PRELIMINARY DRAFT

ENVIRONMENTAL IMPACT STATEMENT

For The

TAILINGS MODERNIZATION PROJECT

January 27, 1995

U.S. Army Corps of Engineers
Sacramento District

Kennecott Utah Copper Corporation
Magna, Utah

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

January 25, 1995

Utah Regulatory Office

RECEIVED
JAN 27 1995
DIV OF OIL, GAS & MINING

Wayne Hedberg
Division of Oil, Gas and Mining
355 West North Temple
3 Triad Center, Suite 350
Salt Lake City, Utah 84180

Dear Mr. Hedberg:

Attached is a second Preliminary Draft Environmental Impact Statement (PDEIS) for the proposed Kennecott Tailings Modernization Project. We are soliciting your comments specific to your regulatory and/or technical expertise in relationship to the various issues addressed. You should provide your comments no later than February 27, 1995 to:

Mr. Michael Schwinn
U.S. Army Corps of Engineers
Utah Regulatory Office
1403 South, 600 West, Suite A,
Bountiful, Utah 84010,
Telephone (801)295-8380.

This document represents changes to the first preliminary draft EIS as a result of previous agency review and comment. There will be additional opportunities to comment on this action when the Draft and Final EIS become available. We look forward to your participation in the environmental process. If you have any questions, contact Mr. Schwinn at the address and phone number listed above.

Sincerely,

Brooks Carter
Chief, Utah Regulatory Office

Enclosure(s)

RECEIVED
JAN 7 1995
DIV OF OIL GAS & MINING

DRAFT ENVIRONMENTAL IMPACT STATEMENT
TAILINGS MODERNIZATION PROJECT
MAGNA, UTAH

LEAD AGENCY: Department of the Army
U.S. Army Engineer District, Sacramento
Corps of Engineers

FOR ADDITIONAL INFORMATION: Mr. Michael Schwinn, Project Manager
U.S. Army Corps of Engineers
Sacramento District
Utah Regulatory Office
1403 South 600 West, Suite A
Bountiful, Utah 84010
(801) 295-8380

The applicant for this project is the Kennecott Utah Copper Corporation (Kennecott). The proposed project, Tailings Modernization Project, would require approval by the U.S. Army Corps of Engineers (Corps). This environmental impact statement (EIS) is a Corps permit action under Section 404 of the Clean Water Act of 1977. Additional specific authorizing actions, including permit approvals from agencies representing the United States, the State of Utah, the County of Salt Lake, and the City of Salt Lake, are pending.

ABSTRACT: Kennecott has undertaken a modernization program at the Bingham Canyon Mine. As part of the overall modernization program, Kennecott is proposing to undertake a tailings modernization project that would transition existing tailings storage operations to a new impoundment north of Kennecott's existing tailings storage impoundment. This would allow for continued storage of tailings, provide a seismic upgrade for the existing impoundment, and allow continued operation of other modernized Kennecott facilities. The tailings modernization project would transition current tailings storage operations to the new impoundment in late 1998. The new impoundment area would accommodate tailings generated over approximately 25 to 30 years of copper production.

COMMENTS: Comments must be received by _____ and should be sent to the Project Manager, Attention: Utah Regulatory Office, at the above Corps address.

SUMMARY

Summary - to be provided with Draft EIS

TABLE OF CONTENTS

TABLE OF CONTENTS

CHAPTER 1 - PURPOSE AND NEED FOR ACTION 1-1

1.1 BACKGROUND 1-1
1.1.1 Bingham Canyon Mine 1-1
1.1.2 Existing Tailings Facility And Operation 1-3
1.1.2.1 Copperton Concentrator and Tailings Discharge System 1-3
1.1.2.2 North Concentrator 1-5
1.1.2.3 Decant Pond And Process Water System 1-5
1.1.2.4 Embankment Operations 1-5
1.1.3 Plant History 1-6

1.2 PROJECT PURPOSE AND NEED 1-6
1.2.1 Expand Tailings Storage Area and Improve the Embankment's Stability 1-7
1.2.2 Provide Storage for 1.9 billion Tons of Tailings 1-8
1.2.3 Allow Kennecott To Operate Competitively 1-9

1.3 NEED FOR THE ENVIRONMENTAL IMPACT STATEMENT 1-9
1.3.1 Need For The Environmental Impact Statement 1-9
1.3.2 Applicable Permits And Authorization 1-12

CHAPTER 2 - DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES . . . 2-1

2.1 DESCRIPTION OF THE PROPOSED ACTION 2-1
2.1.1 Phases of Construction 2-1
2.1.2 Project Components 2-2
2.1.3 Construction Sequence 2-2

2.2 DESCRIPTION OF THE ALTERNATIVES 2-3

2.3 ALTERNATIVES FORMULATION 2-4
2.3.1 Previous Studies 2-5
2.3.1.1 Proposed Action (Initial Plan) 2-5
2.3.1.2 Off-Site Alternatives 2-5
2.3.1.3 Alternatives Expanding the Existing Tailings Impoundment 2-9
2.3.1.4 Section 404 (b)(1) Evaluation 2-10
2.3.2 Alternatives Screening 2-11
2.3.2.1 Analytical Screening Criteria 2-11
2.3.2.2 Alternatives Screening Workshop 2-15

2.4 ALTERNATIVES CONSIDERED BUT ELIMINATED 2-20
2.4.1 North Expansion Alternatives 2-20
2.4.1.1 Proposed Action (Initial Plan) 2-20
2.4.1.2 Continue Raising Existing Tailings Impoundment, Construct Berm 2-21
2.4.1.3 Expand the Existing Facility East (North Expansion East) 2-23
2.4.1.4 Reduced Expansion of the Existing Impoundment (North Expansion Reduced) . . . 2-24

2.4.2 Off-site Alternatives 2-25
2.4.2.1 Barney's Canyon 2-25
2.4.2.2 Coon Canyon 2-27
2.4.2.3 Dry Fork/Carr Fork 2-28
2.4.2.4 Tooele/Carr Fork 2-29
2.4.2.5 Stockton 2-30
2.4.3 Combination Alternative 2-31
2.4.3.1 Reduced North Expansion/Barney's Canyon 2-31

2.5 ALTERNATIVES EVALUATED IN DETAIL 2-36
2.5.1 No Federal Action 2-37
2.5.2 North Expansion West 2-38

2.6 PREFERRED ALTERNATIVE 2-41
2.6.1 Owner Preferred Alternative 2-41
2.6.2 Agency Preferred Alternative 2-41

CHAPTER 3 - AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES 3-1

3.1 INTRODUCTION 3-1
3.1.1 Affected Environment 3-1
3.1.2 Impact Assessment Methodology 3-3
3.1.2.1 Significance Criteria 3-3
3.1.2.2 Impact Levels 3-3
3.1.2.3 Direct Impacts 3-4
3.1.2.4 Indirect Impacts 3-4
3.1.2.5 Cumulative Impacts 3-5
3.1.2.6 Long-Term Productivity and Irreversible and Irretrievable Commitments of Resources 3-5
3.1.2.7 Mitigation Measures 3-5

3.2 BIOLOGICAL RESOURCES 3-6
3.2.1 Overview 3-6
3.2.1.1 Methods 3-6
3.2.1.2 Legislation 3-6
3.2.2 Issues 3-7
3.2.3 Affected Environment 3-7
3.2.3.1 Jurisdictional Wetlands and Waters of the United States 3-7
3.2.3.2 Vegetation 3-10
3.2.3.3 Aquatic Biota 3-13
3.2.3.4 Terrestrial Wildlife 3-15
3.2.3.5 Special Status Species 3-18
3.2.4 Environmental Consequences 3-29
3.2.4.1 Overview 3-29
3.2.4.2 Methods 3-30
3.2.4.3 Wetlands 3-32
3.2.4.4 Vegetation 3-34

3.2.4.5 Aquatic Biota 3-36
3.2.4.6 Terrestrial Wildlife 3-38
3.2.4.7 Special Status Species 3-40

3.3 WATER RESOURCES 3-42
3.3.1 Surface Water Supply 3-42
3.3.1.1 Issues 3-42
3.3.1.2 Affected Environment 3-43
3.3.1.3 Environmental Consequences 3-44
3.3.2 Surface Water Quality 3-47
3.3.2.1 Overview 3-47
3.3.2.2. Affected Environment 3-47
3.3.2.3 Environmental Consequences 3-53
3.3.2 Ground Water Supply 3-58
3.3.2.1 Overview 3-58
3.3.2.2 Issues 3-59
3.3.2.3 Affected Environment 3-59
3.3.2.4 Environmental Consequences 3-63
3.3.3 Ground Water Quality 3-65
3.3.3.1 Overview 3-65
3.3.3.2 Issues 3-66
3.3.3.3 Affected Environment 3-66
3.3.3.4 Environmental Consequences 3-72
3.3.3.5 Comparison of Alternatives 3-86
No Federal Action 3-86
North Expansion West Alternative 3-87
3.3.4 Proposed Mitigation 3-89
3.3.4.1 Surface Water 3-89
3.3.4.2 Ground Water 3-90

3.4 EARTH RESOURCES 3-93
3.4.1 Affected Environment 3-93
3.4.1.1 Geology 3-93
3.4.1.2 Physiography 3-95
3.4.1.3 Seismicity 3-95
3.4.1.4 Soil Resources 3-97
3.4.2 Environmental Consequences 3-97
3.4.2.1 Overview 3-97
3.4.2.2 Methods 3-97
3.4.2.3 Results 3-98
3.4.7 Proposed Mitigation 3-99

3.5 LAND USE, TRANSPORTATION AND UTILITIES 3-100
3.5.1 Overview 3-100
3.5.2 Issues 3-101
3.5.3 Affected Environment 3-102
3.5.3.1 Methods 3-102
3.5.3.2 Results 3-102

3.5.4 Environmental Consequences 3-105
3.5.4.1 Overview 3-105
3.5.4.2 Methods 3-106
3.5.4.3 Results 3-107
3.5.4.4 Proposed Mitigation and Residual Impacts 3-109

3.6 VISUAL RESOURCES 3-112
3.6.1 Regional Overview 3-112
3.6.2 Issues 3-112
3.6.3 Affected Environment 3-113
3.6.3.1 Methods 3-113
3.6.3.2 Results 3-115
3.6.4 Environmental Consequences 3-117
3.6.4.1 Overview 3-117
3.6.4.2 Methods 3-117
3.6.4.3 Results 3-119
3.6.5 Proposed Mitigation 3-122
3.6.6 Residual Impacts 3-124

3.7 SOCIOECONOMICS 3-125
3.7.1 Affected Environment 3-125
3.7.2 Baseline Characteristics 3-126
3.7.2.1 Population 3-126
3.7.2.2 Employment 3-127
3.7.2.3 Personal Income 3-128
3.7.3 Environmental Consequences 3-129
3.7.3.1 No Federal Action 3-129
3.7.3.2 North Expansion West Alternative 3-133

3.8 HAZARDOUS MATERIALS/WASTE 3-140
3.8.1 Overview 3-140
3.8.1.2 Methods 3-140
3.8.1.3 Applicable Statutes 3-140
3.8.2 Issues 3-141
3.8.3 Affected Environment 3-142
3.8.3.1 Kennecott North Zone Proposed Superfund Site 3-142
3.8.3.2 Former Chevron Phosphate Plant 3-146
3.8.3.2 Former Morton Salt Plant 3-150
3.8.3.4 Railroad Right-of-Way 3-151
3.8.3.5 Slag for Drainage Blanket 3-152
3.8.4 Environmental Consequences 3-152
3.8.4.1 Impact Types 3-152
3.8.4.2 Impact Locations 3-152
3.8.5 Comparison of Alternatives 3-153
3.8.5.1 No Federal Action 3-153
3.8.5.2 North Expansion West 3-153
3.8.6 Proposed Mitigation 3-154

3.9 CULTURAL RESOURCES 3-155
3.9.1 Overview 3-155
3.9.2 Issues 3-156
3.9.3 Affected Environment 3-156
3.9.4 Environmental Consequences 3-159
3.9.4.1 Results 3-159
3.9.4.2 No Federal Action 3-161
3.9.4.3 North Expansion West 3-162
3.9.5 Proposed Mitigation 3-162
3.9.6 Cumulative Impacts 3-163

3.10 NOISE 3-164
3.10.1 Overview 3-164
3.10.2 Issues 3-165
3.10.3 Affected Environment 3-165
3.10.3.1 Regulatory Review 3-166
3.10.3.2 Ambient Noise Levels 3-166
3.10.4 Environmental Consequences 3-167
3.10.4.1 Methodology 3-167
3.10.4.2 Construction Impacts 3-170
3.10.4.3 Operational Impacts 3-171
3.10.5 Proposed Mitigation 3-172
3.11.1 Overview 3-173
3.11.2 Issues 3-173
3.11.3 Affected Environment 3-174
3.11.4 Environmental Consequences 3-175
3.11.4.1 No Federal Action 3-177
3.11.4.2 North Expansion West 3-177
3.11.5 Proposed Mitigation 3-177

3.12 SUMMARY OF COMMITTED MITIGATION MEASURES 3-178
3.12.1 Biological Resources 3-178
3.12.1.1 Wetlands 3-179
3.12.1.2 Vegetation 3-179
3.12.1.3 Aquatic Biota 3-179
3.12.1.4 Wildlife 3-180
3.12.1.5 Special Status Species 3-180
3.12.2 Water Resources 3-181
3.12.2.1 Surface Water 3-181
3.12.2.2 Ground Water 3-181
3.12.3 Earth Resources 3-181
3.12.4 Land Use, Transportation and Utilities 3-182
3.12.5 Visual Resources 3-182
3.12.6 Socioeconomics 3-183
3.12.7 Hazardous Materials/Waste 3-183
3.12.8 Cultural Resources 3-183
3.12.9 Noise 3-183
3.12.10 Air Quality 3-184

3.13 UNAVOIDABLE ADVERSE IMPACTS AND IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES 3-184
3.13.1 Biological Resources 3-184
3.13.2 Water Resources 3-185
3.13.2.1 Surface Water 3-185
3.13.2.2 Ground Water 3-185
3.13.3 Earth Resources 3-185
3.13.4 Land Use, Transportation and Utilities 3-185
3.13.5 Visual Resources 3-186
3.13.6 Socioeconomics 3-186
3.13.7 Hazardous Materials/Wastes 3-186
3.13.8 Cultural Resources 3-187
3.13.9 Noise 3-187
3.13.10 Air Quality 3-187

3.14 SHORT TERM USES VERSUS LONG-TERM PRODUCTIVITY 3-187

CHAPTER 4 - CONSULTATION AND COORDINATION 4-1

4.1 INTRODUCTION 4-1

4.2 NOTICE OF INTENT 4-1

4.3 PUBLIC AND AGENCY SCOPING PROCESS 4-1
4.3.1 Early Consultation 4-2
4.3.2 Public Scoping Meeting 4-2
4.3.3 Mailing List and Public Notice 4-3
4.3.4 Scoping Summary 4-4

4.4 PUBLIC AND AGENCY CONSULTATIONS 4-5

4.5 PREVIOUS STUDIES 4-5

4.6 PUBLIC AND AGENCY REVIEW OF EIS 4-6
4.6.1 Preparation of and Notice of Availability of the Draft EIS 4-6
4.6.2 Public Hearing 4-7
4.6.3 Final Environmental Impact Statement 4-7

CHAPTER 5 - PREPARERS AND CONTRIBUTORS 5-1

5.1 PREVIOUS STUDIES 5-1

5.2 ENVIRONMENTAL IMPACT STATEMENT 5-2
5.2.1 U.S. Army Corps of Engineers 5-2
5.2.2 Kennecott Utah Copper Corporation 5-2
5.2.3 Consultants 5-2

CHAPTER 6 - REFERENCES 6-1

CHAPTER 2 6-1

CHAPTER 3 6-2
3.2 - Biological Resources 6-2
3.3 - Water Resources 6-5
3.4 - Earth Resources 6-7
3.5 & 3.6 - Land Use, Transportation, Utilities & Visual Resources 6-8
3.7 - Socioeconomics 6-10
3.8 - Hazardous Materials 6-10
3.9 - Cultural Resources 6-11
3.10 - Noise 6-13
3.11 - Air Quality 6-13

CHAPTER 7 - APPENDICES

APPENDIX A - Sampling Sites and Survey Maps for Biological and Water Resources

APPENDIX B - Conceptual Mitigation Plan for Tailing Modernization Project

APPENDIX C - Glossary, Abbreviations and Acronyms

APPENDIX D - Agencies, Organizations and Individuals Receiving the Preliminary Draft EIS

LIST OF TABLES

TABLE NUMBER		
1-1	Permits and Authorizing Actions for the Tailings Modernization Project	1-13
2-1	Alternative Sites and Their Physiographic Location	2-7
2-2	Evaluation of Alternatives	2-16
2-3	Combination Alternative Comparison	2-36
2-4	North Expansion West	2-40
3-1	Jurisdictional Area that would be Affected by the North Expansion West Alternative	3-35
3-2	Aquatic Life Standards for Analytes Detected in Kennecott Tailings Pond Vicinity	3-50
3-3	Surface Water Sampling Data 1991-92	3-51
3-4a	Estimate of C-7 Channel Diversion Effects on Water Quality at CSC N457 (West C-7 Ditch at I-80)	3-55
3-4	Estimate of C-7 Channel Diversion Effects on Water Quality at LCSW 468 (Lee Creek North of I-80)	3-59
3-5	Background Ground Water Quality in the Bedrock Aquifer	3-70
3-6	Background Water Quality in the Principal Aquifer	3-71
3-7	Background Ground Water Quality in the Shallow Aquifer	3-72
3-8	Tailings Water Compared With Ground Water Quality	3-76
3-9	Metal Concentrations in Tailings	3-78
3-10	Tailings Water Quality	3-81
3-11	Metal Concentrations in Phosphogypsum Stack Solids	3-84
3-12	Leaching Test for Tailings Water	3-85
3-13	Potential Ground Water Quality Impacts	3-92

1	3-14	Typical Quaternary Stratigraphy	3-98
2	3-15	Impact Assessment	3-102
3	3-16	Proposed Mitigation for Land Use and Transportation	3-114
4	3-17	Visual Impact Matrix	3-123
5	3-18	Salt Lake and Tooele Counties Composition of Employment, 1991	3-133
6	3-19	No Federal Action Alternative - Schedule of Payments	3-135
7	3-20	No Federal Action (Shutdown), Annual Impacts, 2004-2027	3-139
8	3-21	Capital Expenditure Schedule	3-140
9	3-22	Capital Summary: North Expansion West - Procurements From Utah Suppliers	3-142
10			
11	3-23	Socioeconomic Impacts - North Expansion West Procurements from Utah Suppliers	3-143
12			
13	3-24	Peak Year (1988) Economic Impacts of North Expansion West	3-144
14	3-25	Results of Soil Sampling Mitigation Site	3-151
15	3-26	Toxicity Characteristics Leach Potential of the Phosphogypsum Stack	3-155
16			
17	3-27	North Expansion West Alternative Effects on hazardous Materials/Waste	3-159
18			
19	3-28	Maximum Allowable Environmental Sound Levels (dBA)	3-172
20	3-29	Construction Equipment Noise Levels at Maximum Power	3-174
21	3-30	Summary of Impacts	3-178
22	4-1	Consulted by Kennecott Utah Copper Corporation During the EIS Process	4-3
23			

LIST OF FIGURES

FIGURE NUMBER		
1-1	Project Location	1-2
1-2	Existing Operations	1-4
2-1	Proposed Action - Initial Plan	2-6
2-2	Off-Site Alternatives	2-8
2-3	Other North Expansion Alternatives	2-22
2-4a	Combined Off-Site and On-Site - On-Site Reduced Expansion Area	2-33
2-4b	Combined Off-Site and On-Site - Barney Canyon Area	2-34
2-5	Cross-Section A-A	2-35
2-6	North Expansion West	2-38
3-1	Jurisdictional Wetland and Waters of the U.S. - Existing Conditions	-
3-2	Hydrogeologic Cross Section of Existing Tailings Impoundment	3-2

CHAPTER 1
PURPOSE AND NEED FOR ACTION

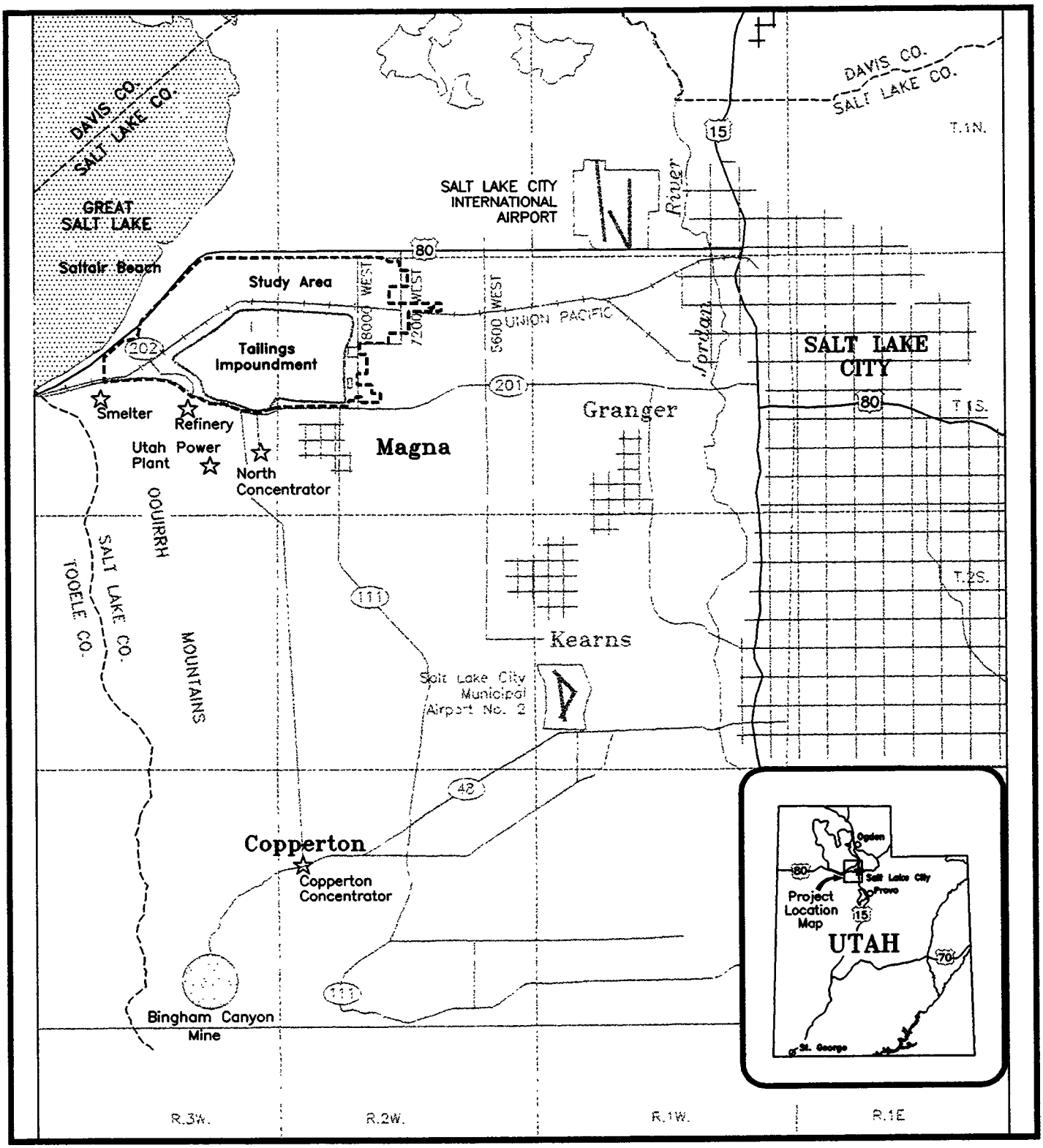
CHAPTER 1 - PURPOSE AND NEED FOR ACTION

1.1 BACKGROUND

1.1.1 Bingham Canyon Mine

Kennecott Utah Copper Corporation (Kennecott) owns and operates the Bingham Canyon Mine, an open-pit copper mine located 30 miles southwest of Salt Lake City (Figure 1-1). Copper ore from the mine is processed at concentrator, smelter, and refinery facilities located in the foothills of the Oquirrh Mountains. The Kennecott complex consists of both above- and below-ground mining and processing operations that have been active in this area since the early 1900s. Bingham Canyon Mine is a major global source of copper, with a current annual production of more than 250,000 tons. Kennecott's Bingham Canyon Mine facilities include the open-pit mine, Copperton and North concentrators, smelter, refinery, and existing tailings impoundment. The mine, concentrators, smelter, refinery, and tailings facilities generally operate 24 hours a day, 365 days a year.

To produce copper metal at the Bingham Canyon Mine, copper-containing ore is mined and transported to the Copperton and North concentrators. There, the ore is crushed and ground, and copper minerals are extracted using a flotation process. The resulting concentrate is sent to Kennecott's smelter and refinery for further processing. After the copper and other economic metals are extracted from the ore, the remaining fine materials, or tailings, are transported as a slurry mixture by a pipeline from the concentrators to the existing impoundment for storage. Tailings are the unused portion of the ore and an unavoidable and non-economic by-product of the extraction of economic minerals from ore.



☆ Kennecott Facility Location

---- Study Area Boundary

Bingham Canyon Mine

NORTH

0 1/2 1 2
MILES

January 1995

PROJECT LOCATION

TAILINGS MODERNIZATION PROJECT
ENVIRONMENTAL IMPACT STATEMENT

KENNECOTT UTAH COPPER CORPORATION

Figure 1-1

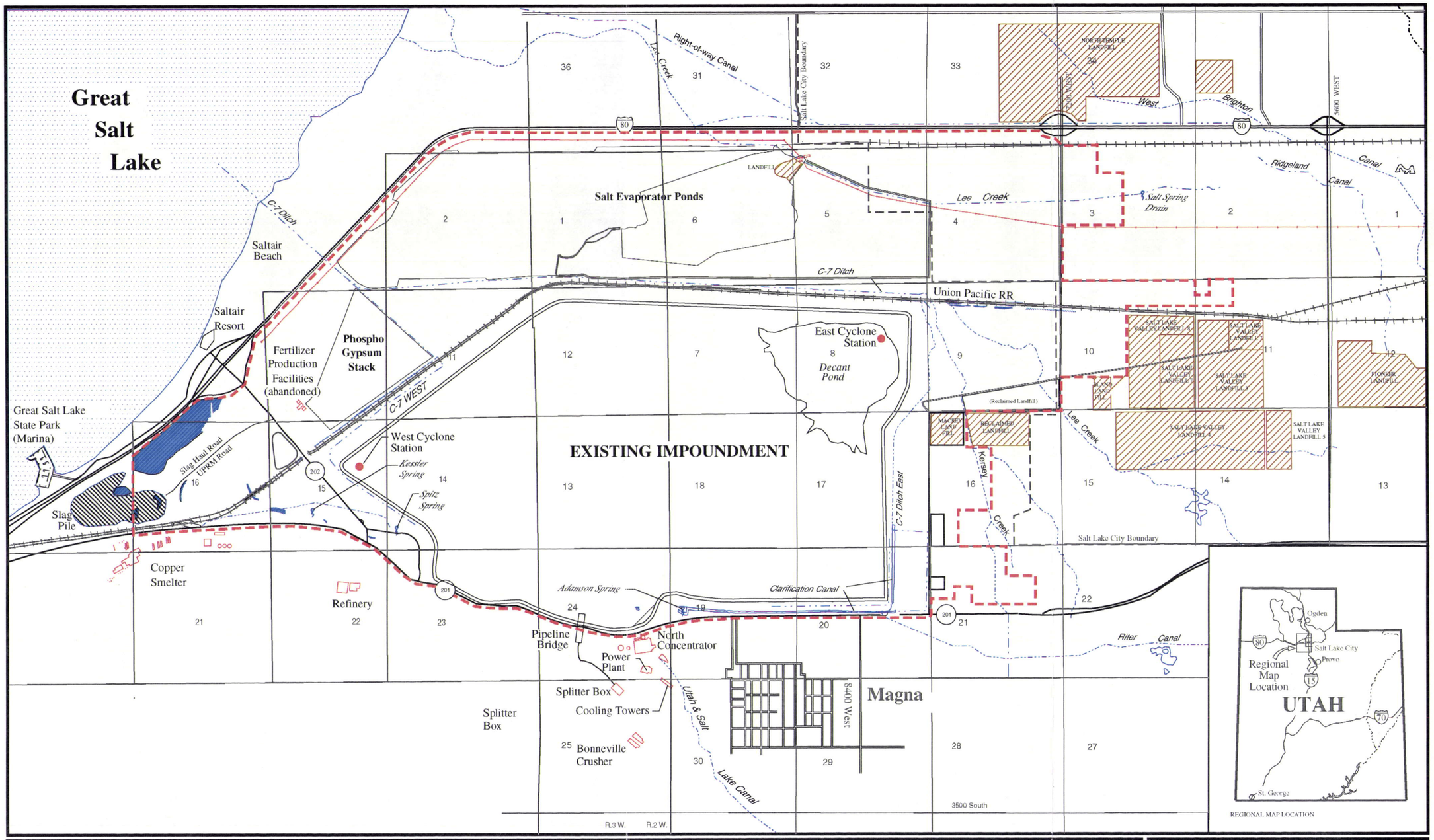
1.1.2 Existing Tailings Facility And Operation

The existing tailings impoundment near Magna, Utah, approximately 15 miles west of downtown Salt Lake City, has received tailings from past copper production and now receives tailings and smelter slag from the Copperton and North Concentrators. The impoundment is bounded by Highway 201 on the south, Highway 202 and a gypsum tailings impoundment on the west, the Union Pacific Railroad tracks on the north, and County Road 8000 West on the east (Figure 1-2). Total tailings production is approximately 152,000 tons per day (TPD) from the two existing Concentrators. Copperton concentrator produces approximately 122,000 TPD and North Concentrator produces approximately 30,000 TPD.

1.1.2.1 Copperton Concentrator and Tailings Discharge System

Approximately 122,000 TPD of tailings from the Copperton Concentrator are sent to the tailings impoundment. The tailings are transported via a 48-inch diameter concrete pipeline to a splitter box (a flow dividing chamber) on the hillside of the north end of the Oquirrh Mountains south of Highway 201. A new pipeline bridge was installed in 1994 to convey tailings from the splitter box to the impoundment. At the splitter box, Copperton's tailings flow is divided between two 28-inch diameter pipelines that feed the existing impoundment peripheral discharge system and a 48-inch diameter pipeline known as the Copperton single-point discharge.

Normally, about two-thirds of the Copperton tailings are sent to the impoundment by the peripheral discharge system, which consists of 4 pipeline segments, each pipe distributing tailings to a single quadrant of the existing impoundment. A total of 39 spigotting pipe sections, each approximately 1,500 feet in length, are used to distribute the tailings. This system of pipes distributes tailings sequentially along the entire perimeter of the impoundment, and provides effective dust control and enhanced beach development since 1988. The remaining Copperton tailings enter the impoundment through the Copperton single-point discharge. During periods of extreme cold or during periods of peripheral discharge system operational upsets, the entire Copperton tailings stream can be routed through the Copperton single-point discharge.



EXISTING OPERATIONS

TAILINGS MODERNIZATION PROJECT
ENVIRONMENTAL IMPACT STATEMENT

KENNECOTT UTAH COPPER CORPORATION

Figure 1-2

1.1.2.2 North Concentrator

The North Concentrator uses two launderers (i.e., concrete flumes) to convey tailings from the concentrator to the pump station and then uses a single point discharge for placement on the impoundment. Tailings from the North Concentrator are discharged at a rate of 30,000 TPD directly into the impoundment through this system.

1.1.2.3 Decant Pond And Process Water System

After being deposited in the impoundment, the solids within the slurry settle out and the water on the surface of the impoundment flows to a decant pond in the northeast corner of the impoundment. Heavier tailings (i.e. sand size) settle initially with finer tailings dropping out of suspension within the impoundment and decant pond area. Three siphons installed in the decant pond collect and direct the process water via HDPE Pipelines to a clarification canal, which flows around the southeast corner of the impoundment. Primary clarification of this tailings water is accomplished in the decant pond. The canal provides secondary clarification of the tailings water and returns the tailings water to Pump Station No. 1. Here, the water is pumped from the canal to a holding reservoir, where it is recycled to the plant and concentrators for reuse in the process water circuit.

1.1.2.4 Embankment Operations

The embankment of the existing impoundment is raised on a continual basis using an upstream construction method to accommodate ongoing tailings deposition. This is accomplished by excavating previously deposited tailings within the embankment and beach area, and placing the material in an 8-foot high, 22-foot wide dike along the perimeter of the impoundment. This operation takes place year-round, curtailed only by severe weather. As the perimeter of the impoundment is raised, the peripheral discharge system and the decant siphons are relocated to the new embankment crest and any disturbed areas are regraded and revegetated.

1.1.3 Plant History

Near the turn of the Twentieth Century, the Bingham Canyon Mine became the first successful low-grade, open-pit copper mine in the world. The mine, North Concentrator, refinery, and existing tailings impoundment have been in operation since the early 1900s. The smelter and Copperton Concentrator were established over fifty years ago as well.

In 1985, declining world copper prices and relatively high production costs forced the mine to shut down. During this period, Kennecott initiated a modernization and capital improvements program and reopened the mine in 1987. The long-term modernization program was undertaken to ensure that the Bingham Canyon Mine would continue to produce copper while meeting demands of both an increasingly competitive world copper market and comprehensive new environmental regulations, while addressing Kennecott's responsibilities as a leading member of the Utah economic community.

Kennecott's modernization studies determined that the existing impoundment should be dynamically upgraded to meet engineering standards (stability, etc.) and increase its operational storage capacity. Modernization efforts implemented in the late 1980s include:

- Improved dynamic stability of the existing impoundment, to enhance its integrity and reduce the risk of failure during a significant earthquake.
- Increased quantity of tailings discharged around the perimeter of the impoundment through the peripheral tailings discharge system to improve the integrity of the impoundment and enhance dust abatement.
- Upgraded decant pond and siphon decant system to avoid potential flood damage to the embankment and adjacent areas.

1.2 PROJECT PURPOSE AND NEED

As part of the modernization program initiated in 1987 at the Bingham Canyon Mine, the Tailings Modernization Project (the Project) has been proposed to transition existing tailings storage operations to a new impoundment area. The purpose of the facility modernization is three-fold:

1) to expand the existing tailings storage area and upgrade the existing embankment to enhance its integrity during a significant earthquake,
2) to provide storage for 1.9 billion tons of tailings to be generated by the mining and concentrating of proven and probable ore reserves within the Bingham Canyon Mine over the next 25 to 30 years, and
3) to allow Kennecott to operate competitively in the world copper market.

Each project purpose is discussed below in more detail.

1.2.1 Expand Tailings Storage Area and Improve the Embankment's Stability

Modernizing the existing impoundment is required to allow for continued copper production. Additionally, recent studies have pointed to the potential instability of the existing impoundment under seismic (i.e., earthquake) conditions.

Two factors—historic impoundment construction methods and the decant pond—contribute to the limitations of the existing impoundment's operational capacity and seismic stability. Since the mine began operation in 1903, the construction techniques used at the impoundment evolved within accepted industry standards for tailings impoundment construction and management. Since 1971, the embankment has been raised using the upstream construction method, where tailings are discharged from spigots along the crest of a perimeter dike to form a "beach" of coarse tailings. This beach then forms the foundation for subsequent perimeter dike construction upstream of, or inside, the initial dike. Beach development continues and successive dikes are constructed as the embankment is progressively raised. As the impoundment raises, the surface area is subsequently reduced and the rate of rise increases.

The coarse-grained tailings in the beach area drain effectively to serve as a stable platform for embankment construction. The finer-grained tailings are unsuitable for embankment construction due to their relatively low strength, low permeability, and high water retention characteristics. The peripheral discharge system has only been in operation since 1988. Prior to this time, tailings were discharged from point discharges located along the southern reach of the impoundment. This results in a thicker and denser embankment at the south end of the impoundment and the northern

portions of the impoundment constructed of finer grained materials. Currently, the north, northwest, and northeast corner embankment slopes predominantly consist of a thin shell of relatively coarse tailings that overlies fine, loose, saturated materials. Most of the embankment and tailings within this area are fully saturated, which potentially could result in instability under dynamic conditions.

Recent studies of the seismic nature of the Salt Lake Valley indicate the increased possibility of a significant earthquake (Woodward-Clyde 1994). If an earthquake were to occur, the highly saturated, fine-grained tailings underlying the relatively thin embankment shell could liquify, potentially causing impoundment failure. The potential for failure, compounded by other factors, such as the rate at which the impoundment rises from tailings deposition (rate of rise), limits the operational capacity of the impoundment for further tailings storage.

The second factor contributing to the limitations of the existing impoundment's stability and capacity is the location of the decant pond. As tailings were deposited on the impoundment surface, process water from the slurry flowed into low lying areas, forming a decant pond. Over the mine's history, decant ponds have developed at various locations on the impoundment. Tailings water has historically been decanted at the northeast corner of the impoundment. This decant pond provides detention time for finer particles to settle, allowing for the primary clarification of the process water, prior to being decanted using a siphon system. The materials settling within the decant pond area are fine-grained, loose, saturated tailings. The large quantity of fine tailings in the northern reaches of the impoundment and the thin shell of coarse-grained tailings in the area increase the susceptibility of this reach of the embankment to dynamic loading, and heightens the need to improve the stability of the impoundment.

1.2.2 Provide Storage for 1.9 billion Tons of Tailings

The Bingham Canyon Mine contains proven and probable ore reserves to support production at current levels for 25 to 30 years. Approximately 1.9 billion tons of tailings will be generated by mining and concentrating of these reserves. Kennecott estimates that the existing impoundment can accommodate about 15 to 20 percent (300 to 400 million tons) of the 1.9 billion tons of

tailings during the transitional period to the new storage facility. Therefore, additional tailings storage must be developed if the Bingham Canyon Mine is to continue to operate at current production levels.

The purpose of the new impoundment is to provide additional storage necessary for the 1.9 billion tons of tailings to be generated by the mining and concentrating of currently known ore reserves. The design would incrementally provide storage of tailings as the embankment was constructed concurrent with tailing storage activities.

1.2.3 Allow Kennecott To Operate Competitively

Bingham Canyon Mine is a major global source of copper, with a current annual production of more than 250,000 tons. Despite high production levels, Kennecott was forced to cease operations at the Bingham Canyon Mine from 1985 to 1987 due to high production costs and low copper prices. To remain competitive in the price sensitive copper market, copper producers worldwide have been required to modernize and upgrade their facilities. Kennecott's ambitious modernization program is directed at keeping the Bingham Canyon Mine and processing facilities' cost competitive within the world market.

Fluctuations in copper prices are expected to continue as new world-class copper producers startup or modernize their operations. Therefore, for Kennecott to continue cost competitive operations at the Bingham Canyon Mine, each component of the modernization effort must be implemented and operated in the most cost-effective manner.

1.3 NEED FOR THE ENVIRONMENTAL IMPACT STATEMENT

1.3.1 Need For The Environmental Impact Statement

The existing tailings impoundment is located in an area characterized by the presence of aquatic environments (i.e., potential jurisdictional wetlands and waters of the U.S.), primarily saline playas. Any upgrade of the tailings impoundment would affect potential jurisdictional waters through

placement of fill materials into those waters. The Clean Water Act (CWA) Section 404(b)(1) guidelines do not permit discharge of fill material into jurisdiction waters if a practicable alternative exists that would less adversely affect an aquatic ecosystem, as long as the alternative itself does not impose significant adverse environmental consequences. For non-water dependent projects, the CWA assumes that practicable alternatives exist that do not involve jurisdictional waters or that have less adverse impact on the aquatic environment, unless clearly demonstrated otherwise. Alternatives that avoided or minimized the impact to jurisdictional wetlands and other waters of the U.S. were included in the development of alternatives.

The Council on Environmental Quality (CEQ) National Environmental Policy Act of 1969 (NEPA) regulations and the U.S. Army Corps of Engineers' (Corps) Environmental Impact Statement (EIS) guidelines provide guidance regarding the test of reasonableness for alternatives. The guidelines indicate that reasonable alternatives include those that are practical or feasible from a technical and economic standpoint, and apply common sense rather than what may simply be desirable from the standpoint of the applicant. The guidelines also state there is no need to disregard the applicant's purposes and needs and the common sense realities of a given situation in the development of alternatives. The full range of location and design alternatives should be evaluated in light of how it meets the project's purpose.

Construction of an expanded tailings impoundment (proposed project) will require a Department of the Army permit pursuant to Section 404 of the Clean Water Act which requires authorization to place fill material into the jurisdictional waters or wetlands of the U.S.. The Corps decision to issue or deny the 404 permit is considered a major federal action, requiring compliance with NEPA. Therefore, the Corps is acting as federal lead agency for NEPA compliance for this project and has determined that an EIS is required prior to making a decision on issuing the 404 permit.

This Draft Environmental Impact Statement (DEIS) has been prepared in accordance with federal guidelines, including NEPA, the CEQ's Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500-1508), and the Corps procedures for implementing NEPA (33 CFR Part 230).

The purpose of this DEIS is to identify the expected environmental impacts of the Proposed Action and to evaluate reasonable and practical alternatives which meet the purpose and need for the project as specified under NEPA. Information contained in this DEIS will serve as the analytical basis for a decision regarding the issuance of a 404 permit.

This DEIS was made available to the public and agencies for review and comment on March, _____, 1995.

A public hearing will be held by the Corps on _____, 1995 on the 404 Permit Application and the DEIS during a 45 to 60-day comment period following announcement of DEIS availability in the Federal Register and distribution of the DEIS to agencies and interested organizations and individuals.

Written comments received by the close of the comment period _____, 1995 and oral written comments received at the March ____, 1995 public hearing will be addressed in the Final Environmental Impact Statement (FEIS).

Following publication of a Notice of Availability in the Federal Register, distribution of the FEIS, and a 30-day waiting period, the Corps will issue a Record of Decision (ROD) announcing its findings regarding the Proposed Action and summarizing its determination in compliance with Section 404 (b)(1), as well as other environmental regulations. The Corps regulatory program under Section 404 of the CWA also involves a public interest review. Following issuance of the ROD, the Corps will conduct the public interest review where the expected project benefits are evaluated and balanced against reasonable foreseeable detriments. This public interest review is the final step before a decision regarding issuance of the 404 permit is made. Corps policy is to provide a timely and carefully weighed decision which reflects the public interest.

1.3.2 Applicable Permits And Authorization

The environmental planning, consultation, and impact assessment processes have been integrated to comply with all applicable federal, state, and local regulations. Table 1-1 outlines the major authorizing actions and permits required for the proposed tailings modernization project.

Table 1-1
Permits And Authorizing Actions For The
Tailings Modernization Project

Name of Permit	Authorizing Agency
Federal	
Environmental Impact Statement	U.S. Army Corps of Engineers and U.S. Environmental Protection Agency
Section 404 Permit, Clean Water Act	U.S. Army Corps of Engineers, Sacramento District
State of Utah	
Fugitive Dust Abatement Program Approval	Utah Department of Environmental Quality Division of Air Quality Utah Air Conservation Committee
Utah Pollution Discharge Elimination System (UPDES) Construction Permit	Utah Department of Environmental Quality Division of Water Quality
UPDES Modification Permit	Utah Department of Environmental Quality Division of Water Quality
Ground Water Discharge Permit	Utah Department of Environmental Quality Division of Water Quality
Dam Safety Permit	Utah Department of Natural Resources Division of Water Rights
Division of Oil, Gas and Mining Permit	Utah Department of Natural Resources Division of Oil, Gas, and Mining
Stream Channel Alteration Permit	Utah Department of Natural Resources Division of Water Rights
Notice of Intent to Drain or Divert a Waterway	Utah Department of Natural Resources Division of Wildlife Resources
Transportation Agreement(s) Railroad Relocation Approval	Utah Department of Transportation
Local	
County Building Permits	Salt Lake County, Public Works Dept., Development Services Division
County Conditional Use Permit	Salt Lake County, Public Works Dept., Development Services Division
County Rezoning Approval	Salt Lake County, Public Works Dept., Development Services Division
County Flood Control Approval	Salt Lake County, Public Works Dept., Flood Control and Water Quality Division
Hazardous Material Storage (SARA Title III) Review, Emergency Response Plan	Salt Lake County Fire Department

CHAPTER 2
DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

CHAPTER 2 - DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

2.1 DESCRIPTION OF THE PROPOSED ACTION

Kennecott Utah Copper Corporation's (Kennecott) upgrade program for the Bingham Canyon Mine includes the Tailings Modernization Project (Project) that would transition existing tailings storage operations to a new impoundment north of Kennecott's existing tailings storage impoundment. This would, 1) allow for continued storage of tailings, 2) upgrade the stability of the existing impoundment, and 3) allow Kennecott to continue operation of its associated facilities.

The Project would transition current tailings storage operations to the new impoundment in late 1998, subject to approval of Project permits. The new impoundment area would accommodate tailings generated over approximately 25 to 30 years of copper production.

1.9 BILLION / 30 YRS = 63 MIL/YR

2.1.1 Phases of Construction

The proposed Project would provide storage for approximately 1.9 billion tons of tailings. The final storage capacity of the new impoundment would reach between 1.5 and 1.6 billion tons of tailings with 300 to 400 million tons of tailings to be stored on the existing impoundment through the engineering, design, permitting and transition of operations to the new facilities.

Thus the total volume of tailings to be accommodated by the existing and proposed impoundment would be approximately 1.9 billion tons.

Transition from the existing impoundment to the proposed impoundment is scheduled to occur between 1998 through 2004. Areas of the existing impoundment will be taken out of service sequentially, generally from west to east, to allow continued use of the decant pond until the transition is complete. This will be done by building transition dikes to subdivide the surface of the existing impoundment into sequentially smaller areas. Underflow sands will be used to construct the transition dikes. Underflow sands are produced by processing tailings through cyclones that separate the coarse-grained sand, or underflow, from the fine-grained tailings fraction

called overflow. Depending on the coarseness and moisture content of the cyclone underflow and the ability of the tailings surface to support equipment, various methods of planting and dust suppression techniques will be employed for the revegetation of the existing impoundment surface.

2.1.2 Project Components

The Project includes the following major activities:

- modifying the tailings distribution system, and installing new pipelines to transport the tailings slurry,
- relocating power lines and other utilities, ditches, and railroad lines,
- preparing the foundation and placing a drainage blanket within the new impoundment embankment footprint,
- constructing the starter dike, header dikes, toe ditch, and toe dike,
- constructing cyclone stations near the new impoundment,
- transitioning from the existing impoundment to the new impoundment and revegetating the existing impoundment,
- constructing the new impoundment embankment, concurrently with operational storage of tailings within the new impoundment, and
- revegetation of the new impoundment area after it is filled to capacity.

2.1.3 Construction Sequence

After the removal or relocation of existing facilities, the foundation of the embankment would be prepared by removing deleterious materials. A blanket drain comprised of crushed slag from the Kennecott stockpile will be put into place on the foundation of what would be the base of the new embankment. A starter dike and header dikes would be constructed using compacted cycloned tailings underflow. Depositing tailings in the impoundment and constructing the new embankment using compacted tailings sand would begin almost simultaneously. A toe ditch would be constructed around the perimeter of the impoundment to collect construction water and seepage.

Kennecott would employ the centerline construction method using compacted cycloned tailings sand to construct the structural shell of the new embankment. Tailings would be cycloned at two locations. Underflow sands would be slurried for delivery to hydraulic deposition cells within the shell of the embankment. There the material would be compacted as the shell raises. Process water would be reclaimed from the deposition cells and returned by way of pumps to the impoundment decant area. The cyclone overflow and excess tailings would be sequentially spigotted into the impoundment similar to the current operation.

The primary clarification system for the process water is the decant pond, which would be centrally located and much larger than the current decant system, providing increased capacity and operating flexibility. The process water system for the proposed impoundment would include a new decant system, embankment toe ditch and reclamation system, sedimentation pond, process water pipelines and pump stations, and water for dust control and reclamation operations.

2.2 DESCRIPTION OF THE ALTERNATIVES

In 1987, Kennecott recognized the need to upgrade and modernize their operations to continue profitable operations for the projected life of the Bingham Canyon Mine (refer to Chapter 1 - Purpose and Need for Action). This included the need for storing additional tailings. Kennecott's modernization studies identified that the existing tailings impoundment would reach its operational limits by 2004, and a storage area for 1.5 billion tons of tailings would be required to complete the remaining 25-30 years of production of the Bingham Canyon Mine.

Between 1987 and 1994, alternatives were identified and evaluated. These studies, described in this section, identified and tested alternative mining technologies, ways to expand the existing tailings impoundment on site, and possible off-site locations for tailings storage. Through this nine-year process, alternatives were formulated to meet the purpose of and need for the Project and to reduce the potential impact on jurisdictional wetlands or other waters of the U.S.

Kennecott's Proposed Action and the alternatives are listed below:

- Proposed Action (Initial Plan) - Full Expansion of the Existing Tailings Impoundment,

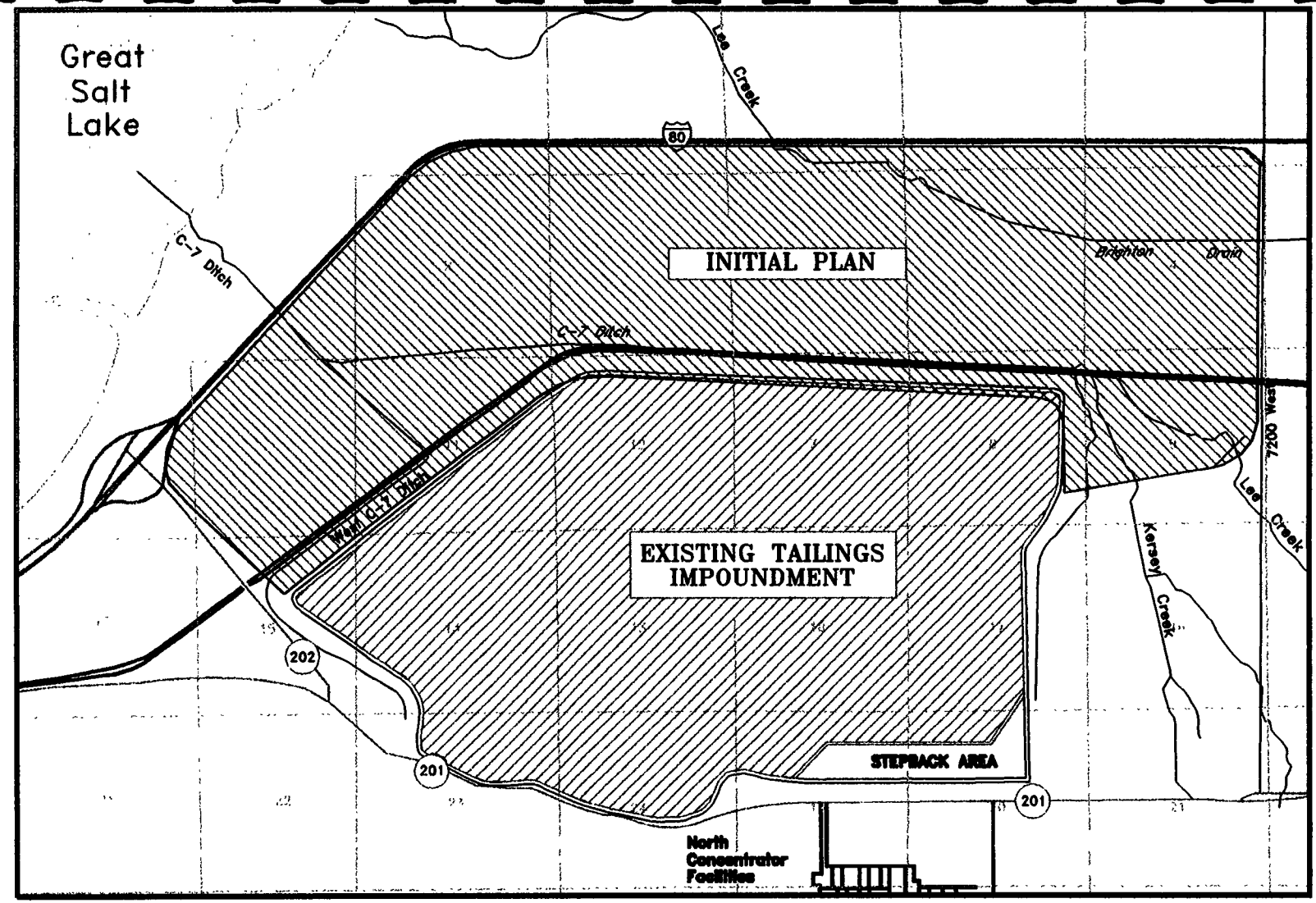
- Expanded Existing Tailings Alternatives (North Expansion),
  - Continue Raising the Existing Impoundment, Construct a Berm
  - Expand the Existing Impoundment (East)
  - Expand the Existing Impoundment (West)
  - Reduced Expansion of the Existing Impoundment with Raised Embankment
- Off-Site Alternatives,
  - Barney's Canyon
  - Coon Canyon
  - Dry Fork/Carr Fork
  - Tooele/Carr Fork
  - Stockton
- Combined Alternative of Reduced Expansion of Existing Impoundment and Construct a new Facility at Barney's Canyon, and
- No Federal Action (no change from current operations).

The remainder of this section describes how the alternatives were developed and includes discussion of:

- previous studies by Kennecott, such as the proposed action (initial plan), on and off-site alternatives, and the Section 404(b)(1) practicability analysis (refer to the Clean Water Act and implementing regulations),
- alternatives screening process and results,
- alternatives considered but eliminated,
- alternatives evaluated in detail, and
- the preferred alternative.

2.3 ALTERNATIVES FORMULATION

Although Kennecott's Proposed Action (i.e., the initial plan), described below, would be the most practical from a logistics and technical standpoint, alternatives were identified and evaluated in the previous studies primarily because of the Corps concern for the amount of jurisdictional wetlands



Existing Impoundment

Expansion Area

NORTH

0 1/2 1
MILES

January 1995

PROPOSED ACTION
INITIAL PLAN

TAILINGS MODERNIZATION PROJECT
ENVIRONMENTAL IMPACT STATEMENT

KENNECOTT UTAH COPPER CORPORATION

Figure 2-1

and other waters of the U.S. that would be filled and the need to evaluate all feasible alternatives that could lessen this impact.

2.3.1 Previous Studies

2.3.1.1 Proposed Action (Initial Plan)

Kennecott's initial plan in 1988, termed the Proposed Action (refer to Figure 2-1), was to expand the existing tailings impoundment west to Highway 202, north to I-80, and east to 7200 West; and to relocate the utilities, railroad tracks and waterways around the north end of the expansion impoundment. This alternative could be developed at a reasonable cost, provide an acceptable rate of return on the capital investment, and be a seismically stable under design earthquake conditions. The embankment for this facility was estimated to be 195 feet in height with an average rate of rise of 7.5 feet year which Kennecott and standard engineering practice considered stable.

2.3.1.2 Off-Site Alternatives

The existing tailings impoundment is approximately 13 miles from the Bingham Canyon pit. Ore is transported to the Copperton and North concentrators for processing, resulting in the generation of tailings (the noneconomic portion of the ore). These tailings are transported and distributed as a slurry, by gravity flow, to the storage facility. Although hauling distances over 5 miles are unusual in the mining industry (Vick 1990), it was decided that alternate locations to store tailings could be at least equidistant from the pit as the existing tailings impoundment, and perhaps as far away as twenty miles from the Bingham Canyon Mine.

It is estimated that the capital cost to implement this alternative would be approximately $372.2 million and the sustaining capital cost is $72.0 million. The 25- to 30-year operating costs are estimated at $290.2 million, or $15 per ton of stored tailings (Morrison-Knudsen, 1993a).

Subsequently, lands within a 20-mile radius from the Copperton Concentrator were examined for siting a tailings facility (refer to Figure 2-2). Developed lands or lands used for military operations were considered unavailable. Four physiographic land types exist within this large area that were available for a facility of this dimension:

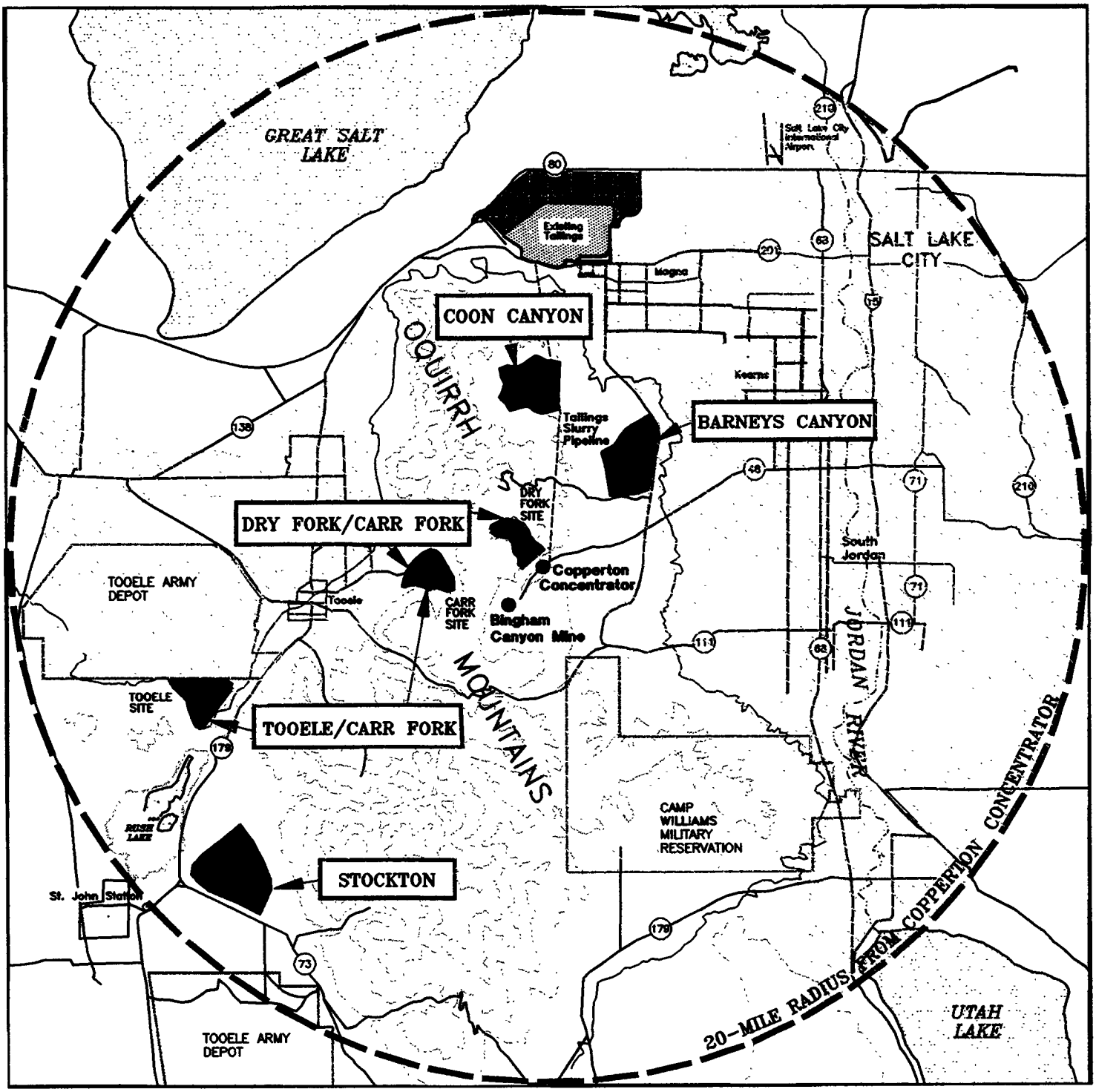
- mountain/canyon terrain underlain by bedrock,
- alluvial fans and prehistoric lake terraces underlain by coarse alluvium,
- valley bottoms underlain with fine-grained lake bed deposits, and
- aquatic playa environments such as Great Salt Lake.

Within these land types, typical locations were identified (refer to Table 2-1) using maps and aerial photography, and evaluated through field studies and engineering analysis for capacity, design characteristics, environmental factors, and economics. The studies determined that the Carr Fork, Dry Fork and Tooele sites would not have enough capacity individually to meet the required capacity of 1.9 billion tons; therefore, they would have to be combined with new tailings impoundments in other locations to meet the storage requirement. The studies also revealed that upland alluvial, lake terrace, and mountain canyon sites which could potentially impact drinking water sources would require installation of an impervious liner membrane to prevent water from the tailings impoundment from percolating into the ground water aquifer.

Table 2-1
Alternative Sites and Their Physiographic Location

Alternative	Physiographic Location	Comments
Barney's Canyon	Lake terrace and alluvial fan	Site originates at the upper end of the lake terrace and is underlain with alluvial deposits from the Oquirrhs
Dry Fork	Mountain/Canyon	Site is entirely contained in the Oquirrh Mountains
Carr Fork	Alluvial fan	Site is backed up against the Oquirrh Mountains and Pine Canyon but is underlain with alluvial deposits.
Coon Canyon	Mountain/Canyon	Site is entirely contained in the Oquirrh Mountains
North Expansion	Valley Bottom	Site is an extension of the existing impoundment
Tooele	Valley Bottom	Site is situated on the valley floor at the head of the Tooele Valley
Stockton	Alluvial fan	Site is underlain with alluvial sediments that originate from the Oquirrh Mountains

Source: SWCA Memorandum to Kennecott dated October 10, 1994



KEY:

- Off-Site Alternative Sites
- Initial Plan Expansion Area
- Land Unavailable for Tailings Storage

NORTH

0 1 2 4 MILES

January 1995

OFF-SITE ALTERNATIVES

TAILINGS MODERNIZATION PROJECT
ENVIRONMENTAL IMPACT STATEMENT

KENNECOTT UTAH COPPER CORPORATION

Figure 2-2

A primary advantage of the "off-site" alternatives would be to avoid filling jurisdictional wetlands and other waters of the U.S. which occur north of the existing tailings impoundment. While examining locations for off-site storage, it was determined that the development of an off-site location only would not meet the Project purpose of stabilizing the existing tailings impoundment. On-site stabilization is required by the State of Utah to prevent potential failure of the existing impoundment. These measures would be required as part of any off-site alternative development to prevent potential inadvertent filling of the adjacent jurisdictional waters. The costs and materials associated with the on-site stabilization would add to the costs of the off-site alternatives estimates; however, the improved stability of the existing impoundment would allow it to be filled to a higher level. The stabilizing measures would fill approximately 296 acres of jurisdictional waters on-site.

Off-site alternatives, that combine seismic upgrade at the existing facility and development of an off-site tailings facility, would require extensive logistic development to include new pipelines, access roads, overflow basins, and in some cases, tunneling and pumping systems and overflow detention basins away from the existing impoundment (refer to Section 2.4.2 for more detail).

2.3.1.3 Alternatives Expanding the Existing Tailings Impoundment

The alternatives to expand the existing tailings impoundment on-site (North Expansion alternatives), while minimizing filling and impacts to jurisdictional wetlands and other waters of the U.S., were fully explored by Kennecott between 1991-1993. Four possible alternatives resulted:

- Raise the Existing Impoundment and Construct a Berm,
- Expand Existing Impoundment (North Expansion East),
- Expand Existing Impoundment (North Expansion West), and
- Reduced Expansion of Existing Impoundment

Each was examined in the *Alternatives Analysis for the Tailings Modernization Project* (SWCA, 1994a), and are further evaluated in Section 2.4.1.

For these alternatives, operations would take place on or adjacent to the existing impoundment, thereby eliminating logistical and many technical constraints of the off-site alternatives. The improvements to the impoundment would be engineered to maximize the capacity, while upgrading its seismic stability. Each of these on-site alternatives would have a different magnitude of effects on jurisdictional wetlands and other waters of the U.S.

Of the four on-site alternatives explored, the North Expansion East would have the greatest impact on wetlands, while constructing the Reduced North Expansion would fill the least amount of wetlands. The Reduced North Expansion alternative would cause the highest static pressures which could cause the impoundment to fail (refer to the screening process in Section 2.3.2 below for a comparison of the engineering and jurisdictional impacts for each of these on-site alternatives).

2.3.1.4 Section 404 (b)(1) Evaluation

In 1994, Kennecot prepared a Section 404 (b)(1) Evaluation (pursuant to the Clean Water Act) based on the Corps' desire to avoid filling jurisdictional wetlands or other waters of the U.S. The report, *Alternatives Analysis for the Tailings Modernization Project,* contained the practicability analysis required by the EPA for non-water dependent projects proposed in aquatic environments (refer to SWCA 1994a).

The report identified two practicable alternatives, from the ten alternatives originally considered: North Expansion East and North Expansion West. These alternatives reduced the amount of filling of jurisdictional wetlands and other waters of the U.S., and were technically and logistically feasible. Kennecott prepared a Section 404 Permit Application for the Project and submitted it to the Corps. A further description of how these alternatives were evaluated is found later in this section. The 404 Permit would be necessary to permit fill within jurisdictional wetlands and other waters of the U.S.

2.3.2 Alternatives Screening

Prior to final approval of the 404 Permit, the Corps requested that Kennecott prepare a DEIS to support the Corps' decision. The 404 Permit would be necessary to permit fill within jurisdictional wetlands and other waters of the U.S. The Notice of Intent to Prepare a DEIS was published by the Corps in August 1994. The Council on Environmental Quality (CEQ) requires that impacts of all reasonable and feasible alternatives be examined within a DEIS. During the preparation of this DEIS, the full range of possible alternatives were again evaluated to determine their feasibility, according to NEPA.

The screening exercise was designed to test each alternative and determine if they were practical or feasible according to the CEQ guidelines to implementing NEPA.

The alternatives screening process used technical, logistical, and economic criteria and considered environmental and jurisdictional (i.e., wetlands and other waters of the U.S.) factors to determine which alternatives would be considered reasonable or feasible, according to NEPA.

2.3.2.1 Analytical Screening Criteria

Maximum thresholds and operating norms for the logistical and technical criteria were established where possible and used to help evaluate the feasibility of constructing and operating the various alternatives. Environmental and regulatory factors were also considered during the screening process. The primary criteria were:

- Technical - based on currently-used engineering practices and best available technology for constructing and operating a tailings impoundment, and permitting feasibility

- Logistical - based on currently-used engineering practices and best available technology, thresholds for storing tailings, and operating norms for constructing and operating a tailings impoundment, and

- Economic - comparative capital costs considerations and long-term competitive viability

The **technical criteria** included:

- The **storage capacity of 1.9 billion** tons of tailings is anticipated to accommodate the mining of currently-known and economical mineral reserves for the next 25 to 30 years. The existing impoundment, without berm construction or embankment expansion, could accommodate approximately 300 to 400 million additional tons. Therefore, 1.5 to 1.6 billion tons of tailings must be accommodated by the proposed expansion or new tailings impoundment.

- **Upgrade of the existing impoundment embankment** is needed to accommodate dynamic stability consideration in case of a seismic event (i.e., earthquake). Significant factors in this upgrade would include properly locating and designing reinforcing berms or embankment, and the availability of suitable construction materials.

- The **rate of rise** is the height increase of the impoundment as tailings are deposited. Factors determining acceptable rate of rise include the time it takes for tailings to settle and form a suitable foundation before more tailings can be added, the time required for the dissipation of pore water pressures before more tailings can be added, and the rate at which pore water dissipation occurs, the amount of tailings available for processing to acceptable construction materials, the amount of water required to dilute tailings for processing and slurry, the method of tailings deposition, the type of embankment construction, the acceptable gradation of the tailings, and the impoundment surface area.

- The **embankment design criteria** include the maximum impoundment heights and embankment section required, the various alternatives and how site and foundation conditions would vary. The acceptable design criteria is based on:
  - location,
  - site conditions,
  - foundation characteristics,
  - potential for seismic activity,
  - site specific seismic hazard criteria,
  - rate of rise,

- construction methodology,
- geotechnical and geohydrologic considerations,
- allowable slope geometry,
- slope geometry, and
- availability of suitable construction materials.

- **Permitting feasibility** is determined by examining the issues for each resource and consulting with the local, state, and federal regulators regarding conditions that would need to be met before issuance of permits. If an effect of the proposal would create long-term adverse effect that could not be mitigated, permitting would be considered highly unlikely or infeasible.

The **logistical criteria** included:

- The **materials required for the embankment** must be available for construction and dynamic upgrade of the existing impoundment. Either sufficient on-site borrow material and/or adequate cycloned tailings (i.e., coarser grained materials) must be available to simultaneously complete the dynamic upgrade of the existing embankment and construct the new embankment over the life of the Project. Each ton of structural cycloned tailings produced for embankment construction generates approximately two tons of fine tailings that must be stored. If the alternative site requires extensive embankment construction, more fine tailings would be produced than there would be embankment constructed to contain them. This results in a shortfall of construction materials, effectively halting the tailings distribution and storage processes (Vick 1990).

- **Reliability** refers to the level of difficulty of maintaining facility operations. Appropriate facility design minimizes maintenance, down-time, and disruptions in tailings delivery or embankment construction. The following components are related to logistic reliability:

  Pumping - Using gravity flow to transport tailings to the impoundment is highly preferable to pumping tailings. Pumping tailings to a higher elevation requires system additions such as booster stations and overflow retention basins which add to the potential impact of the new

facility, as well as significantly increase construction and maintenance cost with somewhat reduced reliability. Research of mines currently operating worldwide reveal that gravity flow systems are utilized more than pumping systems. One of the few operating pumping tailings delivery systems is pumped 164 feet in elevation (PSI, 1994). Gravity systems are much preferred because they require minimal maintenance, have lower failure rate and are significantly more reliable. A tailings delivery system failure would cause mining and ore processing operations to stop for the duration of the upset during the life of the storage project (Vick 1990). The high pressures and velocities in combination with the erosive nature of tailings slurries in a pumped system incur high maintenance and operation costs, and tailings slurry systems can be irreparably clogged with tailings solids. For planning purposes, pumping heads of 1,000 feet or more were considered impracticable due to the increased risk of failure and higher level of maintenance.

Length of Delivery - The shorter the distance that tailings are transported, the better. Longer delivery systems greatly increase the exposure to potential system breakdown with associate loss of reliability and increased environmental risk. Should the delivery system break down, a backup system must be in place, involving major logistical planning and installation of a costly redundant system.

Liners - Under certain soil and aquifer conditions, clay and/or geomembrane liners would be required to prevent infiltration of tailings seepage into the ground water. Under ideal conditions, naturally occurring clay liner material existing beneath a site can functionally serve as a "liner." Installation of liners imposes a certain degree of unreliability and inherently high costs when installed over unstable foundation material. Their effectiveness diminishes in proportion to the size of the area covered. Unstable soil conditions could result in differential settlement, increasing the chance of liner failure. Aside from the technical limitations and high cost, the logistical difficulties in installing an effective liner in a single phase over a 2,500- to 5,000-acre area would render a liner alternative impracticable.

The **economic criterion** included the evaluation of costs for the upgrading, constructing, and operating a tailings impoundment facility. In 1994, Kennecott's operating costs for tailings storage

were about 14 to 18 cents per ton of tailings. Factors that influence operating costs include: type of tailings delivery system (pumping vs. gravity flow), length of delivery, maintenance, number of impoundments operating concurrently, length and type of water recovery system, length and rate of rise of embankment.

For planning purposes, the capital and sustaining capital cost were not used to distinguish one alternative from another. Long-term operating costs that were greater than 100% more than the "No Federal Action" alternative were considered infeasible due to the long-term duration of this cost.

2.3.2.2 Alternatives Screening Workshop

In October 1994, a workshop was held with key representatives from the Project team and other technical consultants for the Project. The purpose of the workshop was to reevaluate all of the alternatives that had been previously studied, to eliminate those that were unreasonable or unfeasible, and to identify those alternatives to be evaluated further. Lands within a 20-mile radius of the Copperton Concentrator were again examined for potential tailings impoundment sites. They were researched, screening criteria were established, and each alternative was tested against the screening criteria (please refer to Table 2-2).

In general, the off-site alternatives had logistical and technical characteristics that would be unacceptable although, the amount of jurisdictional wetlands and other waters of the U.S. affected was in some cases greatly reduced. The north expansion alternatives (on-site) had varying impacts on jurisdictional wetlands and other waters of the U.S. and significantly fewer technical or logistical problems than the off-site alternatives (also refer to Table 2-2).

Through the screening process, the concept for a new alternative emerged that combined desirable features of both the on-site and off-site alternatives. A combination alternative consisting of a Reduced Expansion (on-site) and Barney's Canyon (off-site) would store the majority of tailings

Table 2-2
Evaluation of Alternatives

SCREENING CRITERIA	NO FEDERAL ACTION	NORTH EXPANSION ALTERNATIVES				
		INITIAL PLAN	CONTINUE RAISING EXISTING IMPOUNDMENT, CONSTRUCT BERM	NORTH EXPANSION EAST	REDUCED NORTH EXPANSION	NORTH EXPANSION WEST
TECHNICAL						
Storage capacity (1.9 billion tons required)	0.33 billion tons in existing impoundment only not acceptable	03-0.4 billion tons in existing impoundment only; 1.5 billion tons in expansion	1.9 billion tons	0.3-0.4 billion tons in existing impoundment; 1.5 billion tons in expansion	0.4 billion tons in existing impoundment; 0.4 to 0.5 billion tons in elevated area and 1.1 billion tons in expansion	0.4 billion tons in existing impoundment; 1.5 billion tons in expansion
Seismic upgrade of existing embankment	no seismic upgrade of NE and NW reaches of the imoundment	dewatering along east side, the SE corner and NW reach of the impoundment	new stepback dikes required; dewatering activities would continue	dewatering along east side, the SE corner, and NW reach of the impoundment	statically unstable above 250 ft., a portion of the new impoundment would be overlain on the existing impoundment	north expansion berm; dewatering; process water system modifications
Rate of rise	must be less than capacity of foundation to accept loading conditions	acceptable rate of rise	increased rate of rise for storage of same annual volume to 12 feet per year; new stepback dikes required	average of 7 to 8 feet per year	average of 13.5 feet per year	average of 7 to 8 feet/year
Embankment Design Factors --Footprint (acres) --Seismic Zone Rating --Dam Height Required --Foundation Suitability	no new impoundment existing embankment/impoundment footprint 5065 acres; final dam height less than 200 feet	dam height 195 foot .	diminished surface area of impoundment due to sloping sides; 1,196 acres for the berm; unacceptable dam height of approx. 450 feet height would be required for full capacity	4,095-acre footprint; dam dimensions approx. 250 feet high by 1,125 feet wide	approx. 3,847-acre footprint; dam height approx. 240 to 350-foot; statically and dynamically unstable above 250 feet	approx. 4,018-acre footprint; 250 foot dam height
Construction Materials --Haul distance	13 miles	13 miles	13 miles	13 miles	13 miles	13 miles
--Construction method	none	cycloned tailings	structural berm constructed of cycloned tailings to height of 450 feet and approximately 1,200 feet wide	cycloned tailings	cycloned tailings	cycloned tailings
LOGISTIC						
Materials Available for Embankment	a balance between material required for embankment construction and material that would require storage	a balance between material required for embankment construction and material that would require storage	a balance between material required for embankment construction and material that would require storage	a balance between material required for embankment construction and material that would require storage	a balance between material required for embankment construction and material that would require storage	a balance between material required for embankment construction and material that would require storage
Reliability --Pumping or gravity flow --Length of Delivery --Liners	only acceptable for next 5 to 6 years; gravity flow; existing delivery; natural clay liner	gravity flow; existing delivery; natural clay liner	gravity flow; existing delivery; natural clay liner	gravity flow; existing delivery; natural clay liner	gravity flow; existing delivery; natural clay liner	gravity flow; existing delivery; natural clay liner
ECONOMIC						
Capital Costs (millions, 1992)	$38.0	$541.5	$525.5	$610.5	$653.2	$531.9
Sustaining Capital (millions)	$19.1	$51.5	$22.3	$42.3	$39.8	$41.0
Operating Costs (millions)	$93.8	$401.4	$1542.0	$451.2	$512.0	$471.0
Operating Costs ($/ton) [current $.14 - $.18/ton]	$0.28 - approximately 55% higher than current operating costs	$0.21 - approximately 50% higher than current operating costs	$0.84 - approximately 450% higher than current operating costs	$0.24 - approximately 30% higher than current operating costs	$0.27 - approximately 45% higher than current operating costs	$0.25 - approximately 34% higher than current operating costs

Table 2-2 (cont.)
Evaluation of Alternatives

ENVIRONMENTAL AND REGULATORY CONSIDERATION	NORTH EXPANSION ALTERNATIVES					
	NO FEDERAL ACTION	INITIAL PLAN	CONTINUE RAISING EXISTING IMPOUNDMENT, CONSTRUCT BERM	NORTH EXPANSION EAST	REDUCED NORTH EXPANSION	NORTH EXPANSION WEST
Land Owner and Land Use/Zoning	Kennecott	Kennecott	Kennecott; facilities and utilities would be relocated	Kennecott property within Salt Lake City limits; facilities and utilities would be relocated 1.6 miles additional	Kennecott; facilities and utilities would be relocated	Kennecott; facilities and utilities would be relocated
Jurisdictional Wetlands or Other Waters of the U.S. to be Filled	none	none	408 acres waters of the U.S.	approx. 2,004 acres	950 acres	1055 acres
Surface Water	no change	reroute C-7 ditch	reroute C-7 ditch	reroute C-7 ditch	reroute C-7 ditch	reroute C-7 ditch
Flood Storage and Control	no change	disruption of surface drainage	disruption of surface drainage	disruption of surface drainage	disruption of surface drainage	disruption of surface drainage
Ground Water recharge and discharge	groundwater discharge area site underlain with Bonneville Clay	groundwater discharge area site underlain with Bonneville Clay	groundwater discharge area site underlain with Bonneville Clay	groundwater discharge area site underlain with Bonneville Clay	groundwater discharge area site underlain with Bonneville Clay	groundwater discharge area site underlain with Bonneville Clay
Hazardous Materials or Waste Areas	no change	former salt ponds, phosphogypsum plant	no change	former salt ponds, phosphogypsum plant	former salt ponds, phosphogypsum plant	former salt ponds, phosphogypsum plant
T&E Species and Wildlife Habitat	n o change	No resident threatened or endangered species; snowy plover has been sighted in the area; possible casual overflight and forage by Peregrine Falcon and Bald Eagle	No resident threatened or endangered species; snowy plover has been sighted in the area; possible casual overflight and forage by Peregrine Falcon and Bald Eagle	No resident threatened or endangered species; snowy plover has been sighted in the area; possible casual overflight and forage by Peregrine Falcon and Bald Eagle	No resident threatened or endangered species; snowy plover has been sighted in the area; possible casual overflight and forage by Peregrine Falcon and Bald Eagle	No resident threatened or endangered species; snowy plover has been sighted in the area; possible casual overflight and forage by Peregrine Falcon and Bald Eagle

Table 2-2 (cont.)
Evaluation of Alternatives

SCREENING CRITERIA	OFF-SITE ALTERNATIVES					COMBINATION
	BARNEY'S CANYON	COON CANYON	DRY FORK/CARR FORK	TOOELE/CARR FORK	STOCKTON	REDUCED EXPANSION AND BARNEY'S CANYON
TECHNICAL						
Storage capacity (1.9 billion tons required)	0.4 billion tons in existing impoundment; 1.6 billion tons at Barney's	0.4 billion tons in existing impoundment; 1.6 billion tons at Coon Canyon	0.4 billion tons in existing impoundment; 0.7 billion tons at Dry Fork, if possible; 0.8 billion tons at Carr Fork	0.4 billion tons in existing impoundment; 1.2 billion tons at Tooele; 0.8 billion tons at Carr Fork	0.4 billion tons in existing impoundment; 1.5 billion tons at Stockton	0.4 billion tons in existing impoundment; 1.22 billion tons in Reduced Expansion; 0.39 billion tons at Barney's
Seismic upgrade of existing embankment	insufficient tailings to upgrade the existing impoundment while developing the new off-site embankment	insufficient tailings to upgrade the existing impoundment while developing the new off-site embankment	insufficient tailings to upgrade the existing impoundment while developing the new off-site embankment	insufficient tailings to upgrade the existing impoundment while developing the new off-site embankment	insufficient tailings to upgrade the existing impoundment while developing the new off-site embankment	tailings for off-site location would not be required for 18 years; therefore, sufficient materials are available
Rate of rise	initial rate of rise would be very fast requiring large starter dikes	acceptable rate of rise	acceptable rate of rise	acceptable rate of rise	acceptable rate of rise	unacceptable rate of rise; 18.5 feet per year
Embankment Design Factors --Footprint (acres) --Seismic Zone Rating --Dam Height Required --Foundation Suitability	4,800 acres no major faults 530 foot height differential settlement	3,100 acres no major faults 1,200 foot height differential settlement	1,300 ac Dry Fork; 2,000 ac Carr Fork; major fault at Carr Fork; 600 foot height at Dry Fork; 450 foot height at Carr Fork; differential settlement	2,360 ac Tooele; 1,000 ac Carr Fork; major fault at Carr Fork;400 foot height at Carr Fork; 430 foot height at Tooele; differential settlement	4,400 acres no major faults 440 foot height along highway unknown foundation	2450 ac at N. Expansion and 2380 ac at Barney's Canyon; no major faults; 245 ft. dam height at North Expansion and 160 ft. dam height at Barney's
Construction Materials --Haul distance	approximately 10 miles	approximately 10 miles	approximately 20 miles	approximately 20 miles	approximately 30 miles	approximately 10 miles
--Construction method	waste rock starter dike 230 feet	cycloned tailings	cycloned tailings	cycloned tailings	cycloned tailings	cycloned tailings
LOGISTIC						
Materials Available for Embankment	if the available tailings are used for the seismic upgrade, then insufficient materials for the embankment	if the available tailings are used for the seismic upgrade, then insufficient materials for the embankment	if the available tailings are used for the seismic upgrade, then insufficient materials for the embankment	if the available tailings are used for the seismic upgrade, then insufficient materials for the embankment	if the available tailings are used for the seismic upgrade, then insufficient materials for the embankment	if the available tailings are used for the seismic upgrade, then insufficient materials for the embankment
Reliability --Pumping or gravity flow --Length of Delivery --Liners	gravity from Copperton; pumped from North; less than 1 mile from Copperton; HDPE (60mil) liner required	pumped 1,000 feet head from Copperton; 1,200 feet head from North; two 7.5 mi pipelines; double geomembrane and clay liner over 3,100 acres	pumped 1,600 feet head to Dry Fork; 4.5 mile pipeline; impervious liner required	pumped 280 feet head another source said 1,600 feet head with at grade flume to Tooele; delivery across new trestle bridge over highway; impervious liner required	pumped 645 feet head with 4.7 mile tunnel; 33.5 miles from North; 21 miles from Copperton; impervious liner required	gravity flow from Copperton
ECONOMIC						
Capital Costs (millions, 1992)	$1021.9	$767.6	$947.9	$1046.0	$1218.9	$602.1
Sustaining Capital (millions)	$22.3	$22.3	$26.8	$22.3	$22.3	$55.8
Operating Costs (millions)	$662.5	$620.8	$706.4	$732.4	$738.3	$447.7
Operating Costs ($/ton) [current $.14 - $.18/ton]	$0.349 approximately 89% higher than current operating cost	$0.327 approximately 77% higher than current operating cost	$0.372 approximately 100% higher than current operating cost	$0.385 approximately 108% higher than current operating cost	$0.389 approximately 110% higher than current operating cost	$0.24 - aproximately 71% lower than current operating cost

Table 2-2 (cont.)
Evalutaion of Alternatives

ENVIRONMENTAL AND REGULATORY CONSIDERATION	OFF-SITE ALTERNATIVES					COMBINATION
	BARNEY'S CANYON	COON CANYON	DRY FORK/CARR FORK	TOOELE/CARR FORK	STOCKTON	REDUCED EXPANSION AND BARNEY'S CANYON
Land Owner and Land Use/Zoning	Kennecott; agricultural land	Kennecott	Kennecott	Army at Tooele; Kennecott at Carr Fork; trestle crossing over state highway	BLM land used for grazing and wildlife conservation	BLM land used for grazing and wildlife conservation
Jurisdictional Wetlands or Other Waters of the U.S. to be Filled	313 acres total-- 17 acres waters of the U.S. at Barney; 296 acres wetlands and waters at existing impoundment	313 acres total-- 17 acres waters of the U.S. at Coon Canyon; 296 acres wetlands and waters at existing impoundment	308 acres total-- 12 acres waters of the U.S. at Dry Fork/Carr Fork; 296 acres wetlands and waters at existing impoundment	311 acres total-- 9 acres waters of the U S. at Tooele/Carr Fork; 296 acres wetlands and waters at existing impoundment	308 acres total-- 12 acres wetlands and waters of the U.S. at Stockton; 296 acres wetlands and waters at existing impoundment	308 acres total-- 12 acres wetlands and waters of the U.S. at Stockton; 296 acres wetlands and waters at existing impoundment
Surface Water	no major stream crossings	no major stream crossings	disruption of flow from Dry Creek	disruption of flow from Pine Creek	no major stream crossings	no major stream crossings
Flood Storage and Control	disruption of surface drainage across 14 acres	disruption of surface water drainage	disruption of surface water drainage	disruption of surface water drainage	disruption of surface water drainage	disruption of surface water drainage
Ground Water recharge and discharge	municipal water supply for West Valley recharge area; 300-400 foot depth to water table	unknown	potential groundwater recharge area	potential groundwater recharge area	potential groundwater recharge area	municipal water supply for West Valley recharge area; 300-400 foot depth to water table
Hazardous Materials or Waste Areas	none	none	part waste rock dumps at Dry Fork	Bauer tailings in valley; resin pits; military dump sites; mine mill site; miscellaneous waste dumps	none	former salt ponds
T&E Species and Wildlife Habitat		no T&E; riparian in drainages	no T&E; 137 acres riparian in drainages; 5 acres elk calving ground; bird breeding/nesting areas	no T&E; riparian in drainages; deer and elk habitat	no T&E; 4,000 acres big sage habitat; elk and mule deer winter range; foraging habitat for raptors	no T&E; 4,000 acres big sage habitat; elk and mule deer winter range; foraging habitat for raptors

on-site within a "reduced" footprint, thereby filling fewer acres of jurisdictional lands, and would store the remaining tailings in a smaller "off-site" facility with more acceptable engineering design features than fullsize off-site alternatives (please refer to Section 2.4.2.1 for more information on this alternative).

2.4 ALTERNATIVES CONSIDERED BUT ELIMINATED

Several alternatives were eliminated because they require features that were beyond technological and logistical capabilities available or they did not meet the purpose or need for the Project. Capital and operating costs were compared among the alternatives. Refer to Table 2-2 for the evaluation of each of the operational alternatives.

2.4.1 North Expansion Alternatives

2.4.1.1 Proposed Action (Initial Plan)

The Proposed Action (Initial Plan) was eliminated because it would impact the greatest acreage of jurisdictional wetlands and other waters of the U.S., and additionally it would cover lands within the City of Salt Lake. The Proposed Action, however, would potentially fill 1468 acres of wetlands or other waters of the U.S. under the jurisdiction of the U.S. Army Corps of Engineers (Corps). The Corps identified the need to identify and evaluate alternatives to the Proposed Action. In addition, Kennecott was in favor of evaluating alternatives to the Proposed Action at this time because of the uncertainty of being able to acquire and utilize the old phosphogypsum site (then owned by Chevron) for a part of the facility on the west side, and the rezoning of land within Salt Lake City limits to an industrial zoning classification, near the east end of the Proposed Action.

The City has indicated their unwillingness to rezone the entire area to Manufacturing Industrial, when their comprehensive plan for the area indicates residential uses. This alternative would fill 1,468 acres of jurisdictional wetlands and waters of the U.S., and the other north expansion alternatives would fill fewer acres of jurisdictional land.

2.4.1.2 Continue Raising Existing Tailings Impoundment, Construct Berm

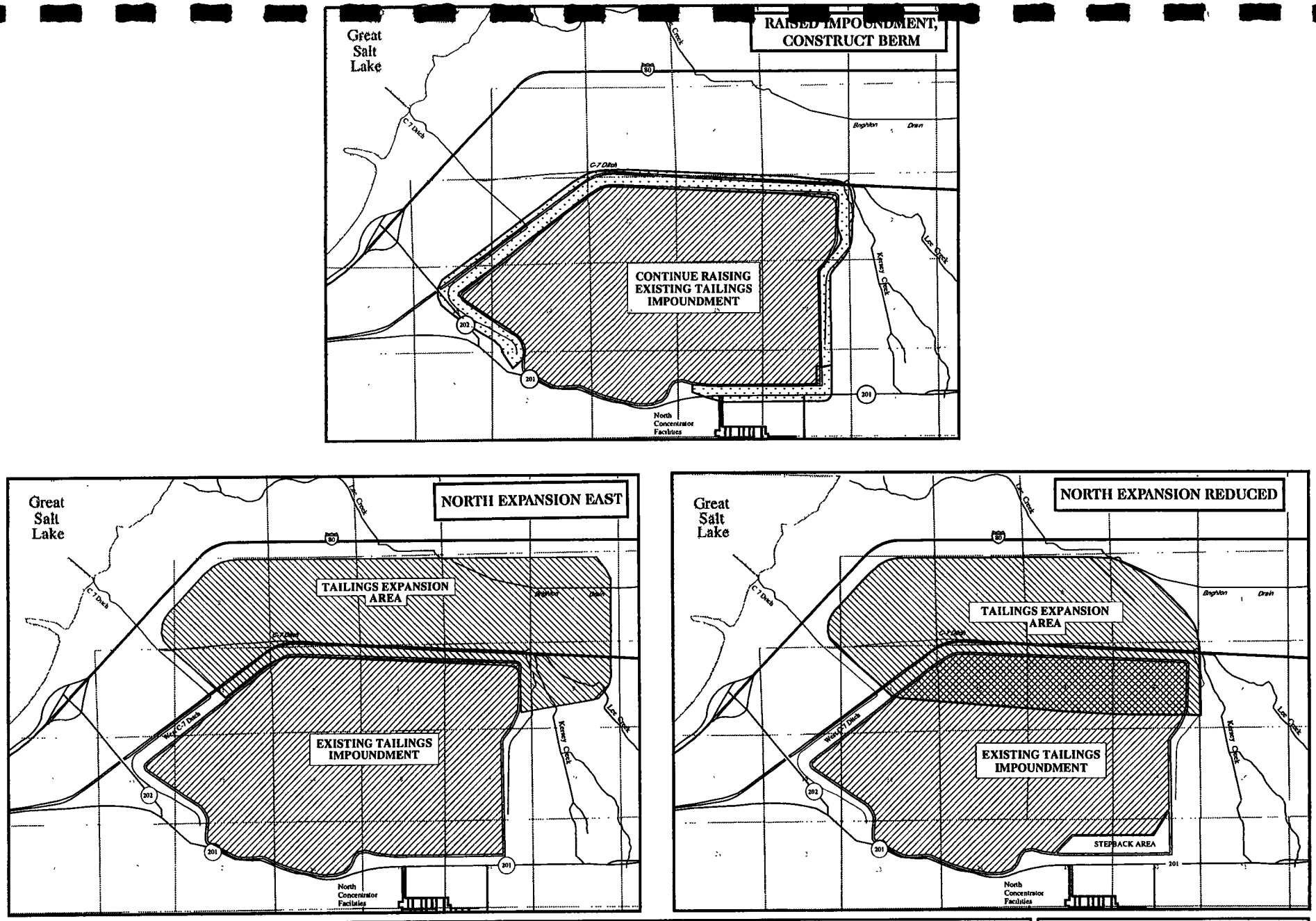
This on-site alternative is considered infeasible. In this alternative, the existing impoundment would continue current operations and a seismic upgrade berm would be constructed around the perimeter of the east, north and west reaches of the impoundment (refer to Figure 2-3). An extensive berm is required under this alternative because the final embankment height would be approximately 450 feet, nearly twice the anticipated 250-foot final height of the existing embankment. The rate of rise would be unacceptable at 18.5 feet per year.

Dewatering a 450-foot high embankment would not be technically practical or economically feasible. In addition, capacity would significantly decline over time because the footprint of the impoundment would slope inward as the embankment and the impoundment is raised. Finally, a seismically stable berm could not be developed along the southwestern portion of the impoundment because of this area's low phreatic levels and natural sloping of the topography toward the Oquirrh Mountains.

Approximately 408 acres of jurisdictional wetlands and waters of the U.S. would be affected by the new berm. The berm footprint would occupy approximately 1,196 acres of land.

The structural berm would be constructed of cycloned tailings sands (underflow) which would be hydraulically placed and compacted. Underflow sands may be available from up to 30 percent of the total tailings stream. The structural berm would be constructed to the full height of the impoundment and be approximately 1200 feet wide at the base. Insufficient quantities of cycloned tailings sands could be produced, thus requiring the need for external berms to construct the alternative. Construction would require relocating major facilities, including the two Union Pacific Railroad lines to the north, State Highway 201 at the southeast corner, and numerous utilities. The placement of the berm would effect historic properties at the southeastern side of the existing impoundment.

Estimated capital cost for construction of this alternative is $525.5 million and sustaining capital cost is $10.5 million. Operating costs over a 25- to 30-year period would be approximately $1,592



OTHER NORTH EXPANSION ALTERNATIVES

TAILINGS MODERNIZATION PROJECT
ENVIRONMENTAL IMPACT STATEMENT

KENNECOTT UTAH COPPER CORPORATION

Figure 2-3

million, resulting in operating costs of $0.84 per ton of stored tailings (Morrison-Knudsen, 1993a).This alternative would not meet the Project need for storage of 1.9 billion tons without imposing a rate of rise of 4 to 5 feet more per year than the existing dam could sustain without imposing unacceptable static factors of safety for the embankment stability.

2.4.1.3 Expand the Existing Facility East (North Expansion East)

This alternative is technically and logistically feasible, but was eliminated due to the difficulty in rezoning and the anticipated delays and projected permitting difficulties. Under this alternative, operations at the existing impoundment would continue, reaching a final average height of about 250 feet and storing an additional 300 to 400 million tons of tailings. The remaining 1.5 to 1.6 billion tons of tailings to be stored would be placed in an expansion area immediately adjacent to and north of the existing impoundment, as shown on Figure 2-3.

The geotechnical investigations completed for this evaluation indicate that the site is acceptable for embankment construction and tailings storage. Soils underlying the expansion area include a contiguous layer of low permeability Bonneville Clay, which would act as a natural liner. It is not anticipated a synthetic liner would be required at this site.

The impoundment/embankment footprint for this alternative would cover approximately 4,316 acres. The total area of impact would be approximately 4,898 acres, and would include industrial salt evaporator impoundments, drainage ditches, roads, railroad tracks, and undeveloped areas. Relocating the Union Pacific Railroad tracks, the drainage channels, and the utilities would be necessary.

The embankment that would impound the tailings would be constructed of the coarse materials from the cycloned tailings (i.e., underflow). This material would be mixed with water and transported as a slurry through a pipeline to the embankment, where it would be deposited on the embankment surface, and compacted. The embankment would be designed for an average final height of approximately 250 feet, with an embankment width of 1,125 feet. A starter dike would

be constructed in much the same manner using the centerline method. This dike would provide early containment of tailings should an earthquake cause the impoundment to fail.

This alternative incorporates heavily disturbed salt impoundment areas, which would minimize the impacts to jurisdictional wetlands. Approximately 250 acres of the 1,344 acres under Corps jurisdiction that would be directly affected are emergent wetlands, which have more diverse flora and structure than the overflow basins, salt ponds or saline playas.

The eastern portion of this site would be within the Salt Lake City limits. The City's position was not to rezone the property to accommodate the tailings facility within the City limits, in order to retain the option for buffering future residential development adjacent to those lands, as indicated in the Northwest Quadrant Master Plan. To prevent further delays in project design and permitting, this alternative was eliminated from further consideration.

It is estimated that the capital cost to implement this alternative would be approximately $610.5 million and the sustaining capital cost is $42.3 million. The 25- to 30-year operating costs are estimated at $451.2 million, or $0.24 per ton of stored tailings (Morrison-Knudsen, 1993a).

2.4.1.4 Reduced Expansion of the Existing Impoundment (North Expansion Reduced)

This alternative was eliminated because it did not meet the Project purpose, and would be statically and dynamically unstable. It's central embankment height would be 350 feet and would require an unacceptable slope of 20H:1V (i.e., horizontal to vertical) on the embankment of the portion of this new impoundment constructed atop the existing impoundment.

The North Expansion Reduced Alternative integrates all aspects of the upgrade measures of North Expansion East Alternative while reducing the footprint of the expansion northeast of the existing tailings impoundment to minimize impacts to jurisdictional waters, as shown on Figure 2-3. This would reduce the total impoundment/embankment footprint to approximately 3,084 acres. In order for the entire 1.9 billion tons of tailings to be stored in this alternative, 300 to 400 million tons would be stored in the existing impoundment, 1.1 billion tons in the expansion area, and the

remaining 400 to 500 million tons in an elevated area comprised of the expansion area and the northern portion of the existing impoundment.

To compensate for the reduced impoundment surface area, the total height of the expansion embankment would be increased to about 350 feet to accommodate the up to 1.6 billion tons of tailings. This significant increase in height would require construction of an additional embankment on top of the northern part of the existing impoundment. The fine-grained tailings present in the existing impoundment are not a suitable foundation for embankment construction and would require the use of unacceptably flat slopes to produce a stable design. The southern slope of the new impoundment area would have to be 20H:1V in order to be suitable for the projected rate of rise for the new facility. Seismic upgrade and dewatering measures similar to those described for the North Expansion East would need to be implemented along the east side and the southeast corner of the existing impoundment.

Under this alternative, the tailings impoundment and associated facilities would cover approximately 3,654 acres and the impact to jurisdictional wetlands and other waters of the U.S. would be approximately 859 acres.

The estimated capital cost for construction of this alternative is $653.2 million and the sustaining capital cost is $39.8 million. The 25- to 30-year operating cost would be $512.0 million, or $0.27 per ton of stored tailings (Morrison-Knudsen, 1993a).

2.4.2 Off-site Alternatives

2.4.2.1 Barney's Canyon

This alternative is considered infeasible because of technical and environmental difficulties. The Barney's Canyon site is located near the Copperton Concentrator in the foothills of the Oquirrh Mountains. The site is bounded by State Highway 111 on the east, Barney's Canyon on the south, and Harker's Canyon on the north. It occupies two distinct watersheds: Clay Hollow and Barney's Canyon. Approximately 313 acres of potential jurisdictional waters would be directly affected by

this alternative—296 acres adjacent to the existing impoundment (required for seismic upgrade of existing facility) and 17 acres at the Barney's Canyon site.

To develop storage for the 1.6 billion tons of tailings, a new embankment would be constructed of cycloned tailings to a height of approximately 530 feet. There would be insufficient cycloned tailings material to construct this size of an embankment while continuing seismic upgrade of the existing facility. The prefeasibility design calls for construction of a 230-foot-high starter dike using mine waste rock, with ongoing cycloned sand production used for expanded dike construction. The impoundment would cover an area of approximately 4,800 acres. The existing gravity-feed pipeline from the Copperton Concentrator would be extended 1 mile and used to deliver tailings to the site. If tailings were to be transported to the Barney's Canyon site from the North Concentrator, they would have to be pumped uphill for a distance of approximately 8 miles.

In addition, the proposed tailings site is in an area of ground water recharge adjacent to an aquifer that is the municipal water supply for the City of West Valley. The water table lies at a depth of 300 to 400 feet below the ground surface. Should a large scale tailings storage facility be constructed, Kennecott's technical consultants have recommended the installation of a composite geomembrane and clay liner, with drainage placed at the base of the tailings to reduce the head (i.e., pressure) above the liner. The 4,800 acres of liner would overly foundation materials varying from deep, semi-consolidated or unconsolidated alluvial deposits (some up to 400 feet thick), interspersed with stable volcanic outcrops. A significant problem would be the expected differential settling of the tailings, which could cause the liner to rupture. The site's location immediately upslope of a major metropolitan area (West Valley), coupled with the potential height of the structure (530 feet), places it in a "high risk" category for dam safety and generally would not be considered suitable if a lower risk alternative exists.

Estimated capital cost to implement this alternative is approximately $1,021.9 million and the sustaining capital cost is $22.3 million. The 25- to 30-year operating costs would be $662.5 million, or $0.35 per ton of tailings stored (Morrison-Knudsen, 1993a).

This alternative was eliminated from further consideration because of the risk of dam failure and the potential for rupture of the geomembrane over time placing the municipal water supply in jeopardy. A composite geomembrane and clay liner with drainage placed at the base of the tailings to reduce head above the liner would most likely be required should a large scale tailings storage facility be constructed at this site.

2.4.2.2 Coon Canyon

This alternative is considered infeasible due to technical and logistical limitations. The Coon Canyon site is on the east slope of the Oquirrh Mountains, approximately 8 miles from the Copperton Concentrator (see Figure 2-2). The impoundment would be located in the upper reaches of Coon Canyon, between the ridges of Harker's Canyon and Little Valley Wash. The land is relatively undisturbed. Similar to the Barney's Canyon site, this alternative would lie over foundation soils potentially susceptible to differential settlement and is located adjacent to an aquifer used for municipal water supply. The impoundment would cover an area of about 3,100 acres. Approximately 313 acres of potential jurisdictional waters would be affected, 17 acres at the Coon Canyon site and 296 acres adjacent to the existing impoundment.

To impound 1.6 billion tons of tailings at this site, an embankment, approximately 1,200 feet high, and a 500-foot-high starter dike would be constructed. Tailings would be pumped uphill from both the Copperton and North concentrators, with a lift of up to 1,000 feet from Copperton and over 1,200 feet from the North Concentrator. Two parallel pipelines, each 7.5 miles long, would be constructed from the Copperton Concentrator to handle the volume. The pipelines could affect additional wetland areas. An emergency retention pond would be constructed to impound tailings backflow in the event of pumping or power failures. Should a large scale tailings storage facility be constructed, Kennecott's technical consultants have recommended the installation of a composite geomembrane and clay liner, with drainage controlled at the base of the tailings to reduce gradients above the liner.

It is estimated that the capital cost to construct this alternative is approximately $767.6 million and the sustaining capital cost is $22.3 million. The 25- to 30-year operating cost would be $620.8 million, or $0.33 per ton of tailings stored (Morrison-Knudsen, 1993a).

This alternative was eliminated from further consideration because an embankment approximately 1,200 feet high would be required to store the 1.6 billion tons of tailings. Also, the tailings would have to be pumped 1,000 feet in elevation from Copperton and 1,200 feet in elevation from the North Concentrator. The entire tailings site would require a liner, approximately 3,100 acres. Each of these factors is well beyond the logistical and technical limits of an acceptable tailings impoundment facility.

2.4.2.3 Dry Fork/Carr Fork

This alternative would require three separate actions: 1) seismic upgrade of the existing impoundment, 2) development of the Dry Fork impoundment, and 3) development of the Carr Fork impoundment. And the Dry Fork and Carr Fork sites would be combined to form an impoundment area of sufficient capacity (Figure 2-2). This alternative calls for the development and operation of two tailings storage sites, one on the existing Dry Fork waste rock pile above Bingham Canyon, and the other at Carr Fork on the west side of the Oquirrh Mountains. The cycloned tailings produced from Copperton and North concentrators would be insufficient to both construct the starter dikes for the off-site location and continue seismic stabilization of the existing impoundment.

In 1993, this alternative had a combined total storage capacity of 1.5 billion tons; the Dry Fork site may now have reduced capacity since there has been a year of additional waste rock deposition. Dry Fork had a storage capacity of approximately 700 million tons, and the Carr Fork site a capacity of about 800 million tons. Under this alternative, after the Dry Fork impoundment reaches capacity, tailings would be stored at the Carr Fork site. Approximately 308 acres of jurisdictional wetlands and other waters of the U.S. would be affected; approximately 12 acres total in Dry Fork and Carr Fork, and 296 acres adjacent to the existing impoundment (SWCA, 1994a).

Under the original analysis in 1989, the Dry Fork impoundment would need to be 600 feet high, and cover an area of approximately 1,300 acres. It would be built upon a 600-foot-deep existing waste rock pile. Waste rock would be reworked to build the starter dike. Following starter dike construction, the embankment would be constructed of cycloned, compacted tailings, placed on the existing rock pile. To improve drainage and prevent piping of tailings through the rock fill, a high-density polyethylene pipe drain system would be installed beneath the tailings impoundment.

A tailings pipeline approximately 4.5 miles long would be constructed from the Copperton Concentrator to the Dry Fork impoundment. This system would require an initial lift of the slurried tailings of 1,000 feet, and a maximum lift of 1,600 feet. Booster pump stations would be required to provide the lift from the Copperton and North concentrators. An emergency retention pond would be developed to receive tailings backflow during maintenance or in the event of a power failure. Once Dry Fork reaches its full capacity, the existing Parvenu tunnel would be renovated to transport tailings to the Carr Fork site. A gravity pipeline would lead from the tunnel to the tailings impoundment. The ultimate impoundment height at Carr Fork would be 450 feet and cover an area of approximately 2,000 acres. Construction of impoundments at Dry Fork and Carr Fork sites would require installation of a liner and drainage system to protect the aquifer.

Estimated costs to construct this alternative are approximately $947.9 million and the sustaining capital cost is $26.8 million. The 25- to 30-year operating costs are estimated to be $706.4 million, or $0.37 per ton of tailings stored. (Morrison Knudsen, 1993a)

This alternative was considered and eliminated because of the lining and differential settlement problems inherent in the alluvial and volcanic deposits in the area, the initial pumping of the tailings slurry 1,000 feet in elevation and over a 20 mile distance (with the maximum lift of 1,600 feet), and downstream risks from potential dam failure. Therefore, this alternative has serious logistical and technical constraints including the downstream risks from potential dam failure.

2.4.2.4 Tooele/Carr Fork

The Tooele site would be combined with the Carr Fork site to achieve the required storage capacity of 1.6 billion tons. This alternative involves storage at two separate sites: one located 3 miles south of the town of Tooele on the west side of the Oquirrh Mountains, and the second at Carr Fork (refer to the description under the Dry Fork/Carr Fork alternative). The Tooele site, shown on Figure 2-2, is at the south boundary of the Tooele Army Depot in the uppermost reaches of the Tooele Valley, overlying an aquifer recharge area. It is estimated that 305 acres of potential jurisdictional waters would be affected; 9 acres, total, at Tooele and Carr Fork, and 296 acres adjacent to the existing impoundment.

In this alternative, 300 to 400 million tons of tailings would be stored at the existing impoundment, 1.2 billion at the Tooele site, and 400 million tons at the Carr Fork site. Once the Tooele site reaches capacity, tailings would be stored at Carr Fork. The Carr Fork impoundment would be approximately 400 feet high and would cover 1,000 acres. This alternative would be a smaller version of the Carr Fork impoundment (refer to Section 2.4.2.3.) due to the decreased storage capacity required under this alternative.

The ultimate impoundment height at Tooele would be 430 feet and would cover an area of approximately 2,360 acres. Tailings from the Copperton Concentrator would be pumped 280 feet in elevation inside a 5.7-mile-long tunnel through the Oquirrh Mountains to the Carr Fork site, then would be transferred to an at-grade concrete flume for a 20 mile transport to the Tooele impoundment. New trestle crossings would be required at Settlement Canyon and State Highway 36. In addition, an impervious liner and sub-drainage system would be required.

It is estimated that this alternative would cost approximately $1,046.0 million to construct and the sustaining capital cost would be $22.3 million. The 25- to 30-year operating costs are estimated at $732.4 million, or $0.39 per ton of tailings stored, which is considered economically infeasible (Morrison-Knudsen, 1993a).

This alternative was eliminated from further consideration because of the logistical constraints. Specifically, it overlies an aquifer recharge area, requires pumping the tailings slurry uphill 280

feet for a 25 mile distance, as well as requires the installation of a liner. The costs associated with these features are unacceptable.

2.4.2.5 Stockton

The Stockton site calls for establishing an impoundment on low-lying foothills west of the Oquirrh Mountains, 6 miles south of the town of Stockton in Rush Valley (see Figure 2-2). The site is situated at the junction of State Highways 36 and 73 on public land managed by the BLM, about 2 miles above Rush Lake. Approximately 308 acres of potential jurisdictional waters would be affected by this alternative; 12 acres at Stockton, and 296 acres adjacent to the existing impoundment.

The ultimate impoundment height at Stockton would be 440 feet and would cover an area of approximately 4,400 acres. The tailings disposal system would consist of a series of pump stations, pressurized pipelines, and a concrete flume. The tailings lift from Copperton would be 645 feet to a 4.7-mile-long tunnel through the Oquirrh Mountains. Beyond the tunnel would be a 16.2-mile-long gravity pipeline to the disposal site. The pipeline would require construction of trestle crossings at Pine Canyon and Settlement Canyon. A composite liner constructed of clay and geomembranes would be required to protect the aquifer. Because the Stockton site is a relatively flat valley bottomland, the liner would have to cover the entire site at the onset rather than be expanded as the site is filled.

The capital cost estimate is approximately $1,218.9 million with the sustaining capital cost estimated at $22.3 million. The 25- to 30-year operating cost estimate is $738.3 million, or approximately $0.39 per ton of tailings stored (Morrison-Knudsen, 1993a).

This alternative was eliminated from further consideration because it would have significant logistical constraints. Specifically, the Stockton site would require installation of tailings pipelines over 21 miles long, with a pumping head of approximately 650 feet in elevation and lining of approximately 4,400 acres.

2.4.3 Combination Alternative

2.4.3.1 Reduced North Expansion/Barney's Canyon

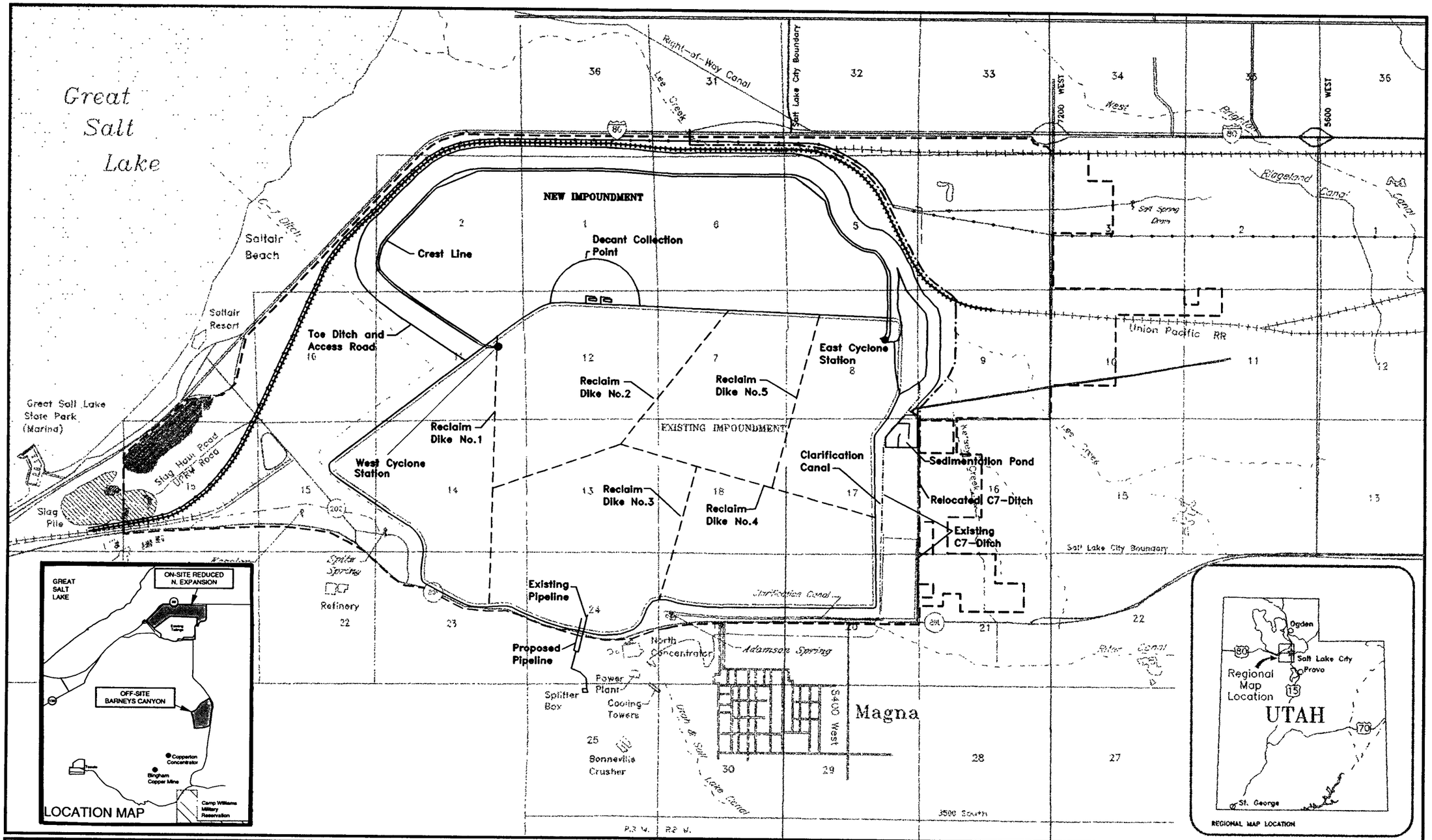
This alternative combines an impoundment immediately north of the existing impoundment with a smaller off-site tailings storage area located at Barney's Canyon.

The Reduced North Expansion tailings impoundment would be constructed with the west perimeter located just to the east of West C-7 Ditch (see Figure 2-4a). The starter dam would be constructed to allow the impoundment embankment to be raised to a height of 245 feet (see Table 2-3). The embankment would be constructed of sand that has been removed from the whole tails by cyclones. At year 20 of operation, tailings from the Copperton Concentrator would be diverted to the Barney's Canyon location. Tailings from the North Concentrator would continue to be deposited in the Reduced North Expansion impoundment for the projected mine life of 28.7 years total.

The embankment would be constructed at Barney's Canyon the same as at the Reduced North Expansion (Figure 2-4b and 2-5) using cyclone tailings. From the first deposits in Barney's Canyon, at year 20 of operations, both impoundments would be in use until the end of the mine life.

Construction of the Reduced North Expansion embankment would require the majority of the sand available from combined tailings from Copperton and North concentrators. Therefore, imported fill material would be required for the construction of the starter structures at the Barney's Canyon Impoundment.

A study was conducted on the Barney's Canyon site to determine dam height, rate of rise, and other design features that would be required to store the tailings. Since the off-site impoundment would not be needed for 20 years, the cost of constructing the facility could be deferred and the North Concentrator would not be required. Barney's Canyon is down slope from the Copperton



Study Area Boundary

Railroad

Spring

UP&L Utility Location

Rerouted C7-Ditch

Rerouted Railroad

NORTH

SCALE: 0 1/2 1 MILES

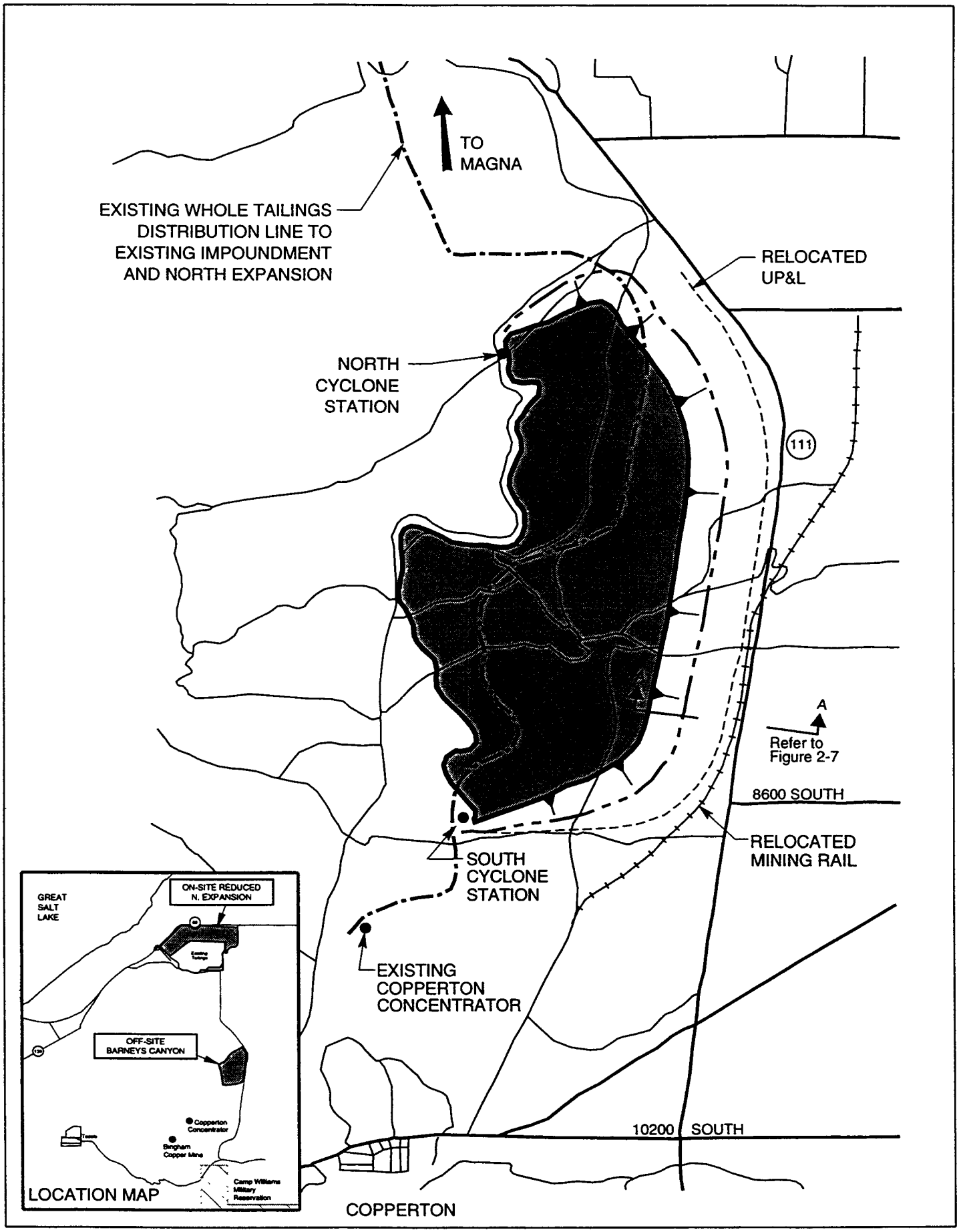
January 1995

COMBINED OFF-SITE AND ON-SITE
On-site Reduced Expansion Area

TAILINGS MODERNIZATION PROJECT
ENVIRONMENTAL IMPACT STATEMENT

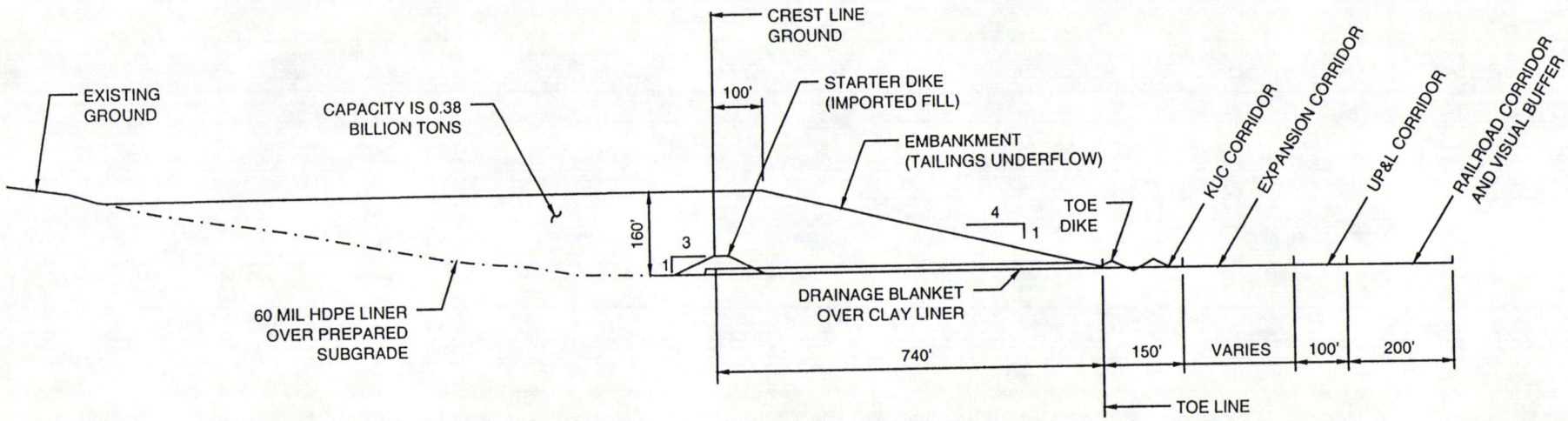
KENNECOTT UTAH COPPER CORPORATION

Figure 2-4a



COMBINED OFF-SITE AND ON-SITE
Barney Canyon Area

Figure 2-4b



TYP. PERIMETER EMBANKMENT CROSS-SECTION A-A
(NOT TO SCALE)

CROSS-SECTION A-A

Figure 2-5

Table 2-3

Combination Alternative Comparison

	Reduced Expansion	Barney's Canyon
Dam Height	245 feet	160 feet
Average Rate of Rise	12.4 ft/yr	18.5 ft/yr
Operating Life	28.7 years	8.7 years
Design Volume	1.22 billion tons	0.39 billion tons
Impoundment Area	2450 acres	2380 acres
Jurisdictional Lands Affected	860 acres	approx. 17 acres

Concentrator (Figure 2-4b); therefore, the tailings could be transported 10 miles by gravity.

Environmental considerations at the Barney's Canyon site relate to surface and ground water quality. There are two drinking water wells immediately down slope at the town of Copperton. A municipal water supply recharge area underlies the entire site at a 300-400 foot depth.

A composite geomembrane and clay liner would be required under the embankment and impoundment (2,380 acres) due to the potential for differential settlement. If the liner were to rupture, ground water resources would be at risk. There would also be a high risk of down stream damage in West Valley should a dam failure occur.

In addition, the planned West Valley future development would be in conflict with large tailings facility. There would be a need for relocation of the Union Pacific Railroad and the Utah Power & Light transmission line. The capital cost estimate is approximately $602.1 million with the sustaining capital cost estimated at $55.8 million. The 25-to-30 year operating cost estimate is $447.7 million, or approximately $0.24 per ton of tailings stored (Morrison-Knudson, 1994).

This alternative was eliminated from further consideration because of the potential risk of contamination of ground water supplies, insufficient cycloned tailings material for construction, risk of dam failure, need for a liner, and the regulatory constraints of attempting to permit the facility.

2.5 ALTERNATIVES EVALUATED IN DETAIL

Those alternatives that could not meet the practicability or feasibility tests were eliminated from further analysis (refer to the section above). Two alternatives, the No Federal Action and the North Expansion West, remain to be examined further within the environmental consequences section of the EIS.

2.5.1 No Federal Action

This alternative would continue the current tailings storage operations without change: stabilizing the existing impoundment, dewatering, filling, and reclaiming the area. According to NEPA, No Federal Action (or No Action) is the alternative that represents projections of current conditions to the most reasonable future conditions that could occur during the life of the Project without the proposed action or other proposed alternatives being implemented. The life of the existing impoundment would be to year 2004, after which the mining operations would cease. This would cause the termination of over 4000 jobs, and socioeconomic impacts to local units of government, as well as local businesses.

Other assumptions used to characterize the No Federal Action include:

- no change to the tailings slurry input volume until mine closure in year 2004,
- continue to stabilize the existing impoundment, raise the step back dike along the southeast, and construct no stabilization berm,
- continue raising the impoundment to an average height of 250 feet,
- fill, cap, and reclaim the existing impoundment by year 2004,
- no direct filling of wetlands or jurisdictional waters,

- no Section 404 permit required, and
- no change to the C-7 Ditch, railroads or utilities.

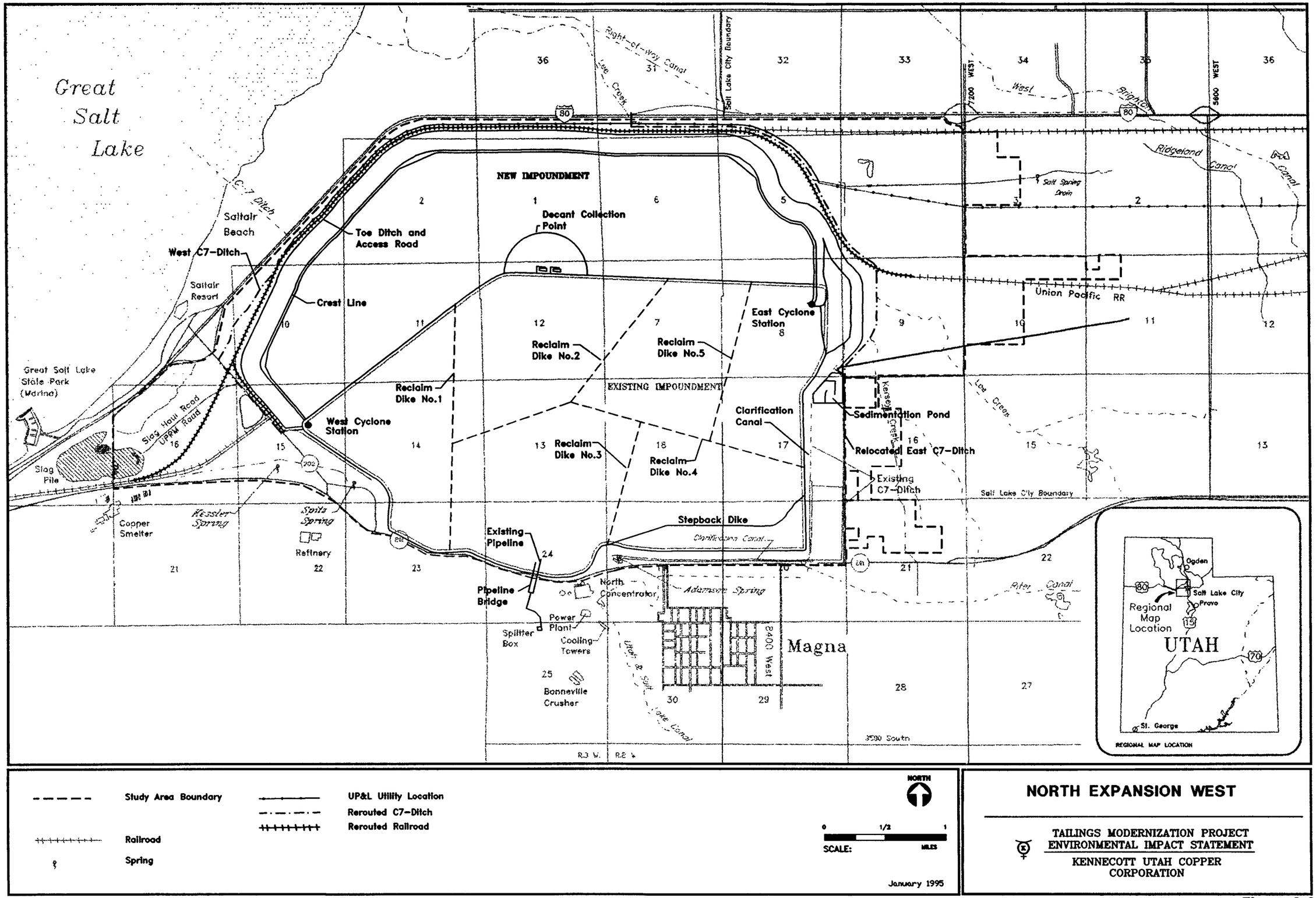
This alternative would not meet the purpose and need for storing 1.9 billion tons of tailings required under the current mine plan, nor would it allow the seismic upgrade of the existing impoundment. The increased risk of dam failure from a seismic event could cause inadvertent filling of the surrounding wetlands and damage or loss of I-80, railroads, and other transportation and utilities. Also, mining operations would have to cease soon after the existing tailings impoundment reached capacity.

2.5.2 North Expansion West

This alternative would accommodate the full projected tailings volume of 1.9 billion tons, by expanding into the area immediately to the north and northwest of the existing impoundment, as shown on Figure 2-6. The North Expansion West impoundment/embankment footprint would be approximately 4,018 acres. The expansion area includes salt evaporator impoundments and the former fertilizer production facilities northwest of the existing impoundment. The former fertilizer production facilities are currently being dismantled; they include the processing buildings, warehouses, and the phosphogypsum stack.

Under this alternative, 300 to 400 million tons of tailings would be placed into the existing impoundment, bringing its final height to approximately 245 feet. The expansion would begin receiving tailings in late 1998, and the forecasted 1.5 to 1.6 billion tons of future tailings would be placed into an area of approximately 4,018 acres immediately adjacent to the existing impoundment. A starter dike would be constructed of underflow sands for early containment of tailings overflow in the event of a seismically induced (i.e., earthquake) failure of the existing impoundment.

Current design is for the construction of an approximate 245-foot-high embankment, approximately 5.6 miles long, to store approximately 1.5 to 1.6 billion tons of tailings produced during the next



Great Salt Lake
NEW IMPOUNDMENT
EXISTING IMPOUNDMENT
Decant Collection Point
Toe Ditch and Access Road
West C7-Ditch
Crest Line
Saltair Beach
Saltair Resort
Great Salt Lake State Park (Marina)
Slag Haul Road
UPRM Road
Slag Pile
Copper Smelter
Kessler Spring
Spits Spring
Refinery
West Cyclone Station
Reclaim Dike No.1
Reclaim Dike No.2
Reclaim Dike No.3
Reclaim Dike No.4
Reclaim Dike No.5
East Cyclone Station
Clarification Canal
Sedimentation Pond
Relocated East C7-Ditch
Existing C7-Ditch
Stepback Dike
Existing Pipeline
Pipeline Bridge
North Concentrator
Power Plant
Cooling Towers
Splitter Box
Bonneville Crusher
Adamson Spring
Magna
8400 West
Union Pacific RR
Salt Lake City Boundary
Right-of-Way Canal
Lee Creek
West Brighton
Ridgeland Canal
Salt Spring Drain
Kersey Creek
Riter Canal
Utah & Salt Lake Canal
3500 South
R.3 W.
R.2 W.
Ogden
Salt Lake City
Provo
Regional Map Location
UTAH
St. George
REGIONAL MAP LOCATION
Study Area Boundary
Railroad
Spring
UP&L Utility Location
Rerouted C7-Ditch
Rerouted Railroad
NORTH
SCALE:
0
1/2
1
MILES
January 1995
NORTH EXPANSION WEST
TAILINGS MODERNIZATION PROJECT
ENVIRONMENTAL IMPACT STATEMENT
KENNECOTT UTAH COPPER CORPORATION

Figure 2-6

25- to 30-years of operation. Dewatering measures would be continued along the east side, the southeast corner, and a northwest reach of the existing impoundment to address seismic upgrade needs for these portions of the embankment (SWCA, 1993a).

Soils in the area north of the existing impoundment are suitable for embankment construction and tailings storage. Due to the presence of a contiguous layer of low-permeability Bonneville Clay underlying the expansion area, no synthetic liner would be included in the design.

Property affected by the North Expansion West includes the former salt evaporator facility, former fertilizer production facilities, phosphogypsum stack and processing facilities (former Chevron site), C-7 Ditch, and Union Pacific railroad tracks. Over 60 percent of the land to be used under this alternative has been previously disturbed by industrial activities.

The footprint for this alternative would be approximately 4,018 acres, which includes 984 acres of jurisdictional wetlands or other waters of the U.S. Refer to Table 2-4 for the approximate area affected by each Project component.

Table 2-4
North Expansion West

Project Component	Jurisdictional Area (acres)	Area Affected (acres)
East C-7 Ditch Reroute	40.56	107.40
West C-7 Ditch Reroute	28.97	61.69
Kennecott Railroad and Buffer Corridor (West)	0	2.03
UP&L Corridor and Visual Buffer	42.46	115.34
UPRR Relocation	62.27	145.74
Toe Ditch and Access Road	58.41	152.23
Tailings Impoundment and Embankment	746.28	3843.39
Sedimentation Pond	5.35	29.61
TOTAL	984.30	4,457.43

Capital cost to implement this alternative is estimated at approximately $531.9 million and the sustaining capital cost is $41 million. Estimated 25- to 30-year operating costs are $471 million, or $0.25 per ton of tailings stored (Morrison-Knudsen, 1993a).

2.6 PREFERRED ALTERNATIVE

2.6.1 Owner Preferred Alternative

Although Kennecott favors the Proposed Action (i.e., the Initial Plan) as their preferred action, they recognize that this plan has jurisdictional and regulatory (e.g., zoning) constraints that overshadow the attractiveness of the economics, logistics, and technical criteria. Therefore, Kennecott's preferred alternative is the remaining action alternative, the North Expansion West alternative. This alternative would allow Kennecott to meet its purpose and need to continue competitive mining operations, allowing the greatest possible capacity for storing tailings with an acceptable dam height, and acceptable cost for capital and operational expenditures.

2.6.2 Agency Preferred Alternative

A Preferred Alternative will be selected by the Corps following the review of the DEIS.

CHAPTER 3
AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

CHAPTER 3 - AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

Note:

The jurisdictional wetlands and other waters of the U.S. impacts are currently being recalculated. Therefore, the area for specific wetland types may be subject to change. These modifications will become part of the public DEIS.

3.1 INTRODUCTION

This chapter combines the affected environment and environmental consequences descriptions in one section in an effort to reduce the volume of the Draft Environmental Impact Statement (DEIS) and make it more understandable. Where applicable, references to previous studies throughout the document lead to the original source of information and detailed supporting data. The previous studies are listed in Chapter 4 - Consultation and Coordination and copies are available at the U.S. Army Corps of Engineers (Corps) office in Bountiful, Utah or at Kennecott Utah Copper Corporation's (Kennecott) library.

3.1.1 Affected Environment

The Affected Environment portions of this chapter describe the existing environmental resources in the study area, in particular focusing on the issues raised during the scoping process. In accordance with the National Environmental Policy Act (NEPA) regulations 40 CFR 1502.15, the affected environment section discusses the conditions in the human and natural environment which would be affected, beneficially and adversely, by the proposed alternatives. In addition, resources or project elements which are subject to statutory or regulatory requirements are described. The key resources, grouped into the following disciplines, are addressed within this chapter:

[1]The study area is defined as the land bounded by Highway 202 on the west, I-80 on the north, 7200 East on the east, and Highway 201 on the south (please refer to Figure 2-1 for study area boundary).

Natural Environment

- Biological Resources
  - jurisdictional wetlands/waters of the U.S.
  - vegetation
  - aquatic biota
  - terrestrial wildlife
  - special status species
- Water Resources
  - surface water, quality and supply
  - ground water supply
- Earth Resources
  - geology and physiograph
  - seismicity
  - soil resources

Human Environment

- Land Use, Transportation and Utilities
  - land jurisdiction/ownership
  - existing and planned land use
  - transportation and access
  - zoning
- Visual Resources
  - landscape character
  - sensitive viewpoints
- Socioeconomics
  - population
  - employment
  - personal income
- Hazardous Materials/Waste
  - proposed North Zone Superfund site
  - Garfield Plant
  - Morton Salt Plant
  - fuels, oils & lubricants
- Cultural Resources
- Noise
- Air Quality

[1]The study area is defined as the land bounded by Highway 202 on the west, I-80 on the north, 7200 East on the east, and Highway 201 on the south (please refer to Figure 2-1 for study area boundary).

3.1.2 Impact Assessment Methodology

3.1.2.1 Significance Criteria

Environmental resources were assigned anticipated impact levels of significant, insignificant or no identifiable impact. The critical determination for each resource was in defining significant impact thresholds. The significance of impacts were analyzed in several contexts: society and the environment as a whole, the affected region and interests, and the locality. In determining whether an impact would be significant or insignificant, several factors relating to the intensity and severity of impacts were considered including, the degree to which:

- effects may be adverse and/or beneficial,
- the project would affect public health/safety,
- the geographic area has unique natural and cultural resource characteristics,
- effects on the quality of the human environment would be highly controversial,
- effects on the human environment would be highly uncertain or involve unknown risks,
- the project may establish a precedent for future actions,
- the project is related to other projects with individually insignificant but cumulatively significant impacts or benefits,
- critical and protected resources would be lost, destroyed, substantially changed or stressed (eg., features on the National Register of Historic Places, special status species or habitat), and
- the project would threaten violation of federal, state, or local law or requirements imposed for protection of the environment.

3.1.2.2 Impact Levels

Impact levels were rated high, moderate, low, no-identifiable, or beneficial. The levels are defined below:

High Impact - A high level of impact would potentially cause a significant or substantial adverse change or stress to an environmental resource(s).

Moderate Impact - A moderate impact would potentially cause some adverse change or stress (ranging between significant and insignificant) to an environmental resource(s).

Low Impact - A low impact would potentially cause an insignificant or small adverse change or stress to an environmental resource(s).

No-Identifiable Impact - No-identifiable impact would be indicated where no measurable impact would occur to the specific environmental resource(s) under investigation.

Beneficial Impact - A beneficial impact would cause a positive change to the specific environmental resource(s) under investigation or to public health and safety.

3.1.2.3 Direct Impacts

Direct impacts are those which would be caused by the action and would occur at the same time and place as that action. Impacts were determined by assessing the initial effects of construction activities anticipated for the Proposed Action or alternative, and the long-term effects of project operation and maintenance (refer to Chapter 2 - Description of the Proposed Action and alternatives). Potential conflicts with the objectives of federal, state, and local plans, policies and controls were also identified. Short-term impacts could be caused by constructing individual components of the Project, such as the fueling facility, the slag haul access road, the starter dike, and sedimentation ponds. Long-term impacts could result from operating and maintaining these facilities, as well as from the long term effects of covering land, potentially altering drainage patterns or recharge of ground waters. Beneficial direct impacts could be from cleaning up hazardous materials while preparing the site for construction.

3.1.2.4 Indirect Impacts

Secondary (or indirect) impacts are caused by development or other activities that are not a direct part of the proposed Project, but occur either later in time or outside the study area. Indirect effects must be reasonably foreseeable. Indirect effects may include changes in land use patterns,

population density or growth rates and related effects on air, water and other natural systems. Beneficial secondary impacts related to the Project may include increased employment and tax revenues to the local government.

3.1.2.5 Cumulative Impacts

Cumulative impacts are the impacts on the environment resulting from the incremental effect of the Project when added to other past, present and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such actions. Cumulative impacts can result from individually minor, but collectively significant actions, taking place over a period of time.

3.1.2.6 Long-Term Productivity and Irreversible and Irretrievable Commitments of Resources

Impacts on the environment are analyzed for long term as well as immediate effects. Each resource is examined to determine if the Project's short-term uses of the environment will effect long term productivity or require irreversible and irretrievable commitments of resources.

3.1.2.7 Mitigation Measures

Mitigation measures are analyzed to determine their effectiveness in reducing either the magnitude or duration of impacts. NEPA does not require that an impact be significant before identifying a mitigation measure. Mitigation should be used when it is effective in reducing the effect and is reasonable. For significant impacts, such as filling wetlands or waters of the U.S., a carefully designed mitigation plan is included as part of this DEIS Proposed Action; and therefore are considered before determining residual impacts (refer to Appendix B).

Mitigation for alternatives includes generic and specific programs. Generic mitigation programs consist of measures or techniques recommended Project-wide basis as part of the Proposed Action. Specific mitigation programs include measures recommended on a case-by-case basis for the environmental resource(s) under investigation. For any proposed mitigation, the reduction of the

impacts is quantified and described. The remaining residual unavoidable adverse impacts, or impacts that cannot be mitigated, are then identified.

3.2 BIOLOGICAL RESOURCES

3.2.1 Overview

3.2.1.1 Methods

Vegetation and wildlife data were obtained from existing information and agency contacts. Vegetation and wildlife of the study area were sampled during field surveys conducted by BIO/WEST (1992), and were summarized by SWCA (1994c). Wetlands were characterized, delineated, and mapped by SWCA (1994). Agency personnel were contacted and asked to identify potential or known occurrences of special status species and sensitive habitats within the study area. Information has been requested from the Utah Division of Wildlife Resources (UDWR), U.S. Fish and Wildlife Service (USFWS), and Utah Natural Heritage Program (UNHP).

3.2.1.2 Legislation

Actions potentially affecting vegetation and wildlife resources are regulated by several federal statutes. The Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.) as amended, provides USFWS the authority to protect wildlife and plant species designated as threatened or endangered. All wild birds except starlings and house sparrows are protected by the Migratory Bird Treaty Act of 1986. The Bald Eagle Act of 1940 (amended in 1962) further protects bald eagles and golden eagles. Additional legislation affording protection to wildlife species and their habitat includes the Sikes Act, Title II (16 U.S.C. 670 et seq.) as amended, the Federal Land Policy and Management Act of 1976 (FLPMA) (43 U.S.C. 1701) and NEPA.

Wetlands are subject to regulation by the U.S. Army Corps of Engineers (Corps) pursuant to Section 404 of the Clean Water Act (33 CFR Section 320-330). Section 404 also regulates activities in "waters of the United States" which includes navigable waters, such as lakes, rivers, and streams, but also includes adjacent wetland impoundments, tributaries, mudflats, sandflats,

sloughs, wet meadows, and playa lakes. Section 404(b)(1) of the Clean Water Act requires that a Proposed Action be evaluated to ensure that alternatives are considered that would avoid impacts to wetlands, and if avoidance is not possible, to minimize impact to the extent possible. Wetlands are also addressed by Executive Order 11990 (1977), Protection of Wetlands that requires federal agencies to take action whenever possible to minimize damage to wetlands.

Legislation directing wildlife management also exists at the state level. In 1971, the Utah legislature passed a Wildlife Resources Code that gave authority and charge to the UDWR to protect, propagate, manage, conserve, and distribute protected wildlife in Utah.

3.2.2 Issues

Issues to be addressed in this DEIS include the potential effects on biological resources, including wetlands, vegetation, aquatic biota, wildlife, and special status species. The Tailings Modernization Project would fill jurisdictional wetlands resulting in the loss of wetlands, vegetation, and habitat for aquatic biota, mammals, birds, reptiles, and amphibians.

3.2.3 Affected Environment

3.2.3.1 Jurisdictional Wetlands and Waters of the United States

Methods

Jurisdictional wetlands were identified using criteria specified in the Corps Wetlands Delineation Manual (Corps, 1987), relevant case law (Leslie Salt vs. United States 1992, Golden Gate Audubon Society vs. Corps 1992), and Corps regulatory guidance bulletins. Wetlands were identified using hydrology, soils, and vegetation characteristics that indicate wetland conditions according to Corps guidelines (1987). All three parameters must be present for a site to qualify as a jurisdictional wetland. In addition to field evaluations, National Wetland Inventory (NWI) maps (USDI, 1990), aerial photography, soils maps (USDA, 1974), and hydrogeology reports (Kennecott, 1992) were used as an information base. Furthermore, information was obtained on the vegetation, soils, and

hydrology of the area that was conducted by BIO\WEST (1992) and a ponding study of the salt evaporator impoundment that was conducted by ERM-Rocky Mountain (1993).

Results

Wetlands

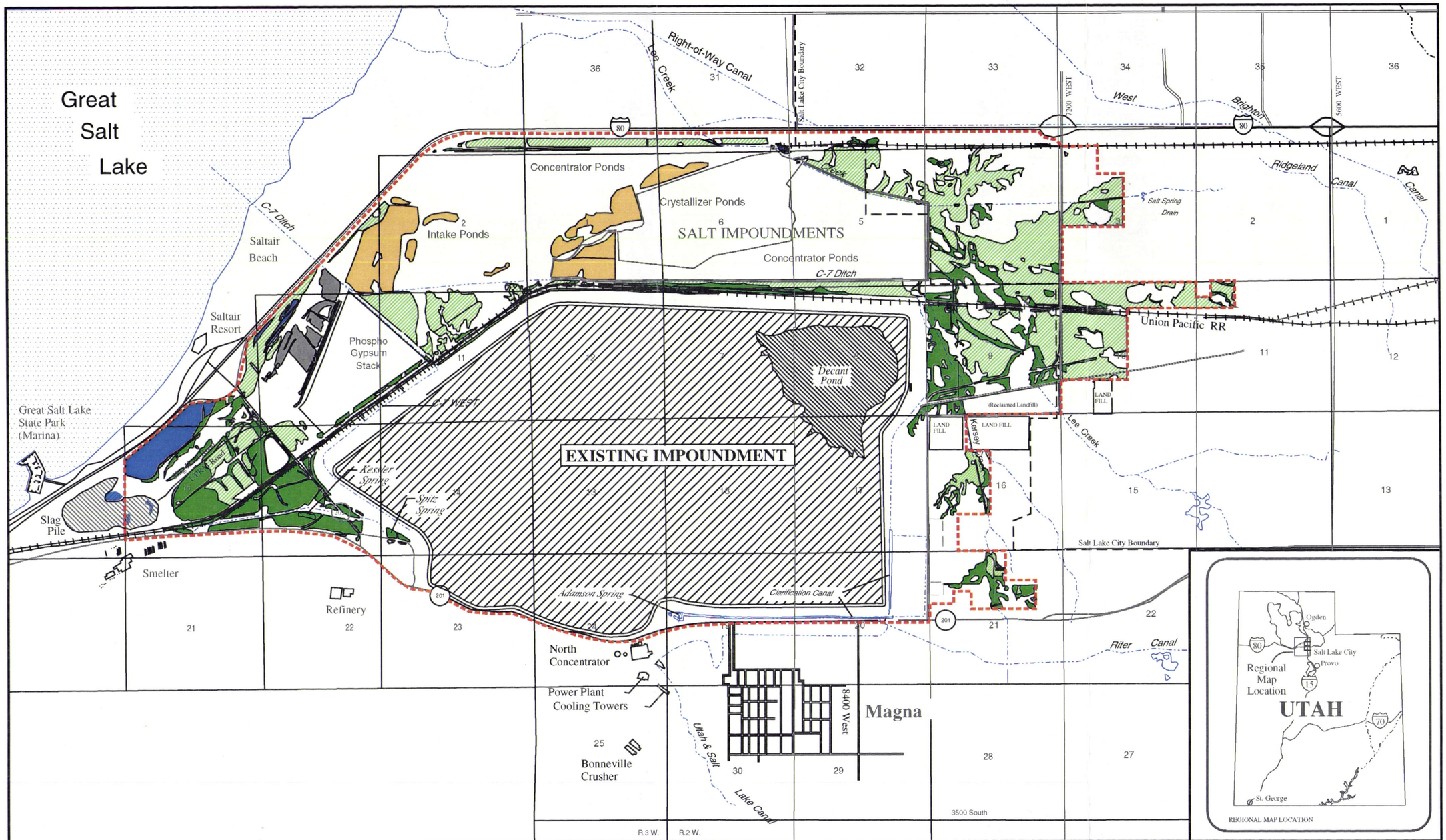
Wetlands primarily occur in the study area as small isolated patches and along ditches or canals and near wells. Wetlands cover approximately 548 acres (4 percent) of the study area. These wetlands occur in response to a shallow water table, and periodic or perennial saturation of the soil occurs during most of the growing season.

Wetlands were amalgamated into two types by SWCA (1994), and approximately 548 acres of wetlands were identified in the Kennecott property as shown on Figure 3-1. The two wetland types include saltgrass flats and common reed-dominated palustrine systems. In addition, approximately 1598 acres were designated as jurisdictional waters of the United States. These areas include saline playas (1,088 acres), open water (133 acres), overflow basins (83 acres), and the gull colony impoundments (294 acres).

Saltgrass (*Distichlis spicata*) flats dominate much of the wetland area that is periodically, but not perennially flooded. Areas containing surface water for most of the growing season are characterized by common reed (*Phragmites australis*), bulrush (*Scirpus* spp.), and cattail (*Typha latifolia*). Slightly elevated areas that have a minimum of periodic surface inundation or soil saturation contain shrubs and small trees of Russian olive (*Eleagnus angustifolius*), tamarisk (*Tamarix ramosissima*), and willows (*Salix* spp.). The understory is dominated by saltgrass and iodine bush (*Allenrolfea occidentalis*).

Saline Playas

Saline playas are sparsely vegetated inland basins that are occasionally or at least historically inundated by Great Salt Lake. These areas are characterized by internal drainage and by a cycle



JURISDICTIONAL WETLANDS & WATERS OF THE U.S.
Existing Conditions

TAILINGS MODERNIZATION PROJECT
ENVIRONMENTAL IMPACT STATEMENT

KENNECOTT UTAH COPPER CORPORATION

Figure 3-1

of seasonal ponding, water evaporation, and surface salt accumulation. The accumulation of salts prevents germination and growth of all but the most saline-tolerant species, such as iodine bush, pickle weed (*Salicornia* spp.), saltgrass, seepweed (*Suaeda* spp.), and Mediterranean barley (*Hordeum hystrix*).

Open Water

Open water typically occurs in topographically low-lying areas that periodically pond surface water runoff or ground water discharge. These areas include ephemeral ponds or intermittent streams and small, isolated ponds and ditches that are man-made. The C-7 Ditch and C-7 West Ditch that occur along the north and east sides of the existing impoundment are considered open water.

Overflow Basins

The overflow basins are located immediately west of the phosphogypsum stack. This area includes a process water canal, and four diked overflow basins. The purpose of the canal was to collect overflow from the phosphogypsum tailings and return it to the processing plant. The overflow basins are adjacent to the open-water canal, and are oriented on the same north-south direction. The basins have not been used for several years and now collect water only seasonally but are saturated. Vegetation is generally sparse or barren, but some areas are dominated by salt grass, young tamarisk, and annual weeds (e.g., mustards, storksbill). Because the basins are not operational, areas of the basins that were saline playas have reverted back to playas, and are mostly barren. Other areas that are slightly higher in elevation contain scattered stands of vegetation (e.g., seepweed, saltgrass).

Gull Colony Impoundments

California gulls have used a series of salt evaporator ponds that occur north and northwest of the existing tailings area for breeding and nesting since at least the 1960s (SWCA, 1994). These evaporator ponds were established by the Morton Salt evaporation operation. Evaporator ponds hold water during spring runoff and are inundated during the spring and early part of the summer,

but often dry out completely in August or September. Because the area is either flooded, and most of the water is eventually lost by evaporation, vegetation is very sparse and resembles that of the saline playas.

3.2.3.2 Vegetation

Methods

Vegetation patterns were identified from aerial and field reconnaissance. Sample plots were then established using 50-foot circles on either side of aquatic communities that were identified during the wetland study. Dominant (at least 50 percent of the total area of the community being sampled) trees were sampled within a 25-foot radius of the plot, shrubs, vines and saplings within a 15-foot radius, and herbaceous within a 5-foot radius. Vegetation types were identified by the dominant species that characterize or typify certain parts of the study area. Data were then collected on the percent foliar cover of each species that occurred within the vegetation type being sampled using a 50-meter transect, on the growth habit of the species (tree, shrub, forb, graminoid), and on the wetland indicator value (BIO/WEST, 1992). Other information recorded included height, relative production estimate, density (number of stems per area), and assessment of reproduction.

A total of fifty 0.2 x 0.5-meter quadrants were located along the transect line to obtain data on the plant species within a particular vegetation type. The data obtained during the field sampling are provided in appendices in BIO/WEST (1992).

Results

Wetland Communities

Five different wetland communities were identified from the field work, and include: saline playa/mudflats, palustrine emergent meadows/marshes, palustrine scrub-shrub, riparian scrub-shrub, and open water (BIO/WEST, 1992).

As described for wetlands, saline playas are sparsely vegetated with saltgrass (*Distichlis spicata*), annual pickleweed (*Salicornia europa*), alkali seepweed (*Suaeda depressa*), and five-hook bassia (*Bassia hyssopifolia*). Vegetation cover ranges from 2 to 20 percent.

Emergent meadows/marshes are characterized by surface water and relatively dense stands of saltgrass, American bulrush (*Scirpus americanus*), Olney's bulrush (*Scirpus olneyi*), five-hook bassia, Baltic rush (*Juncus balticus*), and little barley (*Hordeum pusillum*). Vegetation cover ranges from 50 to 100 percent. Areas of deeper water contain common reed (*Phragmites australis*), broad-leaved cattail (*Typha latifolia*), southern cattail (*T. domingensis*), and hard-stem bulrush (*Scirpus acutus*), as well as the other rushes mentioned previously.

Palustrine scrub-shrub vegetation occurs in topographically low-lying areas along many of the creeks and canals. The vegetation is comprised of a shrub overstory and a herbaceous understory. Dominant shrubs consist of tamarisk (*Tamarix ramosissima*), Russian olive (*Eleagnus angustifolium*), and sandbar willow (*Salix exigua*). Principal understory species are saltgrass, iodine bush, common reed, little barley (*Hordeum pusillum*), foxtail barley (*Hordeum jubatum*), annual rabbit-foot grass (*Polypogon monspeliensis*), and Baltic rush. Cover ranges from 50 to 100 percent.

Riparian scrub-shrub wetlands typically comprise a narrow band of vegetation along water channels, and is especially prominent in the western part of the study area. A typical area of this vegetation type occurs in a 5- to 50-foot wide strip along the C-7 Ditch. Dominant plant species of the overstory are boxelder (*Acer negundo*), sandbar willow, narrowleaf cottonwood (*Populus angustifolia*), tamarisk, Russian olive, and Siberian elm (*Ulmus pumila*). The understory is dominated by Wood's wildrose (*Rosa woodsii*), cattail, common reed, reed canarygrass, redtop (*Agrostis stolonifera*), and saltgrass. Cover of the overstory ranges from 20 to 70 percent, and the understory from 80 to 100 percent.

Areas of open water occur throughout the study area in low-lying basins and closed basins. Typically vegetation is confined to the periphery of these areas, and consists of species that dominate emergent meadows/marshes.

Upland Communities

Upland communities include: grassland, alkali scrub-shrub, urban forest and scrub, pasture, cropped field, and disturbed land. Upland communities are confined to areas near the toe of the tailings and areas that contain enough elevation to distance the soil surface from the water table. Such areas are more prominent near the northeast corner of the tailings pile.

Grasslands, however, are scattered disjunctly throughout the study area, often adjacent to wetland communities in conjunction with a distinct topographic break. Dominant species include cheatgrass (*Bromus tectorum*), saltgrass, little barley, scratchgrass (*Muhlenbergia asperifolia*), halogeton (*Halogeton glomerata*), Russian thistle (*Salsola iberica*), bluebunch wheatgrass (*Agropyron spicatum*), and numerous other grass and forb species (BIO/WEST, 1992). Shrubs of greasewood (*Sarcobatus vermiculatus*), shadscale (*Atriplex confertifolia*), broom snakeweed (*Gutierrezia sarothrae*), rabbit brush (*Chrysothamnus nauseosus/vicidiflorus*), and big sagebrush (*Artemesia tridentata*) are scattered in the grassland areas. Vegetation cover of grass and forb species ranges from 60 to 90 percent.

Alkali scrub-shrub vegetation occurs on slight knolls that are adjacent to saline playas, wet meadows, and also grasslands. The vegetation is characterized by prominent shrub and herbaceous strata. Shrub species include shadscale, Gardner saltbush (*Atriplex gardneri*), gray molly (*Kochia americana*), Mexican summer cypress (*Kochia scoparia*), broom snake weed, greasewood, and rabbitbrush. Principal herbaceous species are foxtail barley, Mediterranean barley, alkali sacaton, storksbill (*Erodium cicutarium*), saltgrass, thyme-leaf spurge (*Euphorbia serphyllifolia*), and scratchgrass. Vegetation cover varies from 20 to 80 percent for shrubs, and 60 to 90 percent for the herbaceous understory.

Cropped fields are confined to the southeast corner of the tailings impoundment near Magna. Principal crops are oats, wheat, and alfalfa.

Pastures also occur near Magna, and consist of a number of grass and forb species such as saltgrass, bluegrasses (*Poa* spp.), scratchgrass, rabbitfoot grass, wheatgrasses, as well as greasewood, broom snakeweed, and rabbitbrush.

Urban forest and scrub also occur in this part of the study area. Common tree species include Siberian elm, cottonwoods, boxelder, Russian olive, tamarisk, and willows. The understory species usually include various ornamental plants as well as tall wheatgrass (*Agropyron elongatum*), intermediate wheatgrass (*A. intermedium*), reed canarygrass (*Phalaris arundinacea*), cheatgrass, curlycup gumweed (*Grindelia squarossa*), and saltgrass.

3.2.3.3 Aquatic Biota

Methods

Field surveys for fish were conducted by BIO/WEST during three sampling periods: September 1991, October 1991, and May 1992. Data were collected such that spatial variability in fish abundance, species composition, and condition could be evaluated. Eleven sites were sampled and included major surface-water bodies within the study area; these sites are identified in Appendix A, Fisheries Sample Sites [Appendix will be provided in the DEIS]. Sites were selected to provide a comparison of ambient conditions of sites located upgradient, on-site, and downgradient of Kennecott's tailings impoundment. Sampling methods included a combination of electrofishing, seining, gill netting, and minnow trapping; site specific methods were dependent upon the physical conditions of the site being sampled.

Field surveys for macroinvertebrates were conducted by BIO/WEST (1993e) over an eleven-month period to compile information on the benthic macroinvertebrates and periphyton communities located in waters within the study area. The objectives of these studies were to determine the types of macroinvertebrates and periphyton at selected sites and to determine their abundances.

A total of 22 sampling sites, distributed among 12 streams, canals, and ditches, were included in the study (Appendix A, Figure A-1). These sample site locations are similar to those studied during the fisheries survey, and are identified in Appendix A (Figure A-1). Sampling methods for macroinvertebrates and periphyton included using a Ponar sampler and a Wildco eight slide self-righting sampler, respectively.

Results

The fish sampling program data are provided in Section 2.1.2, Fisheries, of the Environmental Studies Summary Report (SWCA, 1994). A total of 551 individuals, consisting of 10 species, were collected. Mosquito fish were the most abundant, accounting for 49 percent of all individuals collected. Carp comprised approximately 20 percent and were the most frequently encountered species (i.e., captured at the greatest number of sites). Utah chub comprised approximately 16 of all individuals collected, although it was only collected at the C-7 West Ditch. Fathead minnow and white bass were collected in similar abundances, accounting for about 5 percent of all individuals collected. The remaining fish, namely the Utah sucker, black bullhead, channel catfish, green sunfish, and walleye, comprised a total of approximately 3 percent of all fish collected (SWCA, 1994).

The site with the highest number of individuals collected was on Kersey Creek (located upgradient of the tailings impoundment), although the site had a low diversity as mosquito fish accounted for 94 percent of the catch. C-7 West Ditch was relatively diverse as five species were collected at this site. Initial sampling (October 1991) determined that the conditions at four sites (Adamson Spring, Lee Creek near Salt Lake, Spritz Creek, C-7 Ditch at Interstate-80 Crossing) were unacceptable to maintain fish because of high iron and copper levels, high conductivity, occasional drawdowns, and unstable physical habitat conditions, respectively. No fish were collected at these sites, with the exception of a single mosquito fish in the C-7 Ditch at Interstate 80.

The data of the macroinvertebrate and periphyton sampling program are included in Section 2.1.1.5, Results, and Appendix A1 of the Environmental Studies Report (SWCA, 1994). Thirteen orders and 12 families of macroinvertebrates were collected during these studies. Black fly larva

(Order Diptera, Family Chironomidae) were the most frequently collected species and occurred at all of the sampling sites. Other frequently collected taxa include the Order Mollusca and other families in the Order Diptera. The highest number of taxa collected were in C-7 Ditch after UPDES outfall #002 (CSCN454), Ridgeland South Drainage Canal (RSCN463), and the Brighton Drain (BDCN465) (See Appendix A, Figure A-2, Macroinvertebrate Sampling Sites) [To be provided in the DEIS]. Some of the numerically dominant periphyton taxa collected include *Navicula*, *Nitzschia*, *Cyclotella*, *Achnanthes*, *Gomphonema*, *Chlamydomonas*, *Surirella*, and *Anabaena*.

Aquatic Habitat - Water quality characteristics within selected portions of the Kennecott property are likely unsuitable for supporting resident fish. Levels of total dissolved solids recorded in the Kennecott property are expected to limit the diversity of fish and other aquatic life. Naturally occurring salinity at some sites is expected to exceed levels tolerated by freshwater fish. In general, fish abundance declined with proximity to Great Salt Lake. High, naturally occurring salinity was probably the factor that precluded the survival of fish at most downgradient sites (BIO/WEST, 1992).

Most water bodies are channelized and are dominated by long reaches of swiftly flowing water with little instream cover for fish. Channel bed substrates are typically composed of surficial silt, sand, and organic deposits. Physical habitat of sites located upgradient or adjacent to the tailings impoundments was typically better than downgradient sites as water depths are better and there are more abundant submerged structures that provide cover for fish (BIO/WEST, 1992). The exception to this pattern was the C-7 West Ditch, which contained a low turbidity and shallow runs interspersed with deeper pools with aquatic macrophytes and undercut banks (BIO/WEST, 1992).

3.2.3.4 Terrestrial Wildlife

Existing environmental data were reviewed including field surveys, technical reports, scientific literature, aerial photography, and summaries of existing documents; and, a site visit was conducted by three Dames & Moore biologists on October 27, 1994 for preparation of this document. Surveys of wildlife within the Kennecott property were conducted in late summer of

1991 and 1992 by BIO/WEST (1993). The areas surveyed for birds (Appendix A, Figures A-3, A-4 and A-5) [to be provided in the DEIS], mule deer observations (Appendix A, Figure A-6) and small mammal sampling (Appendix A, Figure A-7) are shown on survey area maps contained in Appendix A. The areas surveyed were: 1) Southwest Section, 2) Kennecott Tailings Impoundment, 3) Kennecott Tailings Impoundment - South embankment, 4) Kennecott Tailings Impoundment - East embankment, 5) East Transect, 6) Disturbed Land, 7) Salt Evaporation Ponds, 8) Saltair North, and 9) Slag Management Area. SWCA also conducted an avian use survey in the area during the spring and summer of 1993 (SWCA 1994e).

An overview of the results of the surveys conducted by BIO/WEST (1992) and the avian use survey (SWCA, 1994e) are presented in this section. Species lists are presented in Appendix A. Surveys were conducted by BIO/WEST and SWCA for birds, small and large mammals, herpetofauna (i.e., reptiles and amphibians), and special status species. Specific methods and survey techniques are described in Appendix A and detailed data can be found in the original documents. Wildlife species occurring in the area are those species associated with wetlands (i.e., emergent marshes, saline playas, mudflats) and upland habitats. Detailed descriptions of the vegetation types are provided in Sections 3.2.3.1 and 3.2.3.2 of this report.

Birds

A total of 82 bird species was recorded in the various habitats during the wildlife field surveys conducted by BIO/WEST (1992). The study area is characterized by man-made ponds, wetlands, and is located near the Oquirrh Mountains, which are considered rich in avifauna (BIO/WEST, 1992). It is also located along the eastern edge of the Pacific Flyway and near the western edge of the Central flyway; and therefore, large numbers of migratory shore birds, ducks, and geese occur where water and wetland habitats exist (Behle et al., 1985). An estimated three to five million migratory ducks and 150,000 to 300,000 migrating geese use the Salt Lake area each year (Bellrose, 1976).

Potential habitat within the north expansion area exists for numerous species of birds including shorebirds, waterfowl, raptors, and upland game. Some of these are permanent or summer

residents while others are migratory, occurring only during spring or fall. A study of avian use patterns conducted in 1993 in the area showed spring (April and May) and summer (June and July) bird counts on the saline playas, uplands, the salt evaporator impoundment, and mudflats (SWCA, 1994e). In May, over 10,000 birds representing 40 different species were recorded; and, in July, 654 birds were observed representing 20 species. In July, much of the water had evaporated and avian activity had greatly decreased; California gulls comprised approximately 80 to 90 percent of the total number. Colonies of nesting California gulls exist in late spring and summer on embankments and dikes along the salt evaporation ponds. Records of these gulls in Great Salt Lake exist from the mid-1800s and the colonies presently utilizing the tailings impoundment have existed since at least the 1960s (Hayward et al, 1976; SWCA, 1994e).

Migrating birds, primarily shorebirds, comprise a large percentage of the overall bird population using the study area (BIO/WEST, 1992). Shorebirds occurring along the shores of Great Salt Lake include lesser yellowlegs, whimbrel, marbled godwit, sanderling, western sandpiper, and the world's largest concentration of Wilson's phalaropes (Paton et al., 1992). Herons and egrets also occur in the area. Open water in the area attracts waterfowl (i.e., mallards, pintails, and gadwalls) primarily during the winter months (BIO/WEST, 1992). Avocets and black-necked stilts occur on the saline playa and mudflats along the southern boundaries of the evaporation ponds and they are known to nest in the area (Paton et al., 1992). Invertebrates (i.e., brine shrimp) provide a food base for waterfowl and shorebirds for feeding their young and foraging during migration (BIO/WEST, 1992).

Upland game species which potentially occur in the vicinity and which use the wetlands for food and cover include ring-necked pheasant (introduced), California quail (introduced), and mourning dove. Mourning dove and pheasants were observed (BIO/WEST, 1992).

Raptor species which are likely to occur in the vicinity on a seasonal basis include bald eagle, golden eagle, peregrine falcon, red-tailed hawk, Swainson's hawk, ferruginous hawk, Cooper's hawk, sharp-shinned hawk, and northern harrier. The condition of gull carcasses found during the avian survey indicate that raptors hunt within the study area and gulls may be an attractant to raptors (SWCA, 1994e). Additional species of raptors may migrate through the area due the close

proximity of additional habitat types of the Wasatch Front and Oquirrh Mountains. No nesting activities by raptors have been observed and potential nesting habitat is limited (BIO/WEST, 1992).

Mammals

BIO/WEST documented the existence of 16 small mammal species during the wildlife field surveys (1992). Mammals in the study area include those associated with upland and riparian habitats adjacent to the existing tailings impoundment. Small mammals observed during a 1992 survey (BIO/WEST 1992) include deer mouse, meadow vole, harvest mouse, house mouse, masked shrew, and vagrant shrew. Larger mammals which have the potential to occur include furbearers such as red fox, striped skunk, mink, raccoon, and coyote. Mule deer and elk are big game species which occur in the vicinity. Mule deer browse on the grasslands and traverse much of the area; elk inhabit the mountains southwest of the mine and may winter on benches, but rarely, if ever, occur in the study area. Numerous roadkills of mule deer along the highway between Interstate-80 and the impoundment have been observed by BIOWEST (1992) throughout the development of the DEIS baseline studies.

Amphibians and Reptiles (Herptofauna)

A total of four herptofauna species were observed during the field surveys (BIO/WEST 1992). Reptiles have the potential to occur in the wetland and upland habitats, while amphibians are likely to be restricted to the aquatic habitats. Surveys for herptofauna were conducted by BIO/WEST (1992) by setting pitfall traps and walking the area (see the original document for detailed methodology). Major water sources, including Kessler and Spitz Springs, Lee and Kersey Creeks, C-7 Ditch, and Riter Canal were sampled. No animals were caught in the traps. One yellow-bellied racer and four sagebrush lizards were observed in the palustrine scrub/shrub zone during the walking survey. Due to the existence of suitable habitat and known range of the northern leopard frog, it also may occur in the study area. No amphibians, however, were observed during diurnal and nocturnal surveys of streams, springs, ponds, and canals. One Woodhouse's toad and one bullsnake were observed during night driving surveys.

3.2.3.5 Special Status Species

Overview

Special status species include plant and animal species that are: currently listed by USFWS; proposed for listing; or are candidates under review for listing as threatened or endangered under the Endangered Species Act; species considered special status or rare by UDWR; and species of sport, commercial, or aesthetic value.

federal codes are defined as follows:

- Endangered (E): Any species that is in danger of extinction throughout all or a significant portion of its range other than a species of the Class Insecta determined to constitute a pest whose protection under the Endangered Species Act would present an overwhelming and overriding risk to man.
- Threatened (T): Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.
- Category 1 Candidate Species (C1): Status review taxa for which the USFWS currently has on file substantial information on biological vulnerability and threat(s) to support the appropriateness of proposing to list the taxa as an endangered or threatened species.
- Category 2 Candidate Species (C2): Status review taxa for which information now in possession of the USFWS indicate that proposing to list the taxa as an endangered or threatened species is possibly appropriate but for which substantial data on biological vulnerability or threat(s) are not currently known or on file to support proposed rules,
- Category 3 (C3): Taxa for which the USFWS has persuasive evidence of extinction (Group 3A); taxa does not meet the Endangered Species Act's definition of a species (Group 3B); or taxa that have proven to be more abundant or widespread than previously believed and/or those that are not subject to an identifiable threat (Group 3C).

State of Utah Codes are defined as follows:

- Extinct: Any species that has disappeared in the world.

- Extirpated: Any species that has disappeared, as a part-time or full-time resident, from the state of Utah since 1800.
- Endangered: Any species, subspecies, or subpopulation which is threatened with extinction resulting from very low to declining numbers, alteration and/or reduction of habitat, detrimental environmental changes, or any combination of the above. Continued survival is unlikely without implementation of special measures.
- Threatened: Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.
- Sensitive: Any species which, although still occurring in numbers adequate for survival, has been greatly depleted or occurring in limited areas and/or numbers due to a restricted or specialized habitat. A management program is needed, including protection or habitat manipulation.

Special Status Plant Species

The USFWS has indicated that no known existence of threatened, endangered, and sensitive plant species occur in the general locale of the Proposed Action.

However, the USFWS indicated that habitat suitable for the Ute ladies' tresses (*Spiranthes diluvialis*), which is a federally-listed threatened plant species, could possibly exist in the general locale of the study area. Ute ladies' tresses occurs in seasonally moist soils and wet meadows near springs, lakes, or perennial streams and their associated flood plains below 6,500 feet elevation in Colorado, Utah, and Nevada. Typical sites include old stream channel and alluvial terraces, subirrigated meadows, and other sites where the soil is saturated within 18 inches of surface at least temporarily during the spring or summer growing seasons (USFWS, 1992).

In Utah, populations are known only from Daggett, Uinta, Duchesne, Wayne, and Garfield Counties. The species has been historically reported along the Wasatch Front in the Jordan River drainage, Salt Lake County, where it was last collected in 1953. Recent surveys have failed to confirm historic populations of the species and all known historic populations of this species along the Wasatch Front and the eastern Great Basin Region of Utah are presumed to be extirpated

(USFWS, 1990). While there is not conclusive evidence, this plant has never been observed to grow in areas with salt-crusted surfaces. Based on these premises, habitat in the majority of the study area appears to be unsuitable due to the level of disturbance and salinity. Surveys for this orchid were conducted by SWCA, concurrent with wetland survey and inventory in the study area between 12 September and 24 October 1991 and during field investigations conducted from 1990 to 1992, but no specimens were located (SWCA, 1993).

Special Status Wildlife Species

Birds

American Peregrine Falcon (*Falco peregrinus anatum*). Federal Endangered

Historically, peregrine falcon nests have been almost exclusively found on open ledges within rocky cliff faces (Skaggs et al., 1986). Such cliffs are associated with deep gorges and riparian habitats which provide the necessary prey base for peregrines. Peregrine falcons have also been found nesting on ledges of tall buildings in urban areas feeding on rock doves. Peregrines do not make their own nests beyond a shallow scrape in some cases. Loss of habitat for peregrines and their prey base, including wetlands and riparian areas, and the historical use of pesticides have contributed to the decline of peregrine falcon populations. Recently, populations have been reestablished in some areas as a result of recovery plans and reintroduction programs (Skaggs et al., 1986).

In the Salt Lake area, peregrine falcons appear to be recovering, and possibly exceeding historical numbers and distribution (SWCA, 1993). They are found in the area from spring until fall. Remains from eyries in the Wasatch Range, east of the study area, indicated that those birds traveled to Great Salt Lake to hunt water birds inhabiting the marshes (Porter and White, 1973 *in* Skaggs et al., 1986). UDWR has reintroduced peregrines in the vicinity of Salt Lake City, providing hack towers, which are manmade structures where prey is placed for raptors that have been hatched in captivity until the birds are able to hunt in the wild. Use of these hack towers has been successful in establishing peregrines in the area and peregrines also have nested successfully

in downtown Salt Lake City. Peregrine falcons, one adult and one juvenile, were seen foraging within or flying over the study area. No suitable nest sites are known to exist (BIO/WEST, 1992).

Bald Eagle (*Haliaeetus leucocephalus*). Federal Endangered

Bald eagles nest in riparian, low-elevation forests. Some populations are migratory and wintering, and others winter throughout the west and southwest where appropriate habitat exists. Wintering bald eagles inhabit areas with roost sites and readily available fish and waterfowl. The decline in bald eagle populations has been attributed to many factors including loss of habitat, human encroachment, and the use of pesticides (Johnsgard, 1990; Terres, 1980). Efforts to protect the eagle have resulted in increasing populations and the reestablishment of eagles in many of their historic locations, however, loss of habitat is still a major threat to the survival of the bald eagle (AOU, 1983; Johnsgard, 1990).

There are only two known bald eagle nest sites in the State of Utah, both in mature, riparian woodlands along the Colorado River (UDWR, 1993). Migratory and winter resident bald eagles occur throughout the state. They occupy higher elevations in the fall, and as open water freezes, they move to the foothills to feed on small mammals and carrion. There are no known roost sites in the study area and no eagles were observed during field surveys conducted by BIO/WEST (1992). There is a limited fisheries resource in some of the creeks and canals which traverse the area (described in the fisheries section) which may attract foraging bald eagles during the winter (SWCA, 1993).

Whooping Crane (*Grus americana*). Federal Endangered

Whooping cranes are wading birds associated with aquatic and wetland habitats. They are summer residents of Grays Lake National Wildlife Refuge in southern Idaho. The migration corridor between summer and winter ranges is not known and whooping cranes have never been reported in the study area (BIO/WEST, 1992). Migrant cranes from Grays Lake most likely fly directly to the Green River, east of the study area, and then fly south to wintering grounds along the Rio Grande in New Mexico (BIO/WEST, 1992; USFWS, 1987).

Arctic Peregrine Falcon (*Falco pergrinus tundrius*). Federal Threatened (Proposed for delisting)

Historically, arctic peregrine falcons occurred in Great Salt Lake area (Johnsgard, 1990). Today they breed in northern Canada and migrate to South America in the winter (Johnsgard, 1990). Their habitats are similar to those described for the American peregrine falcon. They may occur as migrants in the study area, although none have been observed during surveys conducted for this project (BIO/WEST, 1992; SWCA, 1994e).

Western Snowy Plover (*Charadrius alexandrinus nivosus*). Federal Candidate C2

The interior population of western snowy plover occurs in California, Oregon, Nevada, and Utah, including a few records from Arizona. It is an uncommon bird and its numbers are declining due to the degradation of suitable habitat and destruction of nest sites on beaches due to development and recreation (Erlich et al., 1992), nest predation by birds and mammals, adverse weather conditions, and encroachment of vegetation on breeding sites (SWCA, 1993). There have been several surveys conducted and reports written about the nesting habits of the western snowy plover at Great Salt Lake (BIO/WEST, 1992; Paton and Edwards, 1990; Paton et al., 1992; SWCA, 1994e).

Snowy plovers spend most of their time in open areas near water, preferring sandy beaches and mudflats. They feed on aquatic and shore invertebrates, including brine flies, brine shrimp, and beetle larvae. They probe the mud for beetle larvae and catch flies in their bills (SWCA, 1993). Snowy plovers are common nesters along the shores of Great Salt Lake and adjacent areas. Nests are simple structures generally set in shallow depressions on alkaline flats with little to no vegetation. Nests have also been located on substrate of brine fly pupal exuviae, in contrast to the hard alkaline surfaces normally used (Paton and Edwards, 1990). Several nests may be clumped together (Paton and Edwards, 1990). Nests are often found near plants on the ground which apparently disguises the nest and reduces the risk of predation. Snowy plovers are evidently easily adaptable to changing circumstances due to the location of nests on fluctuating shorelines. It also has been suggested that snowy plovers may be fairly tolerant of human activities near their nests (SWCA, 1993).

Population estimates of snowy plover indicate a decline in numbers in the United States in the 1980s, but no significant decline for the species in Utah (Page et al., 1991 *in* SWCA, 1993). It is considered an uncommon to common summer resident in northern Utah and a transient throughout much of the state (Paton and Edwards, 1992; Hayward et al., 1985). They migrate south in the winter, presumably to Mexico. Nesting occurs primarily in May and June and is known to occur on the alkali playa between the Goggin Drain and Lee Creek outside the northern expansion area (Paton et al., 1992). Field surveys conducted in 1992 by BIO/WEST documented snowy plovers in Saltair Resort North and within the Salt Evaporation Ponds. Thirteen individuals and one nest were observed on the northernmost berm of the evaporation ponds east of the Abandoned Morton Salt Company buildings (BIO/WEST, 1992). Nest sites which were active in 1992 were not used during the 1993 nesting season due to the encroachment of smotherweed (*Bassia hypsifolia*), an exotic species (Field Meeting Notes, 1993). Suitable habitat is most likely to exist at the salt impoundments due the absence of vegetation and the unlikely development of vegetation in the future (SWCA, 1993).

Loggerhead Shrike (*Lanius ludovicianus*). Federal Candidate C2

The loggerhead shrike was designated a candidate species because of declining population trends, particularly in the eastern and southeastern United States. They are residents throughout the southern half of the United States extending their range north into Canada during the summer months (Scott, 1987). They hunt in open, brushy areas, and feed on insects and lizards. Their diet may also include rodents or small birds and carrion (Ehrlich et al., 1992). There is some disagreement among biologists as to the cause of decline, but exposure to pesticides and habitat loss are thought by some to be important contributing factors (Ehrlich et al., 1992).

Two loggerhead shrikes were observed at the Kennecott site during the field surveys. Although no nests were observed during the surveys, suitable nesting habitat (e.g., shrub communities) is present in the study area (BIO/WEST, 1992).

Ferruginous Hawk (*Buteo regalis*). Federal Candidate C2

Ferruginous hawks are large raptors that occupy plain and prairie habitats (Johnsgard, 1990). These birds are often seen from roadways as they perch on places offering wide views (i.e., telephone and electrical transmission poles) which has contributed to a reduction in numbers due to illegal shooting (Ehrlich et al., 1992). They may nest in tall conifers or build platforms on cliffs or banks (Terres, 1980; Ehrlich et al., 1992). They usually hunt from a perch, but may use a low cruise to locate prey (Terres, 1980). Johnsgard (1990) cites studies which list favorite prey items as jackrabbits, ground squirrels, pocket gophers, and kangaroo rats. Within each study the order varies, but all agree that some combination of small mammals comprise 80 to 90+ per cent of this hawk's diet. There are indications that brood sizes vary with the size of local jackrabbit populations, one of their preferred prey items.

Ferruginous hawks are summer residents in Utah, rarely occurring during the winter months (Behle and Perry, 1975; Hayward et al., 1976). No ferruginous hawks were observed in the study area during the field surveys. Habitat is not high quality and, based on the small numbers of mammals present during the mammal surveys, the prey base is limited.

White-faced Ibis (*Plegadis chihi*). Federal Candidate C2

This long-legged wader lives in fresh marshes and near irrigated land (Peterson, 1990). It is a colonial nester, in emergent vegetation, often occurring in mixed colonies with herons and egrets (Ryser, 1985). They use their bill to probe the mud for a variety of prey including crayfish, earthworms, insects, mollusks, and amphibians. Nesting success varies greatly from year to year. A colony may decrease in size or disappear entirely, while nearby, new or inactive colonies can become active (Ryser, 1985). Pesticides appear to be the major cause of decline for this species (Terres, 1980).

White-faced ibis occur throughout much of the western United States south to Argentina wherever suitable habitat exists. They were once more common in the Great Basin. The Bear River Refuge in northern Utah supported over 5000 birds, while more recent counts have been less than 1000 (Ryser, 1985). However, there are probably more white-faced ibis nesting in the marshes of Great Salt Lake than anywhere else in the world (Paton et al., 1992). They are common summer

residents, often seen in flocks feeding in the marshes and the agricultural fields on the east shore of the lake.

Northern Goshawk (*Accipiter gentilis*) Federal Candidate C2

Northern goshawks are permanent residents of much of the western United States and Canada inhabiting conifer-dominated mixed woodlands. Although tree species vary, these woodlands generally have a relatively high percent canopy cover. Understory cover and tree size is also highly variable. Nesting usually occurs in late successional or mature forest types and nests are often located in large trees on north to east aspects of flat to moderately sloped lands. Goshawks feed on medium-sized birds and mammals which it captures on the ground, in trees, or in the air (Reynolds et al. 1991). Home ranges for goshawks are estimated to be 6000 acres and consist of three major components: a nest area, a post-fledgling family area, and a foraging area (Reynolds et al. 1991).

Although a common year round resident in Utah, Northern goshawks are unlikely to occur in the study area due to lack of suitable habitat. Occasionally local breeding populations within mountains drift into the adjacent valleys in the winter (Ryser 1985).

Black Tern (*Chlidonas niger*) Federal Candidate C2

This bird nests in wet meadows, sloughs, and fresh-water marshes, and feeds on insects and aquatic invertebrates like crayfish and mollusks. These gregarious terns often return to breed in the colony where they were born (Ehrlich et al. 1992). They are jeopardized primarily by degradation and loss of wetlands, and possibly by exposure to agricultural chemicals (Ehrlich et al. 1992). Their breeding grounds are in the northern United States and Canada (Peterson 1990). Black terns are common summer residents of Utah and breeding colonies occur in wetlands adjacent to lakes in northern Utah, including Utah, Pelican and Great Salt Lake (Hayward et al 1976).

Western Least Bittern (*Ixobrychus exilus hesperis*) Federal Candidate C2

Western least bitterns live in marshy areas, usually nesting over or near fresh water in emergent vegetation. The species' diet varies, including fish, invertebrates, amphibians, small mammals, and possibly the eggs and young of blackbirds, which also nest in marshes where it is found (Ehrlich et al. 1992). It has been Blue-listed (the National Audubon Society's supplemental list designed to provide early warning of population size or range decreases) since 1979 as a result of marsh destruction by draining and filling (Ehrlich et al. 1992).

These bitterns inhabit wetland habitats sporadically across the State of Utah and were known, at least formerly, to nest in marshes around Great Salt Lake. This species is relatively secretive and may be more common than known.

Long-billed Curlew (*Numenius americanus*) Federal Candidate 3C

Long-billed curlews are neotropical migrants which inhabit meadows, pastures, and wetlands occurring on beaches and mudflats during winter and migration. They tend to live and breed in higher and drier meadowlands than do many shorebirds (Hayward et al 1976). Their winter range extends across the southernmost portion of the United States south into Mexico and Central America. Breeding areas exist from southwestern and south-central Canada south to California, Nevada, Utah, and Colorado (AOU 1983). The range of this species has decreased due to human disturbance and loss of habitat.

Long-billed curlews nest in upland meadows and rangelands of northern and central Utah valleys and forage in moist meadow wetland and upland habitats (Hayward et al 1976). Although fairly common summer residents and migrants in Utah, especially through the central and northern valleys, they are rare summer residents ar Great Salt Lake (Paton et al 1992). Three individual curlews were observed at the upland habitat station in April during the avian use survey conducted in 1993 by SWCA (1994e).

Mammals

Pygmy Rabbit (*Brachylagus idahoensis*) Federal Candidate C2

This miniature rabbit, measuring less than one foot in length, is found almost exclusively in the Great Basin and surrounding areas (Zeveloff and Collett 1988). It most frequently occurs on plains ranging from 4,500 to 7,000 feet in elevation which are dominated by sagebrush and within brushy associations on alluvial soils. The pygmy rabbit digs and uses and extensive burrow system with many small entrances located at the base of sagebrush. It feeds primarily on sagebrush and grasses. Principal predators of this species include coyote, red fox, owls, and northern harrier.

Uplands supporting grassland communities which include rabbitbrush, sagebrush, shadscale, and cheatgrass are limited to the northeast corner of the tailings pond. Potential for occurrence of the pygmy rabbit is very low to non-existent because this rabbit generally requires habitat which is characterized by denser shrubs than those in the study area.

Preble's Shrew (*Sorex preblei*) Federal Candidate C2

Preble's shrew is one of the smallest western shrews and little is known about its natural history (Zeveloff and Collett 1988). It is thought to occur throughout much of Montana, central Idaho, eastern Oregon, and surrounding areas in semiarid to arid habitats. More recent records exist from Timpie Springs, along the southern border of Great Salt Lake, inhabiting marshy areas, such as creeks and bogs bordered by willows and other brushy plants and wetter areas at higher elevation open conifer tree stands. There is low potential for occurrences of Preble's shrew in the vicinity of the proposed expansion.

Spotted Bat (*Euderma maculatum*) Federal Candidate C2

The spotted bat is known from central Canada to the western and southwestern United States, and into northeastern Mexico (Hill and Smith 1984). A rare bat, there are few records from any part of its range (Whitaker 1980). Very little is known about the habitat requirements and basic

biology of this species. An average-sized spotted bat with an overall body length of 2-1/2 inches may almost double its length with two-inch ears, which it carries forward during flight. The spotted bat is probably wholly insectivorous, catching insects on the wing or picking them from leaves and other vegetation (Hill and Smith 1984). Moths are thought to be their primary food source. They may also take prey from the ground, including grasshoppers and June bugs (Noel and Johnson 1993).

Spotted bats appear to be relatively solitary, although they sometimes hibernate in small clusters. They may use caves or mines as hibernacula (Findley et al. 1975). For roosting, they appear to be most at home in remote rock crevices high on limestone or sandstone cliffs (Easterla 1973). They emerge late in the evening and have a loud, high-pitched call. Females give birth in early to mid-June.

The spotted bat is associated with a wide variety of habitats throughout its geographic range, including open ponderosa pine, desert scrub, pinyon-juniper woodlands, and open pastures (Findley et al. 1975; Burt and Grossenheider 1976). They are most common in dry, rough desertscrub (Watkins 1977). It is unclear what the preferred habitat of this species is, although many specimen locations are near riparian areas. Factors limiting the distribution and abundance of this species may be availability of suitable roost sites or prey items (Spicer 1991). As with other bat species, the spotted bat may be subject to disturbances at roosts, especially maternity roosts.

Reptiles/Amphibians

Spotted Frog (*Rana pretiosa*) Federal Candidate C2 (Wasatch population is a C1)

The spotted frog is a highly aquatic species found near cool, usually permanent water sources particularly during breeding (Stebbins 1985). It is generally associated with calm water in a variety of habitat types from higher elevation subalpine and mixed conifer forests to grassland and brushland of rabbitbrush and sagebrush. It ranges throughout suitable habitat in the west-central and northwestern United States, including southeast Alaska. Habitat loss, competition with other

frogs, and environmental contaminants may be adversely affecting this species (Federal Register 1993).

Several disjunct populations have been identified which are effectively isolated from one another by geographic and ecological barriers. The two populations in Utah inhabit shallow spring or creek fed marshes and seeps along the Wasatch front and in the West Desert. These populations are considered to be at greater risk than the main population found in the northwest. No spotted frogs were observed during biological surveys conducted by BIO/WEST (1992) although they may occur in the proposed expansion area.

Fish

Least Chub (*Iotichthys phelgethontis*). Federal Candidate C2

Based on distributions of fishes in the Great Basin, no threatened or endangered fish species were anticipated to occur in the study area. However, the study area probably coincides with the historic range of the least chub (*Iotichthys phelgethontis*) (Crist, 1990), a Category 1 candidate species for federal listing. The least chub is also listed as an endangered species by the Utah Division of Wildlife Resources (UDWR, 1992). No least chub, or any other state or federal species of concern, were collected within the vicinity of the Kennecott mine. This species historically occupied a variety of habitats in the Great Basin, including clear water streams, springs, ponds, and swamps (Crist, 1990). Poor water quality and the presence of exotic fish would likely preclude the existence of this species in the study area (Bio/West, 1992).

3.2.4 Environmental Consequences

3.2.4.1 Overview

Impacts to biological resources could be caused by construction, operation, and maintenance of the tailings impoundment. This section explains the methods used and the results of the impact assessment. This process includes assessing potential impacts to biological resources by comparing

the proposed activities with the existing conditions within the alternative study areas. Once these impacts were identified, measures that would reduce the level of impacts were evaluated. The primary issues of the biological resources investigation is the potential for long term effects including: 1) loss or degradation of wetlands and 2) the loss or degradation of habitats for special status species.

3.2.4.2 Methods

The process used for impact assessment is complex, but systematic. Generally, qualitative and quantitative variables of a resource and the level of proposed disturbance are identified and combined to determine the level of potential impact (e.g., high, moderate, or low). Once levels of impacts were defined within the alternatives, specific measures were assigned to avoid or reduce impacts.

Impact Types

After the biological resources inventory was compiled and analyzed, the description of the proposed project activities was reviewed to determine the types of impacts that may occur. Potential impacts can be long-or short-term and direct or indirect. Impact types were generally categorized as ground disturbance associated with construction activities and long-term loss of habitat. Impact types are:

- Direct loss or alteration of habitat for plants and wildlife resulting from the impoundment of tailings materials.
- Direct mortality of wildlife resulting from earth-moving activities and increased vehicular traffic. This includes small, burrowing mammals, reptiles, amphibians, and ground-nesting birds.
- Temporary disturbance or displacement of some wildlife species.
- Changes in habitat conditions adjacent to, but not directly affected by a project action (e.g., changes in water quality downstream of a construction site).

Impact Levels

Three levels of impacts were identified in the assessment: high, moderate, and low. A high impact results when the proposed project action is expected to result in a substantial or significant change to the resource and requires mitigation. A moderate impact results when the proposed project action is expected to cause some adverse change that may be substantial and selective mitigation may be warranted. A low impact results when the proposed project action would result in a slight or insignificant adverse change to the resource.

Habitats for special status species were assigned a sensitivity level based on the following factors: 1) legal status of the species, 2) distribution of the species and its potential for occurrence in the area, and, 3) amount of habitat within the study area relative to the total extent of habitat.

Significance Criteria

Impacts to wetlands are considered to be significant if:

- Changes in wetland acreage occur.
- Changes in wetland function occur.

Secondary impacts that affect areas of adjacent wetlands, such as sedimentation from soil excavation, soil erosion or other construction activities, are also considered in accordance with Section 404 (b)(1) guidelines of the Clean Water Act.

Impacts to vegetation are considered to be significant if:

- Communities or areas of vegetation that are functionally important to the ecosystem are lost for the duration of the project.

Impacts to aquatic biota are considered to be significant if:

- Aquatic biota communities that are functionally important to the ecosystem are lost for the duration of the project.

Impact to wildlife are considered to be significant if:

- A substantial change would occur to wildlife populations or their habitat in the study area relative to the populations in the vicinity.
- Important food sources (e.g., prey species, vegetation) for wildlife populations would be adversely affected by the project relative to the existing food sources in the vicinity.
- Species would be disturbed during critical maintenance periods (i.e., breeding, nesting, fawning) or if the habitats of such areas were disturbed.
- The project created a barrier to, or otherwise altered, wildlife and avian movement patterns in such a way or to such an extent as to result in detrimentaleffects to the population or which results in the elimination of access to an important component of a species habitat (e.g., water source).

Impacts to threatened, endangered, and sensitive species are considered to be significant if:

- The project would adversely affect the continued existence of a T&E species or its designated critical habitat.
- Habitat occupied by the species would be directly or indirectly altered by the project.
- Important food resources (e.g., prey species, vegetation) for the species would be affected by the project.

3.2.4.3 Wetlands

<u>Impacts</u>

No Federal Action

The No Federal Action Alternative would not impact additional wetland acres beyond the existing impoundment and is not expected to cause additional impacts to wetlands.

North Expansion West

Impacts to wetlands for the North Expansion West alternative include: impoundment of wetlands with tailings materials; alterations of surface water; and other land disturbance activities for project support such as road construction. These impacts can be either long-term, as with the impoundment by tailings materials, or short-term, as with land disturbances that would be reclaimed. The extent of these impacts vary with each of the alternatives and are considered to be site specific. The acreage of wetland types identified by SWCA (1994) that would be impounded by tailings expansion of the various alternatives are indicated on Table 3-1 and Figures 3-2, 3-3, and 3-4.

Specifically this alternative would impact saline playas, wetlands, the gull colony impoundment, open water, and overflow basins (Table 3-2). The most significant wetlands impacted by this alternative exist along the C-7 Ditch. The wetland vegetation in this area consists of emergent meadows/marshes and riparian scrub-shrub. A total of 226 acres of these wetlands would be impacted. This area also contains narrow open water areas that border the Union Pacific railroad tracks. Land to the west of the salt impoundment consists of a triangular-shaped section of land that contains primarily saline playas. Gull colony impoundments occur in center and western portions of the salt impoundments. This alternative would also impact additional areas located southwest of the C-7 West Ditch; this area contains wetland and open water areas that border the railroad as well as saline playas, shallow ponds, and overflow basins.

The covering of the wetlands along the C-7 Ditch and railroad tracks are considered to be a high impact due to the floristic diversity (i.e., emergent meadows and riparian scrub-shrub) and structural diversity relative to the surrounding area. The covering of the triangular-shaped land containing the saline playas is considered to be a low impact due to the low floristic and structural diversity of this vegetation type. The covering of the gull colony impoundment is considered to be a low impact as these areas are discretionary wetlands and because the large area of similar habitat for gulls that exists in the vicinity of the study area. The covering of the overflow basin is also considered to be a low impact as the vegetation of these sites resembles the vegetation of the saline playas.

All impacts to jurisdictional waters and wetlands are considered to be significant because of various governmental regulations, including Section 404 of the Clean Water Act that aim to minimize national wetland losses.

TABLE 3-1
Jurisdictional Area that would be Affected by the North Expansion West Alternative

	Saline Playas	Wetlands	Salt Ponds	Open Water	Overflow Basins	Jurisdicational Lands Total	Non-jurisdictional Total
North Expansion West	420.3	170.0	299.1	17.4	77.56	984.3	3466.6

Description	Jurisdictional Area	Area (acres) Affected
East C-7 Ditch Reroute	40.56	107.4
West C-7 Ditch Reroute	28.97	61.69
Kennecott Railroad and Buffer Corridor (West)	0	2.03
UP&L Corridor and Visual Buffer	42.46	115.34
UPRR Relocation	62.27	145.74
Toe Ditch and Access Road	58.41	152.23
Tailings Impoundment and Embankment	746.28	3843.39
Sedimentation Pond	5.35	29.61
All Project Components	984.30	4,457.43

3.2.4.4 Vegetation

Impacts

No Federal Action

This alternative would not impact any additional acres beyond the existing impoundment and is not expected to cause additional impacts to vegetation.

North Expansion West

Potential impacts to vegetation include: impoundment of vegetation with tailings materials, alterations of surface water, and other land disturbance activities for project support such as road construction. These impacts can be either long-term, as with the impoundment by tailings materials, or short-term, as with land disturbances that would be reclaimed.

This alternative would impact approximately 226 acres of vegetated wetlands and 3,090 acres of upland/made-land areas. This alternative would primarily impact the salt impoundment area, which are previously-disturbed lands in the upland/made-land category. The salt impoundment areas contains sparse vegetative cover due to the standing water and the extremely high saline conditions that exist in these areas. Wetland vegetation that will be impacted occurs as a narrow border of riparian scrub-shrub vegetation along the C-7 Ditch and is between the existing tailings impoundment and the salt impoundment. Land to the west of the salt impoundment consists of a triangular-shaped section of land that contains primarily saline playas with small ridges of higher areas with alkali scrub.

The covering of the salt impoundment with tailings materials is considered to be a low impact due to the relative absence of vegetation in this areas. The covering of the land to the east of the salt impoundment and along the C-7 Ditch is considered to be a high impact due to its floristically diversity (i.e., wetlands, scrublands, grasslands) and structural diversity relative to the surrounding area. The covering of the triangular-shaped land to the west of the salt impoundment is considered to a moderate impact due to the presence of vegetation that is not floristically or structurally diverse.

Additional land covered by this alternative, which is not impacted by other alternatives, includes an area located to the west of the existing tailings impoundments. The majority of this area contains upland/made-land in the form of phosphogypsum tailings, which is not vegetated. Other land in this area consists of a mixture of disturbed areas, grasslands, saline playas, overflow basins, and some open water. The covering of this area of land is considered to be a

low impact due to the absence of vegetation in much of the area and the presence of vegetation in other areas that is not structurally or floristically diverse.

Although the impacts to vegetation from this alternative are rated as high for some areas of land, overall these impacts are not considered to be significant as they will be mitigated through replacement at the mitigation site and through revegetation on areas of the tailings impoundment within the life of the project.

3.2.4.5 Aquatic Biota

Habitat for aquatic biota primarily includes 133 acres of open water (or 1 percent of the study area). These areas are typically located in ditches and canals as well as topographically low-lying areas, such as closed basins, that perennially pond surface and/or ground water discharge.

<u>Impacts</u>

No Federal Action

This alternative would not impact any additional acres beyond the existing impoundment and is not expected to cause additional impacts to aquatic biota.

North Expansion West

Potential impacts to aquatic biota for the North Expansion West alternative include: impoundment of open water areas with tailings materials; dewatering of streams and canals and other alterations of surface water; channelization and other surface-disturbing activities; water quality degradation (e.g., increased sedimentation) resulting from construction activities. These impacts can be either long-term, as with the impoundment by tailings materials, or short-term, as with sedimentation impacts. The extent of these impacts vary with each of the alternatives and are considered to be site specific.

The North Expansion West alternative would impound the C-7 Ditch, which is oriented along the length of the north side of existing impoundment, with tailings materials. Water in C-7 Ditch would be diverted around the perimeter of the new tailings impoundment and then into Lee Creek. Fish sampling indicated that C-7 Ditch primarily contains carp; one walleye was also collected in the ditch.

This alternative would impact 63 acres of open water areas. This would include the impoundment of the C-7 Ditch. This alternative would also include the impoundment of approximately 2 miles of the C-7 West Ditch. Additional areas of open water which would be impounded include ponds that exist to the west of the existing impoundment along Interstate 80 and the small, narrow ponds that parallel the Union Pacific Railroad tracks along the C-7 Ditch. Although not categorized as areas of open water, a series of overflow basins occur in the area that would be impounded by this alternative. While containing water, these overflow basins are not considered to contain significant aquatic populations as they only contain water seasonally.

Effects to the aquatic biota in the C-7 Ditch would be a high impact as the entire ditch, approximately 5 miles, would no longer exist and the fish, macroinvertebrates, and periphyton populations are expected to be lost for the life of the project. Effects to the C-7 West Ditch are considered to be a high impact due to the length that would be impacted, and because of the relatively high species diversity of the fish populations that exist in this ditch. C-7 West Ditch had the highest species diversity (5 species) within the study area and was the only canal/stream in the study area which contained the Utah chub. Furthermore, both walleye and white bass were collected at this site. Both of these species are more sensitive to poor habitat quality than other species sampled within the study area (BIO/WEST, 1992).

Effects to other open water areas affected by this alternative are considered to be a low impact because of the highly saline conditions of these shallow ponds. However, specific data regarding the aquatic populations in these ponds are not known as these ponds were not sampled for fish, macroinvertebrates, or periphyton. No changes in water quality are expected with this alternative.

The North Expansion West alternative would impact acres of open water. Although this alternative would result in a high level of impacts to the aquatic biota, namely the C-7 Ditch and C-7 West Ditch, overall the impacts are not considered to be significant because the basically depauperate aquatic system with its high saline conditions is not a functionally complex ecosystem in relation to other areas of the region.

3.2.4.6 Terrestrial Wildlife

Impacts

No Federal Action

Under this alternative, Kennecott would continue current tailings storage operations, raising the existing impoundment.

No direct, immediate impacts would occur to wildlife or potential habitat for shorebirds in the area. However, continued use of the existing tailings impoundment could result in its failure causing significant adverse impacts to surrounding habitats, as well as destroying existing resources (i.e., individual animals).

North Expansion West

Expansion of the existing tailings impoundment would impact wetlands and other waters of the U.S. to some extent. These wetlands provide important habitat for numerous wildlife species, including shorebirds, waterfowl, small mammals, and amphibians. There are upland and made-land areas (man-made), characterized by grasses traversed by channels supporting tamarisk and Russian olive, which provide potential habitat for small and large mammals and herptofauna. Mule deer have been sighted in the eastern portion. Loss of these areas as potential habitat would be negligible for most wildlife species. The eastern portion of the expanded impoundment area is characterized primarily by saline playas which provide habitat for shorebirds.

Several species of small, burrowing mammals occur and would lose some habitat, particularly in the grasslands. Due to the low occurrence of these species and the presence of additional habitat in the area, this loss would be negligible. There may be direct mortality of small mammals as a result of encounters with construction equipment while the berm is being built and during construction of roads and other project support facilities, relocating the Union Pacific Railroad, and utilities.

Big game mammals in the area are mule deer and elk, which graze in the grassy areas adjacent to the existing facilities and in the mountains. The quantity of foraging habitat lost to mule deer would be minimal and, over a short period of time (i.e., by 2005), revegetation of the existing impoundment would provide additional habitat. The currently high number of road kills (mule deer) along Route 202 and Interstate 80 may be increased during the construction period and during the relocation of roads, utilities and the Union Pacific Railroad. The proposed expansion may restrict movement across I-80, increasing the number of deer crossing the highway south of the study area near the interchange. Future restoration work on the slopes of the tailings pond will increase the habitat for mule deer, and encourage greater movement to and from the Oquirrhs. Vehicle/deer collisions in the area, particularly during construction and relocation of utilities, can be decreased by improved highway lighting, signs along the road, reduced speed limits, and deer fencing. Elk are unlikely to be adversely effected since their habitat is generally southwest of the proposed expansion.

Herptofauna is limited in the area. Potential habitat will be destroyed as wetlands and some of the streams and ditches are lost. There may an increased loss of individuals during construction of the berm and relocation of roads, utilities, and the Union Pacific Railroad. These losses would probably not be significant.

The wetlands provide habitat for numerous shorebirds and waterfowl which occur in the area as permanent residents or migratory species. The alternatives for the proposed expansion will result in the loss of habitat for such species. The most common species is the California gull for which breeding colonies exist within the area proposed for all the alternatives. This seabird

is very common and, although, local loss of habitat and displacement will occur, impacts to the species would be minimal.

Several species of raptors are known to hunt in the area for the proposed northern expansion. There would be a minimal loss of prey base as a result of construction of the alternatives. No nest sites or suitable nesting habitat exists in the area proposed for the expansion, so losses of nests and/or potential nesting habitat would not occur. Revegetation programs that establish large areas of grasses on the tailings impoundment could benefit some raptor species by providing a small mammal prey base.

North Expansion West

This alternative would continue to use the existing impoundment until capacity is reached and then expand to the north and northwest of and adjacent to the existing impoundment. The proposed expansion would affect 4,457.43 acres, of which 984.3 acres are classified as jurisdictional waters, and are considered to be important wildlife habitats. In addition to the salt evaporator impoundments, this alternative would also utilize the area occupied by the former fertilizer production facility, northwest of the existing impoundment.

No significant impacts to general wildlife species would result from the construction of the North Expansion West alternative. This alternative would result in the loss of approximately 294 acres of the impoundment colonized by California gulls.

3.2.4.7 Special Status Species

Impacts

Impacts to special status wildlife species which occur or have the potential to occur are similar for both alternatives. Endangered species which may be minimally affected are bald eagle and peregrine falcon. Whooping crane, an endangered species, is not known from the area and, therefore, are unlikely to be adversely effected by the proposed expansion.

Candidate species likely to be present are western snowy plover, white-faced ibis, black tern, western least bittern, and loggerhead shrike. Those candidate species listed by USFWS (1993) as potentially occurring in the region, but which were determined to have low or no potential of occurring in the study area and, therefore, would not be adversely effected by the proposed expansion are northern goshawk, ferruginous hawk, spotted bat, Preble's shrew, pygmy rabbit, spotted frog, least chub, and leatherside chub. Ute ladies' tresses, the only special status plant species listed by USFWS (1993) as potentially occurring is unlikely to occur due to lack of suitable habitat and would, therefore, not be affected by the proposed expansion.

Bald eagles may occasionally forage in the vicinity; however, the prey base is marginal and roost sites do not exist. Adjacent areas and aquatic habitats support a higher quality prey base. Whooping cranes are not known to occur in the area and they are known to migrate along the Green River, east of the study area, to wintering grounds in New Mexico. The proposed alternatives would not have significant direct or indirect impacts on these two species. The future existence of these species would likely not be jeopardized as a result of any action alternative.

Peregrine falcons are known to nest in Salt Lake City, in adjacent mountains, and in artificial nest sites created by UDWR near Salt Lake City. They are known to forage in the northwest portion of the study area. The prey base is not large and the loss of this potential foraging area would probably be insignificant.

Snowy plovers were observed at the salt evaporation impoundments during surveys conducted in April, 1993 in the vicinity of an area known to be used snowy plovers for nesting during previous years. No nesting activity was observed during 1993 (SWCA, 1994e). Potential adverse effects of the proposed tailings impoundment expansion would be minimal and may include the following direct and indirect impacts: loss of actual nest sites during nesting season (April to July); loss of potential nesting habitat; and, loss of foraging habitat. Potential nesting and foraging habitat includes playas, mudflats, and the salt impoundments. Impacts are unlikely to be significant due to the existence of other nesting habitat along the shores of Great Salt Lake; the wide dispersion of snowy plovers around the lake; and, the dependence of the

species on relatively unstable habitats and its subsequent ability to utilize newly created habitats (SWCA, 1993).

Minimal potential habitat for white-faced ibis may be adversely effected by the Proposed Action. This is unlikely to be significant due the number of ibis nesting along the shores of Great Salt Lake and the normal fluctuations in the sizes and locations of colonies.

No special status plant or fish species are known to occur within the study area.

No Federal Action

The No Federal Action alternative would utilize the existing impoundment and would have no adverse impacts on existing special status species populations and habitats.

North Expansion West

No significant impacts to general or special status wildlife species would result from the construction of the North Expansion West alternative. This alternative would continue to use the existing impoundment until capacity is reached and then expand to the north and northwest of the existing impoundment. The proposed expansion would result in direct effects to 4,457.4 acres, of which 984.3 acres are classified as jurisdictional waters, portions of which are important wildlife habitats (see North Expansion East alternative). In addition to the salt evaporator impoundments, this alternative would also utilize the area occupied by a former fertilizer production facility, northwest of the existing impoundment.

3.3 WATER RESOURCES

3.3.1 Surface Water Supply

3.3.1.1 Issues

The main issue associated with surface water is the rerouting of major flows or uninterrupted movement of waters, with the resulting changes in water quantity and quality in the affected reaches, or unbroken stretches of water flow.

3.3.1.2 Affected Environment

Based on a review of the Utah standards (see Section 3.3.2.1), the watercourses in the vicinity of the existing tailings impoundment fall under Class 6 criteria, for which general standards do not exist. For Class 6 waters, standards are set on a site specific basis. The most applicable published standards to be used for comparison purposes are for Class 3D waters, due to the watercourses' short length, proximity to Great Salt Lake, and their non-use as drinking water or for recreational or fisheries purposes. Class 3D waters are protected for waterfowl, shore birds, and other water-oriented wildlife (excluding fish), including the necessary aquatic organisms in their food chain. Class 3C standards are usually the same as, but sometimes more stringent than, Class 3D standards. Class 3C waters support nongame fish and other aquatic wildlife.

The C-7 Ditch is the primary drainage within the study area, receiving the cumulative flows of Lee and Kersey Creeks, Riter Canal, and Utah-Salt Lake Canal, from a combined drainage area of 73 square miles. The current drainage configuration has the C-7 Ditch sited to flow along the perimeter of the tailings impoundment, first north, then west. The C-7 Ditch combines with the West C-7 Ditch at a point along the northeast side of the gypsum stack, then the combined flow proceeds under I-80 to Great Salt Lake. There is a single point of discharge into Great Salt Lake.

3.3.1.3 Environmental Consequences

No Federal Action

No direct impacts to surface water supply are predicted if the No Federal Action alternative is undertaken.

North Expansion West

The North Expansion West alternative involves the rerouting of the C-7 Ditch north to a new confluence or merger with the Brighton Drain/lower Lee Creek system and then discharging to Great Salt Lake through the historic Lee Creek drainage. Although the West C-7 Ditch is rerouted around the new impoundment, the same point of discharge would be used for the West C-7 Ditch under I-80 to Great Salt Lake.

Impacts of this rerouting would include:

- increased flows into lower Lee Creek,
- decreased flows across flats into Great Salt Lake at the existing discharge point,
- change in water quality at the existing discharge point into Great Salt Lake, due to the lack mixing between C-7 Ditch and West C-7 Ditch water, and
- change in water quality in lower Lee Creek from addition of C-7 Ditch water and removal of drainage from Salt Ponds.

All of the above will have potential secondary impacts on channel/wetland morphology, vegetation and habitat, the only current or likely beneficial water uses.

Impact Types

- changes in water quality where flows are rerouted,
- changes in channel morphology where flows are rerouted,
- changes in vegetation/wildlife habitat where flows are rerouted,

- changes in floodplain where flows are rerouted,
- changes in frequency and duration of inundation during wetland vegetation growing seasons, and
- changes in water quality due to potential increased discharge of collected waters from an expanded impoundment.

Changes in water quality. This is the primary expected impact, and is discussed in detail in Section 3.3.2.

Changes in channel morphology. The effect of the re-routing would be to increase flows in Lower Lee Creek, and decrease flows at the current point of discharge of the combined C-7/West C-7 Ditch into Great Salt Lake. The current Lower Lee Creek has a watershed much reduced from the historic watershed, so that the addition of flows could in a sense be viewed as a restoration of historic conditions. Both affected reaches of channel are within the historic flood levels of Great Salt Lake, and as such could be expected to periodically be changed in size and course by inundation and recession of lake water. In both current and changed channels, velocities should not be erosive and water sediment loads would be expected to be low. Channel morphology would therefore not be expected to be a significant impact and is not addressed further.

Changes in habitat, frequency and duration of inundation during growing seasons. These issues are addressed in Section 3.2.

Changes in floodplain. The reaches of channels with increased and decreased flows largely lie within the 100-year floodplain of Great Salt Lake, so that increased flooding from overbank flows during extreme rainfall events would not likely to change defined floodplain levels. Channel floodplain change would therefore not be expected to be a significant impact issue and is not addressed further.

Changes due to increased discharge from the impoundment. Another potential impact is the effect of the impoundment expansion on volume of rainwater and tailings water collected on the surface of the impoundment, and the effect of this change on surface water channels which collect water

discharged from the impoundment or seeping through the base of the impoundment. This issue does not appear to have significant environmental consequences, for the following reasons:

1) The existing flows discharged or seeping from the impoundment into surface waters do not lead to water quality problems in the existing receiving waters (see Section 3.3.2).
2) A rough estimate of the daily water flow into the impoundment via tailings is about 200 acre-feet per day; this flowrate should not appreciably change with the proposed expansion of the facility. This translates to an average 6000 acre-feet per month.
3) For the peak average monthly rainfall for the area (2.12 inches, for April), the volume of water falling on the existing tailings impoundment surface is about 720 acre-feet, for the expanded impoundment, the water volume from rain would increase for the peak month to about 1300 acre-feet.
4) The total water volume, during the peak rainfall month, collected on the impoundment surface is therefore about 6600 acre-feet under the existing operation and 7200 acre-feet after expansion. The point is that despite almost doubling the impoundment surface area with the expansion, the total water volume expected to be collected would increase less than 9 per cent, during the peak rainfall month (and less in other months). The increase in discharge to surface waters from the impoundment is therefore expected to be a total of less than 9 per cent, and would not appreciably change existing surface water quality.

Changes in discharge or seeps from the expanded impoundment to surface water is therefore not expected to be a significant impact issue and is not addressed further.

The following sections exclusively address the expected primary impacts; the changes in water quantity, and quality in the affected channel reaches.

<u>Impact Location</u>

Flows are rerouted to and from the following locations:

- lower Lee Creek north of I-80; and
- existing C-7 Ditch beyond existing point of confluence with West C-7 Ditch.

Impact Intensity and Duration

Impact intensity and duration will depend upon the extent of water quantity and quality changes in the affected channel reaches.

3.3.2 Surface Water Quality

3.3.2.1 Overview

Utah water quality standards are published in Standards of Quality for Waters of the State, R317-2, Utah Administrative Code, February 16, 1994, and the EPA water quality criteria are published in EPA Region VIII Clean Water Act, 304(a) Criteria Chart, revised July 1, 1993.

Utah standards and EPA criteria for relevant constituents are presented in Table 3-2. In all cases but one, Utah standards meet or exceed EPA criteria. The exception is chloride, which Utah does not regulate with respect to Class 3 waters.

3.3.2.2. Affected Environment

Surface waters in the vicinity of the existing tailings impoundment were sampled and tested extensively during 1991 to 1992 to establish a baseline for ambient or surrounding water quality. Samples were collected from locations as shown on Figure A-8, Appendix A. Grab samples were collected monthly at most locations, and less frequently at the remaining locations. The water analyses results, by location and parameter analyzed are presented in Table 3-3. In the following discussions and in Table 3-3, sample analysis results were compared with Utah Class 3D standards where they existed, and Class 3C standards for other cases, with the exception being comparison with EPA aquatic life criteria for chloride.

The conclusions of the 1991 to 1992 study, by water quality parameter, are summarized briefly below. In the discussion below (and in Table 3-3), several parameters are discussed as having been measured in concentrations exceeding wildlife standards. These standards are not strictly

applied in the project vicinity since many of the waters are Class 6 waters, under the Utah classification system.

Field Parameters - Field parameters pH varies in range between 7 and 9, which is to be expected where soils and sediments are carbonate bearing. A few low pH samples were collected from lower Lee Creek, Adamson Spring, and Upper Brighton Drain. There is no explanation for these isolated occurrences. Electrical conductivity is an indicator of salinity, and increases as waters approach Great Salt Lake. Temperature varies from 12.9°C in the Clarification Canal to 19.2°C in Lower Lee Creek. Dissolved oxygen is high during cool months. Isolated measurements of low values, which might limit biological activity were taken at Adamson Spring, and at three sites along Lee Creek. There is no explanation for these isolated occurrences.

Total Dissolved Solids (TDS) - Background, represented by Kersey Creek, upper Brighton Drain, and upper Lee Creek has a TDS range between 1500 to 11,000 parts per million (ppm). TDS in the Clarification Canal is similar. Shallow ground water (which has TDS in the range 63,000 to 87,000 ppm) appears to rise into and evaporate from the saline playas in the lower reaches of Lee Creek and Brighton Drain, significantly raising TDS levels, which in lower Lee Creek exceed 300,000 ppm.

Major Cations and Anions - Sodium and chloride are the major ions in most surface waters. In the Clarification Canal and Adamson Spring, there are higher ratios of calcium and sulfates, expected to be from process or tailings waters. Fluorides have been measured up to 5.4 ppm in the Clarification Canal. As some isolated high fluoride measurements have been taken from shallow ground waters east of the existing tailings impoundment, the source of the fluoride is unclear.

Organics - The sampling report indicated that the majority of organic compounds were not detected at any locations. Those that were detected were present at concentrations that would not pose a hazard to aquatic wildlife.

Table 3-2
Aquatic Life Standards For Analytes Detected In Kennecott Tailings Pond Vicinity

PARAMETER	Utah Class 3D Standards, unless noted						EPA Region VIII Aquatic Life Criteria					
			Hardness-dependent criteria (3)						Hardness-dependent criteria (3)			
			4-day avg		1-hr avg				4-day avg		1-hr avg	
	4-day avg	1-hr avg	A	B	A	B	4-day avg	1-hr avg	A	B	A	B
PHYSICAL												
Min DO: 30-day, 1-day avg	5	3					(4)	(4)				
Max Temp (C, class 3C) ***		27										
pH range ***	6.5	9										
METALS, DISSOLVED												
Aluminum	0.087	0.75					0.087	0.75				
Arsenic, trivalent	0.19	0.36					0.19	0.36				
Cadmium*	0.0011	0.0039	0.7852	-3.49	1.128	-3.828	0.0011	0.0039	0.7852	-3.49	1.128	-3.828
Chromium, trivalent*	0.21	1.7	0.819	1.561	0.819	3.688	0.21	1.7	0.819	1.561	0.819	3.688
Copper* (chronic is class 3C)	0.012	0.018	0.8545	-1.465	0.9422	-1.464	0.012	0.018	0.8545	-1.465	0.9422	-1.464
Iron***		1						1				
Lead*	0.0032	0.082	1.273	-4.705	1.273	-1.46	0.0032	0.082	1.273	-4.705	1.273	-1.46
Mercury	0.000012	0.0024					0.000012	0.0024				
Nickel*	0.16	1.4	0.846	1.1645	0.846	3.3612	0.16	1.4	0.846	1.1645	0.846	3.3612
Selenium	0.005	0.02					0.005	0.02				
Silver** (chronic is class 3C)	0.00012	0.0041			1.72	-6.52		0.0041			1.72	-6.52
Zinc*	0.11	0.12	0.8473	0.7614	0.8473	0.8604	0.11	0.12	0.8473	0.7614	0.8473	0.8604
INORGANICS												
Chloride							230	860				
POLLUTION INDICATORS												
BOD ***		5										
Nitrate as N (class 3C) ***		4										

NOTES:

1. Where standards are listed as 4-day and 1-hour average concentrations, these concentrations should not be exceeded more often than once every three years on the average.
2. Units are mg/l, unless noted.
3. Equation for parameters with hardness dependence: Limit (mg/l) = exp(A*(ln(hardness))+B)/1000, with hardness as mg/l CaCO3.
4. EPA aquatic life criteria for D.O. are as follows:

	Coldwater Criteria		Warmwater criteria	
	early life stages#	other life stages	early life stages	other life stages
30 day mean	NA	6.5	NA	5.5
7 day mean	9.5 (6.5)	NA	6	NA
7 day mean min	NA	5	NA	4
1 day min	8.0 (5.0)	4	5	3

Number in parentheses is for species with early life stages directly exposed to the water column. Preceding number is for other species.

* Hardness dependent. See hardness dependent criteria. Standards listed in 4-day avg and 1-day avg columns correspond to 100 mg/l hardness.
** Acute standard is hardness dependent. Chronic standard is independent of hardness.
*** Standard for instantaneous value.

Table 3-3
Surface Water Sampling Data, 1991-1992

EXCEEDENCES IN KENNECOTT SAMPLING DATA, 1991-1992

	# of locat-ions with exceed-ences	Adam-son Spring	Brigh-ton Drain	Brigh-ton Drain head-waters	Clarifi-cation cnl	C-7 Ditch after outfall 001	C-7 Ditch after outfall 002	C-7 Ditch after Kersey Crk	C-7 Ditch N of Tail-ings Area	C-7 Ditch at I-80	C-7 Ditch at RR Bridge, after Kersey Cr	C-7 West Ditch	Kersey Cr at SR201	Kersey Cr East	Kersey Cr Main Stem	Lee Cr Head-water	Lee Cr Main Stem	Lee Cr N of I-80	Lee Cr near lake	Rgland south Drain-age Cnl	Riter Cnl before C-7 Div	Riter Cnl after C-7 Div	ROW Cnl north of I-80	Spitz Spring	UT & SL cnl
Location ID		ADSP 470	BDCN 465	BDCN 474	CLCN 452	CSCN 453	CSCN 454	CSCN 455	CSCN 456	CSCN 457	CSCN 473	CWSW 471	KCSW 458	KCSW 459	KCSW 460	LCSW 461	LCSW 462	LCSW 468	LCSW 469	RSCN 463	RTCN 450	RTCN 451	RWCN 467	SZSP 466	USCN 472
pH (standard 6.5 - 9.0)																									
# measured		12	11	6	12	12	12	12	0	11	8	12	12	4	12	12	9	12	12	12	12	1	11	12	11
minimum		4.0	3.1	6.6	4.5	5.2	7.5	5.0		5.8	7.6	3.9	7.4	9.0	7.4	7.0	7.1	1.6	6.5	7.6	6.4	6.4	7.6	5.1	7.1
# below lower standard	11	2	1		1	1		1		1		1						3	1		1			1	
avg below lower standard		5.2	3.1		4.5	5.2		5.0		5.8		3.9						4.4	6.5		6.4			5.1	
# above upper standard	1															1									
avg above upper standard																9.4									
TEMP (standard 27, class 3C; detection limit 1)																									
# over detection limit		11	10	6	11	10	11	11	0	10	8	11	10	1	10	9	8	11	11	10	11	1	10	11	10
maximum		15.5	25.8	27.7	24.1	22.5	21	21.4		25.3	21.7	23.8	23.2	17.8	24	25	22.85	28.8	32.8	26.5	23.4	20.5	25.3	29	19.3
# over standard	1			1																					
avg over standard				27.7																					
BOD5 (standard 5; no detection limit)																									
# over detection limit		9	11	3	10	12	12	12	1	2.3	8	9	12	1	11	9	8	10	11	12	10	1	9	10	10
maximum		7.5	8.3	5.9	15	6.4	10.6	4.2	4.98	5	7.2	8.2	5.2	5.3	3.8	27	5.3	19.3	22.7	20.9	10	2.9	7.8	18.4	8.3
# over standard	19	1	1	1	4	2	3				1	3	1	1		4	1	5	7	4	2		1	3	2
avg over standard		7.5	8.3	5.9	9.9	6.3	7.3				7.2	6.5	5.2	5.3		13.8	5.3	11.8	13.2	9.8	7.6		7.8	15.3	6.8
DISSOLVED OXYGEN (30-day-average standard 5.0 minimum; 1-day-average standard 3.0 minimum; detection limit 1)																									
# over detection limit		7	6	5	7	7	7	7	0	6	7	6	7	1	6	7	4	7	7	6	7	0	6	6	7
minimum		3.5	4	7.3	6.7	5.9	7.1	6		6.8	6.2	7	4.4	8.4	6.4	2.7	1.9	1.1	1.3	2.1	5.9		6	2.2	5.3
# below 30-day std	9	6	1										1			1	2	4	4	1				1	
avg below 30-day std		4.1	4										4.4			2.7	2.45	2.3	2.6	2.1				2.2	
# below 1-day std	6															1	1	3	2	1				1	
avg below 1-day std																2.7	1.9	1.8	1.7	2.1				2.2	
NITRATE AS N (standard 4, class 3C; detection limit 1)																									
# over detection limit		1	1	0	6	12	12	12	1	1.7	8	1	5	0	9	0	0	0	1	2	11	1	0	3	6
maximum		13.6	17.5		4.3	3.9	3.5	6.9	3.7	6.5	6.9	1.1	2.1		16.3				1.3	2	4.5	1.4		1.7	3.8
# over standard	8	1	1		1			2		2	1				9						1				
avg over standard		13.6	17.5		4.3			5.9		5.4	6.9				12.9						4.5				
CHLORIDE (4-day-average standard 230; 1-hr-average standard 860, EPA; detection limit 5)																									
# over detection limit		11	11	5	12	12	12	12	1	11	8	12	12	1	12	9	9	12	12	12	12	1	11	12	11
maximum		1770	22800	5120	2160	818	1290	1130	750	1680	1120	3560	620	1810	702	3540	2380	214000	220000	5210	420	352	168000	2020	831
# above 4-day standard	24	11	11	5	12	12	12	12	1	11	8	12	12	1	12	9	9	12	12	12	12	1	11	12	11
avg over 4-day standard		1528	7929	4590	1483	469	655	653	750	1278	656	2874	454	1810	556	1720	1279	98817	79065	1231	327	352	17757	1348	548
# above 1-hr standard	17	11	11	5	12		3	2		11	2	12		1		7	7	12	12	6			8	12	
avg over 1-hr standard		1528	7929	4590	1483		1109	1022		1278	1029	2874		1810		1979	1438	98817	79065	1761			24177	1348	
ALUMINUM dissolved (4-day-average standard 0.087; 1-hr-average standard 0.75; detection limit 0.1)																									
# over detection limit		1	2	1	0	1	2	4	0	4	2	6	2	0	2	3	4	0	2	5	1	0	0	0	1
maximum		0.15	0.17	0.162		0.113	0.215	0.121		0.231	0.143	0.24	0.13		0.1	1.18	1.91		0.25	0.68	0.14				0.12
# above 4-day standard	17	1	2	1		1	2	4		4	2	6	2		2	3	4		2	5	1				1
avg over 4-day standard		0.150	0.135	0.162		0.113	0.158	0.110		0.180	0.132	0.149	0.115		0.100	0.509	0.719		0.180	0.332	0.140				0.120
# above 1-hr standard	2															1	1								
avg over 1-hr standard																1.18	1.91								
ARSENIC dissolved (4-day-average standard 0.19; 1-hr-average standard 0.36; detection limit 0.04)																									
# over detection limit		2	4	0	0	0	0	0	0	4	0	6	4	1	2	9	9	9	9	6	0	0	7	1	1
maximum		0.089	0.177							0.062		0.126	0.101	0.162	0.056	0.229	0.203	0.311	0.201	0.121			0.119	0.117	0.052
# above 4-day standard	4															1	1	1	1						
avg over 4-day standard																0.229	0.203	0.311	0.201						
# above 1-hr standard	0																								
avg over 1-hr standard																									

Table 3-3
Surface Water Sampling Data, 1991-1992

EXCEEDENCES IN KENNECOTT SAMPLING DATA, 1991-1992

	# of locations with exceedences	Adamson Spring	Brighton Drain	Brighton Drain headwaters	Clarification cnl	C-7 Ditch after outfall 001	C-7 Ditch after outfall 002	C-7 Ditch after Kersey Crk	C-7 Ditch N of Tailings Area	C-7 Ditch at I-80	C-7 Ditch at RR Bridge, after Kersey Cr	C-7 West Ditch	Kersey Cr at SR201	Kersey Cr East	Kersey Cr Main Stem	Lee Cr Headwater	Lee Cr Main Stem	Lee Cr N of I-80	Lee Cr near lake	Rgland south Drainage Cnl	Riter Cnl before C-7 Div	Riter Cnl after C-7 Div	ROW Cnl north of I-80	Spitz Spring	UT & SL cnl
Location ID		ADSP 470	BDCN 465	BDCN 474	CLCN 452	CSCN 453	CSCN 454	CSCN 455	CSCN 456	CSCN 457	CSCN 473	CWSW 471	KCSW 458	KCSW 459	KCSW 460	LCSW 461	LCSW 462	LCSW 468	LCSW 469	RSCN 463	RTCN 450	RTCN 451	RWCN 467	SZSP 466	USCN 472
CADMIUM dissolved (4-day-average standard 0.0072 avg*; 1-hr-average standard 0.065 avg*; detection limit 0.0015)																									
# over detection limit		8	1	1	8	1	4	4	0	3	4	8	0	0	0	4	3	0	2	2	2	0	0	2	1
maximum		0.006	0.002	0.002	0.006	0.002	0.002	0.003		0.003	0.002	0.004				0.003	0.003		0.003	0.035	0.003			0 005	0.002
# above 4-day standard	2															3				1					
avg over 4-day standard																0.002				0.035					
# above 1-hr standard	1																			1					
avg over 1-hr standard																				0.035					
COPPER dissolved (4-day-average standard 0.090 avg*; 1-hr-average standard 0.17 avg*; detection limit 0.004)																									
# over detection limit		12	11	6	11	7	8	10	1	11	8	12	9	1	9	9	9	12	12	11	6	0	10	12	8
maximum		1.806	0.241	0.403	0.063	0.028	0.025	0.025	0.02	0.063	0.027	0.201	0.022	0.04	0.022	0.052	0.065	2.353	0.812	0 052	0.02		5.044	0 024	0.203
# above 4-day standard	12	12	4	2								4		1		5	1	7	7				1	1	1
avg over 4-day standard		0.520	0.204	0.283								0.151		0.040		0.034	0.065	0.971	0.523				5.044	0.020	0.203
# above 1-hr standard	10	10		1								1		1		3		5	3				1	1	1
avg over 1-hr standard		0.584		0.403								0.201		0.040		0.045		1.199	0.764				5.044	0 020	0.203
IRON dissolved (standard 1; detection limit 1)																									
# over detection limit		8	0	0	3	1	1	1	0	0	1	5	0	0	0	0	0	3	2	0	0	0	1	0	0
maximum		3.82			2.47	1.53	1.5	1.39			1.37	6.8						3.1	2.3				3.67		
# over standard	10	8			3	1	1	1			1	5						3	2				1		
avg over standard		2.02			2.02	1.53	1.50	1.39			1.37	2.43						1.80	1.74				3.67		
SELENIUM dissolved (4-day-average standard 0.005; 1-hr-average standard 0.02; detection limit 0.035)																									
# over detection limit		0	0	1	5	0	0	0	0	0	0	9	0	0	1	0	0	0	0	0	0	0	0	0	0
maximum				0.04	0.053							0.086			0.14										
# above 4-day standard	4			1	5							9			1										
avg over 4-day standard				0.040	0 042							0.076			0.140										
# above 1-hr standard	4			1	5							9			1										
avg over 1-hr standard				0.040	0.042							0.076			0.140										
SILVER dissolved (4-day-average standard 0.00012; 1-hr-average standard 0.45 avg*; detection limit 0.00012)																									
# over detection limit		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	1	0	0	0	0
maximum		0.002																0.002	0.002		0.01				
# above 4-day standard	4	1																2	1		1				
avg over 4-day standard		0.002																0.0015	0.002		0.01				
# above 1-hr standard	0																								
avg over 1-hr standard																									
ZINC dissolved (4-day-average standard 0.79 avg*; 1-hr-average standard 0.87 avg*; detection limit 0.047)																									
# over detection limit		2	2	1	2	0	1	4	1	6	2	12	0	0	2	0	2	3	4	2	1	0	1	0	0
maximum		0.117	0.24	0.05	0.071		0.06	0.14	0.11	0.185	0.07	0.456			0.47		0.24	0.3	0.094	0.22	0.087		0 21		
# above 4-day standard	1														1										
avg over 4-day standard															0.47										
# above 1-hr standard	1														1										
avg over 1-hr standard															0.47										

NOTES:
1. Standards are per Utah class 3D surface water standards (Feb 16, 1994), except where noted as Utah class 3C standard or EPA aquatic life criteria.
2. Where no value is reported, there were no exceedences.
3. Units are mg/l for all parameters, except for Temperature (degrees C) and pH (standard units).
* Standard is hardness dependent and is different for each sample.

Metals

Cadmium - Isolated cadmium measurements have exceeded standards for wildlife in waters representative of background (headwaters of Lee Creek, on Kersey Creek, and in the Ridgeland South Canal). As the measurements were in no case over continuous months, the conclusion was that cadmium was unlikely to have prolonged adverse impacts on aquatic life.

Iron - Most background waters had at least one measurement for iron which exceeded standards for wildlife. Average annual iron exceeded 1.0 ppm at four sites: West C-7 Ditch, C-7 Ditch at the railroad bridge, C-7 Ditch near I-80, and at Adamson Spring.

Lead - Isolated lead measurements exceeded standards for wildlife in the C-7 Ditch north of Highway 201, in Kersey Creek, and in Ridgeland South Canal. As lead did not exceed standards in the Clarification Canal, these measurements are expected to be from background sources.

Copper - Copper measurements exceeded wildlife standards at ten sampling sites, both from waters indicative of background and process waters.

Arsenic - Isolated arsenic measurements exceeded wildlife standards at four sites along Lee Creek. Levels are high within the background shallow aquifer, and within tailings waters.

Selenium - Nine measurements in the West C-7 Ditch exceeded wildlife standards, with the likely source being water discharged from the Garfield wells.

Aluminum - Measurements of aluminum exceeded wildlife standards at 17 locations, both from waters indicative of background and process waters.

3.3.2.3 Environmental Consequences

No Federal Action

No direct impacts to surface water quality is predicted if the No Federal Action alternative is undertaken.

North Expansion West

Impacts of Proposed Changes on C-7 West Ditch Outlet to Lake

The impact of the proposed changes on water entering Great Salt Lake from the C-7 West Ditch was estimated based on changes at the CSCN457 sampling location (see Figure A-2, Appendix A). CSCN457 is located beyond the current confluence of the C-7 Ditch with the C-7 West Ditch, and is the final sampling location before the C-7 West Ditch discharges to Great Salt Lake. As previously discussed, the C-7 West Ditch would be rerouted to lie west of the gypsum tailings area and the C-7 Ditch would be rerouted so it no longer discharges at this location. No new sources would be introduced in this area, so the only effect of the changes would be to eliminate the flow from the C-7 Ditch. As a result, the future flow and constituent levels at CSCN457 are expected to be the same as at CWSW471 (C-7 West Ditch).

Currently, flow from the C-7 Ditch dilutes the flow from the C-7 West Ditch and causes the water quality to be better at CSCN457 than at CWSW471 (Table 3-4a) Therefore, elimination of this diluting flow will result in lower flows as well as lower water quality at CWSW457. The expected effects on flow and quality at CWSW457, would be as follows:

- average flow would decrease from 73 cubic feet per second (cfs) to 7 cfs,
- average pH and Biological Oxygen Demand (BOD5) would decrease from 7.7 to 7.1 and 3 to 2.6 milligrams per liter (mg/l), respectively, and BOD5 exceedences appear in 25 percent of samples,
- nitrate exceedences would be eliminated,

Table 3-4a
Estimate of C-7 Channel Diversion Effect on Water Quality at CSCN457 (west C-7 Ditch at 1-80)

	1991-92 DATA (includes C-7 ditch flow)					POST-DIVERSION (does not include C-7 ditch flow)				
		1-hour-average standard		4-day-average standard			1-hour-average standard		4-day-average standard	
ANALYTE	average value	percent of values over standard	average value over standard	percent of values over standard	average value over standard	average value	percent of values over standard	average value over standard	percent of values over standard	average value over standard
Flow	73	NA	NA	NA	NA	7	NA	NA	NA	NA
pH*	7.7	8	5.76			7.1	8	3.9		
BOD5*	3	0	0			2.6	25	6.5		
Nitrate*	2.5	16	5.4			<1	0	0		
TDS	3196	NA	NA	NA	NA	6480	NA	NA	NA	NA
Chloride	1278	100	1278	100	1278	2874	100	2874	100	2874
Aluminum	<0.15	0	0	67	0.18	0.15	0	0	85	0.15
Copper	0.029	0	0	0	0	0.094	8	0.2	33	0.15
Iron*	<0.1	0	0			<0.26	42	2.43		
Selenium	<0.035	0	0	0	0	<0.066	75	0.076	75	0.076

Notes:
1. All units are mg/l except for flow (cfs) and pH.
2. Averages with "<" sign are for locations where some samples had concentrations below the detection limit. These concentrations may or may not have been 0, so a precise average could not be calculated.
3. NA denotes analytes for which there is no applicable regulatory standard.
4. Reported values are for grab samples, although some standards are for average concentrations over a period of time.

* Instantaneous standard applies; exceedences are reported in the 1-hour standard columns.

- average chloride concentrations would increase from 1278 to 2874 mg/l, with an accompanying increase in TDS from 3196 to 6480 mg/l,
- average aluminum, copper, iron, and selenium concentrations would increase, and
- standards for all four of the above metals would be exceeded, whereas existing conditions would result in only the 4-day-average standard for aluminum being exceeded.

While average concentrations and frequency of exceedences for a number of constituents increase as a result of the change, total loads would remain the same or decrease since no new sources are added.

Impacts of Proposed Changes on Lee Creek Outlet

The impact of the proposed changes on water entering Great Salt Lake from Lee Creek was estimated based on changes at Lee Creek north of I-80 (the LCSW468 sampling location). Please refer to Figure A-2 Appendix A for sampling site locations. LCSW468 is located north of the former salt evaporation ponds and would receive the rerouted C-7 Ditch flows. LCSW468 and LCSW469 (Lee Creek near Great Salt Lake) are the final sampling locations prior to the outlet of Lee Creek to Great Salt Lake, and measured constituent levels were similar at the two locations. Thus, impacts on water quality at LCSW468 should be representative of impacts at the discharge to Great Salt Lake.

The two actions changing constituent levels at LCSW468 would be the rerouting of the C-7 Ditch to the Lee Creek outlet and the effective closure of the former salt evaporation ponds as they would be annexed to the new tailings impoundment.

Predictions of future constituent levels were calculated by combining the effects of all watercourses that would contribute to LCSW468. The four contributing sampling locations used for these calculations were:

- BDCN465 (Brighton Drain), to include the contribution of the Brighton Drain,

- RWCN467 (Right-of-Way Canal north of I-80), to include the contribution of the Right-of-Way Canal,
- CSCN455 (C-7 Ditch after Kersey Creek), to include the contribution of the rerouted C-7 Ditch, and
- LCSW468 (Lee Creek north of I-80), to include existing flow at the Lee Creek outlet.

The predicted concentrations for each month in the 12-month sampling series were calculated using the following relation, producing flow-weighted average concentrations:

$$C_{pred} = \text{sum}(C_i \times Q_i) / \text{sum}(Q_i) \qquad (1)$$

where C_{pred} = predicted concentration;

C_i = concentration at each sampling location; and

Q_i = flow at each sampling location.

Measured concentrations were combined with measured flows at three of the four locations listed above, with the exception being LCSW468. In order to account for the elimination of loads from the former salt evaporation ponds, concentrations from RWCN467 were paired with flows at LCSW468 in calculating the flow weighted average. This is because, while runoff from the ponds contributes a large load to LCSW468, RWCN467 is believed to be largely unaffected. In this way, existing flows and reasonable constituent loads at LCSW468 would be preserved while high loads due to the ponds would be eliminated.

Adding the flow from the C-7 Ditch would significantly dilute the water and increase the flow entering Great Salt Lake via the Lee Creek outlet. Predicted impacts are summarized in Table 3-4. Highlights of the table are as follows:

- average flow would increase from 5.5 cfs to 92.4 cfs,
- average pH would increase from 6.8 to 7.8, with one, rather than three, exceedences in the twelve-month period,
- average BOD5 would decrease from 9.7 to 2.8 mg/l, with the non-attainment of 64 percent being eliminated (no exceedences),

- average dissolved oxygen would increase from 4.2 to 6.2 mg/l, with all exceedences (originally 43 percent of the samples) eliminated,

Table 3-4
Estimate of C-7 Channel Diversion Effects on Water Quality at LCSW468 (Lee Creek North of I-80)

	1991-92 DATA (does not include C-7 ditch flow)					POST-DIVERSION (includes C-7 ditch flow)				
		1-hour-average standard		4-day-average standard			1-hour-average standard		4-day-average standard	
ANALYTE	average value	percent of values over standard	average value over standard	percent of values over standard	average value over standard	average value	percent of values over standard	average value over standard	percent of values over standard	average value over standard
Flow	5.5	NA	NA	NA	NA	92.4	NA	NA	NA	NA
pH*	6.8	25	4.4			7.8	8	6.4		
BOD5*	9.7	64	13.2			2.8	0	0		
Dissolved oxygen**	4.2	43	1.8	57	2.3	6.2	0	0	0	0
Nitrate*	<1	8	1.3			2.6	17	5.5		
TDS	173706	NA	NA	NA	NA	4456	NA	NA	NA	NA
Chloride	98817	100	98817	100	98817	2198	58	3358	100	2198
Aluminum	<0.12	0	0	29	0.18	<0.101	0	0	14	0.108
Arsenic	<0.096	0	0	17	0.0015	<0.04	0	0	0	0
Copper	0.625	42	1.2	58	0.97	<0.0568	8	0.51	8	0.51
Iron*	<1.2	25	1.8			<1.03	8	1.4		
Silver	<0.00035	0	0	17	0.0015	<0.00012	0	0	0	0

Notes:
1. All units are mg/l except for flow (cfs) and pH.
2. Averages with "<" sign are for locations where some samples had concentrations below the detection limit. These concentrations may or may not have been 0, so a precise average could not be calculated.
3. NA denotes analytes for which there is no applicable regulatory standard.
4. Reported values are for grab samples, although some standards are for average concentrations over a period of time.

* Instantaneous standard applies; exceedences are reported in the 1-hour standard columns.

** One-day- and 30-day-average standards apply; exceedences are reported in the 1-hour- and 4-day-average standard columns, respectively.

- average nitrate concentration would increase, with exceedences rising from 8 percent of samples to 17 percent of samples,
- chloride and dissolved solids loadings would greatly decrease, dropping from averages of 99,000 and 174,000 mg/l to below 5000 mg/l,
- average aluminum, arsenic, copper, iron, and silver concentrations would decrease, with exceedences over 4-day-average standards being eliminated for two of four analytes and greatly reduced for the other two analytes. Exceedences over the 1-hour-average standard and instantaneous standard for copper and iron would decrease to one event apiece during the twelve-month history, and

Based on analysis of the 1991-92 sampling data, the net result of the proposed changes on the water at the Lee Creek outlet would be a much lower solids and chloride loading, as well as increased overall water quality. The only contaminant concentration calculated to increase would be that of nitrates, which would generally meet standards as well.

3.3.2 Ground Water Supply

3.3.2.1 Overview

Methods

An understanding of ground water flow in the vicinity of the tailings impoundment and potential impacts of proposed alternatives was developed from a review of the documents listed in Chapter 6, References Section 3.3.

Applicable Statutes

State of Utah regulatory statues include the Utah Ground Water protection regulations.

3.3.2.2 Issues

Issues associated with the ground water include potential changes to the:

- local vertical and horizontal hydraulic gradients and flow directions,
- quantity of ground water discharged to toe drain collection ditch,
- quantity of ground water discharge to springs and seeps that feed nearby wetland areas, and
- water levels in and capacity of nearby ground water production wells.

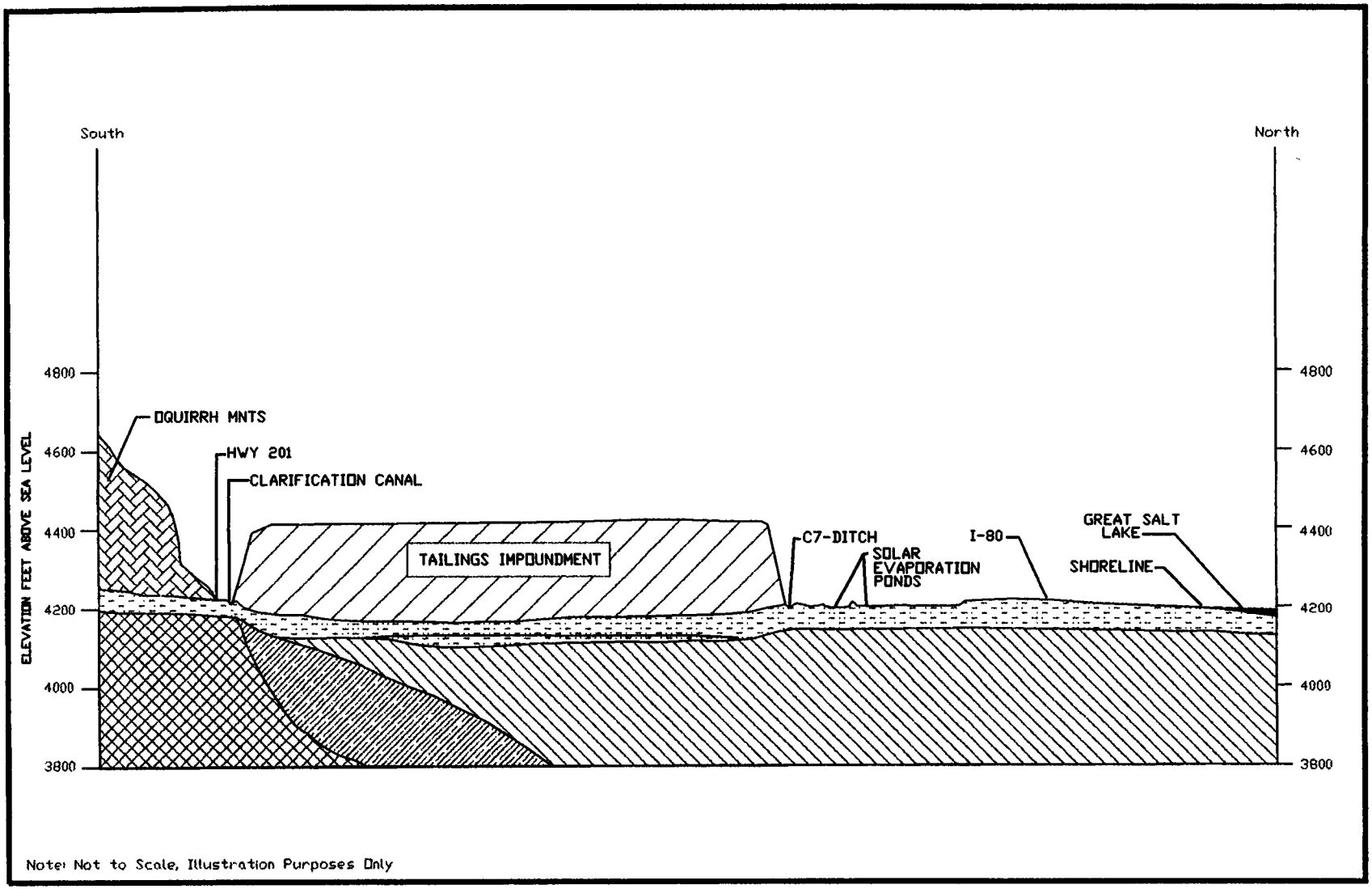
3.3.2.3 Affected Environment

Water quality and water level elevation data for wells and springs in the area have been used in various reports to characterize the occurrence and movement of ground water in the area of the tailings impoundments. Three main aquifers are identified in the GSL area are the Bedrock Aquifer, the confined Principal Aquifer, and the unconfined Shallow Aquifer (Figure 3-2).

<u>Bedrock Aquifer</u>

Bedrock in the Oquirrh Mountains is extensively fractured. Where these fractures are connected and saturated they form the Bedrock Aquifer. Recharge to the Bedrock Aquifer is from precipitation in the Oquirrh Mountains. No perched zones have been reported for the north end of the Oquirrh Mountains which indicates that fracturing is extensive.

Ground water within the Bedrock Aquifer moves downgradient and is discharged from wells and springs. Most springs which discharge from the Bedrock Aquifer are located along the contact between the lacustrine sediments and bedrock that occurs approximately along the 4235-foot topographic elevation contour.. Approximately 500 acres of the existing tailings impoundment is constructed on top of bedrock. Some historic springs have been covered by the tailings impoundment. Ground water is also discharged from the Bedrock Aquifer, via upward vertical hydraulic gradients, to the Principal Aquifer. The remainder of the Tailings Impoundment overlies the fine-grained lacustrine sediments of the unconfined Shallow Aquifer. Hydraulic conductivities



Bedrock Aquifer

Principal Aquifer Gravel Zone

Principal Aquifer Lacustrine Zone

Shallow Aquifer

NORTH

January 1995

HYDROGEOLOGIC CROSS SECTION OF EXISTING TAILINGS IMPOUNDMENT

TAILINGS MODERNIZATION PROJECT
ENVIRONMENTAL IMPACT STATEMENT

KENNECOTT UTAH COPPER CORPORATION

Figure 3-2

in the Bedrock Aquifer are estimated from slug and short-term pumping tests to range from 1X10-4 up to 1x10-1 centimeters per second (cm/s).

Shallow Aquifer

The unconfined Shallow Aquifer consists of lacustrine Bonneville clays and interbedded clays and fine sands of the underlying Cutler Dam Series. These sediments directly overlie the Bedrock Aquifer in some areas, but in most cases, the Shallow Aquifer overlies a 50-foot thick bed of reduced permeability material that confines water in the underlying Principal Aquifer.

Water level elevations measured in the Shallow Aquifer generally follow ground surface elevations. Because ground water is being discharged to lakes, streams, and canals in this area, the locations of these features are reflected in the water level elevations. The potentiometric surface which can be contoured from these elevations indicate that ground water flow is to the north northwest and some ground water is discharged to the GSL.

Slug tests and short-term pumping tests indicate that horizontal hydraulic conductivities range from 5x10-5 to 4x10-3 cm/s. Laboratory tests of samples of the Shallow Aquifer indicate that permeabilities range from 2x10-8 to 4x10-7 cm/s . Triaxial permeability tests were performed for various confining pressures on the Bonneville Clay. Permeabilities ranged from 4x10-7 cm/s at low confining stresses to 6x10-9 cm/s for high confining stresses. These data indicate that:

- horizontal hydraulic conductivities are at least two to three orders of magnitude (100 to 1000 times) greater than vertical permeabilities and
- the vertical permeability of the clays has been reduced by up to two orders of magnitude (100 times) by the weight of the Tailings Impoundment.

Principal Aquifer

The Principal Aquifer is confined and consists of clay, silt, sand, and gravel deposits with individual beds ranging in thickness from less than one to several tens of feet. Sediments located below the Shallow Aquifer and above the underlying semiconsolidated sediments and bedrock are

included in the Principal Aquifer. These sediments include an approximately 50-foot thick confining zone that separates the unconfined shallow aquifer from the confined

Principal Aquifer

The Principal Aquifer in the GSL area is subdivided into a lacustrine zone and a gravel zone. The lacustrine zone consists primarily of clays and interbedded fine-grained sands. The gravel zone consists of coarse-grained sediments transported from the mountains during an extensive cycle of low GSL elevations. Large capacity wells located near the Oquirrh Mountains are completed in the gravel zone of the Principal Aquifer. Slug tests and short-term pumping tests of the upper part of the Principal Aquifer indicate hydraulic conductivities of 3x10-5 cm/s for lacustrine to 4x10-4 cm/s for gravel zone. Horizontal permeabilities within the Principal Aquifer are estimated to be 2x10-3 cm/s versus vertical permeabilities of 3x10-5 to 4x10-4 cm/s.

Hydraulic Gradients

Vertical hydraulic gradients are upward from the Bedrock Aquifer into the Principal Aquifer, from the Principal Aquifer into the Shallow Aquifer, and from the Shallow Aquifer to the ground surface. This upward vertical gradient is reversed and vertical ground water flow is changed from upward to downward under the tailings impoundment. Horizontal hydraulic gradients result in ground water flow that is in a northwest direction across the study area, toward Great Salt Lake.

Horizontal hydraulic gradients flatten toward the north from 0.002 near the Bedrock Aquifer to 0.0005 near the GSL. Vertical hydraulic gradients between the Principal Aquifer and Shallow Aquifer range from 0.05 to -0.3, and average -0.1 with the negative value indicating an upward gradient. The ratio of horizontal to vertical hydraulic gradients (0.001:0.1) when compared to the ratio of horizontal to vertical hydraulic conductivity of the aquifer materials (1000:1) indicate that ground water will be discharged from the Principal Aquifer to the Shallow aquifer within a distance of about ten times the aquifer thickness. These numbers indicate that the length of the ground water flow paths within the Principal Aquifer are relatively short and that transport of water over great distances through the Shallow Aquifer is generally not possible.

Downward vertical gradients beneath the tailings impoundment indicate the potential for discharge of tailings water into the underlying Shallow Aquifer. Although the potential exists, the actual quantity of flow discharged is very small due to the very small vertical and horizontal conductivity of this aquifer at this location. The tailings impoundment overlies part of the Bedrock Aquifer. In these areas, the recharge of the Bedrock Aquifer by overlying tailings impoundment water is not prevented by the presence of the Bonneville Clay in the upper part of the Shallow Aquifer. However recharge from the tailings impoundment into the Bedrock Aquifer has been limited by the small vertical hydraulic conductivity (generally less than 10-6 cm/s) of the overlying tailings.

Ground Water Use

Large quantities of ground water are used in the GSL area for industrial, municipal, and residential purposes. This water is generally obtained from the principal Aquifer and spring discharges from the Bedrock Aquifer. Utilization of the Shallow Aquifer is greatly limited due to its very low well yield potential and general poor quality of water.

Majority of wells completed in the gravel zone of the Principal Aquifer; capacities range from 15 to 10,000 gallons per minute (gpm) according to permitted water rights. Springs are located along contact between the Bedrock Aquifer and unconfined Shallow Aquifer. Adamson spring discharges 6000 gpm and is used by Kennecott as process water.

3.3.2.4 Environmental Consequences

Impact Types

Impact types include potential changes to:

- local vertical and horizontal hydraulic gradients,
- local vertical and horizontal ground water flow directions and rates,
- rate of discharge from springs and seeps which feed wetland areas to north of proposed alternatives, and
- water levels and capacities of nearby ground water production wells.

Impact Location

Impact locations:

- footprints of tailings impoundment and east and west alternatives,
- toe drain collection ditch,
- Sedimentation Pond,
- nearby ground water production wells, and
- nearby springs and seeps near each alternatives.

Impact Intensity and Duration

Changes to Hydraulic Gradients - Hydraulic gradients are expected to be reversed from upward to downward under each alternative and for an area limited to the footprint of each alternative. Hydraulic gradients are expected to remain reversed; however, the magnitude of the gradients are expected to decrease with time after the tailings impoundment of each alternative is closed and pore pressures in the Shallow Aquifer are dissipated.

Changes to Ground Water Flow Directions and Rates - Due to the small vertical permeabilities and relatively larger horizontal permeabilities of the of the Bonneville Clay and of the tailings themselves, horizontal flow is expected to dominate.

Rate of Discharge from Springs and Seeps - The rate of discharge from springs and seeps away for each alternative is not expected to change, because impacts to hydraulic gradients and ground water flow directions are expected to be small and limited to the area of the footprint of each alternative.

Water Levels and Capacities of Wells - Water level elevations and capacities of ground water production wells are not expected to be impacted because ground water will not be extracted as part of the alternatives, and because impacts to hydraulic gradients and flow directions are expected to be small limited to the footprint of each alternative.

3.3.3 Ground Water Quality

3.3.3.1 Overview

Methods

An understanding of ground water quality in the vicinity of the existing tailings impoundment and potential impacts of the proposed alternatives was developed from a review of the documents listed in Chapter 6, References.

Applicable Statutes

Federal regulatory statutes include the:

- Safe Drinking Water Act as amended (42 USC 300f et seq.)
- Clean Water Act of 1977 (33 USC 1251 et seq.)
- Comprehensive Environmental Response, Compensation and Liability Act of 1980 as amended (42 USC 9615)

Utah regulatory statutes include:

- Utah Water Quality Act
- Utah Safe Drinking Water Act
- Utah Ground Water Quality Protection Rules
- Utah Underground Injection Control Program Rules
- Utah Water Quality Standards

3.3.3.2 Issues

Issues associated with the ground water quality include the potential for:

- water used to slurry tailings to seep into and change the quality of ground water in the underlying aquifers,
- leachate generated by tailings to seep into and change the quality of ground water in the underlying aquifers,
- leachate generated by or interstitial pore water contained in the gypsum tailings of the former Chevron Phosphate Plant (North Expansion West alternative) seep into and change ground water quality in the underlying aquifers,
- slag used for drainage blanket to cause changes in water quality of tailings water and underlying aquifers,
- salt left at the former Morton Salt Plant to be dissolved by tailing water and impact underlying aquifers, and
- beneficial use of local ground water to be changed.

3.3.3.3 Affected Environment

Ground water quality is variable and complex in the area of the Existing Tailings Impoundment and alternatives due to the chemical evolution of the waters in a unique natural system (i.e., Great Salt Lake basin). Water qualities represented by total dissolved solids (TDS) range from small concentrations in recharge areas in the Oquirrh Mountains to very large concentrations in the discharge areas near Great Salt Lake. The complexity of the system is increased by the impacts of man-caused activities (e.g., Salt Lake City urban area, Kennecott, other industrial uses, etc.).

The gradient of the ground water indicates that the existing tailings impoundment is located in an area of ground water discharge. Ground water in discharge areas generally contains concentrations of inorganic constituents that are greater than in recharge areas. Concentrations are greater in discharge areas because of the longer residence times (i.e., time in contact with water-bearing layers of rock) and greater opportunity for chemical interactions of the ground water with the

aquifer geology, evapotranspiration, and other mechanisms. Ground water quality near Great Salt Lake is degraded naturally because of the presence of evaporites (i.e., inorganics and metals) in the geologic formations.

Characterizing the background ground water quality in the area is difficult due to many factors, including:

- lack of historical water quality data prior to development,
- influences from modern urban and agricultural activities,
- wide variety of existing geologic and hydrogeologic environments,
- large chemical concentration gradients between recharge and discharge areas,
- degradation by evaporation of ground water discharged to alkali flats,
- degradation by brines and aerosols from Great Salt Lake,
- variations in aquifer matrix, and
- completion of wells in different aquifers of different lithologic units within the same aquifer.

Background water quality has been estimated using analytical results for samples collected from:

- monitor wells,
- editing data to eliminate outliers or points obviously affected by human disturbances, and
- using a probability method to identify characteristic chemical populations.

A comprehensive evaluation of background ground water quality is currently being prepared by Shepard Miller, Inc. (SMI) and is expected to be available during early 1995.

There are three ground water aquifers below the study area:

- the principal aquifer
- the bedrock aquifer
- the shallow aquifer

In general, the general trend in ground water chemistry is from sodium-calcium-carbonate-chloride water in the bedrock aquifer to sodium chloride water in the shallow aquifer near Great Salt Lake. General water quality in each of the three aquifers is summarized in the following paragraphs.

Background TDS, pH, and metal concentrations in the bedrock aquifer are summarized in Table 3-5.

Table 3-5

Background Ground Water Quality in the Bedrock Aquifer

Constituent	Summary of Background Ground Water Quality in the Bedrock Aquifer (mg/l)				
	Utah GWQS	Mean	Minimum	Maximum	Standard Deviation
pH	6.5 - 8.5	7.394	7.2	7.6	0.117
TDS		1498	656	2376	457.5
Antimony		0.020	<0.005	0.229	0.063
Arsenic	0.050	0.006	<0.003	0.012	0.003
Barium	1.0	0.053	0.02	0.130	0.026
Beryllium		0.001	<0.002	<0.005	0.002
Cadmium	0.010	0.002	<0.001	0.008	0.002
Chromium	0.050	0.007	0.002	0.016	0.004
Copper	1.00	0.008	0.002	0.020	0.005
Lead	0.050	0.001	<0.001	<0.005	0.001
Molybdenum		0.009	0.003	0.020	0.006
Nickel		0.009	<0.001	0.052	0.014
Selenium	0.010	0.015	<0.002	0.046	0.015
Silver	0.05	0.002	<0.001	<0.01	0.002
Zinc	5.0	0.018	0.007	0.040	0.009

Note: Data are from the November 1993 Ground Water Quality Discharge Permit Application

General observations about ground water quality in the bedrock aquifer include:

- TDS concentrations range from about 650 milligrams per liter (mg/l) in the Oquirrh Mountains to about 2400 mg/l near the North Concentrator.
- Measured pH values range from 7.2 to 7.6.
- Arsenic concentrations range from less than detection (<0.003) to 0.012 mg/l.
- Metals that exceed Utah Groundwater Quality Protection (GWQP) standards at some locations include arsenic and selenium.

Background ground water quality in the principal aquifer is summarized in Table 3-6.

Table 3-6

Background Water Quality in the Principal Aquifer

Constituent	Summary of Background Ground Water Quality in the Principal				
	Utah	Mean	Minimum	Maximum	Standard
pH	6.5 - 8.5	7.6	6.93	8.6	0.357
TDS		6573	854	44630	8271
Antimony		0.030	<0.005	0.39	0.084
Arsenic	0.050	0.071	0.001	0.437	0.100
Barium	1.0	0.127	<0.01	1.890	0.229
Beryllium		0.001	<0.002	<0.005	0.001
Cadmium	0.010	0.001	<0.001	0.011	0.002
Chromium	0.050	0.004	<0.002	0.068	0.007
Copper	1.00	0.032	0.002	0.210	0.038
Lead	0.050	0.001	<0.001	0.003	0.001
Molybdenum		0.002	<0.001	0.023	0.002
Nickel		0.004	<0.001	0.030	0.006
Selenium	0.010	0.006	<0.002	0.049	0.009
Silver	0.05	0.001	<0.001	<0.01	0.002
Zinc	5.0	0.022	<0.005	0.287	0.032

Note: Data are from the November 1993 Ground Water Quality Discharge Permit Application

General observations about ground water quality in the principal aquifer include:

- Background TDS concentrations range from about 850 to more than 40,000 mg/l and generally increase from south to north, towards Great Salt Lake..
- In the Great Salt Lake area, chloride is the primary constituent of TDS.
- Background arsenic, barium, cadmium, chromium, and selenium exceed the Utah ground water quality standards (GWQS) at some locations.
- There is no apparent correlation between TDS and arsenic or selenium concentrations.

Background ground water quality in the shallow aquifer is summarized in Table 3-7.

Table 3-7

Background Ground Water Quality in the Shallow Aquifer

Constituent	Summary of Background Ground Water Quality in the Shallow Aquifer (mg/l)				
	Utah GWQS	Mean	Minimum	Maximum	Standard
pH	6.5 - 8.5	7.502	6.56	8.3	0.396
TDS		22373	566	217020	34842
Antimony		0.040	<0.005	1.055	0.0228
Arsenic	0.050	0.043	<0.001	0.198	0.056
Barium	1.0	0.137	<0.01	1.42	0.286
Beryllium		0.002	<0.002	<0.005	0.001
Cadmium	0.010	0.002	<0.001	0.016	0.002
Chromium	0.050	0.004	<0.002	0.047	0.005
Copper	1.00	0.118	0.002	0.770	0.178
Lead	0.050	0.001	<0.001	0.022	0.002
Molybdenum		0.012	<0.001	0.053	0.049
Nickel		0.006	<0.001	0.033	0.007
Selenium	0.010	0.005	<0.002	0.04	0.009
Silver	0.05	0.002	<0.001	0.003	0.002
Zinc	5.0	0.022	0.006	0.130	0.019

Note: Data are from the November 1993 Ground Water Quality Discharge Permit Application

General observations about ground water quality in the shallow aquifer include:

- TDS concentrations range up to more than 200,000 mg/l in areas near Great Salt Lake.
- The largest TDS concentrations observed in the shallow aquifer are associated with alkalai flats of Great Salt Lake.
- Background concentrations of arsenic, barium, cadmium, and selenium exceed Utah GWQP standards at some locations.
- There is no apparent correlation between TDS and arsenic, cadmium and selenium concentrations.

Ground water in the Great Salt Lake area is currently unclassified by the Utah Department of Environmental Quality (UDEQ), Division of Water Quality (DWQ). Based on criteria set forth in the Groundwater Quality Protection Regulations and a review of probable background conditions, a preliminary classification of the aquifer system is recommended by Kennecott in the November 1993 Groundwater Discharge Permit Application. This recommendation is to classify the majority of the shallow aquifer as Class IV. In addition, the Principal Aquifer nearest to Great Salt Lake should be classified as Class IV aquifer, and areas near the Oquirrh Mountains should be Class II, with a Class III transition zone between the two areas. These classifications are defined in the Ground Water Quality Protection regulations as follows:

Class II - Drinking Water Quality Ground Water - Ground water with TDS greater than 500 and less than 3,000 mg/l and no contaminant concentrations that exceed ground water quality standards.

Class III - Limited Use Ground Water - Ground Water that has TDS between 3,000 and 10,000 mg/l or has one or more contaminants that exceed the ground water quality standards.

Because of the higher TDS and/or presence of significant levels of contaminants the water is not suitable for drinking water but can be used for some agricultural or industrial uses.

Class IV - Saline Ground Water - Ground water with TDS over 10,000 mg/l composes this class. Class IV ground water is addressed on a case-by-case basis.

Unclassified Ground Water - Unclassified designates ground water that has not been classified as Class I through Class IV. The quality of ground water will be protected to a degree commensurate with current and probable future beneficial uses of the ground water as determined by the existing ground water quality in unclassified areas.

No water users or supply wells have been identified to date within a 2-mile radius downgradient (north) or cross gradient (west and east) of the current or proposed expanded Tailings Impoundment.

3.3.3.4 Environmental Consequences

Impact Types

Impact types include potential changes in:

- ground water quality of underlying aquifers caused by seepage of
  - water used to slurry tailings to the impoundment,
  - leachate generated by tailings,
  - interstitial pore water within and leachate generated by the phosphogypsum tailings at the former Chevron Phosphate Plant,
  - leachate generated by slag to be used in drainage blanket, and
  - leachate generated by resolution of sodium chloride from former evaporation ponds of the former Morton Salt property;
- beneficial use of ground water; and
- the loss of some monitor wells and installation of new wells.

Impact Locations

Impact locations include the following:

- footprints of the existing tailings impoundment and North Expansion West alternative,
- drainage blanket collection ditch, and
- springs and seeps to the north of the alternatives.

Intensity and Duration of Impacts

The intensity and duration of the types of potential impacts identified above are evaluated in the following paragraphs.

Potential Impacts of Water Used to Slurry Tailings

The existing tailings impoundment and proposed North Expansion West alternative have the capacity to impact ground water quality through seepage of water used to slurry tailings. This potential impact is evaluated, in part, by comparing water quality data for slurry water to background water quality in the shallow aquifer.

Tailings are slurried to the existing tailings impoundment at a rate of 45,000 to 60,000 gpm. Water used to slurry tailings is derived from many sources including an integrated water recycling system, ground water discharged from springs and produced from wells in the Bedrock Aquifer and the Principal Aquifer, water produced from mining operations, and water obtained from canals. Water used to slurry the tailings has TDS concentrations of 4,000 to 6,000 mg/l. Water used since the early 1980s to slurry tailings has slightly greater TDS concentrations than prior to the early 1980s. TDS concentrations increased as the result of greater recycling of process water and other changes to control discharge. Analytical results for Kennecott tailings water sampled at UDP 002 are summarized and compared to mean concentrations in the Shallow Aquifer in Table 3-8.

Table 3-8

Tailings Water Compared with Ground Water Quality

Constituent	Utah GWQS (mg/l)	Mean Concentrations in Shallow Aquifer (a) (mg/l)	Kennecott Tailings Water Sampled at UDP 002 (b) (mg/l)
pH	6.5 - 8.5	7.502	6.8 (lab) 7.51 (field)
TDS		22,373	4300
Arsenic	0.050	0.043	0.003
Barium	1.0	0.137	0.11
Cadmium	0.010	0.002	<0.005
Chromium	0.050	0.004	<0.01
Copper	1.0	0.118	<0.01
Lead	0.050	0.001	<0.02
Selenium	0.010	0.005	<0.026
Silver	0.05	0.002	<0.01
Zinc	5.0	0.022	<0.01

(a) Data are from the November 1993 Ground Water Discharge Permit Application

(b) Data are from SMI (1994a)

Because TDS in water used to slurry the tailings are substantially less than and metals concentrations are less than or similar to concentrations in the shallow aquifer, the slurry water is not expected to result in increased TDS or metals concentrations in the shallow aquifer. If slurry water were to seep into the shallow aquifer, then the seepage would be expected to reduce TDS and possibly metals concentrations and cause a overall improvement in water quality.

Potential Groundwater Impacts Due to Tailings

Tailings generated by mineral processing are slurried to the tailings impoundment. In addition, the tailings impoundment receives or has received material from: slag tailings from the slag concentrator, treated effluent from the Water Treatment Plant, power plant ash slurry from the Utah Power Plant, construction, maintenance and lunch room trash, and stabilized sludge from the Kennecott wastewater treatment plant. Material from these other sources total less than one percent of the total tailings, and all of these discharges are permitted.

Some concern has been expressed by the agencies and the public that the existing tailings impoundment and proposed North Expansion West alternative has the potential to impact ground water quality through the generation of leachate containing increased concentrations of metals and other constituents and the seepage of this leachate into the underlying ground water. The following paragraphs evaluate: 1) the potential for metals to be leached from the tailings; and 2) the potential for leachate generated in the tailings to seep into the underlying ground water.

A total of 29 samples were collected from the surface of the existing tailings impoundment by the Utah Bureau of Solid and Hazardous Waste (BSHW). These data are compared to average western soil (Shacklette and Boerngen, 1984) and to native soils under the existing tailings impoundment in Table 3-9.

Results for 111 subsurface tailings samples collected from boreholes yielded similar concentrations. These data indicate than the observed concentrations of these metals are very similar, with the exception of copper, in native soils and tailings. As expected, tailings from a copper mine are enriched in copper.

Table 3-9

Metal Concentrations in Tailings

Metal	Average Western Soil (a)	20 Native Soil Samples Collected Over a 100-Foot Interval Under Tailings Impoundment (mg/kg)			29 Surface Tailings Samples Collected by the BSHW during 1988 (mg/kg)		
		Mean	Minimum	Maximum	Mean	Minimum	Maximum
Arsenic	7.2	14	4	42	6.2	4.2	21
Barium	670	130	55	370	NA	NA	NA
Cadmium	NA	0.55	<0.5	370	0.5	0.4	0.5
Chromium	56	34	22	1	43	6	63
Copper	27	16	1	64	1476.6	780	2600
Lead	20	11	5.6	32	10.8	4.6	39
Selenium	0.34	0.2	<0.4	<0.4	NA	NA	NA
Zinc	65	54	28	97	29.2	15	63

(a) Shacklette and Boerngen, 1984

NA = Not analyzed

Acid Generation Potential

In-situ (i.e., in place) chemical weathering of the tailings could potentially result in the release of metals and other tailing constituents into the tailings pore water. The primary chemical mechanism for the *in-situ* weathering is the oxidation of minerals contained in the tailings, primarily sulfide minerals. When these minerals are oxidized, a low-pH solution can be formed. This low pH solution could then leach metals from the remaining tailings.

Kennecott retained Sheppard Miller, Inc. (SMI) of Fort Collins, Colorado and Shaffer and Associates of Bozeman, Montana to conduct studies to evaluate acid generation potential of the

existing tailings impoundment and the proposed North Expansion West alternative. These studies have included:

- Static testing by acid base accounting methods using 260 samples collected from the existing tailings impoundment,
- Kinetic testing using humidity cells to simulate weathering,
- Field studies on existing tailings including:
  - vegetation studies,
  - lysimeter sampling,
  - moisture profiles,
  - gas profiles, and
- Monitoring of a test fill area.

Preliminary results of these laboratory and field studies indicate that:

- oxygen content in pore water decreases rapidly with depth,
- the oxidation front will migrate slowly downward with time,
- downward migration of the oxidation front will be impeded by the presence of saturated layers within the tailings,
- interior areas of the existing tailings impoundment are not expected to acidify due to a lack of oxygen,
- local areas on tailings surface may develop low pH,
- lateral seepage of alkaline tailings water will prevent acidic conditions from developing,
- step-back areas may develop local areas of acidic conditions, but not for many years, and
- an increased risk of acid generation exists for the North Expansion West alternative areas because of underflow which contains relatively more pyrite.

Results of these ongoing studies of acid generation potential are expected to be summarized in a report to Kennecott in mid-1995.

Acidification of tailings requires oxygen to be introducted into the tailings. The existing tailings water is generally oxygen deficient. Any water added to the impoundment surface would carry some oxygen into the tailings; however, the amount of oxygen that can be carried into the tailings is extremely restricted due to the small flow of water infiltration through the tailings. The slow rate of water flow through the tailings is indicated by:

- profiles of tritium concentrations in tailings water which indicate very little vertical mixing, and

- the great difficulty experienced by Kennecott in dewatering the tailings.

Any acidic water generated would be neutralized in the shallow portions of the aquifer.

Although preliminary results of studies conducted by SMI and Sheppard & Associates indicate that the potential exists for acidic solutions to form; water quality data collected in and on the existing tailings impoundment has never shown potential acidic conditions to exist. Water in contact with tailings for more than 40 years has neutral to basic pH with no evidence of acidification or leaching of metals from the tailings. Water quality in wells completed in the existing tailings impoundment are summarized in Table 3-10.

Table 3-10
Tailings Water Quality

Constituent	Summary of Water Quality in the Tailings Impoundment (mg/l)				
	Utah GWQS	Mean	Minimum	Maximum	Standard Deviation
pH	6.5 - 8.5	7.3	6.9	8.8	0.40
TDS		5600	3700	7000	1040
Antimony		0.010	<0.004	0.211	0.039
Arsenic	0.050	0.0418	0.008	0.107	0.024
Barium	1.0	0.0.0257	0.01	0.07	0.014
Beryllium		0.0.0012	<0.002	<0.005	0.00
Cadmium	0.010	0.0026	<0.001	0.009	0.002
Chromium	0.050	00.0043	<0.002	0.023	0.006
Copper	1.00	0.211	0.004	0.09	0.017
Lead	0.050	0.001	<0.001	0.003	0.001
Molybdenum		0.7945	0.019	2.01	0.524
Nickel		0.0228	<0.001	0.08	0.02
Selenium	0.010	0.0063	<0.002	0.02	0.005
Silver	0.05	0.001	<0.001	<0.01	0.001
Zinc	5.0	0.1036	0.011	1.133	0.20

Note: Data are from the May 1994 Addendum to the November 1993 Ground Water Quality Discharge Permit Application

In summary, with the exception of copper, the trace metal composition of the tailings, as indicated in Table 3-9, is very similar to that of native soils. Whereas, the acidification of tailings water is a potential concern, Kennecott studies indicate that this has not occurred in the impoundment to date. Furthermore, the extremely slow rate at which the acidification may occur and the ultimate fate of these solutions generally alleviates the concern.

Physical Barriers to Flow Underlying the Existing Tailings Impoundment

As discussed earlier, the relatively small vertical hydraulic conductivities and relatively larger horizontal hydraulic conductivities of the tailings and underlying Bonneville Clay result in water flow that is outward toward the drainage blanket. The physical properties of the Bonneville Clay are summarized by Woodward-Clyde in "Report: Continuity of the Upper Bonneville Clay, Kennecott Tailings Modernization Project," dated August 24, 1994. This report was submitted as an addendum to and in support of the November 1993 Ground Water Quality Discharge Permit application. Observations about the Bonneville Clay are summarized as follows:

- The upper Bonneville Clay is generally 9 feet thick and consists of clay and silty clay with occasional thin (<1/2 to 2 inches) discontinuous sand beds that were deposited during the deep lake interval of the Bonneville Lake Cycle;

- A number of thicker sand beds have been encountered in the lower Bonneville Clay;

- The upper Bonneville Clay appears to be continuous across the entire North Expansion West alternative area based on extensive subsurface exploration conducted by Woodward Clyde Consultants and others at the project site and the geological environment in which it was deposited;

- Vertical hydraulic conductivities of the upper Bonneville Clay range from $3x10^{-7}$ cm/s down to $4x10^{-8}$ cm/s where the Bonneville Clay is overlain and compressed by the Existing Tailings Impoundment;

- Desiccation cracks are present but discontinuous and generally do not extend across bedding planes; and

- Desiccation cracks are expected to close upon wetting by placement of tailings.

Summary of Potential Ground Water Impacts Due to Tailings

In summary, water quality data indicate that the existing tailings impoundment has not impacted ground water quality in the area. The lack of impacts is due to:

- relatively good quality of water used to slurry tailings compared to the poor quality of water in the Shallow Aquifer in the area of the existing tailings impoundment which is a discharge area for the shallow aquifer,
- chemical properties of the tailings and tailings water which prevent the development of acidic conditions and leaching of metals,
- the chemical composition of the tailings which, with the exception of copper, is very similar to native soils in the area,
- the small vertical hydraulic conductivities and poor drainage characteristics of the tailings which limits the vertical movement of water within the tailings, and
- the small vertical hydraulic conductivity and relatively larger horizontal hydraulic conductivity of the shallow aquifer which promotes horizontal flow of water to the drainage system.

<u>Potential Impacts of Phosphogypsum Stack</u>

The phosphogypsum stack occupies approximately 300 acres at the former Chevron Phosphate Plant. Implementation of the North Expansion West alternative will result in more than 200 feet of tailings being placed directly on the phosphogypsum stack. Potential impacts to ground water quality which could result from this action include:

- the flushing out of interstitial (in between the spaces) pore water from the phosphogypsum stack which is acidic (pH around 2) and which contains elevated concentrations of metals and other inorganic constituents,

- leaching of metals from the phosphogypsum stack solids, and
- the leaching of radionuclides from the phosphogypsum stack.

A leachability study was conducted by SMI (1994a) to:

- Measure the extent and rate at which the phosphogypsum stack solids will dissolve in Kennecott tailings water, and
- Determine if the phosphogypsum stack materials would impact adjacent surface and ground water if dissolved.

To achieve these objectives samples of phosphogypsum stack solids and Kennecott tailings water were collected and analyzed, solid samples were leached with the tailings water, and geochemical modeling was conducted. Phosphogypsum stack solids composition is summarized in Table 3-11.

Table 3-11
Metal Concentration in Phosphogypsum Stack Solids

Metal	Average Western Soil (a)	Maximum Concentrations in 3 Samples of Phosphogypsum Solids (mg/kg) (b)
Arsenic	7.2	20
Cadmium	NA	41
Chromium	56	96
Copper	27	28
Lead	20	24
Mercury	0.065	0.03
Selenium	0.34	<2
Zinc	65	110
Radium-226	NA	9.55 pCi/g
Radium-228	NA	<0.2 pCi/g
Total Uranium	2.7	4.64

(a) Shacklette and Boerngen, 1994
(b) SMI (1994a)
NA = Not analyzed

SMI (1994a) also reported a saturated-paste pH for the phosphogypsum stack solids of 2.5 to 5, indicating acidic conditions.

Portions of phosphogypsum stack samples were leached using Kennecott tailings water for 12 hours. Samples of the leachate were then analyzed. Reported concentrations of metals in

Kennecott tailings water (the leaching solution) are compared to concentrations in leachate in Table 3-12.

Table 3-12
Leaching Test for Tailings Water

Constituent	Kennecott Tailings Water Sampled at UDP 002 (mg/l)	Leachate Generated Using Kennecott Tailings Water (mg/l) (a)
pH	6.8 (lab) 7.51 field	3.5 to 4.1
TDS	4300	4516 to 4641
Calcium	558	673 to 697
Magnesium	130	131 to 147
Sodium	483	472 to 543
Potassium	66	85 to 90
Alkalinity	36	ND to 20
Chloride	950	1080 to 1120
Sulfate	1846	2116 to 2132
Fluoride	5.2	1.2 to 18.3
Silica	2.6	8.7 to 24.3
Arsenic	0.003	0.012 to 0.66
Barium	0.11	0.02 to 0.10
Cadmium	<0.005	0.022 to 0.689
Chromium	<0.01	<0.010 to 0.010
Copper	<0.01	<0.01 to 0.34
Iron	<0.02	<0.01 to 0.555
Lead	<0.02	<0.001 to 0.084
Mercury	<0.0002	<0.0002 to 0.0011
Selenium	<0.026	0.046 to 0.10
Silver	<0.01	<0.010
Zinc	<0.01	0.06 to 0.60
Total Radium	2.53 pCi/l	0.55 to 2.44 pCi/l
Uranium	18.9	<1 to 23

(a) Range is for leachate generated from the three phosphogypsum stack solid samples (SMI, 1994a).

Comparison of the leachate generated from the phosphogypsum stack solids to the Kennecott tailings water (leaching solution) indicates that: 1) pH was reduced from 6.8 (7.51 in field) to 3.5 to 4.1; 2) concentrations of major cations and anions increased by 10 to 25 percent; 3) cadmium, chromium, copper, mercury, lead and zinc were less than detection in the tailings water but detected in the leachate; 4) salinity increased about 10 to 20 percent; 5) uranium, fluoride, and radium-226 stayed relatively unchanged or decreased substantially; 6) an insoluble residue of quartz and illitic clay remained after dissolution of the gypsum.

These data indicate that:

- the Kennecott tailings water will cause some dissolution of phosphogypsum stack solids,
- dissolution of solids will result in decreased pH and increased concentrations of some constituents including fluoride, arsenic, cadmium, and copper in the tailings water, and
- an insoluble residue of quartz and illitic clay will remain after dissolution of phosphogypsum stack solids.

The potential for radionuclides to be released from the phosphogypsum stack was evaluated for Kennecott by SMI (1994b). Radium-226 and radium-228 and uranium have been detected in phosphogypsum stack solids and interstitial water. Three wells completed within the phosphogypsum stack were sampled and analyzed for radium-226, radium-228, and uranium. Radium-228 was detected in one of three samples at 3 pCi/l. Radium-226 was detected in all three samples at an average concentration of 6.4 pCi/l versus 2.7 pCi/l in the underlying shallow aquifer. Uranium was detected in all three phosphogypsum stack water samples at an average concentration of 0.82 mg/l versus generally less than detection (<0.005 mg/l) in the shallow aquifer. Concentrations of these radionuclides in the phosphogypsum stack solids are listed in Table 3-12. Leaching tests described above indicate that radium-226 and uranium concentrations may actually decrease in the leachate versus the tailings water used for leaching.

The ionic mobility of the radionuclides is controlled by interactions between tailings water, phosphogypsum stack solids, and underlying materials. Concentrations of radionuclides in leachate are reduced by chemical reactions, adsorption, and ion exchange with leaching residue and underlying foundation materials. Clays have a large capacity for ion exchange due to their large surface area. Leaching tests produced an insoluble residue consisting of illitic clay and quartz. Adsorption coefficient (K_d) values in excess of 100 ml/g are reported for desert clays (Arthur D. Little, 1977) and Utah soils (EPA, 1978). Large K_d values (139 ml/g) have also been reported for uranium in illitic clays (Rancon, 1973).

Site data indicate that radium and uranium are strongly adsorbed to not likely to migrate from the phosphogypsum stack. In addition, neutralization of the acidic fluids within the gypstack by the

alkaline tailings water is likely to result in precipitation of iron hydroxide and coprecipitation of radium and uranium and provide additional surface area for adsorption of these radionuclides.

Ongoing studies of radionuclide mobility include the collection of soil samples from the Bonneville Clay which underlies phosphogypsum stack for analysis of radium and uranium. The purpose of this investigation is to see if these radionuclides exist at increased concentrations in the substrate as would be expected by the geochemical evaluation described herein. Results of ongoing investigations are expected to be available later in 1995.

The characteristics of water flushed from the phosphogypsum stack was evaluated for Kennecott by SMI (1994c). Preliminary results of geochemical modeling currently being performed by SMI (1994c) indicates that the acidic water in the phosphogypsum stack will be replaced by the alkaline tailings water; and that sulfate concentrations will decrease to concentrations observed in Kennecott tailings water after about 5 pore volumes of tailings water have been flushed through.

Placement of tailings and tailings water on the phosphogypsum stack is expected to have minimal impacts to ground water quality in the area due to the presence of chemical and physical barriers. A physical barrier is created by the relatively small vertical hydraulic conductivities of the underlying Bonneville Clay ($<1 \times 10^{-6}$ cm/s) and larger hydraulic conductivities of the overlying phosphogypsum stack (up to 6×10^{-4} cm/s). The contrast in hydraulic conductivities will result in radial flow of water out towards the drainage blanket. Even though the primarily direction of flow will be horizontal versus vertical, some water could flow down into the underlying Bonneville Clay. However, the Bonneville Clay contains large amounts of calcium carbonate (17.8 to 27.9 percent) which is expected to buffer the acidic water from the phosphogypsum stack. Overtime, alkaline tailings water will displace acidic phosphogypsum water.

Potential Impacts of Slag for Drainage Blanket

A drainage blanket will be constructed of slag materials produced by KUC smelter operations. This material is currently held in stockpiles north of the smelter and west of the existing

impoundment and will be crushed and screened prior to transport to the drainage blanket construction area. A large database exists for the leachability of the slag materials. Kennecott is currently consolidating and updating these data which indicate that the slag will not generate a leachate that will impact ground water quality.

Potential Impacts of Evaporation Ponds

Evaporation ponds at the former Morton Salt Plant will be covered by the proposed North Expansion West alternative. Because the dominant mineral in the evaporation ponds is sodium chloride, which is very soluble, water that contacts this material is expected to increase in sodium, chloride, and TDS concentrations. This increase in concentrations is expected to be a transient condition and is not expected to impact ground water quality.

Potential Change to Beneficial Use of Ground Water

Beneficial uses of the waters of the State of Utah are defined in the Utah Water Quality Standards to include wildlife, fish and aquatic life, domestic, agricultural, industrial, recreational, and other legitimate uses. No domestic, industrial, recreational or agricultural ground water users or supply wells have been identified to date within a 2-mile radius downgradient (north) or cross gradient (west and east) of the existing impoundment or proposed North Expansion West. Ground water downgradient from the existing tailings impoundment is discharged to these areas generally has TDS concentrations in excess of 10,000 mg/l. Because ground water quality is not expected to be impacted by the existing tailings impoundment or the proposed north expansion area, beneficial use of ground water is not expected to be changed.

Loss/Replacement of Monitor Wells

Construction of North Expansion West alternative will result in the need to abandon and replace some monitor wells. Wells will need to be abandoned to allow for the construction of the alternative. The impacts of the loss/replacement of monitor wells is not expected to be significant.

3.3.3.5 Comparison of Alternatives

Impacts associated with the No Federal Action and the North Expansion West alternative are compared in Table 3-13.

No Federal Action

With No Federal Action, tailings would continue to be discharged to and raise the elevation of the existing tailings impoundment. Water quality data indicate that the existing tailings impoundment has not impacted ground water quality in the area. The lack of impacts is due to:

1) relatively good quality of water used to slurry tailings compared to the poor quality of water in the shallow aquifer in the area of the existing tailings impoundment which is a discharge area for the shallow aquifer,
2) chemical properties of the tailings and tailings water which prevent the development of acidic conditions and leaching of metals,
3) the chemical composition of the tailings which, with the exception of copper, is very similar to native soils in the area,
4) the small vertical hydraulic conductivities and poor drainage characteristics of the tailings which limits the vertical movement of water within the tailings, and
5) the small vertical hydraulic conductivity and relatively larger horizontal hydraulic conductivity of the shallow aquifer which promotes horizontal flow of water to the drainage system.

Implementation of No Federal Action is not expected to cause additional impacts to ground water quality. No monitoring wells will need to be abandoned or replaced to implement this alternative.

North Expansion West Alternative

With the North Expansion West alternative, tailings would continue to be discharged to the existing tailings impoundment until a maximum height of 250 feet is reached. A new 3,294-acre impoundment immediately adjacent and to the north of the existing tailings impoundment would be constructed. This area is underlain by a continuous 9-foot thick layer of the Bonneville Clay. The new tailings impoundment would be 250 feet high and would cover the evaporation ponds at the former Morton Salt Plant and the phosphogypsum stack and other features of the former Chevron Phosphate Plant.

The placement of tailings and tailings water placed on the North Expansion West alternative is expected to have minimal impacts on ground water quality in the area due to:

- the small vertical hydraulic conductivities ($3x10^{-6}$ to $3x10^{-7}$ cm/s) and poor drainage characteristics of the tailings which limits the vertical movement of water within the tailings,
- the relatively larger horizontal hydraulic conductivities ($5x10^{-5}$ to $4x10^{-3}$ cm/s) small vertical hydraulic conductivities ($4x10^{-8}$ to $3x10^{-7}$ cm/s) of the underlying Bonneville Clay which promotes horizontal flow of water to the drainage system,
- relatively good quality of water used to slurry tailings compared to the poor quality of water in the shallow aquifer in the area of the proposed North Expansion West alternative which is a discharge area for the shallow aquifer,
- chemical properties of the tailings and tailings water which prevent the development of acidic conditions and leaching of metals, and
- the chemical composition of the tailings which, with the exception of copper, is very similar to native soils in the area.

Implementation of the North Expansion West alternative will result in more than 200 feet of tailings being placed directly on the former Chevron Phosphate Plant. Placement of tailings and tailings water on the phosphogypsum stack is expected to have minimal impacts to ground water quality in the area due to the presence of chemical and physical barriers. A physical barrier is

created by the relatively small vertical hydraulic conductivities of the underlying Bonneville Clay ($<1x10^{-6}$ cm/s) and larger hydraulic conductivities of the overlying phosphogypsum stack (up to $6x10^{-4}$ cm/s). The contrast in hydraulic conductivities will result in radial flow of water out towards the drainage blanket. Even though the primarily direction of flow will be horizontal versus vertical, some water could flow down into the underlying Bonneville Clay. However, the Bonneville Clay contains large amounts of calcium carbonate (17.8 to 27.9 percent) which is expected to buffer the acidic water from the phosphogypsum stack. Overtime, alkaline tailings water will displace acidic phosphogypsum water. Preliminary results of modeling performed for Kennecott indicates that water in the phosphogypsum stack will be flushed to the drainage blanket within about 10 years.

Monitor wells for this alternative are to be established in various places within the new impoundment (as shown on Figure 1-2). A total of four wells were identified for abandonment and replacement in the May 1994 Addendum to the Ground Water Discharge Permit Application to implement this alternative.

Comparison of Alternatives

Potential Impacts of No Federal Action and proposed North Expansion West alternative are compared in Table 3-13.

Proposed mitigation includes controls of discharges to ground water and monitoring of ground water. The underlying Bonneville Clay will act as a natural liner and provide the needed restriction of vertical flow to limit discharge of tailings water to ground water. Radial flow out from the existing tailings impoundment will be captured by the drainage blanket and reused as process water.

A ground water monitoring program is proposed in the November 1993 Ground Water Discharge Permit Application and in subsequent May 1994 Addendum. Exact locations of monitor wells, analytical parameters, monitoring frequencies, and protection levels will be specified by the DWQ in the Ground Water Discharge Permit is issued

Table 3-13
Potential Ground Water Quality Impacts

Potential Impact	Comparison of Alternatives	
	No Federal Action	North Expansion West Alternative
Potential for Tailings Slurry Water to Degrade Ground Water Quality	No Significant Impact	No Significant Impact
Potential for Leachate to be Generated by Tailings and Degrade Ground Water Quality	No Significant Impact	No Significant Impact
Potential for Phosphogypsum Stack Water and Solids to Impact Ground Water Quality	No Impact	Limited Impact
Potential for Slag in Drainage Blanket to Impact Ground Water Quality	No Impact	No Impact
Potential for Evaporation Pond Solids to Impact Ground Water Quality	No Significant Impact	No Significant Impact
Loss/Replacement of Monitor Wells	No Impact	Minor Impact
Potential for Beneficial Use of Local Ground Water to Be Changed	No Impact	No Impact

3.3.4 Proposed Mitigation

3.3.4.1 Surface Water

The existing wetlands mitigation plan will address mitigation for the wetlands to be displaced by the imprint of the new impoundment and relocated utilities, railroad and sedimentation ponds. It is not expected that additional mitigation, beyond the current plan, will be proposed for mitigation of the displaced wetlands.

The net result of the proposed expansion would be a decrease in total contaminants discharged to Great Salt Lake due to the effective closure of the former salt evaporation ponds. While quality of water in the C-7 West Ditch discharge would decrease due to lower flows, total contaminant discharges to the lake would decrease. Flow at the Lee Creek outlet would increase to an average of near 100 cfs, but the elimination of discharges from the former salt evaporation ponds would result in much higher water quality at this discharge.

The issue of whether the change in water quality at the C-7 West Ditch discharge point would affect wildlife or wildlife habitat is addressed in Section 3.2.

The likely result of further study, based upon data reviewed to date, is that there will be a significant increase in flow in lower Lee Creek, with a significant improvement in water quality in terms of TDS. The likely change in water quality as relates to trace metals is indeterminate at this time (see "Data Gaps" below). Flow at the existing discharge point into Great Salt Lake will decrease in quantity and, probably, quality. The existing West C-7 Ditch has higher copper, lead, selenium, and zinc levels than the C-7 Ditch. The need for mitigation will depend upon an assessment of the effect of the water quality change or regulatory compliance and on growth of any existing wetlands for the stretch of channel located between I-80 and Great Salt Lake at the existing discharge point.

3.3.4.2 Ground Water

For the geochemical and hydrogeologic reasons given herein, neither No Federal Action (Alternative 1) nor North Expansion West (Alternative 5) are expected to degrade ground water quality in the Shallow Aquifer or underlying Principal Aquifer and Bedrock Aquifer. In the November 1993 Ground Water Discharge Permit Application and May 1994 Addendum, Kennecott has proposed discharge control and ground water monitoring in conjunction with contingency and corrective action plans to: 1) assure adequate protection of ground water quality; and 2) prevent any impairment to present and future beneficial uses of the ground water. The permit application is currently in review by DWQ and the compliance monitoring program, discharge controls, and contingency and corrective action plans described herein are subject to change.

Discharge control will be accomplished through: 1) the presence of natural liners with small vertical hydraulic conductivities, provides a natural liner; 2) the small vertical hydraulic conductivity of the tailings themselves ($3x10^{-7}$ to $3x10^{-6}$ cm/s); and 3) radial flow to and capture by the drainage blanket and associated drainage ditches. The Bonneville Clay underlies all of the North Expansion West (Alternative 1) and most of No Federal Action (Alternative 5).

The Bonneville Clay will be used as a natural liner due to its small vertical hydraulic conductivity ($4x10^{-8}$ to $3x10^{-7}$ cm/s). According to the Ground Water Discharge Permit Application, approximately 500 acres of the existing Tailings Impoundment directly overlies the Bedrock Aquifer which consists of fractured quartzite, dolomite, and limestone of Paleozoic age. Drilling and coring by Kennecott indicates that although the Bedrock Aquifer is more permeable at depth, at the surface (now buried by tailings) fractures are filled with fine-grained sediments. The small vertical and relatively larger horizontal hydraulic conductivities of the tailings and Bonneville Clay promote overall horizontal flow of water. Horizontal flow is further promoted by the construction of drainage ditches around the perimeter of each alternative.

Radial flow to the drainage ditches will be further promoted by the upward vertical hydraulic gradient present in the area. Although vertical hydraulic gradients are expected to be reversed from upward to downward under the footprint of each alternative, the area of this reversal is not expected to extend beyond the area of the impoundment. Once outside of the footprint of the Tailings Impoundment, upward vertical gradients will dominate and promote discharge of ground water to the drainage ditches.

The need to implement mitigation measures will be determined by compliance with a proposed ground water monitoring program. Monitor wells are located along the boundary of each facility and are potentially downgradient from each facility. Proposed ground water compliance monitoring parameters include: pH, TDS, sulfate, arsenic, cadmium, copper, lead, and selenium. Concentrations of these parameters observed in compliance monitor wells will be compared with ground water protection standards to determine if ground water quality has been impacted. The DWQ will determine what the ground water protection standards are; however, Kennecott has proposed that a protection standard be established for each parameter in each well. Each protection

standard will be equal to the mean concentration of the parameter observed in the well during a baseline monitoring period plus two standard deviations.

If a ground water protection standard is exceeded during compliance monitoring and 5 rounds of monthly verification monitoring confirm the exceedance, then, according to the permit application, Kennecott will:

- Investigate the source, nature and extent of the release to the ground water which may have caused the exceedance;
- Conduct a risk assessment to evaluate the need for compliance actions;
- Identify corrective action alternatives;
- Evaluate the feasibility of corrective action alternatives; and
- Institute corrective action if necessary and practical.

The risk assessment will consider potential human and ecological receptors and evaluate the potential adverse effects of the release including potential or actual:

- routes of exposure and contaminant concentrations;
- effects of contamination on humans (toxicity);
- human populations at risk;
- adverse effects on affected plants, animals, ecosystems and other natural resources: and
- adverse effects on future use of ground water.

Downgradient water users and water supply wells with a 2-mile radius down and cross gradient (north, west and east) from the site will be considered. No downgradient ground water users or supply wells have been identified to date.

Depending on the results of the risk assessment, Kennecott will then conduct a feasibility study to identify and evaluate potential alternatives for corrective action. Such a feasibility study could include assessment and evaluation of:

- monitoring to determine the potential for concentrations to be reduced to below protection levels by natural processes;
- ground water extraction;
- physical or hydraulic barriers;
- *in-situ* chemical stabilization; and
- petitioning the Water Pollution Control Committee for alternate concentration limits that would still reduce potential risks.

Results of the feasibility study would be submitted to the DWQ in the form of a corrective action plan.

3.4 EARTH RESOURCES

3.4.1 Affected Environment

3.4.1.1 Geology

The existing tailings impoundment and the proposed expansion area at the north end of the impoundment lie within the Jordan Valley. The Jordan Valley is bounded by two mountain ranges: the Oquirrh mountains to the west and the Wasatch mountains to the east. Major fault zones border the eastern slope of each of these ranges. Erosion of sediments from the adjacent mountains were deposited within the Jordan valley through a complex series of rising and falling lake levels. These cycles controlled the location, distance, and depth of sediment deposits in the valley. Based on a Bouguer gravity survey, Quaternary sediments within the valley are up to 1250 feet thick and Tertiary sediments extend to a depth of about 4800 feet (Woodward-Clyde, 1994b). The sediments fill a northwest-southeast channel that extends beneath the existing tailings impoundment and proposed expansion area north of the impoundment. Sediment thickness increases markedly from south to north beneath the current tailings impoundment.

In late Pleistocene time (10,000 to 150,000 years ago), the upper 150 feet of sediments underlying the existing tailings impoundment were deposited in either deep to shallow lakes or during interglacial periods similar to present day conditions. Quaternary sediments deposited within the

last 30,000 years were dominated by Lake Bonneville, of which Great Salt Lake is a present day remnant. Quaternary sediments have been divided into two subgroups: 1) Lake Bonneville and post-Lake Bonneville deposits and 2) pre-Lake Bonneville deposits (Klohn Leonoff, 1992).

Post-Lake Bonneville deposits consist of sediments that have been re-worked by wind and fluvial transport. These deposits range in thickness from 3 to 5 feet. Lake Bonneville sediments include deep lake deposits of clay, silt, and fine sand. Several major cycles of expanding and receding water levels of Lake Bonneville affected how the sediments were deposited. At the existing tailings impoundment, these sediments range up to 15 feet in depth (Klohn Leonoff, 1992).

Soils beneath the Lake Bonneville deposits were deposited within the Cutler Dam and the Interglacial and Little Valley lake cycles (Woodward-Clyde, 1994b). The Cutler Dam lake cycle (30,000 to 45,000 years ago) deposits are similar to the Lake Bonneville deposits and consist of shallow to deep lake lacustrine deposits. These deposits generally range from 15 to 35 feet deep. The Interglacial and Little Valley cycles represent interlacustral environments with occasional short lake cycles are composed of a thick series of sediments. Table 3-14 characterizes the typical layers of sediment found in the Jordan Valley.

The existing tailings impoundment and the proposed expansion area are underlain by the Upper Bonneville Clay sub-unit. This sub-unit averages 9 feet in thickness and consists of clay and silty clay with occasional thin discontinuous beds of sand that were deposited during the deep lake interval of the Bonneville Lake Cycle. The Upper Bonneville Clay appears to be continuous across the proposed expansion area based on extensive subsurface explorations. The Upper Bonneville Clay is underlain by the Lower Bonneville Clay, which is approximately 6 feet thick, and generally consists of lensed clays and sands with occasional beds of sand to 6 inches thick (Woodward-Clyde, 1992b).

Table 3-14
Typical Quaternary Stratigraphy

Lake Cycle	Maximum Thickness (ft)	Depositional Characteristics	Age (1000 Years)
Bonneville	15	Lacustrine clays, silty clays, and sandy clays; interbedded clays and sands	10-30
Cutler Dam	20	Interbedded lacustrine clay, silty clay, and sand.	30-45
Interglacial Period	92	Reworked lacustrine and alluvial deposits; deltaic lensed clay, silt and sand. Beached sand with lensed clay and silt.	60
Little Valley	>1000	Interbedded clays, silts and sand (cyclic glacial shallow to deep lacustrine, and interglacial deltaic deposits)	120+

* From Woodward-Clyde (1994b) and Kennecott (1993)

3.4.1.2 Physiography

The study area is located in the northwest portion of the Jordan Valley within the Basin and Range Physiographic Province at the northern end of the Oquirrh Mountains adjacent to Great Salt Lake. The Jordan Valley is a sediment filled basin extending from Great Salt Lake southward to the Traverse Mountains. During recent geologic time, the dominant changes in the area landforms has been erosion of the mountains into lakes (Lake Bonneville) occupying the adjoining basins, resulting in a series of shallow lake cycles followed by deeper lake cycles (SWCA, 1994c). During shallow lake cycles, coarser grained sand deposits were deposited in the area by the actions of the Jordan River delta.

Landforms associated with the study area generally consist of made land (tailings piles or fill), lacustrine/tidal flat deposits, and minor sand and gravel bars (Bio/West 1993b). Topography throughout the proposed study area is relatively flat with an overall elevation difference of approximately 10 feet across the area. Dominant surface features include fills, drainages, and evaporation ponds.

3.4.1.3 Seismicity

The study area is located within the southern portion of the Intermountain Seismic Belt, a major zone of seismicity in the western United States. The Intermountain Seismic Belt is characterized by late-Quaternary normal faulting, dispersed shallow seismicity generally occurring in the top 15 to 20 km of the crust, and periodic scarp or cliff-forming earthquakes (Woodward-Clyde, 1994a).

Since 1850, the largest historic earthquakes observed within the region have included three earthquakes measuring approximately 5.5 Richter magnitude (M_L). Ten earthquakes have exceeded M_L 5.0, however, none have been greater than M_L 6.0 in historic times. Geologic evidence shows repeated M7 earthquakes and greater occurring along the Wasatch fault zone. The strongest ground shaking in the area in recent times was the 1934 (M_L 6.6) Hansel Valley earthquake which created surface ruptures at the north end of Great Salt Lake (Woodward Clyde, 1994a).

Woodward Clyde (1994a) recognized seven significant seismic sources within the Salt Lake Valley: the Wasatch, East Great Salt Lake (divided into Promontory Mountains and Antelope Island Segments), north Oquirrh, West Valley, Stansbury, the Saltair Resort Structure, and random background seismicity.

Based on deterministic analyses, the Maximum Credible Earthquake at the site was concluded to be a moment magnitude (M_w) 7.0 earthquake occurring on the Antelope Island segment of the East Great Salt Lake fault. The Maximum Credible Earthquake is defined by state statues as "the most severe earthquake that is believed to be possible at the site on the basis of geological and seismological evidence". For source-to-site distances of 1.5 to 3.3 km, the peak horizontal ground acceleration on deep soil was estimated to be 0.52g.

The peak horizontal acceleration for the Operating Basis Earthquake, the maximum earthquake which can be expected to occur during the lifetime of the structure, was 0.29g. This value was based on a probablistic seismic hazard analysis considering an average return period of about 500 years for an M_w 6.5 random earthquake at a source-to-site distance of 8 km.

Stability analyses on the existing tailings impoundment conclude that the impoundment is stable under static conditions, however, it must be upgraded to improve its dynamic stability. If a large earthquake were to occur in the Salt Lake Valley, the saturated, fine-grained tailings underlying the embankment shell could liquefy, potentially causing an impoundment failure.

3.4.1.4 Soil Resources

Soils at expansion area were mapped by Soil Conservation Services (SCS) in 1974. SCS mapping was confirmed by Bio-West (1993b). Soils include the Bramwell silty loam (BrB), Jordan silty clay loam (Jo), Lasil silt loam (LcA), Saltair Resort silty clay loam (Sa), sandy borrow pits (Se), sandy alluvial land (Sd) and dumps. The SCS report indicates that the Bramwell silt loam is the only soil present at the expansion area suitable for reclamation. Additional studies by Morrison Knudsen (Kennecott, DOGM Report) indicate that some soils of the undisturbed sandy alluvial land (Sd) and undisturbed Jordan silty clay loam (Jo) may be suitable for reclamation. Kennecott plans to remove soils suitable for reclamation in the early stages of construction and utilize them in the visual buffer corridor adjacent to Interstate I-80. Kennecott has determined that the depth of soil suitable for reclamation would range up to 15 inches and total approximately 57,500 cu yds. Other soils in the study area are not considered a soil resource for establishing vegetation due to their strong salinity/alkalinity.

where is map & data?

3.4.2 Environmental Consequences

3.4.2.1 Overview

Potential geologic impacts resulting from the North West Expansion alternatives include:

- areal settlement, and
- seismic upgrade of existing tailings impoundment.

Impacts to earth resources will generally be limited to visual impacts resulting from vegetation grubbing and topsoil removal and will be addressed in Section 3.6 Visual Resources.

3.4.2.2 Methods

To assess the significance of areal settlement, the following criteria were utilized:

High Impact - Induces stress or settlement in adjacent structures or compromises the integrity of the existing and/or proposed tailings impoundment.

Moderate Impact - May induce settlement of adjacent structures; integrity of existing and/or proposed tailings impoundment would not be compromised.

Low Impact - Induces tolerable settlement of adjacent structures

No Impact - No measurable impact on adjacent structures

To assess the significance of seismically upgrading the existing tailings impoundment, the following criteria were utilized:

High Impact - Significantly improves the seismic stability of the existing impoundment

Moderate Impact - Provides limited improvement of the existing impoundment

Low Impact - Improves limited areas of the existing impoundment

No Impact - No improvement of existing impoundment

3.4.2.3 Results

Based on the criteria presented in section 3.4.5.1, the geologic impacts resulting from each alternative are presented in Table 3-15.

Table 3-15
Impact Assessment

	IMPACT TYPES							
	Areal Settlement				Seismic Upgrade			
ALTERNATIVE	High	Moderate	Low	No	High	Moderate	Low	No
No Federal Action			X				X	
North Expansion (West)		X				X		

No Federal Action

Kennecott studies have shown that the Upper Bonneville Clay acts as a natural liner.

Areal Settlement - Any facilities within the zone of influence of areal settlement of the existing tailings impoundment should have already settled. Increasing the height of the existing impoundment, as proposed for the No Federal Action alternative would be expected to cause additional settlement of adjacent facilities.

Seismic Upgrade - Under the No Federal Action alternative dewatering and stepbacks of the existing tailings impoundment would continue, however, seismic upgrade would be minimal. This would reduce the potential for impoundment failure should liquefaction of fine-grained tailings occur.

Due to the thickness and lateral extent of the Upper Bonneville Clay, differential settlement of the expansion alternative is not expected to comprise the integrity of the *in situ* clay liner. However, facilities such as bridges, roadways, railroad lines, or buildings could be adversely affected by areal settlement should facility foundations be within the zone of influence of areal settlement.

North Expansion West

Areal Settlement - The North Expansion West alternative would be expected to cause significant settlement within the footprint of the expanded impoundment and may cause settlement of facilities adjacent to the expanded impoundment footprint. Considering the number of facilities in the vicinity of the proposed expansion area, limited settlement of adjacent facilities would be expected.

Seismic Upgrade - The North Expansion West would not provide an extensive stabilizing berm of the northeast corner, however, a berm on the north and northwest perimeter of the existing tailings impoundment would be constructed. Dewatering of the east side and the southeast corner would be implemented.

3.4.7 Proposed Mitigation

Mitigation of settlement of facilities adjacent to the proposed expansion footprint would consist of siting facilities in areas outside of the zone of influence of potential areal settlement. Existing critical facilities that cannot be relocated should be monitored for adverse settlement so that minor modifications of the footprint can be implemented to minimize settlement to tolerable amounts.

The expansion area would utilize the Upper Bonneville Clay as an *in situ* liner. Areas, such as drainages where the thickness of the underlying clay is determined to be inadequate, would be infilled with clay to effect a continuous *in situ* clay liner system.

Seismic upgrade of the existing facility should include adequate stabilizing berms, particularly for the northeast corner and north perimeter of the existing impoundment. Dewatering efforts for critical areas not upgraded by a stabilizing berm should be implemented.

3.5 LAND USE, TRANSPORTATION AND UTILITIES

3.5.1 Overview

The proposed modernization of the tailings impoundment is located west of Salt Lake City, Utah. The majority of the study area is privately owned by Kennecott and is zoned for agriculture or industry. Since near the turn of the century, the study area has been dominated by mining and industrial uses, supporting the following enterprises: Kennecott mine operations, the Morton Salt evaporation and manufacturing facility, and the former phosphate processing facility previously owned by Chevron (see Figure 1-2, Existing Operations).

Numerous small, private, light industries and municipal operations are active in the southeastern portion of the study area, including automobile parts recycling, a drilling company, tire recycling, warehousing, private and municipal landfills, and a wastewater treatment plant. These industries and municipal uses are clustered north of State Highway 201 between County Roads 8000 West and 7200 West, with several landfills located east of the existing impoundment.

The study area is bounded and crossed by numerous transportation corridors, mainly for vehicle traffic. This includes Interstate 80 (I-80) to the north and west, State Highway 201 to the south, and State Highway 202 linking I-80 and Highway 201. Several city-maintained roads cross the study area, and the Union Pacific Railroad (UPRR) operates two interstate commerce railroads in the area.

Other land uses in the study area include non-intensive agricultural uses such as open pasture and grazing, open space, a small amount of residential use, and utilities. Residential use occurs primarily east and southeast of the study area, within the town of Magna. Within the study area, one small area of single-family homes lies east of the Magna Golf Course and less than five private residences are scattered north of State Highway 201 along County Road 8000 West. Several easements for railroads, utilities, and roadways have been granted throughout the study area, including the UPRR, Utah Power & Light Company (UP&L), Mountain Fuel Natural Gas, and a fiber optic telecommunications line.

3.5.2 Issues

The main land use issues associated with the proposed project are:

- potential effects on existing utilities,
- modification or relocation of transportation facilities,
- changes or limitation in access resulting from modifying transportation facilities,
- potential effects on grazing activities, and
- potential effects on other industrial facilities.

The specific land use issues within the study area are discussed in the Environmental Consequences section of this analysis.

3.5.3 Affected Environment

3.5.3.1 Methods

The goal of the land use inventory was to identify and describe all the existing, planned and designated land uses in the study area. The land use study was divided into three major components: land jurisdiction, existing and planned land use, and transportation and access. Data inventories were determined from land use and zoning maps of the study area, aerial photographs, review of existing resource literature, and consultation with land use specialists familiar with the area.

Land jurisdiction refers to the limits of administrative authority of a federal, state, or local government agency. Land owners were also identified for private property in the study area.

Existing and planned land use identifies all surface uses and proposed uses by the land owner or administrator. Three existing and planned land use categories were identified for the study area: industrial, agricultural, and range. Industrial land uses include manufacturing and processing facilities, warehouses and distribution centers, junkyards, landfills and utilities. Agricultural land

uses include all forms of irrigated and non-irrigated farming, commercial production of food crops, and cultivated pasture. Range is primarily open lands that in their natural condition provide habitat for wildlife, and includes public or private lands commonly used for grazing livestock.

The transportation and access component identifies the existing network of roads (e.g., highways, state roads, access roads) to facilities in the study area.

3.5.3.2 Results

Land Jurisdiction and Ownership

Mining operations in the area began in 1903 by the Utah Copper Company. In 1936, the Utah Copper Company was purchased by Kennecott Copper Corporation and became known as Kennecott Utah Copper Corporation. Kennecott currently owns all of the property in the study area, except for the existing railroad track alignment and marshalling yard owned and operated by Union Pacific Railroad (UPRR). Kennecott purchased the Morton Salt property (processing facilities, offices, and the salt impoundment lands) in 1991. In 1994, Kennecott bought the phosphogypsum tailings property from Chevron. Union Pacific Resources-Minerals (UPRM) leases the slag processing facilities west of State Road 202 (Highway 202) from Kennecott (see Figure 1-2).

The study area includes jurisdictional wetlands and other waters of the United States, including saline playas, gull colony areas, open water and overflow basins that are under the administrative authority of the U.S. Army Corps of Engineers.

Jurisdiction for existing transportation and utility facilities includes:

- Utah Power & Light - electrical power lines,
- Mountain Fuel - gas lines,
- US West - fiber optic cables,
- Union Pacific Railroad - rail line,

- Utah Department of Transportation - I-80, Highway 201, Highway 202, and
- Salt Lake City/County Health Department - landfills.

Existing and Planned Land Use

Existing industrial land uses in the study area include the existing tailings impoundment; the phosphogypsum tailings impoundment, UPRM slag processing facility, and Kennecott slag pile to the southwest of the Highway 202; and the smelter, refinery, Arthur Facilities, and North Concentrator to the south and southwest of the existing tailings impoundment. North of the existing impoundment is the property previously owned by Morton Salt for evaporation ponds and salt production. There are seven existing landfills in the area:

- southeast of Highway 202,
- on the southwest section of the existing tailings impoundment,
- at the existing salt evaporation facilities site north of the existing tailings impoundment,
- the Mackey Landfill east of the existing tailings impoundment and south of 2100 South,
- the Salt Lake City/County Landfill Parcel 1 (reclaimed) east of the existing tailings impoundment on the northwest corner of 7200 West and 2100 South,
- the Salt Lake City/County Landfill Parcel 2 east of the existing tailings impoundment and south of 2100 South, and
- east of the existing tailings impoundment, east of 7200 West and north of 2100 South.

Although there are no current agricultural activities in the study area, 3,291 acres of the study area were zoned A-1/A-20 Agriculture until May 1994 at which time an area covering 660 acres to the east of the northeast segment of the existing tailings impoundment and west of 7200 West is currently leased, in part, for grazing by Kennecott to Gilmore Livestock. Prior to a recent zoning change requested by Kennecott, the study area encompassed three classifications of zoning:

M-2 Manufacturing

- existing 5,700-acre tailings impoundment,
- surrounding land north to the current UPRR line,

- surrounding land west to I-80 (including the phosphogypsum tailings impoundment),
- surrounding land east to 8000 West,
- surrounding land south and west toward the Oquirrh Mountains, and
- area of land north of the existing tailings impoundment previously rezoned from A-20 to M-2 by Morton Salt.

A-1 and A-20 Agriculture

- land north of the existing tailings impoundment to I-80, and
- land east to 7200 West.

M-1A Industrial

- area of land in the northeast corner of the study area, west of 7200 West and south of I-80.

In May 1994, Kennecott received approval for rezoning 3,291 acres from A-20 to M-2 for tailings impoundment storage from the Salt Lake County Planning Commission. The majority of the area zoned as A-20 is saline flats and not desirable for agricultural use. This land is not recognized by the Soil Conservation Service as "prime or unique farmland" and was being used as salt impoundments to the north and grazing to the east.

The planning goals for the study area of the Salt Lake County Planning Commission, the Magna Community Plan, and the Salt Lake City Draft Northwest Quadrant Master Plan are mixed industrial use, the preservation and enhancement of wildlife habitat, and open space.

Transportation and Access

Existing transportation and access routes in the study area include:

- I-80, an east-west highway that passes to the north and west of the existing tailings impoundment,
- Highway 201, an east-west highway from Salt Lake City to I-80, which runs along the south boundary of the existing tailings impoundment and north of the town of Magna,

- Highway 202, a southeast-northwest highway that serves as a connector from I-80 to Highway 201 and the mine facilities on the west side of the existing tailings impoundment,
- UPRR rail line,
- UPRM access road to Highway 202,
- 2100 South, an east-west road on the south side of the existing tailings impoundment, and
- access roads on the existing tailings impoundment and through the salt evaporation property;
  - dike road,
  - pipeline road,
  - poleline road,
  - lower road,
  - access road to Bonneville Gate, and
  - C-7 Ditch access road off of 8000 West.

3.5.4 Environmental Consequences

3.5.4.1 Overview

Environmental consequences of the Project to land use were determined by comparing the proposed alternatives with the existing study area. Mitigation was proposed for impacts associated with both alternatives; impacts remaining after mitigation were identified as residual impacts.

3.5.4.2 Methods

Physical impacts to land uses were assessed for each of the land use categories listed earlier in this section. Impacts considered direct and long term include any impact that displaces, alters, or otherwise physically affects:

- any existing, developing or planned residential, commercial, industrial, government, or institutional use or activity,
- any agricultural activity,

- any established, designated or planned park, recreation, preservation, or educational use area or activity, and
- any applicable general or regional plans and/or approved, adopted or officially stated policies, goals or operation of communities or government agencies.

Land Jurisdiction

The effects of the Project to land jurisdiction involve land policies, land management plans, and permitting requirements of local, state, and federal agencies. Land jurisdictions identified in the Affected Environment discussion of this section were used to identify the potentially affected agencies and permitting requirements for both alternatives.

Existing and Planned Land Use

The majority of potential impacts to existing and planned land use would result from the direct physical conflict between the proposed Project and an existing land use feature. Conflicts with existing land uses can be resolved by relocating displaced facilities to comparable locations and mitigating the impact on site.

Transportation and Access

Impacts to highways, roads, and other travel routes would be from direct physical conflicts and right-of-way encroachment. These impacts can be mitigated through permitted relocation or modification of existing transportation routes. Right-of-way crossing agreements or permits will reduce or eliminate the impacts due to encroachment.

3.5.4.3 Results

No Federal Action

This alternative would continue raising the 5,700-acre existing impoundment area until the rate of rise compromised the static integrity of the foundation. The existing land use of the study area would not change.

North Expansion West

The following utilities, transportation facilities, and land uses would be impacted (Figure 3-6):

- relocating three Utah Power & Light (UP&L) electrical power lines (138 kV, 44 kV, 12 kV) to a new alignment adjacent to the southern boundary of the I-80 right-of-way,
- removing or abandoning existing three-inch steel and plastic gas lines,
- abandoning of a 6-inch gas line to the gypsum facility,
- relocating the existing U.S. West fiber optic cables within the new UPRR right-of-way,
- relocating existing Sprint, MCI, and SP communications facilities within the new UPRR right-of-way,
- relocating UPRR tracks approximately 400 feet south of southern boundary of the I-80 right-of-way,
- constructing a new bridge crossing of UPRR tracks on Highway 202,
- modifying existing eastbound I-80 on- and off-ramps,
- removing the existing Highway 202 overpass,
- displacing grazing activities, and
- closing the existing landfill and developing a new licensed solid waste landfill.

Additional uses of the land associated with this alternative include:

- installing Kennecott electrical power lines along the crest and the toe of the existing impoundment and

- constructing a fueling facility immediately north of the new Highway 202 overpass and east of the relocated UPRR tracks.

Kennecott would be required to design all road modifications and additions in accordance with the Utah Department of Transportation (UDOT), FHWA, and applicable local requirements. Agreements with UDOT, and possibly FHWA, would be required for the following transportation facilities:

- drainage structures across I-80,
- railroad crossings on 7200 West,
- haul road (UPRM) crossing Highway 202,
- new overpass/railroad crossing of Highway 202,
- new UPRM access road,
- C-7 Ditch West culverts passing beneath Highway 202 northwest of UPRR overpass,
- potential removal of existing Highway 202 overpass, and
- modification of existing eastbound I-80 on- and off-ramps.

Design of bridges, roads and drainage crossings would be in accordance with standards established by UDOT, UPRR, the American Association of State Highway and Transportation Officials, the American Society for Testing Materials Standards, the American Railway Engineering Association, the American Welding Society, the International Conference of Building Officials, as well as additional standards and guidelines.

Kennecott will coordinate with the Utah Department of Natural Resources, Division of Parks and Recreation regarding the closure of Highway 202, which will affect access to Great Salt Lake State Park.

Kennecott would be required to obtain approval from the following organizations for the modification, removal and/or relocation of facilities:

- US West - fiber optic cables,

- Mountain Fuel - gas lines,
- Utah Power & Light - transmission lines,
- US Sprint, MCI and SP Communications - fiber optic cables,
- Union Pacific Railroad - rail lines, and
- Union Pacific Resource Minerals - access road to slag processing facilities.

Mitigation would include creation of wildlife habitat by establishing vegetation on approximately 3,900 acres of the existing impoundment. This alternative is consistent with the planning goals of the Salt Lake County Planning Commission, the Magna Community Plan, Magna Area Council and the Salt Lake City Draft Northwest Quadrant Master Plan.

This alternative would continue raising the existing impoundment area at the rate of 7 to 8 feet annually to approximately 250 feet the natural above ground elevation, and add a new 4,018-acre impoundment area immediately north and northwest of the existing impoundment. The new area would be enclosed by an embankment approximately 250 feet high.

3.5.4.4 Proposed Mitigation and Residual Impacts

The following table specifies the mitigation that Kennecott will follow to reduce or eliminate the impacts to utilities, transportation facilities, and land uses for the North Expansion West. Residual impacts are also indicated for each planned mitigation measure.

Table 3-16
Proposed Mitigation for Land Use and Transportation

IMPACT	MITIGATION	RESIDUAL IMPACTS
UTILITIES		
Displacement of three UP&L transmission lines (138-Kv, 44-Kv, 12-Kv):	- relocate to a new 200- foot wide alignment adjacent to the southern boundary of the I-80 right-of-way, and - construct UP&L service road in the center or along the southern side of the new UP&L alignment.	None
Cancellation of service of existing Mountain Fuel gas lines to the salt evaporator facility and gypsum facility:	- cap lines and remove abandoned pipes.	None
Displacement of U.S. West fiber optic cables:	- relocate to the new 150-foot wide UPRR right-of-way south of I-80, and - construct a U.S. West microwave facility access road near the northwest end of Highway 202.	None
Displacement of Sprint, MCI and SP Communications fiber optic cables:	- relocate to the new 150-foot wide UPRR right-of-way south of I-80.	None
TRANSPORTATION		
Displacement of Union Pacific Railroad (UPRR) tracks:	- relocate tracks to approximately 400 feet south of southern boundary of I-80 right-of-way, - construct UPRR service road north of the northern rail line along the entire length of the new UPRR alignment,	- Highway 202 construction activities will necessitate a temporary closure of the highway. - Closure of Highway 202 due to construction activities will affect access to Great Salt Lake State Park.
	- possibly remove existing Highway 202 overpass after UPRR relocation, and - construct Union-Pacific Resources-Minerals (UPRM) access road intersecting Highway 202 just south of I-80 eastbound on- and off-ramps.	

Table 3-16
Proposed Mitigation for Land Use and Transportation

IMPACT	MITIGATION	RESIDUAL IMPACTS
Displacement of existing access roads in the study area:	- construct a toe dike access road (specific location to be determined), - construct a slag haul road between the starter dike and the drainage blanket construction area, - construct a slag haul road to be used as the primary route for hauling and placing materials for the first stage of construction of drainage blanket for new impoundment (specific location to be determined), and - construct the following access roads on the existing impoundment; • poleline road • Copperton single-point discharge road, and • reclamation and maintenance roads on crest of the impoundment and reclaim dikes.	None
OTHER LAND USES		
Displacement of existing C-7 West Ditch:	- relocate to an alignment along 8000 West to tie into Lee Creek, and - construct C-7 Ditch access roads on both sides of the ditch.	None
Closure of existing landfill on salt evaporation property:	- remove existing fill and development of new licensed landfill.	None
Displacement of grazing activities:	- allow the lease to expire.	None

3.6 VISUAL RESOURCES

3.6.1 Regional Overview

The Bingham Canyon Mine complex is located in the Great Basin section of the Basin and Range physiographic province (Fenneman 1931), noted for parallel mountain ranges divided by fairly level desert basins. The Wasatch Mountain Range, running east of Great Salt Lake, is approximately 80 miles long with individual peaks characterized by similar heights and slopes. Salt Lake County, population 726,000, fills the valley between the Wasatch Range and Great Salt Lake. At the south end of Great Salt Lake, the Oquirrh Mountains rise up and form the southern boundary of the study area (Figure 3-1, Existing Land Use). Smaller ranges to the west and south of the lake include the Cedar, Lakeside, Newfoundland, and Stansbury mountains. Great Salt Lake, Sevier Lake, and Provo Lake are all remnants of Lake Bonneville, which filled an area of almost 20,000 square miles in western Utah during the Pleistocene geologic era. Despite its continuous fluctuation, Great Salt Lake is considered a permanent lake.

Mountain streams form broad alluvial areas at the base of the mountains and extend into the basins. Standing water accumulates in flats, usually near the center of the basin, creating saline playa lakes.

The study area is primarily industrial with existing facilities (e.g., the smelter, refinery, the coal-fired power plant, the tailings impoundment, utility lines, railroad tracks, etc.) characterizing the landscape.

3.6.2 Issues

Impacts to visual resources are described in detail under environmental consequences in this section. Visual resource issues associated with the construction and operation of the Project include:

- views from Saltair Beach and Resort,
- views from Great Salt Lake State Park, Magna, or Salt Lake City,

- views of the tailings embankment from Interstate 80 (I-80), and
- dust visible during construction.

3.6.3 Affected Environment

3.6.3.1 Methods

This section describes the methods and types of information used in the visual resource analysis.

There are no guidelines to evaluate visual resources on private lands. The visual resource analysis for this study was developed following the methodology established by the Bureau of Land Management (BLM), known as the Visual Resource Management Inventory and Contrast Rating System (BLM, 1986).

Sensitive Viewpoints

Sensitive viewpoints are areas from where the proposed Project would be visible and may have a possible impact on the viewer. Potential critical viewpoints were identified and mapped within a five mile radius of the perimeter of the study area. Viewpoints considered include:

- residences/communities - primary or recreational residences, apartments, mobile homes, and trailer parks,
- parks, recreation, and preservation areas - existing and proposed developed recreation sites, parks, or areas used for camping, picnicking, boating, fishing, swimming, or other recreational activities, and
- travel routes - roads and highways used primarily by origin/destination travelers.

Visual Sensitivity

Visual sensitivity measures a concern by viewers to changes in the landscape. Views by large numbers of people for an extended period of time (e.g., from residences) are usually considered more sensitive. However, a large number of viewers with less concern for the proposed change

in the landscape would not necessarily cause a higher sensitivity (e.g., interstate highway travellers who represent large numbers, but are only exposed to views for a limited period of time). Views from residences are usually considered highly sensitive. Views from recreation areas are generally considered highly sensitive; however, some may be of less concern than others, depending on the significance of the recreation area. Travelers on highways and other roads are typically less sensitive to changes in the landscape, depending on the type of traffic (e.g., if used for commuting, travel to distant destinations, or scenic drives) and the lenth of time they are exposed to a particular view.

Each viewpoint was assigned a level of sensitivity (high, moderate, or low) after taking into account user type, user attitude, use volume, and view duration (see discussion below).

Visibility

Visibility is a measure of how visual changes are perceived in the landscape. The viewer's distance from a viewpoint to the study area affects how they perceive form, texture, color and other visual elements in a landscape. At greater distances, landscape elements become less detailed and less obvious, and form becomes more pronounced than color and texture. Distance zones are used to evaluate visibility. The distance zones are defined as follows:

- Foreground (0 to 1/4 - 1/2 mile) - details in the landscape are perceived and obvious, including texture and the aesthetic qualities of vegetation,
- Middleground (1/4 - 1/2 to 3-5 miles) - less perception of textures and foliage details; vegetation seen in terms of outlines or patterns,
- Background (3-5 to 15 miles) - landforms, rather than individual elements, become the dominant feature of the landscape, while perceptions of color and texture are weak, and
- Seldom Seen (beyond 15 miles) - perception blocked by topographic relief or vegetation.

View duration, viewer orientation, the number of viewers, and lighting conditions are used to determine the sensitivity of an identified viewpoint (e.g., residence, recreation area, travel route). View duration indicates the frequency and length of views from fixed or continuous linear viewpoints. Viewer orientation measures the degree to which a viewer's attention is directed

towards or away from the project in a given viewing situation. The angle of the viewer to the project and the location of distinctive landscape features in relation to the project are also a factor in viewer orientation. The number of viewers is used in combination with other visibility factors to evaluate the level of impact from an identified sensitive viewpoint. Lighting conditions, including seasonal and daily patterns of natural lighting, are used as a measure of visibility of the project from sensitive viewpoints.

3.6.3.2 Results

Landscape Character

Five landscape character types are found in the project vicinity:

- Industrial - includes the current mine operations area, smelter, and refinery,
- Urban - the town of Magna, which lies south of the existing impoundment,
- Wetlands - saline playas on the west, north and east side of the existing impoundment,
- Mountains - the Oquirrh Mountains that extend for 32 miles south from Great Salt Lake, and
- Lakes - the South Arm of Great Salt Lake.

Sensitive Viewpoints

The following sensitive viewpoints are depicted on the Existing Land Use Map Figure 3-1:

- The town of Magna - population 17,829; lies to the south of the existing impoundment; dominant sensitive viewpoints exist at residential or commercial properties along the north perimeter of the town.
- Saltair Beach and Resort - a private beach with some recreational and snack bar facilities on the southern shore of Great Salt Lake and west of the existing tailings impoundment.
- Great Salt Lake State Park - maintains a marina and picnic facilities on the southern shore of Great Salt Lake, south of the main park facility on Antelope Island.
- I-80 - an east-west freeway that passes to the north and west of the existing tailings impoundment.

- State Road 201 (Highway 201) - an east-west highway from Salt Lake City to I-80, which runs along the south boundary of the existing impoundment and north of the town of Magna.
- State Road 202 (Highway 202) - a southeast-northwest highway that serves as a connector from I-80 to Highway 201 and the mine facilities on the west side of the existing tailings impoundment.

Visual Sensitivity and Visibility

Visual sensitivity levels were assigned to the six sensitive viewpoints identified based on the type of user and the visibility factors discussed in the methods section above.

Magna - Moderate Sensitivity. The town of Magna was founded in 1906 initially as a farming community (VanCott, 1990). However, this changed rapidly as the Utah Copper Company opened the Magna Mill in the early 1900's to handle production at the Bingham Canyon Mine, and continued with the purchase of the mine by Kennecott Copper Corporation in 1936. The town of Magna has primarily developed in response to the industrial activity associated with the mine. The town of Magna has more than 80 years of exposure to the industrial character of the area, thus reducing residents' sensitivity as compared to a community viewing the construction and operation of a tailings impoundment as a new feature in the landscape.

Saltair Resort - High Sensitivity. Views from Saltair Beach, a leased beach on the shore of Great Salt Lake and the associated facilities, would have a high sensitivity due to its close proximity to the study area.

Great Salt Lake State Park - High Sensitivity. The park is approximately three to five miles from the proposed project and views include the existing tailings impoundment to the east, the Oquirrh Mountains to the south, and the lake to the north and west. The park includes a 300-slip marina and day use picnicking facilities. Recreational use occurs primarily in the summer months.

I-80 - Moderate Sensitivity. This interstate highway supports primarily distant destination travellers moving at high speeds. One potential area of reorientation is a point where eastbound

I-80 bends, turning due east towards Salt Lake City and westbound I-80 turns southwest following the shoreline of Great Salt Lake. At this bend, the attention of eastbound travelers is drawn by their first view of Great Salt Lake and the Wasatch Range, while westbound travelers see Great Salt Lake and the Kennecott smelter facility.

Highway 201 - Low Sensitivity. The primary users of this highway are travelling to or from Magna or the current mine operations area and are accustomed to the industrial character of the area.

Highway 202 - Low Sensitivity. The primary users of this highway are travelling to or from Magna or the current mine operations area and are accustomed to the industrial character of the area.

3.6.4 Environmental Consequences

3.6.4.1 Overview

Environmental consequences of the proposed Project include potential visual impacts to viewers from Saltair Beach and Resort, Great Salt Lake State Park, Magna, I-80, Highway 201, and Highway 202.

Visual impacts are expected from the following construction activities (see Figure 3-6 Project Plan):

- relocating three Utah Power & Light (UP&L) electrical power lines (138kV, 44kV and 12kV) to a new alignment adjacent to the southern boundary of the I-80 right-of-way,
- relocating the Union Pacific Railroad (UPRR) tracks approximately 400 feet south of southern boundary of the I-80 right-of-way,
- constructing a new crossing of UPRR tracks on Highway 202,
- modifying existing eastbound I-80 on- and off-ramps,
- potentially removing existing Highway 202 overpass,

- relocating the C-7 Ditch approximately 200 feet from the southern boundary of the I-80 right-of-way,
- removing a substantial portion of the existing Kennecott slag pile,
- removing the former fertilizer facility, and
- removing and consolidating existing utility lines and poles south of I-80.

Long term visual impacts are also expected from the new tailings impoundment area and the resulting approximately 250 foot embankment, which would be a visually dominant structure in the middle ground from the Saltair Resort beach area if one looks southeast.

3.6.4.2 Methods

Visual Contrast

Visual contrast is a measure of the physical change in a landscape due to the proposed Project. Three components are used to determine contrast levels:

- landform contrast - contrast identified with changes in landform patterns, disturbance of natural features, exposure of soils, and other disturbances seen as uncharacteristic to the natural landscape,
- vegetation contrast - contrast determined by the diversity and complexity of vegetation types and patterns, and
- structure contrast - examines the compatibility of the proposed project with the landscape.

Three visual contrast levels were assigned to the study area: strong, moderate and weak. These contrasts are based on the predicted disturbance resulting from the modernization of the existing tailings impoundment and the construction of a new impoundment in the study area. Contrasts range from strong (incompatible disturbances to the landscape) to weak (disturbances consistent with existing landscape).

A matrix was developed to compare contrast levels with sensitivity levels from sensitive viewpoints (Table 3-17). Potential visual impacts to sensitive viewers were determined by

evaluating the degree of perceptible visual change from sensitive viewpoints within each distance zone. Impact levels of high, moderate, low and no impact were assigned.

Table 3-17
Visual Impact Matrix

Distance Zones	Contrast Levels		
	Weak	**Moderate**	**Strong**
Foreground	low	moderate-high	high
Middleground	low	low-moderate	moderate-high
Background	low	low	moderate
Seldom Seen	no impact	no impact	no impact

Definitions of the impact levels identified in Table 3-9 are as follows:

- High Impact - Impacts resulting if the construction, operation, or maintenance of the Project would potentially be perceived by the viewer as significant or a substantial adverse change to the landscape.
- Moderate Impact - Impacts resulting if the construction, operation, or maintenance of the Project would potentially be perceived by the viewer as a noticeable change to the landscape.
- Low Impact - Impacts resulting if the construction, operation, or maintenance of the Project would potentially be perceived by the viewer as an insignificant or small change to the landscape.
- No Impact - No identifiable impact would be indicated or no measurable impact to the landscape would potentially be perceived by the viewer.

3.6.4.3 Results

This section discusses the potential impacts on the visual resources and proposed mitigation for each of the proposed alternatives.

No Federal Action

Under this alternative, the industrial landscape character would not change. Views from Magna, Saltair Beach and Resort, Great Salt Lake State Park, and the specified travel routes currently include a tailings impoundment area,with an average height of 190 feet,and the smelter complex. The annual average rate of rise of the impoundment under this alternative would be 7 to 8 feet, eventually reaching approximately 250 feet and capacity by 2004. There would be no perceptible change in views from the current sensitive viewpoints due to gradual rise of the impoundment over nine years.

North Expansion West

This alternative would continue raising the existing tailings impoundment area at the rate of 7 to 8 feet annually to approximately 250 feet and add a new impoundment area immediately north and northwest of the existing impoundment. This new area would be enclosed by an embankment 250 feet high, constructed over 25-30 years of mine operations. The industrial landscape would not change.

The closest views of the new impoundment area from residential and commercial properties on the north perimeter of Magna are more than 2.5 miles away, thus viewer perception, if any, would be in the middleground distance zone and would result in a low impact.

Views from Saltair Beach, a leased beach and concert arena on the shore of the South Arm of Great Salt Lake would have a high sensitivity due to its close proximity to the study area. The views to the southeast would be changed by the new impoundment area and the proposed embankment. However, the full height of the new embankment would not be reached for 25 years

and views to the west would be improved by the reduction in the slag pile to the south and the removal of the fertilizer facility. In some places, the embankment at its ultimate height could obstruct some scenic background views of the Wasatch Mountains. Viewer duration of the embankment would depend on the type of user. Day users would be oriented towards Great Salt Lake or the Wasatch Mountains, depending on their activity. Given the proximity of the new embankment to I-80 and the location of Saltair Beach within one-quarter mile from I-80, viewer perception would be in the foreground and middleground depending on the exact distance zones location (and evaluation) of the viewer. From most locations in or near Saltair Beach, the impact would be moderate and after the impoundment is at full height (i.e., 25-30 years); it could be perceived as significant or high impact.

Great Salt Lake State Park is approximately five miles from the proposed impoundment, thus viewer perception would be in the middleground distance zone. Current views from this park include the South side of the existing impoundment (foreground) and the Wasatch Mountains (background) to the east and Great Salt Lake to the north and west. In some places, the embankment could obstruct current scenic background views of the Wasatch Mountains. Viewer duration of the embankment will depend on the use of the park area. The marina has 300 slips available for boats. During the summer, the marina usually operates at full capacity; during winter, approximately 250 slips are continually occupied. Boats moored at the marina would be oriented either towards Great Salt Lake or inland and would have significant view durations, depending on the length of their stay. Day users would most likely be oriented towards Great Salt Lake and/or the Oquirrh Mountains and Wasatch Range. Impacts of the new impoundment area on viewers would be moderate due to the gradual increase in height of the embankment and that the views of the Wasatch Range would be on the horizon (background).

Views from I-80 would include the new embankment to the east and south and Great Salt Lake to the north and would have a moderate sensitivity. The toe of the proposed 250-foot embankment would be less than 1/4 mile from I-80, thus viewer perception would be in the foreground distance zone. View duration would be intermittent, due to the speed of traffic at 65 mph, and competing views from Great Salt Lake and the Wasatch Range. In addition, travellers would already be exposed to the proposed embankment by the time they reached the primary reorientation point

midway in the study area (the bend in the road as I-80 follows the contour of the lake). Viewer orientation would be primarily at a 90 degree angle, as the embankment would run parallel to the interstate. Impacts of the new impoundment would be moderate due to viewer orientation to the road, competing views, and viewer angle.

Views from Highway 201 include the existing tailings impoundment and would have a low sensitivity. The primary users are travelling either to or from Magna or the mine operations area and the gradual rise of the existing impoundment would not likely alter the perception of views associated with the mine operations. The closest views of the new impoundment area from the highway are more than 2.5 miles away, thus viewer perception would be in the middleground distance zone. A change in the existing impoundment and the addition of a new impoundment away from the road would result in low impacts from this travel route.

Views from Highway 202 include the existing tailings impoundment and mine operations. This viewpoint has a low sensitivity as the primary users are travelling either to the mine operations area or the town of Magna. The closest views of the new impoundment area from the highway would be 1/4 to a 1/2 mile away in this alternative, thus viewer perception would be in the foreground distance zone. A change in the existing impoundment and the addition of a new impoundment away from the road would most likely not alter the drivers' perception of views associated with the mine operations and would result in low impacts.

3.6.5 Proposed Mitigation

Kennecott has proposed specific measures to mitigate the impacts to viewers as a result of a new tailings impoundment. Kennecott's overall mitigation strategy for a visual buffer, embankment planting, and dust control includes a combination of five types of reclamation activities throughout the construction, operation, closure, and post closure of the proposed tailings impoundment.

General features of all the specified reclamation types include:

- watering the tailings area to provide the necessary moisture to control fugitive dust emissions until reclamation activities are carried out in any given area of the impoundment,

- applying tackifier to areas disturbed by construction or on embankment slopes to control dust until vegetation takes hold, and
- treating roads on site with dust pallative and patrolling with water trucks and graders to control fugitive dust.

Reclamation Type 1 - Drill Seeding, would use a range drill seeder to plant both initial and second plantings of seed and fertilizer in areas of the impoundment that are accessible with conventional equipment and can be planted before the surface dries and creates a dust problem. Drill seeding would be used to restore construction disturbances (including the visual buffer), for interim and final exterior slopes and for parts of the top surface of the impoundment. The initial reclamation seed mix would include annual rye, cereal rye, or regreen or rye cultivar. These rapidly growing cereal grasses have shown to be successful in reclaiming portions of Kennecott's existing tailings impoundment. The second seeding would include grasses (e.g., Thickspike wheatgrass, intermediate wheatgrass, western wheatgrass, slender wheatgrass, pubescent wheatgrass and indian rice grass), forbs (e.g., yarrow, pacific aster, utah sweetvetch, lewis flax, 'ranger' alfalfa, yellow sweetclover and rocky mountain penstemon) and shrubs (antelope bitterbrush, stansbury cliffrose, basin big sagebrush and rubber rabbitbrush, among others).

Reclamation Type 2 - Conventional Hydroseeding, would use truck-mounted hydroseeding equipment to place initial and second plantings in areas of the impoundment with steep side slopes, difficult access or where using a spray nozzle or hand line is feasible.

Reclamation Type 3 - Amphibious Hydroseeding, would use amphibious tractors (swamp buggies) for initial planting in areas on top of the impoundment that would not support conventional wheeled or tracked equipment. The surface of the impoundment is expected to dry sufficiently between planting seasons so that second plantings are expected to be carried out using conventional drill seeding equipment.

Reclamation Type 4 - Supplemental Dust Control, involves work by Kennecott's reclamation crew to provide dust control measures (e.g., irrigating, tackifying, hydroseeding dry spots) to reduce

or eliminate fugitive dust in areas of the impoundment that dry out before the previous seeding efforts take hold.

Reclamation Type 5 - Trees and Shrubs, includes plantings in areas previously vegetated using Types 1, 2 or 3 methods. Trees and shrubs would be planted in clusters in the visual buffer and on select areas on the side and top of the impoundment for visual diversity. Plantings of trees and shrubs would also occur on the top of the edge of the impoundment to act as a wind break. Actual tree and shrub species planted in the visual buffer and along the impoundment would depend on the species available at that time, but could include: Trees - bolleana poplar, black locust, russian olive, honey locust, and globe willow; and shrubs - antelope bitterbrush, stansbury cliffrose, basin big sagebrush and rubber rabbitbrush.

Reclamation strategies specific to each phase of the project (construction, operation, closure and post closure) include:

Construction

- limiting the acreage disturbed at any particular time,
- observing sedimentation control practices specified by the Environmental Protection Agency and the Utah Department of Transportation, and
- reclaiming all areas outside of the actual tailings disposal area that are disturbed during construction prior to startup of operations.

Operation

- reclaiming the impoundment exterior with each annual rise in the dike, and
- using the toe ditch at the base of the impoundment to capture sediments and runoff from the impoundment slopes.

Reclamation activities during operations would continue from the start of operation.

Closure

- subdividing the impoundment surface into manageable areas to be reclaimed sequentially

- reclaiming all exterior slopes, access roads, pipeline routes and adjacent facilities including the removal of all unneeded tailings management facilities

Reclamation activities during closure would begin one year before active tailings management ends and would be expected to continue for a number of years.

Post Closure

- ongoing reclamation monitoring and reporting

Reclamation activities during post closure would begin after the last seeding, fertilization and irrigation activity within each area and continue until the Division of Oil, Gas and Mining and Kennecott determine that it is no longer needed.

3.6.6 Residual Impacts

Residual impacts after mitigation would be expected in the construction of the new impoundment area and the resulting approximately 250-foot embankment. The visual buffer placed in front of the embankment would not totally mitigate the visual impacts of the relocated utility lines and the railroad next to I-80. The height of the vegetation in the buffer would not eliminate the visual impacts for viewers at Saltair Beach and Resort, Great Salt Lake State Park, or on I-80 because of the large size of the embankment, even though it also will be revegetated. Views of the Wasatch Mountains from Saltair Beach and Resort, as well as Great Salt Lake State Park would continue to be partially obstructed by the embankment.

3.7 SOCIOECONOMICS

3.7.1 Affected Environment

Kennecott's Tailings Modernization Project (the Project) is located at the northwestern corner of Salt Lake County at the foot of the Oquirrh Mountains next to Great Salt Lake, near the Salt Lake County/Tooele County boundary. The existing tailings impoundment lies adjacent to Kennecott's

smelter complex and the community of Magna, about 15 miles west of downtown Salt Lake City and, just south of Interstate 80 and the Union Pacific Railroad mainline. The Project lies close to a booming metropolitan region whose population, within a one-hour commute, exceeds 1.2 million and is growing by more than 25,000 persons per year.[1]

As one of Utah's major employers, Kennecott directly supports a payroll in excess of 2,500 mine workers, and its purchase of goods and services provides income and employment to many thousands of businesses and households. Kennecott accounts for more than one half of the value of all metals produced from Utah's mines and a major share of Utah's (and nation's) exports (Governor's Office of Planning and Budget, 1994b). All of this activity depends on the operation being able to safely store and manage tailings, which are currently generated at a rate of about 153,000 tons per day. As described earlier, Kennecott's source of copper ore, the Bingham Canyon Mine, contains proven and probable reserves to support production at current levels for another 25 to 30 years. The existing tailings impoundment can accommodate perhaps 15 to 20 percent of the projected 1.9 billion tons of tailings that would be generated over the remaining life of the mine. Unless additional storage capacity is developed, the Utah operation would be forced to shut down within the next decade.

This socioeconomic impact analysis examines the demographic and socioeconomic effects of Kennecott's proposed alternative approach to meeting the tailings storage requirements. The North Expansion West alternative has the lowest total combined capital and long term operating costs (including costs of environmental impact mitigation measures), and is thus the most cost-effective alternative approach to meeting environmental protection requirements. The No Federal Action alternative is also examined. This alternative would entail stopping Kennecott's Utah operations when the existing tailings impoundment reaches its capacity around the year 2004.

Before the impacts of the two alternatives are evaluated, the current levels and trends of socio-economic characteristics in the region will be summarized. The focus will be on Salt Lake and

---

[1]Consisting of the Wasatch Front counties of Salt Lake, Davis, Morgan, Tooele and Weber (Governor's Office of Planning and Budget, 1994a).

Tooele Counties, which account for the bulk of economic and social resources affected by Kennecott's Utah operations.

3.7.2 Baseline Characteristics

3.7.2.1 Population

Utah's population, which was 1.73 million in 1990, is projected to reach 2.13 million in the year 2000, 2.60 million by 2010, and 3.11 million by 2020 (Governor's Office of Planning and Budget, 1994a). Most of the increases will be the result of natural growth (births exceeding deaths), but 29 percent of the projected growth over the next three decades will be due to a net surplus of immigration.

Salt Lake and Tooele counties have been experiencing overall year-to-year population growth rates of one to two percent per year, reaching an estimated combined population of 805,000 in mid-1993 (Salt Lake--777,000, Tooele--28,100; Governor's Office of Planning and Budget, 1994b). Together with Davis, Morgan and Weber Counties, which with Salt Lake and Tooele Counties make up the Wasatch Front group of Utah's counties. Counties in the Project region hold over three-fourths of Utah's total population. Relatively low housing costs and rapidly expanding employment opportunities (from both internal and external forces), fueled by a business climate attractive to industries relocating or expanding operations from elsewhere in the western states, have generated extraordinary growth of population throughout the Wasatch Front.

Utah's population is relatively young, due to Utah's higher than average fertility rate. The 1990 Census revealed that 37 percent of the state population was under 18 years of age versus the national average of just 26 percent. And while the over-65 years component was expanding rapidly, its share of the total state population was still significantly below the 1990 national average--at 8.7 percent versus 12.5 percent, respectively. By 2020, the Wasatch Front counties' population is projected to grow by more than 861,000 persons over the 1990 level, reaching 1.96 million. Of these, 1.28 million will be in Salt Lake County, while about 49,000 will be in Tooele

County, mostly in the northeast corner next to Salt Lake County (Governor's Office of Planning and Budget, 1994a).

3.7.2.2 Employment

As noted earlier, Salt Lake County has a dynamic economy, stemming directly from Utah's overall strong performance in recent years. Rapid growth of jobs has been the result. According to the September 1994 Federal Reserve Bank of San Francisco's *Western Economic Developments*: "Utah continues to report the fastest job growth in the nation, as August employment was up 6.4 percent from a year ago."

Statewide employment in August 1994 stood at 861,500, with only 3.5 percent of the civilian labor force unemployed. The national unemployment rate in the same month was 6.1 percent, with some states higher, such as California at 8.9 percent (SF Federal Reserve Bank, 1994).

Two-thirds of the jobs in Utah are located in the Wasatch Front Counties, with Salt Lake County representing nearly three-fourths of the group total. In 1991, total employed persons in Salt Lake County numbered 469,834 (by place of work), composed of 399,883 wage and salary workers and 69,951 proprietors and self-employed persons (Bureau of Economic Analysis, REIS, 1994). Tooele County's employed population numbered 12,961 persons, 11,058 of whom were wage and salary workers and 1,903 were proprietors and self-employed. Table 3-18, presents the distribution of employment among industrial sectors for Salt Lake and Tooele counties in 1991. This is the primary labor pool that will be affected by the Project.

3.7.2.3 Personal Income

Statewide, there has been strong growth of income due to the rapid expansion of investment, employment and population since the late 1980s. Utah's total income in 1993 was forecast to be $30.4 billion, up 7.3 percent from 1992. The national economy, in comparison, was projected to have income growth of only 4.6 percent in the same period (Governor's Office of Planning and Budget, 1994b). Continued strong growth in income is projected in the future, based on Utah's

Table 3-18

Salt Lake and Tooele Counties

Composition of Employment, 1991

Sector	No. Jobs	Percent
Farming	1,350	0.3%
Agricultural services	2,508	0.5%
Mining	3,610	0.7%
Construction	23,284	4.8%
Manufacturing	52,979	11.0%
Transportation and public utilities	30,499	6.3%
Wholesale, retail trade	109,432	22.7%
Finance, insurance, real estate	44,696	9.3%
Services	139,673	28.9%
Government	74,764	15.5%
Total Employment	482,795	100.0%

Source: Bureau of Economic Analysis, 1994.

great attractiveness to industries seeking a favorable climate for investment, supported by a well-educated work force and pro-business local governments.

Residents of Salt Lake and Tooele counties had total personal income of $13.7 billion in 1992, composed of $11.7 billion in labor earnings, $1.8 billion in transfer payments (mostly Social Security and other retirement), and $1.8 in dividends, interest and rent (BEBR, 1994). These income flows yielded per capita income levels of $17,408 in Salt Lake County and $14,810 in Tooele County.

3.7.3 Environmental Consequences

3.7.3.1 No Federal Action

Projected Costs of Mine Shutdown

Denial of Kennecott's application to carry out the Project would force the company to cease mining activities at the Bingham Canyon mine and associated ore transportation, concentration, smelting and refining operations in 1999. Kennecott estimates that it could continue to operate at current levels until 2027 with the Project. Termination of operations would result in the foregoing of over $22 billion in operating and capital expenditures over the 29-year period (KUC, 1994a).

If the Project does not go forward, Kennecott estimates that it would spend about $38 million in capital expenditures between 1993 and 1997 to prepare the existing tailings impoundment for closure, plus another $19 million between 1999 and 2002 to carry out the actual closure. Table 3-19 presents the schedule of expenditures for the shutdown scenario. Operation of the existing tailings impoundment before shutdown would require outlays of approximately $11 million per year until 1999, after which operating costs would decline to around $4 million per year through 2002 and then drop to $200 thousand per year (for dewatering activities) through the year 2031 (KUC, 1994a).

Kennecott's mining and metal production activities currently include annual operating and capital replacement outlays of approximately $750 million per year, for labor, energy and utilities, materials and equipment, and state and local taxes (KUC, 1994a). These outlays would cease, beginning in 1999. Five hundred million dollars' worth of capital investments in expanded production capacity that was scheduled for the period 2002-2004 would also not be made. A low level of activity would continue at the site, but the expenditures would be negligible: mine closure costs of approximately $5 million per year would be incurred between 2002 and 2014, and property maintenance and security services would be required until the mid-2020s (these would gradually decline over time, initially amounting to about $2 million per year, but declining to $500,000 per year by 2014) (KUC, 1994a).

Table 3-19
No Federal Action Alternative - Schedule of Payments
(in millions of 1993 dollars)

	TAILINGS PROJECT			KENNECOTT UTAH COPPER SHUTDOWN					
YEAR	CAPITAL	CLOSURE	OPERATING	CLOSURE	LOST OPERATING	LOST SUSTAINING CAPITAL	SHUTDOWN MAINT. & SECURITY	LOST CAPITAL	COMBINED TOTAL
1993	4.000								4.000
1994	5.000								5.000
1995	12.000								12.000
1996	12.000								12.000
1997	1.011								1.011
1998									0.000
1999		4.774	10.000	5.000	(650.000)	(100.000)	2.000		(728.226)
2000		4.774	4.000	5.000	(650.000)	(100.000)	2.000		(734.226)
2001		4.774	4.000	5.000	(650.000)	(100.000)	2.000		(734.226)
2002		4.775	3.725	5.000	(650.000)	(100.000)	2.000	(100.000)	(834.500)
2003			0.200	5.000	(650.000)	(100.000)	2.000	(200.000)	(942.800)
2004			0.200	5.000	(650.000)	(100.000)	2.000	(200.000)	(942.800)
2005			0.200	5.000	(650.000)	(100.000)	2.000		(742.800)
2006			0.200	5.000	(650.000)	(100.000)	2.000		(742.800)
2007			0.200	5.000	(650.000)	(100.000)	1.000		(743.800)
2008			0.200	5.000	(650.000)	(100.000)	1.000		(743.800)
2009			0.200	5.000	(650.000)	(100.000)	1.000		(743.800)
2010			0.200	5.000	(650.000)	(100.000)	1.000		(743.800)
2011			0.200	5.000	(650.000)	(100.000)	1.000		(743.800)
2012			0.200	5.000	(650.000)	(100.000)	1.000		(743.800)
2013			0.200	5.000	(650.000)	(100.000)	1.000		(743.800)
2014			0.200	1.350	(650.000)	(100.000)	0.500		(747.950)
2015			0.200		(650.000)	(100.000)	0.500		(749.300)
2016			0.200		(650.000)	(100.000)	0.500		(749.300)
2017			0.200		(650.000)	(100.000)	0.500		(749.300)
2018			0.200		(650.000)	(100.000)	0.500		(749.300)
2019			0.200		(650.000)	(100.000)	0.500		(749.300)
2020			0.200		(650.000)	(100.000)	0.500		(749.300)
2021			0.200		(650.000)	(100.000)	0.500		(749.300)
2022			0.200		(650.000)	(100.000)	0.500		(749.300)
2023			0.200		(650.000)	(100.000)	0.500		(749.300)
2024			0.200		(650.000)	(100.000)	0.500		(749.300)
2025			0.200		(650.000)	(100.000)	0.500		(749.300)
2026			0.200		(650.000)	(100.000)	0.500		(749.300)
2027			0.200		(650.000)	(100.000)	0.500		(749.300)
2028			0.200						0.200
2029			0.200						0.200
2030			0.200						0.200
2031			0.500						0.500
TOTAL	34.011	19.097	27.825	76.350	(18,850.000)	(2,900.000)	30.000	(500.000)	(22,062.717)

Source: KUC, 1994a.

In all, a shut down of Kennecott's Utah operations in 1999, instead of 2027, would result in an initial minor increase in total annual outlays of upwards of $12 million per year over current levels

as existing tailings impoundment closure preparations proceeded. However, from 1999 to 2027 the lost outlays in operating and capital expenditures would amount to around $750 million per year. From 2028 to 2031 the only outlays would be a few hundred thousand dollars per year to continue dewatering the existing tailings impoundment.

Economic and Social Impacts of Kennecott Shutdown

To estimate the economic impacts of the Project, the IMPLAN system of input-output modeling was used. IMPLAN, supported by the Minnesota IMPLAN Group, provides county-based data on interindustry transactions among sectors of the local economy, upon which multiplier effects of changes in demand and output can be estimated. The system is based on the national input-output model developed by the Bureau of Economic Analysis of the U.S. Department of Commerce. Based on economic census data, the national model database is disaggregated to the state level and then to the county level. IMPLAN software then is used to estimate employment, income and industrial output multipliers for any grouping of counties (in this case, the entire state of Utah).

Kennecott's total value of production of copper, gold, silver and other minerals in Utah is currently estimated to be approximately $900 million per year (in 1993 dollars; BEBR, 1991b, and KUC, 1994a). Of this, approximately $750 million is absorbed in direct production and investment costs, as tabulated in Table 3-19. Among these outlays are payroll costs, purchases of goods and services from local and non-local vendors (known as "intermediate inputs") and state and local taxes, all of which become income to households and businesses in the state. The infusion of wages and salaries, purchases, capital earnings (profits, rents and interest) and local taxes has a multiplicative effect on the regional economy because it stimulates successive rounds of spending and investment before ultimately being absorbed in savings or payments to non-local providers of goods and services. The process of economic effects is divided into three levels: direct, indirect, and induced. Direct effects go to the initial recipients of an entity's spending, namely the employees and the owners of the establishment or institution generating the activity, and the tax jurisdictions where the activity is located. Indirect effects go to the suppliers of goods and services bought by the entity, wherein the suppliers, in turn, re-spend their earnings from the initial purchases to resupply their own stocks. Finally, induced effects occur as a result of the households receiving

direct and indirect wage and capital earnings engaging in consumption spending that supports, mainly, the trade and services sectors of the regional economy. By the end of the spending and re-spending cycles, the cumulative level of income, employment and output typically can exceed the initial infusion by factors of two to three or more.

Removal of a stream of direct spending from the economy can have a negative multiplier effect, which would result from shutting down Kennecott's Bingham Canyon Mine operation. To estimate the magnitude and distribution of the economic impacts, IMPLAN models for Utah and for the combined counties of Salt Lake and Tooele were constructed and fed scenarios postulating a $900 million reduction in gross output of copper ore and refined copper, gold and silver. The results are presented in Table 3-20, which shows the three levels of effects in three panels. Reading across the panels, the first column shows the value of final sales by industries in each year. The second column shows the value of intermediate inputs of goods and services purchased by industries from one another and from non-local suppliers to produce the final goods and services. The third column shows the value of worker compensation, including fringe benefits and social security payments. The fourth column shows the earnings of proprietors and other property income (rents, dividends and interest). Local indirect taxes (mainly property and sales taxes) are shown in the fifth column, while the sixth shows the contribution of all sectors to Gross Regional Product.[2] The final column indicates the number of full time equivalent (FTE) annual jobs resulting from the Project.

Reviewing Table 3-20, the company's annual output of $900 million per year ultimately supports more than $1.6 billion per year in gross industrial output throughout Utah, implying additional indirect and induced output equal to 78 percent of the Kennecott's direct value of output (IMPLAN estimate, 1994). The company's payroll of over $100 million (including fringe benefits but not unemployment insurance and workman's compensation) directly supports 2,285 full time equivalent jobs; secondary (indirect plus induced) effects of the operation generate an additional 6,600 jobs throughout the regional economy, yielding a total of nearly 8,900 primary and secondary jobs (3.89

[2]The contribution to Gross Regional Product is equal to Total Value Added by regional industries, which is the sum of employee compensation, proprietors' income and other capital earnings, and indirect business taxes.

times the direct jobs). As the middle panel indicates, most of the indirect and induced employment is generated in the mining, trade and services sectors, supported by secondary wages and salaries totalling about $156 million per year. These jobs and earnings would be lost with shutdown. The Kennecott Utah operation directly and indirectly adds $445 million per year to Utah's Gross Regional Product and generates an estimated $45 million in state and local indirect business taxes.

Loss of the 8,900 direct, indirect and induced jobs, most of which are located in Salt Lake and Tooele counties, would essentially eliminate mining employment in the two counties, reduce wholesale and retail trade employment by about 1.3 percent and reduce services employment by almost 1.6 percent (based on comparison of the jobs data in Panel 3 of Table 3-20 with Table 3-18). While the latter two sectors would not be affected significantly on the whole, establishments located in communities nearby the operation would be seriously impacted, notably in the Magna area and communities near the Bingham Canyon Mine. Geographically, the socioeconomic impacts of shutdown would be concentrated near the Kennecott's operations, and it could be expected that the fiscal conditions and service capabilities of adjacent local governments and districts would be impacted by losses of sales and property taxes. Residential and commercial real estate values in nearby communities would drop as working age owners move away in search of other employment opportunities.

3.7.3.2 North Expansion West Alternative

Resource Requirements

The kinds and amounts of manpower and material resources needed to expand the existing tailings impoundment determine the Project's economic and social impacts. Kennecott has estimated that total costs of labor, procurements of materials, construction and operating equipment, construction management services, land, support services and sales and use taxes for the North Expansion West alternative would amount to $531.91 million (in terms of 1992, fourth quarter prices) (KUC, 1994b). Approximately 90 percent of the expenditures would be made in Utah representing in-state earnings to Utah workers and enterprises of $478.44 million (KUC, 1994b). County and local

governments would be projected to spend an additional $28.56 million from additional sales and property tax earnings related to the Project.

The direct capital expenditures would be made over a period of seven years, two of which--1993 and 1994--have already seen preconstruction outlays of about $90 million. Table 3-21, presents Kennecott's proposed schedule for capital expenditures on the Project. As can be seen, the bulk of the outlays would occur towards the end of the schedule when the majority of work on earthworks and facilities installation would be performed.

Table 3-20
No Federal Action (Shutdown)
Annual Impacts, 2004-2027 (Values in Millions of 1993 Dollars)

PANEL 1: DIRECT EFFECTS							
Sector	Total Expenditures	Intermediate Inputs	Employee Compensation	Capital Earnings	Indirect Taxes	Gross Reg. Product	Jobs (FTE)
AG, FORESTRY & FISHERIES	0.00	0.00	0.00	0.00	0.00	0.00	0
MINING	686.07	562.57	88.87	20.25	14.39	123.50	1,999
CONSTRUCTION	0.00	0.00	0.00	0.00	0.00	0.00	0
MANUFACTURING	213.93	183.30	11.81	17.78	1.04	30.63	286
TRANSP, COMM & UTILITIES	0.00	0.00	0.00	0.00	0.00	0.00	0
TRADE	0.00	0.00	0.00	0.00	0.00	0.00	0
F.I.R.E.	0.00	0.00	0.00	0.00	0.00	0.00	0
SERVICES	0.00	0.00	0.00	0.00	0.00	0.00	0
GOVERNMENT	0.00	0.00	0.00	0.00	0.00	0.00	0
TOTAL	900.00	745.86	100.68	38.03	15.42	154.14	2,285

PANEL 2: INDIRECT + INDUCED EFFECTS							
Sector	Total Expenditures	Intermediate Inputs	Employee Compensation	Capital Earnings	Indirect Taxes	Gross Reg. Product	Jobs (FTE)
AG, FORESTRY & FISHERIES	1.23	0.84	0.22	0.17	0.01	0.40	29
MINING	309.97	261.54	38.58	4.18	5.67	48.43	884
CONSTRUCTION	12.26	4.79	5.74	1.63	0.11	7.47	269
MANUFACTURING	76.31	46.06	15.68	12.96	1.61	30.25	477
TRANSP, COMM & UTILITIES	91.65	35.16	18.65	31.52	6.32	56.49	454
TRADE	44.69	9.61	22.67	5.79	6.62	35.09	1,428
F.I.R.E.	64.82	17.42	12.68	27.43	7.28	47.40	704
SERVICES	93.09	34.34	37.86	18.94	1.95	58.75	2,227
GOVERNMENT	11.84	5.20	4.12	2.52	0.00	6.65	126
TOTAL	705.87	414.94	156.21	105.14	29.57	290.92	6,598

PANEL 3: TOTAL EFFECTS							
Sector	Total Expenditures	Intermediate Inputs	Employee Compensation	Capital Earnings	Indirect Taxes	Gross Reg. Product	Jobs (FTE)
AG, FORESTRY & FISHERIES	1.23	0.84	0.22	0.17	0.01	0.40	29
MINING	996.04	824.11	127.45	24.43	20.05	171.94	2,884
CONSTRUCTION	12.26	4.79	5.74	1.63	0.11	7.47	269
MANUFACTURING	290.24	229.35	27.49	30.74	2.65	60.88	762
TRANSP, COMM & UTILITIES	91.65	35.16	18.65	31.52	6.32	56.49	454
TRADE	44.69	9.61	22.67	5.79	6.62	35.09	1,428
F.I.R.E.	64.82	17.42	12.68	27.43	7.28	47.40	704
SERVICES	93.09	34.34	37.86	18.94	1.95	58.75	2,227
GOVERNMENT	11.84	5.20	4.12	2.52	0.00	6.65	126
TOTAL	1,605.87	1,160.81	256.89	143.18	44.99	445.06	8,883
Multipliers	1.78	1.56	2.55	3.76	2.92	2.89	3.89

Source: KUC, 1994a; IMPLAN, 1994; Dames & Moore estimates.

Economic Impacts

Table 3-22 presents a breakdown of the projected capital expenditures for the North Expansion West alternative to be disbursed to Utah workers and businesses. The data cover all seven years of the construction schedule, and were used to identify the industrial sectors of the regional economy that would be stimulated by the Project. These data were formatted into inputs to the IMPLAN model for the state of Utah. Direct expenditures for construction first impact the Project's construction workers and then the Project's suppliers of construction materials, equipment and services. Their expenditures, in turn, induce rounds of increased consumption spending among households receiving income directly or indirectly from the Project, which ultimately adds up to a multiple of the Project's original direct expenditures. The multiplier effects can, however, work in either direction. Reductions in capital spending following completion of the Project would lead to a reduction in regional incomes and employment over time, as suppliers and households adjust to the removal of the capital spending stimulus and the regional economy returns to its pre-project per capita levels of activity (albeit at a higher overall level of activity due to continued population and economic growth during the intervening years).

Table 3-21
Capital Expenditure Schedule

Year	Capital ($'000 1992:4)	Cumulative
1993	21,088	21,088
1994	68,410	89,498
1995	81,766	171,264
1996	88,668	259,932
1997	123,557	383,489
1998	141,360	524,849
1999	7,060	531,909

Source: KUC, 1994b.

Year-to-year projections of impacts are contained in Table 3-23. As is indicated in the bottom panel of the table, cumulative total industry outlays would be projected at over $830 million (i.e., the sum of total expenditures that would be made directly and indirectly in Utah--all in terms of constant 1992 dollars). Workers would cumulatively earn around $210 million while business profits and other capital earnings would amount to $122 million. Local governments would derive over $48 million in local taxes, while Gross Regional Product would be increased by over $380 million. Total employment generated by the Project would be projected at over 10,000 worker-years, with the largest increments occurring in 1997 and 1998.

The distribution of the project's impacts among economic sectors in the peak year is shown in Table 3-24, again using the three-panel format. In that year, direct employment at the Project site would be estimated at 1,181 FTE jobs. Indirect and induced multiplier effects translate the direct employment and procurements into another 1,707 jobs elsewhere throughout the state economy, for a total of 2,887 jobs. Total worker earnings would be projected at $56 million while total expenditures would be an estimated $220 million.

Table 3-22
Capital Summary: North Expansion West - Procurements From Utah Suppliers
(values in thousands of 1992:4 dollars)

Description	LABOR:				MATERIAL & EQUIP.		CONST.	Home Off.	Supplier	Indirect Business Taxes			TOTAL
	Wages	Fringe	FICA	Total 1/	Amount	Freight	EQUIP.	Ovrhd.	Profit	Sales	Ppty	Total IBT	UTAH
Civil	2,983	230	210	3,423	18,284	367	1,119	1,216	1,348	1,214	321	1,535	27,292
Earthwork	23,720	1,936	1766	27,422	25,653	505	38,296	5,225	7,832	1,699	3,848	5,547	110,479
Concrete	1,752	143	130	2,025	2,557	49	317	426	441	158	282	440	6,255
Steel	501	39	36	576	1,915	39	226	160	151	123	64	187	3,254
Architectural	83	8	6	97	230	5	14	16	22	12	14	26	410
Unit Construction	255	18	16	289	1,699	33	9	149	182	113	12	125	2,486
Mech Bulks	808	55	50	913	1,932	37	2	587	393	132	3	135	3,999
Mech Equipment	554	45	41	640	16,776	341	127	151	275	1,064	83	1,147	19,457
Piping	11,815	979	892	13,686	35,079	705	2,549	705	705	2,256	2,353	4,609	58,037
Electrical Equip.	1,704	126	116	1,946	6,116	124	96	124	124	388	132	520	9,050
Wireway	5	0	0	5	35	1	14	1	1	2	1	3	60
Wire & Cable	169	14	13	196	744	15	11	39	46	47	28	75	1,126
Instrumentation	1,712	118	108	1,938	3,024	59	4	1,206	678	205	16	221	7,130
Subtotal Direct Costs	46,060	3,711	3,384	53,155	114,043	2,280	42,784	10,005	12,198	7,413	7,157	14,570	249,035
Common Distributables	953	79	72	1,104	2,225	45	1,188	0	291	91	217	308	5,161
Construction Management	5,424	450	410	6,284	4,673	94	0	0	1,654	190	1,236	1,426	14,130
Engineering	620	51	47	718	767	15	0	0	189	31	1,271	1,302	2,991
Total EPCM	6,997	580	529	8,106	7,665	154	1,188	0	2,133	312	2,724	3,036	22,282
Total Dir. & EPCM	53,057	4,291	3,913	61,261	121,707	2,434	43,972	10,005	14,331	7,725	9,881	17,606	271,317
Contingency	4,443	359	327	5,129	11,999	240	3,539	978	1,643	739	976	1,715	25,243
Subtotal Field Costs	57,500	4,650	4,240	66,390	133,706	2,674	47,511	10,983	15,974	8,464	10,857	19,321	296,560
*Kennecott Support	4,699	394	356	5,449	376	8	0	55	0	26	925	951	6,839
Supplemental Scope	286	24	22	332	1,299	26	0	0	87	88	59	147	1,891
Land Acquisition	0	0	0	0	53,900	1,100	0	0	0	0	0	0	55,000
Wetland Mitigation	4,596	381	347	5,324	20,859	417	0	0	1,401	1,418	943	2,361	30,362
Ultimate Capacity	12,611	1,046	953	14,610	44,728	899	0	1,359	3,238	3,042	2,178	5,220	70,055
Contingency	914	76	69	1,059	5,487	111	0	0	278	373	187	560	7,495
Subtotal Owner's Cost	23,106	1,921	1,747	26,774	126,649	2,561	0	1,414	5,005	4,947	4,292	9,239	171,642
Total	80,606	6,571	5,987	93,164	260,356	5,235	47,511	12,397	20,979	13,411	15,149	28,560	468,202

Source: KUC, 1994b.

Note 1. Compensation exclusive of employer's contributions to unemployment insurance and workman's compensation.

Table 3-23
Socioeconomic Impacts - North Expansion West

PANEL 1: UTAH EXPENDITURES–DIRECT EFFECTS ($MM 1992:4) (INCL. LOCAL GOVT. SPENDING)							
Year	Total Expenditures	Intermediate Inputs	Employee Compensation	Capital Earnings	Indirect Taxes	Gross Reg. Product	Jobs (FTE)
1993	19.695	13.070	4.789	0.898	0.937	6.625	176
1994	63.890	42.398	15.537	2.915	3.040	21.491	571
1995	76 363	50.676	18.570	3.484	3.633	25.687	683
1996	82.809	54.953	20.138	3.778	3.940	27 856	740
1997	115.393	76.576	28.062	5.264	5.490	38.816	1,031
1998	132.019	87.610	32.105	6.023	6.281	44.409	1,180
1999	6.593	4.376	1.603	0.301	0.314	2.218	59
Total	496.762	329.659	120.806	22.662	23.635	167.103	4,440

PANEL 2: UTAH EXPENDITURES–INDIRECT+INDUCED EFFECTS ($MM 1992:4) (INCL. LOCAL GOVT.)							
Year	Total Expenditures	Intermediate Inputs	Employee Compensation	Capital Earnings	Indirect Taxes	Gross Reg. Product	Jobs (FTE)
1993	13.230	4.742	3.561	3.957	0.971	8.489	254
1994	42.920	15.382	11.553	12.835	3.150	27.538	826
1995	51.299	18.385	13.809	15.341	3.764	32.915	987
1996	55 630	19.937	14.974	16.636	4.082	35.693	1,070
1997	77.519	27.781	20.867	23.182	5.688	49.737	1,491
1998	88.688	31.784	23.873	26.523	6.508	56.904	1,706
1999	4.429	1.587	1.192	1.325	0.325	2.842	85
Total	333.716	119.598	89.830	99.799	24.488	214.118	6,419

PANEL 3: UTAH EXPENDITURES–TOTAL EFFECTS ($MM 1992:4) (INCL. LOCAL GOVT. SPENDING)							
Year	Total Expenditures	Intermediate Inputs	Employee Compensation	Capital Earnings	Indirect Taxes	Gross Reg. Product	Jobs (FTE)
1993	32.925	17.811	8.351	4.855	1.908	15.114	431
1994	106.810	57.780	27.090	15.750	6.189	49.030	1,397
1995	127.663	69.061	32.379	18.825	7.398	58.602	1,669
1996	138.439	74.890	35.113	20.414	8.022	63.549	1,810
1997	192.911	104.358	48.929	28.446	11.179	88.554	2,523
1998	220.708	119.394	55.979	32.545	12.789	101.313	2,886
1999	11.023	5.963	2.796	1.625	0.639	5.060	144
Total	830.478	449.257	210.636	122.461	48.124	381.221	10,859
Multipliers:	1.67	1.36	1.74	5.40	2.04	2.28	2.45

Source: KUC, 1994; IMPLAN, 1994; Dames & Moore estimates

Table 3-24
Peak Year (1998) Economic Impacts of North Expansion West

PANEL 1: DIRECT EFFECTS ($MM 1992:4) (INCL. LOCAL GOVTS. SPENDING)

Sector	Total Expenditures	Intermediate Inputs	Employee Compensation	Capital Earnings	Indirect Taxes	Gross Reg. Product	Jobs (FTE)
AG, FORESTRY & FISHERIES	0.00	0.00	0.00	0.00	0.00	0.00	0
MINING	0.00	0.00	0.00	0.00	0.00	0.00	0
CONSTRUCTION	115.55	84.15	20.31	4.87	6.21	31.39	515
MANUFACTURING	0.00	0.00	0.00	0.00	0.00	0.00	0
TRANSP, COMM & UTILITIES	0.28	0.02	0.08	0.16	0.02	0.26	2
TRADE	0.00	0.00	0.00	0.00	0.00	0.00	0
FIN., INSUR., REAL EST.	0.00	0.00	0.00	0.00	0.00	0.00	0
SERVICES	7.97	3.44	3.48	0.99	0.06	4.53	214
GOVERNMENT	8.23	0.00	8.23	0.00	0.00	8.23	450
TOTAL	132.02	87.61	32.11	6.02	6.28	44.41	1,181

PANEL 2: INDIRECT AND INDUCED EFFECTS ($MM 1992:4) (INCL. LOCAL GOVTS. SPENDING)

Sector	Total Expenditures	Intermediate Inputs	Employee Compensation	Capital Earnings	Indirect Taxes	Gross Reg. Product	Jobs (FTE)
AG, FORESTRY & FISHERIES	3.24	2.15	0.65	0.43	0.01	1.09	90
MINING	5.03	0.75	0.04	4.19	0.05	4.28	1
CONSTRUCTION	1.44	0.78	0.52	0.13	0.02	0.67	26
MANUFACTURING	13.28	8.74	2.45	1.82	0.27	4.55	107
TRANSP, COMM & UTILITIES	6.47	2.76	1.75	1.64	0.32	3.71	57
TRADE	14.91	3.07	7.46	1.96	2.41	11.83	498
FIN., INSUR., REAL EST.	23.96	4.36	2.83	13.17	3.60	19.60	267
SERVICES	26.79	11.18	9.73	5.41	0.46	15.61	635
GOVERNMENT	2.14	1.08	0.74	0.33	0.00	1.07	25
TOTAL	97.26	34.86	26.18	29.09	7.14	62.40	1,707

PANEL 3: TOTAL EFFECTS ($MM 1992:4) (INCL. LOCAL GOVTS. SPENDING)

Sector	Total Expenditures	Intermediate Inputs	Compensation	Capital Earnings	Indirect Taxes	Gross Reg. Product	Jobs (FTE)
AG, FORESTRY & FISHERIES	2.95	1.96	0.59	0.39	0.01	0.99	90
MINING	4.59	0.69	0.04	3.82	0.04	3.90	1
CONSTRUCTION	116.87	84.86	20.79	4.99	6.22	32.00	541
MANUFACTURING	12.11	7.97	2.24	1.66	0.25	4.15	107
TRANSP, COMM & UTILITIES	6.18	2.53	1.68	1.66	0.31	3.65	60
TRADE	13.59	2.80	6.80	1.79	2.20	10.79	498
FIN., INSUR., REAL EST.	21.84	3.97	2.58	12.01	3.28	17.87	267
SERVICES	32.39	13.63	12.36	5.93	0.48	18.76	849
GOVERNMENT	10.18	0.98	8.90	0.30	0.00	9.20	475
TOTAL	220.71	119.39	55.98	32.54	12.79	101.31	2,887

Multipliers	1.67	1.36	1.74	5.40	2.04	2.28	2.45

To place these impacts into some context, the maximum number of new jobs in the peak year would be projected at 2,887 FTE jobs, which is about six-tenths of one percent of the total number of employed persons in Salt Lake and Tooele Counties in 1991 (see Table 3-18, above). Taking further growth into account between 1991 and 1998, by which time the two counties' employed work force would number at least 530,000, it is evident that the Project would not place any significant strains on the local labor supply. Most of the jobs growth would occur in the trade and services sectors, which also are the largest employment sectors in the regional economy. Because the Project would be able to hire most of its workers from the local labor force, it is unlikely that any significant relocation of out-of-state workers and households would take place as a result of

the project; accordingly, no adverse impacts on housing and local government infrastructure and services would be likely to occur.

At the end of the construction phase the work force would be laid off. This is not expected to adversely affect the regional economy, assuming that present robust growth trends continue. Other industrial investments collectively should absorb fluctuations in the work force. For the subsequent two to three decades, Kennecott would have an operating and maintenance crew in place, but their activities would not represent a significant increment to the volume of work in the region; rather, their work would sustain Kennecott's level of activity. Thus, operation and maintenance of the expanded tailings impoundment would of itself have an insignificant but positive impact on the local economy. Far more significant would be the overall level of mining and metals production activity made possible by Kennecott's continued ability to manage and store its tailings.

3.8 HAZARDOUS MATERIALS/WASTE

3.8.1 Overview

3.8.1.2 Methods

An understanding of hazardous materials and waste issues associated with the alternatives was developed from a review of documents related to the inventory, management, closure, and cleanup of the former industrial facilities. In addition, meetings and interviews were conducted with key agencies and environmental personnel from Kennecott Utah Copper Corporation (Kennecott) regarding ongoing programs for hazardous materials handling and disposal.

3.8.1.3 Applicable Statutes

Potential federal regulatory statutes include the:

- Resource Conservation and Recovery Act (RCRA) of 1976 (42 USC 6901 et seq),

- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980 as amended (42 USC 96), and
- National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 CFR Part 61, Subpart R).

Utah regulatory statutes include the:

- Utah Recommended Clean-up Levels (RCLs) in Utah Administrative Code (UAC) R315-101 and
- Utah Radiation Control Rules (UAC R313).

3.8.2 Issues

Hazardous waste issues associated with the alternatives include existing conditions and potential future conditions. The hazardous materials/waste discussion includes petroleum products. Issues associated with existing conditions include the potential for:

- listing under CERCLA of the Kennecott North Zone, which includes the existing tailings impoundment, as a Superfund site;
- hazardous materials and/or waste to be left on site at the Chevron Garfield Phosphate Plant (Garfield Plant);
- hazardous materials and/or waste to be left on site at the former Morton Salt Saltair Facility (former Salt Plant); and
- unreported spills of hazardous materials to exist along the Union Pacific Railroad (UPRR) right-of-way.

Hazardous waste/materials issues associated with future conditions include the potential for:

- crushed and screened slag material used for a drainage blanket to be characterized as a hazardous waste; and

- release of petroleum products from the proposed fuel, oil and lubricant station.

3.8.3 Affected Environment

3.8.3.1 Kennecott North Zone Proposed Superfund Site

On January 18, 1994, the Environmental Protection Agency (EPA) proposed the Kennecott North Zone for inclusion on the National Priorities List (NPL) as a Superfund site under CERCLA. The status of the proposed listing is described by the Utah Department of Environmental Quality, Division of Environmental Response and Remediation (DERR) in a letter to the U.S. Army Corps of Engineers (Corps) dated December 6, 1994, as follows:

> *The proposed listing for the North Zone included 28 sites or facilities suspected of being contaminated or have the potential for releasing contaminants to the environment. Of these 28 sites, 4 were analyzed to score the entire North Zone. They were the Tailings Pond, Magma Soils, Refinery Evaporation Pond and the Smelter Slag Piles. Magna soils were suspected of being contaminated from Smelter emissions and blowing tailings from the pond. These soils were sampled and analyzed by EPA in the summer of 1994 and were found to contain lead and arsenic at concentrations below those of concern. The other 3 sites relate principally to ground water.*
>
> *For the tailings pond in particular, the concentrations of metals are well below levels of concern according to data provided by Kennecott to EPA. Therefore, the tailings themselves are not considered hazardous. A person could live on the tailings without unacceptable exposure to heavy metals.*

The DERR also expressed concern that the large volume of metals that will be deposited in the new tailings impoundment may have the potential to leach into the ground and surface water. Water quality data and geochemical testing data presented in this DEIS, Section 3.3.3 Ground Water Quality, indicate that the potential for metals to leach from the existing tailings impoundment is quite small.

Kennecott submitted an extensive response to the proposed listing for which more than 3,000 comment letters were received by the EPA. The comment period on the Proposed North Zone ended June 20, 1994. EPA is in the process of responding to the public comments, a process which has the potential to take 2 to 3 years. Regardless of the outcome of the proposed listing, Kennecott is tasked to clean up areas of known hazardous substances, such as the former Chevron Phosphate Plant and the former Morton Salt Facility (Preston Chiaro, personal communication, 1994). Cleanup of these facilities is proceeding, however, not under the Superfund program; and the activities are well defined and documented. Cleanup of the former Morton Salt Facility was completed during 1991 and is ongoing at the former Chevron Phosphate Plant. The status of these two facilities are discussed separately within this section.

The process by which the boundaries of the proposed Kennecott North Zone Superfund site will be determined are described in a letter from Region VIII EPA to the Corps, dated October 17, 1994. This process includes:

1. Areas will be identified where historic facilities were located, where dumping of waste is suspected to have occurred, or where soil and/or ground water contamination is suspected to exist. The Garfield Plant, former Salt Plant, existing tailings impoundment, and the proposed wetlands mitigation area are included in this evaluation.

2. EPA expects that Kennecott is conducting an environmental assessment on the properties owned by Kennecott. This assessment will include the collection and analysis of soil, sediment, and water quality samples.

3. Analytical results for the environmental assessment will be compared to screening levels. If screening levels are not exceeded, then the area may not be considered for further action. If screening levels are exceeded, then the area will be considered for further action.

The October 17, 1994 letter from EPA to the Corps also provided a list of nine data requirements for the environmental assessment phase of the Superfund process. In a letter to EPA, dated December 28, 1994, Kennecott provided documents to respond to the nine data requirements.

Kennecott declared many of the documents to be confidential business information pursuant to 40 CFR, Section 2.203. Information that address most of the data requirements are provided herein. The nine data requirements listed by EPA apply to the existing tailings impoundment and proposed North Expansion West area of the Proposed North Zone Superfund Site are as follows:

Data Requirement No. 1- A survey of soil and sediments for hazardous substances in the Wetland Mitigation Area. Primary focus should be on inorganic substances likely to have been emitted by the smelter and runoff from Kennecott operations.

Pending approval by the Corps and U.S. Fish and Wildlife, Kennecott will collect samples of sediments and surface water in the mitigation area for analysis of organic and inorganic constituents, including arsenic, copper and selenium. This sampling program is described in the "Draft Wetlands Water Quality Sampling Program: Kennecott North Expansion Mitigation Project," prepared by SWCA for Kennecott, dated October 1994. Existing analytical data for metal concentrations in soils in the mitigation area are summarized by Kennecott in a letter to Corps dated December 19, 1994 and in this section as well.

Data Requirement No. 2 - Existing water quality for the wetlands in the mitigation area, the Morton Salt ponds, and the Chevron ponds and drainage outlets. Existing water quality of the North Point Canal, Blackhawk Ponds, Goggin Drain, Artesian wells, C-7 Ditch, and Lee Creek.

Surface water quality data are summarized and discussed in Section 3.3, Water Resources.

Data Requirement No. 3 - Existing wastes on the expansion area: chemical analyses, leach tests, volume estimates, evidences of releases off-site, and disposal or other management plans for each; salt piles and ponds, phosphogypsum piles and ponds, vertical migration of wastes, disposal and reuse plans.

Existing wastes in the expansion area are discussed later in this section for the former Chevron Phosphate Plant and the former Morton Salt Plant. The potential for leaching and vertical migration of wastes is discussed in Section 3.3.

Data Requirement No. 4 - Construction details of berms and dikes and sources of materials.

Construction details of berms and dikes and sources of materials are described in Chapter 1, Project Description.

Data Requirement No. 5 - Surface and subsurface drainage plans for the pond itself, and any treatment or other management for such waters

Surface and subsurface drainage plans are described in Chapter 1, Project Description and in Section 3.3, Water Resources.

Data Requirement No. 6 - History of previous breaches of existing dikes - where, when, why, volume, impacts.

Histories of previous breaches of existing dikes are not addressed herein; however, Kennecott submitted four confidential documents in support of their response to this data requirement.

Data Requirement No. 7 - Data on the geophysics of Bonneville clay - continuous? thickness? permeability? fracture zones? Any other engineered features which would protect future ground water impacts?

The physical properties of the Bonneville clay are described in Section 3.3.3 Ground Water Supply.

Data Requirement No. 8 - Impact of previous discharges on the beach materials and sediments of Great Salt Lake.

Kennecott submitted a copy of "Heavy Metals in the Great Salt Lake, Utah," by Paul L. Taylor, Lynn A. Hutchinson, and Melvin K. Muir as their response to this data requirement (1976). The objective of the study described in this document was to determine if copper, zinc, cadmium, mercury, lead and arsenic were concentrating in Great Salt Lake. This 1976 document concludes

that: 1) concentrations of total and dissolved metals in the lake are very small, and in the case of copper, zinc, and cadmium are smaller than in inflowing streams; and 2) it appears that metals are precipitating along with clays, organics and carbonates in bottom sediments where anaerobic bacterial action is immobilizing the metals.

Data Requirement No. 9 - Fill out a revised "Environmental Assessment Check List" for the following areas: Chevron facility, Morton Salt facility, and Wetlands Mitigation site.

Environmental Assessment Check Lists are being prepared and till to be provided to EPA.

Fifteen (15) soil samples were collected in the mitigation area and the analytical data for these samples are compared to concentrations reported by Shacklette and Boerngen (1984) for average western soils are shown in Table 3-25.

Table 3-25
Results of Soil Sampling Mitigation Site

Metal		Total Metal Concentrations in Mitigation Area Soil (mg/kg)				
	Average Western Soil(a)	Number	Mean	Minimum	Maximum	Standard Deviation
Arsenic	7.0	15	11	4.0	22	6.2
Boron	29	6	53	1	98	37
Cadmium	NA	15	0.40	<2.0	1.3	0.30
Lead	20	15	27	7.2	18	18
Mercury	0.065	15	0.033	0.02	0.014	0.014
Selenium	0.34	15	0.56	<0.5	0.67	0.67
Zinc	65	6	58	33	26	26

(a) Shacklette and Boerngen, 1984
NA = not available

how can mean [illegible] be greater than [illegible]

how can [illegible] be greater than range of values

These data indicate that the concentrations in soils in the mitigation area are similar to other western soils. Sample locations proposed in the October 1994 Sampling Plan are shown on Figure A-9, Appendix A. According to Kennecott, analytical data for the sediment samples will be available in mid-January 1995. It appears that the nine data requirements identified by EPA can be addressed using existing data that has been generated or compiled by Kennecott; therefore,

implementation of the North Expansion West alternative would not cause additional impacts to CERCLA investigation actions.

3.8.3.2 Former Chevron Phosphate Plant

The North Expansion West alternative includes the 585-acre former Chevron Phosphate Plant. Beginning in 1952, raw materials consisting of phosphate rock concentrate, sulfuric acid and anhydrous ammonia were imported to the site to produce phosphoric acid and dry phosphate fertilizers. Phosphate rock containing calcium phosphate was dissolved in sulfuric acid to form phosphoric acid and gypsum (calcium sulfate). The gypsum was filtered from the phosphoric acid and slurried to the gypsum tailings impoundment (gypsum stack) and the phosphoric acid was concentrated and sold. At the time production ceased in 1986, phosphoric acid and dry phosphate were being produced at rates of 150 tons per day (tpd) and 200 tpd, respectively. Since 1986, a portion of the gypsum from the phosphogypsum stack was mined, processed for sale, and sold as a soil additive for off-site applications. Reportedly, the footprint of the phosphogypsum stack covers about 385 acres.

Hazardous waste/materials issues associated with the former Chevron Phosphate Plant and their status are summarized as follows:

- **Ground water quality**
  - An addendum to the Ground Water Discharge Permit Application was submitted to the Department of Water Quality (DWQ) during May 1994 which includes ground water quality data, and

  - Sheppard Miller, Inc. (SMI) prepared Investigation of Gypstack Chemistry, Final Report, dated December 1994 which summarizes studies to measure the extent and rate at which gypstack solids will dissolve in tailings water and determine if the gypstack materials would pose any chemical threat to adjacent surface and ground waters if dissolved.

- **Process plant soils** show some impacts including:
  - total petroleum hydrocarbons (TPH) at concentrations up to 6,400 milligrams per kilogram (mg/kg) versus the Utah Level III reference concentration of 500 mg/kg,
  - naphthalene at 28.4 mg/kg versus the Utah Level II reference concentration of 10 mg/kg, and
  - radium-226 at 16.9 (+ or -3.18) pCi/g versus the Utah reference level of 10 pCi/g.

Soils that exceed reference levels are in the process of being removed.

- **Polychlorinated biphenyl (PCB) - containing materials** including capacitors and transformers were identified by Kennecott as part of a detailed assessment of the site. As of November 1994, all PCB-containing materials had been removed from the site, concrete slabs were wiped clean, sealed and tested. Documentation is available in the form of reports, memos, manifests and the like for the testing, removal and disposal of transformers, capacitors, bushings, transformer oils, and concrete slabs.

- **Asbestos-containing materials** were identified on site. Removal of friable asbestos began during August 1994 and was completed during September 1994. Removal of non-friable asbestos is scheduled to be completed during February 1995.

- **Phosphogypsum stack materials** are currently planned to be left in place and at a 10 to 15-feet per year rate of rise, would be covered by tailings after about 2 years and under 200 feet of tailings after about 20 years of spigotting. Issues associated with these materials include the potential impacts to ground water quality, potential for radon flux to exceed the reference level of, and current exemption from RCRA by the Bevill Amendment. The potential for the phosphogypsum stack materials to impact water quality is addressed in several reports submitted to the DWQ and is discussed in Section 3.3, Water Resources.

A mean radon flux of 0.477 pCi/m^2-sec versus the federal standard of 20 pCi/m^2-second was calculated from the results of 147 radon flux measurements (RUST, 1994) made during December 1993. Additional radon flux testing was planned by Kennecott to be conducted during October or November 1994, after consolidation of several piles of phosphogypsum is completed,

to comply with 40 CFR Part 61, Subpart R. Results of these more recent radon flux measurements are not yet available.

- **Process water settling basins and ditches** were sampled and radium-226 was detected. The former process water settling basins and ditches will be encompassed in the proposed tailings expansion area. More than 200 feet of tailings will cover these materials reducing any potential exposure.

- **former landfill** - A landfill that is no longer in use contains a reported 13,800 cubic yards of solid waste. Soil sampling was conducted; however, no hazardous waste or Tordon (herbicide added to fertilizer) were detected. No abatement of the landfill is planned beyond what needs to be removed and placed in a permitted solid waste landfill for construction reasons.

According to letter from Kennecott to the Salt Lake City - County Health Department, dated January 3, 1995, *...Removal of all hazardous materials, such as containerized waste, asbestos, PCBs, and related materials has been completed in accordance with applicable laws and regulations. The dismantling of processing buildings and equipment is scheduled to start in February 1995.* Kennecott plans to place unsalvageable material on the phosphogypsum stack. This material includes *...miscellaneous wood, structural steel, foundation and miscellaneous concrete, similar building materials, as well as miscellaneous equipment from the fertilizer production facility.*

A Kennecott interoffice letter dated May 23, 1991 provides Toxicity Characteristic Leach Potential (TCLP) analysis of a sample of gypsum collected from the gypsum stack. These data indicate that the phosphogypsum stack would not be classified as hazardous material based on TCLP and are summarized in Table 3-26.

Table 3-26
Toxicity Characteristic Leach Potential
of the Phosphogypsum Stack

Metal	TCLP Concentrations in mg/l)		
	Sample	Duplicate	Reference Level
Silver	0.04	0.02	5.0
Cadmium	0.07	<0.01	1.0
Chromium	0.13	0.02	5.0
Barium	<0.01	0.2	100
Lead	0.42	0.14	5.0
Arsenic	0.53	0.72	1.0
Selenium	0.36	0.12	1.0
Mercury	<0.0001	<0.0001	0.2

In addition, phosphogyspum from phosphoric acid production is currently exempted from RCRA by the Bevill Amendment.

3.8.3.2 Former Morton Salt Plant

The former Morton Salt Plant is located at 8800 West North Temple, approximately 11 miles west of Salt Lake City, south and east of Great Salt Lake and Interstate 80 and immediately north of the existing tailings impoundment. Operations began during the late 1800s. In 1991, the plant consisted of 1,650 acres, most of which are shallow evaporation cells, and a processing plant which washed, dried, and processed the product.

To produce salt, water was pumped from Great Salt Lake into a series of evaporation cells. Water was evaporated and the concentrate was pumped to crystallizer ponds for salt crystallization. After crystallization, the remaining liquid, called bittern, was discharged to Great Salt Lake. Salt crystals were scraped from the pond floor, and placed in a storage pile near the processing plant. Salt was washed, dewatered, dried, packaged, and shipped.

Decommissioning of the former Morton Salt Plant began during 1991 and was completed in 1993. Internal Kennecott memos, site activity reports, invoices and contracting documents describe actions taken to remove hazardous and other types of materials from the former Morton Salt Plant. Actions have included the following:

- **Asbestos-containing materials** were sampled and removed.

- **PCB -containing materials** including transformers, were sampled and removed.

- **Buildings** were demolished and clean wood, brick, concrete and other solid debris were disposed.

- **Scrap metal** was removed and recycled.

- **A former landfill** was characterized as containing waste salt, packaging materials, and construction and building debris and will be left in place.

- **Two underground storage tanks** were abandoned in-place, prior to 1991, prior to implementation of federal and Utah UST regulations, and prior to purchase by Kennecott.

- **Oil containers, cleaners and painting supplies** were removed.

3.8.3.4 Railroad Right-of-Way

The Federal Emergency Response Notification System (ERNS) list was reviewed to identify reported spills along the Union Pacific Railroad right-of-way. The ERN system is a national database used to compile information on reported releases of oil and hazardous substances. The database contains information from spill reports made to federal authorities including the EPA, the U.S. Coast Guard, the National Response Center (NRC) and the Department of Transportation.

A search of the database records for the period of 1980 to 1993 revealed that the railroad right-of-way was not on the list.

3.8.3.5 Slag for Drainage Blanket

A drainage blanket would be constructed of slag materials produced by Kennecott smelter operations. This material is currently held in stockpiles north of the smelter and west of the existing tailings impoundment and would be crushed and screened prior to transport to the drainage blanket construction area. A large database exists for the leachability of the slag materials. Kennecott is currently consolidating and updating these data which indicate that leachate from the slag is not hazardous. In addition, slag from primary copper smelting operations is currently accepted from RCRA by the Bevill Amendment.

3.8.4 Environmental Consequences

3.8.4.1 Impact Types

Potential impact types include:

- changes in the cost or scope of ongoing
  - investigation actions,
  - compliance actions, and
  - remediation and/or removal actions,
- changes in the nature and extent of existing contamination,
- generation and release to the environment of hazardous materials/waste, and
- potential compliance actions under current or proposed rules or regulations.

3.8.4.2 Impact Locations

Impact locations include:

- former Chevron Phosphate Plant,

- former Morton Salt Plant,
- former and relocated railroad right-of-ways,
- fuel, oil and lubricant station, and
- existing tailings impoundment.

3.8.5 Comparison of Alternatives

Impact intensity and duration are summarized and compared for the No Federal Action alternative and the North Expansion West alternative.

3.8.5.1 No Federal Action

No Federal Action alternative would have no impact to the hazardous materials/waste types and locations. Clean-up activities of the former Chevron Phosphate Plant and former Mortan Salt Facility would continue; no other sampling/testing would occur on the tailings or expansion area.

3.8.5.2 North Expansion West

A fuel, oil and lubricant station would be required to support the mobile equipment that would be assigned to the North Expansion West alternative area. The design, construction, and operation of this station will be in accordance with federal and state regulations governing the storage of petroleum hydrocarbons. The North Expansion West hazardous materials/waste investigations, compliance action, remediation, and removal actions; and the potential for generation and release of hazardous materials are summarized in Table 3-27.

Table 3-27
North Expansion West Alternative Effects on hazardous Materials/Waste

Impacts Type	Impact Locations				
	Former Chevron Phosphate Plant	Former Morton Salt Plant	Former and Relocated Railroad Right-of-Way	Fuel, Oil, and Lubricant Station	Existing Tailings Impoundment
Changes to Ongoing Investigations	Further investigations of phosphogypsum stack would not be possible	No Impact	No Impact	No Impact	Some monitor wells would need to be abandoned and replaced (a)
Changes to Ongoing Compliance Actions	No Impact	No Impact	No Impact	No Impact	No Impact
Changes to Ongoing Remediation/ Removal Actions	All hazardous waste/materials, would be removed	No Impact	No Impact	No Impact	No Impact
Changes to Nature and Extent of Contamination	Significant impacts to ground water quality are not expected	Tailings water could dissolve and flush out salt (a)	No Impact	No Impact	No Impact
Generation and Release of Hazardous Materials/ Waste	Geochemical studies indicate that potential is small (a)	No Impact	No Impact	Low potential for release of fuels to environment.	No Impact
Potential Compliance Actions under Current or Proposed Rules or Regulations	Bevill exemption of phosphogypsum and slag could be revoked	No Impact	No Impact	No Impact	No Impact

(a) See Section 3.3, Water Resources

3.8.6 Proposed Mitigation

Proposed mitigation for the Project includes the following:

- proposed Kennecott North Zone Superfund site - perform any CERCLA-related investigations or actions prior to construction of the new impoundment,
- former Morton Salt Plant - mitigation is recommended if petroleum hydrocarbons were released from the reported historic UST at the former Salt Plant, then contaminated soils may need to be removed or remediated prior to construction of the alternative,
- railroad right-of-way no mitigation is proposed,
- tailings - no mitigation is proposed.

3.9 CULTURAL RESOURCES

3.9.1 Overview

Cultural resources include historic properties that reflect our heritage. Federal regulations define historic properties as buildings, sites, districts, structures, or objects included in, or eligible for inclusion in, the National Register of Historic Places, as well as artifacts, records, and remains related to such properties. Historic properties are protected by a number of federal and state laws in addition to NEPA, especially the National Historic Preservation Act of 1966, amended, and its implementing regulations (36 CFR 800). The primary purpose of the cultural resources studies undertaken for this Project is to ensure that it is planned and implemented in compliance with this body of legislation. Compliance requires identification of potential impacts upon historic properties, and due consideration for avoiding or minimizing any adverse impacts that might be identified.

Prehistoric resources are defined as properties and associated artifacts that date from before the time of written records, which do not appear before the arrival of Euro-American explorers and settlers in the 1840s. These resources represent Native American cultures and societies and their importance generally stems from their potential to yield valuable information about prehistory and the development of human cultures.

Historic resources are defined as those properties that were occupied or used after the time when written records became available. Ordinarily, properties must be at least 50 years old in order to be deemed historic. The importance of such properties, as viewed from the perspective of federal and state preservation guidelines (36 CFR Part 60), lies in their potential to yield important historic information; from their association with historically important persons or with events that have made a meaningful contribution to the broad patterns of history; or from the fact that they embody distinctive architectural or artistic characteristics, or represent the work of a master.

Ethnohistoric or ethnographic resources are locations of heritage importance to contemporary Native American communities. Major federal legislation requires the consideration of ethnographic

locales and concerns in environmental documents. These requirements are included in the same laws that protect prehistoric and historic properties as well as the American Indian Religious Freedom Act (Public Law 95-431).

The regional overview, records search and inventory, and intensive survey of the study area are documented in several technical reports (Heath, 1993; Heath and Jones, 1994). These are abstracted here.

3.9.2 Issues

Impact issues for cultural resources focus on the potential loss or degradation of archaeological sites, special status cultural resources, and traditional cultural resources. For this Project, the potential for effects on historic resources is the primary concern. Three specific factors that can potentially lead to loss or degradation of archaeological and historic sites are:

Direct effects - Permanent ground alteration during construction, including the covering of historic properties with tailings, or adjacent ground disturbing activities.

Indirect effects - long-term visual and auditory intrusions or disturbance of resources due to increased public accessibility.

3.9.3 Affected Environment

A substantial amount of previous research has been directed at reconstructing the cultural history of this region. The general prehistory of the Eastern Great Basin has been addressed by Heizer and Hester (1978), Jennings (1978) and Madsen and O'Connell (1982).

The region around Great Salt Lake has been occupied since at least 9500 BC. The first 4,000 years of occupation, during the Paleo-Indian period, is poorly represented. Most evidence consists of isolated artifacts left by small bands using large Pleistocene mammals and other resources, especially along the edges of freshwater marshes. This suggests that these bands used a mixed

subsistence strategy associated with marsh resources. (Aikens and Madsen, 1986:154). In Utah, fluted and stemmed points are associated with the Paleo-Indian period, often in association with the bones of mammoths, mastodon and other extinct mammals (Holmer, 1986).

As the megafauna became extinct during the Archaic stage (between 550 BC and AD 450), aboriginal bands modified their subsistence strategies to include a wider ranging hunting and gathering patterns that focused on smaller game and wild plant foods. During this stage, roasting pits and grinding stones, which commonly are taken as evidence for vegetal food processing, become more common. One of the classic ways to define the Archaic stage has been through changes in projectile point technology. The large lanceolate spear point of the Paleo-Indian period gave way to side-notched and corner-notched points used with a throwing stick, or atlatl. Many researchers (i. e. Jennings, 1990, Madsen, 1982) further divide the Archaic stage into the Early, Middle and Late periods.

The Early Archaic (7000-3500 BC) settlement pattern is mostly restricted to caves located just above the lake shoreline and to open encampments near marshes and springs. By the Middle Archaic (3500-1500 BC), an expanded resource base was being utilized and in addition to lacustrian resources, plant and animal resources associated with foothills and high mountain regions came in to play. The late Archaic (1500 BC-AD 400) witnessed a wetter environment during which lake levels rose, submerging many of the previously utilized marsh resources. During this period, many lower elevation sites were abandoned in favor of higher elevation locations, where resources such as pinyon nuts and grass seeds could be exploited (Madsen, 1982).

The Fremont Cultural Complex (AD 400-1300) is a Formative stage development, often associated with greater sedentism, or settled lifestyles, and maize agriculture. This complex characterized by pithouses, surface storage structures, pottery, trough metates, bone tools, ornaments and figurines. While many of these aspects of material culture are a result of *in situ* development of the preceding Archaic cultures, there was also some diffusion from Formative groups to the south, such as the Kayenta and Virgin Anasazi.

Fremont groups varied in their dependence on maize agriculture (Simms, 1986). In northern Utah and in the areas round Great Salt Lake, they were more dependent on marsh resources, although horticultural villages have been identified near Grantsville, west of the study area and along the east shore of Great Salt Lake, near Willard (Judd, 1926). Certainly, any Fremont sites around the Oquirrh Mountains would have been utilizing marsh resources, as the soils are too saline for productive horticulture. This greatly reduces the potential for large Fremont villages within the study area.

During the Late Prehistoric (AD 1300 to 1600s) there was an abandonment of maize-based subsistence and a return to generalized hunting and gathering, especially at the marshes at the fringe of Great Salt Lake (Simms et al., 1991). The period is characterized by a shift to crude pottery and the appearance of small Cottonwood and Desert Side-notched projectile points. These differences in material culture are often attributed to the arrival of Numic (Shoshonean) speaking groups whom linguists suggest expanded across the Great Basin approximately 1500 years ago (Lamb, 1958; Simms, 1990).

The Protohistoric period (AD 1550-1840) refers to the time interval when Euro-American culture initially affected Native American lifeways. The assimilation of European imports, materials, and culture, including the horse, firearms, and manufactured goods had an enormous affect on Native American settlement and subsistence patterns. During this ethnohistoric era, the Affected Environment was principally the territory of the Weber Ute who were almost certainly Northern Shoshone. Other groups included the Timpanogots Ute to the southeast, the Hukunduka or Promontory Shoshone to the northeast and the Skull Valley Gosiute to the west and southwest (Chamberlain, 1911). At the time the Mormons began moving into Great Salt Lake Valley in 1847, the Weber Utes were driven to the south, well away from the study area (James and Singer, 1980).

Like Archaic and Late Prehistoric occupations, protohistoric sites would probably consist of small scatters of lithics and fire-cracked rock. These would most likely be located on terrace edges and on islands, dikes or other elevated landforms in association with fresh water marshes.

The study area was quickly exploited following the settlement of Great Salt Lake Valley. This was due, in part, to its location along the main transportation route between the Salt Lake and Tooele valleys as well as points west, but also because of the range of resources present. By the 1850s, salt was being extracted from the hyper saline waters of Great Salt Lake, mill stones were being quarried from the Oquirrh Mountains, and cattle were brought to graze the land in between. By 1891, three different railroads had been built around the north end of the Oquirrh Mountains and several resorts, including Garfield Beach and Saltair Resort had been built to service the growing population of Salt Lake City (Fuller, 1983).

Development of the area accelerated with the establishment of the Inland Salt Company in 1889 and especially, the Boston Consolidated Copper Mining Company Ltd. in 1898. Veins of copper sulphide ore had been discovered in Bingham Canyon, to the southeast, and by 1907 an efficient system of open-pit mining, using steam shovels, had been developed. In 1903 the Utah Copper Company was founded and huge new smelter, mill, and steam electric generating plant was built by ASARCO in the vicinity of the study area. New rail connections were also made to provide easier access between the mine and production facilities. In addition, several communities of workers were established, including Magna, Ragtown, Garfield, and Bacchus (Arrington and Hansen, 1963; Hulse, 1964; James and Singer, 1980).

Over the years, as the copper market ebbed and flowed, the facilities were periodically upsized, downsized, and occasionally shut down altogether. In 1920, the plants were converted to the new flotation process for extracting and concentrating ore. By 1923, the Guggenheims had consolidated both companies in their Kennecott Utah Copper Corporation. In 1950, and again in the 1960s, major improvements were made of Kennecott's facilities. As a result, and because of expanding salt evaporation ponds, chemical production facilities, and expanded transportation facilities, much of the evidence of earlier occupation and utilization of the this area has been lost (Arrington and Hansen, 1963; Hulse, 1964; James and Singer, 1980).

3.9.4 Environmental Consequences

3.9.4.1 Results

Direct physical impacts to historic properties which might be present can occur during any ground disturbing activities associated with the Project. Direct impacts to archaeological sites will vary as a function of site type, terrain, and construction technique. Whatever the conditions and techniques, they can be expected to impact the integrity of any historic property in the path of construction. Indirect impacts can result during or after construction due to improved access, which makes archaeological sites more vulnerable to accidental or deliberate disturbance. Indirect impacts may also result from altering the setting adjacent to sites that are important for values other than their information content.

To date, most of the potentially affected area has been inventoried and the historic properties identified have been recommended for National Register of Historic Places (NRHP) eligibility (Heath, 1993; Heath and Jones, 1994). These documents have been submitted and unofficially reviewed by the Utah State Historic Preservation Officer (SHPO). However, no formal request for consultation has been made to the SHPO by the Army Corp of Engineers (Jim Dykman, personal communication, December, 1994).

Two portions of the proposed affected areas have yet to be inventoried. The first of these is the existing tailings impoundment along with the pumphouses and associated roads, pipes and facilities. This property may be found to be eligible for the NRHP. However, portions of this vast facility that would be potentially affected by the Project have been heavily modified and it is probable that they would not be viewed as contributing to the significance of the property. Second, large portions north and west of the existing tailings impoundment were left unsurveyed. This area is dominated by salt evaporation ponds and much of the additional areas are heavily disturbed. However, both the Utah State Archaeologist and the Utah SHPO have indicated concern over some portions of these wetlands, especially along any extant natural dikes or sloughs were prehistoric encampments might have occurred and which may have dried out somewhat since the

earlier survey. They have indicated that this area might need to be re-evaluated and some areas field-checked (Kevin Jones and Jim Dykman, personal communication, 1994).

During the two class III surveys, no prehistoric properties were identified within the potentially affected areas. However, six historic sites were identified. These are: 1) the C-7 Canal which dates to at least 1917; 2) the realigned Western Pacific Railroad which dates to 1918 when the existing tailings impoundment was enlarged; 3) the realigned Los Angeles and Salt Lake/Union Pacific Railroad which also dates to 1918; 4) the Brighton Drain which dates to at least 1917; the Riter Drain which dates to at least 1917; and the probable location of the Riter Station located northeast of the existing tailings impoundment and which dates to 1918.

Three additional historic properties appear to delineate the boundaries of some of the proposed affected areas; at this time, it is difficult to evaluate what direct or indirect impacts the Project might have on these resources. These are: 1) the abandoned Salt Lake, Garfield, & Western Railroad which dates to 1892-1893) 2) the abandoned, original Western Pacific Railroad which dates to 1906-1908; and 3) the abandoned, original, San Pedro, Los Angeles & Salt Lake/Los Angeles and Salt Lake Railroad completed in 1905.

Of these properties, the realigned Union Pacific/Los Angeles and Salt Lake Railroad, the realigned Western Pacific Railroad, and the abandoned Salt Lake, Garfield & Western Railroad have all been recommended as eligible for listing on the NRHP. The C-7 Canal and the Brighton and Riter Drains have been recommended as not eligible for listing on the NRHP. Riter Station, the original Western Pacific Railroad, and the original San Pedro, Los Angeles & Salt Lake/Los Angeles and Salt Lake Railroad have yet to have had any significance evaluations although it has been reported that the two original railroads are no longer extant in this vicinity and the station is probably gone as well (Kathleen Heath, personal communication, 1994). These resources would need to be field-checked.

In the preparation of this document, the location of NRHP eligible sites in the vicinity of the study area were identified. These include resources which might be subject to indirect impacts, such as visual intrusions by an expanded impoundment facility or increased access. The only identified

properties are a series of prehistoric caves (Deadman's, Black Rock I, II, and III) which are well to the southwest of the proposed Project and well to the southeast of buildings associated with the town of Magna.

3.9.4.2 No Federal Action

No direct impacts to important cultural resources are predicted if the No Federal Action Alternative is undertaken. However, historic properties within the study area will be subject to degradation. Because none of these historic properties are on public lands, they are not afforded regulatory protection.

3.9.4.3 North Expansion West

The North Expansion West alternative would result in direct impacts to two NRHP eligible sites: the realigned Union Pacific/Los Angeles and Salt Lake Railroad and the realigned Western Pacific Railroad. Also directly impacted would be Kennecott's presently-unevaluated existing tailings impoundment which would be modified. Indirect impacts to three sites which delineate the proposed alternative should be evaluated. These are the unevaluated, original Western Pacific and San Pedro, Los Angeles & Salt Lake/Los Angeles and Salt Lake Railroads, and the NRHP-eligible Salt Lake, Garfield & Western Railroad. In addition, reevaluation and survey in the central, and especially the extreme western portion of this alternative, may turn up additional historic properties.

3.9.5 Proposed Mitigation

This Project would be implemented in compliance with regulations for "Protection of Historic Properties" (36 CFR 800) issued by the Advisory Council on Historic Preservation (ACHP) to implement Section 106 of the National Historic Preservation Act. This requires that all identified cultural resources be evaluated for significance and that a formal determination of effect be made for all NRHP eligible properties. Prudent and feasible measures must then be implemented to reduce any identified adverse impacts to these properties.

In developing a mitigation plan, avoidance of impacts is the preferred option, as other mitigation measures generally entail destruction of the resource. However, where avoidance is not feasible, data recovery prior to construction can often reduce impacts to an acceptable level. Although mitigative archaeological research cannot completely retrieve all data from affected sites, archaeologists routinely accept representative samples as adequate for research purposes. The unretrieved data that might be lost would be a long-term residual impact, but such loss is generally accepted.

Most of the properties which would potentially be impacted by the Proposed Action appear to be railroads or associated structures. Data collection for these types of sites generally involves mapping, photodocumentation, and a written historic context for the property. However, since such sites are often also eligible because of their contribution to important themes in American History (criteria "a"), impacts to them can not be mitigated by data collection alone. In these situations, it will be necessary to have a Memorandum of Agreement signed by the Utah SHPO, the ACHP and the U.S. Army Corps of Engineers (Corps). Such memoranda are routinely produced during the early stages of the consultation process.

3.9.6 Cumulative Impacts

Cumulative impacts are the impacts on the environment that result from the incremental impact of the action when added to the past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

The study area is bounded on the north and west by Great Salt Lake mud flats. Extensive development is not likely here due to wetlands, soil conditions, a high ground water table, flood plain restrictions and strong odors from Great Salt Lake. As a result of previous surveys, the presence as well as the potential for historic properties in this area is well understood. To the east, north and west of the study area, there are almost no historic properties and the potential for

additional unrecorded ones is extremely low. In addition, much of this landscape has been severely disturbed by the development of salt evaporation facilities, landfills and soil reclamation.

The Oquirrh Mountains bound the study area to the south and above an elevation of about 4500 feet, the potential for historic properties is moderate to low. However, there is also little potential for development here, either since the terrain is so steep. The greatest potential for cumulative cultural resource loss is in the region to the south and southwest of the study area, between an elevation of 4300 and 4500 feet. There is a moderate to high potential for cultural resources in these areas which include Kennecott's present industrial facilities and the historic communities of Magna, Garfield and Bacchus. In addition, this area has a high potential for prehistoric sites, especially on the old lake terraces and adjacent caves and rock shelters.

A variety of actions have contributed and continue to contribute to the loss of cultural resources in this area. These include the continuous upgrading of Kennecott's facilities; new residential development, especially in the area east of Magna; new mining exploration and development; and environmental cleanup of past industrial activities. It is estimated that between 5 and 10 historic properties are lost each year as a result of these practices. This amount represents only a small fraction of the estimated 850,000 historic properties in Utah. However, it does include a significant proportion of Utah's industrial mining-related heritage.

3.10 NOISE

3.10.1 Overview

Ambient or surrounding noise can be generated by a number of noise sources, including mobile sources (such as automobiles, trucks, trains, and airplanes) and stationary sources (such as construction sites, machinery, or industrial operations). Often "background" noise sources can contribute substantially to an ambient noise environment; background noise sources can include birds chirping, an occasional vehicle passing by, a television or radio, or leaves rustling in the wind. These background sources can determine the ambient noise environment in areas not dominated by a single major noise source. The noise environment at the proposed Kennecott

Tailings Modernization Project is dominated by traffic noise from Interstate 80 (I-80), local traffic on nearby arterials, airplane, and railroad noises.

Noise is any sound that is undesirable because it interferes with speech and hearing, or is otherwise annoying (unwanted sound). If present in high intensities, loud sounds have the potential to cause hearing damage. Sound is measured in decibels (dB), a logarithmic ratio between pressures caused by a given sound and a standard sound pressure. The human ear is not equally sensitive to all frequencies in the sound spectrum or range of sound. Thus, it is standard to represent sound levels using a scale corresponding to the range and characteristics most consistent with the way human ears perceive sounds: the A-weighted scale. From here on, this report considers Db to represent the A-weighted decibel level (dBA). Because this scale is logarithmic, a Db increase does not always result in a direct increase in loudness. In fact, small Db fluctuations (of less than 3 dB) are not audible.

Using the A-weighted scale, sound levels at an average residence typically range from 45 dB to 55 dB. Sounds associated with freeway and highway traffic are generally louder, ranging from 65 dB to 80 dB, depending on the type, number, and speeds of vehicles on the roadway, distance from noise sensitive receptors to the noise source (traffic), and topographic conditions (attenuation or noise weakening effects). Since traffic sounds do vary, as do construction sounds (which vary depending on equipment type, number, and duration of use), the average sound level, or L_{eq}, is used to represent the acoustical energy equivalent of the fluctuating or changing sound.

The amount of weakening of noise attributed to a given area depends on the terrain between the noise source and receiver. For stationary sources, or sources that do not move distance-wise from a receptor, the decreasing rate of sound is 6 dBA reduction per doubling of distance. For example, if a stationary source generates a noise level equal to 60 dBA measured at 50 feet, the noise measurement at 100 feet for that source would equal 54 dBA.

Noise levels at a given location can usually be reduced by placing barriers between the noise source and receiver. In general, a structure acts as an effective noise barrier only when the structure breaks the line (or line-of-sight) between the noise source and receiver. Buildings, walls,

dense foliage, and intervening topography can all act as noise barriers in various situations. Noise generated by traffic sounds can be reduced substantially when the line-of-sight between the noise source and receptor is broken by some sort of barrier.

3.10.2 Issues

Noise issues associated with the proposed Project include the potential for increases in noise levels to existing receptors both during construction and during the operation of the proposed facilities.

3.10.3 Affected Environment

3.10.3.1 Regulatory Review

Ambient noise is regulated by Salt Lake City County Health Department health regulations (Regulations # 21, Noise Control). Maximum allowable sound levels are summarized in Table 3-28 for sounds beginning within the county. As shown in Table 3-28, the allowable impacts of activities on adjacent properties are dependent upon the time of day and the land use district of the receptor. Corrections to sound levels may be made regarding the duration of sound and the character of the sound. For a given sample period, the reported L_{10} value (the sound level at which noise measurements are exceeded 10 percent of the monitoring period) must not be greater than 15 dBA above the maximum allowable sound levels of the land use district. For pure tone, cyclic, or repetitive sound the allowable sound levels are reduced by 5 dBA. Salt Lake County noise ordinances also address construction noise. During daytime hours (7 AM to 10 PM), construction equipment on site can reach noise levels corresponding to an industrial land use district of 80 dBA. Sounds above the maximum allowable sound levels, or construction activity levels, are prohibited unless a permit is obtained.

Table 3-28
Maximum Allowable Environmental
Sound Levels (dBA)

Time of day sound is generated	Land Use Category		
	Residential	Commercial/ Agricultural	Industrial*
10 PM to 7 AM	50	55	75
7 AM to 10 PM	55	60	80

*** Industrial includes Manufacturing/Heavy Industrial**

3.10.3.2 Ambient Noise Levels

Noise monitoring was conducted at the Saltair Resort by Parsons, Brinkerhoff, Quade & Douglas on February 3 and 4, 1993. The Saltair Resort was selected as the only likely potential receptor site for the proposed Project.

A Metrosonics dB-308 programmable sound level meter, using the A-weighted scale, was used in accordance with Salt Lake County noise regulations for the measurement period. For establishing baseline data regarding existing noise levels, L_{eq} values were observed and compared $_{90}$ regulatory values. Monitoring was performed for a 24-hour period. During this time period, no exceedances were observed of the commercial/agricultural maximum allowable ls. Noise levels ranged from 44 dBA (2 to 3 PM) to 56 dBA (5 to 6 PM). Peak levels, L_{10}, (maximum sound level + 15 dBA for the corresponding land use) were also not exceeded within the monitoring period. For commercial/agricultural land use districts, from 10 PM to 7 AM values can reach up to 70 dBA, while reaching 75 dBA for time periods between 7 AM and 10 PM. The low peak observed for the monitored period reached 46 dBA (2 to 3 PM, 12 to 2 AM) while the high peak values reported reached 58 dBA (9 to 10 AM, 5 to 6 PM, 9 to 10 PM). Ambient noise levels within the Saltair Resort property were dominated by local traffic and highway (I-80) traffic. Peak noises were intermittent emissions of short duration associated with the industrial operations, railroad, large trucks, or airplanes passing overhead.

3.10.4 Environmental Consequences

Noise may be associated with construction and operation of the Kennecott Tailings Modernization Project. The following methodology was used to determine potential noise impact types and significance.

3.10.4.1 Methodology

Impacts regarding noise can be determined based on two factors: (1) type of receptor present and (2) regulations governing the type of receptor. Regulations concerning existing noise levels and noise impacts upon a community in Salt Lake County are based on land use districts. Federal highway noise is regulated by the Federal Highway Administration (FHWA). Because one of the Project alternatives includes a type of modification to an I-80 ramp, federal or state transportation noise regulations may apply. The *Federal-Aid Highway Program Manual*, Volume 7, Chapter 7, Section 3 (FHPM 7-7-3, 1982), "Procedures for Abatement of Highway Traffic Noise and Construction Noise," establishes the requirements for noise studies on federally funded highway projects. The Utah State Department of Transportation noise policy is similar to the FHWA policy. Two criteria are used to determine whether a project would have a noise impact:

Noise Abatement Criteria - Noise abatement criteria have been established according to various types of activity areas. A proposed project would have a noise impact if it were to cause ambient noise levels to approach or exceed the applicable noise abatement criteria. For exterior areas of residences, schools, churches, and parks, the applicable noise abatement criteria is 67 dBA, L_{eq}. In commercial and industrial areas, FHWA's noise abatement criteria is 72 dBA, L_{eq}.

Substantial Noise Increase Criteria - A project can cause noise impacts when project-generated noise levels substantially exceed existing noise levels, even if under project conditions noise levels do not approach or exceed the applicable Noise Abatement Criteria. FHWA considers 10 decibels to be a substantial noise increase.

Both the existing and the proposed tailings impoundment areas are located within a manufacturing-heavy industry zoning district. Most of the construction and operational activities for the proposed alternative is focused on areas located north and west of the existing impoundment. The nearest receptors adjacent to the proposed tailings impoundment area are the Saltair Resort and public beaches along Great Salt Lake. These receptors are zoned commercial/agricultural. No residences are located within the area north and northwest of the proposed impoundment area.

Quantifying impacts using existing data are based on the following example. Typical sound levels produced by construction equipment are presented in Table 3-29. During the construction phase, the highest range of noise generated by construction equipment to be used on the Kennecott facility

Table 3-29
Construction Equipment Noise Levels at Maximum Power[a]

Equipment Type	Noise Level (dBA)	Equipment Type	Noise Level (dBA)
Backhoes	74 to 92	Movable cranes	70 to 84
Front loaders	75 to 96	Derrick cranes	85 to 90
Dozers	70 to 95	Pumps	68 to 78
Graders	72 to 92	Generators	70 to 84
Scrapers	76 to 98	Compressors	64 to 87
Tractors	76 to 96	Jackhammers and rock drills	80 to 98
Pavers	85 to 95	Pile drivers	94 to 106
Trucks	83 to 95	Saws	72 to 82
Concrete mixers	74 to 87		

is a scraper at peak noise generation. Choosing this range to quantify noise impacts on the Saltair Resort (the closest receptor) would be considered a conservative approach. If the noise levels monitored at 50 feet from the source of the sound measured 98 dBA at a constant rate, the noise level at 2,200 feet from the source (approximately 0.5 mile) is predicted to measure 62 dBA. This reduction in noise level is calculated following rules of thumb for sound level reduction for

distances from a stationary source (FHWA). According to this FHWA manual, for a stationary source, sound levels are reduced by 6 dBA for each doubling of distance. The background noise levels reported at the Saltair Resort receptor on February 3, 1993 ranged from 44 dBA to 56 dBA, with peak noise levels reaching 58 dBA. Using rules of thumb for combining sound levels by decibel addition, the ambient noise level at Saltair Resort would reach a maximum noise level 63 dBA. According to the Salt Lake County noise regulations, ambient noise levels for the most restrictive zone within the study area, the agricultural/commercial land use district, can obtain 60 dBA during the daytime hours of 7 AM to 10 PM. For peak noise levels, L_{10}, allowable exposure levels can be exceeded by 15 dBA. Therefore, assuming a constant maximum noise level of 98 dBA for scraper operations (which is highly conservative), during daytime hours, the maximum permissible exposure level for the receptor located within an agricultural/commercial land use district (60 dBA) is expected to be exceeded by 3 dBA at the Saltair Resort (63 dBA). However, according to Salt Lake County noise regulations, during construction activities within the same daytime hours, noise levels for any land use district may reach levels depicted for an industrial land use category, or 80 dBA. Therefore, this construction activity is not expected to produce any exceedance of noise regulations.

The example in Table 3-29, using maximum values for expected construction equipment on site, and peak values reported from the monitoring study, shows that the sounds generated at the Kennecott facility will not likely impact this receptor. This applies to both the construction and operation phases of the on-site alternatives.

3.10.4.2 Construction Impacts

No Federal Action

The No Federal Action alternative does not require construction activities which are not already on-going. Daily operations performed at the Kennecott facility have been previously quantified during the noise survey conducted by Parsons, Brinkerhoff, Quade, & Douglas, Inc. and presented earlier in this section. Noise levels relating to activities for the No Federal Action alternative are not expected to impact the nearest receptor, Saltair Resort. Noise levels at the receptor are

expected to remain the same with the exception of possible increased traffic-related noise from I-80 due to projected growth within the adjacent communities.

North Expansion West

For the North Expansion West alternative, the construction activities would be those proposed in the project description. Construction activities would be scheduled to commence in 1995, and continue until late 1998. While some activities would be continued throughout the entire period, most modifications would be anticipated in 1995 and would be expected to continue for approximately one year.

Activities related to construction of the proposed impoundment would be centered to the north and west of the existing tailings impoundment area. The relocation of the C-7 Ditch and the Union Pacific Railroad and modification of the Highway 202 intersection would begin in 1995 and these activities would not be near sensitive receptors. Probably the major construction activity within 1/4 mile from the nearest receptors, the Saltair Resort and public beaches, would be the I-80/Highway 202 ramp modifications. Excavation, grading, and trucking vehicles would account for most of the equipment generating noise. Due to the distance of the receptors from the work area, increased noise levels generated at the Interstate ramp would be expected to have minimal impacts at the receptor. Because traffic volumes to the proposed modified ramps are relatively low, it is doubtful that either of these criteria would be exceeded for this project. Based on the low projected traffic volumes to the proposed modified ramps, neither of these criteria would be exceeded for this project. The movement of sound from the work site to the receptor would be expected to be low due to terrain, vegetation, and I-80. Also, since the predominant background noise at the receptors would be associated with traffic on I-80 and local streets, increases in noise levels due to construction noise may be perceived to be displaced by the closer traffic noise. In addition, sound levels may increase slightly and persist during construction, but would not expected to have significant impacts on the receptors or exceed Salt Lake County noise regulations for construction.

3.10.4.3 Operational Impacts

No Federal Action

Operational impacts regarding the No Federal Action alternative would not be expected to alter noise levels at the nearest receptor, Saltair Resort. Since no changes to the existing operation would be implemented, the noise levels would continue as measured in February 1993. Once use of the existing impoundment had ended and the existing tailings impoundment was reclaimed as wildlife habitat, the noise levels at Saltair Resort would possibly change due to the lack of human activity and increased wildlife use of the Kennecott site.

North Expansion West

The operation of the new tailings impoundment proposed in the North Expansion West alternative would result in noise levels similar to existing ambient levels directly affecting any of the nearest receptors. Noise levels to the east and south would not be expected to change since no activities would be expected to change in those areas. Noise levels to the north and west of the expanded impoundment area would also not be anticipated to increase. The change in operation lies mainly with new cyclone stations and barge pumps that would be added to the facility. No impact would be expected due to the berm which is in place during routine impoundment operations. This berm would act as a sound barrier, thereby reducing noise levels emanating from the operational area. Also, as part of the expansion project, a visual buffer with trees and vegetation would be constructed adjacent to I-80 within the utility corridor. This would also create an effective sound barrier to receptors in that area. Revegetation would also be done for the existing tailings impoundment embankment.

The relocation of the railroad would be an indirect impact of the expansion project, which may increase noise levels to the north of the proposed impoundment. Relocating the railroad north of its existing location would bring the railroad closer to its nearest receptors, the Saltair Resort and nearby beaches. Railroad operations create perceptibly higher peak noise levels for very short duration as the train passes by the receptor. This may increase peak noise levels at the receptors.

Noise levels generated by the train and warning signals would not be regulated within Salt Lake County noise regulations, which specifically deal with permissible noise levels of stationary sources to receptors within categorized land use districts. Although mitigation would not required for moving the railroad tracks and trains closer to receptors, the visual buffer to be constructed along the railroad corridor would possibly reduce noise levels. The buffer of varied terrain and vegetation would help to deflect noise, thereby decreasing possible impacts on the receptors.

3.10.5 Proposed Mitigation

Table 3-30 summarizes the construction and operational impacts associated with the No Federal Action and the North Expansion West alternatives.

Table 3-30
Summary of Impacts

Alternative	Impact	Mitigation
Construction Activities		
No Federal Action	No impact	None
North Expansion West	Short duration, little to no impact	Use proper noise control devices on construction equipment.
Operational Activities		
No Federal Action	No impact	None
North Expansion West	No impact from operations. Indirect impact from railroad relocation, with possible increases in peak noise levels	Construct visual buffer and revegetate impoundment to create noise buffer

3.11 AIR QUALITY

3.11.1 Overview

The existing and proposed tailings impoundments are located west of Salt Lake City, in Salt Lake County, Utah. The Utah Department of Environmental Quality, Division of Air Quality (UDAQ) has authorized the operation of the existing tailings impoundment subject to certain conditions and parameters as specified in the State Implementation Plan (SIP). Kennecott has requested

authorization from the UDAQ to provide for construction and operation for the proposed modernization of the tailings operations. Issuance of the authorization of the Project is contingent upon a determination that the proposed operations are consistent with the policies of Utah and are protective of the ambient air quality.

3.11.2 Issues

The primary issue associated with the Project regarding air quality is that construction and operation of the North Expansion West alternative are designed to control fugitive dust. Dust generation (specifically respirable particulate matter (PM-10) is the only pollutant with potential for significant contribution to violations of the National Ambient Air Quality Standards (NAAQS). Dust control practices that are proven to be effective would be implemented during construction, operation, and eventual closure of the tailings impoundment.

The Project is not subject to the Utah preconstruction permitting (called an Approval Order) program because it would not result in an increase in emissions to the ambient air environment. However, the existing and proposed tailings impoundment may be subject to a new Operating Permit Program.

3.11.3 Affected Environment

The U.S. Environmental Protection Agency (EPA) has identified Salt Lake County as a Group I non-attainment area for PM-10. The PM-10 NAAQS is attained when the expected number of days per calendar year with a 24-hour average concentration of 150 micrograms/cubic meter ($\mu g/m^3$) is equal to or less than one.

Utah adopted, and EPA approved, revisions to its SIP, including:

- completion of a comprehensive, accurate, and current inventory of actual emissions to provide a basis for determining whether attainment is being adequately demonstrated,
- demonstration (including dispersion modeling) that the provisions in the SIP will provide for attainment as quickly as practicable, and

- provisions to assure that Reasonably Available Control Technology (RACT) will be implemented at new and existing sources.

In addition, Title V of the Clean Air Act as Amended (CAAA) requires that the UDAQ implement a new Operating Permit Program. This new permit program requires the identification of emissions, development of "federally enforceable" permit conditions, payment of fees, and periodic compliance certifications based on monitoring. As presently understood, it is anticipated that any new tailings impoundment will be subject to this new Operating Permit Program, and a complete permit application must be submitted to the UDAQ before July 15, 1995.

It is generally recognized that the emission estimating techniques that are presently available for identifying fugitive dust generated from tailings impoundments are not accurate and may grossly overestimate the PM-10 emissions. For these reasons, neither an air emissions inventory nor dispersion modeling has been completed for the existing or proposed tailings operations. Also, the SIP does not establish allowable emission limits on the existing tailings impoundment; however, it does require that Kennecott implement comprehensive dust control measures. These dust control measures have been evaluated by the UDAQ and established as complying with the RACT requirements.

The existing Kennecott tailings impoundment was identified as the primary source of summertime exceedances of the PM-10 standard occurring during northerly high wind conditions when the plant was shutdown in the mid-eighties. Subsequently, Kennecott and the UDAQ have agreed to various control measures to ensure dust control of the existing tailings impoundment during construction and operation, and during temporary or permanent shutdown. These control measures, including a peripheral discharge system, were implemented in July 1988. The treatment of unpaved roads, vegetation planting, and other dust control techniques were also initiated or enhanced. The meteorological conditions that caused the past exceedances have occurred since the implementation of control measures and no exceedances have occurred in the areas most vulnerable to dust emissions from the existing tailings impoundment.

Analysis of air quality monitoring data collected by Utah in 1991 at Brockbank Junior High School in Magna provides further evidence that the control measure for fugitive dust are effective. These data indicate no instance of PM-10 levels exceeding the NAAQS. There are sufficient data available to establish that the dust control measures that have and will be employed are effective, and that construction and operation of the North Expansion West alternative will not result in significant negative impact to the ambient air quality.

3.11.4 Environmental Consequences

The primary mechanisms for generation of PM-10 emissions are:

- vehicle movement on unpaved surfaces,
- material handling and construction activities, and
- wind erosion.

PM-10 generating activities and proposed dust control activities will occur during construction, operation, and eventual closure of the Project. At the minimum, short-term impacts to the ambient air environment may result from:

- modifying the tailings distribution system and installing new pipelines from the pipeline bridge to the proposed tailings impoundment,
- preparing the Gypsum site and removing salt deposits under the embankment footprint, including backfill as may be requisite and removing or modifying existing salt evaporator dikes,
  - relocating utilities, the C-7 Ditch, and Union Pacific Railroad main line tracks, and modifying the highway,
- mitigating wetlands and constructing a sedimentation pond,
- constructing fueling and support facilities,
- recovering suitable soil from the footprint and developing a visual buffer parallel to I-80,
- constructing cyclone stations near the east and southwest corners of the new impoundment, and
- grading the site, construction of in-plant roads and ditches, reseeding, fencing, and other miscellaneous activities.

Dust generated from these insignificant polluting activities would be mitigated (primarily by watering on an as-needed basis) as specified in the Fugitive Dust Abatement Program (FDAP) and consistent with good management practices.

In addition to these minimal short-term impacts, long-term potential impacts to the ambient air environment may result from:

1) Preparing the foundation and placing a drainage blanket (crushed and screened slag) under the North Expansion West alternative embankment footprint. Particulate emissions would be controlled with water and chemical dust suppressants as needed.
2) Constructing the starter dike, toe dike, and header dikes. Emissions would be controlled by the high moisture content of the dike materials, supplemented with periodic water spray and application of chemical dust suppressants. The slopes would be seeded.
3) Constructing the North Expansion West embankment, concurrent with storing tailings within the impoundment. Underflow from the cyclone separators would be deposited in hydraulic deposition cells, where the material would be decanted, spread, and compacted into lifts. Dust would be controlled by the inherent high moisture content of the material and the use of water trucks to treat dry spots that may occur. Inactive portions of the embankment construction that begin to dry would be wetted as necessary by pumping water into the inactive cells.
4) The North Expansion West alternative tailings deposition would normally include sequential watering using a peripheral discharge system. The specific details of how the peripheral discharge system would be implemented have not been fully established; however, the system would be equivalent or better than the existing system. Further, since the proposed tailings impoundment is smaller than the existing tailings impoundment, some reduction in total dust emissions would be realized in the long-term. Supplemental watering or other dust control methods would be implemented as necessary to treat dry spots that may develop in the impoundment; however, it is anticipated that the need for supplemental dust control would be minimal.

3.11.4.1 No Federal Action

This alternative includes raising the existing tailings impoundment to capacity, then implementing a revegetation plan. Particulate emissions related to these activities would be controlled as described in the mitigation Section 3.11.5. The controlled PM-10 emissions and resulting impacts to the ambient air environment would to be insignificant in achieving compliance with the NAAQS.

3.11.4.2 North Expansion West

The North Expansion West alternative includes raising the existing tailings impoundment to capacity, implementing the revegetation plan, and adding a new impoundment immediately adjacent to and north of the existing impoundment. The alternative would result in a decrease in potential fugitive emissions as the North Expansion West alternative will be smaller than the existing tailings impoundment. Particulate emissions would be mitigated by implementing effective dust control practices as described in Section 3.11.5. The controlled PM-10 emissions and resulting impacts to the ambient air environment would be insignificant in resulting in achievement of the NAAQS.

3.11.5 Proposed Mitigation

To minimize effects on air quality, the following mitigation measures are proposed:

1) Particulate emissions from the active tailings impoundment would be controlled by continued use of a peripheral discharge system. This system would ensure that not more than fifty contiguous acres and not more than five percent of the impoundment's top surface would be dry at any given time.
2) Wind erosion of the existing tailings impoundment would be mitigated by an aggressive revegetation program which would include planting rapid-growing grass, hydromulching, temporary use of water or chemical dust suppressants, and establishment of self sustaining vegetation. Areas of the existing tailings impoundment would be taken out of service

generally in a sequential manner from west to east. The peripheral discharge system would continue to operate to control dust in active portions of the existing impoundment as the transition to the proposed tailings impoundment advanced.

3) Emissions from constructing the North Expansion West embankment, dust would be controlled by the high moisture content of the dike materials, supplemented with periodic water spray and application of chemical dust suppressants. Water trucks would be utilized to treat dry spots that may occur. Inactive portions of the embankment construction that begin to dry would be wetted as necessary by pumping water into the inactive cells.
4) Exposed exterior slopes of the embankment would be stabilized with chemical dust suppressants if necessary. The slopes would be planted with rapidly growing grasses during the first planting period after each new section was formed.
5) Roadway dust control would be a continuation of the existing practice, relying on periodic spraying with dust suppressants, supplemented by watering and regrading as necessary.
6) Revegetation of the new impoundment in the North Expansion West alternative would include activities similar to those used on the existing tailings impoundment. Plantings would be scheduled to start before mine shutdown. Revegetation activity would begin at the eastern third of the impoundment and proceed westward over a period of a few years.

3.12 SUMMARY OF COMMITTED MITIGATION MEASURES

The following mitigation measures have been proposed to reduce or eliminate the adverse impacts to environmental resources. Many of these measures have been incorporated in the project design or are included in the various applications for federal, state, or local permits.

3.12.1 Biological Resources

3.12.1.1 Wetlands

A mitigation site (2,500 acres) north of Interstate 80 has been designated by Kennecott for purposes of compensating wetland impacts if the North Expansion West alternative is approved. Approximately 1,113 acres (45 percent) of the mitigation site was classified as jurisdictional

wetlands. This includes emergent wetlands (28 acres), saline playas (922 acres, including vegetated playas), and open water (163 acres)(SWCA, 1994).

The mitigation concept entails restoring and creating additional habitat to attain the acreages needed for mitigation (SWCA, 1994). Emergent wetlands are the most difficult to replace in terms of functional value; they are a large part of the North Expansion West alternative. Conversely, most wetland values would be enhanced if saline playas are converted to emergent wetlands. The mitigation concept proposed by Kennecott (SWCA, 1994) would be to improve the functional quality of the wetlands of the mitigation site in terms of functional value loss by tailings expansion. The final mitigation design is being developed by an interdisciplinary team of wetland, wildlife and engineering experts. This plan will be incorporated in the Project description during EIS process. The mitigation plan is found in Appendix B of this DEIS.

3.12.1.2 Vegetation

Measures identified in the Mitigation Site Assessment for the Tailings Modernization Project (SWCA, 1994) include: 1) removal of livestock and 2) restriction of use of area by off-road vehicles. Revegetation of the existing tailings impoundment and reclamation of the proposed expansion area after closure of the mine would help reestablish upland vegetation in the area.

3.12.1.3 Aquatic Biota

Mitigation measures proposed to improve aquatic habitat would include the use of best management practices during construction activities to reduce degradation of water quality, especially sedimentation, of the streams and canals. Best management practices include the use of siltation fences and hay bales in drainages to reduce silt entering the stream systems.

Because the C-7 West Ditch is the only site in the study area which is known to contain the Utah chub, mitigation measures could include the transfer of some the Utah chub population from the C-7 West Ditch into sections of the canal that will remain intact. Mitigation measures would also include placeing some instream structures to create fish habitat and to create riffle areas, which are

the primary habitat for macroinvertebrates. Other mitigation measures would include a commitment to more consistent water flows so that certain areas would not experience excessive drawdowns, which appear to be one of the limiting factors to aquatic biota populations. Although problems associated with salinity are considered to be naturally occurring, salinity problems could be reduced by maintaining flows to reduce concentrations.

3.12.1.4 Wildlife

The revegetation activities described above would improve the area for use by terrestrial wildlife. The most effective mitigation measure would be to identify an undeveloped area in close proximity to the proposed expansion that could be enhanced to provide wildlife habitat for displaced species. It is important to mitigate any loss of wetland habitat due the value of these areas to migratory shorebirds and waterfowl. Other measures to improve habitat for mammals would be to place deer crossing signs or deer fence along the Hwy 202 and Hwy 201 to attempt to reduce mule deer mortality. A mitigation site has been designated and a site assessment has been conducted of this area (SWCA, 1994). The detailed wetland mitigation plan would become part of the Proposed Action if the North Expansion West alternative were selected.

3.12.1.5 Special Status Species

Impacts resulting from the proposed expansion project would not be anticipated to be significant for special status wildlife species known or likely to occur within the area. Opportunities for effective on-site mitigation are limited due to the nature of the Project, as it permanently changes habitats from primarily wetland to upland.

The selected mitigation site would provide important opportunities for enhancing habitat components (i.e., nest sites and prey base) for several of these species. Species likely to utilize the mitigation site include Bald Eagle, Peregrine Falcon, Western Snowy Plover, and Loggerhead Shrike. The potential for Snowy Plovers to utilize the mitigation site would be enhanced by protecting freshwater sources, maintaining unvegetated saline playas, reducing human disturbance, and providing suitable nesting substrate.

Since no special status plant species or fish species are known to occur within the study area, impacts are not expected and no mitigation would be necessary.

3.12.2 Water Resources

3.12.2.1 Surface Water

The wetlands mitigation plan would address potential displacement of wetlands if the North Expansion West alternative is approved.

The need for mitigation for the North Expansion West alternative would depend upon an assessment of the effect of the water quality change or regulatory compliance and on growth of any existing wetlands for the stretch of channel located between I-80 and Great Salt Lake at the existing discharge point.

3.12.2.2 Ground Water

Mitigation for ground water would include discharge control, accomplished primarily by the construction of ditches along the edges of the impoundment. The ditches would act as a radial discharge capture zone for tailings water that may be discharged to ground water.

3.12.3 Earth Resources

Areal subsidence (i.e., ground settling) would be reduced by siting critical structures (essential buildings, bridges, overpasses, railroad lines, etc.) in areas outside of the zone of influence of potential areal settlement. Existing critical structures that cannot be relocated should be monitored for adverse settlement effects.

Risk of existing impoundment failure would be minimized by continuing seismic upgrade efforts of the existing tailings impoundment, however, these effects would be minimally successful for

stabilizing new tailings placement. Seismic upgrade procedures should continue and possibly be enhanced for the northeast corner.

Topsoil erosion by wind or water could be minimized on the visual buffer by planting them as soon as possible and by not stockpiling.

3.12.4 Land Use, Transportation and Utilities

Mitigation to impacts if the North Expansion West alternative were approved would include the following:

- relocating three Utah Power & Light (UP&L) transmission lines and the U.S. West, MCI and SP fiber optic cables;
- constructing new access or service roads for the above utilities;
- capping existing gas lines and removing abandoned pipelines;
- relocating Union Pacific Railroad (UPRR) tracks;
- constructing new service roads and railroad overpass;
- relocating and/or constructing new access roads, including the toe dike road, the spine/slag haul road, poleline road, Copperton single-discharge road, and various reclamation and maintenance roads; and
- relocating the C-7 Ditch and constructing access roads on both side of the ditch.

3.12.5 Visual Resources

Mitigation for usual resources include creating a visual buffer, landscaping the embankment, and performing dust control throughout construction, operation, closure, and post-closure of the proposed tailings impoundment if the North Expansion West alternative is approved.

3.12.6 Socioeconomics

No mitigation is proposed. The North Expansion West alternative, if approved, would be a positive impact that would benefit the local employment base and economy.

3.12.7 Hazardous Materials/Waste

Mitigation includes performing any CERCLA-related investigations or actions prior to construction of the Project in accordance with the program for the North Zone Superfund Site. This would be a benefit of the North Expansion West alternative. These investigations are expected to be focused on soil and sediment contamination in the wetland mitigation area.

At the former Morton Salt plant, mitigation is recommended if petroleum hydrocarbons were released from the reported historic UST at the former Salt Plant, then contaminated soils may need to be removed or remediated prior to construction of the alternative.

3.12.8 Cultural Resources

All identified cultural resources would be evaluated for significance and a formal determination of effect would be made for all NRHP-eligible properties. Prudent and feasible measures would then be implemented to reduce any identified adverse impacts to these properties. However, none are expected.

Where avoidance of impacts to NRHP-eligible properties would not be an option, data recovery prior to construction could reduce impacts to an acceptable level. Data for most of the sites potentially impacted by the Proposed Action would involve mapping, photodocumentation, and a written historic context for the property. No historic properties would be expected to be impacted by the North Expansion West alternative.

3.12.9 Noise

No mitigation is proposed as the increase noise levels would be only during construction and for short duration.

3.12.10 Air Quality

Particulate emissions would be controlled with water and chemical dust suppressants. Slag handling conveyors would be covered or equipped with water sprays. A revegetation program would include planting rapid-growing grass seed, hydromulching, temporary use of water or chemical dust suppressants, and establishment of self-sustaining vegetation.

Emissions from construction of the dikes would be controlled by the high moisture content of the dike materials, supplemented with periodic water spray and application of chemical dust suppressants. Supplemental watering or other dust control methodologies would be implemented during construction of the embankment, and tailings deposition. Exposed exterior slopes of the embankment could be stabilized with tackifers. Roadway dust control would include periodic spraying with dust suppressants, supplemented by watering and regrading, as necessary.

3.13 UNAVOIDABLE ADVERSE IMPACTS AND IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

3.13.1 Biological Resources

The filling of jurisdictional wetlands is considered a significant impact. The federal mandate is that there shall be no net loss of wetlands throughout the country. Thus, the Clean Water Act Section 404 program was set up to ensure this mandate is upheld. The long-term conversion of wetlands and waters of the U.S. to upland grasslands and shrublands would be an unavoidable adverse impact. However, the mitigation plan has been developed to compensate for this wetland loss. The plan will create, enhance, and preserve lands that would be of equal or superior value to those that would be filled if the North Expansion West alternative is approved. The plan gives a detailed discussion of the wetland functions and values, mitigation requirements, and the strategy for monitoring the plan's success. No residual, non-mitigatable impact are therefore associated with either the No Federal Action or the North Expansion West alternatives. There would be no irreversible or irretrievable commitments of resources after the mitigation plan is implemented.

3.13.2 Water Resources

3.13.2.1 Surface Water

Approving the North Expansion West could potentially result in a significant increase in the flow in lower Lee Creek. The exact quantity of flow would be established as the mitigation site design is completed (refer to Appendix B). There would be no irreversible or irretrievable commitments of resources after the mitigation plan is implemented.

3.13.2.2 Ground Water

Because ground water resources would not be expected to be impacted in any measurable way, there would be no significant unavoidable adverse impacts, and no irreversible or irretrievable commitment of ground water resources if the North Expansion West alternative is approved.

3.13.3 Earth Resources

Changes in topography resulting from impounding tailings would result in an unavoidable adverse impact to earth resources. There would be an irreversible and irretrievable commitment of resources as the tailing is stored if the North Expansion West alternative is approved. This long-term commitment of resources is not considered significant.

3.13.4 Land Use, Transportation and Utilities

An unavoidable adverse impacts after following mitigation would result from the temporary closure of Highway 202 due to construction activities resulting in traffic detours and limited access to Great Salt Lake State Park if the North Expansion West alternative is approved. There would be no irreversible or irretrievable commitments of land use, transportation, or utility resources.

3.13.5 Visual Resources

Unavoidable adverse impacts after mitigation would be expected if the North Expansion West alternative is approved and the impoundment area is expanded. The visual buffer placed in front of the new embankment and revegetation of the embankment would not totally mitigate the visual impacts of the relocated utility lines and the railroad to adjacent to I-80. And the height of the vegetation buffer would not eliminate the visual impacts to the Saltair Resort beach or Great Salt Lake State Park. Views of the Wasatch Mountains from Saltair Resort beach and Great Salt Lake Park would continue to be partially obstructed by the embankment. There would be an irretrievable and irreversible commitment of visual resources if the North Expansion West alternative is approved. The impacts would be signficant, but to a limited number of viewers.

3.13.6 Socioeconomics

No unavoidable adverse impacts would occur to the local population except under the No Federal Action alternative. Mine closure under this alternative would occur in year 2004 with a loss of 8,900 jobs, a reduction in wholesale and retail trade employment by 1.3 percent, and a reduction of services employment by about 1.6 percent. Establishments located in communities nearby the operation would be seriously impacted. It could be expected that the fiscal conditions and service capabilities of adjacent local governments and districts would be impacted by losses of sales and property taxes, while residential and commercial real estate values in nearby communities would drop and workers move away in search of other employment opportunities. There would be an irreversible and irretrievable commitment of social and economic resources if the No Federal Action were to be selected by the Corps.

3.13.7 Hazardous Materials/Wastes

The mitigation plan would remove concerns for hazardous materials impacting the ground water. No unavoidable adverse impacts and no irretrievable or irretrievable commitment of resources would result from the North Expansion West alternative that would be significantly different from the ongoing operations of the tailings impoundment.

3.13.8 Cultural Resources

No unavoidable adverse impacts or any irreversible or irretrievable commitment of resources would result from the Proposed Action, since the sites identified would not be affected under the North Expansion West alternative. However, cultural resources are not renewable. If degraded, disturbed, or destroyed through direct construction activities, the loss of historic values would not be reversible or retrievable.

3.13.9 Noise

No significant unavoidable adverse impacts and no irreversible or irretrievable commitment of resources would be associated with the North Expansion West alternative.

3.13.10 Air Quality

No significant unavoidable adverse impacts and no irreversible or irretrievable commitment of resources would be associated with the North Expansion West alternative.

3.14 SHORT TERM USES VERSUS LONG-TERM PRODUCTIVITY

The short term use of the proposed area would be for tailings sand storage. After 30 years, the entire site would be converted to an upland vegetated flatland and the mining operations would be decomissioned. The long term productivity of the area without the tailings expansion project would be filling, capping, and reclaiming the existing tailings impoundment as upland with no off-site mitigation.

The project vicinity has been used for tailings storage, mining operations, salt production facilities and fertilizer and other industrial processing/manufacturing for most of the life of the Bingham Canyon Mine that began operating at the turn of the century. If the tailings impoundment is not expanded, the surrounding wetlands would not be cleaned up and the off-site mitigation area would remain disturbed by grazing and off-road vehicle use.

The North Expansion West would result in the conversion of an additional 4,325 acres of land for tailings storage that when reclaimed would be an upland vegetated field. In addition, the proposal is to preserve approximately 2500 - acres as a mitigation site in perpetuity. The mitigation site would contain a mosaic of wetland types, open water and upland habitats especially designed to enhance habitat values for desirable avian species.

CHAPTER 4
CONSULTATION AND COORDINATION

CHAPTER 4 - CONSULTATION AND COORDINATION

4.1 INTRODUCTION

In response to Kennecott Utah Copper Corporation's (Kennecott's) application for a Section 404 permit to place fill material into the jurisdictional waters or wetlands of the U.S., the U.S. Army Corps of Engineers (Corps) determined that the preparation of an Environmental Impact Statement (EIS) would be required prior to a decision regarding the issuance of the 404 permit. In accordance with requirements set forth in the National Environmental Policy Act of 1969 (NEPA) and the Council of Environmental Quality (CEQ) regulations (1978) for implementing NEPA, a consultation and coordination program was developed and implemented for the Tailings Modernization Project (the Project). The purpose of the program was to ensure that all appropriate members of the public and federal, state, and local agencies were contacted, consulted, and given an adequate opportunity to be involved in the environmental analysis and EIS process. This section describes the public and agency scoping process, the consultation and coordination program, issues and concerns identified from public and agency comments, and the EIS review process.

4.2 NOTICE OF INTENT

In accordance with CEQ regulation 40 CFR 1508.22, a Notice of Intent (NOI) to prepare an EIS for the Project was published in the *Federal Register* on Friday, August 19, 1994. Publication of a NOI formally begins "scoping" for an EIS. The purposes of a NOI are to notify persons or agencies interested in, or affected by, a proposed federal action and to seek information and/or participation in scoping.

4.3 PUBLIC AND AGENCY SCOPING PROCESS

Soliciting comments from various federal, state, county, and local agencies as well as interested organizations and individuals is the first step in the EIS preparation process. The comments are used to obtain the most accurate and current environmental information and to incorporate public

opinion into planning and decision making. Scoping is an information gathering process open to the public and agencies early in the course of the EIS preparation process, and is required by NEPA in CEQ regulation 40 CFR 1501.7, 1506.6 and 1508.25. The purpose of the scoping process is not only to characterize significant environmental issues that warrant study or evaluation, but also to identify issues that are not significant so that the environmental analysis and EIS will remain focused. Scoping is not a single, isolated activity, but instead is an ongoing process throughout the preparation of the EIS.

The scoping process for this project consisted of early agency consultation, a public scoping meeting, and public notification to interested parties.

4.3.1 Early Consultation

During a 36-month period (1991 through 1994) in which the project concept and alternatives for the Project were developed, Kennecott coordinated with local, state, and federal agencies. Table 4-1 lists the agencies, organizations and individuals consulted by Kennecott during that period.

4.3.2 Public Scoping Meeting

A widely publicized public scoping meeting on September 19, 1994, was held at the Utah Power & Light Company in Salt Lake City, Utah. The public meeting was announced in the NOI published in the *Federal Register* and in a media release issued September 13, 1994 to Salt Lake Valley television and radio stations and newspapers. Seventeen people attended the scoping meeting. Each attendee was provided a scoping meeting comment response form to identify issues to be addressed in the EIS and to offer comments on the project. The two comment forms received had questions pertaining to ground water protection. No other comments or questions regarding the project or EIS process were made by the meeting attendees.

Table 4-1
Consulted by Kennecott Utah Copper Corporation
During the EIS Process

U.S. Army Corps of Engineers • Michael Schwinn • Brooks Carter	**U.S. Department of the Interior, Fish and Wildlife Service** • Kristi DuBois - Ecological Services • Bob Freeman - Ecological Services
U.S. Environmental Protection Agency • Eva Hoffman - Superfund • Larry Kimmel - Superfund • Bob Mairly - Wetland Regulatory	**Division of State History** • Max Evans - Director • David Madsen - State Archaeologist
Utah Department of Environmental Quality, **Division of Water Quality** • Don Ostler - Division Director • Steve McNeal - Permits and Compliance UPDES • John Whitehead - Ground Water Section **Division of Air Quality** • Russell Roberts - Division Director • Monty Keller - New Source Review **Division of Solid & Hazardous Waste** • Dennis Downs - Division Director	**Utah Department of Natural Resources** **Division of Oil and Gas** • Lowell Braxton - Associate Director • Wayne Hedberg - Permitting Contact **Division of Water Rights** • Robert L. Morgan, P.E. - State Engineer • Richard Hall **Division of Wildlife Resources** • Robert G. Valentine - Interim Director • Catherine E. Quinn - Assistant Chief, Terrestrial Resources
University of Utah	**Utah Department of Transportation** • Craig Zwich - Executive Director • Kenneth Berg - District Two
Utah State Historical Society, Department of Community and Economic Development	**Salt Lake County Department of Development Services** • Kenneth Jones - Director • J. Warren Reynolds
Salt Lake County Engineering Division Flood Control Division • Neil Stack, P.E.	**Salt Lake County Planning** • Jerry Barnes - Director
Great Salt Lake Audubon Society • Wayne Matinson, Utah Wetlands Coordinator	**Salt Lake City Planning Division** • William Wright - Director • Doug Wheelwright, Planning Program Supervisor
South Shore Coalition	

4.3.3 Mailing List and Public Notice

A mailing list was compiled of the agencies and organizations that were contacted during the early studies. Additional names and addresses were included as the public and agency consultation occurred through the preparation of this Draft EIS (DEIS).

The Project was first formally announced in a Notice of Intent issued August 8, 1994, in the Federal Register. The announcement initiated scoping and announced the scoping meeting to take place September 19, 1994, in Salt lake City.

On October 7, 1994, a second public notice was mailed to agencies and interested organizations and individuals to solicit written comments concerning significant issues to be evaluated in the EIS. After a 30-day comment period ending November 7, 1994, letters were received from the following organizations:

- Utah Division of Wildlife Resources - expressing concerns regarding potential impacts of the project to wildlife habitat and mitigation plans,
- Great Salt Lake Audubon Society - regarding the importance of maintaining the quality of wildlife habitat, ground water safety and mitigation plans,
- Utah State Historical Society, Department of Community and Economic Development - regarding the cultural resources inventory,
- Utah Department of Transportation - concurring with transportation plans and permit for the proposed project providing compliance with 404 guidelines,
- Environmental Protection Agency - providing advice on addressing contamination to surface and ground water sources, and discussing the mitigation plans and the Pollution Control Plan for the proposed project, and
- U.S. Fish and Wildlife Service - providing data on threatened and endangered species in the study area; expressing concerns regarding contamination of wildlife habitat, the displacement of the gull colony and mitigation plans.

4.3.4 Scoping Summary

A scoping summary report was prepared and is available to interested parties and agencies upon request from the Corps.

4.4 PUBLIC AND AGENCY CONSULTATIONS

An agency consultation process began in early 1991 when Kennecott initiated studies to evaluate alternatives for tailings modernization and expansion. Table 4-1 lists the agencies that were contacted through letters, meetings, and telephone by Kennecott or their contractors. These agencies participated in a range of capacities which included providing information, recommending level of detail for a variety of environmental and engineering studies, and guidance on permitting requirements.

4.5 PREVIOUS STUDIES

Existing published and unpublished engineering and environmental data, maps and plans, reports, and statements prepared for the Project and related projects in the area were reviewed and evaluated to determine their applicability and adequacy for use in this EIS. The most relevant information was included from the following documents.

- Tailings Impoundment Prefeasibility Study, Bechtel Corporation, 1990.
- Fisheries Technical Report for the Great Salt Lake Area of Operations, Volume I, Bio-West, Inc., 1993.
- Fisheries Technical Report for the Great Salt Lake Area of Operations, Volume IV, Bio-West, Inc., 1993.
- Water Quality Technical Report, Environmental Baseline Monitoring for the Great Salt Lake Area of Operations, Volume V, Bio-West, Inc., 1993.
- Vegetation Technical Report, Environmental Baseline Monitoring for the Great Salt Lake Area of Operations, Volume III, Bio-West, Inc., 1993.
- Wildlife Technical Report, Environmental Baseline Monitoring for the Great Salt Lake Area of Operations, Volume II, Bio-West, Inc., 1993.
- Regional Geochemical Report for the Great Salt Lake Area, Report plus Appendices, Geotrans, Inc., 1992.
- KEL Quality Control Report: Bio-West Baseline Conditions Monitoring, Kennecott Environmental Laboratory, 1993.

- Hydrogeologic Report for the Greater Salt Lake Area, Volumes 1 and 2, Kennecott Utah Copper, 1993.
- Kennecott Tailings Modernization Project Cost Estimates for Tailings Impoundment Alternatives, Morrison Knudsen Corporation, 1993.
- Cultural and Paleontological Inventory of 5,490 Acres in Western Salt Lake County, P-III Associates, 1993.
- Cultural and Paleontological Inventory and Testing of 1,965 Acres in Sections 16, 17, 19, 20 and 21 of T1S R2W, Salt Lake County, Utah, P-III Associates, 1993.
- Alternatives Analysis for the Tailings Modernization Project, SWCA, Inc., 1994.
- Characterization of Potential Jurisdictional Waters of the U.S. that Occur on Kennecott Property Within and Adjacent to the North Expansion Study Area, SWCA, Inc., 1994.
- Environmental Studies Summary Report North Expansion Study Area, SWCA, Inc., 1994.
- Wetland Mitigation Concept for the North Expansion Project, SWCA, Inc., 1994.
- Avian Use Patterns of Salt Evaporator Impoundments and Adjacent Areas, SWCA, Inc., 1994.
- Seismic Hazard and Design Earthquake Ground Motion Evaluation, Woodward-Clyde Consulting Engineers, Inc., 1994.

4.6 PUBLIC AND AGENCY REVIEW OF EIS

4.6.1 Preparation of and Notice of Availability of the Draft EIS

The additional meetings were held with the Department of Environmental Quality, Water Quality Division, and Emergency Remediation, Division of Oil, Gas and Mining and local environmental organizations during the preparation of this DEIS. An extensive mitigation planning process began in early 1994. The technical advisory committee was established to provide guidance to the development of mitigation goals and to review the elements of the mitigation program. The Notice of availability of the DEIS will be published in the Federal Register on March _____, 1995

4.6.2 Public Hearing

A public hearing will be held on March _____, 1995 in Salt Lake City. The hearing will be considered by the Corps on the 404 Permit Application and the EIS during a 45 to 60-day comment period following the release of this DEIS.

Written comments received by the close of the comment period and oral and written comments received at the public hearing will be addressed in the preparation of the Final EIS, which is scheduled for release in June of 1995.

4.6.3 Final Environmental Impact Statement

Following publication of a Notice of Availability in the *Federal Register*, distribution of the Final EIS, and a 30-day comment period, the Corps will issue a Record of Decision (ROD) announcing its findings regarding the Proposed Action and summarizing its determination in compliance with Section 404 (b)(1) of the Clean Water Act as well as other environmental issues. The Corps regulatory program under Section 404 also involves a public interest review. Following issuance of the ROD, the Corps will conduct the public interest review where the expected project benefits are evaluated and balanced against reasonable foreseeable detriments. This public interest review is the final step before a decision regarding issuance of the 404 Permit is made.

CHAPTER 5
LIST OF PREPARERS AND CONTRIBUTORS

CHAPTER 5
LIST OF PREPARERS AND CONTRIBUTORS

CHAPTER 5 - PREPARERS AND CONTRIBUTORS

5.1 PREVIOUS STUDIES

The Environmental Impact Statement baseline studies were prepared over a period of three years by a team of professional resource specialists and environmental consulting firms. The scope of the studies was to survey and record the existing conditions and to observe the dynamics of the study area and alternative sites. The preparers of these baseline studies are listed below with a brief outline of their respective contributions. For a citation of the reference documents prepared from their studies, please refer to Chapter 6 - References.

Copies of these studies are available for review at the U.S. Army Corps of Engineers office, Bountiful, Utah and the Kennecott Utah Copper Corporation Tailings Modernization Project office.

Firm or Organization	Contribution
Bechtel Corporation	Prefeasibility Analyses for Off-site Tailings Locations, Cost Estimates for On-site and On-site/Off-site Alternatives
BIO/WEST, Inc.	Data Collection and Field Surveys for Fisheries, Vegetation, Soils, Aquatic Systems, Wildlife
ENTRIX	Aquatic Resources
GeoTrans	Ground water Analyses
Morrison-Knudsen Corporation	Engineering Descriptions Site Development Design Basis Memorandum Transition of Facilities
P-III Associates, Inc.	Cultural Resources Surveys
SWCA, Inc.	Jurisdictional Waters Delineation and Permit Application Environmental Studies Summary Report and Miscellaneous Environmental Resource Study Practicability Analysis for Alternatives Mitigation Site Assessment Concept and Detailed Mitigation Plans

Shepherd Miller, Inc.	Surface Water Quality
University of Utah	Regional Economic Analysis
Woodward Clyde Consultants	Seismic Characterization

5.2 ENVIRONMENTAL IMPACT STATEMENT

5.2.1 U.S. Army Corps of Engineers

Art Champ, Chief of Regulatory Section, Sacramento District
Brooks Carter, Field Supervisor, Utah Field Office
Michael Schwinn, Project Manager, Utah Field Office

5.2.2 Kennecott Utah Copper Corporation

Robert E. Dunne, Project Manager
Paula Doughty, Environmental Engineer

5.2.3 Consultants

DAMES & MOORE	DEGREE	PROFESSIONAL TITLE	EXPERTISE
Nancy Olmsted	MS, Natural Resource Mgmt	Sr. Project Manager	Project Manager Wetlands/Botanical
Greg Gault	BS, Landscape Architecture	Environmental Planner	Traffic/Noise/Air Quality Transportation/Traffic
Jim Jensen	MA, Environmental Studies	Sr. Project Manager	Sr. Review/Quality Control Land Use/Visual
Jeff Irvin	MSCE, Geotechnical Engineering	Principal Engineer	Surface Water Quality/Hydrology
Loren Hettinger	PhD, Plant Ecology	Sr. Ecologist	Wetlands/Botanical Resources
John Everingham	MS, Systems Ecology	Sr. Project Manager	Public Involvement
John Wallace	MSCE, Geotechnical Engineering	Associate	Project Engineering Alternatives Development

	DAMES & MOORE	DEGREE	PROFESSIONAL TITLE	EXPERTISE
1	Russ Owens	MSCE, Geotechnical Engineering	Sr. Engineer	Geology/Seismicity Earth Resources
2	Bill Loughlin	MS, Geology	Associate	Ground water Resources Hazardous Materials
3	Linwood Smith	PhD, Zoology	Director, Biological Resources Study Group	T&E Species/Wildlife
4	Kim Smith	MS, Environmental Management	Sr. Biologist	T&E Species/Wildlife
5	Leslie Malville	MA, Ecology/ Mammalogy	Staff Biologist	Aquatic Resources
6	George Miller	MS, Environmental Studies	Environmental Planner	Land Use/Visual/Recreation
7	Everett Bassett	BA, Anthropology	Manager, SLC Cultural Resource Services	Cultural Resources
8	Clyde Rhodes	BS, Industrial/Mechanical	Sr. Environmental Engineer	Air Quality
9	Lisa Graham	BA, Biology	Environmental Scientist	Noise
10	Geoff Pool	BS, Landscape Architecture	Graphics Illustrator	Mapping/Graphics
11	Mike Hussey	AS, Construction Technology	Project Manager	Scheduling
12	Jason Pfaff	BS, Landscape Architecture	Environmental Planner	Mapping/Graphics
13	Terry Lane	MS, Political Science MS, Environmental Studies (in progress)	Environmental Scientist	Visual/Land Use
14	Beth Defend	BS, Technical Journalism	Project Coordinator	Document Production/Editing
15	Sandra Steele	BBA, Marketing	Business Administration Manager	Cost Monitoring and Control
16	Jeff Kosewski	AA, Business Administration	Jr. Environmental Analyst	Cost Monitoring and Control
17	Bob Mott	MA, Economics	Consulting Economist	Socioeconomics
18				

CHAPTER 5
LIST OF PREPARERS AND CONTRIBUTORS

CHAPTER 6 - REFERENCES

CHAPTER 2

Alternatives

Bechtel Corporation, 1989. Kennecott Utah Copper Development Project Tailings Site Screening Study. Prepared for Kennecott Utah Copper Corporation. Bechtel Corporation, San Francisco, CA.

_____, 1990. Tailings Impoundment Prefeasibility Study. Prepared for Kennecott Utah Copper Corporation. Bechtel Corporation, San Francisco, CA.

Greer, D.C., 1971. Great Salt Lake, Utah. Map Supplement Number 14. Annals of the Association of American Geographers, Volume 61, Number 1. Weber State College, Ogden, UT.

Morrison Knudsen Corporation, 1993. Kennecott Tailings Modernization Project Cost Estimates for Tailings Impoundment Alternatives. Prepared for Kennecott Utah Copper Corporation. Morrison Knudsen Corporation, Boise, ID.

_____, 1993. Operating Plan Summary Report Rev. B. Prepared for Kennecot Utah Copper Corporation. Morrison Knudsen Corporation, Boise, ID.

State of Utah, Department of Environmental Quality, Division of Air Quality, 1993. Utah State Implementation Plan.

SWCA Inc., 1994b. Characterization of Potential Jurisdictional Waters of the U.S. that Occur on Kennecott Property Within and Adjacent to the North expansion Study Area. Prepared for Kennecott Utah Copper Corporation. SWCA Inc., Salt Lake City, UT.

_____, 1994a. Alternatives Analysis for the Tailings Modernization Project. Salt Lake City, Utah. Prepared for Kennecott Utah Copper Corporation. SWCA Inc., Salt Lake City, UT.

Vick, S.G., 1990. Planning, Design, and Analysis of Tailings Dams. BiTech Publishers, Ltd., Vancouver, B.C., Canada.

Woodward-Clyde Consulting Engineers, 1994. Seismic Hazard and Design, Earthquakes Ground Motion Evaluation. Prepared for Kennecott Utah Copper Corporation. Woodward-Clyde Consulting Engineers, Denver, CO.

CHAPTER 3

3.2 - Biological Resources

American Ornithologists' Union (A.O.U.), 1983. Check-List of North American Birds. 6th ed. The American Ornithologists' Union, Lawrence, KS. 877pp.

Behle, W.H., 1958. The Bird Life of Great Salt Lake. University of Utah Press, Salt Lake City, UT.

Behle, W.H. and M.L. Perry, 1975. Utah Birds: Checklist, Seasonal and Ecological Occurrence Charts and Guides to Bird Finding. Utah Museum of Natural History. Paragon Press, Salt Lake City, UT.

Behle, W.H., E.D. Sorensen, and C.M. White, 1985. Utah Birds: Revised Checklist. Utah Museum of Natural History. Occas, Publication Number 4, Salt Lake City, UT.

Bellrose, F.C., 1976. Ducks, Geese, and Swans of North America. Stackpole Books, Harrisburg, PA. 544 pg.

Bio-West Inc., 1993a. Fisheries Technical Report for the Great Salt Lake Area of Operations, Volume I. Bio-West Inc., Logan, UT.

_____, 1993a. Fisheries Technical Report for the Great Salt Lake Area of Operations, Volume I. Bio-West Inc., Logan, UT.

_____, 1993d. Vegetation Technical Report, Environmental Baseline Monitoring for the Great Salt Lake Area of Operation, Volume III. Bio-West Inc., Logan, UT.

_____, 1993e. Wildlife Technical Report, Environmental Baseline Monitoring for the Great Salt Lake Area of Operation, Volume II. Bio-West, Inc., Logan, UT.

Blinn, D.W., ____., Colonization Rates and Community Structure of Diatoms of Three Different Rock Substrates in a Lotic System. British Phycological Journal, 15:303-310.

Brown, D.E. (ed.) 1982. Biotic Communities of the American Southwest - United States and Northern Mexico. Desert Plants, 4:104.

Burt, W. H. and R. P. Grossenheider, 1976. A Field Guide to the Mammals. 3rd ed. Houghton Mifflin Co., Boston, MA. 289pp.

Easterla, D.A., 1973. Ecology of the 18 Species of Chiroptera at Big Bend National Park, Texas. Northern Missouri State University, Studies 34. 165pp.

Ehrlich, P.R., D.S. Dobkin, and D. Wheye, 1992. Birds in Jeopardy. Stanford University Press, Stanford, CA. 259pp.

Federal Register, 1993. Endangered and Threatened Wildlife and Plants; Finding on Petition to List the Spotted Frog. FR 58 (87). Friday, May 7:27260-27263.

Field Meeting Notes, 1993. Unpublished. Participants: Mark Raming, Kathlyn Collins, Pat Lorello, and Peter Paton on November 17, at the proposed Kennecott Utah Corporation Mitigation Site.

Findley, J.S., A.H. Harris, D.E. Wilson, and C. Jones, 1975. Mammals of New Mexico. University of New Mexico Press, Albuquerque, NM. 360pp.

Hayward, C.L., C. Cottam, A.M. Woodbury, and H.H. Frost, 1976. Birds of Utah. Great Basin Naturalist Memoirs No. 1. Brigham Young University, Provo, UT. 229 pp.

Hill, J.E. and J.D. Smith, 1984. Bats, A Natural History. University of Texas Press, Austin, TX. 243pp.

Jensen, F.C., 1974. Evaluation of Existing Wetland Habitat in Utah. Utah State Division of Wildlife Resources, Salt Lake City, UT. Publication Number 74-17. Federal Aid Project W117 L-D-R C4.

Johnsgard, P.A., 1990. Hawks, Eagles and Falcons of North America. Smithsonian Institution Press, Washington, D.C. 403pp.

Merritt, R.W. and K.W. Cummins, 1988. An Introduction to the Aquatic Insects of North America. Kendall-Hunt Publishing Co., Dubuque, IA.

Noel, D. and T. B. Johnson, 1993. Spotted Bat. Arizona Wildlife Views, Special Edition - Bats of Arizona. August:22.

Page, G.W., L.E. Stenzel, W.D. Shuford, and C.R. Bruce, 1991. Distribution and Abundance of the Snowy Plover on its Western North American Breeding Grounds. Journal of Field Ornithology, 62:245-255.

Paton, P.W.C., and T.C. Edwards, 1990. Status and Nesting Ecology of the Snowy Plover at Great Salt Lake, 1990. Utah Birds, 6:49-66.

Paton, P., C. Kneedy, and E. Sorenson, 1992. Chronology of Shorebird and Ibis Use of Selected Marches at Great Salt Lake. Utah Birds, 6:1-20.

Paton, P.W.C., 1993. Biologist, U.S. Fish and Wildlife Service Cooperative Unit. Personal Communication, November 18.

Pennak, R.W., 1978. Freshwater Invertebrates of the United States. 2nd Edition. John Wiley Publishing, New York, NY.

Peterson, R.T., 1990. A Field Guide to Western Birds. Houghton-Mifflin Co., Boston, MA. 432pp.

Porter, R.D. and C.M. White, 1973. The Peregrine Falcon in Utah, emphasizing ecology and competition with the Prairie Falcon. Brigham Young University Sci. Bull., Biol. Ser. 18:1-74.

Reynolds, R.T., R.T. Graham, M.H. Reiser, R.L. Bassett, P.L. Kennedy, D.A. Boyce, G. Goodwin, R. Smith, and E.L. Fisher, 1991. Management Recommendations for the Northern Goshawk in the Southwestern United States. Northern Goshawk Scientific Committee, USDA Forest Service, Southwestern Region.

Ryser, F.A. Jr., 1986. Birds of the Great Basin: A Natural History. Max C. Fleischmann Series in Great Basin Natural History. University of Nevada Press, Reno, NV. 604pp.

Scott, S. (ed.), 1985. Field Guide to the Birds of North America. National Geographic Society, Washington, D.C.

Skaggs, R.W., D.H. Ellis, W.G. Hunt, and T.H. Johnson, 1986. Peregrine Falcon. Proceedings of the Southwest Raptor Management Symposium and Workshop, University of Arizona. Tucson, AZ. pp. 127-136.

Spicer, R.B., 1991. Spotted Bat. Arizona Wildlife Views. Arizona Game and Fish Department. April:17.

Stebbins, Robert C., 1985. A Field Guide to Western Reptiles and Amphibians. The Peterson Field Guide Series. Houghton Mifflin Co., Boston, MA.

SWCA Inc., 1993. Biological Assessment for the North Expansion Area. Prepared for Kennecott Utah Copper Corporation. SWCA Inc., Salt Lake City, UT.

_____, 1994c. Environmental Studies Summary Report North Expansion Study Area. Prepared for Kennecott Utah Copper Corporation. SWCA Inc., Salt Lake City, UT.

_____, 1994d. Wetland Mitigation Concept for the North Expansion Project. Prepared for Kennecott Utah Copper Corporation. SWCA Inc., Salt Lake City, UT.

_____, 1994e. Avian Use Patterns of Salt Evaporator Impoundment and Adjacent Areas. Prepared for Kennecott Utah Copper Corporation. SWCA Inc., Salt Lake City, UT.

Terres, J.K., 1980. The Audubon Society Encyclopedia of North American Birds. Alfred A. Knopf, NY. 1109pp.

Utah Department of Wildlife Resources, 1993. Native Utah Wildlife Species of Special Concern. DRAFT. Utah Department of Wildlife Resources, Salt Lake City, UT.

U.S. Fish and Wildlife Service, 1990. Federal Register. 57:12. p 2049.

U.S. Army Corps of Engineers, 1987. Corps of Engineers Wetlands Delineation Manual Technical Report Y-87-1.

U.S. Fish and Wildlife Service, 1990. National Wetland Inventory Maps.

U.S. Soil Conservation Service, 1974. Soil Survey of the Salt Lake Area, Utah. Soil Conservation Service, Washington, D.C.

Watkins, L.C., 1977. *Euderma maculatum*. Mammalian Series 77:4.

Whitaker, J.O. Jr., 1980. The Audubon Society Field Guide to North American Mammals. Alfred A. Knopf, New York, NY. 745pp.

Zeveloff, S.I. and F.R. Collett, 1988. Mammals of the Intermountain West. University of Utah Press, Salt Lake City, UT.

3.3 - Water Resources

American Public Health Association, 1989. Standard Methods for the Examination of Water and Wastewater. 17th Edition. American Public Health Association, Washington D.C.

Bio-West Inc., 1993c. Water Quality Technical Report, Environmental Baseline Monitoring for the Great Salt Lake Area of Operations, Volume V. Bio-West Inc., Logan, UT.

Chen-Northern, 1991. Great Salt Lake Area Monitoring Well Construction and Aquifer Testing. Prepared for Kennecott Utah Copper Corporation. Chen-Northern, ???.

Engineering Technologies Associates, Inc., (ETA), 1992. Ground water Assessment Report of the Great Salt Lake Area, Draft Final Report. ETA, ???.

Geotrans, 1993. Regional Geochemical Report for the Great Salt Lake Area. Prepared for Kennecott Utah Copper Corporation. Geotrans, ???.

Hely, Allen G., R.W. Mower, and C. Albert Harr, 1971. Water Resources of Salt Lake County, Utah. State of Utah, Department of Natural Resources, Technical Publication 31.

Kennecott Environmental Laboratory, 1993. KEL Quality Control Report. Bio/West Baseline Conditions Monitoring. Kennecott Environmental Laboratory, Salt Lake City, UT.

Kennecott Utah Copper Corporation, 1992. Hydrogeologic Report for the Great Salt Lake (GSL). (Submitted by Kennecott to the Utah Department of Environmental Quality, Department of Water Quality). Kennecott Utah Copper Corporation, Magna, UT.

_____, 1993. Ground Water Discharge Permit Application for the Kennecott Utah Copper Tailings Impoundment. (Submitted to the Utah Department of Environmental Quality, Division of Water Quality). Kennecott Utah Copper Corporation, Magna, UT.

_____, 1993. Hydrogeologic Report for the Great Salt Lake Area, Volume 1 and 2. Kennecott Utah Copper Corporation, Magna, UT.

_____, 1994a. Addendum to the November 5, 1993 Ground Water Discharge Permit Application for the Kennecott Utah Copper Corporation Tailings Impoundment. (Submitted to the Utah Department of Environmental Quality, Division of Water Quality). Kennecott Utah Copper Corporation, Magna, UT.

Montgomery, James M., 1992. Monitoring Well and Boring Logs for Kennecott Smelter and Refinery Areas. Prepared for Kennecott Utah Copper Corporation.

Shepherd Miller Inc., 1994. Summary Surface Water Report. Prepared for Kennecott Utah Copper Corporation. Shepherd Miller Inc., Fort Collins, CO.

SWCA Inc., 1994c. Environmental Studies Summary Report North Expansion Study Area. Prepared for Kennecott Utah Copper Corporation. SWCA Inc., Salt Lake City, UT.

U.S. Environmental Protection Agency, 1987a. Ambient Water Quality Criteria for Silver (Draft). Office of Research and Development, Environmental Research Laboratories. Duluth, MN.

_____, 1987b. Ambient Water Quality Criteria for Selenium. Office of Research and Development, Criteria and Standards Division. EPA 440/5-87/006.

_____, 1988a. Pesticides. Water Quality Standards Criteria Summaries: a Compilation of State/Federal Criteria. Office of Water, Division of Regulations and Standards. Washington, D.C. EPA 440/5-88/006.

_____, 1988b. Cadmium. Water Quality Standards Criteria Summaries: a Compilation of State/Federal Criteria. Office of Water, Division of Regulations and Standards. Washington, D.C. EPA 440/5-88/014.

_____, 1988c. Iron. Water Quality Standards Criteria Summaries: a Compilation of State/Federal Criteria. Office of Water, Division of Regulations and Standards. Washington, D.C. EPA 440/5-88/-22.

_____, 1988d. Lead. Water Quality Standards Criteria Summaries: a Compliance of State/Federal Criteria. Office of Water, Division of Regulations and Standards. Washington, D.C. EPA 440/5-88/030.

_____, 1988e. Copper. Water Quality Standards Criteria Summaries: a Compilation of State/Federal Criteria. Office of Water, Division of Regulations and Standards. Washington, D.C. EPA 440/5-88/014.

_____, 1988f. Arsenic. Water Quality Standards Criteria Summaries: a Compilation of State/Federal Criteria. Office of Water. Division of Regulations and Standards. Washington, D.C. EPA 440/5-88/018.

Van der Leeden, F., F.L. Troise, and D.K. Todd, 1990. The Water Encyclopedia, Second Edition. Lewis Publishers, Chelsea, MI.

Waddell, K.M., R.L. Seiler, Melissa Santini, and D.K. Solomin, 1987. Ground water Conditions in Salt Lake Valley, Utah, 1963-83, and Predicted Effects of Increased Withdrawals from Wells. State of Utah, Department of Natural Resources, Technical Publication No. 87.

Woodward-Clyde Consulting Engineers, 1994. Continuity of the Upper Bonneville Clay, Kennecott Tailings Modernization Project, WCC Project No. 23224 (Task F). Prepared for Kennecott Utah Copper Corporation. Woodward-Clyde Consulting Engineers, Denver, CO.

3.4 - Earth Resources

Bio-West Inc., 1993b. Soils Technical Report for the Great Salt Lake Area of Operation, Volume IV. Bio-West Inc., Logan, UT.

Geotrans Inc., 1992. Regional Geochemical Report for the Great Salt Lake Area. Prepared for Kennecott Utah Copper Corporation.

Gwynn, J.W., 1980. Great Salt Lake: a Scientific, Historical and Economical Overview. Utah Department of Natural Resources, Utah Geological and Mineral Survey, Bulletin 1116.

Hassibe, W.R. and W.G. Keck, 1991. The Great Salt Lake. U.S. Geological Survey, Washington, D.C. 14.

Kennecott Utah Copper Corporation, 1993. Hydrogeologic Report for the Great Salt Lake Area, Volume 1 and 2. Kennecott Utah Copper Corporation, Magna, UT.

Kennecott Utah Copper Corporation, Tailings Modernization Project, DOGM Notice of Intention to Commence Large Mining Operations.

Klohn Leonoff, 1992. Southeast Corner of Magna Tailings Impoundment, Summary of Geotechnical Site Characterization. Prepared for Kennecott Utah Copper Corporation.

Lindsay, W.L., 1979. Chemical Equilibria in Soils. Wiley-Interscience, New York, NY.

SWCA Inc., 1994a. Alternatives Analysis for the Tailings Modernization Project. SWCA Inc., Salt Lake City, UT.

_____, 1994c. Environmental Studies Summary Report North Expansion Study Area. Prepared for Kennecott Utah Copper Corporation. SWCA Inc., Salt Lake City, UT.

U.S. Soil Conservation Service, 1974. Soil Survey of the Salt Lake Area, Utah. Soil Conservation Service, Washington, D.C.

_____, 1991. Hydric Soils of the United States. Miscellaneous Publication, Number 1491. Soil Conservation Service, Lincoln, NE.

Woodward-Clyde Consulting Engineers, Inc., 1992a, Summary Report, Seismic Hazard Evaluation, Kennecott, Great Salt Lake Area. Prepared for Kennecott Utah Copper Corporation. Woodward-Clyde Consulting Engineers, Denver, CO.

_____, 1992b, Geotechnical Site Characterization, Magna Tailing Impoundment North Perimeter. Prepared for Kennecott Utah Copper Corporation. Woodward-Clyde Consulting Engineers, Denver, CO.

_____, 1994. Seismic Hazard and Design Earthquake Ground Motion Evaluation. Prepared for Kennecott Utah Copper Corporation. Woodward-Clyde Consulting Engineers, Denver, CO. (Currently In Progress)

_____, 1994. Seismic Hazard Evaluation, Kennecott Tailings Impoundment Modernization Project. Prepared for Kennecott Utah Copper Corporation. Woodward-Clyde Consulting Engineers, Denver, CO.

_____, 1994b, Supplemental Data Submittal Requested for Tailings Impoundment Ground water Discharge Permit Application, Continuity of the Upper Bonneville Clay Kennecott Tailings Modernization Project. Prepared for Kennecott Utah Copper Corporation. Woodward-Clyde Consulting Engineers, Denver, CO.

Additional References Not Identified in Text

Bechtel Corporation, 1990. Tailings Impoundment Prefeasibility Study. Prepared for Kennecott Utah Copper Corporation. Bechtel Corporation, San Francisco, CA.

Klohn Leonoff, 1989. Reduction Study. Prepared for Kennecott Utah Copper Corporation.

_____, no date. Magna Berm Preliminary Design. Prepared for Kennecott Utah Copper Corporation.

3.5 & 3.6 - Land Use, Transportation, Utilities & Visual Resources

Bureau of Land Management. 1986. Visual Resource Management Inventory and Contrast Rating System Manuals. Bureau of Land Management, Washington, D.C.

_____, 1986. Visual Resource Management Inventory and Contrast Rating Manuals. Bureau of Land Management, Washington, D.C.

Fenneman, N., 1931. Physiography of the Western United States. First Edition. McGraw-Hill Book Company, Inc., New York, NY.

Kennecott Utah Copper Corporation, no date. Tailings and Water Service Plant Description. File Report. Kennecott Utah Copper Corporation, Magna, UT.

_____, no date. Tailings and Water Service Plant Description. Kennecott Utah Copper Corporation, Magna, UT.

Morrison Knudsen Corporation, 1994. Conditional Use Permit Application. Prepared for Kennecott Utah Copper Corporation. Morrison Knudsen Corporation, Boise, ID.

_____, 1994a. Highway 202 Railroad Overpass Design Basis Memorandum, Rev. B. Prepared for Kennecott Utah Copper Corporation. Morrison Knudsen Corporation, Boise, ID.

_____, 1994b. North Impoundment Reclamation Plan, Rev. D. Prepared for Kennecott Utah Copper Corporation. Morrison Knudsen Corporation, Boise, ID.

_____, 1994c. Operation Plan Summary Report, Rev. 62. Prepared for Kennecott Utah Copper Corporation. Morrison Knudsen Corporation, Boise, ID.

_____, 1994d. Operating Plan Summary Report, Rev. B. Prepared for Kennecott Utah Copper Corporation. Morrison Knudsen Corporation, Boise, ID.

_____, 1994e. Site Development Design Basis Memorandum, Rev. A. Prepared for Kennecott Utah Copper Corporation. Morrison Knudsen Corporation, Boise, ID.

_____, 1994f. Site Plan and Sections Map. Prepared for Kennecott Utah Copper Corporation. Morrison Knudsen Corporation, Boise, ID.

_____, 1994g. Transition of Facilities, Existing Impoundment Surface Transition Design Basis Memorandum, Rev. A. Prepared for Kennecott Utah Copper Corporation. Morrison Knudsen Corporation, Boise, ID.

_____, 1993a. Environmental Reconnaissance Memorandum Report, Rev. A Draft. Prepared for Kennecott Utah Copper Corporation. Morrison Knudsen Corporation, Boise, ID.

_____, 1993b. Permitting Memorandum Report, Rev. A Draft. Prepared for Kennecott Utah Copper Corporation. Morrison Knudsen Corporation, Boise, ID.

_____, 1993c. Project Requirements Report, Rev. B. Prepared for Kennecott Utah Copper Corporation. Morrison Knudsen Corporation, Boise, ID.

_____, 1993d. Rezoning Application North Expansion Tailings Impoundment Modernization Letter. Prepared for Kennecott Utah Copper Corporation. Morrison Knudsen Corporation, Boise, ID.

SWCA Inc., 1994a. Alternatives Analysis for the Tailings Modernization Project. Prepared for Kennecott Utah Copper Corporation. SWCA Inc., Salt Lake City, UT.

_____, 1994b. North Expansion Study Area Map, Figure 1. Land Categories and Potential Jurisdictional Waters of the U.S. Prepared for Kennecott Utah Copper Corporation. SWCA Inc., Salt Lake City, UT.

------, 1994c. Environmental Studies Summary Report North Expansion Study Area. Prepared for Kennecott Utah Copper Corporation. SWCA Inc., Salt Lake City, UT.

VanCott, J., 1990. Utah Places Names. University of Utah Press, Salt Lake City, UT.

3.7 - Socioeconomics

Boyle, Tom, 1994a. Internal memorandum, "Requested cost information for the Dames & Moore Socioeconomic analysis of the no-action alternative." Kennecott Utah Copper Corporation, Magna, UT.

------, 1994b. Internal memorandum, "Requested cost information for the Dames & Moore Socioeconomic analysis of the three action alternatives." Kennecott Utah Copper Corporation, Magna, UT.

Bureau of Business and Economic Research, 1993. Statistical Abstract of Utah 1993. Bureau of Business and Economic Research, David Eccles School of Business, University of Utah, Salt Lake City, UT.

------, 1991. Kennecott Corporation and the Utah Economy. David Eccles School of Business, University of Utah, Salt Lake City, UT.

Bureau of Economic Analysis, 1994. Regional Economic Information System (CD-ROM).

Federal Reserve Bank of San Francisco, 1994. Western Economic Developments.

Governor's Office of Planning and Budget, 1994a. State of Utah Economic and Demographic Projections 1994: Highlights. State of Utah, OPB, Salt Lake City, UT.

_____, 1994b. Economic Report to the Governor. State of Utah, OPB, Salt Lake City, UT.

SWCA Inc., 1994. Environmental Studies Summary Report North Expansion Study Area. Prepared for Kennecott Utah Copper Corporation. SWCA Inc., Salt Lake City, UT.

3.8 - Hazardous Materials

Ardaman and Associates, Inc., 1980. Geotechnical Investigation and Management Recommendations of the Gypsum Stack, Garfield Phosphate Plant, July 24. Ardaman & Associates, Inc., Orlando, FL.

_____, 1986. Closure Analysis and Recommendations for Gypsum Storage Area. Prepared for Chevron Chemical Company. Ardaman and Associates, Inc., Orlando, FL.

Hoffman, Eva, 1994. Region VIII, U.S. Environmental Protection Agency. Personal Correspondence, October 17, 1994.

INTERA, 1991. Environmental Site Assessment of the Chevron Garfield Phosphate Plant. CONFIDENTIAL. Prepared for Kennecott Utah Copper Corporation. INTERA, Inc., Austin, TX.

------, 1991. Environmental Site Assessment of the Morton Salt Saltair Resort Facility. CONFIDENTIAL. Prepared for Kennecott Utah Copper Corporation. INTERA Inc., Austin, TX.

Kennecott Utah Copper Corporation, 1994. Addendum to the November 5, 1993 Ground Water Discharge Permit Application for the Kennecott Utah Copper Corporation Tailings Impoundment. (Submitted to the Utah Department of Environmental Quality, Division of Water Quality).

Larsen, Rod, 1994. Containerized Waste Inventory. Personal Communication. Kennecott Utah Copper Corporation, Magna, UT.

Morrison Knudsen Corporation, 1993. Operating Plan Summary Report, Rev. B. Prepared for Kennecott Utah Copper Corporation. Morrison Knudsen Corporation, Boise, ID.

RUST Environment and Infrastructure, 1994. Field Investigation Chevron Garfield Phosphate Plant. Prepared for Kennecott Utah Copper Corporation, Contract C-006.

3.9 - Cultural Resources

Aikens, C.M. and D.B. Madsen, 1986. Prehistory of the Eastern Area. In D'Azevedos, W.L. (ed.), Great Basin. Handbook of North American Indians 11. Smithsonian Institution, Washington, D.C. pp. 149-160.

Arrington, L.J. and G. Hansen, 1963. The Richest Hole on Earth: A History of the Bingham Copper Mine. Utah State University, Logan, UT.

Chamberlain, R.V., 1911. The Ethno-botany of the Goshute Indians of Utah. Memoirs 2. American Anthropological Association. Washington, D.C.

Fuller, C., 1983. Black Rock Cave: An Historical Overview. In Madsen, D.B. (ed.), Black Rock Cave Revisited. Cultural Resource Series 14. Bureau of Land Management, Utah State Office, Salt Lake City, UT. pp. 86-98.

Heath, K., 1993. Cultural and Paleontological Inventory and Testing of 1965 Acres in Sections 16, 17, 19, 20, 21, of Township 1S, Range 2W, Salt Lake County, Utah. Cultural Resources Report 478-01-9129. P-III Associates, Salt Lake City, UT.

Heath, K. and J. Jones, 1994. Cultural and Paleontological Inventory of 5490 Acres in Western Salt Lake County. Cultural Resources Report 498-01-9211. P-III Associates, Salt Lake City, UT.

Heizer, Robert F. and Thomas R. Hester, 1978. Great Basin. In Taylor, R.E. ad Clement W. Meighan (eds.), Chronologies in New World Archaeology. Academic Press, New York, NY.

Holmer, Richard N., 1986. Common Projectile Points of the Intermountain West. In Condie, Carol J. and Don D. Fowler (eds.), Anthropology of the Desert West: Essays in Honor of Jesse D. Jennings. University of Utah Anthropological Papers No. 110. Salt Lake City, UT. pp. 89-115.

Hulse, I., 1964. From Rags to Riches: A Resume of Area History from the Middle Eighteen Hundreds, Beginning in the Salt Lake Valley to the Present Time. Tooele Transcript Press, Tooele, UT.

James S.R. and D.J. Singer, 1980. Cultural Resources Existing Data Inventory, Salt Lake District, Utah. University of Utah, Archaeological Center, Salt Lake City. Reports of Investigations 80-17.

Jennings, Jesse D., 1990. Prehistory of North America. 3rd ed. Mayfield Publishing Company, Mt. View, CA.

_____, 1978. Prehistory of Utah and the Eastern Great Basin. University of Utah Anthropological Paper No. 98, Salt Lake City, UT.

Lamb, S.M., 1958. Linguistic Prehistory in the Great Basin. International Journal of American Linguistics 24(2):95-100.

Madsen, D.B., 1982. Get It Where the Gettin's Good: A Variable Model of Great Basin Subsistence and Settlement Based on Data from the Eastern Great Basin. In Madsen, D.B. and J.F. O'Connell (eds.), Man and Environment in the Great Basin. SAA Papers 2. Society for American Archaeology, Washington, D.C. pp.207-226.

Madsen, David B. and James F. O'Connell, 1982. Man and Environment in the Great Basin. Society for American Archaeology, Paper No. 2. Washington D.C.

P-III Associates, 1993. Supplemental Report.

Simms, S.R., 1990. Fremont Transitions. Utah Archaeology 1990 3(1):1-18.

_____, 1986. New Evidence for the Fremont Adaptive Diversity. Journal of California and Great Basin Anthropology 8(2):204-216.

Simms, S.R., C.J. Loveland and M.E. Stuart, 1991. Prehistoric Human Skeletal Remains and the Prehistory of the Great Salt Lake Wetlands. Utah State University, Department of Sociology, Social Work, and Anthropology, (Prepared for Utah Department of Natural Resources.) Logan, UT.

Weber, R., 1994. Archaeological Assistant, Utah State Historical Society. Personal Communication. March 2, 1994.

3.10 - Noise

Parsons, Brinkerhoff, Quade & Douglas, 1993. Tailing Impoundment North End Noise Analysis. Prepared for Kennecott-Utah Copper Corporation. Parsons, Brinkerhoff, Quade & Douglas, Seattle, WA.

Federal Highway Administration, 1977. Barrier Design for Highway Projects, U.S. Department of Transportation.

_____, 1977. FHWA Highway Traffic Noise Prediction Model, U.S. Department of Transportation FHWA-RD-77-108.

Salt Lake City-County Health Department, 1991. Health Regulations 21, Noise Control.

Wilson, Charles E., 1989. Noise Control. Harper and Row Publishers, New York, NY.

3.11 - Air Quality

Morrison Knudsen Corporation, 1993. Operating Plan Summary Report Rev. B. Prepared for Kennecott Utah Copper Corporation. Morrison Knudsen Corporation, Boise, ID.

SWCA Inc., 1994. Miscellaneous Information: North Expansion Study. Prepared for Kennecott Utah Copper Corporation. SWCA Inc., Salt Lake City, UT.

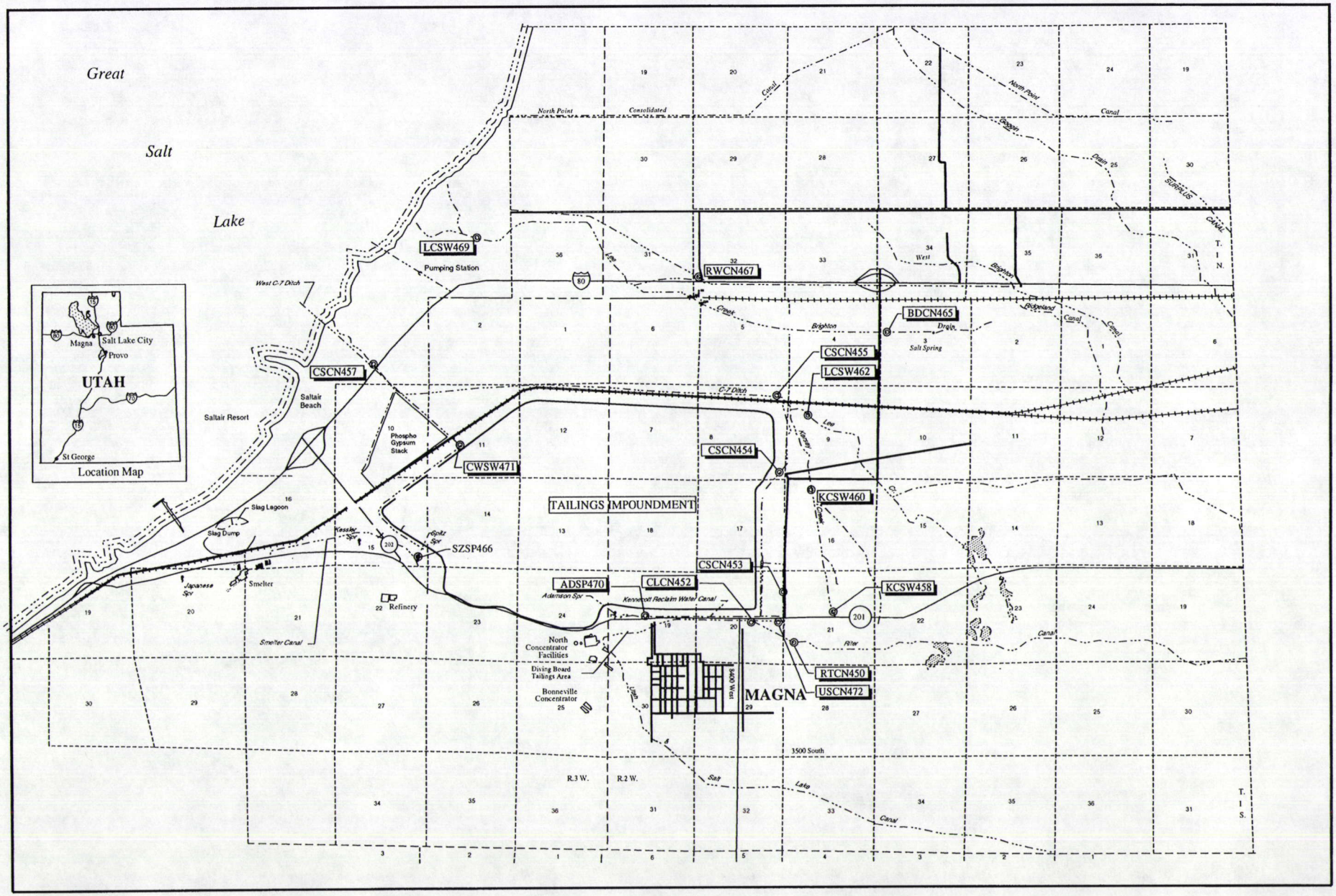
Utah Division of Air Quality, 1993. Utah State Implementation Plan, November 5, 1993.

CHAPTER 7
APPENDICES

APPENDIX A

APPENDIX A

Sampling Site and Survey Maps for
Biological and Water Resources



OPEN WATER
SURFACE WATER
ROAD

XXXXXX
FISHERIES SAMPLE SITES

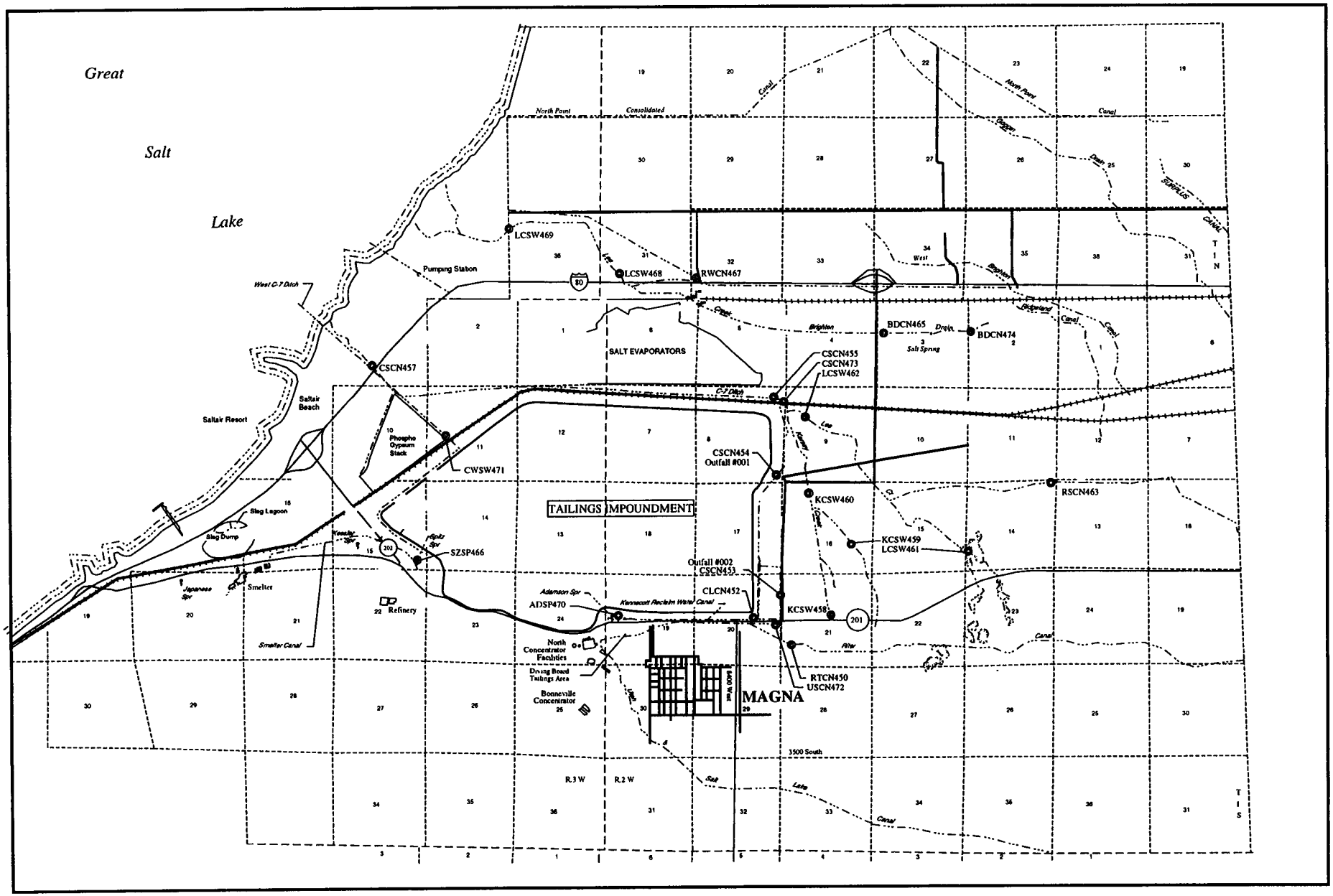
NORTH

0 1/2 1
SCALE: MILES

FISHERIES SAMPLE SITES
BIO/WEST, INC. 1991

TAILINGS MODERNIZATION PROJECT
ENVIRONMENTAL IMPACT STATEMENT
KENNECOTT UTAH COPPER CORPORATION

Figure A-1



OPEN WATER
SURFACE WATER
ROAD

CWSW471 AQUATIC SAMPLE SITES

NORTH

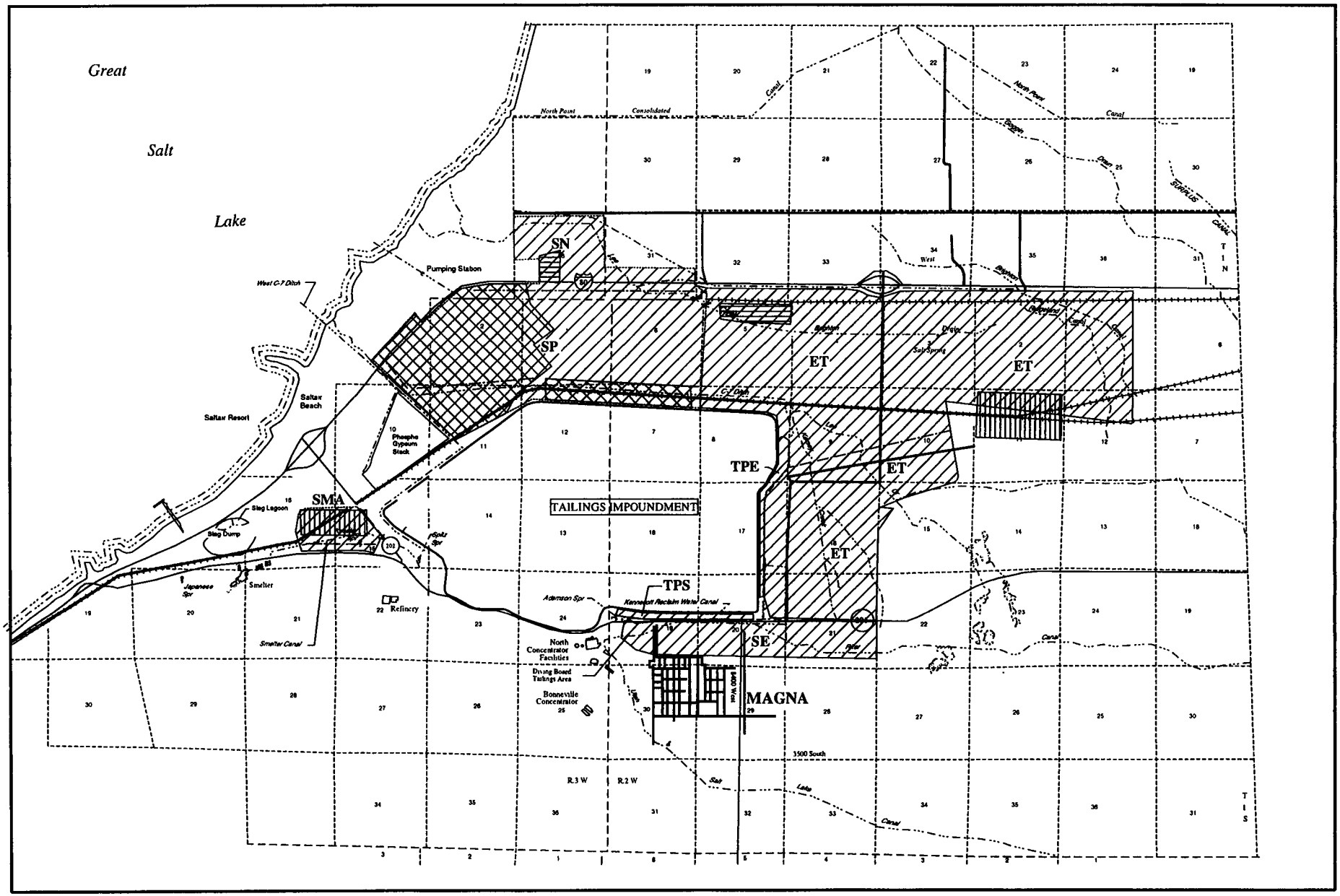
0 1/2 1
SCALE: MILES

WATER QUALITY SAMPLE SITES
BIO/WEST, INC. 1992

TAILINGS MODERNIZATION PROJECT ENVIRONMENTAL IMPACT STATEMENT

KENNECOTT UTAH COPPER CORPORATION

Figure A-2



OPEN WATER
SURFACE WATER
ROAD

ET East Transect
SE Southeast section
SN Saltair North
SP Salt Ponds

Nesting Gull, Avocet, Peregrine Falcon Hunting Areas

SMA Slag Management Area
TPE Tailings Impoundment East
TPS Tailings Impoundment South

Loggerhead Shrike Use Area
Snowy Plover Use Area

Avian Survey Transect Midline
Wildlife Survey Area

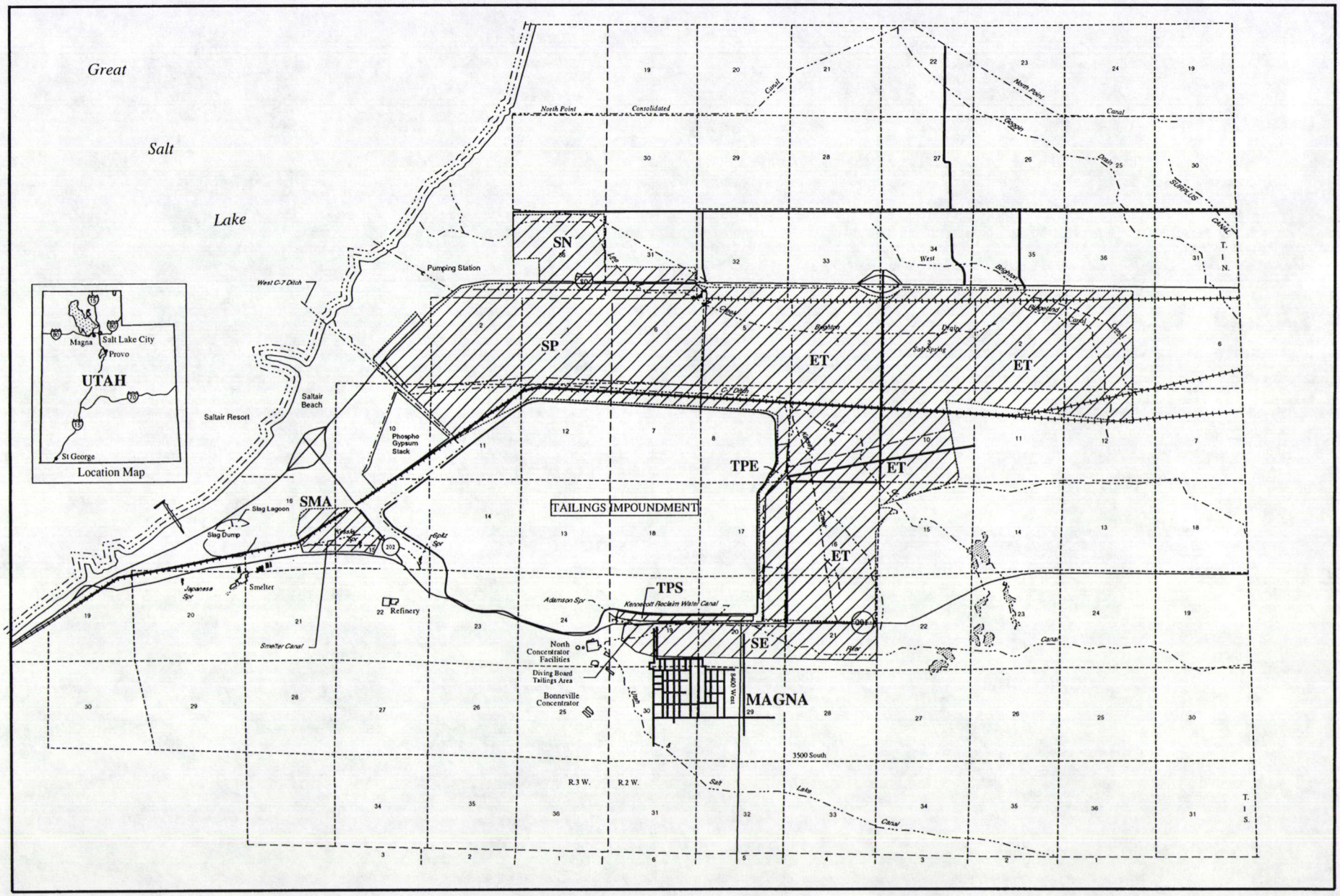
NORTH

0 1/2 1
SCALE: MILES

SAMPLE AREAS FOR AVIAN TRANSECTS COUNTS
BIO/WEST, INC. 1992

TAILINGS MODERNIZATION PROJECT
ENVIRONMENTAL IMPACT STATEMENT
KENNECOTT UTAH COPPER CORPORATION

Figure A-3

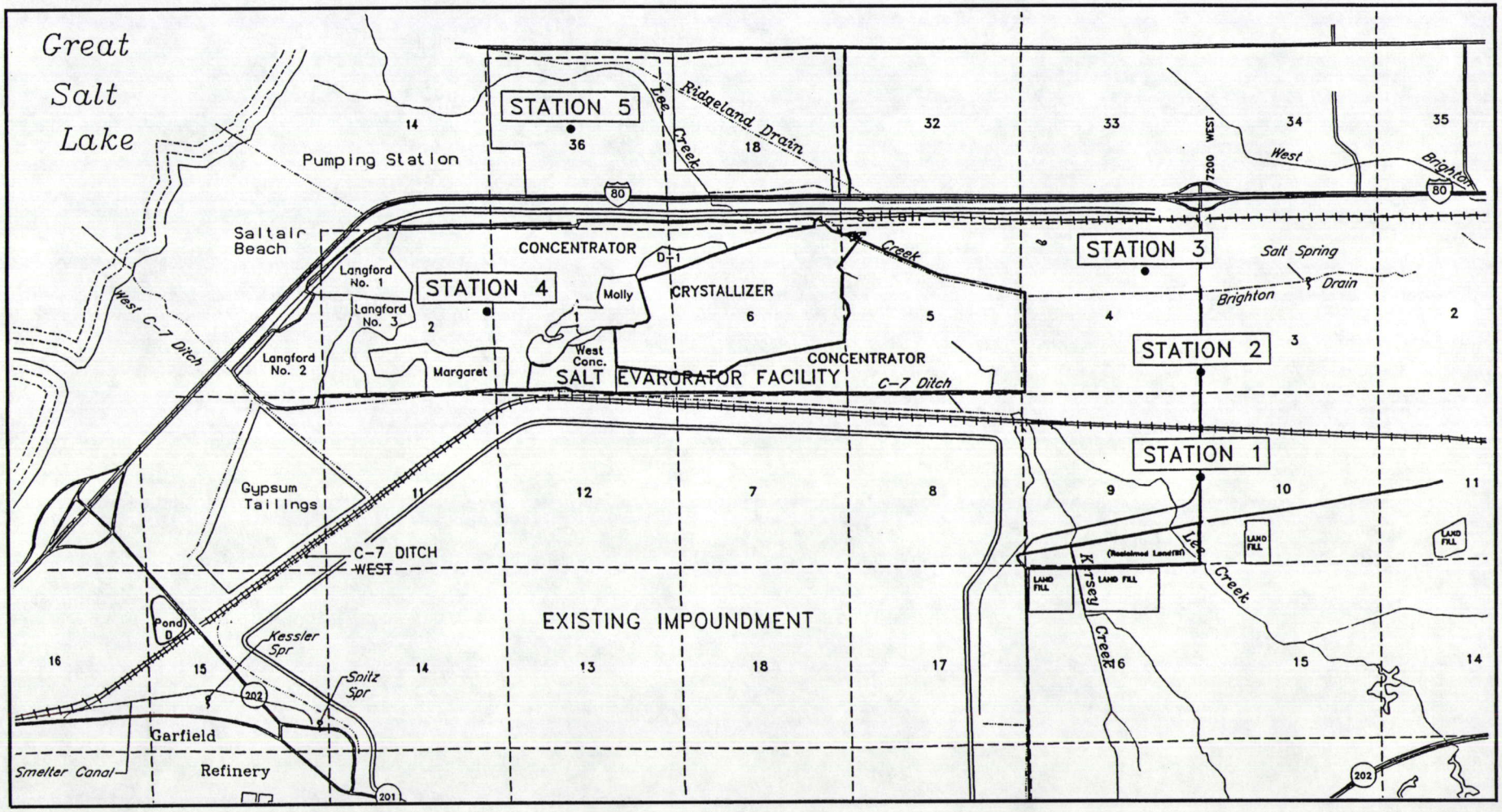


AVIAN MIST NET SURVEY AREAS
BIO/WEST, INC. 1992

TAILINGS MODERNIZATION PROJECT
ENVIRONMENTAL IMPACT STATEMENT

KENNECOTT UTAH COPPER CORPORATION

Figure A-4



NORTH

0 1/4 1/2 1

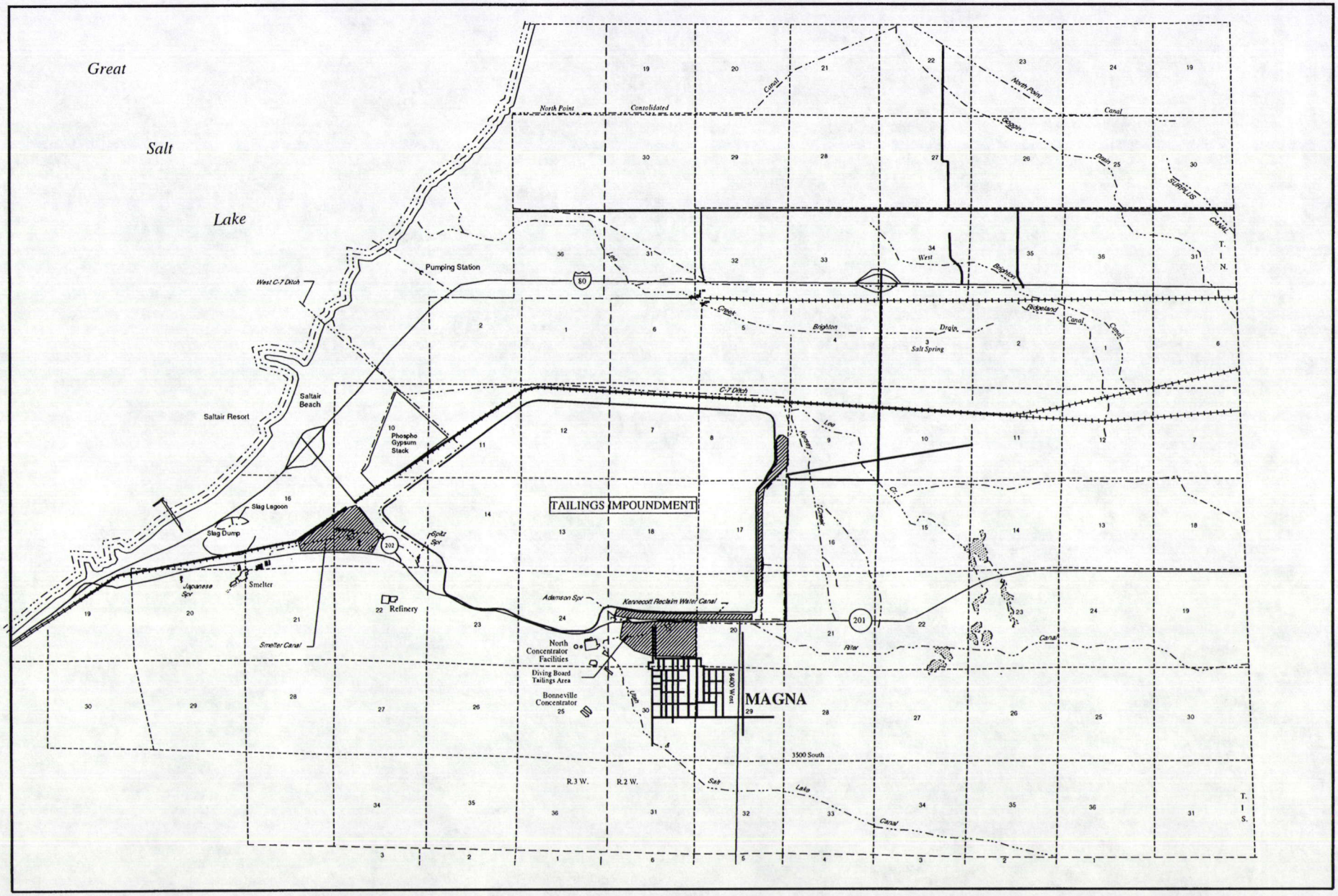
SCALE: MILES

SURVEY AREAS FOR ASSESSMENT OF AVIAN USE PATTERNS
SWCA INC. 1993

TAILINGS MODERNIZATION PROJECT
ENVIRONMENTAL IMPACT STATEMENT

KENNECOTT UTAH COPPER CORPORATION

Figure A-5



OPEN WATER
SURFACE WATER
ROAD

Survey Area with Mule Deer Sightings

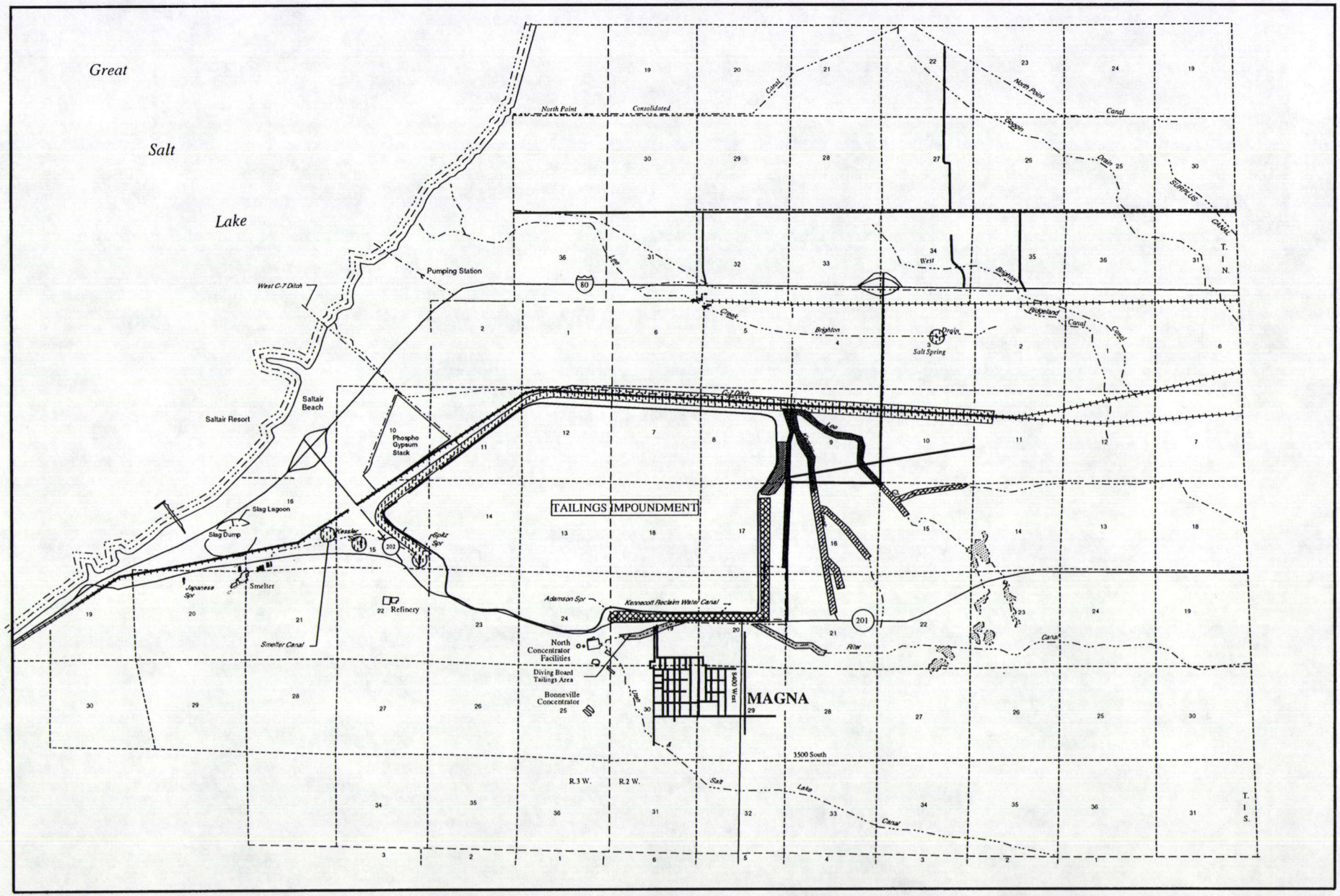
NORTH

0 1/2 1
SCALE: MILES

MULE DEER SURVEY AND SIGHTING AREAS
BIO/WEST, INC. 1992

TAILINGS MODERNIZATION PROJECT
ENVIRONMENTAL IMPACT STATEMENT
KENNECOTT UTAH COPPER CORPORATION

Figure A-6



OPEN WATER
SURFACE WATER
ROAD

Rabbit Brush Shrubland- Tailings Pond Berm
Sambar Willow/Cottonwood- Stream Bank
Springs, Streams, Canals Ponds, Roads

Salt Grass Riparian- Canal Edge
Common Reed Riparian- Canal Edge
Russian Olive Urban Forest- Tailings Pond Berm

NORTH

0 1/2 1
SCALE: MILES

SAMPLING SITES FOR SMALL MAMMAL, AMPHIBIAN AND REPTILE SURVEYS

BIO/WEST, INC. 1991

TAILINGS MODERNIZATION PROJECT
ENVIRONMENTAL IMPACT STATEMENT

KENNECOTT UTAH COPPER CORPORATION

Figure A-7

APPENDIX B

APPENDIX B

Wetland Mitigation Concept for the Tailings Modernization Project

(To be provided in the Draft EIS.)

APPENDIX C

APPENDIX C

Glossary, Acronyms and Abbreviations

GLOSSARY, ACRONYMS AND ABBREVIATIONS

A-weighted scale - weighting scheme applied to sound level measurements; corresponding proximately to human hearing sensitivity. Expressed as decibels. (A-weighted (dBA)

ACHP - Advisory Council on Historic Preservation

acid water -

aggregated - a collection of units or parts somewhat loosely associated with one another

alkali - a substance that neutralizes acids

alkali scrub -

alluvial - pertaining to material or processes associated with transportation or deposition by running water

aluminum (Al) - a silver-white malleable ductile light metallic element

amalgamated -

ambient noise - a mix of all the existing sound within a given location, room, etc.; background noise

analytes -

anhydrous ammonia -

anions - negatively charged ions

aquatic - growing or living in or frequenting water

aquifer - a water bearing layer of permeable rock, sand, or gravel

arsenic (As) - a solid brittle poisonous chemical element of grayish color and metallic luster

arterials -

archaic stage -

atlatl -

AST - Above Ground Storage Tank

attenuation - to weaken

avian - of, relating to, or derived from birds

avifauna -

backfilling - the operation of refill and excavation and finishing the surface

barium (Ba) - a silver-white metallic chemical element that occurs only in combination

BACT - Best Available Control Technology

Bald Eagle Act of 1940 -

barge pumps -

bassia -

BEBR - Bureau of Business and Economic Resources

bedrock - the rock that underlies gravel, soil, or other superficial material

Beneficial Impact -

berm footprint -

berm - a layer of large rock or other relatively heavy, stable material placed at the outside

biota - of or relating to life

biphenyls -

blanket drain -

BLM - Bureau of Land Management

BOD5 -

bolleana -

Bonneville Clay -

booster stations -

bouguer -

Bouguer gravity survey -

Bramwell silty loam -

brine - water saturated with salt

C-7 Ditch - conveyance for water discharged from the tailings impoundment. Transports water from outfall 001 north and then west to the Great Salt Lake

CAAA - Clean Air Act and Amendment

cadmium (Cd) - a bluish white metallic chemical element used in protective platings

cations - a positively charged ion

CEQ - Council on Environmental Quality

CERCLA - Comprehensive Environmental Response, Compensation and Liability Act of 1980

CFR - Code of Federal Regulations

channel bed substrates -

chloride - a compound of chlorine with another element or group

Class 3 waters - Class 6 waters -

closed basins -

concentrator -

Corps - The U.S. Army Corps of Engineers

cultivar -

CWA - Clean Water Act

cyclone - mechanical process of separating slurried tailings into underflow and overflow

cyclone station - the location that the tailings are separated into overflow and underflow

dB - decibel - a logarithmic ration between pressures caused by a given sound and a standard sound pressure; a measurement of noise

dBA - a weighted noise level scale used to correspond to the range and characteristics most consistent with the way human ears perceive sounds

decant pond -

DEIS - Draft Environmental Impact Statement

delisting - removing species from threatened and/or endangered categories of federal and/or state special status lists

depauperate -

dewatering -

disjunct -

disturbed area - an area where vegetation, topsoil, or overburden is removed or upon which topsoil, spoil, and processed waste is placed as a result of mining

DOGM - Division of Oil, Gas, and Mining. State of Utah, Department of _____

drainage blanket -

drawdown -

dry phosphate fertilizers -

DWQ - Division of Water Quality, State of Utah, Department of Environmental Quality

E - Federal code for any species that is in danger of extinction throughout all or a significant portion of its ranger with the exception of a species of the Class Insecta

ecosystem - the complex of an ecological community and its environment functioning as a unit in nature

edaphic - having to do with the influence of soils on living things, particularly plants, including human use of land for plant growth

EIS - Environmental Impact Statement - a detailed document prepared pursuant to the National Environmental Policy Act

electrofishing -

embankment design criteria -

endangered - any species in danger of extinction through all or a significant portion of its range Existence may be endangered because of the destruction, drastic change, or severe curtailment of habitat, or because of overexploitation, disease, predation, or unknown reasons

EPCM -

EPA - U.S. Environmental Protection Agency

ephemeral stream - a stream that flows only in direct response to rainfall and snowmelt events; having no baseflow

equidistant - equally distant

ERM -

ERNS - Emergency Response Notification System

est. - estimated

ethnographic -

ethnohistoric -

evaporation ponds -

extirpated - any species that has disappeared, as a part-time or full-time resident of its range

eyries - cliff nesting site used by birds of prey

FDAP - Fugitive Dust Abatement Program

Federal Register -

FEIS - Final Environmental Impact Statement

FHPM - Federal-Aid Highway Program Manual

FHWA - Federal Highway administration

floristic -

FLPMA - Federal Land Policy and Management Act

fluvial -

footprint -

forb -

former Salt Plant - Morton Salt Facility

FTE - full time equivalents

Garfield Plant - Chevron Garfield Phosphate Plant, Utah

generic mitigation - consists of measures or techniques recommended on a non-specific or project wide basis as part of the proposed action. Specific mitigation include measures recommended on a case-by-case basis

geomembrane -

geomorphic -

geotechnical -

govts - governments

gradient - slope

graminoid -

grasslands - lands covered naturally or under cultivation with grasses and low-growing herbs

gravel zone -

Gross Regional Product -

grubbing - removing vegetation and other material from a surface area prior to mining or mining-related disturbance

GWQP - Ground Water Quality Protection

gypsum - calcium sulfate

habitat - the place where an animal or plant normally lives, often characterized by a dominant plant and codominant form

header dikes -

herpetofauna - amphibians and reptiles

hibernacula -

historypology -

Hwy - Highway -

hydraulic gradients -

hydrogeolody -

hydromulching -

hydroseeding -

IBT -

IMPLAN - System of input/output modeling utilized to estimate economic impacts

impoundment -

in situ - latin for in place

insecta - class of species in danger of extinction but determined to constitute a pest whose protection under the Endangered Species Act would present an overwhelming and overriding risk to man

interlacustral -

interstitial -

inundation - flooding

iron (Fe) - a heavy magnetic metallic chemical element that rusts easily, can be readily shaped, and is vital to biological processes

ISB - Intermountain Seismic Belt

Jo - Jordan silty clay loam

jurisdictional - the limits or territory within which the power, right or authority to interpret and apply the law may be exercised

Kennecott - Kennecott Utah Copper Corporation

kV - kilovolts (1000 volts)

lacustrine -

lanceolate -

land jurisdiction - the limits of administrative authority of a federal, state, or local government agency

landform contrast -

LcA - Lasil silt loam

leach - to pass a liquid through to carry off soluble components

leachate -

lead (Pb) - a heavy bluish white chemical element that is easily bent and shaped

lithics -

loam - a loose soil of mixed clay, sand, and silt

M-la -

macroinvertebrate -

macrophytes -

mammalogy - the study of mammals

mammals - any of the group of vertebrate animals that includes humans and all others which nourish their young with milk

MCE - Maximum Credible Earthquake

Mech - mechanical

megafauna -

metates -

microearthquake -

mitigation - rectifying an impact by repairing, rehabilitating, or restoring the affected environment

morphology - a branch of biology dealing with the form and structure of organisms

MSCE -

NAAQS - National Ambient Air Quality Standards

NEPA - National Environmental Policy Act, 1969 legislation which encourages restoration and maintenance of environmental quality to the overall welfare of living things

NESHAP -

NHPA - National Historic Preservation Act

non-water dependent - an activity associated with a discharge which is proposed for a special aquatic site that does not require access or proximity to or siting within the special aquatic site in question to fulfill its basis purpose

NOA - Notice of Availability

NPL - National Priorities List

NRHP - National Register of Historic Places

numic -

NWI - National Wetland Inventory

overflow - the finer-grained materials of the that are produced when tailings are processed through a cyclone

organic - of, relating to, or deriving from living things

outlier -

overstory species -

overflow retention basins -

OBE - Operating Basis Earthquake

open-pit copper mine -

Ovrhd - Overhead

Paleo-Indian -

paleontology - a science dealing with the life of past geologic periods, especially as known from fossil remains

palliative -

palustrine -

passerine - the largest order of birds, including most songbirds

PCBs - Polychlorinated biphenyls - any of several industrial compounds that are poisonous environmental pollutants

penstemon -

perennial - a plant that lives for an indefinite number of years

peripheral discharge system - the discharge of tailing to the perimeter of the tailings impoundment, providing circumference beach management

periphyton -

permeabilities -

petroleum - an oily flammable liquid obtained from wells drilled in the ground and refined into gasoline, fuel oils, and other products

pH - a value used to express acidity and alkalinity

phosphate - a salt of phosphoric acid

phosphogypsum -

phosphoric acid - any of several oxygen-containing acids of phosphorus

phreatic - hydraulic gradient

physiographic - geography dealing with physical features of the earth

pinyon - any of various low-growing pines of western North America with edible seeds

pithouse -

playa -

PM - particulate matter (e.g. PM-10)

polonium (Po) - a radioactive metallic chemical element

ponar -

Ppty - property

practicable - describes an alternative that is available and capable of being implemented after taking into consideration existing technology, logistics, and economics in light of the overall project purpose

prehistoric PM-10 - particulate matter less than 10 microns in diameter (One micron is equal to one-millionth of a meter)

Protohistoric -

pump house -

Quanternary -

RACT - Reasonably Available Control Technology

radial flow -

radionuclides -

raptors - birds of prey (e.g., hawks, owls, vultures, eagles)

RCLs - Recommended Clean-up Levels

ROD - Record of Decision

REIS - Regional Economic Information System

remediation -

revegetation - plant growth that replaces original ground cover following land disturbance

richter magnitude -

Sa - Saltair silty clay loam

sacaton -

saline playas - sparsely vegetated inland basins that are occasionally or at least historically inundated by Great Salt Lake

SARA -

scoping - an early and open process for determining the scope of issues to be addressed in an EIS and for identifying the significant issues related to a proposed action

SCS - Soil Conservation Services

sedentism -

seismic - of, relating to, resembling, or caused by an earthquake

selenium (Se) - a nonmetallic chemical element that varies in electrical conductivity with the intensity of its illumination

SIP - State Implementation Plan

SHPO - State Historic Preservation Office

single-point discharge -

slag - the waste left after the melting of ores and the separation of metal from them

slurry - a watery mixture of insoluble matter

socioeconomics -

Special Status Species - any species listed by state or federal agencies as threatened or endangered

spigot - refers to a fixture at the end of a tailings delivery pipe, similar to a faucet, used as a discharge point for the slurry

splitter box - a flow dividng chamber

SPLP - Synthetic Precipitation Procedure

starter dike -

static pressures -

strata - a single sedimentary layer of any thickness

subirrigated -

subpopulation -

subsidence - the settling of liquid to the bottom

sulfuric acid - a heavy corrosive oily strong acid

Superfund -

surficial -

T - federal code for any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range

tackifer -

tailings - the unusable portion of the ore and an unavoidable and non-economic by-product of the extraction of economic minerals from ore

tailings impoundment - name of facility. In 1991, the size of the impoundment is 5727 acres, maximum depth of tailings is 200 feet, rate of tailings discharge to the impoundment is 105,000 tons per day and annual rise of tailings is 5.5 feet/year

tamarisk -

taxa -

TCLP -

TDS - Total Dissolved Solids

threatened species - species which, although not presently threatened with extinction, is likely to become endangered in the foreseeable future in the absence of special protection and management efforts

toe dike -

toe ditch -

Tordon - herbicide added to fertilizer

tpd - tons per day

TPH - Total Petroleum Hydrocarbons

transition dikes -

triaxial -

tributaries - waterways that flow into a larger stream or lake

UAC - Utah Administrative Code

UDAQ - Utah Division of Air Quality

UDEQ - Utah Department of Environmental Quality

UDOT - Utah Department of Transportation

UDWR - Utah Division of Wildlife Resources

underflow - the coarser, structural sand fraction of the slurry that is separated out when the tailings are processed through a cyclone; most embankments are made from underflow tailings

underflow sands -

understory species -

UNHP - Utah Natural Heritage Program

UP&L - Utah Power and Light

UPDES - Utah Pollutant Discharge Elimination System

UPRM - Union Pacific Resources-Minerals

UPRR - Union Pacific Railroad

USC - United States Code

USDI - United States Department of Interior

USFWS - United States Fish and Wildlife Service

UST - Underground Storage Tank

volcanic outcrops -

watercourses -

wetlands -

wireway -

INDEX

404 Permit 1-10-12, 2-10, 2-11, 2-37, 4-1, 4-7
A-Weighted scale 3-165, 3-167, C-1
ACHP 3-162, 3-163, C-1
acid water C-1
Advisory Council on Historic Preservation 3-162, C-1
agricultural land 3-102, 3-167
alkali scrub 3-11, 3-12, 3-35, C-1
alluvial 2-7, 2-26, 2-29, 3-20, 3-27, 3-95, 3-97, 3-112, C-1
aluminum 3-52, 3-55, 3-58, C-1
ambient noise 3-164, 3-166-169, C-1
anhydrous ammonia 3-147, C-1
anions 3-48, 3-82, C-1
Approval Order 3-174
aquatic biota 3-2, 3-7, 3-13, 3-31, 3-36-38, 3-179, 3-180
aquatic habitat 3-14, 3-180
aquatic macrophytes 3-15
aquifer . viii, 2-7, 2-14, 2-26, 2-27, 2-29-31, 3-52, 3-59, 3-61-64, 3-66-71, 3-73, 3-74, 3-78, 3-80, 3-83, 3-86, 3-87, 3-90, 3-91, 6-5, C-2
archaeological 3-156, 3-160, 3-160, 3-163, 6-12, 6-13
archaic stage 3-157, C-2
arsenic . . 3-52, 3-58, 3-68-71, 3-74, 3-75, 3-78, 3-81-83, 3-91, 3-143, 3-144-146, 3-150, 6-7, C-2
Arthur Facilities 3-103
ASARCO 3-159
AST C-2
average sound level 3-166
avifauna 3-16, C-2
backfilling C-2
background noise 3-164, 3-169, 3-171, C-1
BACT C-2
bald eagle 3-6, 3-17, 3-21, 3-40, 3-181, C-2
Bald Eagle Act of 1940 . . . . . 3-6, C-2
barge pumps 3-172, C-2
bassia 3-10, 3-11, 3-23, C-2
bedrock . . . . . viii, 2-7, 3-59, 3-61-63, 3-67, 3-68, 3-73, 3-90, 3-91, C-3
Beneficial Impact 3-4, C-3
berm 2-4, 2-9, 2-12, 2-21, 2-37, 3-23, 3-39, 3-99, 3-100, 3-172, 6-8, C-3
Best Available Control Technology C-2
Bingham Canyon Mine . . . 2, 1-1, 1-6-9, 2-1, 2-3, 2-5, 3-112, 3-116, 3-126, 3-129, 3-132, 3-134, 3-1, C-4
biota 3-2, 3-7, 3-13, 3-31, 3-36-38, 3-179, 3-180, C-3
biphenyls C-3, C-14
birds . . . 3-6, 3-7, 3-15, 3-16, 3-20-22, 3-24, 3-25, 3-30, 3-43, 3-164, 6-2-4, C-2, C-7, C-14, C-16
black tern 3-25, 3-41
Blanket Drain 2-2, C-3
BOD5 . . . . . 3-53, 3-56, C-3
bolleana 3-123, C-3

Bonneville Clay . . . 2-23, 2-40, 3-61, 3-63, 3-64, 3-79, 3-84, 3-87, 3-88, 3-91, 3-94, 3-99, 3-100, 3-145, 6-7, 6-8, C-3
Bonneville Gate 3-105
Boston Consolidated Copper Mining Company Ltd. 3-159
Bouguer gravity survey 3-93, C-3
Bramwell silty loam 3-97, C-3
Brighton Drain 3-14, 3-44, 3-48, 3-55, 3-160
brines 3-67
Bureau of Land Management 3-113, 6-8, 6-11, C-3
C-7 Ditch . . viii, 2-31, 2-37, 2-40, 3-9, 3-11, 3-14, 3-18, 3-33-38, 3-43-46, 3-52-56, 3-90, 3-107, 3-108, 3-112, 3-117, 3-144, 3-170, 3-176, 3-182, C-4
C-7 West Ditch 3-9, 3-14, 3-15, 3-33, 3-37, 3-38, 3-53, 3-90, 3-111, 3-180
CAAA 3-174, C-4
cadmium 3-52, 3-68-71, 3-74, 3-75, 3-78, 3-81-83, 3-91, 3-145, 3-146, 3-150, 6-6, C-4
California gull 3-39
Category 1 Candidate Species 3-19
Category 1 Candidate Species (C1) 3-19
Category 2 Candidate Species 3-19
Category 2 Candidate Species (C2) 3-19
Category 3 (C3) 3-19
cations 3-48, 3-82, C-4
Central Flyway 3-16
CEQ 1-10, 2-11, 4-1, 4-2, C-4
CERCLA 3-141, 3-142, 3-146, 3-154, 3-183, C-4
CFR 1-10, 3-1, 3-6, 3-141, 3-143, 3-149, 3-155, 3-162, 3-163, 4-1, 4-2, C-4
channel bed substrates 3-15, C-4
Chevron Phosphate Plant 3-66, 3-72, 3-80, 3-87, 3-143, 3-144, 3-147, 3-147, 3-152-154
chloride 3-47, 3-48, 3-55, 3-58, 3-68, 3-70, 3-72, 3-82, 3-85, C-4
chub 3-14, 3-29, 3-37, 3-41, 3-180
Class 3 waters 3-47, C-4
Class 3D standards 3-43, 3-47
Clay Hollow 2-25
Clean Water Act 2, 1-9, 1-10, 1-12, 2-4, 2-10, 3-6, 3-31, 3-34, 3-47, 3-65, 3-184, 4-7, C-5
closed basins 3-11, 3-36, C-4
composite 2-26, 2-27, 2-31, 2-36
concentrator 1-1, 1-3, 1-5-7, 2-15, 2-25-32, 2-36, 3-68, 3-74, 3-103, C-4
Coon Canyon 2-4, 2-7, 2-27
copper . 2, ix, 1-1, 1-3, 1-6, 1-7, 1-9, 2-1, 3-1, 3-14, 3-52, 3-55, 3-58, 3-68-70, 3-74, 3-75, 3-78, 3-80-83, 3-86, 3-87, 3-90, 3-91, 3-102, 3-116, 3-125, 3-130-132, 3-140, 3-144, 3-145, 3-152, 3-159, 4-1, 4-3, 4-6, 5-1, 5-2, 6-1, 6-4-11, 6-13, C-11, C-13, C-2, C-3
Copperton Concentrator 1-3, 1-6, 2-7, 2-15, 2-25-27, 2-29-31
Corps Wetlands Delineation Manual 3-7
Council of Environmental Quality 4-1
County Road 8000 West 1-3, 3-101
cultural resource 3-3, 3-164, 5-1, 6-11
cyclone station C-5
decant pond 1-5-8, 2-1, 2-3, C-5

delisting 3-22, C-5
Department of Water Quality 3-147, 6-5
depauperate 3-38, C-5
dewatering 2-21, 2-25, 2-37, 2-40, 3-36, 3-77, 3-99, 3-100, 3-130, 3-131, C-5
discharge from springs and seeps 3-63, 3-64
disjunct 3-29, C-5
disturbed area C-5
disturbed land 3-11, 3-15
Division of Oil, Gas and Mining 1-12, 3-124, 4-6
DOGM 3-97, 6-7, C-5
Draft Environmental Impact Statement 1-10, 3-1, C-5, C-2
drainage blanket 2-2, 3-66, 3-72, 3-79, 3-84, 3-85, 3-88, 3-89, 3-91, 3-111, 3-141, 3-152, 3-176, C-5
drawdown C-5
drinking water sources 2-7
Dry Fork/Carr Fork 2-4, 2-28, 2-29
dry phosphate fertilizers 3-147, C-6
dust control 1-3, 2-3, 3-122, 3-123, 3-173-175, 3-177, 3-179, 3-183, 3-184
DWQ 3-71, 3-89, 3-91, 3-92, 3-93, 3-147, 3-148, C-6
early archaic 3-157
edaphic C-6
electrofishing 3-13, C-6
elk 3-17, 3-39
embankment design criteria 2-12, C-6
Emergency Response Notification System 3-151, C-7
emergent meadows 3-10, 3-11, 3-33
emergent wetlands 2-24, 3-179
endangered 3-6, 3-18-22, 3-29, 3-32, 3-40, 4-4, 6-3, C-5, C-6, C-10, C-17-19
Endangered Species Act of 1973 3-6
EPCM 3-137, C-6
ephemeral stream C-6
ERM 3-7, C-7
ERNS 3-151, C-7
ethnographic 3-155, C-7
ethnohistoric 3-155, 3-158, C-7
evaporation ponds . . 3-15-17, 3-23, 3-55, 3-56, 3-72, 3-85, 3-87, 3-90, 3-90, 3-96, 3-104, 3-159, 3-160, C-7
Executive Order 11990 3-7
extinct mammals 3-157
eyries 3-21, C-7
FDAP 3-176, C-7
Federal Highway Administration 3-167, 6-13
Federal Land Policy and Management Act of 1976 3-6
Federal Register 1-11, 3-29, 4-2, 4-3, 4-4, 4-7, 4-7, 6-3, 6-5, C-7
ferruginous hawk 3-17, 3-24, 3-41
FHWA 3-108, 3-168-169, 6-13, C-7
floristic 3-33, C-7
FLPMA 3-6, C-7

forb 3-10, 3-12, C-8
Fremont Cultural Complex 3-157
gadwalls 3-17
Garfield Plant 3-2, 3-141, 3-143, C-8
geomembrane 2-14, 2-26, 2-27, 2-36, C-8
geomorphic C-8
geotechnical 2-13, 2-23, 5-2, 5-3, 6-7, 6-8, 6-10, C-8
Gilmore Livestock 3-104
Goggin Drain 3-23, 3-144
Golden Gate Audubon Society 3-7
gradient 3-62, 3-66, 3-72, 3-85, 3-91, 3-93, C-8, C-14
graminoid 3-10, C-8
Grantsville 3-158
grasslands 3-12, 3-17, 3-35, 3-39, 3-185, C-8
gravel zone 3-62, 3-63, C-8
Grays Lake National Wildlife Refuge 3-22
Great Basin Region 3-20
Great Salt Lake . . . 2-7, 3-8, 3-15, 3-16, 3-21-23, 3-25-27, 3-41-45, 3-48, 3-53, 3-55, 3-56, 3-62, 3-66-71, 3-89, 3-90, 3-93, 3-95, 3-96, 3-109, 3-110, 3-112, 3-115-117, 3-119-121, 3-125, 3-125, 3-145, 3-150, 3-156-158, 3-163, 3-169, 3-182, 3-185, 3-186, 4-4-5, 6-1-3, 6-5, 6-7, 6-8, 6-13, C-4, C-16
Great Salt Lake State Park . . 3-109, 3-110, 3-113, 3-115-117, 3-119, 3-120, 3-125, 3-186, 3-186
Green River 3-22, 3-41
gross regional product 3-132, 3-137, C-9
ground water protection regulations 3-58
GSL 3-59, 3-61-63, 6-5
guggenheims 3-159
gull colony 3-8, 3-9, 3-33, 3-103, 4-5
Hansel valley 3-96
Harker's Canyon 2-25, 2-27
herpetofauna 3-15, C-9
hibernacula 3-28, C-9
historic properties 2-21, 3-155, 3-156, 3-159-164, 3-184
historypology C-9
Hukunduka 3-158
hydraulic gradients 3-59, 3-62-64, 3-91, C-9
hydrogeology 3-7
hydromulching 3-178, 3-184, C-9
hydroseeding 3-123, C-9
IBT 3-137, C-9
IMPLAN 3-131, 3-132, 3-134, 3-139, 3-140, C-10
in situ 3-99, 3-100, 3-157, C-10
industrial land 3-102, 3-103, 3-166, 3-170
interlacustral environments 3-94
Intermountain Seismic Belt 3-96, C-10
interstitial 3-66, 3-72, 3-81, 3-83, C-10
iron 3-14, 3-52, 3-55, 3-58, 3-82, 3-84, 6-6, C-10
ISB C-10

Jordan silty clay loam 3-97, C-10
Jordan Valley 3-93-95
Kersey Creek 3-14, 3-48, 3-52, 3-56
L10 Value 3-166
lacustrine zone 3-62
Lake Bonneville 3-93-95, 3-112
lanceolate 3-157, C-11
landform contrast 3-118, C-11
Landscape character 3-2, 3-115, 3-119
leachate 3-66, 3-72, 3-75, 3-75, 3-81-83, 3-85, 3-89, 3-152, C-11
lead 2, 1-10, 2-29, 3-1, 3-46, 3-52, 3-68-70, 3-74, 3-75, 3-78, 3-81, 3-82, 3-90, 3-91, 3-135, 3-142, 3-145, 3-146, 3-150, 3-156, 6-6, C-11
least chub 3-29, 3-41
Lee Creek viii, 3-14, 3-23, 3-37, 3-44-46, 3-48, 3-52, 3-55, 3-56, 3-58, 3-90, 3-111, 3-144, 3-185
Lee Creek Outlet 3-55, 3-56, 3-58, 3-90
Little Valley Wash 2-27
loggerhead shrike 3-23, 3-41, 3-181
long-billed curlew 3-26
Los Angeles and Salt Lake/Union Pacific Railroad 3-160
Low Impact 3-4, 3-31, 3-33, 3-35, 3-37, 3-98, 3-119, 3-120
low-lying basins 3-11
Lower Bonneville Clay 3-79, 3-95
Lower Lee Creek 3-44-46, 3-48, 3-90, 3-185
Mackey landfill 3-104
macroinvertebrate 3-14, C-11
macrophytes 3-15, C-11
Magna Community Plan 3-105, 3-109
mammalogy 5-3, C-11
Mammals . . 3-7, 3-15, 3-17, 3-22, 3-24-27, 3-30, 3-38, 3-39, 3-157, 3-157, 3-180, 6-2, 6-3, 6-5, C-11
Maximum Credible Earthquake 3-96, C-12
megafauna 3-157, C-12
Memorandum of Agreement 3-163
Migratory Bird Treaty Act of 1986 3-6
monitor wells 3-67, 3-72, 3-86, 3-88, 3-89, 3-91, 3-154
Morton Salt 3-2, 3-9, 3-23, 3-66, 3-72, 3-85, 3-87, 3-100, 3-103, 3-105, 3-141, 3-143, 3-144, 3-146, 3-150-152, 3-154, 3-183, 6-11, C-8
MSCE 5-2, 5-3, C-12
mule deer 3-15, 3-17, 3-38, 3-39, 3-180
National Historic Preservation Act 3-155, 3-162, C-12
National Priorities List 3-142, C-12
National Register of Historic Places 3-3, 3-155, 3-160, C-13
National Wetland Inventory 3-7, 6-5, C-13
Native American . . . . . 3-155, 3-158, C-
NEPA 1-10, 1-11, 2-11, 2-37, 3-1, 3-5, 3-6, 3-155, 4-1, 4-2, C-12
NESHAP 3-141, C-12

No Federal Action . . iii, 2-4, 2-15, 2-37, 3-32, 3-34, 3-36, 3-38, 3-42, 3-44, 3-53, 3-86, 3-88-91, 3-98, 3-99, 3-107, 3-119, 3-126, 3-129, 3-134, 3-153, 3-161, 3-170-172, 3-177, 3-186
No-Identifiable Impact 3-4
Noise Abatement Criteria 3-168
non-water dependent C-12
North Concentrator 1-3, 1-5, 1-6, 2-26-28, 2-32, 3-68, 3-103
North Expansion Reduced 2-24
northern goshawk 3-25, 3-41, 6-4
Northern Shoshone 3-158
Notice of Availability 1-11, 4-6, 4-7, C-12
Notice of Intent 1-12, 2-11, 4-1, 4-4, 6-7
NPL 3-142, C-12
NRHP 3-160-162, 3-183, C-12
NWI 3-7, C-13
OBE C-13
Off-Site Alternatives . . . . . iv, 2-4, 2-5, 2-8, 2-9, 2-15, 2-20, 2-25, 5-1
open-pit copper mine 1-1, 1-6, C-13
Operating Basis Earthquake 3-96, C-13
Oquirrh Mountains . . 1-1, 1-3, 2-7, 2-21, 2-25, 2-27-31, 3-16, 3-17, 3-59, 3-62, 3-66, 3-68, 3-71, 3-93, 3-95, 3-104, 3-112, 3-115, 3-116, 3-121, 3-125, 3-158, 3-159, 3-163
organic 3-15, 3-48, 3-144, C-13
outlier C-13
overflow 2-1, 2-3, 2-9, 2-13, 2-24, 2-38, 3-8, 3-9, 3-33-35, 3-37, 3-103, C-5, C-13
overstory species C-13
Pacific Flyway 3-16
Paleo-Indian 3-156, 3-157, C-13
paleontological 4-6, 6-11, 6-12
pallative 3-122
palustrine 3-8, 3-10, 3-11, 3-18, C-13
passerine C-13
pastures 3-12, 3-26, 3-28
penstemon 3-122, C-14
peregrine falcon 3-17, 3-20-22, 3-40, 3-41, 3-181, 6-4
perennial 3-8, 3-20, C-14
peripheral discharge system 1-3, 1-5, 1-7, 3-175-178, C-14
periphyton 3-13, 3-14, 3-37, C-14
permeabilities 3-61, 3-62, 3-64, C-14
Permitting feasibility 2-11, 2-13
petroleum 3-141, 3-147, 3-153, 3-154, 3-183, C-14, C-19
phalaropes 3-17
phosphate . . . 3-66, 3-72, 3-80, 3-87, 3-100, 3-141, 3-143, 3-144, 3-146, 3-147, 3-152-154, 6-10, 6-11, C-6, C-8, C-14
phosphoric acid 3-147, 3-150, C-14
Pine Canyon 2-7, 2-31
pinyon 3-28, 3-157, C-14
pithouse C-15
plant species 3-6, 3-10, 3-11, 3-19, 3-20, 3-41, 3-181

playa 2-7, 3-6, 3-10, 3-17, 3-23, 3-112, C-15
Pleistocene 3-93, 3-112, 3-156
Polychlorinated biphenyls C-14
ponar 3-13, C-15
population growth rates 3-126
ppm 3-48, 3-52
preble's shrew 3-27, 3-41
prehistoric caves 3-161
principal aquifer . . . . . ii, 3-59, 3-61-63, 3-67, 3-69, 3-71, 3-73, 3-90
Promontory mountains 3-96
Proposed Action . . . iv, 1-10, 1-11, 2-1, 2-3-5, 2-20, 2-37, 2-41, 3-4-6, 3-20, 3-42, 3-162, 3-180, 3-183, 3-187, 4-7, C-8, C-16
Protohistoric 3-158, C-15
Provo Lake 3-112
pump house C-15
pygmy rabbit 3-27, 3-41
Quaternary sediments 3-93
RACT 3-174, C-15
radial flow 3-84, 3-88, 3-91, C-15
radionuclides 3-81, 3-83, 3-84, C-15
Railroad right-of-way 3-154
raptors 3-16, 3-17, 3-21, 3-24, 3-40, C-15
RCLs 3-141, C-16
Reasonably Available Control Technology 3-174, C-15
Recommended Clean-up Levels 3-141, C-16
Record of Decision (ROD) 1-11, 4-7
Reduced North Expansion 2-10, 2-31-33
remediation 3-142, 3-152-154, 4-6, C-16
revegetated 1-5, 3-125
richter magnitude 3-96, C-16
Riter Canal 3-18, 3-43
Riter Drain 3-160
Riter Station 3-160, 3-161
sacaton 3-12, C-16
Safe Drinking Water Act 3-65
saline playas 1-9, 2-24, 3-8-10, 3-12, 3-16, 3-33-35, 3-38, 3-48, 3-103, 3-115, 3-179, 3-181, C-16
salt evaporator impoundments 2-23, 2-38, 3-40, 3-42
Salt Lake City County Health Department 3-166
Salt Lake City Draft Northwest Quadrant Master Plan 3-105, 3-109
Salt Lake City/County Landfill Parcel 3-104
Salt Lake, Garfield, & Western Railroad 3-161
Salt Plant 3-2, 3-66, 3-85, 3-87, 3-141, 3-143, 3-144, 3-150-152, 3-154, 3-183, C-8
Saltair Beach 3-112, 3-115-117, 3-119, 3-120, 3-125
Saltair North 3-15
Saltair Resort 3-23, 3-96, 3-97, 3-116, 3-117, 3-159, 3-166-172, 3-186, 6-11
San Pedro, Los Angeles & Salt Lake/Los Angeles and Salt Lake Railroad 3-161
San Pedro, Los Angeles & Salt Lake/Los Angeles and Salt Lake Railroad 3-161

sanderling 3-17
sandy alluvial land 3-97
sandy borrow pits 3-97
SARA Title III 1-12
screening 2-4, 2-10, 2-11, 2-15, 3-143, 6-1
sedentism 3-157, C-16
seismic . . 2, 1-7-10, 2-12, 2-21, 2-25, 2-26, 2-28, 2-37, 2-40, 3-96-100, 3-182, 4-6, 5-2, 6-1, 6-8, C-10, C-16
selenium . 3-52, 3-55, 3-68-71, 3-74, 3-75, 3-78, 3-81, 3-82, 3-90, 3-91, 3-144, 3-146, 3-150, 6-6, C-16
Sensitive Viewpoints 3-2, 3-113, 3-115, 3-116, 3-118, 3-119
Settlement Canyon 2-30, 2-31
Sevier lake 3-112
shadscale 3-12, 3-27
shallow aquifer . . . . ii, 3-52, 3-59, 3-61-64, 3-67, 3-68, 3-70, 3-71, 3-73, 3-74, 3-80, 3-83, 3-86, 3-87, 3-90
SHPO 3-160, 3-163, C-17
single-point discharge 1-3, 3-111, C-17
SIP 3-173, 3-174, C-17
Skull Valley 3-158
slurry . 1-1, 1-5, 1-8, 2-2, 2-5, 2-12, 2-14, 2-23, 2-29, 2-30, 2-37, 3-66, 3-72-74, 3-80, 3-86, 3-87, 3-89, C-17, C-19
Special Status species 3-2, 3-3, 3-6, 3-7, 3-16, 3-18, 3-30, 3-31, 3-40, 3-42, 3-180, C-17
splitter box 1-3, C-17
spotted bat 3-28, 3-41, 6-3, 6-4
spotted frog 3-28, 3-29, 3-41, 6-3
Spritz Creek 3-14
Stansbury 3-96, 3-112, 3-122, 3-123
starter dike 2-2, 2-23, 2-26-28, 2-38, 3-4, 3-111, 3-176, C-17
State Highway 201 . . . . . 2-21, 3-100, 3-101
State Historic Preservation Office C-17
State Implementation Plan 3-173, 6-1, 6-13, C-17
State Road 201 3-115
State Road 202 . . . . . 3-103, 3-115
subirrigated 3-20, C-17
subpopulation 3-19, C-18
Substantial Noise Increase Criteria 3-168
sulfuric acid 3-147, C-18
superfund site 3-2, 3-141-143, 3-154, 3-183
tackifer C-18
tamarisk 3-8, 3-9, 3-11, 3-12, 3-38, C-18
TCLP 3-149, 3-150, C-18
TDS 3-48, 3-55, 3-66, 3-68-71, 3-73, 3-74, 3-78, 3-82, 3-85, 3-90, 3-91, C-18
threatened 3-6, 3-18-20, 3-22, 3-29, 3-32, 4-4, 6-3, C-5, C-17, C-18
Timpanogots Ute 3-158
toe dike 2-2, 3-111, 3-176, 3-182, C-19
toe ditch 2-2, 2-3, 2-40, 3-34, 3-124, C-19
Tooele Army Depot 2-29

topsoil erosion 3-182
tordon 3-149, C-19
Total Petroleum Hydrocarbons C-19
transition dikes 2-1, C-19
Traverse Mountains 3-95
UAC 3-141, C-19
UDAQ 3-173-175, C-19
UDEQ 3-71, C-19
UDOT 3-108, C-19
UDWR 3-6, 3-7, 3-18, 3-21, 3-29, 3-41, C-19
underflow 2-1-3, 2-21, 2-23, 2-38, 3-77, 3-176, C-5, C-19, C-20
Underground Storage Tank C-20
understory species 3-11, 3-12, C-20
UNHP 3-6, C-20
Union Pacific Railroad . 1-3, 2-21, 2-23, 2-36, 2-40, 3-33, 3-37, 3-39, 3-101, 3-103, 3-109, 3-110, 3-117, 3-125, 3-141, 3-151, 3-160, 3-170, 3-176, 3-182, C-20
Union Pacific Resources-Minerals 3-103, C-20
United States Fish and Wildlife Service C-20
UP&L 2-40, 3-34, 3-101, 3-107, 3-110, 3-117, 3-182, C-20
UPDES 1-12, 3-14, 4-3, C-20
upland communities 3-11
Upper Bonneville Clay 3-79, 3-94, 3-99, 3-100, 6-7, 6-8
UPRM 3-103, 3-105, 3-108, 3-110, C-20
UPRR 2-40, 3-34, 3-101, 3-103-105, 3-107, 3-108, 3-110, 3-117, 3-141, 3-182, C-20
urban forest 3-11, 3-12
USC 3-65, 3-140, 3-141, C-20
USDI 3-7, C-20
USFWS 3-6, 3-18-20, 3-22, 3-41, C-20
UST 3-151, 3-154, 3-183, C-20
Utah Administrative Code 3-47, 3-141, C-19
Utah Department of Environmental Quality . 1-12, 3-71, 3-142, 3-173, 4-3, 6-5, 6-6, 6-11, C-19, C-2, C-3
Utah Division of Wildlife Resources 3-6, 3-29, 4-4, C-19
Utah Natural Heritage Program 3-6, C-20
Utah Pollutant Discharge Elimination System C-20
Utah Power and Light C-20
Utah-Salt Lake Canal 3-43
ute ladies' tresses 3-20, 3-41
vegetated playas 3-179
vegetation contrast 3-118
Visibility 3-114-116
visual buffer 2-40, 3-34, 3-97, 3-122-124, 3-172, 3-173, 3-176, 3-182, 3-186
Visual Resource Management Inventory and Contrast Rating System 3-113, 6-8
Visual Sensitivity 3-113, 3-115, 3-116
Wasatch Front 3-17, 3-20, 3-29, 3-125-127
Wasatch range 3-21, 3-112, 3-116, 3-121
watercourses 3-43, 3-55, C-20
Weber Ute 3-158

West C-7 Ditch . . . . . ii, 2-31, 2-40, 3-34, 3-43-46, 3-52, 3-54, 3-90
West Valley 2-26, 2-36, 3-96
western least bittern 3-26, 3-41
Western Pacific Railroad 3-160-162
western snowy plover 3-22, 3-41, 3-181
whooping crane 3-22, 3-40
Wildlife Resources Code 3-7
wireway 3-137, C-21

APPENDIX D

APPENDIX D

Agencies, Organizations and Individuals Receiving this Preliminary Draft Environmental Impact Statement

APPENDIX D

Mr. Art Champ - Chief of Regulatory Section
U.S. Army Corps of Engineers
Sacramento District

Mr. Larry Vinzant
U.S. Army Corps of Engineers
Sacramento District

Mr. Brooks Carter - Field Supervisor
U.S. Army Corps of Engineers
Utah Regulatory Office

Mr. Michael A. Schwinn - Project Manager
U.S. Army Corps of Engineers
Utah Regulatory Office

Ms. Paula Doughty - Environmental Engineer
Kennecott Utah Copper Corporation

Mr. Robert E. Dunne - Project Manager
Kennecott Utah Copper Corporation

Mr. John Whitehead
Utah Department of Environmental Quality
Division of Water Quality

Mr. Randy Taylor
Utah Department of Environmental Quality
Division of Environmental Response &
Remediaton

Mr. Wayne Hedberg
Utah Department of Natural Resources
Division of Oil, Gas, and Mining

This page is a reference page used to track documents internally for the Division of Oil, Gas and Mining

Mine Permit Number M0350015 Mine Name Kennecott Utah Copper Tailings
Operator Kennecott Utah Copper Date January 27, 1995
TO _____ FROM _____

__CONFIDENTIAL __BOND CLOSURE __LARGE MAPS X EXPANDABLE
__MULTIPUL DOCUMENT TRACKING SHEET __NEW APPROVED NOI
__AMENDMENT _OTHER _____

Description YEAR-Record Number

__NOI X Incoming __Outgoing __Internal __Superceded

Preliminary Draft
Environmental Impact Statement

___NOI __Incoming __Outgoing __Internal __Superceded

__NOI __Incoming __Outgoing __Internal __Superceded

__NOI __Incoming __Outgoing __Internal __Superceded

__TEXT/ 81/2 X 11 MAP PAGES __11 X 17 MAPS __LARGE MAP

COMMENTS: _____

CC: _____