G&M Consulting Engineers, Inc.

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FINAL FEASIBILITY STUDY
MARTIN MARIETTA REDUCTION FACILITY
THE DALLES, OREGON

Prepared for

MARTIN MARIETTA CORPORATION

Bethesda, Maryland

June 1988

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TABLE OF CONTENTS

Section	Title	Page
	EXECUTIVE SUMMARY	E-1
1.0	INTRODUCTION	1-1
	1.1 Site Background	1-2
	1.1.1 Site Location	1-2
	1.1.2 Site History	1-4
	1.1.3 Summary of the Remedial Investigation	1-9
	1.1.4 Physical Characteristics of the Site	1-14
	1.1.4.1 Climate	1-14
	1.1.4.2 Topography	1-42
	1.1.4.3 Surface Water Drainage	1-42
	1.1.4.4 Lithology/Geology	1-45
	1.1.4.5 Hydrogeology	1-47
	1.1.5 Existing and Future Land and Ground-Water Use	1-49
	1.2 Nature and Extent of Problem	1-54
	1.2.1 Development of Remediation Criteria	1-55
	1.2.1.1 Air	1-58
	1.2.1.2 Ground Water	1-58
	1.2.1.3 Surface Water	1-61
	1.2.1.4 Soil/Sediments	1-62
	1.2.1.5 Summary of Sitewide Remediation Criteria	1-74
	1.2.2 Target Remediation Areas	1-74
	1.2.3 Site and Waste Characterization for Target Remediation Areas	1-76
	1.2.3.1 Landfill	1-81
	1.2.3.2 Former Cathode Waste Management Areas	1-91
	1.2.3.3 Management Units in Operation	1-103
	1.2.3.4 Unloading Area	1-105
	1.2.3.5 Scrubber Sludge Ponds	1-108
	1.2.3.6 Ground Water	1-116
	1.3 Objectives of Remedial Action	1-118
2.0	IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES	2-1
	2.1 General Response Actions	2-1

TABLE OF CONTENTS

Section	Title	Page
2.2	Identification and Screening Process....	2-2
2.3	Discussion of Applicable Remedial Technology Components.....	2-8
2.3.1	Access Restrictions.....	2-18
2.3.2	Sediment Removal.....	2-19
2.3.3	Soil/Waste Removal.....	2-20
2.3.4	Solidification/Stabilization.....	2-20
2.3.5	On-site Incineration.....	2-22
2.3.6	Soil, Sediment and Waste Chemical Treatment.....	2-22
2.3.7	Soil, Sediment and Waste Physical Treatment.....	2-23
2.3.8	On-site Land Disposal.....	2-24
2.3.9	Cap.....	2-25
2.3.10	Cover.....	2-26
2.3.11	Dust Suppressants.....	2-27
2.3.12	Hydraulic Barriers.....	2-27
2.3.13	Subsurface Barriers.....	2-27
2.3.14	Surface Water Controls.....	2-29
2.3.15	Leachate Collection.....	2-30
2.3.16	Ground-water Controls.....	2-30
2.3.17	Aqueous Physical Treatment.....	2-31
2.3.18	Aqueous Chemical Treatment.....	2-34
2.3.19	Prevent Withdrawal of Ground Water.....	2-38
2.3.20	Institutional Controls.....	2-38
2.3.21	Alternative Water Supply.....	2-39
2.4	Discussion of Inapplicable Remedial Technology Components.....	2-39
2.4.1	Sediment Removal.....	2-39
2.4.2	Off-site Incineration.....	2-41
2.4.3	Solidification/Stabilization.....	2-41
2.4.4	On-site Incineration.....	2-41
2.4.5	Vitrification.....	2-43
2.4.6	Physical Treatment of Soils, Sediment and Other Wastes.....	2-43
2.4.7	Cap.....	2-44
2.4.8	Cover.....	2-44
2.4.9	Dust Suppressants.....	2-44
2.4.10	Wind Fences/Screens.....	2-45
2.4.11	Hydraulic Barriers.....	2-45
2.4.12	Subsurface Barriers.....	2-45
2.4.13	Surface Water Controls.....	2-46
2.4.14	Ground-water Collection.....	2-47
2.4.15	Physical Treatment for Surface and Ground-water Management.....	2-48

TABLE OF CONTENTS

Section	Title	Page
	2.4.16 Chemical Treatment for Surface and Ground-water Management.....	2-48
	2.4.17 In Situ Treatment.....	2-49
	2.5 Summary of Applicable Remedial Technologies.....	2-49
	2.6 Proposed Waiver.....	2-50
3.0	ASSEMBLY AND SCREENING OF REMEDIAL MEASURES..	3-1
	3.1 Assembly of Remedial Measures.....	3-2
	3.2 Screening of Remedial Measures.....	3-18
	3.2.1 Remedial Measures Screening Criteria.....	3-20
	3.2.1.1 Effectiveness.....	3-20
	3.2.1.2 Implementability.....	3-21
	3.2.1.3 Cost.....	3-21
	3.2.2 Remedial Measures Screening.....	3-22
	3.2.3 Summary of Remedial Measures Eliminated from Further Consideration.....	3-43
	3.2.3.1 Landfill: Inapplicable Remedial Measures.....	3-47
	3.2.3.2 Unloading Area: Inapplicable Remedial Measures.....	3-49
	3.2.3.3 Former Cathode Waste Management Areas: Inapplicable Remedial Measures.....	3-50
	3.2.3.4 Scrubber Sludge Ponds: Inapplicable Remedial Measures.....	3-52
	3.2.3.5 Ground Water: Inapplicable Remedial Measures.....	3-52
4.0	DEVELOPMENT OF SITEWIDE REMEDIAL ALTERNATIVES.....	4-1
	4.1 Assembly of Remedial Alternatives.....	4-1
	4.2 Sitewide Remedial Alternatives.....	4-4
	4.2.1 Limited Action Alternative.....	4-4
	4.2.1.1 Remedial Alternative 1: Limited Action.....	4-4
	4.2.2 Containment Alternatives.....	4-5

TABLE OF CONTENTS

Section	Title	Page
	4.2.2.1 Remedial Alternative 2: Containment with Ground-water Controls.....	4-5
	4.2.2.2 Remedial Alternative 3: Containment with Complete Removal and Ground-water Controls...	4-24
	4.2.2.3 Remedial Alternative 4: Containment, Complete Removal and Hydraulic Barriers with Ground-water Controls.....	4-32
	4.2.2.4 Remedial Alternative 5: Containment with Consolidation and Ground-water Controls.....	4-39
	4.2.2.5 Remedial Alternative 6: RCRA Landfill and Ground-water Controls...	4-45
	4.2.3 Containment with Treatment Alternatives.....	4-52
	4.2.3.1 Remedial Alternative 7: Containment with Consolidation and Ground-water Recovery and Treatment.....	4-52
	4.2.3.2 Remedial Alternative 8: RCRA Landfill and Ground-water Recovery and Treatment.....	4-61
	4.2.3.3 Remedial Alternative 9: Containment with Consolidation, Stabilization and Ground-water Recovery and Treatment..	4-65
	4.2.4 Treatment Alternative.....	4-73
	4.2.4.1 Remedial Alternative 10: Incineration, Stabilization and Ground-water Recovery and Treatment..	4-73
5.0	DETAILED ANALYSIS OF SITEWIDE REMEDIAL ALTERNATIVES.....	5-1
	5.1 Evaluation Criteria.....	5-1
	5.1.1 Technical Engineering Institutional and Cost Considerations.....	5-2

TABLE OF CONTENTS

Section	Title	Page
	5.1.2 Statutory Requirements.....	5-5
	5.1.3 Acceptance of Remedial Alternative.....	5-5
	5.2 Analysis of Remedial Alternatives.....	5-6
	5.2.1 Remedial Alternative 1: Limited Action.....	5-6
	5.2.2 Remedial Alternative 2: Containment with Ground-water Controls and Limited Treatment...	5-11
	5.2.3 Remedial Alternative 3: Containment with Complete Removal and Ground-water Controls.....	5-20
	5.2.4 Remedial Alternative 4: Containment, Complete Removal and Hydraulic Barriers with Ground-water Controls.....	5-31
	5.2.5 Remedial Alternative 5: Containment with Consolidation and Ground-water Controls.....	5-46
	5.2.6 Remedial Alternative 6: RCRA Landfill and Ground-water Controls with Limited Treatment..	5-52
	5.2.7 Remedial Alternative 7: Containment with Consolidation and Ground-water Recovery and Treatment.....	5-67
	5.2.8 Remedial Alternative 8: RCRA Landfill and Ground-water Recovery and Treatment.....	5-72
	5.2.9 Remedial Alternative 9: Containment with Consolidation, Stabilization and Ground-water Recovery and Treatment.....	5-82
	5.2.10 Remedial Alternative 10: Incineration, Stabilization and Ground-water Recovery and Treatment.....	5-93
	5.3 Summary of the Detailed Analysis of Remedial Alternatives.....	5-105
6.0	COMPARISON OF REMEDIAL ALTERNATIVES.....	6-1
	6.1 Remedial Alternative 1: Limited Action..	6-1
	6.2 Remedial Alternative 2: Containment with Ground-Water Controls.....	6-2

TABLE OF CONTENTS

Section	Title	Page
	6.3 Remedial Alternative 3: Containment with Complete Removal and Ground-Water Controls	6-3
	6.4 Remedial Alternative 4: Containment, Complete Removal and Hydraulic Barriers with Ground-Water Controls	6-4
	6.5 Remedial Alternative 5: Containment with Consolidation and Ground-Water Controls	6-4
	6.6 Remedial Alternative 6: RCRA Landfill and Ground-Water Controls	6-5
	6.7 Remedial Alternative 7: Containment with Consolidation and Ground-Water Recovery and Treatment	6-6
	6.8 Remedial Alternative 8: RCRA Landfill and Ground-Water Recovery and Treatment	6-7
	6.9 Remedial Alternative 9: Containment with Consolidation, Stabilization and Ground-Water Recovery and Treatment	6-7
	6.10 Remedial Alternative 10: Incineration, Stabilization and Ground-Water Recovery and Treatment	6-8
7.0	PREFERRED ALTERNATIVE	7-1
	7.1 Preferred Alternative Description	7-1
	7.2 Additional Data Needs for the Preferred Alternative	7-17
	REFERENCES	R-1
APPENDIX A	Drawings	
APPENDIX B	Closure Options for Management Units in Operation	
APPENDIX C	Definition of Appropriate Remediation Criteria for Fluoride in Ground Water	
APPENDIX D	Public Health and Environmental Assessment of Remedial Alternatives for the MMRF site	

LIST OF FIGURES

No.	Title	Page
1-1	Location/Vicinity Map	1-3
1-2	Site Plan	1-11
1-3	Monthly Precipitation and Estimated Evaporatranspiration	1-41
1-4	Wind Rose For The MMRF Site	1-43
1-5	Zoning Map	1-51
1-6	Existing Conditions at Landfill	1-82
1-7	Landfill Runoff Areas	1-83
1-8	Asbestos Disposal Areas	1-86
1-9	Landfill Test Pit Locations	1-88
1-10	Former Cathode Waste Management Areas	1-92
1-11	Potliner Handling Area	1-93
1-12	Salvage Area	1-96
1-13	Old Cathode Waste Pile Area	1-98
1-14	Bath Recovery Pad Area	1-101
1-15	Approximate Lateral Extent of Perched Water Zone	1-104
1-16	Units in Operation	1-106
1-17	Unloading Area	1-107
1-18	Existing Conditions Scrubber Sludge Ponds	1-109
1-19	Pre-Site Development Drainage Scrubber Sludge Ponds	1-110
1-20	Location of Byron Interbed at the Scrubber Sludge Ponds	1-111
1-21	Potentiometric Map: S-aquifer Scrubber Sludge Ponds	1-113
1-22	Interim Operational Conditions Scrubber Sludge Ponds	1-114

LIST OF FIGURES

No.	Title	Page
2-1	General Response Actions.....	2-3
2-2	Potential Remedial Technologies for Soil, Sediment and Waste.....	2-4
2-3	Potential Remedial Technologies for Air Emissions Control.....	2-5
2-4	Potential Remedial Technologies for Surface and Ground Water.....	2-6
4-1	Approximate Location and Configuration of Landfill Cap.....	4-9
4-2	Schematic Aqueous Treatment System.....	4-12
4-3	Aqueous Treatment System Location.....	4-13
4-4	Asphalt Cap Configuration Former Cathode Waste Management Areas.....	4-15
4-5	Approximate Limit of Perched Zone.....	4-18
4-6	Cross Section of Perched Water Collection Trench.....	4-19
4-7	Soil Cover System Cross Section.....	4-20
4-8	Unloading Area Recovery Well.....	4-22
4-9	Multi-Media Cap Typical Cross Section.....	4-27
4-10	Routing of Roof Scrubber Return Lines.....	4-30
4-11	Hydraulic Controls Scrubber Sludge Ponds.....	4-37
4-12	Approximate Location and Configuration of Landfill Cap.....	4-41
4-13	Approximate Location and Configuration of the RCRA Landfill.....	4-46
4-14	RCRA Landfill Bottom Liner System Cross Section.....	4-47
4-15	RCRA Guidance Cap Cross Section.....	4-48

LIST OF FIGURES

No.	Title	Page
4-16	Recovery Wells Former Cathode Waste Management Areas	4-57
4-17	Recovery Wells Scrubber Sludge Ponds	4-59
4-18	Recovery Wells Recycle Pond	4-60
4-19	Approximate Location and Configuration of Landfill for Ash	4-76
5-1	Approximate Location and Configuration of Landfill Cap	5-4
5-2	RCRA Performance Cap Typical Cross-Section	5-6
5-3	Soil Cover System Cross-Section	5-8
5-4	Unloading Area Recovery Well	5-10
5-5	Aqueous Treatment System Location	5-11
5-6	Schematic Aqueous Treatment System	5-13
7-1	Routing of Roof Scrubber Return Lines	7-4
7-2	Approximate Location and Configuration of Landfill Cap	7-6
7-3	RCRA Performance Cap Typical Cross Section	7-7
7-4	Aqueous Treatment System Location	7-10
7-5	Schematic Aqueous Treatment System	7-11
7-6	Soil Cover System Cross Section	7-13
7-7	Unloading Area Recovery Well	7-14

LIST OF TABLES

No.	Title	Page
E-1	Summary of Constituents Measured Above Detection Limits	E-7
E-2	Selected Sitewide Remedial Criteria	E-10
E-3	Summary of Target Remediation Areas	E-14
E-4	Ground-Water Contamination at the MMRF	E-19
E-5	Summary of Remedial Alternatives	E-23
E-6	Effectiveness of Remedial Alternative 3	E-34
1-1	Chronological History of MMRF Operations	1-5
1-2	Summary of Volume Estimates	1-12
1-3	Summary of Analytical Results	1-15
1-4	Summary of EP Toxicity Metals Analysis	1-29
1-5	Principal Site Related Chemicals Detected in Ground Water	1-34
1-6	Worker Exposure Limits for Potential Airborne Constituents of Concern	1-59
1-7	Potential ARARs and Public Health Criteria for Constituents of Concern in Ground Water	1-60
1-8	Potential Surface Water Remediation Criteria for Environmental Receptors	1-63
1-9	Potential Soil Remediation Criteria	1-68
1-10	Proposed Remediation Criteria for Soils	1-75
1-11	Selected Sitewide Remediation Criteria	1-77
1-12	Target Remediation Areas	1-78
1-13	Potential Risks Associated with Target Remediation Areas	1-79
2-1	Screening of Remedial Technologies for Soil, Sediment and Waste Control	2-9
2-2	Screening of Remedial Technologies for Mitigation of Air Exposures During Remediation	2-13

LIST OF TABLES

No.	Title	Page
2-3	Screening of Remedial Technologies for Surface and Ground-water Management.....	2-14
2-4	Summary of Applicable Components for Soil, Sediment and Waste Control.....	2-51
2-5	Summary of Applicable Components for Mitigation of Air Exposures During Remediation.....	2-52
2-6	Summary of Applicable Components for Surface and Ground-water Management.....	2-53
3-1	Assembly of Screened Technologies Into Remedial Measures for the Landfill (LF).....	3-4
3-2	Assembly of Screened Technologies Into Remedial Measures for the Unloading Area (UA)	3-5
3-3	Assembly of Screened Technologies Into Remedial Measures for the Former Cathode Waste Management Areas (FCW).....	3-6
3-4	Assembly of Screened Technologies Into Remedial Measures for the Scrubber Sludge Ponds (SP).....	3-7
3-5	Assembly of Screened Technologies Into Remedial Measures for Ground Water (GW).....	3-8
3-6	Landfill (LF) Remedial Measures.....	3-9
3-7	Unloading Area (UA) Remedial Measures.....	3-11
3-8	Former Cathode Waste Management Areas (FCW) Remedial Measures.....	3-12
3-9	Scrubber Sludge Ponds (SP) Remedial Measures.	3-14
3-10	Ground-Water (GW) Remedial Measures.....	3-15
3-11	Remedial Measures Considered for Implementation.....	3-17
3-12	Potential Location Specific ARARs.....	3-19
3-13	Screening of Remedial Measures for the Landfill (LF).....	3-23

LIST OF TABLES

No.	Title	Page
3-14	Screening of Remedial Measures for the Unloading Area (UA).....	3-27
3-15	Screening of Remedial Measures for the Former Cathode Waste Management Areas (FCW).....	3-31
3-16	Screening of Remedial Measures for the Scrubber Sludge Ponds (SP).....	3-35
3-17	Screening of Remedial Measures for Ground Water.....	3-39
3-18	Remedial Measures Considered Target Remediation Areas.....	3-44
3-19	Potential Action Specific ARARs.....	3-45
4-1	Summary of Assembled Remedial Alternatives and Component Remedial Measures.....	4-3
4-2	Summary of Monitor Wells and Constituents Analyzed for Ground-water Monitoring.....	4-6
4-3	Vendors for Solidification/Stabilization Agents.....	4-71
5-1	Summary of Detailed Analysis Evaluation Criteria.....	5-3
5-2	Cost Analysis of Remedial Alternative 1.....	5-12
5-3	Cost Analysis of Remedial Alternative 2.....	5-21
5-4	Cost Analysis of Remedial Alternative 3.....	5-32
5-5	Cost Analysis of Remedial Alternative 4.....	5-42
5-6	Cost Analysis of Remedial Alternative 5.....	5-53
5-7	Cost Analysis of Remedial Alternative 6.....	5-63
5-8	Cost Analysis of Remedial Alternative 7.....	5-73
5-9	Cost Analysis of Remedial Alternative 8.....	5-83
5-10	Cost Analysis of Remedial Alternative 9.....	5-94
5-11	Cost Analysis of Remedial Alternative 10.....	5-106

LIST OF TABLES

No.	Title	Page
5-12	Detailed Analysis Summary of Remedial Alternative 1	5-110
5-13	Detailed Analysis Summary of Remedial Alternative 2	5-111
5-14	Detailed Analysis Summary of Remedial Alternative 3	5-112
5-15	Detailed Analysis Summary of Remedial Alternative 4	5-113
5-16	Detailed Analysis Summary of Remedial Alternative 5	5-114
5-17	Detailed Analysis Summary of Remedial Alternative 6	5-115
5-18	Detailed Analysis Summary of Remedial Alternative 7	5-116
5-19	Detailed Analysis Summary of Remedial Alternative 8	5-117
5-20	Detailed Analysis Summary of Remedial Alternative 9	5-118
5-21	Detailed Analysis Summary of Remedial Alternative 10	5-119
7-1	Summary of Monitor Wells and Constituents Analyzed for Ground-Water Monitoring	7-16

LIST OF DRAWINGS

No.	Title	Page
A-1	Facility Map.....	A-1
A-2	Well Location Map.....	A-2
A-3	Site Drainage Map.....	A-3
A-4	Identification and Screening of Remedial Technologies.....	A-4
A-5	Identification and Screening of Remedial Technologies.....	A-5
A-6	Detailed Analysis Summary of Remedial Alternatives.....	A-6

099/13

1.0 INTRODUCTION

This document presents the Feasibility Study (FS) for the Martin Marietta Reduction Facility (MMRF) at The Dalles, Oregon. This FS was performed in accordance with Consent Order Number 1085-04-02-106, dated September 1985, for Martin Marietta Corporation and overseen by Region X of the United States Environmental Protection Agency (EPA). The FS incorporates the requirements of the National Contingency Plan (NCP) and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) as revised by the Superfund Amendments and Reauthorization Act of 1986 (SARA) for the development of remedial action alternatives for management of the MMRF site.

The FS is structured for the development of remedial action alternatives which upon implementation, will alter site conditions so that compliance with criteria established for site remediation is obtained. The FS builds upon the data and information contained in the "Remedial Investigation Report" (RI) prepared by Geraghty & Miller, Inc. for the MMRF which includes the "Risk Assessment" (RA), prepared by Clement Associates, Inc. These reports are referenced in the characterization of waste and site features at the MMRF and are the basis for development of remedial actions at the site. Site background information, the nature and extent of the contamination at the site, and the objectives of remedial actions are presented in the following sections of this

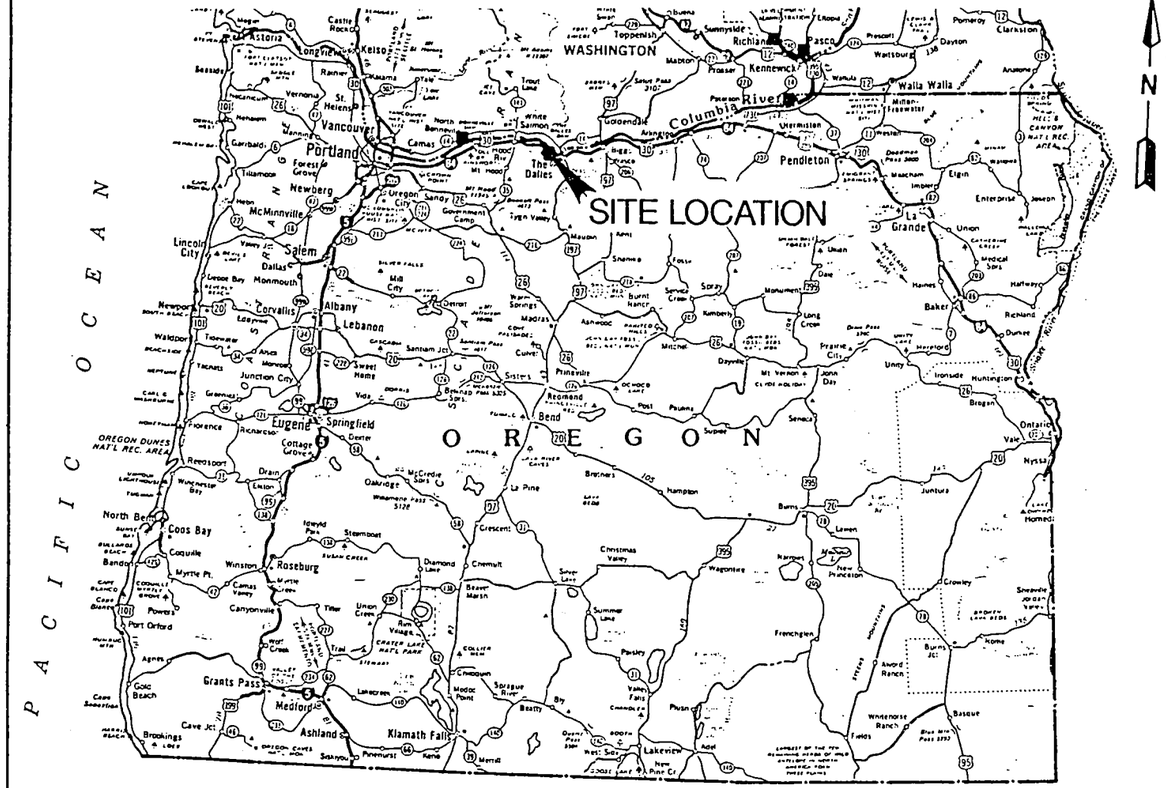
introduction. The remaining sections of the FS deal with utilization of site and waste specific information in order to develop remedial alternatives for the site. The approach used in Sections 2.0 through 7.0 to generate remedial alternatives for the site consists of the following steps:

- Step 1 - Identification and screening of general response actions and related remedial technologies for addressing site problems including attainment of remediation criteria;
- Step 2 - Assembly and screening of area specific remedial measures incorporating applicable remedial technologies;
- Step 3 - Assembly of applicable remedial measures for the target remediation areas into remedial alternatives;
- Step 4 - Detailed assessment of sitewide remedial alternatives; and
- Step 5 - Summary and recommendation of sitewide remedial alternative.

1.1 SITE BACKGROUND

1.1.1 Site Location

The MMRF site is located in The Dalles, Wasco County, Oregon, west of the Columbia River and east of the Union Pacific Railroad as shown in Figure 1-1. The 350 acre site is situated within an 800-acre area zoned for industrial and manufacturing facilities. The MMRF occupies approximately 110 acres for processing operations. The MMRF is bounded near the Mountain Fir wood hauling and chip mill on the



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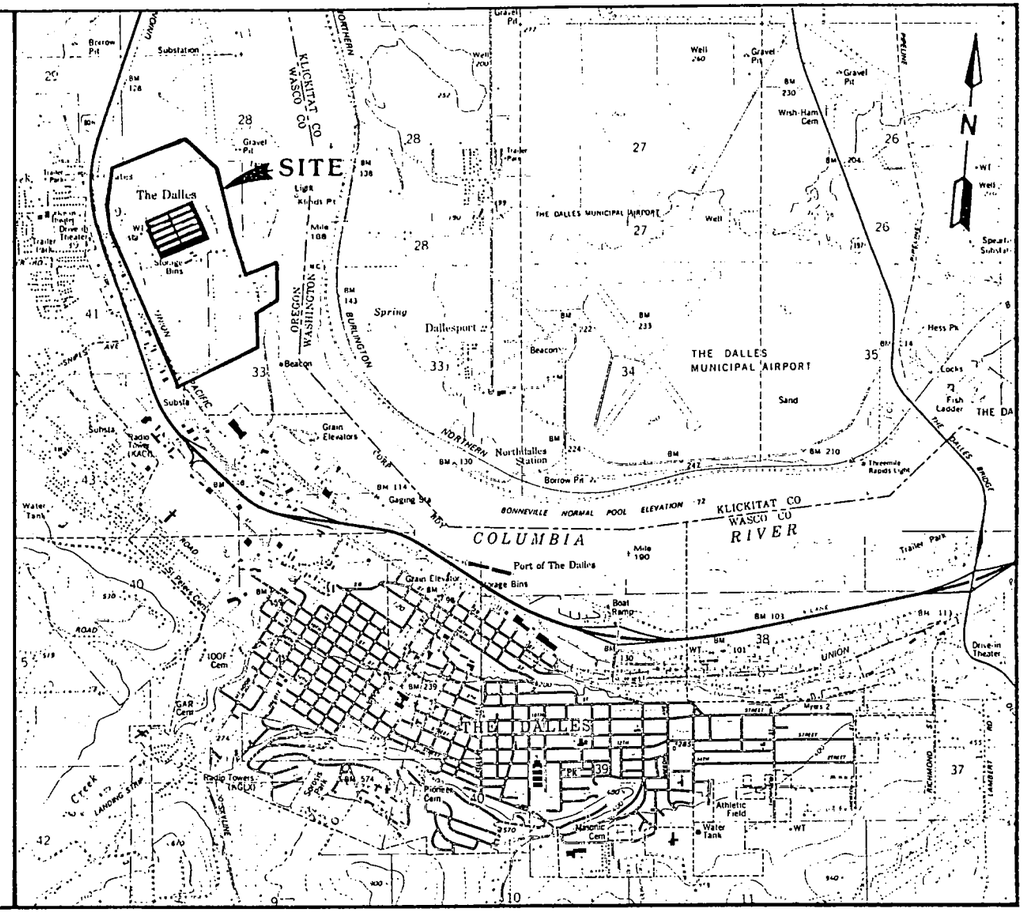
ONE INCH EQUALS APPROXIMATELY 49 MILES

LOCATION MAP



0 1/2 1 MILE

VICINITY MAP

LOCATION MAP

Reference: Goushā/Chek-Chart-United States, Canada, Mexico Road Atlas

VICINITY MAP

Reference: United States Department Of The Interior Geological Survey, 1977.

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FIGURE 1-1

GMCE
G&M CONSULTING ENGINEERS, INC

LOCATION/ VICINITY MAP
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

BAY REPROGRAPHICS 300852

north, Webber Street to the south, the Columbia River on the east, and the Union Pacific Railroad line and West Second Street to the west.

1.1.2 Site History

The MMRF is an aluminum processing facility designed to produce approximately 90,000 tons per year of aluminum from alumina. A facility plan is provided as Drawing A-1 in Appendix A. Operations began at the site in 1958 under the ownership of Harvey Aluminum, Inc. Harvey Aluminum, Inc. became a wholly-owned subsidiary of Martin Marietta Corporation (MMC) in 1970. The MMRF continued operations under the name of Martin Marietta Aluminum, Inc. until 1984, when the plant was shut down and MMC acquired legal title to the property from Martin Marietta Aluminum, Inc. In 1986, MMC leased the plant and portions of property adjacent to the plant to Northwest Aluminum Company, which resumed primary aluminum operations. A chronological history of events and actions related to the aluminum plant operations is provided in Table 1-1. Review of MMC's files on the MMRF indicate that the first and only regulatory enforcement action for the site occurred in September 1985 when Martin Marrietta Corporation signed the consent order with the EPA to conduct the RI/FS.

During the 26 years of aluminum production, waste constituents derived from the process were stored, treated, and disposed of at the MMRF. MMC performed a number of

TABLE 1-1

Chronological History of MMRF Operations
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Dates	Event
1957 and through 1960	Plant construction debris placed in the Landfill. Paper and wood burned in the Landfill. Burning ceased after 1960 as paper and wood waste were crushed and shipped to Wasco County Landfill.
1958	Process operations initiated by Harvey Aluminum, Inc. Plant emissions collected in a wet primary fluoride scrubber system (known as the "Old Tower" system) and discharged to Scrubber Sludge Ponds 2 and 3.
1960's	Primary "Old Tower" system replaced with electrostatic precipitators. Collected emissions sent to Scrubber Sludge Ponds 2 and 3.
1960	Old Cathode Waste Pile started at northeast corner of the plant. Old Cathode Wash Area constructed east of plant and next to River Road.
1961-1971	Bricks separated from cathodes taken out of service and placed in the Landfill. Other cathode waste shipped off-site for processing at Reynolds Aluminum.
1968	Berm and settling basin added to Old Cathode Wash Area.
1968	Martin Marietta Corporation purchased 41% of common stock of Harvey Aluminum.
1969	Secondary scrubber added to existing scrubber system to enhance air emission controls.
1969	Martin Marietta Corporation purchased an additional 41.7% of common stock of Harvey bringing the total stock purchased to 82.7%.
1972	Martin Marietta Corporation purchased the remaining 17.3% of common stock of Harvey Aluminum.
1972	Clarifier placed on-line. Scrubber Sludge Pond 1 use began. Scubber Sludge Ponds 2 and 3 use discontinued except for use as a backup when clarifier was off-line.

TABLE 1-1 (Continued)

Chronological History of MMRF Operations
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Dates	Event
1974	Recycle Pond constructed for use as settling basin for solids separation from secondary scrubber water. Old NPDES Discharge Channel removed from service.
1974-1984	Casthouse, Paste Plant, and plant operations waste deposited in the Landfill.
1976	Scrubber Sludge Pond 4 constructed and used to store dredged materials from Scrubber Sludge Ponds 2 and 3, and the Recycle Pond.
1977	Scrubber Sludge Pond 2 dredged and material placed in Scrubber Sludge Pond 4.
1978	Dry Scrubber system installed to replace electrostatic precipitators. Wet scrubber added downstream of the dry system as a backup and to collect sulfur dioxide emissions. Fluoride adsorbed by activated alumina in the dry scrubber was recycled back to the reduction cell. Solids from the wet system were pumped to the Scrubber Sludge Ponds.
1979	Scrubber Sludge Ponds and Old Cathode Wash Area extended to the east.
1980	Lined pond constructed to reduce volume placed in the Scrubber Sludge Ponds. Martin Marietta Corporation studies control of surface water flow around the Landfill. Hard Pitch Building constructed.
July 1980	Piping from the Landfill to the Landfill leachate collection sump installed. Sump pump installed to eliminate discharges from the Landfill under River Road.
1981	Scrubber Sludge Ponds 1 and 4 use discontinued, ponds capped.
1982	Scrubber Sludge Pond 2 receives runoff from Scrubber Sludge Pond 3. Dredged bottoms of Lined Pond and Recycle Pond placed in Scrubber Sludge Pond 3.

TABLE 1-1 (Continued)

Chronological History of MMRF Operations
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Dates	Event
Spring 1983	Leachate detected migrating from the Landfill under River Road to the Rockline Quarry. Century West Engineering investigated Landfill for depth to bedrock and subsurface/surface runoff. Surface cover added to Landfill to control surface drainage towards the east and drainage ditches were constructed to control runoff and runon (Surface Drainage Ditch and Leachate Collection Ditch). A diversion berm also constructed on west side of ditch to eliminate surface runoff.
1983	Cyanide levels above detection limits observed during routine sampling of Production Well #2. Well subsequently properly abandoned.
Spring 1983	Century West Engineering prepared a leachate collection system design for Landfill. EPA performed hazardous waste ranking of MMRF. State of Oregon Department of Environmental Quality lists potliner (cathode) waste as hazardous. Martin Marietta Corporation builds an approved waste pad to store waste potliner (cathode). Old potliner cathode waste previously stored at the Old Cathode Waste Pile relocated to the permitted storage area.
1984	Martin Marietta Corporation acquired legal title to property from Martin Marietta Aluminum, Inc. Martin Marietta Corporation constructed a leachate collection system for the Landfill and constructed a New Cathode Waste Pad. Remaining Old Cathode Waste Pile waste and six inches of soil relocated to the New Cathode Waste Pad. Area backfilled and graded with clean soil.
December 1984	Martin Marietta Aluminum, Inc. ceases production.
September 1985	Martin Marietta Corporation enters into a consent order with Region X EPA. Requirements of the consent order include the performance of a Remedial Investigation and Feasibility Study (RI/FS) for the MMRF. This was the first regulatory action enforced on the MMRF.
December 1985	Work plan for the RI/FS prepared by Geraghty & Miller, Inc. for Martin Marietta Corporation submitted to the EPA. Camp, Dresser & McKee, Inc. submitted a community relations plan for the MMRF to the EPA.

TABLE 1-1 (Continued)

Chronological History of MMRF Operations
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Dates	Event
February 1986	RI/FS Work Plan modified.
March 1986	RI/FS Work Plan implemented by Geraghty & Miller, Inc.
April 1986	Fencing installed to secure Landfill.
September 1986	Martin Marietta Corporation leased the MMRF to Northwest Aluminum Company under a five year lease/sale agreement. Northwest Aluminum Company resumed primary aluminum operations. Lined Pond, Discharge Channel, and Recycle Pond were reactivated for plant operations.
November 1986	Results of initial RI data collection activities summarized by Geraghty & Miller, Inc. in "Interim Report - Remedial Investigation, MMRF, The Dalles, Oregon" submitted to EPA.
1987	Flows to the Duck Pond were diverted to the Discharge Channel.
January 1987	MMRF designated as a Superfund site.
March 1987	RI/FS Work Plan Addendum submitted to EPA.
May 1987	RI/FS Work Plan Addendum modified.
June 1987	EPA approved RI/FS Work Plan Addendum. Field activities specified in the addendum initiated.
November 1987	Preliminary RI submitted to EPA.
March 1988	Final RI submitted to EPA.
April 1988	Preliminary FS submitted to EPA.

092/12

environmentally responsive actions throughout its operation of the facility to mitigate the environmental effects of plant activities. These include: construction of a Lined Pond; relocation of the Old Cathode Waste Pile to a new lined Cathode Waste Pad containing a leachate collection system; fencing of the Landfill to restrict access (performed as an interim remedial measure); and construction at the Landfill of a leachate collection system consisting of perimeter ditches and a collection sump. Although waste management techniques such as installation of wet and dry scrubbers and continual monitoring were employed and all necessary environmental operating permits were obtained by MMC, some waste constituents, principally fluoride, sodium, sulfates, cyanide, and polynuclear aromatic hydrocarbons (PAHs) have been detected in the environment. As a result of such releases, MMC entered into a Consent Order with Region X of the EPA in September 1985. The Consent Order directed MMC to perform a remedial investigation and this feasibility study for areas at the site which were used for waste management or which were potentially impacted during plant operations.

1.1.3 Summary of the Remedial Investigation

The RI for the site was initiated by Geraghty & Miller, Inc. in March, 1986. The study areas investigated as part of the RI are the:

- Landfill;
- Landfill Runoff Areas (four);
- Metal Pad Storage Area;

- Bath Recovery Pad Area;
- Old Cathode Waste Pile Area;
- Salvage Area;
- Potliner Handling Area;
- Cathode Wash Area;
- Duck Pond;
- Lined Pond;
- Recycle Pond;
- Scrubber Sludge Ponds (four); and
- Ditches
  - Surface Drainage Ditch,
  - Leachate Collection Ditch,
  - Landfill Ditch,
  - North Ditch,
  - River Road Ditch,
  - River Road Curb,
  - Discharge Channel,
  - Drainage Ditch,
  - Old NPDES Discharge Channel,
  - Abandoned Scrubber Sludge Channel.

In addition to the above listed areas, the Unloading Area was identified as an area having potential contaminant source during the RI and has been included in the FS. Figure 1-2 depicts the site plan including the plant location and study areas examined during the RI. Table 1-2 summarizes the volumes of soil, sediment, waste, or surface water estimated to be contained within these waste management areas.

The RI investigated the ground-water systems located beneath the facility for potential impacts from plant operations. Four aquifer systems were identified beneath the facility; from shallowest to deepest, these aquifers were labeled the S, A, B, and the Dalles Ground-Water Reservoir (DGWR). The RI also identified a perched water zone in the Old Cathode Waste Pile and Salvage Areas as well as an alluvial aquifer of limited areal extent north of the plant near Chenoweth Creek.

FS

BAY REPROGRAPHICS 300852

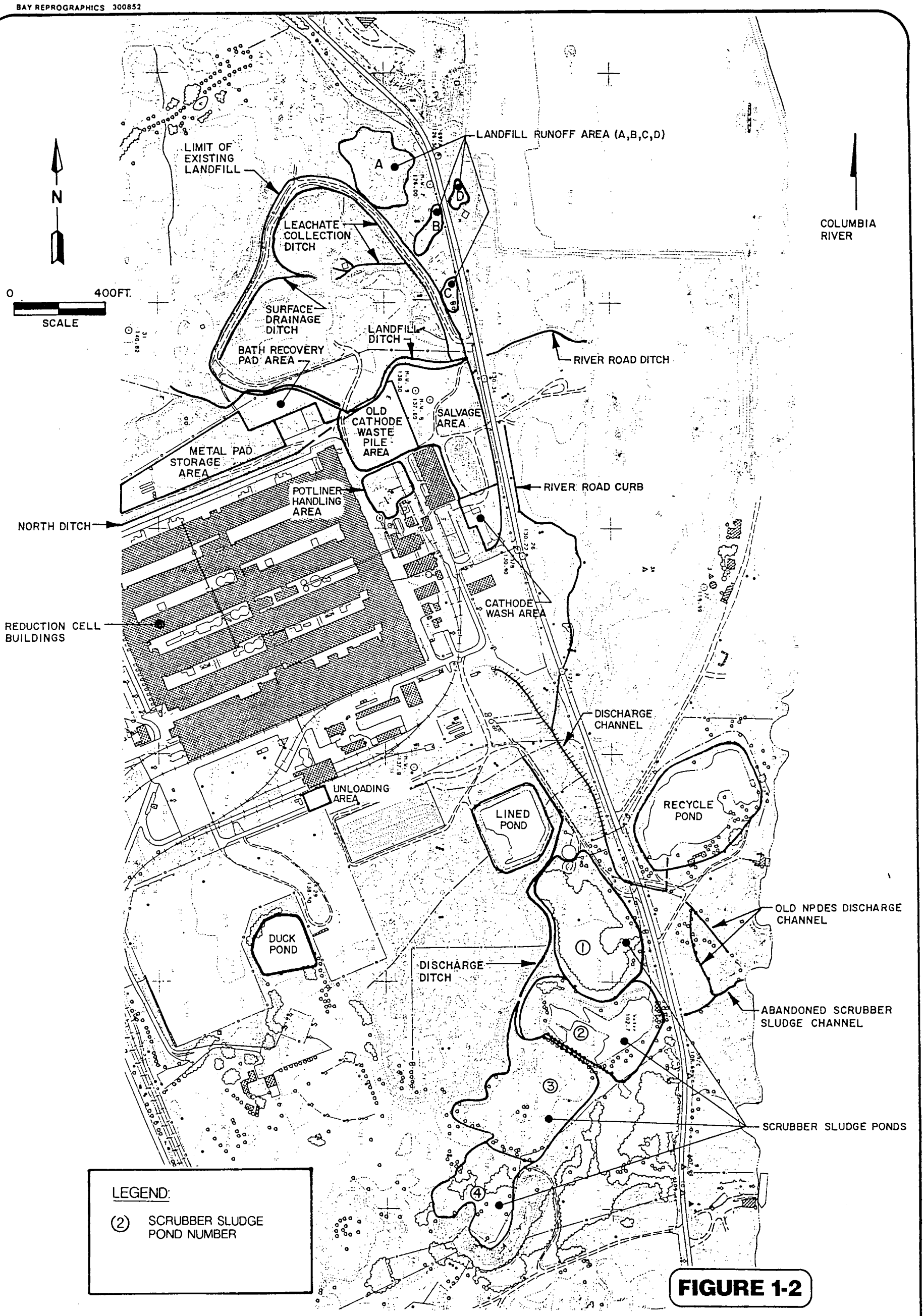

FIGURE 1-2

DRAWING NO: TE0018-P05-B40	
DRAWN BY: KenKMoody	DATE: 25-FEB-88
CHECKED: DKC	DATE: 3/1/88
APPROVED:	DATE: 3/31/88

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SITE PLAN

FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY

MARTIN MARIETTA CORPORATION

THE DALLES, OREGON

TABLE 1-2

Summary of Volume Estimates
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Area of Investigation	Estimated Volume cubic yards		gallons
Landfill	200,000		-
Landfill Runoff Areas			
Area A	510		-
Area B	150		-
Area C	230		-
Area D	138		-
Metal Pad Storage Area	1,690		-
Bath Recovery Pad Area	1,660		-
Old Cathode Waste Pile Area	24,200		-
Salvage Area	28,700		-
Potliner Handling Area	9,910		-
Cathode Wash Area	4,530		-
Duck Pond	2,430		-
Lined Pond	7,700		4,000,000
Recycle Pond	8,915		8,000,000
Scrubber Sludge Ponds			
SSP1	71,700		-(1)
SSP2	9,580		-(1)
SSP3	58,100		-
SSP4	28,500		-
Wind Blown	538		-
Unloading Area	200	(2)	
Ditches			
Surface Drainage Ditch	1,240		-
Leachate Collection Ditch	-	(3)	-
Landfill Ditch	2,050		-
North Ditch	610		-
River Road Ditch	200		-
River Road Curb	-	(4)	-
Discharge Channel	1,100		-
Drainage Ditch	920		-
Old NPDES Discharge Channel	-	(4)	-
Abandon Scrubber Sludge Channel	-	(4)	-

Note: (1) Seasonally affected - Not relevant
(2) Estimated
(3) Lined with concrete, unable to probe soils underneath.
(4) Negligible

072/40

The RI collected samples of sediment, soil, air, surface water, and ground water throughout the site to: (1) characterize the nature and extent of constituents released to the environment; (2) determine the nature and extent of the risk posed to public health, welfare, or the environment by the release of constituents at the MMRF; and (3) gather site data necessary to evaluate potential remedial responses. The locations of ground-water monitor and water supply wells sampled during the RI are shown in Drawing A-2. Soil and sediment samples were collected from the surface of the study areas, test pit excavations, ditches and surface impoundments. Surface water samples were collected from the surface impoundments and ditches where water was present. Air samples were collected under ambient conditions and during drilling operations.

Work performed during the RI included installation of new monitor wells and replacement of old, improperly constructed monitor wells. In addition, aquifer tests were conducted and water level measurements were made to determine geologic and hydrogeologic conditions at the MMRF. New monitor wells were installed on-site to enhance delineation of the direction of ground-water movement and hydraulic relationships among the aquifer systems.

The waste constituents detected in the study areas and ground-water systems at the MMRF were consistent with the types of materials treated, stored, or disposed of at the

site. Table 1-3 presents a summary of the analytical data obtained for soil, sediment, waste, and surface-water samples above detection limits. EP toxicity analyses were also performed on samples obtained from the site. The results of these analyses are presented in Table 1-4. Table 1-5 presents the principal site-related chemicals detected in the ground-water systems at the MMRF.

1.1.4 Physical Characteristics of the Site

The following sections include general information on the physical characteristics of the MMRF site. This information contributes to the development of remedial alternatives in cases where a physical site feature may have an impact on the effectiveness or implementability of an alternative. The physical characteristics of interest at the MMRF consist of: (1) Climate; (2) Topography; (3) Surface water drainage; (4) Lithology/geology; and (5) Hydrogeology. Each of these characteristics will be discussed in the following sections.

1.1.4.1 Climate

The MMRF is located within the semi-arid, temperate region of eastern Oregon where the climate is characterized by warm, dry summers and cold, relatively wet winters. At The Dalles, Oregon the mean annual temperature is about 54°F. July is generally the warmest month with a mean maximum temperature of 86°F. The mean minimum temperature is 34°F in January.

TABLE 1-3

Summary of Analytical Results
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Study Area	Environmental Medium	Contaminant	Average[1] Concentration Detected	Maximum[1] Concentration Detected
Bath Recovery Pad	Soil	Total Cyanide	21.5	26
		Free Cyanide	14.5	17
		Fluoride	838.5	869
		Sodium	44100	51800
Cathode Wash Area	Soil	Total Cyanide	18.7	20
		Free Cyanide	9.8	15
		Fluoride	1099	1330
		Sodium	10073	16900
Discharge Channel	Water	Total Cyanide	3.3	6.5
		Free Cyanide	.04	0.06
		Fluoride	N/A	33
		Arsenic	BDL	BDL
		Sodium	N/A	632
		Sulfate	N/A	66
		VOCs[2]	BDL	BDL
		BASE/NEUTRALS		
		Acenaphthene	BDL	BDL
		Anthracene	BDL	BDL
		Benzo (a) Anthracene	BDL	BDL
		Benzo (a) Pyrene	BDL	BDL
		Benzo (b&k) Fluoranthenes	BDL	BDL
		Benzo (g,h,i) Perylene	BDL	BDL
		Bis (2-Ethylhexyl) Phthalate[3]	BDL	BDL
		Chrysene	BDL	BDL
		Dibenzo (a,h) Anthracene	BDL	BDL
		Fluoranthene	BDL	BDL
		Fluorene	BDL	BDL
		Indeno-1,2,3 (c,d) Pyrene	BDL	BDL
		Naphthalene	BDL	BDL
		Phenanthrene	BDL	BDL
		Pyrene	BDL	BDL
	Sediment	Free Cyanide	2.6	4.7
		Fluoride	781	1240
		Sodium	5104	8200
		VOCs[2]	BDL	BDL

Notes: (1) Soil, waste and sediment concentrations are in mg/kg. Surface water and leachate concentrations are in mg/L. BDL= Below Detection Limits, detection limits are provided in the RI.
(2) A priority pollutant VOC scan was included for samples obtained in the area. Only VOCs detected in the area are listed.
(3) Bis(2-ethylhexyl) phthalate is a plasticizer commonly found in plastic products and may not be representative of site contamination due to plant related releases.
N/A - Not applicable; only one sample collected.
VOCs = Volatile Organic Compounds.

084/12

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TABLE 1-3
(continued)

Summary of Analytical Results
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Study Area	Environmental Medium	Contaminant	Average[1] Concentration Detected	Maximum[1] Concentration Detected
Discharge Channel (Continued)	Sediment	BASE/NEUTRALS		
		Acenaphthene	BDL	BDL
		Anthracene	42	54
		Benzo (a) Anthracene	305	460
		Benzo (a) Pyrene	175	310
		Benzo (b&k) Fluoranthenes	424	640
		Benzo (g,h,i) Perylene	204	320
		Chrysene	422	610
		Dibenzo (a,h) Anthracene	86	120
		Fluoranthene	918	1540
		Indeno-1,2,3 (c,d) Pyrene	138	210
		Phenanthrene	112	200
		Pyrene	640	980
Drainage Ditch	Sediment	Free Cyanide	1.4	3.2
		Fluoride	451	926
		Sodium	7342	15400
Duck Pond	Water	Total Cyanide	.016	BDL
		Free Cyanide	.017	BDL
		Fluoride	12	13
		Arsenic	BDL	BDL
		Sodium	28	33
		Sulfate	43	43
		VOCs[2]	BDL	BDL
		BASE/NEUTRALS		
		Acenaphthene	BDL	BDL
		Anthracene	BDL	BDL
		Benzo (a) Anthracene	BDL	BDL
		Benzo (a) Pyrene	BDL	BDL
		Benzo (b&k) Fluoranthenes	BDL	BDL
		Benzo (g,h,i) Perylene	BDL	BDL
		Bis(2-Ethylhexyl) Phthalate[3]	BDL	BDL
		Chrysene	BDL	BDL
		Dibenzo (a,h) Anthracene	BDL	BDL
		Fluoranthene	BDL	BDL
		Fluorene	BDL	BDL
		Indeno-1,2,3 (c,d) Pyrene	BDL	BDL
		Naphthalene	BDL	BDL
		Phenanthrene	BDL	BDL
		Pyrene	BDL	BDL

Notes: (1) Soil, waste and sediment concentrations are in mg/kg. Surface water and leachate concentrations are in mg/L. BDL= Below Detection Limits, detection limits are provided in the RI.
(2) A priority pollutant VOC scan was included for samples obtained in the area. Only VOCs detected in the area are listed.
(3) Bis(2-ethylhexyl) phthalate is a plasticizer commonly found in plastic products and may not be representative of site contamination due to plant related releases.
VOCs = Volatile Organic Compounds.

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TABLE 1-3
(continued)

Summary of Analytical Results
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Study Area	Environmental Medium	Contaminant	Average[1] Concentration Detected	Maximum[1] Concentration Detected
Duck Pond (Continued)	Sediment	Free Cyanide	BDL	BDL
		Fluoride	230	644
		Sodium	729	1105
Landfill	Soil	Total Cyanide	17	70
		Free Cyanide	11	54
		Fluoride	1502	2880
		Sodium	58823	82200
		VOCs[2]	BDL	BDL
		BASE/NEUTRALS		
		Acenaphthene	13	28
		Anthracene	19	40
		Benzo (a) Anthracene	104	230
		Benzo (a) Pyrene	95	200
		Benzo (b&k) Fluoranthenes	195	440
		Benzo (g,h,i) Perylene	88	200
		Chrysene	103	210
		Dibenzo (a,h) Anthracene	36	83
		Fluoranthene	176	340
		Fluorene	10	16
		Indeno-1,2,3 (c,d) Pyrene	95	210
		Naphthalene	6	10
		Phenanthrene	109	180
		Pyrene	142	260
Landfill Ditch	Water	Total Cyanide	245	1280
		Free Cyanide	19	77.2
		Fluoride	4862	8000
		Arsenic	0.03	0.037
		Sodium	51351	79200
		Sulfate	12700	49300

Notes: (1) Soil, waste and sediment concentrations are in mg/kg. Surface water and leachate concentrations are in mg/L. BDL= Below Detection Limits, detection limits are provided in the RI.
(2) A priority pollutant VOC scan was included for samples obtained in the area. Only VOCs detected in the area are listed.
VOCs = Volatile Organic Compounds.

084/12

G&M Consulting Engineers, Inc.

TABLE 1-3
(continued)

Summary of Analytical Results
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Study Area	Environmental Medium	Contaminant	Average[1] Concentration Detected	Maximum[1] Concentration Detected
Landfill Ditch (Continued)	Water	VOCs[2]	BDL	BDL
		BASE/NEUTRALS		
		Acenaphthene	BDL	BDL
		Anthracene	BDL	BDL
		Benzo (a) Anthracene	BDL	0.025
		Benzo (a) Pyrene	BDL	BDL
		Benzo (b&k) Fluoranthenes	BDL	0.041
		Benzo (g,h,i) Perylene	BDL	BDL
		Bis(2-Ethylhexyl) Phthalate[3]	BDL	0.206
		Chrysene	BDL	0.025
		Dibenzo (a,h) Anthracene	BDL	BDL
		Fluoranthene	BDL	0.028
		Fluorene	BDL	BDL
		Indeno-1,2,3 (c,d) Pyrene	BDL	BDL
		Naphthalene	BDL	BDL
		Phenanthrene	BDL	BDL
		Pyrene	BDL	0.021
	Sediment	Free Cyanide	2.1	3.6
		Fluoride	197	204
		Sodium	2875	3030
Leachate Collection Ditch	Water	Total Cyanide	15.814	31
		Free Cyanide	1.558	4.7
		Fluoride	1940	2440
		Arsenic	0.265	0.455
		Sodium	5183	5900
		Sulfate	1880	2660

Notes: (1) Soil, waste and sediment concentrations are in mg/kg. Surface water and leachate concentrations are in mg/L. BDL= Below Detection Limits, detection limits are provided in the RI.
(2) A priority pollutant VOC scan was included for samples obtained in the area. Only VOCs detected in the area are listed.
(3) Bis(2-ethylhexyl) phthalate is a plasticizer commonly found in plastic products and may not be representative of site contamination due to plant related releases.
VOCs = Volatile Organic Compounds.

084/12

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TABLE 1-3
(continued)

Summary of Analytical Results
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Study Area	Environmental Medium	Contaminant	Average[1] Concentration Detected	Maximum[1] Concentration Detected
Leachate Collection Ditch (Continued)	Water	VOCs[2]		
		Trichloroethylene	0.002	0.008
		BASE/NEUTRALS		
		Acenaphthene	BDL	BDL
		Anthracene	BDL	BDL
		Benzo (a) Anthracene	BDL	BDL
		Benzo (a) Pyrene	BDL	BDL
		Benzo (b&k) Fluoranthenes	BDL	BDL
		Benzo (g,h,i) Perylene	BDL	BDL
		Bis(2-Ethylhexyl) Phthalate[3]	0.012	0.016
		Chrysene	BDL	BDL
		Dibenzo (a,h) Anthracene	BDL	BDL
		Fluoranthene	BDL	BDL
		Fluorene	BDL	BDL
		Indeno-1,2,3 (c,d) Pyrene	BDL	BDL
		Naphthalene	BDL	BDL
		Phenanthrene	BDL	BDL
		Pyrene	BDL	BDL
	Sediment	Gunite lined - sediment samples could not be obtained.		
Landfill Runoff Area A	Soil	Total Cyanide	N/A	10
		Free Cyanide	N/A	0.66
		Fluoride	N/A	2300
		Arsenic	N/A	BDL
		Sodium	N/A	10500
		Sulfate	N/A	510
Landfill Runoff Area B	Soil	Total Cyanide	N/A	7.4
		Free Cyanide	N/A	0.80
		Fluoride	N/A	1830
		Arsenic	N/A	BDL
		Sodium	N/A	12400
		Sulfate	N/A	3440

Notes: (1) Soil, waste and sediment concentrations are in mg/kg. Surface water and leachate concentrations are in mg/L. BDL= Below Detection Limits, detection limits are provided in the RI.
(2) A priority pollutant VOC scan was included for samples obtained in the area. Only VOCs detected in the area are listed.
(3) Bis(2-ethylhexyl) phthalate is a plasticizer commonly found in plastic products and may not be representative of site contamination due to plant related releases.
N/A - Not applicable; only one sample collected.
VOCs = Volatile Organic Compounds.

084/12

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TABLE 1-3
(continued)

Summary of Analytical Results
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Study Area	Environmental Medium	Contaminant	Average[1] Concentration Detected	Maximum[1] Concentration Detected
Landfill Runoff Area C	Soil	Total Cyanide	N/A	60
		Free Cyanide	N/A	5.0
		Fluoride	N/A	604
		Arsenic	N/A	19
		Sodium	N/A	12900
		Sulfate	N/A	3440
Landfill Runoff Area D	Soil	Total Cyanide	N/A	4
		Free Cyanide	N/A	0.5
		Fluoride	N/A	347
		Arsenic	N/A	BDL
		Sodium	N/A	5030
		Sulfate	N/A	BDL
Lined Pond	Water	Total Cyanide	BDL	BDL
		Free Cyanide	BDL	BDL
		Fluoride	16	31.5
		Arsenic	0.02	0.039
		Sodium	441	881
		Sulfate	1180	2360
		VOCs[2]		
		Chloroform	0.0004	0.005
		1,1,1-Trichloroethane	0.0005	0.006
	Water	BASE/NEUTRALS		
		Acenaphthene	BDL	BDL
		Anthracene	BDL	BDL
		Benzo (a) Anthracene	BDL	BDL
		Benzo (a) Pyrene	BDL	BDL
		Benzo (b&k) Fluoranthenes	BDL	BDL
		Benzo (g,h,i) Perylene	BDL	BDL
		Bis(2-Ethylhexyl) Phthalate[3]	BDL	BDL
		Chrysene	BDL	BDL
		Dibenzo (a,h) Anthracene	BDL	BDL
		Fluoranthene	BDL	BDL
		Fluorene	BDL	BDL
		Indeno-1,2,3 (c,d) Pyrene	BDL	BDL
		Naphthalene	BDL	BDL
		Phenanthrene	BDL	BDL
		Pyrene	BDL	BDL

Notes: (1) Soil, waste and sediment concentrations are in mg/kg. Surface water and leachate concentrations are in mg/L. BDL= Below Detection Limits, detection limits are provided in the RI.

(2) A priority pollutant VOC scan was included for samples obtained in the area. Only VOCs detected in the area are listed.

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TABLE 1-3
(continued)

Summary of Analytical Results
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Study Area	Environmental Medium	Contaminant	Average[1] Concentration Detected	Maximum[1] Concentration Detected
Lined Pond (Continued)	Sediment	Free Cyanide	N/A	BDL
		Fluoride	N/A	3730
		VOCs[2]	BDL	BDL
		BASE/NEUTRALS		
		Acenaphthene	N/A	BDL
		Anthracene	N/A	10
		Benzo (a) Anthracene	N/A	1030
		Benzo (a) Pyrene	N/A	500
		Benzo (b&k) Fluoranthenes	N/A	2120
		Benzo (g,h,i) Perylene	N/A	270
		Chrysene	N/A	1310
		Dibenzo (a,h) Anthracene	N/A	110
		Fluoranthene	N/A	1460
		Fluorene	N/A	BDL
		Indeno-1,2,3 (c,d) Pyrene	N/A	290
		Naphthalene	N/A	BDL
		Phenanthrene	N/A	19
		Pyrene	N/A	640
Metal Pad Storage Area	Soil	Total Cyanide	0.88	2.3
		Free Cyanide	BDL	BDL
		Fluoride	697	856
		Sodium	24825	50000
North Ditch	Water	Total Cyanide	0.14	0.39
		Free Cyanide	BDL	BDL
		Fluoride	5.8	3.8
		Arsenic	BDL	0.037
		Sodium	58	88
		Sulfate	35	37

Notes: (1) Soil, waste and sediment concentrations are in mg/kg. Surface water and leachate concentrations are in mg/L. BDL= Below Detection Limits, detection limits are provided in the RI.
(2) A priority pollutant VOC scan was included for samples obtained in the area. Only VOCs detected in the area are listed.
N/A - Not applicable; only one sample collected.
VOCs = Volatile Organic Compounds.

84/12

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TABLE 1-3
(continued)

Summary of Analytical Results
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Study Area	Environmental Medium	Contaminant	Average[1] Concentration Detected	Maximum[1] Concentration Detected
North Ditch (Continued)	Water	VOCs[2]	BDL	BDL
		BASE/NEUTRALS		
		Acenaphthene	BDL	BDL
		Anthracene	BDL	BDL
		Benzo (a) Anthracene	BDL	BDL
		Benzo (a) Pyrene	BDL	BDL
		Benzo (b&k) Fluoranthenes	BDL	BDL
		Benzo (g,h,i) Perylene	BDL	BDL
		Bis(2-Ethylhexyl) Phthalate[3]	BDL	BDL
		Chrysene	BDL	BDL
		Dibenzo (a,h) Anthracene	BDL	BDL
		Fluoranthene	BDL	BDL
		Fluorene	BDL	BDL
		Indeno-1,2,3 (c,d) Pyrene	BDL	BDL
		Naphthalene	BDL	BDL
		Phenanthrene	BDL	BDL
		Pyrene	BDL	BDL
	Sediment	Free Cyanide	1.3	BDL
		Fluoride	119	172
		Sodium	5257	10400
Old Cathode Waste Pile	Soil	Total Cyanide	25	29
		Free Cyanide	N/A	23
		Fluoride	N/A	475
		Sodium	6950	10900
	Water	Total Cyanide	N/A	294
		Free Cyanide	N/A	3.01
		Fluoride	N/A	3000
		Sodium	N/A	10500

Notes: (1) Soil, waste and sediment concentrations are in mg/kg. Surface water and leachate concentrations are in mg/L. BDL= Below Detection Limits, detection limits are provided in the RI.
(2) A priority pollutant VOC scan was included for samples obtained in the area. Only VOCs detected in the area are listed.
(3) Bis(2-ethylhexyl) phthalate is a plasticizer commonly found in plastic products and may not be representative of site contamination due to plant related releases.
N/A - Not applicable; only one sample collected.
VOCs = Volatile Organic Compounds.

84/12

G&M Consulting Engineers, Inc.

TABLE 1-3
(continued)

Summary of Analytical Results
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Study Area	Environmental Medium	Contaminant	Average[1] Concentration Detected	Maximum[1] Concentration Detected
Old Cathode Waste Pile (Continued)		VOCs[2]	BDL	BDL
		BASE/NEUTRALS		
		Acenaphthene	BDL	BDL
		Anthracene	BDL	BDL
		Benzo (a) Anthracene	N/A	0.024
		Benzo (a) Pyrene	BDL	BDL
		Benzo (b&k) Fluoranthenes	0.048	0.048
		Benzo (g,h,i) Perylene	BDL	BDL
		Bis(2-Ethylhexyl) Phthalate[3]	BDL	BDL
		Chrysene	N/A	0.038
		Dibenzo (a,h) Anthracene	BDL	BDL
		Fluoranthene	N/A	0.050
		Fluorene	BDL	BDL
		Indeno-1,2,3 (c,d) Pyrene	BDL	BDL
		Naphthalene	BDL	BDL
		Phenanthrene	N/A	0.029
		Pyrene	N/A	0.066
Potliner Handling Area	Soil	Total Cyanide	15	16
		Free Cyanide	4.4	4.8
		Fluoride	786	898
		Sodium	29100	29600
		BASE/NEUTRALS		
		Acenaphthene	103	114
		Benzo (a) Anthracene	905	989
		Benzo (a) Pyrene	682	778
		Benzo (b&k) Fluoranthenes	1650	1800
		Benzo (g,h,i) Perylene	583	700
		Chrysene	844	872
		Dibenzo (a,h) Anthracene	363	451
		Fluoranthene	1400	1600
		Indeno-1,2,3 (c,d) Pyrene	502	559
		Phenanthrene	625	696
		Pyrene	838	893

Notes: (1) Soil, waste and sediment concentrations are in mg/kg. Surface water and leachate concentrations are in mg/L. BDL= Below Detection Limits, detection limits are provided in the RI.
(2) A priority pollutant VOC scan was included for samples obtained in the area. Only VOCs detected in the area are listed.
(3) Bis(2-ethylhexyl) phthalate is a plasticizer commonly found in plastic products and may not be representative of site contamination due to plant related releases.
N/A - Not applicable; only one sample collected.
VOCs = Volatile Organic Compounds.

84/12

G&M Consulting Engineers, Inc.

TABLE 1-3
(continued)

Summary of Analytical Results
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Study Area	Environmental Medium	Contaminant	Average[1] Concentration Detected	Maximum[1] Concentration Detected
Recycle Pond	Water	Total Cyanide	N/A	BDL
		Free Cyanide	N/A	BDL
		Fluoride	N/A	BDL
		Arsenic	N/A	BDL
		Sodium	N/A	16
		Sulfate	N/A	BDL
		VOCs[2]	BDL	BDL
		BASE/NEUTRALS		
		Acenaphthene	BDL	BDL
		Anthracene	BDL	BDL
		Benzo (a) Anthracene	BDL	BDL
		Benzo (a) Pyrene	BDL	BDL
		Benzo (b&k) Fluoranthenes	BDL	BDL
		Benzo (g,h,i) Perylene	BDL	BDL
		Bis (2-Ethylhexyl) Phthalate[3]	BDL	BDL
		Chrysene	BDL	BDL
		Dibenzo (a,h) Anthracene	BDL	BDL
		Fluoranthene	BDL	BDL
		Fluorene	BDL	BDL
		Indeno-1,2,3 (c,d) Pyrene	BDL	BDL
		Naphthalene	BDL	BDL
		Phenanthrene	BDL	BDL
		Pyrene	BDL	BDL
	Sediment	Free Cyanide	BDL	BDL
		Fluoride	1114	1320
		Sodium	12450	14200
		VOCs[2]	BDL	BDL

Notes: (1) Soil, waste and sediment concentrations are in mg/kg. Surface water and leachate concentrations are in mg/L. BDL= Below Detection Limits, detection limits are provided in the RI.
(2) A priority pollutant VOC scan was included for samples obtained in the area. Only VOCs detected in the area are listed.
(3) Bis(2-ethylhexyl) phthalate is a plasticizer commonly found in plastic products and may not be representative of site contamination due to plant related releases.
N/A - Not applicable; only one sample collected.
VOCs = Volatile Organic Compounds.

84/12

G&M Consulting Engineers, Inc.

Table 1-3
(continued)

Summary of Analytical Results
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Study Area	Environmental Medium	Contaminant	Average[1] Concentration Detected	Maximum[1] Concentration Detected
Recycle Pond (Continued)	Sediment	BASE/NEUTRALS		
		Acenaphthene	BDL	BDL
		Anthracene	55	60.1
		Benzo (a) Anthracene	460	790
		Benzo (a) Pyrene	199	310
		Benzo (b&k) Fluoranthenes	574	920
		Benzo (g,h,i) Perylene	134	148
		Chrysene	699	1040
		Dibenzo (a,h) Anthracene	46	603
		Fluoranthene	1298	2410
		Fluorene	BDL	BDL
		Indeno-1,2,3 (c,d) Pyrene	149	174
		Naphthalene	BDL	BDL
		Phenanthrene	161	270
		Pyrene	892	1330
River Road Ditch	Soil	Free Cyanide	96	BDL
		Fluoride	N/A	232
		Sodium	N/A	3620
River Road Curb	Soil	Free Cyanide	N/A	BDL
		Fluoride	N/A	166
		Sodium	N/A	1480
Salvage Area	Soil	Total Cyanide	N/A	196
		Free Cyanide	45	86
		Fluoride	N/A	67.3
		Sodium	31602	54500
Scrubber Sludge Pond 1	Sediment	Free Cyanide	BDL	BDL
		Fluoride	297	407
		Arsenic	16	64
		Sodium	18850	20700
		VOCs[2]	BDL	BDL

Notes: (1) Soil, waste and sediment concentrations are in mg/kg. Surface water and leachate concentrations are in mg/L. BDL= Below Detection Limits, detection limits are provided in the RI.
(2) A priority pollutant VOC scan was included for samples obtained in the area. Only VOCs detected in the area are listed.
N/A - Not applicable, only one sample collected.
VOCs = Volatile Organic Compounds.

084/12

G&M Consulting Engineers, Inc.

Table 1-3
(continued)

Summary of Analytical Results
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Study Area	Environmental Medium	Contaminant	Average[1] Concentration Detected	Maximum[1] Concentration Detected
Scrubber Sludge Pond 1 (Continued)	Sediment	BASE/NEUTRALS		
		Acenaphthene	BDL	BDL
		Anthracene	BDL	BDL
		Benzo (a) Anthracene	312	530
		Benzo (a) Pyrene	252	360
		Benzo (b&k) Fluoranthenes	765	1310
		Benzo (g,h,i) Perylene	178	380
		Chrysene	755	1230
		Dibenzo (a,h) Anthracene	BDL	BDL
		Fluoranthene	1187	2310
		Indeno-1,2,3 (c,d) Pyrene	160	320
		Phenanthrene	80	140
		Pyrene	922	2000
Scrubber Sludge Pond 2	Sediment	Free Cyanide	BDL	BDL
		Fluoride	290	317
		Arsenic	53	71
		Sodium	16100	17700
		VOCs[2]	BDL	BDL
		BASE/NEUTRALS		
		Acenaphthene	BDL	BDL
		Anthracene	BDL	BDL
		Benzo (a) Anthracene	230	340
		Benzo (a) Pyrene	245	330
		Benzo (b&k) Fluoranthenes	895	1430
		Benzo (g,h,i) Perylene	260	470
		Chrysene	800	1240
		Dibenzo (a,h) Anthracene	BDL	BDL
		Fluoranthene	1170	1780
		Indeno-1,2,3 (c,d) Pyrene	210	370
		Phenanthrene	81	100
		Pyrene	750	1220

Notes: (1) Soil, waste and sediment concentrations are in mg/kg. Surface water and leachate concentrations are in mg/L. BDL= Below Detection Limits, detection limits are provided in the RI.
(2) A priority pollutant VOC scan was included for samples obtained in the area. Only VOCs detected in the area are listed.
VOCs = Volatile Organic Compounds.

084/12

G&M Consulting Engineers, Inc.

Table 1-3
(continued)

Summary of Analytical Results
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Study Area	Environmental Medium	Contaminant	Average[1] Concentration Detected	Maximum[1] Concentration Detected
Scrubber Sludge Pond 3	Sediment	Free Cyanide	BDL	BDL
		Fluoride	500	613
		Arsenic	71	77
		Sodium	31700	45000
		VOCs[2]	BDL	BDL
		BASE/NEUTRALS		
		Acenaphthene	BDL	BDL
		Anthracene	BDL	BDL
		Benzo (a) Anthracene	365	430
		Benzo (a) Pyrene	305	430
		Benzo (b&k) Fluoranthenes	940	1090
		Benzo (g,h,i) Perylene	255	260
		Chrysene	925	1020
		Dibenzo (a,h) Anthracene	BDL	BDL
		Fluoranthene	1610	2590
		Indeno-1,2,3 (c,d) Pyrene	220	260
		Phenanthrene	570	880
		Pyrene	965	1400
Scrubber Sludge Pond 4	Sediment	Free Cyanide	BDL	BDL
		Fluoride	235	258
		Arsenic	25	50
		Sodium	9925	13600
		VOCs[2]	BDL	BDL
		BASE/NEUTRALS		
		Acenaphthene	BDL	BDL
		Anthracene	BDL	BDL
		Benzo (a) Anthracene	171	280
		Benzo (a) Pyrene	160	160
		Benzo (b&k) Fluoranthenes	685	700
		Benzo (g,h,i) Perylene	267	290
		Chrysene	607	625
		Dibenzo (a,h) Anthracene	BDL	BDL
		Fluoranthene	790	1130
		Indeno-1,2,3 (c,d) Pyrene	173	220
		Phenanthrene	BDL	BDL
		Pyrene	565	870

Notes: (1) Soil, waste and sediment concentrations are in mg/kg. Surface water and leachate concentrations are in mg/L. BDL=Below Detection Limits, detection limits are provided in the RI.

(2) A priority pollutant VOC scan was included for samples obtained in the area. Only VOCs detected in the area are listed.

VOCs = Volatile Organic Compounds.

084/12

G&M Consulting Engineers, Inc.

Table 1-3
(continued)

Summary of Analytical Results
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Study Area	Environmental Medium	Contaminant	Average[1] Concentration Detected	Maximum[1] Concentration Detected
Surface Drainage Ditch	Sediment	Free Cyanide	N/A	BDL
		Fluoride	N/A	519
		Sodium	N/A	5600
		VOCs[2]	N/A	BDL
		BASE/NEUTRALS		
		Acenaphthene	BDL	BDL
		Anthracene	BDL	BDL
		Benzo (a) Anthracene	2.2	5.0
		Benzo (a) Pyrene	2.1	4.66
		Benzo (b&k) Fluoranthenes	1.9	0.54
		Benzo (g,h,i) Perylene	2.6	6.36
		Chrysene	3.0	8.26
		Dibenzo (a,h) Anthracene	1.8	3.17
		Fluoranthene	2.9	7.89
		Indeno-1,2,3 (c,d) Pyrene	2.8	7.29
		Phenanthrene	1.4	2.02
		Pyrene	3.2	9.16

Notes: (1) Soil, waste and sediment concentrations are in mg/kg. Surface water and leachate concentrations are in mg/L. BDL=Below Detection Limits, detection limits are provided in the RI.
(2) A priority pollutant VOC scan was included for samples obtained in the area. Only VOCs detected in the area are listed.
N/A - Not applicable, only one sample collected.
VOCs = Volatile Organic Compounds.

084/12

G&M Consulting Engineers, Inc.

Table 1-4
Summary of EP Toxicity Metals Analyses
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Study Area	Media	Contaminant	Average (1) Concentration Detected	Maximum (1) Concentration Detected
Discharge Channel	Water	Arsenic	BDL	BDL
		Barium	BDL	BDL
		Cadmium	BDL	BDL
		Chromium	BDL	BDL
		Lead	BDL	BDL
		Mercury	BDL	BDL
		Selenium	BDL	BDL
		Silver	BDL	BDL
	Sediment	Arsenic	BDL	BDL
		Barium	0.206	0.23
		Cadmium	BDL	BDL
		Chromium	BDL	BDL
		Lead	BDL	BDL
		Mercury	0.00034	0.0004
		Selenium	BDL	BDL
		Silver	BDL	BDL
Duck Pond	Water	Arsenic	BDL	BDL
		Barium	BDL	BDL
		Cadmium	BDL	BDL
		Chromium	BDL	BDL
		Lead	BDL	BDL
		Mercury	0.00052	0.00093
		Selenium	BDL	BDL
		Silver	BDL	BDL
Landfill	Soil	Arsenic	BDL	BDL
		Barium	0.207	0.234
		Cadmium	BDL	BDL
		Chromium	BDL	BDL
		Lead	BDL	BDL
		Mercury	BDL	BDL
		Selenium	BDL	BDL
		Silver	BDL	BDL
Landfill Ditch	Water	Arsenic	BDL	BDL
		Barium	BDL	BDL
		Cadmium	BDL	BDL
		Chromium	BDL	BDL
		Lead	BDL	BDL
		Mercury	0.00019	0.00038
		Selenium	BDL	BDL
		Silver	BDL	BDL

Notes: (1) Soil, waste and sediment concentrations are in mg/kg. Surface water and leachate concentrations are in mg/L.
BDL = Below Detection Limits, detection limits are provided in the RI.

091/13

G&M Consulting Engineers, Inc.

Table 1-4 (Continued)
Summary of EP Toxicity Metals Analyses
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Study Area	Media	Contaminant	Average (1) Concentration Detected	Maximum (1) Concentration Detected
Landfill Ditch (continued)	Sediment	Arsenic	BDL	BDL
		Barium	0.313	0.361
		Cadmium	BDL	BDL
		Chromium	BDL	BDL
		Lead	BDL	BDL
		Mercury	BDL	BDL
		Selenium	BDL	BDL
		Silver	BDL	BDL
Leachate Collection Ditch	Water	Arsenic	0.341	0.390
		Barium	BDL	BDL
		Cadmium	BDL	BDL
		Chromium	0.102	0.161
		Lead	BDL	BDL
		Mercury	0.00050	0.00069
		Selenium	BDL	BDL
		Silver	BDL	BDL
Landfill Runoff Area A	Soil	Arsenic	N/A	BDL
		Barium	N/A	BDL
		Cadmium	N/A	BDL
		Chromium	N/A	BDL
		Lead	N/A	BDL
		Mercury	N/A	BDL
		Selenium	N/A	BDL
		Silver	N/A	BDL
Landfill Runoff Area B	Soil	Arsenic	N/A	BDL
		Barium	N/A	BDL
		Cadmium	N/A	BDL
		Chromium	N/A	BDL
		Lead	N/A	BDL
		Mercury	N/A	BDL
		Selenium	N/A	BDL
		Silver	N/A	BDL

Notes: (1) Soil, waste and sediment concentrations are in mg/kg. Surface water and leachate concentrations are in mg/L.
BDL = Below Detection Limits, detection limits are provided in the RI.
N/A = Not applicable, only one sample analyzed.

091/13

G&M Consulting Engineers, Inc.

Table 1-4 (Continued)
Summary of EP Toxicity Metals Analyses
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Study Area	Media	Contaminant	Average (1) Concentration Detected	Maximum (1) Concentration Detected
Landfill Runoff Area C	Soil	Arsenic	N/A	BDL
		Barium	N/A	0.314
		Cadmium	N/A	BDL
		Chromium	N/A	BDL
		Lead	N/A	BDL
		Mercury	N/A	BDL
		Selenium	N/A	BDL
		Silver	N/A	BDL
Landfill Runoff Area D	Soil	Arsenic	N/A	BDL
		Barium	N/A	BDL
		Cadmium	N/A	BDL
		Chromium	N/A	BDL
		Lead	N/A	BDL
		Mercury	N/A	BDL
		Selenium	N/A	BDL
		Silver	N/A	BDL
Lined Pond	Water	Arsenic	0.092	0.275
		Barium	BDL	BDL
		Cadmium	0.027	0.081
		Chromium	BDL	BDL
		Lead	BDL	BDL
		Mercury	BDL	BDL
		Selenium	BDL	BDL
		Silver	BDL	BDL

Notes: (1) Soil, waste and sediment concentrations are in mg/kg. Surface water and leachate concentrations are in mg/L.
BDL = Below Detection Limits, detection limits are provided in the RI.
N/A = Not applicable, only one sample analyzed.

091/13

G&M Consulting Engineers, Inc.

Table 1-4 (Continued)
Summary of EP Toxicity Metals Analyses
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Study Area	Media	Contaminant	Average (1) Concentration Detected	Maximum (1) Concentration Detected
Lined Pond	Sediment	Arsenic	N/A	0.275
		Barium	N/A	BDL
		Cadmium	N/A	0.081
		Chromium	N/A	BDL
		Lead	N/A	BDL
		Mercury	N/A	BDL
		Selenium	N/A	BDL
		Silver	N/A	BDL
North Ditch	Water	Arsenic	BDL	BDL
		Barium	BDL	BDL
		Cadmium	BDL	BDL
		Chromium	BDL	BDL
		Lead	BDL	BDL
		Mercury	.00085	0.0024
		Selenium	BDL	BDL
		Silver	BDL	BDL
	Sediment	Arsenic	BDL	BDL
		Barium	0.296	0.275
		Cadmium	BDL	BDL
		Chromium	BDL	BDL
		Lead	BDL	BDL
		Mercury	BDL	BDL
		Selenium	BDL	BDL
		Silver	BDL	BDL
Recycle Pond	Water	Arsenic	N/A	BDL
		Barium	N/A	BDL
		Cadmium	N/A	BDL
		Chromium	N/A	BDL
		Lead	N/A	BDL
		Mercury	N/A	BDL
		Selenium	N/A	BDL
		Silver	N/A	BDL

Notes: (1) Soil, waste and sediment concentrations are in mg/kg. Surface water and leachate concentrations are in mg/L.
BDL = Below Detection Limits, detection limits are provided in the RI.
N/A = Not applicable, only one sample analyzed.

091/13

G&M Consulting Engineers, Inc.

Table 1-4 (Continued)
Summary of EP Toxicity Metals Analyses
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Study Area	Media	Contaminant	Average (1) Concentration Detected	Maximum (1) Concentration Detected
Recycle Pond (continued)	Sediment	Arsenic	BDL	BDL
		Barium	BDL	BDL
		Cadmium	BDL	BDL
		Chromium	BDL	BDL
		Lead	BDL	BDL
		Mercury	BDL	BDL
		Selenium	BDL	BDL
		Silver	BDL	BDL
Surface Drainage Ditch	Sediment	Arsenic	N/A	BDL
		Barium	N/A	BDL
		Cadmium	N/A	BDL
		Chromium	N/A	BDL
		Lead	N/A	BDL
		Mercury	N/A	BDL
		Selenium	N/A	BDL
		Silver	N/A	BDL

Notes: (1) Soil, waste and sediment concentrations are in mg/kg. Surface water and leachate concentrations are in mg/L.
BDL = Below Detection Limits, detection limits are provided in the RI.
N/A = Not applicable, only one sample analyzed.

091/13

TABLE 1-5

Principal Site Related Chemicals Detected in Ground Water
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Well No.	Date	Free Cyanide (mg/L)	Total Cyanide (mg/L)	Total Sodium (mg/L)	Fluoride (mg/L)	Sulfate (mg/L)
			S - Aquifer System			
MW-2S	08/04/87	<0.01	<0.01	10.5	<1.0	33
MW-3S	08/09/87	<0.01	<0.01	28.3	<1.0	<5.0
MW-4S	08/28/86	<0.01	0.049	15	0.83	98
MW-4S	08/02/87	<0.01	0.024	12.9	<1.0	25J
MW-5S	08/09/87	0.215	34.10	1270	57	680
MW-5A	08/28/86	<0.01	<0.01	17	0.51	37
MW-5A	08/07/87	<0.01	0.041	17.1	<1.0	59
MW-8S	08/03/87	0.136	7.07	57.2	<1.0	103
MW-9S	08/04/87	0.060	16.7	82.2	1.9	41
MW-10A	08/28/86	<0.01	<0.01	24	0.58	22
MW-10A	08/06/87	<0.01	0.020	26.8	<1.0	21
MW-15S	08/26/86	0.049	0.67	59	7.4	136
MW-15S	08/03/87	0.095	0.312	59.7	4.7	74
MW-16A	08/28/86	<0.01	0.033	43	1.2	22
MW-16A	08/11/87	0.012	0.040J	41.2	<1.0	25
MW-17S	08/26/86	0.024	0.78	22	1.3	143
MW-17S	07/30/87	0.027	0.549	31.4	<1.0	1130J
MW-18S	08/28/86	<0.01	0.05	16	12	617
MW-18S	08/08/87	<0.01	0.05	374	7.1	1810
MW-19S	08/26/86	<0.01	<0.01	184	8.9	573
MW-19S	07/30/87	<0.01	<0.01	246	4.8	117J
MW-20S	08/26/86	<0.01	<0.01	39	0.98	37
MW-20S	07/30/87	<0.01	<0.01UJ	49.9	<1.0	66J
MW-21S	08/27/86	<0.01	<0.01	45	12	74
MW-21S	08/05/87	<0.01	0.014	90.5	5.5	871

Notes: J = value estimated because procedure did not meet QC criteria
U = value estimated because procedure did not meet QC criteria and analytical result was below the detection limit

TABLE 1-5
(continued)

Principal Site Related Chemicals Detected in Ground Water
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Well No.	Date	Free Cyanide (mg/L)	Total Cyanide (mg/L)	Total Sodium (mg/L)	Fluoride (mg/L)	Sulfate (mg/L)
		S - Aquifer System (continued)				
MW-22S	08/02/87	0.012	0.112	32.0	<1.0	46J
MW-23S	07/31/87	0.015	0.18J	18.8	<1.0	16J
MW-24S	08/03/87	<0.01	<0.01	3.93	<1.0	10
MW-25S	08/08/87	<0.01	<0.01	11.3	<1.0	33
MW-26S	07/31/87	<0.01	<0.01UJ	32.3	<1.0	22J
MW-26A	08/10/87	0.025	0.312J	61.2	<1.0	75
MW-27S	08/03/87	0.077	0.795	15.7	<1.0	32
MW-28S	08/07/87	<0.01	<0.01	82.6	<1.0	123
MW-29S	08/08/87	<0.01	<0.01	658.0	<1.0	3020
MW-30S	08/24/87	<0.01	<0.01	84.8	<1.0	924
MW-32S	08/24/87	0.052	1.02	24.5	2.5	45
		A - Aquifer System				
MW-1A	08/29/86	<0.01	<0.01	49	0.93	48
MWR-1A	08/16/87	<0.01	<0.01J	56.4	<1.0	36
MW-2A	08/29/86	<0.01	0.13	23	0.65	20
MWR-2A	08/15/87	0.038	0.608J	31.7	<1.0	91
MW-3A	08/27/86	<0.01	<0.01	24	0.97	30
MWR-3A	08/09/87	<0.01	0.016	23.0	<1.0	38
MW-4A	08/28/86	<0.01	0.059	15	0.86	135
MWR-4A	08/09/87	<0.01	0.213	29.1	<1.0	64

Notes: J = value estimated because procedure did not meet QC criteria
U = value estimated because procedure did not meet QC criteria and analytical result was below the detection limit

TABLE 1-5
(continued)

Principal Site Related Chemicals Detected in Ground Water
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Well No.	Date	Free Cyanide (mg/L)	Total Cyanide (mg/L)	Total Sodium (mg/L)	Fluoride (mg/L)	Sulfate (mg/L)
		A - Aquifer System (continued)				
MW-6A	09/03/86	0.23	0.38	23	1.1	9.1
MW-6AA	09/01/86	0.036	0.32	24	0.97	8.3
MW-6AA	08/12/87	0.062	0.557	34.9	1.0	22
MW-7A	08/28/86	0.086	0.46	19	1.2	18
MWR-7A	08/05/87	0.099	0.803	29.0	<1.0	28
MW-8A	09/03/86	0.48	1.1	38	1.0	44
MWR-8A	07/28/87	0.030J	1.78	42.7	<1.0°	76
MW-9A	09/03/86	0.053	1.8	42	11.4	40
MWR-9A	08/04/87	0.132	12.6	167	10	100
MW-12A	08/27/86	0.013	0.084	25	0.90	13
MW-12A	07/28/87	<0.01	0.096J	29.5	<1.0	<5.0
MW-13A	08/27/86	<0.01	0.13	20	0.85	20
MW-13A	07/29/87	0.037	0.241	20.9	<1.0	21J
MW-14A	08/26/86	<0.01	0.026	29	1.3	14
MW-14A	07/29/87	<0.01	0.023	31.8	1.0	77
MW-15A	08/26/86	0.049	2.4	33	1.1	52
MW-15A	08/11/87	0.052	0.270	37.0	<1.0	44
MW-18A	08/29/87	<0.01	<0.01J	46.7	<1.0	81
MW-20A	08/27/86	<0.01	<0.01	34	1.0	35
MW-20A	08/05/87	<0.01	<0.01	38.4	<1.0	27
MW-24A	08/12/87	<0.01	<0.01	44.7	1.0	23
MW-27A	08/10/87	0.016	0.200J	28.1	1.0	29
MW-31S	08/27/87	<0.01	0.041	58.5	1.0	153

Notes: J = value estimated because procedure did not meet QC criteria
U = value estimated because procedure did not meet QC criteria and analytical result was below the detection limit

TABLE 1-5
(continued)

Principal Site Related Chemicals Detected in Ground Water
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Well No.	Date	Free Cyanide (mg/L)	Total Cyanide (mg/L)	Total Sodium (mg/L)	Fluoride (mg/L)	Sulfate (mg/L)
		A - Aquifer System (continued)				
MW-33A	08/24/87	0.085	1.50	43.2	<1.0	71
MW-34A	08/27/87	<0.01	<0.01	61.4	<1.0	27
		B - Aquifer System				
MW-1B	08/28/86	<0.01	<0.01	30	1.3	22
MWR-1B	08/17/87	<0.01	<0.01	41.1	<1.0	17
MW-2B	08/28/86	0.093	0.57	35	0.9	80
MWR-2B	08/16/87	0.034	1.180J	48.3	<1.0	100
MW-3B	08/28/86	<0.01	0.026	26	1.3	24
MWR-3B	08/13/87	<0.01	0.024J	31.3	<1.0	22
MW-4B	08/13/87	<0.01	<0.01J	33.9	<1.0	54
MW-6B	09/03/86	0.47	1.2	26	0.93	83
MWR-6B	07/28/87	0.051	1.12J	25.1	<1.0	73
MW-7B	09/01/86	0.042	0.77	22	0.71	78
MWR-7B	08/16/87	0.035	0.953J	27.7	<1.0	99
MW-8B	09/03/86	0.19	0.48	25	1.8	67
MWR-8B	07/27/87	0.062J	1.22	43.7	2.9	61
MW-9B	09/04/86	0.54	1.0	32	1.4	50
MWR-9B	08/15/87	0.057	10.00J	195.0	20	92
MW-12B	08/27/86	0.01	0.08	16	0.65	22
MW-12B	07/29/87	0.02	0.099J	17.4	<1.0	9.4
MW-13B	08/27/86	0.025	0.15	13	0.82	24
MW-13B	07/29/87	0.022	0.138	14.8	<1.0	20J
MW-14B	08/26/86	0.058	0.30	24	0.86	73
MW-14B	07/29/87	0.041	0.641	24.8	<1.0	72J

Notes: J = value estimated because procedure did not meet QC criteria
U = value estimated because procedure did not meet QC criteria and analytical result was below the detection limit

TABLE 1-5
(continued)

Principal Site Related Chemicals Detected in Ground Water
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Well No.	Date	Free Cyanide (mg/L)	Total Cyanide (mg/L)	Total Sodium (mg/L)	Fluoride (mg/L)	Sulfate (mg/L)
			B - Aquifer System (continued)			
MW-15B	08/26/86	0.052	1.5	22	1.1	97
MW-15B	08/11/87	0.095	0.802	23.8	<1.0	88
MW-16B	08/28/86	0.030	1.1	34	4.2	31
MW-16B	08/23/87	0.015	0.260	25.1	1.4	21
MW-18B	08/17/87	<0.01	<0.01J	67.0	<1.0	271
MW-26B	08/20/87	0.047	1.28	32.5	<1.0	83
MW-27B	08/26/87	0.033	0.716	27.0	<1.0	34
MW-33B	08/24/87	0.10	0.955	21.7	<1.0	145
MW-34B	08/25/87	<0.01	0.013	37.2	<1.0	12
			The Dalles Ground Water Reservoir			
MW-11D	08/28/86	<0.01	<0.01	17	0.77	24
MW-11D	08/09/87	<0.01	<0.01UJ	16.4	<1.0	22
MW-16D	08/27/86	<0.01	<0.01	17	0.68	24
MW-16D	08/11/87	<0.01	<0.01UJ	17.9	<1.0	21
			Production Wells			
PW-1	09/02/86	<0.01	<0.01	29	1.2	34
PW-1	08/11/87	<0.01	<0.01UJ	29.3	<1.0	29
PW-3	09/01/86	<0.01	<0.01	33	1.1	29
PW-3	08/11/87	<0.01	<0.01UJ	38.9	<1.0	20
PW-4	09/02/86	<0.01	0.01	23	0.72	21
PW-4	08/11/87	<0.01	<0.01UJ	23.8	<1.0	16

Notes: J = value estimated because procedure did not meet QC criteria
U = value estimated because procedure did not meet QC criteria and analytical result was below the detection limit

TABLE 1-5
(continued)

Principal Site Related Chemicals Detected in Ground Water
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Well No.	Date	Free Cyanide (mg/L)	Total Cyanide (mg/L)	Total Sodium (mg/L)	Fluoride (mg/L)	Sulfate (mg/L)
			Potable Wells			
Animal Shelter	09/03/86	<0.01	0.036	7.4	0.38	26
	08/11/87	<0.01	0.023	6.23	<1.0	15
Chenoweth No. 1	09/04/86	<0.01	<0.01	43	1.1	42
	08/13/87	<0.01	<0.01	47.4	<1.0	40
Chenoweth No. 3	09/04/86	<0.01	<0.01	39	1.0	32
	08/13/87	<0.01	<0.01	44.8	1.0	30
Klindt	09/02/86	0.013	0.46	10	0.63	49.5
	08/11/87	0.037	0.177	14.0	<1.0	55
Mt. Fir Lumber	09/02/86	<0.01	0.013	19	1.1	194
	08/11/87	<0.01	<0.01	20.5	<1.0	125
Recreation Well	08/29/86	<0.01	<0.01	36	1.3	22
	08/06/87	<0.01	0.01	40.0	<1.0	33
Rockline	09/03/86	<0.01	0.29	35	2.8	121
	08/11/87	0.023	0.336	4.16	2.2	105
Residence Well	08/19/87	<0.01	0.055	95.1	6.6	429
			Quality During Pump Test			
8B Pump Test Start	08/27/87	0.057	0.608	28.5	<1.0	60
8B Pump Test Middle	08/29/87	0.026	0.402	18.5	<1.0	41
8B Pump Test End	08/30/87	0.038	0.457	18.9	<1.0	38

Notes: J = value estimated because procedure did not meet QC criteria
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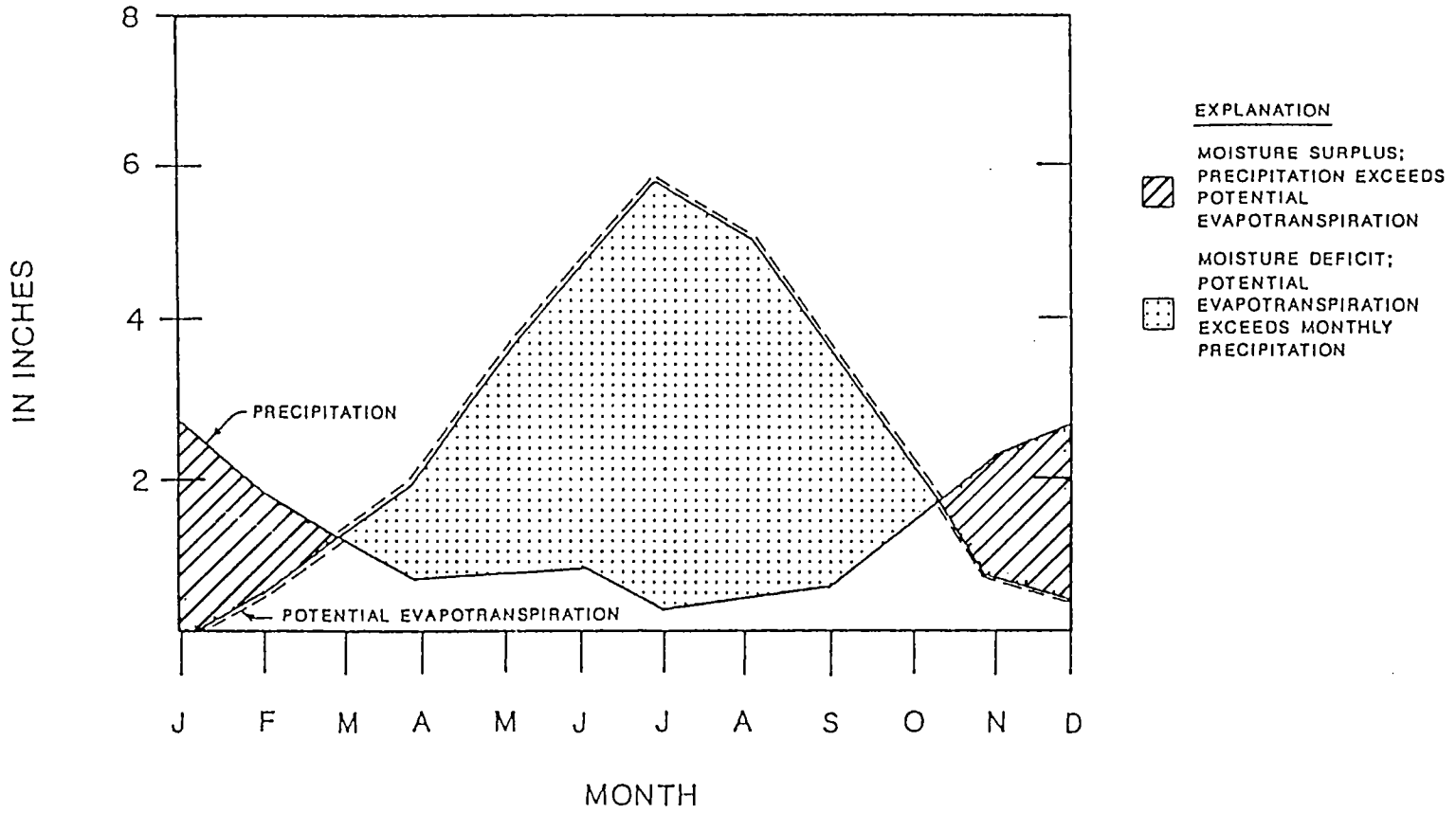
The area receives from ten to fifteen inches of precipitation annually with a mean annual precipitation at the city of The Dalles of 13.7 inches. Average annual evaporation from shallow lakes in the area is approximately 40 inches. Average monthly precipitation and estimated potential evapotranspiration for The Dalles station are documented in Figure 1-3. Months in which precipitation exceeds potential evapotranspiration are moisture surplus months and months in which evaporation exceeds precipitation are moisture deficient months. Totaling the monthly values from records for The Dalles region indicates that a cumulative moisture deficit of about 15 inches per year occurs. This moisture deficit can aid remedial technologies which employ evaporative or enhanced volatilization methods as a means of treatment for such study areas as the Lined Pond, Scrubber Sludge Ponds, Recycle Pond and leachate, perched water or ground water.

Wind velocity measurements were obtained from an on-site meteorological station during the months of June through December 1987. Typical wind speeds ranged from 5 to 20 mph with the highest wind speeds associated with winds blowing out of the northwest. Gusts of 30 mph were common during the RI measurement period with a maximum wind speed of 60 mph recorded. A wind rose for the MMRF site utilizing wind data from June through December, 1987 is presented in Figure 1-4. Review of Figure 1-4 indicates that the predominant wind



SOURCE: GERAGHTY & MILLER, INC., "REMEDIAL INVESTIGATION, MARTIN MARIETTA REDUCTION FACILITY".

FIGURE 1-3

MONTHLY PRECIPITATION AND ESTIMATED EVAPOTRANSPIRATION

FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

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DRAWN BY: SKF.	DATE: 2/4/88
CHECKED: RC	DATE: 3/14/88
APPROVED:	DATE: 3/31/88

BAY REPROGRAPHICS 300852

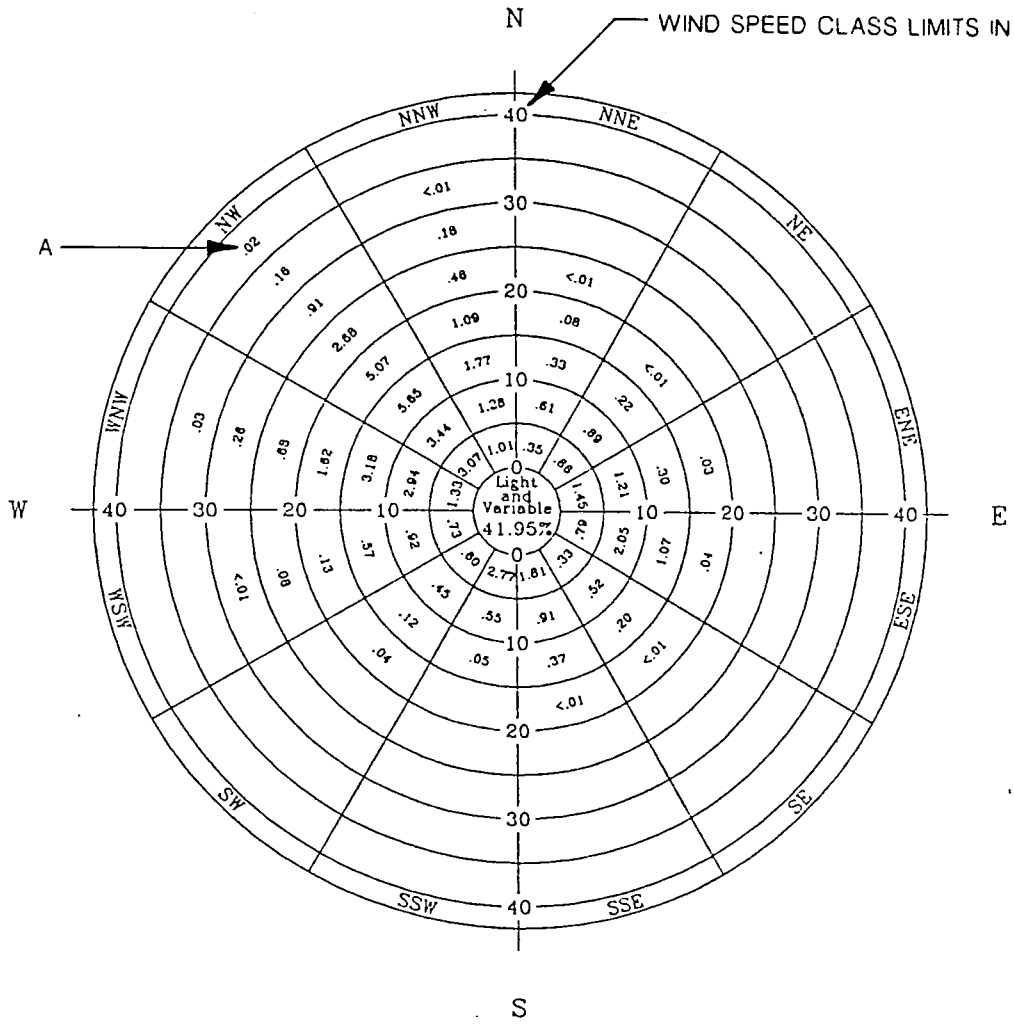
direction at the site is from the northwest. Depending on wind velocities and directions, use of dust suppressants may be required to manage fugitive dust emissions.

1.1.4.2 Topograghy

A topographic map of the MMRF is provided on Drawing A-1. The land surface elevations vary from approximately 100 feet above mean sea level (msl) at the Columbia River to more than 155 msl at the Landfill. The topography of the site has changed over time due to filling of low areas; in general, the site is level with the exception of distinct man-made and natural features. These features include: man-made ponds, the Landfill, drainage ditches, stream channels, and road beds.

1.1.4.3 Surface Water Drainage

The topography of the MMRF largely controls the direction of surface water flow except where man-made structures have been constructed to alter flow patterns. Drawing A-3 presents the site surface drainage patterns for the MMRF. Surface water flows are generally directed towards the Columbia River. The two major natural drainage features in or near the MMRF are Chenoweth Creek and a shallow ravine south of the reduction buildings in the area of the Scrubber Sludge Ponds.



NOTE:

A- PERCENTAGE OF TIME, BETWEEN JUNE 5, 1987 THROUGH DECEMBER 31, 1987, THAT WIND PREVAILED FROM GIVEN DIRECTION WITHIN SPECIFIC WIND SPEED CLASS

SOURCE: GERAGHTY & MILLER, INC., "REMEDIAL INVESTIGATION, MARTIN MARIETTA REDUCTION FACILITY"

FIGURE 1-4

DRAWING NO: TE0018-PO5-A87	
DRAWN BY: SKF.	DATE: 5/10/88
CHECKED: ALC	DATE: 6-7-88
APPROVED:	DATE: 6-7-88

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WIND ROSE FOR THE MMRF SITE

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Surface water runoff from the Landfill is currently intercepted by the leachate collection system and the Landfill Ditch. The leachate collected by the Landfill Ditch gravity drains to a sump and is then pumped to the Discharge Channel where it gravity drains to the Recycle Pond. Prior to the construction of this interception network, runoff from the Landfill followed three primary drainage pathways, all of which discharged northeast of the Landfill.

The ponds at the MMRF include the four Scrubber Sludge Ponds, Recycle Pond, Duck Pond, and Lined Pond. The Recycle Pond serves as a collection point for runoff from the Landfill, the Former Cathode Waste Management Areas, and areas to the immediate south and west of the plant. Waters collected by the Recycle Pond are recycled back to the secondary roof scrubbers in the reduction buildings. Excess flows are discharged to the Columbia River in accordance with a National Pollutant Discharge Elimination System (NPDES) permit. The Recycle Pond is currently in use.

The Lined Pond is used to manage air emission particulates from the aluminum production process. The particulates are kept saturated to prevent fugitive dust emissions. As the name implies, the Lined Pond is a lined unit constructed with a 45-millimeter scrim reinforced hypalon liner. Like the Recycle Pond, the Lined Pond is also currently in use.

The Duck Pond received non-contact cooling waters from cast house operations and a sump in the alumina unloading building. Flows to the Duck Pond were diverted in 1986 to the Discharge Channel, which flows to the Recycle Pond. The Scrubber Sludge Ponds are no longer in use but intersect the water table and are saturated in proportion to the relative ground-water elevation.

Surface-water runoff from the southwest part of the site flows to the south and east through a natural drainage channel prior to discharging to the Columbia River. Surface-water drainage from the non-active part of the MMRF (northwest of the Landfill) discharges to Chenoweth Creek.

1.1.4.4 Lithology/Geology

The soil and rock types at a waste management site influence choices on the remedial methods to be used at the site. Excavation depths would be limited by the basalt underlying the study areas at the MMRF. The presence of the basalt will preclude the construction of certain remedial measures.

The surface soils in The Dalles region are poorly developed and in most places are non-existent. Although found in limited amounts, four native soil groups are known to be present at the MMRF and in order of decreasing surface extent are the: (1) Rock Outcrop-Xeropsamments Complex; (2) Hesslan-Skyline Complex; (3) Van Horn Loam; and (4) Quincy

Loam Fine Sand. During construction and operation of the MMRF, a large portion of these native soils at the site have been covered with fill material.

Underlying these soils at the site is the Columbia River Basalt Group (CRBG). This formation consists of the following layers:

- Lolo flow of Priest Rapids Member;
- Sedimentary (Byron) Interbed;
- Rosalia flow of Priest Rapids Member;
- Sedimentary (Quincy/Squaw Creek) Interbed; and
- Sentinel Gap flow of Frenchman Springs Member.

The rock strata at the site are generally flat lying except in the north where the Chenoweth Fault transects the site. The CRBG is overlain by Pleistocene Age alluvial deposits in the northern parts of the site.

Ground-water systems at the site are found in the Lolo Flow, Byron Interbed, Rosalia flow and the Sentinel Gap. The Lolo Flow and Byron Interbed contain the S-aquifer, the Rosalia Flow contains the A- and B-aquifers, while The Dalles Ground Water Reservoir (DGWR) is located within the Sentinel Gap Flow.

1.1.4.5 Hydrogeology

Identification of the Aquifer Systems

The aquifer systems at the MMRF include a water table aquifer (S-aquifer) overlying a series of confined aquifers (A- and B-aquifers and the DGWR). Zones of perched water and an alluvial aquifer are also present locally.

The unconfined S-aquifer is present within the relatively low permeability basalts of the Lolo flow and the subaerial portion of the Rosalia flow and Byron Interbed. The first confined aquifer (A-aquifer) is within the upper pillow lava horizon of the subaqueous portion of the Rosalia Flow. The A-aquifer ranges from 5 to 45 feet in thickness. The B-aquifer is below the A-aquifer and is locally separated from it by low permeability basalt (lava lobe). The lava lobe is apparently absent north of the site due to non-deposition. The B-aquifer ranges from 30 to 45 feet in thickness. In areas where the lava lobe is absent, the A- and B-aquifers combine to form a single hydrogeologic unit. A thick, low-permeability siltstone and sandstone unit forms the confining unit between the B-aquifer and the underlying DGWR. The top of the DGWR occurs within the permeable zones of the Sentinel Gap flow, and the most permeable portion of the DGWR is within the flow-breccia top of the Sand Hollow flow.

Ground-water flow in the S-aquifer is generally to the east and northeast. The S-aquifer at the site potentially receives recharge from precipitation, perched water, the Recycle Pond and from the Discharge Channel; discharge from the S-aquifer is believed to be into the alluvial aquifer and the Columbia River. Ground-water flow in the A-aquifer is predominantly east to west. The A-aquifer is potentially recharged by the alluvial aquifer, the Columbia River, and the S-aquifer; discharge from the A-aquifer appears to be to the B-aquifer and regional water-supply wells. Ground-water flow in the B-aquifer is generally to the west and south; hydraulic gradients vary, however, depending on the hydrologic and pumping conditions. The B-aquifer is potentially recharged by the Columbia River, the A-aquifer and the DGWR; discharge for the B-aquifer may be to regional water supply wells, the DGWR or the A-aquifer. Ground-water movement in the DGWR was not determined as part of the RI. However, the DGWR is likely to be recharged by the Columbia River and seasonally by the B-aquifer; discharge for the DGWR is likely to regional water supply wells, lower aquifers or the B-aquifer (seasonally).

An alluvial aquifer, approximately 400 feet wide and at least 60 feet deep, is present in the area north of the plant within Pleistocene age sand deposits. The geometry of the alluvial aquifer is apparently controlled by the location of the trace of the Chenoweth fault. Flow in the alluvial

aquifer is expected to be east, toward the Columbia River. The alluvial aquifer potentially receives recharge from precipitation, the S-aquifer, perched water, runoff, and the Columbia River; discharge for the alluvial aquifer is likely to wells, the A- and B-aquifers and the Columbia River.

Perched water has been identified at the site beneath the Old Cathode Waste Pile Area, Salvage Area , Potliner Handling Area and an area just east of River Road adjacent to the Salvage Area. The perched water zone exists within the permeable fill material emplaced during plant construction. The saturated thickness of the perched zone varies depending upon the rate of natural recharge. In August 1987, test pits indicated that the saturated perched water zone was approximately zero to three feet thick. The primary source of the perched water is precipitation although other potential sources include infiltration from the Landfill Ditch, North Ditch and leaks in below grade water distribution lines or process sewers. Perched water potentially discharges to the S-aquifer, the alluvial aquifer, the Landfill Ditch, the Discharge Channel, and/or the hard pitch building sump.

1.1.5 Existing and Future Land and Ground-water Use

Land and water usage is an important factor in the development of remedial actions, as limiting the use of these resources is a potential means of site control. The MMRF, as

previously noted, is located within 800 acres zoned for heavy industry and manufacturing as illustrated in Figure 1-5. Northwest Aluminum is currently the largest industry in this zoning area, employing approximately 350 people.

A small trucking facility, the MMRF recreation area, and the rodeo grounds are located near the southern boundary of this industrial area. The northern portion of the industrial area contains the Mountain Fir facility, Munson Paving and two small areas zoned as community facilities. Located within the community facilities are the Wasco County Animal Shelter, Rockline, Inc. (which consists primarily of a machine shop employing about four people), and an electric power substation.

Currently, there is only one development (Precision Lumber Company, approximately 30 people) along the Columbia River waterfront in the vicinity of the MMRF, although there are plans to use a tract between the site and the Columbia River for industrial development. A small barge company is located on the waterfront approximately one-half mile to the southeast of the MMRF. These companies use potable water supplied by the city of The Dalles Public Works Department and do not have groundwater supply wells.

The remainder of the zoning area is lightly vegetated or wooded without other industrial development. MMRF land that is not used for industrial processes is leased for

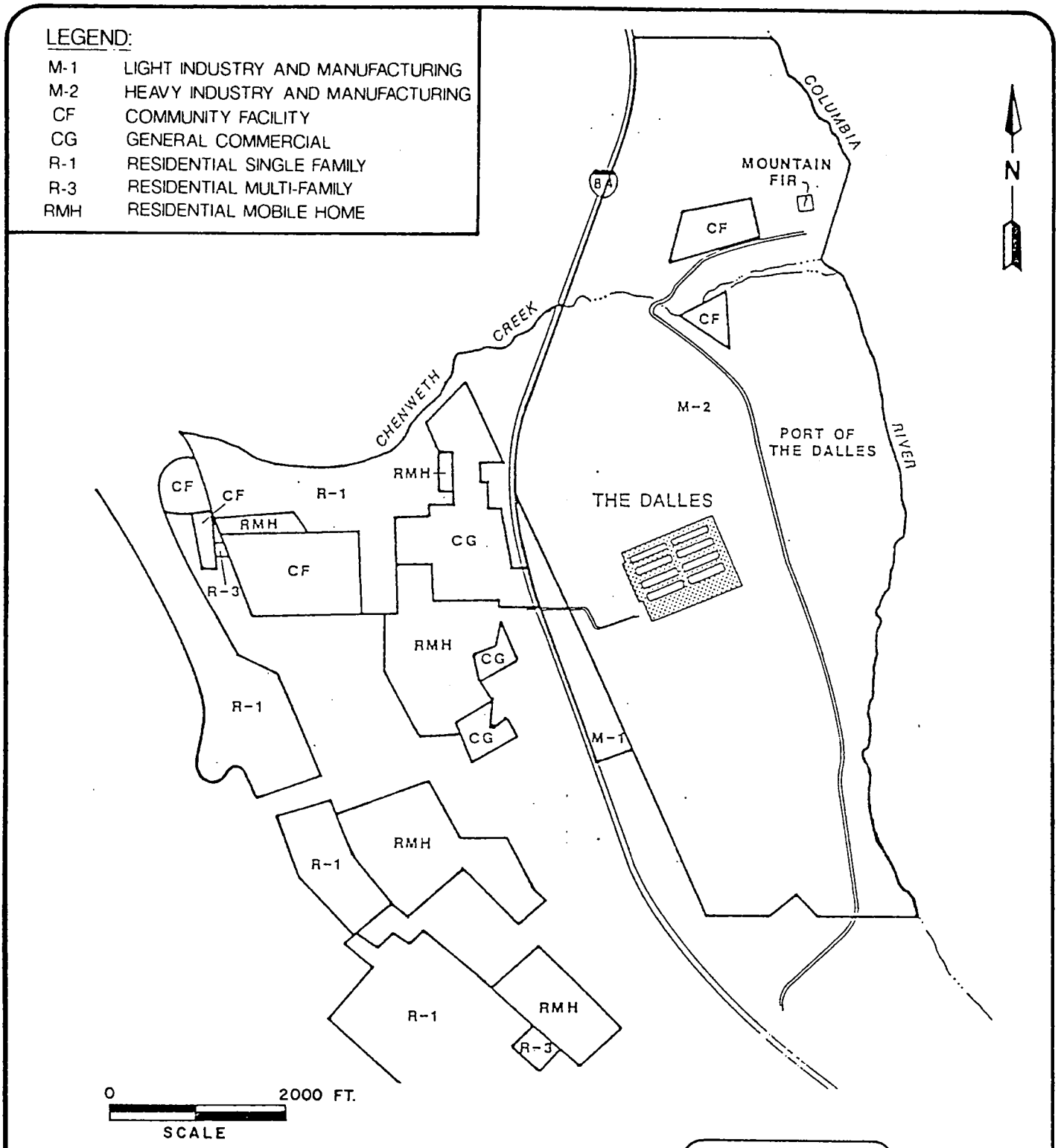

FIGURE 1-5

DRAWING NO: TE0018-P05-A88	
DRAWN BY: ~~S.K.F.~~	DATE: 5/19/88
CHECKED: AZC	DATE: 6-7-88
APPROVED: DJB	DATE: 6-7-88

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ZONING MAP

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agricultural uses such as cattle grazing. Cattle grazing takes place primarily in the vegetated areas northwest of the facility and in the area near the rodeo grounds owned by MMC.

A strip of land zoned for light industrial and manufacturing development is located between the railroad tracks and Interstate 84 directly west of the MMRF main building. In addition to several small businesses, this area currently includes a few residential homes. These homes were in place prior to zoning and upon new ownership or destruction of the homes, the area will be used strictly for light industrial and manufacturing development. Potable water is supplied by the city of The Dalles Public Works Department. Based on recent aerial photographs, there appear to be less than 20 homes and businesses in the area west of the site.

Interstate 84 separates the light and heavy industrial/ manufacturing area discussed above from residential areas. Directly west of the interstate and approximately one-third of a mile from the MMRF site are several areas zoned for residential development, including areas upon which single family homes, multi-family homes, and mobile homes are currently located. General commercial sites, such as an abandoned drive-in theater, are located in and around these residential areas, approximately two-thirds of a mile west of the MMRF. Additional residential areas zoned for single-family, multi-family, and mobile home dwellings are located approximately one-half mile southwest of the site.

The Columbia River and its tributaries represent the major surface water resources in the area, with the Mill Creek Watershed as the principal source of water supply for the city of The Dalles. The Columbia River and its tributaries provide habitat for major commercial and sport fisheries with salmon, sturgen, trout, steelhead, walleye, and bass being among the many game fish common to the river. Local tributaries to the Columbia River including Chenoweth Creek may provide limited spawning grounds for the steelhead and salmonoids when they are not seasonally dry.

Ground water is an important source of water supply in The Dalles area for domestic, industrial, and agricultural uses. The primary aquifer in the area is the DGWR; the alluvial aquifer located in the Chenoweth Creek area is used by the Animal Shelter.

A gravel pit is operated within the quaternary gravels of the alluvial aquifer northeast of the MMRF. This operation is relatively small, and probably could not be expanded significantly owing to the limited extent of the alluvium.

Future development around the MMRF appears to be focused on the Port of The Dalles located northeast of the site on the Columbia River. The area for the proposed port has been leveled, graded, and landscaped in preparation for future industrial development. Currently, five people are estimated

to be employed by the Port of The Dalles in this area. Municipal water lines have been run to the port and water-supply wells are not planned.

Martin Marietta Corporation will obtain deed restrictions on the MMRF to restrict and limit future development at the site. Development at the site will be restricted to industrial use only.

1.2 NATURE AND EXTENT OF PROBLEM

The nature and extent of site derived constituents at the MMRF was defined by assimilating the information obtained from the RI. The information used in the assimilation process included site and waste characteristics and results from the Risk Assessment (RA) which identified potential human health and environmental concerns. Analytical data obtained during the RI were used to ascertain the lateral and vertical extent of the released constituents. Environmental conditions at the MMRF were further evaluated in the RA in order to determine potential exposure pathways. The RA assessed each study area for points of exposure and associated potential risks to human health, welfare or the environment. The criteria used to assess the study areas in the RA consisted of: (1) chemical-specific applicable or relevant and appropriate requirements (ARARs), such as promulgated Federal or State standards or criteria; and (2)

in the absence of ARARs, by quantitative risk assessment using site and exposure parameters with critical toxicity criteria.

The ARARs and health criteria identified by the RA were then utilized to develop site-specific remediation criteria. There are no Federal or State ARARs for soils so additional evaluations were performed to determine appropriate remediation criteria for contaminants in soils which are protective of ground-water quality. The site-specific information used to develop the remediation criteria is presented in Section 1.2.1. Analytical data obtained from the RI were compared to the appropriate remediation criteria. Study areas with analyses which exceeded the remediation criteria or that otherwise were of concern are further discussed in Section 1.2.3.

1.2.1 Development of Remediation Criteria

Results of the RI indicated that cyanide was detected above background levels in the Landfill waste and leachate, soils, perched water associated with the cathode management areas, and in the Discharge Channel sediments. Fluoride concentrations above background were reported in Cathode Wash Area soils, Landfill leachate, Recycle Pond and Lined Pond sediments, and in perched water underlying the Old Cathode Waste Pile and Salvage Area. Carcinogenic polynuclear aromatic hydrocarbons (cPAHs) were detected in

Landfill waste materials, soils and sediments from the Scrubber Sludge Ponds, and soils from the Old Cathode Waste Pile Area, Salvage Area, Bath Recovery Pad Area and Potliner Handling Area. Arsenic was detected in soils at Landfill Runoff Area C, surface water of the Landfill Ditch and Leachate Collection System, sediments of the Lined Pond and the Scrubber Sludge Ponds.

Concentrations of fluoride and sulfate were detected in certain aquifer systems underlying the site. The concentrations were generally localized near the source areas, being mainly confined to the S-aquifer. Concentrations of total and free cyanide were also detected in certain aquifer systems at the MMRF. The levels of site-related chemicals detected in the ground water are presented in Table 1-5.

The RA incorporated the analytical results obtained during the RI to evaluate each study area. The RA concluded that: (1) concentrations of certain chemicals in ground water at the MMRF site exceeded health-based standards; and (2) exposure by direct contact with soils in several areas of the site under certain hypothetical exposure scenarios may pose unacceptable risks. For ground water, fluoride and sulfate concentrations are of potential concern. The constituents in soils that were associated with risk were arsenic, which was detected in only a few study areas at levels of potential concern and cPAHs, which were more

widespread at the site. Fluoride concentrations in soils were not considered to be of concern for direct contact or inhalation exposures but are of potential concern as a source of ground-water contamination.

To support the development of remedial alternatives for the MMRF site, remediation criteria or goals will be identified for the chemicals that may be associated with risk in soil or ground water at the MMRF site. Section 121 of CERCLA, as amended by SARA, requires that remedial actions comply with applicable or relevant and appropriate requirements (ARARs) of federal laws and more stringent, promulgated state laws. There are basically three types of ARARs: (1) chemical-specific; (2) action-specific; and (3) location-specific. Chemical-specific ARARs can be used to define remediation criteria for the MMRF while location-specific ARARs set restrictions on activities within specific locations such as floodplains or wetlands. Action-specific ARARs set controls or restrictions for particular treatment and disposal activities related to the management of hazardous wastes at the MMRF. Of these three types of ARARs, only chemical-specific ARARs can be used as chemical-specific remediation criteria.

Where chemical-specific ARARs such as state and federal standards or criteria exist, EPA directs that these values be used as target concentrations for remedial actions at Superfund sites. Where ARARs are not available, EPA

recommends that criteria, targeted towards levels that protect public health or the environment, be developed using available health or environmental toxicity criteria.

In this section, remediation criteria are identified for the constituents and media (air, ground water, surface water and soil) of concern at the MMRF. Remediation criteria are presented below by exposure medium.

1.2.1.1 Air

Air criteria in the form of occupational exposure limits have been included for constituents which might pose air exposure problems. These have been included in Table 1-6 for the protection of workers involved in remedial activities although, the baseline risk assessment did not identify unacceptable risks from potential air exposures.

1.2.1.2 Ground Water

Table 1-7 lists potential ground-water ARARs and public health criteria for remediation of the constituents of concern detected in ground water at the MMRF. The chemical constituents that exceeded ARARs in ground water in certain wells at the MMRF were fluoride and sulfate.

Fluoride concentrations in the S-aquifer beneath the MMRF range from <1.0 mg/L to 57 mg/L. The following four areas have fluoride concentrations in the S-aquifer above the State of Oregon fluoride standard for drinking water of 2.2 mg/L at 54°F based on the most recent data from the MMRF.

TABLE 1-6

Worker Exposure Limits for Potential Airborne Constituents of Concern
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Chemical	OSHA Permissible Exposure Limit (PEL)[a] (mg/m^3)
Arsenic	0.2[b]
Cyanide (Free)	5.0
Fluoride	2.5[c]
Coal Tar Pitch Volatiles (benzene-soluble fraction)	0.2

Notes:

MMRF does not currently have an air emissions problem. The exposure limits are established for protection of on-site workers during remedial activities.

[a] NIOSH/OSHA Pocket Guide to Chemical Hazards by the US Department of Health, Education, and Welfare.

[b] PEL for arsenic is based on levels of arsine.

[c] PEL for fluoride dust.

084/6

TABLE 1-7

Potential ARARs and Public Health Criteria for Constituents of Concern in Ground Water
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	Federal MCL[a] (SMCL) (mg/L)	Oregon Standards[b] (SCL) (mg/L)	Other (mg/L)
Fluoride	4(2)[c]	1.4-2.4[d]	-
Sulfate	(250)	(250)	400[e]
Free Cyanide	-	-	0.77 (Adults) - 0.22 (Children)[f]

Note:
MCL = Maximum Contaminant Level
SMCL = Secondary Maximum Contaminant Level
SCL = Secondary Contaminant Level

(a) Maximum Contaminant Levels are enforceable drinking water standards from 40 CFR 141.11. These levels are based on health, technical feasibility, and cost benefit analysis. Secondary Contaminant Levels are shown in parenthesis and are goals for drinking water quality based on aesthetic considerations such as taste, odor or straining ability, 40 CFR 143.3.
(b) Oregon Administration Rule 333-61-085 for fluoride concentration and 333-61-030 sulfate concentration. The sulfate concentration presented is a secondary contaminant level and is a goal for drinking water quality based on asthetic considerations.
(c) National Primary and Secondary Drinking Water Regulations. Federal Register 51: 11396-11412, April 1986.
(d) Temperature dependent.
(e) Guidance level proposed by US EPA Office of Drinking Water 50 FR 46936, 13 Nov. 1985.
(f) Guidance level proposed by US EPA Office of Drinking Water for adults and children respectively.

067/22

- The Scrubber Sludge Ponds - maximum fluoride concentration detected is 7.1 mg/L;
- The Unloading Area - maximum fluoride concentration detected is 57 mg/L;
- The Landfill/Former Cathode Waste Management Area - maximum fluoride concentration detected is 4.7 mg/L; and
- Recycle Pond - maximum fluoride concentration detected is 5.5 mg/L.

Sulfate concentrations in the S-aquifer beneath the MMRF range from <5.0 mg/L to 3020 mg/L. The following three areas have sulfate concentrations in the S-aquifer above the State of Oregon secondary contaminant level for sulfate in drinking water of 250 mg/L based on the most recent data from the MMRF.

- The Scrubber Sludge Ponds - maximum concentration detected is 3,020 mg/L;
- The Recycle Pond - maximum concentration detected is 871 mg/L; and
- The Unloading Area - maximum concentration detected is 680 mg/L.

Sulfates were not detected at concentrations above the state secondary contaminant level in the A- and B-aquifers or The Dalles Ground-Water Reservoir except for monitor well 18B, which indicated a sulfate concentration of 271 mg/L.

1.2.1.3 Surface Water

The potential surface water exposures identified in the baseline RA of concern at the MMRF were associated with wildlife ingesting water in the Landfill Ditch and the Leachate Collection Ditch. Remediation criteria in surface

water to protect wildlife from this potential exposure pathway are given in Table 1-8. These criteria were calculated based on the assumption that 1/5 of the LD_{50} is an acceptable daily dose and that the amount of water ingested daily by an animal equals 1 percent of its body weight (for further details see Section B.6.5 of the Risk Assessment in Appendix B of the RI).

With respect to aquatic life, the only aquatic life exposure evaluated (i.e. exposure of aquatic life in the Columbia River to site contaminants) was determined not to be of concern. Impacts on aquatic life in Chenoweth Creek were not evaluated because the detection limits for cyanide and fluoride used to analyze samples from Chenoweth Creek exceeded levels associated with potential adverse effects in aquatic life. This Creek is currently being resampled, and samples will be analyzed in a manner which will yield lower detection limits; aquatic life remediation criteria which may be used when new Chenoweth Creek data become available are presented in Table 1-8.

1.2.1.4 Soil/Sediments

No soil ARARs in the form of chemical-specific federal or Oregon standards, criteria or guidance, have been identified for the constituents of concern in soils or sediments at the MMRF. Therefore, to support the development of remedial alternatives associated with soils at the MMRF,

TABLE 1-8

Potential Surface Water Remediation Criteria
Environmental Receptors
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Chemical of Concern	Terrestrial Life Criteria (mg/L)	Aquatic Life Criteria			
		Water Quality Standard for the Hood Basin[b] (mg/L)	Water Quality Criteria[b] Acute (mg/L)	Chronic (mg/L)	Other[c] (mg/L)
Cyanide	80[a]	0.005	0.022	0.0052	--
Fluoride	4,000-20,000[a]	1.0	--	--	0.2

Notes: (a) Surface water concentration based on LD50 and exposure of mammals via ingestion of surface water. See text and Section B.6.5 of risk assessment for details.
(b) Oregon Water Quality Standards. Oregon Administrative Rule 340-41-525, August 28, 1987.
(c) Based on avoidance behavior of salmon (Dankaer and Douglas, 1986).

074/29

G&M Consulting Engineers, Inc.

health-based soil remediation criteria will be calculated for those constituents of concern (arsenic and cPAHs) for exposures involving direct contact with soils at the MMRF site. Contaminant-specific soil remediation criteria for fluoride will be calculated utilizing the approach applied by EPA for deriving acceptable soil contaminant concentrations based on drinking water standards.

Development of Health-based Soil Criteria

Health-based soil remediation criteria are concentrations of a chemical in soil which, under specified exposure conditions, would not yield a dose of the chemical in excess of an acceptable daily dose. Because the dose received is dependent on the exposure conditions assumed (such as frequency of exposure and quantity of soil contacted) different soil criteria will be associated with different exposure scenarios.

Soil remediation criteria for direct exposure pathways, such as direct contact with soil, will be calculated for two types of potential future land use of the MMRF: industrial use and residential use. Criteria are developed using reverse risk assessment techniques which combine scenario-specific exposure parameters with an acceptable daily dose (D_t) of each chemical for the exposed population. The constituents of concern in soil (arsenic and cPAHs) are both carcinogens. Doses corresponding to excess risks of 10^{-4},

10^{-5} and 10^{-6} are used as the D_t values for these chemicals. Acceptable daily doses are calculated for each target risk level using the following relationship:

$$\text{Excess Cancer Risk} = \underset{(\text{mg/kg/day})^{-1}}{\text{Cancer Potency Factor}} \times \underset{(\text{mg/kg/day})}{\text{Daily Dose}}$$

The oral cancer potency factor for arsenic is 1.5 $(\text{mg/kg/day})^{-1}$, and that of cPAHs (based on benzo(a)pyrene) is 11.5 $(\text{mg/kg/day})^{-1}$.

The following sections provide discussion for developing soil remediation criteria for industrial and future residential use, and based on the protection of ground water plus regional and national background concentrations.

Soil Criteria for Future Industrial Use of the Site

For industrial use of the site, the scenario involving exposure of future outdoor employees to site-related chemicals in soils will be used. Because this scenario was associated with the highest potential risks in the baseline risk assessment presented in the RI report, its use will yield conservative remediation criteria for industrial use of the site. Remediation criteria will be developed for arsenic and cPAHs, the chemicals identified in the risk assessment as being at levels of concern in site soils. Criteria will be based on exposures of these hypothetical workers to soil contaminants by direct contact with soils resulting in dermal

absorption and incidental ingestion under maximum exposure conditions. Although inhalation of particulates resulted in an upperbound excess cancer risk of slightly more than 10^{-6} in one of the proposed remediation areas (the Landfill), this potential route of exposure was much less significant as a contributor to risk than direct contact with soils and would therefore, not have a significant impact on remediation criteria.

The assumed exposure conditions of future site employees to contaminated soil were described in detail in the baseline risk assessment. These workers were assumed to work in contaminated areas and contact soils 180 days per year for 30 years under the maximum scenario conditions. It was further assumed that there would be direct dermal contact with 3 grams (g) of soil and that 100 milligrams (mg) of soil would be incidentally ingested each day of exposure. Absorption of cPAHs was assumed to be 70 percent through the gastrointestinal tract and 4 percent through the skin. Absorption of arsenic was assumed to be 100 percent through the gastrointestinal tract and to be negligible through the skin.

For this exposure pathway, remediation criteria in the form of acceptable concentrations in soils were derived by setting the intake of chemicals from the exposure at the acceptable daily dose and using the following formula together with relevant exposure parameters:

$$C_{soil} = D_t \times \frac{1}{(Ai \times I_i) + (A_d \times I_d)} \times \frac{BW}{F}$$

where C_{soil} = concentration in soil (mg/kg)
D_t = acceptable daily doses (mg/kg/day) based on excess cancer risks of 10^{-4}, 10^{-5} and 10^{-6}

I_i = intake by incidental ingestion ($1.0X10^{-4}$ kg/day)

A_i = oral absorption factor (0.7 for PAHs, 1.0 for arsenic)

A_d = dermal absorption factor (0.04 for PAHs, 0 for arsenic)

I_d = intake by dermal contact ($3X10^{-3}$ kg/day)

BW = body weight (70 kg); and

F = lifetime frequency of exposure = 0.21 (180 days per year for 30 years out of a lifetime of 70 years).

The resulting industrial use remediation criteria for soils by target risk level are shown in Table 1-9.

Soil Criteria Based on
Future Residential Use of the Site

Using the same equation presented above with different exposure parameter values, soil criteria based on the assumed exposure of future hypothetical on-site residents via dermal absorption and incidental ingestion of soil may be calculated. As in the baseline RA, for the residential scenario it will be assumed that a person lives at the site for a 70-year lifetime. Under the maximum exposure conditions for this scenario, residents (whose lifetime average body weight is assumed to be 62 kg) are assumed to be exposed to contaminated soils for 160 days per year over a

TABLE 1-9

Potential Soil Remediation Criteria
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Chemical	Background Levels in Soil (mg/kg)	Target Excess Lifetime Cancer Risk	Soil Remediation Criteria[a] (mg/kg)
		DIRECT CONTACT: HYPOTHETICAL FUTURE OUTDOOR INDUSTRIAL USE OF SITE	
Arsenic	0.1-2.6	10^{-6}	2.2
		10^{-5}	22
		10^{-4}	220
cPAHs	100-175 (urban)	10^{-6}	0.15
		10^{-5}	1.5
		10^{-4}	15
		DIRECT CONTACT: HYPOTHETICAL FUTURE RESIDENTIAL USE OF SITE	
Arsenic	0.1-2.6	10^{-6}	0.65
		10^{-5}	6.5
		10^{-4}	65
cPAHs	100-175 (urban)	10^{-6}	0.047
		10^{-5}	0.47
		10^{-4}	4.7
		PROTECTION OF GROUND WATER	
Fluoride	180-270	--	18,000[b]
			2,200[c]

Notes: [a] Calculated health-based value unless otherwise noted.

[b] State of California, Title 22, Section 66699 - Persistant and Bioaccumulative Toxic Substance based on EPA approach.

[c] Proposed soil concentration based on the laboratory procedure for analysis of fluoride in a solid matrix (Standard Methods 16th Edition, 413.B), assuming an extract concentration equal to the State of Oregon's fluoride standard for drinking water (2.2 mg/L at 54°F) times the 100-fold attenuation factor developed by the EPA (see Section 1.2.1.4 for further explanation).

cPAHs = Carcinogenic Polynuclear Aromatic Hydrocarbons.

074/28

70-year lifetime. They are also assumed to incidentally ingest an average of 145 mg soils and dermally contact 5.4 g of soil each day over a lifetime. These exposure values were derived by calculating time-weighted averages for different activities over a lifetime. Absorption factors for arsenic and cPAHs are the same as those discussed for the future industrial scenario. Again, the acceptable daily doses used to calculate the soil criteria were based on total excess lifetime cancer risks of 10^{-4}, 10^{-5}, and 10^{-6}. The resulting hypothetical future residential use remediation criteria for soils by target risk level are shown in Table 1-9.

Soil Criteria Based on
Protection of Ground Water

As stated earlier, no soil ARARs are available to remediate soils for the protection of ground water. Therefore, it is necessary to derive target soil concentrations for the protection of ground water. EPA has utilized an approach that introduces attenuation and dilution factors which has been widely accepted by the regulatory community. Another approach would be to calculate the theoretical soil concentration utilizing the laboratory analytical procedures developed to detect contaminants present in solid matrices (i.e., sludge, soils, etc.). The current analytical equipment used in laboratories today cannot directly determine the concentration of most constituents in solid phase samples. Instead, the analytical

procedures for solid phase samples typically require the extraction of constituents from the solid matrix using known quantities of liquid or gaseous solvents. The laboratory procedure leaches the constituents into solution and once extracted into a liquid or gaseous media, the contaminants can then be detected using existing laboratory equipment.

The analysis for fluoride in solid phase samples requires an extraction procedure. Versar Laboratories (the lab which analyzed samples from the MMRF) reported taking 20 g of solid sample then extracting the sample with 200 milliliters (mL) of solvent to perform the fluoride analysis. The fluoride concentration in the extract was then determined using an ion selective electrode (Standard Methods 16th Edition, 413.B). To calculate the concentration in the soil, the extract concentration was applied to the following equation:

$$\text{Fluoride Concentration in the Solid (mg/Kg)} = \frac{\text{Extract Concentration (mg/L)} \times 200\ \text{mL}}{20\text{g} \times \%\ \text{solids}}$$

Assuming that analytical procedure is a form of leachability test in which all of the fluoride in the solid matrix is released at once into the solvent (deionized water), the above equation can provide a conservative estimate on the concentration in soil required to leach a given concentration in water.

This technique was utilized to determine an acceptable fluoride concentration in soils and sediments at the MMRF. The extract concentration was set at 220 mg/L (the State of Oregon fluoride standard (2.2 mg/L) times the 100-fold attenuation factor developed by Battelle Memorial Institute and the EPA in such tests as EP Toxicity). Substituting the extract concentration of 220 mg/L into the analytical equation and assuming the sample is 100 percent solids, the fluoride concentration in the solid was calculated to be 2,200 mg/kg. Therefore, based on this discussion, a fluoride concentration less than or equal to 2,200 mg/kg in soils or sediments at the MMRF would be acceptable for the protection of ground water resources. This approach is very conservative in that it does not take into consideration various hydrogeological factors and assumes an instantaneous release.

The State of California recently published a soil concentration for fluoride of 18,000 mg/kg which was derived based on the protection of ground water utilizing the EPA approach. The methodology used by the State of California has been widely accepted by the regulatory agencies. The State of California's acceptable fluoride concentration in soil and the soil concentration developed utilizing the analytical method for determining fluoride in a solid matrix are both presented on Table 1-9.

Background Concentrations of Chemicals of Concern in Soils

Arsenic and fluoride are natural constituents of soils. Regional background soil concentrations of arsenic and fluoride, presented in Table 1 of the RA (Appendix B of the RI report) range from 0.1 to 2.6 mg/kg for arsenic and 180 to 270 mg/kg for fluoride. PAHs are also nearly ubiquitous in soils and are produced by virtually every combustion process, including coal combustion and forest and agricultural fires. Based on data compiled from IARC (1973), White and Vanderslice (1980), and EPA (1982), total carcinogenic PAH (cPAH) concentrations in forest soils can range from 0.02 to 0.26 mg/kg. In urban soils, higher concentrations are found, with total cPAH concentrations ranging from 100 to 175 mg/kg. These background concentrations in soils are given in Table 1-9 together with health-based soil and other soil remediation criteria.

Proposed Soil Remediation Criteria

As can be seen from a comparison of the criteria in Table 1-9, the soil criteria for arsenic and cPAHs calculated to protect future hypothetical residential users of the site are lower than those calculated to protect future hypothetical site employees who work outside full-time. The range of health-based future hypothetical residents remediation criteria developed for arsenic in soils (0.65 to 65 mg/kg) overlaps the range found naturally in soils in this

part of Oregon (<0.1 to 2.6 mg/kg). Of the possible cleanup goals for arsenic, the highest criterion of 65 mg/kg is therefore appropriate because of the conservative nature of the exposure scenario on which these criteria are based, i.e., hypothetical residential use of the site. The range of calculated future hypothetical residential use remediation criteria for exposure of cPAHs (0.047 to 4.7 mg/kg) overlaps the range of background concentrations found in forest soils (0.02 to 0.26 mg/kg), but is well below concentrations that may be found in urban soils. Because the MMRF is located in a commercially zoned area, a remediation criteria corresponding to the high end of urban background concentrations (i.e., 175 mg/kg total cPAHs) is therefore appropriate.

Exposure to fluoride does not pose a risk via direct contact or inhalation of any of the potentially exposed populations considered in the risk assessment. As discussed previously, soil remediation criteria for this chemical has been based on two approaches: EPA methodology used for 40 CFR 261.24 in conjunction with a conservative model based on laboratory protocols or the State of California regulatory standard. The proposed remediation criteria for fluorides in soils or sludges at the MMRF will be 2,200 mg/kg, which is the more conservative value. As stated previously in this section, the fluoride value assumes certain conditions that result in the instantaneous release of fluoride; a situation

which is considered unlikely to occur at the MMRF because of the nature of the wastes generated as part of the reduction process (i.e., calcium fluoride which is relatively insoluble is present) and local climatological conditions.

Based on the above discussion, proposed remediation criteria for soils at the MMRF are presented in Table 1-10. The remediation criteria presented in Section 1.2.1 will be used to compare with analytical data collected from the study areas. Study areas with analyses that exceed the remediation criteria will require further consideration.

1.2.1.5 Selected Sitewide Remediation Criteria

Sections 1.2.1.1 through 1.2.1.4 describe remediation criteria for air, ground water, surface water, and soils and sediments, respectively. Based on the information provided in these discussions, Table 1-11 provides the ARARs for the various constituents of concern.

1.2.2 Target Remediation Areas

The RI investigated 23 study areas listed in Section 1.1.3. Depending on the various media associated with each study area, samples were collected for surface waters, soils, sediments and air. The study areas were also evaluated for potential impact on the ground water beneath the MMRF. The Risk Assessment determined the constituents of concern in the study areas and identified ARARs or health based criteria for

TABLE 1-10

Proposed Remediation Criteria For Soils
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	Arsenic	cPAHs	Fluoride
Criteria	65 mg/kg[a]	175 mg/kg[b]	2,200 mg/kg[c]

cPAHs - Carcinogenic Polynuclear Aromatic Hydrocarbons

[a] Based on health considerations for future hypothetical residential use of the study areas at a 10^{-4} excess lifetime cancer risk.

[b] Based on urban background concentrations in soil.

[c] Proposed soil concentration based on the laboratory procedure for analysis of fluoride in a solid matrix (Standard Methods 16th Edition, 413.B), assuming an extract concentration equal to the State of Oregon's fluoride standard for drinking water (2.2 mg/L at 54°F) times the 100-fold attenuation factor developed by the EPA (see Section 1.2.1.4 for further explanation).

098/8

these constituents. A selected combination of ARARs and health based criteria were defined as remediation criteria. The remediation criteria were compared to the analytical data compiled during the RI to identify study areas which were potential threats to the public and/or environment.

The study areas were then grouped based on similar past waste management practices and referred to as target remediation areas. Study areas containing contaminated media which exceed the remediation criteria presented on Table 1-11 were retained for potential remediation while the study areas which indicated that they were not a threat to the public or the environment, based on the remediation criteria, were eliminated from consideration in this FS.

The target remediation areas and their respective study areas are presented in Table 1-12. Study areas not included in Table 1-12: (1) did not result in chemical concentrations exceeding the remediation criteria; and/or (2) were not of potential concern based on the results of the RA. Table 1-13 again lists the target remediation areas and includes the potential risk identified by the RA for each area.

1.2.3 Site and Waste Characterization for Target Remediation Areas

The development of remedial action alternatives for management of a CERCLA site is dependent upon the site and waste characterization of the areas to be remediated. Site

TABLE 1-11

Selected Sitewide Remediation Criteria
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Environmental Medium/Constituent of Concern	Remediation Criteria: ARAR Concentration	ARAR Reference(1)	Health Based Concentration	Health Based Reference
Air				
Arsenic	0.2 mg/m^3	OSHA PEL	—	—
Free Cyanide	5.0 mg/m^3	OSHA PEL	--	--
Fluoride	2.5 mg/m^3	OSHA PEL	—	--
PAHs	0.2 mg/m^3	OSHA PEL	—	--
Ground Water				
Free Cyanide	—	—	0.77 mg/L(2)	EPA Health Advisory for Adults
Fluoride	2.2 mg/L	OAR 333-61-085	—	--
Sulfate	250 mg/L(3)	OAR 333-61-030	—	--
Surface Water				
Free Cyanide	0.005 mg/L	OAR 340-41-525	—	—
Fluoride	1.0 mg/L	OAR 340-41-525	—	--
Soils/Sediment				
Arsenic	—	--	65 mg/kg(4)	—
Fluoride	--	--	2,200 mg/kg(5)	Protection of Ground Water
cPAHs	--	--	175 mg/kg(6)	Urban Background

Notes: (1) - Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) as found in 29 CFR 1910, Subpart Z. OAR reference stands for Oregon Administrative Rule.

(2) - The EPA Health Advisory of 0.77 mg/L for adult consumption of drinking water containing free cyanide was selected based on the potential for exposure to on-site workers which are all adults. The off-site remediation criteria is .22 mg/L and is based on the EPA Health Advisory for consumption of drinking water containing free cyanide by children. Free cyanide concentrations were not detected above EPA Health Advisory levels for adults (0.77 mg/L) or children (0.22 mg/L) off-site.

(3) - Secondary contaminant level.

(4) - Target risk level for soils (see Section 1.2.1.4).

(5) - Fluoride concentration for soils based on protection of ground water quality utilizing the analytical procedure to determine fluoride a solid in matrix (see Section 1.2.1.4).

(6) - Urban background for total carcinogenic polynuclear aromatic hydrocarbons (PAHs).

074/44

TABLE 1-12

Target Remediation Areas
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Target Remediation Areas	Study Areas
Landfill and Associated Areas	Landfill Landfill Ditch Leachate Collection Ditch Surface Drainage Ditch Landfill Runoff Areas
Former Cathode Waste Management Areas	Bath Recovery Pad Old Cathode Waste Pile Salvage Area Potliner Handling Perched Water
Management Units in Operation	Discharge Channel Lined Pond Recycle Pond
Unloading Area	Unloading Area
Scrubber Sludge Ponds	Scrubber Sludge Pond 1 Scrubber Sludge Pond 2 Scrubber Sludge Pond 3 Scrubber Sludge Pond 4
Ground Water	S-Aquifer A-Aquifer B-Aquifer

098/15

TABLE 1-13

Potential Risks Associated with Target Remediation Areas
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Target Remediation Area	Potential Risks Associated with Target Remediation Area
Landfill and Associated Areas	- Potential future generation of leachate containing cyanide and fluoride from wastes - Potential direct contact by humans with cPAHs in Landfill soils - Potential ingestion by wildlife of fluoride in Leachate Collection Ditch water - Potential ingestion by wildlife of cyanide and fluoride in Landfill Ditch water - Potential direct contact by humans with cPAHs in Surface Drainage Ditch sediments
Former Cathode Waste Management Areas	- Potential future generation of leachate containing cyanide and fluoride from cathode waste residuals in the Old Cathode Waste Pile, Salvage, Bath Recovery Pad and Potliner Handling Areas - Potential source of fluoride and cyanide to perched water - Potential direct contact by humans with cPAHs in Potliner Handling Area waste residuals

TABLE 1-13 (Continued)

Potential Risks Associated with Target Remediation Areas
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Target Remediation Area	Potential Risks Associated with Target Remediation Area
Management Units in Operation	- Potential direct contact by humans with cPAHs in sediments of Discharge Channel, Lined Pond and Recycle Pond - Potential future release to ground water of fluoride from Recycle Pond sediments
Unloading Area	- Potential future release of fluoride to ground water from fill material
Scrubber Sludge Ponds	- Potential future release of fluoride to ground water from sludges - Potential direct contact by humans with cPAHs and arsenic in sediments
Ground Water	- Fluoride and sulfate concentrations exceed remediation criteria in some wells

109/05

and waste features which influence remedial activities include drainage on and off the study area, physical and chemical makeup of the waste, physical and chemical properties of contaminants, and potential contaminant migration pathways. The migration pathways for specific chemicals detected at the MMRF were delineated in the RA for the site. In general, site drainage features and wastes detected have also been defined. The following sections contain specific descriptions of site and waste characteristics for the target remediation areas.

1.2.3.1 Landfill

The study areas included in this target remediation area consist of:

- The Landfill;
- The Leachate Collection Ditch;
- The Surface Drainage Ditch;
- The Landfill Ditch; and
- The Landfill Runoff Areas.

The Landfill occupies approximately 15 acres and is located just north of the reduction buildings as illustrated in Figure 1-6. Review of aerial photos depicting various stages in the development of the Landfill from preconstruction through current conditions, revealed that the Landfill area was a topographic low receiving drainage from the area to the west of the existing Landfill. The major drainage pathways in the Landfill area prior to development of the Landfill are illustrated in Figure 1-7. The Landfill

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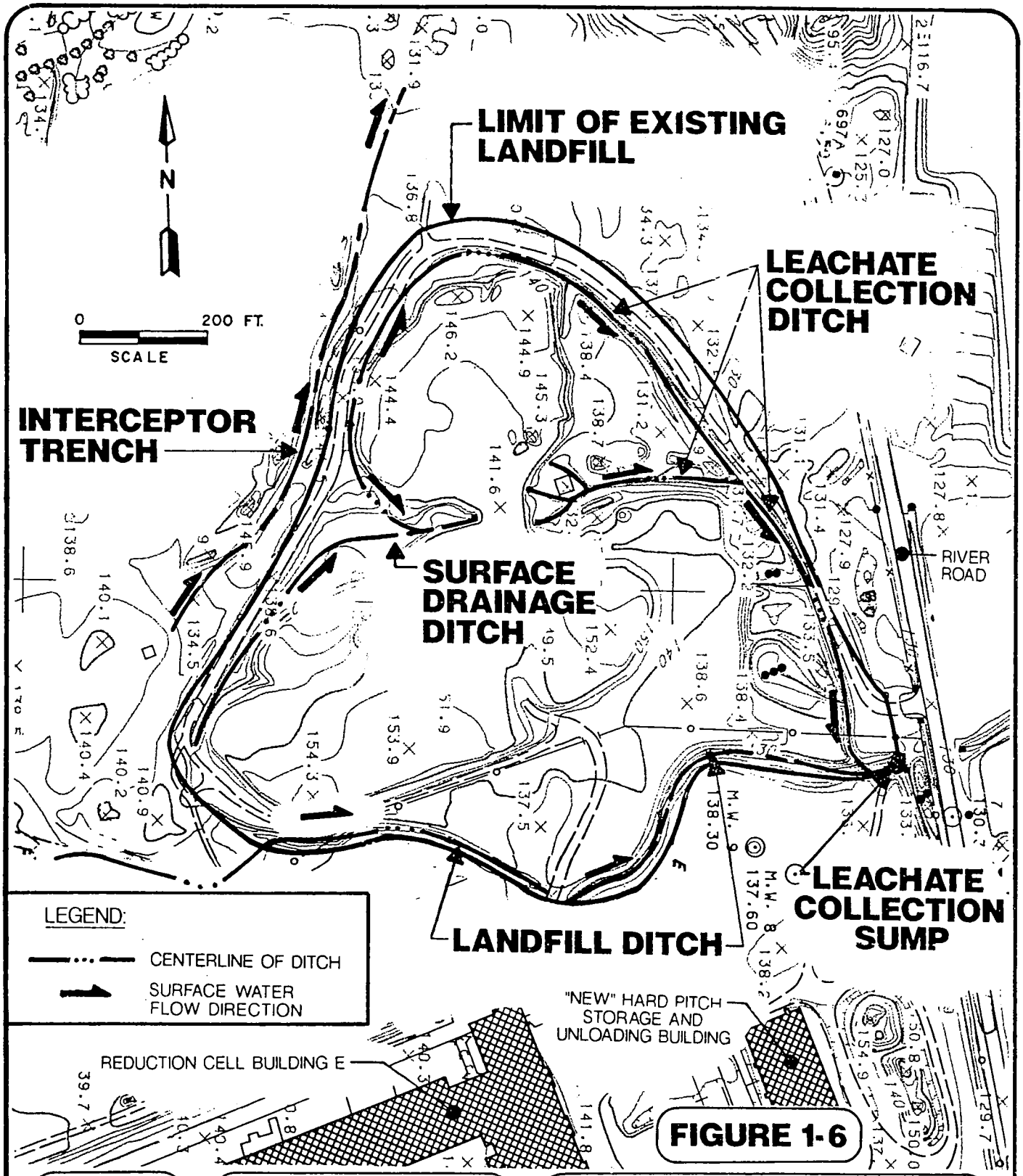

FIGURE 1-6

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DRAWN BY: S.K.F.	DATE: 2/16/88
CHECKED: RC	DATE: 3/14/88
APPROVED:	DATE: 3/31/88

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EXISTING CONDITIONS AT LANDFILL

FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

BAY REPROGRAPHICS 300852

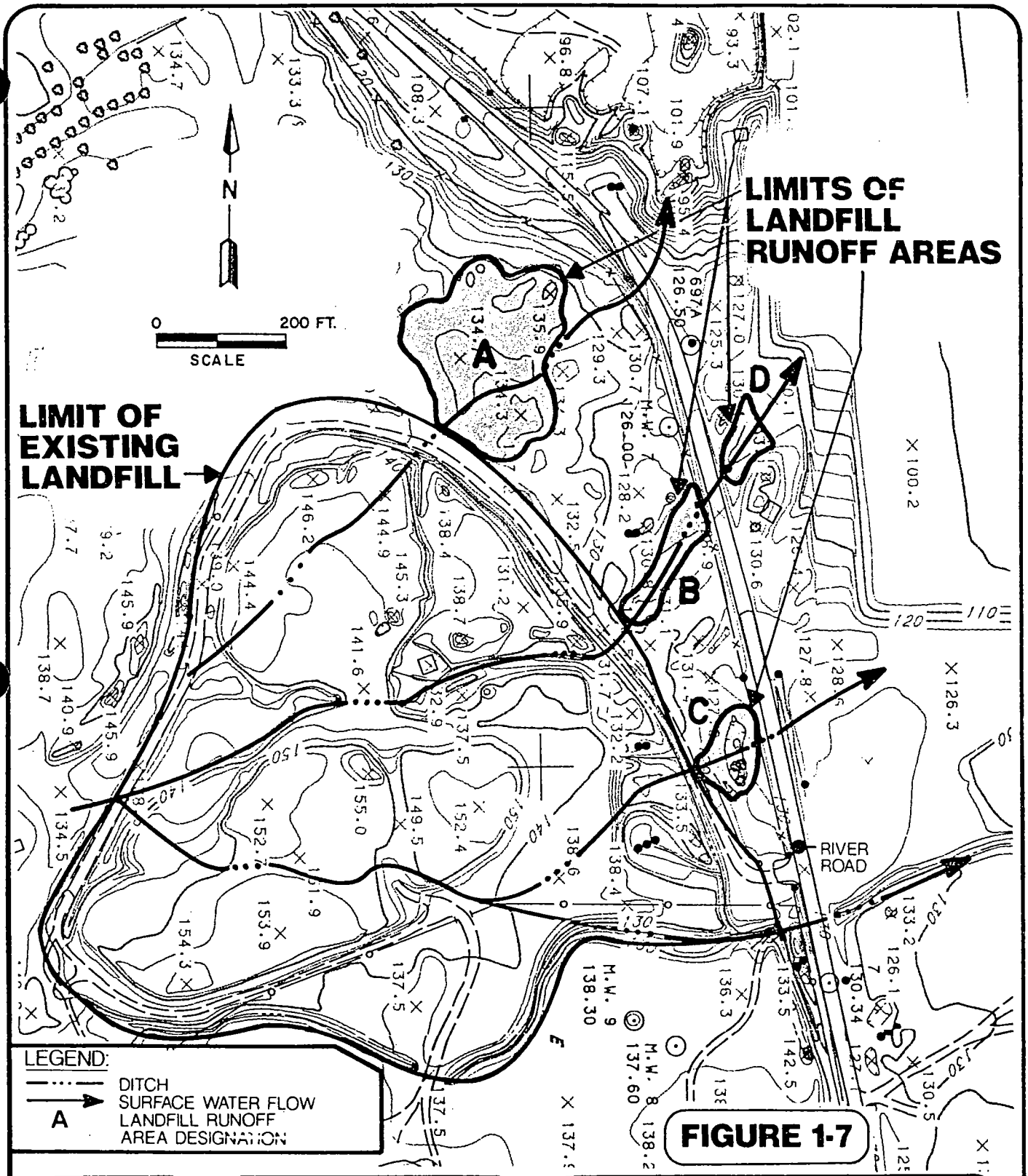

FIGURE 1-7

DRAWING NO: TE0018-P05-A40	
DRAWN BY: Ken Carson	DATE: 18-Feb-88
CHECKED:	DATE: 3/16/88
APPROVED:	DATE: 3/31/88

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LANDFILL RUNOFF AREAS

FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY

MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

Runoff Areas did not contain any constituents of concern which exceeded the selected sitewide remediation criteria presented in Table 1-11 and therefore, were not included for remediation. The installation of the Leachate Collection Ditch, which was later gunite lined, was intended to cut off migration of the leachate from the Landfill. The Leachate Collection Ditch is effective in preventing surface runoff but is apparently less effective in capturing leachate following the contact between surface soils/fill and the underlying basalt.

In an effort to minimize the impact of runoff from the area to the west of the Landfill, MMRF installed an interceptor trench to isolate the Landfill from surface water runoff onto the Landfill. The interceptor trench is providing adequate diversion of surface water.

Wastes at the Landfill were randomly placed on the ground surface and piled to the current configuration which resulted in approximately 200,000 cubic yards. Wastes present in the Landfill generated as a result of the reduction process and construction operations consist of: construction debris which is primarily basalt fragments and broken concrete; unsalvageable cathode waste materials; refractory bricks; off specification carbon block, pitch and coke; cryolite; metallic materials such as concrete rebar, angle iron and collector bar fragments; plus pallets, cans, rags and empty drums. Prior to the regulations of asbestos

disposal and handling practices, asbestos and asbestos containing materials were randomly disposed throughout the Landfill. Since regulation of these materials, MMRF disposed of asbestos in known areas which are identified on Figure 1-8.

The waste within the Landfill can be divided into four (4) main categories:

- Basalt fragments;
- Asbestos;
- Metallic; and
- Target wastes.

The majority of the waste within the Landfill is basalt fragments from construction activities. Particle sizes range from very fine silts to boulders several feet in dimension. Although written records do not exist, the volume of asbestos buried in the known areas of the Landfill is not anticipated to be a large quantity (less than 100 cubic yards). However, it is not possible to accurately estimate the volume of asbestos distributed throughout the Landfill prior to controlled burial. Metallic waste would consist of buss bars, collector studs and miscellaneous drums, cans, etc. There does not appear to be a significant quantity in the metallic waste category. The target waste consists of the remaining materials such as spent cathode waste; refractory bricks; off specification pitch, coke and carbon block etc. The following volumes for the waste types present in the Landfill have been estimated:

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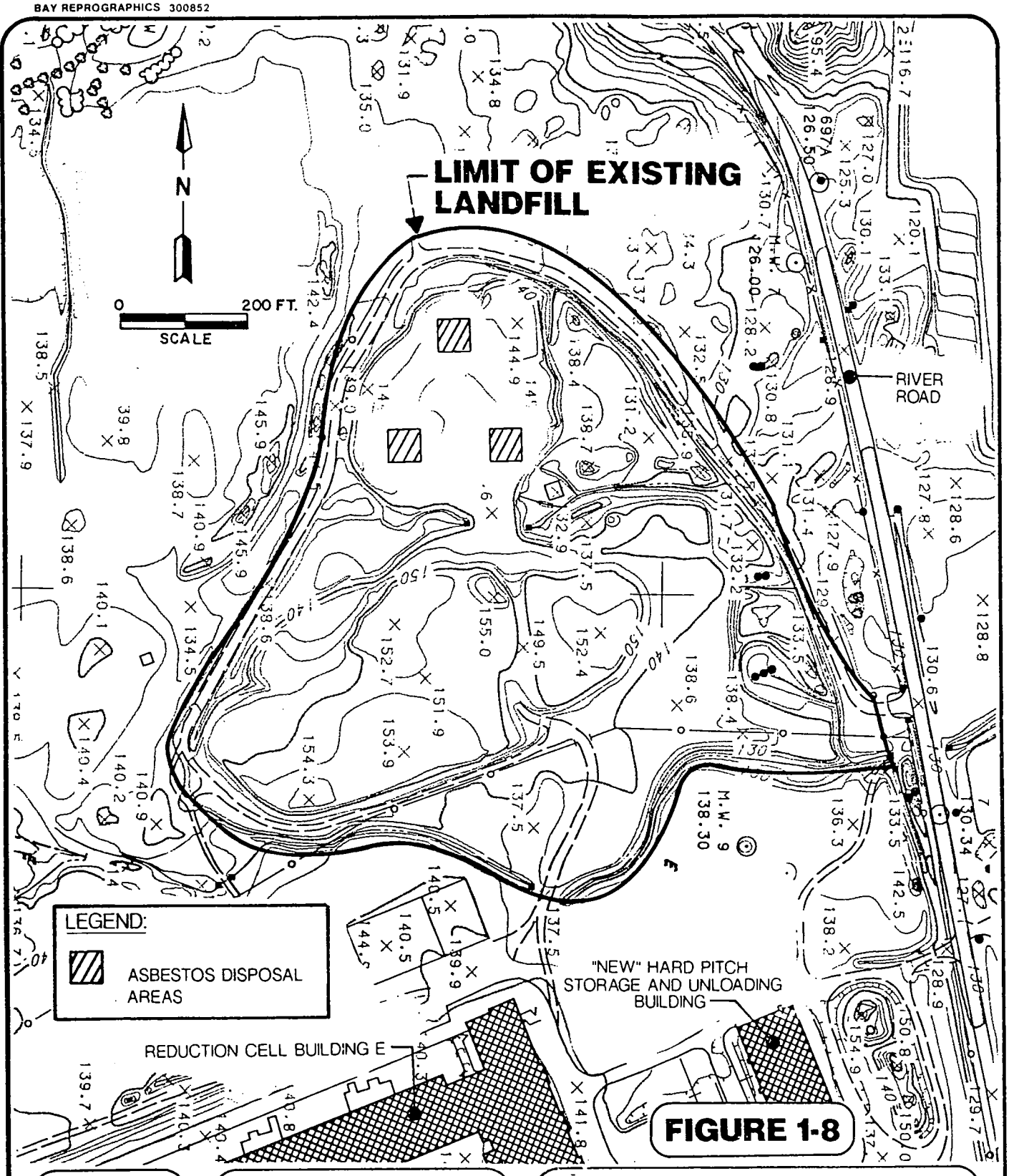

FIGURE 1-8

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DRAWN BY: KenCarroll	DATE: 18-FEB-88
CHECKED: ARC	DATE: 3/16/88
APPROVED: [illegible]	DATE: 3/16/88

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ASBESTOS DISPOSAL AREAS

FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

o Basalt Fragments	100,000 cy
o Asbestos	
- Buried	100 cy
- Distributed	200 cy
o Metallic	500 cy
o Target Wastes	99,200 cy

Appendix A of the RI presents information indicating that 54,381 tons of spent potliner material was shipped off-site from the MMRF (owned and operated by Harvey Aluminum at the time) from July, 1961 to November, 1971. Best estimates based on conversations with Martin Marietta personnel indicate that an additional 5,000 tons of spent potliner (approximately 10% of potliner material sent off-site) was placed in the Landfill. The estimated 5,000 tons of spent cathode waste material present in the Landfill contain high levels of carbon, sulfate, sodium, and fluoride in addition to minor amounts of cyanide. Cryolite, which is composed of fluoride, sodium, and aluminum, is also present in the Landfill. Pitch and coke associated with the continuous anode in the reduction process are present in the Landfill and contain elevated levels of PAHs and low levels of arsenic.

To confirm the composition of the Landfill, five test pits were excavated and their locations are displayed in Figure 1-9. The materials observed ranged from fine dust to very large basalt boulders. Composite samples from the five test pits indicate the presence of the following constituents of concern:

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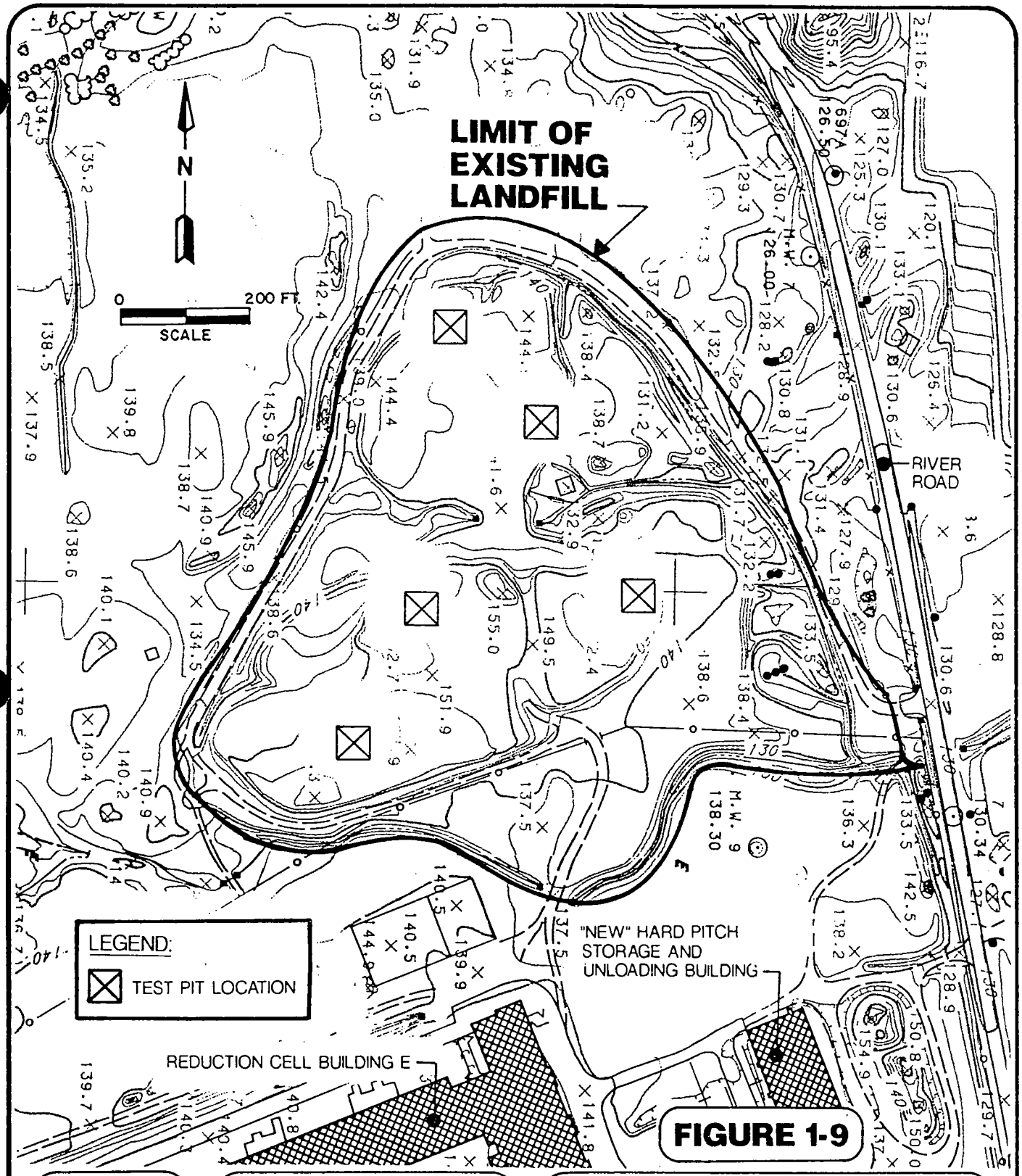

FIGURE 1-9

DRAWING NO:	TE0018-P05-A39
DRAWN BY: Ken Carroll	DATE: 18-FEB-88
CHECKED: RKC	DATE: 3/16/88
APPROVED: DSB	DATE: 3/31/88

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LANDFILL TEST PIT LOCATIONS

FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

o Cyanide	
- Total	0.32 - 70 mg/kg
- Free	0.27 - 54 mg/kg
o Fluoride	204 - 2,880 mg/kg
o PAHs	276 - 2,406 mg/kg

Leachate generated by the Landfill is contained by a leachate collection system that consists of the following study areas:

- o Surface Drainage Ditch;
- o Leachate Collection Ditch; and
- o Landfill Ditch.

Figure 1-6 illustrates the location of the leachate collection system.

The generation of leachate is seasonally dependent and its presence is directly related to precipitation or snow melt. The majority of the precipitation or snow melt occurs from September through May. Available records of leachate collected and pumped range from 0 to 50,000 gallons per day (gpd) with peak flows occurring generally in the early spring.

Analyses of leachate samples from the Leachate Collection Ditch identified the presence of the following constituents of concern:

o Cyanide	
- Total	0.11 - 29 mg/L
- Free	0.01 - 4.7 mg/L
o Fluoride	1,490 - 2,440 mg/L

Analyses of leachate samples from the Landfill Ditch identified the presence of the following constituents of concern:

o Cyanide	
- Total	373 - 1,280 mg/L
- Free	34.2 - 77.2 mg/L
o Fluoride	5,400 - 8,000 mg/L

The Surface Drainage Ditch was dry and leachate was not present for sampling in 1986.

The Leachate Collection Ditch was gunite lined and sediment samples were not available. Sediments from the Surface Drainage Ditch and the Landfill Ditch identified the presence of the following constituent of concern:

o Fluoride	189 - 519 mg/kg

The inorganics in the leachate and sediments are the result of precipitation and/or snow melt percolating through the wastes in the Landfill and flowing to the ditches. A small section of the Landfill Ditch upstream of its intersection with the North Ditch has exposed wastes in the adjacent banks of the Landfill and Bath Recovery Pad Areas, which account for the high levels of constituents in the leachate samples taken from this area. The turbidity of the leachate suggests that it contains high levels of suspended particulates.

1.2.3.2 Former Cathode Waste Management Areas

The study areas included in this target remediation area consist of:

- The Potliner Handling Area;
- The Salvage Area;
- The Old Cathode Waste Pile Area;
- The Bath Recovery Pad Area;
- The Metal Pad Storage Area;
- The Cathode Wash Area; and
- The Perched Water.

The Metal Pad Storage Area and Cathode Wash Area did not contain any constituents of concern which exceeded the remediation criteria presented in Table 1-11 nor did the RA consider these areas to represent a risk. Therefore, these two areas are not considered further. The locations of the four remaining study areas are presented in Figure 1-10.

Potliner Handling Area

The Potliner Handling Area (PHA) occupies approximately 0.9 acre, just east of the reduction building as illustrated in Figure 1-11. The PHA was used during the period when cathode wastes were crushed and loaded onto railroad cars for off-site recycling. As a result of the crushing process and area operations, cathodic dust, pitch, and coke residuals have accumulated on the surface of the PHA. The lateral extent of the residuals on the surface of the PHA is limited by existing pavement and adjacent buildings.

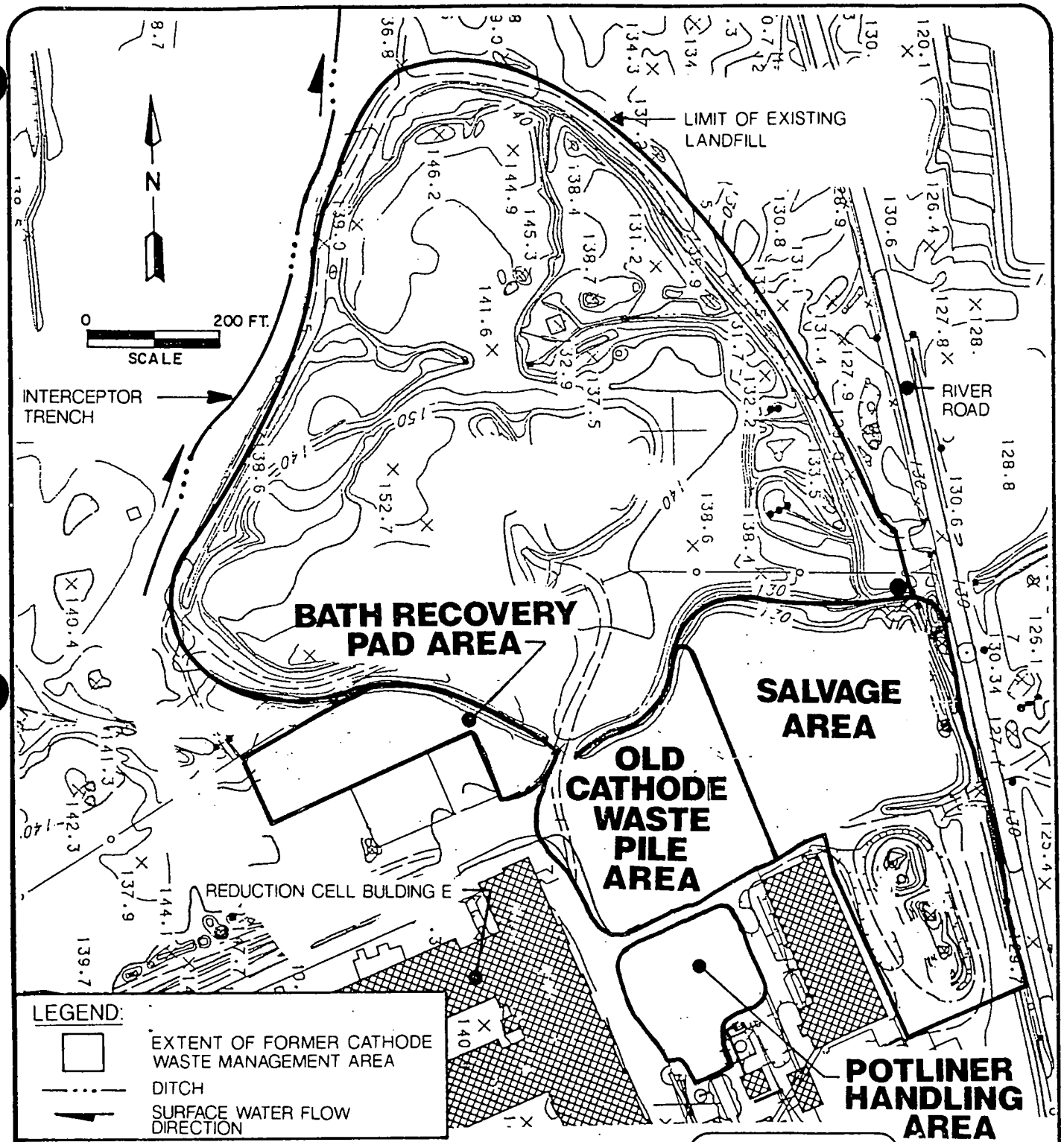

FIGURE 1-10

DRAWING NO: TE0018-P05-A68	
DRAWN BY: Ken Carey	DATE: 3-11-88
CHECKED: MZC	DATE: 3/16/88
APPROVED: DCG	DATE: 3/31/88

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FORMER CATHODE WASTE MANAGEMENT AREAS
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

BAY REPROGRAPHICS 300852

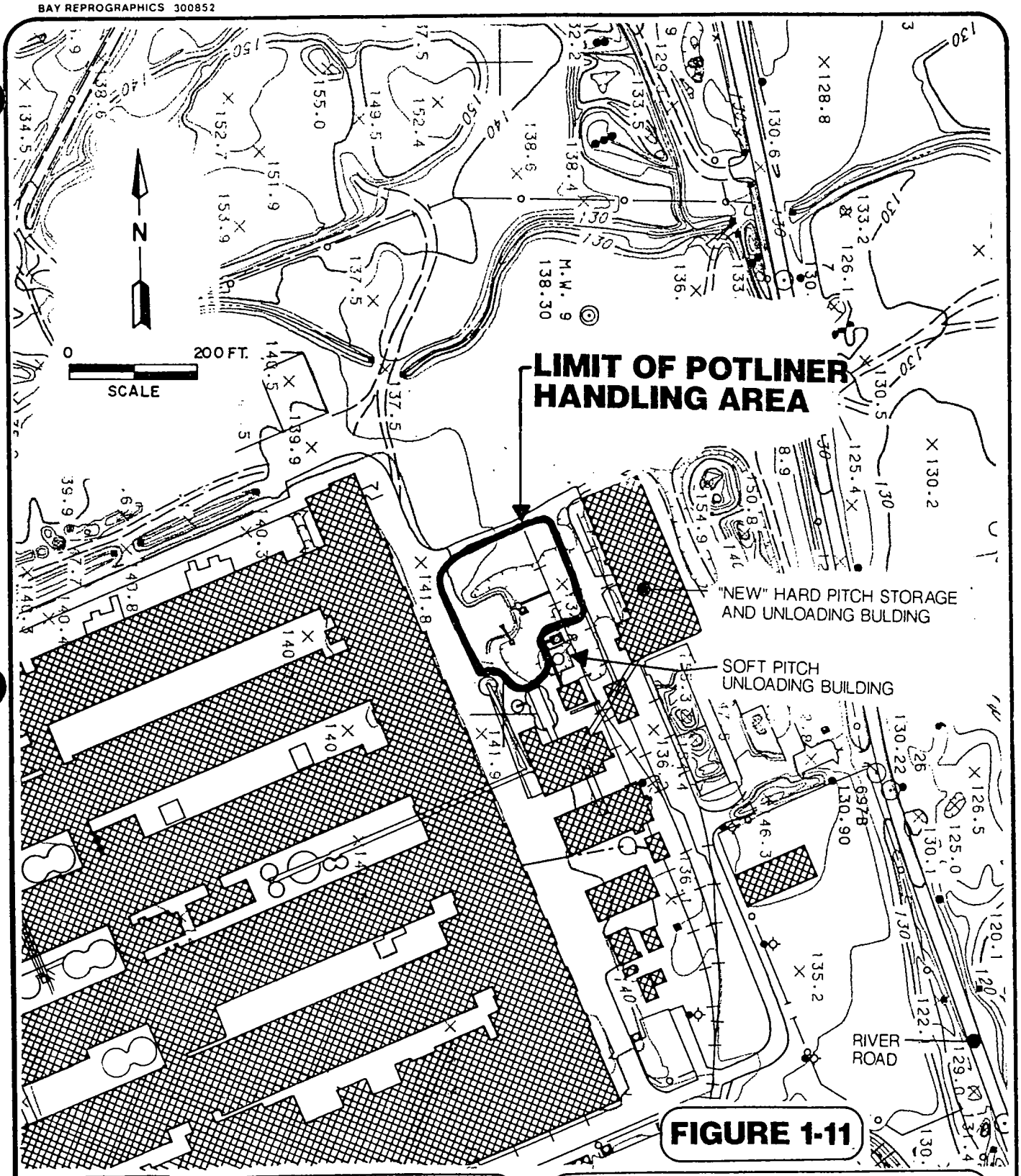

FIGURE 1-11

DRAWING NO: TE0018-P05-A42	
DRAWN BY: KEN CARROLL	DATE: 25 FEB-88
CHECKED: KCC	DATE: 3/14/88
APPROVED:	DATE: 3/31/88

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POTLINER HANDLING AREA

FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY

MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

As shown on Figure 1-11, the PHA is located in a localized topographic depression. Drainage was provided from the PHA by a storm drain adjacent to the soft pitch unloading building. However, a spill of soft pitch entered the PHA storm drain, solidified and obstructed drainage. Currently, precipitation on the PHA collects and either evaporates or percolates through the surface residuals and underlying fill.

Test pits in the Old Cathode Waste Pile Area immediately north of the PHA exposed fill thicknesses between 4.7 and 8.8 feet. Extrapolating this information to the PHA indicates that an estimated 9,910 cubic yards of fill and residuals may be present at the PHA. The 4-inch layer of residuals on the surface of the PHA accounts for approximately 480 cubic yards of the total volume. The primary material crushed for off-site recycling was carbon block. Therefore, the majority of the residuals on the PHA surface is cathode waste. The sample from the PHA surface residuals indicates the presence of the following constituents of concern:

o Cyanide	
- Total	14 mg/kg
- Free	4 mg/kg
o Fluoride	673 mg/kg
o Total PAHs	9,041 mg/kg

The constitents detected are characteristic of cathode waste, coke, and pitch.

Salvage Area

The Salvage Area occupies approximately 2.63 acres, east of the reduction building and just west of River Road as illustrated on Figure 1-12. The Salvage Area was used to store pieces of the reduction cell pot which were reused when rebuilding a pot and to store any salvageable materials for recycling or scrap. The Salvage Area grew to the east towards River Road as the Old Cathode Waste Pile increased in size and additional work and/or storage space was required. The fill material used for expanding the Salvage Area included mostly basalt fragments from construction but limited cathode waste materials are present on the surface.

Test pits in the Salvage Area exposed fill thicknesses between 3.1 and 8.0 feet. Drilling of monitor well 15B determined a fill depth of approximately 12.0 feet. This information indicates that an estimated 28,700 cubic yards of fill with residuals may be present at the Salvage Area. During the excavation of the test pits, it was observed that the residual waste was limited to approximately the top 15-inches. This reduces the fill with residuals down to approximately 5,300 cubic yards.

Two samples were taken from the Salvage Area consisting of a composite of surficial soil and a vertically integrated soils/fill composite from a test pit. The sample from the

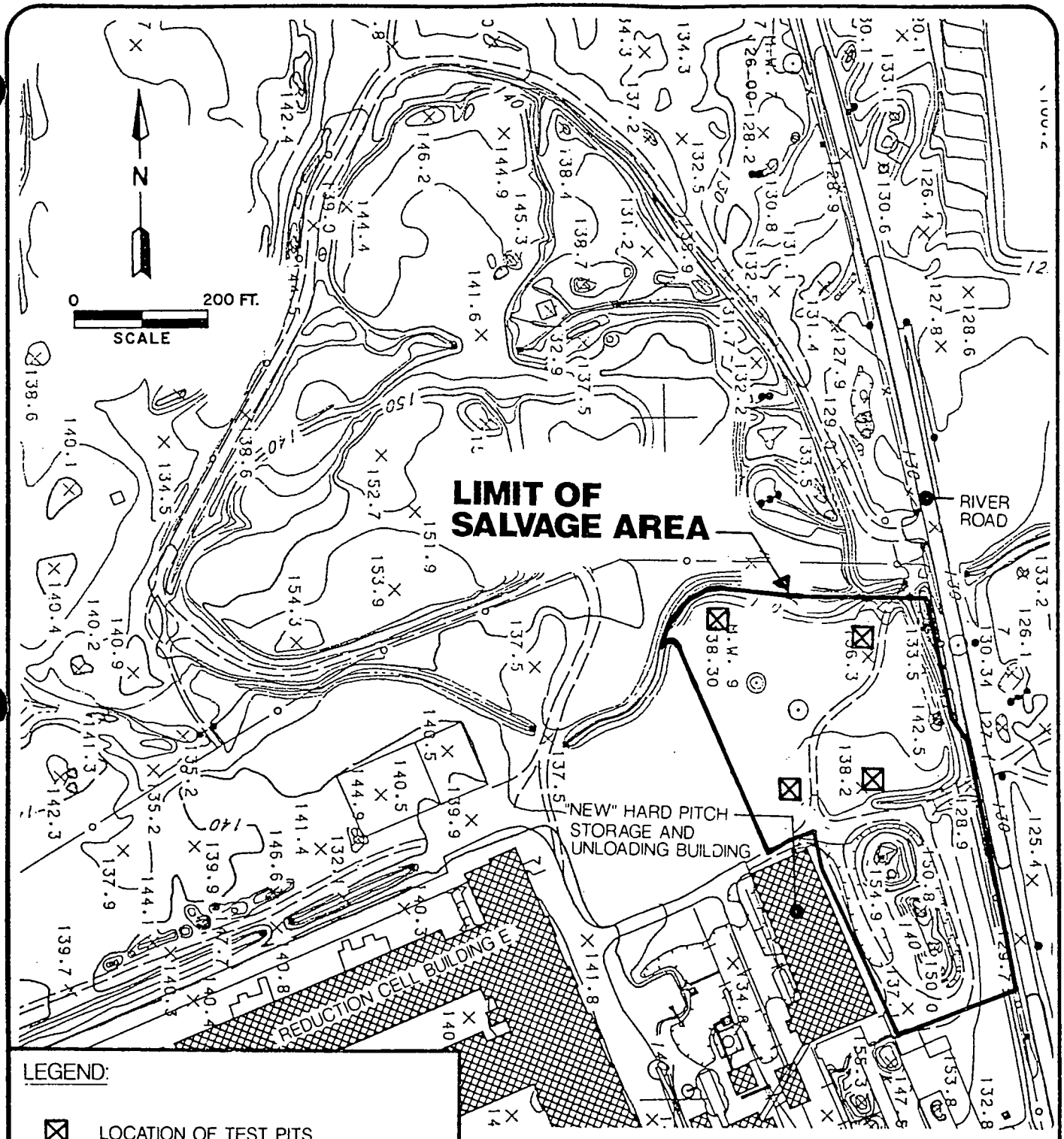

FIGURE 1-12

DRAWING NO: TE0018-P05-A71	
DRAWN BY: KCARROLL	DATE: 3-16-88
CHECKED:	DATE: 3/19/88
APPROVED:	DATE: 3/31/88

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SALVAGE AREA

FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

composite surficial soils indicates the presence of the following constituents of concern:

o Cyanide - Free	4.4 mg/kg
o Fluoride	67.3 mg/kg

The sample taken from the excavation of one of the test pits indicates the presence of the following constituents of concern:

o Cyanide - Total - Free	 196 mg/kg 86 mg/kg

The constitents detected are characteristic of cathode wastes.

Old Cathode Waste Pile Area

The former Old Cathode Waste Pile Area (OCWP) occupies approximately 2.0 acres and is just east of the northwest corner of the reduction building as illustrated in Figure 1-13. The OCWP was used to store cathode waste material from approximately 1961 to 1984. In 1984 the cathode waste and approximately 1 foot of subsoil in contact with the cathode waste was removed and placed on a new cathode waste pad designed to RCRA criteria. A soil cover was placed on the OCWP after removal activities were complete.

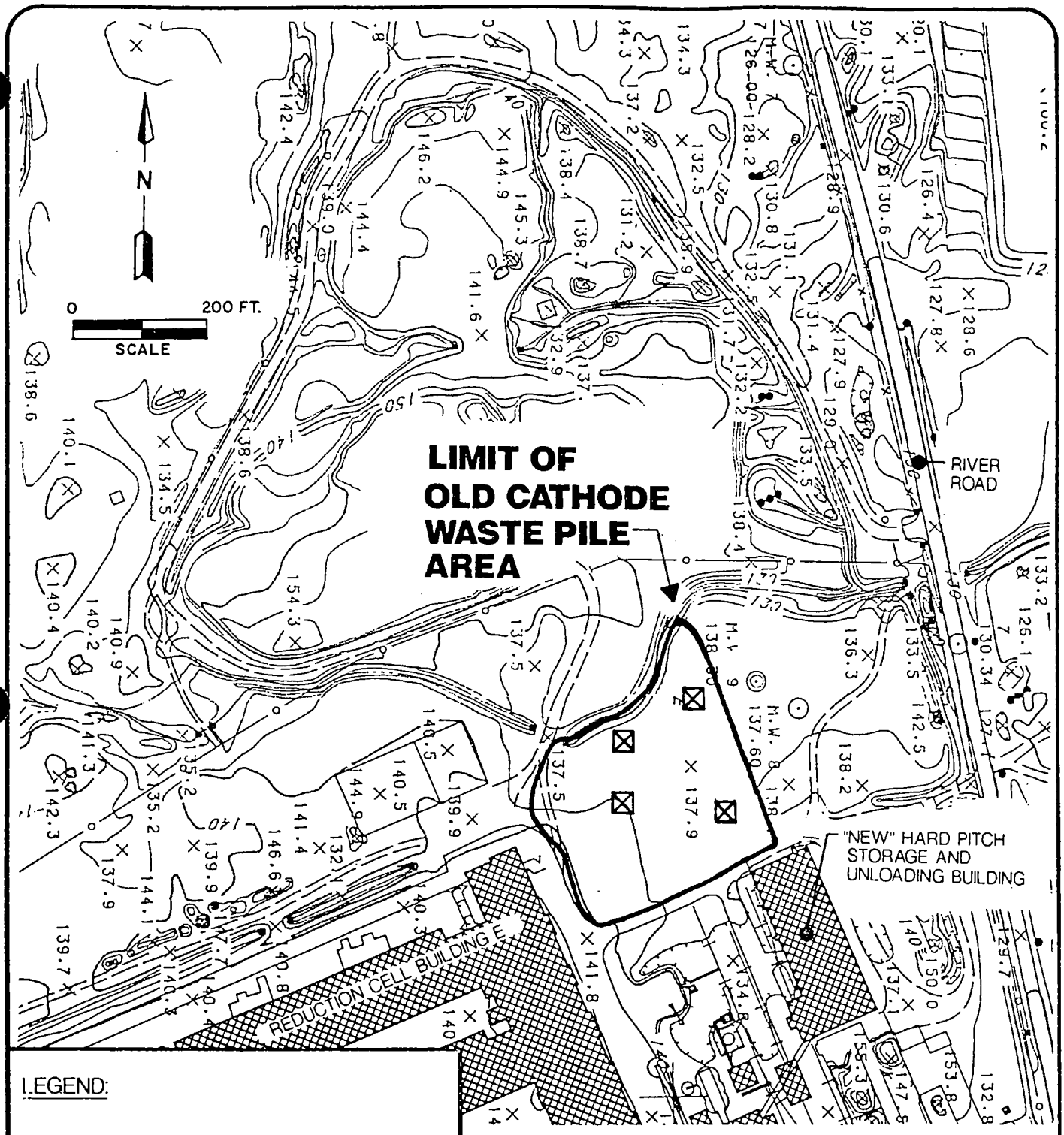

FIGURE 1-13

DRAWING NO: TE0018-P05-A72	
DRAWN BY: K. Carroll	DATE: 3-16-88
CHECKED:	DATE: 3/14/88
APPROVED:	DATE: 3/31/88

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OLD CATHODE WASTE PILE AREA

FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

To determine the thickness of the fill, four test pits were excavated in the OCWP. The exposed fill thickness ranged from between 4.7 and 8.9 feet. This indicates that an estimated 24,200 cubic yards of fill with residuals at the surface may be present at the OCWP. During the excavation of the test pits, it was observed that the waste residuals were limited to approximately the top 9-inches. Thus, this amount of fill with cathode waste residuals is approximately 2,420 cubic yards.

Four samples were taken from the OCWP consisting of a composite surficial soil and vertically composited soil samples from three test pit excavations. The composite surface soil sample indicates the presence of the following constituents of concern:

o Cyanide - Free	23 mg/kg
o Fluoride	475 mg/kg

The three vertically composited test pit samples indicate the presence for the following range of constituents of concern:

o Cyanide - Total	19 - 29 mg/kg
- Free	< 0.56 - 5.2 mg/kg

These constituents detected are characteristic of cathode waste materials.

Bath Recovery Pad Area

The Bath Recovery Pad Area (BRP) occupies approximately one acre and is located between the North Ditch and Landfill Ditch just north of the reduction building as illustrated in Figure 1-14. The BRP consists of a concrete pad with retaining walls and was used to temporarily store bath recovered from a reduction cell when taken off line for reconstruction. The bath was recycled back into the reduction process. In order to pour the concrete slab, the pad footings and base were filled to grade with gravel. The shoulders of the Landfill Ditch had been filled prior to construction of the pad to obtain a larger working area. Some of the fill observed in the shoulder of the Landfill Ditch appeared to be mixed with cathode waste as do exposed areas northwest of the concrete pad.

During sampling for the RI, it was determined that soils around the BRP ranged in depth from a couple of inches to approximately 1 foot in thickness. Fill placed along the Landfill Ditch ranged from 10 to 20 feet in distance from the existing edge of the ditch. A shallow boring through the fill determined a thickness of 8 feet from ground surface to competent basalt. This information indicates that approximately 1,660 cubic yards of fill mixed with cathode waste residuals is present at the BRP.

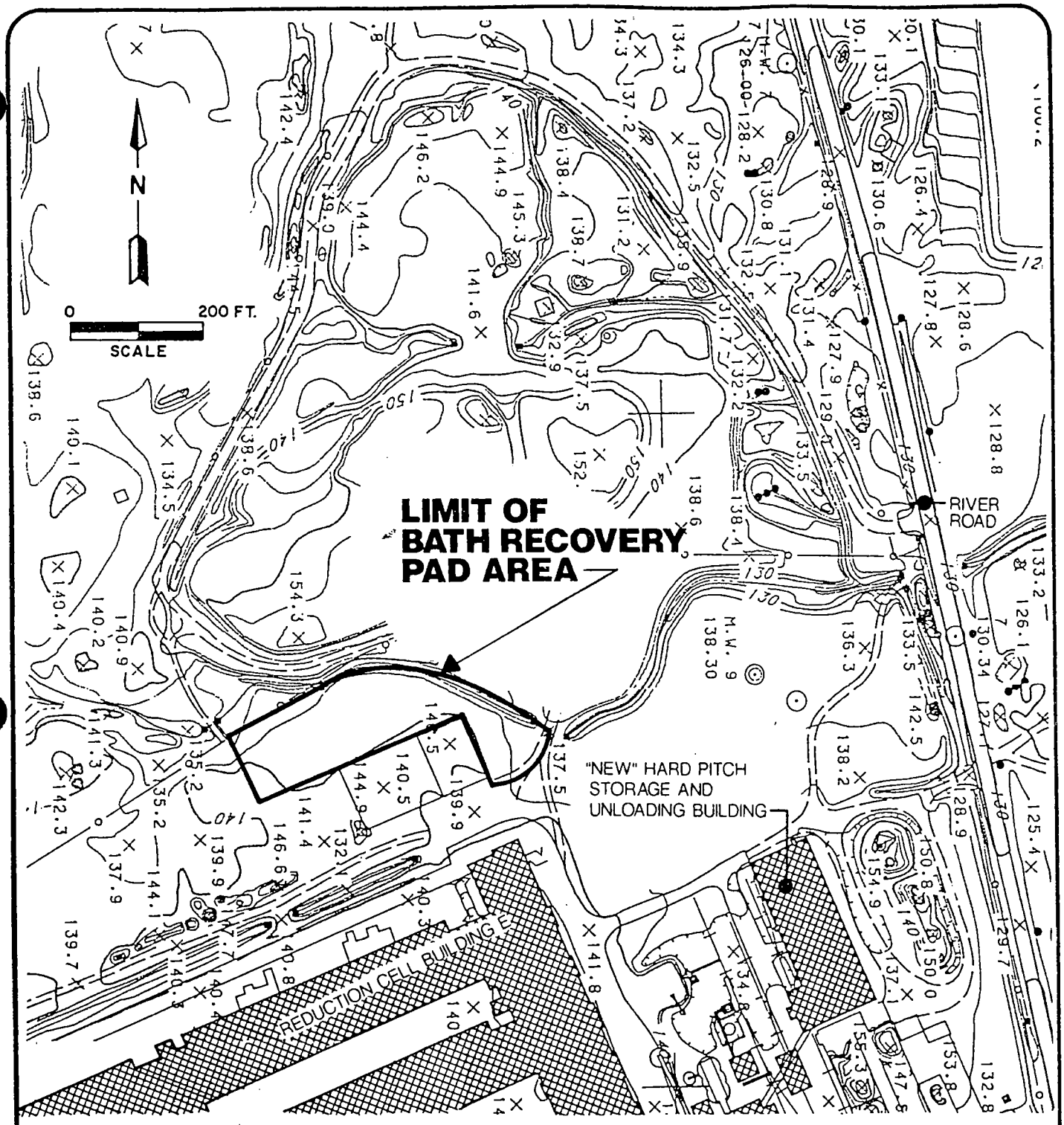

FIGURE 1-14

DRAWING NO: TE0018-P05-A70	
DRAWN BY: Ken Carroll	DATE: 3-16-88
CHECKED: LZC	DATE: 3/16/88
APPROVED:	DATE: 3/31/88

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BATH RECOVERY PAD AREA

FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

Sampling of the surface soils indicates the presence of the following constituents of concern:

o Cyanide	
- Total	17 mg/kg
- Free	17 mg/kg
o Fluoride	808 mg/kg

This information indicates the presence of cathode waste residuals.

Perched Water

During the excavation of the test pits in the Salvage and Old Cathode Waste Pile Areas, a perched water zone was encountered approximately 6 to 8 feet below the surface of the fill. A sample of the perched water was taken from a test pit in the OCWP and analysis indicates the presence of the following constituents of concern:

o Cyanide	
- Total	294 mg/L
- Free	3.1 mg/L
o Fluoride	3,000 mg/L
o Total PAHs	0.255 mg/L

Although total PAHs were detected in the sample referenced above, two additional samples were collected from the same test pit. One sample was filtered and the other sample was not filtered; both were analyzed for total PAHs. Total PAHs were not detected in either sample.

An electromagnetic survey was performed as part of the RI in February of 1988 to delineate the lateral extent of the perched water zone. Figure 1-15 presents the approximate lateral limits of the perched zone based on the results of the electromagnetic survey. (The results of the EM survey are being presented to the EPA as a supplement to the RI.)

The source for the perched water and resultant quality are derived from rainfall or snow melt percolating through the cathode waste material stored in the OCWP from 1961 to 1984. The relocation of the cathode waste to the RCRA facility eliminated the primary source for continued leachate generation to the perched water. The presence of the fill prevented the perched water from evaporating and also prevented the pathways for exposure from being complete as determined by the RA. However, the competency of the basalt underlying the perched water which separates the S-aquifer and the perched water, is not fully characterized and leakage of the perched water into the S-aquifer could potentially occur. Therefore, the potential for the perched water to contaminate underlying aquifers makes it a potential source which must be dealt with during remediation.

1.2.3.3 Management Units in Operation

The management units currently being utilized by Northwest Aluminum (NWA) as part of the reduction process consist of:

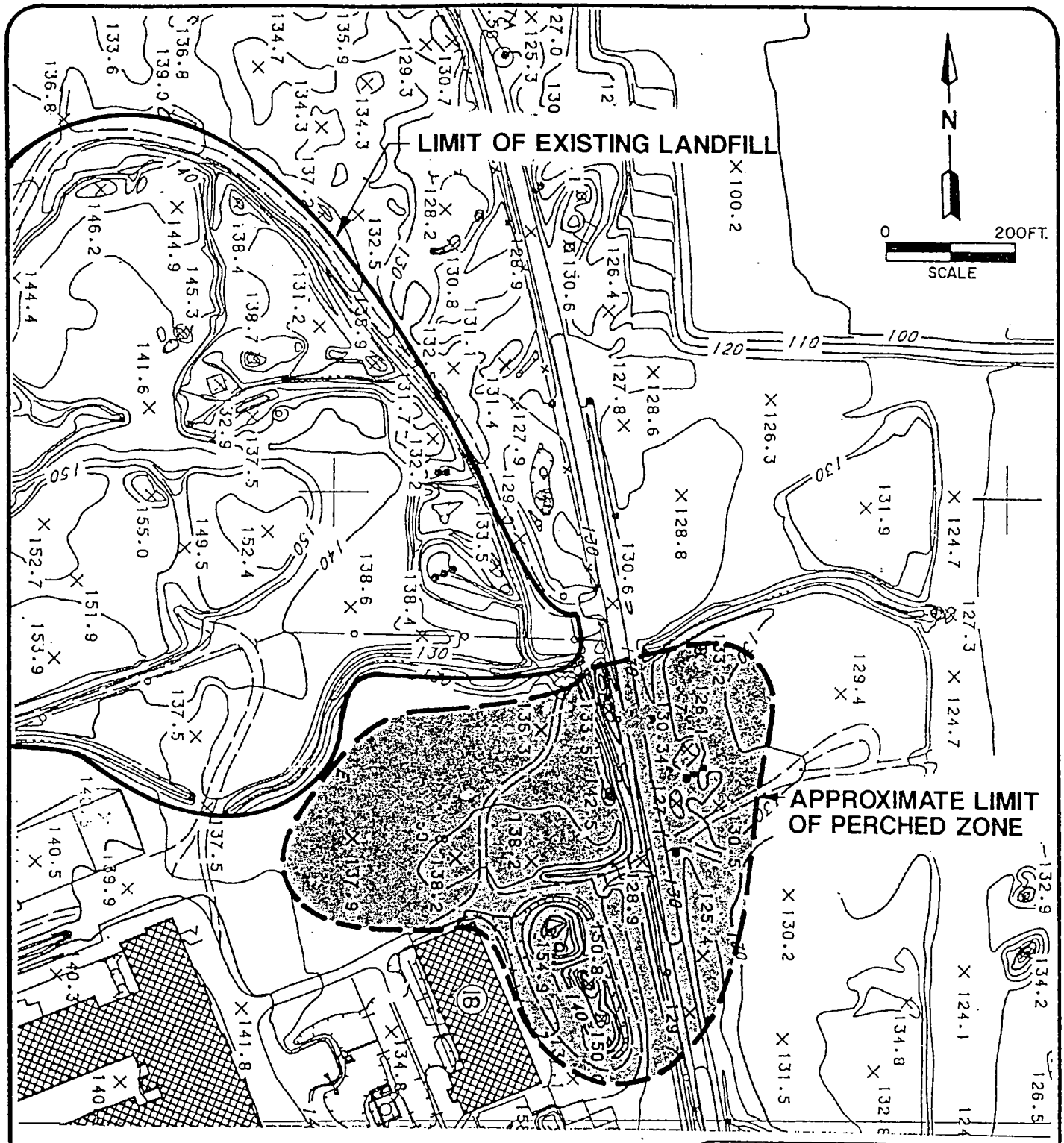

FIGURE 1-15

DRAWING NO: TE0018-P05-A89	
DRAWN BY: Ken Carroll	DATE: May 26, 1988
CHECKED: AZC	DATE: 6-7-88
APPROVED: DGJ	DATE: 6-7-88

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APPROXIMATE LATERAL EXTENT OF PERCHED WATER ZONE

FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

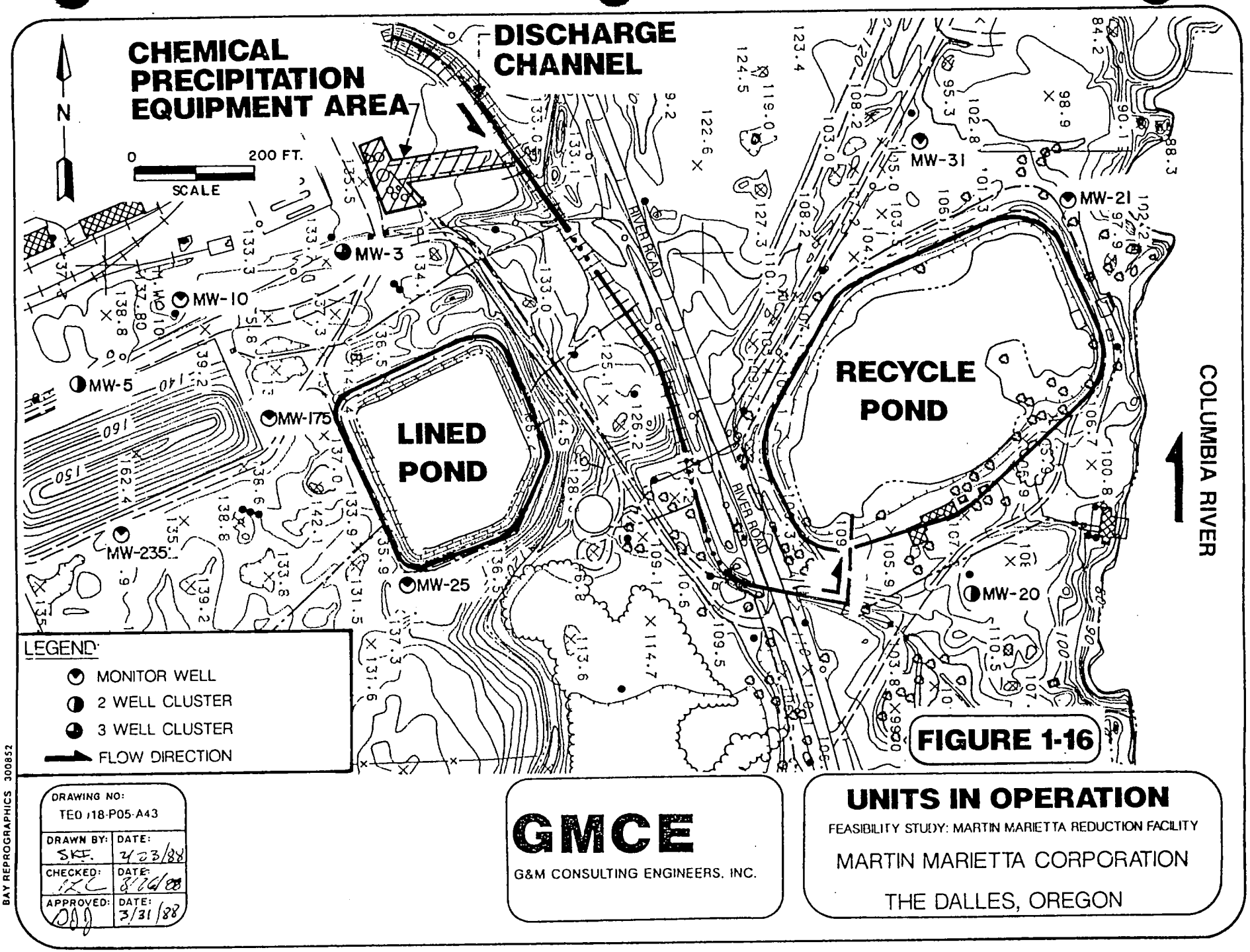
- Lined Pond;
- Recycle Pond; and
- Discharge Channel.

The location for each unit is illustrated in Figure 1-16.

Analysis of samples collected during the RI from these study areas indicate the presence of fluorides and PAHs at various concentrations. The RA evaluated each of these study areas and determined that under certain hypothetical future scenarios there were potential exposures to sediments containing cPAHs which would result in an excess risk. It should be noted that the RA concluded that under existing conditions where sediments are inundated with water at the Lined Pond, Recycle Pond and Discharge Channel should not pose unacceptable health risks. When these units cease to be part of the reduction process operations, they will be closed in accordance with the appropriate environmental regulations using best engineering practices and consistent with the final remedy for the MMRF. Closure options for these units are presented in Appendix A.

1.2.3.4 Unloading Area

The Unloading Area (UA), illustrated in Figure 1-17, is a small area south of the alumina unloading building which received cathode waste material to fill a low spot in the area. The cathode waste material was placed in this area around 1964 and from discussions with MMRF personnel it was determined that the area covers approximately 60 feet x 15


CHEMICAL PRECIPITATION EQUIPMENT AREA
DISCHARGE CHANNEL
N
0
200 FT.
SCALE
LINED POND
RECYCLE POND
RIVER ROAD
RIVER ROAD
COLUMBIA RIVER
MW-3
MW-10
MW-5
MW-175
MW-235
MW-25
MW-31
MW-21
MW-20
LEGEND
MONITOR WELL
2 WELL CLUSTER
3 WELL CLUSTER
FLOW DIRECTION
DRAWING NO:
TEO 118-P05-A43
DRAWN BY: SKF
DATE: 4/23/88
CHECKED: RC
DATE: 8/26/88
APPROVED: DBJ
DATE: 3/31/88
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UNITS IN OPERATION
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON
FIGURE 1-16
BAY REPROGRAPHICS 300852

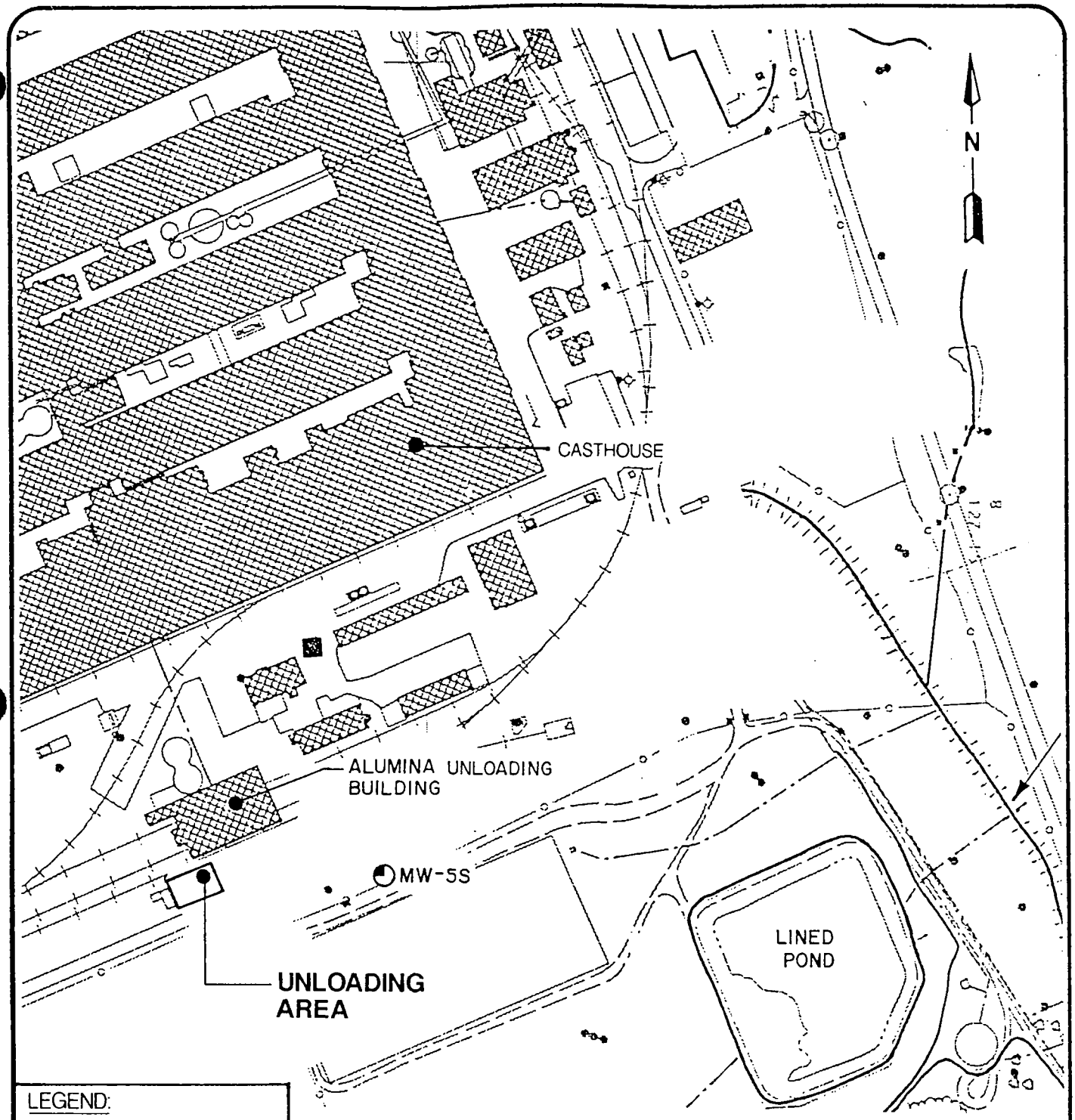

FIGURE 1-17

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DRAWN BY: SEF.	DATE: 3/18/88
CHECKED: RKC	DATE: 3/14/88
APPROVED: [illegible]	DATE: 3/31/88

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UNLOADING AREA

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THE DALLES, OREGON

feet and is approximately 5 feet deep. This results in a maximum volume of cathode waste material of approximately 200 cubic yards.

1.2.3.5 Scrubber Sludge Ponds

The Scrubber Sludge Ponds (SSPs) consist of four surface impoundments (numbered 1 through 4) located south of the reduction buildings and west of River Road as illustrated in Figure 1-18. The locations for the SSPs were selected because the air emission slurry produced in the alumina reduction process could be discharged to the SSPs under gravity conditions. The large surface area and retention capacity of the SSPs allowed for particulate settlement and final discharge of accumulated water to the Columbia River. Figure 1-19 illustrates the location of low areas prior to construction of the SSP and indicated by early aerial photos.

The topographic differences between the plateau just to the northwest of the SSPs to that east of SSP2 is between 30 to 40 feet. The geologic information obtained through the installation of ground-water monitor wells around the SSPs revealed that the Byron Interbed outcrops along the face of the ridge immediately adjacent to the SSPs. The approximate location of the outcropping of the Byron Interbed is illustrated on Figure 1-20. The Byron Interbed is a permeable layer which is considered to be part of the upper portion of the S-aquifer. The Byron Interbed is not present

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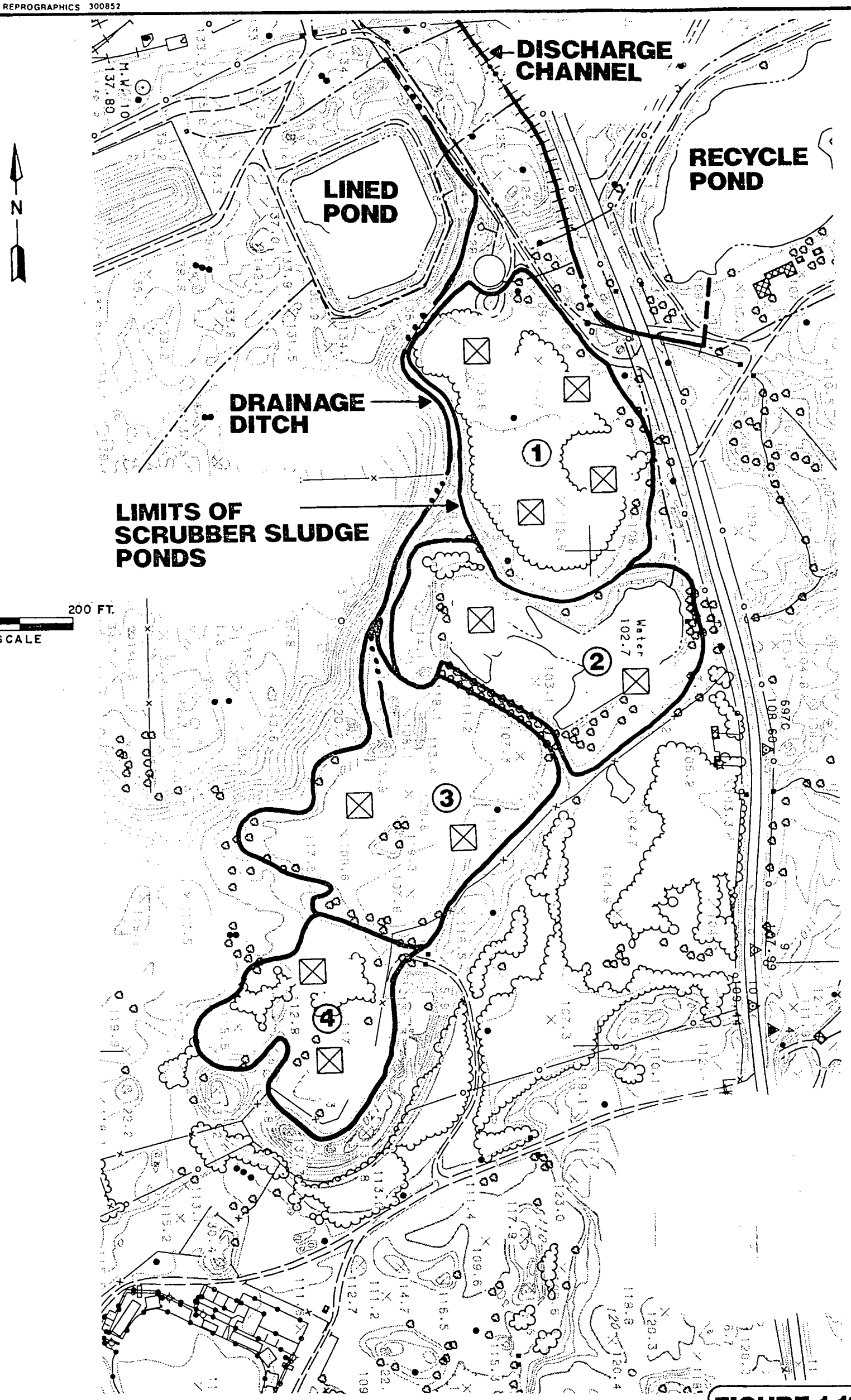

FIGURE 1-18

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DRAWN BY: KEN LARSEN	DATE: 25 FEB 88
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APPROVED:	DATE: 3/31/88

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EXISTING CONDITIONS SCRUBBER SLUDGE PONDS
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MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

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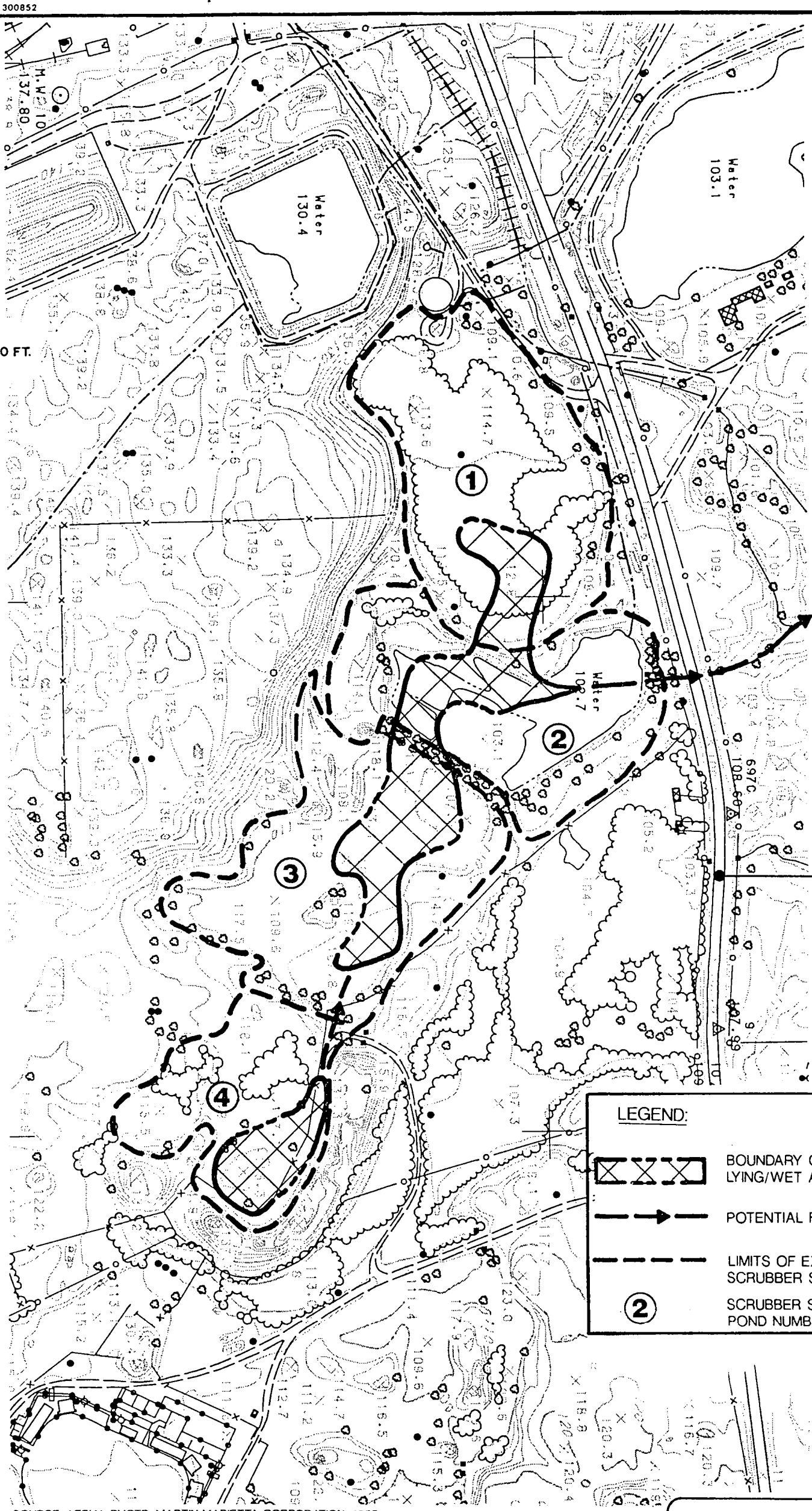

SOURCE: AERIAL PHOTO, MARTIN MARIETTA CORPORATION, 1957

FIGURE 1-19

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DRAWN BY: KEU(illegible)	DATE: 10-Feb-88
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APPROVED: DJJ	DATE: 3/31/88

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PRE-SITE DEVELOPMENT DRAINAGE SCRUBBER SLUDGE PONDS
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

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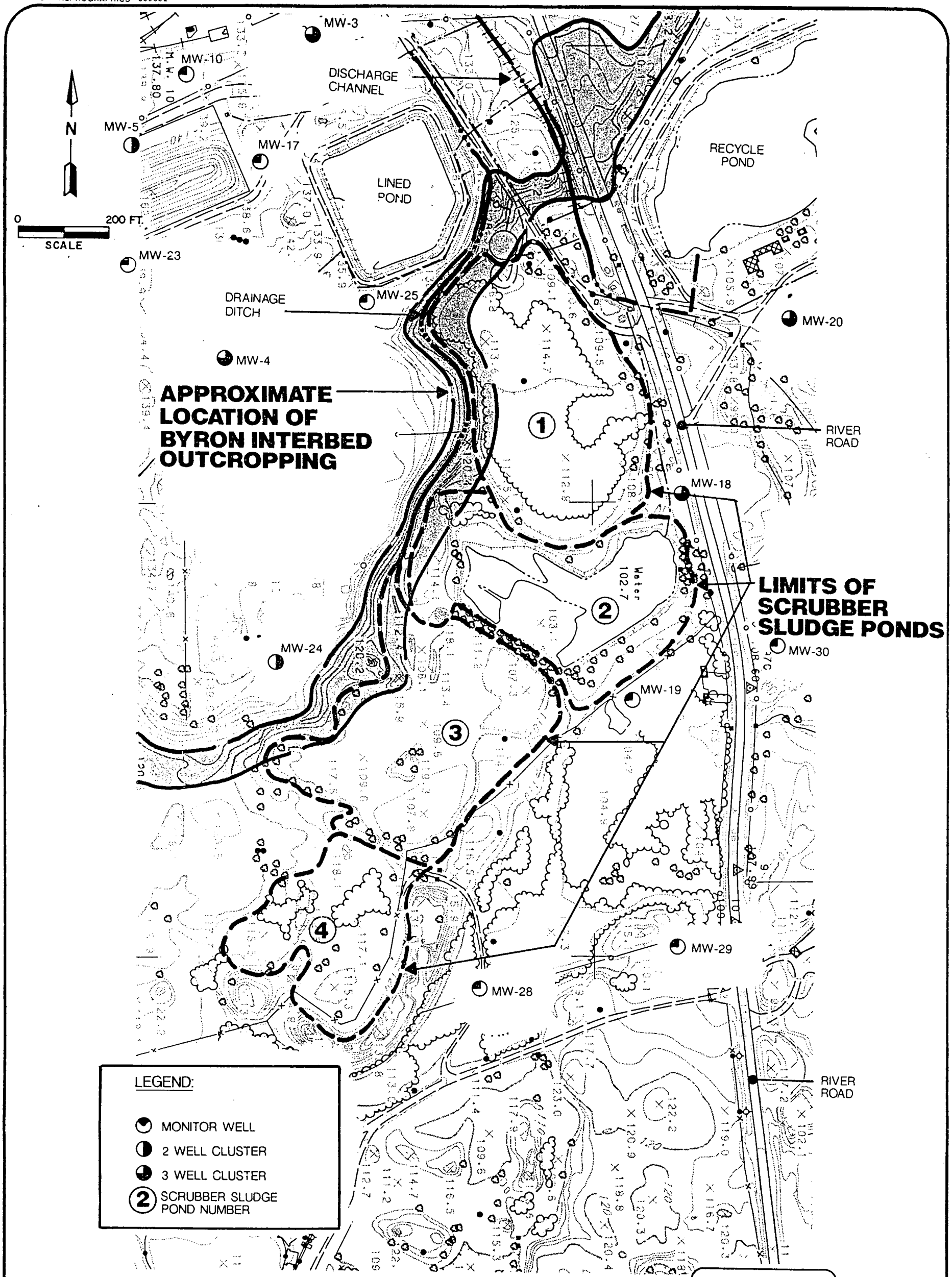

FIGURE 1-20

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DRAWN BY: KGH/ANGOL	DATE: 22-FEB-88
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LOCATION OF BYRON INTERBED AT THE SCRUBBER SLUDGE PONDS
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

G&M Consulting Engineers, Inc.

FINAL FEASIBILITY STUDY
MARTIN MARIETTA REDUCTION FACILITY
THE DALLES, OREGON

Prepared for

MARTIN MARIETTA CORPORATION

Bethesda, Maryland

June 1988

Prepared by

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to the east of the SSPs. The potentiometric contours for the S-aquifer as illustrated in Figure 1-21 indicate that the Byron Interbed is discharging to the SSPs and the saturation of the scrubber sludges in SSP2 is a result of this surface expression of the ground water.

The lateral extent of the SSPs was confined by topographic constraints including basalt outcroppings, a ridge to the north of the SSPs and other local topographic features. Figure 1-19 illustrates the general drainage conditions prior to construction of the SSPs. Figure 1-22 displays the interim configuration of the SSPs during operation prior to 1972 when MMRF began treating the air emission control waters using chemical precipitation and a clarifier.

SSP1 was diked and was used to receive chemical sludges resulting from the lime precipitation of the air emission control waters for fluoride removal. The primary salt formed during the precipitation was calcium fluoride. SSP4 received dredgings from SSP2 and SSP3 and the Recycle Pond. Both SSP1 and SSP4 were removed from service and covered in 1981.

Collectively, the lateral extent of the SSPs is approximately 14.8 acres. SSP1 and SSP4 have soil covers and established vegetation which currently precludes direct contact with the wastes. However, SSP2 and SSP3 are not currently covered. The material present in the SSPs can be

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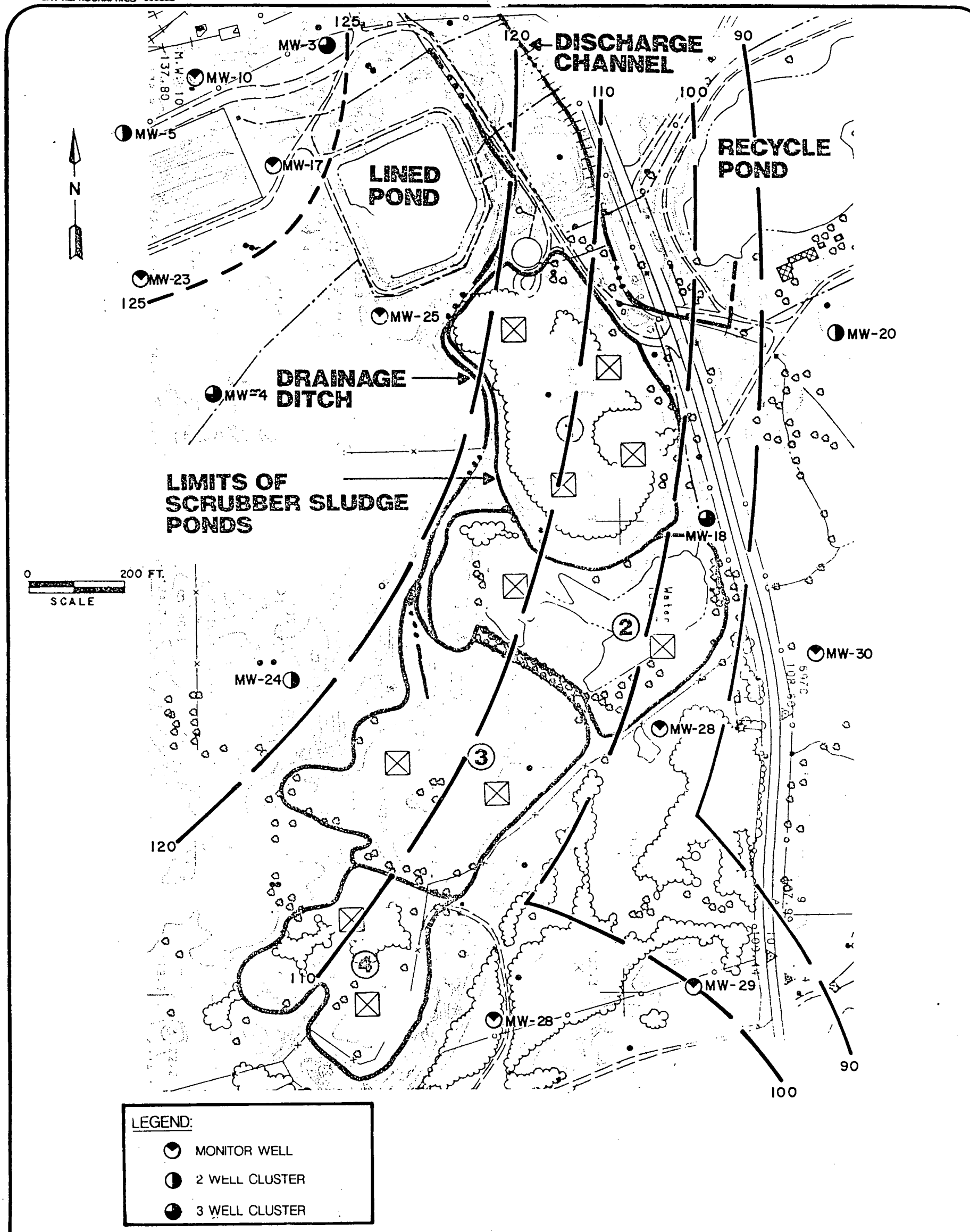

SOURCE: GROUND WATER POTENTIOMETRIC DATA. AUGUST 6, 1987

FIGURE 1-21

DRAWING NO: TE0018-P05-B65	
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CHECKED: AFC	DATE: 3/16/88
APPROVED: DPG	DATE: 3/31/88

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POTENTIOMETRIC MAP: S- AQUIFER SCRUBBER SLUDGE PONDS
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

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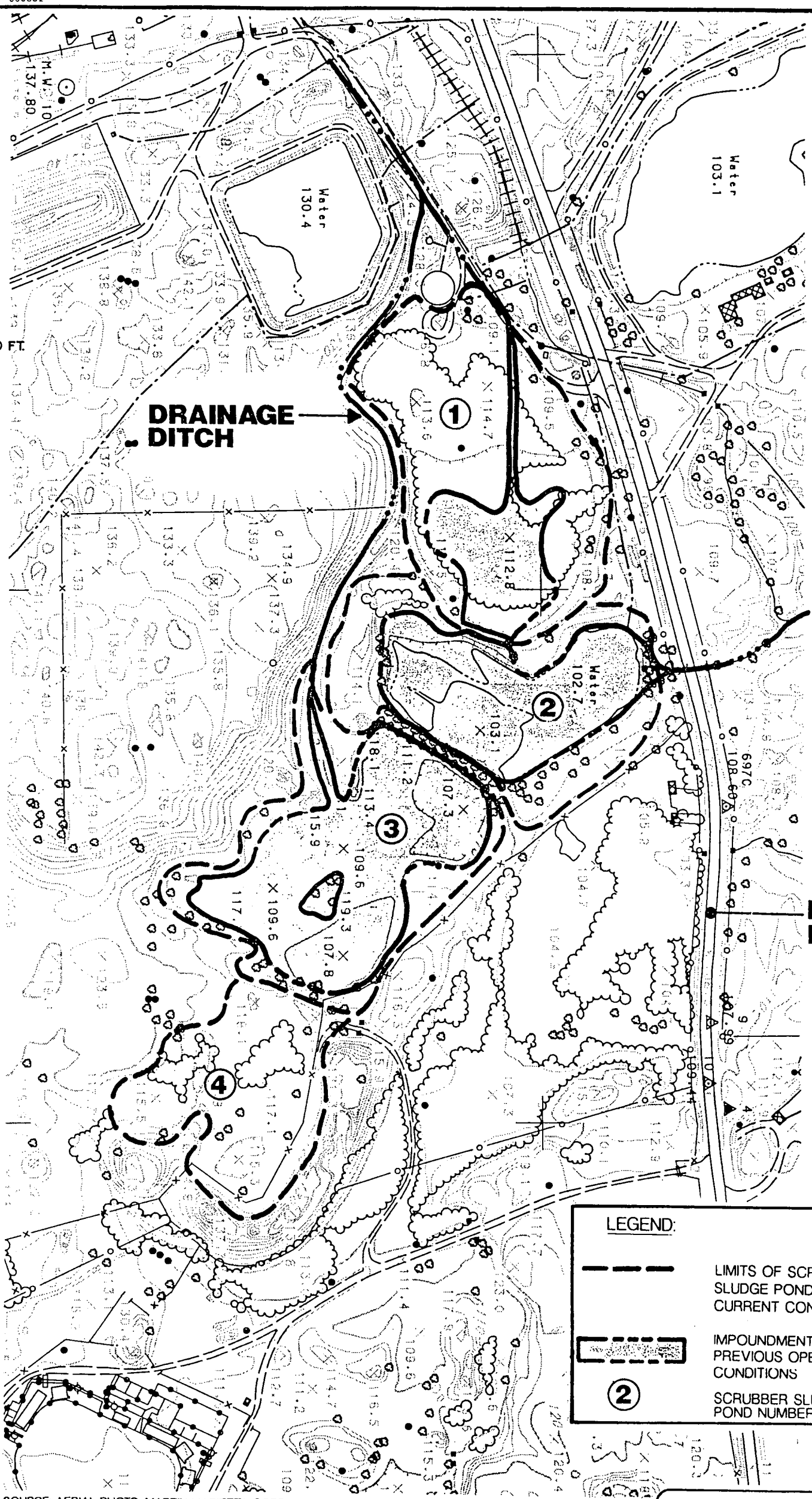

SOURCE: AERIAL PHOTO, MARTIN MARIETTA CORPORATION, PRIOR TO 1972

FIGURE 1-22

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APPROVED:	DATE: 3/31/88

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INTERIM OPERATIONAL CONDITIONS SCRUBBER SLUDGE PONDS
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

divided into three categories: (1) soil cover, (2) sludges, and (3) contaminated subsoils. The volumes of each SSP by category are presented below:

Pond	Cover	Sludge	Subsoil	Subtotal
SSP1	7,970	63,730	-	71,700
SSP2	-	6,820	2,760	9,580
SSP3	-	43,600	14,500	58,100
SSP4	4,640	17,600	6,200	28,500
			TOTAL	167,880

In addition, prevalent winds have scattered approximately 538 cubic yards of sludge south of SSP2 and SSP3.

Samples were collected from each pond and analytical results indicate the presence of the following constituents of concern:

SSP1

o Fluoride	204 -	407 mg/kg
o Arsenic	BDL -	64 mg/kg
o Total PAHs	2,760 -	8,570 mg/kg

SSP2

o Fluoride	263 -	317 mg/kg
o Arsenic	34 -	71 mg/kg
o Total PAHs	1,940 -	7,180 mg/kg

SSP3

o Fluoride	387 -	613 mg/kg
o Arsenic	66 -	77 mg/kg
o Total PAHs	3,950 -	8,360 mg/kg

SSP4

o Fluoride	212 -	258 mg/kg
o Arsenic	BDL -	50 mg/kg
o Total PAHs	2,670 -	3,979 mg/kg

Water was not present in SSP2 when samples were collected and therefore, could not be analyzed.

1.2.3.6 Ground Water

The constituents of concern identified in the ground-water systems are fluoride and sulfate. The highest concentrations of fluoride are present in the perched water with progressively lower concentrations identified within the S-, A-, and B-aquifers. Concentrations of fluoride in wells tapping the DGWR are low and within the range expected for background. Sulfate concentrations exceeding the State of Oregon secondary contaminant level of 250 mg/L were detected in the S-aquifer in the vicinity of the Scrubber Sludge Ponds, the Recycle Pond and the Unloading Area. The maximum sulfate concentration detected in ground water was 3,020 mg/L in the S-aquifer southeast of the Scrubber Sludge Ponds. Sulfates were not detected at concentrations in excess of the State secondary contaminant level in the A- or B-aquifers with the expection of MW-18B which indicated a sulfate concentration of 271 mg/L. Sulfates were also not detected in The Dalles Ground-Water Reservoir above background levels.

Samples from the well in the alluvial aquifer at the Animal Shelter include a total cyanide concentration of 0.023 mg/L, a fluoride concentration of <1.0 mg/L and a sulfate concentration of 15 mg/L. No free cyanide or fluoride was detected in this sample. The remediation criteria is based on free cyanide and because none was detected, there is no reason to retain the alluvial aquifer for further consideration.

Elevated constituent concentrations were identified in the S-aquifer at several locations:

(1) Near the Landfill and Former Cathode Waste Management area. Fluoride concentrations range from <1.0 mg/L to 4.7 mg/L and free cyanide ranged from <0.01 to 0.136 mg/L.

(2) Scrubber Sludge Ponds. This area contains fluoride (4.8 to 7.1 mg/L), sulfate (1,810 to 3,020 mg/L), free cyanide is below detection limits and total cyanide is reported in only one well (MW-18S) at 0.05 mg/L.

(3) Unloading Area. Ground-water samples show detectable fluoride at 57 mg/L at well MW-5S. Sulfate was found at 680 mg/L and 1,130 mg/L.

(4) Recycle Pond. Samples from well MW-31 downgradient of the pond indicates a maximum fluoride concentrations of 5.5 mg/L and well MW-21 indicates a maximum sulfate concentration of 871 mg/L.

Ground-water quality impacts in the A-aquifer are less widespread and at lower concentrations than those identified in the S-aquifer. Recent data indicates that none of the

constituents of concern are present in excess of the sitewide remediation criteria presented in Table 1-11 except for fluoride at a concentration of 10.0 mg/L in monitor well 9A. It is suspected that the detection of this constituent in monitor well 9A is an artifact of well construction. Continued monitoring of this well will be performed to verify this interpretation. Should the results be verified, additional actions will be conducted as discussed in Section 4.0.

In the B-aquifer, elevated constituent concentrations are chiefly confined to monitor wells 9B and 18B near the Landfill and Former Cathode Waste Management Areas and Scrubber Sludge Ponds. Fluoride has been detected in monitor well 9B at 20 mg/L and sulfate has been detected in monitor well 18B at 271 mg/L. It is suspected that the detection of these constituents of concern are artifacts of well construction. Continued monitoring of monitor wells 9B and 18B will be performed to verify this interpretation. Should these results be verified, additional actions will be conducted as discussed in Section 4.0.

1.3 OBJECTIVES OF REMEDIAL ACTION

The remedial action objectives for the MMRF are source control and ground-water management for the protection of human health, welfare and the environment from potential impacts due to constituents introduced to the area by past

processing practices. Remedial action technologies will be identified and screened for combination into comprehensive remedial measures which address these fundamental objectives.

Specific objectives for source control are to:

- Minimize the migration of constituents from the source areas to ground-water systems, surface water, or soils;
- Protect human health and the environment from potential adverse effects caused by direct contact of constituents; and
- Protect human health and the environment from potential adverse effects from exposure to airborne particulates.

Remedial measures for addressing these source control objectives would focus on isolating the source to reduce direct contact with waste, implementing dust control methods, collection and treatment of generated leachate, and minimization of leachate generation.

The source control objective addressed is dependent upon the study area being managed. The target remediation areas being examined in this FS, due to their potential as sources of risk and the specific objectives for mitigating risks associated with the areas, are the following:

Study Area	Objectives
Landfill and Associated Areas	o Prevent the generation of leachate containing fluoride and cyanide. o Prevent direct contact with Landfill waste.
Unloading Area	o Prevent fluoride contamination of the S-aquifer.

	o Prevent direct contact with the Unloading Area waste.
Former Cathode Waste Management Areas	o Prevent contamination of the perched water.
	o Prevent direct contact with Potliner Handling Area waste.
Scrubber Sludge Ponds	o Prevent direct contact by public with sediments and fugitive dust emissions.

Specific ground-water problems at the site include the potential for fluoride and sulfate contamination of the S-aquifer beneath the site. The objective for ground-water management is to satisfy the ground-water remediation criteria for the aquifers beneath the site.

These remedial objectives will be achieved by incorporation of environmental, public health, and safety considerations in the evaluation of remedial technologies and alternatives for management of the site. Remedial actions which result in the treatment of waste constituents to their respective remediation criteria will be applied, as possible, for compliance with the intent of SARA which focuses on implementation of permanent remedies. Evaluations performed and documented in this FS for development of remedial alternatives will include an assessment of the reliability, limitations to implementation, effectiveness, and cost-effectiveness associated with each technology, remedial measure and alternative identified.

092/6

2.0 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

This section presents the identification and screening of remedial technologies for potential applicability to the MMRF. The technologies are screened in accordance with recommendations provided in the EPA's Draft Guidance For Conducting Remedial Investigations and Feasibility Studies Under CERCLA (October 14, 1987), hereafter referred to as the Draft Guidance Document. The Draft Guidance Document suggests the following steps to identify feasible technologies for remediation of a CERCLA Site:

- Identify site contaminants, environmental media of concern and remedial action objectives;
- Identify general response actions that address site problems and have the potential to satisfy the remedial action objectives; and
- Identify specific remedial technologies for each general response action and screen the technologies to eliminate those precluded by site and/or waste characteristics.

Sections 1.2 and 1.3 in Section 1.0 identified the site problems and remedial action objectives for the MMRF. The remaining two steps are discussed in the following sections.

2.1 GENERAL RESPONSE ACTIONS

This section presents the general response actions identified as potential remedial measures for the Landfill, the Unloading Area, the Former Cathode Waste Management Areas, the Scrubber Sludge Ponds, and ground water. The

EPA's Draft Guidance Document defines general response actions as general measures that may be implemented to achieve the remedial action objectives. Although general response actions are not detailed, they categorize technologies which may be pertinent for remediation of the site problems. General response actions are developed to identify technologies which will minimize releases, threats of release, or pathways of exposure from the environmental media of concern at the MMRF.

Figure 2-1 presents the environmental media of concern at the MMRF, the remediation objectives for each of these media and the general response actions developed to attain the remediation objectives. The general response actions presented on Figure 2-1 will assist in identifying remedial technologies for management of the target remediation areas.

2.2 IDENTIFICATION AND SCREENING PROCESS

This section presents the remedial technologies applicable to the general response actions outlined in the previous section. Each technology identified is screened to eliminate those which are limited with respect to attaining the remedial action objectives set forth in Section 1.3. Figures 2-2 through 2-4 present the remedial technologies identified for the general response actions defined in Section 2.1. Note that the remedial technologies are further

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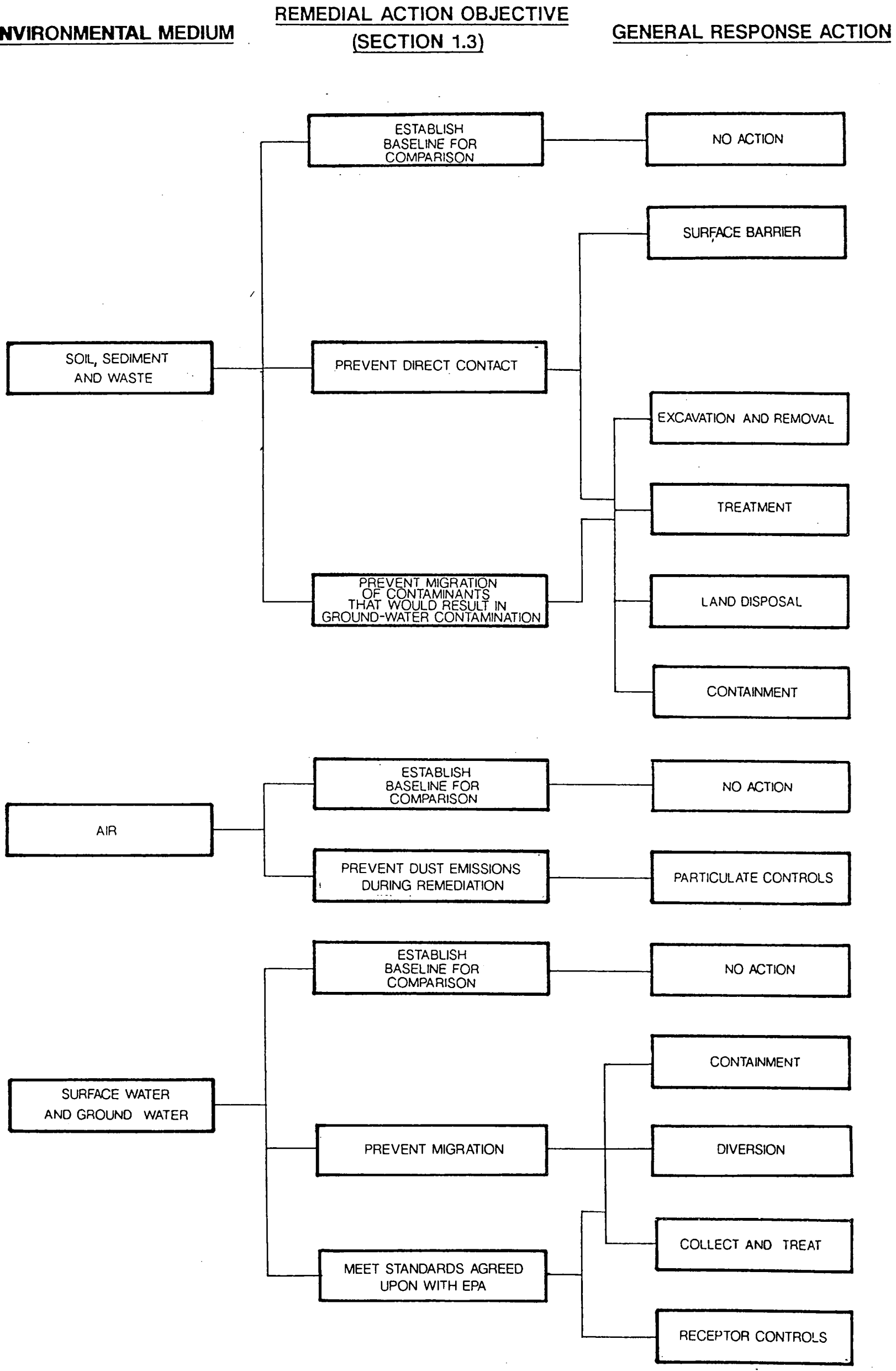

FIGURE 2-1

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GENERAL RESPONSE ACTIONS
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

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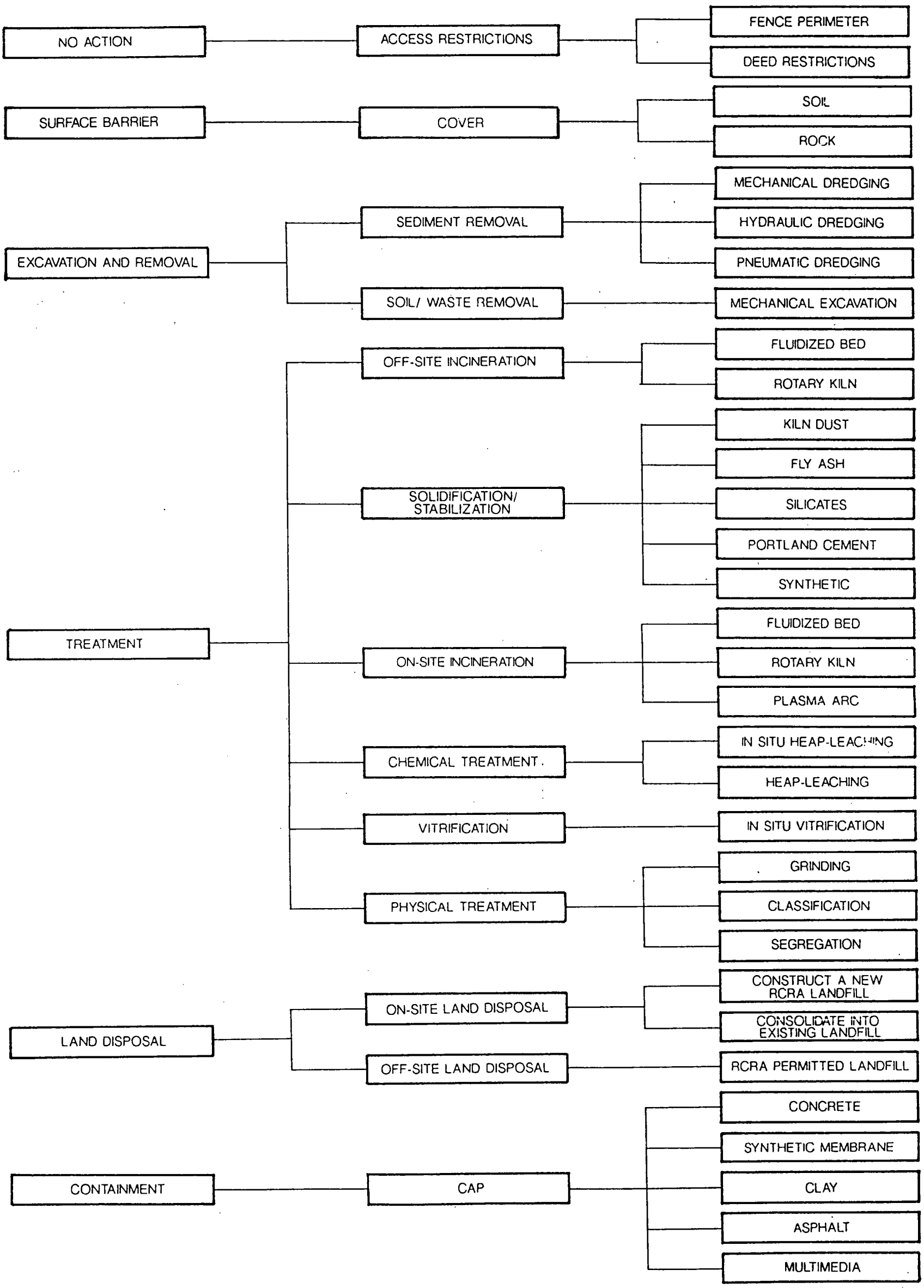

FIGURE 2-2

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CHECKED: AC	DATE: 3-31-88
APPROVED:	DATE: 3/31/88

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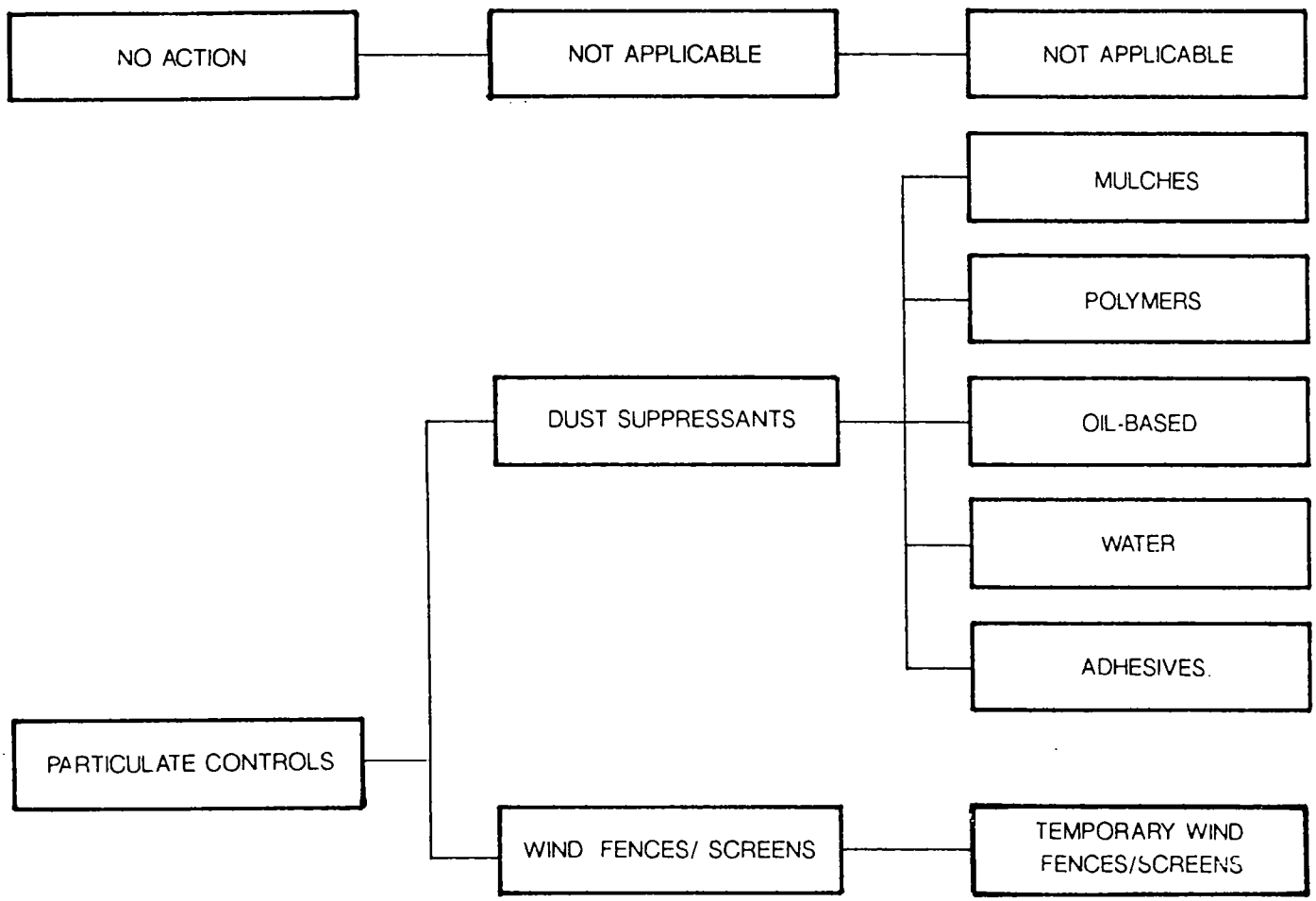
POTENTIAL REMEDIAL TECHNOLOGIES FOR SOIL, SEDIMENT AND WASTE
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

BAY REPROGRAPHICS 300852



NOTE:
AIR CONTROLS ARE SHORT TERM MEASURES THAT MAY BE REQUIRED DURING REMEDIATION.

FIGURE 2-3

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DRAWN BY: S.K.F.	DATE: 1 29 88
CHECKED: RC	DATE: 3-31-88
APPROVED:	DATE: 3/31/88

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POTENTIAL REMEDIAL TECHNOLOGIES FOR AIR EMISSIONS CONTROL
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	COMPONENTS
NO ACTION	EXISTING LEACHATE COLLECTION SYSTEM	DITCHES
	GROUND-WATER MONITORING	NOT APPLICABLE
	INSTITUTIONAL CONTROLS	PREVENT DRILLING OF NEW WELLS
		NEW WELL CONSTRUCTION SPECIFICATIONS
CONTAINMENT	HYDRAULIC BARRIERS	GROUND-WATER PUMPING
		GROUND-WATER INJECTION
	SUBSURFACE BARRIERS	SLURRY WALL
		GROUTING
		SHEET PILING
		BOTTOM SEALING
DIVERSION	SURFACE WATER CONTROL	DITCHES
		CHANNELS
		DOWNPIPES/ CHUTES
		GRADING
COLLECT/ TREAT	LEACHATE COLLECTION	DITCHES
		LEACHATE COLLECTION SYSTEM
	GROUND WATER COLLECTION	SUBSURFACE DRAINS
		INTERCEPTOR TRENCH
		RECOVERY WELLS
		WELL POINTS
	PHYSICAL TREATMENT	FLOW EQUALIZATION
		ACTIVATED CARBON
		ION EXCHANGE
		FILTRATION
		REVERSE OSMOSIS
		EVAPORATION
		STRIPPING
		SORBENTS
		DISSOLVED AIR FLOTATION
		LIQUID EXTRACTION
	CHEMICAL TREATMENT	NEUTRALIZATION
		CHEMICAL PRECIPITATION
		CHEMICAL OXIDATION
		CHEMICAL REDUCTION
		ULTRAVIOLET IRRADIATION
		BIOLOGICAL OXIDATION
	IN SITU TREATMENT	IN SITU BIOLOGICAL
RECEPTOR CONTROLS	ALTERNATIVE WATER SUPPLY	CITY WATER
	PREVENT WITHDRAWAL	PLUG AND ABANDON WELLS

FIGURE 2-4

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DRAWN BY: SKF	DATE: 3/7/88
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APPROVED:	DATE: 3/31/88

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POTENTIAL REMEDIAL TECHNOLOGIES FOR SURFACE AND GROUND-WATER
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

categorized into components. Technologies and corresponding components will subsequently be screened for applicability to the site.

The Draft Guidance Document recommends that the remedial technologies be screened for the following criteria:

- Effectiveness;
- Implementability; and
- Cost.

Effectiveness is defined as the ability of a given technology to handle the estimated waste volumes, to attain the remedial action objectives, and to protect human health and the environment during construction phases of the site remediation. In addition, the technology should be reliable and proven with respect to remediation of the contaminants detected at the site. However, innovative technologies which provide permanent remedies should also be given equal consideration in accordance with the intentions of SARA.

Implementability is defined as the ability of a given technology to obtain necessary approval from government agencies and to comply with location and action specific ARARs. The definition of implementability also includes consideration of the availability of treatment, storage or disposal capacity and the availability of required equipment and trained personnel.

The cost evaluation criteria is defined as the relative capital, operation and maintenance costs associated with a given technology. Costs presented in this section are estimated using best engineering judgment and are presented as low, medium or high. Cost comparisons are only performed between technologies which are in the same technology type (i.e., treatment or non-treatment).

The technologies and their components are screened for effectiveness, implementability and cost in Tables 2-1 through 2-3. Of these three criteria, effectiveness is given the most importance while cost is given the least. Technologies or their components which are environmentally unsound, difficult to implement at the MMRF, ineffective or have limited effectiveness are eliminated from further consideration. The following section briefly describes the technology components which satisfied the screening criteria. Section 2.4 describes the technology components which did not satisfy the screening criteria.

2.3 DISCUSSION OF APPLICABLE REMEDIAL TECHNOLOGY COMPONENTS

This section presents a brief discussion of the applicable remedial technology components identified for remediation at the MMRF. Where remedial technology components apply to more than one medium, the discussion is not repeated.

TABLE 2-1

Screening of Remedial Technologies for Soil, Sediment and Waste Control
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Remedial Technology	Component	Effectiveness	Implementability	Relative Cost	Retain for Remedial Measures (1)
Access Restrictions	Fence Perimeter	Protects against unauthorized entry.	Equipment, materials and contractors available.	Low	Yes
	Deed Restrictions	Dependent upon long-term enforcement.	Legal requirements.	Low	Yes
Sediment Removal	Mechanical Dredging	Effective for removing dry or wet material.	Equipment available; may require dust suppressants.	Low	Yes
	Hydraulic Dredging	Effective for removing wet material (10 to 20 wt.% solids).	Equipment available; does not require dust suppressants. Requires subsequent separation of solids from liquid.	Medium	No
	Pneumatic Dredging	Effective for removing wet material (10 to 20 wt.% solids). Limited production rate.	Limited availability of equipment in the United States. Requires subsequent separation of solids from liquid.	High	No
Soil/Waste Removal	Mechanical Excavation	Proven and reliable for soil/waste excavation.	Equipment available; limited to removal of unconsolidated material or basalt fragments.	Medium	Yes
Off-site Incineration	Fluidized Bed	Proven, effective treatment for spent potliner material.	Available; permit required; potential for waste exposure to humans and/or the environment during transportation to off-site facility.	Very High	No
	Rotary Kiln	Not demonstrated for the destruction of contaminants in spent potliner.	Available; permit required; potential for waste exposure to humans and/or the environment during transportation to off-site facility.	Very High	No

Note: (1) Sections 2.3 and 2.4 explain the reasoning for retaining or rejecting technology components.
067/17

TABLE 2-1
(continued)

Screening of Remedial Technologies for Soil, Sediment and Waste Control
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Remedial Technology	Component	Effectiveness	Implementability	Relative Cost	Retain for Remedial Measures (1)
Solidification/ Stabilization	Kiln Dust	Proven and reliable treatment method.	Sufficient quantities of kiln dust available.	Medium	Yes
	Fly Ash	Solidification agent only. May require other stabilizing agents.	Sufficient quantities of fly ash available.	Low	Yes
	Silicates	Proven and reliable treatment method.	Sufficient quantities of silicates available.	Medium	Yes
	Portland Cement	Proven and reliable treatment method.	Sufficent quantities of Portland Cement available.	Medium	Yes
	Synthetic	New technology which has not been demonstrated to stabilize contaminants detected at the MMRF.	Limited quantity of synthetic additives available.	High	No
On-site Incineration	Fluidized Bed	Proven treatment method for spent potliner. Questionable reliability.	Limited availability; regulatory requirements for air emissions and ash disposal.	Very High	Yes
	Rotary Kiln	Not demonstrated for the destruction of contaminants in spent potliner.	Available; regulatory requirements for air emissions and ash disposal.	Very High	No
	Plasma Arc	Not a demonstrated technology.	Very limited availability; regulatory requirements for air emissions and ash disposal.	Very high	No
Chemical Treatment	In Situ Heap-Leaching	Effective technology for removing leachable constituents from solids. Innovative as a hazardous waste treatment method.	Available technology; fractured geology beneath the site may present problems.	Medium	Yes
	Heap-Leaching	Effective technology for removing leachable constituents. Innovative as a hazardous waste treatment method.	Available technology; requires construction of heap-leaching facility.	High	Yes

TABLE 2-1
(continued)

Screening of Remedial Technologies for Soil, Sediment and Waste Control
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Remedial Technology	Component	Effectiveness	Implementability	Relative Cost	Retain for Remedial Measures (1)
Vitrification	In Situ Vitrification	Limited effectiveness on waste containing a minimum amount of silicates required for fusion.	Limited availability.	High	No
Physical Treatment	Grinding	Effective particle size reduction method.	Equipment available; facilitates waste treatment alternatives.	Medium	Yes
	Classification	Typically limited to slurries.	Equipment available; may be difficult to slurry waste.	Low	No
	Segregation	Effective sorting technique.	Equipment available; facilitates removal or treatment of the waste.	Low	Yes
On-site Land Disposal	Construct a RCRA Landfill	Effective, proven disposal technology.	Available technology; may require blasting into the basalt to create sufficient capacity for the landfill.	High	Yes
	Consolidate into Existing Landfill	Effective for protecting human health and the environment in addition to minimizing the number of waste management units on-site.	Readily available; restrictions on future land use required. Requires capping of the Landfill after consolidation activities cease.	Medium	Yes
Off-site Land Disposal	RCRA Permitted Landfill	Effective and reliable option; transportation required.	Nearest facility is approximately 30 miles away. Potential for waste exposure to humans and/or the environment during transportation to an off-site facility.	High	No

Note: (1) Sections 2.3 and 2.4 explain the reasoning for retaining or rejecting the technology components.
67/17

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TABLE 2-1
(continued)

Screening of Remedial Technologies for Soil, Sediment and Waste Control
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Remedial Technology	Components	Effectiveness	Implementability	Relative Cost	Retain for Remedial Measures (1)
Cap	Concrete	Effective but susceptible to weathering and cracking. Micro-cracks may occur during freeze-thaw conditions common to The Dalles in winter.	Readily available; restrictions on future land use required.	High	No
	Synthetic Membrane	Effective, proven technology.	Materials are available; restrictions on future land use required. Requires a cover after installation of the membrane to protect the integrity of the membrane.	Low	Yes
	Clay	Effective but susceptible to cracking. Has self-healing properties.	Limited availability of materials; restrictions on future land use required.	Medium	Yes
	Asphalt	Effective but susceptible to cracking.	Materials are available; restrictions on future land use required.	Low	Yes
	Engineered	Effective and proven; in essence it is a multimedia cap.	Available; restrictions on future land use required.	High	Yes
Cover	Soil	Effective for preventing direct contact with waste.	Soils are available; restrictions on future land use required.	Low	Yes
	Rock	Rodents may reside in void spaces.	Rock is readily available; restrictions on future land use required.	Low	No

Note: (1) Sections 2.3 and 2.4 explain the reasoning for retaining or rejecting technology components.

067/17

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TABLE 2-2

Screening of Remedial Technologies for Mitigation of Air Exposures During Remediation
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Remedial Technology	Component	Effectiveness	Implementability	Relative Cost	Retain for Remedial Measures (1)
Not Applicable (No Action)(2)	Not Applicable	May not protect on-site workers from fugitive dust emissions during remediation of soils, sediments or wastes at the MMRF.	Not Applicable.	None	Yes
Dust Suppressants	Mulches	Effectiveness is dependent upon vegetative growth. Vegetative growth is limited in semi-arid regions such as The Dalles.	Materials are available; requires vegetative support for long-term effectiveness.	Low	No
	Polymers	Short term effectiveness.	Materials are available; may be required in conjunction with other technologies.	High	Yes
	Oil-based	May not be an environmentally acceptable suppressant.	Materials available; difficult to control and contain oil suppressants.	High	No
	Water	Short-term effectiveness.	Readily available.	Low	Yes
	Adhesives	Susceptible to weathering and cracking. Short-term effectiveness.	Limited availability of materials.	High	No
Wind Fences/Screens	Temporary Wind Fences/ Screens	Limited to relatively flat terrain; a short term measure.	Equipment available; strong winds may present a problem.	Low	No

Notes: (1) Sections 2.3 and 2.4 explain the reasoning for retaining or rejecting technology components.
(2) Remedial technologies are not included in the No Action general response for air emission controls because the Risk Assessment did not identify an air emissions problem at the MMRF.

067/18

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TABLE 2-3

Screening of Remedial Technologies for Surface and Ground-Water Management
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Remedial Technology	Components	Effectiveness	Implementability	Cost	Retain for Remedial Measures (1)
Ground-water Monitoring	Not Applicable	Effective for detecting potential future ground-water quality deteriation.	Available.	Low	Yes
Existing Leachate Collection System	Ditches	Does not treat leachate to meet NPDES discharge requirements.	Available.	Low	Yes
Institutional Control	Prevent drilling of wells.	Effective for protecting human health.	Available; requires legal action.	Low	Yes
	Enact design criteria for the construction of new wells.	Effective as long as enforcement continues.	Available; legal requirements.	Low	No
Hydraulic Barriers	Ground Water Pumping	Effective, proven technology.	Materials are available; fractured geology may present problems for locating recovery wells.	Medium	Yes
	Ground Water Injection	Limited effectiveness in fractured rock.	Available; difficult to install in fractured rock.	Medium	No
Subsurface Barriers	Slurry Wall	Limited effectiveness in fractured rock.	Only implementable in the unconsolidated zones.	High	No
	Grouting	Effective, proven technology.	Materials are available; would require monitoring for effectiveness of barrier.	Medium	Yes
	Sheet Piling	Not effective for fractured rock.	Not implementable in rock.	Medium	No
	Bottom Sealing	Not effective for fractured rock.	Limited availability of equipment and trained personnel.	Medium	No

Note: (1) Sections 2.3 and 2.4 explain the reasoning for retaining or rejecting the technology components.
067/19

G&M Consulting Engineers, Inc.

TABLE 2-3
(continued)

Screening of Remedial Technologies for Surface and Ground Water Management
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Remedial Technology	Components	Effectiveness	Implementability	Cost	Retain for Remedial Measures (1)
Physical Treatment	Flow Equalization	Effective technology for controlling process surges.	Available; helps achieve steady state conditions.	Low	Yes
	Activated Carbon	Limited to hydrocarbons, their derivatives and certain metals.	Available; requires regeneration or disposal of carbon.	High	No
	Ion Exchange	Effective technology for removal of constituents which dissociate.	Limited availability; requires regeneration of exchange bed.	High	Yes
	Filtration	Effective technology for the removal of suspended solids.	Available; requires disposal of filter cake.	Low	Yes
	Reverse Osmosis	Effective technology for the removal of dissolved solids.	Available; generates a concentrated waste stream.	High	Yes
	Evaporation	Effective technology for the removal of dissolved solids.	Available; requires disposal of residual solids.	Medium	Yes
	Stripping	Limited to the removal of volatile constituents.	Available; energy intensive.	Low	No
	Sorbents	Limited to concentrated waste removal.	Limited availability; requires disposal after use.	Medium	No
	Dissolved Air Flotation	Limited to concentrated waste streams.	Available; requires removal and disposal of floculant.	Medium	No
	Liquid Extraction	Effective removal technology.	Available; requires intimate liquid-liquid contact.	Medium	No

Note: (1) Sections 2.3 and 2.4 explain the reasoning for retaining or rejecting the technology components.
067/19

TABLE 2-3
(continued)

Screening of Remedial Technologies for Surface and Ground Water Management
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Remedial Technology	Components	Effectiveness	Implementability	Cost	Retain for Remedial Measures (1)
Surface Water Controls	Ditches	Effective for diversion and collection of surface water.	Technology available, existing ditches may be included in the system.	Low	Yes
	Channels	Effective for transportation of large quantities of water.	Technology available; existing channels may accomplish goals.	Medium	Yes
	Downpipes/Chutes	Limited capacities.	Technology available; site precipitation may limit applications.	Low	No
	Grading	Effective for minimizing surface water infiltration.	Available; may require collection of runoff.	Low	Yes
Leachate Collection	Ditches	Effective for collection of surface leachate.	Available; may utilize existing system.	Low	Yes
	Leachate Collection System	Effective for collection of leachate.	Available; required as part of the design for a new landfill.	High	Yes
Ground-water Collection	Subsurface Drains	Limited effectiveness in fractured rock.	Difficult to construct in fractured rock.	Medium	No
	Interceptor Trench	Effective for lowering ground-water elevations in strata with low or varying hydraulic conductivities.	May be difficult to implement in basalt.	Medium	Yes
	Recovery Wells	Effective and proven.	Available; use of existing wells may be feasible.	High	Yes
	Well Points	Limited to unconsolidated material.	Extremely difficult to implement in rock.	High	No

Note: (1) Sections 2.3 and 2.4 explain the reasoning for retaining or rejecting the technology components.
067/19

TABLE 2-3
(continued)

Screening of Remedial Technologies for Surface and Ground Water Management
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Remedial Technology	Component	Effectiveness	Implementability	Cost	Retain for Remedial Measures (1)
Chemical Treatment	Neutralization	Effective technology for adjusting pH.	Available; requires accurate control scheme.	Medium	Yes
	Chemical Precipitation	Effective technology for the removal of soluble constituents such as fluoride.	Available; requires disposal of sludge.	Medium	Yes
	Chemical Oxidation	Effective technology for the destruction of oxidizable constituents such as cyanide.	Limited availability of oxidizing agents.	High	Yes
	Chemical Reduction	Limited to treatment of constituents which are not oxidizable. There are currently no practical applications involving reduction of organics.	Available; used primarily for the reduction of metals which are not a problem at the MMRF.	High	No
	Ultraviolet Irradiation	Effective catalyst for chemical oxidation.	Available; should be used in conjunction with an oxidant.	Medium	Yes
	Biological Oxidation	Limited effectiveness for treatment of cyanide constituents. Cyanide concentrations detected at the site would not solely support the food requirements of the microorganisms in a biological system for the life of the clean-up efforts.	Available; requires disposal of sludge.	Medium	No
In Situ Treatment	In Situ Biological	Limited effectiveness due to waste constituents and site topography/ hydrogeology at the MMRF.	Available; difficult to distribute nutrients and oxygen to affected areas in fractured bedrock.	Medium	No
Alernative Water Supply	Provide well owners with City water.	Effective for protecting human health.	Available.	Medium	Yes
Prevent Withdrawal	Plug and abandon contaminated wells.	Effective for protecting human health.	Available; requires permission from well owner.	Medium	Yes

Note: (1) Sections 2.3 and 2.4 explain the reasoning for retaining or rejecting the technology components.
067/19

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2.3.1 Access Restrictions

Access restrictions considered for the MMRF consist of installing fences and implementing deed restrictions. Both are retained for potential application to the entire MMRF. Fences protect public health by restricting access to the waste management areas thus, minimizing direct exposure to the waste. The MMRF currently has a perimeter fence around the entire complex. All target remediation areas are within the confines of this fence. In addition to the MMRF perimeter fence, access to the Landfill is restricted by an interior fencing system. The other areas of interest may also require additional fencing to further restrict access.

Deed restrictions protect public health by limiting future land use of the site. Currently, the MMRF is zoned for industrial use. Deed restrictions can be acquired to maintain the industrial status of MMRF property in the future. Acquisition of deed restrictions involves obtaining a "meets and bounds" survey in conjunction with a legal description prepared by a registered land surveyor licensed to practice in the State of Oregon and duly recorded with the local Registrant of Deeds. In addition, deed restrictions inform potential buyers of MMRF property that waste management units exist on-site. Enforcement of the deed restrictions is essential for future public health protection.

2.3.2 Sediment Removal

Sediment removal is retained for potential remediation of the Scrubber Sludge Ponds. Approximately 168,000 cubic yards of sediments are present in the Scrubber Sludge Ponds. Sediment removal via mechanical dredging appears to be the most appropriate technology component for efficiently excavating this volume of sediments. Mechanical dredging removes the sediments at nearly in situ densities, therefore maximizing solids content and minimizing the size of sediment handling equipment. Mechanical dredging involves the use of backhoes, draglines, clamshells, and/or bucket ladder dredges to remove the sediments. Backhoes and clamshells normally operate on land while draglines and bucket ladders are usually vessel-mounted for water operations. The Scrubber Sludge Ponds do not contain enough liquids to float dredging vessels thus, only land-based equipment will be considered (i.e., backhoes and draglines). Dredging activities may increase the potential for fugitive dust emissions from the Scrubber Sludge Ponds. Therefore, dust controls should be considered in conjunction with this remedial technology. The water bodies at the MMRF which may potentially be affected by remediation efforts are part of the on-site waste treatment system and are therefore exempt from the Clean Water Act (CWA) Section 404 requirements as per 40CFR 122.2.

Also, all of the sediments which may require removal are on-site and dredging would not be required in any U.S. waters at the site.

2.3.3 Soil/Waste Removal

Soil/waste removal is retained for potential remediation of all of the target remediation areas at the MMRF. Soil/waste removal is normally accomplished through mechanical excavation. Mechanical excavation utilizes backhoes, front-end loaders, scrapers or clamshells to remove contaminated soils or waste. Soil/waste removal at the MMRF will be limited to unconsolidated material, subsoils, and fill material. The anticipated irregular configuration of the natural basalt underlying the fill material will make total removal of the fill material difficult. The excavated material may subsequently require treatment or disposal.

2.3.4 Solidification/Stabilization

Solidification/stabilization is retained for potential remediation of the Scrubber Sludge Ponds. Solidification is defined by the EPA as a process which introduces chemical agents to a waste to improve the handling or other physical characteristics of the waste. This is normally accomplished through production of a monolithic block of waste with high structural integrity. Contaminants within the waste do not necessarily interact chemically with the solidifying agents, but are mechanically locked within a solid matrix. This

decreases the surface area available for contaminant transfer or loss by grouping many smaller particles of waste material into the monolithic block.

Stabilization involves the addition of chemical agents which limit the solubility or mobility of hazardous waste constituents through chemical reactions. The handling or physical characteristics of the stabilized waste may not improve after this process but, contaminant migration has been minimized. Solidification/stabilization is feasible because of the homogeneity and fine particle size of the scrubber sludges. Mixing the dry portions of the scrubber sludge with the wet portions may improve the handling properties of the sludge.

The solidification/stabilization agents being considered for remediation of the Scrubber Sludge Ponds include fly ash, Portland cement, silicates and kiln dust. To date, bench scale studies have not been performed on the Scrubber Sludge Pond sludges to evaluate the effectiveness of solidification/stabilization agents. If solidification/ stabilization is selected for use, bench studies may be performed to identify an appropriate solidification agent for management of the scrubber sludge.

Contaminated material from the Landfill, the Unloading Area and the Former Cathode Waste Management Areas would require extensive grinding and screening prior to

solidification to homogenize the particle sizes of the waste. The benefits of solidifying/stabilizing waste material from these areas are outweighed by the effort and expense required to perform the grinding operation.

2.3.5 On-Site Incineration

On-site incineration is a thermal destruction method being retained for potential remediation of the Landfill, the Unloading Area and the Former Cathode Waste Management Areas. The incineration process being considered utilizes a mobile fluidized or circulating bed combustion system. This process has been demonstrated for the destruction of spent potliner waste generated by the alumina reduction industry. The mobile circulating bed combustion technology is available to incinerate spent potliner material disposed at the Landfill, the Unloading Area and the Former Cathode Waste Management Areas.

2.3.6 Soil, Sediment and Waste Chemical Treatment

Soil, sediment and waste chemical treatment is retained for potential application at the Landfill, the Unloading Area and the Former Cathode Waste Management Areas. Heap-leaching is the technique selected to chemically treat the waste. It can be accomplished either in situ or at a heap-leaching facility. Heap-leaching is a large scale liquid extraction process. It is commonly used in the mining industry to extract precious metals from their ore. The process involves

applying a liquid solvent to the solid material and leaching the soluble constituents from the solids. Heap-leaching is typically performed in a facility with a leachate collection system. The solids are piled within this facility where the solvent is sprayed onto the material. The solvent infiltrates into the solids, leaches the soluble constituents and the leachate is collected by an underlying system. The dissolved constituents are then removed from the solvent and the solvent is recycled back into the process.

A new on-site heap-leaching facility is being considered for the Landfill, the Unloading Area and the Former Cathode Waste Management Areas. In situ heap-leaching is being considered only for the Landfill since the existing leachate collection system is in place and the waste is already in a pile. Heap-leaching is not being considered for the Scrubber Sludge Ponds. The Scrubber Sludge Ponds contain fluoride precipitate (mainly calcium fluoride) which is not readily amenable to treatment in the aqueous phase.

2.3.7 Soil, Sediment and Waste Physical Treatment

Physical treatment is retained for potential remediation of the Landfill, the Unloading Area and the Former Cathode Waste Management Areas. Applicable components associated with this technology include grinding and segregation. Grinding reduces large particles to more uniform sizes through mechanical means. Segregation is the process of

sorting material according to particle size. Segregation is typically performed on heterogeneous materials with drastic variances in particle sizes. Particle size reduction may be performed to facilitate implementation of other technologies such as incineration.

The materials in the Scrubber Sludge Ponds are relatively homogeneous fine soils and sediments which do not require grinding or segregation. Therefore, physical treatment technologies are not applicable to this area.

2.3.8 On-site Land Disposal

On-site land disposal is retained for all target remediation areas at the MMRF. The components applicable to on-site disposal are construction of a new RCRA landfill and consolidation of waste into the existing Landfill.

Construction of a new RCRA Landfill involves identifying an appropriate location on-site and constructing a landfill in accordance with 40 CFR 264 Subpart N which includes installation of a ground-water monitoring network around the facility. The most probable location for a new RCRA Landfill at the MMRF is the area west of the existing Landfill.

Consolidation of waste into the existing Landfill is retained to minimize the number of waste management units on site. The current capacity of the existing Landfill could handle waste from the Unloading Area and the Former Cathode

Waste Management Areas without significant increase in the size of the existing Landfill. However, should the waste in the Scrubber Sludge Ponds be consolidated with the existing Landfill waste, the final configuration of the existing Landfill would expand significantly to handle the waste volume. The existing Landfill would require capping upon completion of the consolidation operations.

2.3.9 Cap

This technology is retained for all areas of interest at the MMRF. The applicable components associated with this technology are synthetic membranes, clay, asphalt and multimedia caps. The synthetic membrane cap consists of sheet(s) of polyvinyl chloride (PVC), chlorinated polyethylene (CPE), Hypalon, or other man-made materials overlain on the waste and spliced together creating a low permeability barrier. This type of cap would have application at disposal sites with large quantities of concentrated waste such as the existing Landfill and the Scrubber Sludge Ponds.

A clay cap consists of overlaying the waste with clay and compacting the clay to form a low permeability barrier against surface water infiltration. Consideration for the availability of clay in The Dalles region will be taken into account prior to selecting this component. This component is applicable to landfill and waste pile closures such as those being considered for the Landfill and Scrubber Sludge Ponds.

An asphalt cap is one of the more effective single layer cap options available. It consists of compacting bituminous asphalt on top of the waste. This type of cap is effective for minimizing surface water infiltration and may have application at the existing Landfill and the Former Cathode Waste Management Areas to reduce recharge to the perched water zone.

Multimedia caps generally conform to RCRA performance standards (40 CFR 264.310) which recommend a three layered system consisting of an upper vegetative layer, a drainage layer, and an underlying low permeability layer. The semi-arid climate of The Dalles is unlikely to support a vegetative layer. A multimedia cap that attains RCRA performance standards is being considered for closure of the existing Landfill and Scrubber Sludge Ponds.

2.3.10 Cover

Covers are retained to prevent direct contact with the waste at the Scrubber Sludge Ponds. The applicable component associated with this technology is a soil cover. Soil covers provide a buffer zone which limits human and wildlife accessibility to the waste.

2.3.11 Dust Suppressants

Dust suppressants are retained as short-term measures for all target remediation areas to control fugitive dust emissions during remediation. The dust suppressants applicable to the MMRF include polymers and water. These suppressants would be sprayed on the target remediation areas during remedial activities to temporarily bind the material, protecting the community of The Dalles and on-site workers from inhalation of contaminated particulates.

2.3.12 Hydraulic Barriers

Hydraulic barriers are retained for long-term management of the ground water at the Scrubber Sludge Ponds. The hydraulic barrier component applicable to this site is ground-water pumping. Ground-water pumping can be utilized to intercept the Byron Interbed discharge and lower the water table beneath the sludge ponds thus, preventing contact of ground water with the waste. Ground water does not directly interact with any of the other target remediation area at the MMRF. Therefore, these areas will not require hydraulic barriers.

2.3.13 Subsurface Barriers

Subsurface barriers are retained for long-term management of ground water at the Scrubber Sludge Ponds. The subsurface barrier component applicable to this site is

grouting. Grouting is a process in which a variety of fluids are injected into a subsurface geologic formation to strengthen the formation and/or reduce the permeability of the formation. Cement, clays and silicates are typical grouting fluids used to seal voids in subsurface formations.

A variation to grouting applications is the grout curtain. Grout curtains are subsurface barriers created in subsurface materials by pressure injection. Borings are drilled into the strata in which the grout curtain is to terminate. Grout is pressure injected into the borings forming a low permeability barrier from the surface to the bottom of the boring. The initial borings are arranged 20 to 40 feet apart and filled with a predetermined amount of grout. After the grout has time to gel, secondary borings are made and injected with grout. The secondary grout holes are intended to fill the gaps left by the initial borings.

A grout curtain may be installed upgradient (west) of the Scrubber Sludge Ponds to divert the ground water in the Byron Interbed. Diversion of ground water in the Byron Interbed may reduce the amount of ground water discharging into the Scrubber Sludge Ponds thus, minimizing the potential for ground water to leach fluorides from the scrubber sludge.

2.3.14 Surface Water Controls

This remedial action technology is retained for all target remediation areas at the MMRF. The applicable components associated with this technology are ditches, channels and grading.

Ditches are excavations designed to intercept run-off or reduce slope length. They are normally shallow with trapezoidal, triangular or parabolic cross sections. Ditches may be stabilized with vegetation or stone rip-rap to minimize erosion. Surface water controls may be required at the Landfill to collect leachate and intercept surface water run-on. The Former Cathode Waste Management Areas and Scrubber Sludge Ponds may also require ditches to intercept surface water run-on and transport surface water run-off. Therefore, ditches will be retained as a potential remedial component for these target remediation areas.

Channels are similar to ditches except that they are normally deeper and are designed to transport larger volumes of water. Channels are normally fed by a network of ditches and are applicable to all target remediation areas at the MMRF. The channels will transport surface waters collected by the system of ditches at the MMRF.

Grading consists of reshaping the surface of waste areas to control infiltration and run-off while minimizing erosion. Grading can either reduce or increase ponding of surface

water depending on the application required. Grading may be an important function of site preparation work for all target remediation areas at the MMRF.

2.3.15 Leachate Collection

The leachate collection remedial technology is retained for the Landfill. The components associated with this technology for the Landfill are ditches and leachate collection systems. Ditches which were previously discussed can be constructed adjacent to the Landfill to intercept leachate which may otherwise migrate from the site. A leachate collection system is a network of perforated pipe or trenches underlying or constructed within a waste area utilized to collect liquids which percolate through the waste. A leachate collection system would be required if a new on-site landfill were constructed at the MMRF as a remedial action.

2.3.16 Ground-water Controls

Ground-water collection is retained to recover fluoride contaminated water in the S-aquifer. The applicable ground-water collection components are recovery wells and interceptor trenches. Recovery wells are wells installed in/or downgradient of a waste site and are pumped to capture contaminated ground water, minimizing contaminant migration from the site.

Interceptor trenches are buried conduits used to collect and transport ground water. They essentially function like an infinite line of recovery wells. Interceptor trenches are particularly effective in strata with low or variable hydraulic conductivity. The best application for interceptor trenches at the MMRF is collection of perched water beneath the Former Cathode Waste Management Areas.

2.3.17 Aqueous Physical Treatment

Aqueous physical treatment is retained for treatment of recovered ground water from the S-aquifer, contaminated perched water and collected leachate. The applicable physical treatment components are flow equalization, ion exchange, filtration, reverse osmosis and evaporation.

Flow equalization is the damping of flowrate variations such that a constant or nearly constant flowrate is achieved. Flow equalization will be an important part of a ground water and leachate treatment system at the MMRF because of the variation expected in the ground water and leachate streams from wet and dry seasons.

Ion exchange is a mass transfer process in which undesirable ions in wastewater are exchanged with relatively harmless ions from ion exchange material. Ion exchange materials typically consist of synthetic organic materials containing ionic functional groups to which exchangeable ions are attached. Activated alumina has potential application as

an ion exchange media for treatment of contaminated aqueous streams at the MMRF.

Ion exchange is being considered for removal of the following at the MMRF:

- Cyanides in the Landfill leachate and perched water; and
- Fluorides in the Landfill leachate, perched water and ground water from the S-aquifer.

Ion exchange has been demonstrated to remove selective cyanide compounds from aqueous streams. Cyanides are commonly found in wastewater streams in two forms:

- As "free" or ionizable cyanide; or
- As a complex with heavy metals.

Heavy metal complexes of ferrocyanide or ferricyanide are very stable, making treatment difficult. However, ion exchange processes have been developed to selectively remove these complexes from aqueous solutions. Free cyanides can also be removed using ion exchange resins by first converting the free cyanide to iron complexes, such as the ferrocyanide or ferricyanide complexes, using iron salts.

Activated alumina is being considered for removal of fluorides from recovered ground water, contaminated perched water and Landfill leachate. The activated alumina is acid-treated with sulfuric acid, placing sulfate ions on the surface of the activated alumina. The aqueous stream

containing fluorides is contacted with the activated alumina and the fluoride ion exchanges with the sulfate ion on the surface of the alumina.

In time, the exchange sites are filled with fluoride and the activated alumina must be regenerated. This is accomplished by washing the activated alumina with a sodium hydroxide (caustic) solution. The hydroxyl ions in sodium hydroxide exchange with the fluoride ions on the surface of the alumina. The fluorides leave the system in a concentrated stream requiring further treatment prior to discharge or disposal. The activated alumina is then acid-treated to neutralize the hydroxyl ions and place sulfate ions back on the surface of the alumina. The activated alumina is now ready for service again.

Filtration is the process of separating solids from liquids by passing the waste stream through a porous medium. The filter medium can be a variety of materials, including sand, gravel, anthracite, fabric (filter press), wire mesh, or paper. For flow processes, the particles to be removed are generally above 25 microns in size. Smaller particles need pretreatment. Filtration may be used prior to a unit operation to prevent fouling of that operation or as a final "polishing" step before discharge of treated wastewater streams. Filtration is typically required as a pretreatment method on recovered ground water to remove suspended solids thus, it has application at MMRF.

Reverse osmosis involves passing a waste stream at high pressure through a semi-permeable membrane. The waste constituents are retained by the membrane while water molecules pass through the membrane. The constituents retained by the membrane form a concentrated waste stream which must be treated further before disposal or discharge. Reverse osmosis is being considered for removal of cyanide and fluoride from the Landfill leachate and perched water as well as fluoride from recovered ground water in the S-aquifer.

Evaporation is a physical process where dilute aqueous wastes are concentrated by vaporizing the water. Evaporation can occur naturally (as in evaporation ponds) or can be artificially induced by a unit operation appropriately named the evaporator. Artificially induced evaporation is energy intensive and may not be economically feasible unless there is an existing source of steam available at the site. Natural evaporation is more economically attractive especially in areas such as The Dalles, Oregon, where the evaporation rate is high. Evaporation is being considered to reduce the volume of water requiring treatment at the MMRF.

2.3.18 Aqueous Chemical Treatment

Aqueous chemical treatment is retained for treatment of recovered ground water from the S-aquifer, contaminated perched water and collected leachate. The applicable

components associated with this remedial technology are neutralization, chemical precipitation, chemical oxidation and ultraviolet irradiation.

Neutralization consists of adding acid or base to adjust the pH of wastewater to a desired value. Neutralization systems for aqueous waste streams normally consist of a basin or tank where an acid or a base is mechanically mixed with the wastewater to adjust the pH. The basin must be constructed of corrosion resistant material. Neutralization basins or tanks are typically constructed in conjunction with other unit operations to maintain the optimum pH for a given reaction. Neutralization facilities are also used downstream of other unit operations to adjust the effluent pH prior to discharge. Treatment of cyanides and fluorides detected in the Landfill leachate and perched water will require neutralization to attain the proper pH for treatment reactions to occur.

Chemical precipitation is the process of producing a separable solid phase within a liquid medium. The extent to which a component can be separated from solution can be determined from the solubility-product constant obtained by determining the quantity of dissolved substance present in a known amount of saturated solution. This value is known as the solubility. The solubility of a substance can be drastically altered by adding to the solution any of the ions that make up the precipitate. For example, the solubility of

fluoride (as sodium fluoride) is 40,000 mg/L at 20°C. This concentration can be reduced to 20 mg/L at 20°C through addition of lime under alkaline conditions. The lime converts the sodium fluoride to calcium fluoride, removing 99 weight percent of the fluoride from solution as calcium fluoride precipitate. Thus, chemical precipitation has application at the MMRF to remove fluorides from the Landfill leachate, contaminated perched water and recovered ground water in the S-aquifer.

Chemical oxidation is a process in which oxygen reacts with other molecules. The oxygen may be used as elemental oxygen, as in air, or in the form of an oxygen containing molecule such as hydrogen peroxide (H_2O_2), ozone (O_3), sodium hypochlorite (NaClO), or peroxosulfuric acid (H_2SO_5) which is capable of releasing all or part of its oxygen. Oxidation in its broadest sense involves an increase in positive valance of a molecule or removal of electrons and can occur with oxidizing agents which do not contain oxygen such as chlorine gas.

Oxidation is a common technique used to detoxify and destroy cyanide compounds. For instance, sodium hypochlorite or chlorine under alkaline conditions converts cyanides ultimately to bicarbonates and nitrogen. However, if the pH of the above reaction is not carefully controlled, the potential exists for generation of the toxic by-product cyanogen chloride. Use of non-chlorinated oxidizing agents

such as hydrogen peroxide or ozone eliminate the potential to generate cyanogen chloride. Chemical oxidation is being considered for destruction of cyanides in the Landfill leachate and contaminated perched water.

Chemical change brought about by exposure of substances to light is termed photochemistry. The radiant-energy spectrum of ultraviolet light (100-400 nm) greatly increases the number of photochemical reactions. The largest number of reactions occur in the near-and middle-ultraviolet regions between, wavelengths of 250 to 400 nm.

Upon exposure to the ultraviolet light, a molecule will react in one of four ways after absorbing that energy:

1) The most common reaction converts the light energy into vibrational energy within the molecule which is ultimately dissipated as heat;

2) the molecule may fluoresce (i.e., emit the energy);

3) the molecule may be chemically transformed; or

4) the molecule may decompose which is called photolysis.

The last two reactions are the ones of interest for the destruction of cyanides at the MMRF. Lur'e and Ponova (1964) have demonstrated that iron complexed cyanides photo-chemically oxidize in the presence of ultraviolet light and water to iron hydroxides, hydrocyanic acid and simple soluble cyanides. The cyanide compounds can then be converted to non-toxic constituents using chemical oxidizing agents. In

addition to decomposing the iron cyanide complexes, ultraviolet light can also decompose the oxidizing agents such as ozone providing free oxygen for the oxidation reaction.

2.3.19 Prevent Withdrawal of Ground Water

Prevention of ground water withdrawal in the vicinity of the MMRF can be attained by plugging and abandoning the Animal Shelter, Rockline, Klindt and Residence wells east and northeast of the MMRF. The owners of the above wells will have their well water supply replaced with city water. Implementation of this remedial action will require approval by the well owners. Plugging and abandoning wells eliminates existing pathways for human consumption of contaminated ground water and reduces the potential for off-site migration of contaminants by removing artificial hydraulic gradients created by pumping the above wells.

2.3.20 Institutional Controls

Institutional controls involve regulations promulgated by the City of The Dalles restricting the installation of new wells in the vicinity of the MMRF or enforcing design and construction criteria for new well installations. These controls would protect the public from potential exposure to contaminated ground water.

2.3.21 Alternative Water Supply

This technology involves connecting the Animal Shelter, Rockline, Klindt and Residence well users to a potable water supply provided by the city of The Dalles public works. Connecting users to city water would require plugging and abandoning the existing wells at these locations to ensure public health protection.

2.4 DISCUSSION OF INAPPLICABLE REMEDIAL TECHNOLOGY COMPONENTS

During the feasibility study process, many of the identified remedial technology components may be determined to be inapplicable for management of the specific site and waste characteristics of concern. The following discussions highlight the reasoning for not retaining remedial technology components for development of remedial measures for management of the MMRF site based on the technology screening process.

2.4.1 Sediment Removal

Two sediment removal techniques, hydraulic and pneumatic dredging, were determined to be inapplicable for management of sludge disposed in the Scrubber Sludge Ponds. They were determined to be inapplicable based on anticipated difficulties which could occur during implementation of either of the above dredging methods. For instance, both hydraulic and pneumatic dredging are only applicable to low

solids content slurries (10 to 20 weight percent) which is not characteristic of the sludge in the Scrubber Sludge Ponds (samples collected during the RI indicated that the sludge contains 38 to 68 weight per cent solids). Therefore, in order to utilize hydraulic or pneumatic dredging, water would have to be added to the sludge to slurry it to an acceptable weight percent solids. A conservative estimate, based on creating a 20 weight percent slurry with the sludge in the Scrubber Sludge Ponds (approximately 168,00 cubic yards), determined that approximately 150 million gallons of water would be required. Addition of this large quantity of water to the Scrubber Sludge Ponds at the existing location would require construction of a perimeter containment structure to prevent surface run-off of the slurry. In addition, the solids would require separation from the liquid prior to ultimate disposal. Separation of solids from a liquid slurry requires labor intensive filters or settling ponds occupying large areas of land. The liquid would be contaminated with fluoride leached from the sludge during dredging operations and would require treatment prior to discharge. An aqueous fluoride removal system would be required to treat approximately 150 million gallons of contaminated liquid generated by these technology components.

Other dredging methods, such as mechanical dredging, are available to remove the sludge from the Scrubber Sludge Ponds without utilizing large quantities of water which

subsequently become contaminated. Therefore, hydraulic and pneumatic dredging were eliminated from further consideration.

2.4.2 Off-Site Incineration

Off-site incineration was eliminated from further consideration based on potential public health risks associated with accidental exposure while transporting over 200,000 cubic yards of contaminated material containing asbestos, cyanides and carcinogenic polynuclear aromatic hydrocarbons to an off-site incinerator. In this FS, technologies which protect human health and the environment but do not require off-site transport are preferred over equivalent measures which require off-site transportation.

2.4.3 Solidification/Stabilization

Only one of the solidification/stabilization agents identified, application of synthetic additives, will not be considered during treatability studies for management of the wastes at the MMRF. Synthetic additives have not been proven to be effective for stabilizing the constituents detected at the MMRF.

2.4.4 On-Site Incineration

Two of the three incinerators (rotary kiln and plasma arc) considered for remediation of the MMRF were eliminated through the technology screening process. The rotary kiln

and plasma arc incinerators have not been demonstrated for incineration of the spent potliner material present at the MMRF. Rotary Kiln incinerators typically operate at temperatures between 1500 to 3000°F. These operating temperatures approach or exceed the melting points of certain non-combustible fluoride compounds common to the alumina reduction industry such as cryolite (melting point = 1854°F), sodium fluoride (melting point = 1824°F) and calcium fluoride (melting point = 2584°F). Problems could occur when the fluoride compounds begin to melt and stick to the interior of the process equipment causing incinerator malfunctions or shut-downs. The circulating bed combustion process applied to the destruction of spent potliner operates at lower temperatures (1400°F to 1800°F) to avoid melting the non-combustible fluoride compounds. Therefore, the rotary kiln incinerator does not appear to be a reliable destruction technique for treating waste containing fluoride compounds characteristic of the alumina reduction industry.

The plasma arc incineration technology is in the research and development stages and has not been demonstrated for the destruction of spent potliner waste. Therefore, plasma arc incineration will not be given further consideration.

2.4.5 Vitrification

In situ vitrification was considered to be inapplicable for management of wastes at the MMRF based on its limited effectiveness. Vitrification involves encapsulation of waste in molten glass for immobilization of waste constituents. The waste should contain a certain amount of silicates for the fusion process. The waste at the MMRF does not contain the amount or type of silicates required and is therefore not applicable for management of the MMRF.

2.4.6 Physical Treatment of Soils, Sediment and Other Wastes

The physical treatment component of classification is not being retained for remedial measures development. Classification is normally applied to slurried waste to separate solids from the liquid. The wastes located in the target remediation areas at the MMRF are not currently slurried indicating that water would have to be added to the waste to implement classification. The addition of water to the waste would subsequently generate contaminated liquids requiring treatment prior to discharge. Other segregation techniques which do not require slurrying were retained to avoid increasing the mobility of hazardous constituents by leaching them into solution.

2.4.7 Cap

The technology screening process eliminated concrete caps from further consideration based on concrete's limited effectiveness as a cap material. Concrete caps are highly susceptible to weathering and cracking, especially when subjected to the freeze-thaw conditions common to The Dalles. In addition, concrete caps are generally more permeable than other capping media.

2.4.8 Cover

The technology screening process eliminated rock covers from further consideration as a technology component. Rock covers are not as effective in diverting surface water runoff and provide attractive areas for burrowing rodents (ground squirrels) to reside.

2.4.9 Dust Suppressants

Three of the five dust suppressants, mulches, oil-based suppressants, and adhesives identified for management of fugitive particulate emissions expected during remedial actions are not being retained for use at the MMRF. Mulches are very effective when used in conjunction with a vegetative cover. However, the semi-arid climate of The Dalles region does not support vegetation very well; limiting the effectiveness of mulches. Oil-based suppressants may not be environmentally acceptable for use at the MMRF and are more

costly than other suppressants which are equally effective. Adhesive dust suppressants are eliminated from further consideration based on their susceptibility to weather conditions and limited availability. Precipitation washes the water soluble adhesives away while heat dehydrates the adhesives causing cracking which limits their effectiveness.

2.4.10 Wind Fences/Screens

The effectiveness of installing wind fences and/or screens for air emissions control is limited by the terrain and high wind velocities of The Dalles. Implementation of this remedial technology will not be retained for management of the MMRF.

2.4.11 Hydraulic Barriers

Hydraulic barriers were identified as potential means for managing the ground water at the Scrubber Sludge Ponds. Of the identified components, ground-water injection is not being retained for management of the ponds. This component is considered inapplicable as its effectiveness would be limited in the fractured rock beneath the site since it would be difficult to control injected water.

2.4.12 Subsurface Barriers

Installation of slurry walls, sheet piling, and bottom sealing in fractured rock is extremely difficult. These technology components are typically implemented in

unconsolidated zones and are effective when keyed into low permeability formations underlying the contaminated area. The majority of the material underlying the MMRF is basalt rock. To install a slurry wall, the trench which contains the low permeability slurry would require blasting of the basalt. The blasting would fracture the basalt decreasing the effectiveness of the slurry wall.

Installation of sheet piling is normally accomplished by driving the sheet piles into the ground. Attempting to drive sheet piling into rock is physically impossible therefore, eliminating sheet piling as a barrier.

Bottom sealing is dependent upon plugging all of the flow pathways beneath a contaminated site. This is difficult to determine in basalt where the fractures are random and unknown. Therefore, based on implementability factors, these technology components were eliminated from further consideration.

2.4.13 Surface Water Controls

Downpipes and chutes were identified as surface water control components for management of run-on and run-off at the target remediation areas. These structures will not be retained for incorporation into remedial measures due to capacity limitations. Precipitation events at the MMRF are

intense occurring over a short period of time. Drainage structures which would transport larger quantities of water would be more appropriate than downpipes or chutes for use at the MMRF.

2.4.14 Ground-Water Collection

The inapplicable components for use in ground-water collection at the Scrubber Sludge Ponds are subsurface drains and well points. Installation of subsurface drains in the vicinity of the Scrubber Sludge Ponds would require extensive blasting in the bedrock down to a depth of approximately 50 feet below land surface for a distance of approximately 2,000 feet. This depth would place the invert of the drain at approximately 70 feet msl. The water evaluation of the Columbia River is normally 70 feet msl with a maximum elevation of approximately 82 feet msl. Gravity flow towards the River in the drain at most times would be virtually impossible. Other dewatering techniques are available which are suitable to fractured rock. Therefore, subsurface drains will be eliminated from further consideration.

Well points cannot be pushed or jetted into the basalt which underlies the Scrubber Sludge Ponds thus, they are eliminated from further discussion. Both of these components are difficult to construct and monitor for effectiveness in fractured rock.

2.4.15 Physical Treatment for Surface and Ground-Water Management

The physical treatment components considered inapplicable for use at the site are activated carbon, stripping, sorbents, dissolved air flotation and liquid extraction. Activated carbon, stripping, sorbents and dissolved air flotation are not suitable for management of the specific waste constituents detected at the MMRF. Liquid extraction is normally used for more concentrated streams than generated at the MMRF.

2.4.16 Chemical Treatment for Surface and Ground-Water Management

Chemical reduction and biological oxidation were not retained for remedial measures development at the MMRF due to effectiveness limitations in using these chemical treatment components for treating specific wastes at the site. Constituents amenable to chemical reduction are not present in concentrations at the site which would warrant treatment by chemical reduction. The availability of agents used in chemical reduction are also limited. The only constituent of concern detected in aqueous media at the MMRF which has the potential to biologically degrade is cyanide. The cyanide concentrations detected at the site would not solely support a microbiological system. Therefore, biological oxidation was eliminated from further consideration.

2.4.17 In Situ Treatment

In situ biological treatment is inapplicable for management of surface and ground water at the MMRF. In order to effectively implement in situ treatment, the site topography and hydrogeology must be suitable for the addition of nutrients, oxygen and/or microorganisms directly into the waters being remediated. The fractured basalt which underlies the MMRF is not the ideal substrate for in situ biological. Control of nutrients and oxygen injected to support biological growth would be extremely difficult in fractured basalt. The type and concentration of constituents being treated must also be amenable to biodegradation and must provide a sufficient food source to support the microorganisms. These criteria are not characteristic of the MMRF. Therefore, in situ treatment will not be retained for development of remedial measures.

2.5 SUMMARY OF APPLICABLE REMEDIAL TECHNOLOGIES

The remedial technologies screening, conducted in Section 2.2, resulted in a list of remedial technologies and associated components which are applicable for remediation of various sites at the MMRF. Drawings A-4 and A-5 summarize the media of concern at the site, the remediation objectives for each media, the general response actions for each objective, and the remedial technologies and associated components typically utilized to implement the general

response actions. Technology components cross hatched on Drawings A-4 and A-5 are eliminated from further consideration based on the results of the screening process. Technology components not cross hatched on Drawings A-4 and A-5 satisfied the screening criteria and will be utilized to develop remedial measures in Section 3.0. Remedial measures consist of a number of technology components that have been combined to control a target remediation area. The technology components applicable to each target remediation area at the MMRF are summarized in Tables 2-4 through 2-6.

2.6 PROPOSED WAIVER

Fluoride and sulfate have been detected beneath the MMRF at concentrations above ARARs predominantly in the S-aquifer. It has been shown that ground water in the S-aquifer beneath the MMRF flows eastward and discharges to the Columbia River. The ground water in the S-aquifer beneath the target remediation areas migrates in this direction and only beneath MMC property in its route to the Columbia River. Therefore, the potential for migration of affected ground water to off-site production wells or the consumption of affected ground water is very minimal. Review of the applicable remedial technology components in Section 2.5 indicates that removal of aqueous fluoride and sulfates would involve mass transfer unit operations. These ions cannot be destroyed; only transferred from one physical state to another (i.e., liquid to solid). This limitation for treatment in Table 2-4

TABLE 2-4

Summary of Applicable Components for
Soil, Sediment and Waste Control
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Remedial Technology	Component	Target Remediation Area: Landfill	Unloading Area	Former Cathode Waste Management Areas	Scrubber Sludge Ponds
Access Restrictions	Fence Perimeter	X	X	X	X
	Deed Restrictions	X	X	X	X
Sediment Removal	Mechanical Dredging	-	-	-	X
Soil/Waste Removal	Mechanical Excavation	X	X	X	X
Solidification/ Stabilization	Kiln Dust	-	X	-	X
	Fly Ash	-	X	-	X
	Silicates	-	X	-	X
	Portland Cement	-	X	-	X
On-site Incineration	Fluidized Bed	X	-	X	-
Chemical Treatment	In Situ Heap-Leaching	X	-	-	-
	Heap Leaching	X	-	X	-
Physical Treatment	Grinding	X	-	X	-
	Segregation	X	-	X	-
On-site Land Disposal	Construct a RCRA Landfill	X	X	X	X
	Consolidate Into Existing Landfill	-	X	X	X
Off-site Land Disposal	RCRA Permitted Landfill	-	X	-	-
Cap	Synthetic Membrane	X	-	-	X
	Clay	X	-	-	X
	Asphalt	X	X	X	-
	Multimedia	X	-	-	X
Cover	Soil	-	-	-	X
	Rock	-	-	-	-

Notes: X = Process option applicable to target remediation area.
- = Process option not applicable to target remediation area.

TABLE 2-5

Summary of Applicable Components for Mitigation of Air Exposures During Remediation
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Remedial Technology	Component	Target Remediation Area: Landfill	Unloading Area	Former Cathode Waste Management Area	Scrubber Sludge Ponds
Not Applicable (No Action)[1]	Not Applicable[1]	X	X	X	X
Dust Suppressants	Polymers	X	X	X	X
	Water	X	X	X	X

Notes:
1: Remedial technologies and components where not applicable for the No Action general response action for air.

X = Process option applicable to target remediation area.
- = Process option not applicable to target remediation area.

067/24

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TABLE 2-6

Summary of Applicable Components for
Surface and Ground Water Management
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Remedial Technology	Component	Target Remediation Area			
		Landfill	Unloading Area	Former Cathode Waste Management Areas	Scrubber Sludge Ponds
Ground water Monitoring	Not Applicable	GW	GW	PW, GW	GW
Hydraulic Barriers	Ground Water Pumping	-	-	-	GW
Subsurface Barriers	Grouting	-	-	-	GW
Surface Water Collection	Ditches	SW	SW	SW	SW
	Channels	SW	SW	SW	SW
	Grading	SW	SW	SW	SW
Leachate Collection	Ditches	LL, SW	-	-	-
	Leachate Collection System	LL, SW	-	-	-
Ground-water Controls	Recovery Wells	GW	GW	-	GW
	Interceptor Trenches	SW	-	PW	GW
Physical Treatment	Flow Equalization	LL, GW	GW	PW	GW
	Ion Exchange	LL, GW	GW	PW	GW
	Filtration	LL, GW	GW	PW	GW
	Reverse Osmosis	LL, GW	GW	PW	GW
	Evaporation	LL, GW	GW	PW	GW

Notes:
SW = Technology component applicable to surface water in the target remediation area.
GW = Technology component applicable to ground water in the target remediation area.
- = Technology component not applicable in the target remediation area.
PW = Technology component applicable to perched water in the target remediation area.
LL = Technology component applicable to Landfill leachate in the target remediation area.

TABLE 2-6
(Continued)

Summary of Applicable Components for
Surface and Ground Water Management
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Remedial Technology	Component	Target Remediation Area			
		Landfill	Unloading Area	Former Cathode Waste Management Areas	Scrubber Sludge Ponds
Chemical Treatment	Neutralization	LL, GW	GW	PW	GW
	Chemical Precipitation	LL, GW	GW	PW	GW
	Chemical Oxidation	LL, GW	-	PW	-
	Ultraviolet Irradiation	LL, GW	-	PW	-
Prevent Withdrawal	Plug and abandon off-site wells.	GW	-	-	GW
	Reconstruction of existing wells to draw water from specific aquifer.	GW	-	-	GW
Institutional Controls	Prevent drilling of new wells.	GW	-	-	GW
	Enact well design criteria for new wells.	GW	-	-	GW
Alternative Drinking Water Supply	Provide city water to area industries and residents.	GW	-	-	GW

Notes:
SW = Technology component applicable to surface water in the target remediation area.
GW = Technology component applicable to ground water in the target remediation area.
- = Technology component not applicable in the target remediation area.
PW = Technology component applicable to perched water in the target remediation area.
LL = Technology component applicable to Landfill leachate in the target remediation area.

conjunction with the hydrogeologic characteristics of the shallow aquifer beneath the MMRF support a waiver from the State of Oregon fluoride and sulfate standards in drinking water. Justification for the waivers are summarized below. Appendix C presents detailed support and justification for the waivers.

Fluoride has been detected in the aquifers that underlie the MMRF at levels which exceed the current State of Oregon fluoride standard of 2.2 mg/L (OAR 333-61-085 at a mean annual temperature of 54°). The majority of the elevated fluoride levels were detected in the S-aquifer. Fluoride levels in the A- and B- aquifers are typically below the state standard. Only background concentrations of fluoride were detected in the ground-water samples collected from the primary water supply aquifer in the area (the DGWR). Sulfate has also been detected in the aquifers which underlie the MMRF at levels which exceed the State of Oregon secondary drinking water standard for sulfate of 250 mg/L. Sulfate was found in excess of this secondary standard exclusively in the S-aquifer except for monitor well 18B which indicated a sulfate concentration of 271 mg/L. Sulfate was not detected above background levels in the DGWR.

Appropriate remediation criteria should be based upon protectiveness to human health, protectiveness to the

environment and best practical treatment methods. The following remediation criteria for fluoride, which are both protective and practical, are proposed for the MMRF:

S-aquifer Ground Water	9.7 mg/L
A-aquifer Ground Water	4.0 mg/L
B-aquifer Ground Water	4.0 mg/L
DGWR Ground Water	Not applicable

The remediation criteria for sulfate in the S-aquifer is based on protectiveness to human health and available data relating to the aquatic toxicity of sulfate. Initially, a remediation criteria for sulfate in the Columbia River is established at 250 mg/L. This concentration is adopted from the State of Oregon secondary drinking water standard and is protective to aquatic life in the Columbia River. By establishing a remediation criteria in the Columbia River a maximum concentration of sulfate in the S-aquifer can be calculated which would be protective of the river. Therefore, the discharge of sulfate from the S-aquifer to the Columbia River would not adversely affect the Columbia River. This fact is due to the mixing effects of the small amount of discharge from the S-aquifer to the very large amount of flow in the Columbia River.

The proposed waiver concentrations for the S-aquifer are in accordance with the waiver provisions established in section 121(B)(ii) of CERCLA as amended by SARA. The

proposed waiver concentration for fluoride in the A- and B-aquifers is the Federal maximum contaminant level (MCL) for drinking water established by the Safe Drinking Water Act.

Section 121(B)(ii) of CERCLA states that the process for establishing a waiver to an otherwise applicable standard for a given constituent in ground water may be appropriate if:

- There are known and projected points of entry of the contaminated ground water into surface water;
- There is no statistically significant increase of hazaradous constituents from ground water into surface water at the point of entry or where there is reason to believe downstream accumulation may occur; and
- The remedial action includes enforceable measures to preclude human exposure between the facility boundary and points of entry into the surface water.

Results from the RI indicate that the S-aquifer discharges to the Columbia River. Appendix B presents information indicating that the impact of the Columbia River from discharging ground water containing fluoride and sulfate is insignificant. Therefore, the S-aquifer satisfies the criteria for granting a waiver established in Section 121 of CERCLA.

The proposed concentration of 9.7 mg/L for fluoride in the S-aquifer was developed based on best practical treatment techniques available or ultimate disposal of fluoride. Because fluoride is non-destructible ion, treatment is limited to transference from one physical state to another

(i.e., liquid to solid). The most commonly used and best practical treatment method for ultimate removal of fluoride from an aqueous solution is chemical precipitation with lime (see Appendix B). This process involves chemically converting the water soluble fluoride compounds to calcium fluoride (maximum water solubility at 20°C of 20 mg/L). From a fluoride mass balance, it can be demonstrated that a 20 mg/L aqueous solution of calcium fluoride contains 9.7 mg/L soluble fluoride.

Fluoride Mass Balance

Concentration of Soluble Fluoride @ 20°C = (20 mg/L CaF_2 ÷ 78.08 mg CaF_2/mg mole) X (2 mg mole F^-/mg mole CaF_2 x 18.92 mg F^-/mg mole)

Concentration of Soluble Fluoride @ 20°C = 9.7 mg/L

Thus, the remediation criteria proposed for fluoride in ground water beneath the site is based on best practical treatment, protectiveness of the environment and protectiveness of human health. A survey by the EPA (EPA-600/2-84-134, August, 1984) documented that there are more than 2,000 water supplies in the United States in which the Federal MCL for fluoride is exceeded. Of those, nearly all have fluoride concentrations occurring between the MCL and 12 mg/L. The document also established that there are known water supplies with natural fluoride concentrations as high as 30 mg/L.

Like fluoride, sulfate concentrations above 250 mg/L have been detected mainly in the S-aquifer. Elevated sulfate concentrations were not detected in the A- or B- aquifers (except for MW-18B which had a sulfate concentration of 271 mg/L). Sulfate was not detected above background levels in the DGWR.

As previously mentioned, results from the RI indicate that the S-aquifer discharges to the Columbia River. An impact analysis was performed which indicated that sulfates discharging from the S-aquifer into the Columbia River do not significantly impact the River (See Appendix C).

092/2

3.0 ASSEMBLY AND SCREENING OF REMEDIAL MEASURES

The assembly and screening of remedial measures utilizes applicable technologies derived in Section 2.0. The applicable technologies are organized into comprehensive remedial measures which address management for each target remediation area. The following remediation levels were used to guide the assembly of remedial measures:

1. Permanent remedies which eliminate the need for long term management;
2. Containment with treatment remedies;
3. Containment without treatment remedies; and
4. No action (limited action).

After assembly of remedial measures, the remedial measures are evaluated through a screening process in which the effectiveness, implementability and cost of the measures are considered. The screening of remedial measures is performed in a two step process.

Initially, remedial measures are evaluated for effectiveness and implementability. Remedial measures are then evaluated for cost. However, cost is used to compare remedial measures which provide similar remediation levels, and is not used to discriminate between treatment and non-treatment remedial measures. Measures which are clearly infeasible or inappropriate for management of the MMRF are eliminated during the screening. In addition, during the

screening process, remedial measures are eliminated if they are more costly but do not provide a greater level of protection than other remedial measures considered. At the conclusion of the remedial measures screening, the remaining remedial measures are utilized to develop sitewide alternatives. The assembly and detailed analysis of sitewide remedial alternatives is presented in Sections 4.0 and 5.0.

3.1 ASSEMBLY OF REMEDIAL MEASURES

The target remediation areas identified in Section 1.2.2 requiring consideration for remedial action include: (1) the Landfill (LF); (2) the Unloading Area (UA); (3) the Former Cathode Waste Management Areas (FCW); (4) the Scrubber Sludge Ponds (SP); and (5) the ground water (GW). Table 1-11 presents a summary of the rationale for considering the target remediation areas for remedial actions. Based on this information, remediation requirements are developed for each target remediation area. Specific remediation requirements for the Landfill, Former Cathode Waste Management Areas and Unloading Area are:

- Prevent the generation of leachate and the contamination of perched water; and
- Prevent direct contact with the waste.

Remediation requirements for the Scrubber Sludge Ponds are:

- Prevent accumulation of fluoride in the S-aquifer at concentrations in excess of the remediation criteria developed in Section 2.0;

- o Prevent fugitive dust emissions from the ponds; and
- o Prevent direct contact with the waste.

The remediation requirement for managing the ground water is to meet standards for fluoride and sulfate as defined by the remediation criteria developed in Section 2.0.

The assembly of technologies into various remedial measures for the target remediation areas is presented in Tables 3-1 through 3-5. Best engineering judgment was utilized to develop the remedial measures for each target remediation area, span the range of remediation levels and address the previously discussed remediation requirements. As required by the NCP, the no action (limited action) remedial measure is included for each target remediation area. Descriptions of the remedial measures for each target remediation area is presented in Tables 3-6 through 3-10. The description of each remedial measure includes the technologies utilized and corresponding remediation level(s). Table 3-11 summarizes the remedial measures developed for each of the target remediation areas.

Certain remedial measures developed for the target remediation areas include on-site waste management. Implementation of such measures would consider Federal and State laws which address geographical location criteria for waste management facilities. These laws are referred to as location-specific ARARs. A list of potential location-

TABLE 3-1

Assembly of Screened Technologies
Into Remedial Measures For The Landfill (LF)
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Screened Technology[1]	Remedial Measures[2]					
	LF1	LF2	LF3	LF4	LF5	LF6
Access Restrictions	X	X	X	X	X	X
Soil/Waste Removal	-	-	-	X	X	X
On-site Incineration	-	-	-	-	-	X
Chemical Treatment	-	-	X	X	-	-
Physical Treatment	-	-	-	X	X	X
On-site Land Disposal	-	X	X	X	X	X
Cap	-	X	X	X	X	X
Dust Suppressants	-	X	X	X	X	X
Surface Water Collection	-	X	X	X	X	X
Leachate Collection	X	X	X	X	X	X

Notes: (1) Refer to Tables 2-4, 2-5 and 2-6.
(2) X = Technology used as part of remedial measure.
- = Technology not used as part of remedial measure.

074/32

TABLE 3-2

Assembly of Screened Technologies
Into Remedial Measures For The Unloading Area (UA)
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Screened Technology[1]	Remedial Measures[2]					
	UA1	UA2	UA3	UA4	UA5	UA6
Access Restrictions	X	X	X	X	X	X
Soil/Waste Removal	-	X	-	X	X	X
Chemical Treatment	-	-	-	-	X	-
Incineration	-	-	-	-	-	X
On-site Land Disposal	-	X	X	X	X	X
Cap	-	-	X	X	X	X
Dust Suppressants	-	X	-	X	X	X
Surface Water Collection	-	X	X	X	X	X

Notes: (1) Refer to Tables 2-4, 2-5 and 2-6.
(2) X = Technology used as part of remedial measure.
- = Technology not used as part of remedial measure.

074/33

TABLE 3-3

Assembly of Screened Technologies
Into Remedial Measures For The Former
Cathode Waste Management Areas (FCW)
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Screened Technology[1]	Remedial Measures[2]						
	FCW1	FCW2	FCW3	FCW4	FCW5	FCW6	FCW7
Access Restrictions	X	X	X	X	X	X	X
Soil/Waste Removal	-	-	-	X	X	X	X
Partial Soil/ Waste Removal	-	-	X	-	-	-	-
On-site Incineration	-	-	-	-	-	-	X
Chemical Treatment	-	-	-	-	-	X	-
Physical Treatment	-	-	-	-	X	X	X
On-site Land Disposal	-	X	X	X	X	X	X
Cap	-	X	X	X	X	X	X
Dust Suppressants	-	X	X	X	X	X	X
Surface Water Collection	-	X	X	X	X	X	X
Leachate Collection	-	X	X	X	X	X	X

Notes: (1) Refers to Tables 2-4, 2-5 and 2-6.
(2) X = Technology used as part of remedial measure.
- = Technology not used as part of remedial measure.

074/31

TABLE 3-4

Assembly of Screened Technologies
Into Remedial Measures For The Scrubber Sludge Ponds (SP)
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Screened Technology[1]	Remedial Measures[2]						
	SP1	SP2	SP3	SP4	SP5	SP6	SP7
Access Restrictions	X	X	X	X	X	X	X
Sediment Removal	-	-	-	-	X	X	-
Soil/Waste Removal	-	-	-	-	X	X	-
Solidification/ Stabilization	-	-	-	-	-	-	X
On-site Land Disposal	-	X	X	X	X	X	X
Cap	-	-	-	X	X	X	-
Cover	-	X	X	-	-	-	X
Dust Suppressants	-	-	-	-	X	X	X
Hydraulic Barriers	-	-	-	X	-	-	-
Subsurface Barriers	-	-	X	-	-	-	-

Notes: (1) Refer to Tables 2-4, 2-5 and 2-6.
(2) X = Technology used as part of remedial measure.
- = Technology not used as part of remedial measure.

074/34

TABLE 3-5

Assembly of Screened Technologies
Into Remedial Measures For Ground Water (GW)
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Screened Technologies[1]	Remedial Measure[2,3]			
	GW1	GW2	GW3	GW4
Prevent Withdrawal	X	X	X	-
Institutional Controls	X	X	X	-
Alternative Drinking Water Supply	-	-	X	-
Ground-water Controls	-	-	-	X
Water Treatment				
Physical	-	-	-	X
Chemical	-	-	-	X

Notes: (1) Refers to Table 2-6.
(2) X = Technology used as part of remedial measure.
- = Technology not used as part of remedial measure.
(3) Specific to those areas of ground-water contamination presented in Section 1.2.3.6.

074/30

Table 3-6

Landfill (LF) Remedial Measures
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Remedial Measure	Remediation Level(s) (1)	Description
LF1	4	Limited action. The existing fence surrounding the Landfill will be improved and deed restrictions will be recorded to prevent future use of the area. The existing leachate collection system will continue to operate.
LF2	3	Covering of the waste in place with a cap, leachate collection and treatment, and improved drainage controls. Fill adjacent to the Landfill Ditch will be excavated to consolidate waste and reduce the area of the cap. Dust suppressants will be utilized to minimize airborne particulates. Deed restrictions will be recorded to prevent future use of the area.
LF3	1,2	Heap-leaching of the waste in place. The existing surface drainage features will be improved to act as the leachate collection system. Improved drainage controls will also be implemented. Water will be passed through the wastes, collected, treated and recycled. Asbestos in known burial areas will be removed, containerized and stored on-site until heap-leaching is concluded. Asbestos will be subsequently placed back in the Landfill and the Landfill will be capped. Dust suppressants will be utilized to minimize airborne particulates. After treatment, deed retrictions will be recorded to prevent future use of the area.
LF4	1,2	Excavation, segregation, transportation and placement of target waste into a newly constructed on-site heap-leaching facility. During segregation, basalt fragments will be separated from target wastes, left at the Landfill area, regraded and backfilled as required to provide drainage. Dust suppressants will be utilized to minimize airborne particulates. The existing leachate collection system will be improved to collect leachate generated during waste segregation. Collected leachate will be treated. Drainage controls will be improved. Non-metallic target wastes will be ground to obtain acceptable particle sizes. Ground material and metallic wastes will be placed into the heap-leaching facility. Water will be passed through the heap pile, collected, treated and recycled. Asbestos in known burial areas will be removed, containerized and stored on-site until heap leaching is concluded; at which time containerized asbestos shall be placed in the heap, and the heap pile will be capped in place. Deed retrictions will be recorded to prevent future use of the heap-leaching facility.

Notes: (1) Remediation Levels:
1. Treat to minimize or eliminate long-term management
2. Containment with treatment
3. Containment without treatment
4. No action

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Table 3-6
(continued)

Landfill (LF) Remedial Measures
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Remedial Measure	Remediation Level(s) (1)	Description
LF5	3	Excavation, segregation, transportation and placement of target waste into a newly constructed on-site RCRA landfill. Dust suppressants will be utilized to minimize airborne particulates. Leachate generated from the RCRA landfill will be collected and treated. During segregation, basalt fragments will be separated from target wastes, left in place, regraded and backfilled as required to provide drainage. Drainage controls will be improved and deed restrictions will be recorded to prevent future use of the RCRA landfill.
LF6	1,2	Excavation, segregation and transportation of burnable target waste to an on-site incinerator. During segregation, basalt fragments, metallic and burnable target wastes will be isolated. Dust suppressants will be utilized to minimize airborne particulates. The existing surface drainage features will be improved to act as the leachate collection system while waste segregation is being performed and collected leachate will be treated. Grinding of burnable target wastes will be performed to obtain acceptable particle sizes. A new on-site RCRA landfill will be constructed for incinerator ash management. Leachate generated from the RCRA landfill will be collected and treated. Metallic wastes will be placed in the new RCRA landfill. Basalt fragments will be left in the Landfill area, regraded and backfilled as required to provide drainage. Drainage controls will be improved. Upon completion of incineration, the new RCRA landfill will be capped. Deed restrictions will be recorded to prevent future use of the area.

NOTES: (1) Remediation Levels:
1. Treat to minimize or eliminate long-term management
2. Containment with treatment
3. Containment without treatment
4. No action

074/26

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Table 3-7

Unloading Area (UA) Remedial Measures
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Remedial Measure	Remediation[1] Level(s)	Description
UA1	4	Limited action. A fence will be constructed around the Unloading Area and deed restrictions will be recorded to prevent future use of the area.
UA2	3	Excavation, transportation and consolidation of the cathode waste material into the existing Landfill followed by capping of the Landfill. Dust suppressants will be utilized to minimize airborne particulates. The excavation will be backfilled as required to promote drainage.
UA3	3	Covering of the cathode waste material in place with a cap. Drainage controls will be installed. Deed restrictions will be recorded to prevent future use of the area.
UA4	3	Excavation, transportation and placement of the cathode waste material into a newly constructed on-site RCRA Landfill. Dust suppressants will be utilized to minimize airborne particulates. Leachate generated from the RCRA landfill will be collected and treated. The excavation will be backfilled as required to promote drainage. Deed restrictions will be recorded to prevent future use of the RCRA landfill.
UA5	1,2	Excavation, transportation and placement of the cathode waste material into a newly constructed on-site heap-leaching facility. Dust suppressants will be utilized to minimize airborne particulates. The cathode waste material will be ground to obtain acceptable particle sizes. The excavation will be backfilled as required to promote drainage. Water will be passed through the heap pile, collected, treated and recycled. The heap pile will be capped in place after leaching operations cease. Deed restrictions will be recorded to prevent future use of the area.
UA6	1,2	Excavation and transportation of the cathode waste material to an on-site incinerator. Dust suppressants will be utilized to minimize airborne particulates. The excavation will be backfilled as required to promote drainage. The cathode waste material will be ground to obtain an acceptable particle size prior to incineration. The excavation will be backfilled as required to promote drainage and a new on-site RCRA landfill will be constructed to manage the ash generated from the incinerator. Deed restrictions will be recorded to prevent future use of the RCRA landfill.

Notes: (1) Remediation Levels:
1. Treat to minimize or eliminate long-term management
2. Containment with treatment
3. Containment without treatment
4. No action

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Table 3-8

Former Cathode Waste Management Areas (FCW) Remedial Measures
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Remedial Measure	Remediation Level(s) (1)	Description
FCW1	4	Limited action. A fence will be constructed around the Former Cathode Waste Management Areas and deed restrictions will be recorded to prevent future use of the area.
FCW2	3	Covering of the waste in place with an asphalt cap. The area will be regraded to promote drainage prior to installation of the cap. Surface drainage will be collected and diverted to the nearby process sewer. The perched water will be collected in a trench and treated. Deed retrictions will be recorded to prevent future use of the area.
FCW3	3	Excavation, transportation and consolidation of the residual cathode waste material into the existing Landfill followed by capping of the Landfill. Dust suppressants will be utilized to minimize airborne particulates. The underlying fill material at the Former Cathode Waste Management Areas will be graded and capped in place with an asphalt cap. Surface drainage will be collected and diverted to the nearby process sewer. The perched water will be collected in a trench and treated and deed restrictions will be recorded to prevent future use of the area.
FCW4	3	Excavation, transportation and consolidation of the residual cathode waste material and underlying contaminated fill material into the existing Landfill followed by capping of the Landfill. Dust suppressants will be utilized to minimize airborne particulates. Leachate generated from the RCRA landfill will be collected and treated. The excavation will be backfilled as required to promote drainage. Surface drainage will be collected and diverted to the nearby process sewer. The perched water will be collected during excavation and treated and deed restrictions will be recorded to prevent future use of the RCRA landfill.
FCW5	3	Excavation, transportation and consolidation of the residual cathode waste material and underlying contaminated fill material into a newly constructed on-site RCRA landfill. Dust suppressants will be utilized to minimize airborne particulates. Leachate generated from the RCRA landfill will be collected and treated. The excavation will be backfilled as required to promote drainage. Surface water drainage will be collected and diverted to the nearby process sewer. The perched water will be collected during excavation and treated and deed restrictions will be recorded to prevent future use of the RCRA landfill.

Notes: (1) Remediation Levels:
1. Treat to minimize or eliminate long-term management
2. Containment with treatment
3. Containment without treatment
4. No action

074/42

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Table 3-8
(Continued)

Former Cathode Waste Management Areas (FCW) Remedial Measures
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Remedial Measure	Remediation Level(s) (1)	Description
FCW6	1,2	Excavation, transportation and placement of residual cathode waste and underlying contaminated fill into a newly constructed on-site heap-leaching facility. Dust suppressants will be utilized to minimize airborne particulates. Materials will be ground to obtain acceptable particle sizes. The excavation will be backfilled as required to promote drainage and surface water drainage will be collected and diverted to the nearby process sewer. The perched water will be collected during excavation and treated. Water will be passed through the heap-leaching pile, collected, treated and recycled. The heap pile will be capped in place after leaching operations cease. Deed restrictions will be recorded to prevent future use of the heap-leaching facility.
FCW7	1,2	Excavation, segregation and transportation of residual cathode waste and underlying contaminated fill material to an on-site incinerator. Dust suppressants will be utilized to minimize airborne particulates. Materials will be ground to obtain acceptable particle size prior to incineration. The excavation will be backfilled as required to promote drainage and surface drainage will be collected and diverted to the nearby process sewer. The perched water will be collected during excavation and treated. A new on-site RCRA Landfill will be constructed for incinerator ash management. Leachate generated from the RCRA landfill will be collected and treated. Deed restrictions will be recorded to prevent future use of the RCRA landfill.

Notes: (1) Remediation Levels:
1. Treat to minimize or eliminate long-term management
2. Containment with treatment
3. Containment without treatment
4. No action

074/42

Table 3-9

Scrubber Sludge Ponds (SP) Remedial Measures
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Remedial Measures	Remediation Level(s) (1)	Description
SP1	4	Limited action. A fence will be constructed around the Scrubber Sludge Ponds and deed restrictions will be recorded to prevent future use of the area.
SP2	3	Placement of a soil cover over Scrubber Sludge Ponds 2 and 3. Deed restrictions will be recorded to prevent future use of the area.
SP3	3	Placement of a soil cover over Scrubber Sludge Ponds 2 and 3 and the installation of a subsurface barrier to minimize the discharge of ground waters from the Byron Interbed. Deed restrictions will be recorded to prevent future use of the area.
SP4	3	Capping of Scrubber Sludge Ponds 1 through 4. Ground-water controls (hydraulic barriers) will be implemented to prevent the ground water from contacting the waste material. Deed restrictions will be recorded to prevent future use of the area.
SP5	3	Excavation, transportation and placement of the Scrubber Sludge Pond material into the existing Landfill followed by capping of the Landfill. Dust suppressants will be used to minimize airborne particulates. The excavation will be backfilled as required to promote drainage. Deed restrictions will be recorded to prevent future use of the RCRA landfill.
SP6	3	Excavation, transportation and placement of sludges and contaminated subsoils into a newly constructed on-site RCRA landfill and backfilling of the excavation as required to promote drainage. Dust suppressants will be used to minimize airborne particulates. Deed restrictions will be recorded to prevent future use of the RCRA landfill.
SP7	1,2	Stabilization of the waste in place. A soil cover will be placed over the stabilized waste. Dust suppressants will be used to minimize airborne particulates. Deed restrictions will be recorded to prevent future use of the RCRA landfill.

Notes: (1) Remediation Levels:
1. Treat to minimize or eliminate long-term management
2. Containment with treatment
3. Containment without treatment
4. No action

074/43

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TABLE 3-10

Ground Water (GW) Remedial Measures
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Remedial Measure	Remediation[1] Level(s)	Description
GW1	4	Limited action. Development of a ground-water quality monitoring program and institutional requirements to prevent future use of affected ground water.
GW2	3	Recase nearby water supply wells such that water is drawn only from the DGWR and establish institutional requirements limiting or prohibiting the drilling of new wells.[2]
GW3	3	Limited ground-water treatment, plug and abandonment of nearby water supply wells, connection of users to central water supply and establish institutional requirements limiting or prohibiting the drilling of new wells.[2]
GW4[3]		Installation of a ground-water recovery system with treatment and ground-water monitoring.
- A	1,2	Recovered ground water will be sent to a mechanical evaporation unit where the contaminants will be concentrated. The concentrated stream will be discharged to an evaporation pond/UV irradiation for treatment. The residual solid waste in the evaporation pond will be characterized for proper disposal.
- B	1,2	Recovered ground water will be transmitted to an oxidation unit followed by a chemical precipitation unit and an ion exchange polishing unit. Solids from this treatment system will be characterized for proper disposal. The regenerant from the ion exchange unit will be recycled to the chemical precipitation unit.

Notes:

(1) Remediation Levels:
1. Treat to minimize or eliminate long-term management
2. Containment with treatment
3. Containment without treatment
4. No action

(2) Nearby water supply wells include the Rockline, Animal Shelter, Klindt and Residence wells.

(3) Remedial measures GW4-A through GW4-D were developed for ground water from the S-Aquifer; leachate which may potentially be generated from the Landfill or a newly constructed on-site RCRA landfill; perched water from the Former Cathode Waste Management Areas; and process waters from a newly constructed on-site heap-leaching facility or in situ heap-leaching process.

074/27

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TABLE 3-10
(Continued)

Ground Water (GW) Remedial Measures
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Remedial Measure	Remediation[1] Level(s)	Description
GW4[3]		Installation of a ground-water recovery system with treatment and ground-water monitoring.
- C	1,2	Recovered ground water will be treated in an ion exchange unit. The effluent from this unit will be discharged to the existing NPDES facility while the regenerant will be sent to an evaporation pond/UV irradiation. Residual solids from the evaporation pond will be characterized for proper disposal.
- D	1,2	Recovered ground water will be transmitted to an oxidation unit followed by a reverse osmosis polishing unit while the permeate will be discharged through the existing NPDES facility. Concentrate from the reverse osmosis unit will be sent to an evaporation pond. The residual solids from the evaporation pond will be characterized for proper disposal.

Notes: (1) Remediation Levels:
1. Treat to minimize or eliminate long-term management
2. Containment with treatment
3. Containment without treatment
4. No action

(2) Nearby water supply wells include the Rockline, Animal Shelter, Klindt and Residence wells.

(3) Remedial measures GW4-A through GW4-D were developed for ground water from the S-Aquifer; leachate which may potentially be generated from the Landfill or a newly constructed on-site RCRA landfill; perched water from the Former Cathode Waste Management Areas; and process waters from a newly constructed on-site heap-leaching facility or in situ heap-leaching process.

074/27

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TARGET REMEDIATION AREA / REMEDIAL MEASURE	LANDFILL	UNLOADING AREA	FORMER CATHODE WASTE MANAGEMENT AREAS	SCRUBBER SLUDGE PONDS	GROUND WATER
CAPPING IN PLACE	●	●	●		
PARTIAL WASTE REMOVAL AND CAP IN PLACE			●		
CONSOLIDATION INTO EXISTING LANDFILL		●	●	●	
CONSOLIDATION INTO ON-SITE RCRA LANDFILL	●	●	●	●	
CONSTRUCT ON-SITE HEAP-LEACHING FACILITY	●	●	●		
IN-SITU HEAP-LEACHING	●				
INCINERATION	●	●	●		
STABILIZATION IN PLACE				●	
SOIL COVER				●	
SOIL COVER WITH SUBSURFACE BARRIER				●	
GROUND-WATER RECOVERY AND TREATMENT					●
P & A EXISTING WELLS AND PROVIDE CENTRAL WATER SUPPLY					●
RECASE EXISTING WELLS IN THE DGWR					●
CAPPING IN PLACE WITH A HYDRAULIC BARRIER				●	
LIMITED ACTION	●	●	●	●	●

TABLE 3-11

DRAWING NO: TE0018-P05-A74

DRAWN BY: SKF.	DATE: 5/10/88
CHECKED: AZC	DATE: 6-1-88
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REMEDIAL MEASURES CONSIDERED FOR IMPLEMENTATION
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

specific ARARs for the MMRF is presented in Table 3-12. These location-specific ARARs will be utilized with other screening criteria to evaluate the applicability of a given remedial measure to the target remediation area.

3.2 SCREENING OF REMEDIAL MEASURES

The process for screening of the remedial measures consists of evaluating information and criteria in sufficient detail to distinguish among the remedial measures for each target remediation area. Some of the remedial measures for certain target remediation areas are interdependent.

The screening of assembled remedial measures follows the EPA's Draft Guidance Document and includes consideration of effectiveness, implementability and cost criteria. The objective of the screening process is to advance only those remedial measures which are effective and implementable to the development of sitewide remedial alternatives. The screening process accomplishes this objective by eliminating remedial measures which are clearly not feasible or effective.

During the remedial measures screening, cost is not utilized to discriminate between measures which include treatment technologies and those which do not use treatment as a principal element. A cost comparison between treatment and non-treatment remedial measures is evaluated in Section 5.0.

TABLE 3-12

Potential Location Specific ARARs
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Location	Requirement	Prerequisite(s)	Citation
Within 61 meters (200 feet) of a fault displaced in Holocene time.	New treatment, storage or disposal of hazardous waste prohibited	RCRA hazardous waste; treatment,storage or disposal	40 CFR 264.18(a)
Within 100-year floodplain	Facility must be designed, constructed, operated, and maintained to avoid washout	RCRA hazardous waste; treatment, storage or disposal	40 CFR 264.18(h)
Within flood plain	Action to avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values	Action that will occur in a floodplain, i.e. lowlands, and relatively flat areas adjoining inland and coastal waters and other flood prone areas	Executive Order 11988, Protection of Floodplains, (40 CFR6, Appendix A)
Critical habitat upon which endangered species or threatened species depends	Action to conserve endangered species or threatened species, including consultation with the Department of Interior	Determination of endangered species or threatened	Endangered Species Act of 1973 (16 USC 1531 et seq.); 50 CFR Part 200, 50 CFR Part 402
Wetland	Action to minimize the destruction, loss, or degradation of wetlands	Wetland as defined by Executive order 11990 Section 7	Executive Order 11990, Protection of Wetlands, (40 CFR 6, Appendix A)
Wetland	Action to prohibit discharge of dredged or fill material into wetland without permit		Clean Water Act Section 404; 40 CFR Parts 230, 231
Area affecting stream or river	Action to protect fish or wildlife	Diversion channeling or other activity that modifies a stream or river and affects fish or wildlife.	Fish and Wildlife Coordination Act (16 U.S.CC. 661 et seq.); 40 CFR 6.302
Within area affecting national wild, scenic, or recreational river	Avoid taking or assisting in action that will have direct adverse effect on scenic river	Activities that affect or may affect any of the rivers specified in section 1276(a)	Scenic Rivers Act (16 U.S.C. 1271 et seq. section 7(a)); 40 CFR 6.302(c)

022/22

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3.2.1 Remedial Measures Screening Criteria

Remedial measures are screened according to the following criteria:

Effectiveness

- Protectiveness; and
- Reduction of toxicity, mobility or volume.

Implementability

- Technical feasibility;
- Administrative feasibility; and
- Availability.

Cost

- Capital;
- Operation and maintenance; and
- Present worth.

Each of the criteria is further defined in the following sections.

3.2.1.1 Effectiveness

The effectiveness of remedial measures includes:

- o Protectiveness - Refers to the ability of the remedial measure to protect human health and the environment. This criteria includes both long- and short-term components describing protectiveness during and after remedial activities are complete and includes the following criteria:
  - Compliance with chemical and location specific ARARs;
  - Ability to protect the community during remedial actions;
  - Ability to protect workers during remedial actions;
  - Length of time until protection is achieved;

- Magnitude of residual risk after remedial action is complete;
- Ability to prevent future exposure to residual contaminants; and
- Long-term reliability of the remedial actions.

o Reduction of Toxicity, Mobility or Volume - Whether the remedial measure reduces the toxicity, mobility or volume of hazardous constituents through chemical or physical treatment which decreases the threats or risks associated with the hazardous materials present.

3.2.1.2 Implementability

The implementability of remedial measures includes:

o Technical Feasibility - Refers to the ability to construct, operate and maintain the technologies utilized in the remedial measure and includes the following specific criteria:

- Short term reliability of technologies utilized;
- Ability to monitor the effectiveness of the remedial actions; and
- Ability to perform operation and maintenance functions where required.

o Administrative Feasibility - Refers to the ability to obtain approvals from regulatory agencies.

o Availability - Whether the necessary equipment materials, specialists and work force are available to construct and maintain the technologies utilized.

3.2.1.3 Cost

Relative costs are evaluated for the remedial measures developed for each target remediation area. This evaluation considers volumes of material to be removed, waste types, complexity of technologies used to implement the remedial

measure, and other related information. Subsequently, the relative costs are compared to all remedial measures developed for the each target remediation area and assigned a low, medium or high value. A detailed cost analysis including capital, operation and maintenance and total present worth is performed in Section 5.0. The relative cost takes into account the following factors:

- Capital Cost - Capital costs include construction, land and site development, and buildings and services costs.
- Operation and Maintenance Costs - Operation and maintenance costs include operating labor, maintenance materials and labor, auxiliary materials and energy, purchased services and disposal costs.
- Present Worth - Present worth consists of the present value of costs that would be incurred over time.

Relative costs for a similar remedial measure for different target remediation areas may not be assigned the same cost value because of the various considerations given when developing the cost for a specific target remediation area.

3.2.2 Remedial Measures Screening

The screening of remedial measures involves evaluating each remedial measure identified in Section 3.1 using the criteria discussed in Section 3.2.1. A tabular format is utilized to conduct this screening and the results are presented in Tables 3-13 through 3-17.

TABLE 3-13

Screening of Remedial Measures for the Landfill (LF)
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	SCREENING		
Remedial Measure/ Description	LF1: Limited Action o Improve security fence o Deed restrictions	LF2: Cap in Place o Consolidation of waste o Capping waste in place o Leachate collection and treatment	LF3: In Situ Heap-Leaching o Improve surface drainage features o Heap-leach waste in place o Cap treated waste in place
SCREENING CRITERIA:			
Protectiveness	o Reduces risk of exposure o Does not satisfy remediation criteria o Community not affected by remediation o Very low potential for workers' exposure during construction o Remedial action (fence) complete in short time o Potential exists for future exposure o Does not address long-term reliability	o Reduces risk of exposure o Satisfies remediation criteria o Community not affected by remediation o Low potential for workers' exposure during construction o Remedial actions complete in less than five years o Future exposure to residuals can be prevented o Actions are reliable (long term)	o Minimizes risk of exposure o Satisfies remediation criteria o Community not affected by remediation o Potential for workers' exposure to asbestos o Remediation would take longer than five years o Potential exists for future exposure o Technology unproven for waste management and may be difficult to implement due to asbestos present. Also reliability is unknown because of nature of underlying basalt
Reduction of Toxicity, Mobility or Volume	o Does not reduce toxicity, mobility or volume of waste	o Does not reduce toxicity, mobility or volume of waste o Leachate will be collected and treated	o Reduces toxicity of soluble constituents and volume of waste
Technical Feasibility	o Technologies utilized during construction are reliable (short-term) o Fence integrity can be monitored and maintained as necessary o Monitoring could be conducted using existing monitor well network	o Technologies utilized during construction are reliable (short-term) o Requires conventional O&M for containment, leachate collection and treatment systems o Monitoring could be conducted using existing monitor well network	o Technologies utilized during construction are reliable (short-term) o Requires conventional O&M for heap-leaching facility o Monitoring could be conducted using existing monitor well network

099/8

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TABLE 3-13
(Continued)

Screening of Remedial Measures for the Landfill (LF)
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	SCREENING		
Remedial Measure/ Description	LF1: Limited Action o Improve security fence o Deed restrictions	LF2: Cap in Place o Consolidation of waste o Capping of waste in place o Leachate collection and treatment	LF3: In Situ Heap-Leaching o Improve surface drainage features o Heap-leach waste in place o Cap treated waste in place
SCREENING CRITERIA:			
Administrative Feasibility	o Approval from regulatory agencies unlikely	o Approval from regulatory agencies possible	o Approval from regulatory agencies unlikely
Availability	o Adequate work force, specialists and materials available	o Adequate work force, specialists and materials available	o Adequate work force, specialists and materials available
Cost (Relative)	o Low	o Low	o Low
Retained for Assembly of Remedial Alternatives	o Yes	o Yes	o No

099/8

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TABLE 3-13
(Continued)

Screening of Remedial Measures for the Landfill (LF)
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	SCREENING		
Remedial Measure/ Description	LF4: Construct On-site Heap-Leaching Facility	LF5: Construct On-site RCRA Landfill	LF6: Incineration
	o Excavate and transport waste to heap-leaching facility o Heap-leaching of waste o Cap heap pile	o Excavate and segregate waste o Transportation and placement of waste into an on-site RCRA landfill o Leachate collection and treatment	o Excavate and segregate waste o Transportation of burnable waste to an on-site incinerator o Incineration of waste o Management of ash in an on-site RCRA landfill
SCREENING CRITERIA:			
Protectiveness	o Minimizes risk of exposure o Satisfies remediation criteria o Community not affected by remediation o Potential for workers' exposure to asbestos o Remediation would take longer than five years o Future exposure to residuals can be prevented o Technology unproven for waste management	o Reduces risk of exposure o Satisfies remediation criteria o Community not affected by remediation o Potential for workers' exposure to asbestos o Remedial actions complete in less than five years o Future exposure to residuals can be prevented o Actions are reliable (long-term)	o Minimizes risk of exposure o Satisfies remediation criteria o Community not affected by remediation o Potential for exposure to asbestos o Remedial actions would take longer than five years o Future exposure to residuals can be prevented o Technology limited because of low BTU value of waste
Reduction of Toxicity, Mobility or Volume	o Reduces toxicity of soluble constituents and volume of waste	o Does not reduce toxicity, mobility or volume of waste	o Reduces toxicity and volume of waste
Technical Feasibility	o Handling waste may result in air emission problems o Requires conventional O&M for heap-leaching facility o Additional monitor wells would be required	o Handling waste may generate air emission problems o Requires long-term maintenance of cap, leachate collection and treatment o Monitoring could be conducted using existing monitor well network	o Handling waste may generate air emission problems o Substantial O&M requirements for incinerator; RCRA landfill requires long-term maintenance of the cap and leachate collection and treatment systems o Additional monitor wells would be required

099/8

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TABLE 3-13
(Continued)

Screening of Remedial Measures for the Landfill (LF)
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	SCREENING		
Remedial Measure/ Description	LF4: Construct On-site Heap-Leaching Facility	LF5: Construct On-site RCRA Landfill	LF6: Incineration
	o Excavate and transport waste to heap-leaching facility o Heap-leaching of waste o Cap heap pile	o Excavate and segregate waste o Transportation and placement of waste into an on-site RCRA landfill o Leachate collection and treatment	o Excavate and segregate waste o Transportation of burnable waste to an on-site incinerator o Incineration of waste o Management of ash in an on-site RCRA landfill
SCREENING CRITERIA:			
Administrative Feasibility	o Aproval from regulatory agencies possible	o Approval from regulatory agencies possible	o Approval from regulatory agencies may be difficult to obtain due to air emission standards
Availability	o Adequate work force, specialists and materials available	o Adequate work force and specialists available. Materials (clay) difficult to obtain	o Adequate work force and specialists available. Materials (clay) difficult to obtain
Cost (Relative)	o Medium	o Medium	o High
Retained for Assembly of Remedial Alternatives	o No	o Yes	o Yes

099/8

G&M Consulting Engineers, Inc.

TABLE 3-14

Screening of Remedial Measures for the Unloading Area (UA)
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	SCREENING		
Remedial Measures/ Description	UA1: Limited Action	UA2: Consolidate Into Existing Landfill	UA3: Cap in Place
	o Fence Area o Deed restrictions	o Excavate waste and consolidate into existing Landfill and cap o Backfill excavation	o Cap waste in place
SCREENING CRITERIA:			
Protectiveness	o Reduces risk of exposure o Does not satisfy remediation criteria o Community not affected by remediation o Very low potential for workers' exposure during construction o Remedial action complete in short time o Potential exists for future exposure o Does not address long-term reliability	o Reduces risk of exposure o Satisfies remediation criteria o Community not affected by remediation o Very low potential for workers' exposure during construction o Remedial action complete in less than five years o Future exposure to residuals can be prevented o Actions are reliable (long-term)	o Reduces risk of exposure o Satisfies remediation criteria o Community not affected by remediation o Low potential for workers' exposure during construction o Remedial action complete in less than five years o Future exposure to residuals can be prevented o Actions are reliable (long-term)
Reduction of Toxicity, Mobility or Volume	o Does not reduce toxicity, mobility or volume of waste	o Does not reduce toxicity, mobility or volume of waste	o Does not reduce toxicity, mobility or volume of waste
Technical Feasibility	o Technologies utilized during construction are reliable (short-term) o Fence integrity can be monitored and maintained for as long as necessary o Monitoring could be conducted using existing monitor well network	o Exposing waste may generate air emission problems o No long-term monitoring required. Landfill will require conventional O&M for containment, leachate collection and treatment systems	o Technologies utilized during construction are reliable (short-term) o Requires long-term maintenance of cap o Monioring could be conducted using existing monitor well network
Administrative Feasibility	o Approval from regulatory agencies unlikely	o Approval from regulatory agencies possible	o Approval from regulatory agencies possible

099/9

G&M Consulting Engineers, Inc.

TABLE 3-
(Continued)

Screening of Remedial Measures for the Unloading Area (UA)
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	SCREENING		
Remedial Measures/ Description	UA1: Limited Action	UA2: Consolidate Into Existing Landfill	UA3: Cap in Place
	o Fence Area o Deed restrictions	o Excavate waste and consolidate into existing Landfill and cap o Backfill excavation	o Cap waste in place
SCREENING CRITERIA:			
Availability	o Adequate work force, specialists and materials available	o Adequate work force, specialists and materials available	o Adequate work force, specialists and materials available
Cost (Relative)	o Low	o Low	o Low
Retained for Assembly of Remedial Alternative	o Yes	o Yes	o No

099/9

G&M Consulting Engineers, Inc.

TABLE 3-14
(Continued)

Screening of Remedial Measures for the Unloading Area (UA)
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	SCREENING		
Remedial Measures/ Description	UA4: Consolidate Into New On-site RCRA Landfill	UA5: Consolidate Into New Heap-Leaching Facility	UA6: Incineration
	o Excavate waste o Transportation and placement of waste in an on-site RCRA landfill o Backfill excavation	o Excavate and transport waste to heap-leaching facility o Heap-leaching of waste o Cap heap pile in place	o Excavate and transport waste to an on-site incinerator o Incineration of waste o Manage ash in an on-site RCRA landfill
SCREENING CRITERIA:			
Protectiveness	o Reduces risk of exposure o Satisfies remediation criteria o Community not affected by remediation o Low potential for workers' exposure during construction o Remedial action complete in less than five years o Future exposure to residuals can be prevented o Actions are reliable (long-term)	o Minimizes risk of exposure o Satisfies remediation criteria o Community not affected by remediation o Low potential for workers' exposure during construction o Remedial action would take longer than five years o Future exposure to residuals can be prevented o Technology unproven for waste management	o Greatly minimizes risk of exposure o Satisfies remediation criteria o Community not affected by remediation o Potential for workers' exposure during construction o Remedial action would take longer than five years o Future exposure to residuals o can be prevented o Actions are reliable (long-term)
Reduction of Toxicity, Mobility or Volume	o Does not reduce toxicity, mobility or volume of waste	o Reduces toxicity for soluble constituents and volume of waste	o Reduces toxicity and volume of waste
Technical Feasibility	o Handling waste may generate air emission problems o Requires long-term maintenance of cover system and conventional O&M for containment, leachate collection and treatment systems	o Exposing waste may generate air emission problems o Requires conventional O&M for heap-leaching facility	o Handling waste may generate air emission problems o Substantial O&M requirements for incinerator; RCRA landfill requires long-term maintenance of the containment, leachate collection and treatment

099/9

G&M Consulting Engineers, Inc.

TABLE 3-14
(Continued)

Screening of Remedial Measures for the Unloading Area (UA)
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	SCREENING		
Remedial Measures/ Description	UA4: Consolidate Into New On-site RCRA Landfill	UA5: Consolidate Into New Heap-Leaching Facility	UA6: Incineration
	o Excavate waste o Transportation and placement of waste in an on-site RCRA landfill o Backfill excavation	o Excavate and transport waste to heap-leaching facility o Heap-leaching of waste o Cap heap pile in place	o Excavate and transport waste to an on-site incinerator o Incineration of waste o Manage ash in an on-site RCRA landfill
SCREENING CRITERIA:			
Administration Feasibility	o Approval from regulatory agencies possible	o Approval from regulatory agencies possible	o Approval from regulatory agencies may be difficult to obtain due to air emission standards
Availability	o Adequate work force and specialists available. Materials (clay) difficult to obtain.	o Adequate work force, specialists and materials available.	o Adequate work force and specialists available. Materials (clay) difficult to obtain.
Cost (Relative)	o Medium	o Medium	o Very High
Retained for Assembly of Remedial Alternatives	o Yes	o No	o Yes

099/9

G&M Consulting Engineers, Inc.

TABLE 3-15

Screening of Remedial Measures for the Former Cathode Waste Management Areas (FCW)
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	SCREENING			
Remedial Measure/ Description	FCW1: Limited Action	FCW2: Cap in Place	FCW3: Partial Removal and Cap in Place	FCW4: Consolidation Into Existing Landfill
	o Fence areas o Deed restrictions	o Regrade areas to promote drainage and divert surface water to process sewers o Cap areas with asphalt	o Excavate residual cathode waste and consolidate into existing Landfill o Cover remaining fill material with an asphalt cap	o Excavate waste and consolidate into existing Landfill o Cap Landfill o Divert surface water to process sewer
SCREENING CRITERIA:				
Protectiveness	o Reduces risk of exposure o Does not satisfy remediation criteria o Community not affected by remediation o Very low potential for workers' exposure during construction o Remedial action complete in short time o Potential exists for future exposure o Does not address long-term reliability	o Reduces risk of exposure o Satisfies remediation criteria o Community not affected by remediation o Low potential for workers' exposure during construction o Remedial action complete in less than five years o Future exposure to residuals can be prevented o Actions are reliable (long-term)	o Reduces risk of exposure o Satisfies remediation criteria o Community not affected by remediation o Potential for workers' exposure during construction o Remedial action complete in less than five years o Future exposure to residuals can be prevented o Actions are reliable (long-term)	o Reduces risk of exposure o Satisfies remediation criteria o Community not affected by remediation o Low Potential for Workers' exposure during construction o Remedial action complete in less than five years o Future exposure to residuals can be prevented o Actions are reliable (long-term)
Reduction of Toxicity, Mobility or Volume	o Does not reduce toxicity, mobility or volume of waste	o Does not reduce toxicity, mobility or volume of waste	o Does not reduce toxicity, mobility or volume of waste	o Does not reduce toxicity, mobility or volume of waste

091/17

G&M Consulting Engineers, Inc.

TABLE 3-15
(Continued)

Screening of Remedial Measures for the Former Cathode Waste Management Areas (FCW)
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	SCREENING			
Remedial Measure/ Description	FCW1: Limited Action	FCW2: Cap in Place	FCW3: Partial Removal and Cap in Place	FCW4: Consolidation Into Existing Landfill
	o Fence areas o Deed restrictions	o Regrade areas to promote drainage and divert surface water to process sewers o Cap areas with asphalt	o Excavate residual cathode waste and consolidate into existing Landfill o Cover remaining fill material with an asphalt cap	o Excavate waste and consolidate into existing Landfill o Cap Landfill o Divert surface water to process sewer
SCREENING CRITERIA:				
Technical Feasibility	o Technologies utilized during construction are reliable (short-term) o Fence integrity can be maintained for as long as necessary o Monitoring could be conducted using existing monitor well network	o Technologies utilized during construction are reliable (short-term) o Requires long-term maintenance of cap	o Handling waste may generate air emission problems o Requires long-term maintenance of cap o Monitoring could be conducted using existing monitor well network o Landfill will require conventional O&M for containment, leachate collection and treatment systems	o Handling waste may generate air emission problems o Does not require long-term monitoring of Former Cathode Waste Management Areas; requires long-term O&M for Landfill containment, leachate collection, and treatment systems
Administrative Feasibility	o Approval from regulatory agencies unlikely	o Approval from regulatory agencies possible	o Approval from regulatory agencies unlikely	o Approval from regulatory agencies possible
Availability	o Adequate work force, specialists and materials available	o Adequate work force, specialists and materials available	o Adequate work force, specialists and materials available	o Adequate work force and specialists available; materials (clay) may be difficult to obtain
Cost (Relative)	o Low	o Low	o Low	o Low
Retained for Assembly of Remedial Alternatives	o Yes	o Yes	o No	o Yes

091/17

TABLE 3-15
(Continued)

Screening of Remedial Measures for the Former Cathode Waste Management Areas (FCW)
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	SCREENING		
Remedial Measure/ Description	FCW5: Consolidation Into New RCRA Landfill	FCW6: Consolidation Into New Heap-Leaching Facility	FCW7: Incineration
	o Excavate waste and consolidate into new RCRA landfill o Backfill excavations o Regrade areas to promote drainage and divert surface water to process sewers	o Excavate waste and consolidate in new heap-leaching facility o Backfill excavations o Regrade areas to promote drainage and divert surface water to process sewer o Cap heap pile in place	o Excavate and segregate waste o Incinerate cathodic waste and contaminated fill material o Backfill excavation o Regrade areas to promote drainage and divert surface water to process sewer o Manage ash in new on-site RCRA landfill
SCREENING CRITERIA:			
Protectiveness	o Reduces risk of exposure o Satisfies remediation criteria o Community not affected during construction o Low potential for workers' exposure during construction o Remedial action complete in less than five years o Future exposures to residuals can be prevented o Actions are reliable (long-term)	o Minimizes risk of exposure o Satisfies remediation criteria o Community not affected during construction o Potential for workers' exposure during construction o Remedial action would take longer than five years o Future exposure to residuals can be prevented o Technology unproven for waste management and may be difficult to implement	o Greatly minimizes risk of exposure o Satisfies remediation criteria o Community not affected by remediation o Potential for workers' exposure during construction o Remedial action would take longer than five years o Future exposure to residuals can be prevented o Technology is limited by low BTU value of the waste.
Reduction of Toxicity, Mobility or Volume	o Does not reduce toxicity, mobility or volume of waste	o Reduces waste toxicity for soluble constituents and volume	o Reduces waste toxicity and volume

091/18

G&M Consulting Engineers, Inc.

TABLE 3-15
(Continued)

Screening of Remedial Measures for the Former Cathode Waste Management Areas (FCW)
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	SCREENING		
Remedial Measure/ Description	FCW5: Consolidation Into New RCRA Landfill	FCW6: Consolidation Into New Heap-Leaching Facility	FCW7: Incineration
	o Excavate waste and consolidate into new RCRA landfill o Backfill excavations o Regrade areas to promote drainage and divert surface water to process sewers	o Excavate waste and consolidate in new heap-leaching facility o Backfill excavations o Regrade areas to promote drainage and divert surface water to process sewer o Cap heap pile in place	o Excavate and segregate waste o Incinerate cathodic waste and contaminated fill material o Backfill excavation o Regrade areas to promote drainage and divert surface water to process sewer o Manage ash in new on-site RCRA landfill
SCREENING CRITERIA:			
Technical Feasibility	o Exposing waste may generate air emission problems o Does not require long-term monitoring of Former Cathode Waste Management Areas; requires long-term O&M for Landfill containment, leachate collection, and treatment systems	o Exposing waste may generate air emission problems o Requires substantial O&M for operational heap-leaching facility and waste containment system	o Exposing waste may generate air emission problems o Substantial O&M required during incineration operation; RCRA landfill requires long-term O&M for containment, leachate collection and treatment systems
Administrative Feasibility	o Approval from regulatory agencies possible	o Approval from regulatory agencies possible	o Approval from regulatory agencies may be difficult to obtain due to air emission standards
Availability	o Adequate work force, specialists and materials available	o Adequate work force, specialists and materials available	o Adequate work force, and specialists available. Materials (clay) difficult to obtain
Cost (Relative)	o Medium	o Medium	o Very High
Retained for Assembly of Remedial Alternatives	o Yes	o No	o Yes

091/18

G&M Consulting Engineers, Inc.

TABLE 3-16

Screening of Remedial Measures for the Scrubber Sludge Ponds (SP)
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	SCREENING			
Remedial Measure/ Description	SP1: Limited Action	SP2: Soil Cover on Ponds 2 and 3	SP3: Soil cover on Ponds 2 and 3 With a Subsurface Barrier	SP4: Cap in Place With a Hydraulic Barrier
	o Fence area o Deed restrictions	o Cover Scrubber Sludge Ponds 2 and 3 with soil cover system	o Cover Scrubber Sludge Ponds 2 and 3 o Install grout curtain upgradient o Implement ground-water controls	o Cap waste in place o Implement ground-water controls
SCREENING CRITERIA:				
Protectiveness	o Reduces risk of exposure o Does not comply with remediation criteria o Community is not affected by remediation o Low potential for workers' exposure during construction o Remedial action complete within a short time frame o Potential exists for future exposure o Does not address long-term reliability	o Reduces risk of exposure o Satisfies remediation criteria o Community is not affected by remediation o Workers'exposure would be controlled during remediation o Remedial action complete in less than five years o Future exposures to residuals can be prevented o Actions are reliable (long-term)	o Reduces risk of exposure o Satisfies remediation criteria o Community is not affected by remediation o Workers' exposure would be controlled during remediation o Remedial action complete in less than 5 years o Future exposures to residuals can be prevented o Actions are reliable (long-term)	o Reduces risk of exposure o Satisfies remediation criteria o Community is not affected by remediation o Workers' exposure would be conrolled during remediation o Remedial action complete in less than five years o Future exposures to residuals can be prevented o Actions are reliable (long-term)
Reduction of Toxicity, Mobility or Volume	o Does not reduce toxicity, mobility or volume of waste	o Does not reduce toxicity, mobility or volume of waste	o Does not reduce toxicity, mobility or volume of waste	o Does not reduce toxicity, mobility or volume of waste
Technical Feasibility	o Technologies utilized during construction are reliable (short-term) o Fence integrity can be monitored and maintained as necessary o Monitoring could be conducted using existing monitor well network	o Technologies utilized during construction are reliable (short-term) o Requires long-term maintenance of cover system o Monitoring could be conducted using existing monitor well network	o Technologies utilized during construction are reliable (short term) o Requires long-term maintenance of cover system o Monitoring could be conducted using existing monitor well network	o Technologies utilized during construction are reliable (short-term) o Requires long-term maintenance of cap system o Monitoring could be conducted using existing monitor well network

099/10

G&M Consulting Engineers, Inc.

TABLE 3-16
(Continued)

Screening of Remedial Measures for the Scrubber Sludge Ponds (SP)
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	SCREENING			
Remedial Measure/ Description	SP1: Limited Action	SP2: Soil Cover on Ponds 2 and 3	SP3: Soil cover on Ponds 2 and 3 With a Subsurface Barrier	SP4: Cap in Place With a Hydraulic Barrier
	o Fence area o Deed restrictions	o Cover Scrubber Sludge Ponds 2 and 3 with soil cover system	o Cover Scrubber Sludge Ponds 2 and 3 o Install grout curtain upgradient o Implement ground-water controls	o Cap waste in place o Implement ground-water controls
SCREENING CRITERIA:				
Administrative Feasibility	o Agency acceptance required	o Approval from regulatory agencies possible	o Approval from regulatory agencies possible	o Approval from regulatory agencies possible
Availability	o Adequate work force, specialists and materials available	o Adequate work force, specialists and materials available	o Adequate work force, specialists and materials available	o Adequate work force, specialists and materials available
Cost (Relative)	o Low	o Low	o High	o Medium
Retained for Assembly of Remedial Alternatives	o Yes	o Yes	o No	o Yes

099/10

G&M Consulting Engineers, Inc.

TABLE 3-16
(Continued)

Screening of Remedial Measures for the Scrubber Sludge Ponds (SP)
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	SCREENING		
Remedial Measures/ Description	SP5: Consolidate Waste Into Existing Landfill	SP6: Consolidate Into New On-site RCRA Landfill	SP7: Stabilization in Place
	o Excavate and consolidate waste into existing Landfill o Cap Landfill o Backfill excavations	o Excavate waste o Transport and place waste in a new on-site RCRA landfill o Backfill excavations	o Stabilize waste in place o Placement of soil cover on stabilized waste
SCREENING CRITERIA:			
Protectiveness	o Reduces risk of exposure o Satisfies remediation criteria o Community protected during excavations o Workers' exposure would be controlled during remediation o Remedial action complete in less than five years o Future exposures to residuals can be prevented o Actions are reliable (long-term)	o Reduces risk of exposure o Satisfies remediation criteria o Community protected during excavations o Workers' exposure would be controlled during remediation o Remedial action complete in less than five years o Future exposures to residuals can be prevented o Actions are reliable (long-term)	o Minimizes risk of exposure o Satisfies remediation criteria o Community protected during remediation o Workers' exposure would be controlled during remediation o Remedial action complete in less than five years o Future exposures to residuals can be prevented o Technology unproven for management of fluorides in saturated conditions
Reduction of Toxicity, Mobility or Volume	o Does not reduce toxicity, mobility or volume of waste	o Does not reduce toxicity, mobility or volume of waste	o Reduces waste mobility

099/11

G&M Consulting Engineers, Inc.

TABLE 3-16
(Continued)

Screening of Remedial Measures for the Scrubber Sludge Ponds (SP)
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	SCREENING		
Remedial Measures/ Description	SP5: Consolidate Waste Into Existing Landfill	SP6: Consolidate Into New On-site RCRA Landfill	SP7: Stabilization in Place
	o Excavate and consolidate waste into existing Landfill o Cap Landfill o Backfill excavations	o Excavate waste o Transport and place waste in a new on-site RCRA landfill o Backfill excavations	o Stabilize waste in place o Placement of soil cover on stabilized waste
SCREENING CRITERIA:			
Technical Feasibility	o Exposing waste may result in air emission problems o Long-term maintenance would be required at Landfill o Monitoring not required at Scrubber Sludge Ponds	o Exposing waste may result in air emission problems o Long-term maintenance would be required at new RCRA landfill o Monitoring not required at Scrubber Sludge Ponds	o Mixing waste during stabilization may result in air emission problems o Requires long-term maintenance of cover system o Monitoring could be conducted using existing monitor well network
Administrative Feasibility	o Approval from regulatory agencies possible	o Approval from regulatory agencies possible	o Approval from regulatory agencies possible
Availability	o Adequate work force, specialists and materials available	o Adequate work force and specialists available. Materials (clay) difficult to obtain	o Adequate work force, specialists and materials available
Cost (Relative)	o Medium	o High	o High
Retained for Assembly of Remedial Alternatives	o Yes	o Yes	o Yes

099/11

G&M Consulting Engineers, Inc.

TABLE 3-17

Screening of Remedial Measures for Ground Water
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	SCREENING			
Remedial Measure/ Description	GW1: Limited Action	GW2: Recase Existing Wells in DGWR	GW3: Plug and Abandon Existing Wells and Replace With Central Water Supply	GW4A: Recovery With Treatment (UV/Evaporation)
	o Ground-water quality monitoring o Institutional controls	o Recase existing wells such that water is only drawn from the DGWR o Institutional controls	o Plug and abandon potentially contaminated wells o Connect users to central water supply o Institutional controls	o Install ground-water recovery, treatment and monitoring systems o Treat recovered ground water by mechanical evaporation and placement in an evaporation pond o Properly dispose of solid residuals
SCREENING CRITERIA:				
Protectiveness	o Does not address risks o Does not comply with remediation criteria o Community is not affected by remediation o Low potential for workers' exposure during remediation o Remedial action would take longer than five years o Potential mitigated for future exposures o Does not address long-term reliability	o Reduces risk of exposure o Satisfies remediation criteria o Community is not affected by remediation o Workers' exposure would be controlled during remediation o Remedial action complete within five years o Potential mitigated for future exposures o Not applicable for Animal Shelter or Rockline Wells because of absence of DGWR	o Reduces risk of exposure o Satisfies remediation criteria o Community is not affected by remediation o Workers' exposure would be controlled during remediation o Remedial action complete within five years o Potential mitigated for future exposures o Actions are reliable (long-term)	o Greatly minimizes risk of exposure o Satisfies remediation criteria o Community protected during remediation o Workers' exposure would be controlled during remediation o Remedial action would take longer than five years o Future exposures to residuals would be minimized o Measure would be protective on a permanent basis
Reduction of Toxicity, Mobility or Volume	o Does not reduce toxicity, mobility or volume of waste	o Does not reduce toxicity, mobility or volume of waste	o Does not reduce toxicity, mobility or volume of waste	o Reduces toxicity, mobility and volume of waste

091/15

G&M Consulting Engineers, Inc.

TABLE 3-17
(Continued)

Screening of Remedial Measures for Ground Water
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	SCREENING			
Remedial Measure/ Description	GW1: Limited Action	GW2: Recase Existing Wells in DGWR	GW3: Plug and Abandon Existing Wells and Replace With Central Water Supply	GW4A: Recovery With Treatment (UV/Evaporation)
	o Ground-water quality monitoring o Institutional controls	o Recase existing wells such that water is only drawn from the DGWR o Institutional controls	o Plug and abandon potentially contaminated wells o Connect users to central water supply o Institutional controls	o Install ground-water recovery, treatment and monitoring systems o Treat recovered ground water by mechanical evaporation and placement in an evaporation pond o Properly dispose of solid residuals
SCREENING CRITERIA:				
Technical Feasibility	o Monitoring could be conducted using existing monitor well network	o Technologies utilized during construction are reliable o Requires periodic maintenance of wells	o Technologies utilized during construction are reliable o Requires no O&M functions	o Technologies utilized during construction are reliable o Effectiveness can be monitored and verified o Requires O&M for recovery and treatment systems
Administrative Feasibility	o Approval from regulatory agencies unlikely	o Approval from regulatory agencies possible	o Approval from regulatory agencies possible	o Approval from regulatory agencies likely
Availability	o Adequate work force, specialists and materials available	o Adequate work force, specialists and materials available	o Adequate work force, specialists and materials available	o Adequate work force, specialists and materials available
Cost (Relative)	o Low	o Medium	o Low	o High
Retained for Assembly of Remedial Alternatives	o Yes	o No	o Yes	o No

091/15

G&M Consulting Engineers, Inc.

TABLE 3-17
(Continued)

Screening of Remedial Measures for Ground Water
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	SCREENING		
Remedial Measure/ Description	GW4B: Recovery with Treatment (Oxidation, Ion Exchange, Chemical Precipitation)	GW4C: Recovery with Treatment (Ion Exchange, UV, Evaporation)	GW4D: Recovery With Treatment (Oxidation, Reverse Osmosis)
	o Install ground-water recovery, treatment and monitoring systems o Treat recovered ground water by oxidation, chemical precipitation and ion exchange o Properly dispose of solid residuals	o Install ground-water recovery, treatment and monitoring systems o Treat recovered ground water in an ion exchange unit followed by an evaporation pond	o Install ground-water recovery, treatment and monitoring systems o Treat recovered ground water by oxidation and reverse osmosis o Discharge reverse osmosis unit concentrate to an evaporation pond o Properly dispose of solid residues
SCREENING CRITERIA:			
Protectiveness	o Greatly minimizes risk of exposure o Satisfies remediation criteria o Community protected during remediation o Workers' exposure would be controlled during remediation o Remedial action would take longer than five years o Future exposures to residuals would be minimized o Measure would be protective on a permanent basis	o Greatly minimizes risk of exposure o Satisfies remediation criteria o Community protected during remediation o Workers' exposure would be controlled during remediation o Remedial action would take longer than five years o Future exposures to residuals would be minimized o Measure would be protective on a permanent basis	o Greatly minimizes risk of exposure o Satisfies remediation criteria o Community protected during remediation o Workers' exposure would be controlled during remediation o Remedial action would take longer than five years o Future exposures to residuals would be minimized o Measure would be protective on a permanent basis
Reduction of Toxicity, Mobility or Volume	o Reduces toxicity, mobility and volume of waste	o Reduces toxicity, mobility and volume of waste	o Reduces toxicity, mobility and volume of waste

091/16

G&M Consulting Engineers, Inc.

TABLE 3-17
(Continued)

Screening of Remedial Measures for Ground Water
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	SCREENING		
Remedial Measure/ Description	GW4B: Recovery with Treatment (Oxidation, Ion Exchange, Chemical Precipitation)	GW4C: Recovery with Treatment (Ion Exchange, UV, Evaporation)	GW4D: Recovery With Treatment (Oxidation, Reverse Osmosis)
	o Install ground-water recovery, treatment and monitoring systems o Treat recovered ground water by oxidation, chemical precipitation and ion exchange o Properly dispose of solid residuals	o Install ground-water recovery, treatment and monitoring systems o Treat recovered ground water in an ion exchange unit followed by an evaporation pond	o Install ground-water recovery, treatment and monitoring systems o Treat recovered ground water by oxidation and reverse osmosis o Discharge reverse osmosis unit concentrate to an evaporation pond o Properly dispose of solid residues
SCREENING CRITERIA:			
Technical Feasibility	o Technologies utilized during construction are reliable o Effectiveness can be monitored and verified o Requires O&M for recovery and treatment systems	o Technologies utilized during construction are reliable o Effectiveness can be monitored and verified o Requires O&M for recovery and treatment systems	o Technologies utilized during construction are reliable o Effectiveness can be monitored and verified o Requires O&M for recovery and treatment systems
Administrative Feasibility	o Approval from regulatory agencies likely	o Approval from regulatory agencies likely	o Approval from regulatory agencies likely
Availability	o Adequate work force, specialists and materials available	o Adequate work force, specialists and materials available	o Adequate work force, specialists and materials available
Cost (Relative)	o Medium	o Low	o Medium
Retained for Assembly of Remedial Alternatives	o Yes	o No	o Yes

091/16

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After assessing the remedial measures for each evaluation criteria, the remedial measures for the target remediation areas are screened to eliminate those which are clearly not feasible or effective. The screening tables identify those remedial measures which are retained for the development of remedial alternatives. A summary of the remedial measures which are retained for development of sitewide remedial alternatives for each target remediation area are presented in Table 3-18. This table presents the framework used to combine various remedial measures in developing sitewide remedial alternatives. Action specific ARARs which may be applicable to these remedial measures retained are presented in Table 3-19. The remedial measures which are eliminated from further consideration and the reasons for their elimination are discussed in the following sections.

3.2.3 Summary of Remedial Measures Eliminated from Further Consideration

The following presents the remedial measures which were eliminated from further consideration for managing each target remediation area. A discussion of why each of these remedial measures was considered to be an inapplicable remedial action for the MMRF is also presented.

TARGET REMEDIATION AREA / REMEDIAL MEASURES	LANDFILL	UNLOADING AREA	FORMER CATHODE WASTE MANAGEMENT AREAS	SCRUBBER SLUDGE PONDS	GROUND WATER
CAPPING IN PLACE	●		●		
CONSOLIDATION INTO EXISTING LANDFILL		●	●	●	
CONSOLIDATE INTO ON-SITE RCRA LANDFILL	●	●	●	●	
INCINERATION	●	●	●		
STABILIZATION IN PLACE				●	
SOIL COVER				●	
CAPPING IN PLACE WITH A HYDRAULIC BARRIER				●	
GROUND-WATER RECOVERY AND TREATMENT					●
P & A EXISTING WELLS AND PROVIDE CENTRAL WATER SUPPLY					●
LIMITED ACTION	●	●	●	●	●

TABLE 3-18

REMEDIAL MEASURES CONSIDERED FOR TARGET REMEDIATION AREAS

FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY

MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

DRAWING NO: TE0018-P05-A75	
DRAWN BY: S.K.F.	DATE: 5/10/88
CHECKED: dZC	DATE: 6-1-88
APPROVED: DJJ	DATE: 6-1-88

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TABLE 3-19

Potential Action Specific ARARs
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Potential ARAR	Description
29 CFR 1910	Hazardous Waste Operations and Emergency Response
40 CFR 122.44(d)	Water Quality Standards and State Standards
40 CFR 125.100	Criteria and Standards for Best Management Practices
40 CFR 136.1 through 136.4	Guidelines Establishing Test Procedures for the Analysis of Pollutants
40 CFR 264.111	Closure and Post Closure, Closure Performance Standards
40 CFR 264.220	Surface Impoundments, Applicability (Applicable to an Engineered Heap-Leaching Facility)
40 CFR 264.221	Surface Impoundments, Design and Operating Requirements (Applicable to an Engineered Heap-Leaching Facility)
40 CFR 264.301	Landfills, Design and Operating Requirements
40 CFR 264.303	Landfills, Monitoring and Inspection
40 CFR 264.310	Landfills, Closure and Post Closure Care
40 CFR 264.340	Incinerators, Applicability
40 CFR 264.341	Incinerators, Waste Analysis
40 CFR 264.343	Incinerators, Performance Standards
40 CFR 264.344	Hazardous Waste Incinerator Permits (Siting Requirements)
40 CFR 264.347	Incinerators, Monitoring and Inspections
40 CFR 264.351	Incinerators, Closure
40 CFR 268 (Subpart D)	Treatment Standards
OAR 340-61	Solid Waste Management
OAR 333-61-030	Drinking Water Standards
OAR 340-100	Hazardous Waste Management System: General
OAR 340-101	Identification and Listing of Hazardous Waste
OAR 340-104	Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities
OAR 340-108	Oil and Hazardous Material Spills and Releases
OAR 466.005-995	Hazardous Waste and Hazardous Materials
OAR 340-130	Notice of Environmental Hazards
OAR 340-41-001 through 340-41-029 and 340-41-120	Statewide Water Quality Management Plan

Notes:

CFR - Code of Federal Regulations
OAR - Oregon Administrative Rule

TABLE 3-19
(Continued)

Potential Action Specific ARARs
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Potential ARAR	Description
OAR 340-41-522 to 340-41-535	Hood Basin Water Quality
OAR 340-45	Regulations Pertaining to NPDES and WPCF Permits
OAR 340-20	Air Pollution Control
OAR 340-21	General Emission Standards for Particulate Matter
OAR 340-31	Ambient Air Quality Standards
OAR 340-20-001	Highest and Best Practicable Treatment and Control Required
OAR 340-20-040	Air Quality Methods
OAR 340-20-225	Air Quality Significant Emission Rate
OAR 437-40	Oregon Occupational Safety and Health Code (OOSH), General Provisions
OAR 437-50	OOSH, Personal Protective Equipment
OAR 437-83	OOSH, Construction
OAR 437-100	OOSH, Inorganic Arsenic
OAR 437-114	OOSH, Air Contaminants
OAR 437-129	OOSH, Protective Equipment, Apparel and Respirators
OAR 437-136	OOSH, General Occupational Health Regulations
OAR 860-66-055 to 860-66-072	Transportation of Hazardous Materials

Notes:

CFR - Code of Federal Regulations
OAR - Oregon Administrative Rule

099/18

3.2.3.1 Landfill: Inapplicable Remedial Measures

LF3: In Situ Heap-Leaching

The heap-leaching technology is commonly used in the mining industry to extract precious metals from ore. The technology involves leaching specific constituents from solids by contacting the solids with a solvent. The in situ heap-leaching remedial measure for the Landfill involves passing water through the waste, in place, to leach soluble constituents of concern (cyanide and fluoride) from the waste such that they can be treated in an aqueous stream. The heap-leaching technology has not been widely utilized as a hazardous waste treatment operation and it is questionable whether the process would be effective in reducing the concentrations of these constituents in the Landfill waste to environmentally acceptable levels (below remediation criteria). A literature search was conducted and no information was found which would suggest that heap-leaching would reduce the cyanide and PAHs of concern below the remediation criteria. For instance, only one PAH, naphthalene, detected in Landfill waste samples is soluble in water. The remaining PAHs detected in the Landfill are insoluble. Thus, it is likely that the waste remaining after leaching will still contain PAHs.

The effectiveness of this process is also hindered by the heterogeneous nature and size of the wastes and fill materials present which would promote channeling. The protectiveness of this remedial measure greatly depends on the ability to collect all leachate generated. Furthermore, in the case of in situ treatment, the integrity of the basalt underlying the Landfill has not been completely defined. Therefore, protecting ground water during in situ heap-leaching may be extremely difficult.

The cost of this remedial measure was determined to be low in comparison to other remedial measures although the time required to construct and complete treatment of the waste has been estimated to be in excess of 10 years, requiring long term operation and maintenance. In situ heap-leaching is eliminated from further consideration as a remedial measure for the Landfill because of its questionable effectiveness for the waste constituents of concern and the site characteristics of the Landfill.

LF4: Construct On-site Heap-Leaching Facility

The on-site heap-leaching facility remedial measure utilizes the identical treatment technology as in the in situ heap-leaching measure. Therefore, the concerns expressed previously regarding the effectiveness of heap-leaching the Landfill wastes remain. A new heap-leaching facility would effectively contain all leachate generated from the waste but

would require excavation, segregation, grinding or crushing to obtain a minimum acceptable particle size, transportation and placement of the Landfill waste into the facility prior to operation. Waste handling operations would require implementation of appropriate safety measures because of dispersed asbestos present in the Landfill. Excavating and handling the wastes increases the potential risk to on-site workers during construction. The asbestos present in the Landfill waste would also still require containment after treatment.

The cost of this remedial measure was determined to be medium in comparison to other remedial measures for the Landfill. As with in situ heap-leaching, this remedial measure treats only soluble constituents and will not be effective on all but one of the PAHs determined to be present in the Landfill waste. Because the heap-leaching process would be questionable in reducing hazardous constituent concentrations in the Landfill waste, it is eliminated from further consideration as a remedial measure for the Landfill.

3.2.3.2 Unloading Area: Inapplicable Remedial Measures

UA3: Capping in Place

The Unloading Area occupies approximately 0.32 acres and contains an estimated 1600 cubic yards of material. It was determined that capping this target remediation area in place would be effective and relatively inexpensive. However, it

is impractical to cap an area of such small volume and areal extent resulting in long term maintenance and monitoring when other remedial measures were implementable. Other remedial measures are considered which provide at least an equivalent level of protection for similar costs but eliminate the requirement for long term management of the area as a disposal site. Therefore, capping the Unloading Area is eliminated from further consideration.

UA5: Consolidate into New On-site Heap-Leaching Facility

The on-site heap-leaching facility remedial measure for the Unloading Area would be identical to that as discussed previously for the Landfill. The concerns discussed previously relating to heap-leaching the Landfill wastes also apply to managing the Unloading Area wastes except that asbestos is not a constituent of concern. The cost of a heap-leaching facility for the Unloading Area waste was determined to be medium in comparison to other remedial measures. Because the heap-leaching process would be questionable in reducing hazardous constituent concentrations in the Unloading Area wastes, it is eliminated from further consideration as a remedial measure for the Landfill.

3.2.3.3 Former Cathode Waste Management Areas: Inapplicable Remedial Measures

FCW5: Construct On-site Heap-Leaching Facility

The on-site heap-leaching facility remedial measure for the Former Cathode Waste Management Areas would be identical to that as discussed previously for the Landfill. The

concerns discussed previously relating to heap-leaching the Landfill wastes also apply to the Former Cathode Waste Management Areas except that asbestos is not a constituent of concern. The cost of a heap-leaching facility for managing the Former Cathode Waste Management Areas waste was determined to be medium in comparison to other remedial measures which provided at least the same level of protection. A new heap-leaching facility for this target remediation area is therefore eliminated from further consideration as a remedial measure.

FCW3: Partial Removal and Cap in Place

The partial removal and cap in place remedial measure for the Former Cathode Waste Management Areas removes the residual cathode waste material to the existing landfill. The underlying fill would remain and would be capped with asphalt. By performing this remedial measure, the Former Cathode Waste Management Areas are not eliminated as a site which will require long-term management and the remedial measure is not as effective as others which could be implemented for similar cost. Also, by leaving the underlying fill in place and capping the area, the potential for generation of contaminated perched water would remain. For thse reasons the partial removal and cap in place remedial measure is eliminated from further consideration for the Former Cathode Waste Management Areas.

3.2.3.4 Scrubber Sludge Ponds: Inapplicable Remedial Measures

SP3: Soil Cover on SSP2 and SSP3 with a Subsurface Barrier

This remedial measure is identical to remedial measure SP2 except that it also includes a subsurface barrier to minimize the discharge of ground water from the Byron Interbed to the Scrubber Sludge Ponds. This remedial measure is implementable although construction of a subsurface barrier (grout curtain) in hard basalt, as would be required at the Scrubber Sludge Ponds, would be costly and verification of the barrier's integrity would be difficult. Unknown geological factors create a low confidence that the grout curtain would be effective in successfully preventing ground-water movement into the Scrubber Sludge Ponds. Grouting of borings for ground-water monitoring wells across permeable zones during the RI proved to be difficult.

This remedial measure does not provide a significantly greater level of protection than other remedial measures and is more costly. Therefore, it is eliminated from further consideration for management of the Scrubber Sludge Ponds.

3.2.3.5 Ground Water: Inapplicable Remedial Measures

GW2: Recase Existing Wells in DGWR

The production wells which would be recased during implementation of this remedial measure include the Rockline, Animal Shelter, Klindt and the Residence wells. Recasing the

production wells such that water is only drawn from the DGWR would be an effective means of preventing exposure to affected ground water for the Klindt and Residence wells. However, the DGWR does not exist beneath the Rockline and Animal Shelter wells, therefore, implementing this remedial measure would not be applicable for these wells. Additionally, other ground-water remedial measures which provide at least the same level of protection could be implemented at a lower cost. For these reasons, recasing the nearby production wells such that the ground water is only drawn from the DGWR is eliminated from further consideration.

GW4-A and -C: Recovery With Treatment

The recovery with treatment remedial measure includes variations of treatment components. The treatment components are used to focus on treating aqueous streams containing cyanide and fluoride. The treatment components eliminated from ground-water management at the MMRF include ultraviolet irradiation/evaporation and ion exchange in conjunction with ultraviolet irradiation/evaporation.

These treatment components utilize sunlight to provide natural ultraviolet light (UV) to catalyze an oxidation reaction for the destruction of cyanides. The oxidizing agent for this reaction is atmospheric oxygen. The aqueous waste streams would be transported to an aeration pond to increase the concentration of dissolved oxygen in the

liquids. This process is limited by the solubility of oxygen in water and the effectiveness of oxygen as a strong oxidant. Other means of oxidation such as chemical oxidation provide stronger oxidants and therefore faster reaction rates. Because other means of oxidation would provide for faster reaction rates and more complete reactions, ultraviolet irradiation/evaporation and ion exchange in conjunction with ultraviolet irradiation/evaporation are eliminated from further consideration as remedial measures for the ground water.

099/2

4.0 DEVELOPMENT OF SITEWIDE REMEDIAL ALTERNATIVES

In this section, remedial measures for the target remediation areas retained for further analysis from the screening process, Table 3-18, are combined into sitewide remedial alternatives. Ten sitewide remedial alternatives are developed which present a broad range of remedial actions from the limited action alternative to total treatment alternatives.

4.1 ASSEMBLY OF REMEDIAL ALTERNATIVES

Sitewide remedial alternatives were developed by combining remedial measures and, as recommended by EPA guidance memoranda concerning SARA, include at least one alternative for each of the following alternative types:

- o No action alternatives (limited action);
- o Containment alternatives;
- o Containment with treatment alternatives; and
- o Treatment alternatives.

Sitewide remedial alternatives are developed by combining various remedial measures for the target remediation areas which correspond to a given alternative type. In developing the sitewide remedial alternatives, the overall objective is to develop a broad range of alternatives which satisfy the remedial objectives discussed in Section 1.3 and span the four remedial alternative types from the least comprehensive, limited action, to the most

comprehensive, total treatment. The remedial measures are combined such that the sitewide remedial alternatives contain limited actions, containment actions, containment with treatment actions or treatment actions. Because more containment and containment with treatment remedial measures were available for consideration, the majority of the sitewide remedial alternatives were of these alternative types. The number of treatment remedial measures was limited because of the nature of the wastes present at the site which was discussed in Section 3.0.

A summary of the assembled remedial alternatives and component remedial measures is presented in Table 4-1. Of the ten alternatives presented in Table 4-1, Alternatives 2 through 6, require the acceptance of a waiver from the fluoride and sulfate ARAR concentrations. The justification for a waiver from the fluoride and sulfate ARARs was presented in Section 2.0 and is discussed in detail in Appendix C. Should the waiver from the fluoride and sulfate ARARs not be approved, the ground-water remediation plan presented in Appendix D could be implemented as part of the selected alternative. This ground-water remediation plan would also be implemented if it was determined during ground-water monitoring that the remediation criteria established in Section 2.0 were exceeded.

TABLE 4-1

Summary of Assembled Remedial Alternatives and Component Remedial Measures
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Remedial Alternative Type	Remedial Alternative	Target Remediation Areas: Landfill	Unloading Area	Former Cathode Waste Management Areas	Scrubber Sludge Ponds	Ground Water
No Action Alternatives	Alternative 1	LF1: Limited Action	UA1: Limited Action	FCW1: Limited Action	SP1: Limited Action	GW1: Limited Action
Containment Alternatives	Alternative 2	LF2: Cap in Place (asphalt)	UA2: Consolidate into Existing Landfill	FCW2: Cap in Place (asphalt)	SP2: Soil Cover over SSP2 and SSP3	GW3: Ground-water Controls with Limited Treatment
	Alternative 3	LF2: Cap in Place (multi-media)	UA2: Consolidate into Existing Landfill	FCW4: Consolidate into Existing Landfill Landfill	SP2: Soil Cover over SSP2 and SSP3	GW3: Ground-water Controls with Limited Treatment
	Alternative 4	LF2: Cap in Place (multi-media)	UA2: Consolidate into Existing Landfill	FCW4: Consolidate into Existing Landfill	SP4: Cap in Place with Hydraulic Controls	GW3: Ground-water Controls with Limited Treatment
	Alternative 5	LF2: Cap in Place (multi-media)	UA2: Consolidate into Existing Landfill	FCW4: Consolidate into Existing Landfill	SP5: Consolidate into Existing Landfill	GW3: Ground-water Controls with Limited Treatment
	Alternative 6	LF5: Consolidate into New On-site RCRA Landfill	UA4: Consolidate into New On-site RCRA Landfill	FCW5: Consolidate into New On-site RCRA Landfill	SP6: Consolidate into New On-site RCRA Landfill	GW3: Ground-Water Controls with Limited Treatment
Containment with Treatment Alternatives	Alternative 7	LF2: Cap in Place (multi-media)	UA2: Consolidate into Existing Landfill	FCW4: Consolidate into Existing Landfill	SP5: Consolidate into Existing Landfill	GW4 Ground-water Recovery and Treatment
	Alternative 8	LF5: Consolidate into New On-site RCRA Landfill	UA4: Consolidate into New On-site RCRA Landfill	FCW5: Consolidate into New On-site RCRA Landfill	SP6: Consolidate into New On-site RCRA Landfill	GW4: Ground-water Recovery and Treatment
	Alternative 9	LF2: Cap in Place (multi-media)	UA2: Consolidate into Existing Landfill	FCW4: Consolidate into Existing Landfill	SP7: Stabilization in Place	GW4: Ground-water Recovery and Treatment
Treatment Alternatives	Alternative 10	LF6: Incineration	UA6: Incineration	FCW7: Incineration	SP7: Stabilization in Place	GW4: Ground-water Recovery and Treatment

92/3, pg 2

4.2 SITEWIDE REMEDIAL ALTERNATIVES

Ten sitewide remedial alternatives were developed to consider for implementation at the MMRF. At least one remedial alternative was developed for each of the four alternative types. The following sections present detailed descriptions of the alternatives developed for each alternative type.

4.2.1 Limited Action Alternative

4.2.1.1 Remedial Alternative 1: Limited Action

One limited action remedial alternative was developed for the MMRF. Although this alternative represents "no action", certain site activities will be conducted to limit access to, monitor, and prevent future use of the target remediation areas or affected ground water. The Limited Action Alternative includes fencing the Former Cathode Waste Management Areas, the Unloading Area and the Scrubber Sludge Ponds and improving the existing fence surrounding the Landfill to limit access to these areas. Operation of the existing Landfill leachate collection system will continue under this remedial alternative to minimize migration of the leachate. Deed restrictions would also be recorded in the appropriate Registry of Deeds to prevent future use of the target remediation areas. Institutional controls will be enacted to prevent use of affected ground water adjacent to the MMRF between River Road and the Columbia River.

Ground-water monitoring would be conducted to monitor variations in ground-water quality and would serve as the basis for initiating future actions. Table 4-2 presents the monitoring wells which would be utilized in monitoring ground-water quality. The ground-water monitoring well locations are shown on Drawing A-2. Details pertaining to the ground-water monitoring and response plan are presented in Appendix D.

Ground-water monitoring will be conducted quarterly for the first year, semi-annually for the second year and annually thereafter. At the end of five years, the entire ground-water monitoring program will be re-evaluated and adjusted if necessary. This time frame corresponds to the time period required by SARA for re-evaluation of site conditions. Data will be submitted to the EPA shortly after the laboratory analysis have been completed for each period during the first two years. Annual reports will also be submitted during each of the first five years.

4.2.2 Containment Alternatives

4.2.2.1 Remedial Alternative 2: Containment with Ground-Water Controls

Sitewide Remedial Alternative 2 consist of the following remedial measures for the target remediation areas:

- LF2: Cap in place (asphalt);
- UA2: Consolidate into existing Landfill;

TABLE 4-2

Summary of Monitor Wells and Constituents Analyzed for Ground-water Monitoring
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

TARGET REMEDIATION AREAS	CONSTITUENTS ANALYZED	AQUIFER SYSTEM	PROPOSED WELLS MONITORED
Landfill	$CN_{(Total\ and\ Free)}$, F, SO_4, pH Specific Conductance	S A B	9, 15, 26, 32 6, 9, 12, 14, 15, 33 7, 9, 12, 16, 26, 33
Unloading Area	$CN_{(Total\ and\ Free)}$, F, SO_4, pH Specific Conductance	S	5, 17
Former Cathode Waste Management Areas	$CN_{(Total\ and\ Free)}$, F, SO_4, pH Specific Conductance	S A B	8, 27 8 8, 27
Scrubber Sludge Ponds	$CN_{(Total\ and\ Free)}$, F, SO_4, pH Specific Conductance	S A B	18, 19, 24, 29, 30 18 18
Units in Operation	$CN_{(Total\ and\ Free)}$, F, SO_4, pH Specific Conductance	S	21
General Down-Gradient Wells	$CN_{(Total\ and\ Free)}$, F, SO_4, pH Specific Conductance	A B DGWR	1, 34 1, 34 PW1

Note: Final selection may vary depending on sitewide remedial action.
098/4

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- FCW2: Cap in place (asphalt);
- SP2: Soil cover over SSP2 and SSP3; and
- GW3: Ground-water controls with limited treatment.

The Landfill and associated areas will be consolidated prior to capping to limit the actual lateral extent of the cap. The Unloading Area will be excavated to competent basalt. The excavated material will be placed into the existing Landfill prior to its being capped. The Unloading Area would be backfilled as required to promote drainage. The Former Cathode Waste Management Areas will be capped in place and a soil cover will be placed over Scrubber Sludge Ponds 2 and 3. Ground-water controls will consist of institutional controls and limited ground-water recovery. Remedial Measures LF2 and FCW2 provide provisions for the collection and treatment of leachate and perched water, respectively. Dust controls will be utilized during remediation to minimize fugitive dust emissions. Fencing and deed restrictions will be utilized to limit access to and prevent future use of all target remediation areas where materials are managed on-site. Only workers performing necessary maintenance functions would be allowed entry to the Landfill, Former Cathode Waste Management Areas and Scrubber Sludge Ponds after remediation is complete.

Remedial Measure LF2

The study areas associated with remediation of the Landfill consist of the:

- Landfill;
- Leachate Collection Ditch;
- Surface Drainage Ditch; and
- Landfill Ditch.

Consolidating the materials from the ditches into the existing Landfill results in an addition to the Landfill of approximately 3,290 cubic yards. Consolidation of the Unloading Area will contribute approximately 200 cubic yards, resulting in a total volume of material added to the existing Landfill of approximately 3,490 cubic yards.

During consolidation, regrading of the existing Landfill will be required to obtain the desired top and side slopes needed for long-term stability prior to capping. The 3,490 cubic yards from the ditches and Unloading Area will be integrated into the overall design and layout of the cap. Regrading will involve relocating approximately 40,000 cubic yards from within the Landfill to reduce the lateral extent of the cap from 15 acres to approximately 10 acres. The known asbestos disposal areas shall only have fill placed on them during the regrading activities so as not to disturb the material. Figure 4-1 presents the approximate location and configuration of the Landfill cover. The cover for the Landfill will be constructed using a three inch thick

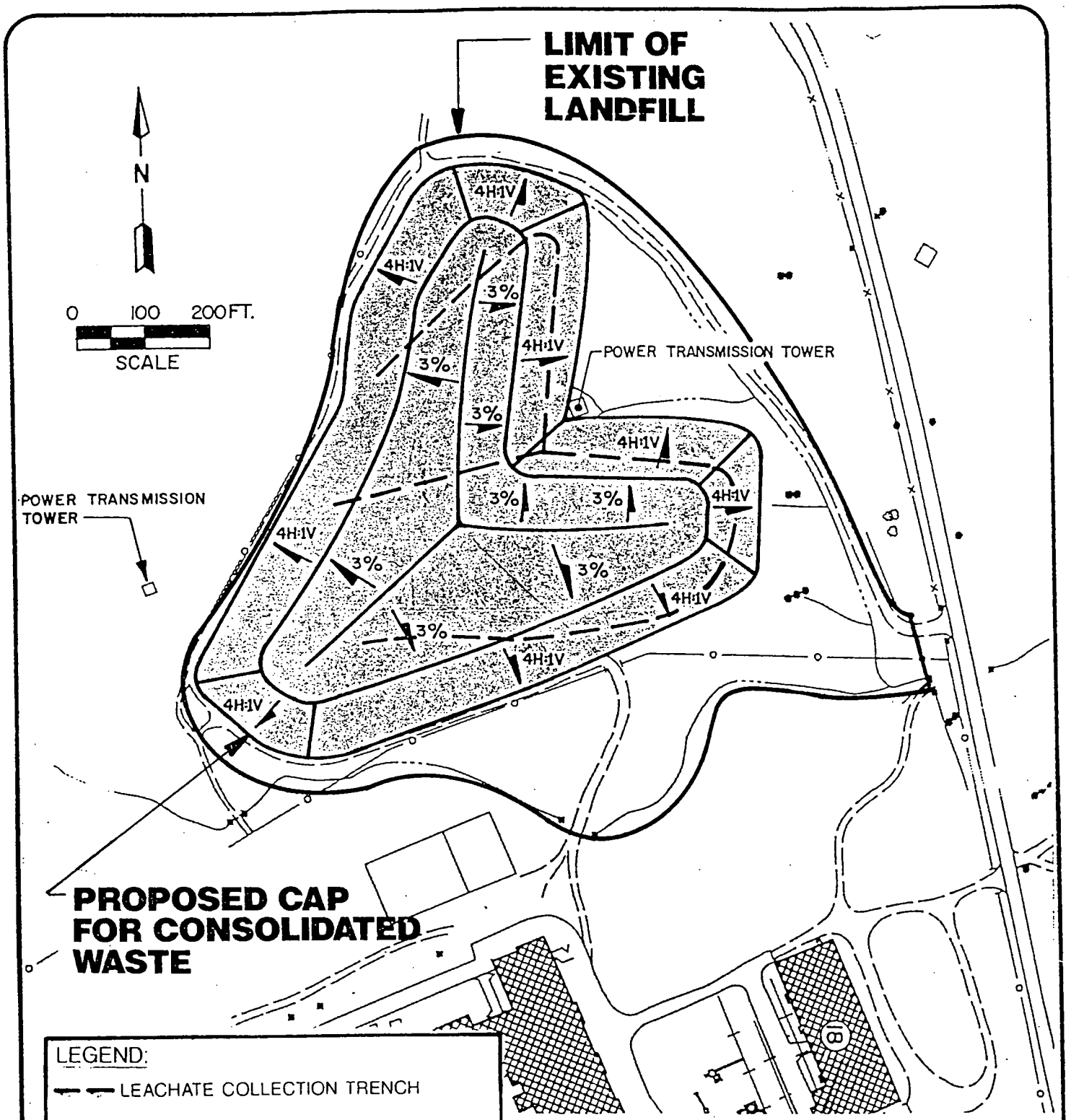

FIGURE 4-1

DRAWING NO: TE0018-P05-A59	
DRAWN BY: KenGroom	DATE: 3-8-88
CHECKED:	DATE: 3/18/88
APPROVED:	DATE: 3/29/88

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APPROXIMATE LOCATION AND CONFIGURATION OF LANDFILL CAP
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

bituminous asphalt subbase with a one inch thick final asphalt top coat. The overall target permeability of the asphalt mixture will be 1 X 10^{-6} cm/sec or less. The top and side slopes of the cap will be constructed as to minimize erosion and the drainage controls around the Landfill would be improved to redirect surface water runoff.

Leachate collection trenches will be constructed to intercept the flow of leachate utilizing the historical surface drainage pathways prior to capping the Landfill. These trenches, illustrated in Figure 4-1, will be placed such that once the cap is constructed, they are located under the cap and will only collect leachate generated from the wastes after capping. Depending on the grade of the subsurface topography, collection sumps may be necessary to transmit the collected leachate to a central location. The collected leachate will be pumped to an on-site aqueous treatment system for cyanide and fluoride removal. The MMRF is located in an arid region and because of this climate, a moisture deficit of approximately 30 inches per year exists. Therefore, it is anticipated that the leachate generated from the Landfill after being capped will gradually decrease from its existing average annual flowrate of approximately 10 gpm to a negligible flow within five years.

The on-site aqueous treatment system would include a chemical oxidation unit for destruction of cyanide followed by a chemical precipitation unit to remove fluoride to an

approximate concentration of 9.7 mg/L. A polishing unit may be required to reduce fluoride concentrations to acceptable plant operational standards prior to discharge. A schematic of the aqueous treatment system is shown in Figure 4-2. The treatment plant will be located between the Cathode Wash Area and River Road as illustrated on Figure 4-3. Effluent from the aqueous treatment system will be discharged to an existing sewer which flows to the Discharge Channel and ultimately to the Recycle Pond.

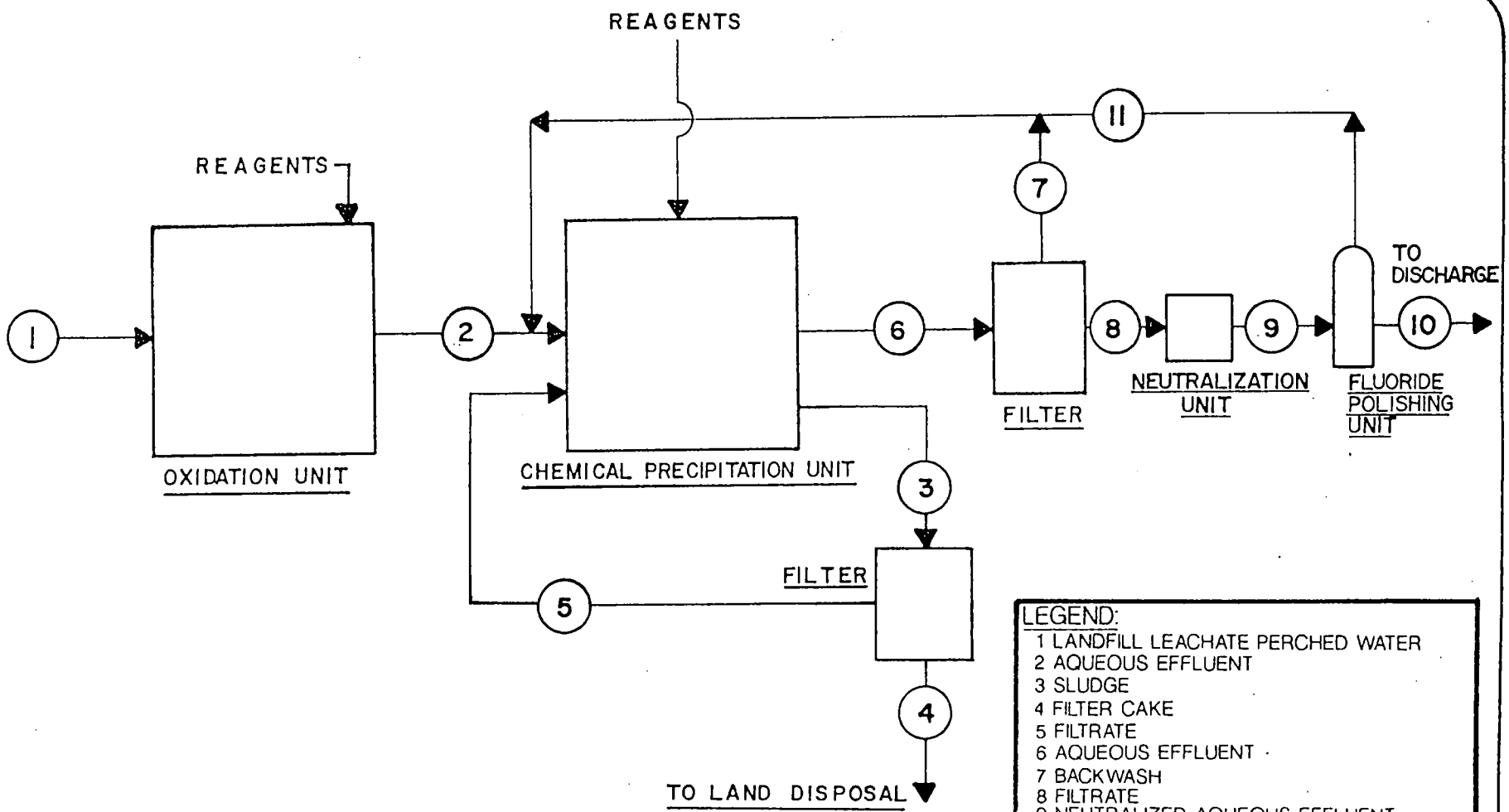
Remedial Measure UA2

The Unloading Area will be excavated resulting in the removal of approximately 200 cubic yards of cathode waste residuals. The lateral and vertical extent of excavation will be limited by the known limits of materials placed by MMRF personnel, historical photographs and depth to competent basalt, respectively. The excavated wastes will be placed into the Landfill for management. The excavation will be backfilled and graded as required to promote drainage.

Remedial Measure FCW2

The Former Cathode Waste Management Areas, which will be graded and capped with asphalt, consist of the following study areas:

- Potliner Handling Area;
- Old Cathode Waste Pile Area;
- Salvage Area; and
- Bath Recovery Pad Area.



LEGEND:
1 LANDFILL LEACHATE PERCHED WATER
2 AQUEOUS EFFLUENT
3 SLUDGE
4 FILTER CAKE
5 FILTRATE
6 AQUEOUS EFFLUENT
7 BACKWASH
8 FILTRATE
9 NEUTRALIZED AQUEOUS EFFLUENT
10 TREATED AQUEOUS EFFLUENT
11 REGENERANT

NOTE:
BENCH STUDIES WILL BE REQUIRED TO DETERMINE EXACT CONFIGURATION OF TREATMENT SYSTEM.

FIGURE 4-2

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CHECKED: ALC	DATE: 3-18-88
APPROVED: DJJ	DATE: 3/29/88

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SCHEMATIC AQUEOUS TREATMENT SYSTEM
FEASIBLITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

BAY REPROGRAPHICS 300852

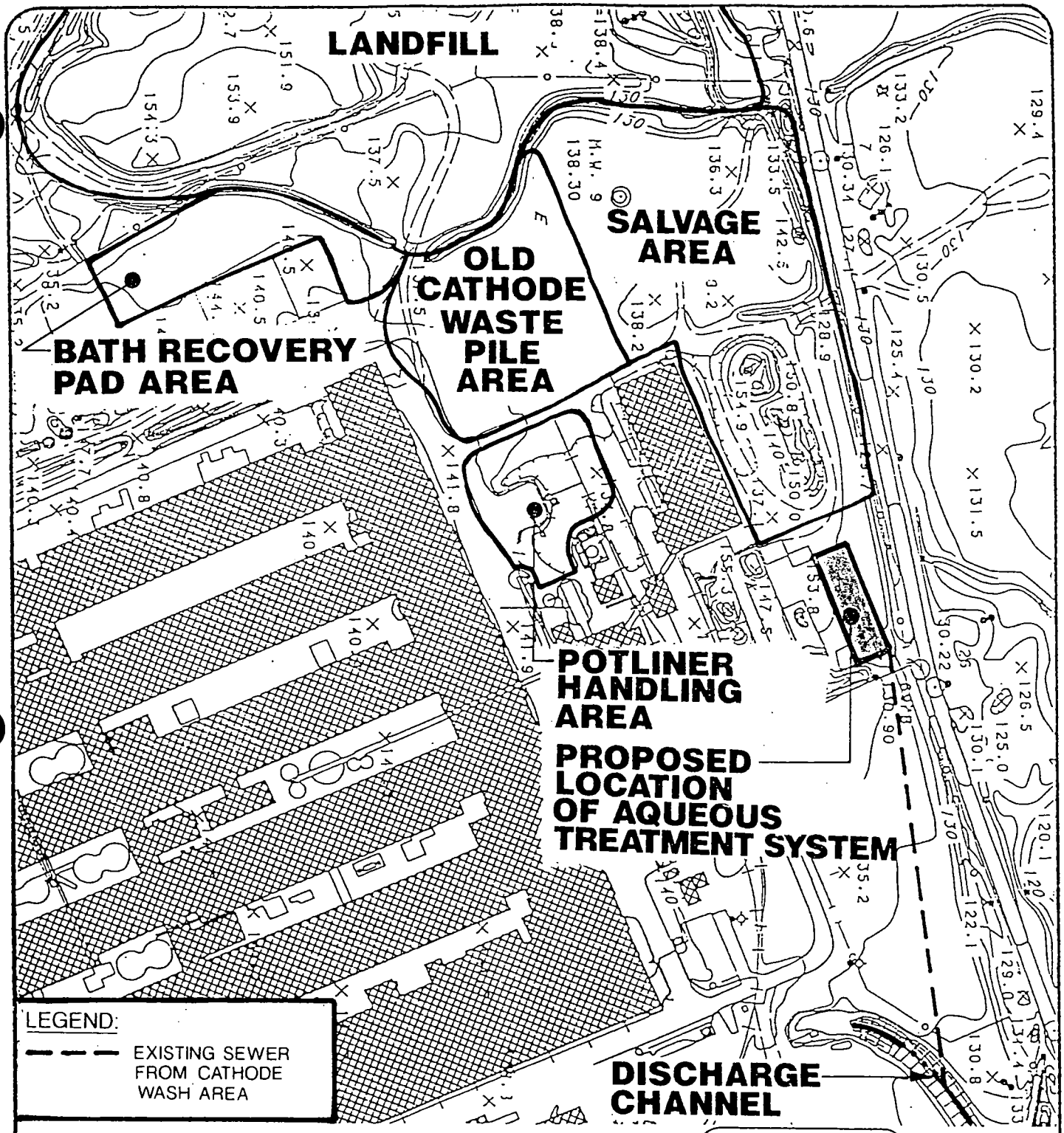

FIGURE 4-3

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CHECKED: dZC	DATE: 5-27-88
APPROVED: DGH	DATE: 6-7-88

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AQUEOUS TREATMENT SYSTEM LOCATION
FEASIBILITY STDUY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

Precapping activities are discussed below. The final configuration for the Former Cathode Waste Management Areas is presented in Figure 4-4.

Surface drainage for the North Ditch and the headwaters leading to the Landfill Ditch will require re-routing through the interceptor ditch to the west of the existing Landfill. This will be accomplished with the use of culverts, surface ditches, and deepening of the interceptor trench to divert uncontaminated flows away from the capped Former Cathode Waste Management Areas.

Grading activities for the Potliner Handling Area will be limited by existing paved surfaces or existing buildings so as not to affect the foundation. The railroad spur, which is utilized for receiving bulk raw materials associated with the reduction process, will require temporary closure for regrading and reconstruction after capping. Surface drainage from the Potliner Handling Area will be collected and diverted to a nearby process sewer. This will entail removal of the existing catch basin, which has been plugged with soft pitch, and approximately 50 feet of affected culvert pipe. The remaining culvert pipe will be plugged with concrete or similar material prior to backfilling with existing overburden. Additional backfill will be used as required to establish grades.

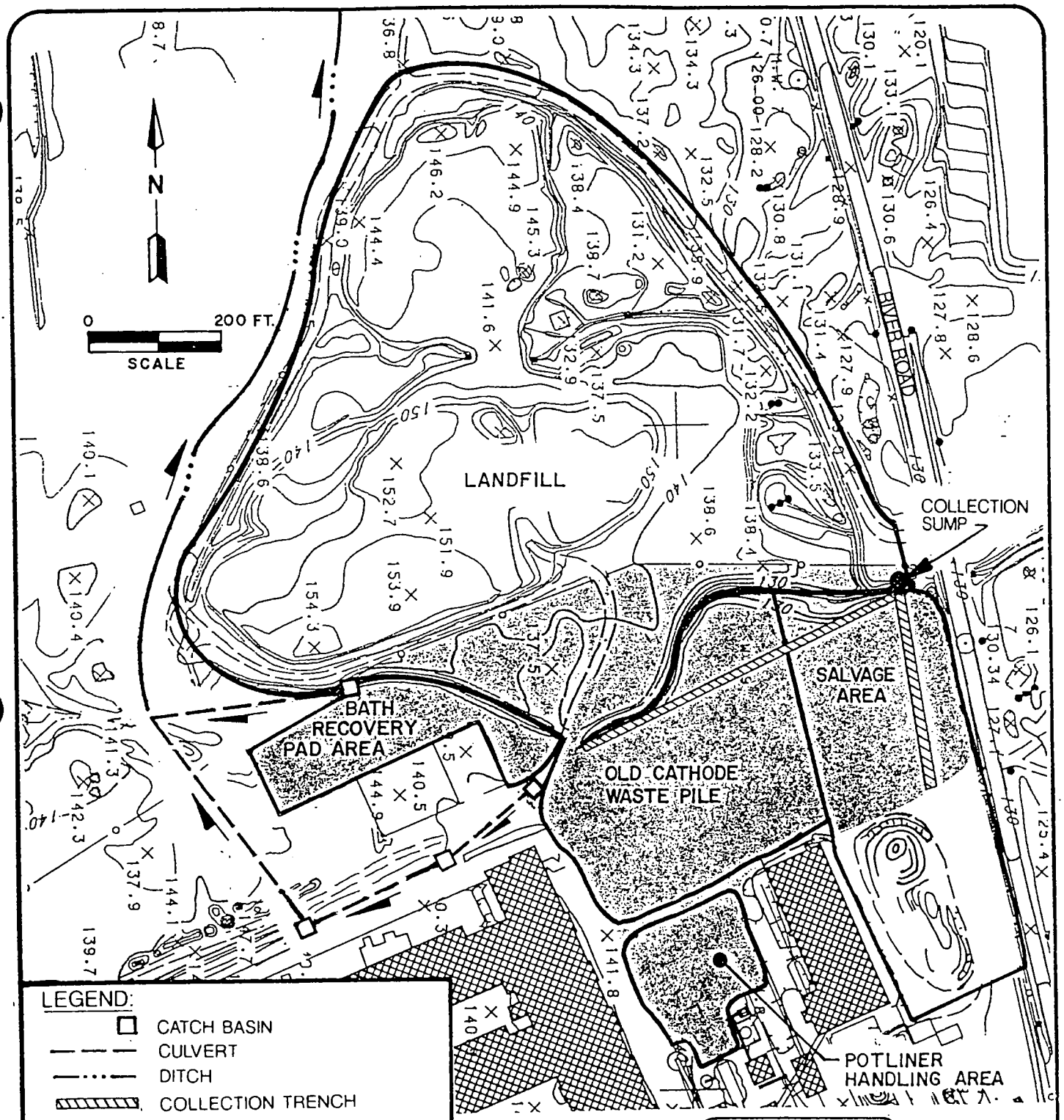

FIGURE 4-4

DRAWING NO: TE0018-P05-A63	
DRAWN BY: Ken Carroll	DATE: 3-10-88
CHECKED: AFC	DATE: 3/10/88
APPROVED:	DATE: 3/29/88

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ASPHALT CAP CONFIGURATION FORMER CATHODE WASTE MANAGEMENT AREAS

FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

Grading activities for the Old Cathode Waste Pile will be minor. A cut/fill balance will be used to establish grades. The portion of the Landfill Ditch adjacent to the Old Cathode Waste Pile will be filled and graded as required to provide drainage prior to capping. The culvert connecting the North Ditch and Landfill Ditch will be removed and a new culvert will be installed to collect surface water runoff as illustrated in Figure 4-4.

Grading activities for the Salvage Area will require resloping the embankment adjacent to River Road. Excess cut will be used to fill the adjacent portion of the Landfill Ditch. Additional fill will be provided to establish necessary grades of the Landfill Ditch as required prior to capping.

As part of the efforts to consolidate the Landfill, the portion of the Landfill between the south fence of the Landfill and the Landfill Ditch will be excavated and consolidated in the Landfill. This area will be backfilled and capped in conjunction with the Former Cathode Waste Management Areas, as illustrated in Figure 4-4, to minimize infiltration of water to the perched water collection trench.

The limit of the asphalt cap over the Former Cathode Waste Management Areas, as presented in Figure 4-4, covers approximately 8.5 acres. The cap will be constructed using a three-inch thick bituminous asphalt subbase with a 1-inch

thick final asphalt top coat. The overall target permeability of the asphalt will be 1 X 10^{-6} cm/sec or less. The bituminous asphalt will provide a hard, durable surface and will be constructed so as to redirect surface water runoff.

The approximate lateral extent of the perched water, as defined by an electromagnetic (EM) survey conducted by Geraghty & Miller, Inc., is illustrated on Figure 4-5. The location of the collection trench is displayed on Figure 4-4 and will consist of a granular backfill as illustrated in Figure 4-6. The trench will be excavated to or into the basalt to establish a gravity drain to a common collection sump. An additional collection sump and/or trench may be required east of River Road. Perched water collected by the trench would be routed to the sump and pumped to the aqueous treatment system used to treat collected leachate from the Landfill. A detailed discussion of this aqueous treatment system is presented in Remedial Measure LF2 of this alternative.

Remedial Measure SP2

This measure involves covering Scrubber Sludge Ponds 2 and 3 with a soil cover. A cross-section of the proposed cover system is illustrated in Figure 4-7. The soil cover consists of two feet of soil and a vegetative cover placed on the Scrubber Sludge Pond sludge.

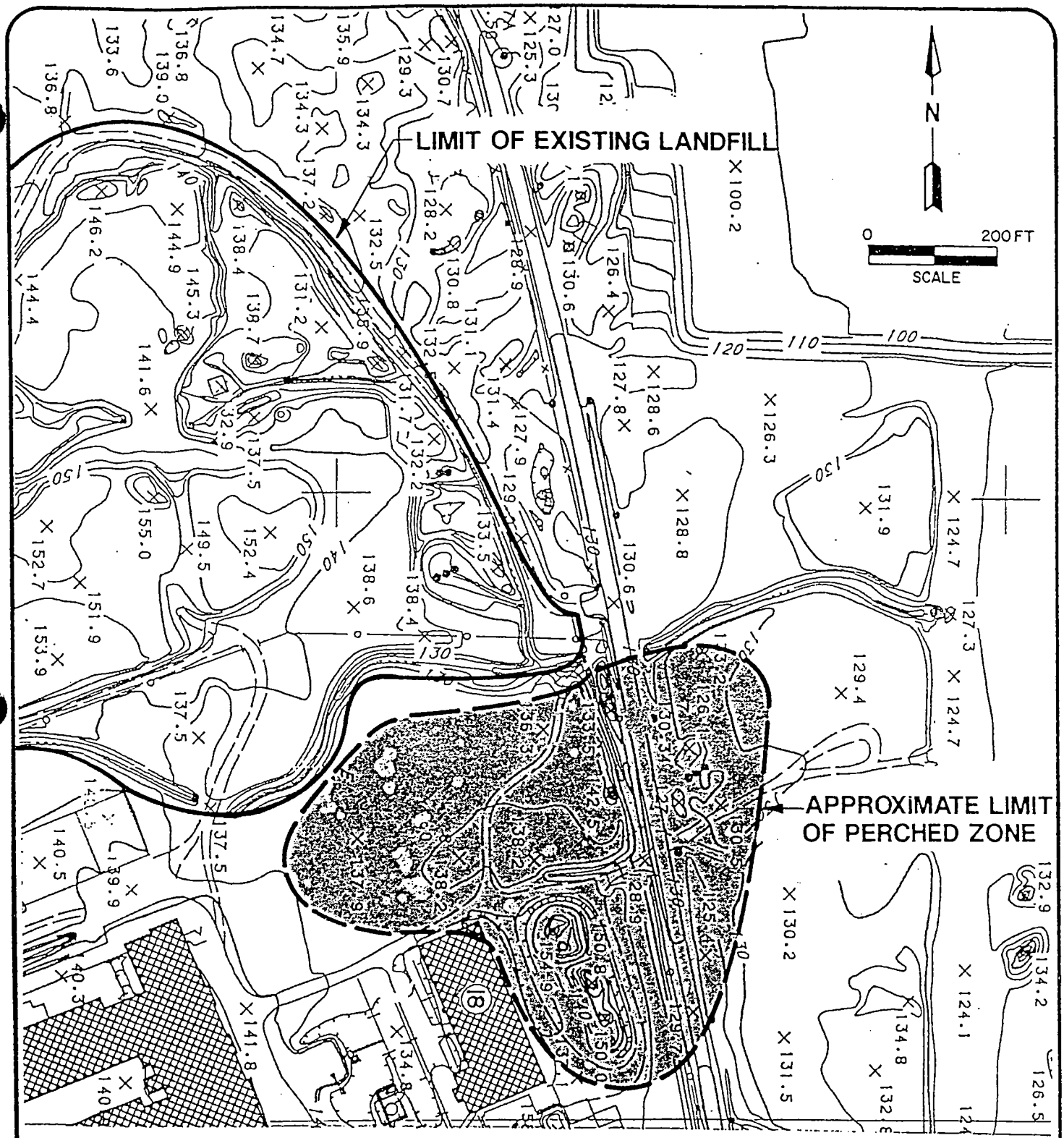

FIGURE 4-5

DRAWING NO: TE0018-P05-A102	
DRAWN BY: Ken Carroll	DATE: May 26, 1988
CHECKED:	DATE: 5-27-88
APPROVED:	DATE: 6-6-88

GMCE
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APPROXIMATE LIMIT OF PERCHED ZONE
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

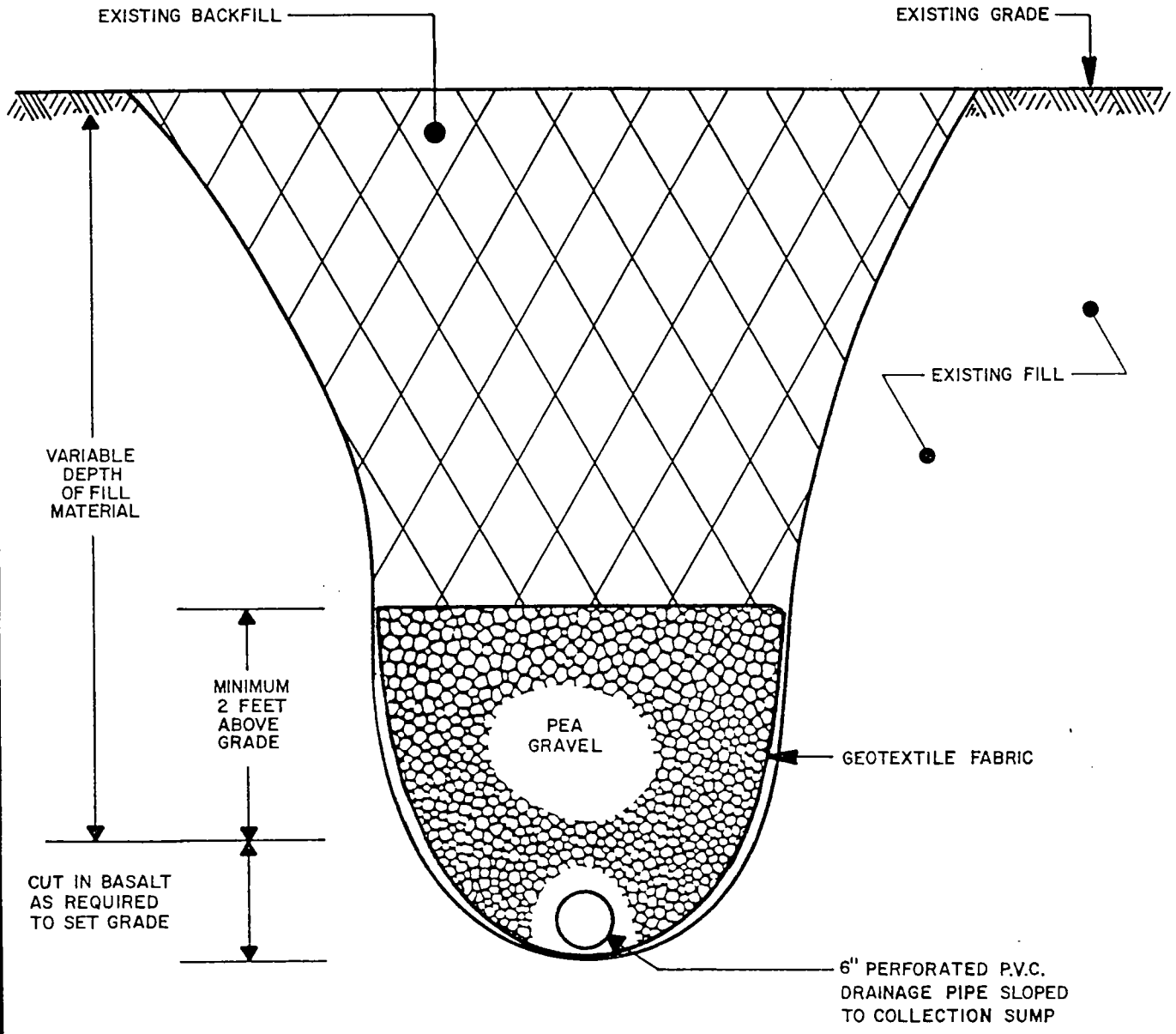

FIGURE 4-6

DRAWING NO: TE0018-P05-A69	
DRAWN BY: KenCarroll	DATE: 12-MAR-88
CHECKED: ALC	DATE: 3-18-88
APPROVED: DJJ	DATE: 3/29/88

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CROSS-SECTION OF PERCHED WATER COLLECTION TRENCH

FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY

MARTIN MARIETTA CORPORATION

THE DALLES, OREGON

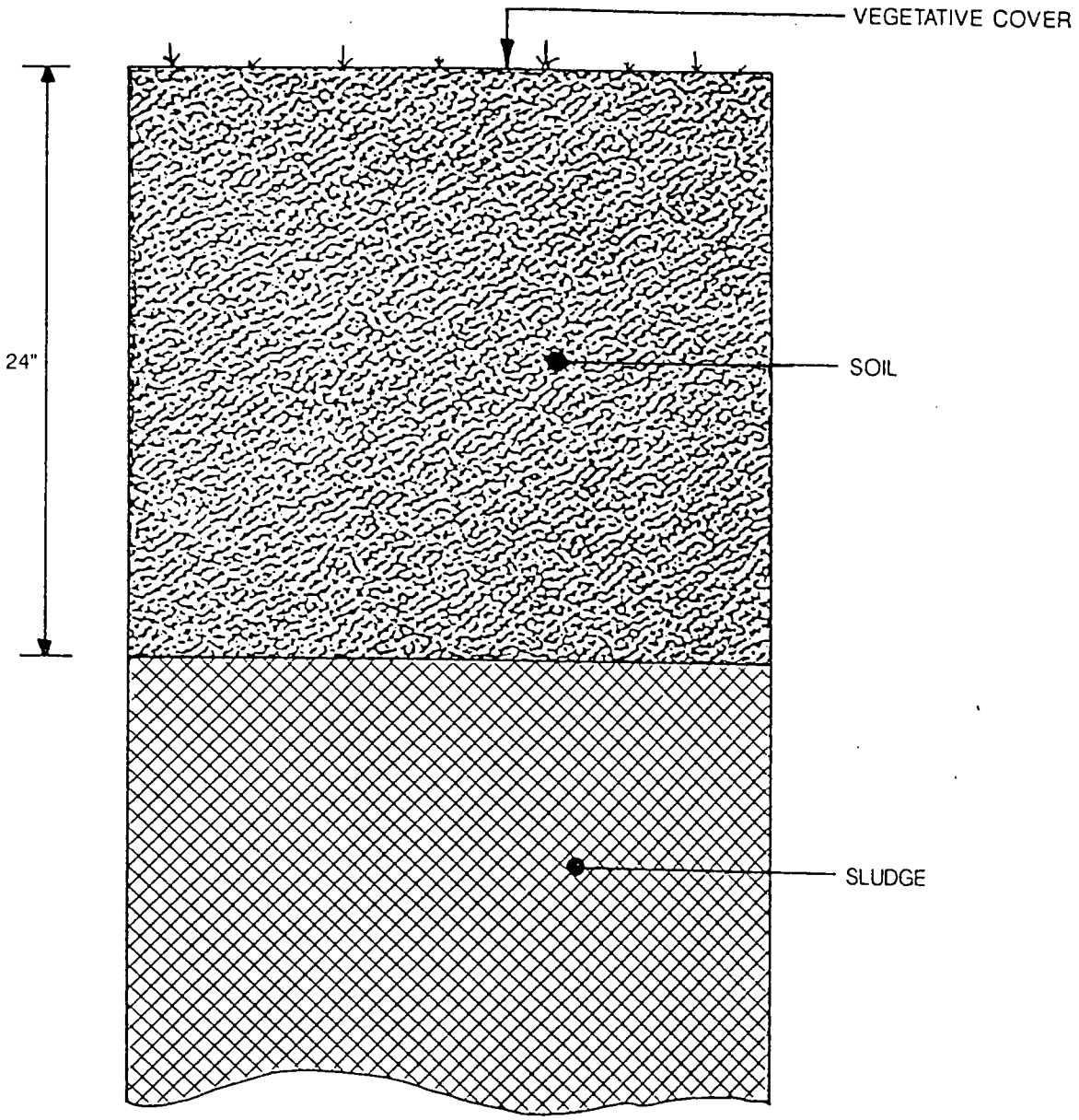

FIGURE 4-7

DRAWING NO: TE0018-P05-A52	
DRAWN BY: KCarroll	DATE: 3-29-88
CHECKED: KC	DATE: 3-29-88
APPROVED:	DATE: 3/29/88

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SOIL COVER SYSTEM CROSS-SECTION
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

The top and side slopes of the cover system will be constructed to minimize erosion. Drainage controls will be installed or improved as necessary to redirect surface water runoff. Scrubber Sludge Ponds 1 and 4 are already covered with established vegetation and do not require additional efforts under this alternative.

Remedial Measure GW3

With the acceptance of a waiver from the fluoride and sulfate ARARs, ground-water recovery and treatment would only be required at the Unloading Area. To recover ground water from the Unloading Area, a 4-inch diameter recovery well will be installed in the area of monitor well 5S as shown in Figure 4-8. This recovery well, RW-1, will be equipped with a submersible pump which will be operated at a continuous flowrate of 2 gpm. It is expected to take approximately five years to reduce fluoride concentrations below the remediation criteria in the ground water. Recovered ground-water from RW-1 will be discharged into the Recycle Pond where it will be recycled to the roof scrubbers or treated by the in-plant process.

Remedial Measure GW3 also includes connecting the users of nearby water supply wells (Animal Shelter, Rockline, Klindt and Residence) to the City of The Dalles water supply system and properly plugging and abandoning the existing wells at these locations. Institutional controls would be

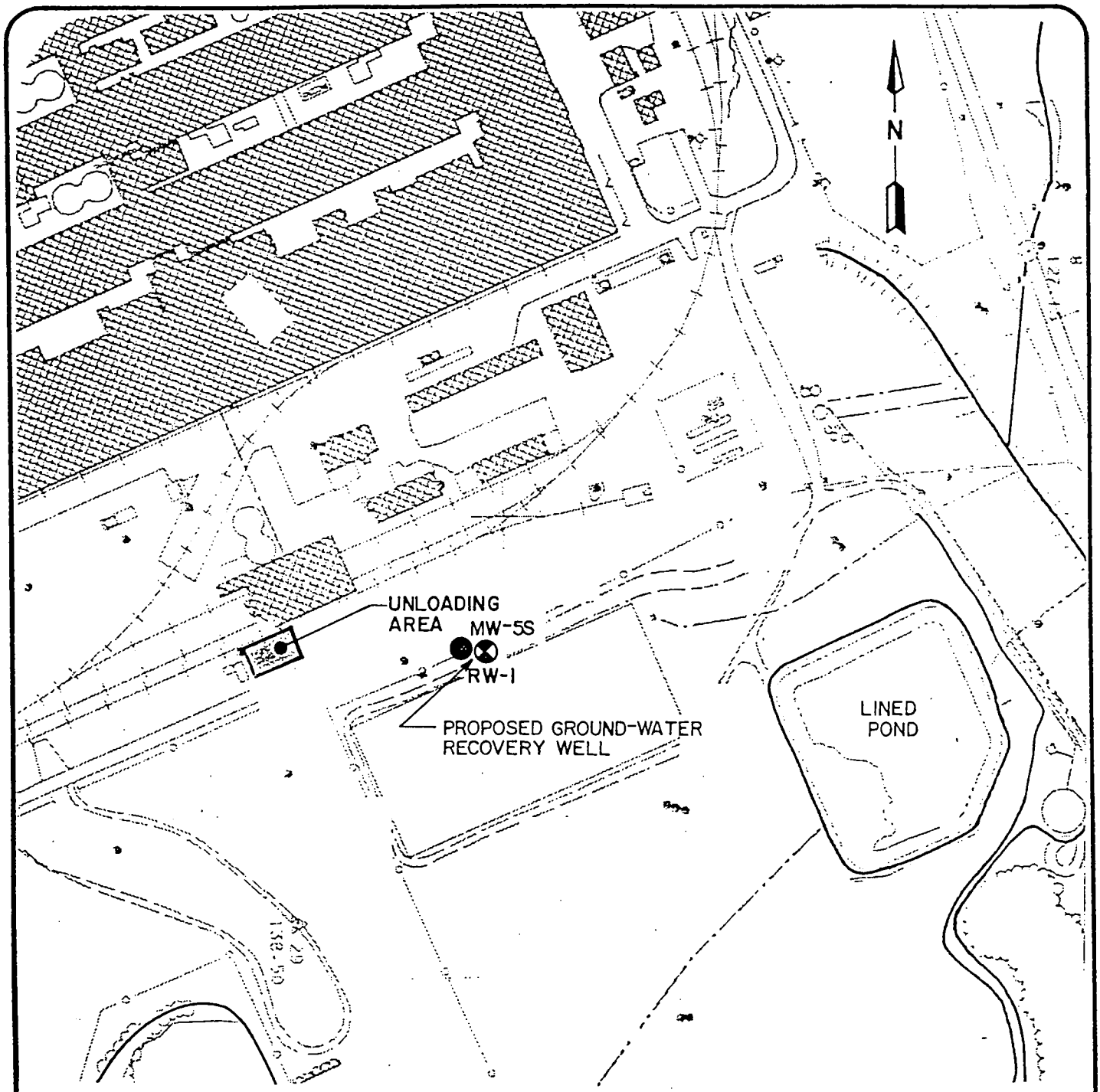

FIGURE 4-8

DRAWING NO: TE0018-P05-A61	
DRAWN BY: SKF	DATE: 3/10/88
CHECKED: RLC	DATE: 3-10-88
APPROVED:	DATE: 3/29/88

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UNLOADING AREA RECOVERY WELL

FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

enacted to prevent future use of ground water which contains fluoride or sulfate concentrations above the ARARs. The potential area affected by the institutional controls includes the property adjacent to the MMRF and east of River Road to the Columbia River.

Ground-water monitoring would be conducted to monitor variations in ground-water quality and would serve as the basis for monitoring remediation effectiveness and initiating future actions if required. Table 4-2 presents the monitoring wells, parameters and the associated target areas being monitored.

Ground-water monitoring will be conducted quarterly for the first year, semi-annually for the second year and annually thereafter. At the end of five years, the entire ground-water monitoring program will be re-evaluated and adjusted if necessary. This time frame corresponds to the time period required by SARA for re-evaluation of site conditions. Data will be submitted to the EPA shortly after the laboratory analysis have been completed for each period during the first two years. Annual reports will also be submitted during each of the first five years. Details pertaining to the ground-water monitoring plan are presented in Appendix D.

4.2.2.2 Remedial Alternative 3: Containment with Complete Removal and Ground-Water Controls

Sitewide Remedial Alternative 3 consists of the following remedial measures for the target remediation areas:

- LF2: Cap in place;
- UA2: Consolidate into existing Landfill;
- FCW4: Consolidate into existing Landfill;
- SP2: Soil Cover over SSP2 and SSP3; and
- GW3: Ground-water controls with limited treatment.

The Landfill and associated areas will be consolidated to limit the actual lateral extent of the cap. The Unloading Area and Former Cathode Waste Management Areas will be excavated down to competent basalt and consolidated into the existing Landfill. Remedial measure LF2 makes provisions for the collection of leachate after capping the Landfill. Perched water, beneath the Former Cathode Waste Management Areas will be collected during excavation activities and treated. This should be effective in collecting perched water on both sides of River Road. However, temporary sump(s) may be necessary to collect perched water east of River Road. A soil cover will be placed over Scrubber Sludge Ponds 2 and 3. Ground-water controls will consist of institutional controls and limited ground-water recovery. Dust controls will be utilized during remediation to minimize fugitive dust emissions. Fencing and deed restrictions will be utilized to limit access and prevent future use of areas where materials are managed on-site. Only authorized personnel would be allowed entry to the Landfill and Scrubber Sludge Ponds after remediation is complete.

Remedial Measure LF2

The Landfill will be covered with a multi-media cap meeting the performance standards as defined in 40 CFR 264.310 after consolidating materials from the Unloading Area and the Former Cathode Waste Management Areas. The volumes of material to be removed and consolidated from each area are presented below:

o	Unloading Area	200 cubic yards
o	Potliner Handling Area	9,910 cubic yards
o	Old Cathode Waste Pile Area	24,200 cubic yards
o	Salvage Area	28,700 cubic yards
o	Bath Recovery Pad Area	1,660 cubic yards

The total volume of additional material from these areas (64,470 cubic yards) will not alter the overall lateral extent of the cap as illustrated in Figure 4-1. However, the overall finished elevation will be increased to accommodate the additional fill.

Regrading of the Landfill into a central location will be performed to minimize the areal extent of the cap to approximately 10 acres as illustrated in Figure 4-1. This activity will include the remediation of the Leachate Collection, Landfill and Surface Drainage Ditches by consolidating material contained in the areas under the cap for the Landfill. The known asbestos disposal areas shall only have fill placed on them during the regrading activities so as not to disturb the material.

The cover system, illustrated in Figure 4-9, will be a multi-media cap designed to meet RCRA performance standards. The multi-media cap would consist of 12-inches of topsoil, a geotextile layer, 6-inches of clean sand, a wire mesh for rodent control, another 6-inches of clean sand, a 60-mil HDPE geomembrane and 6-inches of clean sand overlying the waste which will serve as part of a passive gas venting system. The piping for the gas venting will be constructed of HDPE for compatibility with the geomembrane in the cap. The top and side slopes of the cap will be constructed as to minimize erosion and the drainage controls around the Landfill would be improved to redirect surface water runoff.

As discussed in Remedial Measure LF2 for Alternative 2, leachate collection trenches will be constructed under the cap to intercept the flow of leachate utilizing the historical surface drainage pathways. Post-capping leachate will be collected and treated for cyanide and fluoride. The aqueous treatment system is described in detail in Remedial Measure LF2 for Alternative 2.

Remedial Measure UA2

The Unloading Area will be excavated resulting in the removal of approximately 200 cubic yards of cathode waste residuals and placement into the existing Landfill prior to its capping. Capping of the area will not be required

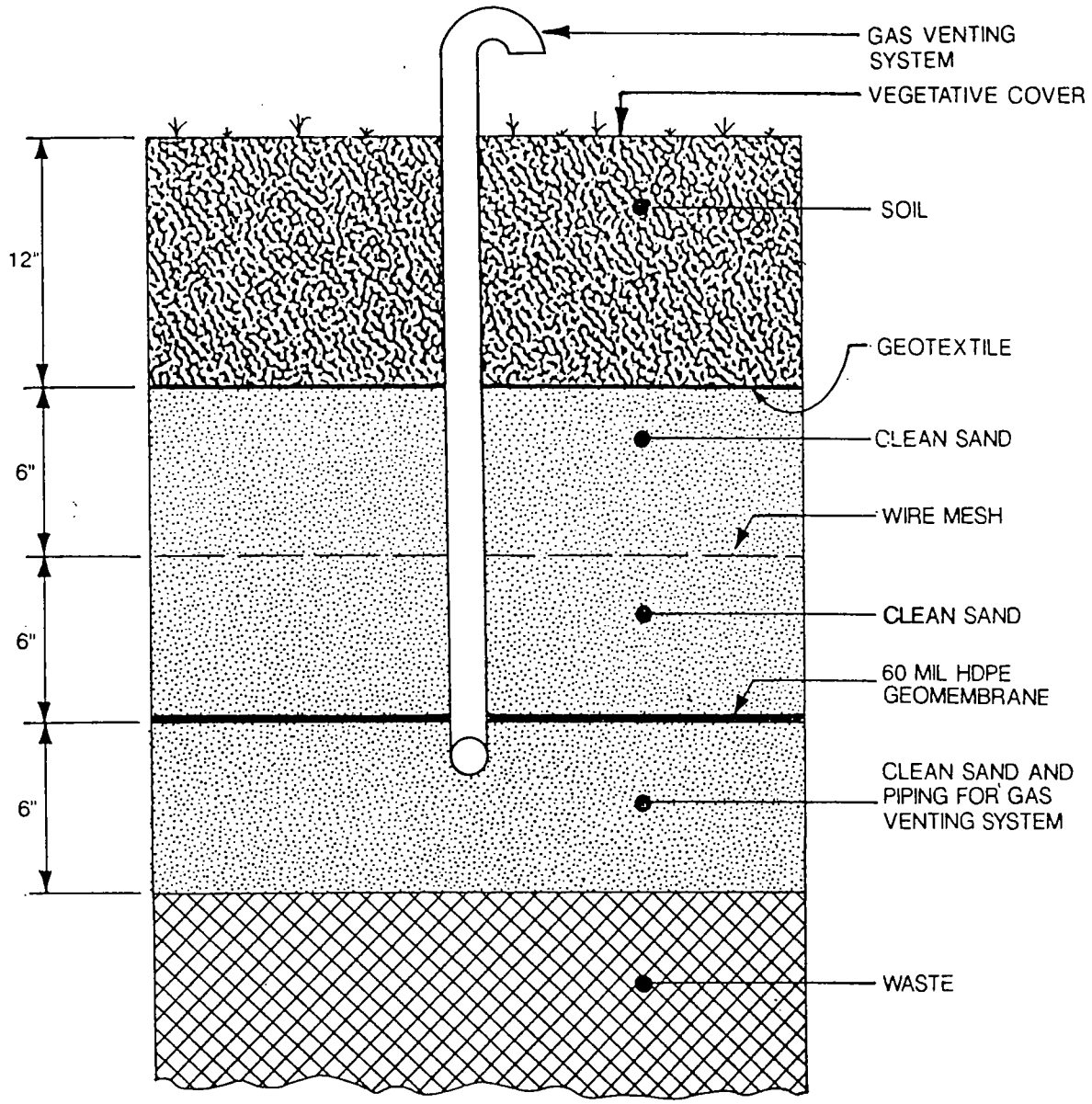

FIGURE 4-9

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DRAWN BY: SKF.	DATE: 2/26/88
CHECKED:	DATE: 3-7-88
APPROVED:	DATE: 3/29/88

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MULTI-MEDIA CAP
TYPICAL CROSS-SECTION
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

because cathode wastes residuals will be removed to competent basalt. However, backfilling will be performed to promote drainage.

Remedial Measure FCW4

The cathode waste residuals and underlying soils from the Former Cathode Waste Management Areas will be excavated and placed into the existing Landfill prior to capping the Landfill.

The Former Cathode Waste Management Areas will be excavated down to competent basalt resulting in a total volume of material removed of 64,470 cubic yards. The excavation for the Bath Recovery Pad Area will also remove the cathode waste materials along the Landfill Ditch. After removal activities have been completed, the Former Cathode Waste Management Areas will be backfilled as required to promote drainage. Capping will not be required because cathode waste residuals and subsoils from the Former Cathode Waste Management Areas will be removed and placed into the Landfill for management. The perched water will be collected during remedial activities and treated for cyanide and fluoride by the aqueous treatment system described in detail in Remedial Measure LF2 for Alternative 2. Long-term collection and treatment of perched water will not be required because materials from the Former Cathode Waste Management Areas will be removed and placed in the Landfill.

Recovery of perched water east of River Road will be limited to a one time extraction during remedial activities. Temporary sump(s) may be required to enhance the collection process.

The use of the roof scrubber return line beneath the former Cathode Waste Management Areas would require temporary disruption of flows to relocate the line or replace it during remedial activities. One possible scenario for rerouting of the roof scrubber return line is illustrated in Figure 4-10.

Remedial Measure SP2

This measure involves covering Scrubber Sludge Ponds 2 and 3 with a soil cover as described in Remedial Measure SP2 for Alternative 2. The cross-section of the proposed cover system is illustrated in Figure 4-7.

Remedial Measure GW3

With the acceptance of a waiver from the fluoride and sulfate ARARs, ground-water recovery and treatment would only be required at the Unloading Area. To recover ground water from the Unloading Area, a 4-inch diameter recovery well will be installed in the area of monitor well 5S as shown in Figure 4-8. This recovery well, RW-1, will be equipped with a submersible pump which will be operated at a continuous flowrate of 2 gpm. It is expected that recovery from RW-1 would continue for approximately five years. Recovered

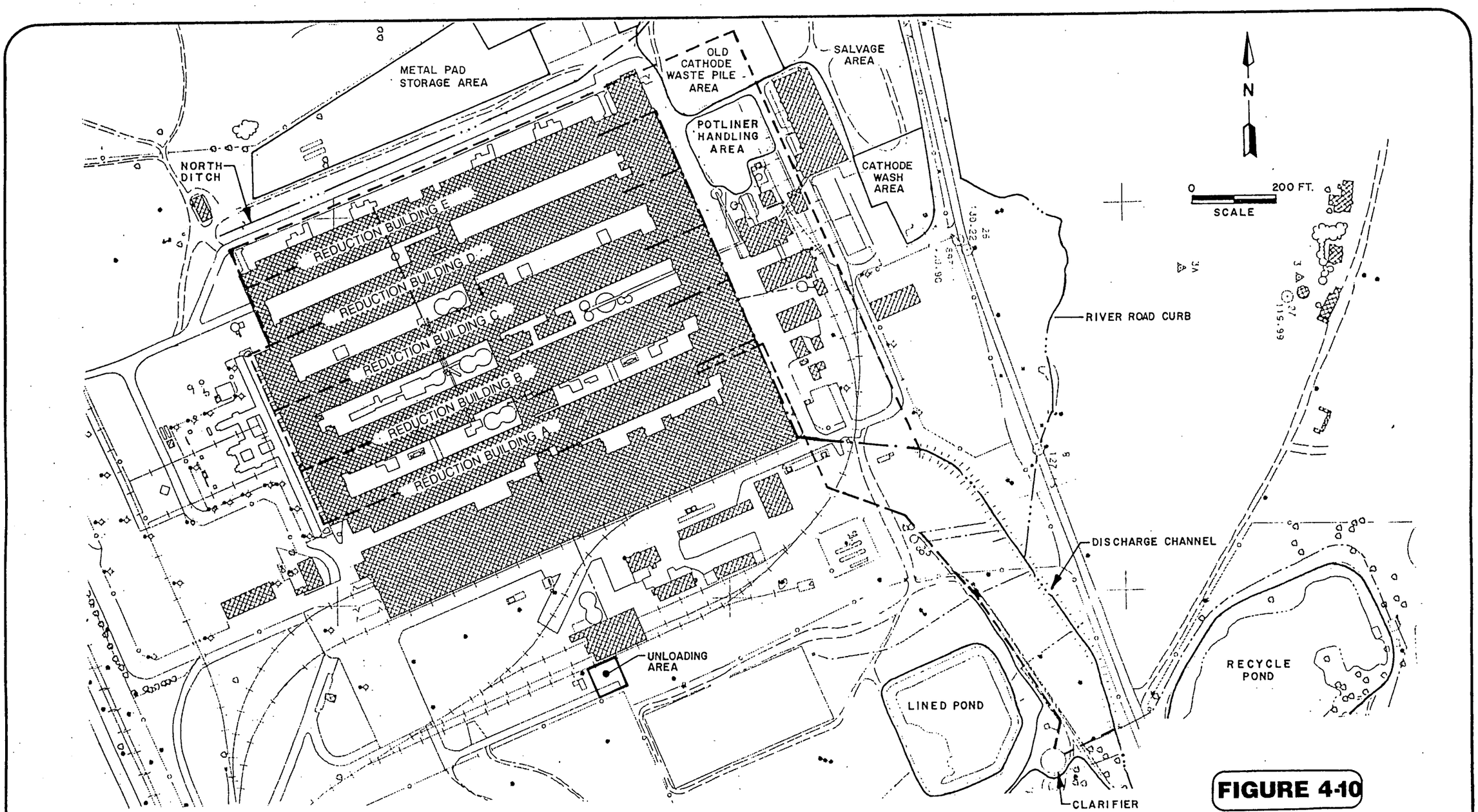

FIGURE 4-10

DRAWING NO: TE0018-P05-B52	
DRAWN BY: JHF.	DATE: 3/11/88
CHECKED:	DATE: 3-18-88
APPROVED:	DATE: 6-7-88

LEGEND:

- EXISTING SCRUBBER RETURN LINES
- PROPOSED SCRUBBER RETURN LINES

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ROUTING OF ROOF SCRUBBER RETURN LINES
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

ground water from RW-1 will be discharged into the Recycle Pond where it will be recycled to the roof scrubbers or treated by the in plant process.

This remedial measure also includes replacement of the existing Animal Shelter, Rockline, Klindt and Residence wells with water from the City of The Dalles water supply system and properly abandoning the existing wells at these locations. Institutional controls would be implemented to prevent future use of ground water adjacent to the MMRF and east of River Road to the Columbia River.

Ground-water monitoring would be conducted to monitor variations in ground-water quality and would serve as the basis for monitoring remediation effectiveness and initiating future actions if required. Table 4-2 presents the monitoring wells, parameters and the associated target areas being monitored. The ground-water monitoring will be conducted quarterly for the first year, semi-annually for the second year and annually thereafter. At the end of five years, the entire ground-water monitoring program will be re-evaluated and adjusted if necessary. This time frame corresponds to the time period required by SARA for re-evaluation of site conditions. Data will be submitted to the EPA shortly after the laboratory analysis has been completed for each period during the first two years. Annual reports will also be submitted during each of the first five years. Details pertaining to the ground-water monitoring plan are presented in Appendix D.

4.2.2.3 Remedial Alternative 4: Containment, Complete Removal and Hydraulic Barriers with Ground-Water Controls

Sitewide Remedial Alternative 4 consists of the following remedial measures for the target remediation areas:

- LF2: Cap in place;
- UA2: Consolidate into existing Landfill;
- FCW4: Consolidate into existing Landfill;
- SP4: Cap in place with hydraulic controls;
- GW3: Ground-water controls with limited treatment.

The Landfill and associated areas will be consolidated prior to capping to limit the actual lateral extent of the cap. The Unloading Area and Former Cathode Waste Management Areas will be excavated down to competent basalt and consolidated into the existing Landfill. Remedial Measure LF2 makes provisions for the collection of leachate after capping of the Landfill. Perched water beneath the Former Cathode Waste Management Areas will be collected during excavation activities and treated. This should be effective in collecting perched water on both sides of River Road. However, temporary sump(s) may be necessary to collect perched water east of River Road. Scrubber Sludge Ponds 1 thru 4 will be covered with a multi-media cap which meets RCRA performance standards. Hydraulic controls will be installed around the Scrubber Sludge Ponds to lower the ground-water table so it does not intersect the sludge. Ground-water controls will consist of institutional controls and limited ground-water recovery. Dust controls will be

utilized during remediation to minimize fugitive dust emissions. Fencing and deed restrictions will be utilized to limit access to and prevent future use of areas where materials are managed on-site. Only workers performing necessary maintenance functions would be allowed entry to the Landfill and Scrubber Sludge Ponds after remediation is complete.

Remedial Measure LF2

The Landfill will be covered with a multi-media cap meeting the performance standards as defined in 40 CFR 264.310 after consolidating materials from the Unloading Area and the Former Cathode Waste Management Areas. This will result in the relocation of approximately 64,670 cubic yards to the Landfill prior to its capping. The volume of the relocated material will not affect the overall lateral extent of the cap as illustrated in Figure 4-1. However, the finished elevation will be increased to accommodate the additional fill. Consolidation of the Landfill and associated areas includes remediating the Leachate Collection Ditch Surface Drainage Ditch and the Landfill Ditch. The known asbestos disposal areas shall only have fill placed on them during regrading activities so as not to disturb the material.

The design of the cover will be a multi-media cap designed to meet RCRA performance standards as illustrated in Figure 4-9 and discussed in detail in Remedial Measure LF2

for Alternative 3. Post-capping leachate will be collected and treated for cyanide and fluoride. The aqueous treatment system is described in detail in Remedial Measure LF2 for Alternative 2.

Remedial Measure UA2

The Unloading Area will be excavated resulting in the removal of approximately 200 cubic yards of cathode waste residuals and placement into the existing Landfill prior to its capping. Backfilling of the area will not be required because cathode waste residuals will be removed to competent basalt. However, backfilling of the area will be performed to promote drainage.

Remedial Measure FCW4:

Removal of cathode waste residuals and contaminated soils will be performed for the Potliner Handling Area, Old Cathode Waste Pile Area, Salvage Area and Bath Recovery Pad Area resulting in the removal of 64,470 cubic yards from the four areas. The removal will be down to competent basalt. The Former Cathode Waste Management Areas will be backfilled as required to promote drainage. Perched water will be collected only during remedial activities and treated for cyanide and fluoride by the aqueous treatment system described in detail in Remedial Measure LF2 for Alternative 2. Temporary sump(s) may be required to enhance the collection process east of River Road. Long-term collection

and treatment of perched water will not be required because the materials from the Former Cathode Waste Management Areas would be removed and placed in the Landfill. The roof scrubber recycle line would be rerouted during remediation, as was discussed in detail in Alternative 3.

Remedial Measure SP4

This measure involves covering Scrubber Sludge Ponds 1 through 4 with a multi-media cap designed to meet RCRA performance standards as proposed for the Landfill and illustrated in Figure 4-9. The multi-media cap will cover approximately 16 acres and consist of 12-inches of topsoil, a geotextile layer, 6-inches of clean sand, a wire mesh for rodent control, another 6-inches of clean sand, a 60-mil HDPE geomembrane, and 6-inches of clean sand overlying the compacted waste which will serve as part of a passive gas venting system. The piping for the gas venting system will be constructed of HDPE for compatibility with the geomembrane in the cap. The top and side slopes of the cap will be constructed as to minimize erosion and the drainage controls around the Scrubber Sludge Ponds would be improved to redirect surface water runoff.

Prior to capping, site preparation will remove vegetation from the soil covers over SSP1 and SSP4. SSP1 will be cut and used as fill for SSP2 and SSP3, and backfill will be used as required to established grades for SSP2, SSP3

and SSP4 prior to capping. The grading activities are expected to relocate approximately 30,000 cubic yards of material from SSP1 and 10,000 cubic yards of fill.

Surface drainage will be intercepted and re-routed as necessary to the local drainage features. Runoff from the cap will be directed to the east into existing surface drainage features.

Hydraulic controls will be installed adjacent to the Scrubber Sludge Ponds to lower the water table below the sludge in the ponds. An estimated seven (7) four-inch recovery wells, RW-2 through RW-8, will be used to provide the hydraulic controls. The approximate locations of these wells are shown in Figure 4-11. Recovered ground water will be pumped to the Recycle Pond where it will be recycled to the roof scrubbers or treated by the in plant process.

Remedial Measure GW3

With the acceptance of a waiver from the fluoride and sulfate ARARs, ground-water recovery and treatment would only be required at the Unloading Area. To recover ground water from the Unloading Area, a 4-inch diameter recovery well will be installed in the area of monitor well 5S as shown in Figure 4-8. This recovery well, RW-1, will be equipped with a submersible pump which will be operated at a continuous flowrate of 2 gpm. It is expected that recovery from RW-1 would continue for approximately five years. Recovered

BAY REPROGRAPHICS 300852

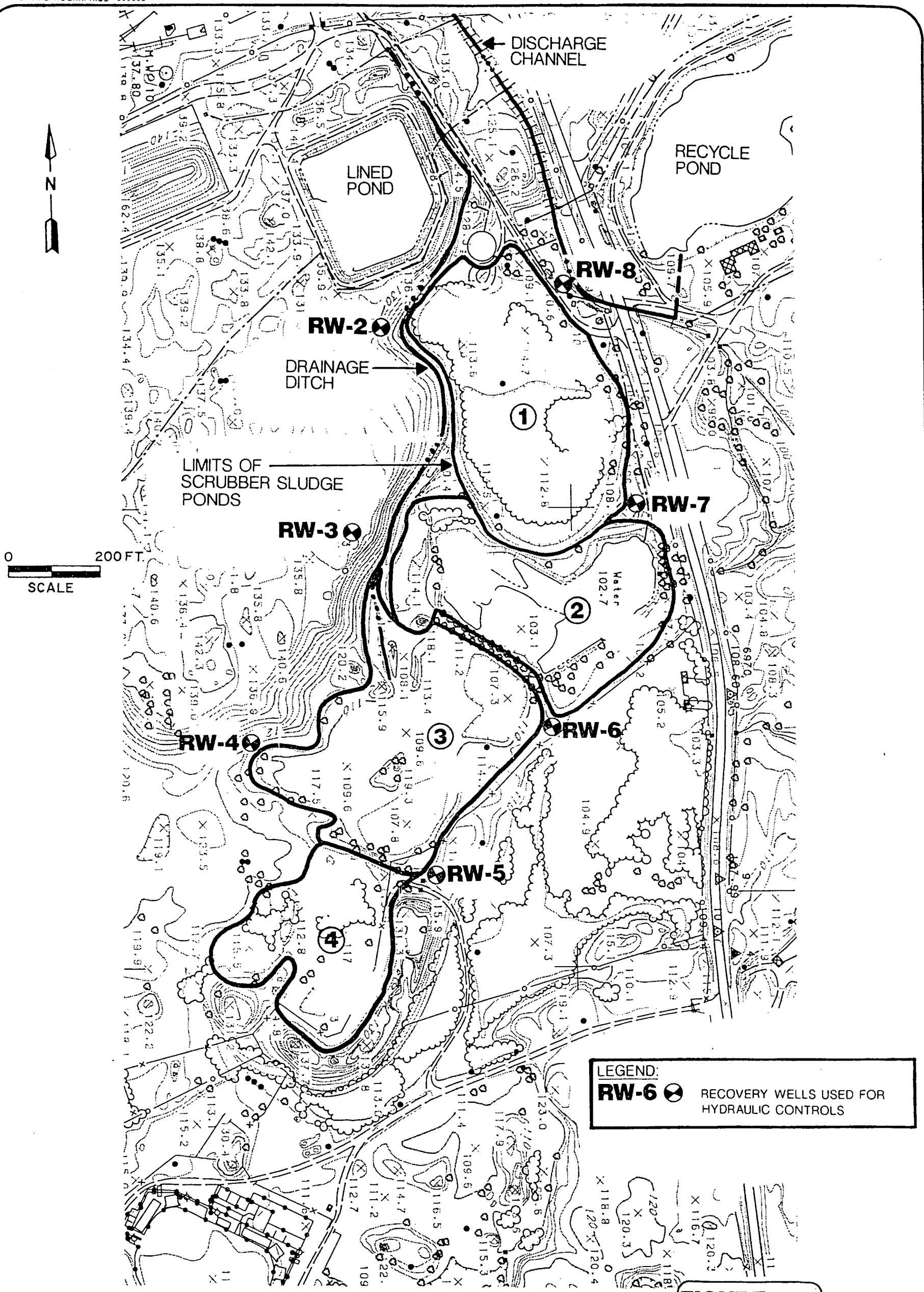

FIGURE 4-11

DRAWING NO: TE0018-P05-B-59	
DRAWN BY: KEN GAREX	DATE: 25 FEB 88
CHECKED: RJC	DATE: 3-28-88
APPROVED: DFY	DATE: 3/29/88

GMCE
G&M CONSULTING ENGINEERS, INC

HYDRAULIC CONTROLS SCRUBBER SLUDGE PONDS
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

ground water from RW-1 will be discharged into the Recycle Pond where it will be recycled to the roof scrubbers or treated by the in plant process.

Replacement of the existing Animal Shelter, Rockline, Klindt and Residence wells with water from the City of The Dalles water supply system and properly abandoning the existing wells will be performed. Institutional controls would be implemented to prevent future use of ground water adjacent to the MMRF and east of River Road to the Columbia River.

Ground-water monitoring would be conducted to monitor variations in ground-water quality and would serve as the basis for monitoring remediation effectiveness and initiating future actions if required. Table 4-2 presents the monitoring wells, parameters, and the associated target areas being monitored. Ground-water monitoring will be conducted quarterly for the first year, semi-annually for the second year and annually thereafter. At the end of the five years, the entire ground-water monitoring program will be re-evaluated and adjusted if necessary. This time frame corresponds to the time period required by SARA for re-evaluation of site conditions. Data will be submitted to the EPA shortly after the laboratory analysis has been completed for each period during the first two years. Annual reports will also be submitted during each of the first five years. Details pertaining to the ground-water monitoring plan are presented in Appendix D.

4.2.2.4 Remedial Alternative 5: Containment with Consolidation and Ground-Water Controls

Sitewide Remedial Alternative 5 consists of the following remedial measures for the target remediation areas:

- LF2: Cap in Place;
- UA2: Consolidate into existing Landfill;
- FCW4: Consolidate into existing Landfill;
- SP5: Consolidate into existing Landfill; and
- GW3: Ground-water controls with limited treatment.

The Unloading Area, Former Cathode Waste Management Areas and Scrubber Sludge Ponds 1 through 4 will be excavated to competent basalt and consolidated into the existing Landfill and the Landfill will be capped in place. Remedial Measure LF2 makes provisions for the collection of leachate after capping the Landfill. Perched water beneath the Former Cathode Waste Management Areas will be collected during excavation activities and treated. This should be effective in collecting perched water on both sides of River Road. However, temporary sump(s) may be necessary to collect perched water east of River Road. Ground-water controls will consist of institutional controls, limited ground-water recovery and treatment for fluoride and ground-water monitoring. Dust controls will be utilized during remediation to minimize fugitive dust emissions. Fencing and deed restrictions will be utilized to limit access to and prevent future use of areas where materials are managed on-site. Only authorized personnel would be allowed entry to the Landfill area after remediation is complete.

Remedial Measure LF2:

The volumes of materials to be removed from the target remediation areas and consolidated into the existing Landfill are presented below:

o Unloading Area	200 cubic yards
o Potliner Handling Area	9,910 cubic yards
o Old Cathode Waste Pile Area	24,200 cubic yards
o Salvage Area	28,700 cubic yards
o Bath Recovery Pad Area	1,660 cubic yards
o Scrubber Sludge Ponds	168,418 cubic yards

The lateral extent of the cap for this remedial measure will be approximately 15 acres as illustrated in Figure 4-12. The high power electrical line tower will be relocated east of the existing Landfill perimeter to allow accommodation of the waste volume to be capped. The existing tower on the west side of the existing Landfill will be reconstructed such that sufficient strength and height can be obtained to span the Landfill after capping. The materials to the south of the existing Landfill fence to the Landfill Ditch will be excavated and consolidated into the Landfill with other wastes from the Leachate Collection, Surface Drainage and Landfill Ditches. The known asbestos disposal areas shall only have fill placed on them during regrading activities so as not to disturb the material.

The design of the cover will be a multi-media cap designed to meet RCRA performance standards as illustrated in Figure 4-9 and discussed in detail in Remedial Measure LF2

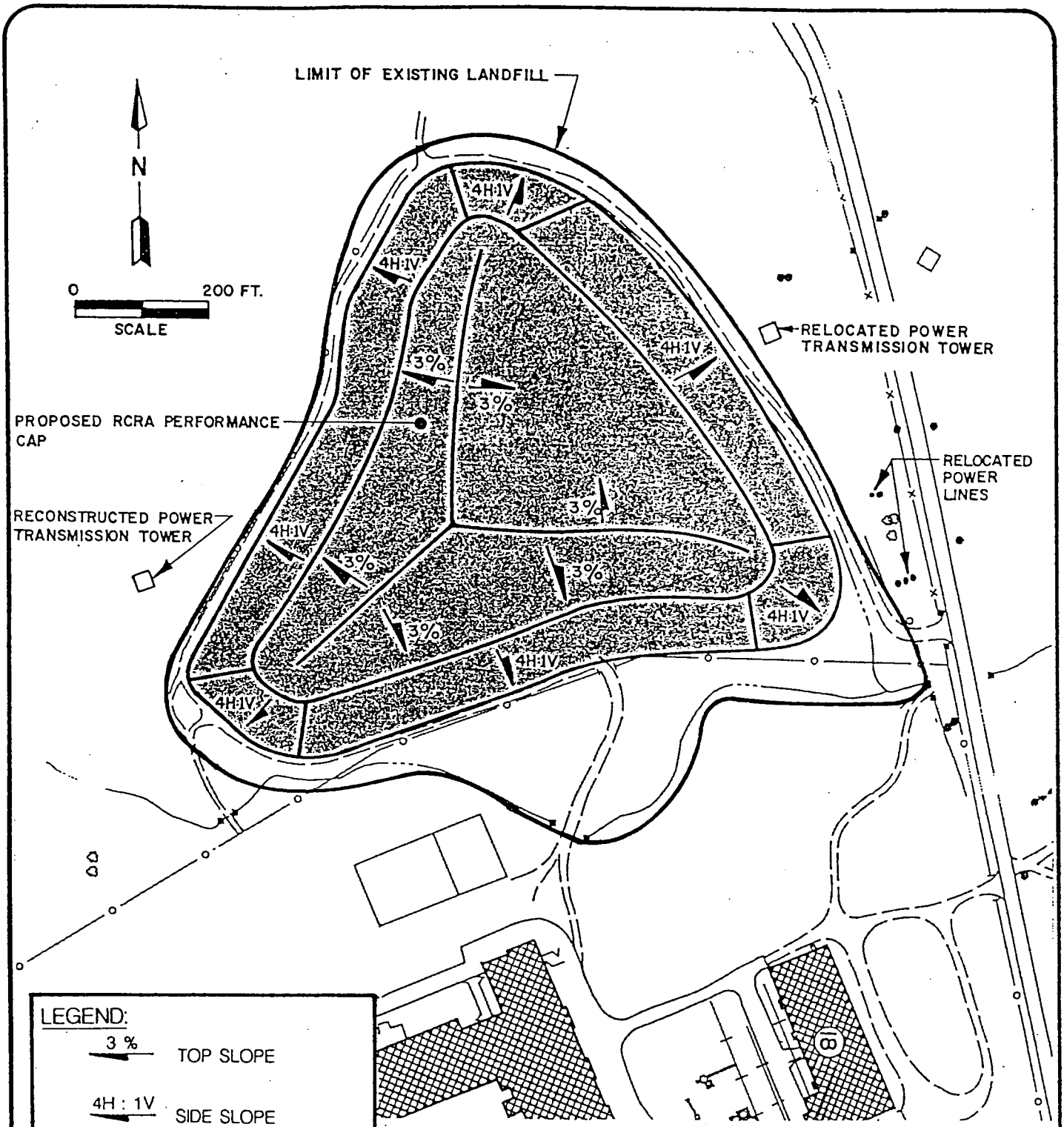

FIGURE 4-12

DRAWING NO: TE0018-P05-A79	
DRAWN BY: KenCaccon	DATE: 3-8-88
CHECKED: RLC	DATE: 3-13-88
APPROVED:	DATE: 3/29/88

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APPROXIMATE LOCATION AND CONFIGURATION OF LANDFILL CAP
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

for Alternative 3. Post-capping leachate will be collected and treated for cyanide and fluoride. The aqueous treatment system is described in detail in Remedial Measure LF2 for Alternative 2.

Remedial Measure UA2

The Unloading Area will be excavated resulting in the removal of approximately 200 cubic yards of cathode waste residuals and placement into the existing Landfill prior to its capping. Capping of the area will not be required because cathode wastes residuals will be excavated down to competent basalt. However, backfilling will be performed to promote drainage.

Remedial Measure FCW4

Removal of cathode waste residuals and contaminated soils will be performed for the Potliner Handling Area, Old Cathode Waste Pile Area, Salvage Area, and Bath Recovery Pad Area resulting in the removal of 64,470 cubic yards from four areas. This material will then be placed into the existing Landfill prior to its capping. The Former Cathode Waste Management Areas will be backfilled as required to promote drainage. Perched water will be collected only during remedial activities and treated for cyanide and fluoride by the aqueous treatment system described in detail in Remedial Measure LF2 for Alternative 2. Temporary sump(s) may be required to enhance the collection process east of River

Road. Long-term collection and treatment of perched water will not be required because the materials from the Former Cathode Waste Management Areas would be removed and placed in the Landfill. The roof scrubber recycle line will be rerouted during remediation as was discussed in Alternative 3.

Remedial Measure SP5

This remedial measure involves the excavation of approximately 168,000 cubic yards of cover soil, sludges and contaminated subsoils down to competent basalt from the Scrubber Sludge Ponds and consolidating the material into the existing Landfill for management. The area will be backfilled as required to promote drainage. The existing surface drainage features will be improved to minimize erosion.

Remedial Measure GW3

With the acceptance of a waiver from the fluoride and sulfate ARARs, ground-water recovery and treatment would only be required at the Unloading Area. To recover ground water from the Unloading Area, a 4-inch diameter recovery well will be installed in the area of monitor well 5S as shown in Figure 4-8. This recovery well, RW-1, will be equipped with a submersible pump which will be operated at a continuous flowrate of 2 gpm. It is expected that recovery from RW-1 would continue for approximately five years. Recovered

ground water from RW-1 will be discharged into the Recycle Pond where it will be recycled to the roof scrubbers or treated by the in plant process.

Replacement of the existing Animal Shelter, Rockline, Klindt and Residence wells with water from the City of The Dalles water supply system and properly abandoning the existing wells will be performed. Institutional controls would be implemented to prevent future use of ground water adjacent to the MMRF and east of River Road to the Columbia River.

Ground-water monitoring would be conducted to monitor variations in ground-water quality and would serve as the basis for monitoring remediation effectiveness and initiating future actions, if required. Table 4-2 presents the monitoring wells, parameters and the associated target areas being monitored. Ground-water monitoring will be conducted quarterly for the first year, semi-annually for the second year and annually thereafter. At the end of five years, the entire ground-water monitoring program will be re-evaluated and adjusted if necessary. This time frame corresponds to the time period required by SARA for re-evaluation of site conditions. Data will be submitted to the EPA shortly after the laboratory analysis has been completed for each period during the first two years. Annual reports will also be submitted during each of the first five years. Details pertaining to the ground-water monitoring plan are presented in Appendix D.

4.2.2.5 Remedial Alternative 6: RCRA Landfill and Ground-Water Controls

Sitewide Remedial Alternative 6 consists of the following remedial measures for the target remediation areas:

- o LF5: Consolidate into on-site RCRA landfill;
- o UA4: Consolidate into on-site RCRA landfill;
- o FCW5: Consolidate into on-site RCRA landfill;
- o SP6: Consolidate into on-site RCRA landfill; and
- o GW3: Ground-Water Controls with limited treatment.

The on-site RCRA Landfill will be constructed to contain approximately 500,000 cubic yards. The location of the new landfill is illustrated in Figure 4-13. The bottom liner system will be constructed to meet 40 CFR 264.301 requirements and a typical cross-section is presented in Figure 4-14. After waste placement, the new RCRA landfill will be capped as illustrated in Figure 4-15. Ground-water controls will consist of institutional controls, limited ground-water recovery and treatment for fluoride and ground-water monitoring. Dust controls will be utilized during remediation to minimize fugitive dust emissions. Fencing and deed restrictions will be utilized to limit access and prevent future use of areas where materials are managed on-site. Only authorized personnel would be allowed entry to the RCRA landfill after remediation is complete.

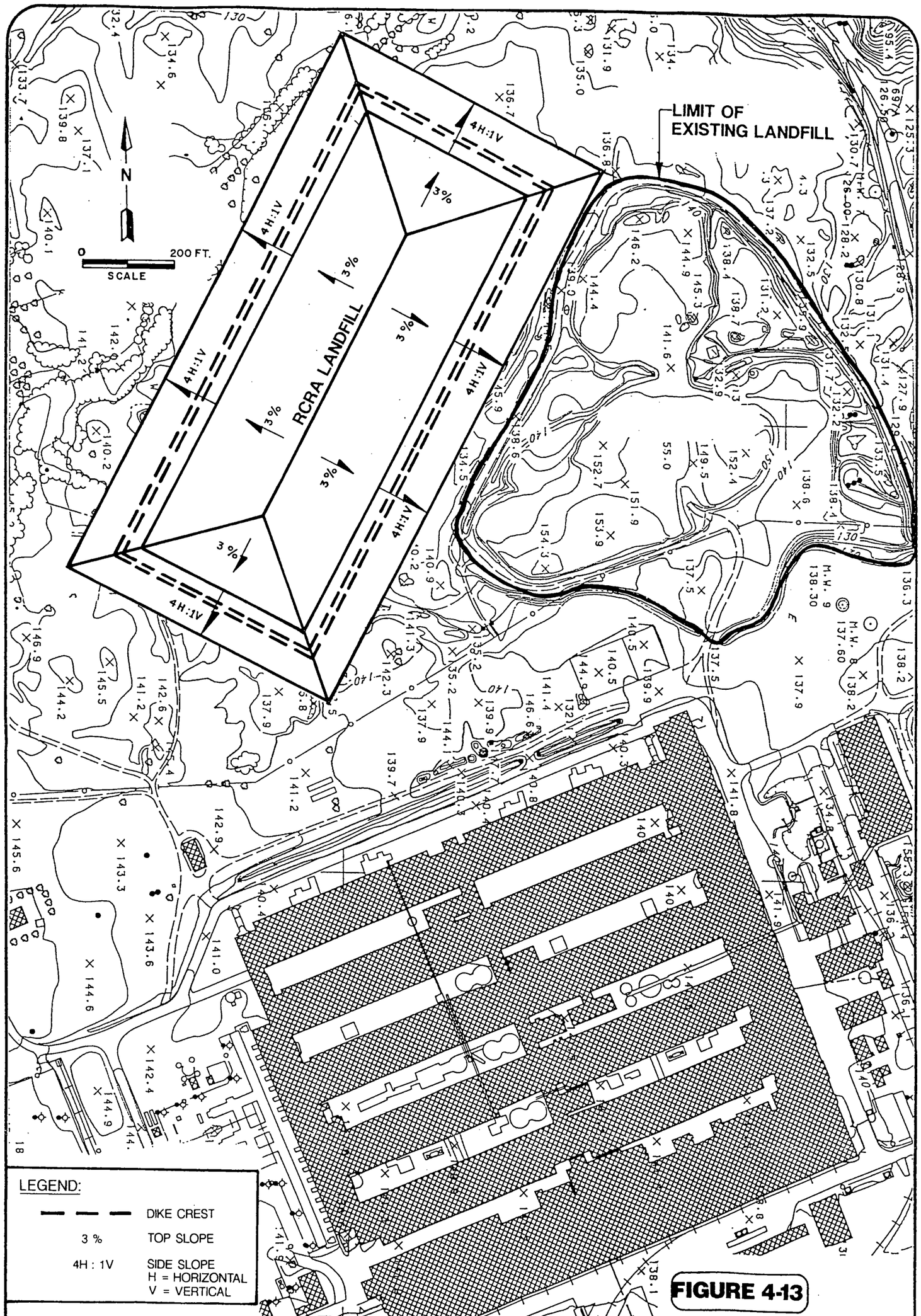

FIGURE 4-13

DRAWING NO: TE0018-P05-A53	
DRAWN BY: SKF.	DATE: 3/14/88
CHECKED:	DATE: 3-16-88
APPROVED:	DATE: 3/29/88

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APPROXIMATE LOCATION AND CONFIGURATION OF THE RCRA LANDFILL
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

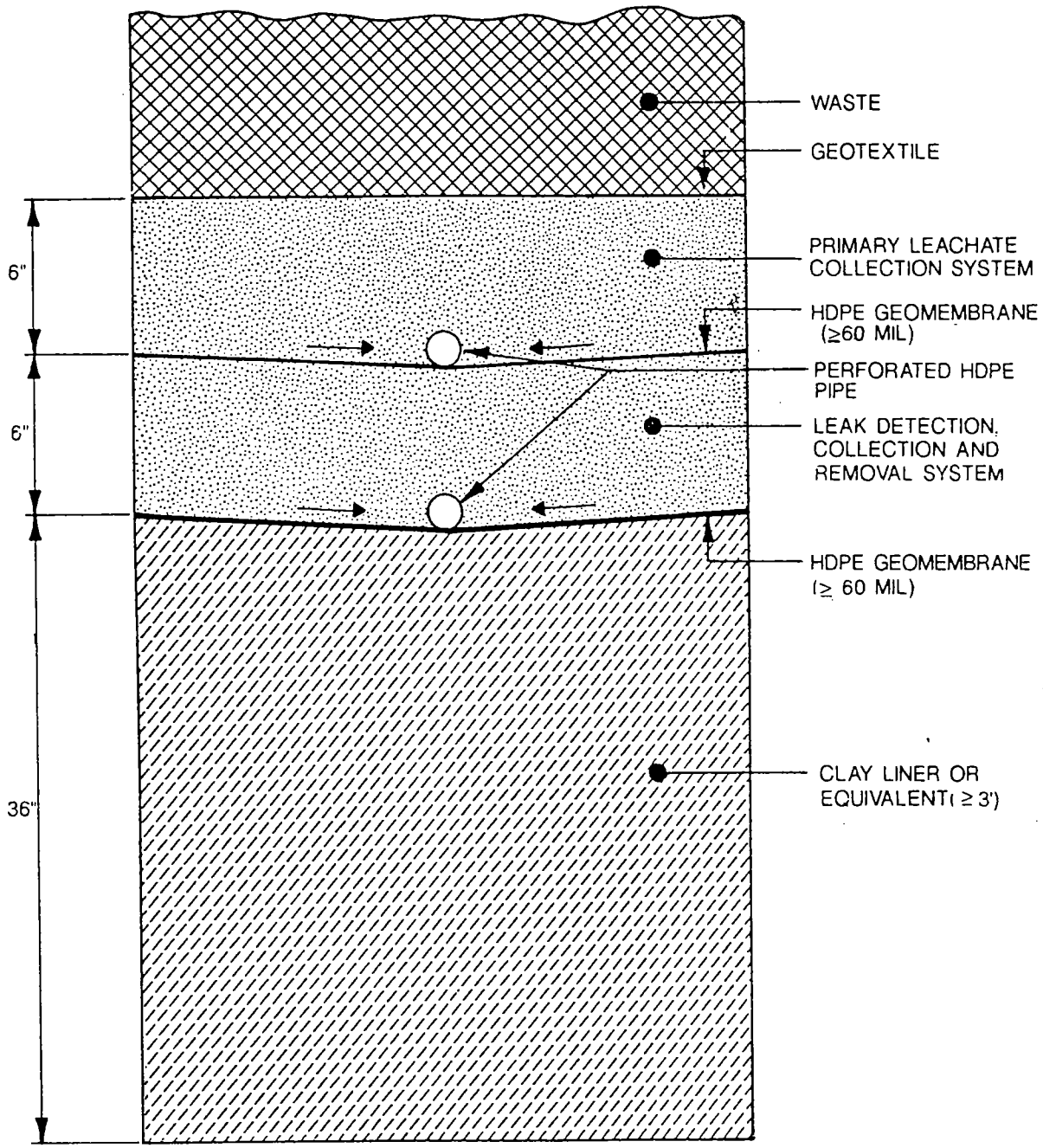

FIGURE 4-14

DRAWING NO: TE0018-P05-A60	
DRAWN BY: SKF	DATE: 3/9/88
CHECKED: [illegible]	DATE: 3-18-88
APPROVED: [illegible]	DATE: 3-29-88

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RCRA LANDFILL BOTTOM LINER SYSTEM CROSS-SECTION
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

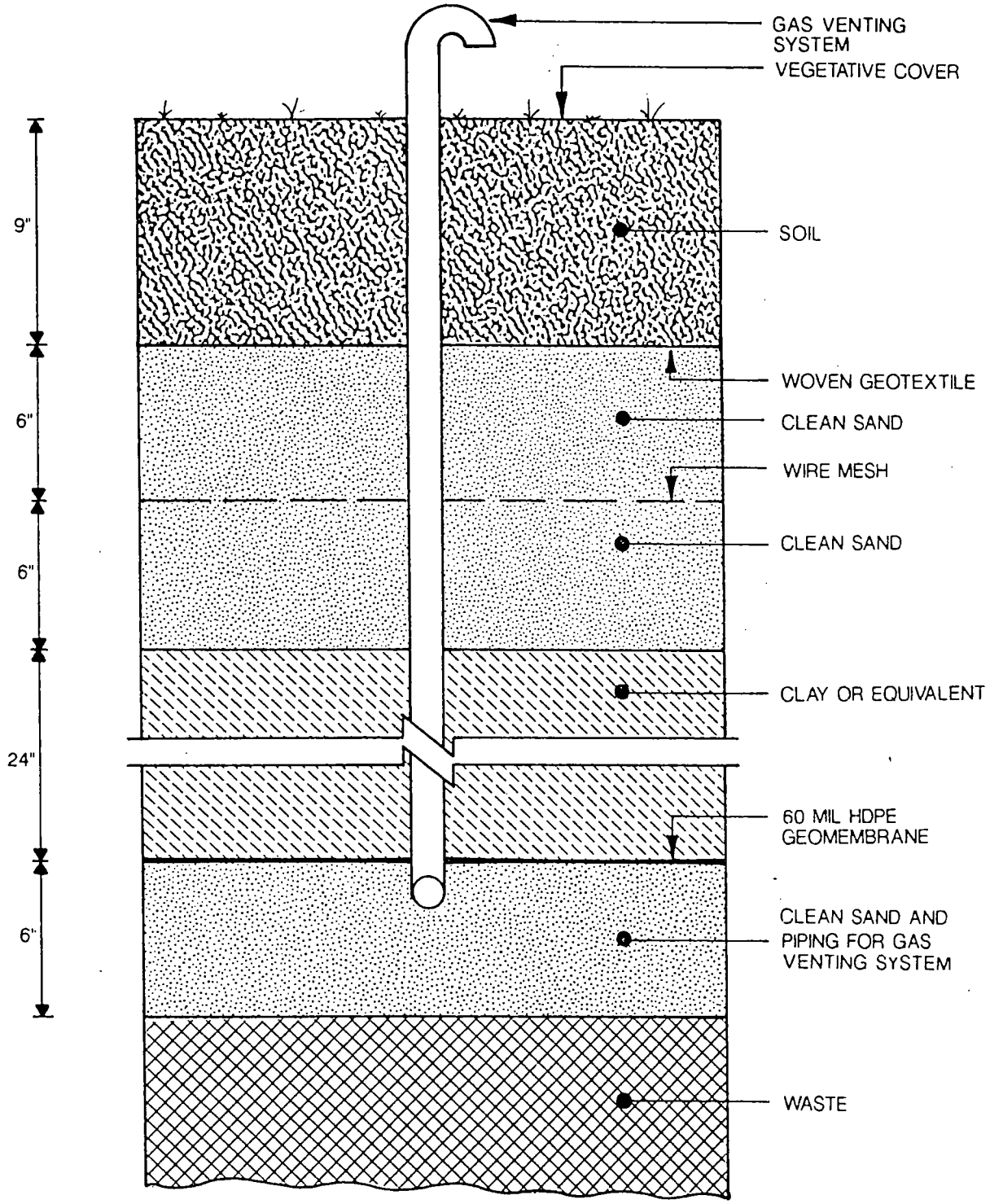

FIGURE 4-15

DRAWING NO: TE0018-P05-A62	
DRAWN BY: SKF.	DATE: 3/10/88
CHECKED:	DATE: 3-18-88
APPROVED:	DATE: 3/29/88

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RCRA GUIDANCE CAP CROSS-SECTION

FEASIBILITY STUDY: MARTIN MAIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

Remedial Measure LF5

The study areas and respective volumes associated with the existing Landfill to be consolidated into the RCRA landfill consist of the:

o Landfill	200,000 cubic yards
o Leachate Collection Ditch	--
o Surface Drainage Ditch	1,240 cubic yards
o Landfill Ditch	2,050 cubic yards

The Leachate Collection Ditch was lined with gunite and the volume of sediments within the ditch could not be determined; however, the volume of material contributed from this area will not impact the overall configuration or size of the RCRA landfill. The Landfill excavation will remove materials down to competent basalt. The area will be backfilled as required to promote drainage.

Remedial Measure UA4

The Unloading Area will be excavated resulting in the removal of approximately 200 cubic yards of cathode waste residuals and placement into the on-site RCRA landfill. The excavation will be backfilled to promote drainage.

Remedial Measure FCW5

Removal of cathode waste residuals and contaminated soils will be performed for the Potliner Handling Area, Old Cathode Waste Pile Area, Salvage Area and Bath Recovery Pad Area resulting in the removal of 64,470 cubic yards of

material from these four areas. This material will then be placed into the new on-site RCRA landfill. The Former Cathode Waste Management Areas will be backfilled as required to promote drainage.

Perched water will be collected only during remedial activities and treated for cyanide and fluoride by the aqueous treatment system described in detail in Remedial Measure LF2 for Alternative 2. Temporary sump(s) may be required to enhance the collection process east of River Road. Long-term collection and treatment of perched water will not be required because the materials from the Former Cathode Waste Management Area would be removed and placed in the RCRA landfill. The roof scrubber recycle line would be rerouted during remediation as was discussed in Alternative 3.

Remedial Measure SP6

This remedial measure involves the excavation of approximately 168,000 cubic yards of cover soil, sludges and contaminated subsoils down to competent basalt from the Scrubber Sludge Ponds and consolidating the material into the on-site RCRA landfill for management. The area will be backfilled as required to promote drainage. The existing surface drainage features will be improved to minimize erosion.

Remedial Measure GW3

With the acceptance of a waiver from the fluoride and sulfate ARARs, ground-water recovery and treatment would only be required at the Unloading Area. To recover ground water from the Unloading Area, a 4-inch diameter recovery well will be installed in the area of monitor well 5S as shown in Figure 4-8. This recovery well, RW-1, will be equipped with a submersible pump which will be operated at a continuous flowrate of 2 gpm. It is expected that recovery of ground water from RW-1 would continue for approximately five years. Recovered ground water from RW-1 will be discharged to the Recycle Pond where it will be recycled to the roof scrubbers or treated by the in plant process.

Replacement of the existing Animal Shelter, Rockline, Klindt and Residence wells with water from the City of The Dalles water supply system and properly abandoning the existing wells will be performed. Institutional controls would be implemented to prevent future use of ground water adjacent to the MMRF and east of River Road to the Columbia River.

Ground-water monitoring would be conducted to monitor variations in ground-water quality and would serve as the basis for monitoring remediation effectiveness and initiating future actions if required. Table 4-2 presents the monitoring wells, parameters, and the associated target areas

being monitored. One upgradient and at least three downgradient wells would be installed around the RCRA landfill. These wells would also be monitored for the same constituents and parameters as those discussed in Appendix D. Ground-water monitoring will be conducted quarterly for the first year, semi-annually for the second year and annually thereafter. At the end of five years, the entire ground-water monitoring program will be re-evaluated and adjusted if necessary. This time frame corresponds to the time period required by SARA for re-evaluation of site conditions. Data will be submitted to the EPA shortly after the laboratory analysis has been completed for each period during the first two years. Annual reports will also be submitted during each of the first five years. Details pertaining to the ground-water monitoring plan are presented in Appendix D.

4.2.3 Containment with Treatment Alternatives

4.2.3.1 Remedial Alternative 7: Containment with Consolidation and Ground-Water Recovery and Treatment

Sitewide Remedial Alternative 7 consists of the following remedial measures for the target remediation areas:

- LF2: Cap in Place;
- UA2: Consolidate into existing Landfill;
- FCW4: Consolidate into existing Landfill;
- SP5: Consolidate into existing Landfill; and
- GW4: Ground-water recovery and treatment.

The Unloading Area, Former Cathode Waste Management Areas and Scrubber Sludge Ponds 1 through 4 will be excavated to competent basalt and consolidated into the existing Landfill. Remedial measure LF2 makes provisions for the collection of leachate after capping of the Landfill. Areas where excavation occurs will be backfilled as required. Ground water will be recovered from various areas as described in Remedial Measure GW4 of this alternative. Dust controls will be utilized during remediation to minimize fugitive dust emissions. Fencing and deed restrictions will be utilized to limit access and to prevent future use of areas where materials are managed on-site. Only authorized personnel would be allowed entry to the Landfill area after remediation is complete.

Remedial Measure LF2:

The volumes of materials to be removed from the target remediation areas and consolidated into the existing Landfill are presented below:

o	Unloading Area	200 cubic yards
o	Potliner Handling Area	9,910 cubic yards
o	Old Cathode Waste Pile Area	24,200 cubic yards
o	Salvage Area	28,700 cubic yards
o	Bath Recovery Pad Area	1,660 cubic yards
o	Scrubber Sludge Ponds	168,000 cubic yards

The lateral extent of the cap for this remedial measure will be approximately 15 acres as illustrated in Figure 4-12. The high power electrical line tower will be relocated to the

east, out of the existing Landfill perimeter to allow accommodation of the waste volume to be capped. The existing tower on the west side of the existing Landfill will be reconstructed such that sufficient strength and height can be obtained to span the Landfill after capping. The materials south of the existing Landfill fence to the Landfill Ditch will be excavated and consolidated into the Landfill with other wastes from the Leachate Collection, Surface Drainage and Landfill Ditches. The known asbestos disposal areas shall only have fill placed on them during regrading activities so as not to disturb the material.

The design of the cover will be a multi-media cap designed to meet RCRA performance standards as illustrated in Figure 4-9 and discussed in detail in Remedial Measure LF2 for Alternative 3. Post-capping leachate will be collected and treated for cyanide and fluoride. The aqueous treatment system is described in detail in Remedial Measure LF2 for Alternative 2.

Remedial Measure UA2

The Unloading Area will be excavated resulting in the removal of approximately 200 cubic yards of cathode waste residuals and placement into the existing Landfill prior to capping. Capping of the area will not be required because cathode wastes residuals will be excavated to competent basalt. However, backfilling will be performed to promote drainage.

Remedial Measure FCW4

Removal of cathode waste residuals and contaminated soils will be performed for the Potliner Handling Area, Old Cathode Waste Pile Area, Salvage Area, and Bath Recovery Pad Area resulting in the removal of 64,470 cubic yards from the four areas. This material will be placed into the existing Landfill prior to its being capped. The Former Cathode Waste Management Areas will be backfilled as required to promote drainage, and because materials have been removed, capping of the area will not be required. Perched water will be collected only during remedial activities and treated for cyanide and fluoride by the aqueous treatment system described in detail in Remedial Measure LF2 for Alternative 2. Temporary sump(s) may be required to enhance the collection process east of River Road. Long-term collection and treatment of perched water will not be required because the materials from the Former Cathode Waste Management Areas would be removed and placed in the Landfill. The roof scrubber recycle line will be rerouted during remediation as was discussed in Alternative 3.

Remedial Measure SP5

This remedial measure involves the excavation of approximately 168,000 cubic yards of cover soil, sludges and contaminated subsoils down to competent basalt from the Scrubber Sludge Ponds and consolidating the material into the

existing Landfill for management. The area will be backfilled as required to promote drainage. The existing surface drainage features will be improved to minimize erosion.

Remedial Measure GW4

This remedial measure includes ground-water recovery from the Landfill and Former Cathode Waste Management Areas, Unloading Area, Scrubber Sludge Ponds, and the Recycle Pond. The recovered ground water will be discharged to the Recycle Pond where it will be recycled to the roof scrubbers or treated by the in plant process.

The recovery system for the Unloading Area would be constructed by installing a 4-inch diameter recovery well, RW-1, in the area of monitor well 5S as illustrated in Figure 4-8. This recovery well would be screened from just below land surface to the base of the S-aquifer and would be equipped with a submersible pump which would be operated at a continuous flow rate of 2 gpm.

The recovery system for the Landfill and Former Cathode Waste Management Areas will consist of installing new 4-inch diameter recovery wells near monitor wells 15S, 32S and 9A, as RW-2, RW-3 and RW-4, while monitor well 9B is 4-inches in diameter and can be utilized as a recovery well, RW-5, without modification. Figure 4-16 shows the approximate locations of recovery wells RW-2 through RW-5. Each well

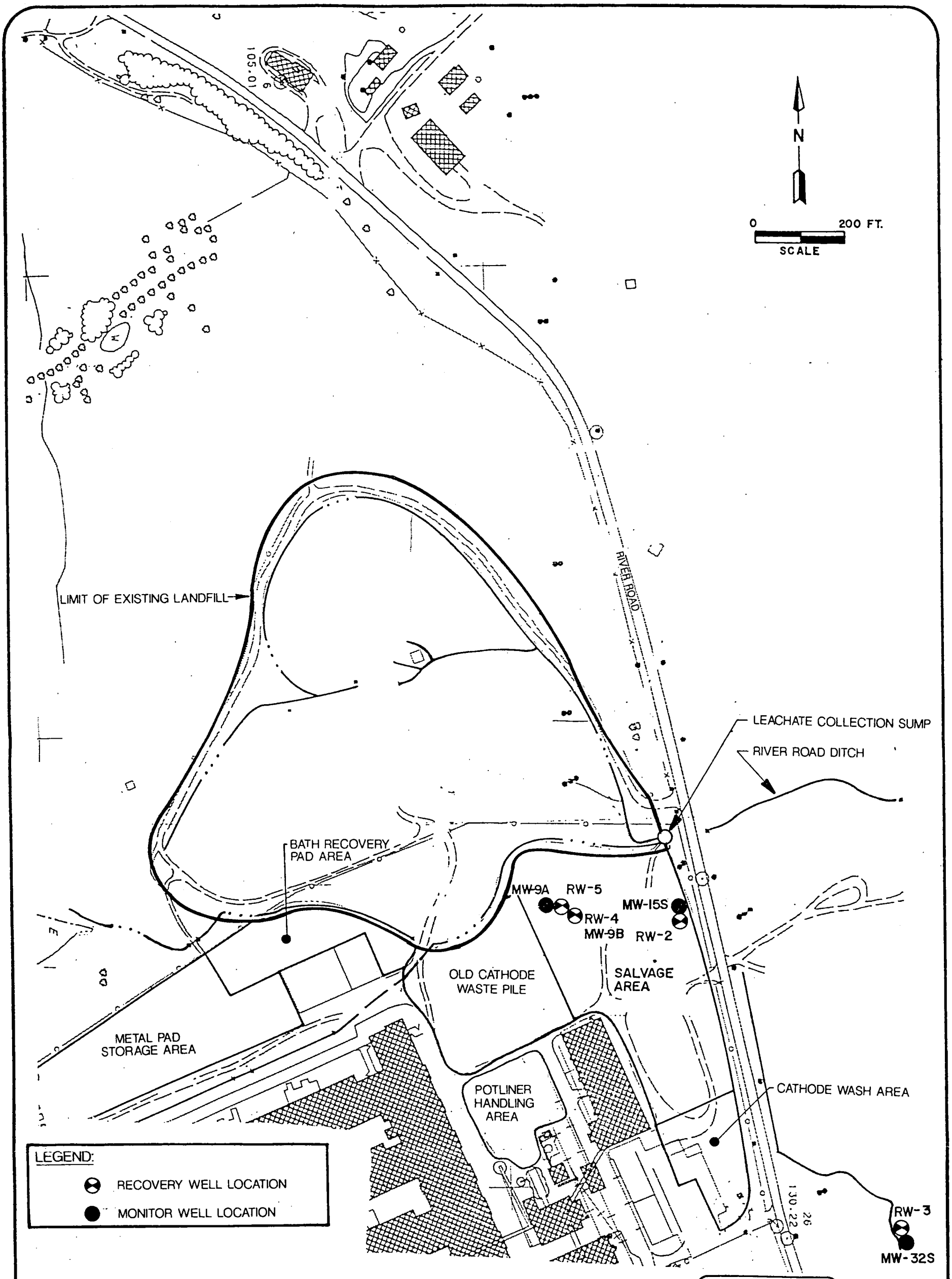

FIGURE 4-16

DRAWING NO: TE0018-P05-B55	
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CHECKED:	DATE: 3-8-88
APPROVED:	DATE: 3/29/88

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RECOVERY WELLS FORMER CATHODE WASTE MANAGEMENT AREAS
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

would be equipped with a submersible pump and would be operated at a continuous flowrate of 5 gpm per well for a combined flowrate of 20 gpm.

The recovery system for the Scrubber Sludge Ponds would consist of seven 4-inch diameter recovery wells, RW-6 through RW-12, shown in Figure 4-17. The recovery wells would be screened from just below land surface to an approximate elevation of 80 feet msl. The recovery wells will be equipped with submersible pumps which would be operated continuously at a flowrate of 2 gpm each for a combined flowrate of 14 gpm.

Three recovery wells will be utilized to recover ground water affected by the Recycle Pond. This recovery system will be installed by constructing a 4-inch well near monitor well 21-S, RW-13, and installing two additional 4-inch recovery wells, RW-14 and RW-15 as shown in Figure 4-18. The recovery wells will be screened from just below land surface to the base of the S-aquifer. Each recovery well will be equipped with a submersible pump that would be operated at a continuous flowrate of 2 gpm per well for a combined flowrate of 6 gpm.

Ground-water monitoring would be conducted to monitor variations in ground-water quality and would serve as the basis for monitoring remediation effectiveness and initiating future actions if required. Table 4-2 presents the

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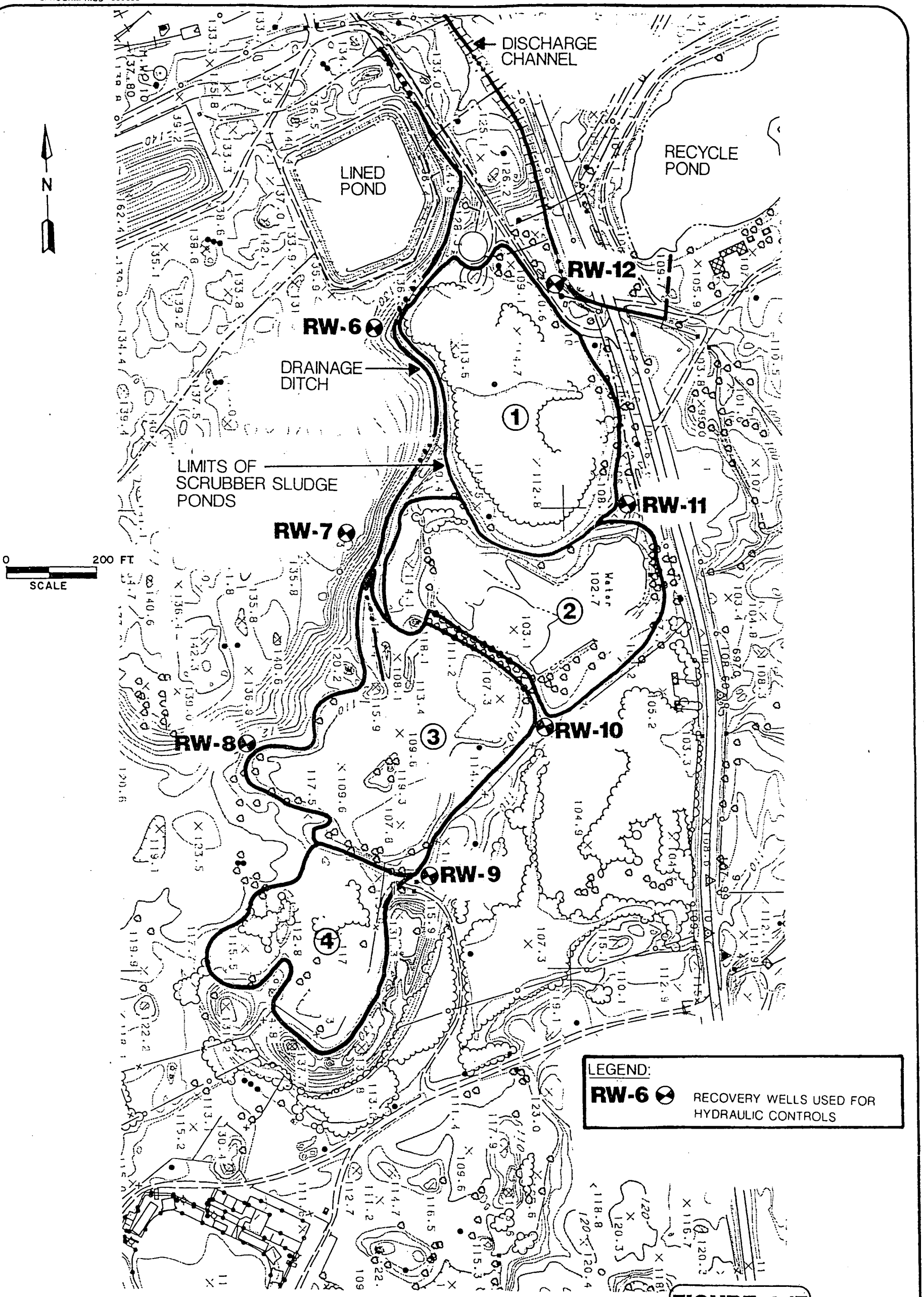

FIGURE 4-17

DRAWING NO: TE0018-P05-B56	
DRAWN BY: KEN LARSEN	DATE: 25 FEB 88
CHECKED: RLC	DATE: 3/28/88
APPROVED: WJF	DATE: 3/29/88

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RECOVERY WELLS
SCRUBBER SLUDGE PONDS
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

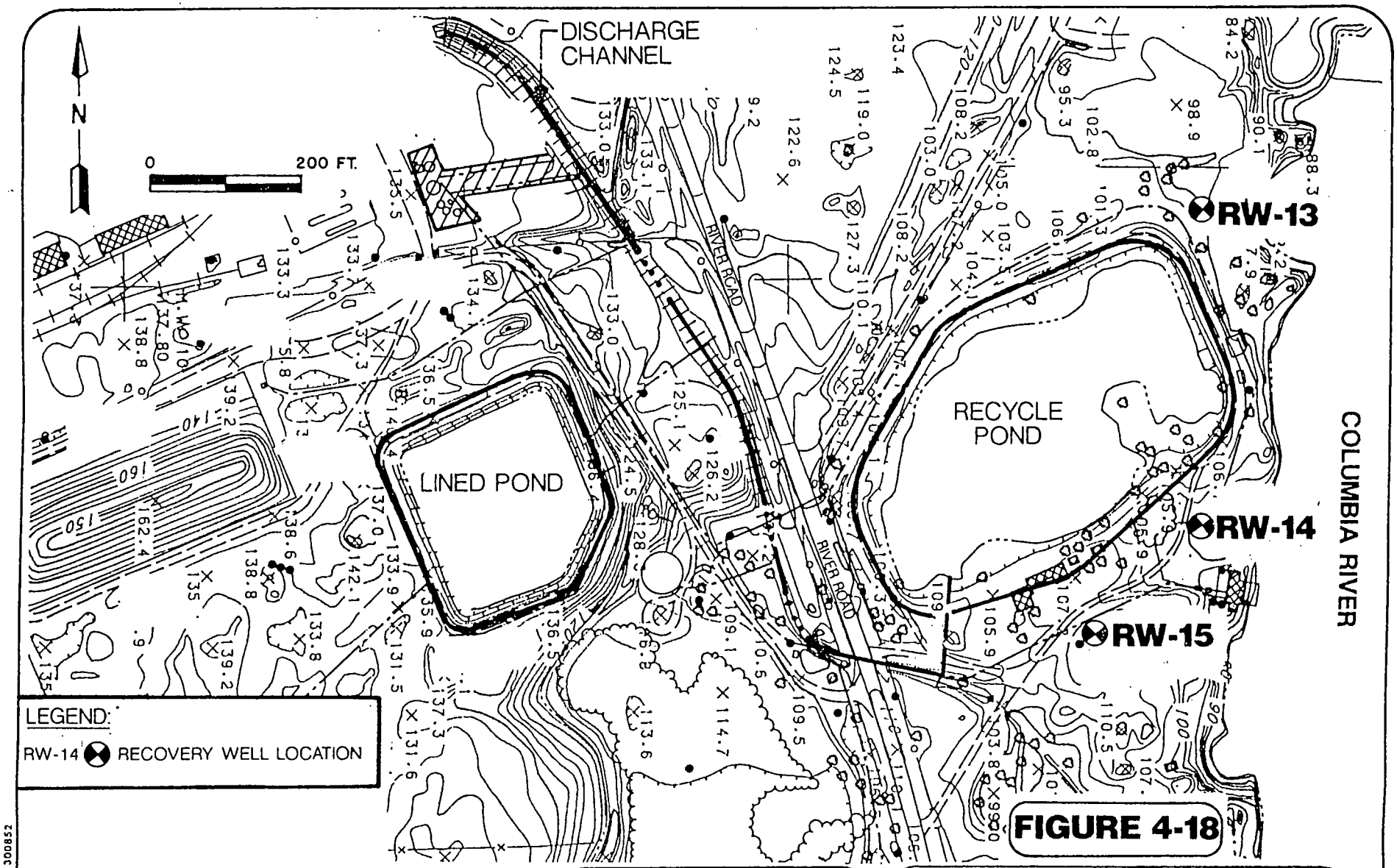

FIGURE 4-18

DRAWING NO: TE0018-P05-A73	
DRAWN BY: Ken Callo	DATE: 4/23/88
CHECKED:	DATE: 3-18-88
APPROVED:	DATE: 3/29/88

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RECOVERY WELLS
RECYCLE POND

FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

BAY REPROGRAPHICS 300852

monitoring wells, parameters and the associated target areas being monitored. Ground-water monitoring will be conducted quarterly for the first year, semi-annually for the second year and annually thereafter. At the end of five years, the entire ground-water monitoring program will be re-evaluated and adjusted if necessary. This time frame corresponds to the time period required by SARA for re-evaluation of site conditions. Data will be submitted to the EPA shortly after the laboratory analysis has been completed for each period during the first two years. Annual reports will also be submitted during each of the first five years. Details pertaining to the ground-water monitoring plan are presented in Appendix D.

4.2.3.2 Remedial Alternative 8: RCRA Landfill and Ground-Water Recovery and Treatment

Sitewide Remedial Alternative 8 consists of the following remedial measures for the target remediation areas:

- o LF5: Consolidate into on-site RCRA landfill;
- o UA4: Consolidate into on-site RCRA landfill;
- o FCW5: Consolidate into on-site RCRA landfill;
- o SP6: Consolidate into on-site RCRA landfill;
- o GW4: Ground-Water recovery and treatment.

The on-site RCRA Landfill will be constructed to contain approximately 500,000 cubic yards. The location of the new landfill is illustrated in Figure 4-13. The bottom liner system will be constructed to meet 40 CFR 264.301 requirements and a typical cross-section is presented in

Figure 4-14. After waste placement, the new RCRA landfill will be capped as illustrated in Figure 4-15. Ground water will be recovered from various areas as described in Remedial Measure GW4 of this alternative. Dust controls will be utilized during remediation to minimize fugitive dust emissions. Fencing and deed restrictions will be utilized to limit access and prevent future use of areas where materials are managed on-site. Only workers performing necessary maintenance functions would be allowed entry to the RCRA landfill after remediation is complete.

Remedial Measure LF5

The study areas and respective volumes associated with the consolidation from the existing Landfill into the RCRA landfill consist of the:

o Landfill	200,000 cubic yards
o Leachate Collection Ditch	--
o Surface Drainage Ditch	1,240 cubic yards
o Landfill Ditch	2,050 cubic yards

The Leachate Collection Ditch was lined with gunite and volume of sediments could not be determined; however, the volume of material contributed from this area will not impact the overall configuration or size of the RCRA landfill. The Landfill excavation will remove materials down to competent basalt. The area will be backfilled as required to promote drainage.

Remedial Measure UA4

The Unloading Area will be excavated resulting in the removal of 200 cubic yards of cathode waste residuals and placement in the on-site RCRA landfill. The excavated area will be backfilled to promote drainage.

Remedial Measure FCW5

Removal of cathode waste residuals and contaminated soils will be performed for the Potliner Handling Area, Old Cathode Waste Pile Area, Salvage Area and Bath Recovery Pad Area resulting in the removal of 64,470 cubic yards of material from these four areas. This material will then be placed into the new on-site RCRA landfill. The Former Cathode Waste Management Areas will be backfilled as required to promote drainage.

Perched water will be collected only during remedial activities and treated for cyanide and fluoride by the aqueous treatment system described in detail in Remedial Measure LF2 for Alternative 2. Temporary sump(s) may be required to enhance the collection process east of River road. Long-term collection and treatment of perched water will not be required because the materials from the Former Cathode Waste Management Areas would be removed and placed in the RCRA landfill. The roof scrubber recycle line would be rerouted during remediation as was discussed in Alternative 3.

Remedial Measure SP6

This remedial measure involves the excavation and consolidation of approximately 168,000 cubic yards of cover soil, sludges and contaminated subsoils down to competent basalt and consolidating the material into the on-site RCRA landfill for management. The area will be backfilled as required to promote drainage. The existing surface drainage features will be approved to minimize erosion.

Remedial Measure GW4

This remedial measure includes ground-water recovery from the Landfill and Former Cathode Waste Management Areas, the Unloading Area, the Scrubber Sludge Ponds and the Recycle Pond. The recovered ground water will be discharged to the Recycle Pond where it will be recycled to the roof scrubbers or treated by the in plant process.

The ground-water recovery system would consist of four wells at the Landfill and Former Cathode Waste Management Areas, one well at the Unloading Area, seven wells at the Scrubber Sludge Ponds and three wells at the Recycle Pond. The locations of these recovery wells for the various areas are shown in Figures 4-8, 4-16, 4-17 and 4-18. All recovery wells would be four inch wells and equipped with submersible pumps to withdraw ground water at sufficient flowrates to effectively recover contaminated ground water.

Ground-water monitoring would be conducted to monitor variations in ground-water quality and would serve as the basis for monitoring remediation effectiveness and initiating future actions, if required. Table 4-2 presents the monitoring wells, parameters and the associated target areas being monitored. Ground-water monitoring will be conducted quarterly for the first year, semi-annually for the second year and annually thereafter. At the end of five years, the entire ground-water monitoring program will be re-evaluated and adjusted if necessary. This time frame corresponds to the time period required by SARA for re-evaluation of site conditions. Data will be submitted to the EPA shortly after the laboratory analysis has been completed for each period during the first two years. Annual reports will also be submitted during each of the first five years. Details pertaining to the ground-water monitoring plan are presented in Appendix D.

4.2.3.3 Remedial Alternative 9: Containment with Consolidation, Stabilization and Ground-Water Recovery and Treatment

Sitewide Remedial Alternative 9 consists of the following remedial measures for the target remediation areas:

- LF2: Cap in place;
- UA2: Consolidate into existing Landfill;
- FCW4: Consolidate into existing Landfill;
- SP7: Sludge stabilization; and
- GW4: Ground-water recovery and treatment.

The Landfill and associated areas will be consolidated to limit the actual lateral extent of the cap. The Unloading Area and Former Cathode Waste Management Areas will be excavated down to competent basalt and consolidated into the existing Landfill. Remedial measure LF2 makes provisions for the collection of leachate after capping the Landfill. Perched water beneath the Former Cathode Waste Management Areas will be collected during excavation activities and treated. This should be effective in collecting perched water on both sides of River Road. However, temporary sump(s) may be necessary to collect perched water east of River Road. Scrubber Sludge Ponds 1 through 4 will be stabilized to minimize the leaching of fluoride. Ground water will be recovered from various areas as described in Remedial Measure GW4 of this alternative. Dust controls will be utilized during remediation to minimize fugitive dust emissions. Fencing and deed restrictions will be utilized to limit access to and prevent future use of areas where materials are managed on-site. Only workers performing necessary maintenance functions would be allowed entry to the Landfill and Scrubber Sludge Ponds after remediation is complete.

Remedial Measure LF2

The Landfill will be covered with a multi-media cap meeting the performance standards as defined in 40 CFR 264.310 after consolidating materials from the Unloading and

the Former Cathode Waste Management Areas. The total volume of material consolidated into the Landfill will be 64,470 cubic yards. The volume of additional material will not alter the overall lateral extent of the cap as illustrated in Figure 4-1. However, the overall finished elevation will be increased to accommodate the additional fill.

Regrading of the Landfill into a central location will be performed to minimize the areal extent of the cap to approximately 10 acres as illustrated in Figure 4-1. This activity will include the remediation of the Leachate Collection, Landfill and Surface Drainage Ditches by consolidating material contained in the areas under the cap for the Landfill. The known asbestos disposal areas shall only have fill placed on them during the regrading activities so as not to disturb the material.

The design of the cover will be a multi-media cap meeting RCRA performance standards as illustrated in Figure 4-9 and discussed in detail in Remedial Measure LF2 for Alternative 3. As discussed in Remedial Measure LF2 for Alternative 2, leachate collection trenches will be constructed under the cap to intercept the flow of leachate utilizing the historical surface drainage pathways. Post-capping leachate will be collected and treated for cyanide and fluoride. The aqueous treatment system is described in detail in Remedial Measure LF2 for Alternative 2.

Remedial Measure UA2

The Unloading Area will be excavated resulting in the removal of approximately 200 cubic yards of cathode waste residuals and placement into the existing Landfill prior to its capping. Capping of the area will not be required since cathode wastes residuals will be removed to competent basalt. However, backfilling will be performed to promote drainage.

Remedial Measure FCW4

The cathode waste residuals and contaminated soils from the Former Cathode Waste Management Areas will be excavated and placed into the existing Landfill prior to capping the landfill. The Former Cathode Waste Management Areas will be excavated down to competent basalt resulting in a total volume of material removed of 64,470 cubic yards. The excavation for the Bath Recovery Pad Area will also remove the cathode waste materials along the Landfill Ditch. After removal activities have been completed, the Former Cathode Waste Management Areas will be backfilled as required to promote drainage. Capping will not be required because cathode waste residuals and contaminated subsoils will be removed from the Former Cathode Waste Management Areas and placed into the Landfill for management. Perched water from the Former Cathode Waste Management Areas will be collected during remedial activities and treated for cyanide and fluoride by the aqueous treatment system described in

Remedial Measure LF2 for Alternative 2. Long-term collection and treatment of perched water from this area will not be required because materials from the Former Cathode Waste Management Areas will be removed and placed in the Landfill. Recovery of perched water east of River Road will be limited to a one time extraction during remedial activities. Temporary sump(s) may be required to enhance the collection process. The roof scrubber recycle line will be rerouted during remediation as was discussed in detail in Alternative 3.

Remedial Measure SP7

The Scrubber Sludge Ponds collectively contain approximately 167,500 cubic yards and 500 cubic yards are immediately south of the ponds. The following volumes of cover soil, sludge and contaminated subsoils are associated with each pond:

Scrubber Sludge Pond	Cover Soil (cubic yards)	Sludge (cubic yards)	Contaminated Subsoils (cubic yards)
1	7,970	63,730	--
2	--	6,820	2,760
3	--	43,600	14,500
4	4,640	17,660	6,200
Wind Blown	--	500	--

The objectives of this remedial measure is to stabilize the sludges and contaminated subsoils to minimize leaching of fluorides. The type of sludge in each Scrubber Sludge Pond varies slightly depending on the history of the pond's use,

but all of the sludge has been generated as a result of treating primary and secondary air emissions from the reduction process. Due to the potential variability of composition between the sludges, bench tests for each pond would be required to select both the appropriate ratio and type of stabilization agent.

A list of vendors and solidification/stabilizing agents which would potentially be utilized is presented in Table 4-3. The stabilization process would include adding the stabilization agent to the sludge and mixing it thoroughly over the entire depth of sludge and contaminated subsoils. Part of the topsoil could be stripped prior to stabilization and stockpiled for later use as soil cover. A soil cover is required after stabilization to remove the potential for direct contact with the wastes. Fugitive emission controls will be required to prevent particulates from migrating off-site. Because the sludges are dry during some seasons, water will most likely be required to obtain the desired stabilization results and will aid in the reduction of fugitive dust emissions. When stabilization is complete, discharges from the Byron Interbed and ground water in contact with the sludges will not result in the release of additional fluoride to the ground water.

TABLE 4-3

Vendors for Solidification/Stabilization Agents
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Vendor	Type of Agent	Remarks	Bench Study Capabilities
Chemfix Technologies	Silicates	Increases volume by only 10%. Not an in situ process.	Yes
Enrico	Portland cement, fly ash silicates, and/or kiln dust	Typical applications for Portland cement or kiln dust are 10 to 25 wt. %. Typical applications for fly ash are 35 to 50 wt. %.	Yes
Envirite	Portland cement, kiln dust, and/or fly ash		Yes
Envirosafe Management Services, Inc.	Portland cement, kiln dust and/or fly ash	Typical applications for Portland cement or kiln dust are 10 wt. %. Typical applications for fly ash are 50 wt. %.	Yes
Fix-Sorb	Kiln dust and/or fly ash	Typical applications require 10 wt. % kiln dust. Typical applications for fly ash are 50 wt. %.	Yes
Geo-Con	Portland cement and/or fly ash		Yes
International Waste Technologies		Typical applications are 10 wt. %.	Yes
Lefco Western	Portland cement and/or fly ash	Typical applications require 25 wt. % agent.	Yes
Silicate Technology, Inc.	Silicates	Not an in situ process.	Yes
U.S. Waste Management	Proprietary stabilizing agents		Yes

098/5

Remedial Measure GW4

This remedial measure includes ground-water recovery from the Landfill and Former Cathode Waste Management Areas, the Unloading Area, the Scrubber Sludge Ponds and the Recycle Pond. The recovered ground water will be discharged to the Recycle Pond where it will be recycled to the roof scrubbers or treated by the in plant process.

The ground-water recovery system would consist of four wells at the Landfill and Former Cathode Waste Management Areas, one well at the Unloading Area, seven wells at the Scrubber Sludge Ponds and three wells at the Recycle Pond. The locations of these recovery wells for the various areas are shown in Figures 4-8, 4-16, 4-17 and 4-18. All recovery wells would be four inch wells equipped with submersible pumps to withdraw ground water at sufficient flowrates to effectively recover contaminated ground water.

Ground-water monitoring would be conducted to monitor variations in ground-water quality and would serve as the basis for monitoring remediation effectiveness and initiating future actions if required. Table 4-2 presents the monitoring wells, parameters and the associated target areas being monitored. Ground-water monitoring will be conducted quarterly for the first year, semi-annually for the second year and annually thereafter. At the end of five years, the entire ground-water monitoring program will be re-evaluated

and adjusted if necessary. This time frame corresponds to the time period required by SARA for re-evaluation of site conditions. Data will be submitted to the EPA shortly after the laboratory analysis has been completed for each period during the first two years. Annual reports will also be submitted during each of the first five years. Details pertaining to the ground-water monitoring plan are presented in Appendix D.

4.2.4 Treatment Alternative

4.2.4.1 Remedial Alternative 10: Incineration, Stabilization, and Ground-Water Recovery and Treatment

Sitewide Remedial Alternative 10 consists of the following remedial measures for the following target remediation areas:

- LF6: Incineration;
- UA6: Incineration;
- FCW7: Incineration;
- SP7: Stabilization; and
- GW4: Ground-water recovery and treatment.

The Landfill, Unloading Area, and Former Cathode Waste Management Areas will be excavated, segregated and incinerated on-site. Incinerator ash residual will be managed as a hazardous waste in an on-site RCRA landfill. Perched water beneath the Former Cathode Waste Management Areas will be collected during excavation activities and treated. This should be effective in collecting perched

water on both sides of River Road. However, temporary sump(s) may be necessary to collect perched water east of River Road. Scrubber Sludge Ponds 1 through 4 will be stabilized to minimize the leaching of fluoride. Ground water will be recovered from various areas as described in Remedial Measure GW4 of this alternative. Dust controls will be utilized during remediation to minimize fugitive dust emissions. Fencing and deed restrictions will be utilized to limit access and prevent future use of areas where materials are managed on-site. Only workers performing necessary maintenance functions would be allowed entry to the RCRA landfill or Scrubber Sludge Ponds after remediation is complete.

Segregation is expected to reduce the initial waste volumes by approximately one-fourth. The volumes of target wastes from the various areas considered for incineration are present below:

o Landfill and associated areas	152,500 cubic yards
o Unloading Area	200 cubic yards
o Former Cathode Waste Management Area	48,400 cubic yards

The ash-management RCRA landfill will be sized to contain the ash after incineration. Due to the high inorganic content of the target wastes to be burned, 90 percent of the original volume has been approximated for the

resultant ash after incineration. This results in an estimated volume of ash of approximately 181,000 cubic yards for management. The location of the RCRA landfill for ash management is illustrated in Figure 4-19. The bottom liner system and cap for the ash-management RCRA landfill are illustrated in Figures 4-14 and 4-15, respectively as presented in Alternative 6.

Remedial Measure LF6

The Landfill consist of approximately 200,000 cubic yards of material, of which only a small portion is incinerable. The waste types from the Landfill have been estimated to be:

o	Basalt Fragments	100,000 cy
o	Asbestos	300 cy
o	Metallic	500 cy
o	Target Wastes	99,200 cy

The target wastes are the materials which require incineration. However, the heterogeneity of the Landfill wastes will make segregation of target wastes from basalt fragments difficult. To facilitate segregation, only those basalt fragments which are easily identified will be separated from the waste. Segregated basalt fragments will remain in the Landfill and backfill will be used as required to establish grades for drainage. The remaining material will be sent with the target waste to a crusher for grinding prior to incineration. Crushing is required to obtain a maximum

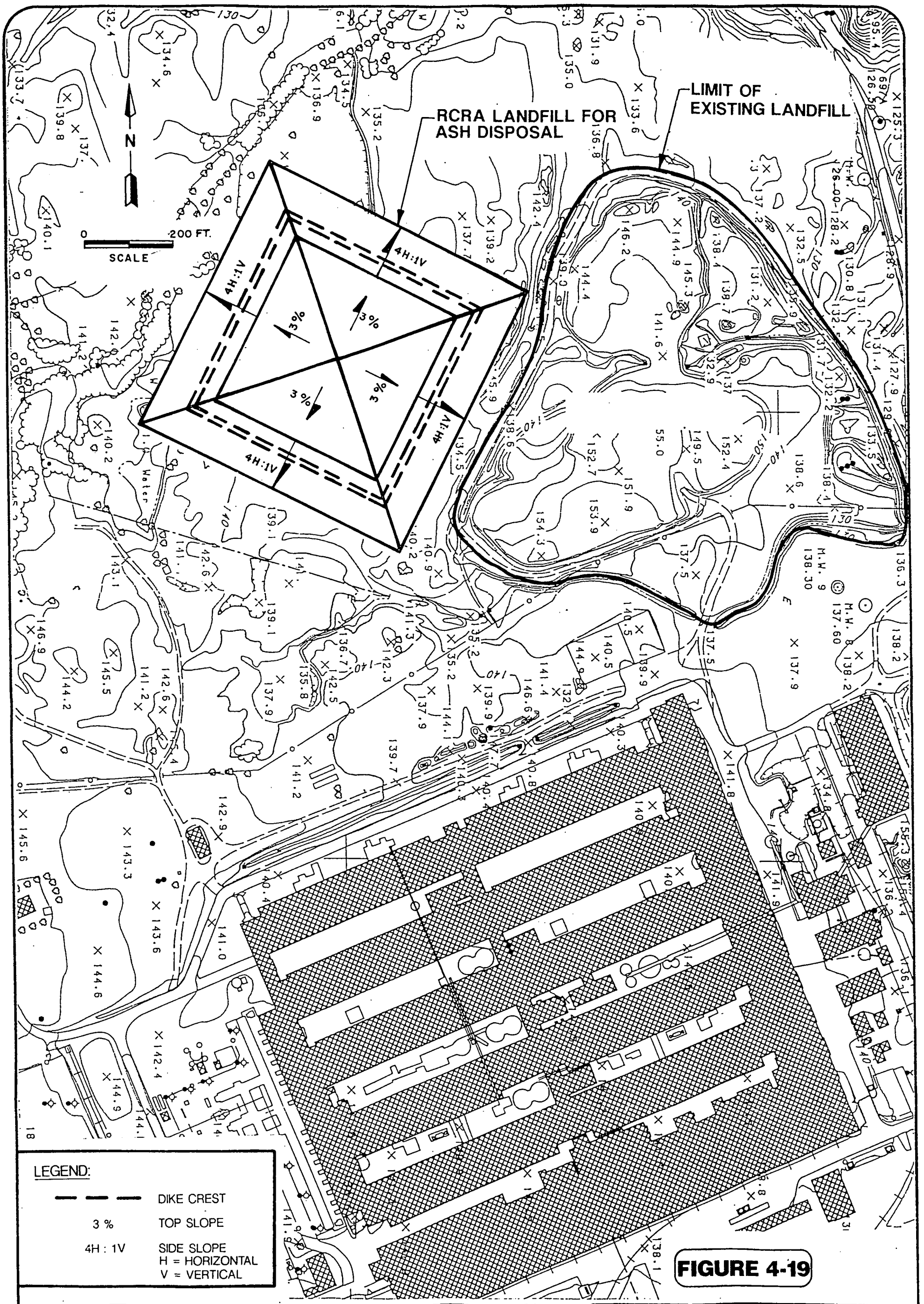

FIGURE 4-19

DRAWING NO: TE0018-P05-B54	
DRAWN BY: S.K.F.	DATE: 3/14/88
CHECKED:	DATE: 3-28-88
APPROVED:	DATE: 3/29/88

GMCE
G&M CONSULTING ENGINEERS, INC

APPROXIMATE LOCATION AND CONFIGURATION OF LANDFILL FOR ASH
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

acceptable particle size for the incinerator and will be performed inside a newly constructed building to minimize fugitive dust emissions. A fluidized bed type incinerator will be utilized in this remedial measure. It is anticipated that incineration of 152,500 cubic yards from the Landfill and Leachate Collection, Surface Drainage, and Landfill Ditches will result in approximately 137,300 cubic yards of ash. Due to the anticipated quality of the residuals, the ash will be managed in an RCRA landfill. Asbestos in known burial areas will be containerized at the onset of the remedial activities and temporarily stored on-site. The containerized asbestos will be placed in the ash management RCRA landfill along with metallic debris after incineration operations cease.

Remedial Measure UA6

The Unloading Area will be excavated down to competent basalt resulting in the removal of approximately 200 cubic yards of cathode waste residuals. The material will be crushed to obtain acceptable particle size for incineration. After incineration, approximately 180 cubic yards of ash from this area will be placed in an on-site RCRA landfill for management.

Remedial Measure FCW7

The total volume of material in the Former Cathode Waste Management Areas is 64,470 cubic yards of which approximately 48,400 cubic yards will be crushed and incinerated. The

remaining 16,070 cubic yards is anticipated to be inert, basalt fragments which will be left in place and will be used to supplement backfill for drainage. The volume of ash generated from this area to be placed in the RCRA landfill is expected to be approximately 43,560 cubic yards. Capping of the Former Cathode Waste Management Areas will not be required because cathode waste and contaminated subsoils will be removed for incineration. Perched water from the Former Cathode Waste Management Areas will be collected during remedial activities and treated for cyanide and fluoride by the aqueous treatment system described in Remedial Measure LF2 for Alternative 2. Long-term collection of the perched water from this area will not be required because materials from the Former Cathode Waste Management Areas will be excavated and incinerated. The roof scrubber recycle line will be rerouted during remediation and was discussed in detail in Alternative 3.

Remedial Measure SP7

The Scrubber Sludge Ponds collectively contain approximately 167,500 cubic yards of sludge. In addition, approximately 500 cubic yards of wind blown sludge are immediately south of the ponds.

The objective of this remedial measure is to stabilize the sludges and contaminated subsoils to minimize leaching of fluoride. The type of sludge in each scrubber sludge pond

varies slightly depending on its history, but all of the sludge has been generated as a result of treating primary and secondary air emissions from the reduction process. Due to the potential variability of composition between the sludges, bench tests for each pond would be required to select both the appropriate ratio and type of stabilization agent.

A list of vendors and solidification/stabilizing agents which would potentially be utilized is presented in Table 4-3. The stabilization process would include adding the stabilization agent to the sludge and blending the mixture thoroughly over the entire depth of sludge and contaminated subsoils. Part of the topsoil could be stripped prior to stabilization and stockpiled for later use as soil cover. A soil cover is required after stabilization to remove the potential or direct contact with the wastes. Fugitive emission controls will be required to prevent particulates from migrating off-site. Since the sludges are dry during some seasons, water will most likely be required to obtain the desire stabilization results and will aid in the reduction of fugitive dust emissions. When stabilization is complete, discharges from the Byron Interbed and ground water in contact with the sludges will not result in the release of additional fluoride to the ground water.

Remedial Measure GW4

This remedial measure includes ground-water recovery from the Landfill and Former Cathode Waste Management Areas, the Unloading Area, the Scrubber Sludge Ponds and the Recycle Pond. The recovered ground water will be discharged to the Recycle Pond were it will be recycled to the roof scrubbers or treated by the in plant process.

The ground-water recovery system would consist of four wells at the Landfill and Former Cathode Waste Management Areas, one well at the Unloading Area, seven wells at the Scrubber Sludge Ponds and three wells at the Recycle Pond. The location of the recovery wells for the areas are shown in Figures 4-8, 4-15, 4-16 and 4-17. All recovery wells would be four inch wells equipped with submersible pumps to withdraw ground water at sufficient flowrates to effectively recover contaminated ground water.

Ground-water monitoring would be conducted to monitor variations in ground-water quality and would serve as the basis for monitoring remediation effectiveness and initiating future actions if required. Table 4-2 presents the monitoring wells, parameters and the associated target areas being monitored. Ground-water monitoring will be conducted quarterly for the first year, semi-annually for the second year and annually thereafter. At the end of the five years, the entire ground-water monitoring program will be

re-evaluated and adjusted if necessary. This time frame corresponds to the time period required by SARA for re-evaluation of site conditions. Data will be submitted to the EPA shortly after the laboratory analysis has been completed for each period during the first two years. Annual reports will also be submitted during each of the first five years. Details pertaining to the ground-water monitoring plan are presented in Appendix D.

108/10

5.0 DETAILED ANALYSIS OF SITEWIDE REMEDIAL ALTERNATIVES

The detailed analysis of the remedial alternatives assesses each remedial alternative based on the evaluation criteria defined in the Draft Guidance Document which were developed from the statutory requirements of CERCLA, Section 121. After assessing each alternative, a summary of the detailed analysis is presented to briefly describe how each alternative performs against the evaluation criteria. This summary is utilized to make comparisons between alternatives in selecting a single best remedy for the MMRF.

5.1 EVALUATION CRITERIA

The evaluation criteria utilized to perform the detailed analysis of remedial alternatives were derived from the Draft Guidance Document which includes the new provisions to CERCLA as amended by SARA. Section 121 of CERCLA suggests that in assessing alternative remedial actions, the following items should be considered:

- the long-term uncertainties associated with land disposal;
- the goals, objectives, and requirements of the Solid Waste Disposal Act;
- the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents;
- short- and long-term potential for adverse health effects from human exposure;
- long-term maintenance costs;

- the potential for future remedial action costs if the alternative remedial action in question were to fail; and
- the potential threat to human health and the environment associated with excavation, transportation, and redisposal, or containment.

The nine evaluation criteria presented in the Draft Guidance Document consider the above items and are grouped into the following categories:

- Technical, engineering, institutional and cost considerations.
  - Short-term Effectiveness
  - Long-term Effectiveness and Permanence
  - Reduction of Toxicity, Mobility and Volume
  - Implementability
  - Cost
- Statutory Requirements
  - Compliance with ARARs
  - Overall Protection
- Acceptance of Remedial Alternative
  - State Acceptance
  - Community Acceptance

Each of the above criteria is further divided into subcategories of criteria which are identified in Table 5-1. A definition of each of the evaluation criteria is presented in the following sections.

5.1.1 Technical Engineering Institutional and Cost Considerations

The criteria associated with technical, engineering, institutional and cost considerations are grouped together because they involve a more technical analysis in which a

TABLE 5-1

Summary of Detailed Analysis Evaluation Criteria
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Evaluation Criteria	Short-Term Effectiveness	Long-Term Effectiveness	Reduction of Toxicity, Mobility, and Volume	Implementability	Cost	Compliance with ARARs	Overall Protection	State Acceptance	Community Acceptance
Sub-Categories of Criteria	o Time until Protection is achieved	o Reduction of existing risks	o Amount of hazardous materials destroyed or treated	o Ability to construct and operate the technology	o Development and construction costs	o Compliance with contaminant specific ARARs	o How alternative provides human health and environmental protection	o Features of the alternative the state supports	o Features of the alternative community supports
	o Short-term reliability of technology	o Magnitude of future risks	o Degree of expected reductions in toxicity, mobility, and volume	o Ability to phase into operable units	o Operating costs for implementing remedial action	o Compliance with some location specific ARARs		o Features of the alternative the state has reservations about	o Features of the alternative community has reservations about
	o Protection of community during remedial actions	o Long-term reliability	o Degree to which treatment is irreversible	o Ease of undertaking additional remedial actions, if necessary	o Other capital and short-term costs until remedial action is complete	o Compliance with some action specific ARARs		o Elements of the alternative the state strongly opposes	o Elements of the alternative community strongly opposes
	o Protection of workers during remedial actions	o Prevention of future exposure to residuals	o Type and quantity of residuals remaining after treatment	o Ability to monitor effectiveness of remedy	o Cost of operation and maintenance for as long as necessary	o Compliance with other criteria, advisories, and guidances			
		o Potential need for replacement		o Ability to obtain approvals from other agencies	o Costs of 5-year reviews (if required)				
				o Coordination with other agencies					
				o Availability of treatment, storage, and disposal services and capacity					
				o Availability of necessary equipment and specialists					

G&M Consulting Engineers, Inc.

number of factors within each criteria are considered. These criteria are defined as follows:

- Short-term effectiveness - Addresses potential human health and environmental impacts of the alternative during the construction and implementation phase until remedial response objectives are met.

- Long-term effectiveness - Addresses the results of a remedial action in terms of the residual risk remaining at the site after the remedial objectives have been met.

- Reduction of Toxicity, Mobility and Volume - Addresses the statutory preference for selecting remedial actions which include treatment technologies which permanently and significantly reduce the toxicity, mobility or volume of the hazardous substances present at the site.

- Implementability - Addresses the technical and administrative feasibility of implementing an alternative and the availability of services and materials required during implementation. Implementability is further categorized into technical feasibility, administrative feasibility and availability criteria.

- Cost - Addresses the capital costs, the operation and maintenance costs and a present worth analysis of all costs. The capital costs are divided into direct costs (construction) and indirect costs (non-construction and overhead). Direct capital costs include construction costs, equipment costs, land and site development costs, relocation expenses and disposal costs. Indirect capital costs include engineering expenses, legal fees and license or permit costs, start-up costs and contingency allowances.

  Operation and maintenance (O&M) costs are post construction costs necessary to ensure the continued effectiveness of a remedial action. These costs include operating labor costs, maintenance materials and labor costs, auxiliary materials and energy, disposal of residues, purchased services, administrative costs, insurance taxes and licensing costs, maintenance reserve and contingency funds, rehabilitation costs and costs of periodic site reviews if required. The cost estimates presented in this FS report were developed utilizing the Remedial Action Costing Procedures Manual (USEPA,

1983); Means Heavy Construction Cost Data (Means, 1987); Means Site Work Cost Data (Means, 1987) and quotations from various vendors. In accordance with EPA guidance, the costs estimates are prepared to provide an accuracy of +50 to -30 percent.

After development of the capital and operation and maintenance costs, a present worth analysis of remedial action costs is conducted. A present worth analysis relates costs that occur over different time periods to present costs by discounting all future costs to the present value. This allows the cost of remedial alternatives to be compared on the basis of a single figure that represents the money required in today's dollars to construct, operate and maintain the remedial alternatives throughout its planned life. For the purposes of this detailed analysis, a period of 30 years is chosen for the performance period of the remedial alternatives.

5.1.2 Statutory Requirements

The criteria associated with statutory requirements include how each alternative meets the statutory requirements of CERCLA, Section 121, and the NCP. These criteria are defined as follows:

- Compliance with ARARs - Addresses whether the remedial alternative complies with applicable or relevant and appropriate Federal and State requirements as defined in CERCLA Section 121.
- Overall protection - Addresses how the alternatives protects human health and the environment. This assessment focuses on how an alternative achieves protection over time and indicates how each source of contamination is to be minimized, reduced, or controlled.

5.1.3 Acceptance of Remedial Alternative

The criteria associated with the acceptance of a remedial alternative present the known and expected perception that others will have towards the remedial action.

These criteria are defined as follows:

- State acceptance - Addresses the technical and administrative issues and concerns the State may have regarding each of the alternatives. This input is limited to formal comments made by the State during previous phases of the RI/FS.
- Community acceptance - This criteria is intended to provide an opportunity to incorporate public input into the analysis of alternatives.

The State and Community acceptance of the Remedial Alternatives is unknown at the present time and will therefore not be discussed in the detailed analysis.

5.2 ANALYSIS OF REMEDIAL ALTERNATIVES

This section consists of an analysis of the ten remedial alternatives described in Section 4.0 for the evaluation criteria discussed in Section 5.1. A Public Health and Environmental Assessment of each alternative was conducted by Clement Associates, Inc. and is attached as Appendix D. The analysis of each remedial alternative considers this Public Health and Environmental Assessment and is presented in the following sections.

5.2.1 Remedial Alternative 1: Limited Action

Although Remedial Alternative 1 represents the Limited Action alternative, certain site actions will be conducted to limit access to, monitor and prevent future use of the target remediation areas or affected ground water. These actions include:

- o Collection of leachate from the Landfill;
- o Access and deed restrictions;
- o Institutional controls; and
- o Ground-water monitoring.

A detailed description of these actions is presented in Section 4.2.1.1.

Short-Term Effectiveness

The only site action implemented in the Limited Action Remedial Alternative is fencing the target remediation areas. To install fences around the target remediation areas, construction workers would only work at the perimeters of these areas and should not be exposed to waste materials. In accordance with proper health and safety measures, these workers would be provided protective clothing and respiratory protection as added precautions.

The construction of fences around the target remediation areas would not cause any adverse environmental impacts and would not create a risk to the surrounding community. Construction of the fences should be completed within approximately six months after initiation of this remedial alternative. Deed restrictions and institutional controls should be acquired within one year after implementing this alternative. The ground-water monitoring could be implemented immediately.

Long-Term Effectiveness and Permanence

Installation of fences in the Limited Action Alternative reduces human and wildlife access to the wastes. However, the Limited Action Alternative does not treat or isolate the waste to prevent migration of hazardous constituents from the target remediation areas nor does it eliminate the risks associated with direct contact. Birds or animals could still potentially ingest contaminated surface water from such areas as the Landfill Ditch and the Landfill leachate collection system.

The Limited Action Alternative does not mitigate ground-water problems. Fluoride and sulfate concentrations in the S-aquifer in specific areas beneath the site will remain above the remediation criteria. The institutional controls enacted for the areas downgradient of the MMRF should minimize the risk associated with human exposure to contaminated ground water. However, the Animal Shelter, the Klindt, the Residence and the Rockline wells will remain operable under this alternative. These four wells are potential exposure points of humans to contaminated ground water.

Contaminated perched water underlying the Former Cathode Waste Management Areas and east of River Road remains a potential source of fluoride and cyanide contamination to

the ground water. The Landfill leachate remains a potential source for surface water, perched water or ground water contamination.

The Limited Action Remedial Alternative requires minimal long-term maintenance. The fences surrounding the target remediation areas would require periodic maintenance and ground-water quality monitoring would be required for all target remediation areas.

Reduction of Toxicity, Mobility and Volume

The Limited Action Remedial Alternative does not treat any waste and therefore does not reduce the toxicity, mobility or volume of the cyanide, fluoride, sulfate or PAHs present at the MMRF.

Implementability

It is anticipated that fences could be constructed around the target remediation areas without significant problems and the existing ditches around the Landfill could be utilized to collect leachate from the Landfill. Also, the existing monitor well network at the MMRF could be utilized to conduct ground-water quality monitoring for the target remediation areas.

Implementation of this remedial alternative requires the approval of institutional controls to prohibit use of potentially affected ground water and the approval of deed

restrictions to restrict future land development of the four target remediation areas. It is anticipated that this approval can be obtained, however, coordination with the regulatory agencies is expected.

The technologies utilized to implement this alternative have been proven at other sites and are available to the MMRF. The materials, equipment, specialists and work force necessary to conduct the remediation activities are also readily available to the MMRF.

Compliance with ARARs

The Limited Action Alternative does not treat the waste constituents present at the MMRF. Therefore, waste constituents in excess of the remediation criteria will continue to be present at the site. The leachate generated from the Landfill will continue to contain free cyanide in excess of the NPDES mandated 0.1 mg/L concentration. Ground water beneath the Landfill and Former Cathode Waste Management Areas, Unloading Area, Scrubber Sludge Ponds and the Recycle Pond would continue to exceed remediation criteria for fluoride and sulfate and perched water would continue to exceed remediation criteria for cyanide and fluoride.

Overall Protection

The Limited Action Alternative limits access to the target remediation areas through construction of perimeter fences. However, some potential for humans or wildlife to contact the waste remains. In addition, the toxicity, mobility and volume of the wastes present at the MMRF is not reduced. The sources of ground-water contamination would remain and therefore, the concentrations of constituents exceeding ground-water remediation criteria may not be reduced under the Limited Action Alternative. For these reasons, this alternative is not fully protective of human health or the environment.

Cost

The capital O&M costs of Alternative 1 is $326,300. The annual O&M cost for years 1-5 is $45,400 and the annual O&M cost for years 6-30 is $25,200. The present worth value of this alternative using a discount rate of 8% is $688,200. The detailed development of these costs is presented in Table 5-2.

5.2.2 Remedial Alternative 2: Containment with Ground-Water Controls and Limited Treatment

Remedial Alternative 2 includes the following actions:

- Consolidation of the cathode waste material from the Unloading Area into the existing Landfill;
- Capping the existing Landfill in place with an asphalt cap;
- Capping the Former Cathode Waste Management Areas with an asphalt cap;

TABLE 5-2

Cost Analysis of Remedial Alternative 1
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
I Capital Cost			
A Security Fences			
Security Fences	15 /foot	9,500	142,500
Security Fence Replacement* (15 yrs)	51,000 LS	1	51,000
Gates	2,750 each	6	16,500
Signs	2,000 LS	1	2,000
		Subtotal	212,000
B Deed Restrictions	5,000 LS	1	5,000
C Institutional Controls	8,000 LS	1	8,000
Alternative 1 Subtotal			225,000
Indirect	10%		22,500
Contingency	25%		56,300
Inspection	10%		22,500
Alternative 1 Total Capital Cost			326,300
II Annual Operating Cost			
A Ground Water Monitoring (36 wells)			
First year (quarterly)	63,000 /year	1	63,000
Second year (semi-annually)	32,000 /year	1	32,000
Remaining years (annually)	16,000 /year	1	16,000
Equivalent Annuity (Years 1-5)	30,400 /year	1	30,400
Annuity (Years 6-30)	16,000 /year	1	16,000
B Security Fence	2,000 /year	1	2,000
Annual Operating Cost Subtotal (Years 1-5)			32,400
Indirect	20%		6,500
Contingency	20%		6,500
Annual Operating Cost (Years 1-5)			45,400

TABLE 5-2 (Continued)

Cost Analysis of Remedial Alternative 1
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
Annual Operating Cost Subtotal (Years 6-30)			18,000
Indirect	20%		3,600
Contingency	20%		3,600
Annual Operating Cost (Years 6-30)			25,200
Present Worth Operating Cost (Years 1-5)			181,300
Present Worth Operating Cost (Years 6-30)			180,600
Present Worth Operating Cost	30 years	@ 8%	361,900
III Present Worth Alternative 1			
Capital Cost			326,300
Operating Cost			361,900
Total Present Worth			688,200

*Present Worth to Replace
098/2

- Placing a soil cover on Scrubber Sludge Ponds 2 and 3;
- Plug and abandon nearby production wells and connect users to the City of The Dalles water supply system;
- Recovery of ground water from the Unloading Area;
- Collection and treatment of leachate generated from the Landfill and perched water from the Former Cathode Waste Management Areas and east of River Road;
- Access and deed restrictions;
- Institutional controls; and
- Ground-water quality monitoring.

A detailed description of these actions is presented in Section 4.2.2.1.

Short-Term Effectiveness

Implementation of Remedial Alternative 2 should not pose a threat to the community and would pose minimal threats to on-site remedial action workers. The potential risks to on-site workers would result from handling the waste materials from the Unloading Area and Landfill during remediation. The use of dust controls, protective clothing and respiratory protection and by implementing a health and safety program during remediation, would greatly minimize risks to remediation workers. No adverse impacts to the environment would result from implementation of this remedial alternative. Remedial Alternative 2 would take less than two years to implement upon initiation of remedial actions.

Long-Term Effectiveness

Alternative 2 would effectively mitigate the existing risks associated with direct contact with contaminated perched water, surface water and/or waste. The potential for direct contact with waste material will be minimized by the use of caps, fences and a cover. The potential for exposure to leachate and contaminated perched water would be minimized through collection and treatment. Contaminated ground water would be recovered until the ground-water quality beneath the MMRF meets the remediation criteria.

The technologies utilized in this alternative including the cap/cover systems, the ground-water recovery system, leachate and perched water collection and the aqueous treatment system are expected to meet performance standards or process efficiencies. The caps installed on the Landfill and Former Cathode Waste Management Areas would effectively reduce leachate generation and isolate the wastes from direct contact with humans or wildlife. Because this alternative removes the residual waste from the Unloading Area, the potential for future exposure at this area is reduced to the maximum extent possible. The soil cover over Scrubber Sludge Ponds 2 and 3 would effectively reduce the potential for direct contact with the waste as well as reduce the potential for fugitive dust emissions. However, the soil cover over the Scrubber Sludge Ponds would not prevent leaching of fluoride from the sludges.

Fencing the Landfill, Former Cathode Waste Management Areas and Scrubber Sludge Ponds and recording deed restrictions would minimize future access to the site which, in turn, should reduce the potential for future contact with the wastes. The institutional controls enacted and replacement of nearby production wells with city water would also minimizes the potential for consumption of affected ground water. The collection and/or treatment systems for the ground water, Landfill leachate and contaminated perched water would be effective in recovering and treating aqueous contaminants.

Long-term maintenance would be required for the cap and cover systems. The caps constructed over the Landfill and Former Cathode Waste Management Areas will require periodic inspections and filling of depressions (should they develop) to maintain the integrity of the cap. The soil cover over the Scrubber Sludge Ponds would require periodic inspections to verify that erosion problems do not exist. The leachate and perched water collection systems will require annual cleaning. The ground-water recovery system would require pump and piping maintenance on an as needed basis. Conventional operation and maintenance functions would be required for the aqueous treatment system. The above maintenance tasks are common and not difficult to implement. Long-term ground-water monitoring would be required for all target remediation areas where materials are managed on-site.

The overall potential for failure of the Landfill and Former Cathode Waste Management Areas caps and the soil cover over the Scrubber Sludge Ponds is minimal. Caps and soil cover systems such as these have been proven reliable at other waste sites and would be effective at the MMRF. The potential for failure of the leachate and perched water collection systems, the ground-water recovery system and the aqueous treatment system are also minimal with proper maintenance.

Reduction of Toxicity, Mobility or Volume

Remedial Alternative 2 treats the leachate generated from the Landfill, perched water east of River Road and from the Former Cathode Waste Management Areas which reduces the toxicity, mobility and volume of aqueous contaminants. However, the contaminated soils, sediments and waste materials remaining at the Landfill, Former Cathode Waste Management Areas and Scrubber Sludge Ponds are not treated.

Implementability

The technologies associated with Remedial Alternative 2 are implementable at the MMRF. The potential for fugitive dust emissions exists during waste handling activities in the Unloading Area and Landfill. However, dust suppressants would be utilized to minimize dust generation. The existing monitor well network at the MMRF is sufficient to monitor

variations in ground water quality at the target remediation areas. The existing monitor well network would also be sufficient to monitor the effectiveness of the ground-water recovery system located in the vicinity of the Unloading Area. It is expected that after successful implementation of this alternative, no additional remedial actions would be required.

Implementation of this remedial alternative requires acceptance by the regulatory agencies of the waiver from the fluoride and sulfate ARARs in the ground water presented in Appendix C. This alternative also requires the approval of institutional controls to prevent the use of potentially affected ground water. Deed restrictions must also be approved to prevent future development on the waste disposal areas.

The equipment, materials, specialists and work force necessary to implement this remedial alternative are available to the MMRF. Also, the technologies associated with this alternative have been proven at other waste management sites and could be implemented at the MMRF without further development except for the aqueous treatment system. A bench scale study would be required to verify the effectiveness of the aqueous treatment system and the results of this study would be utilized in the final design of the full scale system.

Compliance with ARARs

Remedial Alternative 2 collects and treats leachate generated from the Landfill and perched water which meets chemical-specific ARARs for these areas. Also, ground water is recovered from the Unloading Area and treated in the in plant process. However, ground water beneath the Landfill, Former Cathode Waste Management Areas, Scrubber Sludge Ponds and Recycle Pond will remain in excess of the ARAR for fluoride and/or sulfate. Remedial Alternative 2 would meet all applicable location and action-specific ARARs. With the acceptance of a waiver from the fluoride and sulfate ARARs discussed in Appendix C, Remedial Alternative 2 would meet all chemical-specific ARARs.

Overall Protection

Alternative 2 provides protection to the community of The Dalles, on-site workers and the environment (based on acceptance of the waiver from the fluoride and sulfate ARARs in the ground water). The risks at the MMRF will be reduced by containing the waste, recovering ground water and treating contaminated leachate and perched water. Containment of the waste reduces the potential for direct contact with the waste as well as the generation of leachate and fugitive dust emissions. Recovery of ground water and treatment of the leachate and perched water greatly minimizes the potential

for off-site migration of contaminants. Thus, Alternative 2 reduces the potential exposure pathways of concern identified in the RA for each target remediation area.

Cost

The capital cost of Remedial Alternative 2 is $4,111,500. The annual O&M costs for years 1 through 5 will be $158,500. The annual O&M costs for years 6 through 30 will be $69,900. The total present worth of this alternative using a discount rate of 8% is $5,252,300. The detailed development of these costs is presented in Table 5-3.

5.2.3 Remedial Alternative 3: Containment with Complete Removal and Ground-Water Controls

Remedial Alternative 3 includes the following actions:

- Consolidation of the residual cathode waste material and underlying fill material from the Former Cathode Waste Management Areas into the existing Landfill;
- Consolidation of the cathode waste material from the Unloading Area into the existing Landfill;
- Capping the existing Landfill in place with a multi-media cap meeting RCRA performance standards;
- Placing a soil cover over Scrubber Sludge Ponds 2 and 3;
- Plug and abandon nearby production wells and connect users to the City of The Dalles water supply system;
- Collection and treatment of leachate generated from the Landfill and perched water east of River Road and from the Former Cathode Waste Management Areas;
- Recovery of ground water from the Unloading Area;

TABLE 5-3

Cost Analysis of Remedial Alternative 2
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
I Capital Cost			
A Ground Water Recovery System (2 gpm)			
Four-inch Recovery Well	4,000 each	1	4,000
Plumbing System			
Submersible Pump	700 each	1	700
Controls	1,000 LS	1	1,000
Electrical Connection	5,000 LS	1	5,000
One-inch PVC Discharge line	7 /foot	800	5,600
		Subtotal	**16,300**
B Aqueous Treatment System			
Building (20'x40')	25,000 LS	1	25,000
Site Prep	15,000 LS	1	15,000
Oxidation Unit	75,000 LS	1	75,000
Chemical Precip. Unit	76,500 LS	1	76,500
Fluoride Polishing Unit	63,000 LS	1	63,000
Electrical - Controls	10,000 LS	1	10,000
		Subtotal	**264,500**
C Production Well Abandonment P&A Existing Wells and Connect to City Water	**15,000** /house	**4**	**60,000**
D Consolidate Existing Landfill			
Regrade Landfill	3.50 /CY	40,000	140,000
Excavate and Haul Ditches	8 /CY	3,290	26,400
Excavate Unloading Area			
Excavation and Hauling	8 /CY	200	1,600
Backfill	5 /CY	200	1,000
		Subtotal	**169,000**
E Landfill Asphalt Cap (10 Acre)			
Site Preparation	100,000 LS	1	100,000
Soil Backfill	5 /CY	6,200	31,000
Rough Grading	0.75 /CY	48,400	36,300
Perimeter Ditch Grading	15 /foot	4,000	60,000
Asphalt Overlay (3" thick)	7 /SY	48,400	338,800
Asphalt Top Coat (1" thick)	2.50 /SY	48,400	121,000
		Subtotal	**687,100**

TABLE 5-3 (Continued)

Cost Analysis of Remedial Alternative 2
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
F Site Preparation for Former Cathode Waste Management Areas			
Rerouting North Ditch	69,000 LS	1	69,000
Diverting Surface Runoff	10,000 LS	1	10,000
Rerouting Landfill Ditch	36,000 LS	1	36,000
Regrade Embankment	3,000 LS	1	3,000
Remove Railroad Spur	25 /foot	200	5,000
Replace Railroad Spur	125 /foot	200	25,000
Perched Water			
Collection Sump	5,000 /LS	1	5,000
Sub-drain	50 /foot	800	40,000
Pumps and Pad	3,500 /each	3	10,500
Discharge line	30 /foot	2,000	60,000
Disassemble Crusher	5,000 LS	1	5,000
		Subtotal	**268,500**
G Construction of Cap for Cathode Waste Management Areas (8.5 Acres)			
Rough Grading	0.75 /SY	41,140	30,900
Asphalt Overlay (3" thick)	7 /SY	41,140	288,000
Asphalt Top Coat (1" thick)	2.50 /SY	41,140	102,900
		Subtotal	**421,800**
H Soil Cover SSP2 and SSP3			
Rough Grading	0.75 /SY	44,600	33,500
Top Soil	8 /CY	14,900	119,200
Perimeter Drainage Ditch	10 /foot	3,000	30,000
		Subtotal	**182,700**
I Controls			
Security Fences	161,000 LS	1	161,000
Security Fence Replacement (15 yrs)*	51,000 LS	1	51,000
Deed Restrictions	5,000 LS	1	5,000
Institutional Controls	8,000 LS	1	8,000
		Subtotal	**225,000**
Alternative 2 Subtotal			**2,294,900**
Engineering	15%		344,300
Indirect	10%		299,500
Contingency	25%		573,800
Inspection	10%		299,500
Health & Safety	10%		299,500
Alternative 2 Total Capital Cost			**4,111,500**

*Present Worth to Replace

TABLE 5-3 (Continued)

Cost Analysis of Remedial Alternative 2
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
II Annual Operating Cost			
A Ground Water Monitoring (36 wells)			
First year (quarterly)	63,000 /year	1	63,000
Second year (semi-annually)	32,000 /year	1	32,000
Remaining years (annually)	16,000 /year	1	16,000
Equivalent Annuity (Years 1-5)	30,400 /year	1	30,400
Annuity (Years 6-30)	16,000 /year	1	16,000
B Security Fence Maintenance	2,000 /year	1	2,000
C Treatment (5 years only)			
Electric Power			
Recovery System	2,000 /year	1	2,000
Treatment System	5,000 /year	1	5,000
Chemicals	9,000 /year	1	9,000
Operator	30,000 /year	0.5	15,000
Management	50,000 /year	0.1	5,000
Maintenance			
Recovery System	800 /year	1	800
Treatment System	12,000 /year	1	12,000
		Subtotal	48,800
D Landfill Performance Cap Inspection and Maintenance	15,000 /year	1	15,000
E Cathode Waste Cap Inspection and Maintenance	10,300 /year	1	10,300
F Soil Cover Over Sludge Ponds Inspection and Maintenance	6,600 /year	1	6,600
Annual Operating Cost Subtotal (Years 1-5)			113,100
Indirect	20%		22,700
Contingency	20%		22,700
Annual Operating Cost (Years 1-5)			158,500

TABLE 5-3 (Continued)

Cost Analysis of Remedial Alternative 2
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	Description	Unit Cost ($)	Quantity	Cost ($)
	Annual Operating Cost Subtotal (Years 6-30)			49,900
	Indirect	20%		10,000
	Contingency	20%		10,000
	Annual Operating Cost (Years 6-30)			69,900
	Present Worth (Years 1-5)	158,500 /year	@ 8%	632,900
	Present Worth (Years 6-30)	69,900 /year	@ 8%	507,900
	Present Worth Operating Costs			1,140,800
III	Present Worth Alternative 2			
	Capital Cost			4,111,500
	Operating Cost			1,140,800
	Total Present Worth			5,252,300

098/2

- Access and deed restrictions;
- Institutional controls; and
- Ground-water quality monitoring.

A detail description of these actions is presented in Section 4.2.2.2.

Short-Term Effectiveness

Implementation of Remedial Alternative 3 should not pose a threat to the community and would pose minimal threats to on-site construction workers. The only potential risks to on-site workers would result from handling the waste materials from the Unloading Area, Former Cathode Waste Management Areas and Landfill during remediation. However, the use of dust controls, protective clothing and respiratory protection and by implementing a health and safety plan during remediation should greatly reduce the risks. Also, no adverse impacts to the environment would result from implementation of this remedial alternative. Remedial Alternative 3 would take less than two years to implement upon initiation of remedial actions.

Long-Term Effectiveness

Alternative 3 would effectively mitigate the existing risks associated with direct contact with contaminated perched water, leachate and/or waste. Direct contact with the waste material would be reduced through use of a cap,

fences and a cover. Waste material from the Unloading Area and Former Cathode Waste Management Areas will be removed, reducing any existing or future risks from these areas. Potential exposure to leachate or contaminated perched water would be minimized through collection and treatment.

The technologies utilized in this alternative including the cap/cover systems, the ground-water recovery system, the leachate and perched water collection system and the aqueous treatment system are expected to meet performance standards or process efficiencies. The cap installed on the Landfill would effectively reduce leachate generation and isolate the waste from direct contact with humans or wildlife. Because this alternative removes the residual cathode waste and underlying contaminated fill material from the Former Cathode Waste Management Areas and from the Unloading Area, the potential for future exposure at these areas is mitigated. Also, the soil cover over Scrubber Sludge Ponds 2 and 3 would effectively minimize the potential for direct contact with the waste and would reduce the potential for fugitive dust emissions. However, the soil cover over the Scrubber Sludge Ponds would not prevent leaching of fluoride from the sludges. Fencing the Landfill and Scrubber Sludge Ponds and recording deed restrictions for these areas would also reduce future access to the site which, in turn, should reduce the potential for future contact with the wastes. The institutional controls enacted and replacement of nearby

production wells with city water would greatly reduce the potential for consumption of affected ground water. The collection and/or treatment systems for the ground water, Landfill leachate and contaminated perched water would effectively recover and treat the aqueous contaminants.

Long-term maintenance would be required for the cap/cover systems. Periodic inspections, regrading and filling of depressions should they develop in the cap would be required to maintain the integrity of the cap. Periodic inspections of the soil cover would be required to verify that erosion problems do not exist. The leachate collection system would require annual cleaning and the ground-water recovery system would require pump and piping maintenance on an as needed basis. Conventional operation and maintenance functions would also be required for the aqueous treatment system. The above maintenance tasks are common and are not difficult to implement. Long-term ground-water monitoring would be required for areas where management of waste is conducted.

The overall potential for failure of the Landfill cap and soil cover over the Scrubber Sludge Ponds is minimal. Caps and covers of these types have been proven reliable at other waste management sites and would be effective at the MMRF. The potential for failure of the leachate collection and ground-water recovery and treatment systems is also minimal with proper maintenance.

Reduction of Toxicity, Mobility or Volume

Remedial Alternative 3 treats the leachate generated from the Landfill, perched water collected east of River Road and from the Former Cathode Waste Management Areas which reduces the toxicity, mobility and volume of these waste streams. However, the contaminated soils, sediments and waste materials remaining at the Landfill and Scrubber Sludge Ponds are not treated.

Implementability

The technologies associated with Remedial Alternative 3 are implementable at the MMRF. Potential fugitive dust emissions may result from waste handling activities at the Landfill, Former Cathode Waste Management Areas and Unloading Area. However, dust suppressants would be utilized to minimize dust generation. The existing monitor well network at the MMRF is sufficient to monitor variations in ground-water quality at the target remediation areas. The existing monitor well network would also be sufficient to monitor the effectiveness of the recovery system for the Unloading Area and perched water collection system. It is expected that after successful implementation of this alternative, no additional remedial actions would be required.

Implementation of this remedial alternative requires acceptance by the regulatory agencies of the waiver from the fluoride and sulfate ARAR in the ground water presented in Appendix C. This alternative also requires the approval of institutional controls to prevent the use of potentially affected ground water. Deed restrictions must also be approved to prevent future development on the waste disposal areas.

The equipment, materials, specialists and work force necessary to implement this remedial alternative are available to the MMRF. Also, the technologies associated with this alternative have been proven at other waste sites and could be implemented at the MMRF without further development except for the aqueous treatment system. A bench scale study would be required to verify the effectiveness of the aqueous treatment system and the results of this study would be utilized in the final design of the full scale system.

Compliance with ARARs

Remedial Alternative 3 collects and treats leachate generated from the Landfill and perched water which meets chemical-specific ARARs for these areas. Also, ground water is recovered from the Unloading Area and treated in the in plant process. However, ground water beneath the Landfill, Former Cathode Waste Management Areas, Scrubber Sludge Ponds

and Recycle Pond will remain in excess of the ARARs for fluoride and sulfate. Remedial Alternative 3 would meet all applicable location and action-specific ARARs. With the acceptance of a waiver from the fluoride and sulfate ARARs discussed in Appendix C, Remedial Alternative 3 would meet all chemical-specific ARARs.

Overall Protection

Alternative 3 provides protection to the community of The Dalles, on-site workers and the environment (based on acceptance of the waiver from the fluoride and sulfate ARARs in the ground water). The risks at the MMRF would be reduced by containing the waste, recovering ground water and treating affected leachate and perched water. Containment of the waste reduces the potential for direct contact with the waste as well as the generation of leachate and fugitive dust emissions. Recovery of ground water and treatment of the leachate and perched water greatly minimizes the potential for off-site migration of contaminants. Thus, Remedial Alternative 3 effectively mitigates the exposure pathways identified by the RA for the target remediation areas.

Cost

The capital cost of Remedial Alternative 3 is $5,728,400. The annual O&M costs for years 1 through 5 will be $144,00. The annual O&M costs for years 6 through 30 will

be $55,600. The total present worth value of this alternative using a discount rate of 8% is $6,707,400. The detailed development of these costs is presented in Table 5-4.

5.2.4 Remedial Alternative 4: Containment, Complete Removal and Hydraulic Barriers with Ground-Water Controls

Remedial Alternative 4 consists of the following actions:

- Consolidation of the residual cathode waste material and underlying fill material from the Former Cathode Waste Management Areas into the existing Landfill;
- Consolidation of the cathode waste material from the Unloading Area into the existing Landfill;
- Capping the existing Landfill in place with a multi-media cap meeting RCRA performance standards;
- Capping the Scrubber Sludge Ponds in place with a multi-media cap meeting RCRA performance standards and creating a hydraulic barrier to minimize contact between the waste and the ground water;
- Plug and abandon nearby production wells and connect users to the City of The Dalles water supply system;
- Collection and treatment of leachate generated from the Landfill and perched water east of River Road and from the Former Cathode Waste Management Areas;
- Recovery of ground water from the Unloading Area;
- Access and deed restrictions;
- Institutional controls; and
- Ground-water quality monitoring.

A detailed description of these actions is presented in Section 4.2.2.3.

TABLE 5-4

Cost Analysis of Remedial Alternative 3
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
I Capital Cost			
A Ground Water Recovery System (2 gpm)			
Four-inch Recovery Well	4,000 each	1	4,000
Plumbing System			
Submersible Pump	700 each	1	700
Controls	1,000 LS	1	1,000
Electrical Connection	5,000 LS	1	5,000
One-inch PVC Discharge line	7 /foot	800	5,600
		Subtotal	**16,300**
B Aqueous Treatment System			
Building (20'x40')	25,000 LS	1	25,000
Site Prep	15,000 LS	1	15,000
Oxidation Unit	75,000 LS	1	75,000
Chemical Precip. Unit	76,500 LS	1	76,500
Fluoride Polishing Unit	63,000 LS	1	63,000
Electrical - Controls	10,000 LS	1	10,000
		Subtotal	**264,500**
C Production Well Abandonment P&A Existing Wells and Connect to City Water	**15,000** /house	**4**	**60,000**
D Consolidate Existing Landfill			
Regrade Landfill	3.50 /CY	40,000	140,000
Excavate and Haul Ditches	8 /CY	3,290	26,400
Excavate Unloading Area			
Excavation and Hauling	8 /CY	200	1,600
Backfill	5 /CY	200	1,000
Excavate Cathode Waste Areas			
Excavation and Hauling	8 /CY	64,470	515,800
Backfill	5 /CY	64,470	322,400
		Subtotal	**1,007,200**
E Landfill Performance Cap (10 Acre)			
Site Preparation	100,000 LS	1	100,000
Soil Backfill	5 /CY	6,200	31,000
Rough Grading	0.75 /CY	115,600	86,700
Perimeter Ditch Grading	15 /foot	4,000	60,000
Sand Layer	7 /CY	7,800	54,600
Piping/Risers	6 /foot	1,000	6,000
Sterilization	1,000 /acre	10	10,000
Geomembrane	0.70 /SF	440,000	308,000
Soil Layer	7 /CY	15,600	109,200
Wire Mesh	0.75 /SF	435,600	326,700
Geotextile Fabric	0.20 /SF	461,000	92,200
Top Soil	8 /CY	15,600	124,800
Leachate Collection System	66,000 LS	1	66,000
		Subtotal	**1,375,200**

TABLE 5-4 (Continued)

Cost Analysis of Remedial Alternative 3
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	Description	Unit Cost ($)	Quantity	Cost ($)
F	**Perched Water Collection**	60,000	1	60,000
G	**Relocation of Facilities**			
	Rerouting North Ditch	69,000 LS	1	69,000
	Diverting Surface Runoff	10,000 LS	1	10,000
	Rerouting Landfill Ditch	36,000 LS	1	36,000
	Removing Scrubber Discharge	20 /foot	800	16,000
	Replacing Scrubber Discharge	40 /foot	800	32,000
	Removing Railroad Spur	25 /foot	200	5,000
	Replacing Railroad Spur	125 /foot	200	25,000
	Protecting/Repairing Monitor Wells	3,000 each	10	30,000
	Disassemble Crusher	5,000 LS	1	5,000
			Subtotal	**228,000**
H	**Soil Cover Scrubber Sludge Ponds 2 and 3**			
	Rough Grading	0.75 /SY	44,600	33,500
	Top Soil	8 /CY	11,200	89,600
	Perimeter Drainage Ditch	10 /foot	3,000	30,000
			Subtotal	**153,100**
I	**Controls**			
	Security Fences	146,000 LS	1	146,000
	Security Fence Replacement (15 yrs)*	46,200 LS	1	46,200
	Deed Restrictions	5,000 LS	1	5,000
	Institutional Controls	8,000 LS	1	8,000
			Subtotal	**205,200**
	Alternative 3 Subtotal			**3,369,500**
	Engineering	15%		505,500
	Indirect	10%		337,000
	Contingency	25%		842,400
	Inspection	10%		337,000
	Health & Safety	10%		337,000
	Alternative 3 Total Capital Cost			**5,728,400**

*Present Worth to Replace

TABLE 5-4 (Continued)

Cost Analysis of Remedial Alternative 3
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
II Annual Operating Cost			
A Ground-Water Monitoring (36 wells)			
First year (Quarterly)	63,000 /year	1	63,000
Second year (Semi-annually)	32,000 /year	1	32,000
Remaining years (Annually)	16,000 /year	1	16,000
Equivalent Annuity (Years 1-5)	30,400 /year	1	30,400
Annuity (Years 6-30)	16,000 /year	1	16,000
B Security Fence Maintenance	2,000 /year	1	2,000
C Treatment (5 years only)			
Electrical Power			
Recovery System	2,000 /year	1	2,000
Treatment System	5,000 /year	1	5,000
Chemicals	9,000 /year	1	9,000
Operator	30,000 /year	0.5	15,000
Management	50,000 /year	0.1	5,000
Maintenance			
Recovery System	800 /year	1	800
Treatment System	12,000 /year	1	12,000
		Subtotal	48,800
D Landfill Performance Cap Inspection and Maintenance	15,000 /year	1	15,000
E Soil Cover over Sludge Ponds Inspection and Maintenance	6,600 /year	1	6,600
Annual Operating Cost Subtotal (Years 1-5)			102,800
Indirect	20%		20,600
Contingency	20%		20,600
Annual Operating Cost (Years 1-5)			144,000

TABLE 5-4 (Continued)

Cost Analysis of Remedial Alternative 3
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
Annual Operating Cost Subtotal (Years 6-30)			39,600
Indirect	20%		8,000
Contingency	20%		8,000
Annual Operating Cost (Years 6-30)			55,600
Present Worth (Years 1-5)	144,000 /year	@ 8%	575,000
Present Worth (Years 6-30)	55,600 /year	@ 8%	404,000
Present Worth Operating Cost			979,000
III Present Worth Alternative 3			
Capital Cost			5,728,400
Operating Cost			979,000
Total Present Worth			6,707,400

098/2

Short-Term Effectiveness

Implementation of Remedial Alternative 4 would not pose a threat to the community and would pose minimal threats to on-site construction workers. The potential risks to on-site workers would result from waste handling activities at the Unloading Area, Former Cathode Waste Management Areas and Landfill during remediation. However, with the use of dust controls, protective clothing and respiratory protection and by implementing a health and safety program during remediation, this risk would be greatly reduced. Also, no adverse impacts to the environment would result from implementation of this alternative. Remedial Alternative 4 would take less than two years to implement upon initiation of remedial actions.

Long-Term Effectiveness

Alternative 4 would effectively mitigate the existing risks associated with direct contact with contaminated perched water, leachate and/or waste. Direct contact with waste material would be reduced through use of caps and fences. The potential for fluorides leaching from the scrubber sludges would be greatly reduced after installing a multi-media cap and implementing the hydraulic controls to intercept ground-water. The potential for exposure to leachate or contaminated perched water would be minimized through collection and treatment.

The technologies utilized in this alternative including cap systems and ground-water recovery and leachate collection and treatment systems are expected to meet performance standards or process efficiencies. Implementation of hydraulic controls around the Scrubber Sludge Ponds would lower the S-aquifer beneath the bottom of the ponds, thus reducing the potential for leaching of fluorides from the sludges. Because this alternative removes the residual cathode waste and underlying fill material from the Former Cathode Waste Management Areas and the Unloading Area, the potential for future exposure at these areas is greatly minimized. Fencing the Landfill and Scrubber Sludge Ponds and recording deed restrictions for these areas would also reduce the potential for direct contact with the wastes. The institutional controls enacted and replacement of nearby production wells with city water would greatly reduce the potential for consumption of affected ground water. The recovery system for the ground water and recovery and treatment systems for the perched water and Landfill leachate would be effective in recovering and treating the aqueous waste streams to meet remediation criteria.

Long-term maintenance would be required for the cap systems. Periodic inspections, regrading and filling of depressions in the cap would be required should they develop to maintain the integrity of the cap. The leachate collection system would require annual cleaning and the

ground-water recovery system will require pump and piping maintenance on an as needed basis. Conventional operation and maintenance functions would also be required for the aqueous treatment system. The maintenance activities discussed above are common and are not difficult to implement. Ground-water monitoring would be required to monitor variations in ground-water quality at the target remediation areas. Ground-water monitoring would also be required for the Unloading Area to monitor the effectiveness of the recovery system until it was proven that contaminated ground water was recovered.

The overall potential for failure of the Landfill and Scrubber Sludge Pond caps are minimal. Multi-media caps have been proven to be reliable at other waste management sites and would be effective at the MMRF. The potential for failure of the leachate collection, ground-water recovery and treatment systems are also low with proper maintenance.

Reduction of Toxicity, Mobility or Volume

Remedial Alternative 4 treats the leachate generated from the Landfill and Former Cathode Waste Management Areas which reduces the toxicity, mobility and volume of these waste streams.

Implementability

The technologies associated with Remedial Alternative 4 are implementable at the MMRF. The potential for fugitive dust emissions may occur from handling activities at the Landfill, Former Cathode Waste Management Areas, Scrubber Sludge Ponds and Unloading Area. However, dust suppressants would be utilized to reduce this potential. The existing monitor well network at the MMRF is sufficient to monitor variations in ground-water quality at the target remediation areas. The existing monitor well network would also be sufficient to monitor the effectiveness of the hydraulic control at the Scrubber Sludge Ponds as well as the recovery system for the Unloading Area. It is expected that after successful implementation of this alternative, no additional remedial actions would be required.

Implementation of this remedial alternative requires acceptance by the regulatory agencies of the waiver from the fluoride and sulfate ARARs in the ground water presented in Appendix C. This alternative also requires the approval of institutional controls to prevent the use of potentially affected ground water. Deed restrictions must also be approved to prevent future development on the waste management areas. It is anticipated that approval of the waivers, institutional controls and approval to implement Remedial Alternative 4 can be obtained from the regulatory agencies.

The equipment, materials, specialists and work force necessary to implement this remedial alternative are available to the MMRF. Also, the technologies associated with this alternative have been proven at other waste management sites and could be implemented at the MMRF without further development except for the aqueous treatment system. A bench scale study would be required to verify the effectiveness of the aqueous treatment system and the results of this study would be utilized in the final design of the full scale system.

Compliance with ARARs

Remedial Alternative 4 collects and treats leachate generated from the Landfill and perched water which meets chemical-specific ARARs for these areas. Also, ground water is recovered from the Unloading Area and treated in the in plant process. However, ground water beneath the Landfill, Former Cathode Waste Management Areas, Scrubber Sludge Ponds and Recycle Pond will remain in excess of the ARAR for fluoride and/or sulfate. Remedial Alternative 4 would meet all applicable location and action-specific ARARs. With the acceptance of a waiver from the fluoride and sulfate ARARs discussed in Appendix C, Remedial Alternative 4 would meet all chemical-specific ARARs.

Overall Protection

Alternative 4 provides protection to the community of The Dalles, on-site workers and the environment (based on acceptance of the waiver from the fluoride and sulfate ARARs in ground water). The risks at the MMRF will be minimized by removing the waste from the Former Cathode Waste Management Areas and the Unloading Area, containing waste at the Landfill and Scrubber Sludge Ponds, recovering ground water from the Unloading Area and treating affected leachate and perched water to acceptable levels. This alternative would also reduce future leaching of fluoride from waste in the Scrubber Sludge Ponds. Containment of wastes in the Landfill and Scrubber Sludge Ponds reduces the potential for direct contact with the waste. Recovery of ground water and treatment of the leachate and perched water greatly reduces the potential for off-site migration of contaminants. Because this alternative reduces the exposure pathways, it is protective of human health and the environment.

Cost

The capital cost of Remedial Alternative 4 is $9,229,100. The annual O&M costs for years 1 through 5 will be $207,600. The annual O&M costs for years 6 through 30 will be $119,000. The total present worth value of this alternative using a discount rate of 8% is $10,922,600. The detailed development of these costs is presented in Table 5-5.

TABLE 5-5

Cost Analysis of Remedial Alternative 4
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
I Capital Cost			
A Ground Water Recovery System (2 gpm)			
Four-inch Recovery Well	4,000 each	1	4,000
Plumbing System			
Submersible Pump	700 each	1	700
Controls	1,000 LS	1	1,000
Electrical Connection	5,000 LS	1	5,000
One-inch PVC Discharge line	7 /foot	800	5,600
		Subtotal	**16,300**
B Aqueous Treatment System			
Building (20'x40')	25,000 LS	1	25,000
Site Prep	15,000 LS	1	15,000
Oxidation Unit	75,000 LS	1	75,000
Chemical Precip. Unit	76,500 LS	1	76,500
Fluoride Polishing Unit	63,000 LS	1	63,000
Electrical - Controls	10,000 LS	1	10,000
		Subtotal	**264,500**
C Production Well Abandonment	**15,000 /house**	**4**	**60,000**
P&A Existing Wells and Connect to City Water			
D Consolidate Existing Landfill			
Regrade Landfill	3.50 /CY	40,000	140,000
Excavate and Haul Ditches	8 /CY	3,290	26,400
Excavate Unloading Area			
Excavation and Hauling	8 /CY	200	1,600
Backfill	5 /CY	200	1,000
Excavate Cathode Waste Areas			
Excavation and Hauling	8 /CY	64,470	515,800
Backfill	5 /CY	64,470	322,400
		Subtotal	**1,007,200**
E Landfill Performance Cap (10 Acre)			
Site Preparation	100,000 LS	1	100,000
Soil Backfill	5 /CY	6,200	31,000
Rough Grading	0.75 /CY	115,600	86,700
Perimeter Ditch Grading	15 /foot	4,000	60,000
Sand Layer	7 /CY	7,800	54,600
Piping/Risers	6 /foot	1,000	6,000
Sterilization	1,000 /acre	10	10,000
Geomembrane	0.70 /SF	440,000	308,000
Soil Layer	7 /YD	15,600	109,200
Wire Mesh	0.75 /SF	435,600	326,700
Geotextile Fabric	0.20 /SF	461,000	92,200
Top Soil	8 /CY	15,600	124,800
Leachate Collection System	66,000 LS	1	66,000
		Subtotal	**1,375,200**

TABLE 5-5 (Continued)

Cost Analysis of Remedial Alternative 4
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
F Perched Water Collection System	**60,000**	**1**	**60,000**
G Relocation of Facilities			
Rerouting North Ditch	69,000 LS	1	69,000
Diverting Surface Runoff	10,000 LS	1	10,000
Rerouting Landfill Ditch	36,000 LS	1	36,000
Removing Scrubber Discharge	20 /foot	800	16,000
Replacing Scrubber Discharge	40 /foot	800	32,000
Removing Railroad Spur	25 /foot	200	5,000
Replacing Railroad Spur	125 /foot	200	25,000
Protecting/Repairing Monitor Wells	3,000 each	10	30,000
Disassemble Crusher	5,000 LS	1	5,000
		Subtotal	**228,000**
H Scrubber Sludge Pond Performance Cap			
Site Preparation	150,000 LS	1	150,000
Soil Backfill	5 /CY	35,100	175,500
Rough Grading	0.75 /SY	83,700	62,800
Perimeter Ditches	10 /LF	3,000	30,000
Sand Layer	7 /CY	13,960	97,800
Piping/Risers	6 /LF	2,000	12,000
Sterilization	1,000 /acre	15.8	15,800
Geomembrane	0.70 /SF	787,750	551,500
Soil Layer	7 /CY	27,900	195,300
Wire Mesh	0.75 /SF	685,000	513,800
Geotextile Fabric	0.20 /SF	822,000	164,400
Top Soil	8 /CY	20,930	167,500
Dewatering			
Well Construction	4,000 /well	7	28,000
Plumbing and Pumps	48,000 LS	1	48,000
		Subtotal	**2,212,400**
I Controls			
Security Fences	146,000 LS	1	146,000
Security Fence Replacement (15 yrs)	46,200 LS	1	46,200
Deed Restrictions	5,000 LS	1	5,000
Institutional Controls	8,000 LS	1	8,000
		Subtotal	**205,200**
Alternative 4 Subtotal			**5,428,800**
Engineering	15%		814,400
Indirect	10%		542,900
Contingency	25%		1,357,200
Inspection	10%		542,900
Health & Safety	10%		542,900
Alternative 4 Total Capital Cost			**9,229,100**

TABLE 5-5 (Continued)

Cost Analysis of Remedial Alternative 4
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
II Annual Operating Cost			
A Ground-Water Monitoring (36 wells)			
First year (Quarterly)	63,000 /year	1	63,000
Second year (Semi-annually)	32,000 /year	1	32,000
Remaining years (Annually)	16,000 /year	1	16,000
Equivalent Annuity (Years 1-5)	30,400 /year	1	**30,400**
Annuity (Years 6-30)	16,000 /year	1	**16,000**
B Security Fence Maintenance	**2,000 /year**	**1**	**2,000**
C Treatment (5 years only)			
Electric Power			
Recovery System	2,000 /year	1	2,000
Treatment System	5,000 /year	1	5,000
Chemicals	9,000 /year	1	9,000
Operator	30,000 /year	0.5	15,000
Management	50,000 /year	0.1	5,000
Maintenance			
Recovery System	800 /year	1	800
Treatment System	12,000 /year	1	12,000
		Subtotal	**48,800**
D Landfill Performance Cap Inspection and Maintenance	**15,000 /year**	**1**	**15,000**
E Scrubber Sludge Pond Performance Cap			
Inspection and Maintenance	31,000 /year	1	31,000
Hydraulic Controls			
Electrical Power	15,000 /year	1	15,000
Sample Analysis	1,000 /year	1	1,000
Maintenance	5,000 /year	1	5,000
		Subtotal	**52,000**
Annual Operating Cost Subtotal (Years 1-5)			**148,200**
Indirect	20%		29,700
Contingency	20%		29,700
Annual Operating Cost (Years 1-5)			**207,600**

TABLE 5-5 (Continued)

Cost Analysis of Remedial Alternative 4
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
Annual Operating Cost Subtotal (Years 6-30)			85,000
Indirect	20%		17,000
Contingency	20%		17,000
Annual Operating Cost (Years 6-30)			119,000
Present Worth (Years 1-5)	207,600 /year	@ 8%	828,900
Present Worth (Years 6-30)	119,000 /year	@ 8%	864,600
Present Worth Operating Cost			1,693,500
III Present Worth Alternative 4			
Capital Cost			9,229,100
Operating Cost			1,693,500
Total Present Worth			10,922,600

098/2

5.2.5 Remedial Alternative 5: Containment with Consolidation and Ground-water Controls with Limited Treatment

Remedial Alternative 5 consists of the following actions:

- Consolidation of the residual cathode waste material and underlying fill material from the Former Cathode Waste Management Areas into the existing Landfill;
- Consolidation of the cathode waste material from the Unloading Area into the existing Landfill;
- Consolidation of the scrubber sludge material and underlying soils from Scrubber Sludge Ponds 1 through 4 into the existing Landfill;
- Capping the existing Landfill in place with a multi-media cap meeting RCRA performance standards;
- Plug and abandon nearby production wells and connect users to the City of The Dalles water supply system;
- Collection and treatment of leachate generated from the Landfill and perched water east of River Road and from the Former Cathode Waste Management Areas;
- Recovery of ground water from the Unloading Area;
- Access and deed restrictions;
- Institutional controls; and
- Ground-water quality monitoring.

A detailed description of these actions is presented in Section 4.2.1.4.

Short-Term Effectiveness

Implementation of Remedial Alternative 5 would not pose a threat to the community and would pose minimal threats to on-site construction workers. The potential risks to on-site workers would result from waste handling activities during remediation of the Landfill, Former Cathode Waste Management Areas, Unloading Area and Scrubber Sludge Ponds. Utilization of dust suppressants, protective clothing and respiratory protection in conjunction with a health and safety program during remediation would reduce the potential for exposure to on-site workers. The use of dust suppressants would also reduce airborne migration of contaminants, thus protecting the environment from any adverse impacts during implementation. It is expected that implementation of this remedial alternative would take approximately two years.

Long-Term Effectiveness

Remedial Alternative 5 provides protection to the community of The Dalles, on-site workers and the environment (based on the waiver from the fluoride and sulfate ARARs in the ground water). The technologies utilized in this alternative including a cap system, ground-water recovery system and perched water and leachate collection and treatment systems are expected to meet performance standards or process efficiencies. The cap placed over the Landfill would be effective in reducing leachate and in minimizing the

potential for direct contact with the waste from the area. Because this alternative would remove the residual cathode waste and underlying fill material for the Former Cathode Waste Management Areas, the Unloading Area, and the sludge from the Scrubber Sludge Ponds, the potential for future exposure at these areas would be greatly reduced. Fencing the Landfill and recording deed restrictions for this area would also reduce the potential for direct contact with the Landfill waste. The institutional controls enacted and replacement of nearby production wells with city water would greatly reduce the potential for consumption of affected ground water. The recovery system for the ground water and collection and treatment systems for the Landfill leachate and perched water would be effective in recovering, collecting and treating aqueous contaminants.

Long-term maintenance would be required for the Landfill cap. Periodic inspections, regrading and filling of depressions in the cap should they occur would be required to maintain the integrity of the cap. The leachate and perched water collection systems would require annual cleaning and the ground-water recovery system would require pump and piping maintenance on an as-needed basis. Conventional operation and maintenance functions would also be required for the aqueous treatment system.

Long-term ground-water monitoring would be required to monitor variations in ground-water quality at the target remediation areas. Ground-water monitoring would also be

required for the Unloading Area to monitor the effectiveness of the recovery system until it was proven that contaminated ground water was recovered.

The overall potential for failure of the Landfill cap is minimal. Multi-media caps such as the one described for the Landfill have been proven reliable at other waste management sites and would be effective at the MMRF. The potential for failure of the leachate collection, ground-water recovery and aqueous treatment systems are also minimal with proper maintenance.

Reduction of Toxicity, Mobility or Volume

Remedial Alternative 5 treats the leachate generated from the Landfill and Former Cathode Waste Management Areas which reduces the toxicity, mobility and volume of these waste streams. However, the contaminated soils, sediments and waste materials remaining in the Landfill after capping are not treated.

Implementability

The technologies associated with Remedial Alternative 5 are implementable at the MMRF. The potential for fugitive dust emissions may exist during waste handling activities at all of the target remediation areas. However, dust suppressants would be utilized to the maximum extent practical to minimize the generation of dust. The existing

monitor well network at the MMRF is sufficient to monitor variations in ground-water quality at the target remediation areas and is also sufficient to monitor the effectiveness of the recovery system at the Unloading Area. It is expected that after successful implementation of this alternative, no additional remedial actions would be required.

Implementation of this remedial alternative would require acceptance by the regulatory agencies of the waiver from the fluoride and sulfate ARARs in the ground water presented in Appendix C. This alternative also would require the approval of institutional controls to prevent the use of potentially affected ground water. Deed restrictions must also be approved to prevent future development on the Landfill.

The equipment, materials, specialists and work force necessary to implement this remedial alternative are available to the MMRF. Also, the technologies utilized have been proven at other waste management sites and except for the aqueous treatment system, could be implemented without further development. A bench scale study would be required to verify the effectiveness of the aqueous treatment system and the results of this study would be utilized in the final design of the full scale system.

Compliance with ARARs

Remedial Alternative 5 collects and treats leachate generated from the Landfill and perched water which meets chemical-specific ARARs for these areas. Also, ground water is recovered from the Unloading Area and treated in the in plant process. However, ground water beneath the Landfill, Former Cathode Waste Management Areas, Scrubber Sludge Ponds and Recycle Pond will remain in excess of the ARARs for fluoride and/or sulfate. Remedial Alternative 5 would meet all applicable location and action-specific ARARs. With the acceptance of a waiver from the fluoride and sulfate ARARs discussed in Appendix C, Remedial Alternative 5 would meet all chemical-specific ARARs.

Overall Protection

Remedial Alternative 5 provides protection to the community of The Dalles, on-site workers and the environment (based on the waiver from the fluoride and sulfate ARARs in ground water). The risks at the MMRF will be greatly minimized by containing all waste materials from the target remediation areas in the existing Landfill, recovering ground water and collecting and treating leachate and perched water. Containment of the waste reduces the potential for direct contact with the waste and recovery of ground water from the Unloading Area and treatment of the leachate and perched water greatly minimizes the potential for off-site migration of contaminants.

Cost

The capital cost of Remedial Alternative 5 is $9,807,100. The annual O&M costs for years 1 through 5 will be $146,000. The annual O&M costs for years 6 through 30 will be $57,400. The total present worth value of this alternative using a discount rate of 8% is $10,807,100. The detailed development of these costs is presented in Table 5-6.

5.2.6 Remedial Alternative 6: RCRA Landfill and Ground-Water Controls with Limited Treatment

Remedial Alternative 6 consists of the following actions:

- Consolidation of the waste from the existing Landfill to a newly constructed on-site RCRA landfill;
- Consolidation of the residual cathode waste material and underlying fill material from the Former Cathode Waste Management Areas into a newly constructed on-site RCRA landfill;
- Consolidation of the cathode waste material from the Unloading Area into a newly constructed on-site RCRA landfill;
- Consolidation of the scrubber sludge material and underlying fill from Scrubber Sludge Ponds 1 through 4 into a newly constructed on-site RCRA landfill;
- Plug and abandon nearby production wells and connect users to the City of The Dalles water supply system;
- Temporary collection and treatment of leachate generated from the Landfill and perched water from the Former Cathode Waste Management Areas and east of River Road;

TABLE 5-6

Cost Analysis of Remedial Alternative 5
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
I Capital Cost			
A Ground Water Recovery System (2 gpm)			
Four-inch Recovery Well	4,000 each	1	4,000
Plumbing System			
Submersible Pump	700 each	1	700
Controls	1,000 LS	1	1,000
Electrical Connection	5,000 LS	1	5,000
One-inch PVC Discharge line	7 /foot	800	5,600
		Subtotal	**16,300**
B Aqueous Treatment System			
Building (20'x40')	25,000 LS	1	25,000
Site Prep	15,000 LS	1	15,000
Oxidation Unit	75,000 LS	1	75,000
Chemical Precip. Unit	76,500 LS	1	76,500
Fluoride Polishing Unit	63,000 LS	1	63,000
Electrical - Controls	10,000 LS	1	10,000
		Subtotal	**264,500**
C Production Well Abandonment	**15,000 /house**	**4**	**60,000**
P&A Existing Wells and Connect to City Water			
D Consolidate Existing Landfill			
Regrade Landfill	3.50 /CY	40,000	140,000
Excavate and Haul Ditches	8 /CY	3,290	26,400
Excavate Unloading Area			
Excavation and Hauling	8 /CY	200	1,600
Backfill	5 /CY	200	1,000
Excavate Cathode Waste Areas			
Excavation and Hauling	8 /CY	64,470	515,800
Backfill	5 /CY	64,470	322,400
Excavate Scrubber Sludge Ponds			
Soil Mixing	1.25 /CY	139,400	174,300
Excavation	7 /CY	168,418	1,179,000
Backfill	5 /CY	47,755	238,800
		Subtotal	**2,599,300**

TABLE 5-6 (Continued)

Cost Analysis of Remedial Alternative 5
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
E Landfill Performance Cap (15 Acre)			
Site Preparation	100,000 LS	1	100,000
Soil Backfill	5 /CY	9,300	46,500
Rough Grading	0.75 /CY	287,000	215,300
Perimeter Ditch Grading	15 /foot	5,000	75,000
Sand Layer	7 /CY	12,100	84,700
Piping/Risers	6 /foot	1,500	9,000
Sterilization	1,000 /acre	15	15,000
Geomembrane	0.70 /SF	660,000	462,000
Soil Layer	7 /CY	24,200	169,400
Wire Mesh	0.75 /SF	660,000	495,000
Geotextile Fabric	0.20 /SF	700,000	140,000
Top Soil	8 /CY	24,200	193,600
Leachate Collection System	80,000 LS	1	80,000
		Subtotal	**2,085,500**
F Perched Water Collection System	**2,000 LS**	**1**	**60,000**
G Relocation of Facilities			
Rerouting North Ditch	69,000 LS	1	69,000
Diverting Surface Runoff	10,000 LS	1	10,000
Rerouting Landfill Ditch	36,000 LS	1	36,000
Removing Scrubber Discharge	20 /foot	800	16,000
Replacing Scrubber Discharge	40 /foot	800	32,000
Removing Railroad Spur	25 /foot	200	5,000
Replacing Railroad Spur	125 /foot	200	25,000
Protecting/Repairing Monitor Wells	3,000 each	10	30,000
Disassemble Crusher	5,000 LS	1	5,000
Electrical Transmission Line Replacement Towers	250,000 LS	1	250,000
		Subtotal	**478,000**
H Controls			
Security Fences	146,000 LS	1	146,000
Security Fence Replacement (15 yrs)	46,200 LS	1	46,200
Deed Restrictions	5,000 LS	1	5,000
Institutional Controls	8,000 LS	1	8,000
		Subtotal	**205,200**

TABLE 5-6 (Continued)

Cost Analysis of Remedial Alternative 5
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
Alternative 5 Subtotal			5,768,800
Engineering	15%		865,400
Indirect	10%		576,900
Contingency	25%		1,442,200
Inspection	10%		576,900
Health & Safety	10%		576,900
Alternative 5 Total Capital Cost			9,807,100
II Annual Operating Cost			
A Ground-Water Monitoring (36 wells)			
First year (Quarterly)	63,000 /year	1	63,000
Second year (Semi-annually)	32,000 /year	1	32,000
Remaining years (Annually)	16,000 /year	1	16,000
Equivalent Annuity (Years 1-5)	30,400 /year	1	30,400
Annuity (Years 6-30)	16,000 /year	1	16,000
B Security Fence Maintenance	2,000 /year	1	2,000
C Treatment (5 years only)			
Electric Power			
Recovery System	2,000 /year	1	2,000
Treatment System	5,000 /year	1	5,000
Chemicals	9,000 /year	1	9,000
Operator	30,000 /year	0.5	15,000
Management	50,000 /year	0.1	5,000
Maintenance			
Recovery System	800 /year	1	800
Treatment System	12,000 /year	1	12,000
		Subtotal	48,800
D Landfill Performance Cap Inspection and Maintenance	23,000 /year	1	23,000
Annual Operating Cost Subtotal (Years 1-5)			104,200
Indirect	20%		20,900
Contingency	20%		20,900
Annual Operating Cost (Years 1-5)			146,000

TABLE 5-6 (Continued)

Cost Analysis of Remedial Alternative 5
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	Description	Unit Cost ($)	Quantity	Cost ($)
	Annual Operating Cost Subtotal (Years 6-30)			41,000
	Indirect	20%		8,200
	Contingency	20%		8,200
	Annual Operating Cost (Years 6-30)			57,400
	Present Worth (Years 1-5)	146,000 /year	@ 8%	583,000
	Present Worth (Years 6-30)	57,400 /year	@ 8%	417,000
	Present Worth Operating Cost	30 years	@ 8%	1,000,000
III	Present Worth Alternative 5			
	Capital Cost			9,807,100
	Operating Cost			1,000,000
	Total Present Worth			10,807,100

098/2

- o Recovery and treatment of ground water from the Unloading Area;
- o Access and deed restrictions;
- o Institutional controls; and
- o Ground-water quality monitoring.

A detailed description of these actions is presented in Section 4.2.2.5.

Short-Term Effectiveness

Implementation of Remedial Alternative 6 would not pose a threat to the community and would pose minimal threats to on-site construction workers. The potential risks to on-site workers would result from handling wastes from the Landfill, Former Cathode Waste Management Areas, Unloading Area and Scrubber Sludge Ponds during consolidation of these materials into the new on-site RCRA landfill. Utilizing dust suppressants, protective clothing and respiratory protection in conjunction with a health and safety program during remediation would greatly reduce this risk. Dust suppressants should also reduce airborne migration of contaminants thus, protecting the environment from any adverse impacts during implementation. It is expected that implementation of this remedial alternative would take approximately two years to complete.

Long-Term Effectiveness

The technologies utilized in this alternative including a RCRA landfill and ground water recovery and perched water collection and treatment systems are expected to meet performance standards and process efficiencies. The RCRA landfill would be effective in reducing infiltration into the landfill and leachate generated from the landfill. This landfill would also be effective in reducing the potential for direct contact with the waste. Because waste is removed from the existing Landfill, Unloading Area, Former Cathode Waste Management Areas and the Scrubber Sludge Ponds, the potential for future exposure at these areas is greatly minimized. In addition, the sludges from the Scrubber Sludge Ponds are removed from an area where ground water was interacting with the waste, thus minimizing the potential for future leaching of fluorides from the sludges. Fencing the new RCRA landfill and recording deed restrictions for this area would also reduce the potential for direct contact with the waste in the landfill. The institutional controls enacted and replacement of nearby production wells with city water would reduce the potential for consumption of affected ground water. The ground-water recovery system would be effective in recovering affected ground water from the Unloading Area.

Long-term maintenance would be required for the RCRA landfill in the way of periodic inspections, regrading, filling of depressions should they occur and maintenance of

the leachate collection system. The ground-water recovery system would require pump and piping maintenance on an as needed basis and the treatment system would require conventional operation and maintenance functions.

Long-term ground-water monitoring would be required to monitor variations in ground-water quality at the target remediation areas. Ground-water monitoring would also be required to monitor the effectiveness of the recovery system at the Unloading Area and to monitor the RCRA landfill.

The overall potential for failure of the RCRA landfill is minimal. Landfills of this type have been proven reliable at other waste management sites and would be effective at the MMRF. The potential for failure for the leachate collection and ground-water recovery and treatment systems are also minimal with proper maintenance.

Reduction of Toxicity, Mobility or Volume

Remedial Alternative 6 treats the leachate generated from the existing landfill, the RCRA landfill, perched water east of River Road and from the Former Cathode Waste Management Areas which reduces the toxicity, mobility and volume of these waste streams. However, the contaminated soils, sediments and waste materials contained in the RCRA landfill are not treated.

Implementability

The technologies associated with Remedial Alternative 6 are implementable at the MMRF. The potential for fugitive dust emissions exists during waste handling activities at all of the target remediation areas. However, dust suppressants would be utilized to the maximum extent practical to reduce the generation of dust. The existing monitor well network at the MMRF is not sufficient to monitor the effectiveness of the RCRA Landfill. New ground-water monitoring wells would have to be installed around the RCRA landfill. The existing monitor well network would be sufficient to monitor variations in ground-water quality at the target remediation areas and to monitor the effectiveness of the recovery system at the Unloading Area. It is expected that after successful implementation of this alternative, no additional remedial actions would be required.

Implementation of this remedial alternative requires acceptance by the regulatory agencies of the waiver from the fluoride and sulfate ARARs in the ground water presented in Appendix C. This alternative also requires the approval of institutional controls to prevent the use of potentially affected ground water. Deed restrictions would also be required to prevent future development on the RCRA landfill.

The equipment, materials, specialists and work force necessary to implement this remedial alternative are available to the MMRF. Also, the technologies utilized have

been proven at other waste management sites and except for the aqueous treatment system, could be implemented without further development. A bench scale study would be required to verify the effectiveness and configuration of the aqueous treatment system. The results of the study would be utilized in the final design of the full scale system.

Compliance with ARARs

Remedial Alternative 6 collects and treats leachate generated from the Landfill and perched water which meets chemical-specific ARARs for these areas. Also, ground water is recovered from the Unloading Area and treated in the in plant process. However, ground water beneath the Landfill, Former Cathode Waste Management Areas, Scrubber Sludge Ponds and Recycle Pond will remain in excess of the ARAR for fluoride and/or sulfate. Remedial Alternative 6 would meet all applicable location and action-specific ARARs. With the acceptance of a waiver from the fluoride and sulfate ARARs discussed in Appendix C, Remedial Alternative 6 would meet all chemical-specific ARARs.

Overall Protection

Remedial Alternative 6 provides protection to the community of The Dalles, on-site workers and the environment (based on the waiver from the fluoride and sulfate ARARs in the ground water). The risks at the MMRF will be reduced by containing waste materials from the target remediation areas

in the RCRA Landfill, collection and treatment of leachate from the existing Landfill and perched water zone and recovery of ground water from the Unloading Area. Containment of the waste reduces the potential for direct contact with the waste, and recovery of ground water from the Unloading Area and treatment of the leachate and perched water greatly minimizes the potential for off-site migration of contaminates. However, excavation and transport of the wastes from all target remediation areas would greatly increase the potential for workers exposure to the waste materials. This fact is compounded by the nature of the wastes in the Landfill and Scrubber Sludge Ponds (asbestos present in the Landfill and fine grained nature of the Scrubber Sludge Pond wastes) and the prevalent winds present at The Dalles.

Cost

The capital cost of Remedial Alternative 6 is $18,213,000. The annual O&M costs for years 1 through 5 will be 213,900. The annual O&M costs for years 6 through 30 will be $125,300. The total present worth value of this alternative using a discount rate of 8% is $19,977,500. The detailed development of these costs is presented in Table 5-7.

TABLE 5-7

Cost Analysis of Remedial Alternative 6
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
I Capital Cost			
A Ground Water Recovery System(2 gpm)			
Four-inch Recovery Well	4,000 each	1	4,000
Plumbing System			
Submersible Pump	700 each	1	700
Controls	1,000 LS	1	1,000
Electrical Connection	5,000 LS	1	5,000
One-inch PVC Discharge line	7 /foot	800	5,600
		Subtotal	**16,300**
B Aqueous Treatment System			
Building (20'x40')	25,000 LS	1	25,000
Site Prep	15,000 LS	1	15,000
Oxidation Unit	75,000 LS	1	75,000
Chemical Precip. Unit	76,500 LS	1	76,500
Fluoride Polishing Unit	63,000 LS	1	63,000
Electrical - Controls	10,000 LS	1	10,000
		Subtotal	**264,500**
C Production Well Abandonment	**15,000 /house**	**4**	**60,000**
P&A Existing Well and Connect to City Water			
D Consolidate Into On-site RCRA Landfill			
Excavate Landfill	7 /CY	200,000	1,400,000
Asbestos Removal and Handling	150,000 LS	1	150,000
Backfill	5 /CY	24,000	120,000
Excavate Ditches and Hauling	8 /CY	3,290	26,400
Excavate Unloading Area			
Excavation and Hauling	8 /CY	200	1,600
Backfill	5 /CY	200	1,000
Excavate Cathode Waste Areas			
Excavation and Hauling	8 /CY	64,470	515,800
Backfill	5 /CY	64,470	322,400
Excavate Scrubber Sludge Ponds			
Soil Mixing	1.25 /CY	139,400	174,300
Excavation	7 /CY	168,418	1,179,000
Backfill	5 /CY	47,755	238,800
		Subtotal	**4,129,300**

TABLE 5-7 (Continued)

Cost Analysis of Remedial Alternative 6
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
E Construct RCRA Landfill			
Site Preparation	200,000 LS	1	200,000
Containment Dike	5 /CY	169,000	845,000
Clay Liner	30 /CY	31,700	951,000
Geomembrane (60 mil)	0.70 /SF	450,000	315,000
Leak Detection System	5,100 /acre	12.7	64,800
Geomembrane (60 mil)	0.70 /SF	450,000	315,000
Leachate Collection System	12,580 /acre	12.7	159,800
Segregation	10 /CY	50,000	500,000
Gas Venting System	7,100 /acre	12.7	90,200
Geomembrane (60 mil)	0.70 /SF	552,000	386,400
Clay Liner	30 /CY	40,890	1,226,700
Sand Layer	7 /CY	20,440	143,100
Wire Mesh	0.75 /SF	552,000	414,000
Top Soil	8 /CY	15,533	124,300
		Subtotal	5,735,300
F Perched Water Collection System	**60,000 /LS**	1	60,000
G Relocation of Facilities			
Diverting Surface Runoff	10,000 LS	1	10,000
Removing Scrubber Discharge	20 /foot	800	16,000
Replacing Scrubber Discharge	40 /foot	800	32,000
Removing Railroad Spur	25 /foot	200	5,000
Replacing Railroad Spur	125 /foot	200	25,000
Protecting/Repairing Monitor Wells	3,000 /each	10	30,000
Disassemble Crusher	5,000 LS	1	5,000
Electrical Transmission Line Replacement Towers	250,000 LS	1	250,000
		Subtotal	373,000
H Controls			
Security Fences	47,000 LS	1	47,000
Security Fence Replacement (15 yrs)	15,000 LS	1	15,000
Deed Restrictions	5,000 LS	1	5,000
Institutional Controls	8,000 LS	1	8,000
		Subtotal	75,000
Alternative 6 Subtotal			**10,713,400**
Engineering	15%		1,607,000
Indirect	10%		1,071,400
Contingency	25%		2,678,400
Inspection	10%		1,071,400
Health & Safety	10%		1,071,400
Alternative 6 Total Capital Cost			**18,213,000**

TABLE 5-7 (Continued)

Cost Analysis of Remedial Alternative 6
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
II Annual Operating Cost			
A Ground Water Monitoring (36 wells)			
First year (Quarterly)	63,000 /year	1	63,000
Second year (Semi-annually)	32,000 /year	1	32,000
Remaining years (Annually)	16,000 /year	1	16,000
Equivalent annuity (Years 1-5)	30,400 /year	1	30,400
Annuity (Years 6-30)	16,000 /year	1	16,000
B Security Fence Maintenance	2,000 /year	1	2,000
C Treatment (5 years only)			
Electric Power			
Recovery System	2,000 /year	1	2,000
Treatment System	5,000 /year	1	5,000
Chemicals	9,000 /year	1	9,000
Operator	30,000 /year	0.5	15,000
Management	50,000 /year	0.1	5,000
Maintenance			
Recovery System	800 /year	1	800
Treatment System	12,000 /year	1	12,000
		Subtotal	48,800
D On-site RCRA Landfill Inspection and Maintenance	71,500 /year	1	71,500
Annual Operating Cost Subtotal (Years 1-5)			152,700
Indirect	20%		30,600
Contingency	20%		30,600
Annual Operating Cost (Years 1-5)			213,900
Annual Operating Cost Subtotal (Years 6-30)			89,500
Indirect	20%		17,900
Contingency	20%		17,900
Annual Operating Cost (Years 6-30)			125,300
Present Worth (Years 1-5)	213,900 /year	@ 8%	854,100
Present Worth (Years 6-30)	125,300 /year	@ 8%	910,400
Present Worth Operating Cost			1,764,500

TABLE 5-7 (Continued)

Cost Analysis of Remedial Alternative 6
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
III Present Worth Alternative 6			
Capital Cost			18,213,000
Operating Cost			1,764,500
Total Present Worth			19,977,500

098/2

5.2.7 Remedial Alternative 7: Containment with Consolidation and Ground-Water Recovery and Treatment

Remedial Alternative 7 consists of the following actions:

- Consolidation of the residual cathode waste material and underlying fill material from the Former Cathode Waste Management Areas into the existing Landfill;
- Consolidation of the cathode waste material from the Unloading Area into the existing Landfill;
- Consolidation of the Scrubber Sludge material and underlying fill from Scrubber Sludge Ponds 1 through 4 into the existing Landfill;
- Capping the existing Landfill in place with a multi-media cap meeting RCRA performance standards;
- Collection and treatment of leachate generated from the Landfill and perched waters east of River Road and from the Former Cathode Waste Management Areas;
- Ground-water recovery and treatment;
- Ground-water quality monitoring; and
- Access and deed restrictions.

A detailed description of these actions is presented in Section 4.2.3.1.

Short-Term Effectiveness

Implementation of Remedial Alternative 7 should not pose a threat to the community and would pose minimal threats to on-site construction workers. The potential risks to on-site workers would result from handling wastes from the Landfill, Former Cathode Waste Management Areas, Unloading Area and

Scrubber Sludge Ponds during consolidation and capping activities. Although, utilization of dust suppressants, protective clothing and respiratory protection in conjunction with implementing a health and safety plan during remediation would greatly reduce this risk. With the use of dust suppressants, Remedial Alternative 7 would not pose any adverse environmental impacts during implementation. It is expected that implementation of this remedial alternative would take less than two years to complete.

Long-Term Effectiveness

The technologies utilized in this alternative including a cap system, leachate and perched water collection and treatment system and ground-water recovery system are expected to meet performance standards or process efficiencies. The cap placed over the Landfill would be effective in reducing leachate generated from the Landfill and in reducing the potential for direct contact with the waste. Because this alternative removes the residual cathode waste and underlying fill material from the Former Cathode Waste Management Areas, the Unloading Area and the Scrubber Sludge Ponds, the potential for future exposure at these areas is negligible. Fencing the Landfill and recording deed restrictions for this area would also reduce the potential for direct contact with the waste. Also the recovery/ collection and treatment systems for the ground water,

Landfill leachate and perched water would be effective in recovering, collecting and treating the aqueous waste streams to meet remediation criteria.

Long-term maintenance would be required for the Landfill cap in the way of periodic inspections regrading and filling of depressions should they occur. The leachate and perched water collection systems would require annual cleaning and the ground-water recovery system would require pump and piping maintenance on an as-needed basis. Conventional operation and maintenance functions would also be required for the aqueous treatment system.

Ground-water monitoring would be required to monitor variations in ground-water quality at the target remediation areas. Ground-water monitoring would also be required for the Landfill and Former Cathode Waste Management Areas, Unloading Area, Scrubber Sludge Ponds and Recycle Pond to monitor the effectiveness of the ground-water recovery systems until it is proven that contaminated ground water was recovered.

The overall potential for failure of the Landfill cap is minimal. Caps of this type have been proven reliable at other waste management sites and would be effective at the MMRF. The potential for failure of the leachate collection, ground-water recovery and treatment systems are also minimal with proper maintenance.

Reduction of Toxicity, Mobility or Volume

Remedial Alternative 7 treats the leachate generated from the Landfill and perched water for cyanide and fluoride and recovers ground water from the Landfill and Former Cathode Waste Management Areas, Unloading Area, Scrubber Sludge Ponds and Recycle Pond. The toxicity, mobility and volume of these waste streams are therefore, greatly minimized. However, the contaminated soils, sediments and waste materials contained in the Landfill after capping are not treated.

Implementability

The technologies associated with Remedial Alternative 7 are implementable at the MMRF. Air emission problems may result from handling the wastes from all of the target remediation areas. However, dust suppressants would be utilized to the maximum extent practical to minimize emissions. The existing monitor well network at the MMRF is sufficient to monitor variations in ground-water quality at the target remediation areas. The existing monitor well network would also be sufficient to monitor the effectiveness of the recovery systems for the areas requiring ground-water recovery. It is expected that after successful implementation of this alternative, no additional remedial actions would be required. It is also anticipated that approvals can be obtained from the regulatory agencies to implement this alternative.

The equipment, materials, specialists and work force necessary to implement this remedial alternative are available to the MMRF. Also, the technologies utilized have been proven at other waste management sites and except for the aqueous treatment system, could be implemented without further development. A bench scale study would be required to verify the effectiveness and configuration of the aqueous treatment system. The results of this study would be utilized in the final design of the full scale system.

Compliance with ARARs

The leachate generated from the Landfill and perched water from east of River Road and from the Former Cathode Waste Management Areas exceed chemical-specific ARARs for cyanide and fluoride. Ground water at the Landfill and Former Cathode Waste Management Areas, Unloading Area, Scrubber Sludge Ponds and Recycle Pond exceeds the chemical specific ARARs for fluoride and/or sulfate. However, Remedial Alternative 7 includes collection and treatment of the contaminated leachate, perched water and ground water to meet remediation criteria prior to discharge. Remedial Alternative 7 would also meet all applicable location specific ARARs.

Overall Protection

After implementation, Remedial Alternative 7 would meet all applicable location, action, and chemical specific ARARs. The risks at the MMRF will be greatly minimized by consolidating waste materials from the target remediation areas into the existing Landfill, recovery of affected ground water and collection and treatment of leachate and perched water. Containment of the waste reduces the potential for direct contact with the waste. Recovery of affected ground water and treatment of the leachate and perched water minimizes the potential for future off-site migration of contaminants.

Cost

The capital cost of Remedial Alternative 7 is $10,255,500. The annual O&M costs for years 1 through 5 will be $315,600. The annual O&M costs for years 6 through 30 will be $57,400. The total present worth value of this alternative using a discount rate of 8% is $11,932,600. The detailed development of these costs is presented in Table 5-8.

5.2.8 Remedial Alternative 8: RCRA Landfill and Ground-Water Recovery and Treatment

Remedial Alternative 8 consists of the following actions:

- Consolidation of the waste from the existing Landfill into a newly constructed on-site RCRA landfill;

TABLE 5-8

Cost Analysis of Remedial Alternative 7
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
I Capital Cost			
A Ground Water Recovery System (45 gpm)			
Four-inch Recovery Well	4,000 each	14	56,000
Plumbing System			
Submersible Pump	700 each	15	10,500
Controls	1,000 LS	15	15,000
Electrical Connection	5,000 LS	15	75,000
Discharge Line			
Two-inch PVC	10 /foot	5,000	50,000
Three-inch PVC	12 /foot	4,000	48,000
		Subtotal	**254,500**
B Aqueous Treatment System			
Building (20'x40')	25,000 LS	1	25,000
Site Prep	15,000 LS	1	15,000
Oxidation Unit	75,000 LS	1	75,000
Chemical Precip. Unit	90,000 LS	1	90,000
Fluoride Polishing Unit	75,000 LS	1	75,000
Electrical - Controls	10,000 LS	1	10,000
		Subtotal	**290,000**
C Production Well Abandonment P&A Existing Wells and Connect to City Water	15,000 /house	4	60,000
D Consolidate Existing Landfill			
Regrade Landfill	3.50 /CY	40,000	140,000
Excavate and Haul Ditches	8 /CY	3,290	26,400
Excavate Unloading Area			
Excavation and Hauling	8 /CY	200	1,600
Backfill	5 /CY	200	1,000
Excavate Cathode Waste Areas			
Excavation and Hauling	8 /CY	64,470	515,800
Backfill	5 /CY	64,470	322,400
Excavate Scrubber Sludge Ponds			
Soil Mixing	1.25 /CY	139,400	174,300
Excavation	7 /CY	168,418	1,179,000
Backfill	5 /CY	47,755	238,800
		Subtotal	**2,599,300**

TABLE 5-8 (Continued)

Cost Analysis of Remedial Alternative 7
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
E Landfill Performance Cap (15 Acre)			
Site Preparation	100,000 LS	1	100,000
Soil Backfill	5 /CY	9,300	46,500
Rough Grading	0.75 /CY	287,000	215,300
Perimeter Ditches	15 /foot	5,000	75,000
Sand Layer	7 /CY	12,100	84,700
Piping/Risers	6 /foot	1,500	9,000
Sterilization	1,000 /acre	15	15,000
Geomembrane	0.70 /SF	660,000	462,000
Soil Layer	7 /YD	24,200	169,400
Wire Mesh	0.75 /SF	660,000	495,000
Geotextile Fabric	0.20 /SF	700,000	140,000
Top Soil	8 /CY	24,200	193,600
Leachate Collection System	80,000 LS	1	80,000
		Subtotal	**2,085,500**
F Perched Water Collection System	**60,000 /LS**	1	**60,000**
G Relocation of Facilities			
Rerouting North Ditch	69,000 LS	1	69,000
Diverting Surface Runoff	10,000 LS	1	10,000
Rerouting Landfill Ditch	36,000 LS	1	36,000
Removing Scrubber Discharge	20 /foot	800	16,000
Replacing Scrubber Discharge	40 /foot	800	32,000
Removing Railroad Spur	25 /foot	200	5,000
Replacing Railroad Spur	125 /foot	200	25,000
Protecting/Repairing Monitor Wells	3,000 /each	10	30,000
Disassemble Crusher	5,000 LS	1	5,000
Electrical Transmission Line Replacement Towers	250,000 LS	1	250,000
		Subtotal	**478,000**
H Controls			
Security Fences	146,000 LS	1	146,000
Security Fence Replacement (15 yrs)	46,200 LS	1	46,200
Deed Restrictions	5,000 LS	1	5,000
Institutional Controls	8,000 LS	1	8,000
		Subtotal	**205,200**
Alternative 7 Subtotal			**6,032,500**
Engineering	15%		904,900
Indirect	10%		603,300
Contingency	25%		1,508,200
Inspection	10%		603,300
Health & Safety	10%		603,300
Alternative 7 Total Capital Cost			**10,255,500**

TABLE 5-8 (Continued)

Cost Analysis of Remedial Alternative 7
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
II Annual Operating Cost			
A Ground Water Monitoring (36 wells)			
First year (Quarterly)	63,000 /year	1	63,000
Second year (Semi-annually)	32,000 /year	1	32,000
Remaining years (Annually)	16,000 /year	1	16,000
Equivalent Annuity (Years 1-5)	30,400 /year	1	30,400
Annuity (Years 6-30)	16,000 /year	1	16,000
B Security Fence Maintenance	2,000 /year	1	2,000
C Treatment (5 years only)			
Electric Power			
Recovery System	26,000 /year	1	26,000
Treatment System	40,000 /year	1	40,000
Chemicals	15,000 /year	1	15,000
Operator	30,000 /year	1	30,000
Management	50,000 /year	0.25	12,500
Maintenance			
Recovery System	12,000 /year	1	12,000
Treatment System	14,500 /year	1	14,500
Plant Analysis Samples	20,000 /year	1	20,000
		Subtotal	170,000
D Landfill Performance Cap Inspection and Maintenance	23,000 /year	1	23,000
Annual Operating Cost Subtotal (Years 1-5)			225,400
Indirect	20%		45,100
Contingency	20%		45,100
Annual Operating Cost (Years 1-5)			315,600

TABLE 5-8 (Continued)

Cost Analysis of Remedial Alternative 7
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
Annual Operating Cost Subtotal (Years 6-30)			41,000
Indirect	20%		8,200
Contingency	20%		8,200
Annual Operating Cost (Years 6-30)			57,400
Present Worth (Years 1-5)	315,600 /year	@ 8%	1,260,100
Present Worth (Years 6-30)	57,400 /year	@ 8%	417,000
Present Worth Operating Cost			1,677,100
III Present Worth Alternative 7			
Capital Cost			10,255,500
Operating Cost			1,677,100
Total Present Worth			11,932,600

98/2

- Consolidation of the cathode waste material from the Unloading Area into a newly constructed on-site RCRA landfill;
- Consolidation of the residual cathode waste material and underlying fill material from the Former Cathode Waste Management Areas into a newly constructed on-site RCRA landfill;
- Consolidation of the scrubber sludge material and underlying fill from Scrubber Sludge Ponds 1 through 4 into a newly constructed on-site RCRA landfill;
- Temporary collection and treatment of leachate generated from the Landfill and perched water from the Former Cathode Waste Management Areas and east of River Road;
- Ground-water recovery and treatment;
- Ground-water quality monitoring; and
- Access and deed restrictions.

A detailed description of these actions is presented in Section 4.2.3.2.

Short-Term Effectiveness

Implementation of Remedial Alternative 8 should not pose a threat to the community and would pose minimal threats to on-site construction workers. The potential risks to on-site workers would result from handling wastes from the Landfill, Unloading Area, Former Cathode Waste Management Areas and Scrubber Sludge Ponds during consolidation of the waste materials into the new RCRA landfill. Although, utilization of dust suppressants, protective clothing and respiratory protection in conjunction with a health and safety plan

during remediation would greatly reduce this risk, the use of dust suppressants would also reduce the potential for causing any adverse environmental impacts. It is expected that implementation of this remedial alternative would take less than two years to complete.

Long-Term Effectiveness

The technologies utilized in this alternative including a RCRA landfill and ground-water recovery, leachate and perched water collection and treatment systems are expected to meet performance standards or process efficiencies. The RCRA landfill would be effective in reducing infiltration into the landfill and leachate generated from the landfill. This landfill would also be effective in reducing the potential for direct contact with the waste. Fencing the RCRA landfill and recording deed restrictions for this area would also reduce the potential for direct contact with the waste. Because waste is removed from the Landfill, Unloading Area, Former Cathode Waste Management Areas and the Scrubber Sludge Ponds, the potential for future exposure at these areas is greatly minimized.

Long-term maintenance would be required for the RCRA landfill in the way of periodic inspections, regrading, filling of depressions should they occur and periodic inspections of the leachate collection system. The

ground-water recovery system and perched water collection system would require pump and piping maintenance on an as needed basis and the treatment system would require conventional operation and maintenance functions.

Long-term ground-water quality monitoring would be required for the RCRA landfill to monitor its effectiveness and for all target remediation areas to monitor variations in ground-water quality. Ground-water monitoring would also be required to monitor the effectiveness of the recovery systems until it is verified that the affected ground water is recovered.

The overall potential for failure of the RCRA landfill is minimal. Landfills of this type have been proven reliable at other waste management sites and would be effective at the MMRF. The potential for failure of the ground-water recovery system, leachate and perched water collection and treatment systems are also minimal with proper maintenance.

Reduction of Toxicity, Mobility or Volume

Remedial Alternative 8 treats the leachate generated from the existing Landfill, leachate from the RCRA landfill and perched water where required, which reduces the toxicity, mobility and volume of these waste streams. However, the contaminated soils, sediments and waste materials consolidated into the RCRA landfill are not treated.

Implementability

The technologies associated with Remedial Alternative 8 are implementable at the MMRF. Air emission problems may result from handling the wastes from all of the target remediation areas. However, dust suppressants would be utilized to the maximum extent practical to minimize emissions. Additional monitor wells will be required to monitor the effectiveness of the RCRA Landfill. The existing monitor well network would be sufficient to monitor the effectiveness of the ground-water recovery systems and to monitor variations in ground-water quality at the target remediation areas. It is expected that after successful implementation of this alternative, no additional remedial actions would be required.

The equipment, materials, specialists and work force necessary to implement this remedial alternative are available to the MMRF. Also, the technologies utilized have been proven at other waste management sites and except for the aqueous treatment system, could be implemented without further development. A bench scale study would be required to verify the effectiveness and configuration of the aqueous treatment system. The results of this study would be utilized in the final design of the full scale system.

Compliance with ARARs

The existing leachate generated from the Landfill and perched water exceed the chemical specific ARARs for cyanide and fluoride and/or sulfate. Also the ground water at the Landfill, Former Cathode Waste Management Areas, Unloading Area, Scrubber Sludge Ponds and Recycle Pond exceed the chemical-specific ARARs for fluoride and/or sulfate. Remedial Alternative 8 would greatly minimize future leachate generation from the Landfill and former Cathode Waste Management Areas by completely excavating these areas and removing the sources. The existing leachate from the Landfill and perched water east of River Road and from the Former Cathode Waste Management Areas would be collected and treated to meet remediation criteria prior to discharge. The ground water from the areas discussed above would also be recovered. Remedial Alternative 8 would also meet applicable location and action specific ARARs.

Overall Protection

After implementation, Remedial Alternative 8 would meet applicable location, action, and chemical specific ARARs. The risks at the MMRF will be greatly reduced by containing all waste materials from the target remediation areas in the RCRA landfill, recovery of affected ground water and collection and treatment of leachate and perched water. Containment of the waste reduces the potential for direct

contact with the waste and recovery of affected ground water and treatment of the leachate and perched water greatly minimizes the potential for off-site migration of contaminants.

Cost

The capital cost of Remedial Alternative 8 is $18,881,000. The annual O&M costs for years 1 through 5 will be $383,500. The annual O&M costs for years 6 through 30 will be $125,300. The total present worth value of this alternative using a discount rate of 8% is $21,322,700. The detailed development of these costs is presented in Table 5-9.

5.2.9 Remedial Alternative 9: Containment with Consolidation, Stabilization and Ground-Water Recovery and Treatment

Remedial Alternative 9 consists of the following actions:

- Consolidation of the cathode waste material from the Unloading Area into the existing Landfill;
- Consolidation of the residual cathode waste material and underlying fill material from the Former Cathode Waste Management Areas into the existing Landfill;
- Capping the existing Landfill in place with a multi-media cap meeting RCRA performance standards;
- Stabilization of Scrubber Sludge Ponds 1 through 4 and covering the stabilized material;
- Collection and treatment of leachate generated from the Landfill and perched water from the Former Cathode Waste Management Areas and east of River Road;

TABLE 5-9

Cost Analysis of Remedial Alternative 8
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
I Capital Cost			
A Ground Water Recovery System (45 gpm)			
Four-inch Recovery Well	4,000 each	14	56,000
Plumbing System			
Submersible Pump	700 each	15	10,500
Controls	1,000 LS	15	15,000
Electrical Connection	5,000 LS	15	75,000
Discharge Line			
Two-inch PVC	10 /foot	5,000	50,000
Three-inch PVC	12 /foot	4,000	48,000
		Subtotal	**254,500**
B Aqueous Treatment System			
Building (20'x40')	25,000 LS	1	25,000
Site Prep	5,000 LS	1	15,000
Oxidation Unit	75,000 LS	1	75,000
Chemical Precip. Unit	90,000 LS	1	90,000
Fluoride Polishing Unit	75,000 LS	1	75,000
Electrical - Controls	10,000 LS	1	10,000
		Subtotal	**290,000**
C Production Well Abandonment P&A Existing Wells and Connect to City Water	**15,000 /house**	**4**	**60,000**
D Consolidate Into On-site RCRA Landfill			
Excavate Landfill	7 /CY	200,000	1,400,000
Asbestos Removal and Handling	150,000 LS	1	150,000
Backfill	5 /CY	24,000	120,000
Excavate Ditches and Hauling	8 /CY	3,290	26,400
Excavate Unloading Area			
Excavation and Hauling	8 /CY	200	1,600
Backfill	5 /CY	200	1,000
Excavate Cathode Waste Areas			
Excavation and Hauling	8 /CY	64,470	515,800
Backfill	5 /CY	64,470	322,400
Excavate Scrubber Sludge Ponds			
Soil Mixing	1.25 /CY	139,400	174,300
Excavation	7 /CY	168,418	1,179,000
Backfill	5 /CY	47,755	238,800
		Subtotal	**4,129,300**

TABLE 5-9 (Continued)

Cost Analysis of Remedial Alternative 8
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
E Construct RCRA Landfill			
Site Preparation	200,000 LS	1	200,000
Containment Dike	5 /CY	169,000	845,000
Clay Liner	30 /CY	31,700	951,000
Geomembrane (60 mil)	0.70 /SF	450,000	315,000
Leak Detection System	5,100 /acre	12.7	64,800
Geomembrane (60 mil)	0.70 /SF	450,000	315,000
Leachate Collection System	12,580 /acre	12.7	159,800
Segregation	10 /CY	50,000	500,000
Grade and Roll	0.75 /CY	25,000	18,800
Gas Venting System	7,100 /acre	12.7	90,200
Geomembrane (60 mil)	0.70 /SF	552,000	386,400
Clay Liner	30 /CY	40,890	1,226,700
Sand Layer	7 /CY	20,440	143,100
Wire Mesh	0.75 /SF	552,000	414,000
Geotextile Fabric	0.20 /SF	552,000	110,400
Top Soil	8 /CY	15,533	124,300
		Subtotal	**5,864,500**
F Perched Water Collection System	**60,000**	**2**	**60,000**
G Relocation of Facilities			
Diverting Surface Runoff	10,000 LS	1	10,000
Removing Scrubber Discharge	20 /foot	800	16,000
Replacing Scrubber Discharge	40 /foot	800	32,000
Removing Railroad Spur	25 /foot	200	5,000
Replacing Railroad Spur	125 /foot	200	25,000
Protecting/Repairing Monitor Wells	3,000 /each	10	30,000
Disassemble Crusher	5,000 LS	1	5,000
Electrical Transmission Line Replacement Towers	250,000 LS	1	250,000
		Subtotal	**373,000**
H Controls			
Security Fences	47,000 LS	1	47,000
Security Fence Replacment (15 yrs)	15,000 LS	1	15,000
Deed Restrictions	5,000 LS	1	5,000
Institutional Controls	8,000 LS	1	8,000
		Subtotal	**75,000**

TABLE 5-9 (Continued)

Cost Analysis of Remedial Alternative 8
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
Alternative 8 Subtotal			11,106,300
Engineering	15%		1,666,000
Indirect	10%		1,110,700
Contingency	25%		2,776,600
Inspection	10%		1,110,700
Health & Safety	10%		1,110,700
Alternative 8 Total Capital Cost			18,881,000
II Annual Operating Cost			
A Ground Water Monitoring (36 wells)			
First year (Quarterly)	63,000 /year	1	63,000
Second year (Semi-annually)	32,000 /year	1	32,000
Remaining years (Annually)	16,000 /year	1	16,000
Equivalent Annuity (years 1-5)	30,400 /year	1	30,400
Annuity (years 6-30)	16,000 /year	1	16,000
B Security Fence Maintenance	2,000 /year	1	2,000
C Treatment (5 years only)			
Electric Power			
Recovery System	26,000 /year	1	26,000
Treatment System	40,000 /year	1	40,000
Chemicals	15,000 /year	1	15,000
Operator	30,000 /year	1	30,000
Management	50,000 /year	0.25	12,500
Maintenance			
Recovery System	12,000 /year	1	12,000
Treatment System	14,500 /year	1	14,500
Plant Analysis Samples	20,000 /year	1	20,000
		Subtotal	170,000
D On-site RCRA Landfill Inspection and Maintenance	71,500 /year	1	71,500
Annual Operating Cost Subtotal (Years 1-5)			273,900
Indirect	20%		54,800
Contingency	20%		54,800
Annual Operating Cost (Years 1-5)			383,500

TABLE 5-9 (Continued)

Cost Analysis of Remedial Alternative 8
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
Annual Operating Cost Subtotal (Years 6-30)			89,500
Indirect	20%		17,900
Contingency	20%		17,900
Annual Operating Cost (Years 6-30)			125,300
Present Worth (Years 1-5)	383,500 /year	@ 8%	1,531,300
Present Worth (Years 6-30)	125,300 /year	@ 8%	910,400
Present Worth Operating Cost			2,441,700
III Present Worth Alternative 8			
Capital Cost			18,881,000
Operating Cost			2,441,700
Total Present Worth			21,322,700

098/2

- Ground-water recovery and treatment;
- Ground-water quality monitoring; and
- Access and deed restrictions.

A detailed description of these actions is presented in Section 4.2.3.3.

Short-Term Effectiveness

Implementation of Remedial Alternative 9 should not pose a threat to the community and would pose minimal threats to on-site construction workers. Potential risks to on-site workers would result from dust generation during waste handling activities at the Landfill, Unloading Area, and the Former Cathode Waste Management Areas during consolidation of the waste materials into the existing Landfill. Dust emissions may also occur during mixing operations at the Scrubber Sludge Ponds to stabilize the sludge. Utilization of the dust suppressants, protective clothing and respiratory protection discussed previously and implementing a health and safety plan during remediation would minimize this risk. The use of dust suppressants would also reduce the potential for airborne migration of contaminants to the environment. It is expected that implementation of this remedial alternative would take less than two years to complete.

Long-Term Effectiveness

Remedial Alternative 9 would effectively mitigate the existing risks at the site and would adequately protect the public and the environment from future exposure to the waste. The Landfill cap would isolate the waste from infiltrating surface water, thus reducing leachate generation to negligible quantities. In addition, the cap would reduce the potential for direct contact with the waste. Stabilization of the waste in the Scrubber Sludge Ponds would reduce leaching of fluoride from the sludge while the soil cover on the waste would reduce the potential for human or wildlife contact with the waste. Recovery of contaminated ground water would minimize the potential for off-site migration of ground-water contaminants and would ultimately minimize ground-water contamination at the site. Perched water and leachate would be collected and treated.

The technologies utilized in this alternative including a cap, stabilization, ground-water recovery, leachate and perched water collection and treatment systems are expected to meet performance standards or process efficiencies, although bench scale studies would have to be performed to verify the effectiveness of the aqueous treatment system and stabilization agent utilized. Because waste is removed from the Unloading Area and Former Cathode Waste Management Areas the potential for future exposure at these areas is greatly

minimized. Fencing the Landfill and Scrubber Sludge Ponds would also reduce the potential for direct contact with the waste.

Long-term maintenance would be required for the Landfill cap and Scrubber Sludge Pond cover system in the way of periodic inspections, regrading and filling of depressions should they occur. The leachate collection system for the Landfill and perched water collection system would require periodic inspections and cleaning as necessary. The ground-water recovery system would require pump and piping maintenance on an as needed basis and the treatment system would require conventional operation and maintenance functions.

Long-term ground water quality monitoring would be required for the target remediation areas to monitor variations in ground-water quality. Ground-water monitoring would also be required to monitor the effectiveness of the recovery systems until it is verified that affected ground water is recovered.

The overall potential for failure of the Landfill cap and Scrubber Sludge Ponds cover are minimal. Caps and cover systems such as the ones utilized in this alternative have been proven reliable at other waste management sites and would be effective at the MMRF. The potential for failure of the leachate and perched water collection systems and

ground-water recovery and treatment systems are also minimal with proper maintenance. The potential for failure of the stabilized Scrubber Sludge Pond sludge is unknown. Data is not available to verify the long-term effectiveness of the stabilization process for materials such as those present in the Scrubber Sludge Ponds.

Reduction of Toxicity, Mobility or Volume

Remedial Alternative 9 recovers ground water from the areas of affected ground water and treats leachate and perched water which reduces the toxicity, mobility and volume of these waste streams. Stabilization will increase the volume of sludge in the Scrubber Sludge Ponds which is contrary to the objective of SARA, while failing to reduce the potential risk from polynuclear aromatic hydrocarbons to the public; requiring subsequent covering. Furthermore, stabilization for leaching of fluoride from the sludge has not been specifically conducted and bench scale testing will be required. Reduction of the mobility of fluoride from the sludge through stabilization may occur. Contaminated soils, sediments and waste materials consolidated into the existing Landfill are not treated.

Implementability

The technologies associated with Remedial Alternative 9 are implementable at the MMRF. Air emission problems may result from handling the wastes from the Landfill, Unloading

Area, and Former Cathode Waste Management Areas and from mixing required for stabilization of the waste in the Scrubber Sludge Ponds. However, dust suppressants would be utilized to the maximum extent practical to minimize emissions. The existing monitor well network at the MMRF is sufficient to monitor variations in ground-water quality at the target remediation areas. The existing monitor well network would also be sufficient to monitor the effectiveness of the recovery systems for the areas of affected ground water. It is expected that after successful implementation of this alternative, no additional remedial actions would be required.

The equipment materials, specialists and work force necessary to implement this remedial alternative are available to the MMRF. Also, the technologies utilized have been proven at other waste management sites and except for the aqueous treatment system and stabilization could be implemented without further development. A bench scale study would be required to verify the effectiveness and configuration of the aqueous treatment system. The results of this study would be utilized in the final design of the full scale system. A bench scale study would also be required to determine if stabilization of the Scrubber Sludge Pond sludges will be effective.

Compliance with ARARs

The existing leachate generated from the Landfill and the perched water east of River Road and from the Former Cathode Waste Management Areas exceed the chemical-specific ARARs for cyanide and fluoride and/or sulfate. Also the ground-water at the Landfill and Former Cathode Waste Management Areas, Unloading Area, Scrubber Sludge Ponds and Recycle Pond exceed the chemical-specific ARAR for fluoride. Remedial Alternative 9 would greatly minimize future generation of perched water from the Former Cathode Waste Management Areas by completely excavating these areas and removing the source. The leachate generated from the Landfill and perched water would be collected and treated to meet remediation criteria prior to discharge. The ground water from the affected areas would also be recovered. Remedial Alternative 9 would also meet applicable location-specific ARARs.

Overall Protection

After implementation, Remedial Alternative 9 would meet applicable location, action, and chemical specific ARARs. The risks at the MMRF would be minimized by containing all waste materials from the Unloading Area and Former Cathode Waste Management Areas into the existing Landfill, recovering affected ground water and collection and treatment of leachate and perched water. Containment of these wastes

reduces the potential for direct contact with the waste and also reduces the potential for leachate generation. Stabilizing the Scrubber Sludge Ponds requires covering the stabilized material with a soil cover to reduce the potential risks associated with cPAHs. The effectiveness of stabilizing the sludge in the Scrubber Sludge Ponds to minimize the leaching of fluorides is questionable without bench testing. Also, recovery of ground water and collection and treatment of leachate and perched water greatly minimizes the potential for future off-site migration of contaminants.

Costs

The capital cost of Remedial Alternative 9 is $14,530,700. The annual O&M costs for years 1 through 5 will be $312,000. The annual O&M costs for years 6 through 30 will be $53,800. The total present worth value of this alternative using a discount rate of 8% is $16,167,400. The detailed development of these costs is presented in Table 5-10.

5.2.10 Remedial Alternative 10: Incineration, Stabilization, and Ground-Water Recovery and Treatment

Remedial Alternative 10 consists of the following actions:

- Excavation, segregation where possible, transportation and incineration of the contaminated soils, sediments and wastes from the Landfill, Unloading Area and Former Cathode Waste Management Areas;

TABLE 5-10

Cost Analysis of Remedial Alternative 9
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
I Capital Cost			
A Ground Water Recovery System (45 gpm)			
Four-inch Recovery Well	4,000 each	14	56,000
Plumbing System			
Submersible Pump	700 each	15	10,500
Controls	1,000 LS	15	15,000
Electrical Connection	5,000 LS	15	75,000
Discharge line			
Two-inch PVC	10 /foot	5,000	50,000
Three-inch PVC	12 /foot	4,000	48,000
		Subtotal	**254,500**
B Aqueous Treatment System			
Building (20'x40')	25,000 LS	1	25,000
Site Prep	15,000 LS	1	15,000
Oxidation Unit	75,000 LS	1	75,000
Chemical Precip. Unit	90,000 LS	1	90,000
Fluoride Polishing Unit	75,000 LS	1	75,000
Electrical - Controls	10,000 LS	1	10,000
		Subtotal	**290,000**
C Production Well Abandonment P&A Existing Wells and Connect to City Water	**15,000 /house**	**4**	**60,000**
D Consolidate Existing Landfill			
Regrade Landfill	3.50 /CY	40,000	140,000
Excavate and Haul Ditches	8 /CY	3,290	26,400
Excavate Unloading Area			
Excavation and Hauling	8 /CY	200	1,600
Backfill	5 /CY	200	1,000
Excavate Cathode Waste Areas			
Excavation and Hauling	8 /CY	64,470	515,800
Backfill	5 /CY	64,470	322,400
		Subtotal	**1,007,200**
E Landfill Performance Cap (10 Acre)			
Site Preparation	100,000 LS	1	100,000
Soil Backfill	5 /CY	6,200	31,000
Rough Grading	0.75 /CY	115,600	86,700
Perimeter Ditches	15 /foot	4,000	60,000
Sand Layer	7 /CY	7,800	54,600
Piping/Risers	6 /foot	1,000	6,000
Sterilization	1,000 /acre	10	10,000
Geomembrane	0.70 /SF	440,000	308,000
Soil Layer	7 /YD	15,600	109,200
Wire Mesh	0.75 /SF	435,600	326,700
Geotextile Fabric	0.20 /SF	461,000	92,200
Top Soil	8 /CY	15,600	124,800
Leachate Collection System	66,000 LS	1	66,000
		Subtotal	**1,375,200**

TABLE 5-10 (Continued)

Cost Analysis of Remedial Alternative 9
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
F Perched Water Collection System	**60,000 /LS**	**1**	**60,000**
G Relocation of Facilities			
Rerouting North Ditch	69,000 LS	1	69,000
Diverting Surface Runoff	10,000 LS	1	10,000
Rerouting Landfill Ditch	36,000 LS	1	36,000
Removing Scrubber Discharge	20 /foot	800	16,000
Replacing Scrubber Discharge	40 /foot	800	32,000
Removing Railroad Spur	25 /foot	200	5,000
Replacing Railroad Spur	125 /foot	200	25,000
Protecting/Repairing Monitor Wells	3,000 /each	10	30,000
Disassemble Crusher	5,000 LS	1	5,000
Electrical Transmission Line Replacement Towers	250,000 LS	1	250,000
		Subtotal	**478,000**
H Sludge Pond Stabilization			
Site Preparation	200,000 LS	1	200,000
Agent Mixing	25 /CY	168,400	4,210,000
Top Soil	8 /CY	47,600	380,800
Drainage	10 /foot	3,000	30,000
		Subtotal	**4,820,800**
I Controls			
Security Fences	146,000 LS	1	146,000
Security Fence Replacment (15 yrs)	42,600 LS	1	42,600
Deed Restrictions	5,000 LS	1	5,000
Institutional Controls	8,000 LS	1	8,000
		Subtotal	**201,600**
Alternative 9 Subtotal			**8,547,300**
Engineering	15%		1,282,100
Indirect	10%		854,800
Contingency	25%		2,136,900
Inspection	10%		854,800
Health & Safety	10%		854,800
Alternative 9 Total Capital Cost			**14,530,700**

TABLE 5-10 (Continued)

Cost Analysis of Remedial Alternative 9
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
II Annual Operating Cost			
A Ground Water Monitoring (36 wells)			
First year (Quarterly)	60,000 /year	1	63,000
Second year (Semi-annually)	32,000 /year	1	32,000
Remaining Years (Annually)	16,000 /year	1	16,000
Equivalent Annuity (Years 1-5)	30,400 /year	1	30,400
Annuity (Years 6-30)	16,000 /year	1	16,000
B Security Fence Maintenance	2,000 /year	1	2,000
C Treatment (5 years only)			
Electric Power			
Recovery System	26,000 /year	1	26,000
Treatment System	40,000 /year	1	40,000
Chemicals	15,000 /year	1	15,000
Operator	30,000 /year	1	30,000
Management	50,000 /year	0.25	12,500
Maintenance			
Recovery System	12,000 /year	1	12,000
Treatment System	14,500 /year	1	14,500
Plant Analysis Samples	20,000 /year	1	20,000
		Subtotal	170,000
D Scrubber Pond Maintenance	5,400 /year	1	5,400
E Landfill Performance Cap Inspection and Maintenance	15,000 /year	1	15,000
Annual Operating Cost Subtotal (Years 1-5)			222,800
Indirect	20%		44,600
Contingency	20%		44,600
Annual Operating Cost (Years 1-5)			312,000

TABLE 5-10 (Continued)

Cost Analysis of Remedial Alternative 9
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
Annual Operating Cost Subtotal (Years 6-30)			38,400
Indirect	20%		7,700
Contingency	20%		7,700
Annual Operating Cost (Years 6-30)			53,800
Present Worth (Years 1-5)	312,000 /year	@ 8%	1,245,800
Present Worth (Years 6-30)	53,800 /year	@ 8%	390,900
Present Worth Operating Cost			1,636,700
III Present Worth Alternative 9			
Capital Cost			14,530,700
Operating Cost			1,636,700
Total Present Worth			16,167,400

098/2

- Containment of the incinerator ash in an on-site RCRA landfill;
- Stabilization of Scrubber Sludge Ponds 1 through 4 and covering the stabilized material with a soil cover;
- Collection and treatment of leachate from the existing Landfill and perched water east of River Road and from the Former Cathode Waste Management Areas;
- Ground-water recovery and treatment;
- Ground-water quality monitoring; and
- Access and deed restrictions.

A detailed description of these actions is presented in Section 4.2.4.1.

Short-Term Effectiveness

Implementation of Remedial Alternative 10 should not pose a threat to the community and would pose minimal threats to on-site construction workers. The potential risks to on-site workers would result from handling wastes from the Landfill, Unloading Area and Former Cathode Waste Management Areas, while preparing the wastes for incineration and from mixing the material in the Scrubber Sludge Ponds during the stabilization process. However, utilization of the dust suppressants, protective clothing and respiratory protection in conjunction with a health and safety plan during remediation would greatly reduce these risks. The use of dust suppressants would also minimize the potential for adverse effects to the environment to occur during waste

management operations. Stringent air emission controls would be required on the flue stack of the incinerator to minimize releases of hydrogen fluoride or asbestos to the atmosphere. Stabilization of the Scrubber Sludge Ponds should take less than two years to complete. Incineration of the Landfill, Unloading Area and Former Cathode Waste Management Areas wastes is estimated to take more than five years to complete.

Long-Term Effectiveness

Implementation of Remedial Alternative 10 would thermally destroy the majority of the cyanide; and its effect on the polynuclear aromatic hydrocarbons contained in the waste is unknown. However, incineration of the waste material at the MMRF would generate an ash which contains residual cyanide, polynuclear aromatic hydrocarbons, fluoride, asbestos and other constituents. This ash would require land disposal in a secure landfill to adequately protect public health and the environment. Ground-water recovery would minimize the potential for contaminated ground water or perched water to migrate off-site. Landfill leachate would be collected and treated as the Landfill waste is being removed for incineration, minimizing the risk associated with wildlife contacting the contaminated liquid. Likewise, perched water would be collected and treated as the contaminated material from the Former Cathode Waste Management Areas is removed for incineration. The potential for contaminated perched water to migrate should be greatly

minimized upon completion of this alternative. The technologies utilized in this alternative including incineration, stabilization, containment in a RCRA landfill as well as a soil cover system and ground-water recovery system and aqueous treatment system are expected to meet performance standards or process efficiencies.

Ash management requires an on-site RCRA landfill to reduce the potential for generation of leachate and to minimize direct contact with the waste. The RCRA landfill would be effective in performing both of these functions.

Stabilization of Scrubber Sludge Ponds 1 through 4 may reduce the potential for leaching of fluoride from the sludge while the soil cover placed on the stabilized material is required to minimize potential risks associated with PAHs for direct contact with the waste. The ground-water recovery and treatment system would be effective in recovering and treating ground water containing fluoride.

Long-term maintenance would be required for the RCRA landfill and Scrubber Sludge Pond cover system in the way of periodic inspections, regrading and filling of depressions should they occur. The ground-water recovery system and leachate and perched water collection system would require pump and piping maintenance on an as needed basis and the aqueous treatment system would require conventional operation and maintenance functions.

Long-term ground-water quality monitoring would be required for the RCRA Landfill to monitor the effectiveness of the containment system and for all target remediation areas to monitor variations in ground-water quality. Ground-water monitoring would also be required for the areas where ground-water recovery is required to monitor the effectiveness of the ground-water recovery systems until it is verified that affected ground water is recovered.

The overall potential for failure of the cap on the RCRA landfill and soil cover on the Scrubber Sludge Ponds is minimal. The RCRA landfill and soil cover systems such as the ones utilized in this alternative have been proven reliable at other waste management sites and would be effective at the MMRF. The potential for failure of the perched water and leachate collection systems, ground-water recovery system and aqueous treatment system are also minimal with proper maintenance. The potential for failure of the stabilized Scrubber Sludge Pond sludge is unknown. Data is not available to verify the long-term effectiveness of the stabilization process for materials such as those present in the Scrubber Sludge Ponds.

Reduction of Toxicity, Mobility or Volume

Although the major actions implemented in Remedial Alternative 10 (incineration and stabilization) were developed for treatment of wastes, the majority of the wastes

present at the MMRF are not treated by these processes. The incineration process will not reduce constituents below the remediation criteria and only reduces the volume of the wastes by approximately 10 percent. The treatment processes utilized reduces the toxicity, mobility and/or volume of the wastes. Incineration of the Landfill, Unloading Area and Former Cathode Waste Management Area wastes reduces the volume of these wastes but the toxicity for the constituents of concern may be reduced only to have new toxic constituents formed as a result of the combustion process. Stabilization of the Scrubber Sludge Ponds may reduce the mobility of fluoride leaching from the waste.

Implementability

The technologies associated with Remedial Alternative 10 are implementable at the MMRF. Air emission problems may result from handling the waste from the Landfill, Unloading Area and Former Cathode Waste Management Areas in preparation for incineration. Emissions may also result from mixing the Scrubber Sludge Ponds material during stabilization. However, dust suppressants would be utilized to the maximum extent practical to minimize emissions.

A monitor well network will be required to monitor the effectiveness of the RCRA landfill. The existing monitor well network would also be sufficient to monitor variations in ground-water quality at the target remediation areas and

the effectiveness of the ground-water recovery systems. It is expected that after successful implementation of this alternative, no additional remedial actions would be required. It is also anticipated that approvals, although difficult, could be obtained from the regulatory agencies to implement this alternative. The equipment, materials and specialists necessary to implement this remedial alternative are available to the MMRF. The containment systems and ground-water recovery systems have been proven at other waste management sites and could be implemented at the MMRF without further development. However, bench scale studies would have to be performed for stabilization of the Scrubber Sludge Pond sludges to select an adequate stabilization agent and for the aqueous treatment system to aid in final design of the full scale treatment system. Also, the incineration process would require a trial burn to verify the effectiveness of the system.

Compliance with ARARs

The existing leachate generated from the Landfill and the perched water east of River Road and at the Former Cathode Waste Management Areas exceed the chemical-specific ARARs for cyanide and fluoride. Also, the ground-water at the Landfill and Former Cathode Waste Management Areas, Unloading Area, Scrubber Sludge Ponds and Recycle Pond exceed the chemical-specific ARARs for fluoride and/or sulfate. Remedial Alternative 10 would greatly minimize future

generation of leachate from the Landfill and perched water by excavating these areas and removing the sources. The existing leachate and perched water would be collected and treated to meet remediation criteria prior to discharge. The ground water from the areas of affected ground water would also be recovered.

Overall Protection

After implementation, Remedial Alternative 10 would meet location, action, and chemical specific ARARs. The risks at the MMRF would be greatly minimized by partially treating and containing all waste materials from the target remediation areas, recovering affected ground water and collection and treatment of leachate and perched water. Containment of the incinerator ash minimizes the potential for direct contact with the waste and also minimizes the potential for leachate generation. Stabilizing the Scrubber Sludge Ponds and covering the stabilized material with a soil cover greatly reduces the potential for future leachate generation and also reduces the potential for direct contact with the waste. Recovery of affected ground water and treatment of the leachate and perched water greatly minimizes the potential for off-site migration of contaminants. Because this alternative minimizes the pathways of exposure, it is protective of human health and the environment.

Cost

The capital cost of Remedial Alternative 10 is $15,948,900. The annual O&M costs for years 1 through 5 will be $5,987,000. The annual O&M costs for years 6 through 30 will be $67,200. The total present worth value of this alternative using a discount rate of 8% is $40,341,500. The detailed development of these costs is presented in Table 5-11.

5.3 SUMMARY OF THE DETAILED ANALYSIS OF ALTERNATIVES

A summary of the detailed analysis of the ten remedial alternatives is presented in Tables 5-12 through 5-21 and Drawing A-6. This summary provides a means to compare the remedial alternatives for the nine evaluation criteria discussed in Section 5.1. With the exception of Alternative 1, Limited Action, all alternatives involve source control and management of migration actions. The precision of the information presented on Tables 5-12 through 5-21 is consistent with the present level and extent of knowledge concerning waste management areas at the MMRF.

109/2

TABLE 5-11

Cost Analysis of Remedial Alternative 10
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
I Capital Cost			
A Ground Water Recovery System (45 gpm)			
Four-inch Recovery Well	4,000 each	14	56,000
Plumbing System			
Submersible Pump	700 each	15	10,500
Controls	1,000 LS	15	15,000
Electrical Connection	5,000 LS	15	75,000
Discharge line			
Two-inch PVC	10 /foot	5,000	50,000
Three-inch PVC	12 /foot	4,000	48,000
		Subtotal	**254,500**
B Aqueous Treatment System			
Building (20'x40')	25,000 LS	1	25,000
Site Prep	15,000 LS	1	15,000
Oxidation Unit	75,000 LS	1	75,000
Chemical Precip. Unit	90,000 LS	1	90,000
Fluoride Polishing Unit	75,000 LS	1	75,000
Electrical - Controls	10,000 LS	1	10,000
		Subtotal	**290,000**
C Production Well Abandonment P&A Existing Wells and Connect to City Water	**15,000 /house**	**4**	**60,000**
D Incineration			
Site Preparation	1,000,000 LS	1	1,000,000
Equipment Building	500,000 LS	1	500,000
Air Polution Controls	60,000 LS	1	60,000
		Subtotal	**1,560,000**
E Construct RCRA Landfill for Ash Management			
Site Preparation	100,000 LS	1	100,000
Perimeter Dike	5 /CY	103,700	518,500
Clay Liner	30 /CY	13,100	393,000
Geomembrane (60 mil)	0.70 /SF	183,200	128,300
Leak Detection System	5,100 /acre	5.7	29,100
Geomembrane (60 mil)	0.70 /SF	183,200	128,300
Leachate Collection System	12,315 /acre	5.7	70,200
Grade and Roll	0.75 /CY	20,000	15,000
Gas Venting System	7,525 /acre	5.7	42,900
Geomembrane (60 mil)	0.70 /SF	250,000	175,000
Clay Liner	30 /CY	4,630	138,900
Clean Sand Layer	7 /CY	4,630	32,500
Wire Mesh	0.75 /SF	250,000	187,500
Geotextile Fabric	0.20 /SF	250,000	50,000
Top Soil	8 /CY	4,630	37,100
		Subtotal	**2,046,300**

TABLE 5-11 (Continued)

Cost Analysis of Remedial Alternative 10
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
F Perched Water Collection System	60,000 /LS	1	60,000
G Relocation of Facilities			
Diverting Surface Runoff	10,000 LS	1	10,000
Removing Scrubber Discharge	20 /foot	800	16,000
Replacing Scrubber Discharge	40 /foot	800	32,000
Removing Railroad Spur	25 /foot	200	5,000
Replacing Railroad Spur	125 /foot	200	25,000
Protecting/Repairing Monitor Wells	3,000 /each	10	30,000
Disassemble Crusher	5,000 LS	1	5,000
		Subtotal	**123,000**
H Sludge Pond Stabilization			
Site Preparation	200,000 LS	1	200,000
Agent Mixing	25 /CY	168,400	4,210,000
Top Soil	8 /CY	47,600	380,800
Drainage	10 /foot	3,000	30,000
		Subtotal	**4,820,800**
I Controls			
Security Fences	117,000 LS	1	117,000
Security Fence Replacment (15 yrs)	37,000 LS	1	37,000
Deed Restrictions	5,000 LS	1	5,000
Institutional Controls	8,000 LS	1	8,000
		Subtotal	**167,000**
Alternative 10 Subtotal			**9,381,600**
Engineering	15%		1,407,300
Indirect	10%		938,200
Contingency	25%		2,345,400
Inspection	10%		938,200
Health & Safety	10%		938,200
Alternative 10 Total Capital Cost			**15,948,900**

TABLE 5-11 (Continued)

Cost Analysis of Remedial Alternative 10
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
II Annual Operating Cost			
A Ground Water Monitoring (36 wells)			
First year (Quarterly)	63,000 /year	1	63,000
Second year (Semi-annually)	32,000 /year	1	32,000
Remaining years (Annually)	16,000 /year	1	16,000
Equivalent Annuity (Years 1-5)	30,400 /year	1	30,400
Annuity (Years 6-30)	16,000 /year	1	16,000
B Security Fence Maintenance	2,000 /year	1	2,000
C Treatment (5 years only)			
Electric Power			
Recovery System	26,000 /year	1	26,000
Treatment System	40,000 /year	1	40,000
Chemicals	15,000 /year	1	15,000
Operator	30,000 /year	1	30,000
Management	50,000 /year	0.25	12,500
Maintenance			
Recovery System	12,000 /year	1	12,000
Treatment System	14,500 /year	1	14,500
Plant Analysis Samples	20,000 /year	1	20,000
		Subtotal	170,000
D Scrubber Sludge Ponds	5,400 /year	1	5,400
E RCRA Landfill	24,600 /year	1	24,600
F Incineration (5 years only)			
Segregation	10 /CY	13,690	136,900
Loading and Hauling	3.60 /CY	40,500	145,800
Crush and Grind	8 /CY	40,500	324,000
Incineration Process	45 /ton	75,940	3,417,300
Sampling Analysis	20,000 LS	1	20,000
		Subtotal	4,044,000
Annual Operating Cost Subtotal (Years 1-5)			4,276,400
Indirect	20%		855,300
Contingency	20%		855,300
Annual Operating Cost (Years 1-5)			5,987,000

TABLE 5-11 (Continued)

Cost Analysis of Remedial Alternative 10
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	Description	Unit Cost ($)	Quantity	Cost ($)
	Annual Operating Cost Subtotal (Years 6-30)			48,000
	Indirect	20%		9,600
	Contingency	20%		9,600
	Annual Operating Cost (Years 6-30)			67,200
	Present Worth (Years 1-5)	5,987,000 /year	@ 8%	23,904,300
	Present Worth (Years 6-30)	67,200 /year	@ 8%	488,300
	Present Worth Operating Cost			24,392,600
III	Present Worth Alternative 11			
	Capital Cost			15,948,900
	Operating Cost			24,392,600
	Total Present Worth			40,341,500

098/2

TABLE 5-12

Detailed Analysis Summary of Remedial Alternative 1
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

REMEDIAL ALTERNATIVE 1

Limited Action

- o LF - Fence and Leachate Collection
- o UA - Fence
- o FCW - Fence
- o SSP - Fence
- o GW - Monitoring
  - Deed Restrictions
  - Institutional Controls

Detailed Analysis Criteria

Short-Term Effectiveness	o Implementation should not pose a threat to the community or environment. o On-site workers erecting fences would work along the perimeters of the target remediation areas and would not be exposed to waste material. o Completed in approximately 6 months.
Long-Term Effectiveness	o Residual risks are associated with LF leachate, perched water, UA ground water, SSP surface waters and wastes at the target remediation areas. o Actions do not meet performance standards or process efficiencies. o Actions will be reliable.
Reduction of Toxicity, Mobility and Volume	o Alternative 1 does not treat the waste to reduce the toxicity, mobility or volume.
Implement-ability	o Fences could be erected around the target remediation areas without significant problems. o Existing GW monitoring network is sufficient to detect changes in ground-water quality at the target remediation areas. o Institutional controls must be approved by the City of The Dalles, the ODEQ and the EPA Region X prior to implementation. o Equipment, materials, specialists and work force are available.
Compliance with ARARs	o Compliance with chemical specific ARARs will not be attained.
Overall Protection	o Reduces risks of direct contact with waste constituents on-site and with affected GW.
State Acceptance	o Unknown
Community Acceptance	o Unknown

Cost

Capital	$326,300
Annual O&M	
(years 1-5)	45,400
(years 6-30)	25,200
Total Present Worth	$688,200

125/11

TABLE 5-13

Detailed Analysis Summary of Remedial Alternative 2
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

REMEDIAL ALTERNATIVE 2

Containment with Ground-Water Controls

- o LF - Cap (asphalt)
- o UA - Consolidate into LF
- o FCW - Cap (asphalt)
- o SSP - Cover (soil)
- o GW - Alternate Drinking Water Supply, Monitoring and Limited Treatment
  - Access and Deed Restrictions
  - Institutional Controls

Detailed Analysis Criteria

Short-Term Effectiveness	o Implementation should not pose a threat to the community or environment. o Minimal risk may result to on-site workers from exposure to wastes or particulates. o Completed in less than 2 years.
Long-Term Effectiveness	o Potential residual risks are associated with LF leachate, perched water and ground water. o Potential residual risks greatly reduced within 5 years. o Actions will meet performance standards and process efficiencies. o Cap/cover, GW monitoring and recovery, leachate and perched water collection and treatment systems require long-term maintenance. o Actions will be reliable.
Reduction of Toxicity, Mobility and Volume	o Leachate generated from the LF and perched water are treated to reduce mobility, volume, and toxicity of wastes. o Contaminated soils, sediments and waste materials remaining at LF, FCW and SSP are not treated.
Implement-ability	o Air emission problems may result from exposing LF and UA wastes. o Existing monitor well network at MMRF sufficient to monitor the target remediation areas and effectiveness of remedial actions including cover and recovery systems. o It is expected that after implementation of this alternative, additional remedial actions would not be required. o Requires regulatory agency acceptance of the waiver from the fluoride and sulfate ARARs. o Requires approval of institutional controls by City of The Dalles, ODEQ and EPA Region X. o Equipment, materials, specialists and work force are available. o Technologies have been proven at other waste management sites. o Bench scale treatability studies required to verify effectiveness of aqueous treatment system.
Compliance with ARARs	o Compliance with chemical specific ARARs for fluoride and sulfate in ground water will not be attained. o Compliance with location specific ARARs attained. o Compliance with action specific ARARs attained.
Overall Protection	o Minimizes exposure pathways and associated risks via waste containment and treatment of leachate, perched water and ground water.
State Acceptance	o Unknown
Community Acceptance	o Unknown

Cost

Capital	$4,111,500
Annual O&M	
(years 1-5)	158,500
(years 6-30)	69,900
Total Present Worth	$5,252,300

125/12

TABLE 5-14

Detailed Analysis Summary of Remedial Alternative 3
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

REMEDIAL ALTERNATIVE 3

Containment with Complete Removal and Ground-Water Controls

- o LF - Cap (multi-media)
- o UA - Consolidate into LF
- o FCW - Consolidate into LF
- o SSP - Cover (soil)
- o GW - Alternate Drinking Water Supply, Monitoring and Limited Treatment
  - Access and Deed Restrictions
  - Institutional Controls

Detailed Analysis Criteria

Short-Term Effectiveness	o Implementation should not pose a threat to the community or environment. o Minimal risk may result to on-site workers from exposure to wastes or particulates. o Completed in less than 2 years.
Long-Term Effectiveness	o Potential residual risks are associated with LF leachate and ground water. o Potential residual risks greatly reduced within 5 years. o Actions will meet performance standards and process efficiencies. o Cap/cover, GW monitoring and recovery, leachate collection and treatment systems require long-term maintenance. o Actions will be reliable.
Reduction of Toxicity, Mobility and Volume	o Leachate generated from the LF and perched water are treated to reduce mobility, volume, and toxicity of wastes. o Contaminated soils, sediments and waste materials remaining at LF and SSP are not treated.
Implement-ability	o Air emission problems may result from exposing LF, UA and FCW wastes. o Existing monitor well network at MMRF sufficient to monitor the target remediation areas and effectiveness of remedial actions including cover and recovery systems. o It is expected that after implementation of this alternative, additional remedial actions would not be required. o Requires regulatory agency acceptance of the waiver from the fluoride and sulfate APARs. o Requires approval of institutional controls by City of The Dalles, ODEQ and EPA Region X. o Equipment, materials, specialists and work force are available. o Technologies have been proven at other waste management sites. o Bench scale treatability studies required to verify effectiveness of aqueous treatment system.
Compliance with ARARs	o Compliance with chemical specific ARARs for fluoride and sulfate will not be attained. o Compliance with location specific ARARs attained. o Compliance with action specific ARARs attained.
Overall Protection	o Minimizes exposure pathways and associated risks via waste containment and treatment of leachate, perched water and ground water.
State Acceptance	o Unknown
Community Acceptance	o Unknown

Cost

Capital	$5,728,400
Annual O&M	
(years 1-5)	144,000
(years 6-30)	55,600
Total Present Worth	$6,707,400

125/13

TABLE 5-15

Detailed Analysis Summary of Remedial Alternative 4
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

REMEDIAL ALTERNATIVE 4

Containment, Complete Removal and Hydraulic Barriers with Ground-water Controls

- o LF - Cap (multi-media)
- o UA - Consolidation Into LF
- o PCW - Consolidation Into LF
- o SSP - Cap (multi-media) with Hydraulic Barriers
- o GW - Alternate Drinking Water Supply, Monitoring and Limited Treatment
  - Access and Deed Restrictions
  - Institutional Controls

Detailed Analysis Criteria

Short-Term Effectiveness	o Implementation should not pose a threat to the community or environment. o Minimal risk may result to on-site workers from exposure to wastes or particulates. o Completed in less than 2 years.
Long-Term Effectiveness	o Potential residual risks are associated with LF leachate and ground water. o Potential residual risks greatly minimized within 5 years. o Actions will meet performance standards and process efficiencies. o Caps, hydraulic barriers, GW monitoring and recovery systems, and leachate collection and treatment systems require long-term maintenance. o Actions will be reliable.
Reduction of Toxicity, Mobility and Volume	o Treatment of leachate from LF and perched water reduces the toxicity, mobility, and volume of these waste streams. o Contaminated soils, sediments and waste materials remaining at LF and SSP are not treated.
Implement-ability	o Air emission problems may result from exposing LF, PCW and UA wastes. o Existing monitoring well network is sufficient to monitor the target remediation areas and effectiveness of remedial actions including caps, hydraulic controls and recovery system. o It is expected that after implementation of this alternative, additional remedial actions would not be required. o Requires regulatory agency acceptance of the waiver from the fluoride and sulfate ARARs. o Requires approval of institutional controls by the City of The Dalles, ODEQ and EPA Region X. o Equipment, materials, specialists and work force are available. o Technologies have been proven at other waste management sites. o Bench scale treatability studies required to verify effectiveness of the aqueous treatment system.
Compliance with ARARs	o Compliance with chemical specific ARARs for fluoride and sulfate in ground water will not be attained. o Compliance with location specific ARARs attained. o Compliance with action specific ARARs attained.
Overall Protection	o Minimizes exposure pathways via waste containment and treatment of leachate, perched water and ground water.
State Acceptance	o Unknown
Community Acceptance	o Unknown

Cost

Capital	$9,229,100
Annual O&M	
(years 1-5)	207,600
(years 6-30)	119,000
Total Present Worth	$10,922,600

125/7

TABLE 5-16

Detailed Analysis Summary of Remedial Alternative 5
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

REMEDIAL ALTERNATIVE 5

Containment with Consolidation with Ground-water Controls

- o LF - Cap (multi-media)
- o UA - Consolidation Into LF
- o FCW - Consolidation Into LF
- o SSP - Consolidate SSP 1-4 into LF
- o GW - Alternate Drinking Water Supply, Monitoring and Limited Treatment
  - Access and Deed Restrictions
  - Institutional Controls

Detailed Analysis Criteria

Short-Term Effectiveness	o Implementation should not pose a threat to the community or environment. o Significant risk may result to on-site workers from exposure to wastes or particulates. o Completed in 2 years.
Long-Term Effectiveness	o Potential residual risks are associated with LF leachate and ground water. o Potential residual risks greatly minimized within 5 years. o Actions will meet performance standards and process efficiencies. o Cap, GW monitoring and recovery systems, and leachate collection and treatment systems require long-term maintenance. o Actions will be reliable.
Reduction of Toxicity, Mobility and Volume	o Treatment of leachate from LF and perched water reduces the toxicity, mobility, and volume of these waste streams. o Contaminated soils, sediments and waste materials remaining at LF and SSP are not treated.
Implement-ability	o Air emission problems may result from exposing LF, FCW and UA wastes. o Existing monitoring well network is sufficient to monitor the target remediation areas and effectiveness of remedial actions including cap, and recovery system. o It is expected that after implementation of this alternative, additional remedial actions would not be required. o Requires regulatory agency acceptance of the waiver from the fluoride and sulfate ARARs. o Requires approval of institutional controls from the City of The Dalles. o Equipment, materials, specialists and work force are available. o Technologies have been proven at other waste management sites. o Bench scale treatability studies required to verify effectiveness of the aqueous treatment system.
Compliance with ARARs	o Compliance with chemical specific ARARs for fluoride and sulfate will not be attained. o Compliance with location specific ARARs attained. o Compliance with action specific ARARs attained.
Overall Protection	o Minimizes exposure pathways and associated risks via waste containment and treatment of leachate, perched water and ground water.
State Acceptance	o Unknown
Community Acceptance	o Unknown

Cost

Capital	$9,807,100
Annual O&M	
(years 1-5)	146,000
(years 6-30)	57,400
Total Present Worth	$10,807,100

125/8

TABLE 5-17

Detailed Analysis Summary of Remedial Alternative 6
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

REMEDIAL ALTERNATIVE 6

RCRA Landfill and Ground-water Controls

- o LF - Consolidate into Newly Constructed On-site RCRA LF
- o UA - Consolidate Into RCRA LF
- o FCW - Consolidate Into RCRA LF
- o SSP - Consolidate Into RCRA LF
- o GW - Alternate Drinking Water Supply, Monitoring and Limited Treatment
  - Access and Deed Restrictions
  - Institutional Controls

Detailed Analysis Criteria

Short-Term Effectiveness	o Implementation should not pose a threat to the community or environment. o Significant risk may result to on-site workers from exposure to wastes or particulates. o Completed in 2 years.
Long-Term Effectiveness	o Potential residual risk are associated with ground water. o Potential residual risks greatly minimized within 5 years. o Actions will meet performance standards and process efficiencies. o LF, GW monitoring and recovery systems and leachate collection and treatment systems require long-term maintenance. o Actions will be reliable.
Reduction of Toxicity, Mobility and Volume	o Treatment of leachate from RCRA landfill and perched water reduces the toxicity, mobility and volume of these waste streams. o Contaminated soils, sediments and waste materials consolidated in RCRA landfill are not treated.
Implement-ability	o Air emission problems may result from exposing LF, FCW and UA wastes. o Monitor wells will be required to monitor the effectiveness of the RCRA landfill. o It is expected that after implementation of this alternative, additional remedial actions would not be required. o Requires regulatory agency acceptance of the waiver from the fluoride and sulfate ARARs. o Requires approval of institutional controls by the City of The Dalles. o Equipment, specialists and work force are available; clay may be difficult to obtain. o Technologies have been proven at other waste management sites. o Bench scale treatability studies required to verify the effectiveness of the aqueous treatment system.
Compliance with ARARs	o Compliance with chemical specific ARARs for fluoride and sulfate will not be attained. o Compliance with location specific ARARs attained. o Compliance with action specific ARARs attained.
Overall Protection	o Minimizes exposure pathways via waste containment and treatment of leachate, perched water and ground water.
State Acceptance	o Unknown
Community Acceptance	o Unknown

Cost

Capital	$18,213,000
Annual O&M	
(years 1-5)	213,900
(years 6-30)	125,300
Total Present Worth	$19,977,500

125/9

TABLE 5-18

Detailed Analysis Summary of Remedial Alternative 7
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

REMEDIAL ALTERNATIVE 7

Containment with Consolidation and
Ground-water Recovery and Treatment

- o LF - Cap (multi-media)
- o UA - Consolidate Into LF
- o FCW - Consolidate Into LF
- o SSP - Consolidate Into LF
- o GW - Recovery, Treatment and Monitoring
  - Access and Deed Restrictions

Detailed Analysis Criteria

Short-Term Effectiveness	o Implementation should not pose a threat to the community or environment. o Significant risk may result to on-site workers from exposure to wastes or particulates. o Completed in 2 years.
Long-Term Effectiveness	o Potential residual risks are assdciated with ground water at the LF, SSP, UA, Recycle Pond and Former Cathode Waste Management Areas and LF leachate. o Potential residual risks greatly minimized within 5 years. o Actions will meet performance standards and process efficiencies. o Cap, GW monitoring and recovery systems and leachate collection and treatment systems require long-term maintenance. o Actions will be reliable.
Reduction of Toxicity, Mobility and Volume	o Treatment of leachate from LF and perched water reduces the toxicity, mobility and volume of these waste streams. o Contaminated soils, sediments and waste materials consolidated in LF are not treated.
Implement-ability	o Air emission problems may result from exposing LF, FCW and UA wastes. o Existing monitoring well network sufficient to monitor the target remediation areas and effectiveness of remedial actions including cap and recovery systems. o It is expected that after implementation of this alternative, additional remedial actions would not be required. o Equipment, materials, specialists and work force are available. o Technologies have been proven at other waste management sites. o Bench scale treatability studies required to verify the effectiveness of the aqueous treatment system.
Compliance with ARARs	o Compliance with chemical specific ARARs attained. o Compliance with location specific ARARs attained. o Compliance with action specific ARARs attained.
Overall Protection	o Minimizes exposure pathways via waste containment and treatment of leachate, perched water and ground water.
State Acceptance	o Unknown
Community Acceptance	o Unknown

Cost

Capital	$10,255,500
Annual O&M	
(years 1-5)	315,600
(years 6-30)	57,400
Total Present Worth	$11,932,600

125/10

TABLE 5-19

Detailed Analysis Summary of Remedial Alternative 8
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

REMEDIAL ALTERNATIVE 8

RCRA Landfill and Ground-water Recovery and Treatment

- o LF - Consolidate Into RCRA Landfill
- o UA - Consolidate Into RCRA Landfill
- o FCW - Consolidate Into RCRA Landfill
- o SSP - Consolidate Into RCRA Landfill
- o GW - Recovery and Treatment, Monitoring
  - Access and Deed Restrictions

Detailed Analysis Criteria

Short-Term Effectiveness	o Implementation should not pose a threat to the community or environment. o Significant risk may result to on-site workers from exposure to wastes or particulates. o Completion in approximately 2 years.
Long-Term Effectiveness	o Potential residual risks are associated with ground water at LF, UA, SSP, Recycle Pond and Former Cathode Waste Management Areas. o Potential residual risk greatly minimized in approximately 5 years. o Actions will meet performance standards and process efficiencies. o RCRA landfill, ground-water monitoring and recovery, leachate collection and treatment systems require long-term maintenance. o Actions will be reliable.
Reduction of Toxicity, Mobility and Volume	o Treatment of leachate from the RCRA landfill and perched water reduces the toxicity, mobility and volume of these waste streams. o Contaminated soils, sediments and waste materials consolidated into RCRA landfill are not treated.
Implement-ability	o Air emission problems may result from exposing wastes from the target remediation areas. o Monitor wells will be required to monitor the RCRA Landfill. The existing monitoring system is sufficient to monitor the target remediation areas. o It is expected that after implementation of this alternative, additional remedial actions would not be necessary. o Equipment, specialists and work force are available; clay may be difficult to obtain. o Technologies have been proven at other waste management sites. o Bench scale treatability studies required to verify effectiveness of the aqueous treatment system.
Compliance with ARARs	o Compliance with chemical specific ARARs attained. o Compliance with location specific ARARs attained. o Compliance with action specific ARARs attained.
Overall Protection	o Minimizes exposure pathways via waste contaminant and treatment of leachate, perched water and ground water.
State Acceptance	o Unknown
Community Acceptance	o Unknown

Cost

Capital	$18,881,000
Annual O&M	
(years 1-5)	383,500
(years 6-30)	125,300
Total Present Worth	$21,322,700

125/4

TABLE 5-20

Detailed Analysis Summary of Remedial Alternative 9
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

REMEDIAL ALTERNATIVE 9

Containment with Consolidation, Stabilization and
Ground-water Recovery and Treatment

- o LF - Cap (multi-media)
- o UA - Consolidation Into LF
- o PCW - Consolidation Into LF
- o SSP - Stabilize and Cover (soil)
- o GW - Recovery and Treatment, Monitoring
  - Access and Deed Restrictions

Detailed Analysis Criteria

Short-Term Effectiveness	o Implementation should not pose a threat to the community or environment. o Significant risk may result to on-site workers from exposure to wastes or particulates. o Completion in approximately 2 years.
Long-Term Effectiveness	o Potential residual risks are associated with ground water at LF, PCW, UA, SSP and Recycle Pond and LF leachate. o Potential residual risk greatly minimized in approximately 5 years. o Actions will meet performance standards and process efficiencies. o RCRA landfill, ground-water monitoring and recovery, leachate collection and treatment system require long-term maintenance. o Actions will be reliable.
Reduction of Toxicity, Mobility and Volume	o Treatment of leachate from LF and perched water reduces the toxicity, mobility and volume of these waste streams. o Mobility of SSP waste is reduced by stabilization. o Contaminated soils, sediments and waste materials consolidated into LF are not treated.
Implement-ability	o Air emission problems may result from exposing wastes from the target remediation areas. o Existing monitoring well network is sufficient to monitor the target remediation areas and effectiveness of remedial actions including cap, cover, and GW recovery system. o It is expected that after implementation of this alternative, additional remedial actions would not be necessary. o Equipment, materials, specialists and work force are available. o Technologies have been proven at other waste management sites. o Bench scale treatability studies required to verify effectiveness of the aqueous treatment system. o Bench scale study required to select stabilization agent for SSP.
Compliance with ARARs	o Compliance with chemical specific ARARs attained. o Compliance with location specific ARARs attained. o Compliance with action specific ARARs attained.
Overall Protection	o Minimizes exposure pathways via waste stabilization, containment and treatment of leachate, perched water and ground water.
State Acceptance	o Unknown
Community Acceptance	o Unknown

Cost

Capital	$14,530,700
Annual O&M	
(years 1-5)	312,000
(years 6-30)	53,800
Total Present Worth	$16,167,400

125/5

TABLE 5-21

Detailed Analysis Summary of Remedial Alternative 10
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

REMEDIAL ALTERNATIVE 10

Incineration, Stabilization and
Ground-water Recovery and Treatment

- o LF - Incineration of Contaminated Soils and Wastes
- o UA - Incineration of Contaminated Soils and Wastes
- o FCW - Incineration of Contaminated Soils and Wastes
- o SSP - Stabilize and Cover (soil)
- o GW - Recovery and Treatment, Monitoring Containment of Incinerator Ash in On-site RCRA Landfill
  - Access and Deed Restrictions

Detailed Analysis Criteria

Short-Term Effectiveness	o Implementation should not pose a threat to the community or environment. o Significant risk may result to on-site workers from exposure to wastes or particulates. o Stabilization of SSP would take approximately 2 years to complete. o Incineration of LF, UA and FCW wastes will take over 5 years to complete.
Long-Term Effectiveness	o Potential residual risks associated with ground water at LF, UA, SSP and Recycle Pond and Former Cathode Waste Management Areas. o Potential residual risk greatly minimized after 5 years. o Actions will meet performance standards and process efficiencies. o Long-term maintenance of RCRA landfill, ground-water monitoring and recovery systems, SSP cover system and leachate collection and treatment systems required. o Actions will be reliable.
Reduction of Toxicity, Mobility and Volume	o Alternative 10 treats all of the waste present at MMRF, however none of the wastes are completely destroyed. Toxicity, mobility and volume is reduced.
Implement-ability	o Air emission problems may result from exposing wastes from the target remediation areas. o Monitor wells will be required to monitor the RCRA landfill. The existing monitoring system is sufficient to monitor the target remediation areas. o It is expected that after implementation of this alternative, additional remedial actions would not be necessary. o Equipment, specialists and work force are available; clay may be difficult to obtain. o Containment system and GW recovery systems have been proven at other waste management sites and would be implemented without further development. o Bench scale treatability studies required to verify effectiveness of the aqueous treatment system. o Trial burn required for incineration process to verify the effectiveness of the system. o Bench scale study required to select stabilization agent for SSP.
Compliance with ARARs	o Compliance with chemical specific ARARs attained. o Compliance with location specific ARARs attained. o Compliance with action specific ARARs attained.
Overall Protection	o Minimizes exposure pathways via incineration, stabilization, containment and treatment of leachate, perched water and ground water.
State Acceptance	o Unknown
Community Acceptance	o Unknown

Cost

Capital	$15,948,900
Annual O&M	
(years 1-5)	5,987,000
(years 6-30)	67,200
Total Present Worth	$40,341,500

125/6

6.0 COMPARISON OF REMEDIAL ALTERNATIVES

In Sections 2 through 5, ten (10) remedial alternatives have been developed, described and evaluated based on the nine evaluation criteria presented in the Draft Guidance Document. This section presents a comparison of the ten alternatives and evaluates the relative performance of each alternative in relation to the evaluation criteria. The acceptance of the remedial alternatives by the State and Community are unknown at the present time and are not included in the comparison of alternatives.

6.1 REMEDIAL ALTERNATIVE 1: LIMITED ACTION

Remedial Alternative 1 consists of limited remedial actions. The potential for direct contact with the wastes is reduced by fencing the target remediation areas and by recording deed restrictions to prevent future development of these areas. Also, to minimize the migration of the Landfill leachate, the existing leachate collection system will continue to be operated. This alternative reduces the potential for consumption of affected ground water by imposing institutional controls. Remedial Alternative 1 does not reduce the toxicity, mobility or volume of waste at the MMRF and does not meet action or chemical specific ARARs. This alternative is the least costly alternative considered; however, it does not adequately protect human health and the environment.

6.2 REMEDIAL ALTERNATIVE 2: CONTAINMENT WITH GROUND-WATER CONTROLS

Remedial Alternative 2 includes consolidating the Unloading Area waste into the existing Landfill, capping the Landfill and Former Cathode Waste Management Areas with an asphalt cap, covering the Scrubber Sludge Ponds with a soil cover, limited ground-water treatment, replacement of nearby water supply wells with city water, institutional controls and deed restrictions. This alternative is much more protective than Alternative 1 in that wastes are contained to reduce the potential for direct contact with the wastes and waste streams are treated to reduce the potential for migration of contaminants. A minimal potential risk will result from handling the waste from the Unloading Area and from reshaping the Landfill. However, handling these wastes will reduce the number of target remediation areas requiring long-term management and will reduce the area of the Landfill cap. The potential for migration of ground water in excess of remediation criteria is reduced by recovery and treatment and the potential for exposure to Landfill leachate and perched water are minimized by collection and treatment. Treatment of these aqueous streams reduces the toxicity, mobility and volume of the ground water, perched water and Landfill leachate. Remedial Alternative 2 is protective of human health and the environment and this alternative is the second least costly alternative considered.

6.3 REMEDIAL ALTERNATIVE 3: CONTAINMENT WITH COMPLETE REMOVAL AND GROUND-WATER CONTROLS

Remedial Alternative 3 includes consolidating the Unloading Area and Former Cathode Waste Management Areas into the Landfill and covering the Landfill with a cap meeting RCRA performance standards. This alternative also includes covering the Scrubber Sludge Ponds with a soil cover, limited ground-water treatment, replacement of nearby water supply wells with city water, institutional controls and deed restrictions. This alternative is similar to Alternative 2 although it provides a greater level of protection than Alternative 2. Consolidating the Former Cathode Waste Management Areas into the existing Landfill further reduces the number of target remediation areas requiring long-term management. Also, Alternative 3 provides for a greater level of containment for the Landfill by upgrading the asphalt cap in Alternative 2 to a cap meeting RCRA performance standards. This cap system greatly reduces the potential for infiltration into the cap and the generation of leachate from the Landfill. Handling the Former Cathode Waste Management Area waste during consolidation activities increases the potential exposure of on-site construction workers. However, the nature of the Former Cathode Waste Management Areas waste is similar to that of the Unloading Area and is not very susceptible to being dispersed by the wind. Alternative 3 is the third least costly remedial alternative and is protective of human health and the environment.

6.4 REMEDIAL ALTERNATIVE 4: CONTAINMENT, COMPLETE REMOVAL AND HYDRAULIC BARRIERS WITH GROUND-WATER CONTROLS

Remedial Alternative 4 consists of the same activities as discussed in Remedial Alternative 3 except that the cover system over the Scrubber Sludge Ponds is upgraded and the ground water beneath the Scrubber Sludge Ponds is depressed. Remedial Alternative 4 provides for a cap to be placed over the Scrubber Sludge Ponds identical to that as used on the Landfill. Also, hydraulic controls will be implemented to prevent the ground-water table from coming in contact with the Scrubber Sludge Pond sludge. The benefit this alternative provides over Alternative 3 is that the potential for infiltration into and generation of leachate from the Scrubber Sludge Pond sludges is greatly reduced by implementing hydraulic controls. However, this requires long-term operation and maintenance of the recovery system utilized to create the hydraulic controls. With the acceptance of a waiver from the fluoride ARAR, this alternative does not provide a greater level of protection to human health or the environment and is more costly than Remedial Alternative 3.

6.5 REMEDIAL ALTERNATIVE 5: CONTAINMENT WITH CONSOLIDATION AND GROUND-WATER CONTROLS

Remedial Alternative 5 consists of the same activities as discussed in Remedial Alternative 3 except, instead of covering the Scrubber Sludge Ponds with a soil cover, they would be excavated and consolidated into the existing Landfill prior to capping. Although Remedial Alternative 3

is protective of human health and the environment, the Scrubber Sludge Pond sludges are a very fine grained material and would be extremely hard to consolidate into the existing Landfill without causing a potential exposure problem for on-site construction workers. Sucessful consolidation of the Scrubber Sludge Pond sludges into the existing Landfill would provide a greater level of containment. However, with the acceptance of a waiver from the fluoride and sulfate ARARs in the S-aquifer, this greater level of containment does not provide a greater level of protection to human health or the environment while substantially increasing the remedial action cost.

6.6 REMEDIAL ALTERNATIVE 6: RCRA LANDFILL AND GROUND-WATER CONTROLS

Remedial Alternative 6 provides for excavation of the wastes from all target remediation areas and placement of the wastes into a newly constructed on-site RCRA landfill. As previously discussed, the potential problems associated with excavation and movement of the wastes from the Unloading Area and Former Cathode Waste Management Areas are minimal. Excavation and movement of the Scrubber Sludge Pond sludges, as discussed in Alternative 5, would cause a potential exposure problem to on-site construction workers. Remedial Alternative 6 also includes excavation and placement of the Landfill wastes in an alternate location. The wastes contained in the Landfill contain both dispersed and

containerized asbestos which would create a potential for exposure to on-site construction workers during remedial activities. The benefit realized from this alternative is that the waste at the MMRF would be contained in a facility which meets minimum technology requirements; however, the cost expended to achieve this level of containment is substantial. As in Remedial Alternative 3, Remedial Alternative 6 ultimately provides for containment of the wastes. The level of containment achieved in Remedial Alternative 6, while substantially more costly, does not provide an equivalent increase in protection to human health or the environment.

6.7 REMEDIAL ALTERNATIVE 7: CONTAINMENT WITH CONSOLIDATION AND GROUND-WATER RECOVERY AND TREATMENT

Remedial Alternative 7 is identical to Remedial Alternative 5 except that a more extensive ground-water recovery and treatment program is utilized. This alternative assumes that the waiver from the fluoride and sulfate ARARs are not accepted and ground-water recovery and treatment would be required where fluoride and sulfate concentrations in the ground water exceed 2.2 mg/L and 250 mg/L respectively. This alternative provides a similar level of protection as Alternative 5 and is more costly because of the additional ground-water recovery and treatment requirements.

6.8 REMEDIAL ALTERNATIVE 8: RCRA LANDFILL AND GROUND-WATER RECOVERY AND TREATMENT

Remedial Alternative 8 is identical to Remedial Alterantive 6 except that a more extensive ground-water recovery and treatment program is utilized. This alternative assumes that the waiver from the fluoride and sulfate ARARs are not accepted and ground-water recovery and treatment is required where fluoride concentratrions in the ground water exceed 2.2 mg/L and 250 mg/L respectively. This alternative provides a similar level of protection as Alternative 6; however, it is more costly because of the additional ground-water recovery and treatment requirements.

6.9 REMEDIAL ALTERNATIVE 9: CONTAINMENT WITH CONSOLIDATION, STABILIZATION AND GROUND-WATER RECOVERY AND TREATMENT

Remedial Alternative 9 consists of consolidating the Unloading Area and Former Cathode Waste Management Areas into the existing Landfill and covering the Landfill with a cap meeting RCRA performance standards. This alternative also includes stabilization of the Scrubber Sludge Ponds and covering these ponds with a soil cover, ground-water recovery and treatment where ground water contains fluoride and sulfate in excess of ARARs and access and deed restrictions to prevent future use of the Landfill and Scrubber Sludge Ponds. This remedial alternative is identical to Remedial Alternative 7 except that instead of consolidating the Scrubber Sludge Pond sludges into the Landfill, the sludges

would be stabilized in place and covered with a soil cover. Stabilizing the sludges in place removes the potential for exposure of on-site construction workers during consolidation activities. However, to effectively stabilize the sludges, the stabilization agent would have to be thoroughly mixed with the sludge material. This mixing process could generate airborne particulates and could create a potential exposure risk to on-site construction workers. The stabilization process would reduce the potential for the generation of leachate from the Scrubber Sludge Pond sludges. However, the potential for direct contact with the waste containing cPAHs would remain. To mitigate this risk, the Scrubber Sludge Ponds would be covered with a soil cover. Stabilization of the Scrubber Sludge Ponds would be costly and after stabilization, the ponds would still require containment. As was previously discussed, other containment remedial measures for the Scrubber Sludge Ponds provide at least the same level of protection as stabilization and are less costly.

6.10 REMEDIAL ALTERNATIVE 10: INCINERATION, STABILIZATION AND GROUND-WATER RECOVERY AND TREATMENT

Remedial Alternative 10 consists of excavation and incineration of the Landfill, Unloading Area and Former Cathode Waste Management Areas wastes, containment of the incinerator ash in a newly constructed on-site RCRA landfill, stabilization in place of the Scrubber Sludge Ponds, ground-water monitoring, ground-water recovery and treatment

and access and deed restrictions to prevent future use of the new RCRA landfill and Scrubber Sludge Ponds. Excavation and incineration of the Landfill, Unloading Area and Former Cathode Waste Management Areas will create a potential for exposure to on-site construction workers to airborne particulates. As discussed previously, the potential risk resulting from excavation and movement of the Unloading Area and Former Cathode Waste Management Areas will be minimal. However, because the Landfill contains dispersed and containerized asbestos, the potential risk to on-site construction workers associated with movement of this waste is greater. These risks are compounded because the materials from these areas will require crushing prior to incineration which would increase the potential for generation of airborne particulates. After incineration of these wastes, the ash generated would require containment in an on-site RCRA landfill.

The risks and advantages of stabilizing the Scrubber Sludge Ponds in place were discussed in Alternative 9. Remedial Alternative 10 provides for treatment of the waste material disposed of at the site. The treatment methods presented in this alternative include incineration and stabilization. It has been demonstrated that incineration of cathodic waste does not completely destroy the hazardous constituents present in the waste. The residual ash will contain hazardous constituents in quantities that will

require land disposal in a secure facility. Similarly, stabilization of the Scrubber Sludge Ponds would require containment to prevent direct contact with the wastes. Therefore, some form of waste containment would be required to protect the public and the environment from the residuals generated by Alternative 10. Because of this, the level of protection affforded by Remedial Alternative 10 is not substantially greater than that of Alternatives 3, 4 or 5 which also provide for containment at significantly lower cost.

125/15

7.0 PREFERRED ALTERNATIVE

7.1 PREFERRED ALTERNATIVE DESCRIPTION

Remedial Alternative 3, as presented in Section 4.2.2.2, is selected as the preferred remedial alternative for management of the Martin Marietta Reduction Facility. Alternative 3, which is discussed in detail below, consists of the following:

- Excavation of contaminated soils, fill and waste from the Unloading Area and the Former Cathode Waste Management Areas for subsequent consolidation into the existing Landfill;
- Installation of a multi-media cap which meets RCRA performance standards on the Landfill after waste consolidation activities cease. Capping of the Landfill would include installation of a leachate collection system beneath the cap;
- Installation of a soil cover over Scrubber Sludge Ponds 2 and 3 (Ponds 1 and 4 are already covered with soil.);
- On-site treatment of the Landfill leachate for destruction/removal of fluoride and cyanide constituents;
- Collection of contaminated perched water during excavation and consolidation activities for subsequent treatment in the on-site aqueous treatment system;
- Collection of contaminated ground water in the vicinity of the Unloading Area. The recovered ground water will be discharged to the Recycle Pond where it will be recycled to the roof scrubbers or treated in the in plant process;
- Proper abandonment of off-site water supply wells (i.e., the Animal Shelter, Rockline, Klindt and Residence wells). The well users would be connected to the nearby city water system to replace their water supply; and

- The enforcement of institutional controls to limit future use of the S-aquifer and, deed restrictions to prevent future development of areas where wastes are managed on-site. Access to the site would be further restricted through the installation of fences around the capped Landfill and covered Scrubber Sludge Ponds.

The Unloading Area will be excavated resulting in the removal of approximately 200 cubic yards of cathode waste residuals. The lateral and vertical extent of the excavation will be limited by the known boundary of materials placed in the area, historical photographs, verification sampling and depth to competent basalt, respectively. The excavated wastes will be placed into the Landfill for management prior to capping the Landfill. The Unloading Area will then be backfilled to promote drainage. Capping of the Unloading Area will not be required because cathode waste residuals and contaminated subsoils will be removed.

Residual cathode waste material contaminated soils or both would be excavated from the study areas comprising the Former Cathode Waste Management Areas and consolidated into the existing Landfill. The areas and volume of waste and contaminated soils removed from the Former Cathode Waste Management Areas are indicated below:

o Potliner Handling	9,910 cubic yards
o Old Cathode Waste Pile	24,200 cubic yards
o Salvage	28,700 cubic yards
o Bath Recovery Pad	1,660 cubic yards
Total	64,470 cubic yards

The Former Cathode Waste Management Areas will be excavated down to competent basalt. The excavation for the Bath Recovery Pad Area will also remove the cathode waste materials along the Landfill Ditch. After removal activities have been completed, the Former Cathode Waste Management Areas will be backfilled as required to promote drainage. Capping of this area will not be required because cathode waste residuals and contaminated subsoils will be removed and placed into the Landfill for management. The perched water from the Former Cathode Waste Management Areas will be recovered by a one time collection during remedial activities and treated for cyanide and fluoride in an on-site aqueous treatment system. Long-term collection and treatment of perched water from this area will not be required because materials from the Former Cathode Waste Management Areas will be removed and placed in the Landfill. Recovery of perched water east of River Road will be limited to a one time extraction during remedial activities. Temporary sump(s) may be required to enhance the collection process. Long-term collection and treatment of perched water east of River Road would also not be required because the source of the contamination would be removed. The roof scrubber recycle line, which currently lies beneath the Former Cathode Waste Management Areas, would require temporary disruption of flows to relocate the line or replace it during remediation activities. One possible scenario for rerouting the roof scrubber return line is illustrated in Figure 7-1.

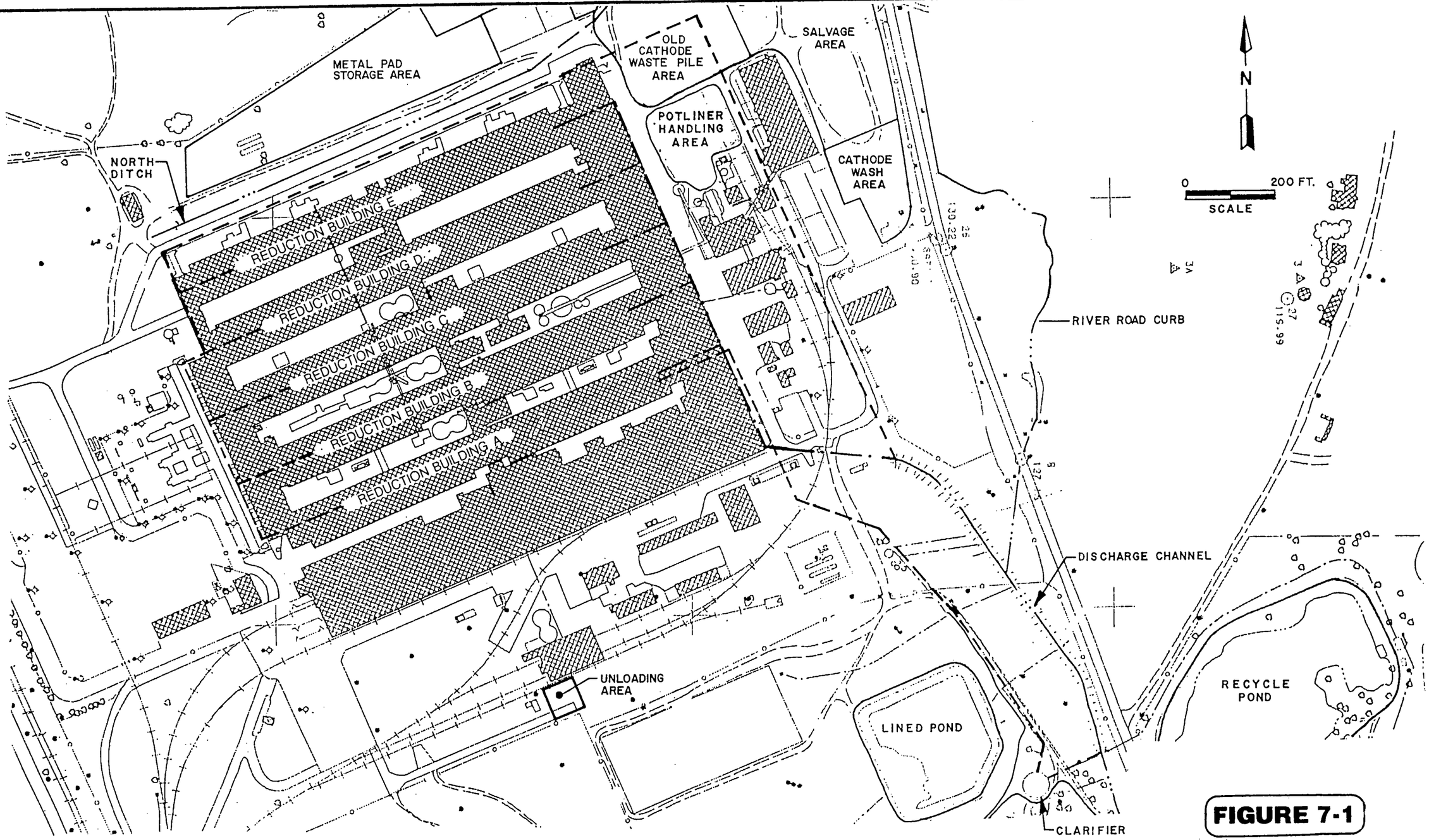

FIGURE 7-1

DRAWING NO: TE0018-P05-B61	
DRAWN BY: SHF.	DATE: 3/11/88
CHECKED:	DATE: 3-18-88
APPROVED:	DATE: 6-7-88

LEGEND:

- EXISTING SCRUBBER RETURN LINES
- PROPOSED SCRUBBER RETURN LINES

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ROUTING OF ROOF SCRUBBER RETURN LINES
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

After consolidation of the materials from the Unloading Area and Former Cathode Waste Management Areas into the existing Landfill, the Landfill will be covered with a multi-media cap meeting the performance standards as defined in 40 CFR 264.310. The volumes of material to be removed and consolidated into the existing Landfill from each target remediation area are presented below:

o Unloading Area	200 cubic yards
o Former Cathode Waste Management Areas	
- Potliner Handling Area	9,910 cubic yards
- Old Cathode Waste Pile Area	24,200 cubic yards
- Salvage Area	28,700 cubic yards
- Bath Recovery Pad Area	1,660 cubic yards
Total	64,670 cubic yards

Regrading of the Landfill into a central location will be performed to minimize the areal extent of the cap to approximately 10 acres as illustrated in Figure 7-2. This activity will include the remediation of the Leachate Collection, Landfill and Surface Drainage Ditches by consolidating material contained in these areas into the Landfill prior to capping. The known asbestos disposal areas will not be disturbed during remediation and will only receive fill during the regrading activities.

The cap will be designed to meet RCRA performance standards as illustrated in Figure 7-3. The multi-media cap would consist of 12-inches of topsoil, a geotextile layer, 6-inches of clean sand, a wire mesh for rodent control,

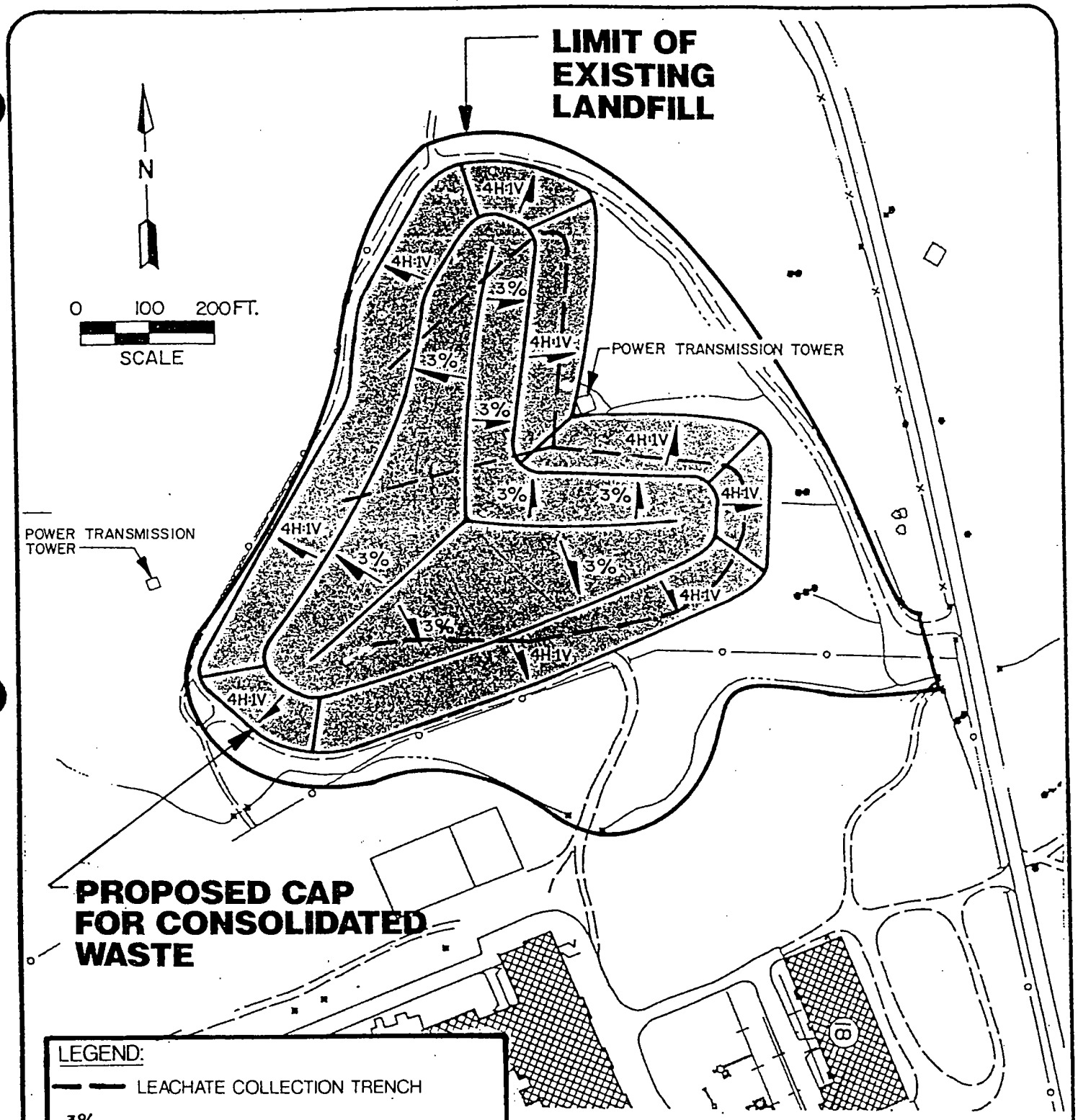

FIGURE 7-2

DRAWING NO: TE0018-P05-A81	
DRAWN BY: KenCarroll	DATE: 3-8-88
CHECKED:	DATE: 3/18/88
APPROVED:	DATE: 3/21/88

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APPROXIMATE LOCATION AND CONFIGURATION OF LANDFILL CAP
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

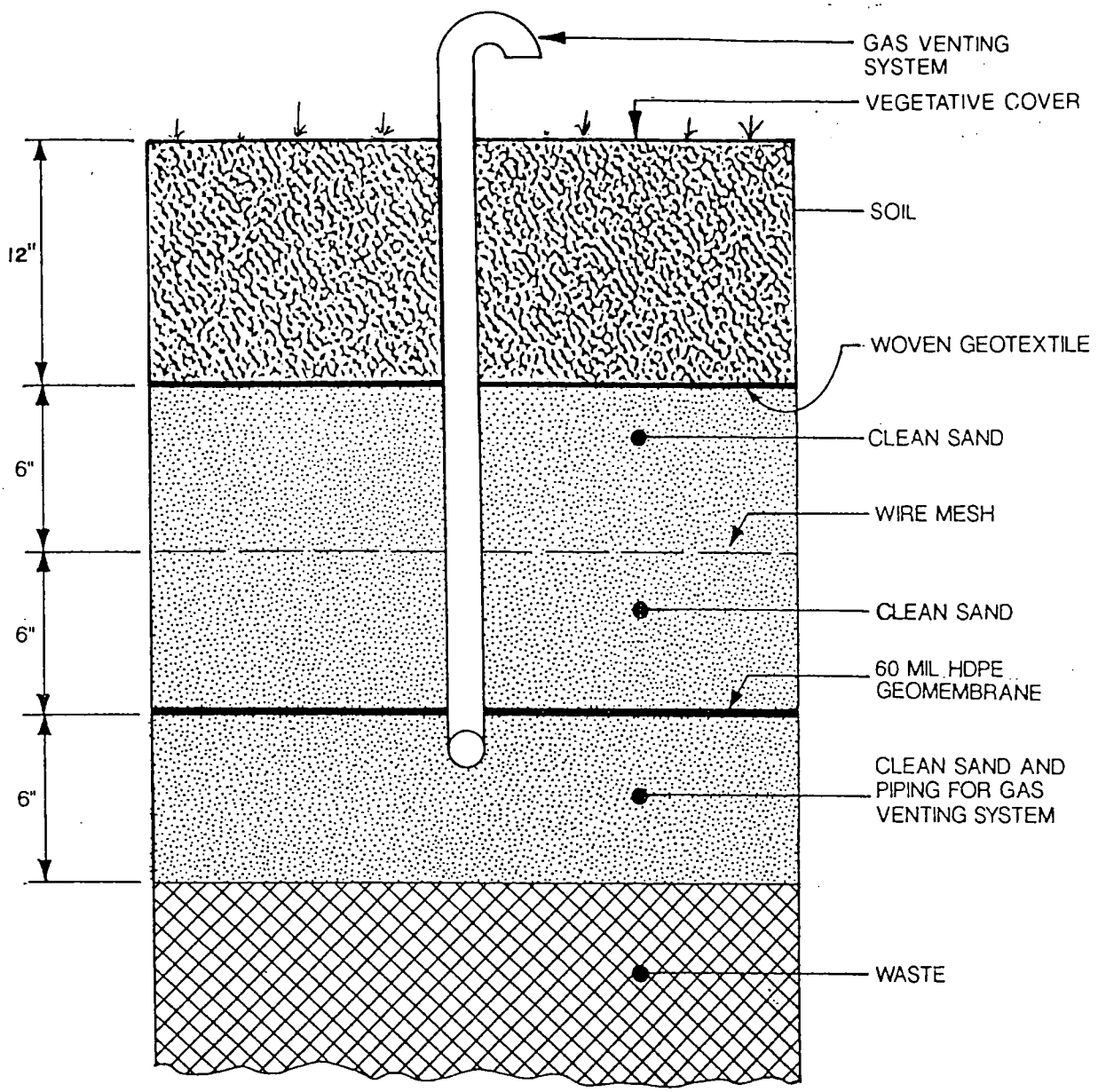

FIGURE 7-3

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DRAWN BY: BKF	DATE: 2/26/88
CHECKED:	DATE: 3-10-88
APPROVED:	DATE: 3/29/88

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RCRA PERFORMANCE CAP TYPICAL CROSS-SECTION
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

another 6-inches of clean sand, a 60-mil HDPE geomembrane, and 6-inches of clean sand overlying the waste which will serve as part of a passive gas venting system. The piping for the gas venting will be constructed of HDPE for compatibility with the geomembrane in the cap. The top and side slopes of the cap will be constructed so as to minimize erosion and the drainage controls around the Landfill would be improved to redirect surface water runoff.

Leachate collection trenches will be constructed under the cap to intercept the flow of leachate utilizing the historical surface drainage pathways. The leachate collection trenches, illustrated in Figure 7-2, will be constructed such that they only collect leachate generated from the wastes after capping.

The MMRF is located in an arid region and because of this climate, a moisture deficit of approximately 30 inches per year exists. Installation of the cap should occur in the summer months, when precipitation at the MMRF is lowest, to minimize the amount of leachate generated after capping. Therefore, it is anticipated that the leachate generated from the Landfill after being capped will gradually decrease from its existing average flowrate of approximately 10 gpm to a negligible flow within five years. Treatment of the leachate will be conducted in an on-site aqueous treatment system for removal of cyanide and fluoride. The aqueous treatment system would be located adjacent to the area of the existing

domestic wastewater treatment system shown in Figure 7-4 and would include a chemical oxidation unit for destruction of cyanide followed by a chemical precipitation unit to remove fluoride and, if required, a fluoride polishing unit to further reduce concentrations of fluoride below the remediation criteria.

Leachate generated from the Landfill along with collected perched water east of River Road and from the Former Cathode Waste Management Areas would be introduced into the chemical oxidation unit for destruction of cyanide. The effluent from the oxidation unit would flow into a chemical precipitation unit for fluoride removal. The effluent from the chemical precipitator would be neutralized prior to discharge. A schematic of the aqueous treatment system is shown in Figure 7-5.

After the Landfill is capped, the Landfill area will be fenced to limit access to the area. Only authorized personnel performing necessary maintenance functions would be allowed entry to the Landfill area after the cap is constructed.

Remediation of the Scrubber Sludge Ponds under Alternative 3 will involve consolidating the pond dikes into the ponds along with the windblown sediments which migrated from the pond. Scrubber Sludge Ponds 2 and 3 would then be covered with a soil cover. The cover system will consist of

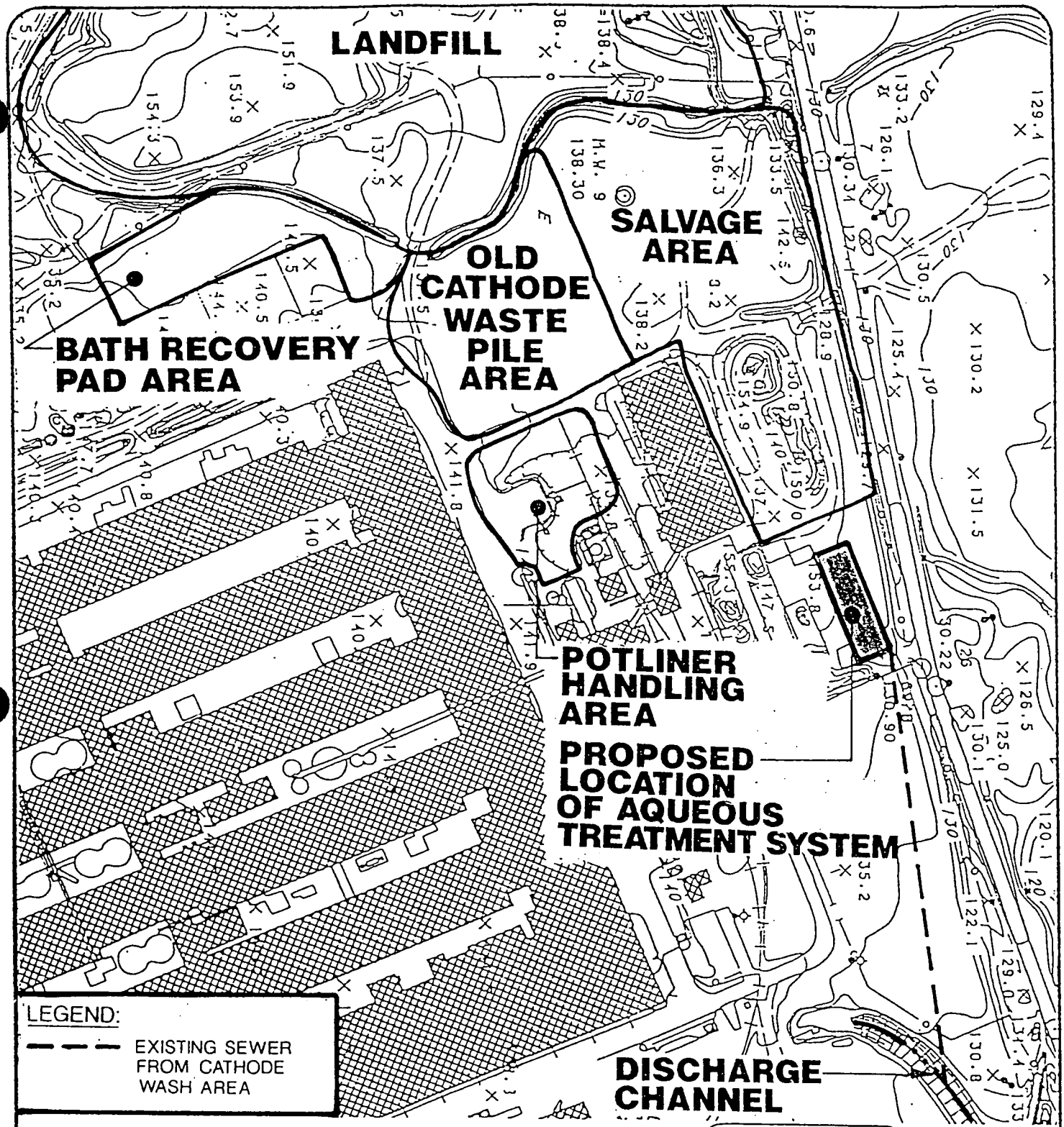

FIGURE 7-4

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DRAWN BY: SKF	DATE: 5/23/88
CHECKED: dZC	DATE: 5-27-88
APPROVED: [illegible]	DATE: 6-7-88

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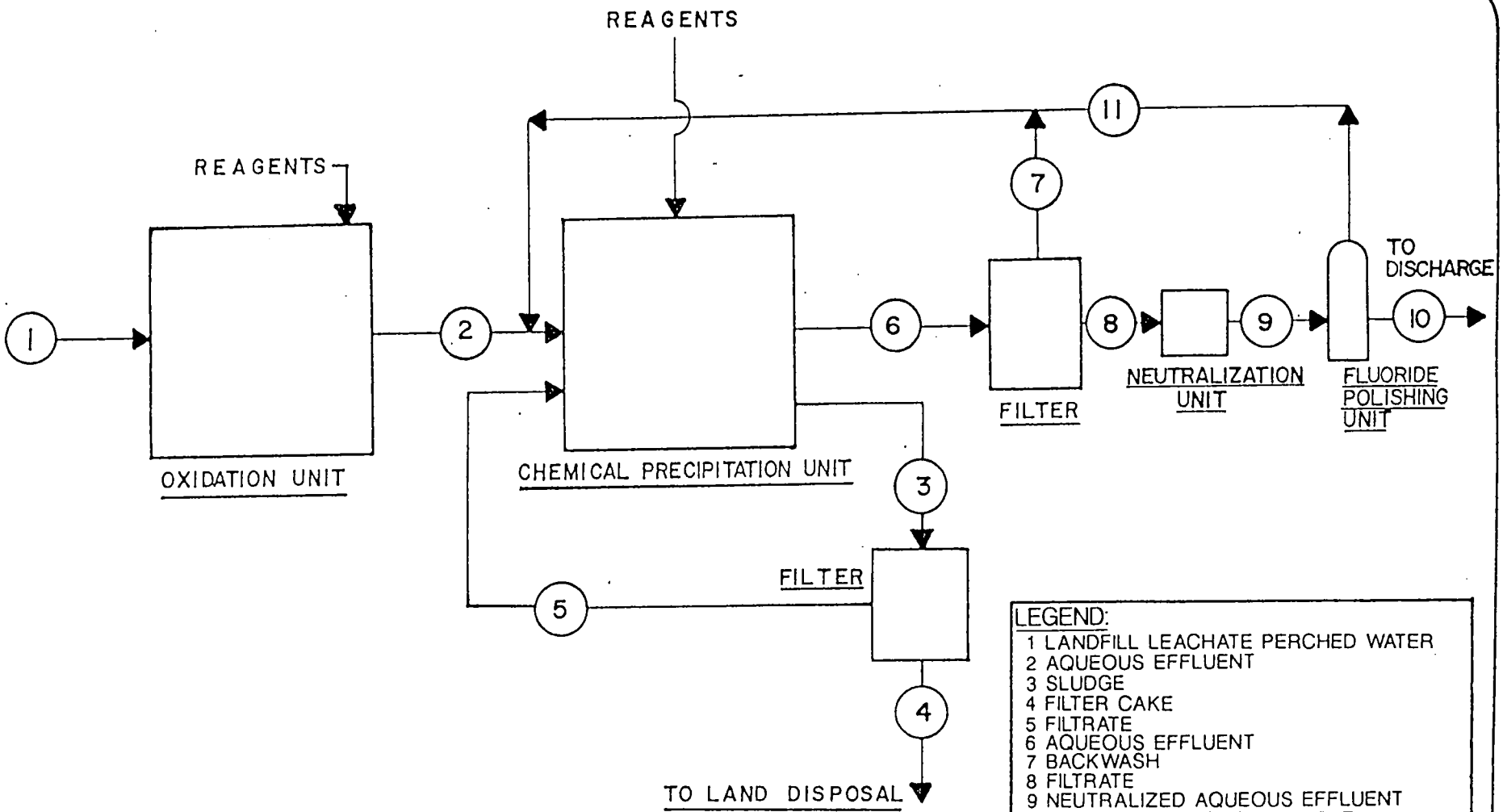
AQUEOUS TREATMENT SYSTEM LOCATION
FEASIBILITY STDUY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON



NOTE:
BENCH STUDIES WILL BE REQUIRED TO DETERMINE EXACT CONFIGURATION OF TREATMENT SYSTEM.

FIGURE 7-5

DRAWING NO: TE0018-P05-A83

DRAWN BY: Ken Sherrill	DATE: 11/10/87
CHECKED: GLC	DATE: 3-7-88
APPROVED:	DATE: 3/29/88

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SCHEMATIC AQUEOUS TREATMENT SYSTEM

FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON

BAY REPROGRAPHICS 300852

2 feet of topsoil overlying the Scrubber Sludge Pond sludge. The cover system will be seeded and fertilized to provide an appropriate vegetative cover for The Dalles region. A cross-section of this cover system is illustrated in Figure 7-6. The top and side slopes of the cover system will be constructed to minimize erosion. Drainage controls will be installed to improve, as necessary, or redirect surface water runoff. Scrubber Sludge Ponds 1 and 4 are already covered with established vegetation and do not require additional efforts under this alternative.

After Scrubber Sludge Ponds 2 and 3 are covered, the entire Scrubber Sludge Pond area would be fenced to limit access to the area. Only authorized personnel performing necessary maintenance functions would be allowed entry to the Scrubber Sludge Pond area after the cover is constructed.

With the acceptance of a waiver for fluoride of 9.7 mg/L in the ground water, ground-water recovery and treatment would only be required at the Unloading Area. To recover ground water from this area, a 4-inch diameter recovery well, RW-1, will be installed in the area of monitor well 5S as shown in Figure 7-7. This recovery well will be equipped with a submersible pump which will be operated at an approximate flowrate of 2 gpm. It is expected that recovery from RW-1 would continue for approximately 5 years. The recovered ground water would be discharged to the Recycle Pond where it will be recycled to the roof scrubbers or treated by the in-plant process.

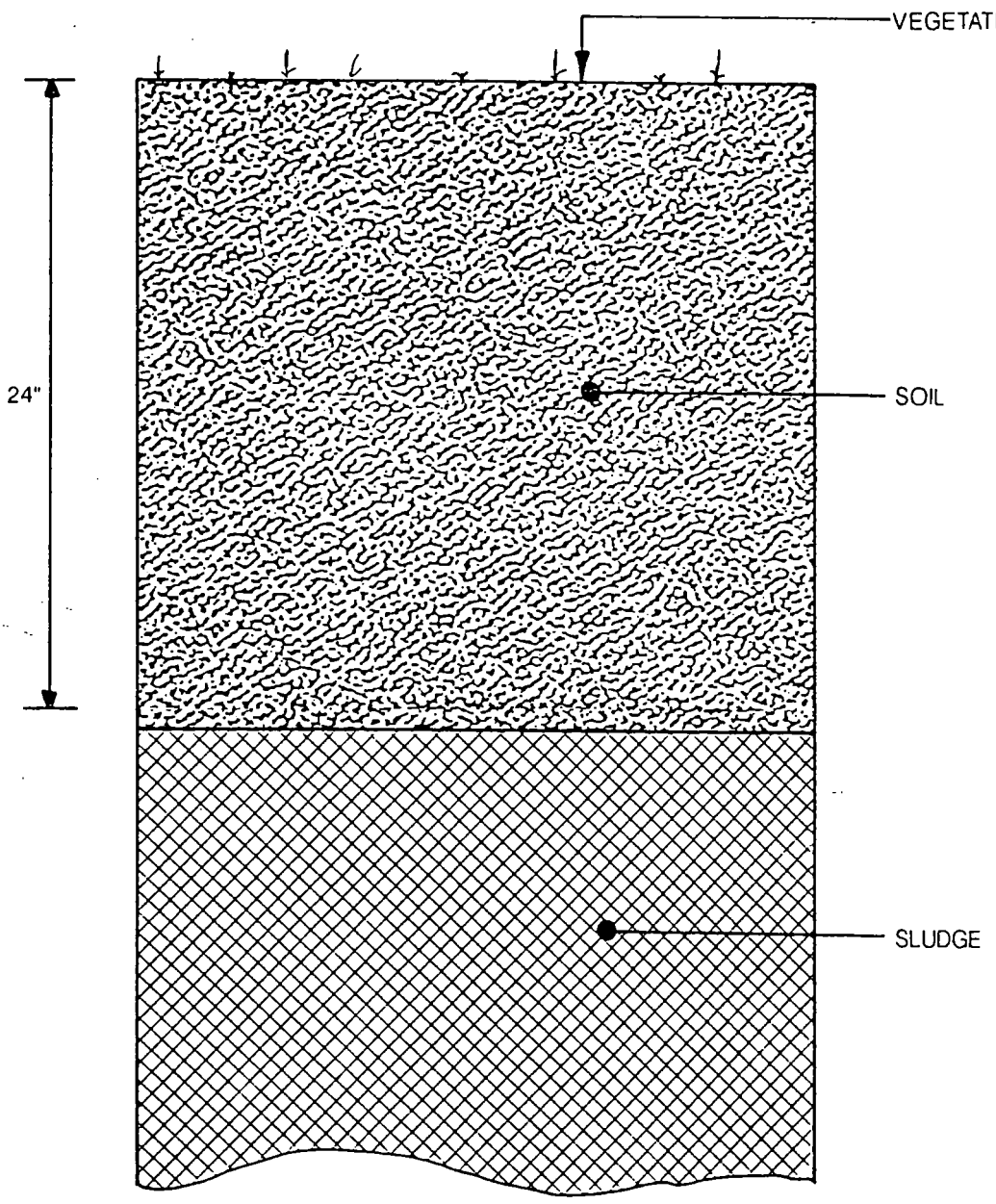

FIGURE 7-6

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DRAWN BY: KCanals	DATE: 3-29-88
CHECKED: KC	DATE: 3-29-88
APPROVED:	DATE: 3/29/88

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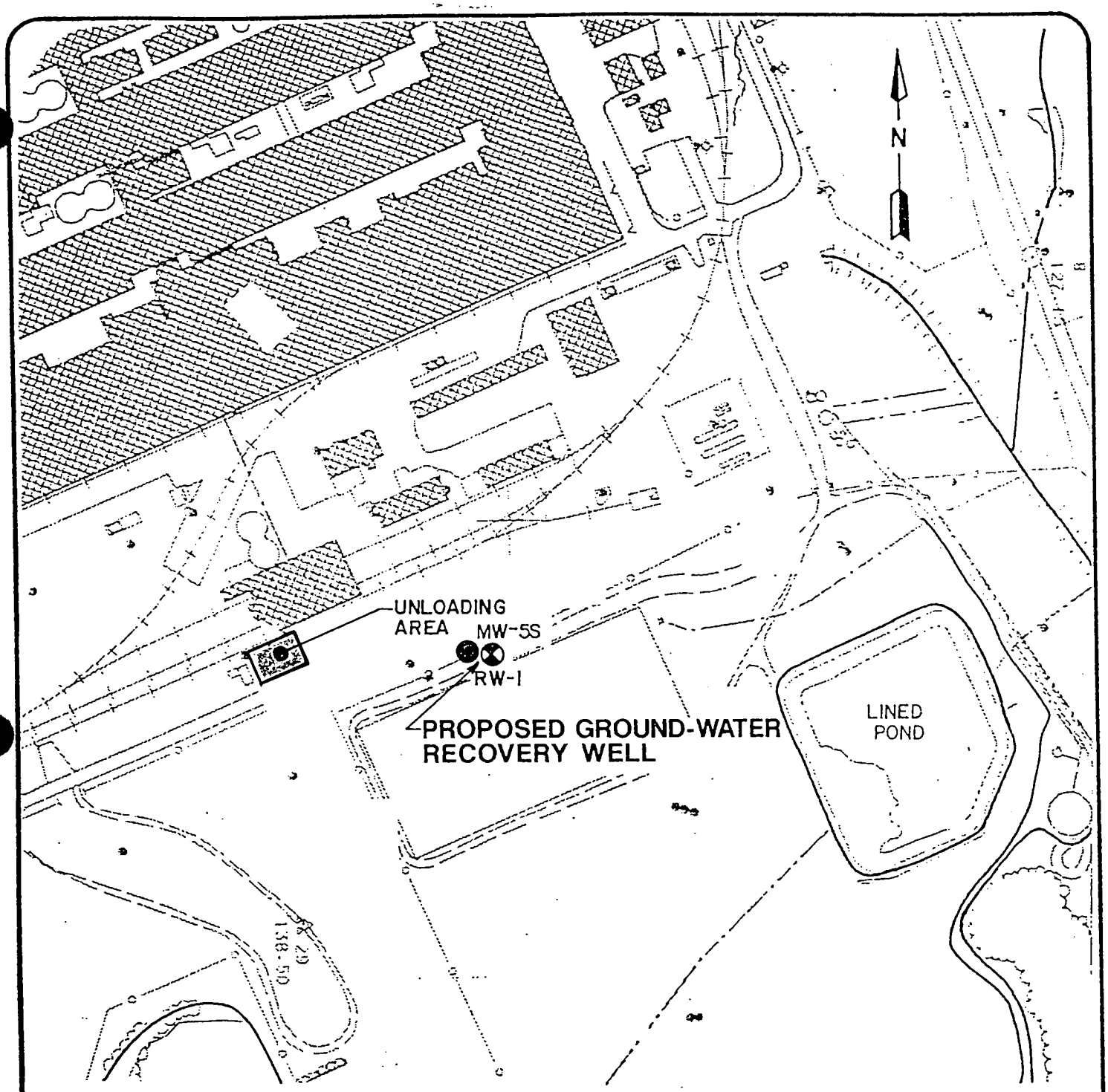
SOIL COVER SYSTEM CROSS-SECTION
FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY
MARTIN MARIETTA CORPORATION
THE DALLES, OREGON



LEGEND:

RW-1 ⊗ RECOVERY WELL LOCATION

MW-5S ● MONITORING WELL

FIGURE 7-7

DRAWING NO: TE0018-P05-A85	
DRAWN BY: SKF	DATE: 3/10/88
CHECKED: RLC	DATE: 3-18-88
APPROVED:	DATE: 3/24/88

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UNLOADING AREA RECOVERY WELL

FEASIBILITY STUDY: MARTIN MARIETTA REDUCTION FACILITY

MARTIN MARIETTA CORPORATION

THE DALLES, OREGON

Alternative 3 also includes connecting the users of the Animal Shelter, Rockline, Klindt and Residence wells to the nearby city of The Dalles water supply system and properly plugging and abandoning the existing wells at these locations. Institutional controls would be enacted to prevent future use of ground water which contains fluoride and sulfate concentrations in excess of the current State of Oregon standards for drinking water (2.2 mg/L and 250 mg/L, respectively). The potential area affected by the institutional controls includes the property adjacent to the MMRF east of River Road to the Columbia River.

Ground-water quality monitoring will also be conducted to monitor variations in ground-water quality at the target remediation areas and the effectiveness of the ground-water recovery system at the Unloading Area. Table 7-1 presents the monitoring wells which will be sampled, the parameters being monitored and the associated target remediation areas being monitored. Ground-water monitoring will be conducted quarterly for the first year, semi-annually for the second year and annually thereafter. At the end of five years, the entire ground-water monitoring program will be re-evaluated and adjusted, if necessary. This time frame corresponds to the time period required by SARA for re-evaluation of site conditions. Data will be submitted to the EPA shortly after the laboratory analysis have been completed for each sampling period during the first two years. Annual reports will also

TABLE 7-1

Summary of Monitor Wells and Constituents Analyzed for Ground-water Monitoring
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

TARGET REMEDIATION AREAS	CONSTITUENTS ANALYZED	AQUIFER SYSTEM	PROPOSED WELLS MONITORED
Landfill	$CN_{(Total\ and\ Free)}$, F, SO_4, pH Specific Conductance	S A B	9, 15, 26, 32 6, 9, 12, 14, 15, 33 7, 9, 12, 16, 26, 33
Unloading Area	$CN_{(Total\ and\ Free)}$, F, SO_4, pH Specific Conductance	S	5, 17
Former Cathode Waste Management Areas	$CN_{(Total\ and\ Free)}$, F, SO_4, pH Specific Conductance	S A B	8, 27 8 8, 27
Scrubber Sludge Ponds	$CN_{(Total\ and\ Free)}$, F, SO_4, pH Specific Conductance	S A B	18, 19, 24, 29, 30 18 18
Units in Operation	$CN_{(Total\ and\ Free)}$, F, SO_4, pH Specific Conductance	S	21
General Down-Gradient Wells	$CN_{(Total\ and\ Free)}$, F, SO_4, pH Specific Conductance	A B DGWR	1, 34 1, 34 PW1

Note: Final selection may vary depending on sitewide remedial action.
098/16

be submitted during each of the first five years. Details pertaining to the ground-water monitoring plan are presented in Appendix D.

Implementation of Remedial Alternative 3 addresses the remedial action objectives defined in Section 1.3 by:

- Minimizing the migration of constituents from the source areas to ground-water systems, surface water, or soils;
- Protecting human health and the environment from potential adverse effects caused by direct contact with constituents; and
- Protecting human health and the environment from potential adverse effects from exposure to airborne particulates.

The Remedial Investigation and Risk Assessment conducted for the MMRF were discussed in Section 1.0. These studies identified those study areas which posed potential risks at the MMRF. In Section 1.0 and 2.0, remedial action objectives and remediation criteria were developed which, when implemented, would effectively mitigate the potential risks which exists. The specifics of how the remedial actions conducted in Remedial Alternative 3 satisfy the remedial action objectives are discussed below.

Excavation of the wastes and contaminated soils from the Unloading Area and Former Cathode Waste Management Areas minimizes to the extent practical, the potential for migration of waste constituents to the underlying aquifers

and removes the potential for direct contact with the wastes from these areas. Consolidation of the wastes and contaminated soils from these areas into the existing Landfill also reduces the number of areas requiring long-term management. Compatibility of the wastes from the Former Cathode Waste Management Areas and the wastes in the existing Landfill would not present a problem because the residuals and contaminated soils resulted from related plant activities. The recovery and treatment of contaminated perched water during removal activities would also minimize the impact on the underlying aquifers from future contamination.

The multi-media cap placed on the existing Landfill will be effective in reducing the potential for direct contact with the waste materials and will also be effective in reducing the amount of future leachate generated from the Landfill.

The following considerations promote capping of the existing Landfill as an appropriate remedial action:

- The constituents of concern consist of inorganics (cyanide and fluoride) and heavy-end organics (polynuclear aromatic hydrocarbons) and are derived from a small volume of target wastes (cathode waste, pitch, coke, bath, cryolite, etc.) mixed with a large volume of inert material (basalt fragments and construction debris).
- Treatment of cyanide in a solid matrix by incineration was determined to be not entirely effective in completely destroying this constituent; requiring long-term management of residual by landfilling.

- Fluoride is an element which naturally occurs and therefore, cannot be destroyed, only transformed from one media to another (liquid or solid).

- The RA evaluated current conditions under various hypothetical scenarios indicated that possible risks were associated with direct contact by humans with the wastes due to PAHs and animals exposed to leachate containing cyanide and fluoride.

- The PAH compounds detected in the Landfill are practically insoluble in water.

- The concentrations of cyanide and fluoride in the Landfill did not represent an unacceptable risks when evaluated under certain hypothetical scenarios for future construction workers, employees or residential occupants.

- Asbestos and asbestos containing material have been disposed of throughout the waste materials and in known burial locations.

- The RI indicated that the S-aquifer may not be present beneath the Landfill.

- The average annual rainfall is less than 14-inches due to the semi-arid region in which The Dalles is located. Precipitation occurs primarily between the late fall and winter months, therefore providing a relatively short season during which the cap must be effective.

- Fugitive dust emissions would be minimal during construction when compared to other remedial actions requiring excavation, therefore, reducing the potential for exposure of the construction workers, on-site workers and off-site populace.

The soil cover placed over the Scrubber Sludge Ponds will be effective in reducing the potential for direct contact with the Scrubber Sludge Pond sludges and would virtually eliminate the potential for exposure to airborne particulates from this area. The constituent of concern in the Scrubber Sludge Ponds, PAHs, are relatively immobile in water and are not expected to migrate or leach from the area.

A waiver from the fluoride and sulfate ARARs in the S-aquifer is proposed based on hydrologic conditions present at the MMRF which meet the criteria set forth in Section 121 of CERCLA as amended by SARA. The federal MCL of 4.0 mg/L for fluoride is proposed for the limited number of wells indicating the presence of fluoride in the A- and B-aquifers. This waiver, in conjunction with institutional controls to limit future use of ground water adjacent to the MMRF east of River Road to the Columbia River and replacement of existing domestic water supply wells with city water, would effectively minimize the potential for consumption of ground water containing fluoride and sulfate in excess of the drinking water standards. Ground water downgradient of the Unloading Area will be recovered and utilized or treated by the in plant process. Remediation of ground water in the Unloading Area is anticipated to take less than five years.

In summary, implementation of Remedial Alternative 3, will satisfy the site remedial objectives presented in Section 1.3. This alternative provides an equivalent level of protection as other remedial alternatives considered, can be readily implemented and maintained, limits the number of areas requiring long-term management, consists of proven and effective remedial technologies and is cost-effective.

7.2 ADDITIONAL DATA NEEDS FOR THE PREFERRED ALTERNATIVE

Remedial Alternative 3 involves recovery and treatment of perched water and Landfill leachate. To accurately define the flowrates for design of piping, pumps and treatment

equipment, additional flow data from the current Landfill leachate collection system will be required. The subsurface topography of the area where the perched zone exists will require further investigation to identify low points for placement of sumps and collection trenches. An analysis of aquifer conditions will also be required to verify estimated flowrates from the perched zone and S-aquifer.

Design of the aqueous treatment system will require bench studies to determine chemical reagent usage rates, reactor residence times, equipment necessary to attain acceptable discharge limits, contaminant removal efficiencies and proper disposal techniques for solids generated or removed in the treatment process. Information from the bench studies will also be used to evaluate the effective operating range of the treatment system.

Remedial Alternative 3 also involves constructing a cover over Scrubber Sludge Ponds 2 and 3. A geotechnical investigation will be required for Ponds 2 and 3 to determine the physical properties of the sludge, such as bearing capacity, settlement and shear strength prior to installation of the cover.

125/02

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084/14

APPENDIX B

Closure Options for the Management Units
in Operation are currently being developed

APPENDIX C

DEFINITION OF APPROPRIATE REMEDIATION CRITERIA FOR FLUORIDE AND SULFATE IN GROUND WATER

INTRODUCTION

Fluoride has been detected in the aquifers that underlie the MMRF at levels which exceed the current State of Oregon fluoride standard for drinking water; the State standard, which is temperature dependent, is 2.2 mg/L (OAR 333-61-085 at 54°F) for the MMRF site. However, fluoride levels in the A- and B-aquifers are typically below this standard. Only background concentrations of fluoride were detected in ground water within the DGWR, the primary water supply aquifer in the area.

Sulfate has also been detected in the aquifers which underlie the MMRF at levels which exceed the State of Oregon secondary drinking water standard for sulfate which is 250 mg/L. Sulfate was found in excess of this secondary standard exclusively in the S-aquifer except for monitor well 18B which indicated a sulfate concentration of 271 mg/L. Sulfate was not detected above background levels in the DGWR.

Appropriate remediation criteria for these constituents should be based upon protectiveness to human health and the environment, and best practical treatment methods. The following remediation criteria for fluoride, which are both protective and practical, are proposed for the MMRF:

S-aquifer Ground Water	9.7 mg/L
A-aquifer Ground Water	4.0 mg/L
B-aquifer Ground Water	4.0 mg/L
DGWR Ground Water	Not Applicable

The remediation criteria for sulfate is based on protectiveness to human health and available data relating to the aquatic toxicity of sulfate. A remediation criteria for sulfate of 250 mg/L in the Columbia River is proposed and is based on the State secondary drinking water standard. In establishing this concentration in the Columbia River a maximum concentration is likewise established in the S-aquifer. However, the calculated allowable concentration in the S-aquifer which would increase the concentration in the Columbia River above 250 mg/L is orders of magnitude higher than the concentrations of sulfate currently detected in the S-aquifer. This implies that sulfates in the S-aquifer are not adversely affecting human health or aquatic receptors.

The support and justification for these criteria are provided in the following sections.

PROTECTIVENESS OF PROPOSED CLEAN-UP CRITERIA

The S-aquifer is the first significant water bearing horizon which underlies the MMRF. However, it is important to note that this water bearing horizon is not used as a water supply source nor is it likely to be used as a water supply source because of the relatively low productivity of the horizon and because of the availability of municipal water in the area of the site. Because the S-aquifer is not a significant water supply source for human consumption, the

primary focus of protection of human health and the environment is on ground water impacts to surface water bodies in the area.

Elevated levels of fluoride have been detected in the S-aquifer near several areas of the site (the Scrubber Sludge Ponds, the Recycle Pond, the Unloading Area and the Landfill/ Former Cathode Waste Management Area). The maximum level detected was near the Unloading Area; 57 mg/L of fluoride was detected in well 5S. Recent data indicates that all other detections of fluoride in the S-aquifer were below 10 mg/L.

Elevated levels of sulfate have been detected in the S-aquifer near the Scrubber Sludge Ponds, the Recycle Pond and the Unloading Area. The maximum level detected was found in monitor well 29S at 3,020 mg/L. The analytical results of ground-water samples taken at the MMRF are presented in Table 1-5.

Ground-water flow in the S-aquifer from the areas where elevated fluoride and sulfate levels were detected, and for the site as a whole, is towards the Columbia River. Thus the primary exposure route of concern is ground-water discharge to the Columbia River. The Risk Assessment has shown that under current and future scenarios, the ground-water quality at the site will have no significant impact on human health and the environment via surface water. In fact, predicted fluoride and sulfate concentrations in the river are many

orders of magnitude below levels of concern. The high flow of the Columbia River in the area of the site overshadows the minor influx of site derived constituents to the river through ground-water discharge.

The following calculations are provided to show the relative impact of ground-water quality on Columbia River water quality.

Calculation of an Alternate Concentration Limit (ACL)

The concept of an ACL is derived from the USEPA RCRA program; this concept has also been built into SARA in defining ARARs. An ACL is the concentration of a constituent (fluoride or sulfate) present in ground water at the point of compliance (edge of Scrubber Sludge Ponds, for example) which will not result in a statistically significant increase in constituent concentration in surface water near the point of ground-water discharge and will not result in substantial present or future risks to human health or the environment. Requirements for use of an ACL also include: ground-water users should not be present or affected between the point of compliance and the surface water discharge area; and, it should be clear that ground-water discharges to the surface water bodies. As described above, these latter two points are met in the S-aquifer at the MMRF; no users are present or likely to be present and ground-water flow is clearly towards the Columbia River.

To calculate an ACL for fluoride at the site, the following simple mass-balance formula can be used (Draft RCRA Permit Writer's Manual, Ground-Water Protection, prepared by Geotrans, Inc. October 1983):

$$ACL = \frac{QuCa + QgwCa - QuCu}{Qgw}$$

Where:
- Qgw = ground water flow rate
- Qu = river flow rate upstream of site
- Ca = acceptable upper concentration limit for constituent in river
- Cu = concentration of constituents in river upstream of site

Ground-water flow can be calculated using Darcy's Law:

$$Qgw = kiA$$

Where:
- k = hydraulic conductivity
- i = hydraulic gradient
- A = cross sectional area

For the S-aquifer, the hydraulic conductivity is estimated to be 2.1 ft/day based upon field tests performed on wells completed in the lower portions of the aquifer. The upper portion of the S-aquifer crops out on the site. The hydraulic gradient is estimated to be 0.05 ft/ft based upon water level measurements. The cross sectional area of the ground-water discharge area in the Columbia River is estimated to be approximately 300,000 square feet. This area is based upon an average S-aquifer thickness of 50 ft at the river and a 6000 ft length of river adjacent to the MMRF which may receive discharge from the site as a whole (this

length is significantly greater than the actual length of river which may receive ground-water discharge from impacted areas of the site). Using the above parameters, the flow of ground water to the Columbia River from the S-aquifer is estimated to be approximately 10 L/sec. The average flow in the Columbia River is estimated to be 192,820 cfs or 5,500,000 L/sec.

To determine an acceptable concentration of fluoride and sulfate in the Columbia River, the most sensitive receptor should be addressed to assure that the concentration is protective. In this case, the acceptable concentration for fluoride is 0.2 mg/L based upon avoidance behavior of fish to fluoride in the river. An alternate target may be 1.0 mg/L, the water-quality standard for the Hood Basin. The acceptable concentration for sulfate in the Columbia River is set at 250 mg/L which is based on the State secondary drinking water standard. This concentration is well below available adverse aquatic toxicity levels for diatoms and bluegills. Patrick et. al. (1968) reported a LC50 of 1900 mg/L of sulfate in diatoms and a LC50 of 13,500 mg/L sulfate in bluegills. It is assumed that the concentration of fluoride and sulfate in upstream river water is 0.0 mg/L. Based upon an acceptable fluoride concentration of 0.2 mg/L in the Columbia River, the following fluoride ACL for the S-aquifer can be calculated:

$$\text{ACL (fluoride)} = \frac{(5{,}500{,}000\ \text{L/sec})(0.2\ \text{mg/L}) + (10\ \text{L/sec})(0.2\ \text{mg/L}) - (5{,}500{,}000\ \text{L/sec})(0.0\ \text{mg/L})}{10\ \text{L/sec}}$$

ACL (fluoride) = 110,000 mg/L

That is, ground water within the S-aquifer (the entire S-aquifer) could contain up to 110,000 mg/L fluoride and water quality in the Columbia River would still be protective to human health and the environment. Using a similar calculation for sulfate, assuming that an acceptable level of sulfate in the Columbia River is 250 mg/L, a sulfate concentration of 1.38×10^{8} mg/L is calculated. This calculation shows that existing sulfate concentrations in the S-aquifer (maximum = 3.02×10^{3} mg/L) could not possibly increase the concentration in the Columbia River to a level greater than 250 mg/L.

If background levels of fluoride are accounted for in the ACL calculation (as presented in the Risk Assessment, background levels of fluoride in the Columbia River range from 0.24-0.7 mg/L) an acceptable concentration of 0.2 mg/L is not appropriate because ambient levels exceed the acceptable concentration. However, the more appropriate standard for the ACL analysis is the Hood Basin standard because of its regulatory significance. Therefore, an ACL for fluoride can be calculated as:

$$\text{ACL (fluoride)} = \frac{(5{,}500{,}000\ \text{L/sec})(1.0\ \text{mg/L}) + (10\ \text{L/sec})(1.0\ \text{mg/L}) - (5{,}500{,}000\ \text{L/sec})(0.7\ \text{mg/L})}{10\ \text{L/sec}}$$

ACL (fluoride) = 165,000 mg/L

The RA has also reported typical background concentrations of sulfate in surface waters of 15.9-34 mg/L. The ACL for sulfate considering maximum background concentrations is found to be 1.19×10^8 mg/L which again is physically impossible to attain.

The above ACL analyses assume mixing of constituents (fluoride or sulfate) in ground water instantaneously and completely with the entire average flow of the Columbia River. However, it is not uncommon to use some percentage of river flow to calculate allowable discharges. For example, the NPDES discharge permit for the MMRF is based upon a 300 foot radius mixing area and is not directly flow related. Another number often used in calculating allowable discharges is to assume that mixing occurs in 25% of the 7Q10 of the river; that is, 25% of the 7-day, 10-year low flow. The 7Q10 for the Columbia River near the MMRF is 81,800 cfs (personnel communication, Ed Hubbard, U.S. Geological Survey, Portand, OR). Using 25% of the 7Q10 for the river with an acceptable concentration of 1.0 mg/L yields a fluoride ACL of greater than 17,000 mg/L of fluoride in ground water. Likewise, using 25% of the 7Q10 for the river with an acceptable concentration of 250 mg/L, a sulfate concentration in the S-aquifer of 1.25×10^7 mg/L is calculated which again is orders of magnitude above existing sulfate concentrations.

It is important to note that these ACL analyses are extremely conservative; no attenuation (dispersion, retardation or degradation) was accounted during ground-water transport.

Calculation of Ground-water Mass Flux

As demonstrated above, extremely high levels of fluoride in S-aquifer ground water at the site may be acceptable and protective. However, the calculated ACL is not only extremely high, it has orders of magnitude above detected levels at the site and would thus result in extensive addition of fluoride to the ground-water system should it be utilized. Instead, an acceptable level based upon existing conditions and practical treatment technology for fluoride in ground water will be utilized. The proposed acceptable concentration for fluoride in S-aquifer ground water is 9.7 mg/L. This criteria is based primarily upon practical treatment considerations as described in a subsequent section. All ground water in the S-aquifer meets this criteria with the exception of well 5S near the Unloading Area. The potential effect on Columbia River water quality can be calculated as shown above. That is, a flux of ground water at 10 L/sec containing 9.7 mg/L of fluoride results in a mass flux of fluoride to the river of 97 mg of F^-/sec. The flow in the Columbia River is 5,500,000 L/sec; therefore, the concentration in the river is 97 mg/5,500,000 L or 1.76×10^{-5} mg/L (assumes total mixing and ground water flow is

negligible). A concentration of 1.6×10^{-4} mg/L is calculated if 25% of the 7Q10 is assumed for the zone of mixing.

The calculated concentration in the Columbia River (1.76×10^{-5} mg/L or 1.6×10^{-4} mg/L) is both orders of magnitude below available acceptable criteria and orders of magnitude below detection limits for fluoride. That is, the proposed value of 9.7 mg/L in S-aquifer ground water is both protective and will not result in statistically significant water quality changes in the Columbia River.

Likewise, the ground-water mass flux calculation for sulfate in the S-aquifer discharging to the Columbia River also demonstrates that the Columbia River is not significantly impacted. That is, a flux of ground water at 10 L/sec containing 3,020 mg/L of sulfate results in a mass flux of sulfate to the river of 30,200 mg of SO_4/sec. the flow in the Columbia River is 5,500,000 L/sec; therefore, the sulfate concentration in the River is 30,200 mg/L divided by 5,500,000 L/sec or 5.49×10^{-3} mg/L (assumes total mixing and a negligible ground-water flow). A concentration of 5.2×10^{-2} mg/L is calculated if 25% of the 7Q10 is assumed for the zone of mixing. This indicates that the existing sulfate concentrations are not adversely impacting the Columbia River.

A-aquifer and B-aquifer Ground Water

Fluoride has been detected in ground water in both the A- and the B-aquifers. Detected levels of fluoride are generally below 4.0 mg/L with the exception of wells 9A and 9B; elevated fluoride concentrations in wells 9A and 9B are interpreted to be a function of well completion and concentrations are anticipated to decrease rapidly through time. Because water from the A- and B-aquifers may potentially be used for water supplies (no current users utilize these zones exclusively for water supplies downgradient of the site) and because ground water movement may be away from the Columbia River (the direction of ground water flow in the A- and B-aquifers is likely to vary depending upon pumping conditions) the Federal MCL is proposed for use as a remedial criteria. This standard is both appropriate and protective.

Sulfate has not been detected in the A-aquifer at the MMRF above the State secondary drinking water standard and only exceeds this standard in one well, 18B, in the B-aquifer at 271 mg/L. However, the presence of sulfate at levels nominally above the 250 mg/L standard may be an artifact of well construction and is anticipated to decrease rapidly within a short distance. Given the hydraulic conditions present in the vicinity of monitor well 18B and the concentration detected at this location, it is anticipated that the sulfate concentration in the ground water in the

B-aquifer would attenuate to a level below the State secondary standard at a distance of less than several hundred feet from monitor well 18B. Therefore, the concentration of sulfate migrating from the MMRF in the B-aquifer would not exceed the State secondary drinking water standard off-site and would not adversely affect human health or the environment.

TECHNICAL APPROPRIATENESS OF FLUORIDE REMEDIATION CRITERIA BASED UPON BEST PRACTICAL TREATMENT TECHNOLOGY

The following text presents information which supports use of the proposed fluoride waiver based on the chemical and physical properties of fluorides and the best practical and available treatment for fluorides. Fluoride is never detected in its elemental state (fluorine gas) but occurs in combination with other constituents as fluoride compounds. Ground water typically has higher fluoride concentrations than surface waters due to the fact that ground water is exposed to fluoride-bearing minerals in the subsurface. An EPA document entitled Design Manual: Removal of Fluoride from Drinking Water Supplies by Activated Alumina, EPA-600/2-84-134, August 1984, states that "there are more than 2,000 water supplies in the United States in which the fluoride MCL is exceeded. Of those, nearly all have fluoride levels occurring between the MCL and 12 mg/L. There are known water supplies with natural fluoride levels as high as 30 mg/L".

Fluoride concentrations in the S-aquifer beneath the MMRF range from <1.0 mg/L to 57 mg/L. Recent ground-water analyses from samples collected at the MMRF indicate that the S-aquifer in specific areas of the MMRF contain fluorides at concentrations in excess of the ODEQ primary drinking water standard and the Federal MCL as follows:

Area	Maximum Fluoride Concentration
o The Scrubber Sludge Ponds	7.1 mg/L
o The Recycle Pond	5.5 mg/L
o The Unloading Area	57 mg/L
o The Landfill/Former Cathode Waste Management Area	4.7 mg/L

Only one area (the Unloading Area) has fluoride concentrations in the S-aquifer above the proposed waiver concentration of 9.7 mg/L.

The waiver of 9.7 mg/L is based on the solubility of fluoride in water after the best practical treatment for ultimate removal of fluoride from aqueous streams has been performed. There are several methods for removing fluorides from ground water or other aqueous streams including the following:

- o Ion Exchange;
- o Chemical precipitation; and
- o Membrane separation.

The following paragraphs provide information on these fluoride management methods.

Ion Exchange

Activated alumina is the common media used in an ion exchange process for the removal of fluorides. An article written by Dennis Clifford, Jack Matson and Ralph Kennedy entitled "Activated Alumina: Rediscovered "Adsorbent" For Fluoride, Humic Acids and Silica" (Industrial Water Engineering, December 1978) states that acid-treated activated alumina prefers the following ions in the order given:

1. Hydroxyl ions (OH^-);
2. Phosphate ions (PO_3^{3-});
3. Fluoride ions (F^-);
4. Sulfite ions (SO_3^{2-});
5. Hexacyanoferrate ions ($[Fe(CN)_6]^{4-}$);
6. Chromate ions (CrO_4^{2-}); and
7. Sulfate ions (SO_4^{2-}).

Prior to placing the ion exchange unit "on-line", the activated alumina is treated with sulfuric acid, such that sulfate ions are placed on the exchange sites of the alumina. Aqueous streams containing fluoride are then contacted with the activated alumina and the sulfate ions are exchanged for the preferred fluoride ions. When a significant portion of the exchange sites on the activated alumina have adsorbed fluoride, the removal efficiency for fluoride becomes unacceptable and the activated alumina must be regenerated.

Regeneration involves backwashing the activated alumina to remove trapped solid particles and flushing the activated alumina with a sodium hydroxide solution. The activated alumina prefers the hydroxyl ions (OH^-) supplied by the sodium hydroxide solution over any other ion. Thus, hydroxyl ions replace the fluoride ions on the surface of the activated alumina. The fluorides are removed from the unit in a concentrated stream commonly referred to as the regenerant. Sulfuric acid is then added to the activated alumina to neutralize the sodium hydroxide and reinstall the sulfate ions on the surface of the alumina. The activated alumina has now been regenerated and is ready for operation.

The concentrated fluoride stream generated in the activated alumina process requires ultimate disposal. The toxicity or mobility of the fluoride is not reduced in the activated alumina process but the volume of fluoride contaminated water requiring disposal is minimized.

An article in the May/June, 1986 Hazardous Waste Consultant entitled "Activated Alumina Used To Remove Inorganics From Ground Water" gives an example of the activated alumina process. An aqueous stream containing 3 mg/L of fluoride was fed to an activated alumina bed until unacceptable discharge levels of fluoride were detected in the effluent. The activated alumina was then regenerated with a 1% sodium hydroxide solution at a flow equivalent to 9 bed volumes of the activated alumina. Regeneration of the

bed produced a waste stream containing 85 to 120 mg/L of fluoride. Although the volume of water contaminated with fluorides was reduced, the fluoride concentration was increased 28 to 40 times. Assuming that aqueous waste streams generated by the activated alumina process are discharged to surface waters, the concentrated regenerant stream requires further treatment prior to ultimate disposal. Secondary treatment of the regenerant stream from an activated alumina column is normally accomplished through use of a chemical precipitator.

Chemical Precipitation

Chemical precipitation is the process of producing a separable solid phase within an aqueous medium through the addition of chemical agents. The chemical agents react with undesirable, soluble contaminants, such as fluoride, forming new compounds which have limited solubilities in water. These new, slightly soluble compounds precipitate from solution as a solid. Precipitation continues until the maximum solubility of the newly formed compound is reached. Table C-1 presents the solubilities of selected fluoride compounds.

Review of Table C-1 indicates that calcium fluoride is one of the least soluble fluoride compounds in water (20 mg/L at 20°C). From the following material balance, it can be

Table C-1

Solubility of Selected Fluoride Compounds
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Compound	Formula	Solubility in Water (mg/L)
Aluminum Fluoride	AlF_3	6,700 @ 20°C
Ammonium Fluoride	NH_4F	1,000,000 @ 0°C
Antimony (III) Fluoride	SbF_3	4,440,000 @ 20°C
Barium Fluoride	BaF_2	1,600 @ 20°C
Cadmium Fluoride	CdF_2	40,000 @ 20°C
Calcium Fluoride	CaF_2	20 @ 20°C
Cesium Fluoride	CsF	3,220,000 @ 18°C
Cobalt Fluoride	CoF_2	13,600 @ 20°C
Copper (II) Fluoride	CuF_2	750 @ 25°C
Indium Fluoride	InF_3	400 @ 25°C
Lead (II) Fluoride	PbF_3	640 @ 20°C
Lithium Fluoride	LiF	1,300 @ 25°C
Magnesium Fluoride	MgF_2	130 @ 25°C
Manganese Fluoride	MnF_2	10,060 @ 20°C
Nickel Fluoride	NiF_2	25,600 @ 20°C
Potassium Fluoride	kF	950,000 @ 20°C
Silver Fluoride	AgF	1,720,000 @ 20°C
Sodium Fluoride	NaF	40,000 @ 20°C
Thallium Fluoride	TlF	780,000 @ 15°C
Tin (II) Fluoride	SnF_2	300,000 @ 25°C
Zinc Fluoride	ZnF_2	16,000 @ 20°C

Reference: Lange's Handbook of Chemistry, 13th edition, John A. Dean, 1985, McGraw-Hill Book Company

demonstrated that calcium fluoride (solubility of 20 mg/L in water) produces a fluoride concentration in solution of 9.7 mg/L.

$$\text{Soluble Fluoride Concentration} = \frac{20 \text{ mg } CaF_2}{L} \times \frac{\text{mg mole } CaF_2}{78.08 \text{ mg } CaF_2} \times \frac{2 \text{ mg mole } F^-}{\text{mg mole } CaF_2}$$

$$\times \frac{18.9184 \text{ mg } F^-}{\text{mg mole } F} = 9.7 \text{ mg/L } F^-$$

$$\text{Soluble Fluoride Concentration} = 9.7 \text{ mg/L } F^-$$

Therefore, 9.7 mg/L was chosen as the proposed waiver concentration for fluoride in the S-aquifer.

Conversion of a more soluble compound into a less soluble compound by chemical substitution may result in the removal of a certain species from the aqueous phase. For example, conversion of sodium fluoride (solubility of 40,000 mg/L at 20°C) to calcium fluoride (solubility of 20 mg/L at 20°C) would reduce the fluoride in solution by 99.95 percent. This change in solubility to remove constituents from more mobile media is the principal behind the chemical precipitation process for the removal of fluorides.

Lime (calcium hydroxide - $Ca(OH)_2$) is the oldest and most commonly used precipitating agent for the removal of fluoride compounds. An article written in the Environmental Progress, November, 1982 by Gregory Mooney, A.T. Nogueiro and David C. Cope entitled "Two-Stage Lime Treatment in Practice" states that fluoride removal using lime precipitation can decrease fluoride concentrations to 20 mg/L at a pH between 11 and 12.

The article describes the precipitation reaction as follows:

$$\underset{\text{Lime}}{Ca(OH)_2} + \underset{\substack{\text{Fluoride}\\\text{Compound}}}{XF} \rightleftharpoons \underset{\text{Calcium Fluoride}}{CaF_2} + \underset{\substack{\text{Hydroxide}\\\text{Compound}}}{X(OH)_2}$$

The above reaction removes fluoride from solution as a calcium fluoride precipitate. This chemistry was utilized by Martin Marietta Aluminum, Inc. to remove fluorides from effluent process waters at the MMRF. The Recycle Pond served as a retention basin providing sufficient time for the lime to react with the fluoride compounds. The fluoride compounds were subsequently converted to calcium fluoride which precipitated from solution for ultimate disposal in the Scrubber Sludge Ponds.

Other chemical additives have been utilized to remove fluorides from aqueous streams. The Environmental Progress article (November, 1982) states that "precipitation of chukhrovite, $Ca_4AlF_6SiF_6(FOH)SO_4 \cdot 10H_20$, rather than calcium fluoride has been reported; however, in these efforts, stoichiometric quantities of precipitated aluminum, silicon, and sulfate required to precipitate chukhrovite were not observed".

An article written by Thomas Sorg for the Journal AWWA, February, 1978 entitled "Treatment Technology to Meet Interim Primary Drinking Water Regulations for Inorganics" notes that lime in conjunction with magnesium could reduce fluoride concentrations in water below that of lime alone. The

article states that "79 mg/L of magnesium must be removed to reduce the fluoride level from 4 mg/L to 1.5 mg/L and 137 mg/L of magnesium removed for a reduction from 8 to 1.5 mg/L. If sufficient amounts of magnesium are not present in the water, a magnesium salt must be added in quantities necessary to accomplish the desired level of fluoride removal. This treatment method ... has limited application. Because of the large quantities of chemical that would normally be required, the method is adaptable to only low fluoride-high-magnesium water requiring softening".

The article presented the following empirical formula to predict the amount of magnesium that must be present to attain the fluoride removal rates desired:

$$F_{Final} = F_{initial} - (0.07 F_{initial} \times Mg)$$

- F_{Final}=final fluoride concentration;
- $F_{initial}$=initial fluoride concentration; and
- Mg=magnesium concentration required to attain F_{Final}.

Fluoride concentrations above the State of Oregon fluoride standard for drinking water of 2.2 mg/L at 54°F in the S-aquifer beneath the site range from 4.7 mg/L to 57 mg/L. Substituting these concentrations for $F_{initial}$ and the State of Oregon fluoride standard for drinking water of 2.2 mg/L for F_{Final}, the magnesium required to remove the fluoride ranges from 58 mg/L to 189 mg/L. The average magnesium concentration detected in ground-water samples

collected from the S-aquifer beneath the MMRF is 34 mg/L. Comparing this value to the predicted minimum magnesium concentration of 57 mg/L required to reduce fluoride to acceptable levels, it is obvious that the average magnesium concentration detected in the S-aquifer is almost an order of magnitude deficient from that estimated by the empirical formula. This deficiency would have to be eliminated by adding magnesium to the water. As the Journal AWWA article stated, this method becomes impractical when addition of large quantities of magnesium is required.

In summary, the best practical chemical precipitation treatment method for removal of fluorides involves the addition of lime. Lime addition would reduce soluble fluoride levels to approximately 9.7 mg/L (the fluoride ion solubility in water as calcium fluoride; assuming 100 per cent efficiency of the chemical precipitator) and would generate a calcium fluoride sludge.

Membrane Separation

Membrane separation is another technology available for concentrating fluorides and removing them from solution. The most common membrane separation technique for the removal of dissolved solids involves the use of reverse osmosis. Reverse osmosis involves separation of inorganic salts from water by forcing only the water through a membrane at pressures ranging from 200 to 1,500 pounds per square inch

gauge (psig). The membrane, normally made of cellulose acetate or some synthetic polymer, restricts the passage of the inorganic salts, concentrating them on the face of the membrane for subsequent removal.

Literature published by the various reverse osmosis manufacturers indicate a wide inorganic removal rate ranging from 45 to 90 percent. However, Thomas Sorg states in his Journal AWWA article that "reverse osmosis is not normally used on low total dissolved solids (TDS) water and has not been used specifically for fluoride removal ....". Sorg does state that this technology should work for fluoride removal applications.

Like activated alumina, reverse osmosis generates a waste stream containing concentrated quantities of fluoride. This concentrated stream normally requires treatment prior to ultimate disposal. The typical treatment method is chemical precipitation with lime producing an effluent with a minimum fluoride effluent concentration of approximately 9.7 mg/L fluoride and a calcium fluoride sludge.

In summary ultimate disposal of fluoride removed from an aqueous stream generally involves chemical precipitation of the fluoride. The best practical treatment method for precipitating fluorides is the addition of lime which converts the fluoride compounds to slightly soluble calcium fluoride (20 mg/L at 20°C). In the precipitation unit,

calcium fluoride concentrations exceed the 20 mg/L level, forcing the calcium fluoride to precipitate out of solution as a solid until the solubility concentration is reached (20 mg/L). This leaves approximately 9.7 mg/L fluoride in solution based on the soluble fluoride present as calcium fluoride. This process was used to generate the sludges in the Scrubber Sludge Ponds which are the largest sources of fluoride of all the areas investigated at the MMRF.

SUMMARY

Remediation criteria for fluoride in the ground water at the MMRF have been proposed based upon best practical treatment technologies and protectiveness to human health and the environment. These remediation criteria are:

S-aquifer Ground Water	9.7 mg/L
A-aquifer Ground Water	4.0 mg/L
B-aquifer Ground Water	4.0 mg/L
DGWR Ground Water	Not Applicable

These criteria are protective of current and future potential ground-water users, human and environmental receptors in the Columbia River, and are appropriate long term goals based upon best practical technology and the solubility of fluoride compounds at the site. It has been shown that the best practical treatment method for precipitation of fluorides involves the addition of lime to the waste stream which converts the fluoride compounds to

slightly soluble calcium fluoride. The resulting waste stream will contain approximately 9.7 mg/L fluoride in solution as calcium fluoride. The remediation criteria will result in the following actions regarding on-site ground-water conditions:

- No Action regarding ground water in all aquifers in most areas of the site.
- Remediation of ground water in the S-aquifer near the Unloading area.
- Long term monitoring of wells 9A and 9B to verify ambient water quality conditions.
- Long term monitoring in all aquifers to monitor water quality conditions and to determine if future response actions are necessary.

The remediation criteria for sulfate in the S-aquifer has been proposed based on a maximum concentration of sulfate in the Columbia River of 250 mg/L and the absence of users of this aquifer system between the sources and the Columbia River. The concentration established for the Columbia River is adapted from the State of Oregon secondary drinking water standard and would be protective of human health and the environment. By setting a maximum permissible concentration in the river, a maximum concentration in the S-aquifer which discharges to the Columbia River is thereby established. Calculations show that the permissible level of sulfate in the S-aquifer is orders of magnitude greater than that level which currently exist. The discharge of ground water from the S-aquifer to the Columbia River would not adversely

affect the Columbia River. Therefore, remediation criteria for sulfate is protective of current and future ground water users, human health and environmental receptors in the Columbia River.

022/23

APPENDIX D

GROUND-WATER MONITORING AND RESPONSE PLAN

APPENDIX D

GROUND-WATER MONITORING AND RESPONSE PLAN

INTRODUCTION

A long term ground-water monitoring program will be part of the site remediation. This program will provide post remediation monitoring and verification of the ground-water data, such as flow paths and migration rates developed during the Remedial Investigation (RI). A response plan will also be developed in the event that ARARs or remediation criteria are exceeded during one of the monitoring events.

Ground-Water Quality

The major chemical indicator parameters presented in Table 4.6 of the Remedial Investigation (RI) were cyanide (total and free), sodium, fluoride and sulfate.

The distribution of free cyanide in the ground water is of greater concern than total cyanide as discussed in the RI. A remedial criteria concentration of 0.77 mg/L free cyanide was established in the Risk Assessment (RA) as the selected health-based risk standard for on-site ground water. The concentration of free cyanide currently does not exceed the remedial criteria in any of the four monitored aquifers (S, A, B and DGWR).

The sulfate concentrations are elevated in the S-aquifer with the highest reported concentration downgradient from the Scrubber Sludge Ponds (SSPs) ranging from 123 mg/L for well MW-28S to 3020 mg/L for well MW-29S. Sulfate concentrations at wells MW-17S and MW-5S, 1130 mg/L and 680 mg/L, respectively, most likely result from the cathode waste material placed near the Unloading Area. The sulfate concentrations in the A, B and DGWR Aquifers were several orders of magnitude lower and comparable to background. When the remediation has been completed in the Unloading Area, concentrations of sulfate will likely decrease below the ARAR of 250 mg/L. Sulfate is a secondary standard according to the federal and State of Oregon Drinking Water Standards. Based upon our understanding of the MMRF, sulfate is presently impacting only a small portion of the S-aquifer which ultimately discharges into the Columbia River where significant dilution occurs.

Sodium was selected as an indicator parameter, because it is a constituent of materials used at the MMRF. However, it has no regulated concentration and no selected health-based risk standard established. The concentrations detected in the monitoring wells screened in the A- and B-aquifers are comparable to background. The sodium concentration distribution in the S-aquifer is very similar to sulfate.

A discussion of the appropriate remediation criteria for fluoride is presented in Appendix B. Concentrations of 9.7 mg/L for the S-aquifer and 4 mg/L (Federal Maximum Concentration Limit [MCL]) for the A- and B-aquifers have been proposed. Monitor well 5S had a reported concentration of 57 mg/L which is the only well to exceed the proposed remediation criteria. Several of the wells in the vicinity of the SSPs (MW-18S, MW-19S), the Landfill (MW-15S) and the Recycle Pond (MW-21S) had reported concentrations of 7.1 mg/L, 4.8 mg/L, 4.7 mg/L and 5.5 mg/L, respectively during the 1987 sampling period. All other wells screened in the S-aquifer were below 2.2 mg/L. With the exception of 9A and 9B, which had concentrations of 10 mg/L and 20 mg/L respectively, all other wells screened in the A- and B-aquifers are below the remediation criteria of 4 mg/L. Wells 9A and 9B are being resampled and have been pumped extensively because of the suspected introduction of contaminated perched water during the installation of the wells in July 1987.

Monitoring Program

The proposed monitoring program will focus on the Landfill area, Former Cathode Waste Management Areas (FCW), the Scrubber Sludge Ponds (SSPs), the Recycle Pond and the Unloading Area. In addition, the site as a whole will be monitored. The purpose of the monitoring program is to

monitor the effect of the remediation activities on water quality and to monitor for unsuspected changes in ground-water quality that occur on or off-site. It will also serve to verify the interpretation of the water quality data discussed in the RI/FS, as well as the hydrogeology. The program will provide for a comprehensive monitoring well network around ground-water contamination source areas and those areas which could potentially act as sources. In addition, wells MW-1, MW-34 and PW-1 will monitor ground water moving downgradient (off-site) in the A- and B-aquifers and DGWR. These aquifers flow away from the Columbia River as discussed in the RI. Table D-1 presents a listing of the wells to be monitored, the associated area of the site and the aquifer of concern.

Each of the monitoring wells will be sampled for specific conductance, pH, cyanide (free and total), fluoride and sulfate. These parameters best reflect the MMRF activities and are appropriate indicator parameters based upon a review of water quality data collected for the site. Monitoring for sodium has been suspended because its migration and distribution for the MMRF has been similar to sulfate. However, elevated sodium concentrations can be reflected in the measurement of specific conductance because sodium, in its dissociated form, is a conductive ion.

The monitoring frequency will be quarterly for the first year, semi-annually for the second year and then annually for three more years. At the end of five years the entire

TABLE D-1

Summary of Monitor Wells and Constituents Analyzed for Ground-water Monitoring
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

TARGET REMEDIATION AREAS	CONSTITUENTS ANALYZED	AQUIFER SYSTEM	PROPOSED WELLS MONITORED
Landfill	$CN_{(Total\ and\ Free)}$, F, SO_4, pH	S	9, 15, 26, 32
		A	6, 9, 12, 14, 15, 33
	Specific Conductance	B	7, 9, 12, 16, 26, 33
Unloading Area	$CN_{(Total\ and\ Free)}$, F, SO_4, pH	S	5, 17
	Specific Conductance		
Former Cathode Waste Management Areas	$CN_{(Total\ and\ Free)}$, F, SO_4, pH	S	8, 27
		A	8
	Specific Conductance	B	8, 27
Scrubber Sludge Ponds	$CN_{(Total\ and\ Free)}$, F, SO_4, pH	S	18, 19, 24, 29, 30
		A	18
	Specific Conductance	B	18
Units in Operation	$CN_{(Total\ and\ Free)}$, F, SO_4, pH	S	21
	Specific Conductance		
General Down-Gradient Wells	$CN_{(Total\ and\ Free)}$, F, SO_4, pH	A	1, 34
		B	1, 34
	Specific Conductance	DGWR	PW1

Note: Final selection may vary depending on sitewide remedial action.
098/16

monitoring program will be reevaluated. Data will be submitted to the USEPA shortly after the laboratory analyses have been completed for each period during the first two years. An annual report will also be submitted during each of the first five years.

Response Plan

If during the regular monitoring program it is determined that appropriate ARARs or remediation criteria are exceeded, a verification sampling will occur immediately. If the resulting concentration still exceeds the concentration of concern, then ground-water recovery will begin.

The potential well yields for the S-, A- and B-aquifers increases dramatically with depth according to the hydrogeological data presented in the RI. Wells in the S-, A- and B-aquifers have been pumped at approximately 2 gallons per minute (gpm), 20 gpm and 500 gpm respectively. In the event that ground-water recovery is initiated, a specific pumping rate will be derived on a case-by-case basis. The pumping rate and radius of influence may make it necessary to install additional wells in some situations. The horizontal ground-water movement for each of the three aquifers is generally less than one to several feet per day. Contaminant migration is even slower, because of various retardation factors, such as sorption, dilution and dispersion.

The well being pumped as part of remedial activities will be sampled initially on a weekly basis and adjusted accordingly once pumping has been initiated. When the concentration of the constituent which exceeded the ARAR or remediation criteria falls within the accepted range for three successive sampling periods, pumping will be suspended. This can occur rapidly based upon the results of test pumping in MW-8B. This well was pumped for about 5 1/2 days at 490 gpm and no fluoride was detected during three sampling events during pumping. An initial concentration of 2.4 mg/L fluoride was reported. Total cyanide was also half of the initial reported concentration during the three sampling periods when pumping.

Several options are possible regarding ground-water collection. The pumping rate in the S- and A-quifers would probably be low enough to pump into a tanker truck, but a temporary piping system to the Recycle Pond would probably be necessary for pumping the B-aquifer. However, it would also be possible to use this water to supplement process water used by Northwest Aluminum, currently supplied by the on-site production wells which draw from The Dalles Ground Water Reservoir.

According to the present National Pollutant Discharge Elminiation System (NPDES) permit a daily maximum of 497.8 pounds per day (lbs/day) of fluoride can be discharged. The monthly average discharge from April 1 to March 31 must not

exceed 243.2 lbs/day. Pumping wells in the S-, A- and B-aquifers at 2 gpm, 15 gpm and 500 gpm respectively would contribute 0.2 lbs/day, 0.7 lbs/day and 24 lbs/day respectively assuming concentrations of 9.7 mg/L for the S-aquifer and 4 mg/L for the A- and B-aquifers. Therefore, remediation pumping in any of the three aquifers would not contribute significant quantities to the NPDES limit.

The free cyanide NPDES discharge concentration limit is a concentration of 0.4 mg/L. This concentration will decrease to 0.1 mg/L when the site remediation has been completed. Free cyanide has not exceeded the remediation criteria of 0.77 mg/L in any of the ground water at the site and when the site remediation has been completed, the possibility of further ground-water degradation will become even more remote.

Monitor well 5S will be pumped as part of the recommended remedial measure. The experience and results developed during the pumping and testing of this well will provide useful aquifer parameters regarding contaminant transport in the S-aquifer. These data can be extrapolated to other potential remediation areas, if necessary.

123/3

APPENDIX E

PUBLIC HEALTH AND ENVIRONMENTAL ASSESSMENT OF REMEDIAL ALTERNATIVES FOR THE MMRF SITE

Prepared by:

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May, 1988

PUBLIC HEALTH AND ENVIRONMENTAL ASSESSMENT OF REMEDIAL ALTERNATIVES FOR THE MMRF SITE

Under all the remedial alternatives discussed below, the workers implementing the alternatives may be exposed to contaminants via direct contact and inhalation while the remedial activities are being conducted. These workers are assumed to be adequately protected, however, and therefore, potential health impacts to these remedial action workers are not assessed. Potential impacts of the remedial alternatives on current and potential future industrial employees (not remedial alternative workers), future hypothetical residents, and environmental receptors both during and after implementation are discussed below.

1. Remedial Alternative 1: Limited Action.

- o Development of a ground-water quality monitoring program and institutional requirements to prevent future use of affected ground water.
- o Target remediation areas (i.e., Former Cathode Waste Management Areas, Unloading Area, Scrubber Sludge Ponds, and Landfill) will be fenced and deed restrictions will be recorded to prevent future use of these areas.

The risks associated with taking no action at the site were discussed in detail in the risk assessment, presented as Appendix B of the remedial investigation (RI) report.

The major conclusions of this risk assessment were that:

(1) Fluoride concentrations in some ground-water wells exceeded ARARs. Sulfate concentrations in some ground-water wells exceeded secondary drinking

water standards. Suspected past or present sources of ground-water contaminants are perched water, and soils and sediments in the Scrubber Sludge Ponds, Landfill, Former Cathode Waste Management Areas, and Unloading Area;

(2) The noncarcinogenic constituents of concern in soils (i.e., fluoride and cyanide) are not expected to pose adverse health effects to humans exposed to them through direct contact (incidental ingestion and dermal absorption) with soils and sediments, inhalation of dust generated by wind erosion and soil-disturbing activities under any of the soil-related exposure scenarios quantitatively evaluated.

(3) Certain hypothetical future exposure pathways involving direct contact with soils and sediments containing carcinogenic compounds, such as polynuclear aromatic hydrocarbons (PAHs), were identified as being associated with potentially unacceptable carcinogenic risk include the Landfill, Former Cathode Waste Management Areas, and the Scrubber Sludge Ponds.

(4) Water in the Leachate Collection Ditch and in the Landfill Ditch may potentially cause adverse health impacts on environmental receptors drinking this water, due to the presence of current concentrations of fluoride and cyanide.

(5) No impacts on aquatic life in Chenoweth Creek or in the Columbia River resulting from discharges from the MMRF study areas were seen.

The results of the alternative risk evaluation summarized above assumed that no remedial actions at all would be taken at the MMRF. However, the limited action alternative considered in this feasibility study assumes that certain minimal actions would be associated with this alternative. These actions consist of fencing the target remediation areas (i.e., the Former Cathode Waste Management Areas, Unloading Area, Scrubber Sludge Ponds, and the Landfill), and the institution of deed restrictions which

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TE0018-PO5

July 8, 1988

Mr. David A. Tetta
Superfund Site Manager
U.S. Environmental Protection Agency
Region X
1200 Sixth Avenue
Seattle, Washington 98101

RE: Errata Sheet for the Final Feasibility Study Report for the Martin Marietta Reduction Facility in The Dalles, Oregon

Dear Mr. Tetta:

Enclosed for your review is the Errata Sheet for the Final Feasibility Study Report for the Martin Marietta Reduction Facility in The Dalles, Oregon. The corrections listed reflect those items which we feel are of significance and improve the comprehensibility of the Report.

We hope that this Sheet clarifies any discrepancies with the Report that you may have. However, if you have any questions or comments concerning the enclosed information, please feel free to call.

Sincerely,

G&M CONSULTING ENGINEERS, INC.

Sonny Chestnut, P.E.
Project Engineer

Richard J. Cameron
Assistant Staff Engineer

SC/RJC:sck

Enclosure

cc: Mr. Jose Bou
Ms. Loretta Grabowski
Mr. Chuck Wahtola
Ms. Barbara Turnham
Mr. Jerry Kubal
Ms. Jo Anne Mason
Mr. Ed Rothschild
Mr. David Smith
Mr. William R. Keyser
Mr. Bill Renfroe
Mr. Mike Gross
Mr. Charlie Craig
Mr. Charles Politica
Mr. Russell Rhodes
Mr. Dennis Illingsworth
Dr. Alden Pierce

ErrataSh.ltr

ERRATA SHEET
FOR THE
FINAL FEASIBILITY STUDY
MARTIN MARIETTA REDUCTION FACILITY
THE DALLES, OREGON

Corrections to the Feasibility Study which bear a significant role in the comprehensibility of the text material are presented in Table 1. Some insignificant errors within the report have been omitted for the sake of clarity. On Table 1, the column labeled "Page Number" shows the number of the page where a correction has been made. The column labeled "Page Line" indicates the line of text where the correction has been made. The area of concern on Tables and Figures is physically described. The column labeled "Corrected Text" shows how the text should properly read, with the changed area underlined. (A line that reads "Fluorides presents a problem" in the text reads "Fluorides present a problem" in the Corrected Text column.) In some cases, bold face letters are used to describe a change.

TABLE 1

Errata Sheet
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Page Number	Page Line	Corrected Text (changed areas underlined)
E-1	11	the EPA Region X in March 1988
E-4	1	roughly 200 feet below land surface
E-5	6	presence of cyanide compounds was detected
E-7	Bottom	Cd = Cadmium
E-8	Bottom	Cd = Cadmium
E-10	Note 3	(see Appendix C for waiver explanation)
E-15	6	In addition the RA determined that
E-15	9	polynuclear aromatic hydrocarbons
E-16	6	Like the Potliner **begins a new paragraph**
E-17	2	contains approximately 200 cubic yards
E-17	11	volume of each pond is as follows
E-17	23	Potentiometric ground-water elevations
E-19	Middle	Scrubber Sludge Ponds
E-19	Note 3	and may not be representative of ambient
E-19	Bottom	**Add Note:** (4) BDL = Below Detection Limit
E-20	29	alternatives; (4) detailed analysis
E-22	27	difficult to implement on solid waste; and
E-22	32	increases this potential, thus limiting

TABLE 1 (Continued)

Errata Sheet
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Page Number	Page Line	Corrected Text (changed areas underlined)
E-23	Middle	REMEDIAL ALTERNATIVE 6 RCRA Landfill and Ground-water Controls REMEDIAL ALTERNATIVE 7 Containment with Consolidation and Ground-water Recovery and Treatment
E-28	7	Remediation of the MMRF; however,
E-28	8	like Alternative 4, it is more costly
E-28	14	the potential for workers' exposure
E-28	16	increases the potential for workers' exposure
E-30	5	action at a Superfund site
E-30	10	increase the potential for workers'
E-30	22	some of the waste constituents; however, it
E-32	10	handling which reduces potential health-based risks to construction workers and off-site
E-33	25	months; therefore,
E-34	SP2	Replace "Rock" with "Soil" in three places
vi	27	Additional Data Needs for the Preferred Alternative..... 7-20
vi	31	APPENDIX B Remedial Alternative for the Management Units in Operation
	33	APPENDIX C Definition of Appropriate Remediation Criteria for Fluoride and Sulfate in Ground Water

TABLE 1 (Continued)

Errata Sheet
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Page Number	Page Line	Corrected Text (changed areas underlined)
vi	35	APPENDIX D Ground-Water Monitoring and Response Plan
	Bottom	APPENDIX E Public Health and Environmental Assessment of Remedial Alternatives for the MMRF Site
ix	8-14	**Delete Figures 5-1, 5-2, 5-3, 5-4, 5-5, 5-6**
x	4	Selected Sitewide Remediation Criteria
x	12	Summary of EP Toxicity Metals Analyses
x	19	Potential Surface Water Remediation Criteria Environmental Receptors
xii	10	Remedial Measures Considered for Target Remediation Areas
1-2	25	The 350-acre site
1-4	7	A facility map is provided
1-9	3	These included: construction
1-35	MW-26S	**Under Total Cyanide Column** ≤0.01U
1-36	MWR-8A	**Under Fluoride column** ≤1.0 **instead of** <1.0°
1-38		**Under Total Cyanide column in rows MW-11D, MW-16D, PW-1, PW-3, and PW-4** ≤0.01U instead of <0.01UJ
1-53	6	fisheries with salmon, sturgeon, trout
1-58	12	involved in remedial activities. However, the baseline risk

TABLE 1 (Continued)

Errata Sheet
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Page Number	Page Line	Corrected Text (changed areas underlined)
1-60	Note (b)	on aesthetic considerations
1-77	Note 5	to determine fluoride in a solid matrix
1-85	20	waste would consist of bus
1-87	1	o Basalt Fragments 100,000 cubic yards (cy)
1-94	24	The constituents detected
1-97	12	The constituents detected
1-100	14	mixed with cathode waste as did exposed
1-105	5	Analyses of samples collected
1-105	18	MMRF. A proposed remedial alternative for these units is presented in Appendix B.
1-108	15	construction of the SSP as indicated by
Figure 1-18		Add page number 1-109 to the bottom
1-112	23	which currently preclude direct
1-117	16	indicate a maximum fluoride concentration of
2-14	Ground-water Monitoring	water quality deterioration
2-15	Dissolved Air Flotation	removal and disposal of flocculant
2-17	Alternative Water Supply	Alternative Water Supply

TABLE 1 (Continued)

Errata Sheet
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Page Number	Page Line	Corrected Text (changed areas underlined)
2-19	24	requirements as per 40 CFR 122.2.
2-21	16	include fly ash, portland cement,
2-27	18	target remediation areas at the
2-30	15	new, on-site landfill is constructed
2-36	16	increase in a positive valence
2-37	10	between wavelengths of 250 to 400 nm
2-39	4	by the City of The Dalles public works
2-47	15	Gravity flow in the drain, towards the river, would (at times) be virtually impossible.
2-49	10	biological treatment. Control of nutrients
2-55	1	in conjunction with the hydrogeologic
2-57	10	hazardous constituents from ground water
2-57	18	Columbia River. Appendix C presents
2-57	19	the impact on the Columbia River
2-57	27	Because fluoride is a non-destructible
2-58	4	(see Appendix C). This process involves
3-19	Middle	threatened species depend
3-22	3	developed for each target remediation area
3-26	Middle under LF4 column	Approval from regulatory
3-29	Middle under UA6 column	Future exposure to residuals can be prevented
3-30	Middle under UA6 column	Adequate work force and specialists available.

TABLE 1 (Continued)

Errata Sheet
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Page Number	Page Line	Corrected Text (changed areas underlined)
3-43	9	area is presented in Table 3-18
3-49	2	particle size, and transportation
3-49	23	contains an estimated 200 cubic yards
3-51	23	For these reasons, the partial removal
4-4	14	remediation areas and affected ground water
4-5	16	the laboratory analysis has been completed
4-5	22	Alternative 2 consists of the following
4-10	19	moisture deficit of approximately 15 inches
4-23	19	the laboratory analysis has been completed
4-35	25	as required to establish grades
4-56	20	consist of installing new, 4-inch
4-62	20	the volume of sediments could not be
4-64	8	features will be improved to minimize
4-64	22	would be 4 inch diameter wells
4-68	5	area will not be required because
4-72	14	would be four inch diameter wells
4-74	17	presented below:
4-75	9	The Landfill consists of approximately
4-79	15	potential for direct contact
4-79	19	the desired stabilization results
4-80	14	be four inch diameter wells equipped
5-2	27	Technical, Engineering, Institutional,

TABLE 1 (Continued)

Errata Sheet
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Page Number	Page Line	Corrected Text (changed areas underlined)
5-5	28	Addresses how the alternative
5-8	15	controls enacted for the area
5-11	14	The capital cost of Alternative 1
5-14	22	clothing, and respiratory protection,
5-49	9	treatment systems is also minimal
5-69	24	treatment systems is also minimal
5-79	17	systems is also minimal
5-90	1	treatment systems is also minimal
6-6	18	assumes that the waivers from
6-7	4	Alternative 6 except that a more
6-7	6	assumes that the waivers from
6-7	8	required where fluoride concentrations
6-9	13	incineration. The crushing process would increase the potential
7-1	4	Reduction Facility wastes
7-2	19	waste materials, contaminated soils, or
7-8	16	deficit of approximately 15 inches
7-17	18	In Sections 1.0 and 2.0, remedial action
7-19	5	hypothetical scenarios and indicated that
7-19	12	Landfill did not represent unacceptable

TABLE 1 (Continued)

Errata Sheet
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Page Number	Page Line	Corrected Text (changed areas underlined)
B-2	23	in Section 1.0 of this FS. The risk
C-8	22	MMRF is 81,800 cfs (personal
C-24	27	which currently exists. The discharge
D-6	2	the laboratory analysis has been
D-10	5	response scenario would be $ 227,000.

errtarpt

G&M Consulting Engineers, Inc.

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(813) 968-2248

TE0018-PO5

June 30, 1988

Mr. David A. Tetta
Superfund Site Manager
U.S. Environmental Protection Agency
Region X
1200 Sixth Avenue
Seattle, Washington 98101

RE: Appendix B and additions to Appendix D of the Final Feasibility Study Report for the Martin Marietta Reduction Facility in The Dalles, Oregon

Dear Mr. Tetta:

At the request of Mr. Jose Bou, twelve copies of Appendix B, Proposed Remedial Alternative for the Management Units in Operation, of the Final Feasibility Study Report for the Martin Marietta Reduction Facility in The Dalles, Oregon are enclosed for your review. Also enclosed, are twelve copies of the additions to Appendix D which you requested during the June 16, 1988 meeting in Seattle, Washington.

We look forward to the upcoming Public Meeting on July 14, 1988. However, should you have any questions concerning the enclosed information, please do not hesitate to call.

Sincerely,

G&M CONSULTING ENGINEERS, INC.

Frank D. Edwards
Staff Engineer

Allen L. Chestnut, P.E.
Project Engineer

David J. Jessup, P.E.
Vice President

Enclosures

cc: Mr. Jose Bou
Ms. Loretta Grabowski
Dr. Alden Pierce
Mr. Chuck Wahtola
Ms. Barbara Turnham
Mr. Jerry Kubal
Ms. Jo Anne Mason
Mr. Ed Rothschild
Mr. David Smith
Mr. William R. Keyser
Mr. Bill Renfroe
Mr. Mike Gross
Mr. Charlie Craig
Mr. Charles Politica
Mr. Russell Rhodes
Mr. Dennis Illingsworth

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 SIXTH AVENUE
SEATTLE, WA 98101

TARGET SHEET

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Drawings A2 through A6.

APPENDIX B

PROPOSED REMEDIAL ALTERNATIVE FOR THE MANAGEMENT UNITS IN OPERATION

INTRODUCTION

This appendix presents a description and a detailed evaulation of the remedial alternative proposed for the three (3) waste management units currently being operated by Northwest Aluminum (NWA) at the Martin Marietta Reduction Facility (MMRF) in The Dalles, Oregon. These management units in operation consist of:

- The Lined Pond;
- The Recycle Pond; and
- The Discharge Channel.

These management units were investigated in the Remedial Investigation (RI) but were not identified as target remediation areas in the Feasibility Study (FS) because they were operational units and did not pose a risk under the current operational scenario. The proposed remedial alternative discussed in this appendix would be implemented when the management units were taken out of operation and could potentially cause a risk by direct contact with sediments contained within the units. The alternative proposed for remediation of the management units in operation was developed by combining various remedial action technologies which, when implemented, would effectively protect human health and the environment. The proposed alternative protects human health and the environment by minimizing the exposure pathways associated with the

management units in operation. The proposed remedial alternative is also consistent with other actions which have been recommended for remediation of the MMRF.

SITE BACKGROUND

The Lined Pond is located in the southern portion of the MMRF, southeast of the reduction cell buildings. The Lined Pond is approximately 1.6 acres in size with a liquid capacity of 4 million gallons with 2-feet of freeboard during operation. It is used to store particulates collected by the primary air emissions control system at the MMRF. At the time of the remedial investigation sampling, the Lined Pond contained approximately 7,570 cubic yards of sediment but only a small quantity of water because the plant was not in operation.

There is a small amount of wind-blown sediments south of the Lined Pond which accumulated during the period when the MMRF was not in operation. The wind-blown sediments cover about 0.16 acres to a depth of approximately 6 inches. This results in approximately 130 cubic yards of sediment outside of the Lined Pond.

Sediment and surface water samples were collected from the Lined Pond during the RI. Results of the analyses performed on these samples are presented in Section 1.0 of FS. The Risk Assessment (RA) evaluated the analytical results and determined under certain hypothetical scenarios

that the carcinogenic polynuclear aromatic hydrocarbons (cPAHs) present posed a potential risk to human health and the environment through direct contact with the waste.

The Recycle Pond is located between River Road and the Columbia River in the eastern portion of the MMRF. The Recycle Pond occupies approximately 3.0 acres and has a capacity of 8 million gallons. The pond, which is located in a natural low and intersects the water table, functions as a settling basin and a plant recycle water reservoir. The RI determined that approximately 7,700 cubic yards of sediment existed in the Recycle Pond at the time of the investigation. Sediment and surface water samples were collected and the analytical results are presented in Section 1.0 of this FS.

As with the Lined Pond, the RA determined, under certain hypothetical scenarios, that the potential for direct contact with sediments contained in the Recycle Pond is a potential concern because of the cPAHs present. However, the potential exposure pathway (i.e., direct contact) was not present at the Recycle Pond as at the Lined Pond because the Recycle Pond sediments are continuously submerged.

The third management unit in operation investigated by the RI was the Discharge Channel. The Discharge Channel is a primary drainage feature located in the eastern portion of the MMRF and discharges into the Recycle Pond. It has been estimated that the Discharge Channel contains approximately

1,100 cubic yards of sediment. Sediment and surface samples were collected during the RI and the analytical results are presented in Section 1.0 of this FS. The RA evaluated the analyses and determined under certain hypothetical scenarios that a potential risk exists for direct contact with sediments containing cPAHs at the Discharge Channel. However, because the sediments in the Discharge Channel are always submerged during plant operations, the potential risk is minimal.

PROPOSED REMEDIAL ALTERNATIVE

The alternative proposed for remediation of the management units in operation consists of actions which minimize the pathways of potential exposure. These actions are accomplished by consolidation and containment of the sediments within the three units into Scrubber Sludge Pond No. 3. Scrubber Sludge Pond No. 3 contains particulates generated from the secondary air emissions control system and is similar in nature to the sediments contained in the management units. A more detailed description of the actions for each unit follows.

The sediments, liner and any affected subsoils from the Lined Pond would be excavated (dredged) and placed into Scrubber Sludge Pond No. 3. Placement of the sediment into Scrubber Sludge Pond No. 3 would assure that the sediments were kept above the ground-water table which would minimize

the potential for leachate generation. The excavation at the Lined Pond would be backfilled and graded to promote drainage.

The sediments contained in the Recycle Pond would be dredged and placed into Scrubber Sludge Pond No. 3. As with the Lined Pond, placement of the sediments from the Recycle Pond into Scrubber Sludge Pond No. 3 would assure that the sediments were kept above the ground-water table which would minimize the potential for leachate generation.

The sediments contained in the Discharge Channel would also be excavated and placed into Scrubber Sludge Pond No. 3. As discussed with the Lined Pond and Recycle Pond, placement of the sediment into Scrubber Sludge Pond No. 3 would assure that the sediments were kept above the ground-water table which would minimize the potential for leachate generation.

After consolidation of the sediments, liner and affected subsoils from the Lined Pond and sediments from the Recycle Pond and Discharge Channel into Scrubber Sludge Pond No. 3, Scrubber Sludge Pond No. 3 would be covered with a soil cover as discussed in Remedial Alternative 3 of this FS.

DETAILED ANALYSIS OF PROPOSED REMEDIAL ALTERNATIVE

This section presents a detailed analysis of the proposed remedial alternative to determine how the alternative performs against the selected evaluation

criteria. The seven evaluation criteria utilized are included in the EPA's Draft Guidance Document for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (March 1988) and were recommended by the EPA for use in this analysis. The seven evaluation criteria used to analyze the proposed remedial alternative are as follows:

- Short-Term Effectiveness;
- Long-Term Effectiveness;
- Reduction of Toxicity, Mobility and Volume;
- Implementability;
- Cost;
- Compliance with ARARs; and
- Overall Protection.

These evaluation criteria are discussed in detail in Section 5.1 of this FS. Table B-1 presents the detailed analysis of the proposed remedial alternative for the management units in operation.

SUMMARY

The RA conducted as part of the RI for the MMRF in The Dalles, Oregon identified three (3) waste management units which may potentially pose a risk for direct contact with affected sediments under certain potential hypothetical scenarios. These management units, currently being operated by Northwest Aluminum, consist of:

TABLE B-1

Detailed Analysis of Proposed Remedial Alternative for the Management Units in Operation
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

	Proposed Remedial Alternative
	o Lined Pond - Consolidate Sediments, Liner and Affected Subsoils into SSP3 and Backfill Pond o Recycle Pond - Excavate and Consolidate Sediments from the Pond into SSP3 o Discharge Channel - Excavate and Consolidate Sediments from the Channel into SSP3
Screening Criteria	
Short-Term Effectiveness	o Implementation should not pose a threat to the community or the environment. o Minimal risk may result to on-site workers during excavation of sediments. o Remedial actions could be completed within one year after the management units are closed.
Long-Term Effectiveness	o Mitigates potential risks at the Lined Pond, Recycle Pond and Discharge Channel. o Closure of the management units will attain action specific ARARs. o Long-term maintenance required for soil cover on SSP3. o All three management units are eliminated as sites requiring long-term management. o Actions associated with the remedial alternative will be reliable.
Reduction of Toxicity, Mobility and Volume	o Does not treat the waste to reduce toxicity, mobility or volume.
Implementability	o It is expected that after implementation of this alternative, additional remedial actions would not be required. o The technologies utilized in this remedial alternative have been proven at other waste management sites and could be implemented without further development. o The required equipment, materials and trained personnel are available.
Compliance with ARARs	o Alternative complies with applicable action and location specific ARARs.
Overall Protection	o Minimizes exposure pathways and associated risks via waste containment. o Actions are consistent with other remedial actions recommended for the MMRF.
Cost	
Capital	$ 522,900
Annual O&M	0
Total Present Worth	$ 522,900

123/19

- The Lined Pond;
- The Recycle Pond; and
- The Discharge Channel.

The potential risk for direct contact with the sediments contained in these units results from the cPAHs present. Currently the sediments are submerged and the potential for risk is non-existent. However, the RA evaluated certain hyothetical scenarios which evaluated the sediments in a dry state which did result in a potential risk.

To mitigate the potential risk at the management units in operation identified by the RA, a remedial alternative has been proposed for implementation. The proposed alternative includes the following:

- Excavation and consolidation of the sediments, liner and affected subsoils from the Lined Pond into SSP3 and backfill the excavation at the Lined Pond;
- Excavation and consolidation of the sediments from the Recycle Pond into SSP3; and
- Excavation and consolidation of the sediments from the Discharge Channnel into SSP3.

Analysis of this remedial alternative has shown that it would minimize the exposure pathways and risks associated with the management units in operation by removing and consolidating the sediments from the management units into Scrubber Sludge Pond No. 3. Scrubber Sludge Pond No. 3 would subsequently be covered as discussed in Remedial Alternative 3 of this FS. An analysis of the cover system for Scrubber

Sludge Pond No. 3 is discussed in Section 5.2.3. Implementing the proposed alternative would minimize existing risk to the maximum extent practicable and would reduce the number of areas requiring long-term management. Eliminating use of the management units as part of the plant process would prevent future generation of sediments in the units and would eliminate the potential for future exposure at these areas. Dredging and discontinuing use of the Recycle Pond would also eliminate this unit as a source of fluoride contamination to the S-aquifer above the ARAR.

Consolidation of the existing sediments into Scrubber Sludge Pond No. 3 is an appropriate method of disposal for the sediments contained in the management units in operation because of the following reasons:

- The fluoride present in the sediments is an element which naturally occurs and therefore, cannot be destroyed, only transformed from one media to another (liquid or solid);
- The PAH compounds present in the sediments are practically insoluble in water;
- Because the sediments are currently under water, the potential for generation of fugitive dust emissions is minimal;
- Consolidation of the sediments from the management units in operation into SSP3 would assure that the sediments will be kept in a dry environment (above the water table) which would minimize the potential for leachate generation; and
- Consolidation of the sediments from the management units in operation into SSP3 is consistent with the other actions recommended for the MMRF by this FS.

Hypothetical Scenarios for Ground-Water Response Actions

The following provides additional information concerning the actions which would be conducted if the ground-water monitoring program indicates that appropriate ARARs or remediation criteria are exceeded. Several possible scenarios exists which would require ground-water response actions. Two possible scenarios are considered in this section including 1) cyanide and fluoride are found above the ARAR or remediation criteria in the A-aquifer beneath the Landfill; and 2) cyanide and fluoride are found above the ARAR or remediation criteria in the B-aquifer beneath the Landfill. Should the ARAR or remediation criteria be exceeded in both the A- and B-aquifers, the response actions for both scenarios would be conducted simultaneously.

A-Aquifer Response Plan

Should the ARAR and remediation criteria for cyanide and fluoride be exceeded in the A-aquifer, the ground water from the A-aquifer would be recovered and treated for cyanide and fluoride. It is anticipated that recovery of ground water from the Landfill could be conducted by installing two four-inch diameter recovery wells downgradient of the Landfill. It has been estimated that each well would be pumped at a continuous flowrate of 20 gpm for a total recovery rate of 40 gpm. The recovered ground water would be

transmitted to a cyanide treatment unit for destruction of cyanide and would then be routed to the roof scrubber system or treated for fluoride by the in-plant process.

The capital cost of implementing this ground water response scenario would be $277,000. The annual O&M cost for this scenario would be $48,000. The total present worth of this scenario using a discount rate of 8% is $767,000. Table D-2 presents a detailed description of these costs.

B-Aquifer Response Plan

Should the ARAR and remediation criteria for cyanide and fluoride be exceeded in the B-aquifer, the ground water from the B-aquifer would be recovered and treated for cyanide and fluoride. The recovery system would be constructed by installing three four-inch diameter recovery wells in the B-aquifer downgradient of the Landfill. The recovery wells would be operated at a continuous flowrate of approximately 100 gpm for a combined flowrate of 300 gpm. The recovered ground water would be transmitted to a cyanide treatment unit for cyanide destruction and would then be routed to the roof scrubber system or treated by the in-plant process.

The capital cost of implementing this ground water response scenario would be $495,000. The annual O&M cost for this scenario would be $55,000. The total present worth of this scenario using a discount rate of 8% is $1,114,000. Table D-3 presents a detailed description of these costs.

TABLE D-2

Cost Analysis of A-Aquifer Response Plan
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
I Capital Cost			
A. Ground Water Recovery System (40 gpm)			
Four-inch Recovery Well	25,000 each	2	50,000
Plumbing System			
Pump	1,000 each	2	2,000
Controls	1,000 LS	1	1,000
Electrical Connection	2,000 LS	1	2,000
Two-inch PVC Discharge line	8 /foot	2700	22,000
		Subtotal	**47,000**
B. Aqueous Treatment System			
Site Prep	10,000 LS	1	10,000
Cyanide Treatment Unit	65,000 LS	1	65,000
Electrical - Controls	10,000 LS	1	10,000
		Subtotal	**85,000**
A-Aquifer Response Plan Subtotal			**132,000**
Engineering	15%		20,000
Indirect	10%		14,000
Contingency	25%		33,000
Inspection	10%		14,000
Health & Safety	10%		14,000
A-Aquifer Response Plan Total Capital Cost			**227,000**
II Annual Operating Cost			
A. Ground Water Recovery System			
Recovery Wells	2,000 LS	1	2,000
Pumps	5,000 LS	1	5,000
Electrical	2,000 LS	1	2,000
		Subtotal	**9,000**
B. Treatment System			
Electrical	1,000 LS	1	1,000
Chemicals	2,000 /year	1	2,000
Operator	30,000 /year	0.5	15,000
Management	50,000 /year	0.1	5,000
Maintenance	2,000 /year	1	2,000
		Subtotal	**25,000**

TABLE D-2 (Continued)

Cost Analysis of A-Aquifer Response Plan
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
Annual Operating Cost Subtotal			34,000
Indirect	20%		7,000
Contingency	20%		7,000
Annual Operating Cost			48,000
Present Worth Operating Cost			540,000
III Present Worth A-Aquifer Response Plan			
Capital Cost			227,000
Operating Cost			540,000
Total Present Worth			767,000

098/17

TABLE D-3

Cost Analysis of B-Aquifer Response Plan
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
I Capital Cost			
A. Ground Water Recovery System (300 gpm)			
Four-inch Recovery Well	40,000 each	3	120,000
Plumbing System			
Submersible Pump	1,000 each	3	3,000
Controls	1,000 LS	1	1,000
Electrical Connection	5,000 LS	1	5,000
Six-inch PVC Discharge line	25 /foot	2500	63,000
		Subtotal	**192,000**
B. Aqueous Treatment System			
Site Prep	10,000 LS	1	10,000
Cyanide Treatment Unit	95,000 LS	1	95,000
Controls	5,000 LS	1	5,000
Electrical Connnection	5,000 LS	1	5,000
		Subtotal	**115,000**
B-Aquifer Response Plan Subtotal			**307,000**
Engineering	15%		40,000
Indirect	10%		27,000
Contingency	25%		67,000
Inspection	10%		27,000
Health & Safety	10%		27,000
B-Aquifer Response Plan Total Capital Cost			**495,000**
II Annual Operating Cost			
A. Ground Water Recovery System			
Recovery Wells	2,000 LS	1	2,000
Pumps	5,000 LS	1	5,000
Electrical	2,000 LS	1	2,000
		Subtotal	**9,000**
B. Treatment System			
Electrical	5,000 LS	1	5,000
Chemicals	3,000 /year	1	3,000
Operator	30,000 /year	0.5	15,000
Management	50,000 /year	0.1	5,000
Maintenance	2,000 /year	1	2,000
		Subtotal	**30,000**

TABLE D-3 (Continued)

Cost Analysis of B-Aquifer Response Plan
Feasibility Study: Martin Marietta Reduction Facility
Martin Marietta Corporation
The Dalles, Oregon

Description	Unit Cost ($)	Quantity	Cost ($)
Annual Operating Cost Subtotal			39,000
Indirect	20%		8,000
Contingency	20%		8,000
Annual Operating Cost			55,000
Present Worth Operating Cost			619,000
III Present Worth B-Aquifer Response Plan			
Capital Cost			495,000
Operating Cost			619,000
Total Present Worth			1,114,000

098/18

would preclude future use of these areas. This combination of fencing and deed restrictions would prevent direct contact with the soils in these areas by most humans and therefore preclude the associated risks. However, since utility piping may run under some of these areas, maintenance workers may still have to work for relatively short periods of time within these fenced-in areas. Although these workers may be exposed to soil contaminants in these areas, the exposures are expected to be of short duration and were determined from the no action alternative risk assessment to be insignificant.

Fences may not prevent birds and small mammals from using contaminated surface waters (e.g., leachate in the Landfill area) as drinking water sources, neither would they prevent contaminants from migrating in these areas.

Institutional controls on use of ground water adjacent to the MMRF between River Road and the Columbia River would prevent humans from ingesting ground water migrating towards the river (the S-aquifer), precluding potential health effects from this potential exposure. However, migration of contaminants from target remediation areas into and within ground water would still occur.

2. Remedial Alternative 2: Containment with Ground-water Controls

- Plug and abandonment of potentially contaminated wells, connection of users to the city water system and establish institutional requirements limiting

or prohibiting the drilling of new wells. Ground-water recovery and treatment in the Unloading Area (included in the treatment of the perched water and leachate from the Former Cathode Waste Management Areas and the Landfill, respectively).

- Deed restrictions under this alternative would prevent future routine industrial use or development of target remediation areas. All target remediation areas will be fenced.

- Placement of soil cover over Scrubber Sludge Ponds 2 and 3.

- Covering waste/soils in Former Cathode Waste Management Areas with an asphalt cap. Deed restrictions will prevent disturbance of cap. Surface drainage promoted prior to capping will be collected and diverted to a process sewer. Perched water will be collected and treated with ground water.

- Consolidation of cathode waste material from Unloading Area and areas associated with the Landfill (i.e., materials in the Leachate Collection Ditch, Surface Drainage Ditch, and Landfill Ditch) into existing Landfill followed by capping of the Landfill with an asphalt cap. The Unloading Area would be backfilled to promote drainage.

Capping of the Former Cathode Waste Management Areas and the Landfill and associated areas which have been consolidated into the Landfill would significantly reduce infiltration and subsequent leaching of contaminants from fill or residual materials by precipitation. A collection system for leachate from the Landfill and perched water east of River Road and from the Former Cathode Waste Management Areas will be below grade precluding birds and mammals from potentially using the water as a source of drinking water. Therefore, potential risks to these birds and mammals is negligible.

As long as digging, trenching, etc., is not allowed to occur in the capped areas, capping would also prevent direct contact with contaminated materials. Deed and zoning restrictions under this alternative would also prevent future routine industrial use or future development of the fenced target remediation areas. Short-term risks due to inhalation of dust generated during excavation and consolidation would be negligible since dust suppressants will be used.

Placement of a soil cover on, and a fence around Scrubber Sludge Ponds 1 through 4, and subsequent deed restrictions preventing future routine industrial use or future development of all of the Scrubber Sludge Ponds would preclude risks associated with direct contact with Scrubber Sludge Pond sediments. The Scrubber Sludge Ponds are potential sources of fluoride and sulfate in the ground water; a soil cover would not affect the release of contaminants from the sediment into the ground water via infiltration. In addition, some of the Scrubber Sludge Pond sediments are currently beneath the water table; these sediments may continue to leach contaminants into ground water. Based upon these two factors, ground-water concentrations of fluoride in the area of the Scrubber Sludge Ponds may not be reduced below remediation criteria. This situation would be addressed by the ground-water monitoring program proposed in this alternative.

To eliminate the potential for human exposure to contaminated ground water, this alternative also includes ground-water controls such as the plugging and abandonment of the Animal Shelter, Rockline, Klindt, and Residence wells. In addition, current users of these wells would be placed on the city water system. Although the potential would still exist for contaminants to migrate into ground water, the ground-water monitoring and deed restrictions on general ground-water use proposed under this alternative would also prevent human exposure to contaminated ground water and eliminate associated potential risks.

3. Remedial Alternative 3: Containment with Complete Removal and Ground-water Controls

- Placement of soil cover over Scrubber Sludge Ponds 2 and 3.
- Excavation, transportation and consolidation of residual cathode waste material and underlying fill material from Former Cathode Waste Management Areas into Landfill followed by capping of Landfill. The excavation will be backfilled as needed to promote drainage. Perched water will be collected and treated during remediation.
- Consolidation of cathode waste material from Unloading Area into existing Landfill followed by capping of the Landfill as described below.
- Capping of Landfill with a multi-media cap, leachate collection and treatment, improved drainage controls. Deed restrictions will prevent disturbance of the cap.
- Plug and abandonment of potentially contaminated water supply wells, connection of users to the city water system and establish institutional requirements limiting or prohibiting the drilling of new wells.

- Deed restrictions under this alternative would prevent future routine industrial use or development of target remediation areas. All target remediation areas will be fenced.

The impacts on risk associated with capping and fencing are generally the same as those discussed for Remedial Alternative 2. That is, consolidation of materials from the Former Cathode Waste Management Areas and the Unloading Area into the Landfill and subsequent capping of the Landfill with a multi-media cap would significantly reduce infiltration and subsequent leaching of materials from these areas. In addition to treating collected Landfill leachate, the leachate treatment system in the Landfill area will also be used to treat ground water recovered from the Unloading Area and perched water collected east of River Road and from the Former Cathode Waste Management Areas. A leachate collection system will be installed beneath the cap to collect leachate from the Landfill. The potential risks to birds and mammals contacting contaminated leachate from the Landfill should therefore, be negligible.

Capping the Landfill, together with deed and zoning restrictions to prevent future routine industrial use or future development of the fenced target remediation areas, would prevent direct contact with contaminated materials in the target remediation areas, and the potential health risks posed to the individuals directly contacting contaminated materials in these areas would be precluded.

Short-term risks due to inhalation of dust generated during the excavation and consolidation needed to implement these remedial measures would be minimal since dust suppressants will be used.

The difference between this alternative and that of Remedial Alternative 2 is that residual cathode waste material and the underlying fill in the Former Cathode Waste Management Areas will be consolidated into the Landfill instead of being capped in place. Because residual material above basalt will be removed from the Former Cathode Waste Management Areas, no further leaching of contaminants will occur in this area. This also eliminates the need for a trench to collect leachate in the Former Cathode Waste Management Areas.

This alternative also includes the replacement of local production wells with city water, ground-water monitoring, and deed restrictions as discussed in Remedial Alternative 2. These measures would prevent human exposure to contaminated ground water and associated risks.

4. Remedial Alternative 4: Containment, Complete Removal and Hydraulic Barriers with Ground-water Controls

- Plug and abandonment of potentially contaminated wells, connections of users to the city water system and establish institutional requirements limiting or prohibiting the drilling of new wells.
- Deed restrictions under this alternative would prevent future routine industrial use or development of target remediation areas. All target remediation areas will be fenced.

- Capping of Scrubber Sludge Ponds 1 and 4, and hydraulic barriers would be implemented to prevent ground water from contacting waste materials.

- Excavation, transportation and consolidation of residual cathode waste material and underlying fill material from Former Cathode Waste Management Areas into the Landfill followed by capping of Landfill. The excavation will be backfilled as needed to promote drainage. Perched water will be collected and treated during remediation.

- Consolidation of cathode waste material from Unloading Area into existing Landfill followed by capping of the Landfill as described below.

- Capping of Landfill with a multi-media cap, leachate collection and treatment, improved drainage controls. Deed restrictions will prevent disturbance of cap.

The impact on risk associated with consolidation, capping and fencing are generally the same as those discussed for Remedial Alternative 3. That is, consolidation of materials from the Former Cathode Waste Management Areas and the Unloading Area into the Landfill and subsequent capping of the Landfill would significantly reduce infiltration and subsequent leaching of materials by infiltration from these areas. In addition to treating collected Landfill leachate, the leachate treatment system in the Landfill area will also be used to treat ground water recovered from the Unloading Area and perched water collected east of River Road and from the Former Cathode Waste Management Areas. A leachate collection system will be installed beneath the Landfill cap to collect leachate. This leachate collection system should preclude the potential risks to birds and mammals associated with contact of leachate.

Capping of the Landfill and removal of wastes from Former Cathode Waste Management and Unloading Areas, together with deed and zoning restrictions to prevent future routine industrial use or future development of the target remediation areas, would prevent direct contact with contaminated materials and the potential health risks posed to individuals directly contacting contaminated materials in these target remediation areas would be precluded.

Short-term risks due to inhalation of dust generated during the excavation and consolidation needed to implement these remedial measures would be minimal since dust suppressants will be used.

Reduction in risk associated with the establishment of ground-water controls are the same as those discussed in Remedial Alternative 2. That is, this alternative includes ground-water controls such as the plugging and abandonment of the Animal Shelter, Rockline, Klindt, and Residence wells. In addition, current users of these wells would be connected to the city water system. Ground-water monitoring and deed restrictions on ground-water use under this alternative would also prevent exposure to contaminated ground water and hence reduce associated risks.

5. Remedial Alternative 5: Containment with Consolidation and Ground-water Controls

- Plug and abandonment of potentially contaminated wells, connection of users to the city water system and establish institutional requirements limiting or prohibiting the drilling of new wells.
- Deed restrictions under this alternative would prevent future routine industrial use or development of target remediation areas. All target remediation areas will be fenced.
- Excavation of cover soils, sludges, and sediments in the Scrubber Sludge Ponds to basalt, transportation and consolidation into the Landfill with subsequent capping of the Landfill.
- Excavation, transportation and consolidation of residual cathode waste material and underlying fill material from Former Cathode Waste Management Areas into the Landfill followed by capping of the Landfill. The excavation will be backfilled as needed to promote drainage. Perched water will be collected and treated during remediation.
- Consolidation of cathode waste material from Unloading Area into the existing Landfill followed by capping of the Landfill as described below.
- Capping of Landfill with a multi-media cap, leachate collection and treatment and improved drainage controls. Deed restrictions will prevent disturbance of the cap.

Consolidation of materials from the Landfill, Unloading Area, Former Cathode Waste Management Areas, and the Scrubber Sludge Ponds into the existing Landfill and subsequent capping of the Landfill would significantly reduce infiltration and subsequent leaching of materials from these areas. In addition to treating collected Landfill leachate, the leachate treatment system in the Landfill area will also be used to treat ground water recovered from the Unloading

Area and perched water collected east of River Road and from the Former Cathode Waste Management Areas. A leachate collection system will be installed beneath the Landfill cap. This leachate collection system should preclude the potential risks to birds and mammals associated with direct contact with leachate.

Capping of the Landfill, including the consolidated materials from the Former Cathode Waste Management Areas, Unloading Area, and the Scrubber Sludge Ponds, together with deed and zoning restrictions to prevent future routine industrial use or future development of the target remediation areas, would reduce the potential for direct contact with contaminated materials and the potential health risks posed to individuals directly contacting contaminated materials would be precluded.

Risks potentially associated with ground-water controls would be the same as those in Remedial Alternative 2. That is, this alternative includes ground-water controls such as the plugging and abandonment of the Animal Shelter, Rockline, Klindt, and Resident wells. In addition, current users of these wells would be connected to the city water system. Ground-water monitoring and deed restrictions on ground-water use under this alternative would also reduce the potential for exposure to contaminated ground water and hence minimize associated risks.

6. Remedial Alternative 6: RCRA Landfill and Ground-water Controls

- Plug and abandonment of potentially contaminated wells, connection of users to the city water system and establish institutional requirements limiting or prohibiting the drilling of new wells.
- Deed restrictions under this alternative would prevent future routine industrial use or development of target remediation areas. All target remediation areas will be fenced.
- Excavation of cover soil, sludges, and sediments in the Scrubber Sludge Ponds down to competent basalt, transport and consolidation of this material into an on-site RCRA landfill.
- Excavation, transportation, and consolidation of residual cathode waste material and underlying fill material from Former Cathode Waste Management Areas into an on-site RCRA landfill. The excavation will be backfilled as needed to promote drainage. Perched water will be collected and treated during remediation.
- Consolidation of cathode waste material from Unloading Area into an on-site RCRA landfill. Excavated areas will be backfilled as necessary to promote drainage.
- Excavation, segregation, transportation and placement of target wastes in the Landfill and associated areas (i.e., Leachate Collection Ditch, Surface Drainage Ditch, and Landfill Ditch) into an on-site RCRA landfill with improved drainage controls.

Consolidation of materials from the Landfill, Unloading Area, Former Cathode Waste Management Areas, and Scrubber Sludge Ponds into an on-site RCRA landfill would significantly reduce the long-term risks associated with these areas by managing the materials in a facility designed to meet minimum technology requirements. Since leachate formation would be reduced, risks to birds and mammals

ingesting water from ditches would be alleviated. Short-term risks to on-site employees and off-site residents via airborne transport of contaminated dust from the handling of these materials during placement into the RCRA facility should not be significant due to use of a dust suppressant.

Risks associated with the establishment of ground-water controls are the same as those discussed in Remedial Alternative 2. That is, this alternative includes ground-water controls such as the plugging and abandonment of the Animal Shelter, Rockline, Klindt, and Resident wells. In addition, current users of these wells would be connected to the city water system. Ground-water monitoring and deed restrictions on ground-water use under this alternative would also reduce the potential for exposure to contaminated ground water.

7. Remedial Alternative 7: Containment with Consolidation and Ground-water Recovery and Treatment

- Installation of a ground-water recovery system with treatment and ground-water monitoring.
- Deed restrictions under this alternative would prevent future routine industrial use or development of target remediation areas. All target remediation areas will be fenced.
- Excavation of soil cover, sludges, and sediments from the Scrubber Sludge Ponds down to competent basalt, transport and consolidation into the Landfill with subsequent capping of the Landfill.
- Excavation, transportation and consolidation of residual cathode waste material and underlying fill material from Former Cathode Waste Management Areas into the Landfill followed by capping of the

Landfill. The excavation will be backfilled as needed to promote drainage. Perched water will be collected and treated during remediation.

- o Consolidation of cathode waste material from the Unloading Area into the existing Landfill followed by capping of the Landfill as described below.
- o Capping of the Landfill with a multi-media cap, leachate collection and treatment and improved drainage controls. Deed restrictions will prevent disturbance of the cap.

The risks associated with consolidation of various areas into the existing Landfill and subsequent capping of the Landfill are the same as those discussed in Remedial Alternative 5. That is, consolidation of materials from the Landfill, Unloading Area, Former Cathode Waste Management Areas, and the Scrubber Sludge Ponds into the existing Landfill and subsequent capping of the Landfill would remove the potential for leaching of contaminants from the target remediation areas except the Landfill. Risks to birds and mammals ingesting water from the ditches would be alleviated because the ditches would be replaced with a leachate collection system installed beneath the cap.

Capping of the Landfill, including the consolidated materials from the Former Cathode Waste Management Areas, Unloading Area, and the Scrubber Sludge Ponds, together with deed and zoning restrictions to prevent future routine industrial use or future development of the target remediation areas, would prevent direct contact with the

contaminated materials and the potential health risks posed to individuals directly contacting contaminated materials would be precluded.

The additional measure of recovery and treatment of the ground water, including recovery and treatment of perched water and leachate generated from the Landfill for a short time following capping, would reduce current ground-water contamination below remediation criteria. Therefore, there would be no human exposure to these contaminants at levels above remediation criteria through the use of this ground water and hence, no associated unacceptable health risks. Significant short-term risks during ground-water treatment are not expected since the system is enclosed; no releases into the air are expected, and under this alternative, discharge into surface waters would be conducted according to NPDES specifications.

8. Remedial Alternative 8: RCRA Landfill and Ground-water Recovery and Treatment

- Installation of a ground-water recovery system with treatment and ground-water monitoring.
- Deed restrictions under this alternative would prevent future routine industrial use or development of target remediation areas. All target remediation areas will be fenced.
- Excavation of soil cover, sludges, and sediments from the Scrubber Sludge Ponds down to competent basalt, transportation and consolidation into an on-site RCRA landfill.
- Excavation, transportation and consolidation of residual cathode waste material and underlying fill material from Former Cathode Waste Management Areas

into an on-site RCRA landfill. The excavation will be backfilled as required to promote drainage. Perched water will be collected and treated during remediation.

- Consolidation of cathode waste material from the Unloading Area into an on-site RCRA landfill. Excavated areas will be backfilled as necessary and the drainage controls will be improved.

- Excavation, segregation, transportation and placement of target wastes from the Landfill and associated areas (i.e., Leachate Collection Ditch, Surface Drainage Ditch, and Landfill Ditch) into an on-site RCRA landfill with improved drainage controls.

Risks associated with consolidation of materials from the Landfill, Unloading Area, Former Cathode Waste Management Areas, and Scrubber Sludge Ponds into an on-site RCRA landfill are the same as those discussed in Remedial Alternative 6. That is, consolidation of materials from the Landfill, Unloading Area, Former Cathode Waste Management Areas, and Scrubber Sludge Ponds into an on-site RCRA landfill would significantly reduce the long-term risks associated with these areas by managing the material in a facility designed to meet minimum technology requirements. Risks to birds and mammals ingesting water from ditches would be alleviated because the ditches would be replaced with a leachate collection system installed beneath the cap. Short-term risks to on-site employees and off-site residents via airborne transport of contaminated dust from the handling of these materials during placement into the RCRA facility should not be significant due to use of dust suppressants.

Risks associated with recovery and treatment of the ground water are the same as those discussed in Remedial Alternative 7. That is, recovery and treatment of the ground water, including recovery and treatment of perched water and leachate generated from the Landfill for a short time following capping, would reduce current ground-water contamination below remediation criteria. Therefore, there would be no exposure to these contaminants through use of this ground water at levels above remediation criteria and hence, no associated unacceptable risk. Significant short-term risks during ground-water treatment are not expected since the system is enclosed; no releases into air are expected, and under this alternative, discharge into surface waters would be conducted according to NPDES specifications.

9. Remedial Alternative 9: Containment with Consolidation, Stabilization and Ground-water Recovery and Treatment

- Installation of a ground-water recovery system with treatment and ground-water monitoring.
- Deed restrictions under this alternative would prevent future routine industrial use or development of target remediation areas. All target remediation areas will be fenced.
- Stabilization (in place) of sediments in the Scrubber Sludge Ponds, with a soil cover over the stabilized sediment.
- Excavation, transportation and consolidation of residual cathode waste material and underlying fill material from Former Cathode Waste Management Areas into the Landfill followed by capping of the Landfill. The excavations will be backfilled as needed to promote drainage. Perched water will be collected and treated during remediation.

- Consolidation of cathode waste material from the Unloading Area into the existing Landfill followed by capping of the Landfill as described below.
- Capping of the Landfill with a multi-media cap, leachate collection and treatment and improved drainage controls. Deed restrictions will prevent disturbance of the cap.

Risks associated with consolidation of materials in the Unloading Area and Former Cathode Waste Management Areas into the existing Landfill and subsequent capping of the Landfill are the same as those discussed in Remedial Alternative 4. That is, capping of the Landfill and the areas which have been consolidated into the Landfill would significantly reduce infiltration and subsequent leaching of materials from these areas. In addition to treating collected Landfill leachate, the leachate collection system in the Landfill area will also be used to treat ground water recovered from the Unloading Area and perched water collected east of River Road and from the Former Cathode Waste Management Areas. A leachate collection system will be installed beneath the cap. This system should preclude the potential risks to birds and mammals associated with direct contact of leachate.

Capping of the Landfill, together with deed and zoning restrictions to prevent future routine industrial use or future development of the fenced target remediation areas, would prevent direct contact with contaminated materials and the potential health risks posed to individuals directly contacting contaminated materials would be precluded.

Stabilization of the Scrubber Sludge Pond sediments would significantly reduce or eliminate further leaching of contaminants into ground water. Stabilization would not, however, necessarily alter the particulate size of the sediment materials, and therefore may not reduce the potential health risks associated with directly contacting contaminated Scrubber Sludge Pond sediment materials. Therefore, a soil cover will be placed over the Scrubber Sludge Ponds after stabilization, eliminating the potential for individuals to directly contact the contaminated material, and thus eliminating risks associated with direct contact exposures in the Scrubber Sludge Pond areas.

Risks associated with the recovery and treatment of ground water are the same as those discussed in Remedial Alternative 7. That is, recovery and treatment of the ground water, landfill leachate, and perched water would reduce current ground-water contamination below remediation criteria. Therefore, there would be no exposure to these contaminants through use of this ground water and hence no associated risk. Significant short-term risks during treatment are not expected since the system is enclosed; no releases into air are expected, and under this alternative, discharge into surface waters would be conducted according to NPDES specifications.

10. Remedial Alternative 10: Incineration, Stabilization and Ground-water Recovery and Treatment

- Stabilization (in place) of sediments in the Scrubber Sludge Ponds, with a soil cover over the stabilized material.
- Installation of a ground-water recovery system with treatment and ground-water monitoring.
- Excavation, segregation, and transportation of cathode waste material from Unloading Area, Former Cathode Waste Management Areas and Landfill to an on-site incinerator. Ash from the incinerator will be managed in an on-site RCRA landfill. The excavations will be backfilled as needed to promote drainage. Perched water will be collected and treated during remediation.

The risks associated with stabilization of the Scrubber Sludge Ponds are the same as those discussed in Remedial Alternative 9. That is, stabilization of the Scrubber Sludge Pond sediments would significantly reduce or eliminate further leaching of contaminants into ground water. Stabilization would not, however, necessarily alter the particulate size of the sediment materials, and therefore may not reduce the potential health risks associated with directly contacting contaminated Scrubber Sludge Pond sediment materials. Therefore, a soil cover will be placed over the Scrubber Sludge Ponds after stabilization, eliminating the potential for individuals to directly contact the contaminated material, and thus eliminating risks associated with direct contact exposures in the Scrubber Sludge Pond areas.

Risks associated with the recovery and treatment of ground water are the same as those discussed in Remedial Alternative 7. That is, recovery and treatment of the ground water, leachate, and perched water would reduce current ground-water contamination below remediation criteria. Therefore, there would be no exposure to these contaminants through use of this ground water and hence no associated risk. Significant short-term risks during treatment are not expected since the system is enclosed; no releases into air are expected, and under this alternative, discharge into surface waters would be conducted according to NPDES specifications.

Prior to incineration, contaminated materials from the Landfill, Unloading Area, and the Former Cathode Waste Management Areas would have to be excavated and moved to the on-site location of the incinerator. Short-term risks during this excavation and transport may result from the emissions of contaminated dust and organics and subsequent inhalation by on-site and off-site employees and off-site residents. Additional short-term risks may result from atmospheric contaminations caused by incinerator offgases, but these risks are expected to be minimal because air quality standards designed to reduce risk to human health and the environment must be met; requiring extensive, sophisticated air emission control equipment. Incineration would significantly reduce any risks associated with the

contaminants in the soils and reduce the long-term risk associated with direct contact with the soils from these various areas. Because the volume of waste would be reduced, it is expected that the formulation of leachate in these areas would be reduced. This reduction would serve to reduce potential adverse impacts on birds and mammals since they could no longer use the leachate as a source of drinking water.

123/2