver International Airport (DIA)

Table 2-2. Akron Climatology, 1950-1995
TAPS Station: AKRON 4 E, CO0109
Start yr. -1950 End yr. -1995
Temperature: 42 years available out of 78 requested in this analysis.
Precipitation: 42 years available out of 78 requested in this analysis.

	Temperature (°F)						Precipitation (inches)				
	Avg. Daily	Avg. Daily		2 years in 10 will have		Avg. # of grow		2 years in 10 will have		Avg. # of days	Avg Total
Month	Max	Min.	Avg.	Max Temp >than	Min Temp <than	deg days*	Avg.	Less than	More than	w/.1 or more	Snowfall
January	37.6	12.5	25.0	64	-16	8	0.36	0.10	0.62	1	4.6
February	43.1	17.5	30.3	71	-14	28	0.33	0.12	0.57	0	3.5
March	50.4	24.0	37.2	77	-5	96	0.95	0.31	1.47	2	5.9
April	59.6	32.3	46.0	86	10	240	1.68	0.72	2.49	4	4.5
May	69.6	42.5	56.1	91	26	502	3.06	1.40	4.49	6	0.1
June	81.5	52.1	66.8	101	36	798	2.41	1.18	3.47	5	0.0
July	89.0	57.8	73.4	104	44	1,013	2.76	1.47	3.89	5	0.0
August	86.6	56.1	71.4	101	43	939	2.11	0.86	3.17	4	0.0
September	78.2	46.9	62.5	98	26	667	1.06	0.25	1.74	2	0.2
October	65.5	34.5	50.0	88	13	341	0.81	0.24	1.38	2	1.2
November	49.0	22.5	35.8	77	-2	77	0.68	0.24	1.06	1	7.0
December	39.4	14.4	26.9	68	-17	16	0.43	0.12	0.70	1	5.0
Yearly											
Average	62.5	34.4	48.4								
Extreme	107.0	-32.0		105	-22						
Total						4,726	16.65	11.60	18.74	33	32.2

Average number of days per year with at least 1 inch of snow on the ground: 36.
A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (Threshold. 40.0°F).

were used. The most recent 9 years (1984 to 1992) of wind data for Stapleton was obtained from the U.S. Environmental Protection Agency (EPA) Regulatory Air Models Bulletin Board. Data for DIA, which were available only for March 1995 to April 1997, were obtained from the Desert Research Institute, Western Regional Climate Center, Reno, Nevada.

2.2.1.2 Temperature

The average annual temperature is 48.4°F, with an annual monthly average range of 25.0°F in January to 73.4°F in July. Maximum temperatures range from 37.6°F in January to 89.0°F in July, while minimum temperatures range from 12.5°F in January to 57.8°F in July. A statistical analysis of the 35-year data indicates the maximum temperature will exceed 100°F two times in a 10-year period during June, July, and August. Minimum temperatures will fall below -15°F two times in a 10-year period during December, January, and February.

2.2.1.3 Precipitation, Humidity, and Evapotranspiration

The 30-year climatology data for Akron indicate an annual precipitation average of 16.65 inches, which is in general agreement with the 7 years of Lindon data (annual average of 15.90 inches). Considerable variation occurs from year to year. As listed in Table 2-1, annual precipitation has ranged from 12.76 to 20.88 inches at Akron and from 12.18 to 21.54 inches at Lindon in just 7 years. The average relative humidity is approximately 40% during the daylight hours and 62% at night. Relative humidity is slightly higher during the winter.

On average, the sun shines approximately 70% of possible sunlight hours annually. Moisture loss from soils through evaporation and transpiration exceeds precipitation from the middle of June to the early part of November. During this period, the moisture supply on the upper 3 to 12 inches of soil is depleted below the wilting point, and plants must depend on summer rain for additional growth. The normal mean lake evaporation is approximately 55 inches per year, with approximately 74% occurring from May to October. Table 2-3 lists the approximate annual distribution of evaporation.

Precipitation in a 24-hour period varies from none to more than 2.00 inches, depending on the proximity and intensity of thunderstorms or large-scale weather systems. *Analysis of Pertinent Weather Factors Related to the Permit Application for Proposed Highway 36 Waste*

Table 2-3. Mean Evaporation for Project Area.

Month	Mean Monthly Evaporation (inches)
January	1.6
February	1.8
March	2.5
April	3.7
May	5.0
June	7.4
July	8.8
August	8.4
September	6.7
October	4.6
November	3.0
December	1.9
Annual Total	55.4

Management Facility **(Crow 1987 – see Volume 6 of this application)** presented an analysis of 24-hour maximum precipitation occurrences. That document presented daily precipitation totals during June, July, and August for various locations through 1986. Appendix A of that document contains equivalent data for Akron from 1987 to 1995 and for Lindon from 1989 to 1995.

Two-inch precipitation totals in 24 hours are fairly rare events. Two inches or more of precipitation in 24 hours has been observed only three times at Akron and Lindon since 1989, or approximately an average of once every 3 years. Crow's report documented the occurrence of 2-inches-in-24-hours precipitation events at selected reporting locations in eastern Colorado for 1949 to 1986 (Table 2-4). Significant precipitation events ranged from once every 3.7 years at Byers to once every 9.2 years at Parker and Joes. Akron's occurrence of once every 4.1 years from 1949 to 1986 agrees reasonably well with the occurrence of once every 3 years during the past 6 years.

Table 2-4. Two-Inch Precipitation in 24-Hour Periods at Locations near Deer Trail Project.

Location	Distance/Direction from Project	Number of Events	Average Event Interval
Akron	39 miles northeast	9	4.1
Byers	27 miles west-southwest	10	3.7
Deer Trail	19 miles southwest	7	5.3
Hoyt	27 miles northwest	6	6.2
Hugo	44 miles south-southeast	8	4.6
Joes	54 east-southeast	9	4.1
Parker	58 miles west-southwest	4	9.2
Seibert	54 miles southeast	7	5.3
Shaw	16 miles southeast	4	9.2
Simla	45 miles south-southwest	8	4.6

2.2.1.4 Significant Meteorological Events

The area experiences thunderstorms approximately 50 days per year from late spring to early fall. Although the occurrence of tornadoes or severe thunderstorms with large hail and

damaging winds is uncommon, these phenomena can occur with any thunderstorm. The period for the highest probability of tornadoes and severe thunderstorms is from the middle of May through the end of June. Small hail and weaker tornadoes can occur at any time throughout the summer.

2.2.1.5 Wind

The nearest meteorological station with a sufficiently long period of record of required observations is Denver Stapleton Airport. Data from 1984 through 1992 were used to determine air sampling system configuration. The wind data from Denver Stapleton Airport were downloaded from the EPA Regulatory Air Models Bulletin Board. The data were formatted for input into the EPA computer program WRPLOT to generate a table of wind direction and frequency and a windrose that presents the data graphically. The Stapleton wind has a distinct prevailing direction from the south through south-southwest, and a secondary prevailing direction from the north. While DIA has a predominant wind from the southwest, the wind is more evenly distributed around the compass. Differences in the two wind roses might be due to the brief period of record for DIA. Table 2-5 compares winds from the two Denver airports. Wind flow and atmospheric stability are best evaluated using the longer period of record at Stapleton. The DIA data are not suitable for this analysis because the period of record is limited to 2 years.

Table 2-5. Comparison of Stapleton and DIA Winds (Stapleton 1984-1992; DIA March 1995-April 1997).

Direction	Stapleton % Occurrence	DIA% Occurrence
N	8.0482	6.1553
NNE	4.2376	5.5280
NE	7.3770	5.5868
ENE	3.9196	5.2209
E	4.1933	5.1751
ESE	5.7254	4.4956
SE	7.2790	5.8481
SSE	8.2687	7.3968
S	14.3869	6.2794
SSW	11.3177	9.4550
SW	4.7483	9.8275
WSW	1.9794	5.8808

Direction	Stapleton % Occurrence	DIA% Occurrence
W	2.4825	5.5410
WNW	3.8118	5.5476
NW	4.4619	4.4041
NNW	5.0449	3.8552
Calm	5.7178	3.8029
1-3	9.0519	5.0575
4-6	40.1650	27.7574
7-10	30.3376	36.1670
11-16	11.7435	21.1840
17-21	2.2126	4.3910
>21	0.7717	1.6401

The data show that winds from the south-southwest through the east-southeast (five sectors) account for 47% of all occurrences, and winds from the north account for an additional 8%. All

remaining 10 sectors combined account for only 39% of the occurrences. It is calm 6% of the time. Attachment 1 to the RCRA Permit Renewal **(CHDT 2004 – see Volume 4 of this application)** contains the reference windrose. Joint frequency tables and graphic windrose plots were prepared for the Stapleton and DIA wind data.

2.2.1.6 Air Quality

The EPA and the Colorado Department of Public Health and Environment have established National Ambient Air Quality Standards (NAAQS) for six air pollutants, known as "criteria pollutants." For the Deer Trail facility, the only pollutant reasonably of concern is particulate matter (PM). Since 1987, the NAAQS PM standard has been defined as suspended particles with an aerodynamic diameter of 10 microns or less. The State of Colorado has adopted the same standard: the average for any 24-hour period cannot exceed 150 micrograms per cubic meter ($\mu g/m^3$), and the annual mean cannot exceed 50 $\mu g/m^3$.

The Deer Trail facility is in an agricultural, rural area, and air quality in this region is good. The only significant sources of particulates are agricultural activities and wind-blown dust from exposed areas. The Colorado Air Pollution Control Division (CAPCD) has performed limited monitoring of particulates at two locations. Total suspended particulates (TSP) were measured at Brush from 1975 to 1984, and PM_{10} was measured at Limon from mid-1990 to mid-1992. During the period of monitoring at Brush, applicable National and Colorado standards limited TSP to 260 $\mu g/m^3$ in a 24-hour period and 75 $\mu g/m^3$ for an annual mean. During the monitoring period, the highest 24-hour concentration was 233 $\mu g/m^3$, and the secondary maximums were 150 to 160 $\mu g/m^3$. Monitoring ended in 1985 because the CAPCD determined that TSP ambient air concentrations were considerably below air quality standards. Concentrations of PM at Limon were also well below air quality standards. The maximum 24-hour measurement was 55 $\mu g/m^3$. The only complete year of data, 1991, had an annual average of 22 $\mu g/m^3$. Approximately 6 months of data were collected for 1990 and 1992. The 6 months of 1990 data had an average of 24 $\mu g/m^3$. Like the Brush data, the CAPCD discontinued monitoring in mid-1992 because the data clearly demonstrated that the area was in compliance with ambient air quality standards and was likely to remain so.

2.3 GEOLOGY AND SEISMOLOGY

Several geologic investigations have described and classified the geology in the Deer Trail area. Several of these studies are summarized in the two Technical Reports by BFI **(BFI 1981 and 1982 – see Volumes 2 and 3, respectively, of this application)**. Other notable reports include an evaluation conducted by the Colorado Geologic Survey **(CGS 1986 – see Volume 3 of this application)** and the current *Permit Renewal Report* **(CHDT 2004 – see Volumes 4 and 5 of this application)**.

The following sections summarize some of the information in these documents. For more information, refer to these documents in Volumes 2 through 6 of this application.

2.3.1 Regional Geology

This section describes the regional geology, with a focus on the structural geology and stratigraphy of the Deer Trail area. This information is summarized from the BFI Technical Reports **(BFI 1981 and 1982 – see Volumes 2 and 3, respectively, of this application)**.

2.3.1.1 Structural Geology

The facility is situated on the eastern flank of a large structural basin (i.e., the Denver Basin), which encompasses northeastern Colorado, southeastern Wyoming, and southwestern Nebraska. The Denver Basin is a broad asymmetrical north-south trending structure east of the Front Range; the axis of the basin is approximated by a line from Cheyenne, Wyoming, to Denver, Colorado. The basin is characterized by a steeply dipping western limb truncated by the uplifted Rocky Mountains. The basin rises steeply immediately east of Denver, and more gently with eastward extent; bedrock beneath the facility dips at approximately 1 degree (i.e., 30 to 50 feet per mile) to the west.

Faulting associated with the Rocky Mountain uplift occurs in the western portions of the basin. Faulting in the eastern portion of the basin is rare to nonexistent **(CGS 1986 –see Volume 3 of this application)**. Results from geologic site characterization activities at the facility have not revealed evidence of structural deformation inside the facility permit boundary.

Regional bedrock geology in the Basin includes Precambrian rocks and marine and nonmarine deposits originating from the Pennsylvanian through Upper Cretaceous periods. Basement

materials consist of Precambrian igneous and metamorphic rocks, primarily gneiss and granite, which occur at depths ranging from 8,000 to 10,000 feet. Cretaceous-age bedrock occurs at depths ranging from 2,000 to 4,000 feet in the western portion of the Basin, and at or near the surface in the eastern portion. The majority of rocks that outcrop at the surface are Upper Cretaceous age or younger. Additional information on the structural geology is in the report by the Colorado Geologic Survey **(CGS 1986 – see Volume 3 of this application)** and the current *Permit Renewal Report* **(CHDT 2004 – see Volumes 4 and 5 of this application)**.

2.3.1.2 Stratigraphy

No bedrock units outcrop within a 6-mile radius of the facility. Surficial geology in the vicinity of the facility consists of (1) nonalluvial clay and silt deposits (i.e., loess) and (2) sandy clays and clayey sands, both of Quaternary origin. The loess, apparently deposited during the most recent glacial period, covers a large portion of the facility area, and consists mainly of massive, well-sorted silt, with occasional medium-grained fluvial sands in the bottom foot of the deposit. Discontinuous alluvial deposits are present within intermittent drainages in the vicinity of the facility; the composition of the alluvial deposits is a direct function of the parent rocks **(BFI 1982 – see Volume 3 of this application)**.

The uppermost bedrock unit underlying the facility, the Pierre Shale, is a gray to black, silty, fossiliferous shale, approximately 4,300 feet thick. Inside the site boundary, the Pierre Shale occurs at depths ranging from 15 to 30 feet below the ground surface. Site-specific characteristics of the Pierre Shale, including a discussion of the weathered and unweathered portions, are presented below. The Pierre Shale is underlain by the gray, calcareous shale of the Niobrara Formation, which contains limestone and bentonite interbeds. The Niobrara Formation is approximately 500 feet thick, and contains two major members, the Smokey Hill Shale and the Fort Hayes Limestone. The Niobrara Formation has produced natural gas in portions of the Denver Basin, but is not known to contain natural gas under the facility.

The Niobrara Formation is underlain by the Benton Group, which includes the Carlisle Shale, the Greenhorn Limestone, and the Graneros Shale. The Carlisle Shale includes approximately 80 feet of gray, noncalcareous siltstone with occasional limestone interbeds. The Greenhorn Limestone consists of gray limestone with gray to black clayey shale, and is approximately

80 feet thick. The Graneros Shale, which is a gray clayey shale with interbedded siltstones, comprises the bottom 220 feet of the Benton Group **(BFI 1982 – see Volume 3 of this application)**.

The Dakota Group, including the 'D' and 'J' Sandstones, underlies the Benton Group at an approximate depth of 5,000 feet below the ground surface. Regionally, both sandstones, characterized by 10 to 20 feet of medium-grained quartz sandstone, contain commercial quantities of oil and gas. Several other Mesozoic and Paleozoic deposits occur between the Dakota Group and the Precambrian basement rocks. Because these deposits are quite deep, and bear no significance to the permitting or operation of the facility, this application does not discuss them.

2.3.2 Site Geology

This section discusses the shallow geologic units underlying the site in descending order. The subsurface geology in the site vicinity is relatively simple due to the limited number of stratigraphic horizons, and the lack of significant secondary structural processes that could have affected either surficial or bedrock units **(CGS 1986 – see Volume 3 of this application)**. The shallowest bedrock formation of significant importance with regard to the permitting and operation of the facility is the Pierre Shale. Due to their extreme depth, this application does not discuss the units underlying the Pierre Shale further.

2.3.2.1 Site Stratigraphy

Early field activities provided information on the stratigraphy of the deposits underlying the facility to depths of more than 400 feet. Those activities included test borings, *in situ* permeability tests, laboratory permeability tests (on retrieved core), and a seismic refraction investigation. BFI **(1982 – see Volume 3 of this application)** summarizes the detailed analysis of those data, and evaluates other regional information (i.e., regional geology, seismic information, and information from oil and gas wells).

Additional investigations by the Colorado Geological Survey **(CGS 1986 – see Volume 3 of this application)** provided information related to specific geologic and hydrologic characteristics of the site. Based on analysis of the previous investigations, McCulley, Frick, and Gilman presented

the most recent and detailed classification of surficial deposits and weathered and unweathered Pierre Shale **(McCulley, Frick, and Gilman 1997 – see Volume 6 of this application)**.

The subsurface geology includes 1 to 2 feet of silty clay topsoil sequentially underlain by three stratigraphic units: (1) unconsolidated Quaternary sediments, including nonalluvial clay/silt deposits (referred to as the Silty Clay Unit) and sandy clays and clayey sands (referred to as the L3 Sand Unit), (2) weathered Pierre Shale, and (3) unweathered Pierre Shale.

The unconsolidated sediments (comprising the Silty Clay) have been classified **(McCulley, Frick, and Gilman 1997 – see Volume 6 of this application)** as wind-blown loess deposits (presumably originating from the northern and western portions of the Denver Basin) consisting of calcareous clayey silt and silty clay. A portion of the clay composition might have been due, in part, to in-place weathering of the Pierre Shale. The clay content of this unit, classified as CL according to the Unified Soil Classification System, increases with depth **(McCulley, Frick, and Gilman 1997 – see Volume 6 of this application)**. Inside the facility boundary, this unit typically occurs between the ground surface and depths of 9 to 32 feet below the surface. The specific gravity of the soils ranged from 2.61 to 2.78; the pH ranged from 7.9 to 8.2. Analysis of moisture content in the unsaturated soils indicated that the clayey sands average 3%, and the sandy clays 11%.

Alluvial deposits in the intermittent drainages outside the facility boundary typically consist of fine silt and sand, and weathered clays originating from the Pierre Shale. The average sand content in these deposits was less than 3%. These sediments do not occur inside the facility boundary; however, monitoring wells have been installed in these deposits (and the underlying weathered Pierre Shale); they are referred to as the L6 wells.

A linear sand body has been defined in the Silty Clay Unit beneath the eastern portion of the facility. This sand body, referred to as the L3 Sand Unit, consists of sandy clays and clayey sand. The L3 Sand Unit varies in width from 350 to 700 feet, and trends north-northeast to south-southwest across the facility. Where present, this unit varies in thickness from 3 to 5 feet; the maximum documented thickness underlying the facility is 10 feet. Stratigraphically, the unit becomes fine with decreasing depth, and has a gradational upper contact with the Silty Clay

Unit. The L3 Sand is not known to contain ground water; however, monitoring wells (designated as L3 wells) have been installed in this unit.

Weathered Pierre Shale, commonly encountered between 10 and 30 feet below the ground surface and typically 15 to 35 feet thick, is classified as CH. This section is characterized by gray-brown to yellow-brown, silty, medium to hard, moist shale, with occasional low-angle fractures filled with gypsum and stained with iron. Occasional lenses of massive, gray calcite-cemented siltstone, approximately 3 to 5 feet thick and 2 to 12 feet long, occur in the weathered shale **(McCulley, Frick, and Gilman 1997 – see Volume 6 of this application)**. The dry density of this section ranges from 91 to 124 pounds per cubic foot.

The contact between the L3 Sand (where present) and the underlying weathered Pierre Shale is often distinct, but can be gradational. The contact between the unconsolidated deposits and the weathered shale is characterized by bedding planes and tight fractures, usually occurring over a 1- to 2-foot interval. The contact between the unconsolidated deposits and the weathered shale is classified as the L4A hydrostratigraphic unit. Ground-water monitoring wells in the weathered shale are referred to as L4 wells.

Between depths of 40 to 55 feet, the weathered shale grades to unweathered shale consisting of gray to dark gray, silty, laminated, slightly calcareous, hard shale. The shale is thinly laminated and interbedded with silt and traces of very fine sand. Hard, dry calcareous silt beds occur intermittently, ranging in thickness from about 2 inches to 1.5 feet. The silt beds appear to be discontinuous, because they cannot be correlated from one well to another. Rare, low-angle fractures in the silt are typically filled with gypsum and stained with iron. The unweathered unit typically grades from blocky structure, hard and slightly moist near the top to uniform structure with depth **(CGS 1986 – see Volume 3 of this application)**.

The weathered shale is distinguished from the unweathered shale by brown color and less massive structure. The thickness of the gradational contact between the weathered and unweathered shale varies from 10 to 20 feet; in some areas this transition zone comprises the majority of the weathered shale unit **(McCulley, Frick, and Gilman 1997 – see Volume 6 of this application)**. The unweathered Pierre Shale has engineering and hydrologic characteristics similar to those of the weathered Pierre Shale, except it is generally unfractured. The

unweathered shale contains limited amounts of ground water, typically occurring at depths ranging from 250 to 415 feet below the ground surface, which is monitored by the L5 wells.

2.3.3 Surface Soils

As discussed above, surficial soils in the vicinity of the facility consist of clay and silt (loess) deposits formed (1) from materials deposited and reworked by wind, or (2) by weathering of materials from underlying formations (i.e., the Pierre Shale). No bedrock units outcrop within a 6-mile radius of the facility.

An evaluation of the surface soils inside the facility boundary and surrounding the facility, based on information from the Soil Conservation Service (SCS; U.S. Department of Agriculture), was performed. The following site-specific discussion is based on the most recent SCS report for Adams County. The soils include general soil types, and specific soil mapping units inside the facility boundary (SW % of Section 25 and the NW % of Section 36, Township 3 South, Range 57 West (6th PM), Adams County, Colorado. Two major soil types at the Deer Trail facility are the Weld Series and the Wiley Series.

The Weld Series consists of well-drained, nearly level soils on uplands. These soils formed in wind-worked loamy materials. The Series is characterized by a noncalcareous surface layer of brown loam about 6 inches thick. The lower part of the subsoil includes about 20 inches of pale-brown very fine sandy loam. The underlying material is highly calcareous, pale-brown silt loam with light yellowish-brown fine sandy loam. Weld soils absorb water at a moderate rate, and the available water capacity is high. Permeability is slow, and the entire soil is suitable for plant roots.

The Wiley Series consists of well-drained, gently sloping to strongly sloping soils on uplands. These soils formed in wind-worked loamy material. The surface layer is noncalcareous grayish-brown loam about 3 inches thick. The upper part of the subsoil, about 5 inches thick, is slightly calcareous, light brownish-gray loam. This material is underlain by highly calcareous pale brown loam and very fine sandy loam. Wiley soils will absorb water at a moderate rate, and the available water capacity is high. Permeability is moderately slow, and the entire soil is suitable for plant roots.

2.3.3.1 Soil Mapping Units

Specific soil types that occur in the general soil series presented above have been identified and mapped as follows:

- Adena Loam, 0 to 3% slopes (AaB): This soil is in the eastern two-thirds of Adams County. Surface runoff is medium to rapid, and the hazard of water erosion is moderate. Soil blowing is a severe hazard in unprotected areas. Most areas of this soil are cultivated. Many small scattered areas have a cover of native grass used for grazing.

- Adena-Colby Association, gently sloping (AcC): This association consists of intermingled Adena, Colby, and Wiley loams. Adena loam, 3% to 5% slopes, is the dominant soil and makes up about 40% of the association. It normally has slopes facing east and southeast. Colby loam, 3% to 5% slopes, makes up about 30% of the association. It occurs on ridge tops and knolls that are more exposed to the wind. Wiley loam occurs in slightly more sloping areas facing west to north; it forms about 30% of the association. Soils of this mapping unit are suitable for carefully managed dry farming. These soils are commonly used for rangeland where they are adjacent to steep Colby soils.

- Adena-Colby Association, moderately sloping (AcD): This association is similar to Adena-Colby Association, gently sloping, but occupies the more rolling parts of the landscape. It has a slightly lower percentage of Adena soil and slightly higher percentage of Colby soil. In addition, the surface layer tends to be thinner and lime is near the surface in most areas. Adena loam makes up about 35% of this association, Colby loam about 30%, and Wiley loam 25%. This association is unsuitable for cultivation because of slope and hazards of soil blowing and water erosion. It is more suitable for grazing.

- Weld-Deertrail Complex, 0 to 3% slopes (WrB): This complex is on the uplands. About 60% is Weld loam and 40% is Deertrail loam. The Weld soil is similar to the Weld loam, 113% slopes, but it is closely intermingled with patches of the Deertrail soil. The patches are bare and are commonly called slick spots. Areas of the complex in native pasture can be readily recognized by bare spots that are characteristic of Deertrail soils. These have a

growth of bunchgrass or buffalo grass around their edges and are surrounded by a cover of grama grasses. In cultivated fields the slick spots are difficult to see in some areas, but they cause crop growth to be stunted and the surface layer to crust. Much of the complex is dry farmed, but a large acreage remains in native grass. The main crops are winter wheat and sorghums. Runoff is slow. The hazards of water erosion and soil blowing are moderate, but increase in severity if gullies form. Soil blowing is a severe hazard if the soils are dry farmed in years when rainfall is not sufficient.

- Wiley-Adena-Renohill Complex, 3% to 20% slopes (WuE): The soils in this complex have intermediate slopes between river terraces or upland drainage channels and the gently sloping soils in the uplands. Wiley loam makes up about 40% of the complex; Adena loam about 35%; Renohill loam about 20%; and Loamy alluvial land nearly 5%. The mapping includes small areas of Colby, Samsil, and Shingle soils, and scattered slick spots. Adena loam is the smoothest of the major soils. It is at the top of slopes in narrow bands and has slopes of 3% to 5%. Wiley loam has somewhat stronger slopes. It adjoins narrow thin ridges of Colby soils that are generally at right angles to the slopes around the brow of the hill or extend downward parallel to the slope as steeper ridges outlining drainage channels. Renohill loam is in the heads of drainage ways. Loamy alluvial land is fill material in the drainage ways. Some less sloping areas of the complex have been cultivated, but most have been abandoned and allowed to return to grass cover. The remaining soils are not suitable for cultivation because of the strong slopes and the severe hazard of soil erosion.

Based on these soil descriptions, it is apparent that disturbed soils present the potential for blowing hazards and erosion. In this regard, the amount of disturbed area inside the facility boundary has been minimized and reseeding efforts on disturbed areas appear to have been successful. As such, the references to blowing soil hazards and erosion are more applicable to the surrounding agricultural land than to land inside the facility boundary.

2.3.4 Seismology

As noted in earlier reports on the design of the secure cells, the facility is in an area of low seismic risk. Based on information supplied by the National Earthquake Information Center

(USGS) *Eastern Colorado is nearly aseismic, with just a few epicenters in the Arkansas and Platte River Valleys*. The limited tectonic history of the Denver Basin includes minor disturbances (i.e., less than 5.5 on the Richter scale) focused in the Denver area.

The horizontal acceleration used for the secure cell design is 0.06*g*, where 1*g* is the gravitational acceleration of 32.2 ft/s^2. This value is based on USGS maps that delineate horizontal acceleration in rock due to earthquake loading with a 90% probability of not being exceeded in 250 years.

2.4 HYDROLOGY

The surface- and ground-water hydrology of the facility has been studied extensively. Example information on the surface- and ground-water hydrology is contained in the BFI Technical Reports **(BFI 1981 and 1982 – see Volumes 2 and 3, respectively, of this application)**. The following sections summarize surface- and ground-water hydrology information from these documents.

2.4.1 Surface-Water Hydrology

As noted, the site vicinity is characterized by broadly rolling topography. The surface slope of the facility ranges from flat to about 6%. Topographic relief in the site vicinity results from erosional drainages, such as Beaver Creek (east of the facility), and Wetzel Creek (on the west), and their tributaries, that are incised in the highly erodable clay-loam soils. The limited alluvial deposits associated with these drainages typically consist of discontinuous lenses of clayey sand, sandy clay, and silty clay. There are no perennial streams, rivers, or surface-water impoundments (other than stock tanks/ponds) near the facility. The only use of surface water within a 6-mile radius of the facility is in small retention ponds for watering stock.

Because the facility is topographically above the surrounding land, little or no potential for drainage onto the site exists (i.e., there are no upstream drainage areas). Downstream drainage basins include the Wetzel and Beaver Creek drainages, which ultimately discharge to the South Platte River approximately 30 miles north of the facility.

Evaluation of the potential for precipitation-induced runoff from the facility calculated the average annual runoff from the 325-acre site, based on annual precipitation of 14 inches, to be

approximately 13 million gallons. Variations from a dry year (8 inches annual precipitation) to a wet year (20 inches) produce annual runoff of less than 1 million gallons to about 57 million gallons, respectively. In addition, the drainage basins were assessed and a floodplain analysis was performed for the confluence of the Beaver and Wetzel Creek drainages. Results of that study, based on a 100-year flood depth of 22 feet above the average stream elevation at the confluence, indicate that the lowest part of the facility is at least 93 feet above the predicted floodplain elevation.

Due to the lack of perennial streams and shallow ground-water aquifers, ground-/surface-water interaction in the vicinity of the facility is limited. Because there are no perennial streams near the facility, few data regarding the quality of surface waters are available. One sample collected from a stock pond near the facility was reported to contain a total dissolved solids concentration of 385 milligrams per liter (mg/L) **(CGS 1986 – see Volume 3 of this application)**.

2.4.2 Ground-Water Hydrology

As mentioned, numerous reports pertaining to regional and local ground-water occurrence and flow were prepared for earlier RCRA permitting and operational activities related to the facility. Those reports form the basis for the discussion of regional and local ground-water conditions in this section.

2.4.2.1 Regional Ground-Water Occurrence

Regionally, the Denver Basin encompasses several ground-water aquifers located stratigraphically above the Pierre Shale. The principal aquifers in the western and central portions of the Basin are the Fox Hills Sandstone, Arapahoe/Denver Formation, and Dawson Formation. These geologic units have been eroded away at the site location; the nearest outcrop (the Fox Hills Sandstone) is approximately 10 miles west of the facility. The Ogallala Formation is the primary aquifer in the eastern part of the Basin; the site is approximately 20 miles from the eastern-most outcrop of the Ogallala Formation. Because all regional aquifers have been eroded away, the facility is geologically and hydraulically isolated. Ground-water flow in the regional aquifers is generally to the east. The Denver-area aquifers are recharged by precipitation and infiltration at outcrops in the extreme western portion of the Basin. In the eastern portion of the Basin, the Ogallala Formation is recharged at outcrops extending over eastern Colorado, southwestern Nebraska, and western Kansas.

2.4.2.2 Local Ground-Water Occurrence and Flow

Ground-water occurrence in the vicinity of the site is based on information from exploratory and site characterization activities over the life of the facility, information from the Colorado State Engineer's Office, and the ongoing facility ground-water monitoring program. The existing or potential hydrostratigraphic units underlying the facility are classified in accordance with the geologic stratigraphy presented in Section 2.3.2, and consistent with the nomenclature used for the current ground-water monitoring program.

As mentioned, due to the unique geological setting in the vicinity of the facility, the underlying deposits are hydraulically isolated from the regional aquifers. Therefore, in a classical sense, there are no major ground-water "aquifers" in either unconsolidated surficial deposits or the underlying bedrock (the Pierre Shale) in the vicinity of the site. Further, ground-water supply wells in the vicinity are limited; all potable water is trucked to the site.

The facility is generally underlain by 150 to 175 feet of unsaturated materials (through which the potential for infiltration is negligible) overlying the Pierre Shale. Beneath the Pierre Shale, potential water-bearing zones underlying the facility are limited to the 'D' and 'J' Sandstones of the Dakota Group, which are approximately 5,000 feet below the ground surface at the site location. Both sandstones are primarily oil and gas production zones; the water quality is poor due to naturally occurring concentrations of total dissolved solids and hydrocarbons. No other identifiable water-bearing zones occur between the Dakota Group and the Pierre Shale.

Naturally occurring ground water does occur in discontinuous perched zones underlying the facility. These isolated saturated zones are the focus of the discussion in the following section.

In addition, disposal of produced water from an onsite oil well (the Jolly-Axtell #2) to a pond (referred to as the "brine pond") in the northern portion of the facility has resulted in the presence of shallow ground water beneath the facility. In 1988, Triegel & Associates evaluated the relationship between the pond operation and ground-water quality with respect to RCRA ground-water monitoring requirements. The Jolly-Axtell well and another oil well inside the property boundary (Zexco-State #1-36), were plugged and abandoned in 1986 and 1984, respectively, in accordance with Colorado Oil and Gas Commission regulations. The brine pond was closed in 1986.

2.4.2.3 Identification of Hydrostratigraphic Units

Based on historical characterization activities at the facility and the current ground-water monitoring program, the hydrostratigraphic units underlying the facility have been classified in different zones as follows **(McCulley, Frick, and Gilman 1997 – see Volume 6 of this application)**:

- The L3 Zone (the sand lens occurring in the surficial Silty Clay Unit);
- The L4A Zone (the interface between the surficial Silty Clay Unit and the underlying weathered Pierre Shale);
- The L4 Zone (the interface between the weathered Pierre Shale and the unweathered Pierre Shale);
- The L5 Zone (the uppermost water-bearing unit beneath the facility; defined as the uppermost saturated portion of the unweathered Pierre Shale); and
- The L6 Zone (the first occurrence of saturated conditions in the alluvial drainages outside the compliance boundary).

Monitoring wells have been installed in these hydrostratigraphic zones to assess ground-water conditions and quality beneath the facility. The wells included in the facility monitoring program are labeled in accordance with the zone classification presented here (e.g., L3 Zone well numbers begin with L3). Eight L5 wells comprise the detection monitoring program for the facility and fulfill the ground-water monitoring requirements in 6 CCR 1007-3, Subpart F, Part 264 for permitted hazardous waste disposal facilities. The L3, L4A, L4, and L6 wells comprise the inspection monitoring program for the facility, and supplement the regulatory-required detection monitoring well network. Additional wells were installed in the L4 and L4A Zones as part of the RCRA Facility Investigation of the closed brine pond associated with the Jolly-Axtell #2 oil well. These wells, referred to as the BP wells, are inside and outside the northern compliance boundary. Water quality data from the BP wells has been used historically in establishing part of the background water-quality database. These wells, however, are no longer included in the facility monitoring program.

The L3 Zone is defined as the discrete lenticular sand body (i.e., the L3 Sand Unit) that occurs infrequently in the surficial Silty Clay Unit. Monitoring wells were historically installed at 50-foot intervals along the compliance boundary and in those areas where the L3 Zone is present. However, in a recent Class 2 Modification to the Part B Permit, the approach to the number and location of new Level 3 Zone wells was modified; new Level 3 wells are located along potential fluid migration pathways in the L3 Sand Unit. Level 3 wells are screened from approximately 9 to 36 feet below the ground surface; no water has been detected in any L3 Zone wells during 10 years of quarterly monitoring. During the construction of future cells at the facility, a large part of the L3 Sand will be removed. In addition, the cell construction specifications require the removal of L3 Sand and replacement with an engineered clay barrier (minimum hydraulic conductivity of 1×10^{-8} cm/sec) of sufficient thickness to provide a 1,000-year travel time barrier to any migration of fluids from the secure cell to the remaining L3 Sand.

The L4A Zone is defined as the interface between the surficial Silty Clay Unit and the underlying weathered Pierre Shale. Monitoring wells are installed at 100-foot intervals in areas where the L4A Zone is (or historically was) saturated. Level 4A Zone wells are screened from approximately 12 to 19 feet below the ground surface. The saturated conditions requiring L4A wells occur only along the northern compliance boundary in the vicinity of a former oil field brine pond near well L4-33.

The L4 Zone is defined as the interface between the weathered Pierre Shale and the underlying unweathered Pierre Shale. Level 4 Zone wells are screened from approximately 32 to 64 feet below the ground surface. The typical depth of the weathered/unweathered shale contact is approximately coincident with the proposed depths of the landfill cells. Monitoring wells are installed at 300-foot intervals along the compliance boundary except in areas where the L4 Zone is (or historically was) saturated, where closer (approximately 100-foot) spacings are required.

The saturated conditions requiring tighter spacing occur only along portions of the northern compliance boundary in the vicinity of the former brine pond and along the western compliance boundary in the vicinity of Cells 1 and 2. Several L4 Zone wells have been installed inside the compliance boundary adjacent to Cells 1 and 2, and one L4 Zone well (L4-9W) is installed outside the compliance boundary west of Cell 2. The occurrence of saturated conditions adjacent

to Cell 2 results from recharge of incident precipitation through the base of the Cell 2 excavation, which was unlined from about August 1989 to July 1995, prior to construction of the liner system.

Although standing rainwater and snowmelt were historically pumped from Cell 2, water remained in the excavation for several days prior to removal. During this time, water apparently seeped into the weathered portion of the Pierre Shale that was exposed in the base and walls of the unlined excavation and slowly moved along the weathered/unweathered Pierre Shale interface.

The L5 Zone represents the uppermost water-bearing unit at the facility and is defined as the uppermost saturated portion of the unweathered Pierre Shale. Eight L5 Zone monitoring wells installed along the compliance boundary comprise the facility's ground-water detection monitoring network. The L5 wells are screened in the silt lenses that occur at various depths in the unweathered Pierre Shale, ranging from approximately 250 to 415 feet below the ground surface.

The L6 Zone is defined as the first occurrence of saturated conditions in the alluvial drainages outside the compliance boundary. Focused recharge in offsite drainages results in limited areas of saturation that occur in shallow alluvial materials. Three L6 Zone wells are in the vicinity of the facility. The wells are screened in silt and fine sand units overlying the weathered Pierre Shale, and in the unweathered Pierre Shale. Depth to water in the L6 Zone wells ranges from approximately 10 to 50 feet below the ground surface.

2.4.2.4 Historic Water-Level Trends

The facility has conducted extensive ground-water monitoring around the current permitted area. Of the 120 monitoring wells at the facility, most of which have been monitored since 1986, 85 are dry **(McCulley, Frick, and Gilman 1997 – see Volume 6 of this application)**. Water has never been detected in any of the L3 wells. Further, water levels for many of the L4A, L4, and L6 wells were consistently below the screened intervals (i.e., only minor amounts of condensation was observed in the 5-foot-long sumps below the screened intervals). Water detected in most of the L4A and L4 wells near the former brine pond has consistently declined with time, which reflects the cessation of pond use and subsequent elimination of the source of

recharge to shallow ground water. Water levels in several L4 wells near Cell 2 have increased, which probably reflects the focused recharge of precipitation through the unlined cell base during the time the cell was unlined **(McCulley, Frick, and Gilman 1997 – see Volume 6 of this application)**.

The only zone that consistently contains water, and therefore can be periodically monitored with respect to ground-water quality and historical water level trends, is L5. The early water levels measured in L5 Zone wells were erratic, indicative of the slow recovery of the wells between quarterly sampling events. However, since 1992, due to a longer period between sampling events, the water levels appear to be more consistent than the earlier measurements indicate.

2.4.2.5 Hydraulic Characteristics

Discussion of hydraulic characteristics (i.e., ground-water flow direction and velocity) is somewhat misleading because it implies the presence of a conventional aquifer system, which is not the case for the facility. However, ground water does exist in discrete perched systems. The only zone that exhibits consistent saturation is the L5 zone (the unweathered Pierre Shale), which is characterized by thin laminated beds of silt and clay, probably recharged by horizontal flow through localized fracture networks **(McCulley, Frick, and Gilman 1997 – see Volume 6 of this application)**.

The initial investigations conducted to complete the Part B Permit application thoroughly evaluated the hydraulic properties of current or potential hydrostratigraphic units in the vicinity of the facility. Testing included 30 *in situ* standpipe permeability tests, 31 packer tests, 2 pumping tests, and 10 laboratory analyses on undisturbed and remolded samples.

In addition, 34 slug tests were performed in all wells at and near the facility in which static water levels were in or above the screened intervals (24 L4 and L4A wells, 8 L5 wells, and 2 L6 wells).

Based on results from these investigations, McCulley, Frick, and Gilman **(1997 – see Volume 6 of this application)** presented a summary of hydraulic conductivity values and average linear ground-water flow velocities (based on Darcy's Law calculations) for the different hydrostratigraphic units. The saturated, horizontal hydraulic conductivity of the water-bearing units underlying the facility varies from 1.4×10^{-5} to 2.8×10^{-6} cm/sec. Estimated average linear

ground-water flow velocities for the limited areas of saturation in the L4A, L4, and L5 units are approximately 35, 14, and 13 feet per year, respectively **(McCulley, Frick, and Gilman 1997 – see Volume 6 of this application)**.

Because the extent of saturation in the L4 and L4A Zones is limited, and the L5 Zone wells yield so little water, the performance of long-term multiwell pumping tests at the facility has not been possible. Therefore, no estimates of formation storativity are available.

Depending on moisture content (sometimes less than 1/100,000 of the saturation value), flow velocities in the unsaturated portions of the L4A, L4, and L5 zones, which are generally more extensive than the areas of saturation, can be several orders of magnitude lower than saturated flow velocities **(McCulley, Frick, and Gilman 1997 –see Volume 6 of this application)**.

Because hydrogeologic conditions at the facility result in limited areas of saturation in shallow hydrostratigraphic zones and there is no definable hydraulic gradient in the L5 Zone, presentation of potentiometric surface maps to assess ground-water flow direction in each zone is not warranted. However, the following general statements can be made about ground-water flow beneath the facility **(McCulley, Frick, and Gilman 1997 – see Volume 6 of this application)**:

- Saturated conditions have never been detected in the L3 Sand Unit during 10 years of quarterly monitoring. If saturated conditions were established, the primary flow direction would be in the downdip direction (generally to the east) along the base of the unit.

- The low hydraulic conductivity of the geologic units at the facility limits the amount of recharge to wells between sampling events. As a result, a mound associated with the former brine pond along the northern compliance boundary has been dissipating with time since the elimination of the source of the water (i.e., brine pond seepage) in the period from 1984 to 1985. In general, the perched ground-water flow direction is radially outward from the location of the brine pond (i.e., near well L4-33). With the elimination of the driving force (head), lateral movement of perched brine pond remnants in the L4A Zone currently appears minimal.

- As indicated by the historical vertical head differences in adjacent wells completed in the upper L4A Zone and in the lower L4 Zone, the primary ground-water flow direction now

appears to be vertical, as the residual water in the surficial Silty Clay Unit drains vertically into the underlying Pierre Shale.

- Water that infiltrated through the previously unlined base and sides of the Cell 2 excavation into the L4 Zone near Cell 2 generally migrates along the interface between the weathered and unweathered Pierre Shale toward the southwest.

- The L5 Zone represents the "uppermost aquifer" at the facility, as that term is used in the regulatory context (40 CFR §260.10). In a conventional hydrogeologic sense, the L5 Zone is not an aquifer, as evidenced by low yields to wells and very slow recovery rates following purging and sampling. Saturated zones monitored by the L5 Zone wells zones might not be hydraulically interconnected.

- Ground water in the L6 Zone is assumed to flow horizontally along the offsite drainages, with a small amount of vertical leakage to the underlying geologic units.

2.4.2.6 Ground-Water Chemistry, Quality, and Monitoring

The background chemistry and quality of ground water underlying the facility were initially evaluated and background water quality monitoring have occurred on a quarterly to annual basis since 1986. Ground-water quality data collected after the first acceptance of waste at the facility (i.e., after the fourth quarter 1991) are added to the background database in accordance with procedures specified in Permit Attachment GW-9 and in the body of the Permit.

In general, the quality of ground water beneath the facility is poor (i.e., contains elevated concentrations of total dissolved solids [TDS]), primarily due to (1) historical brine disposal practices associated with production from the Jolly-Axtell #2 and Zexco-State #1-36 oil wells, which affected water quality in the L4A and L4 Zones along the northern compliance boundary, (2) dissolution of evaporites and weathered components of the Silty Clay Unit and weathered Pierre Shale, which affected water quality in the L4A and L4 Zones, and (3) long residence times (e.g., the L5 Zone). In addition to elevated concentrations of TDS, concentrations of many inorganic parameters are naturally elevated. Mean concentrations of chloride, sulfate, fluoride, nitrate, selenium, and manganese are elevated in many of the wells at the facility, and often

exceed drinking water and/or agricultural standards **(McCulley, Frick, and Gilman 1997 – see Volume 6 of this application).**

The various hydrostratigraphic units beneath the facility have distinct ground-water chemistries, which further indicates the lack of hydraulic connection between the limited areas of saturation in the L4A and L4 Zones and the uppermost continuous water-bearing zone (i.e., the L5 Zone) in the unweathered Pierre Shale.

Ground-water quality data from the monitoring wells at the facility are classified in six distinct groups for characterizing the composition of ground water and evaluating potential impacts from hypothetical releases from the secure cells. The well groupings were developed from a comprehensive evaluation of hydrogeologic properties (depth to water, proximity to brine pond, etc.) and water chemistry data using standard geochemical techniques such as construction of bivariate plots of the major ions and trilinear diagrams, and evaluating the appropriateness of the well groupings using a multivariate statistical procedure referred to as a discriminant function analysis.

The well groupings appear to separate wells based on their position relative to the evolutionary flow path of the brine pond seepage. Ground water becomes more concentrated in solutes as it moves laterally and vertically away from the brine pond through the subsurface, apparently as a result of the travel (i.e., residence) time in the subsurface geologic units and subsequent dissolution of the abundant evaporitic (gypsum, anhydrite, etc.) and other minerals **(McCulley, Frick, and Gilman 1997 – see Volume 6 of this application).** The shallow seepage waters lowest in TDS concentrations are from the wells near the brine pond. Although this seems counterintuitive, the brine pond liquids were actually very dilute, and the term "brine" is a misnomer. Results of chemical analyses on water samples collected from the former brine pond from January 1981 to February 1984 indicate that the oil-field water had an average TDS concentration of 1,879 milligrams per liter (mg/L), which is much lower than true brines (TDS concentrations greater than 100,000 mg/L). Only after the seepage migrates downward and away from the former brine pond does the water increase in TDS, through the dissolution of evaporite minerals along the flow paths, and take on the characteristics considered typical of

saline waters (i.e., TDS greater than 10,000 mg/L). None of the ground water at the facility approaches the composition of a true brine.

Group 1 wells, which are the shallow L4A wells adjacent to the former brine pond along the northern compliance boundary, are the shallowest and screen the least geochemically "mature" shallow ground water at the Facility. Group 1 wells generally exhibit low concentrations of most major cations and anions. The wells in Groups 2 and 3, which monitor water quality in the dissipating brine pond seepage plume, are generally farther from the brine pond than Group 1 wells, or they are screened at greater depths. Group 4 wells produce the deepest of the "shallow" waters at the facility, and monitor water related, at least in part, to former oil-field activities. The wells in Group 4 that are along the western compliance boundary adjacent to Cell 2 are generally the deepest of the shallow wells and produce the most geochemically "mature" shallow water at the facility. The concentrations of most major cations and anions increase from the levels in Group 1 (and Group 6 wells, which are discussed below) to the concentrations exhibited by wells in Group 4.

Concentrations of major ions in Group 5 wells, the deep wells in the unweathered Pierre Shale (i.e., Level 5), are generally quite different from the concentrations observed in shallower wells at the facility.

The concentrations of major anions and cations in Group 6 (Level 6) wells are relatively low and similar in many respects to Group 1 wells. Group 6 wells, which are in shallow geologic materials in surface-water drainages outside the compliance boundary, are presumably subject to a greater recharge of dilute incident precipitation and shorter residence times than other wells at the facility. As a consequence, ground water in the Group 6 wells exhibits low concentrations of major ions.

2.4.2.7 Ground-Water/Surface-Water Interaction

As discussed above, surface water near the facility is limited to intermittent drainages that discharge to Wetzel and Beaver Creeks. Both creeks are ephemeral in the vicinity of the facility; the nearest perennial stream is about 30 miles away. Therefore, ground-water/surface-water interaction is limited to (1) recharge to the limited alluvial deposits in the drainages following precipitation events, and (2) subsequent discharge from those deposits to surface waters. Based

on water-level data provided by McCulley, Frick, and Gilman **(1997 – see Volume 6 of this application)** for the L6 wells, which show little if any temporal variation, the significance of this interaction is limited. Thus, if surface-water/ground-water interaction occurs, the occurrence time is less than the time between quarterly water-level monitoring events for the L6 wells.

2.4.2.8 Evaluation of Potential Releases to Ground Water

As discussed above, shallow ground-water resources are limited in the vicinity of the facility, and the hydraulic conductivity of the water-bearing zones (L4, L4A, and L5) is low. However, as part of the Ground Water Protection Plan, McCulley, Frick, and Gilman **(1997 – See Volume 6 of this application)** performed a worst-case assessment of a hypothetical release from *a* cell to the most permeable zone (L3), and subsequently to underlying saturated zones. This analysis was performed for the L3 Sand because this is the only hydrostratigraphic unit underlying the facility that could theoretically enable transport of a significant amount of fluid under saturated conditions. Cell design criteria and geologic/hydrogeologic factors that reduce the potential for a release to the L3 sand include:

- Cell construction specifications provide for the removal of a large portion of the L3 Sand, and isolation of the remainder with an engineered clay liner.

- The secondary liner components and sumps of the secure cells are approximately 20 to 40 feet below the elevation of the L3 and L4A Zones.

- The cells are designed such that the sloping liner components rapidly transmit leachate and other fluids to sumps so a leachate mound does not develop. As a result, the hydraulic head (driving force) is insufficient to cause leachate to leak laterally through the side-slope liner at an elevation equivalent to the L3 Zone (the L3 Sand Unit) or the L4A Zone (i.e., the interface between the Silty Clay Unit and weathered Pierre Shale).

These construction methods are designed to reduce/eliminate the potential for a release of leachate to the subsurface underlying and surrounding the facility. For leachate to accumulate and migrate through the liner system and out of a permanent sump to the subsurface, the following events would have to occur following placement of the final cover **(McCulley, Frick, and Gilman 1997 – see Volume 6 of this application)**:

- The geocomposite drainage layer in the final cover (i.e., cap) would have to fail, allowing infiltrated water to pond on the underlying synthetic, 80-mil, geomembrane liner in the cap.

- Infiltration would have to occur through the synthetic liner in the cap, allowing the ponded water to seep into the underlying low-permeability clay liner in the cap.

- The low-permeability clay liner in the cap would have to absorb water until its moisture content increased to field capacity, allowing water to seep into the underlying wastes, which have been emplaced in accordance with Land Disposal Restrictions (LDRs) and waste treatment operations that are designed to restrict the amount and composition of leachate that can be generated.

- Leachate that percolates through the stabilized waste would enter the LCS, where it is monitored and removed. For a significant head to develop on the underlying liner system, the pump and monitoring system would have to fail.

- The leachate that collects in the nonfunctioning LCS would have to permeate through the primary liner system, which consists of an 80-mil liner and 3 feet of compacted clay with a permeability of less than 1×10^{-8} cm/sec.

- Any leachate that penetrates the primary liner would accumulate in the LDS sump, where it is monitored and removed. This system would have to fail as described above for the LCS sump for any significant seepage into the secondary liner system.

- The leachate would have to permeate the secondary clay liner system, which consists of an 80-mil liner and 3 feet of compacted clay with a permeability of less than 1×10^{-8} cm/sec.

- Leachate that penetrates the secondary liner system would accumulate in the permanent sump, which is also monitored.

Because of the secure cell construction and RCRA regulations pertaining to the routine monitoring and removal of fluids from the sumps of the secure cells, it is extremely unlikely that the release scenario described above could occur or go undetected.

2.4.2.9 Migration Pathway Analysis

It is evident from the previous section that the potential for a release from a secure cell at the facility is minimal. However, as part of the Ground Water Protection Plan, McCulley, Frick, and Gilman **(1997 – see Volume 6 of this application)** performed an analysis of potential migration pathways from a hypothetical release as follows.

In the extremely unlikely event of a release from the permanent sumps, which are approximately at the interface of the weathered and unweathered Pierre Shale, leachate would enter the underlying geologic materials and migrate under unsaturated flow conditions. Fluids in the unsaturated zone are subject to capillary suction (i.e., surface-tension forces between the water and the geologic materials) and gravitational forces. Since capillary force is proportional to pore size, the fine-grained materials, such as the weathered and unweathered Pierre Shale, have higher capillary forces than coarser grained materials such as the L3 Sand Unit. As a result, unsaturated conditions (under capillary suction and gravitational forces) can cause fluids to migrate downward and laterally. Where a permanent sump is above the interface between the weathered and unweathered Pierre Shale, fluids would eventually accumulate at the interface and migrate laterally toward the L4 wells. Where a permanent sump is below the interface between the weathered and unweathered Pierre Shale, fluids would probably migrate principally downward through fractures toward the L5 Zone wells. Due to the minute potential for a release from the secure cells, additional discussion (regarding dispersion, sorption, etc.) is not warranted.

2.4.2.10 Ground-Water Use

As mentioned above, potable water for the facility is provided by trucks; there are no water-supply wells inside the facility boundary. In addition, nonpotable water for the facility is provided by collection and storage of noncontaminated surface-water runoff during precipitation events.

All water supply wells within a 6-mile radius of the facility are used for domestic, stock, or agricultural purposes. Because the facility uses no ground water, its operations have no impact on these wells or ground-water resources in the vicinity of the site.

A survey of registered wells within a 6- mile radius of the permit area was conducted in conjunction with the preparation of this application using records of the Colorado State Engineer. These records indicate the identification of 369 wells on the site and within a 6-mile radius. More than half of the wells are on the site and within a 0.5-mile buffer zone. Most of these are used for ground-water monitoring. Of the wells used for water supply, most are in the Pierre Shale bedrock, capturing small, discontinuous lenses of ground water in this otherwise relatively impermeable formation. A few of the shallower wells might capture limited alluvial ground water in the valleys of the larger intermittent streams in the area, such as Beaver and Wetzel Creeks.

Water supply wells range in depths from 20 to 480 feet with a mean depth of 52 feet and a median depth of 40 feet. Yields of these wells range from 3 to 175 gallons per minute (gpm) with a mean of 15.6 gpm and a median of 10 gpm. Table 2-6 lists types of use for the water supply wells.

Table 2-6. Types of Ground-Water Use - Water Supply Wells.

Type of Use	Number of Wells
Livestock	103
Livestock and domestic	11
Domestic	13
Industrial	12
Irrigation	6
Irrigation and municipal	4
Municipal	2

2.5 BIOTIC FEATURES

Information on the biotic resources in the facility area was gathered from four primary sources: information and reports prepared to support previous applications for permitting the existing facility, available data for the general area from resource management agencies (the U.S. Fish and Wildlife Service [FWS] and the Colorado Division of Wildlife [CDOW]), published and unpublished information to supplement and corroborate the agency information, and a site reconnaissance conducted on May 1, 1997.

2.5.1 Site and Vicinity Description

The Deer Trail facility consists of a fence-enclosed, 325-acre permit area that is surrounded by a 5,435-acre buffer zone. Deer Trail owns nine sections of land, which include Sections 21, 22, 23, 25, 26, 27, 34, 35, and 36 in Township 3 South, Range 57 West in southeast Adams County. This section uses the terms "project area" to refer to the combined permit area and buffer zone and "study area" to refer to the area within a 3-mile radius of the project area.

2.5.2 Onsite Major Vegetation Types

A quantitative analysis of native grassland communities was not conducted because most of the native vegetation was removed for construction of the existing facility, and no additional disturbance is anticipated in native plant communities. However, four main habitat types – row-crop agricultural, disturbed, reclaimed grassland, and mixed grass prairie – occur in the project area. The site reconnaissance observed no wetlands in the permit area or buffer zone.

The reclaimed grassland plant community covers nearly the entire permit area and adjacent buffer zone. These two areas were disturbed by previous agricultural practices and were revegetated with a grassland seed mixture approved by the Natural Resources Conservation Service (NRCS). The seed mixture included blue grama *(Bouteloua gracilis),* western wheatgrass *(Agropyron smithii),* and buffalo grass *(Buchloe dactyloides),* with rye *(Secale cereale)* as a cover crop. Although most of the permit area and buffer zone is dominated by blue grama and western wheatgrass, annual weed species dominate intermittent areas. This community is devoid of trees or shrubs and is typically hayed and bailed in late August or early September. Natural vegetation covers approximately 2% of the project area and is characterized as mixed grass prairie.

2.5.2.1 Onsite Natural and Human-Induced Conditions, Including the Successional State

The Deer Trail facility permit area and adjacent buffer zone were revegetated about 8 years ago using a native prairie seed mixture approved by the NRCS. The plant community in the project area is a reclaimed native grassland. The buffer zone, which includes portions of Sections 25, 26, 35, and 36, contains about 1,500 acres of reclaimed grassland that is harvested as an annual hay crop in the fall of the year. Row-crop agricultural fields are not planted, and cattle grazing is

not allowed inside the buffer zone boundary. A paved roadway leads into the buffer zone to the disposal site along with a power transmission line.

2.5.3 Offsite Major Vegetation Types

Mixed grass prairie cover is almost entirely restricted to the narrow stream valley of Wetzel Creek and its tributaries. Mid-grass prairie species generally predominate on the deeper, moister soils of flood plains, whereas shortgrass species predominate on the dry upland soils. Common mid-grass species found along Wetzel Creek include needle-and-thread grass *(Stipa comata)*, sand dropseed *(Sporobolus cryptandrus)*, and alkali sacaton *(Sporobolus airoides)*. Shortgrass prairie species occur on some dry upland areas along the upper terraces of the creek. Dominant perennial grasses include blue grama, buffalo grass, and Indian ricegrass *(Oryzopsis hymenoides)*.

Mixed grass prairie in the surrounding 3-mile study area is similar to the mixed grass prairie in the project area. These mixed grass prairie areas are used primarily as pasture land for cattle and, to a lesser extent, horses, and are heavily grazed. The row-crop agricultural community consists of monocultures of winter wheat. This community covers the majority of the acreage in the study area and is characterized by a 2-year crop rotation; that is, half the field is planted in a dormant seeding in the fall of the year while the other half is left to be plowed into fallow, typically in late summer. The rotation is switched in the next planting season. Vegetative cover is generally lacking in fallow portions of this community.

The disturbed community is generally restricted to portions of the permit area that include stripped topsoil and subsoil and open land cells for waste disposal. Like the fallow row crop agricultural lands, this community generally lacks vegetative cover. Because of the highly altered nature of most plant communities in the project and study areas and the absence of special habitats, this section dose not include plant community maps.

2.5.4 Wildlife Resources

The wildlife resources in the area are typically upland in nature. However, semiaquatic species can occur in suitable habitats. Species occurring in the area are typical of shortgrass prairies. Wildlife in the area includes the following groups: big game, predators, small mammals, raptors,

upland game birds, songbirds, and reptiles and amphibians. Big game species in the area include mule deer *(Odocoileus hemionus)* and pronghorn antelope *(Antilocapra americana)*. Both mule deer and pronghorn antelope are likely to use all plant community types within the project area.

To facilitate its management of wildlife, CDOW divided the state into Game Management Units (GMUs). These GMUs typically comprise all or a portion of the home range for a single herd. The permit area is in GMU 99. The buffer zone and adjacent areas are in GMUs 100, 106, and 107.

Mule deer in the area are part of the Table Lands Herd, which occurs on GMUs 87, 88, 89, 90, 93, 95, 98, 100, 101, and 102. In 1994, CDOW estimated the herd's size at 4,391 animals, with a buck-to-doe ratio of 42:100. By 1995, CDOW estimated this herd had grown to 4,675 animals, with a buck-to-doe ratio of 31:100. The surrounding area contains the Bijou Creek and Big Sandy Herds. The Bijou Creek herd encompasses GMUs 104, 105, and 106, and the Big Sandy Creek herd encompasses GMUs 107, 112, 113, 114, 115, 120, and 121. These herds occupy areas southeast of the project area. CDOW estimates the 1995 populations of these herds were 6,111 and 2,674, respectively, with buck-to-doe ratios of 73:100 and 70:100, respectively (CDOW, 1995). In general, the project area is year-round range.

Pronghorn antelope in the project area are part of the Hardpan Herd. CDOW estimated the population in 1995 to be 1,157 animals, with a buck-to-doe ratio of 26:100. The 1994 population estimate was 1,155 animals, with a buck-to-doe ratio of 22:100. In addition, the general project area is adjacent to the Last Chance Herd. The 1995 estimate for this herd was 1,815 animals, and the 1994 estimate was 1,756 animals. The buck-to-doe ratio for this herd varied from 28:100 in 1995 to 23:100 in 1994. The project area is year-round range for pronghorn antelope.

Numerous predators occur or potentially occur in the project area. They include coyotes *(Canis latrans)*, badgers *(Taxidea taxus)*, and long-tailed weasels *(Mustela frenata)*. Some predator species, such as coyotes, use a large home range that might include only portions of the project area.

Small mammal species occurring in the project area include deer mice *(Peromyscus maniculatus)*, prairie voles *(Microtus ochrogaster)*, thirteen-lined ground squirrels

(Spermophilus tridecemlineatus), and hispid pocket mice *(Perognathus hispidus)*. Small mammals occur in all plant community types in the project area, with the exception of the fallow agricultural type. Although the project area is in the range of the black-tailed prairie dog *(Cynomys ludovicianus)*, the site reconnaissance observed no prairie dogs or their colonies.

Due to a lack of suitable habitats, nesting raptors are generally lacking in the project area. However, species such as red-tailed hawk *(Buteo jamaicensis)*, Swainson's hawk *(Buteo swainsoni)*, American kestrel *(Falco sparverius)*, northern harrier *(Circus cyaneus)*, and rough-legged hawk *(Buteo lagopus)* are likely to use the area as foraging habitat. Raptors are likely to use all plant community types in the project area.

Several species of upland game birds are likely to use portions of the project area. They include ring-necked pheasant *(Phasianus colchicus)* and mourning dove *(Zenaida macroura)*. These species are likely to occur commonly in the row crop agricultural and mixed grass prairie habitat types.

Numerous songbirds occur or potentially occur in the project area. However, the diversity and numbers of these species vary seasonally. Common species include the western meadow lark *(Stumella neglecta)*, horned lark *(Eremophila alpestris)*, lark bunting *(Calamospiza melanocorys)*, western kingbird *(Tyrannus verticalis)*, and McCown's longspur *(Calcarius mccownii)*. These species are likely to occur commonly in all four habitat types.

Several species of reptiles might occur in the project area; however, suitable habitats for amphibians are generally lacking. Reptile species potentially occurring in the area include the eastern short-horned lizard *(Phrynosoma douglassi brevirostre)*, prairie rattlesnake *(Crotalus viridis viridis)*, and bullsnake *(Pituophis melanoleucus)*. No invertebrates of local importance or concern as disease vectors or pests occur on the property.

The entire study area is privately owned with hunting and fishing opportunities being the prerogative of each landowner. Harvestable wildlife populations are relatively low and a sport fishery is nonexistent. Deer hunting in the northeastern region of the State is characterized as average at best. However, the region is well populated with pronghorn antelope in sizable herds on the eastern plains. The absence of surface water, dense nesting cover, and suitable habitat

precludes most game animals that are sought for these purposes. Species that could be hunted in season are mourning dove, ring-necked pheasant, mule deer, pronghorn antelope, and waterfowl.

The FWS indicates that 11 species listed as threatened or endangered could occur in the project area. CDOW identified 10 additional State-listed threatened or endangered species or species of special concern that potentially occur in the project area.

The study area, including land in the vicinity of the project area, is vegetated by one plant community – mixed grass prairie, which is dominated by blue grama and western wheatgrass.

Grazing of domestic cattle does not occur in the permit area or buffer zone. Cattle are generally not the primary agricultural crop produced in the study area due to the low amount of precipitation and the overall low productivity of the native grasslands.

2.6 PREOPERATIONAL ENVIRONMENTAL MONITORING

The focus of the preoperational environmental monitoring program was to verify the ability of the local geology and hydrogeology to isolate hazardous waste from the environment over the long term. As described above, a variety of studies characterized various aspects of the site, its environmental setting, and its basic technical properties. In terms of radiation, preoperational monitoring consisted of establishing the ambient background radiation level for purposes of calibrating the gate monitor system. This was performed by the Colorado Department of Public Health and Environment on behalf of Adams County, and the gate monitor was set to alarm if dose rates in excess of 16 microroentgens per hour occurred. In addition, the radioactive constituents in the ground water beneath the site were determined. The ground-water sampling evaluated alpha, beta-gamma, and uranium levels. These parameters, which have been part of the operational monitoring program, have shown no change from the initial measurements, largely reflecting background concentrations of NORM/TENORM radionuclides. Because the Deer Trail facility has not accepted manmade radionuclides in radioactive waste, no ambient background levels of these radionuclides have been recorded.

2.7 REFERENCES CITED

Browning-Ferris Industries, Inc. (BFI). 1981. *Chemical Waste Treatment/Solidification & Disposal Facility Plan.* Volume I - Technical Report. Highway 36 Land

Development Company, Adams County, Colorado, Draft for Review and Comment (provided in Volume 5 of this application).

Browning-Ferris Industries, Inc. (BFI). 1982. *Chemical Waste Treatment/Solidification & Disposal Facility Plan.* Volume I - Technical Report. Highway 36 Land Development Company, Adams County, Colorado, Revised October 1982 (provided in Volume 3 of this application).

Cameron-Cole. 2004. *2003 Annual Groundwater Protection Monitoring Report.* Prepared for Clean Harbors (Deer Trail), LLC. (Provided in Volume 6 of this application).

Clean Harbors Deer Trail (CHDT). 2004. Permit Renewal Report for Incorporation of a Geosynthetic Clay Liner (GCL) in the Liner Section for Secure Cells 3 Through 7 and in the Cover Section for Secure Cells 1 Through 7 (the *Permit Renewal Report* – provided in Volumes 4 and 5 of this application).

Colorado Geological Survey (CGS). 1986. *Candidate Area Evaluation Report, Low-Level Radioactive Waste Disposal, Colorado.* Open File 86-7 (provided in Volume 3 of this application).

Crow, L. W. 1987. *Analysis of Pertinent Weather Factors Related to the Permit Application for Proposed Highway 36 Waste Management Facility.* Prepared for Morrison-Knudsen Engineers, Inc., Denver, Colorado (provided in Volume 6 of this application).

McCulley, Frick, and Gilman, Inc. 1997. *Highway 36 Facility Groundwater Protection Program Design and Rationale.* Prepared for the Highway 36 Land Development Company, Deer Trail, Colorado (provided in Volume 6 of this application).

Figure 2-1. Representative windrose for the Deer Trail Facility.

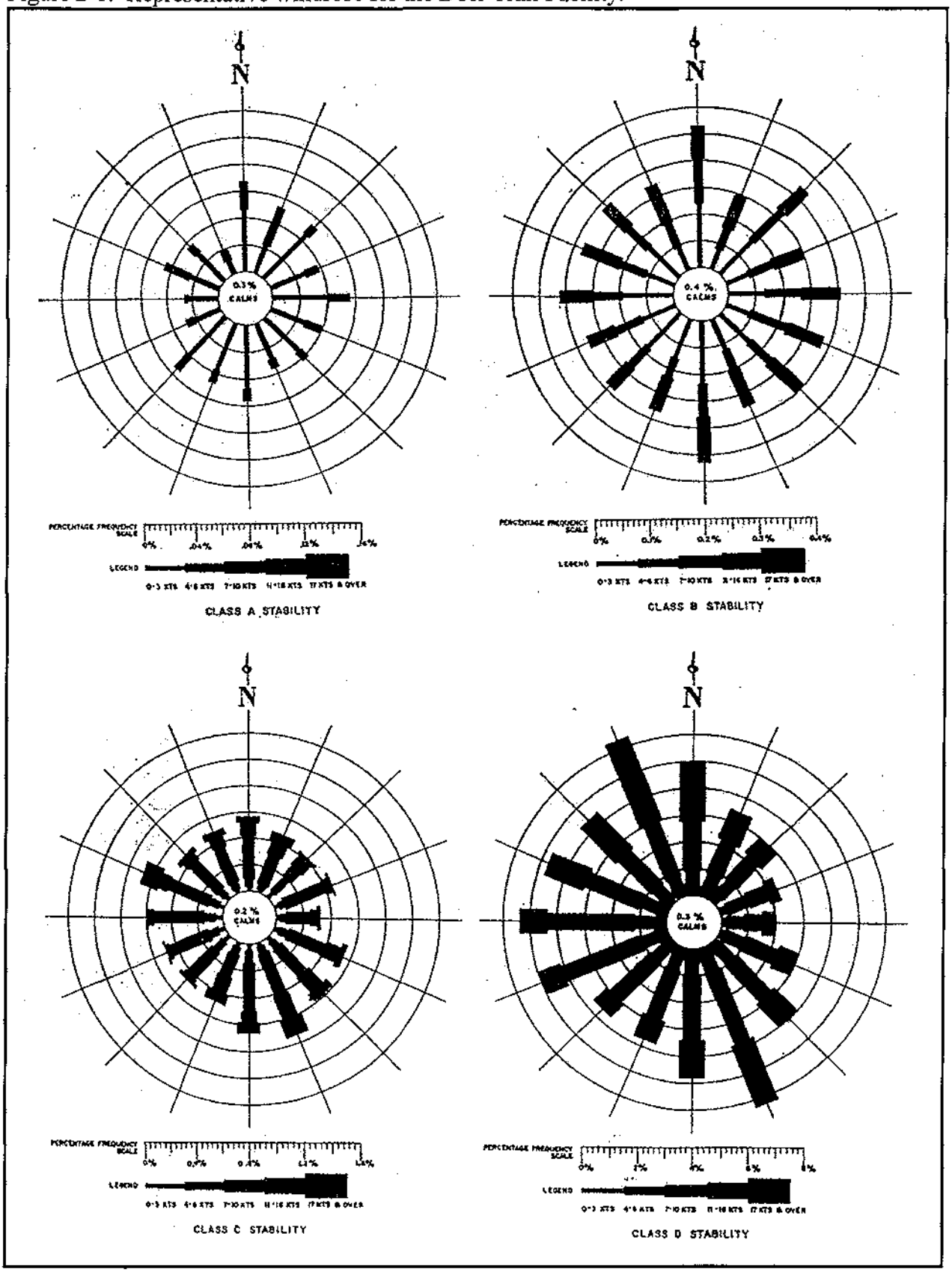
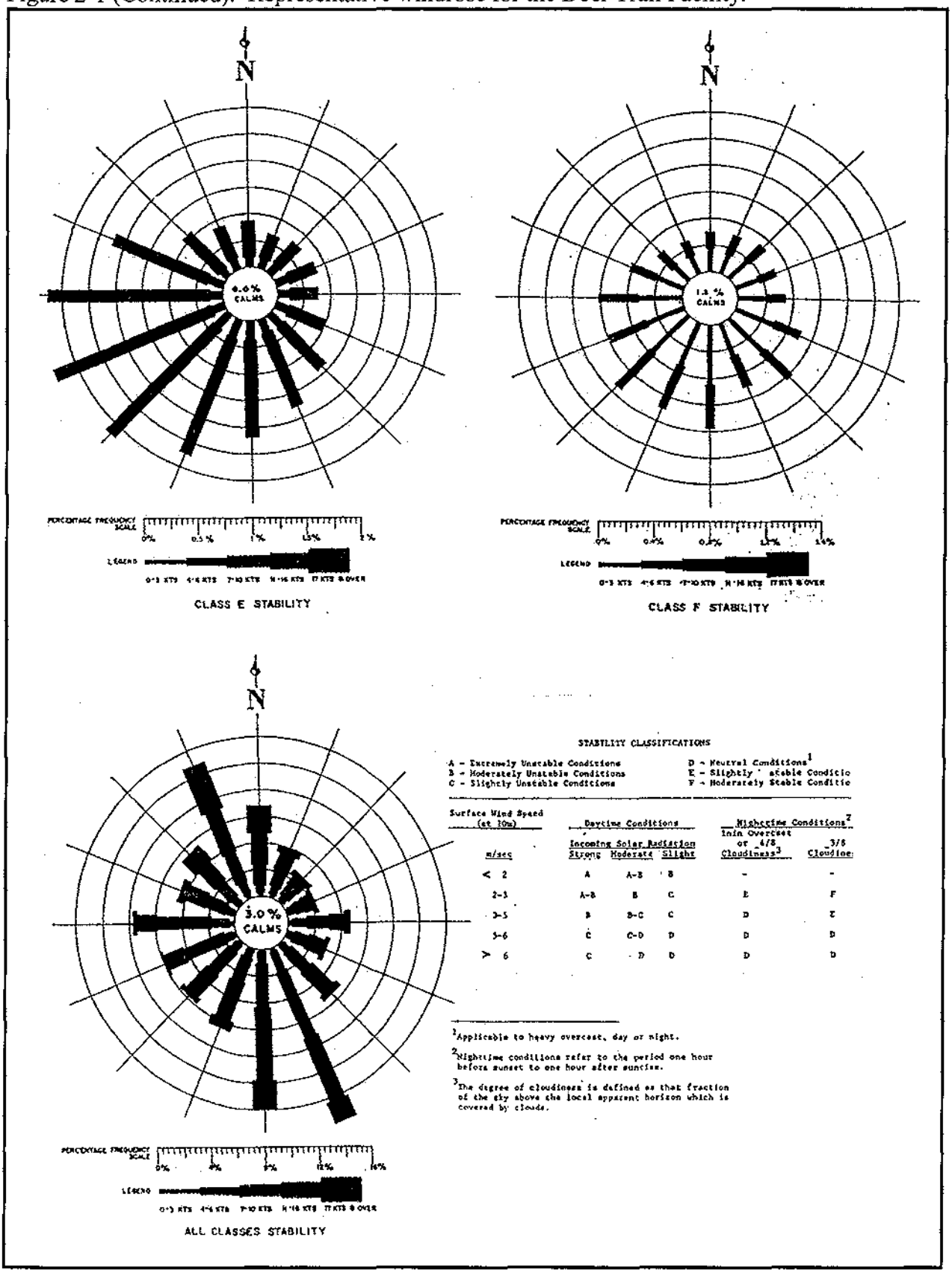


Figure 2-1 (Continued). Representative windrose for the Deer Trail Facility.



STABILITY CLASSIFICATIONS

A - Extremely Unstable Conditions
B - Moderately Unstable Conditions
C - Slightly Unstable Conditions
D - Neutral Conditions[1]
E - Slightly Stable Conditio
F - Moderately Stable Conditio

Surface Wind Speed (at 10m)	Daytime Conditions			Nighttime Conditions[2]	
	Incoming Solar Radiation			1min Overcast or ≥4/8 Cloudiness[3]	≤3/8 Cloudine
m/sec	Strong	Moderate	Slight		
< 2	A	A-B	B	-	-
2-3	A-B	B	C	E	F
3-5	B	B-C	C	D	E
5-6	C	C-D	D	D	D
> 6	C	D	D	D	D

[1] Applicable to heavy overcast, day or night.

[2] Nighttime conditions refer to the period one hour before sunset to one hour after sunrise.

[3] The degree of cloudiness is defined as that fraction of the sky above the local apparent horizon which is covered by clouds.

3.0 DESIGN AND CONSTRUCTION

This section describes the design and construction of the Resource Conservation and Recovery Act (RCRA) Subtitle C landfill at the Deer Trail facility, using references and descriptions from the records used to obtain the RCRA Permit. As stated in Section 1.1, the process used to site and permit the Deer Trail facility under RCRA was thorough and complete, and quite similar to the process for licensing low-level radioactive waste disposal facilities. This means that the technical evaluation of the Deer Trail facility was as thorough and complete as the process used to license radioactive waste disposal facilities. The strategy in this license application relies on referencing wherever possible the technical information originally developed to obtain the Certificate of Designation and providing supplemental information on the radioactive properties of Naturally Occurring Radioactive Material (NORM)/Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) waste. For example, Sections 6 and 7 of this application contain additional information on the inadvertent intruder barrier and occupational exposure conditions.

Most of the principal low-level radioactive waste disposal design features described in this section are largely requirements of the RCRA Permit process and are specific to meeting RCRA requirements. These include:

1. Minimizing the infiltration of water into the disposal cells through proper closure design,
2. Ensuring the integrity of the disposal unit covers (through engineering design and regulation),
3. Providing structural stability of the disposal system (through receipt and compaction of bulk waste),
4. Minimizing waste contact with standing water (through contouring of site surface features and operation of the leachate collection system),
5. Providing adequate site drainage during operations and after closure,
6. Facilitating site closure and stabilization,

7. Minimizing the need for long-term maintenance,

8. Providing adequate disposal site monitoring, and

9. Providing an adequate buffer zone for monitoring and potential mitigative action.

The two notable exceptions for radiation protection include:

1. Providing a barrier against inadvertent intrusion, and

2. Maintaining occupational exposure as low as is reasonably achievable (ALARA).

The following sections discuss the principal design features of the Deer Trail facility, design considerations for normal and abnormal (accidental) conditions, construction considerations, and the design of auxiliary systems and facilities.

3.1 PRINCIPAL DESIGN FEATURES

As noted above, the purpose of the principal design features of the facility is to satisfy the 11 functional requirements identified in NUREG-1199 (NRC 1991). The following sections describe these features in terms of their use to satisfy the functional requirements. The following documents contain design details and drawings:

> Permit Renewal Report for Incorporation of a Geosynthetic Clay Liner (GCL) in the Liner Section for Secure Cells 3 Through 7 and in the Cover Section for Secure Cells 1 Through 7 (Highway 36 Land Development Company 1996).
>
> State RCRA Permit Renewal Application, Volume Two, Section 10.1 Specifications for Secure Cell Construction, **(CHDT 2004a – see Volume 5 of this application).**[4]
>
> State RCRA Permit Renewal Application, Volume Two, Section 10.2 Drawings for Secure Cell Construction, **(CHDT 2004a – see Volume 5 of this application).**
>
> State RCRA Permit Renewal Application, Volume Two, Section 10.3 Construction Quality Assurance Plan (CQA), **(CHDT 2004a – see Volume 5 of this application).**

[4] For ease of review, references in **bold** are in Volumes 2 through 6 of this application.

Waste Filling Plan and Drawings for Secure Cell Number 2, Revision 1, **(CHDT 2004b – see Volume 6 of this application)**.

3.1.1 Water Infiltration

Numerous design features at the Deer Trail facility reduce the possibility that water will infiltrate the disposal cells and contact waste. The principal features are the disposal cell covers and the drainage system.

The disposal cell cover design, which is applicable to each of the seven cells, incorporates multiple elements to minimize the potential for water infiltration from the surface to the waste. Specifically, the cell covers include the layers listed below and shown in Drawing Number 25 of the *State RCRA Permit Renewal Application, Volume Two, Section 10.2 Drawings for Secure Cell Construction*, **(CHDT 2004a – see Volume 5 of this application)**. The list is in order from the surface of the cover to the surface of the waste.

- *Topsoil* - An 8-inch topsoil layer supports vegetation, which contributes significantly to the prevention of water infiltration to other layers of the cover; its primary contributions are evapotranspiration and erosion control. As noted in the 1996 Permit Renewal Report, Appendix A-14, the Hydrologic Evaluation Landfill Performance (HELP) Model evaluation of the cell cover design predicts that all precipitation that infiltrates the topsoil layer will be lost to evapotranspiration (Highway 36 Land Development Company 1996). The establishment of native vegetation will minimize erosion caused by precipitation runoff and wind, thereby preventing exposure of other layers of the cover. The establishment of vegetation will be in accordance with the facility's Run-Off Management System Design Drawings and Specifications.

- *General Fill* - A 3-foot general fill soil layer is immediately beneath the topsoil layer. General fill provides protection to the underlying geocomposite, geomembrane, and geosynthetic layers against damage from frost, erosion, deep-rooted plants, and burrowing animals.

- *Geocomposite Drainage Layer* - This layer consists of a geocomposite of high-density, polyethylene (HDPE) geonet laminated between two layers of nonwoven

geotextile. The geocomposite directs water that passes through the topsoil and general fill layers outward from the center of the cell cover to a surface drainage pipe at the toe of the cell cover.

- *HDPE Geomembrane* - An 80-mil textured geomembrane serves as a low-permeability barrier and provides protection to underlying layers against burrowing rodents and deep-rooted plants.

- *Geosynthetic Clay Layer (GCL)* - The GCL is a substitute for a compacted clay layer. Manufactured by Bentofix, it consists of an inner core of sodium bentonite surrounded by a woven geotextile on one side and a nonwoven geotextile on the other. The GCL, which has a thickness of approximately 10 millimeters, functions as an infiltration barrier, meeting the cover design requirement for permeability of less than or equal to 1×10^{-7} centimeter per second (cm/s).

- *Interim Soil Cover*- The interim soil cover, which has a minimum thickness of 0.5 foot, is placed over the waste to function as an "operations" base for the placement of the layers listed above.

There is essentially no potential for ground water to infiltrate the disposal cells because there is no water in any of the formations near the cells. In addition, cell liners consist of multiple layers of low-permeability materials, including a GCL and a compacted clay layer, each with a permeability less than or equal to 1×10^{-7} cm/s. The liner will prevent the infiltration of water from beneath the facility surface to the waste.

The facility drainage system consists of integrated elements that minimize the potential for negative impacts on the waste due to precipitation. Two key defenses against infiltration, in terms of drainage design, are the location of the facility at the top of a knoll and the sloping of the cell covers. The disposal cells are centered around a knoll that promotes storm water runoff in all directions. Runoff from the east side of the knoll flows to the Beaver Creek drainage; runoff from the west side flows to the Wetzel Creek drainage. The covers are sloped at least 5% at closure, as shown in Drawing Number 25 of the *State RCRA Permit Renewal Application, Volume Two, Section 10.2 Drawings for Secure Cell Construction*, **(CHDT 2004a – see Volume**

5 of this application). Because the waste is disposed of in bulk form and stabilized in place, settlement of waste material in the cells probably will not be extensive enough to allow the slope to decrease to less than 3% in the future. The grading promotes precipitation runoff without significant risk for runoff velocities that could lead to significant erosion.

3.1.2 Disposal Unit Cover Integrity

Consistent with RCRA requirements, the purpose of the disposal cell covers is to perform over a long period with no maintenance. The design elements in the covers (e.g., vegetation and earth-bermed ditches that are in the transitional cover slope [outboard of the anchor trench] on 10-foot centers) maintain erosion rates at or below the U.S. Environmental Protection Agency (EPA)-recommended maximum erosion rate of 2 tons/acre/year. Clean Harbor Deer Trail (CHDT) will monitor erosion that leads to gullying over the 30-year postclosure period, and will repair gullies that appear during this period with riprap.

The cover has been analyzed with regard to potential deterioration from frost penetration. A single-layer analysis for soils likely to be used for the general fill layer calculated the depth of freeze to be between 2.4 and 2.6 feet. The vegetative layer and the structural fill layers overlying the geosynthetic cover components are 3.7 feet thick. Therefore, frost penetration should not affect the HDPE membrane and the GCL. Supporting calculations related to frost penetration at the facility are included in the 1996 Permit Renewal Report, Volume II, Appendix A-7 (Highway 36 Land Development Company 1996).

Measures to mitigate erosion problems during the 30-year postclosure period, such as the placement of riprap in gullies, will maintain the integrity of the disposal cell covers over the long term. Cell covers could be vulnerable to burrowing animals; however, the 80-mil textured geomembrane and overlying geonet component of the drainage geocomposite should provide a formidable barrier to burrowing rodents. Inspections through the postclosure period will monitor potential impacts to the integrity of the cell covers.

3.1.3 Structural Stability

Ground water in the disposal cell area is at a depth of more than 4,000 feet. This is a significant factor in maintaining the stability of the cells. In addition, the placement of waste and backfill

will follow practices that significantly minimize the risk for subsidence over the long term, thereby providing reasonable assurance that the integrity of the engineered covers will be maintained.

3.1.4 Contact with Standing Water

Several features designed into the disposal cells, including a leachate collection system and a sump, will prevent waste contact with standing water. In addition, waste stored at the facility temporarily, prior to its permanent disposal in a cell, is stored in a roll off box on a graded pad and kept from contacting standing water.

The leachate collection system will remove water that might percolate through the waste. The system at the base of each disposal cell consists of a 1-foot-thick, multicomponent, high-permeability layer; 8-inch-diameter drainage pipes; and a 24-inch-diameter collection sump pipe (see details in the Conceptual Site Development Drawings in Volume I of the Permit Renewal Report; **CHDT 2004a – see Volume 4 of this application)**. On the side slopes of the cell, the leachate collection system consists of geocomposite, which is covered with 1.5 feet of soil for protection. The collection system, including the geocomposite layer on the side slopes, directs collected liquids to the cell's low point sump. Pumping through a riser pipe will remove liquids in the sump. The leachate collection system will be operational before the placement of any waste in the cell. Ponding surface liquids on the operational layer of each disposal cell will be removed during filling operations to the extent practicable.

Waste handling procedures will preclude the contact of waste with standing water during any period of waste staging prior to the placement of waste into a disposal cell. Waste brought on the site is sampled while it is in the truck, which is parked in a covered area; the waste remains covered in the transporting truck while sample analysis occurs over a period not to exceed 10 days; processed waste remains indoors until its final disposal in an active cell.

3.1.5 Site Drainage

CHDT will control surface-water drainage to minimize the potential to contact waste and cause erosion at the facility. A Surface Water Management Plan will be used to manage drainage during disposal cell operations (i.e., during placement of wastes in the cells). The Conceptual

Site Development Drawings in Volume I of the Permit Renewal Report **(CHDT 2004a – see Volume 4 of this application)** show the surface-water drainage patterns during the different phases of disposal cell activities. In general, the drainage pattern at the end of disposal activities will reflect the drainage pattern at the facility prior to construction of the disposal cells. The facility's location on a knoll enables the natural drainage of surface water away from the cells in all directions.

Site drainage features include storm water drainage channels and drop structures – as required to reduce channel slopes and consequential erosion culverts – and erosion control structures such as temporary ridges, swales, or straw bales. Details on the design of surface-water control systems are in Run-Off Management System Design Drawings and Specifications **(CHDT 2004a – see Volume 4 of this application)**.

3.1.6 Site Closure and Stabilization

The use of multilayer liners and covers for each disposal cell is the key element of site closure and stabilization. The liner design, which is common to each cell except Cells 1 and 2 (see the discussion on incorporation of a GCL in Volume I of the Permit Renewal Report, **CHDT 2004a – see Volume 4 of this application)**, includes multiple layers of low- and high-permeability materials to prevent migration of contaminants outside the disposal cell and collect contaminated leachate, respectively. The cover design, which is common to each cell, includes multiple layers and sloping to minimize the potential for precipitation to infiltrate to the buried waste. The thickness of the multiple layers and the use of synthetic materials minimize the potential for burrowing animals to damage the cover to the extent that a significant risk would develop for the release of waste contaminants to the local environment. Sloping of the cell cover promotes precipitation runoff away from the disposal cell area.

The most significant negative impacts to the long-term integrity of the disposal cells would stem from wind and water erosion. CHDT will minimize each type of erosion through the facility design, including the use of native vegetation on the surface of the disposal area, the incorporation of an appropriate level of grading to promote effective precipitation runoff without significant erosion, and the use of surface drainage features, such as culverts, to direct surface water away from the cells quickly.

Disposal cell subsidence can have a negative effect on the designed surface-water drainage system. The potential for subsidence is minimized through strict waste placement practices, as outlined in the Operations Narrative **(CHDT 2004a -- see Volume 4 of this application)**. These practices, including disposal of bulk waste that is stabilized in place, should preclude a level of subsidence that would require significant active maintenance of the cover during the 30-year postclosure period and beyond.

Because the facility is centered at the top of a knoll, precipitation will drain naturally away from the disposal cells. The design of the engineered surface-water control features will enhance natural surface-water runoff at the knoll. During long-term maintenance, CHDT will identify and correct surface-water drainage problems that could develop over time. Thirty years (as required by RCRA) is sufficient to evaluate and correct foreseeable surface-water drainage problems that could compromise the integrity of the cells beyond the 30-year maintenance period.

3.1.7 Long-Term Maintenance

Strict facility management practices, including the placement of waste in the disposal pits using practices that minimize the risk for future waste subsidence, the use of multiple layers of cover and liner materials designed to ensure long-term isolation of the waste without the need for maintenance, and the placement of surface-water drainage features that function with the natural drainage tendencies of the disposal area, will avoid the need for long-term maintenance.

3.1.8 Inadvertent Intruder Barrier

Although RCRA requirements do not specifically address application of human intruder barriers, appropriate measures will limit the likelihood of such intrusion. For example, the remote location of the site (lack of an identified growth corridor), sparse population, extensive buffer zone, and postclosure controls are effective measures to prevent human intrusion. The primary barrier to human intrusion is the RCRA closure system (i.e., the cover placed over the waste), which isolates the waste from activities that disturb the site surface. In addition, CHDT proposes to accept for disposal only NORM/TENORM wastes at relatively low concentrations and dose rates compared to the broader definition of low-level waste. As described in Section 6, the

limitations on waste concentration will help mitigate potential consequences of human intrusion after closure.

3.1.9 Occupational Exposure

As discussed in Section 1, the strategy of this license application is to limit concentrations of NORM/TENORM waste to low levels so workers will be considered members of the public and radiation exposures will be less than 100 millirem per year (mrem/yr), with a goal of 25 mrem/yr or less. If worker dosimetry results indicate that selected worker doses could exceed 25 mrem/yr, an assessment of the potential for other manmade exposures for these workers will ensure that maximum individual doses from manmade sources do not exceed 100 mrem/yr. This assessment will consider real individuals working at Deer Trail, not hypothetical members of the public.

Several operational features will be effective in maintaining worker doses ALARA. For example, the RCRA Permit requires that workers in the cells wear protective clothing and respirators to prevent inhalation exposures. Although originally intended to limit intake of hazardous chemicals such as asbestos, these measures are equally effective in reducing intakes of radionuclides in the NORM/TENORM waste. Further, the RCRA Permit requires daily cover of clean soil as dust mitigation and to promote overall cell stability; the daily cover will also provide shielding and reduce ambient dose rates, which is an effective ALARA measure.

3.1.10 Site Monitoring

CHDT will monitor potential pathways to detect the release of radionuclides or other waste materials from the site. The site environmental monitoring program consists of three phases:

- Preoperational environmental monitoring (discussed in detail in Section 2.9) to determine the baseline conditions of the site prior to acceptance of NORM/TENORM waste

- Operational environmental monitoring (discussed in detail in Section 4.4) to determine if releases have occurred during the operational phase

- Postoperational environmental monitoring (discussed in detail in Section 5.3) to demonstrate that the site is stable

CHDT will monitor potential pathways, including air, ground water, soil, and vegetation, during the operational and postoperational phases of the environmental monitoring program.

3.1.11 Buffer Zone

The buffer zone is under the disposal unit and between the disposal units and the property boundary, in accordance with 10 CFR 61.52(a)(8) and 6 CCR 1007-1-14.2. The buffer zone must be of adequate size to allow environmental monitoring activities and corrective actions if there is detection of radionuclide migration. From the Colorado guidelines, the minimum size of the buffer zone area is 30 meters.

The facility's current Colorado RCRA Permit authorizes hazardous waste treatment, storage, and/or disposal activities on 325 acres of Sections 25 and 36, Township 3 North, Range 57 West (the RCRA Permitted Area). CHDT owns 5,435 additional acres that surround the Permitted Area, creating a substantial buffer zone.

3.2 DESIGN CONSIDERATIONS FOR NORMAL AND ABNORMAL ACCIDENT CONDITIONS

The following sections describe design considerations for normal and abnormal accident conditions.

3.2.1 Water Infiltration

The multilayer cover design for each disposal cell was analyzed using the EPA HELP code. The assumed worst-case precipitation event was 8.2 inches in 24 hours. The results of the analysis (noted in the 1996 Permit Renewal Report, Volume III, Appendix A-12) indicated that no water would accumulate on the HDPE liner at the base of the geocomposite drainage layer of the cover, and that all precipitation that infiltrated the upper layers of the cover would be lost to evapotranspiration (Highway 36 Land Development Company 1996).

The HELP model was also used to estimate the volume of water that would pass through the waste and liner system during waste placement in a disposal cell (i.e., during the active phase of

a cell). The HELP model runs are in Appendix A-12, Volume III of the Permit Renewal Report (Highway 36 Land Development Company 1996). An active cell was analyzed for short- and long-term demands on the leachate collection system based on waste depths of 10 and 60 feet, respectively. The HELP model estimated temperature and solar radiation assuming a location of Denver, Colorado. Daily precipitation was modeled for a 5-year period using the Denver rainfall record. Sensitivity analyses show that the leachate production rate is dependent on the available liquid storage of the waste.

To determine if the leachate collection system will be adequate during the early stages of filling, the peak daily volume was used in the calculation because the collection system is more likely to experience large flow fluctuations in the short term because of the short distance rainwater percolates before it reaches the system. The drainage layer was analyzed to determine if the volume of leachate predicted by the HELP model could be transmitted by the primary and secondary collection systems with a maximum depth of liquid above the liner systems not over 8 inches. The analysis showed that the transmissivity of the drain layer is much greater than required and can limit water accumulation on the liner to approximately 1 inch for the primary system and 0 inch for the secondary system, as described in the Permit Renewal Report, 2 Volume III, Appendix A-12 (Highway 36 Land Development Company 1996).

For the long term, the same approach determined the peak daily head over 20 years, as predicted by the HELP model. The HELP output for long-term conditions showed that the maximum water accumulation on the primary liner was approximately 1 inch and the maximum head on the secondary liner was approximately 0 inch.

With disposal cell covers sloped at 5%, an 8.2-inch, 24-hour precipitation event would probably result in the formation of drainage gullies on the covers. CHDT will line any gullies that form during the 30-year postclosure period with riprap to lessen the potential for gully formation in the years after the postclosure period.

There are no design criteria associated with the direction and control of seasonal perched ground water because there is no perched ground water near the disposal cells that could affect the waste. Insignificant amounts of perched ground water have been detected in drainage swales outside the perimeter of the cell area at depths of 35 to 45 feet. In addition, the uppermost

continuous water-bearing zone outside the perimeter of the cell area is 250 to 390 feet deep – well below the bottom of the cells.

3.2.2 Disposal Unit Cover Integrity

The analysis for determination of cover erosion used equations outlined in the U.S. Nuclear Regulatory Commission Staff Technical Position, Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites. Results for the cover slope of 5% indicate that the 8.2-inch, 24-hour storm will cause gully erosion. Actual flow velocities, however, are approximately equal to permissible velocities for grass-lined channels. To mitigate potential gullying, CHDT will monitor the cover during the 30-year postclosure period and will repair gullies that appear during this period with riprap. Calculation details are in Appendix A-15 of Volume III of the Permit Renewal Report (Highway 36 Land Development Company 1996).

The total wind and precipitation erosion losses have been modeled at 1.1 tons/acre/year, with 0.6 ton/acre/year due to water erosion and 0.5 ton/acre/year due to wind erosion. The total projected erosion rate of 1.1 tons/acre/year does not exceed the acceptable EPA projection value of 2 tons/acre/year.

Precipitation erosion modeling indicates that the steeper slope of the cell covers outside the anchor trench (i.e., around the perimeter of each cover) would erode at a rate greater than the acceptable EPA value of 2 tons/acre/year if the site received the assumed 8.2-inch, 24-hour "worst-case" precipitation event. To combat this unacceptable erosion rate at the perimeter of each cell cover, the design includes the use of half pipes and/or lined ditches to intercept runoff and direct the collected water away from the disposal cell.

Selection of the 5% slope of each disposal cell cover was based on a predicted 4.7% settlement factor for the disposal cell waste and construction materials. Settlement of 4.7% after cell closure would result in a final cover slope of 3%, which is the minimum acceptable slope for the cells. Prior to placement of the final cover, waste settlement will be monitored and compared to the projected settlement factor of 4.7%. If the settlement is greater than 4.7%, the cover slope will be increased to accommodate the increased settlement to maintain the minimum 3% slope.

3.2.3 Structural Stability

The projected settlement factor of 4.7% discussed above for the functional requirement Disposal Unit Integrity considers waste disposal practices that should preclude the formation of voids by placing and compacting waste in lifts (4-foot maximum depth). Waste placement practices at Deer Trail should result in structurally stable disposal cells.

Prior to filling, unsupported cut slopes will exist on all sides of each disposal cell. These slopes were analyzed for static and dynamic stability using Bishop's method of slides. A computerized slope stability program (XSTABL) analyzed the cut slopes. Strength parameters for soil and rock materials were interpreted from earlier testing for the facility. Material properties used in the analyses are summarized in Section 6 of the Site Development Plan Design and Construction Narrative (Highway 36 Land Development Company 1997a). The site grading plans, shown in the Site Development Drawings of the Permit Renewal Report **(CHDT 2004a – see Volume 4 of this application)**, indicate that the maximum cut slopes will be 3 horizontal to 1 vertical, and the maximum height will be about 70 feet. Results for the critical 3-horizontal-to-1-vertical slope indicate a static safety factor of 2.1 for the short-term (undrained) condition and 1.5 for the long-term (drained) condition. Stability during seismic loading was estimated by applying a pseudostatic earthquake force in the Bishop analysis. Results based on the 0.06*g* design acceleration indicate a dynamic safety factor of 1.7 for the short-term condition and 1.3 for the long-term condition. Appendix A-1 of the Permit Renewal Report contains details of the cut slope stability analysis.

A waste stability analysis considered face failure through the waste and along the lining system, and a basal failure along the lining system. The analysis considered a 4-horizontal-to-1-vertical waste fill slope and a base grade of 3%. Strength parameters for liner components and liner interfaces were determined from site-specific testing programs, which are described in Appendixes A-2 and B of the 1996 Permit Renewal Report (Highway 36 Land Development Company 1996). The assumed strength parameters for the waste materials were based on a description of the materials.

The XSTABL program was used to search for circular failure modes through the waste materials and for basal failure modes through the waste and liner components. Details of the waste

stability analysis are in Appendix A-2 of the 1996 Permit Renewal Report (Highway 36 Land Development Company 1996).

Three different components of the secure cells – subgrade, clay liner, and waste – were analyzed for settlement. Settlement modeling assumed that the subgrade behaves as an elastic medium. This assumption implies that any settlement that occurs will take place during placement of a waste load. Therefore, settlement in the subgrade should occur during the operating life of the cell, and postclosure settlement should be negligibly small. The most important parameter in this analysis is the elastic modules of the subgrade. The maximum calculated settlement near the center of the cell should be about 1 inch. Settlement should decrease to about 0.75 inch at the toe of side slopes.

The clay liner will settle by the mechanisms of primary and secondary consolidation. The analysis evaluated consolidation properties of loess and weathered Pierre shale to determine which liner material was critical. The weathered Pierre shale was determined to have the most critical consolidation properties due to its higher plasticity and compacted moisture content. This calculation used a compression index of 0.1927 for the primary settlement and 0.002 for the secondary settlement. The sum of the primary and secondary settlements will be approximately 0.04 and 0.07 foot for secondary clay liner on the base and slopes, respectively, and 0.4 foot for the primary clay liner on the floor. This settlement should be relatively uniform over the cell base. Appendix A-4 of the 1996 Permit Renewal Report (Highway 36 Land Development Company 1996) describes linear settlement. Interim waste settlement is not a concern if the standard waste disposal practices in the Operation Narrative are applied **(CHDT 2004a – see Volume 4 of this application).** The waste placement practices are likely to minimize the presence of voids in the waste.

3.2.4 Contact with Standing Water

As discussed in Section 3.2.1, there is essentially no risk for ground water to affect the waste in disposal cells at the facility. Multiple design elements will control surface water to minimize its impact on the cells, including sloping of the final covers to ensure appropriate precipitation runoff, placement of drainage channels at the perimeter of each cell to control erosion caused by runoff, use of riprap to control impacts to the cell covers caused by the formation of gullies, and

location of the facility at the top of a knoll that naturally drains surface water away from the cells.

The disposal cell design includes a sump beneath the secondary liner system for the collection and removal of water that might pool on the disposal unit floor, which is sloped at 3%. Water could be naturally occurring vadose zone water or could be released as a result of consolidation of the secondary clay layer. In the improbable event of leakage through the secondary liner, the permanent sump would detect, collect, and remove the leakage. A submersible pump will remove liquid collected in the sump through the sump riser pipe.

Temporary waste storage areas are associated with the receipt, sampling, and stabilization of wastes brought to the facility for disposal. CHDT samples waste brought to the site while it is in the transporting truck, which is parked in a covered area; waste remains covered in the truck during sample analysis over a period not to exceed 10 days; processed waste remains indoors until its final disposal in an active cell.

3.2.5 Site Drainage

As discussed in Section 3.2.1, there is essentially no risk for ground water to affect the waste in disposal cells at the facility. Multiple design elements will control surface water to minimize its impact on the disposal cells, including sloping of the final covers to ensure appropriate precipitation runoff, placement of drainage channels at the perimeter of each cell to control erosion caused by precipitation runoff, use of riprap to control the impacts to the cell covers caused by the formation of gullies, and location of the facility at the top of a knoll that naturally drains surface water away from the cells.

The location of the facility at the top of a knoll promotes the drainage of surface water away from disposal cells. In addition, surface drainage features direct and contain the flow of storm water runoff and improve the quality of surface water. Three systems are or will be employed at the facility to manage rainfall from inactive areas, operations areas, and active cells. These systems segregate and isolate uncontaminated, segregated, and contaminated storm water. The types of surface features used or to be installed at the facility include:

- Storm water drainage channels to intercept upslope runoff from drainage areas above haul roads and secure cells (active and closed) and runoff from drainage areas that otherwise would run to the facility area. Drainage channels will intercept uncontaminated and segregated runoff. Uncontaminated runoff will flow to an Uncontaminated Storm Water Detention Pond (UCDP). Segregated runoff will flow to lift stations or the Segregated Storm Water Retention Basin (SSRB). Minor drainage swales and berms could be used as necessary to direct runoff away from open cells and haul roads.

- Drop structures as necessary to reduce channel slopes. This results in reduced flow velocity and, therefore, reduced erosion potential.

- Culverts as necessary to direct storm water flow off steep slopes, under haul roads and ramps leading into secure cells, and when uncontaminated and segregated storm water channels cross.

- An SSRB that will receive segregated runoff directly from drainage channels, lift stations, and clean areas in the active secure cells.

- A UCDP that will contain and attenuate storm water flow directed to it by the uncontaminated storm water drainage channels.

- Erosion control structures such as temporary ridges, swales, or straw bales to divert or reduce total upslope runoff from small drainage areas above a recently disturbed area; slope protection (riprap or concrete slabs) as necessary in channels and at culvert openings to minimize erosion.

In general, the surface-water drainage pattern at the completion of the final cover will reflect the drainage pattern existing at the site prior to construction of the disposal cells. The Conceptual Site Development Drawings included with Volume I of the Permit Renewal Report show the drainage patterns to be established during disposal cell construction and closure **(CHDT 2004a – see Volume 4 of this application)**.

The hydrologic design of surface control structures is based on rainfall events. Snowmelt events produce lower peak runoffs for the small drainage areas at the facility. The 8.2-inch magnitude of the 24-hour storm event is the value in a January 2, 1990, settlement agreement and stipulation for the RCRA Permit.

The hydraulic design criteria for the surface control structures deal mainly with storm water drainage channels. The designs of channels, culverts, and drop structures are in accordance with generally accepted engineering practices.

The following design criteria for storm water drainage channels were used:

- Channels will be grass-lined, V-shaped, with side slopes no steeper that 3 horizontal to 1 vertical for temporary channels and no steeper than 4 horizontal to 1 vertical for permanent channels.
- Maximum storm water flow depth in all channels will be limited to 4 feet.
- Based on construction considerations, a minimum freeboard of 0.3 foot will be provided for all future channels in the disposal site area. Freeboard at channel junctions and curved channel sections will be increased to allow for elevated flow conditions.
- A maximum flow velocity of 5 feet per second in the vegetated channels is allowed during a design storm peak flow event. If estimated velocities exceed 5 feet per second, the channels will be lined with riprap or other suitable erosion protection.
- Normal channel flow velocity for a design flow peak event will be less than the critical flow velocity – all channel flows will be less than critical.
- Erosion protection will be placed at all channel junctions requiring such protection.
- Erosion protection will be installed at the outlets of all culverts.

- Channels with side slopes of 8 horizontal to 1 vertical or milder have been constructed with trapezoidal-shaped low-flow channels in their inverts to concentrate low flows and prevent siltation.

Sizing of the storm water drainage channels was based on the Manning equation for determining depth of flow in channels. The design flow rates used were based on the highest calculated flow rate in the channels. A summary of runoff management specifications is in a report by the Highway 36 Land Development Company (1997b).

3.2.6 Site Closure and Stabilization

After Secure Disposal Cells 1 and 2 are excavated, filled, and capped, closure activities for this area will begin. Temporary drainage ditches and channels will be restored to permanent structures. Closure of Cells 1 and 2 and access roads will be as described in Sections III and IV of the RCRA Permit Closure Plan **(CHDT 2004a – see Volume 5 of this application)**.

Disposal Cells 3 through 7 will be constructed, filled, and closed in the general sequence shown in the Site Development Drawings **(CHDT 2004a – see Volume 4 of this application)**.

At the time of final facility closure, and assuming construction of all permitted disposal cells, CHDT will have capped, graded, and vegetated all cells except Cell 7. Activities to complete final closure of the facility will consist primarily of decontamination of appropriate structures and equipment, closure of the Treatment Building Surface Impoundment, closure of Cell 7, final grading of the entire facility to provide uniform drainage, and vegetation of graded and previously unvegetated areas to prevent erosion. Sections III and IV of the Facility RCRA Closure Plan **(CHDT 2004a – see Volume 5 of this application)** describe these activities.

To maintain the security of the closed Disposal Cells, CHDT will inspect the partially closed areas as part of normal facility operations in accordance with the Facility RCRA Inspection Plan. Maintenance will occur as required in response to inspections and in accordance with procedures outlined in the Closure Plan **(CHDT 2004a – see Volume 5 of this application)**.

3.2.7 Long-Term Maintenance

Erosional effects are discussed above for the functional requirements of water infiltration and disposal unit cover integrity (see Section 3.2.2). The only long-term maintenance planned to combat the effects of erosion is the lining of gullies that could form in the disposal cell covers during the 30-year postclosure period required under the RCRA Permit with riprap.

3.2.8 Inadvertent Intruder Barrier

As described in Section 3.1.8, the requirements of RCRA do not specifically address human intruder barriers. The primary barrier to human intrusion is the RCRA closure system (i.e., the cover placed over the waste), which isolates the waste from human activities that disturb the site surface. Detailed requirements are provided for the cell closure system, with the use of engineered and natural materials. Because CHDT proposes to accept for disposal only NORM/ TENORM wastes at relatively low concentrations and dose rates compared to the broader definition of low-level waste, this would mitigate potential consequences if human intrusion occurred after closure. A more complete analysis of intruder doses is in Section 6.0 of this application.

3.2.9 Occupational Exposure

The strategy of this license application is to limit concentrations of NORM/TENORM waste to low levels so workers will be considered members of the public and radiation exposures will be limited to less than 100 mrem/yr, with a goal of 25 mrem/yr or less. CHDT has developed an appropriately tailored radiation protection program specific to NORM/TENORM waste. If worker dosimetry results determine that selected worker doses could exceed 25 mrem/yr, an assessment of the potential for other manmade exposures for these workers would ensure that maximum individual doses from manmade sources would not exceed 100 mrem/yr. This assessment will consider real individuals working at Deer Trail, not hypothetical members of the public.

Several operational features and procedures will be effective in maintaining worker doses ALARA. For example, the RCRA Permit requires that workers in the cells wear protective clothing and respirators to prevent inhalation exposures. Although originally intended to limit intake of hazardous chemicals such as asbestos, these measures are equally effective in reducing

intakes of radionuclides in NORM/TENORM waste. Further, the RCRA Permit requires emplacement of a daily cover of clean soil, mostly as dust mitigation and to promote overall cell stability. The daily cover will also provide shielding and reduce ambient dose rates, which is an effective ALARA measure.

3.2.10 Site Monitoring

For this discussion, site monitoring occurs in two phases: preoperational monitoring to establish the essential background radiation levels and operational monitoring to detect any environmental effluents or releases resulting from site operations.

As described in Section 2.9, preoperational monitoring consisted of establishing the ambient background radiation level for calibrating the gate monitor system and determining the radioactive constituents in the ground water beneath the site. Ground-water sampling evaluated alpha, beta-gamma, and uranium levels.

Operational monitoring will include continued sampling of the radiation levels in ground water, external radiation levels at various areas of the facility, and airborne monitoring for concentrations of NORM/TENORM waste. The purpose of the operational monitoring program is to ensure that doses to Deer Trail workers and the public will be less than 100 mrem/yr (plus ALARA), and that contamination control procedures are working. Since this application considers only disposal of NORM/TENORM waste (i.e., the facility will accept no manmade radionuclides), operational monitoring (including use of the gate monitor and waste sampling and analysis), will confirm operations within the waste acceptance criteria. Section 7.0 of this application contains additional details on site monitoring.

3.2.11 Buffer Zone

As described in Section 3.1.11, establishment of the buffer zone under the disposal unit and between the disposal units and the property boundary is in accord with 10 CFR 61.52(a)(8) and 6 CCR 1007-1-14.2. The buffer zone must be of adequate size to allow environmental monitoring activities and corrective actions if there is detection of radionuclide migration, and to isolate releases from accidental events. From the Colorado guidelines, the minimum size of the buffer zone area is 30 meters.

The facility's current Colorado RCRA Permit authorizes hazardous waste treatment, storage, and/or disposal activities on 325 acres of Sections 25 and 36, Township 3 North, Range 57 West (the RCRA Permitted Area). CHDT owns 5,435 additional acres that surround the Permitted Area, creating a substantial buffer zone for monitoring environmental releases of NORM/ TENORM waste during routine operations and accident events.

3.3 DISPOSAL CELL CONSTRUCTION CONSIDERATIONS

The Permit Renewal Report **(CHDT 2004a – see Volume 4 of this application)** includes detailed site plans, engineering drawings, and construction specifications. The following sections provide additional information on the construction of the disposal cells.

3.3.1 Site Preparation

Sections 02010, Subsurface Investigation, and 02110, Site Preparation and Earthwork, of the Specifications for Secure Cell Construction (Cells 3 Through 7) and Surface Impoundment Liner and Cover System Construction (Cells 1 Through 7) in the 1996 Permit Renewal Report (Highway 36 Land Development Company 1996) provide detailed requirements for the excavation of new cells at Deer Trail, including requirements for test borings, excavation, and stockpiling. CHDT will decommission test borings after drilling, logging, sampling, and water level measurement. Decommissioning will occur by grouting the boreholes using the tremie method; borings will be grouted to their full depth after the 24-hour water level reading.

3.3.2 Control and Diversion of Water

The Surface Water Management Plan and the Run-Off Management System Design Drawings and Specifications provide details on the control of surface water at the facility. Ground water, as discussed in Section 3.1.1, has no impact on operations at the facility. The general concept of the Surface Water Management Plan is to work with the natural topography and drainage patterns. This concept minimizes the areas that drain to the site's treatment facilities.

CHDT will develop the plan over time as it opens and closes cells. The plan includes the following general criteria:

- The minimum land slope across a closed cell will be 3% to allow adequate drainage across the cell cap and minimize ponding of storm water in surface depressions.

- The maximum land slope across a closed cell will be 5% to minimize the soil erosion potential and protect the integrity of the cell cap from gully erosion.

- Vegetation will be established on the cap during site closure.

- Drainage will not be allowed to flow into open cells or across a completed cell cap from upslope areas. Interceptor channels will collect such drainage and convey it off the site.

- The plan will use the existing natural topography as much as possible.

The Conceptual Site Development Drawings and the construction specifications in Volume I of the 2004 Permit Renewal Report **(CHDT 2004a – see Volume 4 of this application)** provide details of the proposed drainage of precipitation during the construction, filling, and closure of the disposal cells.

CHDT will control contaminated and potentially contaminated surface water during waste placement activities in a cell. A berm at the operational level of an active cell will separate contaminated and potentially contaminated water that pools (primarily from precipitation during waste placement operations). This water will be transferred to the Contaminated Water Storage Tanks or Potentially Contaminated Retention Basin.

3.3.3 Construction of Disposal Units

The Conceptual Site Development Drawings in Volume I of the 2004 Permit Renewal Report **(CHDT 2004a – see Volume 4 of this application)** show the general development sequence for disposal cells and major components of each cell liner and leachate collection and detection system. In addition, the drawings indicate facilities required for uncontaminated water control, potentially contaminated water control, and contaminated water control.

CHDT will use the same construction sequence for each disposal cell. The cell construction specifications in the 1996 Permit Renewal Report, Appendix B (Highway 36 Land Development

Company 1996), provide requirements for excavation, fill, and other activities. The major steps of disposal unit construction are as follows; all necessary components of cell construction will be complete before waste placement operations begin:

- *Subsurface Investigation* – As outlined in the disposal cell construction specifications, a subsurface investigation will occur for each disposal cell site prior to construction. Specifically, Section 02010, Subsurface Investigation, of the 1996 Permit Renewal (Highway 36 Land Development Company 1996) identifies surveying requirements that must occur prior to construction of the cells.

- *Site Preparation* – Construction of site clearing, erosion control, diversion ditches, and haul roads will comply with specifications and final design (construction) drawings prepared for each cell.

- *Stockpiling* – Select fill, spoils, and overburden will be stockpiled in accordance with the construction specifications. Cells 3 to 7, as shown in the Conceptual Site Development Drawings (**CHDT 2004a – see Volume 4 of this application**), will generate an average net volume of 373,000 to 425,000 bank cubic yards of overburden per cell during construction. A total of 2.1 million bank cubic yards of overburden will be stockpiled. The general guideline for management of overburden includes the following:

  1. Overburden not used for cell construction or cover material will be placed outside the active disposal area; Conceptual Site Development Drawing 12 (**CHDT 2004a – see Volume 4 of this application**) shows possible stockpile locations with an approximate total volume of 1.2 million loose cubic yards.

  2. Overburden will not be placed in areas designated for the processing facilities, including the disposal cell sites and main haul roads.

  3. Overburden will be placed in a manner that minimizes erosion.

- *Excavation* - The construction specifications include disposal cell excavation. Each cell will be excavated to the lines and grades shown on the final design drawings,

which, in general, will be consistent with the configuration in the Conceptual Site Development Drawings. Side slopes will be excavated to a maximum slope of 3 horizontal to 1 vertical. The floor of each cell will slope to a sump at a minimum slope of 3%. A single-lane access ramp incorporated in the side slope will have a nominal grade of 10%.

- *Base Liner System* - Section 1.2.2 discusses the base liner system, which is shown in the Conceptual Site Development Drawings (**CHDT 2004a – see Volume 4 of this application**).

- *Permanent Sump* - Conceptual Site Development Drawing 20 (**CHDT 2004a – see Volume 4 of this application**) shows the typical configuration of the permanent sump. The permanent sump pipe will collect naturally occurring vadose water and water from consolidation of the secondary clay layer. In the improbable event of leakage through the secondary liner, the permanent sump would detect, collect, and remove the leakage. A submersible pump will pump out liquid collected in the sump through the sump riser pipe.

- *Side-Slope Liner System* - Conceptual Site Development Drawing 18 (**CHDT 2004a – see Volume 4 of this application**) shows the typical side-slope liner system for disposal cell units 3 through 7. Units 1 and 2 do not have a GCL; each was constructed with a 4.5-foot layer of clay as the primary composite liner in the side slope.

- *Leachate Collection and Leak Detection Systems* – CHDT will install Leachate Collection and Leak Detection Systems on top of the primary and secondary HDPE geomembranes, respectively. The Leachate Collection System will collect and transmit liquid above the primary composite liner to a collection sump. The Leak Detection System will detect and collect water released during primary clay layer consolidation, or leachate in the improbable event that leachate penetrates the primary composite liner. System details are included in the Conceptual Site Development Drawings.

3.3.4 Concrete and Steel Construction

CHDT will use cement mixers for the grouting of soil test boreholes and placement of pads around the riser pipes associated with the leachate removal system of each disposal cell. After drilling, logging, sampling, and water level measurement, each test boring will be decommissioned. Decommissioning will occur by grouting using the tremie method with a grout mix of 7 gallons of water to 1 bag (94 pounds) of Type 1 Portland cement and 2% bentonite (by dry weight of cement). Test borings will be grouted to their full depth after the 24-hour water level reading. The amount of grout used in each borehole will be recorded on the boring log.

CHDT will install concrete pads around the riser pipes in accordance with applicable requirements of Sections 601.05 through 601.14 of the Colorado Highway Specifications, and as shown on the construction drawings. The following tests will occur: at a minimum, one slump test in accordance with ASTM C 143 for the concrete crest pad; and one air entrainment test for the concrete crest pad in accordance with either ASTM C 173 or C 231. Three concrete cylinders will be obtained from the crest pad in accordance with ASTM C 31; the cylinders will be tested after 28 days in accordance with ASTM C 39.

There are no significant steel structures associated with the construction of the disposal cells. Details on the use of cement are in the construction specifications.

3.3.5 Backfilling

All necessary components of disposal cell construction will occur prior to the start of waste placement operations. This includes the leachate collection system, the access ramp, and the operations material overlying the leachate collection system.

Waste will be placed in horizontal lifts and compacted in place. The face of the waste slope will typically be no steeper than 4 horizontal to 1 vertical. However, individual lifts (not exceeding 10 feet) will be placed at approximately the angles of repose. Each lift will be set back from the toe of the preceding lift by a distance equal to four times the height of the lift.

Waste materials to be placed in the disposal cells have been physically characterized as bulk solids, solidified blocks, and drummed solids. Bulk solids will consist of solidified sludge, treated material, and direct landfilled solids. Any intact drums will be filled with solids or

crushed to eliminate significant voids. To the extent practicable, space between drums will be filled with bulk solids to eliminate void space.

CHDT could use a subcell divider berm to segregate contaminated water from potentially contaminated water. The toe of the waste fill slope will be behind the divider berm at a distance specified in the final design drawings for each cell. Ponding surface liquids will be removed to the extent practicable. Liquids collected in this manner will be transferred to the Contaminated Water Storage Tanks or Potentially Contaminated Retention Basin in the process area. The volume of contaminated water and potentially contaminated water collected as a result of an 8.2-inch, 24-hour precipitation event is approximately 1.1 million gallons for each cell. The facility has the capacity to store 1.4 million gallons of contaminated water and 1.5 million gallons of potentially contaminated water. The final design studies will prepare a site-specific filling plan for each cell that will include evaluation of static and dynamic stability during interim filling stages and at the final fill configuration.

3.3.6 Closure of Individual Disposal Units

The final cover for each disposal cell will, over the long term, minimize the migration of liquids to the underlying waste, function with minimum maintenance, promote drainage and minimize erosion, accommodate settlement and subsidence, and have a permeability less than or equal to 1×10^{-7}cm/s.

Each disposal cell cover will consist of the layers discussed in Section 3.1.1. Drawing 25 of the Conceptual Site Development Drawings found in the 1996 Permit Renewal Report (Highway 36 Land Development Company 1996) shows these layers.

3.3.7 Applicable Codes, Standards, and Specifications

Volume I of the Permit Renewal Report **(CHDT 2004a – see Volume 4 of this application)** identifies applicable codes and standards and the detailed construction specifications.

3.3.8 Construction Materials and Quality Assurance

All materials used to construct disposal cells are typical of materials used for RCRA Subtitle C hazardous waste disposal facilities. The construction specifications in Volume I of the Permit

Renewal Report **(CHDT 2004a – see Volume 4 of this application)** describe acceptable materials for constructing each cell liner and cover system.

3.3.9 Site Plans, Engineering Drawings, and Construction Specifications

The Conceptual Site Development Drawings in the Permit Renewal Report **(CHDT 2004a – see Volume 4 of this application)** include site plans and conceptual engineering drawings. CHDT will complete detailed engineering drawings for the construction of each disposal cell. Volume I of the Permit Renewal Report contains construction specifications, which detail requirements for techniques, materials, etc.

3.3.10 Construction Equipment

Table 3.1 summarizes the construction equipment needed for construction, off-loading waste, handling waste, and placing waste in the disposal cell.

Table 3.1. Deer Trail Construction Equipment Summary.

Number	Type	Function/Capacity	Location
2	VME A 25 dump trucks (or equiv.)	Haul: 25 yd max, 18 yd avg. speed: 30 mph max, 15 mph avg.	Solidification building, active cell
1	ML90 loader	Load: 200 yd/hr mix: 100 yd/hr spread/compact: 100 yd/hr 4-drum handler pallet forks	Active cell
1	140G motor grader	Spread soil 20 mph	Active cell maintenance parking area
1	Vacuum truck	Capacity: 1,500 gal.	Maintenance parking lot
1	Water truck	Capacity: 3,500 gal.	Maintenance parking lot
1	Forklift M-30D	Capacity: 2,000 lbs.	Solidification building (drum handling)
1	Fuel tank	C-3 hydraulic 55 gal., 10-w hydraulic 55 gal., 30-w motor oil 55 gal., diesel 300 gal.	Solidification building active cell site
1	D6 LPG bulldozer		Stock pile buffer site maintenance
1	D8N bulldozer	Handle waste	Active cell
1	815 B compactor	Compact waste	Active cell
1	170 C excavator	1-1/2 yd 2,324 lbs	Solidification building
1	Skid steer loader	1/2 yd bucket 42-in. pallet forks 2-drum handler	Site maintenance
1	Sweeper	Sweep haul road and site roads and parking lot, general cleaning	

3.4 DESIGN OF AUXILIARY SYSTEMS AND FACILITIES

The following sections describe auxiliary systems and facilities at Deer Trail.

3.4.1 Utility Systems

As stated in Section 1, key utilities for the Deer Trail RCRA Subtitle C landfill include telephone communications, electric power, propane and other fuel services, drinking water, and sanitary

waste disposal. None of these utilities is a critical component in nuclear safety accident situations because the landfill handles bulk waste and relies on passive performance of safety features. This means that redundant features, such as backup power supplied by diesel generators, are unnecessary. For routine and emergency use, the facility has telephone communications via surface lines and cell phone service to the General Manager and key staff members. In addition to the site telephone system, the facility has site-wide intercom paging and alarm warning systems. In addition, two-way mobile radio systems communicate with personnel in operational areas. Overhead transmission lines from a county substation supply electrical service. There are no natural gas lines to the facility. For indoor heating, the facility uses two large tanks used to store propane for gas furnaces. Gasoline and diesel storage is provided for onsite vehicles. Septic tanks for human sewage and county garbage collection services for other solid waste provide sanitary waste disposal. Because of the scarcity of potable water, a bottled water service provides drinking water.

3.4.2 Auxiliary Facilities

Cells will be constructed in phases along temporary haul roads connecting the cells to the site processing area, as shown on the Conceptual Site Development Drawings in Volume I of the Permit Renewal Report **(CHDT 2004a – see Volume 4 of this application)**. The temporary roads coupled with drainage systems will isolate spills and separate potentially contaminated runoff, uncontaminated run-on, and contaminated water. The roads are an integral part of the facility drainage system. The phased development of the temporary roads and ditches, along with the sequence of cell construction, will minimize the amount of potentially contaminated runoff water that the facility will handle during its life.

Drawing 21 of the Conceptual Site Development Drawings **(CHDT 2004a – see Volume 4 of this application)** shows haul road and disposal cell access ramp construction details. Traffic will be limited to the haul roads as operations progress through the seven cells, as shown in the Conceptual Site Development Drawings. Construction drawings prepared for each cell will show temporary access roads to be installed for use during cell construction. After all cells are closed, CHDT will close the access road and that portion of the facility area will receive final grading.

3.4.3 Fire Protection System

The facility has a water-pressure system for fighting fires; the system consists of:

- One 48,000-gallon underground fiberglass water storage tank;
- Yard water distribution system with 2.5-inch hydrants connected to fire hose cabinet stations designed to meet National Fire Protection Association (NFPA) Standard 24. Each hydrant cabinet has the capability to induct aqueous film-forming foam directly into the fire hose streams;
- Two fire pumps, each capable of providing a flow value of 500 gallons per minute (gpm) for the first hydrant and 250 gpm for other hydrants at 65 pounds per square inch (psi). The total flow rate will be 1,500 gpm at 65-psi residual pressure. The primary pump is driven by electricity. The secondary diesel-fueled pump activates automatically at a loss of power from the utility company; and
- An automatic fire alarm and detection system with remote heat-sensing thermostats at strategic locations in the buildings.

The minimum combined volume of water that will always be available from the fiberglass tank and the plant water tank for firefighting is 228,000 gallons.

A jockey pump maintains a static pressure of 90 psi in the system. When the water nozzle is turned on in the hose cabinet and the system pressure drops, a pressure sensor turns on one of the water pumps that maintains a 65-psi residual pressure at a 1,500 gpm flow rate. If the pressure drops below 65 psi, the second pump will turn on automatically. When the water flow stops and the pressure returns to 90 psi, the pump(s) shut off automatically. The facility has fire detection and alarm systems, which are activated by heat, installed in accordance with NFPA 72a and 72e.

3.4.4 Erosion and Flood Control System

The facility is designed to minimize the potential for the release of waste contaminants as a result of erosion. The engineered disposal cell covers, drainage culverts, and the location of cells at the

top of a knoll are elements to combat the effects of precipitation. Sections 3.1 and 3.2 describe these design elements.

The storm water drainage structures can handle site drainage for the 100-year peak storm flow with no flooding outside the drainage system (channel network). Run-Off Management System Design Drawings and Specifications contain details on flood analyses performed for the facility.

3.5 REFERENCES CITED

Clean Harbors Deer Trail (CHDT). 2004a. ***Permit Renewal Report for Incorporation of a Geosynthetic Clay Liner (GCL) in the Liner Section for Secure Cells 3 Through 7 and in the Cover Section for Secure Cells 1 Through 7 (the Permit Renewal Report –*** **provided in Volumes 4 and 5 of this application).**

Clean Harbors Deer Trail (CHDT). 2004b. ***Waste Filling Plan and Drawings for Secure Cell Number 2, Revision 1,*** **(CHDT 2004b – provided in Volume 6 of this application).**

Highway 36 Land Development Company. 1996. *Permit Renewal Report for Incorporation of a Geosynthetic Clay Liner (GCL) in the Liner Section for Secure Cells 3 Through 7 and in the Cover Section for Secure Cells 1 Through 7.* Deer Trail, Colorado.

Highway 36 Land Development Company. 1997a. *Site Development Plan Design and Construction Narrative.* Deer Trail, Colorado.

Highway 36 Land Development Company. 1997b. *Run-Off Management System Design Drawings and Specifications.* Deer Trail, Colorado.

State of Colorado. 1985. *License Application Guidelines For Land Disposal of Low-Level Radioactive Waste In Colorado.* Denver, Colorado.

U.S. Nuclear Regulatory Commission (NRC). 1991. *Standard Format and Content of a License Application for a Low-Level Radioactive Waste Disposal Facility.* NUREG 1199, Rev. 2. Washington, D.C.

4.0 FACILITY OPERATIONS

As described in Section 1.0, numerous studies, evaluations, and reports have been developed for the Deer Trail facility, including several documents that discuss facility operations. This section describes those operations that pertain to hazardous and Naturally Occurring Radioactive Material (NORM) and Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) waste. The following documents contain more detailed discussions:

- *State RCRA Permit Renewal Application, Volume One,* Clean Harbors Deer Trail, October 2004 (**CHDT 2004a – see Volume 4 of this application)**[5]
- *State RCRA Permit Renewal Application, Volume Two,* Clean Harbors Deer Trail, October 2004 (**CHDT 2004b – see Volume 5 of this application)**
- Facility Standard Operating Procedures (SOP) (CHDT 2004c)
- Waste Filling Plan and Drawings for Secure Cell Number 2, Revision 1 **(CHDT 2004d – see Volume 6 of this application)**

4.1 RECEIPT AND INSPECTION OF WASTE

Receipt and inspection of incoming vehicles and waste packages ensures that the waste is acceptable for disposal at the facility. The facility currently has an approved Waste Analysis Plan (WAP), which specifies the detailed waste analysis and evaluation procedures required for to fulfill obligations related to 40 CFR §264.13 and §268.7 and 6 CCR 1007-3. Clean Harbors Deer Trail (CHDT) modified the WAP in the October 2004 State Resource Conservation and Recovery Act (RCRA) Permit Renewal Application to provide assurance that NORM/TENORM wastes meet the requirements for acceptance **(CHDT 2004a, Attachment 2 – see Volume 4 of this application).**

The WAP addresses the following objectives:

[5] For ease of review, references in **bold** are included in Volumes 2 through 6 of this application.

- Preacceptance procedures and waste analyses to determine specific physical and chemical properties of waste materials and appropriate treatment, storage, and disposal procedures;

- Onsite inspection of waste shipments to verify the identity of incoming wastes and to identify requirements for the safe handling of waste materials at the facility;

- Onsite waste transfer procedures to provide controlled transfer of waste materials in the facility. These procedures address waste to waste compatibility and, for nonconforming waste, the ability to successfully treat the waste for storage or disposal at an alternative facility. In addition, the onsite transfer procedures verify that wastes treated at the facility meet all applicable regulatory treatment requirements prior to land disposal.

The information in this section concerns waste acceptance steps the facility will take for NORM/ TENORM waste in addition to the current practices performed under the WAP.

4.1.1 Waste Stream Preacceptance Review and Approval Process

The following sections describe the preacceptance review and approval process for accepting hazardous waste, including NORM/TENORM waste, at the Deer Trail facility.

4.1.1.1 Waste Stream Characterization

Before waste can be accepted by the facility for treatment, storage, and/or disposal, CHDT must review the waste stream in accordance with procedures outlined in the WAP. The review process determines if the physical and chemical characteristics of the waste stream are compatible with the treatment, storage, and/or disposal capabilities of the facility and if the waste stream meets, or can be made to meet through treatment, the limitations imposed by the permit. If the waste stream can meet the acceptance criteria, it can receive a preacceptance approval. For NORM/TENORM waste, the waste acceptance criteria are set at 400 picocuries per gram (pCi/g) of ^{226}Ra, measured on a per-shipment basis. The total activity of NORM/TENORM waste, including alpha- and beta-emitting radionuclides in the uranium and thorium decay chains, will be enforced to the limit of 0.002 microcuries per gram (2,000 pCi/g) used to define radioactive

waste in Colorado, as long as the radium concentration limit of 400 pCi/g per shipment is maintained.

The waste generator or CHDT can provide the analytical data required for the Preacceptance Evaluation process. CHDT will perform verifying analyses if there is reason to believe that analytical data provided by the waste generator are inadequate. When generator data are used to comply with the requirements of the Preacceptance Evaluation process, CHDT will review the analytical methods and quality control and quality assurance programs implemented by the generator to evaluate the acceptability of those data.

4.1.1.2 Preacceptance Waste Characterization Review

Following review of the physical, chemical, and radiological characteristics of the waste material, CHDT will evaluate the waste for management at the Deer Trail facility. This evaluation will include the following:

- Documentation Review. A review of appropriate documents to ensure that receipt of the waste material is in compliance with company policies, the Permit, and applicable Federal and State laws and regulations.

- Management Capabilities Review. A review of the characteristics of the waste material in relation to the facility's existing treatment, storage, and disposal capabilities to ensure that one or more of these capabilities can satisfactorily manage the waste material; a comparison of identified hazardous waste codes for hazardous and NORM/TENORM waste to the list of waste codes approved for management at the facility.

- Physical and Chemical Characteristics Review. A review of the physical and chemical characteristics of the waste material to ensure that the waste will be compatible with treatment reagents, other wastes with which it is to be commingled, and the treatment unit construction materials, or that onsite capability exists (e.g. waste segregation and/or treatment) to eliminate incompatibilities.

- Radiological Characteristics Review. A review of the radiological characterization of the waste stream to ensure that the waste is acceptable for treatment, storage, and/or disposal at the facility.

- Waste Management Byproducts. A review of the characteristics of anticipated byproducts of the selected waste management method to ensure that onsite units or a properly permitted offsite facility can manage them.

- Waste Acceptance. CHDT will use the waste stream Preacceptance Review process to evaluate the acceptability of NORM and TENORM material proposed for treatment, storage, and/or disposal. Appropriate facility personnel will approve waste acceptance. The process results in two potential outcomes:

  - Pretreatment and Disposal Recommendation (PDR): A PDR form will document waste stream approval. This form will be part of the Operating Record for a specific waste stream. Each approved waste stream will receive a unique identification number.

  - Waste Rejection: If the facility rejects a waste stream is rejected, CHDT will advise the generator of the rejection and the reasons for rejection.

4.1.2 Inspection and Evaluation of Waste

The following list describes the inspection and evaluation of waste on arrival at the Deer Trail facility.

- Examination of Shipping Documents. Qualified personnel will perform a thorough review of the documentation accompanying a waste shipment.

- Land Disposal Restrictions. CHDT will review waste shipments and preacceptance approval documents that determine if the waste stream is subject to the Land Disposal Restrictions (LDRs) in 40 CFR Part 268 for completeness.

- Identification of Document Discrepancies. CHDT will consider the following for significant discrepancies in the document verification process:

- Weight discrepancy: The weight of a bulk shipment disagrees with the weight indicated on the accompanying manifest by more than 10%;

- Count discrepancy: The piece count of an item shipment disagrees with the piece count indicated on the accompanying manifest;

- Incomplete manifests: The information in the generator or transporter portions of the manifest is incomplete or inconsistent with that expected based on information;

- Incomplete waste certification: The information in the waste certification is incomplete;

- Signatures: The generator and transporter portion of the manifest is unsigned or not dated;

- Preacceptance file incomplete: A PDR form is not on file for the shipment.

- Document Discrepancy Resolution. If CHDT identifies any of the discrepancies listed above, it will not treat or dispose of the shipment until resolution of the discrepancy. CHDT will record resolved discrepancies in the Operating Record with a clear and concise explanation of the resolution to allow acceptance of the waste. If no resolution is possible, CHDT will return the shipment to the waste generator.

- Onsite Inspection Procedures. On arrival at the sampling/staging area, trained site personnel will conduct the required inspections. Inspections for NORM and TENORM waste will be in conjunction with the sampling, analysis, and inspections currently required for hazardous waste shipments under the WAP.

- Visual Check of the Waste Package. Visual inspection of the waste package will verify compliance with license and regulatory requirements and application of proper handling techniques. This inspection will verify package integrity, proper labeling and marking, and that the packages are the same as those identified on the manifest. Nonconforming packages will be identified and appropriate action will be taken.

CHDT will maintain a permanent record of nonconforming packages or shipments and their disposition.

- Verification of Waste Characteristics. Sampling and analysis of waste shipments will occur as required by the WAP to ensure documentation of the waste characteristics.

4.2 WASTE HANDLING AND INTERIM STORAGE

The following sections describe the procedures Deer Trail employs to manage waste that the facility accepts.

4.2.1 Waste Handling

After inspection and acceptance of NORM and TENORM at the facility, CHDT will direct the waste to the treatment building if additional treatment prior to disposal is required or to the disposal cell for direct disposal. Waste for direct disposal will move to the cell with a minimum of intermediate handling to reduce personnel exposure and to prevent damage to packaging. Following waste acceptance, the transport vehicle will be staged in the appropriate area for treatment or disposal.

4.2.2 Waste Treatment

As described in Section 1.2, the Waste Treatment and Container Storage Building is a 6 CCR 1007-3 Part 264 Subpart DD RCRA unit. This building consists of two operational areas, the Treatment Area and a Staging Area; waste receipt can occur at either. The design and construction of the Treatment Area and Staging Area is in compliance with applicable requirements of Part 264.1100 for the management of hazardous waste-containing liquids. The Treatment Area is a metal fabricated building on a spread footing foundation. The building is underlain with a double-liner system described in Permit Condition VI.C (CHDT RCRA Permit). Figures 1 and 2 of the RCRA Permit Renewal Attachment 1 **(CHDT 2004a – see Volume 4 of this application)** show the location of the Treatment Building.

Hazardous waste treatment occurs in eight mixing basins, designated A-1, A-2, A-3, A-4, D-1, D-2, D-3, and Basins B and C. Permit Condition VI.D (CHDT RCRA Permit) describes the treatment processes. The treatment mixing basins and the process equipment in the basins are

reinforced concrete with a protective, sacrificial steel liner inside each basin. Basins A-1, A-2, A-3, D-1, and D-2 have an approximate capacity of 150 cubic yards (yd^3) each. Basin D-3 has an approximate capacity of 300 yd^3. Basins B and C have an approximate capacity of 600 yd^3 each. Waste treatment will be required only for NORM/TENORM waste that does not meet the Deer Trail waste acceptance criteria under RCRA.

Hazardous waste storage and staging occurs in the western portion of the Waste Treatment and Container Storage Building, designated Staging Area No. 1, which is approximately 120 feet long by 60 feet wide. Waste will be stored in containers. The maximum capacity for storing or staging in Staging Area No. 1 is 600 yds^3.

4.2.3 Operational Controls and Procedures

CHDT will use the Waste Treatment and Container Storage Building for waste receiving, waste staging, storage of treated and untreated wastes, waste sizing, preparation, and mixing. Waste delivery trucks will move to a specified Treatment Building door for unloading. The building doors will be opened only to allow entry or exit of waste via truck or in emergencies.

Staging Area No. 1 will be used for waste receiving, waste staging and accumulation, and addition of reagents to solidify liquids and improve waste handling.

Waste will be transferred to the Treatment Basins directly from waste receiving trucks, the Container Management Building A, the Container Storage Area A or B, or Staging Area No.1. All transfers will comply with the Waste Analysis Plan as specified in the State RCRA Permit. CHDT will separately (based on waste compatibility) pretreat, treat, stabilize, or solidify each waste or group of similar wastes (potentially including NORM/TENORM waste) that require the addition of additives or reagents, to meet the LDRs of 6 CCR 1007-3 Part 268. Dilution of wastes to achieve LDR standards is prohibited. Wastes will be treated by stabilization, solidification, encapsulation, or chemical treatment. The type and quantity of reagents will be predetermined by a treatment recipe, and will be recorded in the Operating Record. Treatment process will be performed through shredding and/or backhoe mixing.

4.2.4 Special Requirements for Ignitable, Reactive, and Incompatible Waste

The Waste Analysis Plan contains procedures for processing ignitable or reactive wastes in the Waste Treatment and Container Storage Building. Special requirements include:

1. After treatment of the resulting waste mixture, or dissolution of material that will no longer meet the definition of ignitable or reactive waste under Section 261.21 or 261.23 of the Colorado Hazardous Waste Regulations; and

2. Precautions to prevent reactions that could generate extreme heat or pressure, fire or explosions, or violent reactions; produce uncontrolled toxic mists, fumes, dust, or gases in sufficient quantities to threaten human health or the environment; produce uncontrolled flammable fumes or gases in sufficient quantities to pose a risk of fire or explosions; or through other like means that threaten human health or the environment.

4.3 WASTE DISPOSAL OPERATIONS

The primary goals of waste emplacement are to maximize the long-term stability of the facility and to provide maximum protection to the environment, the public, and facility personnel during operations. Waste emplacement will proceed generally in horizontal lifts to near the crest of the landfill. Above that point, the filling geometry will be modified to form a V-trench around the perimeter of the landfill that will have sufficient capacity to hold runoff from active waste areas from a 24-hour, 8.2-inch rainfall with 1 inch of freeboard. The V-trench will be formed by the side slopes of the secure cell and a 5-horizontal-to-1-vertical (5H:1V) waste fill slope. The depth of the V-trench will vary depending on the required storage capacity. The 5H:1V slope will continue until it intercepts the 5% final cover slope. During final cover construction, the V-trench can be filled with waste as the active cell area is reduced.

Waste placement will progress such that liquid leaching through the waste will be minimized. Standing liquids on the surface of the waste and in segregated contaminated water areas will be removed to the extent necessary to prevent excessive ponding. All liquids collected in this manner will be transferred to the Contaminated Water Storage Tanks in the process area. During waste placement above the crest, standing surface liquids that collect in the V-trench will be removed within 24 hours after a storm event, and special inspections will occur as described in

the Inspection Plan (CHDT RCRA Permit). Waste will generally be placed in horizontal lifts and compacted in place. An operating face required beyond that for an individual lift will be sloped no steeper than 4H:1V from the base of the landfill to the planned maximum cover elevation.

A daily cover will minimize wind dispersion of waste material. The daily cover placed over the wastes will be a 6-inch soil cover, a geosynthetic cover, or a soil stabilization product. The geosynthetic cover will be either a geotextile or a geomembrane. A geosynthetic or geomembrane cover will be anchored to hold the cover in place.

CHDT will minimize void spaces between waste materials and containers to ensure the long-term stability of the cover by minimizing subsidence or slumping. Filling void spaces will be concurrent with waste emplacement to ensure that several layers of waste material are not in place prior to placing backfill materials. Attempting to fill void spaces in several layers at once is generally ineffective.

4.4 OPERATIONAL ENVIRONMENTAL MONITORING AND SURVEILLANCE

The facility's Groundwater Protection Program is described in Part VII of the RCRA Permit and referenced attachments. The program consists of three monitoring programs:

- Secure Cell and Surface Impoundment Performance Monitoring Program;
- Inspection Well Monitoring Program; and
- Detection Well Monitoring Program.

The Secure Cell Performance Monitoring includes Cell 1 and Cell 2 leachate detection and collection systems. The Surface Impoundment Monitoring consists of the Waste Treatment Building leachate detection system sampling.

The Detection and Inspection Monitoring Program wells are inside, outside, and along the compliance boundary. Inspection wells are screened at depths of less than 60 feet below the ground surface. Detection and inspection wells are in several different shallow geologic levels. From shallowest to deepest, the following list describes these levels:

- Level 3 (L3) is the discrete lenticular sand bodies that occur infrequently in the surficial Silty Clay Unit. Monitoring wells are at 50-foot intervals along the compliance boundary in areas where the L3 is present. Water has not been detected in L3 wells with the exception of L3-42. The L3 wells are included in the Inspection Monitoring Program.

- Level 4A (L4A) is the interface between the surficial Silty Clay Unit and the underlying weathered Pierre Shale. Monitoring wells are at 100-foot intervals in areas where L4A is (or historically was) saturated. The saturated conditions requiring L4A wells occur only along the northern compliance boundary in the vicinity of a former oil field brine pond. The L4A wells are included in the Inspection Monitoring Program.

- Level 4 (L4) is the interface between the weathered Pierre Shale and the underlying unweathered Pierre Shale. Monitoring wells are at 300-foot intervals along the compliance boundary except in areas where L4 is (or historically was) saturated, where closer spacing (typically 100-foot intervals) is required. The saturated conditions requiring tighter spacing of the L4 wells occur only along portions of the northern compliance boundary and along part of the western compliance boundary. Several L4 wells are along part of the western compliance boundary adjacent to Cells 1 and 2, and one well (L4-9W) is outside the compliance boundary west of Cell 2. The L4 wells are included in the Inspection Monitoring Program.

- Level 5 (L5), the uppermost water-bearing unit at the facility, is the uppermost saturated portion of the unweathered Pierre Shale. Eight L5 monitoring wells, installed along the compliance boundary (Plate 1), comprise the facility's groundwater detection monitoring network. The L5 wells are screened in silty partings that occur at varying depths (about 250 to 435 feet below the ground surface) in the unweathered Pierre Shale. The L5 wells are included in the Detection Monitoring Program.

- Level 6 (L6) is the first occurrence of saturated conditions in the alluvial drainages outside the compliance boundary. Three L6 wells are in the vicinity of the facility.

The wells are screened in silt and fine sand units overlying weathered Pierre Shale, and in the weathered Pierre Shale. The L6 wells are included in the Inspection Monitoring Program.

Ground-water quality data from monitoring wells are assembled into well groupings. The development of the groupings was based on a comprehensive evaluation of hydrogeologic and water chemistry data. These groupings were discussed in the Supplemental Background Data Evaluation Report, Revision No. 1, prepared by McCulley, Frick & Gilman, Inc. (MFG), which the facility submitted to the Colorado Department of Public Health and Environment on November 15, 1991 (MFG 1991). The groupings were verified in the 1991, 1992, 1993, 1994, and 1998 Annual Groundwater Monitoring Reports for the facility prepared by MFG and Cameron-Cole, LLC. Cameron-Cole, LLC, has verified the well groupings annually since 1998 **(Cameron-Cole 2003 – see Volume 6 of this application)**.

The background ground-water quality database consists of monitoring data collected on a quarterly, semiannual, or annual basis at the facility since 1986. Ground-water quality data collected after the initial acceptance of waste at the facility (i.e., after the fourth quarter 1991) are added to the background database in accordance with Permit-specified procedures. The continued incorporation of new data and the reevaluation, and possible reorganization, of well groupings are especially necessary for wells that monitor decaying brine pond seepage plumes (i.e., L4A and L4 wells).

The facility will perform monitoring for ambient radiation levels and ambient air concentrations for particulate NORM/TENORM radionuclides, as discussed n Section 7 of this application. The potential source area from which contaminants could be generated included the entire area inside the current compliance boundary, excluding Cells 1 and 2. This area contains proposed Cells 3, 4, 5, 6, and 7, the Waste Treatment and Container Storage Building, and the internal haul roads.

The air monitoring system configuration is determined primarily by prevailing wind patterns in the vicinity of the facility. The nearest meteorological station with a sufficiently long period of record of required observations is Denver Stapleton Airport. Data from 1984 through 1992 were used to determine air sampling system configuration. Wind data from Denver Stapleton Airport were downloaded from the U.S. Environmental Protection Agency (EPA) Regulatory Air

Models Bulletin Board. The data were formatted for input to the EPA WRPLOT computer program to generate a table of wind direction and frequency and a windrose that shows the data.

The data show that winds from the south-southwest through the east-southeast (five sectors) account for 47% of all occurrences, and winds from the north account for an additional 8%. All remaining 10 sectors combined account for only 39% of the occurrences. It is calm 6% of the time.

Given these wind patterns, air quality associated with the facility can be monitored with three samplers. One sampler will be at the northeast corner of the compliance boundary to detect any contaminants carried by winds from the south-southwest and south, the two sectors with the greatest frequency of occurrence. The second sampler will be at the northwest corner of the compliance boundary to detect contaminants carried by winds from the south-southeast through east-southeast sectors. A third sampler will be on the south compliance boundary, halfway between the southwest and southeast comers; this sampler will detect contaminants carried by winds from the north-northwest through north-northeast sectors.

These three locations will be downwind of at least a portion of the source area at least 77% of the time that winds occur. Only winds from the west-southwest through west-northwest and east-southeast would be largely excluded.

A fourth sampler to provide background data will be on the CHDT property remote from the source area to the east or west.

Each station will consist of a continuous low-volume air sampler in a weatherproof housing. The samplers will have a flow measurement device to enable determination of the total air volume collected for each sample. The sampler collection head will be approximately 1.8 meters above the ground surface.

Samples will be collected on glass fiber filters or membrane filters depending on the requirements of the analytical laboratory and dust loading conditions. Glass fiber filters have excellent filtering characteristics but require dissolution in hydrofluoric acid for analysis. Membrane filters also have excellent filtering characteristics, but can present difficulties because they load with particulate material quickly and are mechanically weak.

Filters will be changed every 12 days. Filters will be sent quarterly to a certified laboratory for screening for gross alpha and gross beta radioactivity.

Surface soil sampling will be performed by taking a grab sample from the top 5 centimeters of soil. Soil samples will be collected from each air monitoring location for analysis once per year. Soil samples will be analyzed for the radionuclides listed in the groundwater-sampling program.

4.5 REFERENCES CITED

6 CCR 1007-3, Part 268 - Land Disposal Regulations.

6 CCR 1007-3, Part 264 - Standards for Owners & Operators of Permitted HW Treatment, Storage, & Disposal Facilities.

Clean Harbors Deer Trail (CHDT). 2004a. ***Permit Renewal Report for Incorporation of a Geosynthetic Clay Liner (GCL) in the Liner Section for Secure Cells 3 Through 7 and in the Cover Section for Secure Cells 1 Through 7 (the Permit Renewal Report Volume 1*** **– Provided in Volume 4 of this Application).**

Clean Harbors Deer Trail (CHDT). 2004b. ***Permit Renewal Report for Incorporation of a Geosynthetic Clay Liner (GCL) in the Liner Section for Secure Cells 3 Through 7 and in the Cover Section for Secure Cells 1 Through 7 (the Permit Renewal Report Volume 2*** **– Provided in Volume 5 of this Application).**

Clean Harbors Deer Trail (CHDT). 2004c. *Facility Standard Operating Procedures (SOP).*

Clean Harbors Deer Trail (CHDT). 2004d. ***Waste Filling Plan and Drawings for Secure Cell Number 2, Revision 1,*** **(Provided in Volume 6 of this Application).**

Cameron-Cole. 2004. ***2003 Annual Groundwater Protection Monitoring Report.*** **Prepared for Clean Harbors (Deer Trail), LLC. (Provided in Volume 6 of this Application).**

McCulley, Frick, & Gilman, Inc. (MFG). 1991. *Supplemental Background Data Evaluation Report, Highway 36 Land Development Company Treatment, Storage and Disposal Facility.* Prepared for the Highway 36 Land Development Company, Revision No. 1.

McCulley, Frick, & Gilman, Inc. (MFG). 1992. *1991 Annual Groundwater Monitoring Report: Highway 36 Land Development Company Treatment, Storage and Disposal Facility.* Prepared for the Highway 36 Land Development Company.

McCulley, Frick, & Gilman, Inc. (MFG). 1993. *1992 Annual Groundwater Monitoring Report: Highway 36 Land Development Company Treatment, Storage and Disposal Facility.* Prepared for the Highway 36 Land Development Company.

McCulley, Frick, & Gilman, Inc. (MFG). 1994. *1993 Annual Groundwater Monitoring Report: Highway 36 Land Development Company Treatment, Storage and Disposal Facility.* Prepared for the Highway 36 Land Development Company.

McCulley, Frick, & Gilman, Inc. (MFG). 1999. 1998 Annual Groundwater Monitoring Report: Highway 36 Land Development Company Treatment, Storage and Disposal Facility. Prepared for the Highway 36 Land Development Company.

5.0 SITE CLOSURE PLAN AND INSTITUTIONAL CONTROLS

The Deer Trail Permit Renewal Report **(CHDT 2004a – see Volume 5 of this application)**[6] provides a detailed site Closure Plan, which identifies the overall methodology Clean Harbor Deer Trail (CHDT) will follow in the closure of disposal Cells 1 through 7. CHDT will apply this methodology to hazardous and Naturally Occurring Radioactive Material (NORM) and Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) waste in the facility. Section 3.0 of this application discusses the design features of the facility, which include the layered closure system to be placed over the cells, as required by the Resource Conservation and Recovery Act (RCRA). This final cover system includes an 8-inch-thick layer of topsoil that could be necessary in areas other than the disposal cells (e.g., potentially contaminated ditches, gravel roadways, former stockpile areas) to provide adequate drainage and return the site to a pristine state. The following documents contain design details and drawings:

Permit Renewal Report for Incorporation of a Geosynthetic Clay Liner (GCL) in the Liner Section for Secure Cells 3 Through 7 and in the Cover Section for Secure Cells 1 Through 7 (Highway 36 Land Development Company 1996).

State RCRA Permit Renewal Application, Volume Two, Section 10.1 Specifications for Secure Cell Construction **(CHDT 2004a – see Volume 5 of this application)**

State RCRA Permit Renewal Application, Volume Two, Section 10.2 Drawings for Secure Cell Construction **(CHDT 2004a – see Volume 5 of this application)**

State RCRA Permit Renewal Application, Volume Two, Section 10.3 Construction Quality Assurance Plan (CQA) **(CHDT 2004a – see Volume 5 of this application)**

Waste Filling Plan and Drawings for Secure Cell Number 2, Revision 1 **(CHDT 2004b – see Volume 6 of this application)**

This section describes the major features required for RCRA closure.

[6] For ease of review, references in **bold** are provided in Volumes 2 through 6 of this application.

5.1 SITE STABILIZATION

Each disposal cell will be a RCRA Subtitle C unit designed for the long-term isolation of waste contaminants, including NORM/TENORM waste, without the need for ongoing active maintenance. The cell design meets all requirements for hazardous waste land disposal unit designs. The focus of the design is prevention of water infiltration to disposed waste and elimination of the need for active cell maintenance. The discussions in Section 3.0 of this application on the design of the disposal cells with regard to prevention of water infiltration, control of surface drainage, and the long-term integrity of cell covers are applicable to the discussions in this section.

Because the disposal units are designed as RCRA Subtitle C facilities, an accepted and approved design for the long-term isolation of wastes in land disposal applications, this application does not provide supporting information from field tests of prototype and model covers.

5.1.1 Surface Drainage and Erosion Protection

Section 3.0 discusses surface drainage and erosion protection; most of the discussion is in the sections on Water Infiltration, Disposal Unit Cover Integrity, Site Drainage, and Site Closure and Stabilization. In summary, surface-water drainage will be controlled to minimize its potential to contact waste and cause erosion at the facility. CHDT will use a Surface-Water Management Plan to manage surface-water drainage during disposal cell operation (i.e., during placement of wastes in the cells). The Conceptual Site Development Drawings in Volume I of the Permit Renewal Report **(CHDT 2004a – see Volume 4 of this application)** show the surface-water drainage patterns to be established during the different phases of disposal cell activities. The drainage pattern at the end of disposal activities will generally reflect the drainage pattern present at the facility before construction of the cells. The facility's location on a knoll enables the natural drainage of surface water away from the cells in all directions.

Site drainage features include storm water drainage channels and drop structures – as required to reduce channel slopes and consequential erosion culverts and erosion control structures such as temporary ridges, swales, or straw bales. Details on the design of surface-water control systems are in Run-Off Management System Design Drawings and Specifications **(CHDT 2004a – see Volume 4 of this application)**.

5.1.2 Geotechnical Stability

Section 3.0 includes discusses geotechnical stability for the Deer Trail facility, including information on the disposal unit cover design, water infiltration, and surface-water drainage. Additional details on the construction sequence of the covers for Cells 1 through 7 are provided below.

Cover operations will begin when the final fill elevations of each disposal cell are reached. After Cells 1 and 2 are excavated, filled, and capped in sequence, closure activities for this area will begin. Temporary drainage ditches and channels will be restored to permanent drainage structures. Cells 3 through 7 will be constructed, filled, and closed in the general sequence shown in the Conceptual Site Development Plans in Volume I of the Permit Renewal Report for Incorporation of a GCL in the Liner Section for Secure Cells 3 Through 7 and in the Cover Section for Secure Cells 1 Through 7 **(CHDT 2004a – see Volume 4 of this application).** Cover systems for each cell will be constructed in increments as soon as weather conditions permit after final waste placement. Vegetative cover seeding will be completed no more than 6 months after completion of the cover system construction.

At the time of final facility closure, all cells except Cell 7 will have been capped, graded, and vegetated. Activities remaining to complete final closure of the facility will consist primarily of decontamination of appropriate structures and equipment, closure of Cell 7, final grading of the entire facility to provide uniform drainage, and vegetation of graded and previously unvegetated areas to prevent erosion.

5.2 DECONTAMINATION AND DECOMMISSIONING

Decontamination and decommissioning activities will begin as Disposal Cell 7 nears capacity. These activities are discussed in detail in the Deer Trail facility Closure Plan **(CHDT 2004a – see Volume 5 of this application)**. Cells 1 through 6 will have been closed. The following sections summarize elements of the Closure Plan with a focus on radiation protection issues associated with NORM/TENORM waste.

5.2.1 Facility Radiation Protection Design Features

It is the policy of CHDT management to maintain personnel exposure to levels that are as low as reasonably achievable (ALARA), consistent with efficient disposal site operations and fully compliant with 10 CFR 20, *Standards for Protection Against Radiation*, and 10 CFR 19, *Notices and Instructions to Workers*. Section 7.0 of this application contains details on radiation protection, including protection design features.

5.2.2 Survey Methods

The Radiation Protection Plan and supporting Standard Operating Procedures (SOPs) have been approved by the CHDT Corporate Staff and facility General Manager, and are included in Attachment A of this application. Although the RCRA permit requires numerous SOPs, those pertaining specifically to various types of radiation surveys or monitoring systems for NORM/ TENORM waste include:

- Standard Operating Procedure on Individual and Area Dosimetry
- Standard Operating Procedure on Airborne Monitoring
- Standard Operating Procedure on Radiation Surveys
- Standard Operating Procedure on Use of the Gate Monitoring System

Radiation surveys at Deer Trail will verify waste concentrations, limit the exposure of Deer Trail workers, and ensure that radiation doses to Deer Trail workers are maintained at levels less than 100 millirem per year (mrem/yr). These survey methods will be applied during decontamination and decommissioning of the facility. Because minimal waste handling and treatment is anticipated for most NORM/TENORM waste, and because operational procedures will ensure contamination control for areas outside the disposal cells, small decontamination efforts are anticipated. Where equipment or building surfaces are to be released for unrestricted use, the relevant surface contamination levels in U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 1.86 or alternative levels approved by the State of Colorado will be applied (NRC 1974). Where soil contamination is found, residual levels will be derived for an unrestricted release limit of 25 mrem/yr using the methodology defined in *Residual Radioactive Contamination from Decommissioning: Volume 1 – Technical Basis for Translating*

Contamination Levels to Annual Total Effective Dose Equivalent (Kennedy and Strenge 1992) or other methods approved by the State of Colorado.

5.2.3 Quantities and Types of Decontamination and Decommissioning Wastes

The currently permitted site occupies approximately 325 acres. The Deer Trail facility, at the time of closure, will include:

- Six closed, capped, graded, and vegetated disposal cells occupying approximately 90 acres;
- One open, active disposal cell occupying approximately 10.3 acres of surface area, with approximately 12,500 cubic yards (yd^3) of capacity available (Cell 7);
- Two Contaminated Water Storage Tanks with a capacity of approximately 250,000 gallons each;
- One Treatment Building with 15,000 ft^2 of Treatment Area. The Treatment Area includes four steel-lined treatment mixing basins (each 20 ft wide × 80 ft long × 10 ft deep with a 2,400-yd^3 capacity). The Treatment Building is underlain with a clay, synthetic, and concrete lining system that occupies approximately 89,000 ft^2;
- One 2,760-ft^2 Offsite Truck Wash building, including a 3,300-gallon washwater recycling system with lined collection sump (17,000-gallon capacity) and lift pump to the Contaminated Water Storage Tanks;
- An Onsite Truck Wash bay with a 4,000-gallon underground sump collection tank;
- A 4,000-gallon Operations Building/Laboratory/Sampling Station underground collection tank;
- Two packed column air scrubber systems, each with 2,500-gallon liquid capacity;
- Three dust conveyer systems from the Treatment Building baghouses;

- One decontamination room attached to the south side of the Containment Building with a 500-gallon-capacity sump;

- One Container Management Area in the Treatment Building, including a Class I and II drum storage area (11,000-gallon capacity), Class III drum storage area (22,000-gallon capacity), drum shredder, and conveyor system; and

- Two Container Storage Areas totaling 65,400 ft^2 of concrete paving plus curbing.

The Closure Plan assumes that the listed waste storage units will be filled to capacity when the closure period begins. The actual volume of hazardous wastes on the site when the closure period begins probably will be less. The following list summarizes estimated liquid, sludge, and solid wastes at the time of closure that could be contaminated with hazardous and NORM/ TENORM waste.

- Liquids - 563,800 gallons as follows:

  - 11,000 gallons (200 drums) of oils and solvents in the Class I and II Drum Storage Area;

  - 500,000 gallons of contaminated water in the Contaminated Water Storage Tanks;

  - 28,800 gallons of contaminated water in the following locations:

    3,300 gallons in the Offsite Truck Wash recycle tanks
    17,000 gallons in the Offsite Truck Wash sump
    4,000 gallons in the Maintenance Building sump collection tank
    4,000 gallons in the Operations Building/Sampling Station sump collection tank
    500 gallons in the Treatment Building decontamination room sump

  The water in the Contaminated Water Storage Tanks will be treated on the site with the available wastewater treatment system. The treated water will be discharged in accordance with the Deer Trail Permit.

- Sludges - 2,509 yd^3 of untreated waste as follows:

- 109 yd^3 (22,000 gallons) of untreated containerized waste (assumed to be sludge) in the Class III Drum Storage Area; and
- 2,400 yd^3 of untreated waste in the treatment mixing basins.

- Solids - 1,994 yd^3 as follows:
  - 14 yd^3 of untreated solids in the floor drains, collection tanks, and the Truck Wash recycle unit; and
  - 1,980 yd^3 of untreated containerized waste in the Container Storage Area.

5.2.4 Facility Decontamination, Sampling, and Closure Methods

General facility decontamination methods have been developed with a focus on hazardous materials. Because of the low concentrations of NORM/TENORM waste, and because of operational contamination control methods, the following methods will be more than adequate for any residual NORM/TENORM waste at the Deer Trail facility.

5.2.4.1 Process and Operations Area/Roads

The process area and site roads that could require decontamination consist of:

- The concrete paved entrance road from U.S. Highway 36 to the bermed processing area in the facility (approximately 413,400 ft^2)
- The concrete paving in the active waste management area including the Cell 7 haul road (approximately 371,300 ft^2)
- The concrete paving in the Container Storage Area (approximately 65,400 ft^2)
- The gravel roadways around the disposal cell area (approximately 150,000 ft^2)

All roadways in the Deer Trail facility are designated for on- and offsite vehicle use. Offsite vehicles will travel only on the paved site entrance road and the roadways in the process and operations area or on designated gravel roads for construction support or facility monitoring. Because vehicles leaving the active waste management area must be washed in either the On- or

Offsite Truck Wash, contamination of the paved and unpaved roadways outside the active waste management area is not anticipated. All roads (including the access road) will be inspected for areas of obvious contamination and the facility Operating Record will be consulted to determine locations of past spills or contamination. The active waste management area is expected to consist of the concrete paved process area north of the Maintenance Building and the concrete paved access road to the active Secure Disposal Cell.

The following sections describe background sampling and testing, decontamination, and closure procedures for the roadways listed above.

5.2.4.2 Background Sampling and Testing

A background soil sampling and testing program was conducted in the process and operations areas and access roads after initial construction and prior to acceptance of hazardous wastes at the Deer Trail facility. This program included determination of background dose rates for calibrating the gate radiation monitor. These levels will be used for comparison against derived soil contamination limits, based on 25 mrem/yr to an individual, for making decisions on soil that might be contaminated with NORM/TENORM waste.

5.2.4.3 Concrete Paved Areas

As discussed above, the Closure Plan assumes that only the concrete paved areas, including the Container Storage Area in the active waste management area, will require decontamination (approximately 436,700 ft^2). Decontamination of the active waste management area will employ the onsite high-pressure-water cleaning unit. The concrete surfaces will be hydroblasted with an appropriate industrial-strength detergent solution. Washwater will drain to adjacent Segregated Storm Water Drainage Ditches and the Segregated Storm Water Retention Basin (SSRB), or temporary storage containers. Representative rinsate samples will be collected from the ditches, SSRB, or temporary storage containers. The paved areas will be considered decontaminated on the removal of all visible residues and when a final rinsate volume of 300 gallons or less, at 400-foot intervals, produces a total organic content level of less than 50 parts per million and pH between 6 and 9. For NORM/TENORM waste, subsequent surface contamination surveys must meet established unrestricted surface contamination levels (NRC 1974). Test methods will be those specified in the Waste Analysis Plan. The contaminated rinse water will be collected for

onsite treatment in the wastewater treatment facility or for disposal at an interim status or permitted hazardous waste disposal facility.

5.2.4.4 Gravel Roads

The facility Closure Plan assumes that no gravel roads will require decontamination. If decontamination is necessary, the decontamination of all gravel roads used to transport waste material will employ the procedures described in the following sections:

Decontamination

Samples will be taken in the areas described above and analyzed for soil pH, 6 CCR 1007-3 §261 - Appendix VIII constituents, and NORM/TENORM waste disposed of in the cell being closed. If contamination is found, its extent must be determined in a horizontal and vertical direction. Contaminated soils must be removed until a 6-inch horizontal and vertical stratum of soil in the contaminated area meets the requirements specified below for decontamination as determined by representative soil samples in the contamination zone. Soils will be considered decontaminated when analysis of soil pH, 6 CCR 1007-3 §261 - Appendix VIII constituents, and NORM/ TENORM waste results indicate that background levels have been met. Test methods and procedures will be those specified in the Waste Analysis Plan. Contaminated soils will be transferred to the active disposal cell or an offsite permitted hazardous waste disposal facility.

Sampling

A sampling program will be initiated to determine the existence and extent of any contamination (hazardous and NORM/TENORM waste) that might be present on the gravel roadways utilized by equipment going into or out of a disposal cell.

The gravel and soil sampling program will utilize a grid system as defined under RCRA. Samples will be obtained in any areas of obvious contamination in the grid system. Samples will be taken at a depth of 0 to 6 inches. Composites could be prepared from these samples at a ratio of 5:1 and analyzed. The dimensions of the grids will be 400 ft by 50 ft with the long axis parallel to the centerline of the access roads. Five sampling locations in each grid will be selected randomly. However, in each grid, if an area(s) of potential contamination is noted (i.e., soil discoloration and/or odor), one of the sampling locations will be in that area. At each

sampling location, the sample will be obtained by advancing a bucket or hand auger to a depth of 0 to 6 inches. Each sample will be visually characterized, noted in a field logbook, and placed in precleaned glassware with Teflon-lined caps. Each sample container will be labeled as to sample location and depth interval, and the chain of custody will be initiated for shipment to an approved analytical laboratory. During the sampling activity, the bucket-type hand auger and auxiliary sampling equipment will be cleaned using detergent, distilled water, and acetone. The sampling equipment will be rinsed using distilled water to avoid cross-contamination. A minimum of five samples will be taken for every 400 ft of gravel roadway in the landfill area.

5.2.4.5 Treatment Building - Primary and Secondary Containment

Treatment Building closure will include the Treatment Building primary and secondary liner systems. Prior to placement of the Treatment Building liner systems, a background soil sampling program was conducted in the area of each impoundment. These preoperational data were used to establish background parameters and to specify the extent of closure activities.

Ten representative soil samples were taken at a depth of 0 to 6 inches for each unit impoundment and analyzed for soil pH, heavy metals, priority pollutants, and the first 10 major peaks that are quantifiable above 25% of the internal standard of 10 parts per billion, as identified by gas chromatograph/mass spectrometer analysis. Background levels for inorganics (except pH) were established at the mean value plus 2 standard deviations; for organics, background was established at the practical quantification limit. The sampling methods, procedures, recordkeeping protocol, and soil sampling equipment were those specified in the Closure Plan **(CHDT 2004a – see Volume 5 of this application)**. In some cases, composite soil samples might have been taken in a ratio of 2:1 (i.e., two samples might have been combined for one analysis). Test methods and procedures were those specified in the Waste Analysis Plan (**CHDT 2004a – see Volume 5 of this application)**.

5.2.4.6 Decontamination

The soil sampling program will generate at least 20 representative samples (that might be combined into 4 samples) taken at a depth of 0 to 6 inches. Samples will be taken in areas of obvious contamination. If contamination is found, its extent must be determined in a horizontal and vertical direction. Contaminated soil must be removed until a 6-inch horizontal and vertical

stratum of soil in the contaminated area meets the decontamination criteria specified below, as determined by five representative soil samples or a composite of these five samples in the contamination zone. Soil will be considered decontaminated when analysis of soil pH, 6 CCR 1007-3 §261 - Appendix VIII constituents, and NORM/TENORM residual concentration results indicate that background or unrestricted release levels have been achieved. Test methods and procedures will be those specified in the Waste Analysis Plan **(CHDT 2004a – see Volume 5 of this application)**. Sampling methods, procedures, recordkeeping protocol, and soil sampling equipment will be those specified above. Contaminated soils will be transferred to Disposal Cell 7 or to a permitted hazardous waste disposal facility.

5.2.4.7 Closure Sampling Program

For closure, it is assumed that the closure sampling program will not be required **(CHDT 2004a – see Volume 5 of this application)**. If a leak is detected during the active life of the facility, the Leak Detection System of the Treatment Building, the Closure Plan, and Closure Cost Estimate must be modified. The Department must be notified within 15 days of the determination and the Modification Request must be submitted within 30 days of the determination. If required, the sampling program for the excavated area will utilize a grid system. Samples will be obtained in the grid system from a depth of 0 to 6 inches. Composites will be prepared from these samples at a ratio of 5:1 (five samples might be combined into one) and analyzed. The dimensions of the grids will be 100 ft by 100 ft. Five sampling locations in each grid will be selected randomly. At each sampling location, samples will be obtained by advancing a bucket-type hand auger to a depth of 0 to 6 inches. The samples will be visually characterized, noted in a field logbook, and placed in precleaned glassware with Teflon-lined caps. Each sample container will be labeled as to sample location and depth interval, and the chain of custody will be initiated for shipment to an approved analytical laboratory. During the sampling activity, the hand auger and auxiliary sampling equipment will be cleaned with detergent, distilled water, and acetone. The sampling equipment will be rinsed using distilled water to avoid cross-contamination.

5.2.4.8 Final Closure

If required, following decontamination and testing of the Waste Treatment and Container Storage Building, the excavation will be backfilled and a final cover will be placed over the backfill. For closure, the estimated amount of solids generated during closure that might require disposal is 8,973 yd^3 **(CHDT 2004a – see Volume 5 of this application)**. This is based on the assumption that 25% of the Waste Treatment and Container Storage Building containment system will require disposal. If a leak is detected in the building's Leak Detection System during the active life of the facility, the Closure Plan and Closure Cost Estimate must be modified to include the entire containment system. The Department must be notified within 15 days of the determination and the Modification Request must be submitted within 30 days of the determination.

Equipment and Structures

Potentially contaminated equipment and structures will be decontaminated, disposed of in Disposal Cell 7, or transferred to an interim status or permitted facility for disposal. The Closure Plan assumes the use of decontamination procedures **(CHDT 2004a – see Volume 5 of this application)**. Potentially contaminated equipment and structures will be decontaminated by hydroblasting with an appropriate industrial-strength detergent solution or another appropriate 40 CFR 268.45 procedure, or transferred to an industrial or hazardous waste service. Hydroblasting is assumed for closure cost estimate purposes. The hydroblasting will occur in the on- or offsite Truck Wash areas, where practical, or *in situ* when necessary. The washwater in the Truck Wash areas will drain to the sump before being transferred for onsite treatment or off the site for disposal. The washwater generated from *in situ* cleaning will be collected by a pump or vacuum truck or similar equipment before being treated or shipped off the site. All contaminated facility equipment, structures, and protective clothing that will not be decontaminated will be disposed of in Cell 7 or shipped to a permitted or interim status hazardous waste disposal facility. The volume of wastewater generated during the decontamination of the equipment and structures at the facility includes washwater from the decontamination of the associated concrete systems and concrete pads.

The decontamination activities will generate an estimated 250,000 gallons of wastewater with an amount of sediment equal to 5% of the wastewater created by mass, and an estimated 12,500 gallons (62 yd^3) of sediment will be disposed of in Disposal Cell 7 after decontamination.

The decontamination criteria and specific procedures for the Container Management Building, tanks, sumps, Treatment Building, and heavy equipment are as follows: equipment, tanks, and structures will be considered decontaminated on the removal of all visible residuals and when a final rinsate volume of 300 gallons or less from 10% of like equipment produces analytical results that indicate that 6 CCR 1007-3 §261 - Appendix VIII constituent concentrations are no greater than maximum contaminant levels for drinking water and the pH is between 6 and 9. Test methods will be those specified in the Waste Analysis Plan. Rinsate that does not meet the above specifications will be collected for onsite treatment or disposal at an interim status or permitted waste disposal facility. In addition, the residual NORM/TENORM surface activity levels shall not exceed the appropriate criteria (NRC 1974).

Container Management Building

Equipment in the Container Management Building (including the drum shredder and drum conveying system) will be disassembled and decontaminated in the On- or Offsite Truck Wash areas or disposed of by an approved method. It might be transferred to another permitted hazardous waste facility to be used in hazardous waste service without decontamination or to an industrial application after removal of gross contamination by visual inspection. Decontamination is assumed for closure cost estimate proposes. Representative rinsate samples will be collected at the drain of the Truck Wash area. The Container Management Building floor, berms, and any remaining structures will be decontaminated in place. Representative samples will be collected at the Container Management Building sumps.

Tanks

The Contaminated Water Storage Tanks and the Offsite Truck Wash recycling system surge tanks will be emptied during closure. The contents will be treated on the site or transferred to a permitted facility. The empty tanks, foundations, structural supports, piping, and containment systems will be decontaminated, disposed of, or transferred to a hazardous waste or industrial

waste service without being decontaminated as described above. Representative samples will be collected from each tank's containment area sump.

Collection Sumps

The Maintenance Building underground sump collection tank, the Operations Building/ Sampling Station underground sump collection tank, and the in-floor sump of the Offsite Truck Wash will be emptied during closure. The contents will be treated on the site or transferred to an appropriately permitted facility. If leaks have not been detected in the leak detection system throughout the life of the tank, the tank and all associated piping will be decontaminated and closed in place. If leaks have been detected, the double-walled fiberglass tank piping and associated structures will be removed. A soil sampling program will be implemented in the excavation pit created by removal of the tank and associated materials.

The soil sampling program will include a minimum of 10 samples taken at a depth of 0 to 6 inches and additional samples will be taken in areas of obvious contamination. (These samples will be collected as follows: two samples will be taken from the floor of each excavation pit, one sample will be taken from the wall of each excavation pit, and four samples will be taken from the pipeline excavations). The extent of contamination found will be determined in a horizontal and vertical direction. Contaminated solids will be removed until a 6-inch horizontal and vertical stratum of soil in the excavation pit no longer contains hazardous constituents as determined by 10 representative soil samples in the contamination zone.

Soil will be considered decontaminated when analysis of soil pH and 6 CCR 1007-3 §261 - Appendix VIII results indicate values within the mean plus 2 standard deviations background soil sampling values for inorganics, and values below the practical quantification limits for organics have been achieved. In addition, the derived unrestricted release criteria for NORM/ TENORM waste in soil must be met. Test methods and procedures will be those specified in the Waste Analysis Plan (**CHDT 2004a – see Volume 5 of this application**). Sampling methods, procedures, recordkeeping protocol, and soil sampling equipment will be those specified for the closure of surface impoundments. Contaminated soils will be disposed of in Cell 7 or at an interim status or permitted hazardous waste disposal facility. All equipment and associated

piping removed from the collection sump area will be decontaminated in the On- or Offsite Truck Wash.

Treatment Building

Prior to dismantling (removing walls and roof) the Treatment Building, its walls and roof, process equipment, and treatment mixing basins will be decontaminated. The building will be considered decontaminated on the removal of all visible residues and when two representative rinse water samples (from two different locations along the face) collected from each face of the building meet the decontamination criteria specified in the Closure Plan, and when the NORM/ TENORM unrestricted release criteria are met..

Heavy Equipment

All equipment and heavy machinery remaining at final closure will be decontaminated in the On- or Offsite Truck Wash and will meet the sampling standard for unrestricted use, or will be transferred to another industrial user standard or to another hazardous waste use standard.

Disposal Volumes

During closure, the concrete floor, high-density polyethylene (HDPE) liners, clay liners, and all associated components including the leak detection systems, riser pipes, and geotextile will be removed. These removed materials will be transferred to Disposal Cell 7 or to an appropriately permitted waste disposal facility. If monitoring of the leak detection system indicated a failure of the primary containment system during the life of the building, a soil sampling program will be conducted in the excavated area. If required, this program will occur following removal of the liners. The following table lists estimated volumes of materials of the Waste Treatment and Container Storage Building's primary and secondary containment systems:

Treatment Building Primary and Secondary Containment Systems

Backfill Between Building and Liner	14,600 yd^3
Clay Liner	17,000 yd^3
Concrete	3,822 yd^3
Steel Plate Liner	150 yd^3
HDPE/Geonet	318 yd^3
Total	35,890 yd^3

5.2.5 Measured Residual Contamination

Radiation surveys at Deer Trail will verify compliance with unrestricted release criteria for NORM/TENORM waste on equipment or building surfaces. The relevant surface contamination levels in NRC Regulatory Guide 1.86, or alternative levels approved by the State of Colorado, will be applied (NRC 1974). If soil contamination is found, residual levels will be derived for an unrestricted release limit of 25 mrem/yr using the methodology defined in *Residual Radioactive Contamination from Decommissioning: Volume 1 – Technical Basis for Translating Contamination Levels to Annual Total Effective Dose Equivalent* (Kennedy and Strenge 1992), or other methods approved by the State of Colorado.

5.2.6 Disposal of Decontamination Wastes

All material that meets the release criteria specified in the Closure Plan **(CHDT 2004a – see Volume 5 of this application)** and in Regulatory Guide 1.86 will be removed from the facility. All decontamination waste produced during decommissioning activities will be disposed of in Cell 7. The types of waste generated during decommissioning activities will include radiological sampling materials. The facility operating philosophy is to minimize contamination generated during operations and, if contamination occurs, to decontaminate the area at that time. If soil contamination is found, residual levels will be derived for an unrestricted release limit of 25 mrem/yr using the methodology defined in *Residual Radioactive Contamination from Decommissioning: Volume 1 – Technical Basis for Translating Contamination Levels to Annual Total Effective Dose Equivalent* (Kennedy and Strenge 1992), or other methods approved by the State of Colorado.

5.2.7 Site Radiological Characterization Following Closure

Final radiological characterization of the facility following closure under RCRA will be in accordance with the recommendations in the *Multiagency Radiation Survey and Site Investigation Manual* (MARSSIM) (NRC 1997). A formal site characterization plan will be developed, reviewed, and approved; the plan will include characterization of external radiation dose rates and residual soil concentrations of NORM/TENORM waste. During operations, the facility will be under continuous radiological characterization and monitoring. The result of the

operational monitoring will not only provide an extensive history of radiological conditions at the site, but also serve as screening information on which to develop the characterization plan.

5.2.8 Records

As part of the MARSSIM process, a review of facility operating records will occur prior to decommissioning to ensure that any areas potentially affected during operations receive the appropriate level of attention during decommissioning activities. This information will be evaluated during preparation of the final characterization plan. All records generated during decontamination and decommissioning activities will be retained in the facility records.

5.3 POSTOPERATIONAL ENVIRONMENTAL MONITORING AND SURVEILLANCE

As described above, the site and facility will be closed as defined under RCRA and consistent with the Deer Trail Closure Plan **(CHDT 2004a – see Volume 5 of this application)**. The postclosure period will begin at the date of certification of closure and continue for 30 years, unless extended by the Department. Postclosure monitoring of the ground-water, secure cell leachate, and leak detection systems will continue as defined in the Post Closure Plan **(CHDT 2004a – see Volume 5 of this application)**. Although the quantities of leachate generated from the disposal cells will be minimal, the expected average yield from all collection systems will be about 40 gallons per acre of cap per year in the first year of the postclosure period. At final closure, there will be 65 acres of landfill cap, which will yield an average of 2,600 gallons of leachate in the first year. This value should decrease by about 10% per year thereafter. Based of this projection, the total volume of leachate will be about 14,245 gallons during the postclosure period.

Additional postclosure inspections will cover security devices (chain-link fence, warning signs, and other postings), site vegetation on and around the closed cells, remaining buildings or structures, run-on/run-off control structures, ground-water monitoring wells, final cover, and the leachate collection and leak detection systems. During the postclosure period, a sudden (or nonsudden) release of hazardous constituents (including NORM/TENORM radionuclides), will cause implementation of the appropriate sections of the Deer Trail Contingency Plan **(CHDT 2004a, Attachment 4 – see Volume 4 of this application)**.

5.4 REFERENCES CITED

10 CFR 19. 2004. *Notices and Instructions to Workers.* U.S. Nuclear Regulatory Commission, Washington, D.C.

10 CFR 20. 2004. *Standards for Protection Against Radiation.* U.S. Nuclear Regulatory Commission, Washington, D.C.

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Clean Harbors Deer Trail (CHDT). 2004b. ***Waste Filling Plan and Drawings for Secure Cell Number 2, Revision 1,*** **(CHDT 2004b – Provided in Volume 6 of this Application).**

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State of Colorado. 1985. *License Application Guidelines For Land Disposal of Low-Level Radioactive Waste In Colorado.* Denver, Colorado.

U.S. Nuclear Regulatory Commission (NRC). 1974. *Termination of Operating Licenses for Nuclear Reactors.* Regulatory Guide 1.86. Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1991. *Standard Format and Content of a License Application for a Low-Level Radioactive Waste Disposal Facility.* NUREG 1199, Rev. 2. Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1997. *Multiagency Radiation Survey and Site Investigation Manual.* NUREG 1575. Washington, D.C.

6.0 SAFETY ASSESSMENT

As described in previous sections of this application, since obtaining a Certificate of Designation from Adams County on November 12, 1987, the Deer Trail facility has been operating as a Resource Conservation and Recovery Act (RCRA) Subtitle C hazardous waste disposal facility. To receive the Certificate of Designation, the site owner [Browning-Ferris Industries, Inc. (BFI)] conducted lengthy studies of the site, its geology and hydrogeology, environmental setting, potential environmental impacts, and engineering design. The State of Colorado evaluated and approved these studies before issuing the Certificate of Designation. The studies evaluated the engineered disposal system, the performance of the synthetic liner system, ground-water protection, worker protection, and environmental protection among other safety issues **(BFI 1981 and 1982 – see Volumes 2 and 3, respectively, of this application)**.[7]

In support of the May 2001 rulemaking, "Storage, Treatment, Transportation, and Disposal of Mixed Wastes" (FR 66, pp. 27218 – 27266), the U.S. Environmental Protection Agency (EPA) contracted the Research Triangle Institute to report on the containment effectiveness of low-level radioactive waste disposal facilities regulated under 10 CFR 61 in comparison to Subtitle C RCRA facilities regulated under 40 CFR 260-299 (EPA 2001). The EPA report concluded that Subtitle C RCRA disposal facilities provide ground-water protection similar to U.S. Nuclear Regulatory Commission (NRC)-regulated low-level radioactive waste disposal facilities and would be protective of long-term human health and the environment. The report also concluded that NRC-regulated low-level radioactive waste disposal facilities would be protective of human health and the environment for the disposal of RCRA hazardous wastes following the prescribed Land Disposal Restriction (LDR) treatment for containerized waste. Although there might be some issues regarding bulk waste disposal and closure conditions, the general conclusions were based on the similarities of the overall facility designs and estimates of long-term performance regarding ground-water protection. The overall EPA position is consistent with the findings of this safety assessment.

The strategy used in this license application relies on referencing the technical information originally developed for obtaining the Certificate of Designation wherever possible, and providing supplemental information on the radioactive properties of Naturally Occurring

[7] For ease of review, references in **bold** are included in Volumes 2 through 6 of this application.

Radioactive Material (NORM) and Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) waste. The focus of the safety assessment described in this section is on NORM/TENORM radiation protection issues and is largely based on a report by Kennedy (2004) entitled *Development of Waste Acceptance Criteria for the Disposal of NORM/TENORM Waste at the Deer Trail, RCRA Subtitle C Landfill,* which is included in Attachment B of this application.

For this application, concentrations of NORM/TENORM waste are limited to low levels so workers will be considered members of the public and radiation exposures will be limited to 100 millirem per year (mrem/yr), plus ALARA (as low as reasonably achievable), with a goal of 25 mrem/yr or less. If worker dosimetry results determine that selected worker doses could exceed 25 mrem/yr, an assessment of the potential for other manmade exposures for these workers will occur to ensure that maximum individual doses from manmade sources will not exceed 100 mrem/yr. This assessment will consider real individuals working at Deer Trail, not hypothetical members of the public. Other members of the public will be limited to an annual dose of 25 mrem/yr, consistent with the Performance Objectives outlined in 6 CCR 1007-1, Radiation Control, Part 14: *Licensing Requirements for Land Disposal of Low-Level Radioactive Waste.* Thus, the release, transport, and exposure scenarios that follow consider individuals who are members of the public, not radiation workers.

6.1 RELEASE OF RADIOACTIVITY

As the basis of the public and environmental safety assessment, and for comparison against the Performance Objectives in 6 CCR 1007-1, Radiation Control, Part 14: *Licensing Requirements for Land Disposal of Low-Level Radioactive Waste*, there must be estimates of radioactive material releases from the disposal system over time. The process of estimating radionuclide releases begins with an estimate of the potential inventory of radioactive material to be disposed of in the facility, followed by identification and modeling of specific release and transport mechanisms for both routine (i.e., undisturbed performance) and accident situations. Finally, the process estimates potential radiation doses to members of critical groups of the general public (including Deer Trail workers who are treated as members of the public).

6.1.1 Determination of Types, Kinds, and Quantities of Waste

This application allows for transfer of a specific and limited type of licensed radioactive material to the Deer Trail facility for disposal. This application applies only to radioactive material consistent with the radionuclides found in NORM and TENORM waste with concentrations that are less than the Colorado statutory definition of radioactive waste (C.R.S. § 25-11-201). However, because of waste-specific regulatory determinations, some of this waste might require disposal in a licensed facility. The limited concentrations considered in this application are a total activity of less than 2,000 picocuries per gram (pCi/g; natural uranium and thorium decay chain products only), with a maximum ^{226}Ra concentration less than 400 pCi/g. These materials will have external dose rates that are generally less than 100 microroentgens per hour (μR/hr), exclusive of background. This license application does not include radioactive waste in the broader definition of low-level radioactive waste, including other licensed forms of manmade radioactive materials.

The Deer Trail facility is permitted for seven secure disposal cells. The approximate volume of each cell is:

Cell 1: 173,000 cubic yards
Cell 2: 220,600 cubic yards
Cell 3: 480,240 cubic yards
Cell 4: 491,840 cubic yards
Cell 5: 472,120 cubic yards
Cell 6: 433,840 cubic yards
Cell 7: 466,320 cubic yards

The total maximum permitted capacity is 2,737,960 cubic yards. Cell 1 is closed and capped. As of April 29, 2003, Cell 2 had 30,200 cubic yards of airspace remaining. Cell 3 is partially constructed. All cells will be excavated to have the entire floor set on unweathered Pierre Shale. Because past operations of Cells 1 and 2 did not permit disposal of NORM/TENORM waste, the total maximum capacity (assuming that all waste received is NORM/TENORM) to fill Cells 3 through 7 is about 2,344,360 cubic yards.

As discussed in Section 1.0, the Deer Trail waste acceptance criteria exclude disposal of licensed manmade radionuclides in radioactive waste. This means that the site will not accept licensed waste from the nuclear power industry, medical industry, research institutes, or general industry. The only waste streams under consideration are those that contain radionuclides consistent with NORM/TENORM radionuclides. Further, under the RCRA Permit, the site must dispose of stabilized bulk wastes (no containers allowed). This restriction is to help ensure long-term stability of the site and eliminate subsidence problems. A more complete description of acceptable wastes and waste forms under the RCRA Permit is in two reports **(BFI 1981 and 1982 – see Volumes 2 and 3, respectively, of this application).**

At this time considerable uncertainty is associated with projected waste volumes and total activity to be disposed of during each year of future operation. This is because the Deer Trail facility receives waste from a number of sources, including hazardous (i.e., non-NORM/ TENORM) sources. Historical operations reveal that a significant fraction of the waste comes from specific cleanup campaigns that rely on funding through the Comprehensive Environmental Response, Liability, and Recovery Act (CERCLA) or industry sources rather than sources that generate predictable quantities of waste on an annual basis. Further, Deer Trail must compete against other facilities to obtain disposal contracts. However, based on current cell designs, the Deer Trail facility has enough estimated disposal capacity to operate for at least the next 30 years.

Because operations under the RCRA Permit require use of clean daily cover material, and because no long-term contamination of processing buildings or facilities is anticipated, there are no anticipated closure wastes.

6.1.2 Infiltration

Transport of waste by the infiltration of precipitation through the cells to ground and surface waters is a primary concern for both RCRA landfills and low-level radioactive waste disposal facilities. Numerous design features at the Deer Trail facility will greatly reduce the possibility that water will infiltrate the disposal cells and contact the waste. Specifically, after closure, a cap will be placed over the waste to enable drainage of precipitation away from the cells. This cap will include layers of soil and geotextiles, with a graded slope to improve drainage away from

the waste. The cap is designed as a multilayer system that includes topsoil to support vegetation and reduce infiltrating water through evapotranspiration; 3 feet of general fill to protect the underlying layers against frost, erosion, deep-rooted plants, and burrowing animals; a geocomposite drainage layer to direct water outward from the center of the cell to a surface drainage pipe; an 80-mil textured geomembrane that functions as a low-permeability barrier (and protects against biotic intrusion); and the interim soil cover of 0.5 foot of soil to serve as an operations base for placement of the cover system. Section 3.2 discusses evaluations of the closure system to ensure long-term stability; these evaluations rely on information developed in two reports **(BFI 1981 and 1982 – see Volumes 2 and 3, respectively, of this application)**. The conclusions reached in the RCRA siting and permit process confirmed the adequacy of the site and engineered systems to provide long-term stability.

During operations, a leachate collection system removes infiltrating water from the waste cells, as described in Section 3.2. This system ensures minimum contact of the waste with infiltrating water during disposal operations. Section 6.1.5.1 contains additional information on the ground-water analysis.

6.1.3 Radionuclide Releases and Individual Exposures – Normal Conditions

In general, the modeling process used to evaluate potential releases of radioactive materials begins with the establishment of a suite of release and exposure mechanisms and conditions across the operational and closure periods. Table 6.1 summarizes potential scenarios considered for estimating offsite impacts. The following paragraphs discuss these scenarios, whether they are considered for full analysis, and if included, both bounding and best-estimate doses.

- Truck Drivers Hauling Waste – Deer Trail Landfill Workers: For this analysis, the NORM/TENORM waste is assumed to be hauled to the Deer Trail facility in standard roll-off boxes, with dimensions of 1.8 × 2.4 × 6.5 m (5 ft 10 in. × 8 ft × 21 ft 3 in.). The analysis treats the truck drivers as members of the public. The waste is assumed to have a density of 1.4 grams per cubic centimeter (g/cm^3), largely reflecting random loading of the roll-off boxes with consideration of void spaces. The TSD-Dose computer program (Pfingston et al., 1998) was used to evaluate doses to truck drivers hauling waste. TSD-

Table 6.1. Scenarios Considered for Impacts Analysis for the Deer Trail Facility from Normal Operations and Undisturbed Closure.

Exposure Scenario	Type of Radiation	Transport Mechanism	Exposure Period
Deer Trail Workers - Truck Drivers Hauling Waste	Photon	None	Operational
Deer Trail Landfill Workers – Waste Receipt and Sampling	Alpha, Beta, Photon	Air	Operational
Deer Trail Landfill Workers – Workers Exposed to Waste in the Disposal Cell	Alpha, Beta, Photon	Air	Operational
Doses to Individuals Near Transport Containers	Photon	None	Operational
Doses to Nearby Residents During Operation	Alpha, Beta, Photon	Air	Operational
Doses to Nearby Residents – Post Closure	Photon	None	Post Closure
Waterborne Releases to Surface Water	Alpha, Beta, Photon	Surface Water (Precipitation)	Operational, Closure, Post Closure
Waterborne Releases from Disposal Cells	Alpha, Beta, Photon	Surface Water (Precipitation)	Operational, Closure, Post Closure
Radionuclide Leaching and Migration – Drinking Water	Alpha, Beta, Photon	Ground Water	Operational, Closure, Post Closure
Release Through Biotic Pathways	Alpha, Beta, Photon	Biota	Operational, Closure, Postclosure

Dose was developed to estimate potential radiation doses to onsite workers and the offsite public from waste handling operations at a RCRA treatment, storage, and disposal facility (TSDF). The code is based on detailed assessments and assumptions regarding potential operations and activities at a TSDF. Table 6.2 lists the input parameters used to model this scenario. As listed in this table, the driver is assumed to be near the waste during the following operations: loading and securing the bulk shipment, driving to the landfill, resting during transit, and truck maintenance during transit. For this analysis, loading, resting, and truck maintenance are assumed to occur at a rate of 5 minutes (each) per hour of drive time. The general shielding properties of the roll-off box and truck are assumed to be consistent with 12-gauge steel construction, or 0.32 cm (0.125 in.) of steel.

For this scenario, unit concentration dose conversion factors were developed with TSD-Dose, assuming 1 hr of drive time at a unit activity of 1 Ci per roll-off box of ^{226}Ra plus decay chain progeny, and ^{238}U plus decay chain members. Modifications to the unit dose conversion factors using a spreadsheet allowed consideration of different waste concentrations and a variable total drive time per year, independent of the distance traveled. The resulting dose factor per each hour of driving (plus 5 minutes each of loading, resting, and truck maintenance) is 6 mrem/hr per Ci per box, and is dominated by ^{226}Ra plus decay chain progeny. Dividing this value by the total activity in the waste

Table 6.2. TSD-Dose Input Parameters for the Truck Driver and Receipt/Sampling Scenarios.

Parameter/Scenario	Value	Comment
Truck Driver Scenario		
Roll-off Box Dimensions	1.8 × 2.4 × 6.5 m (5'10" × 8' × 21'3")	Dimensions of a standard 19 m^3 (25 yd^3) roll-off box.
Waste Density	1.4 g/cm^3	Solid bulk waste density.
Load Bulk Waste Duration	0.082 hr (5 minutes)	Average time to load roll-off box with driver present.
Driver Distance During Loading	1.5 m (5')	Average driver proximity to roll-off box.
Driver Shielding During Loading	0.32 cm (1/8")	Assumed 12-gauge steel roll-off box.
Normalized Drive Time	1 h	To produce unit duration dose factors
Driver Distance From Waste	2.1 m (7')	From cab to roll-off box.
Driver Shielding	0.63 cm (1/4")	Combined roll-off box and cab.
Driver Rest Duration	5 minutes	Assumed 5 minutes of rest per hour of driving.
Driver Rest Location	0.61 m (2')	Assumed close proximity to roll-off box.
Driver Rest Shielding	0.32 cm (1/8")	Assumed 12-gauge steel roll-off box.
Driver – Maintenance Duration	5 minutes	Assumed 5 minutes maintenance per hour of driving.
Driver – Maintenance Location	0.91 m (3')	Assumed close proximity to waste
Driver Rest Shielding	0.32 cm (1/8")	Assumed 12-gauge steel roll-off box.
Receipt/Sampling Scenario		
Weigh Truck: Average Distance	3.6 m(12')	The worker is in the weigh station to record readings.
Weigh Truck: Duration	10 minutes	Estimated time to inspect the manifest and record the weight.
Inspect/Sample Waste: Average Distance	0.3 m(12")	Sampling near contact with the waste roll-off box.
Inspect/Sample Waste: Time per Drum	11.4 seconds	Assigned duration per drum to equal a total of 15 minutes per truck (80 drums).
Airborne Dust Concentration	10 mg/m^3	TSD-Dose default value.
Respiratory Protection Factor	1	No credit for the protection provided by dust masks.

divided by the mass of waste per box (i.e., 2E+12 pCi/3.97E+07 g) yields a unit concentration dose conversion factor of 1.2E-4 mrem/hr per pCi/g.

For the bounding dose estimate to the truck driver, it is assumed that a driver could be hauling NORM/TENORM waste 1,000 hr/yr (with an empty truck the remaining 1,000 hr of the work year); the resulting dose per hour of driving would be 0.12 mrem/yr per pCi/g. The estimated bounding radiation dose for a ^{226}Ra plus decay chain progeny concentration of 400 pCi/g is 48 mrem/yr. The derivation of the best-estimate radiation doses for this scenario consider that the truck driver is exposed for 500 hr/yr with 1 minute per hour of driving for loading, resting, and truck maintenance, at an average waste concentration 20% of the maximum concentration defined by the waste acceptance criteria, with a resulting dose of about 3 mrem/yr. Attachment B of this application contains the TSD-Dose input/output supporting this analysis.

The bounding analysis is highly conservative for at least two reasons. First, not all waste received in a year at the Deer Trail facility would be NORM/TENORM waste at the maximum concentration allowed; thus, the actual average concentrations per year will be

much less than 400 pCi/g. Second, 5 minutes each of loading, resting, and truck maintenance, closer to the waste than inside the cab, per hour of driving is an overestimate of the actual time and location of the driver during these activities.

- Deer Trail Landfill Workers – Waste Receipt and Sampling: CHDT considered the TSD-Dose computer program (Pfingston et al. 1998) to evaluate doses to workers exposed during waste receipt and sampling operations. Although the purpose of the program is to represent a broad range of activities, it is largely based on handling drums of waste, not bulk waste as would be the case at Deer Trail. As a result, activities associated with waste receipt and sampling for bulk wastes are not very well represented. The relevant portion of the TSD-Dose program is "Operation 2 – Receiving and Sampling"; the relevant aspects of Operation 2 include weighing the vehicle, inspecting the manifest, unloading drums of waste, and inspecting and sampling the drums. The default times and exposure geometries are those associated with drums, not bulk waste. For example, the code asks the user to input the sampling time per drum, for a total time of as long as 5 hours per truck to sample the waste.

  For bulk waste, composite samples are collected for each shipment, with a total exposure duration of between 10 to 15 minutes per truckload. TSD-Dose assumes 80 drums per truck; therefore, the sampling time per drum needs to be 0.19 minute to arrive at 15 minutes per shipment sampling time for the bulk load. Table 6.2 lists detailed TSD-Dose input parameters and assumptions for this scenario. Consistent with the truck driver scenario, unit concentration dose conversion factors were developed for this scenario using TSD-Dose, assuming 1 Ci per roll-off box of ^{226}Ra plus decay chain progeny and 1 Ci of ^{238}U plus decay chain progeny, which equates to an average waste concentration of 5.1×10^{4} pCi/g. From a spreadsheet calculation using the unit concentration dose conversion factor, the resulting dose per shipment, at this unit waste concentration, is 3.9 mrem. This dose is dominated by the external exposure pathway and ^{226}Ra plus decay chain progeny, with a small additional contribution from inhalation. Dividing this value by the waste concentration in pCi yields a unit concentration dose conversion factor of 7.7×10^{-5} mrem per pCi/g per shipment. At full capacity, the Deer Trail facility could

handle an estimated 2,500 shipments per year. If 2,000 of these shipments were assumed to be NORM/TENORM waste, and if a single worker were exposed to all shipments, the annual unit concentration dose conversion factor would be 0.154 mrem/yr per pCi/g. The estimated bounding radiation dose for a ^{226}Ra plus decay chain progeny concentration of 400 pCi/g is about 62 mrem/yr. Derivation of the best-estimate radiation doses for this scenario considered that a worker could be exposed at most about 50% of the time, and that the average annual waste concentration would be 20% of the waste acceptance criteria upper limit, with a resulting dose of about 6.2 mrem/yr. Attachment B of this application provides the TSD-Dose input/output supporting this analysis.

Again, the bounding value is a conservative overestimate because not all of the waste received in a year at the Deer Trail facility would be NORM/TENORM waste at the maximum average concentration, and because one worker might not be exposed to all shipments.

- Deer Trail Workers – Workers Exposed to Waste in the Disposal Cell: Although there are several job descriptions associated with operations at the Deer Trail facility, those that would result in the highest potential radiation doses would be associated with work in the disposal cells. These individuals would have the closest proximity to the waste for the longest duration. Most of the activities are associated with positioning the waste in the cell and applying daily cover materials with heavy equipment. Because of the presence of hazardous materials, RCRA Permit conditions require that these workers wear protective clothing to reduce skin contact and dust masks to reduce inhalation hazards, thereby reducing the inhalation hazard for NORM/TENORM waste.

  The TSD-Dose computer program (Pfingston et al. 1998) was first considered to evaluate doses to in-cell workers for this scenario. Although the purpose of the program is to represent a broad range of activities, it is largely based on handling drums of waste, not bulk waste as is the case for Deer Trail. The best representation in TSD-Dose for workers in a disposal cell is for "Operation 5 – Onsite Landfill." However, on closer inspection, these activities in TSD-Dose account only for unloading waste in a mixing

pit, adding stabilizers (i.e., fly ash), and trucking the processed waste to the cell. The user's manual indicates that: *The actual burial of the waste at the landfill is not included because of the amount of shielding (i.e., bulldozer and 8 in. of soil) between the worker and the source* (Pfingston et al. 1998, p. 9). This means that it is not possible to model this scenario accurately with TSD-Dose.

CHDT considered the RESRAD computer program (Yu et al. 2001) for this scenario for the external and inhalation pathways only. The default parameter values in RESRAD are consistent with those recommended by the EPA in its *Exposure Factor Handbook* (1997) for conducting environmental risk assessments. The RESRAD program was developed by the U.S. Department of Energy to support the evaluation of radiation doses and risks from **RES**idual **RAD**ioactive materials in soil at sites undergoing remediation. This program has undergone extensive review, benchmarking, verification, and validation. It has been widely used by the NRC, EPA, U.S. Army Corps of Engineers, industrial firms, universities, and foreign government agencies and institutions.

For this scenario, two RESRAD computer runs were performed and the results were summed. The first was an analysis of external exposure, and the second was an analysis of inhalation exposure. As a bounding case, the external exposure analysis assumed that the worker would be in the cell 1,000 hr/yr, including other job activities, time spent hauling clean cover material, and time to change into and out of protective clothing. To account for shielding provided by the heavy equipment and the daily cover of soil, it further assumed that the waste would be shielded by soil equivalent to a depth of 18 cm (7 in.). This assumption accounts for an equivalent thickness of steel from the heavy equipment of about 1 cm (modeled as 16 cm of soil) with an additional margin of about 2 cm of soil to account for the daily soil cover. The analysis further assumed that source geometry has a surface area of 500 m^2 to a depth of 1.5 m (i.e., infinite slab source geometry).

A separate RESRAD analysis used an air concentration of 0.01 mg/m^3 of air at the default inhalation rate without correction for respiratory protection or particle size. This analysis was required because the soil cover assumed in the external exposure analysis

effectively covered the waste resulting in no airborne material, so there was no inhalation dose. This is a conservative approach to inhalation dose because the workers wear dust masks or are in air-conditioned cabs that would limit the potential for inhalation, and because TENORM material could be associated with large-particle-sized material, which would reduce the inhalation hazard. Finally, for modeling purposes to determine potential bounding radionuclides in NORM/TENORM waste, unit concentrations of 1 pCi/g of the following radionuclides were used: ^{238}U + decay chain progeny, ^{234}U, ^{234}Th, ^{226}Ra + decay chain progeny, and ^{210}Po + decay chain progeny. These radionuclides and decay chains provide dose contributions for both the inhalation and external radiation exposure pathways.

Attachment B of this application provides the input/output from the RESRAD program that serves as the basis for this analysis. It is not necessary to modify the default parameters for pathways that were not considered (i.e., ground-water or agricultural pathway) because they do not contribute to external or inhalation doses. The maximum individual radiation dose results for the bounding analysis were dominated by external exposure from ^{226}Ra plus its progeny, with less than about 2% of the total dose from inhalation of all the radionuclides. The dose results for the bounding analysis were about 0.125 mrem/yr per pCi/g of ^{226}Ra. The estimated bounding radiation dose for a ^{226}Ra plus decay chain progeny concentration of 400 pCi/g is about 50 mrem/yr. The best-estimate individual dose for this scenario assumes that a worker could be exposed to waste 1,000 hr/yr with an average annual waste concentration 20% of the waste acceptance criteria upper limit, with a resulting dose of about 10 mrem/yr.

Again, the bounding analysis is conservative because it assumes that a single worker is exposed for 1,000 hr/yr to the peak concentrations of NORM/TENORM waste allowed under the waste acceptance criteria. In addition, both the bounding and best estimates for this scenario are based on modeling assumptions. The best way to relate waste concentration to worker dose is through personal dosimetry and workplace monitoring because measured data provide the most direct link between estimated exposure conditions and the actual radiation doses that result. Measured dose rate information is available from the Clean Harbors Buttonwillow RCRA Subtitle C facility about dose

rates workers could experience handling NORM/TENORM waste. The Buttonwillow facility consists of waste management units (WMUs) designed to receive specific types of hazardous waste. Buttonwillow is limited to receiving waste that is less than 2,000 pCi/g, with maximum ^{226}Ra content around 400 pCi/g, the same values requested in this license application. The most significant sources of waste received at the Buttonwillow facility are from geothermal and oilfield operations. Virtually all waste from California geothermal or oilfield operations contains NORM/TENORM radionuclides above background levels. Because of an awareness of potential radiation exposure concerns for facility workers, Clean Harbors has established a program to monitor radiation doses for key areas and workers at the facility using thermoluminescent dosimeters from Landauer® Inc., which are exchanged and read on a monthly basis. Although the Buttonwillow facility estimates that average waste concentrations are around 400 pCi/g of ^{226}Ra based on manifest records, most data collected from January 1999 through March 2003 are at levels that are indistinguishable from background. Even when accounting for the missed dose, which is about 1 mrem per month, the estimated average annual doses to facility workers, about 12 mrem/yr, are well within the 100-mrem/yr limit for members of the public in California. This estimate, based on real measurements, is consistent with the best-estimate dose to cell workers discussed above.

There are several likely reasons for these small measured doses:

1. The manifest values typically conservatively report peak concentrations, not average concentrations across a shipment, to not underestimate the concentrations encountered.

2. The waste provides significant self-shielding because it is handled in bulk form.

3. Most operations (i.e., weighing and sampling) are of short duration for bulk operations compared to operations involving drums or other containers.

4. Most operations are rather remote from the waste (i.e., outside a dump truck or a roll-off container).

5. Operations involving heavy equipment provide at least 1 cm of steel shielding, thereby reducing dose rates to operators.

6. Clean cover materials of about 10 cm are applied to disposed waste, which provides additional shielding for workers.

These data provide strong evidence that the real radiation doses to workers from bulk NORM/TENORM material handling and disposal tasks at a RCRA Subtitle C facility are well within the regulatory limits for members of the public, are consistent with the best-estimate dose analyses in this assessment, and are probably ALARA (i.e., nothing further should be done to reduce the annual doses).

- Doses to Individuals near Transport Containers: A simple, yet conservative, scenario is evaluated for two individuals: a hypothetical landfill worker, and a member of the offsite public who might be exposed to trucks or containers of waste. For these individuals, a conservative assumption is that they could be 1 m from a truck or container of waste. External exposure to penetrating radiation (photons and x rays) from the waste material would be the only exposure pathway for this scenario because workers or members of the public would not come into direct contact with the waste. The modeling of dose rates from the waste container used the MicroShield® computer code (Grove Engineering 1998). The industry-accepted MicroShield® code estimates radiation doses for various source/shield/receptor geometries. For this analysis, the waste truck or container is assumed to have dimensions of 2.2 × 5.6 × 1 m (7.2 × 18.4 × 3.3 ft), consistent with typical waste boxes used at Deer Trail. The analysis considered 0.32 cm (0.125 in.) of steel shielding to account for the side of the truck or waste container. The waste density was set at 1.4 g/cm^3, or the approximate density of soil. The analysis was conducted for ^{226}Ra and four shorter-lived, photon-emitting progeny: ^{214}Pb, ^{210}Pb, ^{214}Bi, and ^{210}Bi. As shown in Attachment B of this application, the modeling results are 2.76×10^{-4} mR/hr (or 0.276 μR/hr) per pCi/g of ^{226}Ra in the waste.

  The bounding estimated radiation dose for a Deer Trail worker assuming a waste concentration of ^{226}Ra plus decay chain progeny of 400 pCi/g for 25% of a work year

(i.e., 500 hr/yr of exposure) is about 55 mrem/yr. The best-estimate individual dose to a worker for this scenario assumes a worker could be exposed at most about 10% of a work year (i.e., 200 hr/yr of exposure), and the average annual waste concentration would be 20% of the waste acceptance criteria upper limit, with a resulting dose of about 4.4 mrem/yr.

Again, the bounding estimate is an extremely conservative estimate because it is unrealistic to assume an individual would spend a large fraction of the work year in proximity to a waste truck or container, and that the average container would contain the maximum concentration of NORM/TENORM radionuclides.

The second individual considered in this analysis is a member of the public who could be exposed to a waste container during transport. The estimated bounding radiation dose to this individual is found by assuming a concentration of ^{226}Ra plus decay chain progeny of 400 pCi/g, with 20 hr/yr of exposure. The bounding dose estimate is about 2.2 mrem/yr. The best-estimate individual dose to a member of the public for this scenario assumes that an individual could be exposed at most about 5 hr/yr, and that the average annual waste concentration would be about 20% of the waste acceptance criteria upper limit, with a resulting dose of about 0.1 mrem/yr.

The bounding estimate is overly conservative because it is unlikely that an individual could spend 20 hr/yr near trucks in transit to Deer Trail, and that the average container would have a concentration at the maximum allowed by the waste acceptance criteria.

- Doses to Nearby Residents During Operation: A conservative analysis of the potential for doses to nearby residents during operation of the Deer Trail facility uses the screening models for release of radionuclides to the atmosphere provided by the National Council on Radiation Protection and Measurements (NCRP 1996). The NCRP objective is to provide conservative models and methods to demonstrate compliance with environmental standards. For atmospheric releases, the analysis considers active releases over 30 years, with exposure occurring in the last year of the release period. This accounts for potential buildup of radionuclides in soil from long-term operations. At Deer Trail, the active release would be blowing dust during

periods when the waste is exposed to air (i.e., before the daily cover is in place). The bounding analysis assumes that the active release is continuous (i.e., 24 hours per day, 365 days per year) with an active air concentration of 0.01 mg/m^3 of air. The exposure pathways included from the NCRP screening model are inhalation and exposure to material deposited on the ground surface. The screening models are based on conservative atmospheric (i.e., neutral) conditions, a ground-level release (i.e., no plume rise), with transport over flat terrain. The receptor is assumed to be 1 km from the facility, much closer than the actual nearest resident. The resulting bounding doses are 19 mrem/yr from ^{238}U plus decay chain radionuclides (at a concentration of 2,000 pCi/g), and 6 mrem/yr from ^{226}Ra plus decay chain radionuclides (at a concentration of 400 pCi/g), for a total dose of 25 mrem/yr for both radionuclides and their associated decay chains. For this scenario, the best-estimate individual radiation dose is found by accounting only for exposure of the waste for 2,000 hr/yr (rather than 8,760 hr/yr) and assuming waste concentrations are on average 20% of the maximum concentrations in the waste acceptance criteria. The best-estimate, yet still conservative, doses are about 1 mrem/yr.

This bounding estimate is an overestimate for several reasons including (1) the design of the NCRP screening model to not underestimate potential doses to determine when more detailed analysis may be warranted, (2) continuous 24-hr/yr releases (not accounting for periods when the daily cover material is in place), and (3) release of material at the maximum concentrations in the waste acceptance criteria.

- Doses to Nearby Residents After Closure: As described in Section 1.0, the Deer Trail facility will be closed consistent with the RCRA environmental regulations. The relevant regulation for closure and postclosure of the Deer Trail facility is in 40 CFR Part 264.117 (2002), *Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities,* Subpart G – *Closure and Post-Closure.* This regulation is included in the Colorado Code of Regulations, 1007-3, Section 264.117, and specifically in §264.117(c) and 6 CCR 1007-3 §264.11:

> *Post-closure use of property on or in which hazardous wastes remain after partial or final closure must never be allowed to disturb the integrity of the final cover, liner(s), or any other components of the containment system, or the function of the facility's monitoring systems...*

Although the RCRA regulations prohibit trespass on the site and human intrusion into the waste, the site resident scenario, an individual who constructs a house on top of the closure cap is defined to serve as a bounding estimate of future doses and risks to nearby residents. This group of individuals could be those who would be the most exposed to radioactive material following closure of the Deer Trail facility; this is termed the "critical group" of individuals for expected postclosure performance. The purpose of the site resident scenario is to consider individuals who might reside directly over the buried waste without disturbing the disposal system. Although this scenario could occur at any time, this analysis is for 100 years in the future. The analysis time of 100 years provides a conservative basis for the undisturbed performance evaluation because the attenuating effects of radioactive decay and migration of radionuclides deeper in the WMU from the surface should be minimal. To provide a conservative estimate of potential radiation doses, the analysis assumed that the entire waste cell is filled with a unit concentration of each radionuclide in the NORM/TENORM waste. This scenario considers the lifestyle and potential radiation exposure pathways associated with residential farming activities. The pathways considered for this scenario include direct exposure to external radiation, inhalation, ingestion of soil, and ingestion of plant and animal food products raised on the site. As a bounding estimate, the scenario assumed that this individual raised the entire diet of fruit, vegetables, and animal products (milk, meat, and eggs). It assumed no access to well water for household uses or irrigation because drilling a well would require intrusion into the waste. This scenario was evaluated using the RESRAD program (Yu et al. 2001) with default parameters and assumptions. The default parameter values are consistent with those recommended by the EPA in its *Exposure Factor Handbook* (1997) for conducting environmental risk assessments. Table 6.3 summarizes the RESRAD exposure pathway parameters considered for this scenario.

Table 6.3. Exposure Pathway Parameters Considered for the Site Resident Scenario.

	Factor/Units
General – All Pathways	
Cover Depth	1.0 m
Area of Contaminated Zone	330,000 m^2
Depth of Contaminated Zone	10 m
Food Product Ingestion:	
Plant Foods – Fruits, Vegetables, and Grain	160 kg/yr
Plant Foods – Leafy Vegetables	14 kg/yr
Meat and Poultry	63 kg/yr
Milk	92 L/yr
Soil Ingestion	
Soil Ingestion Rate	36 g/yr
Inhalation	
Airborne Dust Concentration (Mass Loading Factor)	1.0×10^{-4} g/m^3
Inhalation Rate	8.4×10^3 m^3/yr
Shielding Factor (Indoor)	0.4
External	
Shielding Factor (Indoor)	0.7
Fraction of Time Spent Indoors	0.5
Fraction of Time Spent Outdoors	0.25
Fraction of Time Offsite	0.25

The only pathway contributing to the total radiation dose was external exposure to penetrating radiation. However, because of the presence of the layered closure system with roughly a 1-m (about 4-ft) layer of compacted clay and surface soil, the resulting radiation doses are quite small: 2.3×10^{-5} mrem/yr per pCi/g. For the bounding case, the concentration of waste is assumed to be at the maximum concentration defined by the waste acceptance criteria, 400 pCi/g ^{226}Ra; the individual dose is about 4.6×10^{-2} mrem/yr.

Because the doses are small, the lifetime risks are at the lower end of the risk range considered by the EPA for CERCLA cleanup (i.e., an individual lifetime cancer mortality risk of one in a million).

The best-estimate evaluation for this scenario assumes that the nearby resident is not directly over the closed cell. In this case the doses are further reduced because of shielding and extra distance to the source of radiation, and would approach zero. Attachment B of this application provides the RESRAD input/output.

- Waterborne Releases to Surface Water: The location of the Deer Trail facility at the top of a knoll promotes the drainage of surface water away from disposal cells. In addition, surface drainage features are used during and after operation to direct and contain the flow of storm water runoff and improve the quality of surface water. Several systems are used to manage precipitation runoff from inactive areas, operations areas, and the active landfill cells. These systems include storm water drainage channels (to intercept upslope runoff and rout the water around the facility, drop structures to reduce channel slopes and reduce flow velocity to reduce potential erosion, culverts to divert storm water, a segregated storm water retention basin to receive segregated runoff, and erosion control structures to divert or reduce total upslope runoff. The hydrologic design of these systems is based on rainfall events defined in the RCRA Permit process because snowmelt events at this site produce lower peak runoff. Because the waste disposed in a cell is covered daily, storm water systems minimize contact with the waste, precipitation is relatively low, and there are no flowing streams in the nearby vicinity of the facility, no analysis is conducted for waterborne releases to surface waters **(BFI 1981 and 1982 – see Volumes 2 and 3, respectively, of this application)**.

- Waterborne Releases from Disposal Cells: Several design features have been included to prevent the contact of waste with standing water. These include a leachate collection and treatment system. The leachate collection system removes water that might percolate through the waste, thereby preventing it from contact with surface or ground water. The system at the base of each disposal cell consists of a 1-foot-thick, multicomponent, high-permeability layer; 8-inch-diameter drainage pipes; and a 24-inch-diameter collection sump pipe. Because the waste disposed of in a cell is covered daily, storm water systems minimize contact with the waste, precipitation is relatively low, the leachate collection system removes water from the trench before it can contact ground or surface water, and there are no flowing streams in the nearby vicinity of the facility, there was no analysis for waterborne releases from the disposal cells to surface waters **(BFI 1981 and 1982 – see Volumes 2 and 3, respectively, of this application)**.

- Radionuclide Leaching and Migration – Drinking Water: During the site evaluation phase for the Deer Trail landfill, the hydrogeologic analysis demonstrated more than 10,000 years of containment for all the waste. Geotechnical evaluations have found that the site is underlain by no aquifers, apart from unusable, ancient groundwater perched at a depth of 4,000 feet. The site is underlain with Pierre Shale with a natural permeability of 1×10^{-7} (Colorado GeoLogic, Inc. 1986). Therefore, there will be no future ground-water protection issues associated with disposal of NORM/TENORM materials at the Deer Trail landfill. This conclusion is consistent with previous analyses used in the initial permit process for Deer Trail.

- Releases Through Biotic Pathways: Biotic transport pathways have been identified as an historical and potential future release mechanism for low-level radioactive waste disposal sites (Kennedy, Caldwell, and McKenzie 1985). To minimize potential impacts of biotic pathways, special provisions have been made in the closure system design for RCRA facilities. After closure, a cap will be placed over the waste to enable drainage of precipitation away from cells and to limit biotic intrusion. This cap will include layers of soil and geotextiles, with a graded slope to improve drainage away from the waste. The cap is a multilayer system that includes topsoil (to support vegetation and reduce infiltrating water through evapotranspiration), 3 feet of general fill to protect underlying layers against frost, erosion, deep-rooted plants, and burrowing animals, a geocomposite drainage layer to direct water outward from the center of the cell to a surface drainage pipe, an 80-mil textured geomembrane that functions as a low-permeability barrier that further protects against biotic intrusion, and the interim soil cover of 0.5 foot of soil to serve as an operations base for the placement of the cover system. Because of these measures, there was no additional analysis for biotic release pathways.

6.1.4 Summary of Impacts and Regulatory Compliance

Table 6.4 summarizes individual dose impacts with a comparison against the performance objective dose limits in 6 CCR 1007-1, Radiation Control, Part 14: *Licensing Requirements for Land Disposal of Low-Level Radioactive Waste*. All estimated radiation doses, both bounding and best-estimate, are within the performance objectives cited for workers and members of the

Table 6.4. Estimated Impacts Analysis for the Deer Trail Facility from Normal Operations and Undisturbed Closure (mrem/yr).[a]

Exposure Scenario	Performance Objective	Bounding Analysis	Best-estimate Analysis
Deer Trail Workers - Truck Drivers Hauling Waste	100	48	3
Deer Trail Landfill Workers – Waste Receipt and Sampling	100	62	6.2
Deer Trail Landfill Workers – Workers Exposed to Waste in the Disposal Cell	100	50	10
Doses to Individuals Near Transport Containers – Deer Trail Workers	100	55	4.4
Doses to Individuals Near Transport Containers – Members of the Public	25	2.2	0.1
Doses to Nearby Residents During Operation	25	25	1
Doses to Nearby Residents – Post Closure	25	0.046	~0
Waterborne Releases to Surface Water	25	N/A	N/A
Waterborne Releases from Disposal Cells	25	N/A	N/A
Radionuclide Leaching and Migration – Drinking Water	25	N/A	N/A
Release Through Biotic Pathways	25	N/A	N/A

a. All Performance Objectives are reduced through application of the ALARA process.

general public. The best-estimate values reflect expected conditions and provide assurance that doses can be maintained ALARA. Further, as mentioned in Section 6.1.3 for the Deer Trail worker scenario for exposure to waste in the disposal cell, the best way to relate waste concentration to worker dose is through personal dosimetry and workplace monitoring because measured data provide the most direct link between estimated exposure conditions and the actual radiation doses that result. Historical measured dose rate information from the Clean Harbors Buttonwillow RCRA Subtitle C facility provides a good source of information about dose rates that workers might experience when handling TENORM waste. The Buttonwillow facility consists of WMUs designed to receive specific types of hazardous waste. Buttonwillow is limited to receiving waste that is less than 2,000 pCi/g, with an average ^{226}Ra content reported to be around 400 pCi/g, the same values requested in this license application. Even when accounting for the missed dose, which is about 1 mrem per month, the estimated average annual doses to the facility workers, about 12 mrem/yr, are well within the 100-mrem/yr limit for members of the public in California. In summary, this radiological safety assessment provides reasonable assurance that CHDT can operate the facility safely to receive limited concentrations of NORM/TENORM waste in bulk form, consistent with the RCRA Permit.

6.2 INTRUDER PROTECTION

The NRC guidance requires that the applicant provide information on intruder protection measures that would be used to prevent an intruder from coming into contact with Class C waste

after the institutional control period (NRC 1991). A strict reading of this guidance would indicate that such information is not required for this application because the Deer Trail facility will not accept Class C low-level radioactive waste. The low-level radioactive waste classification system was developed to prevent excessive doses to human intruders, and the waste acceptance criteria proposed in this application are a small fraction of the Class A disposal limits for the identified radionuclides. This means that intruder doses should be well within the public dose limits and be acceptably low. Further, RCRA does not require analysis of potential health risks associated with intrusion into disposed hazardous waste. What is required is a cell closure system (i.e., a multilayered cap) for long-term stability that will reduce infiltration and help protect against biotic and human intrusion. No further intruder analysis is necessary for this application.

6.3 LONG-TERM STABILITY

As discussed in Section 3.2, the selected design criteria will ensure that the principal design features provide long-term isolation of disposed waste under normal, abnormal, and accident conditions. These criteria address features to minimize the need for long-term care (active maintenance) and improve the site's natural characteristics to protect public health and safety. The discussion in Section 3.2 references information developed to obtain the Certificate of Designation, and is included in two key references **(BFI 1981 and 1982 – see Volumes 2 and 3, respectively, of this application)**. In summary, these analyses considered water infiltration into the disposal cells, evaluation of disposal cell cover integrity, maximum earthquake ground motions, contact with standing water, and site drainage among other topics. The conclusions reached in the RCRA siting and permit process confirmed the adequacy of the site and engineered systems to provide long-term stability.

6.4 REFERENCES CITED

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Yu, C., A. J. Zielen, J. J. Cheng, D. J. LePoire, E. Gnanapragasam, S. Kamboj, J. Arnish, A. Wallo, III, W. A. Williams, and H. Peterson. 2001. *User's Manual for RESRAD Version 6.* ANL/EAD-4, Argonne National Laboratory, Argonne, Illinois.

7.0 OCCUPATIONAL RADIATION PROTECTION

The Clean Harbors Deer Trail (CHDT) Naturally Occurring Radioactive Material (NORM)/ Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) Radiation Protection Program establishes necessary precautions, procedures, and plans for working directly with NORM/TENORM waste during disposal operations. Existing protective measures for hazardous materials are generally suitable for protection from the levels of radiation found in NORM/TENORM waste. Every employee who works with and around ionizing radiation from NORM/TENORM waste must follow the plan and supporting policies and Standard Operating Procedures (SOPs). The Deer Trail Radiation Safety Officer (RSO) or his/her designee is responsible for ensuring that all employees have read, understand, and comply with the procedures and conditions in the Radiation Protection Plan. No Deer Trail employee will be allowed to work unsupervised with NORM/TENORM waste until they complete appropriate radiation safety training. The RSO or his/her designee will maintain a file containing signature sheets acknowledging that all new employees have received the appropriate radiation safety training within 10 days of employment. The facility will accept no other types or forms of radioactive material for disposal beyond NORM/TENORM materials and other radioactive materials that have been exempted, excluded, or cleared for unrestricted use by the public by Federal or State of Colorado agencies.

For exposure to NORM/TENORM waste, Deer Trail workers will be considered members of the public, and radiation exposures will be limited to no more than 100 mrem/yr, with a goal of 25 mrem/yr or less. The ALARA (As Low As Reasonably Achievable) process will be applied to limit potential radiation doses. If worker dosimetry results determine that selected worker doses could exceed 25 mrem/yr, an assessment of the potential for other manmade exposures for these workers will occur to ensure that maximum individual doses from manmade sources will not exceed 100 mrem/yr. This assessment will consider real individuals working at Deer Trail, not hypothetical members of the public.

As stated in the Deer Trail Resource Conservation and Recovery Act (RCRA) permit, waste acceptance criteria are set at 400 pCi/g of ^{226}Ra, measured on a per-shipment basis. The total activity of NORM/TENORM waste, including the alpha- and beta-emitting radionuclides in the uranium and thorium decay chains, will be enforced to the limit of 0.002 µCi/g (2,000 pCi/g)

used to define radioactive waste in Colorado (C.R.S. § 25-11-201), as long as the radium concentration limit of 400 pCi/g per shipment is maintained. If applied as a peak value for setting gate monitor alarms, the average concentrations received will be less (probably about 10% of the peak concentration) and, therefore, average doses to workers will be also be less (probably about 10 mrem/yr), consistent with ALARA. This limit is equated to a gate monitor alarm setpoint of 100 μR/h above background. Because that background is about 16 μR/h, the alarm setpoint is 116 μR/h. The alarm setpoint, which is about seven times the background level, will permit the detection of lost radiation sources in a waste shipment. Any waste that exceeds the alarm setpoint will be evaluated against the manifest and rejected. The Radiation Protection Program has been tailored to fit the type of NORM/ TENORM waste to be accepted, at low concentrations and dose rates, with application of the public dose limits to Deer Trail workers.

7.1 OCCUPATIONAL RADIATION EXPOSURES

The Radiation Protection Program at the CHDT RCRA landfill is designed to protect employees, the public, and the environment from the harmful effects of exposure to ionizing radiation from NORM/TENORM waste disposed of in accordance with its waste acceptance criteria. CHDT policy is to meet all applicable regulatory requirements imposed by the State and the Federal Government and to keep doses from NORM/TENORM material ALARA.

The Radiation Protection Program provides the following:

- Personal instruction in radiation safety from radiation safety staff and field supervisors,
- Relevant manuals, installation and test instructions, and SOPs for equipment and activities at the landfill,
- Radiation safety seminars,
- A personal monitoring system, as required (thermoluminescent dosimeters [TLDs]),
- Gate monitors, radiation monitors, air sampling, and portable radiation survey meters when required, and

- A Radiation Protection Program Plan.

The Radiation Protection Plan and supporting SOPs have been approved by the CHDT Corporate Staff and facility General Manager, and are included in Attachment A of this application. Although the RCRA Permit requires numerous SOPs, those specifically pertaining to safe handling and disposal of NORM/TENORM waste include:

- Standard Operating Procedure on Individual and Area Dosimetry
- Standard Operating Procedure on Airborne Monitoring
- Standard Operating Procedure on Estimating Inhalation Doses
- Standard Operating Procedure on Radiation Surveys
- Standard Operating Procedure on Use of the Gate Monitoring System
- Standard Operating Procedure on Radiation Safety Training
- Standard Operating Procedure on Radiation Records

The Deer Trail RCRA Permit Attachment 4, "Contingency Plan" **(CHDT 2004 – see Volume 4 of this application)**[8] contains general procedures for dealing with emergency situations such as spills or accidents. The Contingency Plan contains procedures for spill cleanup, notification of authorities, and other responses. It describes the equipment and staff available to deal with such situations. In the event of a radiological incident, such as a spill of NORM/TENORM waste, or another emergency potentially involving NORM/TENORM waste, the RSO and Deer Trail General Manager must be notified immediately. If there is doubt about whether such notification is necessary, notification should be made to enable the RSO and Deer Trail General Manager to assess the situation and initiate the appropriate response. If appropriate, the measures in the Contingency Plan will be implemented.

7.2 RADIATION SOURCES

This radioactive waste disposal license application allows for transfer of a specific and limited type of licensed radioactive material to CHDT for disposal. This application applies only to radioactive material consistent with the radionuclides in NORM/TENORM waste, with concentrations that are less than the Colorado statutory definition of radioactive waste.

[8] For ease of review, references in **bold** are provided in Volumes 2 through 6 of this application.

However, because of waste-specific regulatory determinations, some of this waste might be licensed, requiring disposal in a licensed facility. The limited concentrations considered in this application comprise a total activity of less than 2,000 pCi/g (natural uranium and thorium decay chain products only), with a maximum ^{226}Ra concentration less than 400 pCi/g. These materials will have external dose rates that are generally less than 100 μR/h, exclusive of background. This application does not include radioactive waste in the broader definition of low-level radioactive waste, including other licensed forms of manmade radioactive materials.

7.3 RADIATION PROTECTION DESIGN FEATURES

Several design features of the Deer Trail facility ensure or enhance environmental or occupational radiation protection. However, most of the principal radiation protection design features described in Section 3.0 are largely mandated through the RCRA Permit process and are specific to meeting RCRA requirements. For environmental radiation protection, these include:

- Minimizing the infiltration of water into the disposal cells through proper closure design,
- Ensuring the integrity of disposal unit covers through engineering design and regulation,
- Providing structural stability of the disposal system through receipt and compaction of bulk waste,
- Minimizing contact of waste with standing water through contouring surface site features and operation of the Leachate Collection System,
- Providing adequate site drainage during operations and after closure,
- Facilitating site closure and stabilization,
- Minimizing the need for long-term maintenance,
- Providing adequate disposal site monitoring, and
- Providing an adequate buffer zone for monitoring and potential mitigative action.

Additional design features and operating procedures for the Deer Trail facility required by the RCRA Permit provide radiation protection functions for workers. These features, which are described in Sections 3.0 and 4.0, include:

- Shielding. Two primary sources of shielding are provided for routine operations: the steel roll-off boxes used to transport bulk waste and the daily soil cover required by the RCRA Permit. In addition, operational procedures ensure that the minimum number of workers will be in proximity to waste (i.e., waste sampling and in-cell disposal operations). Other workers, such as heavy equipment operators, have additional shielding provided by the steel construction of the equipment.

- Protective Clothing and Respiratory Protection. The RCRA Permit requires that workers in proximity to waste wear protective clothing and respiratory protection, as described in Section 4. The use of protective clothing reduces skin contact with the waste and is an effective contamination control measure. The use of respiratory protection reduces the potential for inhalation exposures for workers during in-cell operations.

- Bulk Disposal. Receipt, sampling, and disposal operations for bulk wastes minimize contact times and potential exposure durations for workers. This is an effective ALARA measure because it minimizes the number of workers who could be exposed to NORM/ TENORM waste (compared to handling containerized waste), and because it minimizes exposure durations (through rapid unloading in the disposal cell).

Section 6.0 contains a summary of individual dose impacts with a comparison against the performance objective dose limits in 6 CCR 1007-1, Radiation Control, Part 14: *Licensing Requirements for Land Disposal of Low-Level Radioactive Waste*. All estimated radiation doses, bounding and best-estimate, are within the performance objectives cited for workers and members of the general public. The best-estimate values reflect expected conditions and provide assurance that doses can be maintained ALARA.

7.4 RADIATION PROTECTION PROGRAM

Attachment A of this application contains the Radiation Protection Program and the radiation protection SOPs. Section 1.4 describes the Company organizational structure. The responsibilities for maintaining radiation safety at the Deer Trail landfill are assigned to the RSO or his/her designee and Deer Trail employees. The duties and responsibilities of these individuals are described below.

7.4.1 Radiation Safety Officer

The RSO or his/her designee directs the Company Radiation Protection Program and is responsible for surveillance of all operations involving NORM/TENORM material. Specifically, the RSO will:

1. Be empowered to impose conditions of work, restrictions on work, and termination of work involving NORM/TENORM waste as necessary to protect personnel, the public, or the environment or to ensure regulatory compliance;

2. Review the NORM/TENORM protection program at least annually;

3. Serve as the Company point of contact with State and Federal regulatory agencies on all matters related to radiation safety;

4. Maintain a personnel dosimetry program, including evaluation of the need for issuance of dosimetry; maintain a contract for commercial dosimetry services; maintain dose records; and provide reports to individuals consistent with 6 CCR 1007-1, § 4.56 (Reports of Individual Monitoring);

5. Maintain radiation protection records including approved procedures, amendments, revisions and renewals consistent with 6 CCR 1007-1, § 4.40, 4.41, 4.42, 4.44, 4.47, and 4.50;

6. Provide radiation safety training for Company personnel;

7. Provide information and consultation on matters related to radiation safety.

7.4.2 Deer Trail Employees

Each CHDT employee who works with NORM/TENORM material must take responsibility for their own protection and for reporting any condition that, in the individual's opinion, constitutes unsafe or improper working conditions. Each individual is responsible for:

1. Maintaining their own exposures to radiation from NORM/TENORM materials ALARA,
2. Following procedures and accepted safe work practices so as not to endanger him or herself, the public, or the environment,
3. Reporting unsafe working conditions, violations of the rules prescribed in this document, or violations of applicable State regulations to their supervisor and/or the Deer Trail RSO, and
4. If serving as a visitor escort, pointing out any hazardous area that a visitor might be entering and ensure the observation of all Company radiation safety rules and precautions.

7.4.3 Key Standard Operating Procedures

Of the seven SOPs listed in Section 7.1 (included in Attachment A of this application), those on Individual and Area Radiation and Airborne Radioactivity Monitoring are key. These SOPs define general and specific methods and procedures for conducting operations at Deer Trail.

Individual dosimetry is required for all Deer Trail workers who could be exposed to radiation from NORM/TENORM waste and for identified areas in the landfill and the immediate area around the landfill. This dosimetry will determine individual worker doses from external radiation and background and ambient radiation levels. It is CHDT policy that individual and area dosimetry will verify maintenance of radiation doses to Deer Trail workers and members of the public at levels of 100 mrem/yr plus ALARA. The standard issue will be a TLD in a plastic case, consistent with the manufacturer's specifications and requirements. All Deer Trail workers in the proximity of radiation from NORM/TENORM waste as part of their routine employment will receive and wear an individual dosimeter. Dosimeters will be worn at the part on the body likely to receive the highest dose, consistent with manufacturer specifications (typically on the

chest area or between the waist and the neck). Lost or damaged dosimeters will be reported to the RSO or his/her designee as soon as possible. Persons who have lost or damaged their dosimeters will be required to provide documentation of work activities and NORM/TENORM exposures as necessary for the RSO or his/her designee to assess doses. Dosimeters will be issued only to personnel formally instructed in their use, and will be worn only by those to whom the dosimeters were issued.

As part of the area monitoring program, quarterly dose rates will be measured in specific areas of the Deer Trail facility, using special-issue individual dosimeters in locations where:

- Workers are routinely in the proximity of NORM/TENORM waste such as the weigh station and disposal cell,
- It is unlikely that NORM/TENORM waste would be present such as the change room, lunch room, and maintenance areas to confirm contamination control, and
- Ambient background can be recorded without contribution from NORM/TENORM waste.

Inhalation radiation doses for workers exposed to airborne concentrations of NORM/TENORM waste will determine potential internal doses to landfill workers, and will be reported as part of the annual total committed effective dose equivalent to facility workers. It is CHDT policy to estimate inhalation doses to workers to verify that annual total committed effective dose equivalents are maintained below 100 mrem/yr. Radiation doses to workers will be maintained ALARA below this level. Airborne concentrations and NORM/TENORM waste radionuclide distributions will be established on a quarterly basis from the air sampling program, consistent with the SOP on Air Sampling (Attachment A of this application). The quarterly data will be specific to work location and will include background ambient concentrations to enable determination of localized net airborne concentrations of NORM/TENORM waste (i.e., background corrected concentrations).

Because air samplers provide the total activity on a sample (in pCi) by radionuclide, the average background corrected air concentration is found by dividing the net activity on the sample by the volume of air passing through the sampler to produce the average pCi/m^3 in air. The volume of

air passing through the sampler is the product of the rate of airflow (m^3/hr) times the number of hours the sampler is in operation. This average value could underestimate workplace concentrations during receipt and disposal of NORM/TENORM waste because it includes lower air concentrations during periods of RCRA waste (i.e., non-NORM/TENORM waste) disposal, periods when the daily cover is in place and there is no possibility for airborne NORM/ TENORM material, and off-hour periods when no workers are present.

To correct for this potential underestimate of air concentration, the RSO or his designee will estimate the potential number of hours during the quarter that might pose an airborne hazard for NORM/TENORM waste. The airborne concentration during waste disposal operations is found by dividing the sample activity for each radionuclide by the volume of air passing through the sampler for the estimated number of hours of airborne NORM/TENORM hazard. This is expressed by the following equation:

$$C_{a,i} = [S_{a,i}]/[V_{a,T} \times T]$$

where:

$C_{a,I}$ = Corrected airborne concentration of radionuclide i (pCi/m^3),
$S_{a,I}$ = Sample activity for radionuclide i (pCi),
$V_{a,T}$ = Volume airflow rate for the sampler (m^3/h), and
T = Duration of worker airborne exposure to NORM/TENORM hazard (h).

Once the estimated radionuclide mixtures and airborne contamination levels are established, individual worker intake by inhalation can be estimated. The intake by inhalation of a radionuclide i (I_i) is estimated using:

$$I_i = [T_w] \times [\text{Breathing Rate}] \times [C_{a,i}]$$

For each worker potentially exposed to airborne NORM/TENORM waste, an estimate will be made of the amount of time they spend in a specific work location (T_w). Based on information provided in Publication 66 of the International Commission on Radiation Protection (ICRP 1993), the adult male breathing rate during light exercise is 1.5 m^3/hr. The estimated intake will account for time spent away from potential airborne NORM/TENORM waste, for example time

conducting routine maintenance in unaffected areas, in training, or conducting offsite activities. If a worker could have onsite exposures of different concentrations at many airborne NORM/ TENORM locations, the highest measured airborne waste concentration will be used in estimating individual radionuclide intakes.

Quarterly radiation doses to workers (committed effective dose equivalents) will be estimated using the following equation:

$$H_{E,50} = \Sigma_i \Sigma W_t H_{T,50,i}$$

where:

$H_{E,50}$ = The sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to each of these organs or tissues,

Wt = Weighting factors for each specific bodily tissue or organ, and

$H_{T,50,I}$ = Committed effective dose equivalent for radionuclide i (mrem).

The committed effective dose equivalent for radionuclide i ($H_{T,50,i}$) is found by multiplying the intake of each radionuclide (I_i) by the unit intake committed dose conversion factor for each radionuclide and tissue or organ ($DCF_{T,i}$), as shown in the following equation:

$$H_{T,50,i} = (I_i) \times (DCF_{T,i})$$

To streamline the process, and for consistency with the doses recorded by the external dosimetry program, unit intake effective dose coefficients, $DCF_{E,i}$ (i.e., $\Sigma_T DCF_{T,i}$) have been tabulated by the U.S. Environmental Protection Agency (EPA). Modifying the above equations to account for the use of unit intake effective dose coefficients is shown in the following equation:

$$H_{E,50} = ([T_w] \times [\text{Breathing Rate}]) \Sigma_i ([C_{a,i}] \times (DCF_{E,i})$$

The unit intake effective dose coefficients are based on Federal Guidance Report No. 11 (Eckerman et al. 1988) for the NORM/TENORM waste radionuclides of concern. These values are the most conservative (highest) across all solubility classes considered by the EPA.

The Deer Trail RCRA Permit requires the use of respiratory protection for all activities when workers are in proximity to the waste. These activities include sampling, treatment (when required), and in-cell disposal. Full-facepiece, air-purifying respirators are used for these activities. Consistent with 6 CCR 1007-1, § 4.24 and Part 4 - Appendix A, a respiratory protection factor of 50 will be applied to all appropriate work when the use of respirators is mandatory.

7.5 REFERENCES CITED

6 CCR 1007-1 Radiation Control, § 4.24 and Part 4 - Appendix A

Clean Harbors Deer Trail (CHDT). 2004. ***Permit Renewal Report for Incorporation of a Geosynthetic Clay Liner (GCL) in the Liner Section for Secure Cells 3 Through 7 and in the Cover Section for Secure Cells 1 Through 7 (*****the Permit Renewal Report – Provided in Volume 4 of this Application.**

C.R.S. Title 25, Article 11, *Radiation Control*, Part 2, *Radioactive Waste Disposal,* § 201, *Definitions.*

Eckerman, K. F., A. B. Wolbarst, and A. C. B. Richardson. 1988. *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion.* Federal Guidance Report No. 11, EPA-520/1-88-020, U.S. Environmental Protection Agency, Washington, D.C.

International Commission on Radiation Protection (ICRP). 1993. *Human Respiratory Track Model for Radiological Protection.* ICRP Publication 66, Annals of the ICRP, Vol. 23, Nos. 1-3.

8.0 CONDUCT OF OPERATIONS

The Deer Trail facility is a Resource Conservation and Recovery Act (RCRA) Subtitle C landfill and is fully permitted to treat, store, and dispose of a wide variety of regulated materials including RCRA hazardous waste, reactive wastes (cyanides, sulfates), oxidizers, micro-encapsulation waste, and nonregulated materials. As described in Section 3.0, this facility has the capability to store, treat, and dispose of these wastes in bulk form.

Clean Harbors owns and operates more than 50 waste management facilities in the United States and Canada that offer options including incineration, landfill, fuels blending, lab chemical disposal, explosives management, waste water treatment, PCB disposal, and recycling. The philosophy associated with such operations must include the deliberate application of controls and methods to ensure safe, compliant, and productive operation of the facility or activity. Conduct of Operations, sometimes referred to as "formality of operations," is the application of that philosophy. The proper application of the associated principles ensures safe operation that yields quality results.

Operating facilities employ varying degrees of formality when implementing Conduct of Operations guidelines. These can range from operations checklists to formal and detailed procedures for each significant activity; and represent the concept of "graded approach." Clean Harbors Deer Trail (CHDT) has determined the level of rigor needed based on various attributes of operations, such as regulatory compliance under RCRA, complexity of operations, consequences of improper execution, relevance to safety and health, and other risks associated with operations. The Deer Trail Permit Renewal Report **(CHDT 2004 – see Volumes 4 and 5 of this Application)**[1] contains additional details related to Conduct of Operations. The following sections describe CHDT waste management activities and experience related to Conduct of Operations.

8.1 ORGANIZATIONAL STRUCTURE

Clean Harbors currently operates the Deer Trail facility for the treatment, storage, handling, and disposal of hazardous waste. The State of Colorado has permitted the facility, which has been in full operation since the early 1990s, for these activities. The preoperational phase as it relates to

[1] For ease of review, references in **bold** are in Volumes 2 through 6.

this application will consist of efforts by Clean Harbors to implement modifications to existing procedures and staff to enable the safe acceptance and disposal of Naturally Occurring Radioactive Material (NORM)/Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) waste. The Clean Harbors organizational structure is essentially in place at the facility and corporate level. Figures 8.1 and 8.2 show the Clean Harbors Corporate Organization and the Clean Harbors U.S. operations organization, respectively.[2] In the Clean Harbors organization, three divisions provide corporate oversight for Environmental Compliance (Figure 8.3), Health and Safety (Figure 8.4), and Training and Consulting (Figure 8.5). The Clean Harbors staff has the experience and expertise to perform most required activities. Outside consultants and contractors supplement internal resources by supplying capabilities that are not available internally. These outside technical experts are under the direction and supervision of experienced CHDT personnel.

The previous sections of this application provide technical and operational information on Deer Trail facility design and construction, operations, site closure, radiological safety, and occupational radiation protection. Sections 9.0 and 10.0 contain more information on Quality Assurance and Financial Assurance, respectively.

The General Manager of the Deer Trail facility, Jack Kehoe, has the overall day-to-day management responsibility for operations. The Facility General Manager or his/her designee has the responsibility for safety program implementation, including the radiological safety program. The CHDT Radiation Safety Officer (RSO), Charles Smith, has the responsibility to ensure that all employees have read, understand, and comply with the procedures and conditions defined in the Radiation Protection Plan (see the NORM/TENORM Radiation Protection Plan in Attachment A of this application).

8.2 QUALIFICATIONS OF APPLICANT

Clean Harbors, Inc., a publicly owned corporation, is North America's leading provider of environmental and hazardous waste management services. The Company owns 48 waste management facilities in the United States including 9 landfills, 5 incineration locations, and 7 wastewater treatment centers. It provides essential services to more than 30,000 customers,

[2] Figures are provided following the references at the end of this section.

including more than 175 Fortune 500 companies, thousand of smaller private entities, and many government agencies. The headquarters of Clean Harbors, Inc., is in Braintree, Massachusetts.

Clean Harbors Deer Trail, LLC (referred to as the Deer Trail facility), is a wholly owned subsidiary of Clean Harbors Disposal Services, Inc. The Deer Trail facility is an existing RCRA Subtitle C hazardous waste disposal facility. Figure 8.6 shows the Deer Trail organization. Supervision of daily operations is provided by Jack Kehoe, General Manager, Mike Webb, Senior Facility Compliance Manager, and Charles Smith, RSO. Full resumes for these individuals follow the figures at the end of this section. Example training certifications for Mr. Smith follow his resume. In summary:

- **John H. Kehoe, Facility General Manager**. Mr. Kehoe has a B.S. in Chemistry from George Mason University, graduate studies in Chemical Engineering and Chemistry at Virginia Polytechnic Institute, and an M.S. degree in Environmental Engineering from Johns Hopkins University. He has been an employee of Clean Harbors since 1999, with management assignments at the Grassy Mountain Landfill in Clive, Utah, prior to his assignment as General Manager at Deer Trail in 2003. Mr. Kehoe has a broad background of scientific and engineering study for radioactive and hazardous waste management, including applicable regulatory requirements. He has experience managing laboratory, technical, and operational employees associated with Deer Trail operations, and is a primary contributor to permit renewal and NORM/TENORM license application development. Mr. Kehoe has attended many training courses, including the Laboratory Radiation Safety course at the National Institutes of Health and the Mixed Waste Management course through Chem-Nuclear Systems.

- **Michael Maxwell Webb, Senior Facility Compliance Manager**. Mr. Webb served in the U.S. Navy and had university training at the University of Northern Iowa. He has been a Clean Harbors employee since 1996, with assignments at the Kimball, Nebraska, and Deer Trail landfills. Mr. Webb has managed all environmental monitoring procedures for Deer Trail, prepared required quarterly and annual reports, and developed corrective actions for compliance programs. He has developed and revised Standard Operating Procedures (SOPs), Emergency Response Plans, Contingency Plans, Health

and Safety Plans, and Environmental Monitoring Plans and Procedures. Mr. Webb has many certifications and has attended several training courses, including Hazardous Waste Site Training, Occupational Safety and Health Association Training, and Supervisor Training.

- **Charles H. Smith, Radiation Safety Officer**. Mr. Smith has a B.S. degree in General Engineering from Kennedy Western University, and is currently completing his M.S. thesis in Environmental Engineering. He joined Clean Harbors in 2000 as a Certified Trainer for transportation, environmental compliance, and health and safety. Before joining Clean Harbors, he founded Applied Radwaste Management, providing consultation to clients who generate low-level radioactive waste regulated by the U.S. Nuclear Regulatory Commission (NRC). He was the radioactive waste coordinator for Main Yankee Atomic Power Company, supervising radioactive waste processing, packaging, and shipping. From 1989 to 1991, he served as an RSO for Chem-Nuclear Systems, Inc., at its Department of Defense Consolidation Facility. He has completed many training courses, including Hazardous Waste Operations and Emergency Response (HAZWOPER) and HAZWOPER Supervisor training. He was qualified as a waste broker for Chem-Nuclear Systems, Inc., and completed the required training to be a Senior Radiological Control Technician. He had training on Radwaste Management Regulations and Practices, and Packaging and Transportation of Radioactive Waste

8.3 TRAINING PROGRAM

CHDT conducts a comprehensive training program to equip Deer Trail employees with the skills necessary to perform their duties effectively and safely. This section describes the current training program at the facility and the modifications and additions that CHDT will make to address training requirements for handling low-level radioactive materials.

8.3.1 Current Training Program

CHDT trains Deer Trail employees on hazardous waste management procedures and elements of the Contingency Plan to ensure safe facility operations and effective emergency management. Employees receive training for the positions in which they are working. Documentation of employee training and training reviews are part of the operating record. Section 7 and the SOP

on Radiation Safety Training (in Attachment A to this application) describe specific radiation safety training. Deer Trail maintains on file at the facility a detailed written personnel training program, a written job description for each current position, a current organization chart, and a record of employees presently working in each position. Job descriptions include requisite skills, education or other qualifications, and duties of employees assigned to each position.

The objectives of the personnel training program include instruction of each employee in the proper performance of job duties and assurance that designated employees can effectively implement proper emergency procedures should the need arise. The primary elements of the current training program are Formal Training, On-the-Job Training (OJT), and Annual Refresher Training.

All Deer Trail personnel receive designated formal training for the positions they fill. Mastery of initial classroom training is demonstrated by either completion of a unit quiz for each required instructional session or certificates of course completion. On completion of formal training, the employee signs an affidavit for the training. Initial training must be completed within 180 days after the date of employment or assignment to the hazardous waste management facility. Emergency response team members, the emergency coordinator, and backup emergency coordinators receive additional formal training as described in 29 CFR 1910.120 Subpart L, which is documented on an affidavit or with certificates.

CHDT conducts OJT to familiarize new employees and employees transferring to new positions with their duties including hazards associated with the job, required personal protective equipment, emergency procedures, and environmental protection. CHDT maintains on file at the facility documentation of the OJT required for each job title, which includes descriptions of training to be provided, frequency of training, and records of OJT received by personnel. OJT training is based on job descriptions and managed through an OJT worksheet or comparable mechanism. The OJT trainer (senior manager, area supervisor, or foreman) authenticates trainee proficient with an operating test (performance/written), verbal test, or other performance demonstration. Final assignment is contingent on satisfactory completion of OJT. Initial OJT training must be completed within 42 days of employment or reassignment. Training documents must be completed as OJT progresses during the training period (initial or quarter). Both the

employee and the individual supervising the training must sign and date the OJT form when training is complete for that training period. A line supervisor or an experienced coworker in the same job classification must conduct the OJT.

Deer Trail provides annual refresher training to employees within 400 days of the date of his/her initial training or last annual refresher training. This training provides a review and update of the formal training lessons as they pertain to individual employee job descriptions.

CHDT maintains written documentation that personnel have received and completed required training until closure of the facility for current employees and for 3 years from the date the employee last worked at the facility for former employees. Facility management personnel review personnel training plan requirements annually and modify the plan as necessary. Records of the review specify the contents of each evaluation including such topics as:

- Changes in types or quantities of wastes accepted and receipt, treatment, storage, or disposal processes;
- Changes or revisions to permit requirements, emergency coordinators and general operations; and
- Any incident requiring implementation of the contingency plan, notification requirements.

After the annual training program review, CHDT makes required modifications to each affected training segment and incorporates them in the next training cycle.

8.3.2 Radiological Safety Training Program

As described in Section 7.0, Deer Trail has developed supplemental training requirements to ensure that appropriate employees at the facility have the necessary training prior to acceptance of NORM /TENORM waste. All site employees and contracted personnel, when present, at the facility will be receive a training program based on the Deer Trail Radiation Safety Training Plan covering radioactive material handling and radiological emergency procedures. CHDT will administer this program in keeping with standard radiological protection guidelines. The

technical content of the training program will be under the direction of the RSO. The RSO or a qualified designee will provide the training.

Visitors to the Deer Trail disposal facility who have not received training will be escorted by onsite personnel properly trained and knowledgeable about facility hazards. At a minimum, visitors will receive instruction specifically on what they should do to avoid possible hazards in the areas they are visiting. Contractors with work assignments at the facility will receive appropriate training and safety instruction. Contract workers who will be performing work in restricted areas will receive the same training required of permanent workers. The Deer Trail Radiation Safety Training Program incorporates the following topics:

Fundamentals of health protection

- Using respirators when appropriate
- Eating, drinking, and smoking only in designated areas
- Using proper methods for decontamination

Facility-provided protection

- Cleanliness of working space
- Safety designed features for facility equipment
- Engineering control systems
- Standard operating procedures
- Security and access control to designated areas

Health protection measurements

- Measurements of airborne radioactive material
- Bioassay Program
- Surveys to detect contamination of personnel and equipment
- Personnel dosimetry

Radiation protection regulations

- Regulatory authority of the State of Colorado and the NRC
- Employee rights in 10 CFR Part 19 and 6 CCR 1007-1-10
- Radiation protection requirements in 10 CFR Part 20 and 6 CCR 1007-1-4

- Radioactive waste disposal requirements in 6 CCR 1007-1-14

All new workers, including supervisors, will receive specialized instruction on the health and safety aspects of the jobs they will perform. This instruction will be in the form of individualized OJT. Retraining will occur annually and will be documented.

Every 2 months, all workers attend a general safety meeting. Each worker will take a written test with questions directly relevant to the principles of radiation safety and health protection covered in the training course. The instructor will review test results and discuss incorrect answers with the worker until worker understanding occurs. CHDT will retest workers who fail the test; testing results will remain on file.

Following initial radiation safety training, all permanent employees will receive ongoing radiation safety training as part of the routine bimonthly safety meetings. This training will discuss problems and questions that have arisen, any relevant information or regulations that have changed, exposure trends and other pertinent topics.

8.4 EMERGENCY PLANNING

The Deer Trail RCRA Permit, Attachment 4, "Contingency Plan" **(CHDT 2004 – see Volume 4 of this Application)** describes general procedures for dealing with emergency situations such as spills, fires, or accidents. The Contingency Plan contains procedures for spill cleanup, notification of authorities, and other responses. It describes the equipment and staff available to deal with such situations. In the event of a radiological incident, such as a spill of NORM/ TENORM waste, or other emergency potentially involving NORM/TENORM waste, the RSO and General Manager must receive immediate notification. If there is doubt about whether such notification is necessary, the RSO and General Manager will be contacted to enable them to assess the situation and initiate the appropriate response. If appropriate, the measures described in the Contingency Plan will be implemented. The Contingency Plan provides detailed plans for responding to emergency situations. It also provides definition and direction for the following circumstances.

The instructions contained in the Contingency Plan for fire relate to the following events:

- A fire that results in release of a reportable quantity of hazardous substances to the environment
- Fire threatening an explosion
- Fire that could spread beyond the U.S. Highway 36 fence
- Fire in which the water and/or chemical suppressant or other firefighting material used could result in contaminated runoff to surface waters or surface soil infiltration

The Contingency Plan provides instructions for responding:

- To an explosion involving hazardous material or waste and to a spill or release of a reportable quantity of hazardous material as defined in 40 CFR, Parts 117, 302, and 355 where secondary containment is not provided
- To a flood or precipitation event that results in wastes being exposed to precipitation where runoff is not contained
- When wastes are undergoing violent chemical reactions, and the reaction cannot be safely controlled or stopped
- When a loss of electric power results in accumulation or release of toxic vapors or fumes that threaten human health or the environment or could result in a fire or explosion

8.5 REVIEW AND AUDIT

As part of Conduct of Operations, CHDT conducts a program of inspections, audits, and reports for Deer Trail facility operations. The RSO or a qualified designee will perform a daily walkthrough inspection of the facility. The inspection includes a visual examination of compliance with procedures and any problems. The Standard Operating Procedure on Radiation Surveys (in Attachment A) describes radiation surveys. The RSO will provide a written summary of the month's NORM/TENORM waste activities at the facility. The report will include a review of all monitoring and exposure data for the month, a summary of worker protection activities, a summary of pertinent radiation survey records, a discussion of trends in

the As-Low-As-Reasonably-Achievable (ALARA) Program, and a review of the adequacy of the implementation of facility radioactive materials license conditions. In addition, it will contain recommendations for corrective actions or improvements in disposal operations or safety programs.

The RSO will conduct quarterly reviews of personnel exposure data and evaluations of the data to ensure that exposures are ALARA, and will recommend changes to operating procedures to maintain exposures ALARA.

On an annual basis, an independent radiation safety auditor will conduct an audit of the radiation protection and ALARA programs. The RSO can accompany the auditor, but cannot participate in the conclusions of the audit.

The annual ALARA audit report will summarize the following data:

- Employee exposure records
- Inspection log entries and summary reports RSO inspections
- Documented training program activities
- Applicable safety meeting reports
- Radiological survey and sampling data
- Operating procedures reviewed during this period

The ALARA audit report will specifically discuss the following:

- Trends in personnel exposures;
- Proper use, maintenance and inspection of equipment used for exposure control; and
- Recommendations on ways to further reduce personnel exposures.

The ALARA audit report will be submitted to and reviewed by the CHDT Vice President, the RSO, and the General Manager. Implementation of the recommendations to reduce employee exposures or improvements to the ALARA program will be reviewed with the ALARA auditor.

An individual qualified in analytical and monitoring techniques who does not have direct responsibilities in the areas being audited will conduct an annual audit of the Quality Assurance/

Quality Control (QA/QC) program. The results of the QA/QC audit will be documented and reported to the Deer Trail Vice President and RSO. The RSO has the primary responsibility for implementation of the QA/QC program as it relates to radiation protection at the facility.

Deer Trail will prepare an annual report for submittal to the Colorado Department of Public Health and Environment (CDPHE) in accordance with the requirements of 6 CCR 1007-1-14.33.7. This report will contain the following information.

- The quantity of each principal contaminant released to unrestricted areas in liquid and airborne effluents during the preceding year
- The results of the environmental monitoring program
- A summary of disposal unit survey and maintenance activities
- A summary of the NORM/TENORM waste average activity and quantity disposed of
- Instances in which observed site characteristics were significantly different than those described in the license application
- Cases in which the quantity of waste released, monitoring results, or maintenance performed varied significantly from those predicted
- Other information required by CDPHE

8.6 FACILITY ADMINISTRATIVE OPERATING PROCEDURES

CHDT has developed SOPs for receipt, handling, treatment, and disposal activities involving NORM/TENORM waste for the Deer Trail facility (included in Attachment A). These radiation safety procedures will supplement the Operations Manual currently in place at Deer Trail. Where NORM/TENORM waste handling is involved, pertinent radiation safety practices have been incorporated in the Operations Manual. CHDT has developed SOPs for nonoperational activities including area and environmental monitoring, use of the gate monitor, estimating inhalation doses, and other support health physics procedures. The RSO reviews and approves SOPs for radiological protection aspects prior to their implementation. CHDT will revise SOPs

as necessary to meet changing operational and regulatory requirements. The RSO and appropriate supervisor will review and approve revisions to the SOPs prior to their implementation. SOPs will be kept in the areas of the facility where they are used for easy access by employees.

8.7 PHYSICAL SECURITY

Under the provisions of the RCRA Permit, CHDT prevents the unknowing entry and minimizes the possibility for the unauthorized entry of persons or livestock to the facility in accordance with 6 CCR 1007-3, Part 264,14(a).

CHDT will control entry at all times through fences, gates, doors, and other entrances to the site. The fence that surrounds the facility is an 8-foot chain-link fence topped with barbed wire. It includes a gate at the east side of the facility. CHDT has posted warning signs at the entry gate and at a maximum of 200-foot intervals along the perimeter fence that read "Danger - Unauthorized Personnel Keep Out."

8.8 REFERENCES CITED

6 CCR 1007-1, Radiation Control, Part 1: *General Requirements.*

6 CCR 1007-1, Radiation Control, Part 4: *Standards for Protection Against Radiation.*

6 CCR 1007-1, Radiation Control, Part 14: *Licensing Requirements for Land Disposal of Low-Level Radioactive Waste.*

6 CCR 1007-3, Part 264 - Standards for Owners & Operators of Permitted HW Treatment, Storage, & Disposal Facilities.

10 CFR 19. 2004. *Notices and Instructions to Workers.* U.S. Nuclear Regulatory Commission, Washington, D.C.

10 CFR 20. 2004. *Standards for Protection Against Radiation.* U.S. Nuclear Regulatory Commission, Washington, D.C.

40 CFR 117. 2004. *Determination of Reportable Quantities for Hazardous Substances.* U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 302. 2004. *Designation, Reportable Quantities, and Notification.* U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 355. 2004. *EPA Regulations for Emergency Planning and Notification Under CERCLA.* U.S. Environmental Protection Agency, Washington, D.C.

Clean Harbors Deer Trail (CHDT). 2004. *Permit Renewal Report for Incorporation of a Geosynthetic Clay Liner (GCL) in the Liner Section for Secure Cells 3 Through 7 and in the Cover Section for Secure Cells 1 Through 7 (the Permit Renewal Report* – Included in Volumes 4 and 5 of this Application).

Figure 8.1. Corporate Organization Chart.

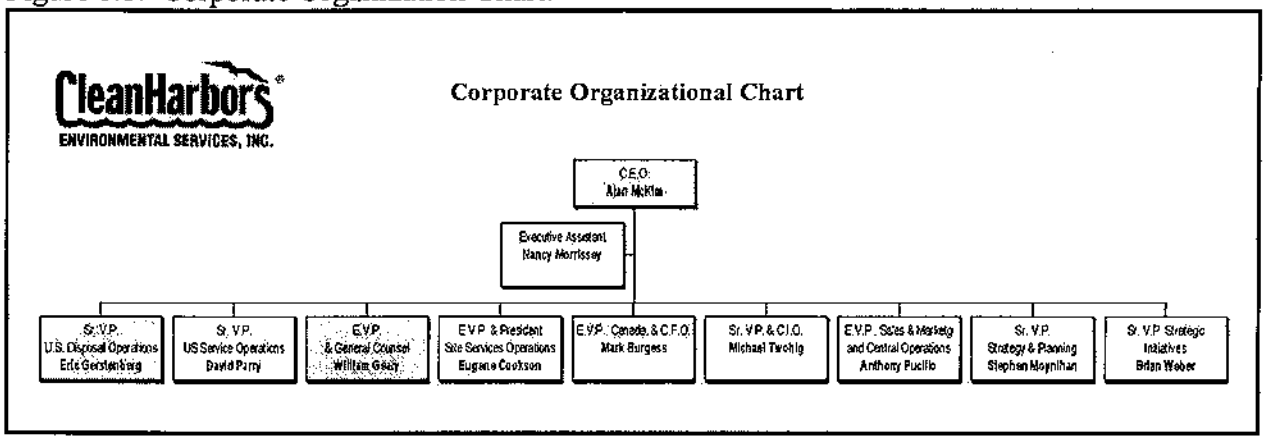


Figure 8.2. U.S. Operations Organization Chart.

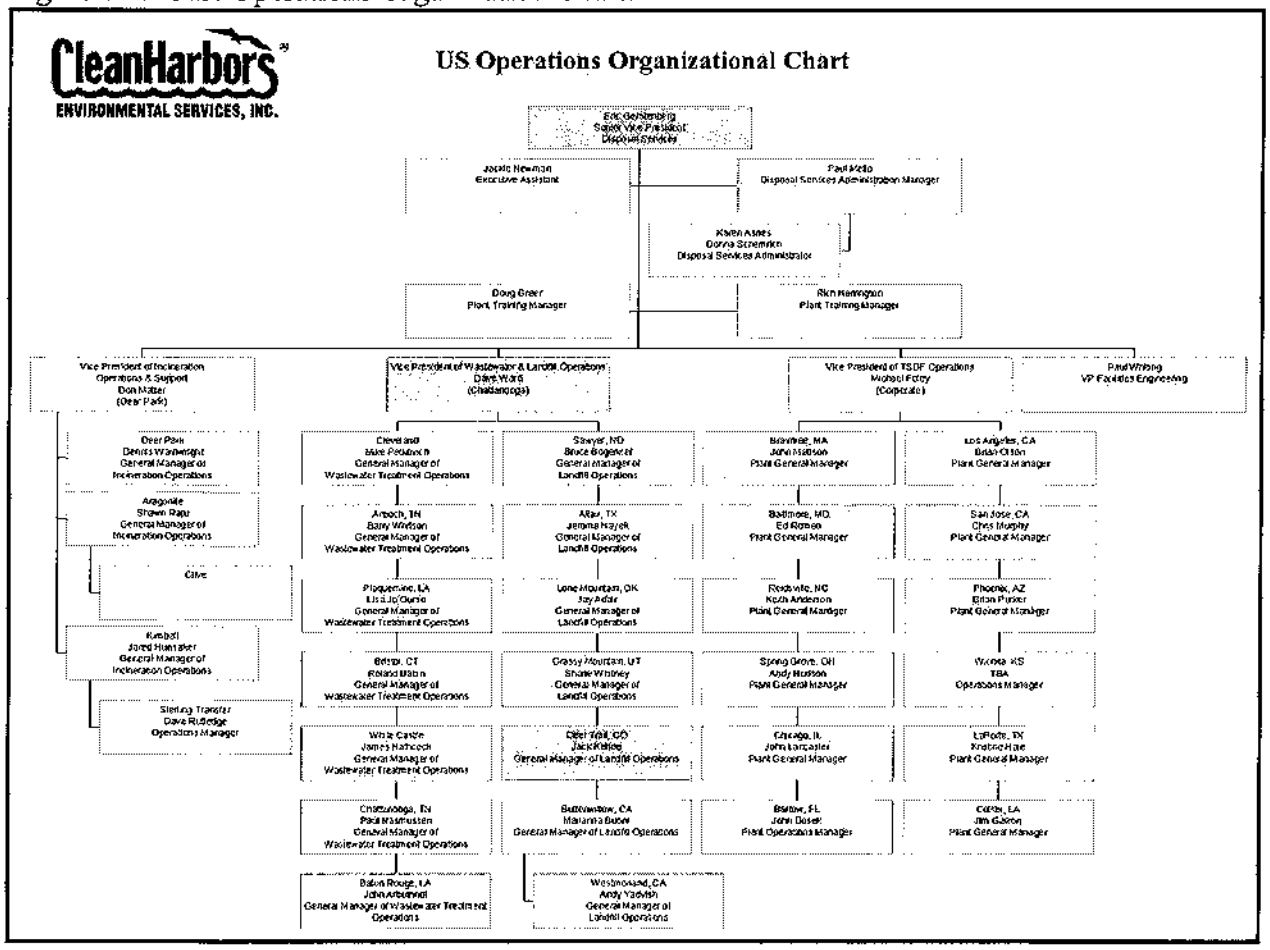


Figure 8.3. Environmental Compliance Organization Chart.

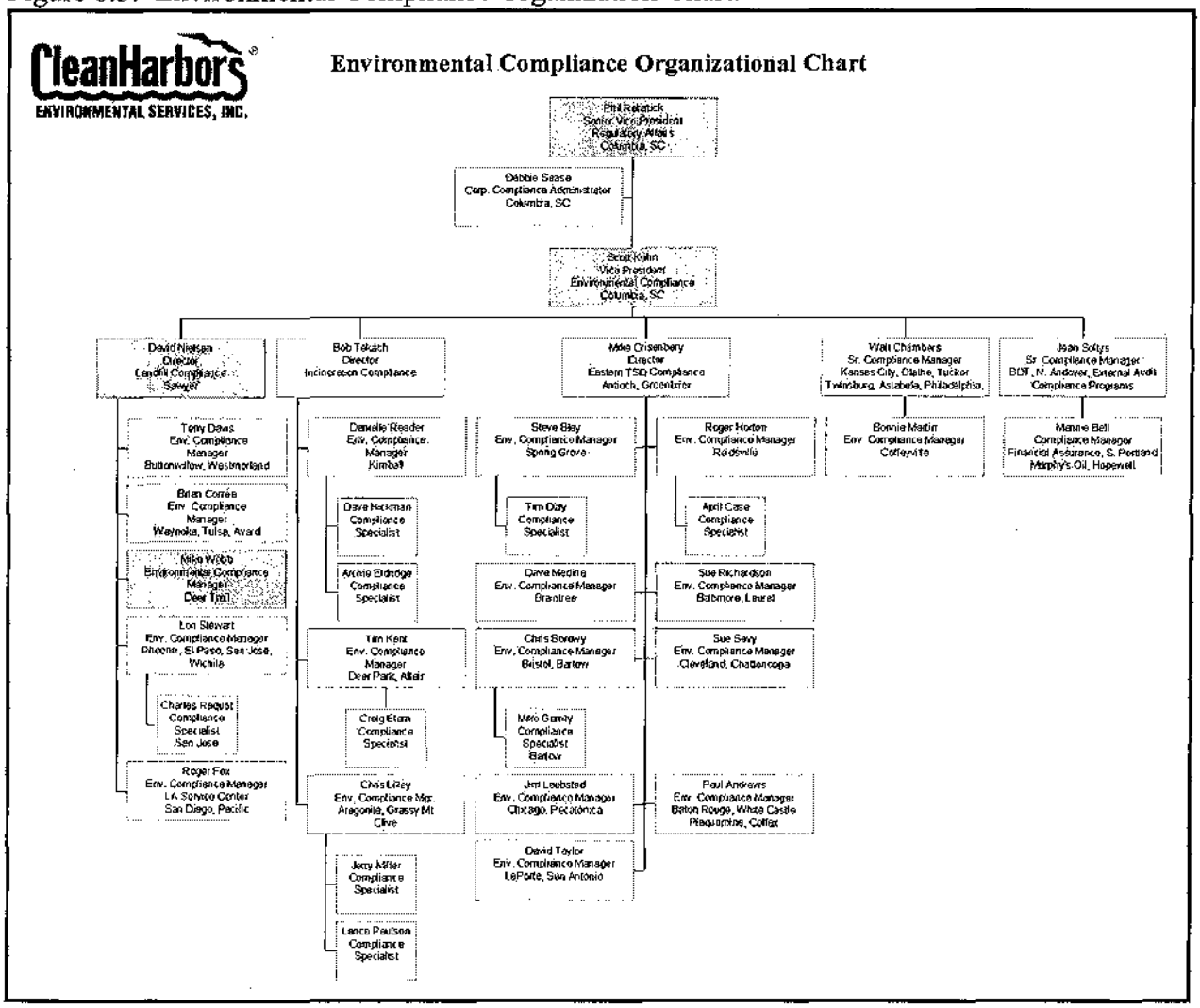


Figure 8.4. Health and Safety Organization Chart.

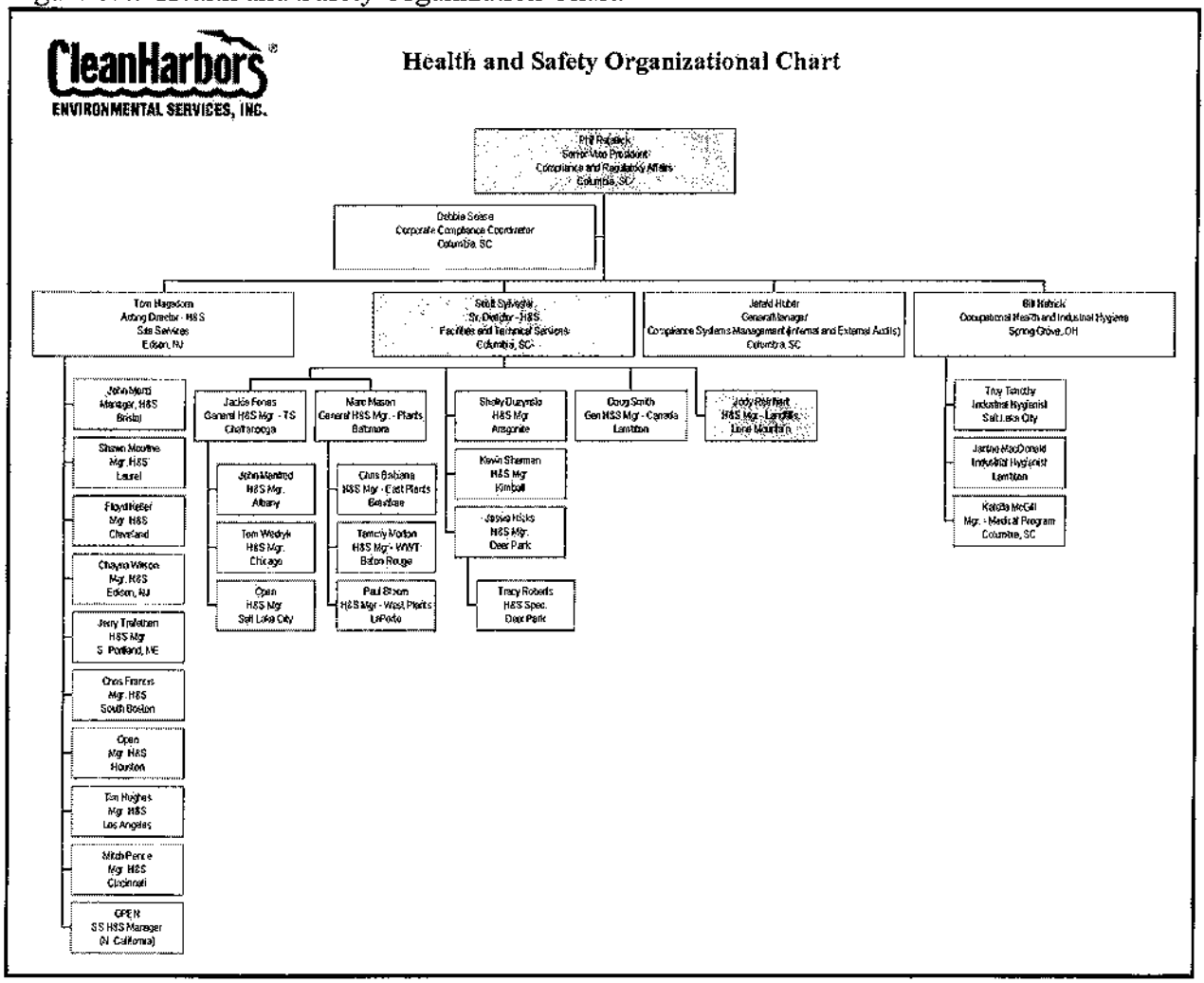


Figure 8.5. Training and Consulting Organization Chart.

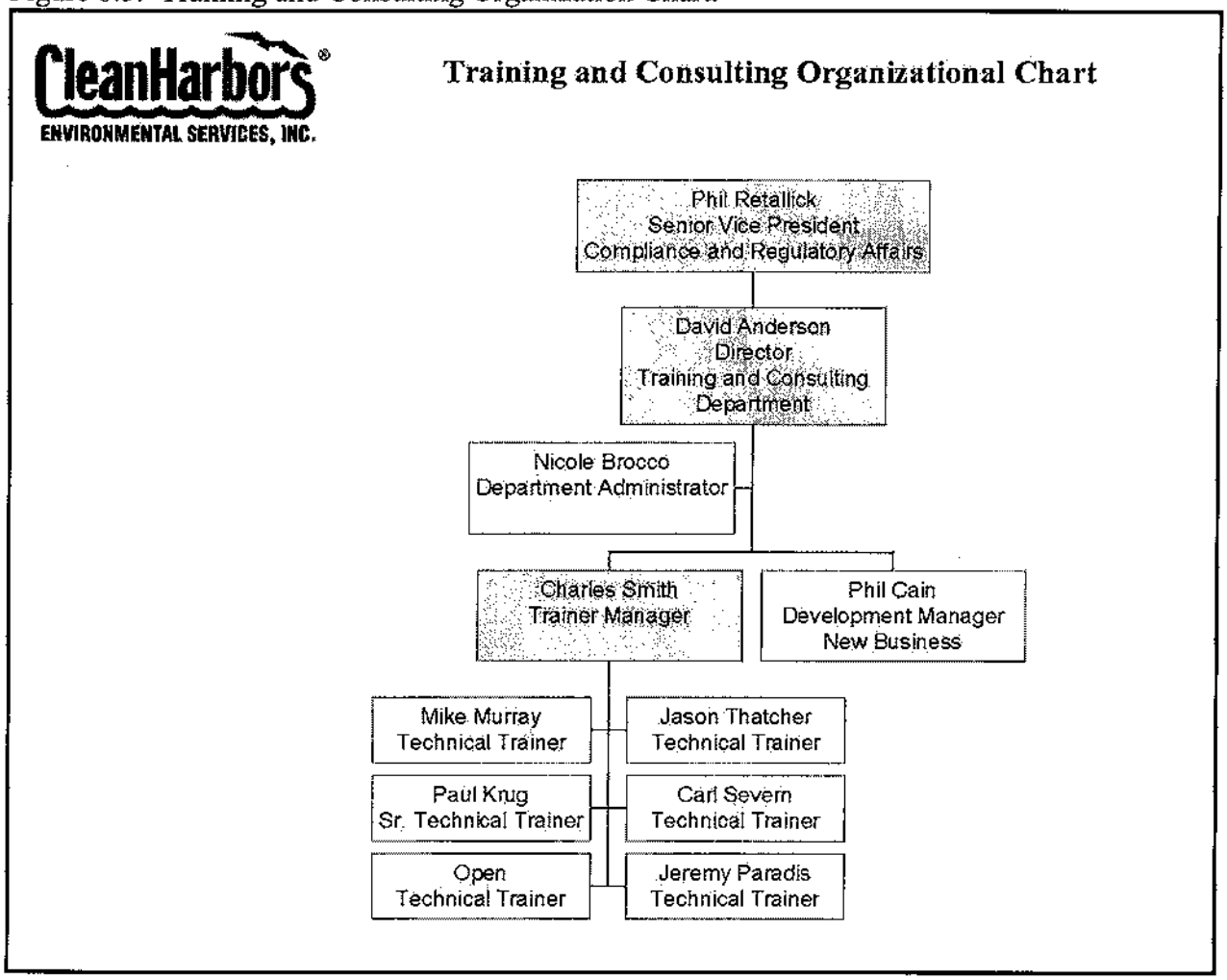
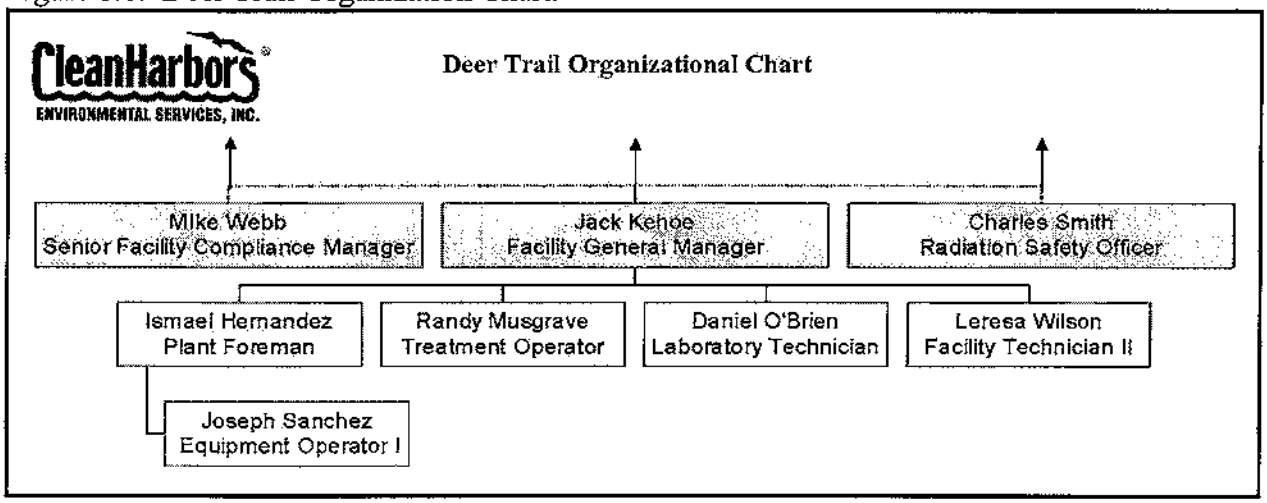


Figure 8.6. Deer Trail Organization Chart.



Resume of:

John H. Kehoe, Clean Harbors Deer Trail, LLC

EDUCATION:

M.S. - Environmental Engineering, 1998-Johns Hopkins University, Baltimore, MD. Included study in landfill design and management, hydrology, groundwater, water and wastewater treatment, geomorphology, and environmental law.

Graduate study Chemical Engineering and Chemistry- Virginia Polytechnic Institute, Blacksburg, VA 1982-1983;

B.S. - Chemistry, 1982 - George Mason University, Fairfax, VA

KNOWLEDGE, SKILLS, ABILITIES:

Skilled at analytical thinking and systems evaluation; effective at managing personnel to accomplish difficult projects; skilled at the training and development of staff; excellent technical writer; broad background of scientific and engineering knowledge gained from both study and experience; thorough understanding of the political and regulatory process; expert knowledge of Hazardous Waste, Analytical chemistry, Radioactive Waste, Wastewater, Drinking water, Environmental management systems, Pollution prevention; experienced with computer applications such as Excel, Word, Arc View GIS, Corel Draw.

PROFESSIONAL EXPERIENCE:

General Manager Deer Trail Landfill,
Clean Harbors Deer Trail, LLC, Deer Trail, CO., Dec. 2003-Present

Manage all the operations and staff of a hazardous waste landfill and treatment facility; implement procedures needed to keep facility operating in a safe and efficient manner; responsible for safety, environmental compliance, and financial performance of the facility.

Technical Manager- Grassy Mountain Landfill,
Safety-Kleen Grassy Mountain Facility Clive, Utah: 2001- 2003.

Managed laboratory staff, technical staff, and customer service staff; implemented procedures needed to keep facility operating in a safe and efficient manner; oversaw waste treatment operations; developed waste treatment operations; maintained regulatory compliance at the facility; oversaw laboratory operations at the facility; developed and maintained good relations with customers; interfaced with outside sales staff in order to develop increased business for the company.

Operations Manager- Grassy Mountain Landfill
Safety-Kleen Grassy Mountain Facility Clive, Utah: 1999- 2001.

Managed all the operations of a hazardous waste landfill and treatment facility; supervised the operating staff, laboratory staff, and technical staff; implemented procedures needed to keep facility operating in a safe and efficient manner; wrote and successfully obtained four variances from the Land Disposal Restrictions; completely overhauled all waste treatment operations at the facility; substantially reduced the operating costs of the facility; improved the environmental compliance record of the facility.

NIH Project Consultant
Safety-Kleen/Laidlaw Environmental Services, Laurel, MD: 1998 - 1999.

Provided technical and management consulting services for Laidlaw Environmental's contract with the National Institutes of Health; Performed quality control audits, wrote standard operating procedures, designed waste treatment equipment, provided quality assurance auditing and guidance for analytical lab operations.

Manager-NIH Project
Laidlaw Environmental Services at NIH, Bethesda, MD: 1992--1998.

Managed all aspects of a $6 Million/year contract; Directed environmental operating and consulting services, facility compliance and environmental operations for the NIH (National Institutes of Health) waste facility, a government owned permitted TSDF. Hired and supervised staff of 27 in management of low-level radioactive waste, hazardous waste, mixed waste, wastewater and analytical services. Oversaw tremendous expansion of services provided under this contract. Conducted environmental cleanup work and site remediation; operated computerized waste tracking systems. Conducted environmental sampling and directed lab analysis. Performed inspections and audits; Maintained liaison with government officials. Provided annual, quarterly and other reports; Designed, built, and operated waste treatment systems; Kept operating costs accountable with government contracting regulations. This contract was successfully rebid for another five-year term starting April 1998.

Operations Manager-Laurel Facility
Laidlaw Environmental Services, Laurel, MD: 1991- 1992

Managed compliance and operations of a TSDF storage facility which provided hazardous waste management and field services; Hired and supervised operations personnel; Kept staff informed of changes to federal and state regulations; Conducted compliance audits for customers; Conducted environmental audits of disposal facilities.

Senior Routing Supervisor-Laurel Facility
Laidlaw Environmental (formerly known as GSX): 1985- 1991

Reviewed waste stream profiles for acceptability; determined land disposal restrictions applicability for all waste streams. Reviewed laboratory analysis for all waste streams; Responsible for hazardous waste manifest acceptance. Conducted employee-training programs in RCRA and DOT regulations.

Chemist-Laurel Facility
Laidlaw Environmental (formerly known as GSX, SCA Services, and Triangle Resource Industries): 1984-1985

Responsible for identification, segregation, and manifest preparation for disposal of hazardous chemicals for customers; supervised chemical technicians and provided regulatory guidance.

SPECIAL ACCOMPLISHMENTS:

1994-98 - UV Oxidation Treatment of Mixed Radioactive Hazardous Waste

Developed and designed treatment and pretreatment parameters and system configuration for UV/Hydrogen Peroxide oxidation treatment system for destruction of organic chemicals in mixed low level radioactive/hazardous waste water, at the NIH. This on site treatment operation has provided substantial cost savings and enhanced compliance for the customer.

1993-95 - Activated Carbon System for Treatment of Aqueous Radioactive Waste.

Developed, set up, and created treatment parameters and analytical protocols for the NIH activated carbon treatment unit for removal of organic contamination from low level radioactive waste water at NIH. This has enabled NIH to routinely meet discharge limits preventing fines and legal costs

1995 _ Aqueous Radioactive Waste Storage Tank Remediation and Redesign.

Developed procedures, supervised and implemented tank man way installation, sludge removal and remediation and treatment operations from nine low-level radioactive waste storage tanks at NIH. Completed project ahead of schedule and at 40% lower cost than the other bidder. This enabled the NIH to maintain and enhance their radioactive waste operations and their compliance.

1993-98 - Environmental Lab. Set up and directed on-site environmental lab operations at NIH including volatile and semi volatile GCMS analysis, metals, TOC, and wet chemistry. This increased the scope of operations under this contract and has provided the Company with increased revenue.

1992 - 1997 - Provided wastewater compliance testing, biannual and batch, for toxic organic chemicals and other constituents for the NIH POTW discharge permit.

1993 - 1997 Provided testing for the NIH NPDES discharge permit.

1992 - Designed and implemented screening and testing techniques to keep organic contamination of NIH low level radioactive waste water below RCRA limits.

1994 - Provided air emissions compliance testing at NIH medical waste incinerators.

1994 – Provided air emissions compliance testing at NIH fuel oil and gas fired steam boilers.

1987 - Temporary Lab Manager and waste profile approval staff at the Pinewood, SC Landfill Facility during staff shortage.

1986, 1985 - Temporary waste profile approval and lab pack list approval at the Pinewood, SC facility.

Writing and Publications

- "UV Oxidation Treatment of Aqueous Radioactive Waste Standard Operating Procedure", 1998.
- "NIH Laboratory Quality Assurance and Quality Control Plan", 1998
- "Carbon Adsorption Treatment of Aqueous Radioactive Waste", 1998
- "Digestion of Organic Samples for Mercury Screening Using Cold Vapor Atomic Absorption", 1998.
- "NIH Contract Hazardous and Radioactive Waste Operations Quality Assurance Plan", 1998
- "NIH Contract Health, Safety and Radiation Protection Plan" (Edited), 1998
- "Standard Operating Procedure (SOP) for Counting Aqueous Radioactive Waste", 1998
- "Sampling and Analysis of Wastewater Discharges at the National Institutes of Health", Fall, 1997.
- "NIH Contract Technical Proposal" (Co-author), Sept., 1997
- "Sampling and Analysis of Wastewater Discharges at the National Institutes of Health", Spring, 1997
- "Sampling and Analysis of Wastewater Discharges at the National Institutes of Health", Fall, 1996.

Selected Training Courses

- 1996-Radiation Safety in the Laboratory, NIH, Bethesda, MD.
- 1995-Mixed Waste Management, DSSI Chem-Nuclear Systems, Inc., Kingston. TN
- 1995-HM-126f training pursuant to 49 CFR 172-702, Laidlaw Environmental Services, Laurel, MD
- 1993-HM-181 Performance Oriented Packaging Standards, Laidlaw Environmental Services, Laurel, Md
- 1993-HMTUSA training program, Laidlaw Environmental Services, Laurel, MD
- 1993-40 hours Equivalency Training, Hazardous Waste Operations according to 29 CFR 1910.120
- 1988-Explosion Prevention and Protection, Hercules, Inc., Edison, NJ

MICHAEL MAXWELL WEBB

EXPERIENCE

1996–2002 Clean Harbors Kimball, NE
2002–Present Clean Harbors Deer Trail, CO

Senior Facility Compliance Manager

- Manage all environmental-monitoring projects at a Hazardous Waste Incinerator and a RCRA Subtitle C Landfill including ambient air, groundwater, soil, point source emissions, ash delisting, Monofill, NPDES, and indoor air quality. Duties include collecting, organizing and the presentation of data. Preparing quarterly and annual reports for submittal to the State of Nebraska Department of Environmental Quality and the United States EPA. Act as liaison with governmental agencies, contractors and vendors. Make recommendation to management with respect to program direction, corrective actions and purchases.
- Preparation of RCRA Part B Permit applications, Title V Air Permit applications, annual air emissions inventories, Toxic Release Inventory (TRI), Risk Management Plan (RMP), coordination of the annual stack performance test, annual Relative Accuracy Test Audit (RATA), quarterly Relative Accuracy Audit (RAA), Cylinder Gas Audit (CGA) and performing facility inspections to ensure compliance with all state and federal permits.
- Design Microsoft Access and Excel applications to manage and report data associated with the tracking of hazardous waste for incineration, personnel training records, laboratory data and reports of analysis, equipment maintenance and repairs and plant wide inspections and records.
- Assist in the planning and implementation of OSHA and RCRA training programs.
- Develop and revise Standard Operating Procedures, Emergency Response Plans, Contingency Plans, Health and Safety Plans and Environmental Monitoring Plans and Procedures.
- Maintain an understanding of all applicable EPA regulations and test methods and communicate any changes or revisions to management.

EXPERIENCE (CONTINUED)

1994–1996 HSE Consulting Omaha, NE

Project Manager / QA Officer

- Prepared Title V Air Emissions Permit Applications, Air Emissions Inventories, Health and Safety Plans and Indoor Air Quality Surveys.
- Conducted Phase I and Phase II environmental property assessments.
- Designed a database in Lotus Approach called "Chem Chaser" which tracked air emissions through inventory, purchasing and the MSDS.
- Prepare graphical presentations of all data collected and perform statistical analysis of that data.
- Instructed numerous OSHA training courses related to hazardous waste operations and the employee right to know.

CLEAN HARBORS DEER TRAIL • PHONE (970) 386-2293
• EMAIL: webbm@cleanharbors.com

1985–1994 EnviRx, Ltd. Hollywood, FL

Quality Assurance Officer

- Responsible for the Quality control of all field and laboratory data gathered for RCRA and UST remediation projects.
- Conducted Phase I and Phase II environmental property assessments.
- Maintained quality control and adherence to job specification.
- Prepare graphical presentations of all data collected and perform statistical analysis of that data.
- Instructed numerous OSHA training courses related to hazardous waste operations and the employee right to know.

1979–1985 York Research Consultants, Inc. Denver, CO

Technician

- Conducted numerous stationary source test and designed, implemented and managed several ambient air monitoring programs.

1978–1979 Plains Exploration Denver, CO

Advance Party Manager

- As an advance Party Manager for a seismic exploration crew duties included negotiation with land owners for access rights and fees, contracting survey crews and shot hole drillers, purchasing explosives and making all preparations needed in advance if the crews arrival.

1976–1978 Corning Laboratories, Inc. Cedar Falls, IA

Technician

- Conducted numerous stationary source tests. Responsible for the calibration and maintenance of all test equipment.

CLEAN HARBORS DEER TRAIL • PHONE (970) 386-2293
•EMAIL: webbm@cleanharbors.com

RELATED SKILLS

- Proficient in the use of Microsoft, Corel and Lotus; word processing, spreadsheet, database and presentation software.
- Self-motivated and works well without supervision.
- Communicates well as a team member, ability to make decisions and solve problems.

EDUCATION

1971, 1976 University of Northern Iowa Cedar Falls, IA

MILITARY

- United States Navy, 1971-1975
- Interior Communications Electrician
- Mark 19 and Mark 23 Gyro-Compass repair (submarine fleet)
- Nuclear Spill Response Team

CERTIFICATIONS

- AHERA Asbestos Inspector
- AHERA Asbestos Management Planner
- State Of Nebraska Asbestos Regulations
- State Of Nebraska, Storage Tank Closure, #CL 2592

(Current employer has allowed the above certifications to expire)

TRAINING

- Occupational Safety And Health Association (OSHA)
- 40 Hour Hazardous Waste Site Training
- 8 Hour Supervisor Course

CLEAN HARBORS DEER TRAIL • PHONE (970) 386-2293
•EMAIL: webbm@cleanharbors.com

Charles H. Smith
100 Mill Pond Road
Cayce SC 29033
(803) 796-7521
arminc01@aol.com

EDUCATION

- B.S. General Engineering, 1989, Kennedy Western University, Augoura Hills, CA. (Currently completing Master's Thesis in Environmental Engineering)

PROFESSIONAL EXPERIENCE

9/00 to Present **Regulatory Specialist**, (SK Certified Trainer) Safety-Kleen Corporation

- Presented transportation, environmental, health/safety and train-the-trainer courses,
- Identified regulatory change and their impact on various department within the organization,
- Developed audit checklists for regulatory compliance verification in the health/safety, transportation and environmental areas,
- Created access database responsible for reducing monthly deviation report generation by two days,
- Developed Basic Hazardous Waste topical presentation for waste accounting group,
- Initiated software purchase that reduced the CD-ROM creation time, and web based training environment development,
- Appointed the single SK point-of-contact for regulatory computer based training related issues,
- Created health/safety and transportation modular training CD-ROMs,
- Initiated/ deployed intranet based training and testing,
- Created internet based health/safety and environmental training courses,
- Created SK Regulatory Compliance website for environmental, health/safety and transportation topics http://skcompliance.com,
- Administered company-wide health/safety training and testing from corporate location,
- Created departmental intranet site specifically designed for information dissemination, online training and testing purposes,
- Lead regulatory trainer for Centra intranet training courses.

7/94 to 9/00 Founder, Applied Radwaste Management, Inc. (ARM Inc.)

- Provided client consultations and disposal documentation for disposal shipments,
- Performed environmental, health/safety and transportation audits per client requests,

- Instructed utility, processor, state and federal regulatory personnel in compliance with DOT and NRC (IE 79-19) transportation and disposal regulations,
- Instructed client low level radioactive waste brokers,
- Developed and instructed Hazardous Waste (RCRA) Identification and Transportation Course,
- Developed CD-ROM based "Changes to US Radioactive Material Transportation Regulations" training course
- Developed and instructed Mixed Waste Identification and Transportation Course,
- Performed radwaste procedural reviews/rewrites for compliance with changing transportation regulations,
- Completed USNRC low-level waste manifests for waste processor shipments into licensed disposal facilities,
- Developed instructor led over-the-web transportation course,
- Provided documentation for formally licensed USNRC packages for compliance with USDOT packaging regulations.
- Developed/maintain company and related websites,

4/93 to 7/94 **Radioactive Waste Coordinator**, Maine Yankee Atomic Power Company,

- Supervised 5 technicians during radwaste processing, packaging and shipping evolutions,
- Supervised material decontamination consistent with company policy,
- Successfully initiated radioactive waste minimization program resulting in 50% reduction in DAW production,
- Implemented cost efficient waste processing consistent with disposal site criteria and transportation regulations,
- Saved Maine Yankee $190,000 per year by fundamental waste processing procedural changes,
- Successfully completed NRC Radioactive Waste audits covering transportation, processing and long term storage,
- Utilized WMG, Inc. software for waste and non-waste classification and characterization,
- Managing $600,000 radwaste budget,
- Developed spreadsheets to classify varying quantities of filters, and classify high integrity containers containing varying resin concentrations,
- Organized stored/processed radioactive waste data for traceability for anticipated future disposal manifesting.

2/91 to 4/93 **Training Specialist**, Chem-Nuclear Systems, Inc.

- Revised/presented NRC Radioactive Materials Transportation course (H-308),
- Revised/presented AMMCOM and SAALC Radioactive Materials Transportation course,

- Instructed compliance with DOT and NRC (IE 79-19) transportation and disposal regulations,
- Instructed compliance with Low Level Radioactive Waste Disposal Site Agreement State regulations and criteria,
- Instructed in-house low-level radioactive waste brokers,
- Developed and instructed Hazardous Waste (RCRA) Identification and Transportation Course,
- Developed and instructed Mixed Waste Identification and Transportation Course,
- Developed procedures governing transportation and disposal of radioactive waste,
- Developed Quality Assurance course for radioactive material inspections,
- Instructed Quality Assurance personnel on DOT Out-of-Service Criteria,

7/89 to 2/91 **Radiation Safety Officer**, Chem-Nuclear Systems, Inc., **Department of Defense Consolidation Facility**.

- Supervised radiological controls technicians during M1-A1 battle tank and Sykorski helicopter decontamination operations,
- Supervised radioactive waste supercompactor operators,
- Maintained calibrated radiation monitoring instrumentation in accordance with ANSI standards,
- Established multichannel analyzer and alpha spectroscopy operations,
- Monitored personnel external radiation exposure and internal biological uptake data,
- Reported environmental radionuclide emissions to SCDHEC,
- Maintained environmental monitoring devices,
- Initiated radiation work permit system for radiological operations,
- Supervised senior radiological control technicians during Wright-Patterson Air Force Base Radioactive Waste Disposal Site Excavation Project,
- Supervised senior radiological control technicians during USEPA Superfund project,
- Authorized by Chem-Nuclear to certify radioactive and hazardous waste manifests for shipment over public highways,
- Authorized by U. S. Army AMCCOM to certify Department of Defense radioactive and hazardous waste manifests for shipment over public highways,
- Developed user login scripts for Novell 386 network,
- Initiated computer system security structure,

11/87 to 7/89 **Associate Training Specialist (Nuclear)**, Texas Utilities Electric Company, Comanche Peak Steam Electric Station.

9/87 to 11/87 **ANSI 3.1 Senior Health Physics Technician**, Numanco Inc., Alabama Power Company, J. M. Farley refueling Outage.

7/87 to 9/87 **Health Physics Technician,** Nuclear Support Services, Connecticut Yankee Atomic Power Company, Refueling Outage.

6/80 to 5/86 US Naval Nuclear Power Program; Machinist Mate 1st Class (E-6).Qualified **Engineering Laboratory Technician**

VOLUNTEERING ACTIVITIES

Computer Committee, Trinity Baptist Church, Cayce, SC.

- Provide network administration functions for 24 node Windows NT 4.0
- server with DSL TCP/IP internet connectivity, workstation setup, server maintenance and upgrades, backup automation, software deployment and upgrades, new user setup/connectivity, web page setup and maintenance.
- Created/maintain church websites - visitor http://amazinglove.org and member - http://my.trinitybaptistchurch.info
- Created/maintain daughter's soccer team website: http://geocities.com/sgsstorm
- Created/maintain local State Congressman's website archived at: http://web.archive.org/web/20010927060901/http://kennybingham.com/

OTHER RELATED ACTIVITIES

- Instruct 1 or 2 commercial classes per year "Radioactive Material Transportation and Disposal Workshop",
- Instructed web design and deployment classes for local Baptist church association,
- Created/maintain personal website http://charleshsmith.com
- Webmaster (currently redesigning-php/mysql) http://appliedradwaste.com
- Webmaster http://trainerstuff.com in php/mysql database driven site
- Webmaster http://ebookprimer.com (converting to php/mysql database driven site),
- Developing digital video series for small business owners.

RELEVANT SOFTWARE

MS Word, PowerPoint, Excel, Access, Publisher, Outlook,

OTHER SOFTWARE

Dreamweaver, Namo Web Editor, Hot Metal Pro, Cool Page, Astound, Digital Trainer, Trainersoft, E-ditor, Lightning, Ember, Paint Shop Pro, ICQ, MS NetMeeting, Windows Media Encoder, Real Publisher, Real Producer Pro, Broadway, Adobe Premier, LeeLou, Emblaze Audio/Video, Illuminatus, Sound Forge, Net Objects Fusion, Astound, Ulead Media Pro, Adobe Premier, Acrobat Writer; Lotus Notes 4.6, R5; Novell NetWare; MS Exchange, MS Windows NT 3.51, 4; Windows 95, 98, 98SE; WSFTP Pro, PC Anywhere, Unix,

RELEVANT WEB LINKS
My function with the active websites is design, develop, deploy and maintain (unless otherwise noted).

http://skcompliance.com
SK Compliance Website

http://skcompliance.com/training/et144
Online Internet Waste Profile Training/Testing

http://skcompliance.com/training/hs106
Demo online training course (Starring Heather Alexander)

http://skcompliance.com/training/ddc
Demo online testing

http://charleshsmith.com
Personal site (redesigning into php/mySql database driven site)

http://appliedradwste.com
Personal site (redesigning into php/mySql database driven site)

http://trainerstuff.com
Personal site (redesigning into php/mySql database driven site)

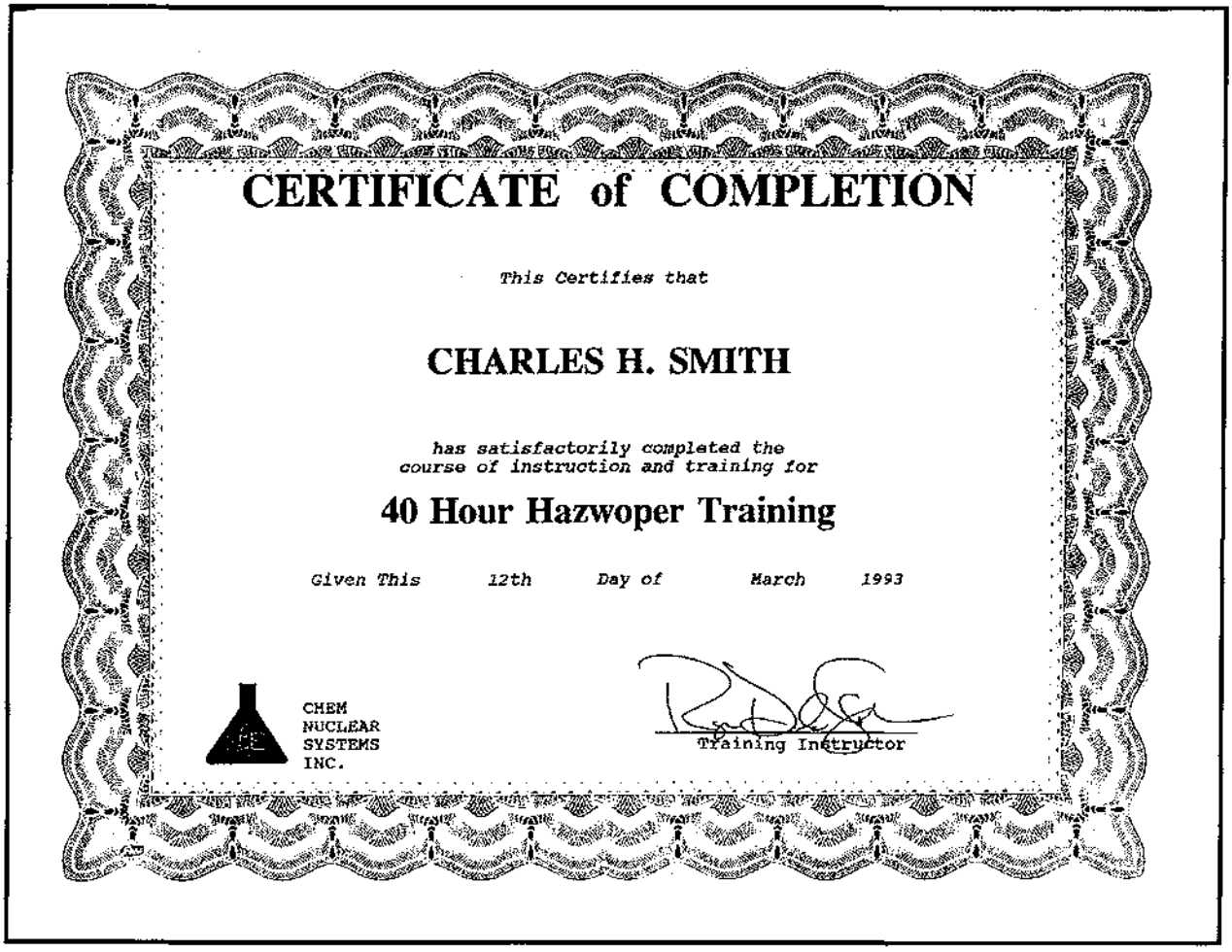
http://geocities.com/sgsstorm

http://amazinglove.org
Trinity Baptist Church Visitor Site

http://my.trinitybaptistchurch.info
Trinity Baptist Church Member Site

http://web.archive.org/web/20010927060901/http://kennybingham.com/
Local State Congressman's site archive

http://ebookprimer.com
Personal site (redesigning into php/mySql database driven site)



CERTIFICATE of COMPLETION

This Certifies that

CHARLES H. SMITH

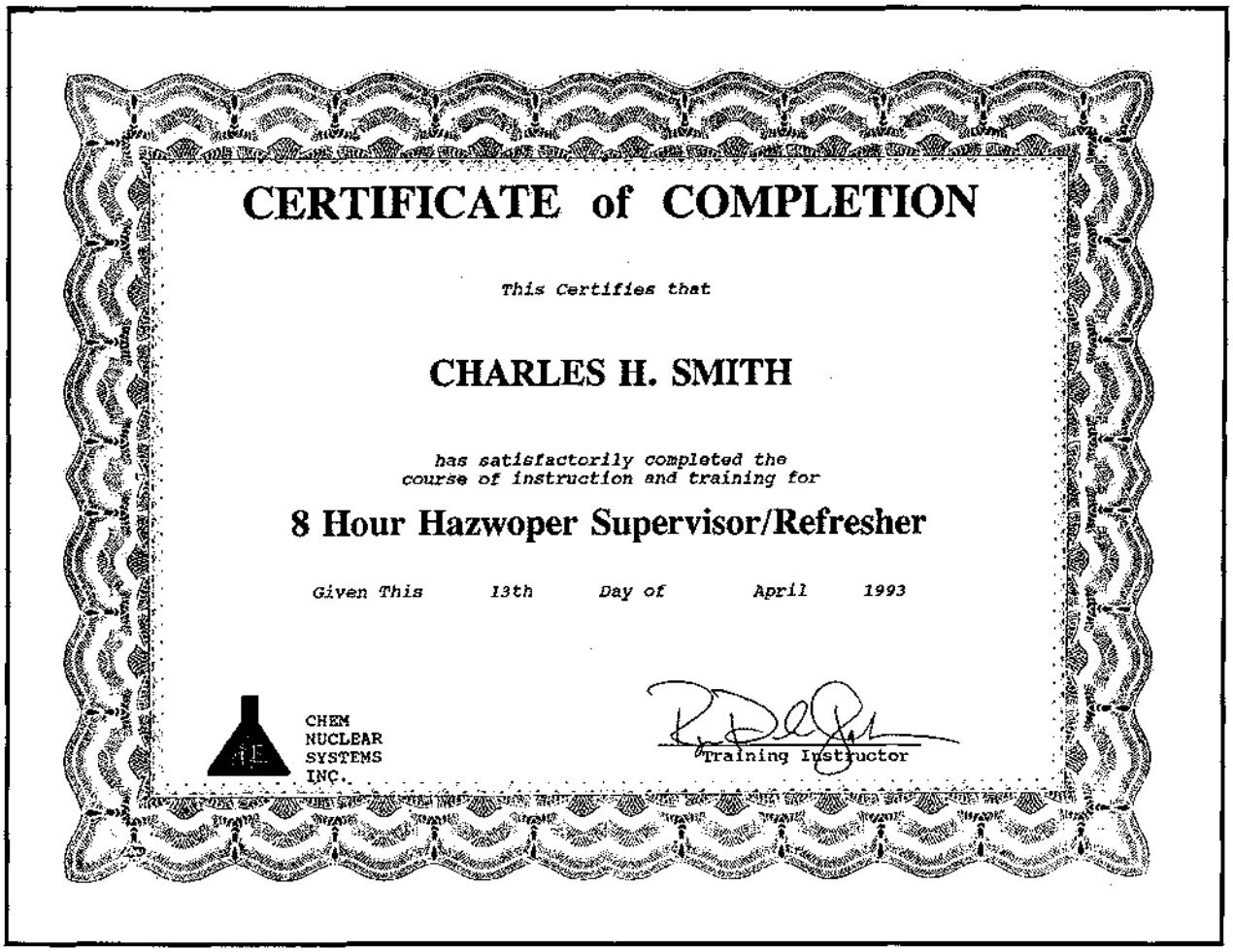
has satisfactorily completed the course of instruction and training for

40 Hour Hazwoper Training

Given This 12th Day of March 1993

CHEM NUCLEAR SYSTEMS INC.

Training Instructor



CERTIFICATE of COMPLETION

This Certifies that

CHARLES H. SMITH

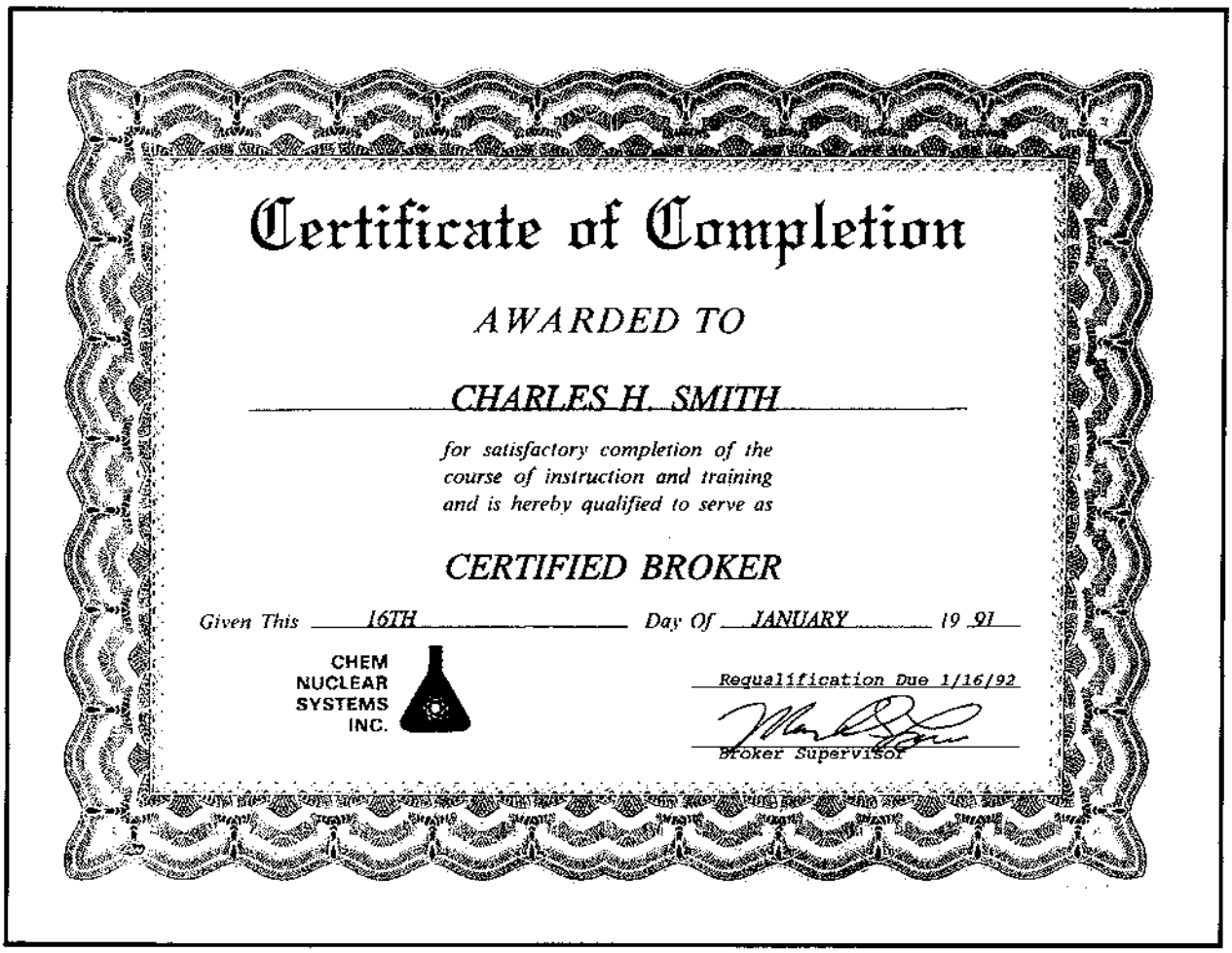
has satisfactorily completed the course of instruction and training for

8 Hour Hazwoper Supervisor/Refresher

Given This 13th Day of April 1993

CHEM
NUCLEAR
SYSTEMS
INC.

Training Instructor



Certificate of Completion

AWARDED TO

CHARLES H. SMITH

for satisfactory completion of the course of instruction and training and is hereby qualified to serve as

CERTIFIED BROKER

Given This 16TH *Day Of* JANUARY *19* 91

CHEM NUCLEAR SYSTEMS INC.

Requalification Due 1/16/92

Broker Supervisor

CHEM-NUCLEAR SYSTEMS, INC.

DATE: January 15, 1991

TO: BROKER FILE

FROM: CHAIRMAN, SAFETY REVIEW BOARD

SUBJECT: SAFETY REVIEW BOARD BROKER RECERTIFICATION

By recommendation of the Broker Subcommittee and the authority vested in me according to CNSI Procedure RA-TN-001, Rev. G, **Charles Smith** is recertified as a Radioactive Materials Broker.

This approval and certification will be presented to the next Safety Review Board meeting to ensure there are no objections.

M S Whittle 16 Jan 91
Alternate Chairman,
Safety Review Board

c: Charles Smith

BF-12-A

CHEM-NUCLEAR SYSTEMS, INC.

January 4, 1991

TO: CHAIRMAN, SAFETY REVIEW BOARD

FROM: BROKER SUBCOMMITTEE

SUBJECT: BROKER RECERTIFICATION

The Broker Subcommittee recommends the recertification of the Charles Smith by the Safety Review Board. He has successfully completed the procedural requirements, attended a refresher class, and passed the recertification exam with not less than 90%.

Evidence of the required two shipments since last recertification is documented on his Broker exam.

SUBCOMMITTEE CONCURRENCE:

(Please print name)	Signature	Date
Chairman: M.S. Whittaker	M.S. Whittaker	4 Jan 91
JOHN A. BENDER	John A. Bender	1-7-91
Michael Benjamin	Michael Benjamin	1-8-91
Joseph I. Stiles	Joseph I. Stiles	1/8/91
D. Hanshew	D. Hanshew	1-8-91
R.W. Johnson	R.W. Johnson	1/15/91
Mark S. Lewis	Mark S. Lewis	1/10/91

/nhs

TO: Charles Smith DATE: 01-05-90

FROM: Linda Bragg lb, Nuclear Plant Services/Government Programs Training Department

SUBJECT: Certification

NAME: Charles Smith SSN: 260-17-2850

EMPLOYEE #: 260172850

The above named individual has completed the Chem-Nuclear Systems, Inc. Nuclear Plant Services/Government Programs Training Program in accordance with Chem-Nuclear Systems, Inc. procedure FO-AD-005.

Certification examinations, practical factor checksheets, and refresher training records are available for audit and inspection at the Barnwell Waste Management Facility in Barnwell, SC.

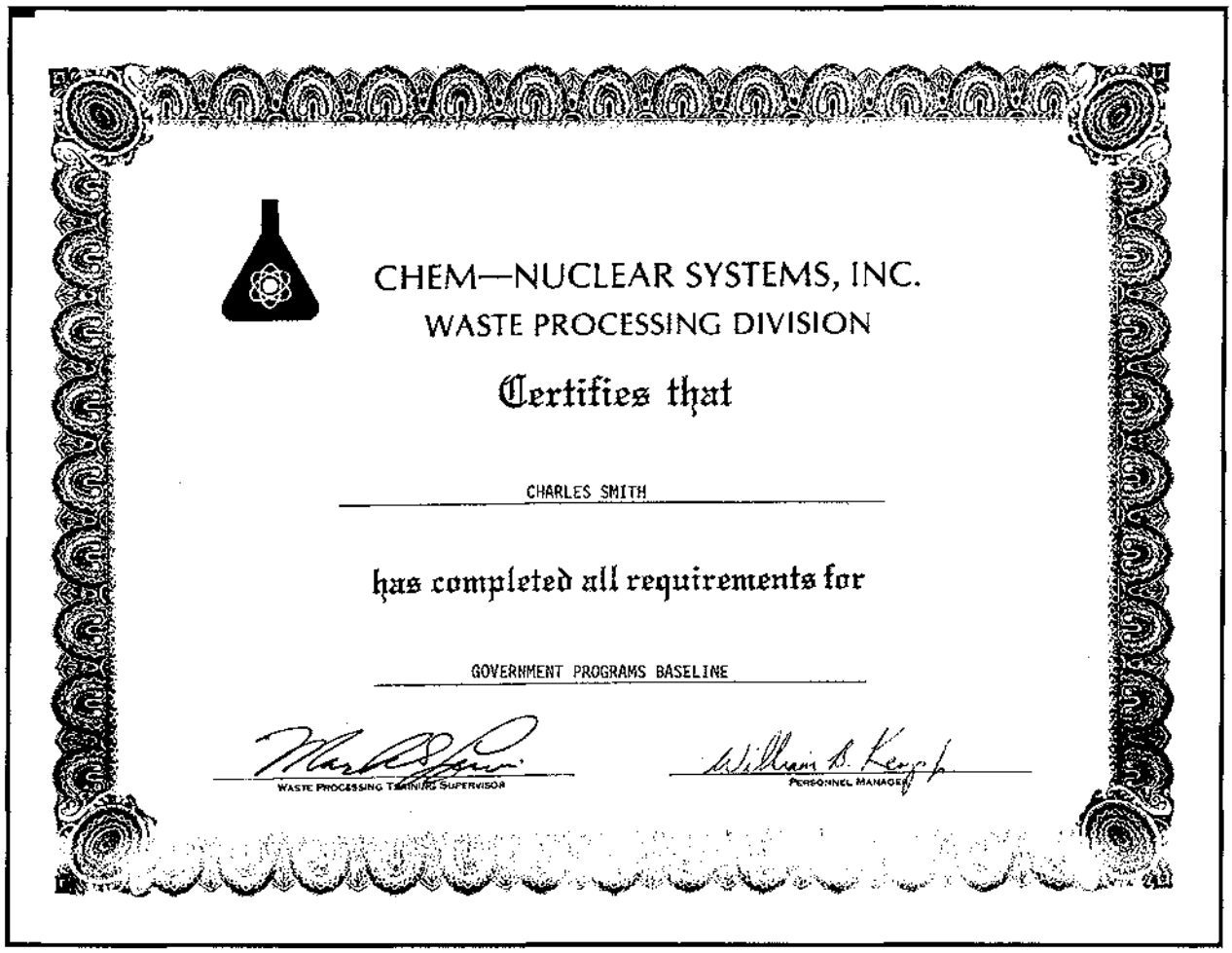
Certification is granted in the following Nuclear Plant Services/Government Programs operation(s):

Nuclear Services Junior Technician
Solidification Technician/Solidification Senior Technician
Demineralization Technician/Demineralization Senior Technician
Fuel Pool Technician/Fuel Pool Senior Technician
Dewatering Technician/RDS-1000 Dewatering Technician
Pressure/Temperature Comparison Technician
Oil Solidification Technician
(Government Programs Baseline)
Waste Treatment/Senior Waste Treatment
Radiological Control/Senior Radiological Control
Waste Management/Senior Waste Management
Cost/Scheduling/Senior Cost/Scheduling
Defense Consolidation Facility/Senior Defense Consolidation Facility
Other: _____

His/Her refresher qualification date is: N/A

Rev. 12/89

CHEM-NUCLEAR SYSTEMS, INC.



CHEM—NUCLEAR SYSTEMS, INC.
WASTE PROCESSING DIVISION

Certifies that

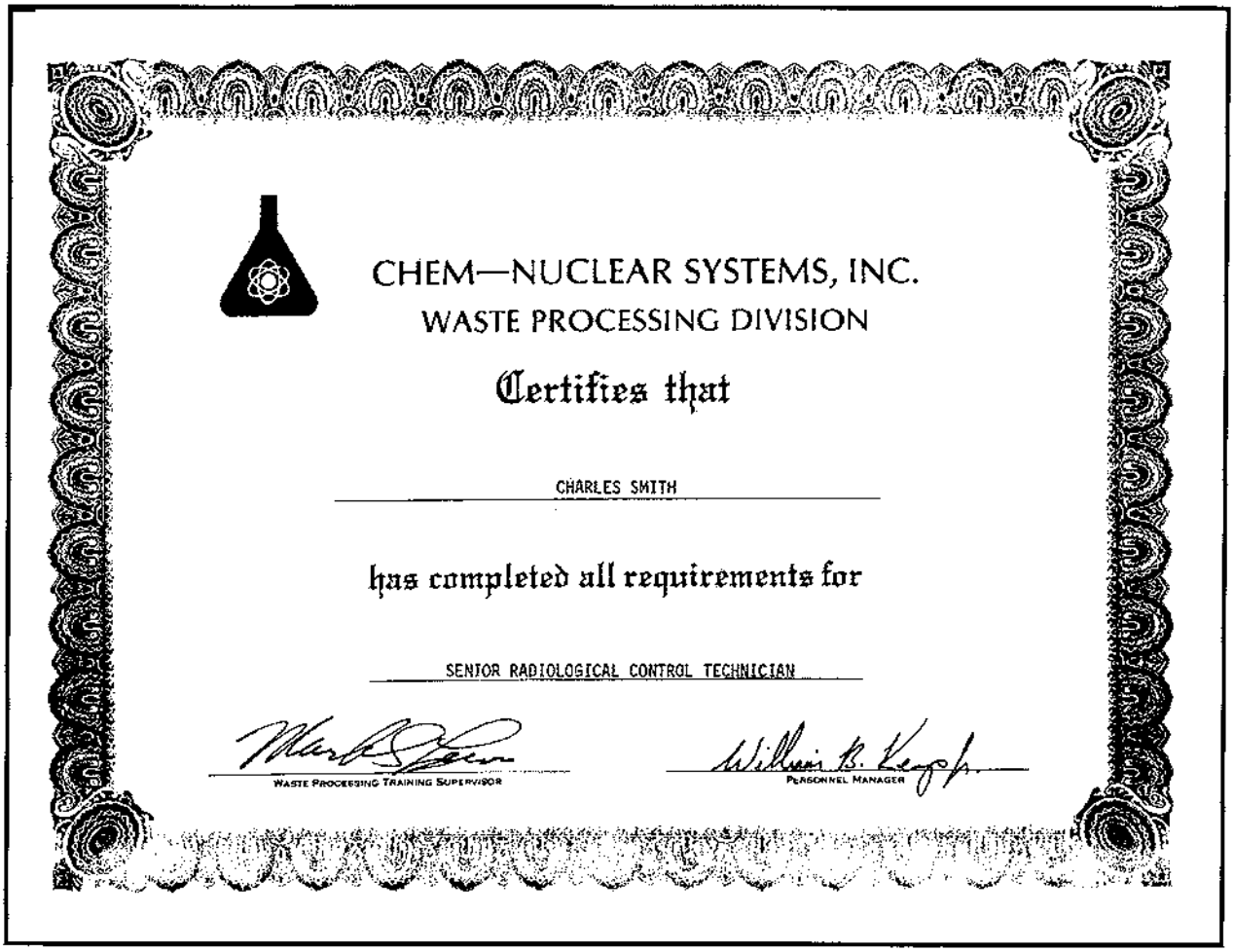
CHARLES SMITH

has completed all requirements for

GOVERNMENT PROGRAMS BASELINE

WASTE PROCESSING TRAINING SUPERVISOR

PERSONNEL MANAGER



CHEM—NUCLEAR SYSTEMS, INC.
WASTE PROCESSING DIVISION

Certifies that

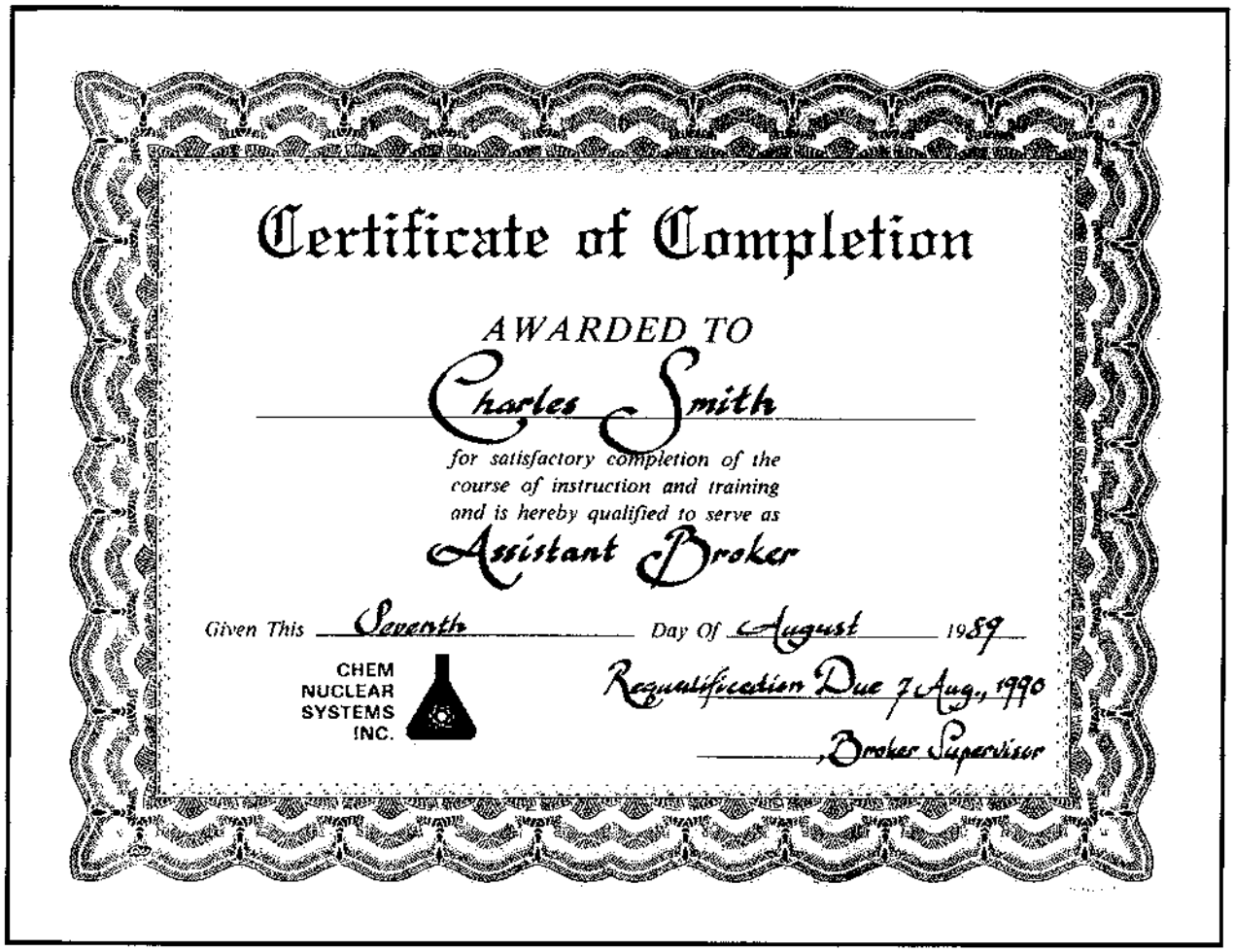
CHARLES SMITH

has completed all requirements for

SENIOR RADIOLOGICAL CONTROL TECHNICIAN

WASTE PROCESSING TRAINING SUPERVISOR

PERSONNEL MANAGER



Certificate of Completion

AWARDED TO

Charles Smith

for satisfactory completion of the course of instruction and training and is hereby qualified to serve as

Assistant Broker

Given This Seventh Day Of August 1989

CHEM NUCLEAR SYSTEMS INC.

Requalification Due 7 Aug., 1990

Broker Supervisor

TO: Charles Smith DATE: 10-13-89

FROM: Linda Bragg lb, Nuclear Plant Services/Government Programs Training Department

SUBJECT: Technician Certification

Name: Charles Smith SSN: 260-17-2850

Employee #: 260172850

The above named individual has completed the Chem-Nuclear Systems, Inc. Nuclear Plant Services/Government Programs Training Program in accordance with Chem-Nuclear Systems, Inc. procedure FO-AD-005.

Certification examinations, practical factor checksheets, and refresher training records are available for audit and inspection at the Barnwell Waste Management Facility in Barnwell, SC.

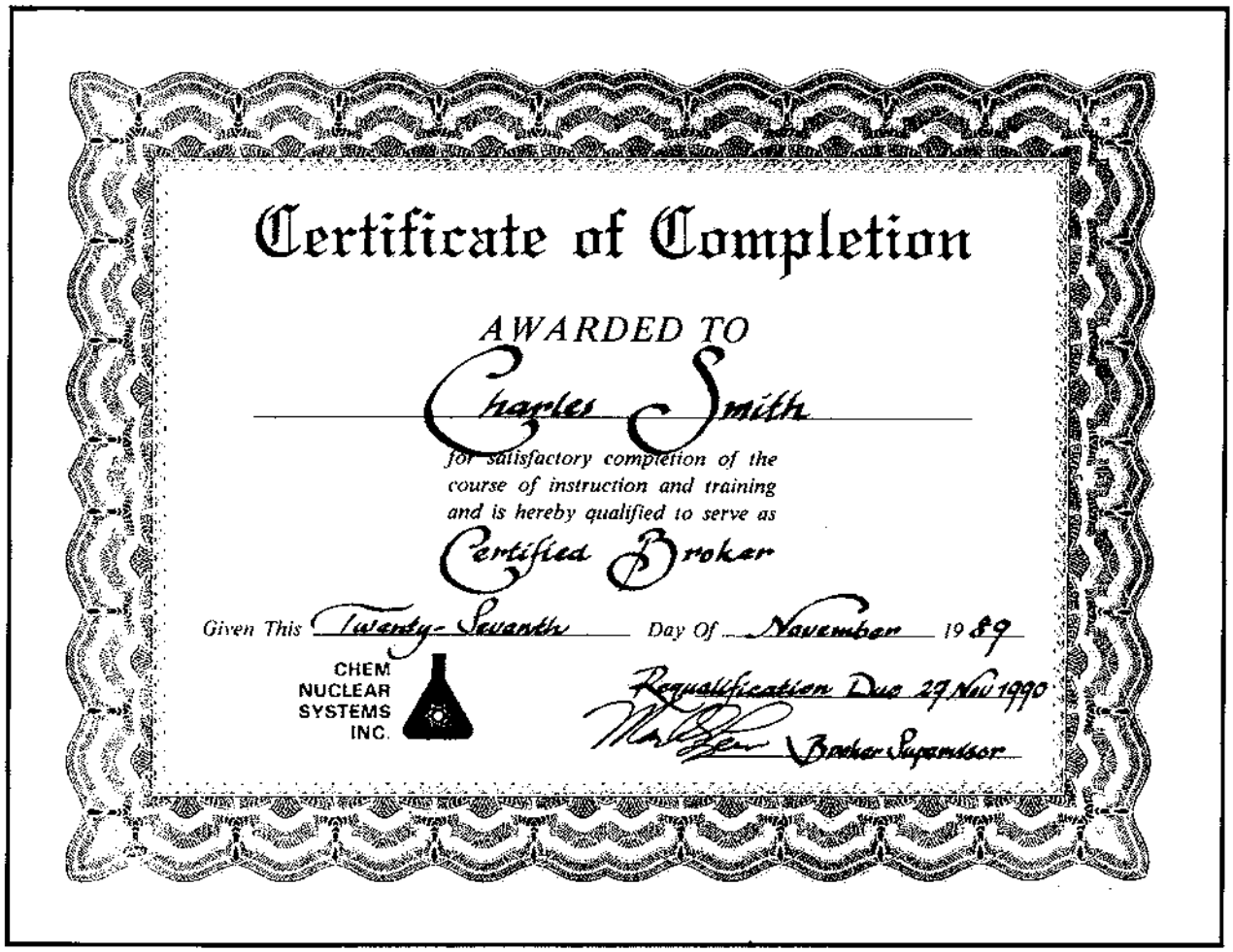
Certification is granted in the following Nuclear Plant Services/Government Programs operation(s):

Nuclear Services Junior Technician
Solidification Technician/Senior Technician
Demineralization Technician/Senior Technician
Fuel Pool Technician/Senior Technician
Dewatering/RDS-1000 Dewatering Technician
Pressure/Temperature Comparison Technician
Oil Solidification Technician
Government Programs Waste Treatment Junior Technician
Government Programs Waste Treatment Technician/Senior Technician
Radiation Control Technician
(Senior Radiological Control Technician)
Other: _____

His/Her refresher qualification date is: 10/91

Rev. 10/89

CHEM-NUCLEAR SYSTEMS, INC.



Certificate of Completion

AWARDED TO

Charles Smith

for satisfactory completion of the course of instruction and training and is hereby qualified to serve as

Certified Broker

Given This Twenty-Seventh Day Of November 1989

CHEM NUCLEAR SYSTEMS INC.

Requalification Due 27 Nov 1990

Broker Supervisor

DATE: November 27, 1989

TO: BROKER FILE: Charles Smith

FROM: CHAIRMAN, SAFETY REVIEW BOARD

SUBJECT: SAFETY REVIEW BOARD BROKER CERTIFICATION

After recommendation of the Broker Subcommittee, the Safety Review Board approves Charles Smith as a certified CNSI Radioactive Materials Broker effective November 27, 1989.

Chairman,
Safety Review Board

c: L. Sears
J. Voorhies

CHEM-NUCLEAR SYSTEMS, INC.

WMG inc.
16 BANK STREET, PEEKSKILL, NEW YORK 10566
Telephone: 914-736-7100
Telefax: 914-736-7170

July 6, 1993

Mr. Charles Smith
Maine Yankee Atomic Power Company
Maine Yankee Nuclear Station
P. O. Box 408
Wiscasset, ME 04578

Subject: Off-Site RADMAN and Regulatory Compliance Training at the WMG Training Center

Reference: Course Presented June 9-11, 1993

Dear Charlie,

Enclosed is a certificate verifying that you successfully completed WMG's training course RC-101, a comprehensive refresher course for personnel at facilities using the RADMAN computer code.

We appreciate your continued use of WMG to support your regulatory training needs.

Sincerely yours,

Michael O'Kelley
Associate

MOK/jm

Enclosure

Certificate of Completion

AWARDED TO

CHARLES SMITH

For satisfactory completion of the Site Personnel Training Program

Given This 19TH Day of JULY 1989

CHEM NUCLEAR SYSTEMS INC.

Training Co-ordinator

WMG Inc.

Presents this Certificate of Training to

CHARLES SMITH

For successfully completing the Training Course

RC-101

RADMAN AND REGULATORY COMPLIANCE

on

Radwaste Management Regulations and Practices

Presented at WMG Training Center on June 9 - 11, 1993

P. Traite
Peter T. Traite
President

Training Instructor

USEcology Nuclear

Presents this certificate to

CHARLES H. SMITH

for attending the seminar:

PACKAGING & TRANSPORTATION OF RADIOACTIVE WASTE MATERIAL

on OCTOBER 11, 12, 13, 19 88

Instructor

President

Instructor

a division of American Ecology

NetWare® 386: System Manager Course

Charles Smith
NAME

Chem Nuclear Environmental Services
COMPANY

June 29, 1990
DATE

Ray Woods
PRESIDENT

Mary Jo Bradley / Businessland
INSTRUCTOR/EDUCATION CENTER

NOVELL
EDUCATION
SERVICES

9.0 QUALITY ASSURANCE

Clean Harbors Deer Trail (CHDT) has prepared quality assurance (QA) plans and procedures for the Deer Trail landfill, as a Resource Conservation and Recovery Act (RCRA) Subtitle C landfill, to fulfill the requirements of the U.S. Environmental Protection Agency (EPA) Hazardous Solid Waste Amendments Permit. For the construction of new cells for the disposal of Naturally Occurring Radioactive Material (NORM)/Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) waste, CHDT will apply the Construction Quality Assurance (CQA) Plan, which meets the requirements of the Part B Permit issued by the Colorado Department of Public Health and Environment (CDPHE). The Plan, Attachment 10.3 to the Part B Permit **(CHDT 2004 – see Volumes 4 and 5 of this application)**,[9] addresses construction quality assurance of soils, geosynthetics, and related liner system components for secure cells and surface impoundments at the Deer Trail facility. The Plan includes the following sections:

Section I - General
Section II - Soils CQA
Section III - Geosynthetic Clay Liner CQA
Section IV - Geomembrane CQA
Section V - Geotextile CQA
Section VI - Geonet CQA
Section VII - Geocomposite CQA
Section VIII - Polyethylene Pipe and Fittings CQA
Section IX - CQA Documentation

The CQA Plan is a site-specific document that addresses personnel responsibilities, authorities, and qualifications; inspection, monitoring, and testing activities to ensure that facility construction meets or exceeds design criteria, plans, and specifications; and documentation requirements. The Plan is the basis of the discussion that follows.

[9] For ease of review, references in **bold** are in Volumes 2 through 6 of this application.

9.1 QUALITY ASSURANCE DURING DESIGN, CONSTRUCTION, AND OPERATION

This application uses the following definitions:

- Construction Quality Assurance – A planned and systematic pattern of the means and actions designed to provide adequate confidence that items or services meet contractual and regulatory requirements, and that they will perform satisfactorily in service.

- Construction Quality Control (CQC) – Those actions that provide a means to measure and control the characteristics of an item or service to meet contractual and regulatory requirements.

CQA includes actions employed by the CQA Engineer to ensure conformity of liner system preparation, production, and installation with the CQA Plan, General Specifications, and Construction Drawings. CQA is provided by a party independent from the product Manufacturer and the Contractor.

CQC includes actions taken by manufacturers, suppliers, contractors, or owners, and their designated representatives, to ensure that materials and workmanship meet the requirements of the General Specifications and Construction Drawings. For soils, CQC is typically part of CQA requirements and is provided by the CQA Engineer. For geosynthetic and other nonsoil components, the manufacturers and installers of the geosynthetics provide CQC.

9.1.1 Organization

Figure 9.1 is a typical project organization chart for the construction of secure cells and surface impoundments. The following paragraphs discuss the principal parties to cell construction:

- Design Engineer. The Design Engineer is the individual, firm, or corporation with direct responsibility for the design of the secure cell or surface impoundment. During construction, the Design Engineer must approve any significant deviation from the design requirements of the Contract Documents. The Design Engineer can be a CHDT

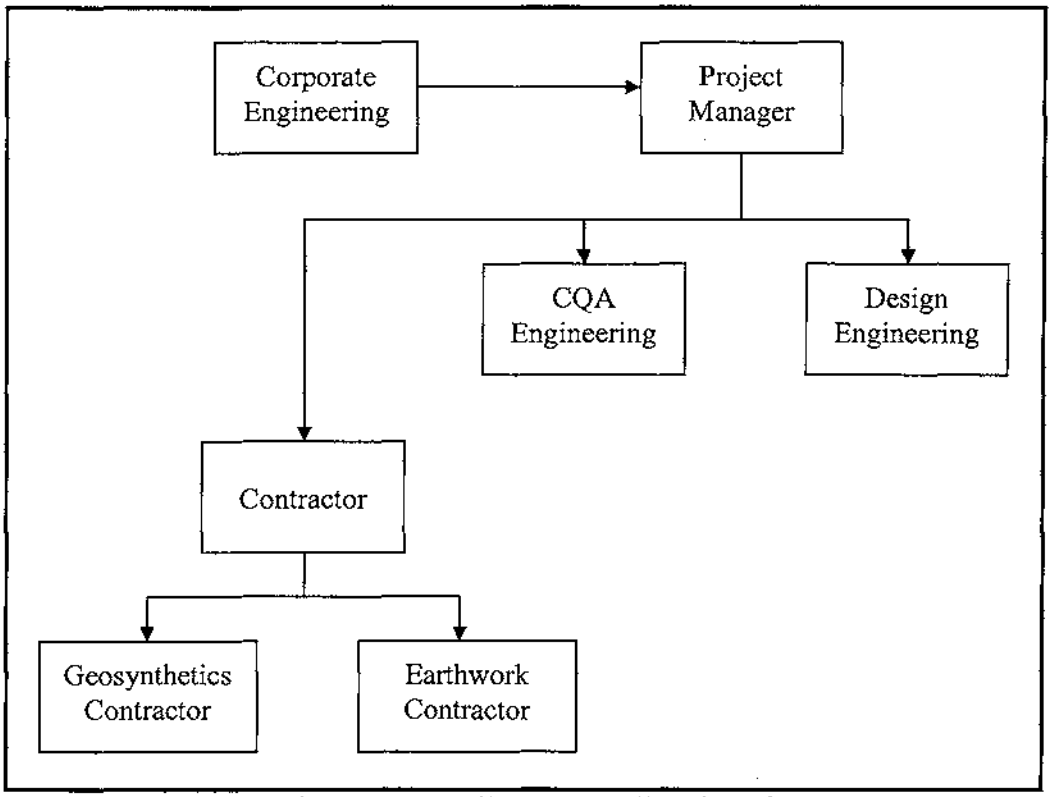


Figure 9.1. Clean Harbors Deer Trail Secure Cell and Surface Impoundment Project Organizational Chart.

employee. The individual representing the Design Engineer who is directly responsible for the project must be a registered Professional Engineer in the State of Colorado.

- Contractor. The individual, firm, or corporation undertaking execution of the work under the terms of the Contract Documents. The Contractor might be responsible for constructing the entire liner system (earthwork and geosynthetics) or selected components of the system. Reference to Contractor refers to the General Contractor and all subcontractors the General Contractor might employ to meet the requirements of the Contract Documents.

- Manufacturer. The Manufacturer manufactures a specific component (e.g., geomembrane, geosynthetic clay liner, geotextile, geocomposite, geonet, or pipe) of the proposed liner system and delivers the component to the Contractor at the site. In the General Specifications, the term Manufacturer can refer to the geomembrane, geotextile, geocomposite, geonet, or pipe manufacturer.

- Construction Quality Assurance Engineer. The CQA Engineer is an individual, firm, or corporation, independent from CHDT, Contractor, and Manufacturer, that observes, tests, and documents activities related to the CQA of the earthworks at the site, and observes, tests, and documents activities related to the CQA of installation of the geosynthetic components of the liner system. The CQA Engineer (or designated experienced field personnel) observes, tests, and documents activities related to the CQA of pipes and other liner system components. The CQA Engineer must provide experienced field personnel who can manage CQA activities under the direct supervision of a Professional Engineer registered in the State of Colorado. The CQA Engineer can be the same as the Design Engineer, but must be independent from CHDT.

- Soils Construction Quality Assurance Laboratory. The Soils CQA Laboratory is independent from CHDT, gravel supplier, granular material supplier, and Contractor. This Laboratory conducts tests in a laboratory that could be on or off the site on samples of soil from the borrow pits, stockpiles, or liner system.

- Geosynthetics Construction Quality Assurance Laboratory. The Geosynthetics CQA Laboratory is independent from CHDT, resin supplier, Manufacturer, and Contractor. This Laboratory conducts tests on samples of geosynthetics from the site, and might conduct tests on pipes or other liner system components. The Laboratory service cannot be provided by any party involved with the manufacture or installation of any of the geosynthetic components.

9.1.2 Quality Assurance Program

The CQA Plan includes CQA of the subgrade, and soil, pipe, and geosynthetic components of the liner and cover system. The Plan also includes CQA of manufacturing, shipping, handling, and installation of geosynthetics and pipe. It does not address design guidelines, installation specifications, or selection of soils, geosynthetics, pipe, or other liner system components that are described in the General Specifications. The Plan does not include Construction Quality Control, which the Contractor can undertake independently to facilitate the achievement of Contractor requirements under the General Specifications.

In addition to the CQA Plan for secure cell construction, CHDT has Quality Assurance Project Plans for laboratory activities and environmental sampling. These plans follow guidance from *The EPA Quality Manual for Environmental Programs* and *EPA Guidance for Quality Assurance Project Plans (QA/G-5)* (EPA 1998), which provide suggestions for EPA and non-EPA organizations on preparing, reviewing, and implementing QA Project Plans that satisfy the requirements defined in this document.

9.2 DESIGN CONTROLS

Prior to the start of construction of each secure cell, CHDT will execute the subsurface investigation described in this section. The investigation will include test borings, sampling, and analysis in the area selected for the cell location.

9.2.1 Test Borings

At a minimum, test borings will be made at each corner and in the center of the cell (five total). Additional test borings can be performed at the discretion of CHDT, depending on the variability of the stratigraphy at a given cell location. The number of test borings required within the cell perimeter will be kept to a minimum. The Contractor should not assume that sufficient subsurface information will be developed to accurately reflect soil or bedrock conditions at all locations in the project area.

Test borings will be to depths selected by CHDT. The borings at the perimeter of the cell will penetrate at least 10 feet below the lowest planned excavation. Other test borings inside the cell perimeter could be advanced to a shallower depth as directed by CHDT.

A qualified geologist or geotechnical engineer supplied by CHDT will log each test boring. Accurate logs of the materials encountered will be maintained. The boring logs will include the method of drilling, diameter of the borehole, and other pertinent information.

The type and characteristics of the soil or bedrock encountered, as well as strata depths and thicknesses, will be evaluated from the test borings and noted on the boring logs. The geologist or geotechnical engineer will investigate the macrostructure of the strata. The boring log will include a detailed description of these features.

If water is encountered during drilling, the water level in each test boring will be observed and recorded. The initial water level and the water level after a 24-hour period (or cave-in depth, should that situation occur) will be noted.

After drilling, logging, sampling, and water level measurement, each test boring will be decommissioned. Decommissioning will be accomplished by grouting using the tremie method with a grout mix of 7 gallons of water to 1 bag (94 lb) of Type 1 Portland cement and 2% bentonite (by dry weight of cement). Test borings will be grouted to their full depth after the 24-hour water level reading. The boring log will record the amount of grout used at each borehole.

9.2.2 Sampling and Record Keeping

Soil samples will be taken from the borings and carefully transported to the laboratory to minimize disturbance of the soil and thereby maintain its physical and index properties and other pertinent *in situ* characteristics.

At least two of the five borings (at opposite corners of the cell) will be sampled semicontinuously (typically at 2-foot intervals) to a minimum depth of 40 feet and sampled at 5-foot intervals thereafter. Depending on the subsurface conditions encountered in the test borings, the remaining borings might also be sampled semicontinuously or, as an alternative, they might be sampled at a predetermined sample interval not to exceed 5 feet. Typically, cohesive soils will be sampled by hydraulically advancing a thin-walled tube sampler, and cohesionless soils will be sampled by driving a 2-inch-diameter, split-spoon sampler. A pitcher-barrel sampler, dennison sampler, or other sampler could be used, depending on the actual soil conditions encountered in the borings.

9.2.3 Laboratory Analysis

Laboratory tests will be performed on selected soil samples recovered from the test borings to characterize the samples to develop a description of subsurface conditions at the boring locations. Tests will include, but might not be limited to, moisture content, Atterberg limits, permeability (clays), particle size, and standard Proctor compaction. Not all tests will be performed on all samples.

9.2.4 Surveying

A licensed Land Surveyor in the State of Colorado will survey the locations and elevations of the test borings before the test borings are decommissioned.

9.2.5 Geotechnical Report

A geotechnical report will provide field and laboratory data, including documentation of the borehole grouting. A Professional Engineer registered in the State of Colorado or a qualified geologist will prepare the report, which will provide boring logs, laboratory test results, cross-sections of subsurface soil, bedrock, and groundwater conditions encountered in test borings at proposed cell locations, and other information that might be pertinent to cell construction and applicable regulations.

9.2.6 Other Subsurface Investigation Techniques

Electrical resistivity, seismic refraction, or other remote sensing techniques might be utilized in conjunction with the sample borings.

9.3 PROCUREMENT CONTROL

When procuring the services of specific parties for construction of the secure cells, the following qualifications will be required.

9.3.1 Design Engineer

The representative of the Design Engineer who is directly responsible for the project will be a qualified Professional Engineer registered in the State of Colorado. The Design Engineer will have a history that demonstrates familiarity with all liner system components, including detailed design methods and procedures.

9.3.2 Geomembrane Installer

The Geomembrane Installer (who could be either the Contractor or a subcontractor) will be trained and qualified to install geosynthetics and other liner system components such as pipe, if necessary. All personnel performing seaming operations will be qualified by experience (i.e., each seamer will have installed no less than 100,000 square feet of geomembrane using the same seaming methods as those used on this project). At least one seamer will have experience

seaming a minimum of 1,000,000 square feet of geomembrane using the same method as that used on this project. The most experienced seamer, the "master seamer," will provide direct supervision, as required, of less experienced seamers. Field seaming cannot occur without an approved master seamer present. The Contractor will provide CHDT and the CQA Engineer with a list of proposed seaming personnel and their professional records; personnel deemed insufficiently experienced will not be accepted by CHDT or will be required to pass a seaming test prior to working on the project.

9.3.3 Construction Quality Assurance Engineer Personnel

Personnel representing the CQA Engineer shall be properly trained and qualified to test and inspect soils, including high- and low-permeability soils; geosynthetics including geomembranes, geotextiles, geocomposites, and geonets; and pipe. The CQA Engineer will be represented by an experienced field person with direct responsibility for management of CQA activities. The field personnel will be experienced in construction, CQA of soils; CQA of geosynthetics and pipe; and preparation of CQA documentation including forms, reports, and plans. This person will perform under the direct supervision of a registered Professional Engineer.

9.3.4 Soils Construction Quality Assurance Laboratory

The Soils CQA Laboratory will have experience with the physical testing of soils, meet all applicable regulatory requirements, and be familiar with American Society for Testing and Materials (ASTM) and other required test standards. The Laboratory will be capable of providing test results in accordance with the specifications.

9.3.5 Geosynthetics Construction Quality Assurance Laboratory

The Geosynthetics CQA Laboratory will have experience in testing geosynthetics and other relevant liner system components and be familiar with ASTM and other applicable test standards.

9.4 DUTIES OF THE CONSTRUCTION QUALITY ASSURANCE ENGINEER

The overall responsibility of the CQA Engineer is to perform the activities specified in the CQA Plan (e.g., inspection, sampling, testing, and documentation final certification). At a minimum,

the CQA Engineer will be represented by an onsite CQA Engineer and necessary supporting CQA inspection personnel. Specific responsibilities of the CQA Engineer could include:

- Reviewing design criteria, plans, and specifications for clarity and completeness to enable implementation of the CQA Plan.
- Educating CQA inspection personnel on CQA requirements and procedures.
- Scheduling and coordinating CQA inspection activities.
- Directing and supporting CQA inspection personnel in performing observations and tests by:
  - Confirming that regular calibration of testing equipment is properly conducted and recorded;
  - Confirming that testing equipment, personnel, and procedures do not change adversely over time and verifying that changes do not adversely affect the inspection process;
  - Confirming that test data are accurately recorded and maintained; and,
  - Verifying that raw data are properly recorded, validated, reduced, summarized, and interpreted.
- Providing to CHDT reports on the inspection results including:
  - Review and interpretation of data sheets and reports;
  - Identification of work the CQA Engineer believes should be accepted, rejected, or uncovered for observation, or that might require special testing, inspection, or approval; and,
  - Rejection of defective work and verification of the implementation of corrective measures.

- Verifying that the Contractor's construction quality control plan, if required, is in accordance with the site-specific CQA Plan.

- At the request of CHDT, reporting to the Contractor results of observations and tests as the work progresses and interacting with the Contractor to provide assistance in codifying the materials and work to comply with the specified design.

- Providing the final report and certifications required by the CQA Plan.

Specific responsibilities for CQA inspection personnel could include:

- Performing independent onsite inspections of the work in progress to verify conformance with facility design criteria, plans, and specifications;

- Verifying that the equipment used in testing meets test requirements and that the tests occur according to the standardized procedures defined by the CQA Plan; and,

- Reporting to the CQA Engineer results of all inspections, including work that is not of acceptable quality or that fails to meet the specified design.

9.5 DOCUMENT CONTROL

An effective CQA plan depends largely on recognition of all construction activities that require monitoring, and on assigning responsibilities for the monitoring of each activity. This is accomplished most effectively and verified by the documentation of CQA activities. The CQA Engineer will document that all QA requirements have been addressed and satisfied.

The CQA Engineer will provide CHDT with signed descriptive remarks, data sheets, and logs to verify and document the performance of all monitoring activities. CHDT will maintain at the site a complete file of Construction Drawings, the CQA plan (Part B Permit Attachment LF-10), the General Specifications (Part B Permit Attachment LF-1), test procedures, daily reports, testing logs, and other pertinent forms and documents. The forms used for CQA documentation should include, at a minimum, those presented in the CQA Plan. The CQA Engineer can revise these forms as necessary.

- Daily Recordkeeping. Daily records completed in the field will document CQA project administration, soils CQA, geosynthetics CQA, and other required CQA activities. The forms to be completed that pertain to each of these categories are discussed below.

- Project Administration Records. The CQA Engineer will complete most project administration records daily and submits them weekly to CHDT. Examples of these records are included in the State RCRA Permit Application, Appendixes A, B, and C, and are described below **(CHDT 2004 – see Volumes 4 and 5 of this application).**

- Daily Field Report. The CQA Engineer will prepare a Daily Field Report and submit it weekly to CHDT. At a minimum, the Daily Field Report will include the following information:

  - The date, project name, location, and other identification
  - A narrative of events and activities, including meetings and observations that occurred during a given day
  - Weather conditions
  - Source and amount of water used to construct the clay liner, if any
  - The name of parties to any discussions
  - The relevant subject matter or issues
  - Activities planned and performed
  - The schedule
  - The signature of the CQA Engineer

- Daily Temperature Log. The CQA Engineer will record ambient temperatures and liner temperatures on the Daily Temperature Log at various times during the day. This log will be available for review at the site and will be part of the Final Report.

- Personnel Daily Log. The CQA Engineer will prepare the Personnel Daily Log at the beginning of the project and will update it each day. This log will list Contractor and CQA Engineer personnel involved with the project, and will be a record of attendance for each day. This log will be available for review at the site and will be part of the Final Report.

- Contractor Personnel Log. The CQA Engineer will prepare the Contractor Personnel Log at the beginning of the project and will update it as required. This log will summarize Contractor and CQA Engineer personnel involved in the project (on and off the site), describe their positions, and list their periods of involvement with site work. It will be available for review at the site and will be part of the Final Report.

- Weekly Field Report. On a weekly basis, the CQA Engineer will summarize the activities recorded on the Daily Field Reports in a Weekly Field Report, and will submit it each week to CHDT along with the Daily Field Reports; the report will include, at a minimum, the following information:

  - The date, project name, location, and other information
  - A summary of work activities during the reporting period
  - A summary of construction situations, deficiencies, and defects occurring during the reporting period
  - A summary of actions taken to remedy such situations, deficiencies, and defects
  - A summary of test results, failures, and retests; and
  - The signature of the CQA Resident Engineer

- Soils CQA Records. The CQA Engineer will complete records kept for soil-related activities. The information will be recorded as testing occurs in the field or as results are received from the laboratory. The records will be available for review on the site, and will be part of the Final Report. Examples of the relevant forms are included in Appendix B and are listed below.

- Field Laboratory Compaction Test Log (ASTM D 698 Method A, B, C, D and ASTM D 1557 Method A, B, C).

- The results of field compaction tests will be recorded on the Field Laboratory Compaction Test Log. Separate forms are available for each test method used.

- Field Sand Cone and Rubber Balloon Density Test Log. The results of the sand cone and rubber balloon *in situ* density test on soils will be recorded on the Field Sand Cone or rubber balloon Density Test Log. The results will be used for comparison or calibration with nuclear density test results.

- Geosynthetics CQA Records. The CQA Engineer will complete records for the installation of geosynthetics. The information will be recorded as work progresses. The records will be available for review on site and will be part of the final CQA report.

- Certificate of Acceptance Subgrade Surface. The Contractor must sign the Certificate of Acceptance prior to installation of the geomembrane. The certificate must describe the area being accepted.

- Survey Records. The CQA Engineer and CHDT will review Record Drawings resulting from surveys by the CQA Surveyor. The drawings will be available for review on the site, and copies will be issued as part of the final CQA Report issued by the CQA Engineer. At a minimum, these Record Drawings will include as-built survey data for the following liner system components:

  - Excavated subgrade;
  - Structural fill;
  - Secondary clay liner;
  - Primary clay liner;
  - Polyethylene pipe and fittings;
  - Geomembrane liners;
  - Granular leachate collection layer; and,

- Protective soil layer.

- Photographic Documentation. Photographic documentation will serve as a pictorial record of work progress, problems, and mitigation activities. The basic file will contain color prints; negatives will be stored in a separate file in chronological order. These photographs will be available for review by CHDT, the CQA Engineer, and other interested parties. Selected photographs will be part of the Final Report. The remaining photographs will be transmitted to CHDT and archived as part of the operating records.

- Design or Specification Changes. Design or specification changes could be required during construction. In such cases, the CQA Engineer will notify CHDT, who will notify CDPHE, and, when necessary, the Design Engineer. Major design or specification changes will occur only with the written agreement of the Design Engineer and CHDT and will take the form of an addendum to the General Specifications.

- Signatures and Final Report. At the completion of the work, the CQA Engineer will submit a final CQA report to CHDT. At a minimum, this report will include summaries of all construction activities; sources and amounts of water used to construct the clay liners; results of chemical quality analyses of construction water from each source; observation logs and testing data sheets including sample location plans; a discussion of changes from design and material specifications; CQA Record Drawings; and a summary statement sealed and signed by a Professional Engineer registered in the State of Colorado that construction quality assurance was as described in the CQA Plan and, based on visual observations and data generated in accordance with the CQA Plan, secure cell or surface impoundment construction was in accordance with Construction Drawings, the CQA Plan, and General Specifications, except as properly authorized and documented in the CQA final report. CQA Record Drawings will include the following: primary and secondary geomembrane panel layout drawings; all drawings (including cross-sections) showing deviations from the Construction Drawings; and all survey conformance data.

9.6 CONTROL OF PURCHASED MATERIAL, EQUIPMENT, AND SERVICES

As an example of control of purchased material, equipment, and services, the following paragraphs are relevant to geosynthetic clay liner (GCL) manufacture and delivery.

- Manufacture and Quality Control. Prior to installation of the GCL, the Contractor will provide the CQA Engineer with the following information from the GCL Manufacturer:

  - The certification required by the General Specifications signed by a responsible party employed by the GCL Manufacturer based on sampling interval of 1/40,000 ft^2; and,

  - The manufacturing quality control certificates for each shift's production of GCL, signed by a responsible party employed by the GCL Manufacturer (such as the production manager). The quality control certificates will include:

    1.0 Roll numbers and identification; and

    2.0 Sampling procedures and results of quality control tests specified by the General Specifications including descriptions of the test methods used for GCL rolls assigned to the project.

  The CQA Engineer will verify and document that:

  - The property values certified by the GCL Manufacturer meet all the values specified in the General Specifications;

  - The measurements of properties by the GCL Manufacturer are properly documented and the test methods used are in accordance with the General Specifications; and,

  - The quality control certificates have been provided at the specified frequency for GCL rolls, and each certificate identifies the rolls or batch number related to that certificate.

  The CQA Engineer will report deviations from the above requirements to CHDT prior to installation of the GCL.

Identification and Control of Material, Parts, and Components

A field panel is the unit area of GCL to be placed in the field (i.e., a roll or a portion of roll cut in the field). The CQA Engineer will verify that each field panel receives an identification code (number or letter/number) consistent with the layout plan. CHDT and the Contractor will agree on this code, which should be as simple and logical as possible. (Note: manufacturing plant roll numbers are usually cumbersome and are not related to location in the field.) It will be the responsibility of the Contractor to ensure that each field panel placed is marked with the manufacturing plant roll number. The roll number will be marked in the center of the panel in a color to enable easy inspection. The CQA Engineer will establish a table or chart showing the correspondence between manufacturing plant roll numbers and field panel identification codes. The field panel identification code will be used for all CQA records.

9.7 INSPECTION

The CQA Engineer will conduct a visual inspection of all rolls when they are delivered at the site for defects and for damage. This examination will occur without unrolling rolls unless there are visible defects or damage. The CQA Engineer will indicate to CHDT:

- Any rolls that should be unrolled to enable their inspection;
- Any rolls, or portions thereof, that should be rejected and removed from the site because they have severe flaws; and,
- Any rolls that include minor repairable flaws.

9.8 TEST CONTROL

Either at the Manufacture's plant or on delivery of the GCL rolls, the CQA Engineer will ensure that samples are removed at the specified frequency and forwarded to the Geosynthetics CQA Laboratory for testing to verify and document conformance with the General Specifications..

Unless otherwise specified, samples will be taken at a rate of one per lot or one per 100,000 ft^2, whichever is greater. These samples will be tested for:

- Bentonite Moisture Content ASTM D 4643

- GCL Grab Strength, Elongation, Per Strength ASTM D 4632
- GCL Permeability ASTM D-5887
- GCL Interface Shear Strength ASTM D 5321

Conformance samples will be taken across the entire width of the roll and will not include the first 3 feet along the length of the roll. Unless otherwise specified, samples will be 1.5 feet (minimum) long by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow; examine all results from laboratory conformance testing and compare the results to the specifications in Table 02780-1 of the General Specifications; and report any nonconformance to CHDT as soon practical after the test results are available. The following procedure will apply when a sample fails a conformance test by the Geosynthetics CQA Laboratory:

- The Contractor will be required to replace the roll (or rolls) of geotextile not in conformance with the specifications with a roll (or rolls) that meets the requirements of the General Specifications.

- The CQA Engineer will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the roll from which the failed sample was obtained. These two samples must pass the conformance tests discussed above. If either of these samples fails to meet requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed samples and tested by the Laboratory. These 10 samples must pass the conformance tests discussed above. If any of these samples fail, the Laboratory must conformance-test a sample from every roll of geotextile on the site and from every roll that is subsequently delivered from the same Manufacturer. The Contractor will bear the costs of all such tests.

- The CQA Engineer will document actions taken in conjunction with conformance test failures and report all actions to CHDT.

9.9 CONTROL OF MEASURING AND TEST EQUIPMENT

Processes approved by the General Specifications for field seaming are extrusion seaming and fusion seaming. Proposed alternative processes must be documented and submitted to CHDT for approval. Only seaming apparatus that CHDT has specifically approved by make and model will be used. The Contractor will use a pyrometer to ensure achievement of accurate temperatures of the extrudate and seamer nozzle. The extrusion-seaming apparatus will have gauges that indicate the temperatures of the extrudate and nozzle. The Contractor will provide to the CQA Engineer the Manufacturer certification that the extrudate is compatible with the General Specifications and consists of the same resin as the geomembrane. The CQA Engineer will log ambient temperatures, seaming apparatus temperatures, and extrudate temperatures or fusion-seaming apparatus speeds. Ambient temperatures will be measured as specified in the General Specifications.

9.10 HANDLING, STORAGE, AND SHIPPING

The CQA Engineer will:

- Verify and document that the GCL Manufacturer has labeled each roll of GCL as specified in the General Specifications;
- Examine GCL rolls on delivery and report deviation from the above requirements to CHDT prior to installation of the GCL;
- Observe and document that the type of GCL handling equipment used by the installer is consistent with handling equipment identified in the General Specifications; and
- On delivery of the rolls to the site, conduct a visual inspection of all rolls for defects and for damage. This examination will occur without unrolling rolls unless there are visible defects or damage.

The CQA Engineer will indicate to CHDT:

- Any rolls that should be unrolled to enable their inspection;

- Any rolls, or portions thereof, that should be rejected and removed from the site because they have severe flaws; and,

- Any rolls that have minor repairable flaws.

The CQA Engineer will verify and document that storage of the GCL is in accordance with the General Specifications.

9.11 INSPECTIONS, TESTS, AND OPERATING STATUS

An inspection is an examination or measurement that verifies conformance of an item to specified requirements or criteria, as discussed below.

9.11.1 Criteria

Inspection criteria are typically defined in applicable Federal and state regulations or site-specific permits. They can be referenced or repeated in procedures or instructions. Procedures or instructions often specify that:

- Inspections be performed by personnel who did not perform the work being evaluated.

- Criteria be defined for when inspections are required (including frequency) or how and when they are to be performed.

The inspection process should identify problems; initiate, recommend, or provide solutions; and verify implementation of corrective actions for problems identified by previous inspections.

9.11.2 Inspection Procedures

Inspections will occur in accordance with CHDT inspection procedures, instructions, or checklists, and will include the following, as applicable:

- Identification of characteristics and activities to be inspected
- Description of the method of inspection (e.g., visual)
- Identification of the individuals performing the inspection
- Acceptance and rejection criteria

- Documentation of corrective action(s)
- The results of the inspection, signed (and/or initialed) and dated by the inspector

9.12 NONCONFORMING MATERIAL, PARTS, OR COMPONENTS

When an inspection has identified a serious nonconformance in the use, movement/ installation, or operation of items, instruments, or equipment, the nonconformance status will be indicated on the items or in documents traceable to the items. Examples of status indicators are the use of tags, labels, or other means (e.g., taping off an area) to inform personnel that:

- Equipment is broken and should not be used.
- There has been a incident in the area and the area has been secured and should not be disturbed.

Removal of nonconformance status indicators can occur only after documentation of the corrective action and approval from the appropriate facility department manager.

9.13 CORRECTIVE ACTIONS

Nonconformances will be identified utilizing the process specified in the CHDT Quality Assurance Plan **(CHDT 2004 – see Volumes 4 and 5 of this application).** Documentation of each nonconformance will use the audit or inspection report. Documentation will, as applicable, include:

- Identification of the individuals identifying the nonconformance
- Description of the nonconformance
- A decision by the department manager on the appropriate corrective action
- Notification to all persons who must be notified of the nonconformance

9.13.1 Initiation of Corrective Actions

When a nonconformance has been identified, the need for corrective action will be documented and reported on the audit or inspection form. Depending on the nature of the nonconformance, the report will be submitted to the Manager of Health and Safety or

Environmental Compliance, or the specific Department Manager. The responsible manager must evaluate the need for corrective action. If corrective action is required, the manager is responsible for working with other departments and facility management to resolve the nonconformance. Effective corrective action includes:

- Documentation of Corrective Action and Close-out
- Determination of the procedure, equipment, training, etc., needed to remove the nonconformance
- For long-term corrective actions, if necessary, development of a schedule describing the plan to remedy the nonconformance
- When appropriate, a root cause analysis

9.13.2 Documentation of Corrective Action

The responsible person evaluating the corrective action will document it. Documentation will, as applicable, include:

- Identification of the individuals defining and implementing the corrective action
- Description of the corrective action
- Reference to the inspection or audit report
- Verification of completion of the corrective action.

9.14 QUALITY ASSURANCE RECORDS

To facilitate management involvement in the CHDT Quality Program, the corporate Director of Quality Assurance or a designee will conduct periodic management assessments. The assessment will include a summary of internal and external audits performed on the facility as well as an overall quality performance analysis. In addition, an assessment of the effectiveness of inspection, audits, and SOPs will be summarized. The QA reports can include the following:

- Training sessions conducted

- Quality trend analysis that identifies any increase or decrease in the quality of work performed at the facility
- Audits/reviews and inspections conducted on the facility
- Effectiveness of the facility Quality Assurance Plan
- Actions taken to incorporate changes into the facility Quality Assurance Plan and Standard Operating Procedures

In addition, the facility has developed Key Performance Indicators (KPIs) to measure and report on various aspects of facility quality and performance. KPIs can include measurements such as waste acceptance cycle time, customer service feedback, basin failure ratio, and safety incident statistics.

9.15 AUDITS, SURVEILLANCES, AND MANAGERIAL CONTROLS

Audits of the CHDT facility are conducted periodically by independent individuals and/or organizations.

9.15.1 Performance and Systems Audits

QA performance and system audits consist of internal, customer, regulatory, and third-party audits. The results of these audits and/or inspections are recorded and measured in terms of system, procedure, or policy conformance. Documentation of corrective actions is required in accordance with Section 14 of the Quality Assurance Plan.

9.15.2 External Audits

The Deer Trail facility is subject to Federal, State, and private industry audit programs:

- Federal Agency Audits. Deer Trail has been audited by EPA, the U.S. Department of Transportation, and the Occupational Safety and Health Administration.
- State Agency Audits. Deer Trail is audited by CDPHE on a regular basis for compliance with the hazardous waste Part B Permit.

- Private Industry Audits. From time to time the Deer Trail facility is audited by its major customers.

- Third-Party Audits. From time to time, the Deer Trail facility might engage an independent consultant to audit the facility against the guidelines established by the facility permit. Results of these external audits provide a nonbiased perspective on the progress of Deer Trail environmental compliance and quality efforts.

- Internal Audits. Planned periodic audits provide an objective evaluation of the facility Quality Assurance Plan and its implementation. These audits review procedures, instructions, and records and are performed by an internal auditor following a written plan (using checklists). Audits might use technical specialists as determined by the internal auditor. The internal auditor will not have direct responsibilities in the areas being audited. Following the audit, the auditor will prepare a report describing all major and minor nonconformances. CHDT will prepare a response describing corrective actions to be taken. The internal auditor will perform follow-up actions, including verification of the satisfactory completion of corrective actions.

9.16 REFERENCES CITED

Clean Harbors Deer Trail (CHDT). 2004. Permit Renewal Report for Incorporation of a Geosynthetic Clay Liner (GCL) in the Liner Section for Secure Cells 3 Through 7 and in the Cover Section for Secure Cells 1 Through 7 (the Permit Renewal Report – provided in Volumes 4 and 5 of this application).

10.0 FINANCIAL ASSURANCE

Title 10 of the Code of Federal Regulations (CFR), Sections 61.61 (Subpart E – Financial Assurances: Applicant Qualifications and Assurances) and 61.62 (Subpart E – Financial Assurances: Funding for Disposal Site Closure and Stabilization) require financial assurance for low-level waste disposal facilities. As mentioned in Section 1.0, this application applies only to radioactive material consistent with the radionuclides found in Naturally Occurring Radioactive Material (NORM) and Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) wastes with concentrations that are less than the Colorado statutory definition of radioactive waste (C.R.S. § 25-11-201). However, because of waste-specific regulatory determinations, some of the waste could be licensed at the generating source and require disposal in a licensed disposal facility. The limited concentrations considered in this application have a total activity of less than 2,000 picocuries per gram (pCi/g; natural uranium and thorium decay products only) with a maximum ^{226}Ra concentration of less than 400 pCi/g. This license application does not include radioactive waste in the broader definition of low-level radioactive waste, including other licensed forms of man-made radioactive materials.

Clean Harbors Deer Trail, LLC (CHDT) proposes to accept only limited concentrations of NORM/TENORM waste for treatment, storage, or disposal. In addition, CHDT will not accept other forms of low-level radioactive waste. As a consequence of these limitations, CHDT proposes to provide financial assurance pursuant to the State and Federal environmental regulations consistent with its status as a Resource Conservation and Recovery Act (RCRA) Subtitle C landfill rather than the financial assurance information requested in 10 CFR 61.61 and 61.62. In addition, closure will occur in a manner consistent with the technical and financial conditions specified in the regulations for a RCRA Subtitle C facility. Section 10.1 describes CHDT's financial qualifications, and Section 10.2 discusses funding assurances, in relation to the regulations.

10.1 FINANCIAL QUALIFICATIONS

Clean Harbors is North America's leading provider of environmental and hazardous waste management services. The Company owns 48 waste management facilities including nine landfills, five incineration locations, and seven wastewater treatment centers. It provides

essential services to more than 30,000 customers, including more than 175 Fortune 500 companies, thousands of smaller private entities, and numerous government agencies.

10.1.1 General Information

The Clean Harbors, Inc. headquarters is in Braintree, Massachusetts. Clean Harbors, Inc. is a publicly owned corporation traded on the NASDAQ stock exchange under the CLHB symbol. Attachment C contains copies of the Company's annual reports for the last 3 years.

CHDT (the Deer Trail facility) is a wholly owned subsidiary of Clean Harbors Disposal Services, Inc. The Deer Trail facility is an existing RCRA Subtitle C hazardous waste disposal facility. Complete funding for facility construction as required under RCRA already exists. CHDT expects that acceptance of NORM/TENORM waste will not engender any new extraordinary expenses. Therefore, CHDT believes that the facility does not require a general financing plan. The normal CHDT capital budgeting process would provide all funding for new improvements to the facility.

10.1.2 Specific Information Requirements Pursuant to 10 CFR 61.61

The following sections discuss the information required by 10 CFR 61.61 as it pertains to the Deer Trail facility. CHDT has tailored the information in relation to the existing financial requirements under RCRA and the fact that the Deer Trail facility will only accept limited concentrations of NORM and TENORM waste.

10.1.2.1 Legal Designation of Applicant

CHDT is a limited liability corporation that is a subsidiary of Clean Harbors Disposal Services, Inc. The principal place of business is 108555 East U.S. Highway 36, Deer Trail, Colorado, 80105-9611. Attachment D contains a copy of the "Articles of Incorporation" and Bylaws for CHDT.

10.1.2.2 Description of Applicant's Operation

As discussed in Section 4.0 of this application, the Deer Trail facility is a fully permitted RCRA Subtitle C treatment, storage, and disposal facility. Current Deer Trail operations include the treatment, storage, transfer, and disposal of hazardous and nonhazardous wastes. Deer Trail is

requesting authorization for the acceptance of NORM/TENORM waste. With the exception of routine construction of new secure cells as existing landfill capacity becomes full, Deer Trail does not propose construction of new structures for the management of NORM/TENORM waste.

10.1.2.3 Applicant's Financing Plan

As mentioned earlier, because the Deer Trail facility is an existing and operational RCRA Subtitle C treatment, storage, and disposal facility (TSDF), the support infrastructure (road, buildings, landfills, etc.) already exists. Therefore, there is no need for special or additional financing to construct and operate this facility for accepting NORM/TENORM waste. As such, CHDT believes that it does not need a financing plan for the facility because the Company will dispose of the NORM/TENORM waste in the same landfill as hazardous and nonhazardous waste. Clean Harbor's capital budgeting process will provide funding for capital improvements such as new secure cells. Form 10K in Attachment D provides details about the Company's financial position (e.g., balance sheets, income statements, and earnings statements). CHDT has not prepared a *pro forma* for the acceptance of NORM/TENORM waste. In addition, Clean Harbors considers this information confidential.

10.1.2.4 Other Applicable Information

As noted, Clean Harbors, Inc. is the parent company of Clean Harbors Deer Trail, LLC. Attachment D contains copies of Form 10K for Clean Harbors, Inc.

10.2 FUNDING ASSURANCES

Title 40 CFR Sections 264.143, 264.145, and 264.147 and Title 6 of the CCR 1007-3 § 266 require financial assurance for RCRA hazardous waste TSDFs. Financial assurance includes environmental liability impairment insurance as well as closure and postclosure financial assurance. The following sections describe these financial assurance mechanisms.

10.2.1 Liability Impairment Insurance

Title 40 CFR 264.147 and 6 CCR 1007-3 § 266.16 require liability coverage for sudden and nonsudden accidental occurrences. These regulations contain strict prescriptive standards for this coverage.

The Deer Trail facility maintains a certificate of insurance of $1 million per occurrence with an annual aggregate of $2 million for sudden occurrences and $3 million with an annual aggregate of $6 million for nonsudden occurrences. Attachment E contains a copy of the Liability Certificate of Insurance.

10.2.2 Closure and Postclosure Financial Assurance

As described in Sections 3.0 and 6.0, site closure, including the installation of final caps over the secure cells and environmental monitoring systems, will occur in a manner consistent with the current approved design for the CHDT RCRA Subtitle C facility (**CHDT 2004; see Volumes 4 and 5 of this application**). The relevant Federal and State environmental regulations (40 CFR 264.143 and 264.145, and 6 CCR 1007-3 § 266.12 and 266.13, respectively) require the owner of the facility to establish a financial assurance mechanism for closure and postclosure maintenance of the facility. The current estimated cost to close the facility is $3,619,006, and the estimated cost for the 30-year postclosure monitoring period required under RCRA is $2,700,537. Attachments 6 and 7 of the *RCRA Permit Renewal Report* (**CHDT 2004; see Volumes 4 and 5 of this application**) contain the detailed closure and postclosure cost estimates for the facility.

The environmental regulations allow the facility to demonstrate financial assurance through the use of sureties or performance bonds, letters of credit, corporate guarantees, or certificates of insurance. At this time, CHDT uses a certificate of liability insurance to provide financial assurance for the Deer Trail facility. Attachment F contains a copy of the certificate of closure and postclosure assurance.

In addition, the environmental regulations require that the closure and postclosure financial assurance mechanism include an annual adjustment for inflation. CHDT updates its financial assurance mechanism annually for inflation and submits the update to the Colorado Department of Public Health for review.

10.3 REFERENCES CITED

C.R.S. Title 25, Article 11, *Radiation Control*, Part 2, *Radioactive Waste Disposal*, § 201, *Definitions*.

6 CCR 1007-1, Radiation Control, Part 14: *Licensing Requirements for Land Disposal of Low-Level Radioactive Waste.*

6 CCR 1007-3 § 266.12. 2002. *Cost Estimate for Facility Closure.*

6 CCR 1007-3 § 266.13). 2002. *Cost Estimate for Post-Closure Care.*

6 CCR 1007-3 § 266.16). 2002. *Liability Requirements.*

10 CFR 61. 1990. *Licensing Requirements for Land Disposal of Radioactive Waste.*

10 CFR 61.61. 2002. *Subpart E – Financial Assurances: Applicant Qualifications and Assurances.*

10 CFR 61.62. 2002. *Subpart E – Funding for Disposal Site Closure and Stabilization.*

40 CFR 264.117. 2002. *Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Subpart G – Closure and Post-Closure.*

40 CFR 264.143. 2002. *Financial Assurance for Facility Closure.*

40 CFR 264.145. 2002. *Financial Assurance for Post-Closure Monitoring and Maintenance.*

40 CFR 264.147. 2002. *Liability Requirements.*

Clean Harbors Deer Trail (CHDT). 2004. *Permit Renewal Report for Incorporation of a Geosynthetic Clay Liner (GCL) in the Liner Section for Secure Cells 3 Through 7 and in the Cover Section for Secure Cells 1 Through 7* (the Permit Renewal Report – provided in Volumes 4 and 5 of this application).