From: "Phil Stoffey" <Philip.Stoffey@state.co.us>
To: <TAB2@nrc.gov>
Date: Mon, Jun 6, 2005 4:34 PM
Subject: Re: Revised draft Hecla CRR 6-6-05

Thanks for your help.

February 10, 2005

Mr. Steve Tarlton, Unit Manger
Radiation Management Unit
Hazardous Materials and Waste Management Division
Colorado Department of Public Health
and Environment (CDPHE)
4300 Cherry Creek Drive South
Denver, Colorado 80246-1530

Dear Mr. Tarlton,

I am responding to your October 1, 2004 submittal requesting our review and comment on the draft Completion Review Report (CRR) for the license termination of the Durita Uranium Mill Site (Colorado Radioactive Materials License # 317-02). We appreciate the opportunity to comment on this draft version of the CRR and we look forward to working with your staff to facilitate the submittal of the final CRR.

We have reviewed the draft CRR in accordance with the criteria in the Office of State and Tribal Programs (STP) Procedure *SA-900: Termination of Uranium Milling Licenses in Agreement States*. STP Procedure SA-900 describes NRC's review process for making the determination that all applicable standards and requirements have been met prior to Agreement State uranium milling license termination, as required by 10 CFR 150.15a(a) and Section 274c of the Atomic Energy Act of 1954, as amended (Act).

We appreciate CDPHE's effort to follow the suggested format in STP Procedure SA-900. Enclosed is a list of our comments on the draft CRR that we request be addressed before your submittal of the final CRR. We are prepared to hold a teleconference (or meeting) with you and your staff to discuss our comments and to assist you in resolving the comments prior to your submittal of the final CRR. We would appreciate receiving your response, to these comments, within 90 days of the date of this letter. Please let us know if you need additional time.

If you have any questions on the comments, or if you would like to schedule a teleconference or meeting, please contact me, or Terry Brock of my staff at 301-415-2323; Email: tab2@nrc.gov.

Sincerely,

/RA/
Paul H. Lohaus, Director
Office of State and Tribal Programs

Enclosure:
As stated

Mr. Steve Tarlton, Unit Manger
Radiation Management Unit
Hazardous Materials and Waste Management Division
Colorado Department of Public Health
and Environment (CDPHE)
4300 Cherry Creek Drive South
Denver, Colorado 80246-1530

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Sincerely,

/RA/
Paul H. Lohaus, Director
Office of State and Tribal Programs

Enclosure:
As stated

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U.S. Nuclear Regulatory Commission (NRC) Review Comments
of the
Colorado Department of Public Health and the Environment's (CDPHE)
Draft Completion Review Report (CRR)
for the
License Termination of the Durita Uranium Mill Site (RML 317-02).

The NRC staff, in its review of the Draft CRR for the Durita Uranium Mill Site, followed procedures, guidance, and criteria found in STP Procedure SA-900 "Termination of Uranium Milling Licenses in Agreement States." Based on the review, staff offers the following four general and thirty-seven specific comments for your review and resolution. In the *Specific Comments* section we request each identified issue be addressed in the final CRR or explained to us for resolution.

General Comments

The reviewers believe the organization of the document can be improved to help better present the findings and determinations in the final CRR. Some examples follow:

(1) Section III "Description of Remedial Actions" appears to be a subordinate heading, but it appears to be presented as a main heading. **Changed title.**

(2) Page 6, Section 2, "Geotechnical Stability," this section contains subsections that address site history, operations, general design features, and erosion protection. It would be helpful to have the general information and a detailed description of the site before the discussion of contamination cleanup in Section 1.3. **Did not change. Thinking about eliminating section 2.3 Information is discussed in other sections of the report.**

(3) Page 9, Section 2.1.8, "Surface Restoration," provides information on erosion protection and soil cover characteristics rather than surface restoration. **Consider soil cover and erosion protection as surface restoration. If you have another title will be glad to change.**

(4) Design features are discussed in several pieces and places. It was difficult to follow what was accomplished. **Site had several different design features for various structures and activities. Tried to separate site features and describe separately.**

One suggestion that may help organize the report is to develop a table of "applicable standards and requirements related to topics discussed in the CRR", similar to Table B-1 in STP Procedure SA-900 Appendix B, page B-6. We believe the addition of this table will help future reviewers and readers of the CRR to succinctly find the most relevant sections of the CRR. **Done see Table 1 on page 3.**

Specific Comments

The specific comments on the draft CRR are divided into four technical review areas: (1) geotechnical stability; (2) surface water protection and erosion control; (3) radiation cleanup and control, and radon emanation; and (4) groundwater remediation.

ENCLOSURE

I. Geotechnical Stability

Our review of the Geotechnical Stability section of the CRR indicates that all applicable standards and requirements have been met for this section. However, the following additional information, or areas of comment, need to be addressed to provide a more substantial basis or understanding of the bases used by CDPHE in making its' determination.

Comment	Section of CRR	Reviewer Comment	Comment Resolution
1	Page 5, Section II.1.3, paragraphs 2 and 3	Additional information regarding the treatment of uncrushable debris could be provided to assure that long-term stability is attainable.	See 2.3 p. 16
2	Page 8, Section III.2.1.4, paragraph 3	How does the measured total settlement compare to the estimate? If the numbers vary, provide discussion regarding the reason(s).	See 3.1.4 p. 19 See 4.6 p.34
3	Page 8, Section III.2.1.5, paragraph 2	How was the temporary cover placed and compacted?	See 3.1.5 p.20
4	Page 9, Section III.2.1.6, paragraph 1	Additional discussion regarding the nature of the solidified and neutralized contaminants would be relevant and helpful.	See 3.1.6 p. 20 See 3.1.8 p.23
5	Page 11, Section III.2.1.9, paragraph 3:	The history of frost penetration is not as relevant as the potential for the penetration depth to vary in the next 200 years. A statistical approach to confirm likely worst-case future frost penetration would be consistent with previous work by others and is recommended. However, the frost protection design does appear to be robust.	See 3.1.6 p.21 See 3.1.9 p.24
6	Page 14, Section III.2.1.11, paragraph 1	A brief discussion of the requirements for liquefaction (loose, saturated granular materials) would be helpful. The state can likely show that the conditions conducive to liquefaction are highly unlikely to occur.	See 3.1.11 p.28
7	Page 17, Section III.3.3, paragraph 3	It should be confirmed that compaction test locations and records are available for review.	See 3.1.5 p.21 See 4.3 p.31

8	Page 17, Section III.3.3, paragraph 5	How was it determined that "all chemical reactions had taken place"? Discuss the relevance of this statement.	See 3.1.6 p. 21 See 3.1.8 p.23 See 4.4.3 p.32 **

** possibly relevant that the acid tailings have been neutralized and water infiltration,if any, will not mobilize metals in this neutral environment.

II. Surface Water Hydrology and Erosion Protection

Our review of the Surface Water Hydrology and Erosion Protection section of the CRR indicates that additional information is needed to provide sufficient information on the bases used by CDPHE in making its' determination that the site will meet Criteria 1, 4, and 6. This information is needed to help us in making our determination that all applicable standards and requirements have been met for this section. The following comments should be addressed in the next version of the CRR or in the Comment Resolution section provided.

Comment	Section of CRR	Reviewer Comment	Comment Resolution
1	Page 11, Section III.2.1.9	The specifics of the *probable maximum precipitation* (PMP) storm event were not included in the summary. The parameter used to determine and calculate the precipitation should be discussed.	See 6.3 p. 44
2	Page 11, Section III.2.1.9	The basis of the *probable maximum flood* (PMF) should be included. The methods used to establish a PMF from the PMP and the variables used should be included in the documentation.	See 6.3 p. 44
3	Page 11, Section III.2.1.9	The methodology used to size erosion control should be clarified. The Horten method was applied to some areas of the site requiring rock. It should be clarified what methods were used to determine the need and size of erosion protection for all areas of the project site.	See 6.3 p. 44 See 6.4.1 p. 47
4	Page 24, Section III.5.1	The methods used to determine the amount of rock cover along with the assumptions should be discussed.	See 6.3 p. 44

5	Page 24, Section III.5.1	The methods used to determine the amount of scour protection required should be included in the review. In addition, variables, including the design flows and all other variables used in the calculations, should be discussed for applicability to the design.	See 6.3 p. 44 See 6.4.1 p.47
6	Page 24, Section III.5.1	Explain the basis for determining the tributary area riprap including design flow, methodology and results.	See 6.3 p. 44 See 6.4.2 p.47
7	Page 24, Section III.5.1	The erosion protection requirements referred to in the last paragraph of the section should be summarized. A summary of changes and why the changes are necessary should also be included.	See 4.1 and 4.2 and 6.1.
8	Page 24, Section III.5.2	Any areas where water flow will converge should be considered and discussed for additional erosion protection.	See 6.2 p.43
9	Page 24, Section III.5.2	Specific characteristics of the draw should be stated including flow characteristics, time of concentration and drainage area.	See 6.3 p. 44
10	Page 24, Section III.5.2	State what methods were used to establish the geometry of the channels.	See 6.2 p. 43
11	Page 24, Section III.5.2	The methods for determining the magnitude and the routing of the PMF should be included in the report.	See 6.3 p. 44
12	Page 25, Section III.5.4	Analysis of the cover should be discussed and should include the method by which a vegetated cover was deemed satisfactory.	See 3.1.7 p.23 See 6.6 p.49
13	Page 26, Section III.5.5	Please expand on the reason that the cover materials utilized during construction where deemed acceptable.	See 3.1.7 p. 23 See 4.3 and 4.4. p.30
14	Page 26, Section III.5.5	Please expand on the methods used in construction that were observed and considered acceptable.	See 3.1.7, 3.1.8, 3.1.9 p.22 and 4.4
15	Page 26, Section III.5.5	Please clarify that the testing requirements that the materials met where specified in an approved reclamation plan.	See 4.3 p.30 and look at the references.

16	Page 26, Section III.5.5	Discuss whether the remaining mancos shale top surface ("upper 2-4 inches") was considered as a source of sediment to the channel and whether capacity would be effected.	See p.6.7 p. 50
17	Page 27, Section III.5.6	Monster Engineering evaluated the sedimentation and concurred with the conclusion. The evaluation should be provided in more detail (what analysis was performed, etc.). The methods used to evaluate the conclusion should be stated.	See 6.7 p.50

III. Radiation Cleanup and Control / Radon Emanation

Our review of the Radiation Cleanup and Control / Radon Emanation section of the CRR indicates that additional information is needed to provide sufficient information on the bases used by CDPHE in making its' determination that all applicable standards and requirements have been met. The following comments should be addressed in the next version of the CRR or in the Comment Resolution section provided.

Comment	Section of CRR	Reviewer Comment	Comment Resolution
1	Page 8, Section III.2.1.4, first paragraph, last sentence	There appears to be a discrepancy between this section where rock is used as cover for the cells (referring to leach tanks and closure cell), yet in section 2.1.5, second paragraph, a vegetative cover is utilized as the final cover over the ponds and the leach tanks (this is also repeated in section 3.) Are these sections discussing the raffinate or evaporation ponds, or both?	See 3.1.5 p.20 See 3.1.6 p.21
2	Pages 8-10	There is limited discussion of decommissioning the four raffinate ponds (Figure 2), unless these are referred to as process-liquid storage ponds as found on page 14, section 3, instead of the six waste liquid evaporation ponds. Please clarify and use consistent language to describe the ponds.	See 3.1.6 p.21 See 5.4 p.36,38, and 40
3	Page 11, Section III.2.1.9, second paragraph	The radon emanation discussion addresses only one cell (with a cover thickness of 5.28 feet). This seems to describe the heap tanks as the closure cell and is said to have 3 feet of soil and 6 inches of rock cover (page 9, second paragraph and page 51, last paragraph). Please address the radon emanation for all the cells.	See 3.1.5 p.20 See 3.1.6 p.21
4	Page 11, Section III.2.1.9, third paragraph	The CRR indicates a frost depth of 2 feet or less for the site (regional data indicates at least 4 ft likely). Apparently the radon flux model did not use density and porosity input values for the upper cover soil that were modified to reflect the degradation by freeze-thaw damage over the years. Even if this revised modeling shows that the long-term radon flux results meet the limit for the heap tanks (maybe not for the closure cell), the assumed degree of conservatism is not there.	See 3.1.9 p.24 See 5.5.1 p.41

5	Page 17, Section III.3.3, first paragraph	The soil samples were taken on 100-meter grids, which suggests one sample representing 2500 m^2 was used to demonstrate compliance with a 100 m^2 standard, or demonstration of conformance relied heavily on the gamma survey. Since U-nat and Th-230 would not be detected by gamma surveys, the soil sampling design and results for these radionuclides should be mentioned on this page, or the appropriate section referenced.	Corrected to square meter
6	Page 19, Section III.4.1, second paragraph, first sentence	The seven agglomerator head samples were tested six times to set cleanup criteria for some heavy metals. Explain why these samples were chosen. Also, there appears to be a contradiction in that vanadium was tested in these samples, yet the fourth sentence says vanadium analysis was not conducted, then in the next sentence, a cleanup criterion for vanadium is provided. It also appears that the Th-230 and Ra-226 background values were based on only three samples. How are these average values representative of the entire area?	See 4.5 p.33 See 5.1 p.34
7	Page 22, Section III.4.4	Some areas were remediated for Th-230, but the volume of Th-230 contaminated soil is not indicated (bottom of page 22, an additional four feet of material removed in the pond for Th-230). If appreciable amounts of Th-230 (significantly above 14 pCi/g) are in any cell, the 1000-year Ra-226 value would need to be used in the model to estimate the long-term radon flux.	See 5.4 p.36
8	Page 23, Section III.4.5.1	Radon flux was measured at 138 locations according to EPA Method 115. There are apparently three heap tank cells and the closure cell that contain byproduct material. Method 115 states that at least 100 radon flux measurements be taken on each disposal cell. Please clarify or explain this variance.	See 3.1.5 p.20 See 5.5.1 p.41
9	Page 23, Section III.4.5.1	The language will need to be changed to reflect that the RADON code was used and is not a dose assessment code, but a radon flux code. We acknowledge the language in the sample CRR in appendix B of SA-900 will need to be changed to be more accurate and to reflect this comment.	See 5.5.1 p.41

10	Page 51, Criterion 6	The leach tank soil covers are reported as at least 4 feet thick and the closure cell cover at least 2.5 feet thick (presumably there is a thicker layer over the higher source term.) However, this does not support the value of 5.28-foot cover thickness mentioned in second paragraph of section 2.1.9. The average thickness of these various soil covers should be stated in this criterion, in addition to the minimum and maximum thickness values.	See p. 14 Criterion 6 See 3.1.3 p.18

Look at references

IV. Groundwater Remediation

Our review of the Groundwater Remediation section of the CRR indicates that additional information is needed to provide sufficient information on the bases used by CDPHE in making its' determination that all applicable standards and requirements have been met. The following comments should be addressed in the next version of the CRR or in the Comment resolution section provided.

Comment	Section of CRR	Reviewer Comment	Comment Resolution
1	Page 29, Section III.6.2.1	The report states that the groundwater detection monitoring program was changed to a compliance monitoring program. Why did this occur? The report states earlier that the wells did not show releases of constituents, however, typically a groundwater monitoring program is only changed from detection to compliance monitoring when a leak has been detected.	Revised 7.2.1 p.52
2	Page 30, Section III.6.2.2	The report states that constituents of concern were uranium, radium 226, radium 228, thorium 230, arsenic, nickel, and thallium. The report states earlier that the wells did not show releases of constituents, so it is unclear why these constituents are of concern.	Revised 7.2.2 p.53
3		Well abandonment	See 7.2.3 p.54

Please review section A Criterion p. 4.

TECHNICAL REVIEWERS

Name	Area Covered
Terry Brock, Ph.D. Health Physicist, STP	Project Manager
Elaine S. Brummet, Ph.D. Health Physicist, NMSS	Radiation Cleanup and Control, Radon Emanation
John Lusher Health Physicist, NMSS	Radiation Cleanup and Control, Radon Emanation
Jill Caverly, P.E. Surface Water Hydrologist, NMSS	Surface Water Hydrology and Erosion Protection
William von Till Groundwater Hydrologist, NMSS	Groundwater Remediation
Daniel S. Rom Geotechnical Engineer, NMSS	Geotechnical Stability
Dennis Sollenberger, Ph.D. Senior Health Physicist, STP	Technical Resource

Note:

NMSS: Office of Nuclear Material Safety and Safeguards
STP: Office of State and Tribal Programs

Draft COMPLETION REVIEW REPORT for the Durita Site

Table of Contents

Colorado Radiation Control Program

Draft COMPLETION REVIEW REPORT (CRR) for the DURITA SITE

Date: July 2005

Licensee: Hecla Mining Company
License Number: Colorado RML-317-02
Facility Name: Durita Site
Location: Montrose County, Colorado
Licensed Area Being Terminated: approximately 160 acres for full termination
Manager: Philip S. Stoffey
Technical Reviewers: Ken Weaver (Health Physicist), Jeff Deckler (Program Manager)

I SUMMARY

This Completion Review Report (CRR) documents the Colorado Department of Health and Environment Hazardous Materials and Waste Management Division (CDPHE – HMWMD) staff 's conclusions that the licensee has completed remedial actions at the Hecla Mining Company's Durita site in accordance with approved plans. This summary section of the report contains in Section A staff's bases in summary form for its conclusion that all applicable standards and requirements have been met.

The Hecla Mining Company's Durita site is a heap leach tailings facility site which has been decommissioned and reclaimed under Colorado Department of Public Health and Environment Hazardous Materials and Waste Management Division (CDPHE - HMWMD) Agreement State authority, derived from Title II of the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA). UMTRCA requires that prior to termination of the license, the U.S. Nuclear Regulatory Commission (NRC) shall make a determination that the licensee has complied with all applicable standards and requirements. Under the Agreement State program, the State of Colorado is responsible for approval of remediation plans for the Durita site and for inspections to ensure that the actual remedial actions have been completed pursuant to the approved plans.

This report documents CDPHE-HMWMD's bases for its conclusion that decommissioning and reclamation have been acceptably completed at the Durita site. Staff reviewed remedial actions at the Hecla site to ensure that they were constructed in accordance with approved plans and specifications. Licensed professional engineers prepared these design plans and specifications. Areas of review included as-built drawings, construction operations, laboratory testing and field-testing, and quality assurance audits. In addition, the review was based on state staff observations of the remedial actions and reviews of records and testing during onsite inspections. Documents reviewed in preparing this CRR are referenced at the end of this report and are available for review at the Colorado Department of Public Health and Environment Hazardous Materials and Waste Management Division's record center. The NRC STP Procedure SA-900 entitled, "Termination of Uranium Milling Licenses in Agreement

States," was used as guidance to prepare this report. **It should be noted that site reclamation was completed by 1999. Procedure SA-900 was finalized December 31, 2002. Activities described in SA-900, such as cone penetrometer tests, were not done at the site, but the CDPHE-HMWMD believes that the site was properly remediated in accordance with applicable regulations.**

The applicable standard for uranium mill reclamation is Part 18 of the Colorado Rules and Regulations Pertaining to Radiation (6 CCR 1007-1-18), entitled *Licensing Requirements for Uranium and Thorium Processing*. This State regulation is consistent with and compatible with NRC regulations, as required by the State's Agreement with the NRC.

All applicable standards and requirements, with appropriate references to related sections of this CRR, are identified in Table 1of this summary. Section A summarizes how each Criterion has been met. CDPHE-HMWMD (the Department) has performed a complete review of the Durita site for compliance with all applicable standards and requirements. The Department's review of licensee submittals were conducted by using guidance documents NRC NUREG-1620, NUREG/CR-5849, NUREG-1506, NUREG/-3199, NUREG/CR-4192, NUREG/CR-3747, NUREG/CR-4323 and other appropriate documents.

The purpose of this report is to provide the State of Colorado's current evaluation of the completed uranium mill tailings repositories and final site drainage control at the Durita heap leach site. The Durita site is owned by the Hecla Mining Company (Hecla) and has been operated under Colorado Specific Radioactive Materials License Number 317-02. Site cleanup and construction of final waste repositories on site have been completed in accordance with the Reclamation Plan submitted by Hecla in 1991 (AK Geoconsult, 1991). The elements of the reclamation plan have been evaluated based upon scientific and engineering principles. The construction and underlying design have also been evaluated against the requirements of Appendix A of Part 18 of the State of Colorado *Rules and Regulations Pertaining to Radiation Control*, 6 CCR 1007-1 (the Regulations). This evaluation can be found in Appendix A of this *Completion Review Report*. The finding of the State with regard to conformance with the radiation regulations is presented in the Licensing Statement for the Radioactive Materials License 317-02 prepared in 1993 and also in 1999. Review of construction verification reports together with field visits during construction and reclamation indicate that the tailings repositories and runoff control structures have been constructed in accordance with the state-approved reclamation plan.

The following table leads the reviewer to the appropriate sections in the CCR that the appropriate regulatory standards have been met and the following Appendix A describes how each Criterion has been met in summary form.

Table 1

Applicable Standards / Requirements		Page of Section A	CRR Sections
Appendix A Part 18 Colorado's Rules and Regulations Pertaining to Radiation Control	Criterion 1		
	1A. Tailings Siting	4	Sections 2; 3.1.1 to 3.1.3 Section 3.1.1
	1B. Site Features	5	Section 3.1.3
	1C. Tailings Isolation	6	Section 3.1.4
	1D. No Active Maintenance	6	
	Criterion 2 Non-Proliferation	6	Section 3.13
	Criterion 3 Above or Below Grade	7	Section3.13
	Criterion 4	7	
	4A Erosion Potential		Sections 3.1.7, 3.1.8, 6.4
	4B Wind Protection		Sections 3.1.7 and 3.1.9
	4C Flatness of Slopes		Section 6.7
	4D Rock and Vegetative Cover		Sections 4.4, 6.4.2, 6.5 and 6.6
	4E Seismic Design		Sections 3.1.10
	4F Sediment Deposition		Section 6.2 and 6.7
	Criterion 5 Ground Water Protection	8	Section 7.0
	Criterion 6	14	
	(1) Radon Cover Longevity		Sections 3.1.5, 3.1.6 and 5.2
	(2) Radon Flux		Sections 3.1.9 and 3.1.11
	(3) Phased Flux		Section 3.1.6 and 5.5
	(4) Flux Reports		Not Applicable
	(5) Cover Materials Activity		Section 5.5.1
	(6) Soil Clean-up Criteria		Sections 3.1.6 and 5.1 Sections 4.3, 4.5, and 5.4
	7) Nonradiological Hazards		Sections 5.1 and 5.4
	6A		
	(1) Timeliness of Cover Placement		Section 5.5.1
	(2) Construction Extensions		Not Applicable
	(3) Acceptance of NORM Materials		Not Applicable
	Criterion 7 Ground Water Detection Monitoring	14	Section 7.2.1
	Criterion 8 Milling Operations	14	Section 3.1.3
	Criterion 9 Ownership and Long Term Surveillance	14	Section 9.0

	Criterion 10 Ground Water Hazardous Constituents	15	Section 6.0
Compliance with License Conditions			Section 8.0

Section A-Compliance with Appendix A of Part 18 of the Colorado Rules and Regulations Pertaining to Radiation Control.

Part 18, Appendix A, of the Colorado *Rules and Regulations Pertaining to Radiation Control* establishes criteria relating to the disposition of radioactive tailings or wastes.

Criterion 1:

Criterion 1A: The broad objective in siting and design decisions is the permanent isolation of radioactive materials so that disturbance and dispersion of these materials by natural forces are minimized and the closed site requires no ongoing maintenance.

The siting of all the repositories, including alternative sites, was thoroughly evaluated during the license renewal process in the early 1990's. The Durita site is located on gently north sloping terrain at the southeast end of the Paradox Valley, in western Montrose County, approximately 100 miles south of Grand Junction and 2.5 miles southwest of the town of Naturita. The climate is semiarid. The Paradox Valley is a collapsed salt dome and a closed geologic and topographic basin. The Durita site sits at an elevation of 5500 feet with the surrounding edges of the Paradox Valley at 7000 feet. Marine Mancos Shale underlies the site. Most of the site is blanketed with alluvium (stream derived soils) and colluvium (slope wash derived soils) composed of sandy clay, which is up to 20 feet thick. This soil contains variable amounts of rock fragments, primarily sandstone of cobble to boulder size. Near the east-central portion of the site, an un-eroded remnant or outlier of the Mancos Shale forms a hill some 100 feet higher than the local terrain.

Two unnamed ephemeral tributaries to Dry Creek cross the site and another one cuts across the northwest corner. These tributaries drain 800 acres of watershed that originate in the southwest margin of the valley. The channels from these watersheds will occasionally carry large amounts on runoff in response to infrequent, intense thunderstorms. At the site, the channels are narrow, five to ten feet wide, up to 14 feet deep, and exist within 100 to 300 foot wide floodplains.

The site is located toward the center of the valley, away from geologic hazards such as rock falls, landslides or snow slides. Overall, the site is isolated such that disturbance from natural forces is minimal.

Criterion 1B: The site selection process must be an optimization to the maximum extent reasonably achievable in terms of the following features:

(1) Remoteness from populated areas;

(2) Hydrologic and other natural conditions as they contribute to continued immobilization and isolation of contaminants from groundwater sources;

(3) Potential for minimizing erosion, disturbance, and dispersion by natural forces over the long-term.

The Durita site was found to be favorable among potential alternative sites for final disposal of uranium mill tailings for several reasons, including:

a. The regional geology is well known.

b. The site is located in a stable geologic area.

c. The site is located in a closed structural basin.

d. The site contains geologic media favorable for radioactive waste disposal.

e. No major resource deposits exist at the site.

f. Impacts of the facility on ground and surface water use are non-existent.

g. There are no major population centers located near the Durita site. The population of Naturita, the closest town located about two and one-half miles northeast of the site, is approximately 450 people. The nearest residence is at the Coke Oven Ranch, located about one-half mile north of the site.

Removal of these materials to another site would have increased human exposures to radioactive and non-radioactive materials without an overall improvement to long-term control or reductions to long-term impacts.

The regional ground water resources for western Colorado have been described by Pearl 1974. Generally, ground water is found in alluvial deposits adjacent to perennial streams. Ground water is also present locally throughout the western slope in several of the formations that underlie the site including the Mancos Shale, Dakota Sandstone, Burro Canyon Formation and Morrison Formation. The nearest user of ground water is the Coke Oven Ranch located approximately one-half mile north of the Durita Site. The well at the ranch is reported to be developed in the Morrison Formation. This well is not hydraulically connected to the uppermost water-bearing zone beneath the site.

Monitoring wells drilled beneath the Durita Site indicate that there are two rock units that appear to be hydraulically connected and constitute a single upper-most water-bearing stratum. Under most of the site, the uppermost water-bearing unit is a sandstone-claystone that appears to be at least ten feet thick. The top of this unit was encountered from 20 to 55 feet below the ground surface. Along the north side of the site

in the vicinity of monitor wells MW-11 and MW-12, the uppermost water-bearing unit is a one-foot thick sandstone. This unit is also present in the other up gradient wells, but it is dry. The repositories on site are separated from this upper water-bearing stratum by the Mancos Shale, which is extremely impermeable to water flow. The calcareous shale would also react geochemically with any infiltration that did pass through. Detection monitoring was conducted on the site from 1976 until early 1998 and showed no impacts to the ground water.

The potential for erosion and dispersion of contaminated materials is minimized through the cover design employed for the disposal repositories. Wind and water erosion are minimized by the application of a rock cover across the side-slopes of the repositories. The location of the closure cell down gradient from the Mancos Hill protects it from flooding.

The site together with the design features assure that the tailings and associated waste will be isolated from populated areas and ground water. Erosion and other dispersive forces were minimized.

Criterion 1C: In the selection of disposal sites, primary emphasis must be given to isolation of tailings or wastes, a matter having long-term impacts, as opposed to consideration only of short-term convenience or benefits, such as minimization of transportation or land acquisition costs.

The Durita Site was selected as the primary site for long-term isolation of tailings due to its remote location and demonstrated ability to isolate wastes over the long-term.

Criterion 1D: Tailings should be disposed of in a manner that no active maintenance is required to preserve conditions of the site.

The Durita site and cover design have been thoroughly evaluated for long-term containment of the waste under the existing license. The cover and repository configurations are designed in a manner that meets the requirements of the State of Colorado *Rules and Regulations Pertaining to Radiation Control*, policies of the Department, and regulatory guidance of the U.S. Nuclear Regulatory Commission. The side slopes of the repositories are covered by rock on gentle slopes and vegetative top cover occurs on the very gently sloping tops of the leach tank repositories. Rock covers the top and sides of the closure cell. These regulations and policies are designed to assure that no active maintenance is required. This site is geologically stable and will be adequate for the long-term containment of radioactive waste.

As discussed in the CRR Sections 5.1 and 5.3, CDPHE staff considers that the riprap layers will require little active maintenance over and beyond the 1000-year design life, for the following reasons: (1) the riprap has been designed to protect the tailings from rainfall and flooding which have very low probabilities of occurrence over a 1000-year period, resulting in no damage to the layers from these events: (2) the rock of the riprap layers is designed to be durable and is not expected to deteriorate significantly over the 1000-year

design life; and (3) during construction, the rock layers have been placed in accordance with appropriate engineering and testing practices, minimizing the potential for damage, dispersion and segregation of rock.

Criterion 2: To avoid proliferation of small waste disposal sites and thereby reduce perpetual surveillance obligations.

Combining the evaporation pond residues into one cell (the closure cell) and placing the mill residues in the existing heap leach cells and closure cell avoid the proliferation of small waste sites. The disposal of all these materials at one location reduced reclamation costs and long-term maintenance costs.

Criterion 3: The "prime option" for disposal of tailings is placement below grade.

The pre-existing condition and nature of the tailings disposal sites at Durita made below-grade disposal impractical. Below grade disposal would bring the wastes closer to ground water and reduce the isolation features of the existing site. This location and its designed liners, covers and diversion channels are adequate to resist the long-term forces of erosion.

Criterion 4: Design criteria for a repository include minimization of upstream catchment areas, good wind protection and flat covers to minimize erosion constructed of vegetation or durable rock. A rock cover should be designed to withstand the Probable Maximum Precipitation (PMP) Event and areas of concentrated runoff need to be rip-rapped. The repository should not be sited near a capable fault and should be designed to withstand the maximum credible earthquake ("MCE").

The watershed area upstream of the Durita site is 800 acres. The repositories are located on upland slopes, away from the drainage channels, and three of the cells are protected by small hills. Ephemeral channels that exist adjacent to the disposal cells were realigned, regraded, and armored to protect the disposal cells from the PMP event. Protection against floodplain scour adjacent to the existing ephemeral channels is provided by the use of rock fill trenches from channel bed elevation to the calculated vertical scour depth. A rip rap blanket not less than 18 inches was constructed to protect floodplain banks from lateral erosion under conditions up to the Probable Maximum Flood (PMF) discharge. A surface water diversion channel was completed along the south side of the Closure Cell to minimize the upstream watershed area.

A temporary cover of 2.5 feet was placed over the tailings leach tanks when active operations ceased. An additional 2.8 feet to 5.0 feet of soil cover was placed on the leach tanks to reduce the radon emanations to less than 20 pCi/m^2s. The tops of the leach tanks were vegetated.

The sides of the leach tanks have 5H: 1V slopes and utilize a rock cover designed to withstand the PMP event. Surface water diversions and erosion protection are designed to assure stability of the repository during maximum probable precipitation and/or

flooding. The Closure Cell was designed with a 2.5-foot thick radon cover, 5H: 1V slopes and a rock cover over the entire cell. The rock cover is designed to withstand the PMP event.

The Durita site is located within the Colorado Plateau Seismotectonic Province as described by Kirkham and Rogers (1981). They have estimated a Maximum Credible Earthquake (MCE) of 5.5 to 6.5, for the province, making it one of the more stable provinces in Colorado. Recent faulting according to F.M. Fox & Associates (1982) is rare in this province except for faults related to the Uncompahgre Plateau or collapse of the salt anticlines. According to the report by F.M. Fox (1982), evidence indicates that the collapse of salt structures was active in the last 500,000 years and may be active at present. However, the faults associated with collapse are gravity faults that are generally slow moving with a low potential for generating even moderate earthquakes. There is no evidence for recent movement along faults in the immediate vicinity of the site. The site does not appear to be located adjacent to a capable fault. There is no evidence either at the surface or in the holes drilled for monitor wells to indicate faulting or even abrupt structural changes under the site. The MCE for an one-thousand-year event would generate a peak acceleration of 0.12g. Stability analyses indicate that the repositories have significant factors of safety for static and psuedostatic conditions. All design analyses indicate that the covers will withstand wind and water erosion for more than one thousand years. Based upon the existing information, the site will provide permanent isolation of the tailings.

Criterion 5 Criterion 5 of State of Colorado *Rules and Regulations Pertaining to Radiation Control* sets forth ground water protection standards. Criterion 5A-D and Criterion 10 incorporate the basic ground-water standards imposed by the Environmental Protection Agency in 40 CFR Part 192, Subparts D and E (48 FR45926: October 7, 1983) which apply during operations and prior to the end of closure.

Criterion5A (1) The primary ground-water protection standard is a design standard for surface impoundments used to manage byproduct material. Unless exempted under paragraph 5A(3) of this criterion, surface impoundments shall have a liner that is designed, constructed, and installed to prevent any migration of wastes out of the impoundment to the adjacent subsurface soil, ground water, or surface water at any time during the active life (including the closure period) of the impoundment.

The leach areas and evaporation ponds were constructed with appropriate liners. The closure cell was constructed with an appropriate liner and was seated in the upper portion of the Mancos shale.

Criterion5A (2) The liner shall be:

(a) Constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to pressure gradients, physical contact with the waste or leachate to which they are exposed, climatic conditions, the stress of installation and the stress of daily operation;

(b) Placed on a foundation of base capable of providing support to the liner and resistant to pressure gradients above and below the liner to prevent failure of the liner due to settlement, compression, or uplift; and

(c) Installed to cover all surrounding earth likely to be in contact with the wastes or leachate.

The evaporation ponds, leach tank cells and the closure cell were constructed with compacted clay liners on top of scarified Mancos Shale and were installed to cover all surrounding earth likely to be in contact with the waste.

Criterion 5A (3) Hydrogeologic Setting

The licensee did not request exemption from the requirements of paragraph 5A(1). However, the closure of the site will protect the ground water because the waste in the neutralization ponds were treated and stabilized. They were then transferred into the closure cell in order to minimize on-site disposal locations. The leach tanks were stabilized and dewatered. Closure cells and leach tank areas were constructed to promote runoff. The compacted clay cover would reduce infiltration. Precipitation in the area is 12 inches per year, while the evaporation rate is 49 inches per year; therefore infiltration is limited. The HELP (version 3.3) Model was used to evaluate infiltration. The 1997 calculations for percolation/infiltration in the closure cell was determined to be 0.00043 inches per year and for the leach tanks was determined to be 0.00103 inches/year. These calculations compare closely to those done in 1993.

The site is underlain by low permeability shales having a high attenuation capacity and is over 20 feet thick before reaching the first water bearing layer and 70 feet deep to the first usable aquifer. Permeability decreases with depth in the Mancos Shale.

The treatment of the waste, the design and construction of the closure cells and the hydrogeologic conditions at the site reduce the potential of the leachate produced to migrate to ground water or surface water.

Criterion 5B(1) The Department shall identify hazardous constituents, establish concentration limits, set the compliance points and may adjust the point of compliance if needed in accord with developed data and site information as to the flow of ground water contaminants, when the detection monitoring established under Criterion 7 indicates leakage of hazardous constituents from the disposal area.

License amendment 10, dated May 15, 1997, established background and point of compliance wells. Concentration limits were established after representative samples of waste and background water quality parameters were evaluated. Based upon analysis of data collected from 1991 to 1997, it was determined that no releases of hazardous constituents had been detected by the groundwater monitoring system.

Criterion 5B(2) Describes the 3 tests to determine if a constituent is a hazardous

constituent.

Selenium, arsenic, and uranium were selected as indicators for the determination of impoundment leakage because they were present in the feed tails and in the disposed byproducts. These metals are listed in Criterion 10, and are the most mobile of expected hazardous constituents. The constituents were detected in the uppermost aquifer. The constituents meet the three tests described in paragraph 5B (2) and are considered to be hazardous.

Criterion 5B(3) Even when constituents meet all three tests in Paragraph 5B(2) of this criterion, the Department may exclude a detected constituent from the set of hazardous constituents on a site-specific basis if it finds that the constituent is not capable of posing a substantial present or potential hazard to human health or the environment.

The only well user is at Coke Ranch and ground water is obtained from the Dakota Sandstone that is located below the Mancos Shale and therefore does not pose a threat to human health or the environment. The hazardous constituents were not excluded from the detection monitoring or compliance monitoring programs.

Criterion 5B(4) In making any determinations under paragraphs 5B(3) and 5B(6) of this criterion about the use of ground water in the area around the facility, the Department will consider any identification of underground sources of drinking water and exempted aquifers by the Colorado Water Quality Control Commission or any other agency having jurisdiction.

The Mancos Shale has not been generally identified as an underground source of drinking water nor is it an exempted aquifer. If potable water is obtained from this formation it can be used, but no wells near the site obtain water from the Mancos Formation. A determination under paragraphs 5B(3) and 5B(6) on the use of ground water was not made as monitoring indicates that there is no impact or release from the facility.

Criterion 5B(5) Concentrations at the Point of Compliance

Ground water in the compliance wells was compared against ground water in the background wells. The historical groundwater data were analyzed for descriptive and comparative statistics. The descriptive statistics characterized the number of measurements/analysis, frequency of detection range, average concentration, and variability of each parameter for each well. A comparative statistical analysis was performed for the relevant indicator parameters: arsenic, selenium, and uranium. The comparative statistical analysis consisted of a Test of Proportions procedure. Although a statistically significant difference was noted for arsenic between up gradient well MW-14 and down gradient well MW-12, the difference resulted from a greater number of detections in the up gradient well than the down gradient well. Therefore, the difference in the occurrence in arsenic between these two wells is not related to a release from the site. Based on the comparative statistical analysis, no evidence of a release related to the site was observed in groundwater. (1995 Annual Groundwater Report)

Criterion 5B(6) Alternate Concentration Limits

Not applicable because there is no evidence of a release to ground water.

Criterion 5C Maximum Values for Ground Water Protection

Arsenic, barium, lead and selenium were present in the ground water during the detection monitoring program, as well as radium-226 and gross alpha particle activity. All of the detected concentrations were below drinking water standards and the maximum values for ground water protection described in Criterion 5C. The Department set standards that are consistent with paragraph (5) of Criterion 5. Uranium levels are higher in the background well than in the down gradient or cross gradient wells. The results of the ground water monitoring program supports the conclusion that the activities at the Hecla-Durita site have not adversely impacted the underlying ground water.

The 1996 annual report includes temporal graphs for arsenic, selenium and uranium for the period from 1991 thru 1996. These three constituents were determined to be relevant indicator parameters because they were found in the byproduct materials placed in the disposal areas. A lack of detections above the analytical detection limit for arsenic and selenium prevent meaningful trend analysis.

The temporal graphs for uranium concentrations indicate higher values were observed for five of the seven wells (MW-9, MW-10, MW-12, MW-13, and MW-14) during 1991, the first year of monitoring. Lower levels were observed for each of the five wells during the next five years. The average uranium concentrations in all down gradient wells were less than the values observed in up gradient well MW-14. This information indicates that the down gradient wells have not been impacted by seepage from the wastes.

Criterion 5D Corrective Action Program

A corrective action program was not implemented at this site because the ground water protection standards established under paragraph 5B(1) were not exceeded.

Criterion 5E In developing and conducting ground water protection programs, applicants and licensees shall also consider the following:

Installation of clay liners,

Mill process designs to reduce the net input of liquid to the tailings impoundment,

Dewatering of tailings, and

Neutralization to promote immobilization of hazardous constituents.

Because there is no evidence of ground water contamination from the site, development of a ground water protection program was not needed. Nevertheless, prior to mill closure, liners were already in place or were constructed; liquids were removed from the leach

tank areas via in-situ drainage systems; liquids in the neutralization ponds were solidified and neutralized; and relatively impermeable clay caps covered these areas in order to limit infiltration. These activities will help to protect the ground water by limiting infiltration. The annual average yearly precipitation is less than 12 inches, while the evaporation rate is 49 inches per year. The HELP (version 3.3) Model was used to evaluate infiltration. The 1997 calculations for percolation/infiltration in the closure cell was determined to be 0.0011 inches per year and for the leach tanks was determined to be 0.0019 inches/year. These calculations compare closely to those done in 1993.

Criterion 5E: In conducting ground water protection programs, licensees shall also consider: (1) Installation of liners and leak detection systems, (2) mill process designs which provide the maximum practicable recycle of solutions and conservation of water, (3) dewatering of tailings by process devices and/or in situ drainage systems and (4) neutralization to promote immobilization of hazardous constituents.

The heap leach tanks were lined in order to collect leached uranium. The mill was designed to capture the liquid solutions from the tanks. Thus, the operation was designed to preclude releases to ground water. No impacts to ground water have been observed from the impoundments.

Criterion 5F Where ground water impacts are occurring at an existing site due to seepage, actions must be taken.

The ground water data indicates that there is no evidence of ground water impacts due to seepage occurring at the site.

Criterion 5G Information on the tailings disposal system needed to be provided regarding the following:

(1) Chemical, physical and radioactive characteristics of the waste solutions

In 1991, four evaporation ponds were sampled. Chemicals found in the salts were chloride, sulfate, arsenic, barium, calcium, iron, potassium, sodium, lead, gross alpha, gross beta, radium-226, thorium-230, and uranium. Molybdenum was below the detection limit.

To determine what potential contaminants were brought on site, agglomerator samples were analyzed (AK Geoconsult Inc., 1993). The agglomerator was used in the ore preparation area to mix acid with tailings from the Naturita site prior to placement in the leach tanks. In 1992, seven agglomerator head samples were analyzed for nonradiological and three samples were analyzed for radiological parameters. The nonradiological elements were arsenic, cadmium, lead, molybdenum and selenium. The radiological elements were thorium-230 and radium-226. Arsenic, lead, and selenium were detected in the feed tails, while cadmium and molybdenum were not. Vanadium was not analyzed since it was extracted from the feed tails by the facility and therefore would not be present on site as a contaminant. Radium-226 and thorium-230 were also

present in the feedstock and were the principal source of radioactive contamination at the Durita site.

Radionuclides commonly found in relatively high concentrations in tailings from acid leach mills are Ra-226, Pb-210, Po-210, Th-230, and uranium. Metals including barium, beryllium, cadmium, chromium, nickel, antimony, lead, mercury, silver, molybdenum and vanadium may be found in elevated concentrations, as may the regulated nonmetals nitrate, cyanide, selenium, and arsenic. Some chemicals like organic tertiary amines mixed with the dilutants kerosene or benzene may also be present along with sulfates from the addition of sulfuric acid to the process.

A comprehensive ground water sampling program was done in 1991 after the new wells had been installed. Ground water samples were analyzed for all of the constituents above except antimony, nitrate, and polonium-210. Polonium-210 was analyzed for in 1995 and was not detected. This data was reviewed by CDPHE.

Most metals and other inorganic constituents were determined to be below analytical detection levels. Molybdenum in ground water samples was generally below detection level except at MW-13 (0.08 ppm). As discussed above, molybdenum was not detected in the feed tails brought on site. Barium concentrations ranged from 0.01 to 0.05 ppm, well below drinking water limits. The concentrations of radiochemical parameters were all below drinking water standards and showed no significant difference between up-gradient and down-gradient locations. Uranium activity was highest in the up-gradient and cross-gradient wells along the eastern side of the site. These concentrations are probably derived from host rock rather than from seepage from the surface.

Volatile and semi-volatile organic compounds utilized in the extraction plant were below detection levels in all of the samples. A nontarget compound identified as decyl alcohol was found at trace levels in a duplicate sample for MW-8. Decyl alcohol was not identified in the MW-8 sample or in any of the other ground water samples. Because the decyl alcohol was only found in a duplicate sample and in no other samples, it was considered to be an anomaly.

Hecla-Durita's CRML License No. 317-02, Amendment 06, September 30, 1993, License Condition 26.2.2 required that total dissolved solids, chloride, sodium, carbonate and bicarbonate, sulfate, arsenic, molybdenum, selenium, gross alpha, gross beta, radium-225, thorium-230 and natural uranium be monitored quarterly in the ground water as these constituents were detected in the ground water or were found in the waste products.

The physical properties of the tailings are described as silty or clayey sand with an average in-place density of 79-99 pcf and a long-term moisture weight of 16.2%. Porosity at in-place density was 0.52.

(2) Characteristics of the underlying soil and geohydrology, particularly as to how they will control transport of contaminants and solutions.

Depth from the ground surface to the water surface ranges from approximately 15 feet to 35 feet, with the exception at monitoring location MW-14 where it is at approximately 50 feet. In the vicinity of the Durita site, the direction of ground water flow is generally from south to north/northwest at a gradient of 0.034 feet / foot. The water-bearing units produce very low yields (approximately 1 gpm) and have low permeabilities (10^{-5} to 10^{-8} cm per second). Transmissivity would also be low. Higher permeabilities occur in the weathered or fractured zones and decrease with depth thus preventing downward migration of possible contaminants.

(3) Location, extent, quality and current uses of any ground water at and near the site.

Wells on site are only used for monitoring. The nearest drinking water well is at the Coke Oven Ranch, located approximately one-half mile north of the site and away from the north/northeast direction of the shallow ground water flow from the site. This well is located in the Dakota Sandstone below the Mancos Shale and is not hydraulically connected to the uppermost water-bearing zone beneath the site. Regional ground water in this aquifer moves to the south, opposite to what is in the upper Mancos shale at this site.

Criterion 6: An earthen cover shall be placed over tailings or wastes which provides reasonable assurance of control of radiological hazards for 1,000 years to the extent reasonably achievable, and, in any case, for at least 200 years.

The earth and clay covers designed for the leach tanks are at least 5.28 feet thick on top and four feet thick on the sides, with at least six inches of rock on the top and sides of the earthen cover, and additional rock protection in the diversion channels adjacent to the cells. The closure cell cover is at least 2.5 feet thick and has a six-inch rock cover over the sides and top. The covers are designed to reduce radon emanations to less than 20 pCi/m^2s. The covers are designed to withstand the PMP. All design analyses indicate that the covers will provide adequate radiological protection for over 1000 years. Compaction of the materials was monitored and measured during placement of the waste and the soil cover to assure longevity of control. Settlement was also monitored with surveys of settlement monuments placed on the structures. This type of monitoring assures that the cover has not settled at significantly different rates, which could lead to a breach of containment. The cover was placed in accordance with approved plans and schedules.

Criterion 7: The licensee shall establish a detection-monitoring program to detect leakage of hazardous constituents and to demonstrate compliance with established protection standards.

A detection-monitoring program was established for the site in 1976. These wells were monitored until 1991. In 1991 new wells were drilled and completed at the site when a review of the completion records for the 1976 wells indicated that the construction and completion techniques used could allow surface water to enter the wells. Seven new wells were drilled in 1991 including three wells to act as background. Evaluation of the

data from the 1991 wells performed in late 1997 indicated that the point of compliance wells did not exceed applicable concentrations of background constituents. There is no evidence of seepage from the existing cells.

Criterion 8: Milling operations must be conducted so that all airborne effluent releases are reduced to levels as low as is reasonably achievable ("ALARA").

Point emissions sources no longer exist at the Durita site.

Criterion 9: The ownership of the tailings and the disposal sites must be transferred to the United States or the State in which such land is located prior to termination of the license.

Current license condition (LC) 13.4 requires that ownership and control of the tailings and/or waste confinement areas shall be such that ownership of the property may be transferred to the federal government under the provisions of the Regulations.

Criterion 10: Concentration limits for non-radioactive hazardous constituents.

All the applicable hazardous constituents from the Criterion 10 table were monitored and isolated at the Durita site.

In conclusion, CDPHE believes that the Hecla Mining Company's Durita site has met all applicable standards and requirements. With a determination by NRC, as required by Section 274c(4) of the Act, that all applicable standards and requirements have been met, the Colorado radioactive material license, 317-02, may be terminated.

II DOCUMENTATION OF BASES FOR CONCLUSION

2.0 Description of Decommissioning and Reclamation Activities

2.1 Reclamation Plan Framework

Hecla Mining Company submitted a conceptual reclamation plan to the Colorado Department of Health in 1990. The reclamation plan together with the quality control procedures and the construction verification program formed the basis for construction activities at the site. The final reclamation plan was submitted in 1991 and after several modifications was approved by the Department in 1993. The Preliminary Licensing Statement, dated May 1993, provided the analysis of the plan and rationale for approval. A portion of the plan called for further testing of materials in order to confirm their characteristics, select the proper materials and determine appropriate design considerations. Based upon testing of materials and the collection of additional data, detailed specifications were submitted in 1994 for review and approval. The Quality Control Procedures included a work breakdown structure of the reclamation activities and the documentation needed for each portion of the project. Documentation included daily

journals, nonconformance reports, variance reports and project verification reports. The Quality Control Procedures also included a description of the testing methods to be used for each phase of the project. The Construction Verification Program for the Durita Site was submitted in March 1995 prior to the first construction season. This document included a description of the activities to be verified, including: soils testing, rock testing, land surveying, and field observations. The Annual Report submitted for each year by Hecla contained the Construction Verification Report for each year's construction activities. Various contractors performed the quality control testing at the site. An independent contractor, Monster Engineering, performed verification of testing and construction. State personnel visited the site on numerous occasions to observe construction and cleanup activities.

2.2 Conceptual Plan

The reclamation plan approved under the radioactive materials license called for construction of permanent disposal structures on the Durita site and placement of radioactive materials (tailings; contaminated soils and construction materials) into these structures. The plan was composed of six elements:

- Contamination cleanup,
- Leach tank stabilization,
- Evaporation pond stabilization,
- Surface water diversion,
- Erosion protection and
- Surface restoration.

2.3 Contamination Cleanup

Contamination cleanup consisted of cleanup of solid materials and liquid materials. Solid materials (debris and soils) were derived from the mill area and surface soils. These materials were contaminated with radioactivity due to transportation and storage of tailings to be processed in the leach tanks. The leach tanks were constructed of large earthen dikes approximately twenty feet wide with an out slope of 2H: 1V and a 12-inch compacted clay liner. Liquid material cleanup involved solidification of evaporation pond residues and relocation of these residues to a final closure cell. A map of the site is attached.

Equipment and facilities in the process plant and ore process areas were demolished or salvaged. The items salvaged were decontaminated and removed from the site in accordance with the release criteria from a Table in the U. S. Nuclear Regulatory Agency

Regulatory Guidance 1.86 (NRC, 1974). Demolition and other mill debris were disposed of by on-site burial in the out slopes of the leach tanks, primarily in the north out slope of Tank 201 and Tank 203. Un-crushable debris with significant void spaces was filled with a sand-cement slurry grout prior to burial.

Non-salvaged equipment and structures, including concrete foundations, pads, support structures, tanks and other materials not decontaminated in accordance with release criteria, were buried on-site, in place, or buried in the toe of Leach Tank 201 or Leach Tank 203. Structural materials left in place were covered with clean soil. Tanks and other materials were crushed or cut where feasible, or filled with sand/concrete slurry when crushing or cutting was not feasible, and placed either in the leach tank out slope or the toe of the leach tanks for burial. At out slope locations of LT-201 and LT-203 where demolition debris and other disposable material were placed, special placement and compaction methods were used. Debris was distributed as uniformly as possible, placed in lifts, and soil was placed and compacted around the debris by hand-guided tampers. Materials in the leach tank toes were covered and the outslopes reconfigured from 2H: 1V to 5H: 1V slopes. Covered mill areas were graded to provide positive sheet flow drainage, smooth contours, and minimum surface gradient. Final grades in the process plant and ore preparation areas were restored to approximately original grades in the area. The other five elements are discussed in the following sections.

III DOCUMENTATION OF WORK MEETING APPLICABLE STANDARDS AND REQUIREMENTS

2.0 Geotechnical Stability

2.1 Introduction

The Hecla Mining Company's Durita site is a heap leach uranium milling and tailings site which has been decommissioned and reclaimed under Colorado Department of Public Health –Hazardous Materials and Waste Management Division's (CDPHE-HMWMD) Agreement State authority, derived from Title II of the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA). UMTRCA requires that prior to termination of the license, the U.S. Nuclear Regulatory Commission (NRC) shall make a determination that the licensee has complied with all applicable standards and requirements. Under the Agreement State program, the State of Colorado is responsible for approval of the remediation plans for the Durita site and for site inspections to ensure that the actual remedial actions have been completed pursuant to the approved plans. This report documents CDPHE-HMWMD's basis for its conclusion that decommissioning and reclamation have been acceptably completed at the Durita site.

2.1.1 Site Description

The site encompasses 160 acres and is located on gently north-sloping terrain at the

southeast end of the Paradox Valley, in western Montrose County, approximately 100 miles south of Grand Junction and 2.5 miles southwest of the town of Naturita, Colorado (Figure 1).

The site is relatively flat with a geologic remnant of the Mancos Shale Formation sticking up about 100 feet near the north center of the site. The site is located near 5600 feet above mean sea level and is in an arid climate with about 12 inches of rain per year. No perennial streams exist on the site, but three small drainages run through the center of the site and along the east side and the northwest corner of the site. Vegetation is sparse, consisting of shrubs: primarily sagebrush, widely spaced trees, grasses and forbs.

2.1.2 Site History

The original license for the site was issued on November 12, 1976 to Ranchers Exploration and Development Corp. of Albuquerque, New Mexico, for the "storage" of uranium mill tailings. Ranchers was later authorized to transport and process 600,000 tons of uranium mill tailings at the site. A new license was issued by the Colorado Department of Public Health and Environment in 1977 and was amended several times, and renewed, in full, in 1993. The last full renewal of the license took place on September 4, 2003.

Ranchers Exploration and Development Corporation in 1977 constructed the facility and operated it as a secondary-extraction heap leach facility that recovered uranium and vanadium from mill tailings originally processed through the Uranium Corporation of America mill in Naturita, Colorado. The tailings were placed in clay-lined leach tanks where percolating dilute sulfuric acid leached the uranium and vanadium from the tailings. Slotted pipes located in the bottom of each leach tank, transferred the leachate by gravity flow through a network of subsurface pipes to the extraction plant that collected the pregnant solution. The waste liquid was stored in six evaporation ponds located in the northeast quarter of the site. After operations ceased on May 22, 1979, a 2.5-foot-thick interim cover was placed over the leach tanks. Operations from 1979 to 1993 consisted of custodial care, ground water monitoring, and some decontamination and salvage.

Hecla Mining Company merged with Ranchers in 1984 and became owners of the property. Hecla submitted a reclamation plan in October 1991 (AK Geoconsult, 1991). The Department accepted this plan in May 1993. The plan was implemented and completed in 1999. Construction completion reports were submitted each year after the construction season.

2.1.3 Operations

The facility operated by heap leaching uranium mill tailings with dilute sulfuric acid in three large earth-bermed leach tanks (Figure 2). The leaching tanks were constructed of

earthen dikes approximately twenty feet wide with an out slope of 2H: 1V and a 12 inch compacted clay liner. The acid leachate containing uranium and vanadium was collected by slotted pipe at the bottom of each leach tank and transferred through a series of subsurface pipes to the extraction plant. Uranium and vanadium were removed by ion exchange and solvent extraction.

The leach tanks had a compacted twelve-inch clay liner on the bottom and inside slopes. Permeability tests showed that liquids would not penetrate the liner during its active life, approximately 19 months. Each tank also contained a network of collection lines that transported the extracted uranium to the mill. The tanks were originally designed to contain 727,500 cubic yards of tailings materials. At the close of operations, tank 203 was 65% filled, and tanks 201 and 202 were 100% full.

- Tank No. 201 267,300 CY
- Tank No. 202 287,100 CY
- Tank No. 203 178,100 CY

Waste liquids from the process were stored in a series of evaporation ponds located onsite.

At the conclusion of operations, a temporary soil cover was placed over mill tailings contained in the leach tanks. 2.5 feet of random fill was placed on top of the leach tanks. License Condition (LC) 17.1.2 required that a minimum of 5.28 feet be the minimum cover. A minimum 2.8 feet of radon cover thickness was placed over the contaminated soils and random cover. Following is a summary of the measured radon cover after placement. Lt –201 cover averaged 3.7 feet with a maximum thickness of 4.6 feet and a minimum thickness of 2.8. Lt-202 had an average thickness of 3.0 feet with a maximum thickness of 3.9 feet and a minimum thickness of 2.8 feet. LT-203 had an average thickness of 4.3 feet with a maximum thickness of 5.8 feet and a minimum thickness of 2.8 feet. The evaporation ponds were left uncovered due to the amount of liquid remaining in the ponds. Processing of uranium at the site resulted in the need for cleanup of contaminated soils and evaporation pond residues.

Combining the evaporation pond residues into one cell (the closure cell) and placing the mill residues in the existing heap leach cells and closure cell avoid the proliferation of small waste sites. The disposal of all these materials at one location reduced reclamation costs and long-term maintenance costs.

The pre-existing condition and nature of the tailings disposal sites at Durita made below-grade disposal impractical. Below grade disposal would bring the wastes closer to ground water and reduce the isolation features of the existing site. This location and its designed liners, covers and diversion channels are adequate to resist the long-term forces of erosion.

2.1.4 Design Basis of the Leach Tanks

The reclaimed leach tanks and the closure cell were designed to maximize structural stability, minimize settlement, and remove the potential for liquefaction and to minimize active long-term maintenance. The soil covers for these cells were designed to reduce radon release, reduce the infiltration of moisture, reduce the effects of freeze/thaw cycles, and reduce the potential for gully erosion. Leach tanks had rock on the side slopes and a vegetative cover on the top.

Runoff diversion channels were designed to withstand any extreme flooding. The rock cover material for the cells and riprap for the diversion channels were selected for long-term durability.

The structural stability of the cells was evaluated using the STABL5 computer code and the Modified Bishop Method of stability analysis, one of several slope stability calculational methods in common use. Under the extreme hypothetical conditions modeled (an earthquake with 0.12 peak acceleration and complete saturation of all leach tank slopes and natural ground) the lowest factor of safety for the highest leach tank slope (27 feet) is 1.61. This is well above the limiting value of 1.00 for a psuedostatic factor of safety.

The leach tank tailings materials consisted of sandy soils with some silt and clay and were unsaturated and had been in place since 1980. They had been covered with a temporary cover of a minimum of 2.5 feet. An additional final cover of 2.8 feet was added for final closure. The additional cover would cause a surcharge of about 550 pounds per square foot. Therefore, any settlement resulting from this surcharge would be small. This was confirmed by field measurements. Settlement calculations were not done, probably based on the low load from the additional cover and the weight of equipment used for soil placement and compaction. Settlement monitors were constructed on the cells to observe changes as construction took place. During the period of waste placement and cover construction for the closure cell, from early 1996 to late 1998, total settlement was less than one-inch.

2.1.5 Leach Tank Stabilization

Leach tank stabilization involved the contouring and covering of the three earthen heap leach tanks that were constructed in 1976 to extract uranium. The sideslopes of the leach tanks were regraded to a slope of 5H: 1V from a slope of 2H: 1V. Some of the material used in the regrading was cut from the crest of the existing tanks and the remainder was obtained from the approved borrow sources. Mill debris was also placed on the out slopes of Tank 201 and Tank 203. The top slopes of the leach tanks were graded to slopes of 0.5%.

A temporary cover of 2.5 feet was placed over the tailings when active operations ceased.

This cover used on site soils classified as CL or SC in the Unified Soil Classification system and was placed in 8 inch lifts compacted to 95% of Standard Proctor, ASTM-698. A minimum additional 2.8 feet of soil cover was placed on the leach tanks to reduce the radon emanations to less than 20 pCi/m^2s. Radon testing indicated that the measured flux rate through the engineered covers, from a total of 138 measurements over the three heap leach tanks and the closure cell at Durita, averaged 0.91 pCi/m^2s. Results ranged from a low of less of less than 0.5 pCi/m^2s (the analytical practical quantification limit) to a maximum radon flux reading of 17.6 pCi/m^2s. The materials used for the soil cover were obtained from the realignment and excavation of ephemeral channels that cross the site. Settlement monitors were also constructed early in the process to assure that differential settlement was minimized. The final cover over the leach tanks had 5H: 1V slopes and utilized a vegetative cover. Surface water diversions and erosion protection were designed to assure stability of the repository during maximum probable precipitation and/or flooding. The rock was tested for durability and properly sized for placement.

The soil-covered tops of all three leach tanks are stable as designed and constructed. The following items all indicate that the covers are stable in their current configuration:

- The design engineer (AKG Consultants) utilized an NRC approved analysis method for stable covers in the Final Reclamation Plan (AKG, 1991). This was the Horton NRC Method. They utilized NRC's Final Staff Technical Position – *Erosion Protection Covers for Stabilization of Uranium Mill Tailings Site*, August 1990 (NRC STP).
- AKG designed all of the leach tank top slopes so that they were flatter than the Critical Slopes calculated by the Orton/NRC method. A slope flatter than the Critical Slope is stable from erosion. All of the leach tank slopes were designed and built at a slope of 0.005, which is 1 foot of drop for 200 feet of run.
- Acceptable cover materials were utilized during construction.
- Acceptable construction methods were observed.
- Placed cover materials passed all testing equipment.
- To date, the soil covers are performing as designed. There are no signs of erosion on top of the leach tanks.

Results of all design, calculations, test results and reports can be found at the Colorado Department of Health and Environment – Hazardous Materials and Waste Management Division's Record Center.

2.1.6 Evaporation Pond and Raffinate Pond Stabilization-Closure Cell

Six evaporation ponds contained residual soils and liquids that were byproducts of the leachate-extraction process. They occupied an area of approximately 13.4 acres. The

salts, gels and liquids were mixed and solidified and consolidated into a single 4-acre repository or closure cell adjacent to the "Mancos Hill". The closure cell was designed to contain these wastes for not less than 200 years.

The evaporation pond materials were mixed with Mancos Shale in order to solidify and neutralize the contaminants present. Laboratory tests performed in 1992 showed that mixing of the calcareous shale with the pond material would help to neutralize the pond material. The materials were mixed at an approximate ratio of 1 part shale to 2 parts pond material by volume until it was dry enough to be placed as a soil. This mixed material was called solidified pond material (SPM). Any SPM containing moisture contents higher than those that would allow the required compaction were reworked, disked, scarified, or otherwise manipulated so as to dry those materials to the necessary moisture content for compaction prior to their relocation and placement within the closure cell.

SPM materials that had sufficiently reacted, solidified, and allowed to dry were excavated and hauled to locations within the closure cell and placed in lifts not to exceed 8.0 inch uncompacted lift thickness. Each lift of SPM was compacted to not less than 90% of maximum Standard Procter density before placement of subsequent lifts.

Four small (80 ft. wide by 80 ft. long and 10 ft. deep) lined raffinate ponds were located near the north side of leach tank 201. The raffinate was mixed in place with Mancos shale so that it could be solidified sufficiently to be hauled to the evaporation ponds and mixed with the SPM and eventually taken to the closure cell.

The closure cell was constructed with a one-foot compacted clay liner on top of scarified Mancos Shale. The liner was constructed to meet a permeability of $1x10^{-7}$ cm/sec. The sideslopes of the cell have a 5H: 1V slope and the top of the cell is sloped at 2 percent. A three-foot thick soil cover was constructed on the top and on the sideslopes of the waste cell. A rock cover for erosion protection was also placed on the top and on the sideslopes. The rock cover prevents the soil from becoming airborne and being dispersed from the closure cell. This eliminated the need to consider the air pathway for off-site exposure.

The radium-226 activity throughout the closure cell, including the SPM, is low. The radium –226 activity of the SPM averages 6.4 pCi/g. This is only slightly elevated over the approved site cleanup level for radium-226 of 6 pCi/g. The measured average radium-226 activity of each layer of the upper 12.7 feet of the closure cell ranges from 1.8-2.3 pCi/g. The top 0.5 feet of the closure cover has an average radium-226 activity of 1.8 pCi/g. When the thorium-230 and radium-226 activities are decayed for 1,000 years, the radium activity in the upper 0.5 feet of the cell calculates to 6 pCi/g, which is equivalent to the radium activity used as the cutoff for site cleanup. Therefore the cover radium-226 activity is essentially the same as in the surrounding surface soils both currently and in 1,000 years. Further, a 0.5 –feet layer of rock, which will help to maintain high moisture content in the cover, overlies the cover. The cell cover meets the condition of criterion 6 for longevity and control of radon release.

2.1.7 Slope Protection Measures for the Waste Repositories

Slope protection measures were constructed to protect the waste repositories. These measures included construction of a new closure cell for the evaporation pond residues and the placement of rock cover on the sideslopes of the leach tanks and new closure cell. Rock cover was also placed on top of the closure cell. The leach tanks were constructed with a relatively flat top surface slope of 0.5 %, which is a drop of 1 foot for 200 feet of run, and revegetated to minimize erosion. The outslopes were protected by a minimum 6-inch thick rock cover consisting of rock with composite durability scores of 80% or more (AK Geoconsult, Inc.). Field measurements were taken of rock depth on April 19 and April 26, 1996 of rock depth. Measurements indicated an average rock cover of 6.7 inches and no single depth less than 6 inches on LT-201, an average depth of 6.7 inches and no single depth less than 6 inches on LT-202, and an average depth of 6.5 inches on LT-203. A small area with a depth of 4 inches was found on the west slope. The contractor later placed additional rock at this location. The size and gradation of the rock used was calculated according to guidelines provided by the U.S. Nuclear Regulatory Commission NUREG/CR 4620. All design analyses indicate that the covers will withstand wind and water erosion for more than one thousand years.

The rock placement crew consisted of two dozer operators and a grade setter. A Caterpillar D5H dozer was used for rough grading. A D5LGP was used for final placement and finish grading. The most effective method to thin the rock to six inches and leave a smooth surface was to back drag with the D5LGP. A Caterpillar 12G grader and a water truck maintained the haul routes. A front-end loader and several trucks were employed to move rock from the stockpiles to the haul roads.

The potential for gullying and soil erosion were evaluated for the leach tanks using the Horton Method. Based on the soils that were to be used for cover, and the slope gradients and lengths, all of the top slopes would be stable. For the sideslopes, the gradients generally exceeded the critical slopes of the Horton Analysis but were within the range of slopes that are recognized as stable under Appendix A, Criteria 4c, of part 18 of the Colorado Regulations. These slopes were provided with a rock cover to assure erosional stability. The size of the rock cover was determined using the safety factor method as described in the NRC Final Staff Technical Position ((US NRC, 1990). The median size ranged from 1.0 to 1.7 inches. Rock used for cover was 2 inch. CDPHE concurred with the analysis performed and agreed that the slopes would be stable. Subsequent annual inspections have shown that the slopes remain stable.

2.1.8 Surface Restoration

Surface restoration is the final element of the reclamation plan. This element involved regrading and reseeding of the mill and ancillary areas. The tops of the heap leach repositories were also vegetated to reduce infiltration through the cells.

The four most important elements of the reclamation plan that control the longevity and effectiveness are:

- The stability of the evaporation pond materials placed in the closure cell;
- Low permeability of the soil cover material;
- Durability of the rock used for riprap and:
- Proper alignment and protection of the runoff control channels.

The evaporation pond residues are chemically altered materials that do not behave as normal soil. Hecla performed extensive testing on the evaporation pond materials. The method selected to stabilize the materials, to assure more soil-like properties, was to add shale to the materials. The calcareous shale acted to chemically neutralize the acidic material and allowed for proper compaction. The method used to stabilize the evaporation pond materials provided an inert, well-compacted material.

Soil used for cover material was obtained from the excavation of clean materials to re-align the runoff control channels that cross the site. These soils were derived from the nearby rocks and contained significant amounts of clay. The interim soil covers on the leach tanks were also sampled and found to contain about 28% clay. The permeability of compacted samples averaged $2.0 * 10^{-7}$ cm/sec. The soil was also found to be non-dispersive and acceptable from the standpoint of minimizing radon flux and infiltration of precipitation. Specifications for all soils used as cover included classification of the soil as an SC, CL or CH under the Unified Soils Classification System. During placement, compaction was specified to 95% of ASTM D 698, Standard Proctor Density, to assure limited permeability.

Rock cover and riprap materials were obtained from two borrow source areas. The majority of the rock is composed of gravels found along the San Miguel River. A small amount of the largest riprap material was a marine limestone obtained from a quarry in La Sal, Utah. Both of these sources were tested for durability using standard engineering tests. Both materials were found to meet durability recommendations of the NRC, and did not need to be oversized. From a geologic perspective, these materials have resisted degradation for thousands of years. The terrace gravels used for the rock cover and riprap were located adjacent to the San Miguel River. The deposit contained primarily igneous rock that had been carried downstream some 50 miles from the headwaters of the San Miguel River. Alluvial transport of the material from the San Juan Mountains resulted in the selection and deposition of the most durable materials.

The second source of the largest rock size (over 10-inch) was a limestone member of the Upper Hermosa Formation taken from a quarry near La Sal, Utah. The rock is a Pennsylvanian-aged (300 million years old) fine-grained, marine limestone. It is sound, dense and free of lineations, partings or other areas of weakness. The limestone does not contain a significant amount of minerals that will weaken the rock during its service life.

Durability testing confirmed that the material met NRC guidance without the need for over sizing.

Channel alignment and the control of runoff passing through the site was initially a serious concern. However, the conceptual design submitted by Hecla provided an innovative solution to flood routing past the repositories. The three pre-existing ephemeral channels were re-aligned to the grades that existed prior to construction of the leach tanks. The channels were widened slightly to reduce the potential for scour. Scour protection walls and riprap blankets were designed to be placed along the edge of the flood plain in order to protect the upland areas from the effects of the Probable Maximum Flood event (see section 5.3).

2.1.9 Cover

The covers for the cells were constructed from soils, available at the site, and found to meet the design criterion. The soils ranged in type from clayey sand to sandy clay. The permeability of the soils used ranged from $5.0x10^{-7}$ to $3.7x10^{-8}$ cm/sec with an average permeability of $1.9x\ 10^{-7}$ cm/sec. These soils are relatively impermeable which means that they will not transmit large volumes of water or radon gas. The compacted soils were suitable for use as cover material to reduce both radon flux and infiltration of precipitation.

Radon emanation was evaluated using the U.S. Nuclear Regulatory Commission RADON Model. The parameter values selected for the model were also evaluated and found to be reasonable. The RADON model resulted in an estimate of 2.8 feet of soil cover to meet the radon flux requirement of 20 pCi/ m^2s. The final cover thickness was 5.28 feet thick (see Section 4.5 for further discussion on radon emanation).

The frost depth in the area does not exceed two feet according to the U.S. Soil Conservation Service and local contractors. Top slopes were designed to promote runoff. In a response to State comments, Hecla indicated that soil that is not saturated will not experience frost damage and that due to the low permeability of the compacted cover, the depth of saturation will be a few inches at most. Hecla stated that a few inches of frozen soil would not alter the effectiveness of the cover as a radon barrier. In the worst case, the frost depth is not anticipated to exceed 24 inches. Nevertheless, the five-foot plus cover thickness on the leach tanks provided an adequate margin of safety to control radon and to insure that frost heaving will not impact the performance of the cover.

The compacted cover for the closure cell was 2. 5 feet. The evaporation pond material was mixed with Mancos Shale and was compacted into a soil-like state at a moisture content that met compaction criteria (see Section 4.3).

The infiltration through the cover was evaluated using the Hydraulic Evaluation of Landfill Performance (HELP) model developed by the US Army Engineer Waterways Experiment Station under a cooperative agreement with the U.S. Environmental

Protection Agency. The model tends to predict more infiltration than is actually observed and thus is an appropriate model for evaluating the potential for long-term failures. In addition to reviewing Hecla's model, the Division prepared it's own evaluation of the data. The evaluation showed a steady state flux of liquids through the cover. Concerns were expressed about the buildup of liquids on the liner at the bottom of the cell. However, the underdrains were dry for several years prior to the start of reclamation. Borings conducted to characterize the leach tank materials indicated that the bottom few feet of tailings, in some locations might be saturated. The placement of low permeability cover material and the establishment of vegetation would reduce potential for infiltration and soil from becoming airborne.

The erosion potential of the vegetated top slopes was evaluated using the Horton Method; one of the U.S. Nuclear Regulatory Commission-approved methods to evaluate gully erosion. The top slopes were designed to be less than 2 percent and were shown to be stable for flows up to the probable maximum flood event, 8.4 inches per hour of rainfall. Regrading the side slopes to 5H: 1V reduced the potential for erosion of the side slopes. The slopes were also protected with a rock cover. The size of the rock was calculated in order to withstand the erosive forces of the probable maximum flood. In the original design the D_{50} rock sizes varied from 4 inches to 20 inches. The plans were revised in 1997 to reduce the number of different sizes of rock needed. The D_{50} sizes either increased or remained the same.

During a May 2001 site visit, U. S. Nuclear Energy Division staff requested an evaluation of the top cover's resistance to erosion. Hecla Mining Company submitted a stability evaluation done by Monster Engineering dated October 31, 2001. The State concurred with the findings of the evaluation that the top-slope covers were stable (CDPHE, Nov. 2001). The cover would provide long-term protection from radon emanation and erosion.

2.1.10 Seismic Evaluation

The Durita site is located within the Colorado Plateau Seismotectonic Province as described by Kirkham and Rogers (1981). They estimated a Maximum Credible Earthquake (MCE) of 5.5 to 6.5 for the province, making it one of the more stable provinces in Colorado. Recent faulting according to F.M. Fox & Associates (1982) is rare in this province except for faults related to the Uncompahgre Plateau or collapse of the salt anticlines. According to the report by F.M. Fox, evidence indicates that the collapse of salt structures was active in the last 500,000 years and may be active at present. However, the faults associated with collapse are gravity faults that are generally slow moving with a low potential for generating even moderate earthquakes. There is no evidence for recent movement along faults in the immediate vicinity of the site. The site does not appear to be located adjacent to a capable fault. There is no evidence either at the surface or in the holes drilled for monitor wells to indicate faulting or even abrupt structural changes under the site. The MCE for an one-thousand-year event would generate a peak acceleration of 0.12g. Stability analyses indicate that the repositories have more than adequate factors of safety for static and psuedostatic conditions. Based

upon the existing information, the site will provide permanent isolation of the tailings for the long term.

The first recorded earthquake in the Colorado Plateau region occurred in 1870. The epicentral locations of pre-instrumental events are poorly defined, probably because of the sparseness of population. As a general rule, the historical record is probably reliable for moderate to large earthquakes since about 1890. Since the 1950's, magnitudes of greater than 4.0 with a location uncertainty of 30 miles were able to be determined. For magnitudes of 3.5 or greater since 1963, the instrumental record is probably reliable with a location uncertainty of 12 miles. Published estimated maximum earthquake magnitudes based on regional source zones are presented below (Naturita RAP, 1998):

Estimated Maximum Earthquake Magnitude, Intensity, and Acceleration for the Site Region

Maximum	Source	Probabilistic Estimate		
Source	Magnitude (M_L)	Region	Intensity	Acceleration
Liu and De Capua	7.0	Utah		
(1975)	6.5	Colorado	IV	0.02g
Algermissen and	6.1	Paradox Basin	0.07	
And others (1982)	7.2	Uncompahgre-		0.12
San Juan Mountains exceedance in 250 years	90% probability of no			
Thenhaus (1983)	6.0	Paradox Basin	Not given	
	6.5	Uncompahgre-San Juan Mountains		
Kirkham and	5.5-6.0	Colorado Plateau	Not given	
Rogers (1981)	6.0-6.5	Western Mountains		

Geologic Suitability and Site Stability-Additional Information

DOE proposed constructing a disposal cell for the Naturita Tailings on a site called Dry

Flats located approximately one-half mile due east of the Durita site. They prepared a report that evaluated geologic stability and suitability, geomorphic stability and seismotectonic stability. Their evaluation determined that geomorphic processes are not likely to affect the long-term stability of the disposal cell. Potential geologic events, including seismic shaking, liquefaction, on-site rupture, ground collapse and salt core flow, are ruled out as potential disturbing forces on the disposal cell because they will not occur because the geotechnical design of the cell is formulated to resist such forces (DOE. 1994).

The report indicated that the geologic site lithology, stratigraphy, and structural conditions were suitable for the disposal cell. Based on their evaluations, DOE concluded that the site was geomorphically stable and would continue to be stable for the performance period of the disposal cell. There is little likelihood of salt core flow inducing and developing collapse structures adjacent to the site, given the present stability of the region and of the Colorado Plateau. The site was little disturbed by the Tertiary activity that developed Coke Oven Valley and Paradox Valley, since it lies on the flanks of the salt core structure.

The DOE determined that the disposal site and cell design would provide long-term stability during seismic events by analyzing the anticipated ground motion at the site as a result of those events. They analyzed potentially active faults and the remote seismotechtonic sources with the calculated maximum earthquake (ME), as well as the estimated ME of previous studies. Using the appropriate attenuation relationships for the site region, the criticality of these faults was evaluated. Four fault groups were shown to be within critical distance and to have critical length regardless of known capability. One salt core structure was also determined to be in the critical group.

In a brief summary, the design earthquake for this site was determined to be an $M_L = 7.1$ event occurring at a distance of 24.1 kilometers from the site based on the conservative assumption that the largest critical tectonic fault was capable.

Seismic design parameters are presented below. The acceleration attenuation relationship of Campbell (1981) was used to derive the on-site horizontal acceleration.

<u>Design criteria</u>

- Long-term slope stability seismic coefficient: K=0.17 (two-thirds of peak horizontal acceleration).
- Short-term slope stability seismic coefficient: K=0.13 (one-half of peak horizontal acceleration).
- Liquefaction analysis: ground surface acceleration $a_{max} = 0.24$ g.

The seismic potential for the site had a design of 0.25 peak horizontal acceleration. "Because of the stability of the bedrock that underlies the cell foundation, the potential

for failure of the foundation is considered negligible."

"On the basis of the site characterization described in this section and supporting documents, and the provisions for stability included in the design of the disposal cell, the DOE concludes that there is reasonable assurance that the regional and site geologic conditions have been characterized adequately to meet 40 CFR Part 192." (DOE, 1994)

2.1.11 Liquefaction Potential

The liquefaction potential of the cells was considered during design. Liquefaction requires saturated fine sand or silt under conditions where confinement is inadequate or where it could be lost, leading to dilation of soil due to pore-liquid pressure sufficient to destroy the continuity of soil solids and to suspend soil solids in liquid (liquefaction). Conditions preventing this from occurring in the leach tanks are: a) absence of a saturated zone (These cells were designed to drain as heap leaches and were dry for a period of 15 years prior to the placement of a final cover) b) total confinement laterally by dikes and vertically by a thick section of unsaturated tailings and cover material, and c) low seismicity of the area. The pond residues in the closure cell were also evaluated for liquefaction potential. Although initially a wetter material, the addition of large amounts of Mancos Shale to the residues resulted in the creation of a dry, chemically altered, heterogeneous material, with "concrete like" properties.

3.0 Site Remediation

Hecla submitted a final reclamation plan for the site in October 1991, which was approved by CDPHE in May 1993. Decommissioning began shortly afterwards with demolition of the process mill and tailings preparation equipment. After heap drainage ceased, the collection pipes at the base of the heaps were plugged with concrete. The interim top and out slope covers over the heaps were replaced with engineered earthen radon barriers and out slopes received six-inch layers of rock for erosion protection. The clay radon barriers were also compacted to reduce water infiltration from precipitation events and were sloped to facilitate runoff. The tops of the heaps were revegetated.

Liquids in the process-liquid storage ponds and the evaporation ponds were neutralized and solidified with Mancos shale and the solidified material was consolidated and placed in an 8-acre engineered closure cell built to isolate the contaminated material from the environment. Demolition debris and radionuclide contaminated soils were also placed in the closure cell. The cell is imbedded in the Mancos Shale formation, has a compacted clay liner, and an engineered cover to reduce radon and infiltration of precipitation. The cover has been graded and contoured to promote runoff.

3.1 Implementation of the Reclamation Plan

Reclamation of the Durita site took place during the period from 1992 to 1999. Implementation of the reclamation plan started in 1992 with the testing of evaporation

pond residues to determine the best means of solidification. Testing of the methods to solidify the pond residues continued in 1993. Cleanup of the mill and ore preparation areas at the site started during the 1993 construction season. In 1994, solidification of the pond material commenced and removal of contaminated soil was undertaken. Oversight of reclamation activities was performed by the State during 28 site visits and inspections between 1992 and 1999 including independent verification surveys and sampling.

The 1995 construction season saw the removal of the remaining debris from the mill and ore preparation areas. Removal of the majority of contaminated soil was completed across the site. Solidification of the pond material continued and the liner for the new closure cell was constructed. Placement of solidified pond materials in the closure cell commenced in 1995. The leach tank outslopes were contoured to a 5H: 1V slope. Contouring was performed through a combination of placement of contaminated soil and debris and regrading of the remaining cells, pits, dikes and other topographic features. Other work completed in 1995 included the sealing of the heap leach underdrain system and the establishment of temporary settlement monitors on the leach tanks and the closure cell.

During 1996, removal of contaminated soil continued. The contaminated soils were placed in the closure cell. Rock was placed on the out slopes of the leach tanks. The thickness of the rock already placed was confirmed during the 1996 construction season. Settlement monitors were placed on the leach tank tops in early 1996. Measurements commenced in March of 1996.

Activities in 1997 included removal of contaminated soil from the evaporation pond area, continued with placement of this material in the closure cell. Other work conducted during the 1997 construction season included regrading of some leach tank out slopes, regrading work on the East and Central Diversion Channels, placement of rock cover material on the slopes of the leach tanks, and regrading of areas where contaminated soil removal had taken place.

During the 1998 construction season, work continued on regrading of channels, placement of rock cover on the leach tanks and regrading of the old evaporation pond area. Rock cover was also placed on the closure cell. Riprap and scour protection were placed on the Closure Cell during this period.

The last major construction season was 1999. Work included regrading of various areas across the site including the diversion channels, placement of riprap and rock cover material, and seeding of the tops of the leach tanks. In 1999, representatives from the State of Colorado performed confirmatory gamma surveys.

After construction was completed in the spring of 1999, a series of intense storms passed through the area. A routine inspection of the site in August of 1999 indicated that concentrated runoff adjacent to the rock cover aprons on Leach Tanks 201 and 203 caused some erosion. The potential for a similar situation also existed in the channel between tanks 201 and 202. Upland flow near tank 203 was also washing down behind

the riprap curtain along a twenty-foot portion of the east side of the Central Diversion Channel. In response to these observations, Hecla repaired the erosion problems noted and constructed additional measures to handle the areas where concentrated runoff was noted. A follow-up site visit in November showed that Hecla had repaired the problem areas and performed additional work. This work included the construction of additional length to the 201/202-diversion channel, improvements to the channel below the west end of tank 201 and improvements to the runoff collection channel above the Closure Cell. None of the repairs or improvements needed were the result of riprap failure due to water flowing through the diversion channels, but resulted from channelized upland flows. The regrading of the upland areas, and placement of additional rock aprons will preclude future problems.

3.2 Design Changes and Modifications

During the course of construction activities, conditions encountered in the field led to the need for design changes or minor modifications to the reclamation plan. The majority of the changes and modifications took place during the 1995 construction season. A detailed description of the design changes and modifications are found in the 1995 Annual Report and subsequent annual reports. Over 25 minor modifications were made to the plan. The most significant ones involved relocation and widening of diversion channels, minor decreases to leach tank elevations and reduction in the number of rock gradations. Six design changes were made, including changes to cell configurations, diversion channel grades and configurations, location of contaminated soil placement and disposal location for some mill debris. Design changes and minor modifications that affected reclamation plan design were prepared by a registered professional engineer and submitted for Department approval. Where needed, appropriate calculations confirming the performance of the change were submitted for review. All modifications were reviewed and approved by the Department prior to construction. Results of all design, design changes, calculations, test results and reports can be found at the Colorado Department of Health and Environment – Hazardous Materials and Waste Management Division's Records Center.

3.3 Specifications and Quality Control

Each element of the reclamation activities was performed according to written specifications that were submitted by Hecla as outlined in the 1991 Reclamation Plan and presented in detail in a series of 1994 submittals. Quality control for the project involved assurance that the specifications were met. The quality control framework was implemented through the establishment of Quality Control Procedures and a Construction Verification Program. Quality Control Procedures established specifications for testing, inspection and documentation. Construction verification provided the framework for independent quality assurance and the preparation of construction completion reports and drawings. Various contractors performed quality control procedures. Quality assurance for the construction work was performed by an independent contractor (Monster

Engineering Inc).

Annual updates were provided to the Colorado Department of Public Health and Environment each year for the previous year's reclamation activities. These updates included a description of the work performed, construction verification and quality control, test results and a summary of modifications. Daily activity logs and a summary of all quality control work were included in the annual reports.

Initial clean up of contaminated soil was governed in the field by gamma radiation surveys. Gamma meters were used to guide field removal of contaminated materials. Uncorrected field readings of 30 μR/hr together with visual evidence were used to determine the need for removal. Conformance with soil clean up standards was verified through soil samples taken on 100-square meter grids. Soils cleanup verification was described and documented in a report entitled "Soil Cleanup Verification Report" Hecla Mining Company, November 14, 1996.

Standard earth moving equipment and methods were used on site for soil removal, transportation, disposal, placement and compaction. This included excavating equipment such as backhoes, end loaders, and scrapers, as well as trucks for hauling materials and machinery for placement and compaction. Equipment used during reclamation was included in reports submitted to the department and the reports are available for review at the Colorado Department of Public Health and Environment - Hazardous Materials and Waste Management Division's Record Center.

Placement of contaminated soils was controlled through the use of proper compactive effort. Stabilization of the leach tanks involved placement and compaction of contaminated soils, debris and clean soil on the outslopes and within the cells. The material density was controlled through the thickness of the layer placed and compaction. Layer or lift thickness was limited to 8 inches. Compaction was tested using Standard Proctor density. The specification for placement of contaminated material was 90% of Standard Proctor density. The lift thickness for the clean soil cover was also 8 inches. Compaction of the cover material was specified as 95 % of Standard Proctor density, with moisture contents of +/- 2% of optimum. Compaction was tested once every 10,000 cubic yards. The size of material placed in each lift was limited to 6 inches. The type of material used for the radon barrier portion of the cover was specified as a clay or silty clay. Material type was confirmed using standard soil engineering tests. The final grade of the leach tank outslopes and top slopes were confirmed using land survey equipment. Rock cover was placed on top of the final soil cover. Rock durability was tested for each 1000 cubic yards of material. The tests used included specific gravity, absorption, sulfate soundness and Los Angeles Abrasion test. Rock size and proper placement were observed in the field. Rock layer thickness was evaluated with land survey data and verified by digging test pits. Design documents, specifications, quality control data including compaction tests and locations, gamma survey results, laboratory test results, and annual reports describing activities on the site are available for review at the Colorado Department of Public Health and Environment - Hazardous Materials and Waste Management Division's Record Center.

3.4 Field Quality Control Testing Included the Following Frequencies:

3.4.1 Soils

a) Soil Classification: For soils used in the containment berms, clay liners, and radon barriers and for contaminated soils, not less than one per 10,000 cubic yards (c.y) or at least one per each two acres of borrow area, whichever is greater.

b) Standard Procter Density (ASTM D-698): At least one per 10,000 c.y. for soils used in the containment berms, clay liners, radon barrier, diversion channels, for SPM and contaminated soils.

c) In-place density tests: At least one per 5,000 c. y. per ASTM D-1556 for all compacted materials. ASTM Method D-2992 may be used if sufficient correlation with method D-1556 can be established based on not less than 10 comparative tests.

3.4.2 Rock

a) Rock quality testing (sodium sulfate soundness per ASTM C88, specific gravity and absorption per ASTM C97).

b) Rock size and gradation: one test per 1,000 c.y. of each gradation using ASTM C-136 or other approved method.

c) Rock layer thickness: Leach tank out slope cover and closure cell: one measurement per 4,000 square feet.

3.4.3 Channel Riprap Placement

a) Visual inspection of rock screening operations and rock placement was performed at least once daily.
b) Rock quality testing (sodium sulfate soundness per ASTM C88, specific gravity and absorption per ASTM C97): one test per thousand cubic yards.
c) Rock size and gradation: one test per 1,000 c.y. of each gradation using ASTM-136 or other approved method for rock sizes exceeding the range of applicability of AST-136.
d) Rock layer thickness: one measurement for each 200 feet of length.

Results of compaction tests, surveys, field and laboratory tests, plans, specifications, designs, records and correspondence are available at the Colorado Department of Health, Hazardous Materials and Waste Management Record Center.

Evaporation pond stabilization involved construction of a containment berm as part of the closure cell, construction of the clay liner for the cell, placement of contaminated pond residues and placement of a radon barrier. A rock cover was placed on top of the radon barrier. Containment berm specifications included material type, size, compaction and layer thickness. Size of individual clasts could not exceed 6 inches, within an 8-inch lift. Compaction was set at 95% of Standard Proctor density, with a moisture content of +/- 2% of optimum. The clay liner specifications included a clay-only material type, individual clast size of 3 inches and compaction of 90% Standard Proctor density. The contaminated pond residues and contaminated soils were subject to lift thickness and compaction requirements, specifically, 8-inch lifts and 90% of Standard Proctor density.

The specification for Solidified Pond Material (SPM) called for mixing of the pond residues with shale until all chemical reactions had taken place and the material took on a dry, soil like consistency capable of being compacted in the closure cell. Laboratory tests performed in 1992 showed that mixing of the calcareous shale with the pond material would help to neutralize the pond material. The materials were mixed at an approximate ratio of 1 part shale to 2 parts pond material by volume until it was dry enough to be placed as a soil. This mixed material was called solidified pond material. Any SPM containing moisture contents higher than those that would not allow the required compaction were reworked, disked, scarified, or otherwise manipulated so as to dry those materials to the necessary moisture content for compaction prior to their relocation and placement within the closure cell. These conditions were verified by visual observation in the field. Outslope grades were confirmed through land survey to determine conformance with the 5H: 1V slope requirements. Rock size and proper placement were observed in the field. Rock layer thickness was checked by digging test pits and through land survey data. Rock durability testing was performed as described previously.

Development of surface water control structures involved excavation and placement of fill in floodplains and channels, construction of scour protection trenches and specifications for riprap material to be placed in the trenches. Excavation was controlled by tolerances to the design drawings as observed in the field. Placement involved compaction of 12-inch lifts by at least three passes of a D8 bulldozer. Thickness of the scour protection features and the size of rock used were measured in the field during construction. Rock durability was tested for each 1000 cubic yards of material, according to the tests discussed previously.

Erosion protection involved specifying the placement, thickness, gradation, size and extent of rock cover and riprap materials (rock) for all aspects of the project. Seeding of the disturbed areas included specifications for the mixture, time of year and requirement to mulch after seeding.

3.5 Soil Cleanup Plan

Soils, contaminated with radioactive materials and/or metals associated with operations, were excavated from locations around the process plant, ore preparation areas, and on site

roads and disposed of within the out slopes of the leach tanks or the closure pond materials containment cell as described in Revision 1 of Hecla's reclamation plan. The cleanup standard for radium was based upon U.S. Environmental Protection Agency standard, 40 Code of Federal Regulations 192, of 5 pCi/g over background for contamination in the upper 15 cm, and 15 pCi/g for soils at a depth greater than 15 cm. Soil metals including arsenic, cadmium, lead, molybdenum, and selenium were cleaned down to background ranges. Background values for radium and metals associated with plant operations were determined based upon samples taken from several locations as described in Volume 1 *Text, Tables, and Figures* of the *Final Reclamation Plan* (AK Geoconsult, Inc., 1991). This information was also contained in the report entitled "Soil Clean-up Verification Report" Hecla Mining Company, Durita Site, November 14, 1996.

3.6 Settlement and Cover Cracking

The settlement of the leach tank cells was evaluated based upon time dependent consolidation of the materials. The small surcharge to the leach tanks added an additional 550 lbs per cubic foot to the load. Settlement monitors were constructed on the cells to observe changes as construction took place. During the period of waste placement at the leach tanks, 1996, total settlements for each tank were less than one half inch. In a letter report, it was concluded, "Based on all available data the following is evident:

- Settlement on the Closure Cell has been very minor over the past 4 years
- Settlement rates will continue to decrease
- Total settlement from this point forward will be insignificant."

An August 10, 2000 letter from CDPHE to Hecla Mining Corporation stated, " The settlement data for the closure cell monuments indicate that total settlement since 1996 has been insignificant (less than 0.1 foot) and has not changed over the last two years. Based upon these findings, settlement monitoring is no longer necessary or required under License Condition 17.3." (CDPHE, 2000)

4.0 Radiation Cleanup and Control Including Oversight

4.1 Background Soils Cleanup Criteria

On November 24, 1976, a gamma survey of the Durita site was made. The counter Model was SC 131-A, Serial # 348; readings were made with a time constant setting of 4 seconds. Readings from the site and immediate vicinity varied from a median 2.5 count per second (cps) near the top of the knoll to 1.65 cps in the southeast corner of the site. This correlates to a conversion of cps to μR/hr, using a multiplication factor of 4.4, of 7.3 μR/hr to 11.0 μR/hr. (Four Corners Environmental Research Institute, February 1977). A gamma/ radium correlation determined that an uncorrected gamma reading of 35 μR/hr

corresponded to 6.0 pCi/g Ra-226. This correlation is discussed in the *Final Reclamation Plan Durita Site, Volume 1- Text, Tables and Fig*ures report (AK Geoconsult, Inc., 1991). In a letter from CDPHE-HMWMD to Hecla, it indicated that the 35-µR/hr-gamma correlation represented the radium cleanup limit with little margin for error. It was recommended to use a field gamma screening level of 30 µR/hr as a guide for directing cleanup activities. This would be in keeping with the ALARA principle and would create little or no additional cleanup work. By so doing, the chance of missing areas requiring cleanup would be reduced (CDPHE, 1994).

Soil cleanup criteria was described in Hecla's May 1995 Health and Safety Procedure C-1.2. Areas would be considered clean when the cleanup criteria for radium-226 and/or thorium-230, as is applicable, have been achieved. Cleanup criteria for these two radionuclides will be 5.0 pCi/g above background, or 6.0 pCi/g for radium and 5.8 pCi/g for thorium-230.

Achieving cleanup levels at/or below the background mean plus three standard deviations for the metals of concern were a goal of cleanup (18.5 ppm-arsenic, 84.8 ppm-lead, 450 ppm-vanadium, 5.0 ppm cadmium, and 1.1 selenium). It should be noted that clean-up goals for the metals are not considered specific clean-up criteria, but levels, which pose no health risk to the public. As lead values were consistent with all feed samples and associated with pure tailings, it was determined that any cleanup of tails, resulting in a reduction of radium-226 to the 6.0 pCi/g cleanup standard would result in almost all if not all of the lead associated with the tails being removed. It was decided that a lead cleanup standard was not necessary. (Hecla, May 1992, July 1992).

In 2003, the Hazardous Materials and Waste Management Division established a soils cleanup standard for lead of 400 mg/kg (ppm) (HMWMD, April 2003). The lead in the samples obtained at the Durita Site varied from 93 ppm to 130 ppm, well below this soil standard.

4.2 State Oversight

Oversight by the State of Colorado was conducted under the auspices of the State of Colorado *Rules and Regulations Pertaining to Radiation Control.* Conformance with the regulations was assured through establishment of license conditions for the reclamation activities, review and approval of the reclamation plan, quality control program and construction verification program. The elements of the reclamation plan were required to meet the criterion of Appendix A of Part 18 of the Regulations. The license conditions assured that proper documentation was submitted. Oversight also consisted of a series of site visits and formal license inspections. State personnel recorded a total of 28 visits to the site, during the period from spring of 1992 to the fall of 1999. Many of these site visits involved observation of construction activities such as placement of cover material, excavation of runoff control channels and preparation and placement of contaminated evaporation pond material. State personnel also reviewed the Annual Reports submitted each year. Included in those reports was a construction verification summary for each year. Observation of remedial activities, ground water sampling techniques, soil

sampling procedures, and gamma soil surveys were performed during remediation activities and after they were completed.

Hecla Mining Company had a commendable record of compliance with the conditions of its Durita Site radioactive materials license. Results of inspections during the reclamation period from 1995 to 1999 showed no items of non-compliance.

Hecla submitted a report discussing the Closure Cell cover and compliance with Criterion 6 of Appendix A of the *Colorado rules and regulations Pertaining to Radiation Control* Hecla 199a). In a letter dated January 28, 2000, the Department determined that the construction of the closure cell, as constructed, met the requirements of Criterion 6 of Appendix A, Part 18 of the *Rules and Regulations Pertaining to Radiation Control (Requirements)* (CDPHE, 2000).

Post construction inspections were performed in 2000, 2001, 2002, and 2003. Two areas of minor erosion were noted in 2000. These areas were regraded and rock was added in one instance. The fall of 1999 and the spring of 2000 featured numerous intense thunderstorms. The 2001 inspection found no areas of erosion in spite of intense thunderstorms in early 2001. Settlement monitoring data collected during and after cover construction, was reviewed in 2000. The results indicated that settlement has ceased.

The 2002 inspection noted that erosion areas observed during previous inspections had been repaired and were found to be in good condition. There was no evidence of erosion. The top slopes of the leach tanks were stable and free of gulleys. Vegetation was in good condition. The rock on side slopes appeared durable with no sign of breakdown.

The 2003 inspection showed that the fence was intact. There was no new evidence of erosion on the constructed structures. Mancos Hill had slight erosion, which was entering the channel between the hill and the closure cell. Channels and side slopes were intact. Rock durability is good. Vegetation on top of the leach tanks is good. Ground water wells had been plugged and the settlement monuments, except for one, had been removed. Vehicle tracks were observed on the top of the closure cell, however the Licensee had the contractor rake these over.

4.3 Discussion of Results of State's Site Closure Inspection(s).

CDPHE-HMWMD has performed site closure inspections over the years as the site remediation moved from one phase to the next. CDPHE-HMWMD has employed inspection staff with geotechnical and geohydrological training or provided specialized consultants from the Colorado Geological Survey to review and verify virtually every aspect of site closure.

CDPHE-HMWMD's site inspections were conducted to ensure that the site reclamation activities were performed as required by regulations and license conditions. For significant aspects of reclamation, Hecla Mining Company submitted detailed plans and specifications for the work. These plans were reviewed and approved by CDPHE-

HMWMD. In these cases, CDPHE-HMWMD inspectors performed frequent field inspections to verify conformance of site activities to approved plans. This is particularly the case for reclamation construction of the disposal structures, diversion channel and thick, vegetated cover. Of particular emphasis was inspection of soil, rock, vegetation, and groundwater.

Monitoring during site closure has continued to evaluate environmental media and site performance. Hecla Mining Company has been required to perform this monitoring and to report results annually. CDPHE-HMWMD and Hecla have performed annual inspections since remediation has been completed. Minor repair of grading, fencing, drainage and erosion have been completed.

4.4 Final Status Survey

Staff from the CDPHE-HMWMD and the Colorado Geological Survey performed gamma surveys during site inspections in areas that were reported to be cleaned up. At times it was determined that additional work was required. Confirmation soil cleanup surveys were performed on May 18 and 19, 1997; August 7, 1997; October 7, 1997 and in May 1999. Confirmatory testing included doing gamma surveys with Ludlum-Model 19 scintillometers and taking core samples. A gamma/ radium correlation determined that an uncorrected gamma reading of 35 μR/hr corresponded to 6.0 pCi/g Ra-226. This correlation is discussed in the 1991 AK Geoconsult, Inc. *Final Reclamation Plan Durita Site, Volume 1- Text, Tables and Fig*ures report. It was recommended to use a field gamma screening level of 30 μR/hr as a guide for directing cleanup activities. This would be in keeping with the ALARA principle and would create little or no additional cleanup work. By so doing, the chance of missing areas requiring cleanup would be reduced (CDPHE, 1994).

A confirmation –verification survey was performed after receiving Hecla's *Soil Verification Report* in November of 1996 (Hecla 1996). A memo to the CDPHE-HMWMD files describes confirmatory gamma surveying and soil sampling that was done on March 18 & 19, 1997 (CDPHE, 1997). Four state representatives used Ludlum, Model 19 Micro-R-Meters for gamma monitoring and traversed the site by walking a grid at a 10-ft. wide spacing and walking side-by side. The team walked all areas reported in Hecla's *Soil Verification R*eport and also traversed unreported areas as a further check on clean up. Whenever a 30-µR/hr level was exceeded, a preliminary assessment level used by Hecla to guide clean up, the spot was flagged for later inspection and possible soil sampling. It was determined that most of the site was below the 30 μR/hr cleanup objective, but that the evaporation ponds and fresh water pond area needed additional work. During reclamation of the evaporation ponds, 801 composite soil samples were taken by the contractor (MEI, September 1997).

Nine soil samples were obtained and all were tested for radium-226. Five samples were tested for thorium-230 and three samples were tested for metals (arsenic, lead, selenium, vanadium and cadmium). Soil sampling indicated that the carbon pit, raffinate ponds and mill areas were adequately cleaned up. In the slime pit area, radium-226 was low, but

thorium was high. Hecla requested re-analysis of the material for thorium. Additional work indicated that the ore prep area and haul road next to the ore prep area needed additional cleanup (HMWMD, April 1997).

Hecla performed additional cleanup and verification sampling in 1997. Verification test results indicated that six of the seven areas met the clean-up criteria (calculated radium-226 activity of 6.0 pCi/g at 1,000 years) and required no additional cleanup. One area had a calculated radium –226 activity of 7.2 pCi/g at 1,000 years, and was covered with at least 1-foot of clean soils compacted with a minimum of three passes with a CAT dozer equivalent (MEI, July1997). Analytical results from the thorium based samples collected in the Slime Pond and for all radium based samples were well below the clean-up criteria for radium-226.

Analysis of soils was either thorium or radium based. The basis of analysis was dependent on past processing and current reclamation activities. Thorium-based analysis entailed collection of samples from 30 foot grid points, compositing samples from distinct areas, splitting of samples, and analysis for thorium-230, arsenic, cadmium, lead, selenium, and vanadium. Radium-based analysis entailed preliminary assessment with a field gamma survey instrument at 30 foot grid spacing. Random collection of samples from 20% of grid points, splitting of samples, and analysis for radium-226, arsenic, lead, selenium, and vanadium. Areas that demonstrated thorium-230 activity levels above 5.8 pCi/g (background level plus 5pCi/g) were also analyzed for radium-226 activity to ensure that the radioactive decay of thorium-230 above 5.8 pCi/g would not result in radium-226 activity levels above 6.0 pCi/g in one thousand years time (background level plus 5.0 pCi/g).

Areas in which sample collection and analysis were thorium-based included the evaporation ponds surrounding the closure cell and the raffinate pond area. The character of the solutions and materials processed or stored in the carbon pit and slime pit areas indicated that the level of thorium-230 after cleanup was assessed in addition to radium-226 in these areas. Generally, these were areas that were considered to be potentially contaminated from waste leach solutions and solids.

Upon being considered initially "clean" by a visual assessment for physical evidence of products or waste from leaching operations, a 30-foot grid pattern was laid out for the specific areas to be sampled; 30-foot grid spacings were established by pacing and recorded on maps provided with each clean-up documentation form. The carbon pit and raffinate pond area were tested as distinct areas because of the relative size of these areas. Composited samples from thorium-based analyses were comprised of as few as four grid point samples to as many as 30 grid point samples depending on the physical characterization of the distinct area.

Areas in which sample collection were radium-based included the former mill area, the ore preparation area, haul road areas, and other areas where tailings management activities were evident, generally identified by gamma instrument surveys. Preliminary assessments of distinct radium-based areas were conducted with a field gamma survey

instrument. Field readings for all grid points were measured on a 30-foot grid pattern at approximately 2 inches above the soil surface. A radium-based area was considered clean if all grid point field gamma readings for the distinct area were at or below, 30 uR/hr-an approximate equivalent of 6.0-pCi/g radium-226.

Clean-up activities were conducted in 1995, 1996 and 1997. The 1995 clean up is documented in the Durita Site Reclamation and Construction Verification Report, included as Section 3 of the 1995 Annual Report for the site. Clean-up activities conducted during 1996 and 1997 are discussed in the annual reports for the site for each respective year. A summary of the clean-up activity for each area is provided below:

- Mill area -all excavated soils were disposed in the closure cell. Thorium-230 results ranged from 1.1 to 6.1 pCi/g. The 6.1 pCi/g sample result was obtained at mill point B-13 that also yielded a radium-226 activity of 4.3 pCi/g. Accounting for decay of the radium-226 activity and in growth of radium-226 from the thorium-230, the radium-226 activity in one thousand years is calculated to be 4.9 pCi/g, below the 6.0 pCi/g clean-up level.

- Raffinate ponds – Solidified pond material from the four-raffinate ponds were relocated to the closure cell in 1995. Additional soils were also excavated in 1996. Analytical results for metals are consistent with the clean-up goals for the site. Final radium-226 activities are all low ranging from 1,1 to 2.3 pCi/g. Thorium –230 activities were slightly elevated above the 5.8-pCi/g clean-up criterion in three of the six sampling areas. However, all three areas demonstrated radium-226 activities below the 6.0 pCi/g clean-up level after one thousand years radioactive decay.

- Carbon pits – Waste carbon from processing, approximately 2 to 5 feet deep, was covered with several feet of on-site soils. This material was placed on the north out slope of LT-201, and in the closure cell. Radium-226 results ranged from 0.5 to 3.3 pCi/g, all below the cleanup criterion of 6.0 pCi/g. Thorium results were generally low except for one location where it was 7.1 pCi/g. When the current thorium-230 activity and radium-226 activity of 1.2 pCi/g is decayed for one thousand years, a radium activity of 3.3 pCi/g was calculated.

- Slime pits – This was material that resembled tailings slimes. A layer of material approximately one foot thick was buried under 6 to 8 feet of clean overburden. These materials were transported to the closure cell. Samples were generally below the clean-up goals for metals and radionuclides. In two areas the thorium-230 activity was 6.0 and 7.1 pCi/g. However when the current thorium-230 activity and the radium-226 are decayed for one thousand years, a radium activity of 2.75 pCi/g and 3.14 pCi/g were calculated for the respective areas.

- Haul Roads – These were roads on which tailings were transferred on-site by truck. All excavated soils were placed in the north out slope of LT-203 or in

the closure cell. Sample results were all below the cleanup criterion for radium-226 and the clean-up goals for metals. The results demonstrate that the three haul roads had been cleaned-up to metals and radionuclide levels that require no further action.

- LT-203 areas – Two areas near LT-203 required soils excavation as a result of slightly elevated gamma readings. The areas were the south berm at the southwest corner of the leach tank and the area along the south side of the leach tank at and adjacent to the silt fence. Materials were placed on LT-203 and the closure cell. Sampling results were all below the clean-up criterion for radium-226 and for the cleanup of metals.

- Ore Preparation area – This was the largest area-requiring cleanup on the site and was located directly south of Mancos Hill. Tailings from the Naturita Mill were initially brought to and processed in the area. All excavated soils were placed in the closure cell. The radium-226 results were all below the clean-up criterion of 6.0 pCi/g with an overall average of 2.9 pCi/g. Measured metal concentrations were all below the cleanup goals with the exception of five selenium values. They were slightly above the cleanup objective. The overall average selenium concentration for the ore preparation area was <0.88 mg/kg, which is below the cleanup criteria.

- Truck load out – This area was located west of the ore preparation area. All analytical results were below the cleanup criterion for radiun-226 and the cleanup goals for metals.

- Acid Pit – This area was located immediately west of the ore preparation area at the base of Mancos Hill. It appears that tailings and soils were placed as backfill material to create a level storage area for large acid storage tanks. Contaminated soils were excavated from this area and placed in the closure cell. All analytical results were well below the cleanup criterion for radium-226 and the cleanup goals for metals with the exception of 4 selenium results.

- Evaporation ponds – There were six original evaporation ponds that contained approximately 2 to 4 feet of SPM after mixing. SPM was excavated from the six ponds and relocated to the closure cell. Analytical results were consistent with the cleanup goals for the site with the exception of cadmium results from 3 sampling areas that were slightly elevated above the cleanup goal of <5 mg/mg for this metal. The cadmium concentrations were 5.3mg/kg, 5.2 mg/kg, and 5.3 mg/kg. However, the average concentration for the entire evaporation pond area of 4.0 mg/kg was below the cleanup objective. Some areas did not meet the radium-226 cleanup objective when the thorium in-growth was considered. Areas were further cleaned up to meet the radium-226 objective. It should be noted that the evaporation area was backfilled and covered in-place with at least one foot of clayey soils compacted with a minimum of three passes of a Cat dozer. This ensures that the area will meet

the Criterion 6 of Appendix A of Part 18 of the *Colorado Rules and Regulations Pertaining to Radiation Control* that allows up to 6-pCi/g radium-226 in the upper 6 inches of soil and 15-pCi/g radium-226 in soils 6 inches or more below the surface.

Note: Detailed sample test results can be found in the *Soil Cleanup Verification Report* Hecla, 1996) and the Annual Reports.

A second phase of confirmatory sampling was done on August 7, 1997 (CDPHE, August 1997). Two state representatives performed a gamma survey, similar to the previous survey. The 30-μR/hr cutoff was again used. Most readings were below 25 μR/hr. Seven soil samples were taken from the evaporation pond area and the slime pit area since these areas were thorium contaminated areas and the survey meters would not indicate the presence of thorium. All seven samples were tested for thorium; four were tested for radium-226 and two were tested for metals (arsenic, lead, selenium, vanadium, and cadmium).

Two of the soil samples from the evaporation pond did not meet clean-up objectives for thorium. An additional four feet of material was removed and was placed in the closure cell. On October 7, 1997, two CDPHE-HMWMD representatives performed confirmation gamma surveys and obtained two confirmation soil samples from the remediated areas. Gamma scintillometer readings were near background. One soil sample was tested for thorium –230, radium –226 and for cadmium. The other soil sample was tested for thorium-230 and radium-226. Test results were near background and met clean-up criteria.

On May 20, 1999, two representatives from HMWMD-CDPHE performed gamma surveys at 10-meter intervals on the tops of leach tanks 201, 202, and 203 and on top of the closure cell (see Figure 3). Gamma readings ranged from 10 μR/hr to 16 μR/hr. It was concluded that the gamma scintillometer readings obtained on top of the three leach tanks and on the outslopes and top of the closure cell were the same as background readings in the area (CDPHE, May 1999).

In summary, when field and laboratory data showed that areas did not meet cleanup objectives, the contractor returned and removed the contaminated materials. These areas were retested and showed that they met cleanup objectives.

4.5 Radon Emanation

4.5.1 Radon 222 Measurements

Hecla Mining Company submitted a reclamation plan, which provided the design of a cover system, which would reduce the radon-222 flux to 20 picocuries per square meter per second (pCi/m^2s) or less. Use of a published radon flux model with the design information provided by the licensee confirmed the radon flux reduction provided by the

cover system. Hecla Mining Company also demonstrated that the cover system would continue to reduce radon flux for 1000 years or at least 200 years by using the NRC Radon model Version 1.2 to confirm that the cover system would perform adequately. The calculations took into consideration such factors as moisture content (10 –15 %), soil density (1.61-1.86g/cm^3), soil porosity (0.30-0.39), and emanation coefficient (model default emanation coefficient value of 0.35) and layer thickness (15 cm to 300 cm) of deposited material and cover materials. Radon emissions from cover material were considered in the calculations.

Calculations performed by the model gave the following results for radon flux from the closure cell surface: current conditions 1.4 pCi/m^{2}s and conditions at 1,000 years 6.5 pCi/m^{2}s. Exit flux for both conditions is well below 20 pCi/m^{2}s. Porosity was calculated based on a solids specific gravity of 2.65.

The radon cover for the 5.5-acre closure cell was tested twice. From August 27 through August 1996, a total of 22 flux measurements were taken on the closure cell demonstrating flux measurements of <0.5 pCi/m^{2}s to 1.19 pCi/m^{2}s, with an average of 0.55 pCi/m^{2}s. Of the 22 measurements, 12 demonstrated results below the detection level. The second set of readings was done from August 7 to August 9, 1997. This additional testing was conducted because soils were placed on the closure cell after completion of the initial testing. A total of 10 additional measurements were conducted demonstrating results of <0.5 pCi/m^{2}s to 0.5 pCi/m^{2}s. Nine of ten measurements were below the method detection limit.

The cover was placed in accordance with approved plans and schedules. After completion of the cover system, Hecla Mining Company made radon flux measurements using the radon flux measurement methodology [Appendix B, Method 115, 40 CFR Part 61]. Monitoring was conducted according to Hecla's May 1996 *Radon –222 Flux Monitoring Plan, Revision I*, and a supplemental plan for the closure cell, July 22, 1997. The approved radon testing plan originally called for placing 128 charcoal canisters (collectors) on the 31.5 acres of cover of the combined leach tanks and closure cell or approximately four per acre of radon cover. An additional 10 canisters were placed on the slope of LT –201 where materials had been buried against the original slope. The reports show that the measured flux rate through the engineered covers, from a total of 138 measurements over the three heap leach tanks and the closure cell at Durita, averaged 0.91 pCi/m^{2}s. Results ranged from a low of less of less than 0.5-pCi/m^{2}s (the analytical practical quantification limit) to a maximum radon flux reading of 17.6 pCi/m^{2}s. This measurement is well below the regulatory standard of 20 pCi/m^{2}s in Criterion 6 of Appendix A to Part 18 of the *Colorado Rules and Regulations Pertaining to Radiation Control* and is consistent with the design based on analytical evaluations.

4.5.2 Conclusion

The combination of the RADON modeling for current conditions, conditions in 1,000 years, and the radon-222 flux monitoring demonstrates that the as-constructed closure cell satisfies the radon-222 emission stipulations of Criterion 6, and specifically, that the radon-222 surface exhalation from the closure cell is not significantly above background.

CDPHE approved the radon flux measurement reports and accepted the findings of the reports that document compliance with the standards stated in Criterion 6 of Appendix A to Part 18 of the Regulations in a letter to Hecla Mining dated January 28, 2000.

5.0 Surface Water Hydrology and Erosion Protection

5.1 Erosion Protection

Erosion protection work was necessary to:

- Limit extent of nominal flow channel erosion during high flow periods
- Protect floodplain banks during PMF discharge
- Protect leach tank outslopes and cell cover from erosion.

Containment facility rock cover placement included:

- Leach Tank Outslopes- a minimum of 6 inches of rock cover was placed over all outslopes on all three leach tanks. Rock thickness was not less than 6 inches.
- Closure Cell Top and Outslopes- a minimum of 6 inches of rock cover was placed on all Closure Cell slopes (top and outslopes). The top surface and flatter outslopes (20% and 13%) were covered with D_{50}=2 inch rock. The steeper outslopes (3:1) were covered with D_{50}= 3.6 inch rock. Rock thickness averaged 6.8 inches and was not less than 6 inches.

Riprap and scour protection placement work was divided into the Closure Cell, the Main Diversions, and Tributary areas as follows:

- Closure Cell Scour Protection- a minimum of 12 inches of scour protection rock was placed along the Cell's west, north, and east out slope toes.
- Main Diversion Riprap and Scour Protection- Riprap and scour protection rock sizing varies based on location (station) within each of the diversions. In general, rock size decreased with increasing stationing (going downstream), as the width of the diversions increases, and as the slope decreased.
- Tributary Area riprap- Areas where significant erosion had occurred since work was completed in 1995 were regraded and covered with riprap. Two of these areas were covered with 1 foot of rock (D_{50} = 6 inch). Near the toe of LT-201 – the transition between the northwest toe of LT-201 and the arroyo immediately north of the toe was rip rapped with two types of rock. The bottom of the slope (and narrowest area where flows concentrate) was covered with on-site boulders and rock (maximum diameter of approximately 4 feet). Immediately above this area where the slopes flattened to 5:1, riprap transitioned to D_{50}= 2 inch rock. Subsequent inspections have shown no new areas of scour.

Erosion protection project requirements were provided in Reclamation Plan specifications B7 (AKG, 1991) and Construction Specifications 9014-S3 and 9014-S5 (AKG, 1994c and 1994e). Changes and modifications to rock sizing specifications are referred to in the 1998 Durita Site Reclamation and Construction Verification Report (Monster, 1998). These documents are available for review at the CDPHE-HMWMD records center.

5.2 Surface Water Diversion and Flood Flow

Surface water diversion elements involved realignment and regrading of the wide ephemeral draws that are adjacent to the site. Prior to the construction of the site in 1977, five small tributaries to Dry Creek had watersheds which started upstream or south of the Durita site. All of the watersheds above the site are less than one square mile. Site construction caused the consolidation of discharges from the two eastern watersheds, East 1 and East 2, into one channel that is now called the East channel. The other three watershed channels have remained essentially unchanged in their upstream portions during and after the Durita site construction, with the exception that the west channel has been diverted around the southeast corner of LT-202. The reclamation plan used a unique approach to protect the leach tanks. The original incised narrow channels existed within the wide ephemeral draws and conveyed normal storm and snowmelt runoff. The narrow incised channels were 5 to 10 feet wide and up to 14 feet deep. The wide draws, 100 to 300 feet wide, acted as the floodplains for these channels. Calculation and routing of the probable maximum flood (PMF) show that the wide draws act as the floodplains for the ephemeral channels, and contain the flood flows. The reclamation plan called for placing rock revetments in trenches at the edge of the draws in order to control PMF flows at the floodplain margins. Regrading and re-establishment of runoff channels were also undertaken to assure proper control of flood flows.

It was not possible to reestablish the channels to their pre-1977 gradients along the same drainage courses in all locations on the site because of the location of the leach tanks. Therefore, the reclamation design included the design of new normal flow channels in the vicinity of the leach tanks that would reestablish, as nearly as possible, the pre-1977 gradients and also allow alignments that would provide offsets from the leach tanks sufficient to protect the leach tanks from erosion due to normal flow as well as lateral migration and meander development that might evolve over long periods of time. The reclamation design for normal runoff will slightly reduce the overall gradient of the combined West, Mid-1, and Mid-2 channels (the Central channel) to approximately 0.021 over the controlled channel length of 2,643 feet. The west channel drained the largest of the upstream watersheds and had a pre-1977 gradient of 0.026 within the Durita site and slightly greater, 0.027, if the channel several hundred feet upstream is included.
In addition to a slightly flattened overall gradient, this new channel has a 10-foot base width, wider than the average width of the existing or pre-1977 channels. The original channels were V-shaped with narrow channel bottoms, usually less than 5 to 10 feet wide and up to 14 feet deep. The greater width compensates somewhat for the shallower gradient by helping to reduce normal flow depths in the channels, thereby suppressing low velocities and shear stresses on the channel bed.

The same design approach was used for the east channel. However, for the east channel it was possible to reestablish the pre-1977 gradient of 0.037 along the established alignment. This channel was also 10 feet wide at the base. Although not as necessary as a 10-foot width on the Central channel, the 10-foot width on the east channel is more of a

construction expediency, i.e. the minimum practical width for dozed or scraper excavation. It also allowed normal flows to be diverted with shallower flow depths and, therefore, lower peak velocities and shear stresses than would have been the case in the previous natural channels.

The overall effect of the widened normal flow channels was to reduce the potential for scour and enhance the conditions for aggradation, i.e. for sedimentation of traction and suspended load derived from upstream erosion. Conditions favoring aggradation of the channel beds provide additional protection against potential erosion during runoff events.

5.3 Probable Maximum Flood (PMF) Runoff Control

The most severe storm event, the one-hour local Probable Maximum Precipitation (PMP) event applicable to watersheds up to one square mile, was derived from HMR 49 (Hansen et al, 1984). All watersheds above the site are less than 1 square mile in size. This storm event would produce rainfall depths with one-hour total rainfall of 7.81 inches on the upstream watersheds and 8.15 inches on the site. The runoff or Probable Maximum Flood (PMF) resulting from the storm was calculated using the Rational Method per Nureg/CR-4920. The PMF parameters are tabulated below:

HYDROLOGIC PARAMETERS OF UPSTREAM WATERSHEDS

	WATERERSHED			
PARAMETER	WEST	MID 1	MID 2	East
Area, acres	494	32.5	122	155.7
Longest flow path (channel) ft.	14500	3950	6900	9150
Maximum change in elevation, ft.	1705	469	904	1050
Longest flow path gradient	0.1176	0.1187	0.1310	0.1148
Time of concentration, tc, hrs	0.47	0.17	0.26	0.34
PMP 1-hour storm rainfall depth in tc, inches	6.85	4.7	5.85	6.4
PMF peak discharge, cfs	4280	528	1667	1780
Flow concentration factor	3	3	3	3

Note: The two east watersheds were combined.

The largest PMF rises in the West watershed, 4280 cfs. The PMF combines at the south side of the site with the PMF's of the Mid-1 watershed (528cfs) and the Mid-2 watershed (1667 cfs). It is conservative to assume that all PMF flood peaks arrive at the site at the same time, giving a combined PMF for the Central channel of 6475cfs. The east watersheds cover approximately 156 acres and have a combined PMF discharge of 1780 cfs. The PMF's of the combined Central and the East watersheds were used for the design of the PMF runoff controls within the site, to which were incrementally added the flows of on-site tributary areas. It was also conservative to assume that each tributary area within the site adds its peak PMP runoff to the watershed at the same time as the control structure was carrying the PMF discharge from upstream runoff, producing progressively larger peak discharges from south to north across the site in both combined watersheds. In reality, concurrence of individual PMF peaks is extremely unlikely,

making a cumulative peak discharge a true worst-case value. The normal runoff control provides containment of normal flow within a constructed channel. For PMF control the peak discharge will be contained within a wide shallow channel that lies above and to each side of the normal flow channel. In effect, the PMF channel is really the flood plain of the normal flow channel. This flood plain is designed to keep the PMF peak discharge within the design boundaries.

The flood plains terminated at locations sufficiently downstream or laterally separated from containment structures to preclude the risk of erosion of these structures from the PMF's in the flood plains. The central flood plain ends downstream of the leach tanks and the reclaimed area and is topographically downslope from those locations. This flood plain widens after it passes through the constricted area between the leach tanks, then discharges onto the northwest quadrant of the site, which has no containment structures and consists of natural channels separated by unobstructed, relatively flat terrain. The east flood plain terminates north or downslope from the leach tanks and in the direction of a system of deep natural channels adjacent to the east of the property line of the site. The closure cell is protected from the PMF of either flood plain on the upstream side by the Mancos Hill and laterally by at least 300 feet of terrain that was sloped away from the cell and towards the flood plain.

The following is an analysis performed for completion of LT-203. The U. S. Army Corps of Engineers HEC-1 model was used to determine peak runoff from a 500-foot wide section of LT-203. The watershed was composed of two basins: the first 205 feet long with a slope of 0.5 percent and the second 205 feet long having a slope of 20 percent. An SCS curve with a number of 80 was selected for both basins. This curve number is representative of soil group D with good pasture and soil group C with fair pasture. A curve number of 80 is believed to be representative of the slope area because even though the slope will essentially be bare ground, the 6-inch layer of rock should have a storage capacity similar to a vegetative cover.

The 1-hour Probable Maximum Precipitation (PMP) was determined from storm depths listed in other Durita documents. Listed PMP values were: Elevation = 5, 000 ft., depth =8.4 inches and elevation = 6450 ft. depth = 7.8 inches. A PMP depth of 8.1 inches was interpolated for a site of 5700 feet. The storm was distributed using an SCS type II storm distribution. The following table lists peak flow values determined with the HEC-1 model.

Summary of HEC-1 Results

Hydrograph at	Peak Flow	Time at Peak (hours)
Basin 1	38	0.47
Route to Slope Crest	34	0.53
Route to Slope Toe	33	0.55
Basin 2	75	0.35
Node	79	0.35

The combined peak flow at the bottom of the slope due to runoff from basins is

comparable to the peak flow from the slope basin. This is primarily due to a longer lag time for the top basin compared to the slope basin. This is shown by a time to peak of 0.47 hours for the top and a time to peak of 0.35 hours for the slope.
The peak flow estimated from the HEC-1 model was analyzed using Manning's formula to determine depth and velocity of flow. Flow velocities were used to determine routing parameters utilized in the HEC-1 model.

Peak discharge per unit width and test data from the in-place rock were analyzed with Stephenson's method to calculate a suitable D_{50} (median diameter for rock at the North Slope toe of LT-203. Typically, a concentration factor is included to account for surface variability producing areas of concentrated flow. Concentration factors of up to three were recommended, however given the 20 percent grade of the tank outslope, a concentration factor of 3 may be overly conservative. The following table lists calculated D_{50} sizes for concentration factors of 1, 2, and 3.

Summary of Riprap Sizing Calculations

Concentration Factor	1	2	3
Flow (cfs) 500 feet	79	158	237
Flow (cfs/ft)	0.16	0.32	0.47
Rock Fill Porosity	0.3	0.3	0.3
Specific Gravity	2.68	2.68	2.68
Slope (%)	20	20	20
Friction Angle	46	46	46
Empirical Factor	0.22	0.22	0.22
Olivier's Constant	1.2	1,2	1.2
Calculated D_{50} (in)	0.95	1.52	1.96

Note: Empirical factor and Olivier's Constant Values are those recommended for rounded gravel.

It should be noted that methods for calculating rock stability analyze flow over the top of the rock, which is not expected to be the case for leach tank outslopes. With calculated flow depths (less than 0.2 feet for a concentration factor of 3) being significantly less than the thickness of the rock layer (0.5 feet), the additional confining force of overlying rock is ignored in the stability calculation (Dan Williams P.E. March, 1997).

5.4 Erosion Protection

5.4.1 Protection Against Flood Plain Scour

Due to the terrain and spatial constraints imposed by the site, it was not possible to provide protection against all erosion under all flow conditions. Normal flow channels will experience some bed and bank erosion during periods of high flow but should recover most, if not all, of the bed scour during subsequent periods of declining flows when sedimentation occurs because of the widened channel beds. Under peak PMF discharge, scour will occur along the bed of the flood plain. Using methods developed by the U. S. Bureau of Reclamation (Pemberton and Lara, 1984), scour depths were

calculated for reaches along both flood plains. Three methods were used and the results were averaged, as recommended in the referenced document, to determine design scour depths along the flood plain banks.

Rock-filled trenches from channel bed elevation to the calculated vertical scour depth protected each reach of flood plain that is formed by soil and is adjacent to the containment structure. These scour trenches were excavated to the design depth and slope, then backfilled with rock to a thickness of not less than 18 inches as described in the specifications. (AK Geoconsult, Inc. 1991)

5.4.2 Riprap

A riprap blanket was used to protect flood plain banks in soil from lateral erosion under conditions up to the PMF discharge. Those portions of the banks cut into rock did not require riprap protection. The riprap was applied to the banks in the same locations specified for scour protection, adjacent to containment structure areas. The riprap layer was a minimum of 18 inches thick and was placed on 2H: 1V slope. The riprap was sized in accordance with methods described by the NRC (1990) and by Nelson et al, Abt et al and Coe, 1970. Those methods generally relied on the calculation of shear stresses at the protected boundary and on the use of the Corps of Engineers or the Stephenson method to determine the D_{50} size of rock needed to resist movement under the PMF peak velocity. These calculations that are available at the CDPHE-HMWMD records center indicate that the largest rock needed, D_{50} = 18.3 inches, was placed against soil exposed along the left bank of the Central Channel from station 0+00 to Station 5+22. The maximum D_{50} along the downstream reaches of the Central flood plain ranges from 5.6 inches to 11.7 inches. Along the East flood plain the maximum D_{50} is 10.2 inches along soil exposed in the left bank from Station 0+00 to Station 2+05 and downstream the D_{50} will range from 3.8 inches to 9.6 inches. Maximum rock sizes were 1.5 times the D_{50}. (AK Geoconsult, Inc. 1991).

Input data and calculations are available for review at the Colorado Department of Public Health and Environment Hazardous Materials and Waste Management Division Records Center for the following subjects:

- Slope Stability Analysis,
- Radon Analysis for Leach Tank Covers,
- Radon Analysis for Evaporation Pond Covers,
- Hydrologic Parameters and Equations,
- Pre-Reclamation Surface Water Channel Gradients,
- PMP/PMF Event Hydrologic Analysis,
- Tributary-Area Surface Water Discharges from PMP within the Site,
- Diversion Channel and Flood Plain Line, Grade and Dimension Control,
- Calculation of Depth of Scour at the Toe of Flood Plain Banks Due to PMF Flow,
- PMF Erosion Protection Analysis,
- Rock Gradations to Erosion Protection Applications, and

- Leach Tank and Evaporation Pond Cover Erosion Protection (AK Geoconsult, Inc., October 1991).

Note: Registered professional engineers prepared these documents and they are available for review at the Colorado Department of Public Health and Environment-Hazardous Materials and Waste Management Division's Records Center.

5.5 Rock Durability and Gradation

Rock durability and gradation were evaluated during construction to meet approved construction design plans and specifications. "Field and lab testing frequencies were based on those required by the 1997/1998 Reclamation Plan (MEI, 1997a and Monster, 1998). Sufficient tests were conducted to satisfy each frequency.

Erosion protection was tested by ASTM methods C136 and D1559 (gradation), C88 (sodium sulfate soundness, and C97 (specific gravity and absorption). The gradations were within the specifications for each respective rock type. Bulk specific gravity (SSD) varied fróm 2.98 gm/cc to 2.67 gm/cc. Absorption ranged from 0.77% to 1.15% and sodium sulfate loss varied from 0.08% to 0.19 %. The average percentage of rock types in samples was 97% igneous, 1.5% limestone, and 1.5% sandstone. The composited rock quality scoring ranged from 83.9% to 88.3% (Monster, 1998). Lambert and Associates of Montrose, Colorado conducted erosion protection durability testing and the on-site project manager performed on-site testing.

The durability of the rock used for covering the slopes and for drainage channel riprap was evaluated using field observation and testing of the material and the U.S. Nuclear Regulatory Commission's rock scoring criterion. Rock that scored higher than 80 was used at the site. Field-testing during construction showed that the rock scored between 80.6 and 96 (Hecla 1999b). Two sources of rock were used, stream terrace gravel adjacent to the San Miguel River and a massive limestone from a quarry near LaSal, Utah. The rock was found to be sound and dense, in order to meet the requirements of continued wetting and drying.

5.6 Vegetative Cover

Reclamation at the Durita Site was completed in 1999. As part of the reclamation, Hecla Mining Company must show adequate vegetative cover on the Durita Site. Bamberg Associates prepared a document (Bamberg Associates, 1998) to determine proposed standards for revegetation and methods for monitoring. They completed two years of monitoring in 2000 and 2001 (Bamberg Associates, 2001).

Vegetation standards proposed were based on vegetation types surrounding the site and the environmental conditions on the reclaimed areas. The standard for desirable plant cover in the reclaimed surface areas was set at 20% for the native grass and shrub cover on thin soils adjacent to the site. Onsite and adjacent areas were sampled concurrently during the 2000 and 2001 monitoring periods. The sampling methods used were a

combination of quantitatively measured transects, and qualitative assessment of conditions.

Monitoring results showed a stable, increasing trend in desirable vegetative cover, and a proportional reduction in weeds and bare ground. Desirable plant cover in the quantitative sampling on the site averaged 22.5%. Offsite vegetation cover averaged 33.3% for comparison and standards. Comparison of 2000 average plant cover (12.3%) with 2001 average plant cover (22.5%) showed increasing desirable plant cover and general site stability for the Durita site. The vegetation was stable and self-sustaining and met the proposed standards. Trends in the vegetation indicate successful plant growth, and the existing cover values equals or exceeds the proposed standards. Therefore the Hecla Mining Company has met the vegetation requirements for release of the Durita site (Hecla, 2000).

Rock, soil, and vegetative cover met the testing requirements in the approved reclamation plan and other appropriate documents. These documents are available for review at the Colorado Department of Public Health Hazardous Materials and Waste Management Division's Records Center.

5.7 Sedimentation

During a May 21, 2001 NRC site visit, NRC commented that the sediment accumulation in the channel up gradient of the closure cell should be evaluated and that the top slopes of the leach tanks should be evaluated using the stable slope equations in the NRC guidance. Hecla Mining Company responded with a stability evaluation of the leach tanks and the Closure Cell diversion for the Durita Site (Hecla, 2001.)

In doing this evaluation, Douglas Gibbs, P.E. used the following documents:

- Nuclear Regulatory Commission's Final Staff Technical Position (STP) on the "Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites" (NRC, 1990)
- AK Geoconsult's Final Reclamation Plan (AKG, 1991)
- MEI's construction verification reports (Monster, 1996 and MEI 1997 through 1999), and his experience with the Durita site cover materials, construction activities and materials testing.

It was concluded that the soil-covered tops of all three leach tanks are stable as designed and constructed. The following items all indicate that the covers are stable in their configuration:

- AKG utilized an NRC approved analysis method for stable slope covers in the Final Reclamation Plan (AKG, 1991). This was the Horton/NRC Method.
- AKG designed all of the leach tank top slopes so that they were flatter than the Critical Slopes calculated by the Horton/NRC method. A slope flatter than the Critical Slope is stable from erosion. All of the leach tank top slopes were

designed and built at a slope of 0.5%, which is 1 foot of drop in 200 feet of run.

- AKG's analysis appears to be reasonable and accurate. In particular AKG's Hydrologic Parameters and Equations (calculation C114), and Leach Tank and Evaporation Pond Cover Erosion Protection (calculation C12) from the Final Reclamation Plan (AKG, 1991) were reviewed and determined to be reasonable and accurate.
- Acceptable cover materials were utilized during construction.
- Acceptable construction methods were observed.
- Placed cover materials passed all testing requirements.
- Subsequent inspections have shown that the soil covers are performing as designed. There are no signs of erosion on top of the leach tanks.
- The success of the reclamation on the tops of the heap tanks is dependent upon the vegetation. Both the flat slopes and the vegetation on the tops of the leach tanks contribute to erosional stability. Revegetation has been successful on top of the leach tanks.

It was concluded that no erosion had occurred, and no significant erosion is likely to occur, in the future, on the leach tank covers.

Sediment had been observed in the Closure Cell Diversion Channel located between the north side of the closure cell and Mancos Hill, an uneroded geologic remnant of the Mancos Formation located south of the channel. Silt and clay sediments were deposited into the channel from Mancos Hill after a very large precipitation event. Erosion was exacerbated by the required removal of vegetation from the north face of Mancos Hill during construction of the diversion in 1995 and 1997.

The estimated average depth and quantity of sediment deposited into the diversion was 3 inches and less than 0.5 cubic yards, respectively. A recent cut area made during the 1995 and 1997 construction seasons funneled concentrated runoff though a bowl shaped area. Total quantity of sediment coming off the hillside was relatively small due to the short flow distance and competent shale bedrock material through which it flowed. Although the Mancos shale does weather at the surface, it becomes fairly competent at shallow depths (typically 2 to 4 inches). The following shows evidence of this competence:

- Mancos Hill is still protruding up approximately 100 feet higher than all of the surrounding areas on the project sit
- Erosion channels from the large precipitation event, several years after the completion of the diversion were fairly shallow (1 to 3 inches).

The cut area and the bowl shaped area and an additional area directly upslope from the original channel were covered with a uniform graded, rounded river rock with a D_{50} of approximately 2 inches. It is the opinion of the professional engineer evaluating this area, that no significant erosion will occur at this specific location on Mancos Hill and very little sediment will be deposited into the Closure Cell Diversion in the future from similar

events. Subsequent inspections have shown no sediment in the channel.

5.8 Conclusion

It was determined that no additional significant erosion will occur at this specific location on Mancos Hill and very little sediment will be deposited into the Closure Cell Diversion in the future from similar events. After a site inspection by NRC staff in May 2001, a request was made to evaluate the Closure Cell Runoff Control Cell Channel. Monster Engineering evaluated the sedimentation and concurred with their findings that there is little likelihood of further sediment entering the channel. Annual inspections by the U. S. Department of Energy will insure that future sediment buildup is not excessive. The evaluation was acceptable as written (CDPHE, 2001).

In conclusion, CDPHE-HMWMD's review of surface water hydrology and erosion protection has found the Durita site to be in conformance with Colorado regulatory requirements of criteria 1, 3, 4, and 6 in Part 18 Appendix A of the regulations.

6.0 Ground Water

6.1 Description

6.1.1 Location

The Durita uranium heap leach site occupies 160 acres of Montrose County, Colorado, about two and a half miles southwest of the town of Naturita. The nearest neighbor is the Coke Oven Ranch, about one-half mile northwest of the site. No perennial streams exist on the site. Dry Creek, which passes near the northwest corner of the site, has seasonal flow.

6.1.2 Geology

The Durita site is located on gently north sloping terrain at the southeast end of a collapsed salt dome called the Paradox valley. Mancos Shale directly underlies the site with a maximum thickness of shale and interbedded sandstones of 70 feet.

Most of the site is blanketed with alluvium and colluvium composed of sandy clay that is up to 20 feet thick. This soil contains variable amounts of rock fragments, primarily sandstone of cobble to boulder size. Near the east-central portion of the site, an un-eroded remnant or outlier of the Mancos Shale forms a hill some 100 feet higher than the local terrain. The Mancos shale is clay rich, thus featuring low-permeability and high adsorption capacity.

Below the Mancos Shale is the Dakota Formation, which is composed of marine sandstone, conglomerate, and shale. At least one sandstone bed at the bottom of the

Mancos is water bearing under the site. Below the Dakota Formation lies the Burro Canyon Formation consisting of sandstone and shale and the Morrison Formation consisting of various interbedded shales, sandstones and limestones. Field reconnaissance and monitoring well drilling revealed no discernible faulting or other abrupt structural changes under the site.

6.1.3 Hydrology

Generally, ground water is found in the alluvial deposits adjacent to perennial streams. Ground water is also present locally throughout the western slope in several of the formations that underlie the site including the Mancos Shale, Dakota sandstone, Burro Canyon Formation, and the Morrison Formation. The Mancos Shale has not been generally identified as an underground source of drinking water nor is it an exempted aquifer. If potable water is obtained from this formation it can be used, but no wells near the site obtain water from the Mancos Formation. The nearest user of ground water is the Coke Oven Ranch located approximately one-half mile north of the Durita site. The well is developed in the Dakota Sandstone. This well is not hydraulically connected to the uppermost water bearing-zone beneath the site.

Ground water monitoring wells drilled beneath the Durita site indicate that there are two rock units of the formation that appear to be hydraulically connected and constitute a single upper-most water-bearing stratum. Beneath most of the site, the uppermost water-bearing unit is a sandstone-claystone that appears to be at least 19 feet thick. Along the north side of the site the uppermost unit is a one-foot thick sandstone. This unit is also present in the other up gradient wells, but it is dry.

6.2 Monitoring Wells

6.2.1 Ground Water Monitoring Program

Monitoring wells MW-2 through MW-7 were drilled in 1976 and were sampled on a quarterly basis until 1991. MW-1 was destroyed and/or abandoned prior to site development. MW-2 through MW-7 were abandoned in 1991 when seven new wells were installed. These wells were sampled for TDS, chloride, ammonia, nitrogen, zinc, radium-226, lead-210, and uranium. The sample results were submitted to CDPHE as part of the Durita license condition.

The documentation on the drill logs and installation records for the 1976 wells indicated that these wells were installed to relatively shallow depths at the base of the Mancos Formation. The installation records were incomplete, but indicated that the screen portion of each well was not sand-packed, did not have a seal above the screen zone, and the wells were not backfilled to the ground surface. The seals, which were placed around the casing at ground surface of all of the wells, deteriorated with time on some of the wells. Therefore, the possibility existed that the ground water level and ground water

quality in these wells could have been influenced by in-flows of surface water through the defective seals and along the unbackfilled annulus of the wells.

Detection monitoring of ground water was conducted on a quarterly basis in six wells on site during the period from 1976 to 1991. Analysis of the data from these wells did not show releases of constituents from the Durita facility. However, there were questions and concerns about the construction of the wells and quality of the data.

In 1990, the data from these wells was examined and it was determined that these data could not support a credible assessment of the natural hydrologic conditions as required by Criteria 5G of Part 18, Appendix A of the Regulations. Data from these wells, although erratic, did not indicate increases in total dissolved solids or other constituents that would indicate releases from the heap leach during operations.

As a result of the uncertainty about the data being collected from these wells, a second phase of well installation was done. Seven new wells, MW-8 through MW-14, were drilled and installed during April 23-28, 1991. The new wells were completed in a sandstone member of the Mancos Shale and included both background and detection monitoring wells. The old wells were abandoned and closed in accordance to procedures required by the State Engineer's Office.

6.2.2 Monitoring Well Sampling

The water sampled from the new wells during Phase II was tested for many more constituents. These constituents included the major cations and anions, more metals, and a suite of organic compounds in addition to several radiological species. The location, construction and documentation of these seven wells were acceptable for purposes of conducting a detection-monitoring program at the Durita site.

These new wells were sampled for some 30 inorganic constituents and a number of organic constituents known to be found in tailings. It was determined that the following constituents were reasonably expected to be in or derived from the uranium and thorium byproduct material in the disposal area: uranium, radium 226, radium 228, thorium 230, arsenic, nickel, and thallium. Therefore, groundwater samples were analyzed for these constituents along with other indicator parameters such as TDS, pH, temperature, sulfate, chloride, and other metals. No organic compounds were detected. Samples were obtained quarterly by Hecla Mining Company.

Further the total dissolved solids and other constituents monitored were in the same range as the six old wells. Well completion data and results of the initial well sampling are found in Final Reclamation Plan, Durita Site, Volume 2 Appendices, and October 1991. Detection monitoring continued on the seven new wells until 1998. On December 28, 1998 the Department allowed Hecla to cease sampling of the wells. The Department's analysis of the data indicated that no releases of hazardous constituents had been detected.

6.2.3 Well Closure

Review of the ground water data showed no impact to ground water from the Hecla Site. Review of the geology, hydrology, construction design, atmospheric conditions, and potential users of the ground water that would be impacted by contamination from the site were considered before plugging of the wells. Underlying the impoundments is the Mancos Shale, a relatively impervious calcareous clayey formation not used as a ground water source in the area. The one well in the area is one-half mile north and cross gradient to the direction of ground-water flow from the site. Ground water from this well is obtained from the Dakota Sandstone. This well is not hydraulically connected to the upper most water bearing-zone beneath the site, which is in the Mancos Shale. Recharge to the Dakota Formation is to the north and regional flow would be to the south, opposite the direction of flow in the upper bearing water zone in the Mancos Shale.

Ground water in the compliance wells was compared against ground water in the background wells. The historical groundwater data were analyzed for descriptive and comparative statistics. The descriptive statistics characterized the number of measurements/analysis, frequency of detection range, average concentration, and variability of each parameter for each well. A comparative statistical analysis was performed for the relevant indicator parameters: arsenic, selenium, and uranium. The comparative statistical analysis consisted of a Test of Proportions procedure. Although a statistically significant difference was noted for arsenic between up gradient well MW-14 and down gradient well MW-12, the difference resulted from a greater number of detections in the up gradient well than the down gradient well. Therefore, the difference in the occurrence in arsenic between these two wells is not related to a release from the site. Based on the comparative statistical analysis, no evidence of a release related to the site was observed in groundwater. (1995 Annual Groundwater Report)

In addition, CDPHE requested that the travel time for ground water from the leach tanks to the existing site boundary be estimated. The licensee responded that there is no hydraulic connection between the leach tanks and the shallow ground water. However, if a hydraulic connection is assumed in order to permit a calculation and Darcinian flow along the pathway is assumed, and then the following parameters were used to perform the calculations:

Horizontal travel distance, 1 = 2400 feet

Change in water surface elevation over distance, 1 = 104 feet

Hydraulic gradient, I = 0.0433

Permeability, k = 7 x 10-5 feet per day (average values from Domenico and Schwartz, Physical and Chemical Hydrogeology, 1990 and U.S. Department of Interior Ground Water Manual, 1981)

V = ki

V = 3 x 10-6 ft/day = 1.1 x 10-3 ft/year

Time, t = 2400 ft/v = 2.18 million years.

Because no dependable field measurements of hydraulic conductivity could be performed, the value used for the above calculations was based on two well-established but general references. The actual value could vary by one or two orders of magnitude higher or lower. If the hydraulic conductivity were assumed to be 100 times greater, then the travel time would be approximately 22,000 years. This meets the 200 to 1000 year criteria of protectiveness in the Colorado regulations for radiation control.

In addition, the materials in the closure cell were mixed with clay and compacted near the optimum moisture content. This compacted clay like material would limit vertical flow. A two and one-half foot compacted clay cover and radon barrier were constructed above the radioactive waste placed in the closure cell that would limit infiltration. CDPHE reviewed the input data considered to be representative of the cover design values and performed independent infiltration analysis using the Help model. It was determined that average annual percolation through the closure cell cover would be 0.0011 inches and 0.0019 inches in the leach tank covers. All of the cells were designed to enhance runoff. The leach tank cells have over five feet of compacted clayey soil above the waste material. All of the cells have clay liners. The evaporation rate in the area is approximately 49 inches per year and the precipitation rate is approximately 12 inches per year. In over 15 years of monitoring, contamination was not detected in any of the wells. The closure cell consisted of neutralized acid tailings and were placed in a non-saturated condition and were compacted to a dense state. For the above reasons, it was agreed that the ground-water monitoring wells could be plugged.

The seven monitoring wells were plugged using bentonite pellets and the upper steel casing was pulled. The wells were abandoned and a report filed with the State of Colorado, Office of the State Engineer on October 27, 2002 (Rex Wyatt Drilling Company, 2002).

6.3 Conclusion

The results of the ground water monitoring programs, which were submitted to and reviewed by CDPHE, supported the conclusion that the activities at the Hecla-Durita facility had not adversely impacted the underlying ground water. Therefore there has been no need for a ground water corrective program at this site.

CDPHE-HMWMD has made a determination that the closure of Hecla Mining Company's facility is in compliance with State groundwater regulations associated with uranium mill closure. The closure is specifically in compliance with the following groundwater criteria delineated in Part 18 - Appendix A of the Colorado Rules and

Regulations Pertaining to Radiation Control, Criterion 5A-5D, Criterion 7 and Criterion 10, which incorporate the basic groundwater protection standards imposed by EPA in 40 CFR Part 192, Subparts D and E; and imposed by NRC in 10 CFR Part 40, Appendix A which specifies groundwater monitoring requirements.

7.0 Compliance With License Conditions

The conditions of the radioactive materials license, Amendment 12, that control the design and construction were:

LC 11.2 Final Reclamation Plan

The Final Reclamation Report was submitted in October 1991. CDPHE approved the Final Reclamation Plan in May 1993.

LC 11.6 Quality Control Procedures and Construction Verification Program

The Quality Control Procedures and Construction Verification Program for the Durita Site Reclamation were submitted March 24, 1995.

LC 17 Design and Engineering

The following documents were submitted:

AK Geoconsult Inc. 1994 Specification for Construction of Erosion Protection of Containment Structures, Durita Site, Colorado prepared for Hecla Mining Company. January 26, 1994.

AK Geoconsult Inc. 1994 Specification for Excavation and Disposal of Contaminated Soil, Durita Site, Colorado prepared for Hecla Mining Company. August 20, 1994.

AK Geoconsult Inc. 1994 Specification for Site Regrading and Revegetation, Durita Site, Colorado prepared for Hecla Mining Company. January 26, 1994.

AK Geoconsult Inc. 1994 Specification for Surface Water Control Structures, Durita Site, Colorado prepared for Hecla Mining Company. January 26, 1994.

AK Geoconsult Inc. 1994 Specification for Closure of Evaporation Ponds and Raffinate Ponds, Durita Site, Colorado prepared for Hecla Mining Company. August 20, 1994.

AK Geoconsult Inc. 1994 Specification for Leach Tank Outslopes and Radon Barrier Construction, Durita Site, Colorado prepared for Hecla Mining Company. August 20, 1994.

LC 28.2 Annual Reclamation Report.

Monster Engineering, Inc. (MEI). 1996. 1995 Durita Site Reclamation and Construction

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A decision analysis for the proposed amendment to renew the license was completed in 1999 (CDPHE, 1999). The decision analysis determined that license conditions were in place to assure adequacy of equipment, facilities, and procedures to protect public health and safety and property. License compliance was monitored by the Department through annual license compliance inspections. Compliance was also monitored through periodic site visits, review of the licensee's Annual ALARA Reports and review and approval of procedures in the *Hecla Mining Company Health and Safety Program (Hecla, 1990).*

8.0 License Termination Conclusion

CDPHE-HMWMD has determined that the Hecla Mining Company has complied with the Colorado Rules and Regulations Pertaining to Radiation Control and other State and Federal Regulations with regards to Decommissioning. CDPHE-HMWMD staff has determined that by inspections, communications and review of documents and reports that reclamation at the Durita Site was done to the following:

- Work was performed according to the approved plans, specifications, and practices,
- That any deviations from the approved plans, specifications, and practices were identified and corrected promptly,
- That variances from the approved plans, specifications, and practices were evaluated and justified sufficiently to support acceptance prior to implementation,
- Hecla Mining Company prepared a long-term monitoring and maintenance report (March 2000). This report discussed transfer of the Durita site to the US Department of Energy,
- That the Durita Site in Montrose County, Colorado can be released to DOE, and
- That the Colorado Radioactive Materials License RML-317-02 can be terminated.

In conclusion, CDPHE-HMWMD believes that the Hecla Mining Company's Durita site has met all applicable standards and requirements. With a determination by NRC, as

required by Section 274c. (4) of the Act, that all applicable standards and requirements have been met, the Colorado Radioactive Material License 317-02 may be terminated.

In a letter dated April 12, 1996 to DOE, Governor Roy Romer declined the Colorado State's option to be custodian of the Durita site and the Maybell site. In a letter dated February 27, 2001 from Gary Gamble to DOE, notification was given that they planned to transfer the site to the USDOE by June 30, 2002. On January 18, 2002 Ann Robison of Hecla wrote a letter to DOE regarding transfer of the Durita Site to the United States Department of Energy (DOE). Pending acceptance of this CRR and an approved Long-Term Surveillance Plan, it is anticipated that the Durita Site can be transferred to the DOE.

IV FIGURES:

Figure 1- Site Location Map

Figure 2- Durita Site Map before Reclamation

Figure 3 - Durita Site Map after Reclamation

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