Final Construction Completion Report
Gas Hills, Wyoming Site

VOLUME III
ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT

June 2007

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FINAL CONSTRUCTION COMPLETION REPORT INDEX
GAS HILLS, WYOMING SITE

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* Although Volumes II through V are intended to be largely stand-alone reports, Volume I is necessary as it presents important information related to license termination and transfer of the site. It also documents all erosion protection quality control test results—e.g., rock durability and gradation tests—which apply to all construction areas.

For Volumes II through V, two binders are provided. The first includes the main text and appendices documenting the quality control test results. Plates are provided separately in the second binder.

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Definition of Terms

Acronym / Abbreviation	Definition
AGTI	Above-Grade Tailings Impoundment
ASTM	American Society for Testing and Materials
CH	Fat Clay
CL	Lean Clay
cm/s	centimeter per second
cm^2/s	centimeters squared per second
CY	cubic yards
D_{50}	Minimum median particle size
ECC	East Canyon Creek
FSSR	Final Status Survey Report
GHP	Gas Hills Pond (e.g., GHP-1)
g/cm^3	grams per cubic centimeter
ISRM	International Society for Rock Mechanics
µR/hr	microRoentgens per hour
n	number
NA	Not Applicable
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NRC	U. S. Nuclear Regulatory Commission
pcf	pounds per cubic foot
pCi/g	picoCuries per gram
pCi/m^2s	picoCuries per square meter per second
PI	plastic index
PM	percent moisture
Ra-226	Radium-226
SC	Clayey sand (ASTM designation)
SM	Silty sand (ASTM designation)
TER	Technical Evaluation Report

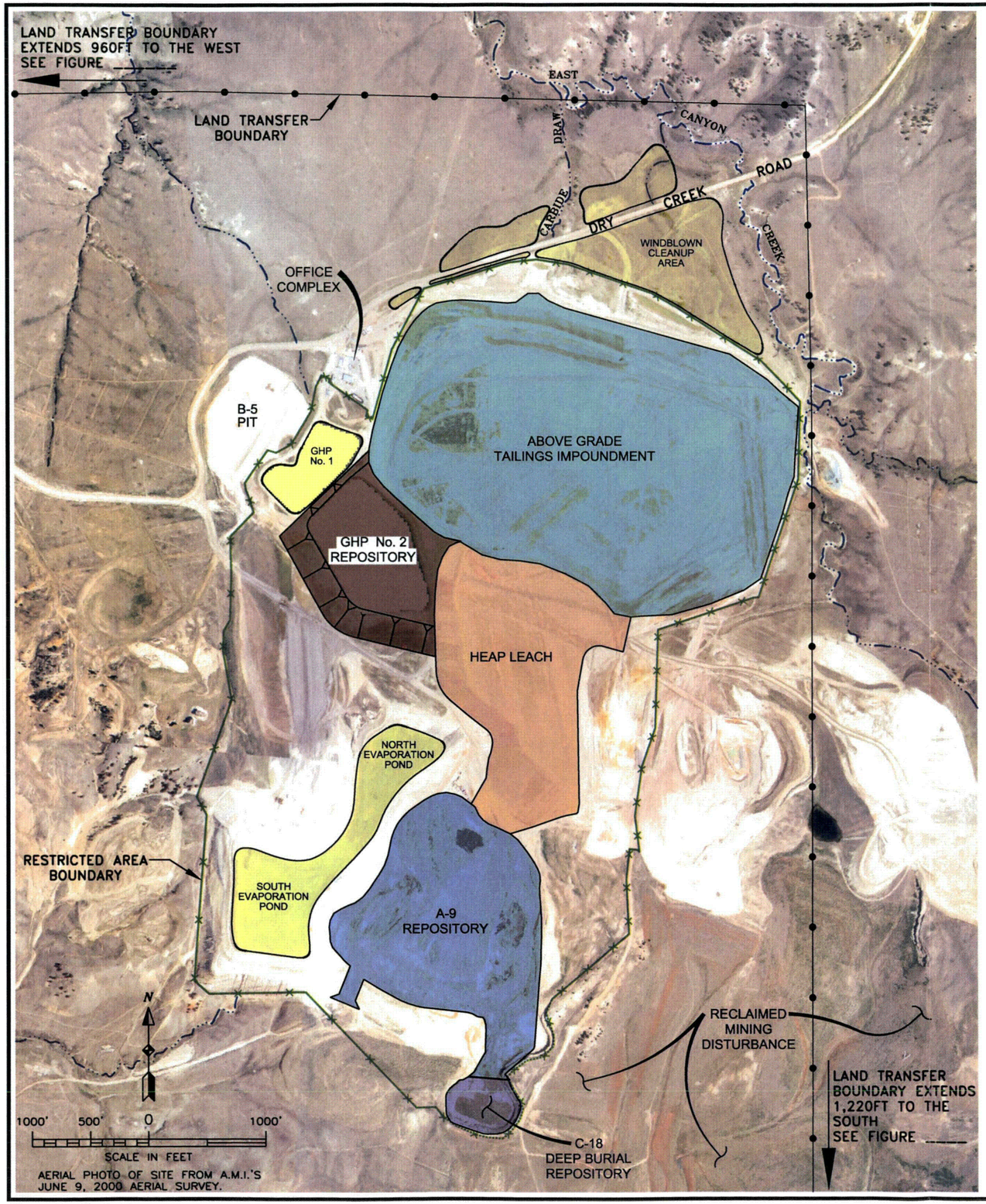
1.0 INTRODUCTION

This volume of the Construction Completion Report documents the conduct and completion of reclamation construction activities for the Above-Grade Tailings Impoundment (AGTI) at the Umetco Minerals Corporation (Umetco) former uranium mill site located in East Gas Hills, Wyoming (Figure 1.1). The Gas Hills site is licensed by the U.S. Nuclear Regulatory Commission (NRC) under Source Materials License SUA-648, Docket No. 40-0299 to possess byproduct material in the form of uranium tailings, as well as other radioactive wastes generated by past milling operations. All construction work described herein was performed in accordance with the specifications documented in the design report entitled *Design for Enhancement of the Previously Approved Reclamation Plan for the Above-Grade Inactive Tailings Impoundment* (SMI 1997) and subsequent submittals provided in response to NRC comments. This modified plan was approved by the NRC on July 16, 1999 (License Amendment 41). Drawing 1 shows the final as-built topography and erosion protection placement for the Above-Grade Tailings Impoundment demonstrating construction completion.

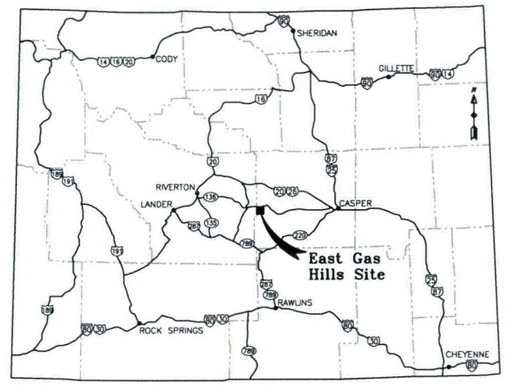
1.1 Area Description and Background

The Above-Grade Tailings Impoundment, the largest of the three tailings impoundments at the Gas Hills site (175 acres), was built in 1960 and operated until 1979. In 1980, Umetco submitted a reclamation plan for the AGTI, which was approved by the NRC with modifications in 1982. This previously-approved cover design consisted of 1 foot of clay, 1 foot of filter soil, and 7.5 feet of overburden soil. The impoundment was reclaimed in accordance with this plan between 1985 and 1992. Reclamation included regrading the impoundment to a 10:1 or flatter slope (reclamation cut/fill) and construction of the radon barrier and cover.

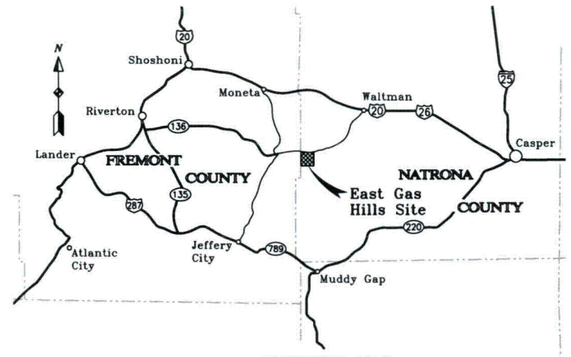
Several years after construction, erosion of the cover was evident along the east toe of the AGTI and the closure of the north toe drain, and additional contamination was found near the north edge of the impoundment. To address these findings, as well as the NRC's 1995 policy statement regarding previously approved reclamation plans for Title II sites, Umetco submitted an enhanced design plan for the AGTI in 1997. The enhanced reclamation design included (with subsequent NRC approval) evaluation of the existing reclamation cover construction (i.e., that completed in 1992), which was completed in accordance with the previously-approved reclamation design as shown on Drawing 2. Endpoints evaluated included seismic design, slope stability, liquefaction potential, settlement, radon barrier cover cracking potential, and radon attenuation. This evaluation is documented in the Technical Evaluation Report (TER) supporting the NRC's approval of the enhanced design (License Amendment 41, TER dated June 21, 1999, transmitted by letter from the NRC dated July 16, 1999), which is provided herein as Attachment 1. Subsequent to this approval, full-scale reclamation activities at the AGTI began and continued until 2002. This report documents the conduct and completion of those activities.



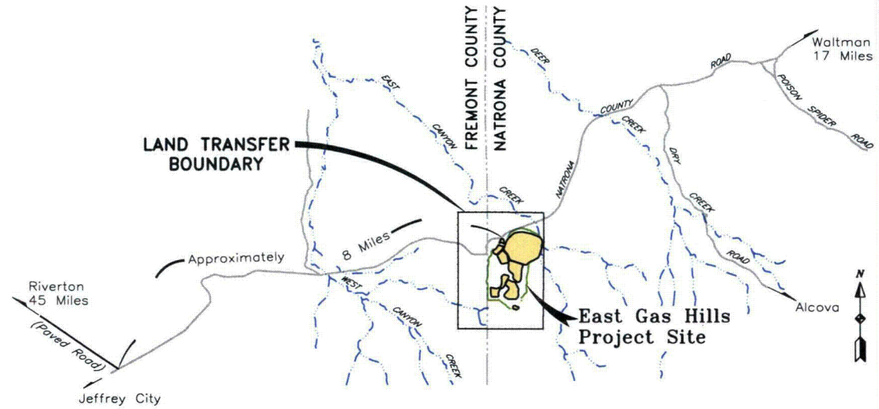
AERIAL PHOTO OF SITE FROM A.M.I.'S JUNE 9, 2000 AERIAL SURVEY.



STATE OF WYOMING
NOT TO SCALE



VICINITY MAP
NOT TO SCALE



LOCATION MAP
NOT TO SCALE

LEGEND:

- ABOVE-GRADE TAILINGS IMPOUNDMENT
  RADON BARRIER LIMITS = 170.59 AC
  REPOSITORY LIMITS = 170.24 AC
- HEAP LEACH REPOSITORY
  RADON BARRIER LIMITS = 48.91 AC
  REPOSITORY LIMITS = 56.93 AC
- A-9 REPOSITORY
  RADON BARRIER LIMITS = 51.29 AC
  REPOSITORY LIMITS = 61.70 AC
- GHP No. 2 REPOSITORY
  RADON BARRIER LIMITS = 35.73 AC
  REPOSITORY LIMITS = 46.14 AC
- C-18 DEEP BURIAL REPOSITORY
  REPOSITORY LIMITS = 5.97 AC
- FINAL STATUS SURVEY AREAS
- LAND TRANSFER BOUNDARY
- RESTRICTED AREA BOUNDARY
- FEATURE BOUNDARIES
- DRAINAGEWAYS

LEGAL DESCRIPTION OF LAND TRANSFER BOUNDARY:

LAND TRANSFER BOUNDARY INCLUDES ALL OF SECTION 15, THE NORTH HALF OF SECTION 22, THE NORTHEAST QUARTER OF SECTION 21, THE EAST HALF OF SECTION 16, THE SOUTHEAST QUARTER OF SECTION 9 AND THE SOUTH HALF OF SECTION 10, ALL LOCATED IN TOWNSHIP 33 NORTH, RANGE 89 WEST OF THE SIXTH PRINCIPAL MERIDIAN. SAID LAND CONTAINS APPROXIMATELY 1920 ACRES.

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SITE PLAN AND LOCATION MAP

GAS HILLS, WYOMING

JUNE 2007 FIGURE 1.1

GH-Loc-Map-Fig-1-1.dwg

1.2 Scope of Work Addressed in this Report

The primary scope of work addressed herein includes the following:

1) Extension of the existing 12-inch thick radon barrier;
2) Regrading of the previously reclaimed impoundment;
3) Placement of a 54-inch thick frost protection layer over the radon barrier extension;
4) Addition of erosion protection (riprap) along a portion of East Canyon Creek to protect the toe of the impoundment; and
5) Replacement of the previously approved vegetative cover with riprap erosion protection.

At the outset, it is important to note that this report only addresses construction completed since development of the enhanced reclamation plan (i.e., after 1997). Any reclamation construction work performed prior to that, under the previous NRC-approved reclamation plan, is documented in detail and incorporated in the AGTI design enhancement (SMI 1997). Although the latter information is summarized herein, the reader is referred to the enhanced reclamation plan for as-builts and geotechnical data documenting the existing cover construction and characteristics.

1.3 License Condition and Regulatory Framework

The requirements for reclamation of the AGTI construction reclamation are established in SUA-648 License Condition 54, which states the following:

> The final reclamation of the inactive above-grade tailings impoundment (includes experimental heap leach site[†]) shall be in accordance with the December 18, 1980 Reclamation Plan and the April 19, 1979 and May 13, 1982 letters, except as superseded by the *Design for Enhancement of the Previously Approved Reclamation Plan for the Above-Grade Inactive Tailings Impoundment Design Report* of October 6 and October 28, 1997, as modified by submittals dated May 22, June 26, July 20, July 28, September 8, September 15, and November 23, 1998, as well as April 9 and June 7, 1999, and December 20, 2000.

This report will demonstrate that the conditions of this license condition have been met and also that the completed construction at the AGTI satisfies the requirements set forth in 10 CFR 40, Appendix A regarding stability and radon flux. As discussed in Volume I, this Construction Completion Report is the final in a series of submittals demonstrating that the Gas Hills site meets the requirements for license termination. The other key submittal related to reclamation of the Above-Grade Tailings Impoundment is the Final Status Survey Report (Umetco 2003, 2004). This report, which was approved by the NRC on September 27, 2004, documents the results of the gamma exposure survey for the AGTI cover, demonstrating conformance with the applicable criteria in 10 CFR 40, Appendix A.

[†] Note that this is distinct from the main Heap Leach disposal area addressed in Volume II.

1.4 Volume III Organization

The completion of this work in accordance with the approved plan is demonstrated primarily in the quality assurance/quality control test records provided in the appendices and the as-built drawings. To facilitate review, final as-built drawings are provided in two formats—standard (24 x 36 inch) plates, allowing examination of all construction details and final topography and, for easier access and reference, 11 x 17 inch format.

Although this volume is intended to serve largely as a stand-alone report, Volume I is requisite reading, as it presents important information regarding the quality and placement of erosion protection materials for all repository areas, including the results of rock durability and gradation tests and in-place visual depth checks (Volume I, Section 5). Volume I also presents detailed historical information and summarizes the issues and reports most germane to license termination.

Following this introduction, Section 2 summarizes the AGTI history and the evolution of reclamation plans preceding the enhanced reclamation plan addressed herein. Section 3 summarizes the aspects of the enhanced design plan that are most germane to this report, including the material and quality control specifications. Section 4 provides an overview of the construction activities, documenting volumes of material placed, activities conducted in preparation for the cover extension, and general aspects of earthwork placement. Section 5 summarizes the results of the quality control testing for all soil placement—contaminated fill used to re-shape the existing cover, the radon barrier extension, frost protection, re-grading, toe protection, and the East Canyon Creek realignment fill.

Section 6 documents the erosion protection placement, referencing Volume I for additional details. Section 7 documents the final radiological status of the AGTI, including the frost protection radium-226 (Ra-226) content, results of radon-222 flux measurements, and gamma exposure survey results. Section 8 summarizes the findings of this construction completion report; references are provided in Section 9.

Finally, Attachments 1 and 2 duplicate the key NRC approval letters and supporting TERs affecting the AGTI reclamation. These include the approval of the 1997 enhanced design plan (License Amendment 41, Attachment 1) and the 2000 modifications to the erosion protection design (License Amendment 44, Attachment 2).

Quality control test results are provided in the appendices, which are organized as follows:

Appendix A – Contaminated Fill
Appendix B – Radon Barrier
Appendix C – Frost Protection
Appendix D – Toe Protection, Regrade of Existing Cover, and East Canyon Creek Realignment

2.0 BACKGROUND

2.1 AGTI History

The above-grade inactive tailings impoundment was operated between 1960 and 1979. During this period, mill waste in the form of tailings and tailings raffinate were discharged into the above-grade impoundment from 1960 to 1979. The original impoundment was built in 1960 by constructing an earth dam of locally available silty clayey sands, which were placed in stages across a gully through the site (1960 impoundment).

The 1960 impoundment was enlarged between 1969 and 1974 by the construction of several earth-filled dams in a terraced configuration downstream (north) and east of the original impoundment. In 1969, another impoundment was constructed east of and adjoining the 1960 impoundment. The 1960 and 1969 impoundments had reached capacity by 1972, at which time the 1972 impoundment was constructed north of the 1960 impoundment. The third and final addition to the tailings impoundment was completed in 1974, east of the 1972 and 1969 impoundments. Figure 2.1 shows the layout of the AGTI reflecting these expansions.

2.2 December 1980 Reclamation Plan (D' Appolonia) and Corresponding Cover Construction

The initial reclamation plan for the Above-Grade Tailings Impoundment was submitted in 1980. This plan, which also included the experimental heap leach area[‡], was approved by the NRC in 1982. The impoundment was reclaimed between 1985 and 1992. Reclamation included regrading the impoundment to a 10:1 or flatter slope (reclamation cut/fill) and construction of a radon barrier and cover. All work specified in the 1980 plan had been completed except for the placement of topsoil and seed. [Note that an interim reclamation fill had been placed over the tailings between the time of tailings deposition and cover placement in 1985.]

2.3 Re-Evaluation of the Previously Approved Plan

This plan was re-evaluated in the mid-1990s, when the NRC updated their policies pertaining to Title II site reclamation. On July 18, 1995, the NRC published its *Final Position on Review of Previously Approved Reclamation Plans* (NRC 1995). This position stated that NRC approval previously granted to reclamation plans would remain a final NRC action, provided that the licensee demonstrate satisfaction of the requirements established in 10 CFR 40, Appendix A regarding slope and seismic stability and limitation of radon flux. As such, the previously approved plan for the AGTI was reviewed for effectiveness by the NRC and Umetco. This review identified evident erosion of the cover along the east toe of the AGTI and the north toe drain. Also, additional contamination was found near the north edge of the impoundment.

[‡] Note that this is distinct from the main Heap Leach disposal area addressed in Volume II. The experimental heap leach area/operation involved experimental heap pads located immediately south of the Above-Grade Tailings Impoundment. Designed in 1972, construction began in 1973, and the experimental heap operated until approximately 1978, after which the heaps were incorporated into the Above-Grade Tailings Impoundment – as referred to above – in 1980.

836,000 E
837,000 E
838,000 E
839,000 E
840,000 E
795,000 N
794,000 N
793,000 N
792,000 N
1972 IMPOUNDMENT
1960 IMPOUNDMENT
1969 IMPOUNDMENT
1974 IMPOUNDMENT
MILL AREA
TOP BERM 6985.70
N
SCALE IN FEET
200' 0 400'
CONTOUR INTERVAL: 2' AND 10'

NOTE:
TOPOGRAPHY AS PER WATER, WASTE AND LAND (1984) AND AERIAL PHOTOGRAPHS (1972).

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ABOVE GRADE TAILINGS IMPOUNDMENT EXPANSIONS

GAS HILLS SITE

FIGURE 2.1

AG-Fig-2-1.DWG

2.4 Pre-Enhancement Cover Conditions

At the time the Design Enhancement was developed, the existing AGTI cover consisted of a 1-foot thick compacted clay radon barrier covered with a 1-foot thick filter layer and 7.5 feet of cover. The radon barrier was placed and compacted in two 6-inch lifts with a D9 dozer at moisture contents between optimum minus 2 percent and optimum plus 2 percent. [The approved reclamation required that the clay be compacted to at least 90 percent of its Standard Proctor maximum dry density.] The suitability of the existing radon barrier layer and cover soils were evaluated, i.e., field permeability, density, etc., in the enhanced reclamation design. The radon barrier soil consists of a gray brown silty clay excavated from a local Cody Shale borrow source. The filter layer consists of 1 foot of locally obtained material similar to the final cover. The 7.5-foot-thick final cover was placed and compacted in two approximately equal lifts. The final cover soils were obtained from local sources and consist of yellow-brown fine to medium silty clay. Additional details are documented in the enhanced reclamation plan (SMI 1997). The as-built extent of the radon barrier and the pre-enhancement impoundment topography are shown on Drawing 4 in this plan.

2.5 East Canyon Creek Drainage

A key feature related to the AGTI and which influenced the cover and riprap design is East Canyon Creek, the ephemeral drainage located east of the impoundment. This area has been the subject of investigation for several reasons—one being the large drainage area east of the site, and also the presence of cultural resources and wetlands considerations. These aspects are addressed at length in previous reports (Umetco 2000a, 2004) and therefore are not reiterated here.

3.0 1997 ENHANCED DESIGN RECLAMATION PLAN

This section presents an overview of the enhanced reclamation plan—*Design for Enhancement of the Previously Approved Reclamation Plan for the Above-Grade Inactive Tailings Impoundment*—on which the design and construction documented herein was based. This plan was submitted on October 6, 1997 (Part I, Design Report) and October 28, 1997 (Parts II and III, Construction Plans and Specifications and Quality Plan). The bulk of the material in this section is presented largely in the tables provided at the end of this section. Given the large scope of the enhanced reclamation plan, Table 3.1 provides a cross-reference, identifying where various aspects of the modeling underlying the design (e.g., settlement analyses) are addressed. Table 3.2 documents the plan submittal history, including revisions and NRC approvals. Table 3.3 summarizes the parameters used for the AGTI radon flux modeling (i.e., the cover radon attenuation design), a key component of the design plan. Table 3.4 summarizes the main requirements specified in the plan. These tables are provided at the end of this section.

3.1 Scope of Work

The major proposed enhancements to the previously approved reclamation for the above-grade inactive tailings impoundment are:

1. Extension of the radon barrier on the north and east sides to accommodate closure of the toe drain system and cover contamination found along the downstream toe – ultimately this was more of a horseshoe configuration (i.e., on west side as well)...

2. Addition of erosion protection (riprap) along a portion of East Canyon Creek to protect the toe of the impoundment; and

3. Replacement of the previously approved vegetative cover with riprap erosion protection.

Specific aspects of this general enhanced plan include:

- Grouting the existing toe drain
- Preparing the existing surface around the edge of the impoundment to receive new construction
- Exposing the edge of the existing radon barrier
- Extending the radon barrier
- Installing riprap toe protection
- Re-grading the previously reclaimed impoundment
- Placing a frost protection layer over the new section of radon barrier, and toe protection
- Placing riprap on the re-graded impoundment and new section of the cover
- Regrading an adjacent stream (East Canyon Creek)
- Placing riprap on the west stream bank of East Canyon Creek; and
- Regrading the surrounding area to site wide grading plan and seeding.

3.2 Plan Modifications and NRC Approval(s)

In response to NRC comments and requests for additional information, this plan was amended by nine submittals prior to the NRC's approval of the enhanced reclamation plan in July 1999 (Table 3.2). It is important to note that Umetco's response to NRC comments dated September 8, 1998 included several updates to the modeling and appendices provided in the original 1997 plan.

The plan was approved by the NRC on July 16, 1999 by License Amendment 41. In their letter and corresponding TER, the NRC staff concluded that Umetco's proposed enhanced impoundment design would meet NRC requirements regarding stability and control of the contaminated material and limitation of the radon flux from the disposal area to the atmosphere to 20 picoCuries per square meter per second (pCi/m^2s) (see Attachment 1).

In December 2000, Umetco submitted the *Proposal for Erosion Protection Modification for the Above-Grade Tailings Impoundment and Heap Leach.* This submittal documented proposed changes for erosion protection, discussed in Section 7, and was approved by the NRC in April 2001 (License Amendment 44). It is duplicated herein as Attachment 2.

Table 3.1. Enhanced Reclamation Plan for the Above-Grade Tailings Impoundment Design: Summary of Contents[†]

Preface: The enhanced reclamation plan entitled *Design for Enhancement of the Previously Approved Reclamation Plan for the Above-Grade Inactive Tailings Impoundment Design Report*, prepared by Shepherd Miller, Inc. (SMI) was submitted on October 6, 1997 (Part I) and October 8, 1997 (Parts II and III). Because of the extensive scope of the document, the following summary was developed for use as a cross-reference. Asterisked (*) sections document the design and geotechnical testing requirements that are most germane to this reclamation completion report. As documented in the preceding table, this plan underwent several rounds of comments prior to NRC's approval of the enhanced reclamation plan and license amendment request on July 16, 1999. (Amendment No. 41)

Plan Volume or Section No.	**Title**	**Description of Contents** (left blank if section title is sufficiently descriptive)
Part I: Design Report	(Documents technical basis for Part II construction specifications)	
Section 1	Introduction	Introductory background information and factors underlying development of enhanced design plan
Section 2	Site Description	Provides a historical overview of the AGTI and the previously-approved (1980) reclamation plan and documents the modifications to this plan required by the NRC. The drawings referenced in this section formed the basis for the enhanced reclamation plan. In particular, Drawing 4 shows the impoundment topography after the 1985-1992 reclamation, including the as-built extent of the radon barrier.
Section 3	Proposed Enhancements to Reclamation Plan	Summarizes the proposed enhancements for 1) site-wide grading, 2) the AGTI cover extension, and 3) erosion protection.
Section 4	Soil Engineering Parameters	Table 4.1 ("Parameters Used in Analyses") summarizes the results of the following: • 1995 permeameter tests; • laboratory tests performed in 1996 by Western Engineers (WEI), including grain size analyses, hydraulic conductivity tests, and consolidation tests on tailings material; • 1997 Inberg-Miller shear strength tests on the radon barrier and hydraulic conductivity tests on the filter layer. These soil engineering parameters were used in SMI's modeling and enhanced design development.
Section 5	Cover Stability	Description of the Cover (as of 1997); Settlement; Liquefaction Analysis; Slope Stability Analysis; and Radon Barrier Cracking Potential. Note that some of these analyses were later updated in response to NRC comments; see Table 3.1 and the 1998 Comment Response submittals.

Table 3.1. Enhanced Reclamation Plan for the Above-Grade Tailings Impoundment Design: Summary of Contents[†]

Plan Volume or Section No.	Title	Description of Contents (left blank if section title is sufficiently descriptive)
Part I: Design Report, Cont.		
Section 6	Drainage of Tailings	Discusses seepage analysis and abandonment of the toe drain.
Section 7	Radon Attenuation	Presented radon flux modeling values for existing cover system and extended cover – note that some of the parameter values listed in this section were later changed in response to NRC comments (e.g., see Table 2 of the September 8, 1998 submittal).
Section 8	Surface Water Hydrology and Erosion Protection	Hydrologic Description of the Site; Geomorphic Stability; East Canyon Creek Erosion Protection Design; Cover Erosion Protection Design; and Riprap Gradations
Sections 9 & 10	Summary and References	
Drawings	--	Drawings 4 and 5 show the impoundment topography and the extent of the radon barrier as of 1997—i.e., the cover construction/ configuration on which the Design Enhancement was based. Drawing 4 also shows the boring locations – part of SMI's study.
Appendix A	Background Information	
Appendix B	Settlement Analyses* Later updated in response to NRC comments.	In response to NRC comments about the number of settlement points, Umetco conducted additional settlement analyses using tailings deposit thickness data. These analyses were subsequently approved by the NRC.
Appendix C	Cracking Potential of Radon Barrier	Later revised
Appendix D	Slope Stability Analyses	Later revised
Appendix E	Liquefaction Analyses	
Appendix F	Radon Attenuation Analyses	
Appendix G	Hydrologic Analysis	This later revised in September 1998 (see Table 3.2)
Appendix H	Field Data	
Appendix I	Laboratory Data	Results of 1995 permeameter tests conducted on the radon barrier (W.T. Cohan & Associates) and 1997 permeameter tests on the filter layer (Western Engineers).

Table 3.1. Enhanced Reclamation Plan for the Above-Grade Tailings Impoundment Design: Summary of Contents[†]

Plan Volume or Section No.	Title	Description of Contents (left blank if section title is sufficiently descriptive)
Part II: Construction Specifications		
Sections 1-2	Introduction and General Requirements	
Section 3	General Earthwork Requirements	General specifications for clearing, grading, excavating, subgrade preparation, fill placement, and riprap requirements.
Section 4 *	Site Work	Documents construction specifications for abandonment of the toe drain (4.1), all aspects of the cover extension (Section 4.2—radon barrier, frost protection, and riprap), toe protection (4.3), regrading (4.4), and the East Canyon Creek realignment (4.5)
Attachment 1	Riprap Gradation Requirements	Note that this later revised based on December 20, 2000 submittal.
Part III: Quality Control Plan		
Sections 1-3	Scope, Objectives, Definitions	
Section 4	Quality Control and Quality Assurance	Provides a general discussion of QA/QC activities and compliance report procedures.
Sections 5-7	Organizational Structure, Changes and Corrective Actions, Documentation	
Section 8 *	Construction Inspection and Testing	Specifies the inspection and testing, QC procedures, and required testing frequencies for all construction work (Subgrade preparation, radon barrier, frost protection, riprap, and seeding).
Sections 9 and Appendix A	Quality Control Procedures	Section 9 references Appendix A, which documents all quality control procedures, test methods, and associated documentation and reporting requirements.

Table 3.2 AGTI Enhanced Design Plan Submittal History

Preface: License Condition 54, the primary license condition pertaining to the AGTI reclamation, states the following: The final reclamation of the inactive above-grade tailings impoundment (includes experimental heap leach site) shall be in accordance with the December 18, 1980 Reclamation Plan and the April 19, 1979 and May 13, 1982 letters, except as superseded by the *Design for Enhancement of the Previously Approved Reclamation Plan for the Above-Grade Inactive Tailings Impoundment Design Report* of October 6 and October 28, 1997, as modified by submittals dated May 22, June 26, July 20, July 28, September 8, September 15, and November 23, 1998, as well as April 9 and June 7, 1999, and December 20, 2000. [Applicable Amendments: 4, 6, 7, 32, 38, 41, 44.]. *(The latter language reflects the most recent revised license as of April 2007.)* To facilitate review, the following table summarizes the contents of each of these submittals and any associated license condition changes.

Report or Submittal	Submittal Date(s)	Summary of Contents
Union Carbide Corporation (UCC) letter/reclamation plan	April 19, 1979	UCC's initial reclamation plan for the East Gas Hills Heap Leach
Reclamation Plan – Inactive Tailings Areas and Heap Leach Site (D'Appolonia 1980)	December 18, 1980	The original cover design plan, documenting specifications for the radon barrier, frost and filter layers completed in 1992, later enhanced in the late 1990s.
UCC letters with attachments	April 20, May 13, and May 26, 1982	Modifications to the December 1980 reclamation plan in response to NRC comments.
Water, Waste and Land, Inc. (WWL) report entitled *Stabilization and Reclamation of an Inactive Tailings Impoundment*	1984	This document provided details regarding the impoundment's construction and operation—although no longer cited in the LC 54, it does provide pertinent background information.
Design for Enhancement of the Previously Approved Reclamation Plan for the Above-Grade Inactive Tailings Impoundment Design Report (SMI 1997)	Part I: October 6, 1997 Parts II and III: October 28, 1997	Enhanced reclamation design consisting of three parts: Part I – Design Report; Part II – Construction Plans and Specifications; and Part III – Quality Plan (see Table 3.1).
Submittals in Response to NRC Interim Requests for Additional Information (During Plan Review)		
Radon Barrier	May 22, 1998	Explanation of parameters used for radon attenuation analyses of the existing cover – Requested by the NRC on May 12, 1998
Settlement	June 26, 1998	Loading History for Settlement Analyses – Requested by the NRC on June 15, 1998
Surface Water Hydrology	July 20, 1998	Surface water hydrology calculations and data – Requested by the NRC on July 7, 1998
Slope Stability & Cover Cracking	July 28, 1998	Additional slope stability analysis and revised cover cracking analysis – Requested by the NRC on July 10, 1998

Table 3.2 AGTI Enhanced Design Plan Submittal History

Report or Submittal	Submittal Date(s)	Summary of Contents
Submittals in Response to NRC Formal Written Comments Dated August 6, 1998 and August 13, 1998		
Response to NRC Review Comments, Design for Enhancement of the Previously Approved Reclamation Plan, Above-Grade Inactive Tailings Impoundment (SMI 1998)	September 8, 1998	Responses to comments – including proposed revisions to several radon code values (dry density, long-term moisture). This submittal included additional information and/or revisions regarding the following endpoints: RADON modeling; Umetco's soil sampling strategy; AGT radiological borings; hydrology analysis, carbide draw (headcutting analysis); drainage channel plans from approved Heap Leach plan; infiltration analyses; seepage analyses; toe drain seepage analyses; slope stability analyses; settlement analyses; and cover cracking analyses.
Response to NRC Review Comments II, Design for Enhancement of the Previously Approved Reclamation Plan, Above-Grade Inactive Tailings Impoundment (SMI 1998)	November 23, 1998	Responses to comments dated October 29, 1998 (fax) and November 9, 1998 – including proposed revisions to discharge in the drainage channel, downstream boundary condition, flow depth and shear stress, scour depth and depth to bedrock, effects of roadway embankment. This submittal included three appendices, with revisions to the following design/model aspects: Discharge Rating Curve Calculations; HEC-1 Output; HEC-RAS Output; revised Appendices G.3 and G.4 (HEC-RAS Analysis and Riprap Calculations – East Canyon Creek); and replacement Figures and Drawings (Figure 8-3, Drawing 1 and 9)
Umetco letter with attachment	April 9, 1999	Revisions providing additional information regarding gradation of erosion protection material
Umetco letter with attachments	June 7, 1999	Umetco proposal to provide a low-flow channel to augment the wetland area in East Canyon Creek (ECC)
Note: All above approved by the NRC as License Amendment 41 dated July 16, 1999 (see Attachment 1).		
Proposal for Erosion Protection Modification for the Above-Grade Tailings Impoundment and Heap Leach	December 20, 2000	Modified Type A rock and ECC aspects of rock placement for the AGTI. This was approved by the NRC as part of License Amendment 44 in April 2001.

Table 3.3 RADON Code Input Parameters Used as the Basis for the Above-Grade Tailings Impoundment Enhanced Reclamation Design: Final Values

Input Parameter	Tailings	Radon Barrier	Frost Protection	Comment (Basis)
Radium content (average)	310 pCi/g	3.6 pCi/g	10 pCi/g	Radon barrier was maximum measured value
Layer Thickness	16 ft	1 ft	Existing cover: 8.5 ft Extension: 4.5 ft	Value assumed for tailings value is default
Emanation Coefficient	0.35	0.23	0.264	Default value for tailings; maximum and average measured values for the radon barrier and frost protection layers, respectively
Specific Gravity	2.65	2.65	2.65	Default value
Dry Density * (average)	1.43 g/cm^3 (89.3 pcf)	1.67 g/cm^3 * (104.3 pcf)	1.78 g/cm^3 * (111.1 pcf)	Site-specific measurements
Porosity	0.46	0.37	0.328	RADON-code calculated
Moisture Content (average long-term)	6 %	12.44% *	11.48% *	Default value used for tailings; values assumed for the radon barrier and frost layers are the lower bound of the measured long-term moisture content (@ 15 bar).
Diffusion coefficient* (all units = cm^2/s)	0.03887	8.044 x 10^{-3}	5.225 x 10^{-3}	Initial proposed values were based on laboratory measurements, but ultimate values were RADON-code calculated

All values and assumptions listed above were accepted by the NRC, as documented in the Technical Evaluation Report (TER) supporting their approval of the AGTI enhanced reclamation design and corresponding license amendment (License Amendment 41, July 16, 1999, TER dated June 21, 1999).

* Values provided in initial plan (Part I, October 1997) were later changed in response to NRC comments, as documented in SMI's September 8, 1998 comment response submittal. The values listed above reflect the final NRC-approved values.

Table 3.4 Summary of Specifications for the Above-Grade Tailings Impoundment Reclamation

Layer	Specifications / Requirements
Contaminated Fill	• Lift thickness: ≤ 12 inches (compacted depth) • Percent compaction: ≥ 90 percent of Standard Proctor maximum density
Radon Barrier	Soil Characteristics * • ≥ 50 % passing the No. 200 sieve • Maximum particle size of 1 inch • Liquid limit ≥ 25 (percent) • Plasticity index ≥ 10 • Maximum hydraulic conductivity of 1 x 10^{-7} cm/sec* Placement • Layer thickness: 12 inches • Lift thickness: ≤ 6 inches (compacted depth) • Percent compaction: ≥ 95 percent of Standard Proctor maximum density • Optimum ≤ Moisture Content ≤ Optimum + 4 percent * *No classification requirements were specified in the 1997 SMI Plan; however for other repository areas, the radon barrier was required to be classified as CL or CH (based on ASTM D2487). Also, because the homogeneity of the clay borrow material used for radon barrier construction and satisfaction of the ≤ 1E-7 cm/sec hydraulic conductivity requirement had already been demonstrated for the Heap Leach (see Volume I, Section 4), these tests were not repeated for subsequent repository reclamation.*
Frost Protection	Soil Characteristics • Classification as SC and/or SC-SM (clayey and/or silty sand) Placement • Layer thickness: 4.5 feet • Lift thickness: ≤ 12 inches when compacted • Percent compaction: ≥ 95 percent of Standard Proctor maximum density • Moisture content: ≥ Optimum minus 2 percent
Toe Protection, ECC Realignment, and Regrade	• Lift thickness: ≤ 12 inches (compacted depth) • ≥ 95 percent of Standard Proctor maximum density and moisture content ≥ Optimum minus 2 percent except for subgrade portions, for which ≥ 90 percent compaction was required (and no moisture requirement)

See Section 6 for Riprap requirements.

4.0 OVERVIEW OF DESIGN ENHANCEMENT CONSTRUCTION ACTIVITIES

As a prelude to the following section, this section provides an overview of construction activities performed for the AGTI design enhancement. Section 4.1 describes the preliminary preparatory work (e.g., removal of existing riprap). Section 4.2 describes general aspects of the earthwork for which quality control testing was not required. Section 4.3 summarizes the quality control testing frequencies. Table 4.1 shows the sequence of construction activities and documents the quantities of material placed.

4.1 Preliminary Activities and General Earthwork

4.1.1 Abandonment of the Toe Drain

One of the initial requirements in the enhanced reclamation plan was that the toe drain running along the north and northeast toe of the tailings impoundment (1972 and 1974 embankments) be abandoned. Although the plan called for removal and subsequent grouting, ultimately this was not feasible, as the drain system was too deep and well-cemented. Therefore, in lieu of grouting the drain system, each manhole was cut off to below finish grade of the contaminated fill and then filled with concrete, leaving no voids. This deviation is not considered to have any adverse effect on the stability of the repository or the satisfaction of 10 CFR 40 Appendix A requirements, as the overlying radon barrier would prevent infiltration of water.

4.1.2 Excavation of Existing Cover and Foundation Soils

As preparation for the cover extension, the existing cover and foundation soils were excavated to expose the edge of the existing radon barrier and establish the subgrade for construction of the cover extension. During these activities, Umetco continuously surveyed the existing frost protection material to ensure that the material met the 10 pCi/g Ra-226 plan requirement. This material was then stockpiled and then scanned again prior to re-placement. When the existing radon barrier was encountered, the material was re-graded and compacted. While tying in to the existing radon barrier, Umetco quality control personnel noted that the soils were in good condition—i.e., visually acceptable for moisture and thickness and consistent with the assumptions in the enhanced reclamation plan.

4.1.3 Removal of Existing Riprap

The existing riprap on the east side of the tailings embankment, which varied in thickness from 12 to 18 inches, was removed prior to excavation of the existing cover and foundation soils in accordance with the reclamation plan.

Table 4.1. Summary of AGTI Design Enhancement Reclamation Activities: 1999-2002

Year	Activity	Cubic Yards Placed
Initial Preparatory Activities		
1998	Removed piping from the existing AGTI cover that was used for the revere osmosis recovery and injection and placed in the A-9 Repository.	--
1999	Removed existing frost protection cover and erosion protection cover	--
" "	Reshaped and compacted the existing contaminated materials layer	16,307
1999-2001	Archeological study of the East Canyon Creek realignment area	--
	Total Quantities Placed, Contaminated Fill:	**16,307**
Radon Barrier Layer (12-inch thick)		
1999	Placement and compaction of clay for radon barrier layer	100,692
2000	Radon Barrier Tie-In to Heap Leach Gap	1,095
	Total Quantities Placed, Radon Barrier Layer:	**101,787**
Frost Protection Extension (4.5 ft thick)		
1999	Placement and compaction of frost protection material	342,025
2000	Completed frost protection extension	154,530
	Total Quantities Placed, Frost Protection Layer:	**496,555**
Toe Protection Backfill		
2000	Placement and compaction of backfill material for the toe protection excavation	5,109
2001	" "	40,299
2002	" "	27,712
	Total Quantities Placed, Toe Protection:	**73,120**
Other: Regrade and East Canyon Creek Realignment		
2000	Re-shaping and compaction of the existing AGTI cover	21,252
2002	Fill material placed for the East Canyon Creek Realignment	26,193
Erosion Protection Placement: 2000-2002		
Type A Rock –	Top of AGTI	16,826
Type B Rock –	Upper half of the AGTI slope	63,302
Type C Rock –	Bottom half of slope and scour protection for Carbide Draw	117,736
Type E Rock –	ECC Launched Stone Embankment and Scour Apron	18,639

4.2 Quality Control Test Frequencies and Methods

Quality control testing frequencies, as specified in Part III of the enhanced reclamation plan (Quality Control Plan), are summarized below.

Quality Control Test	Required Frequency	Method
Field Moisture and Density	Contaminated Fill: 1: 1000 CY All other work: 1: 500 CY	ASTM D2922 ASTM D3017
Sand Cone Correlation	1:10 nuclear gauge test	ASTM D1556 ASTM D2216
Laboratory Compaction (Standard Proctor)	1: 5000 CY	ASTM D698
Soil Classification • Particle Size Analysis • Atterberg Limits	Radon Barrier: 1:1000 CY Frost Protection: 1:2000 CY (NA for Contaminated Fill, Regrade, Toe and ECC Realignment)	ASTM D2487 ASTM D4318 ASTM D1140 ASTM D422

CY cubic yards
NA Not Applicable

As demonstrated in the following sections (Tables 5.1 through 5.3), these frequencies were met and in many cases testing frequencies were much more conservative.

Field density and moisture tests were taken using a nuclear density gauge. The gauge was field standardized at each test location and was correlated by a sand-cone test at a minimum frequency of one for every ten nuclear gauge tests. For non-clay material, field rock corrections were performed at each compaction test location. Material placed at densities lower than the specified minimum density or at moisture contents outside the specified acceptable range of moisture content were reworked to meet the density and moisture requirements or removed and replaced by acceptable fill compacted to meet these requirements.

5.0 CONSTRUCTION ACTIVITIES AND QUALITY CONTROL TEST RESULTS

This section describes the construction activities performed for the Above-Grade Tailings Impoundment design enhancement and summarizes the results of the field and laboratory quality control tests. The completion of construction activities in accordance with the enhanced reclamation plan is demonstrated largely by the quality assurance/quality control records provided in the appendices and in the following as-built drawings and plates:

Layer/Aspect	Drawing/Plate No.(s)
Final AGTI Site Plan	1
Existing Cover* and 1997-2002 Enhancement	2
Contaminated Fill	3 and 4
Radon Barrier	5 and 6
Frost Protection	7 through 9
Toe Protection and ECC Realignment	10 and 11
AGTI Regrade and ECC Realignment Fill Area	12 and 13
Erosion Protection (addressed in Section 6)	14 and 15

**The existing cover refers to that portion of the cover completed in 1992 (see Section 2).*

For each layer or construction aspect, these drawings show the final contours and survey verification points, representative cross-sections, and corresponding quality control test locations. As stated in the introduction, these drawings are provided in two formats: standard plate (provided in the following binder) and, for easier access and reference, 11 x 17 inch format. Geotechnical quality control tests conducted during placement of these materials and documented in detail in the appendices include field density tests, laboratory Standard Proctors, gradations, and Atterberg Limits.

5.1 Contaminated Fill

Placement (daily load counts) and quality control test records associated with contaminated fill placement are documented in detail in Appendix A. Table A.1 lists the daily quantities and corresponding daily testing frequencies. Field compaction tests are documented in Table A.2. Table A.3 documents the Standard Proctor test results, and Table A.4 presents the sand-cone correlation tests. As-built Drawings 3 and 4 show the final contours and survey verification points and compaction test locations. Quality control test results associated with these activities are summarized in Table 5.1 and 5.2 for field and laboratory tests, respectively.

5.1.1 Placement

As preparation for the AGTI cover extension, the existing contaminated fill was re-shaped and compacted in accordance with the enhanced reclamation plan requirements. Fill materials were placed in maximum lift thicknesses of 12 inches (compacted depth) and were compacted to a minimum of 90 percent of the Standard Proctor maximum dry density (ASTM D698). In 1999, 16,307 cubic yards of material were placed as part of this effort (Table 4.1, 5.1, and Appendix A, Table A.1).

Table 5.1 Summary of Field Quality Control Test Results for the Above-Grade Tailings Impoundment Design Enhancement Construction: Contaminated Fill, Radon Barrier, and Frost Protection Extension

Layer	Total Yards Placed	Design (Plan) Requirements	Nuclear Density Gauge Test Results				Sand-Cone Correlation
			Frequency (No. of Tests)	Dry Density (pcf)	Percent Moisture	Percent Compaction	Frequency (No. of Tests)
Contaminated Fill: 1999	16,307 CY	Frequency: 1:1000 CY % Compaction: ≥ 90 % Moisture: NA	1:143 CY (n = 114)	*avg:* 113.6 *range:* 101.7 - 125.2	*avg:* 12.7 *range:* 3.0 - 21.0	*avg:* 97.8 *range:* 88.1 - 108.1	1:5 (n = 23)
Radon Barrier: 1999-2000	101,787 CY	Frequency: 1:500 CY % Compaction: ≥ 95 % Moisture (PM): Opt. ≤ PM ≤ Opt.+4	1:421 CY (n = 242)	*avg:* 101.0 *range:* 97.8 - 105.5	*avg:* 21.7 *range:* 19.2 - 24.6	*avg:* 96.5 *range:* 94.9 - 100.7	1: 9 (n = 28)
Frost Protection (Extension): 1999-2000	496,555 CY	Frequency: 1:500 CY % Compaction: ≥ 95 % Moisture: ≥ Opt. -2	1:500 CY (n = 993)	*avg:* 113.5 *range:* 102.1 – 123.2	*avg:* 13.8 *range:* 9.0 – 22.5	*avg:* 97.5 *range:* 94.9 - 103.1	1:10 (n = 100)

Note: This summary reflects passing tests only. Failed field tests resulted in re-compaction of the area and re-testing, as documented in detail in Appendix A, B, and C for contaminated fill, radon barrier, and frost protection material, respectively.

Abbreviations

avg	average (arithmetic mean)
CY	cubic yards
n	number
NA	Not Applicable
Opt.	Optimum
pcf	pounds per cubic feet
PM	percent moisture
%	percent

Table 5.2 Summary of Laboratory Quality Control Test Results for the Above-Grade Tailings Impoundment Design Enhancement: Contaminated Fill, Radon Barrier, and Frost Protection

Layer	Design (Plan) Requirements	Laboratory Standard Proctor [1]			Atterberg Limits			Soil Classification & Gradation
		Frequency (Number of Tests)	Maximum Dry Density (pcf)	Optimum Moisture (%)	Frequency (Number of Tests)	Liquid Limit Results	Plastic Index (PI)* Results	
Contaminated Fill: 16,307 CY	NA for all except Proctor frequency	1:679 CY (n = 249)	*avg:* 116.1 *range:* 109.7 – 121.4	*avg:* 13.7 *range:* 11.7 – 16.7	NA	NA	NA	NA
Radon Barrier: 101,787 CY	Gradation-Atterberg Frequency: 1:1000 CY Liquid limit: ≥ 25 Plasticity index: ≥ 10 ≥ 50% passing #200 sieve Max. particle size = 1"	1:4071 CY (n = 25)	*avg:* 104.7 *range:* 102.8 – 107.2	*avg:* 20.1 *range:* 17.6 – 21.4	1: 684 CY (n = 157)	*avg:* 54.7 *range:* 48 – 64	*avg:* 35.8 *range:* 28 - 44	Fat Clay (CH): 97% Lean Clay (CL): 3% % Passing #200 sieve: avg = 94.4% *range:* 82.9 – 97.9% Maximum particle size = 3/8." All gradation requirements were met.
Frost Protection: 496,555 CY	Gradation-Atterberg Frequency: 1:2000 CY Unified Soil Classification: SC and/or S-SM	1:4684 CY (n = 106)	*avg:* 116.4 *range:* 107.5 - 121.9	*avg:* 13.3 *range:* 10.6 - 17.9	1:1460 CY (n = 340)	*avg:* 35.7 *range:* 22 - 47	*avg:* 18.0 *range:* 5 - 30	SC 92.9% (n=316) CL 6.2% (n=21) SC-SM 0.6% (n=2) SW-SM 0.4% (n=1)

[1] Proctor frequency requirements for all layers are 1: 5000 CY. PI averages exclude non-plastic results for contaminated fill and frost protection material.

Abbreviations

avg	average (arithmetic mean)
CY	cubic yards
n	number
NA	Not Applicable
pcf	pounds per cubic foot

ASTM 2487 Term Definitions

CH	Fat Clay
CL	Lean Clay
SC	Clayey Sand
SC-SM	Silty, Clayey Sand
SW-SM	Well-Graded Sand w/ silt

5.1.2 Quality Control Test Results

As summarized in Table 5.1, based on 114 passing tests, contaminated fill soils were compacted in accordance with the reclamation plan, to an average of 97.8 percent of the maximum dry density. The average dry density and moisture content of this material are summarized in Table 5.1. The maximum dry density and optimum moisture as determined by Standard Proctors are summarized in Table 5.2. These tables demonstrate that compaction requirements were met and that the quality control tests for the contaminated fill were conducted at much higher frequencies than those called for in the plan. For example, the compaction test frequency was 1:143 cubic yards, well exceeding the required 1:1000 CY frequency. Similarly, sand-cone tests were performed at a frequency of 1:5 nuclear gauge tests (vs. the 1:10 requirement). Standard Proctors were performed at a frequency of 1:679 CY, vs. the required 1:5000 CY.

5.2 Radon Barrier Extension

Construction activities for extension of the radon barrier took place in 1999 and 2000, with the bulk of the work completed in 1999. [Work in 2000 was primarily the tie-in to Heap Leach Gap.] During this time, 101,787 cubic yards of Cody Shale clay material were placed as part of the radon barrier extension.

Placement (daily load counts) and quality control test records associated with radon barrier placement are documented in detail in Appendix B. Table B.1 lists the daily quantities and corresponding daily testing frequencies. Field compaction tests are documented in Table B.2. Tables B.3 and B.4 provide the laboratory Standard Proctor and sand-cone correlation test results, respectively. Radon barrier soil classification and gradation test results are listed in Table B.5. Quality control tests results obtained for the radon barrier extension are summarized in Table 5.1 and 5.2 for field and laboratory tests, respectively.

5.2.1 Placement

Clayey soils used for construction of the radon barrier were excavated from the Clay Borrow area, discussed in detail in Section 4 of Volume I. In accordance with the enhanced reclamation plan, this material was placed in equal continuous layers not exceeding 6 inches compacted depth and compacted to a minimum of 95 percent of the maximum dry density (ASTM D698), at a moisture content between optimum and 4 percent above optimum (Table 5.1, Appendix B, Table B.2).

Drawing 5 shows the placement areas, thickness, final grades, and survey verification points for the radon barrier extension. This drawing also provides several cross-sections showing the tie-in to the existing radon barrier (i.e., the radon barrier constructed under the previously-approved plan). Drawing 6 shows the compaction test locations, demonstrating their high density and extensive spatial coverage.

Although not specified in the enhanced reclamation plan, Umetco conducted regular checks of the in-place thickness of the radon barrier layer to ensure that depths met the 12-inch specification. Based on 53 tests at locations shown on Drawing 6, depths ranged from 1 to 2

feet, with an average depth of 1.2 feet and standard deviation of 0.23 feet (3 inches). Appendix B, Table B.6 documents these results.

5.2.2 Quality Control Test Results

Field Compaction Test Results. As summarized in Table 5.1, based on 242 passing tests, radon barrier soils were compacted to an average of 96.5 percent of the maximum dry density, ranging from 94.9 to 100.7. The average dry density of this material was 101.0 pounds per cubic foot (pcf), ranging from 97.8 to 105.5 pcf. The average moisture content was 21.7 percent, ranging from 19.2 percent to 24.6 percent (Appendix B, Table B.2).

Standard Proctor Test Results. Table 5.2 summarizes the Standard Proctor results, which yielded an average maximum dry density of 104.7 pcf, ranging from 102.8 to 107.2 pcf. The optimum moisture was 20.1 percent, and ranges from 17.6 to 21.4 percent.

Soil Classification, Atterberg Limits, and Gradations. The enhanced reclamation plan included the following specifications for radon barrier material characteristics:

- at least 50 percent passing the No. 200 sieve
- maximum particle size of 1 inch
- minimum liquid limit of 25 percent; and
- minimum plasticity index of 10.

As documented in Table B.5 and summarized in Table 5.2, all AGTI soil classification tests met the design specifications. The maximum particle size was 3/8 inch, with an average of 94.4 percent passing the #200 sieve. Liquid limits and plastic indices were all well above the plan requirements; averages were 54.7 and 35.8 percent, respectively. Although no soil classes were specified in the AGTI plan, 97% of the material placed for the AGTI radon barrier consisted of fat clay (CH); 3% was lean clay (CL).

5.3 Frost Protection Cover Extension

Construction activities for extension of the frost protection layer took place in 1999 and 2000. During this period, 496,555 cubic yards of frost protection material were placed on the AGTI. This section will demonstrate the homogeneity of frost protection soils and that all plan requirements were met. Placement (daily load counts) and quality control test records associated with frost protection placement are documented in detail in Appendix C. Table C.1 lists the daily quantities and corresponding daily testing frequencies. Field compaction tests are documented in Table C.2. Tables C.3 and C.4 provide the laboratory Standard Proctor and sand-cone correlation test results, respectively. Results of soil classification and gradation tests are documented in Table C.5. These results are summarized in Tables 5.1 and 5.2 for field and laboratory tests, respectively. Primary findings are discussed below.

5.3.1 Placement

The frost protection layer of the AGTI cover extension was constructed with soils obtained from the B-Spoils Borrow Area and in part from the East Canyon Creek realignment cut. Sources and characteristics of this material are discussed in detail in Volume I, Section 4. As discussed in that section, borrow excavations were continuously monitored by Umetco in the field to ensure that the 10 pCi/g Ra-226 criterion was met.

Frost protection soils were placed in equal continuous layers not exceeding 12-inches compacted depth and compacted to a minimum of 95 percent of maximum dry density (ASTM D698), and at a water content above minus 2 percent of optimum. The final contours and survey verification points are shown on Drawing 7. Drawings 8 and 9 show the compaction test locations for 1999 and 2000, respectively.

5.3.2 Quality Control Test Results

Field Compaction Test Results. As summarized in Table 5.1, based on 993 passing tests, frost protection soils were compacted to an average of 97.5 percent of the maximum dry density, ranging from 94.9 to 103.1. The average dry density of this material was 113.5 pcf, ranging from 102.1 to 123.2 pcf. The average moisture content was 13.8 percent, ranging from 9.0 percent to 22.5 percent (Appendix C, Table C.2).

Standard Proctor Test Results. Table 5.2 summarizes the Standard Proctor results, which yielded an average maximum dry density for frost protection materials of 116.4 pcf, ranging from 107.5 to 121.9 pcf. The optimum moisture was 13.3 percent, and ranges from 10.6 to 17.9 percent.

Soil Classification. The enhanced reclamation plan specified that frost protection materials shall consist of clayey and/or silty sand, classified as SC and/or S-SM. As documented in Appendix C, Table C.2 and summarized in Table 5.2, these requirements were generally met. Based on the 340 soil classification tests performed, frost protection soils consisted primarily (93%) of clayey sand (SC). Although a small percentage (6%) of clay was identified, this is not considered to have an adverse effect on the cover construction, especially in light of the fact that the main criterion for frost protection material characteristics was satisfaction of the 10 pCi/g Ra-226 requirement.

5.4 Regrading of the Previous Impoundment, Toe Protection, and East Canyon Creek Realignment Fill

Placement (daily load counts) and quality control test records associated with construction of the regrade, toe protection, and ECC realignment fill aspects of the enhanced design are documented in Appendices D through F and summarized in Table 5.3. Drawing 10 shows the final contours and survey verification points for the toe protection excavation and ECC realignment. Corresponding test locations are shown on Drawing 11. Drawing 12 shows the final contours and survey verification points for the regrading of the previously reclaimed impoundment and ECC realignment fill area; test locations are shown in Drawing 13.

Table 5.3 Summary of Field Quality Control Test Results for the Above-Grade Tailings Impoundment Design Enhancement Construction: Regrade, Toe Protection, and East Canyon Creek Realignment

Layer	Total Yards Placed	Design (Plan) Requirements	Nuclear Density Gauge Test Results				Sand-Cone Correlation
			Frequency (No. of Tests)	Dry Density (pcf)	Percent Moisture	Percent Compaction	Frequency (No. of Tests)
Regrade (2000-2001)	21,252 CY	Frequency: 1:1000 CY % Compaction: ≥ 90 % Moisture: NA	1:733 CY (n = 29)	avg: 114.6 range: 108.7 – 119.5	avg: 13.6 range: 7.9 – 18.9	avg: 99.5 range: 95.0 - 104.3	1:6 (n = 5)
Toe Protection (2000-2002)	73,120 CY	Frequency: 1:1000 CY Subgrade % Compaction: ≥ 90 % Moisture: NA Toe Backfill % Compaction: ≥ 95 % Moisture: ≥ Opt. -2	1:435 CY (n = 168)	avg: 114.5 range: 105.4 – 129.5	avg: 12.8 range: 7.2 - 17.5	avg: 98.2 range: 94.9 – 112.6	1: 9 (n = 18)
ECC Realignment (2002)	26,193 CY	Frequency: 1:1000 CY % Compaction: ≥ 95 % Moisture: NA	1:422 CY (n = 62)	avg: 111.2 range: 105.5 – 118.6	avg: 15.0 range: 11.1 – 20.3	avg: 98.4 range: 95.0 - 105.7	1:10 (n = 6)

This summary reflects passing tests only; see Appendix for supporting detailed documentation.

6.0 EROSION PROTECTION

Erosion protection placement at the AGTI began in 2000 and continued until 2002. During this period, close to 412,000 tons of erosion protection material were place on the AGTI, including the East Canyon Creek realignment. As-built Drawing 13 shows the placement areas, the final contours and survey verification points, and relevant cross-sections showing placement details. Drawing 14 shows the corresponding in-place gradation test locations.

For detailed information regarding rock quality, gradation test results, and in-place depth check documentation, the reader is referred to Volume I, Section 5. This section demonstrates that the combination of the erosion protection source and the quality control program used during production and placement at the Gas Hills site repositories has resulted in a finished product which satisfies the erosion protection requirements of 10 CFR 40, Appendix A.

6.1 Scope of Work

The scope of work for AGTI erosion protection placement is summarized below (Table 6.1) and reflected in Drawings 14 and 15. Details regarding the design and underlying assumptions are documented in detail in the enhanced design plan and in the TERs accompanying the NRC's approval of the plan and modifications.

Table 6.1 Summary of Rock Types and Placement for the AGTI Enhancement

Scope of Work	Rock Type Specifications	Comment
Cover Extension	Type B Type C	Riprap for the extended cover
Toe Protection	Type C	
Carbide Draw	Type C	Buried rock layer; see Section 6.4
Regrading of Previously Reclaimed Impoundment	Type A Type B Type C	Riprap for the previously existing impoundment surface
East Canyon Creek Realignment and Protection	Type A Type C Type E	Although Type D rock was initially specified in the 1997 reclamation plan, this was ultimately revised in Umetco's December 2000 license amendment request, which was approved in April 2001 by license Amendment 44

Specifications by Rock Type

Type A – D_{50} = 0.5 inches, minimum in-place thickness of 0.5 feet.

Type B – D_{50} = 3.0 inches, minimum in-place thickness of 0.5 feet

Type C – D_{50} = 6.0 inches; minimum in-place thickness of 1.0 foot

Type D – D_{50} = 16.0 inches; minimum in-place thickness of 2.0 feet

6.2 December 2000 Modifications

On December 20, 2000, Umetco submitted a request to modify the erosion protection design for the AGTI entitled *Proposal for Erosion Protection Modification for the Above-Grade Tailings Impoundment and Heap Leach* (December 18, 2000). The re-design for the AGTI included riprap armoring of the East Canyon Creek slope adjacent to the tailings embankment on the east side, entailing a launched stone design which was developed to replace the previously developed below-grade scour apron design. These changes were made given discovery of historic artifacts in that area (Section 2). This submittal also included a request to modify gradation requirements for Type A rock, by increasing the maximum size from 1 to 3 inches. The latter modification is discussed in Volume I, Section 5. This section focuses on the erosion protection design changes.

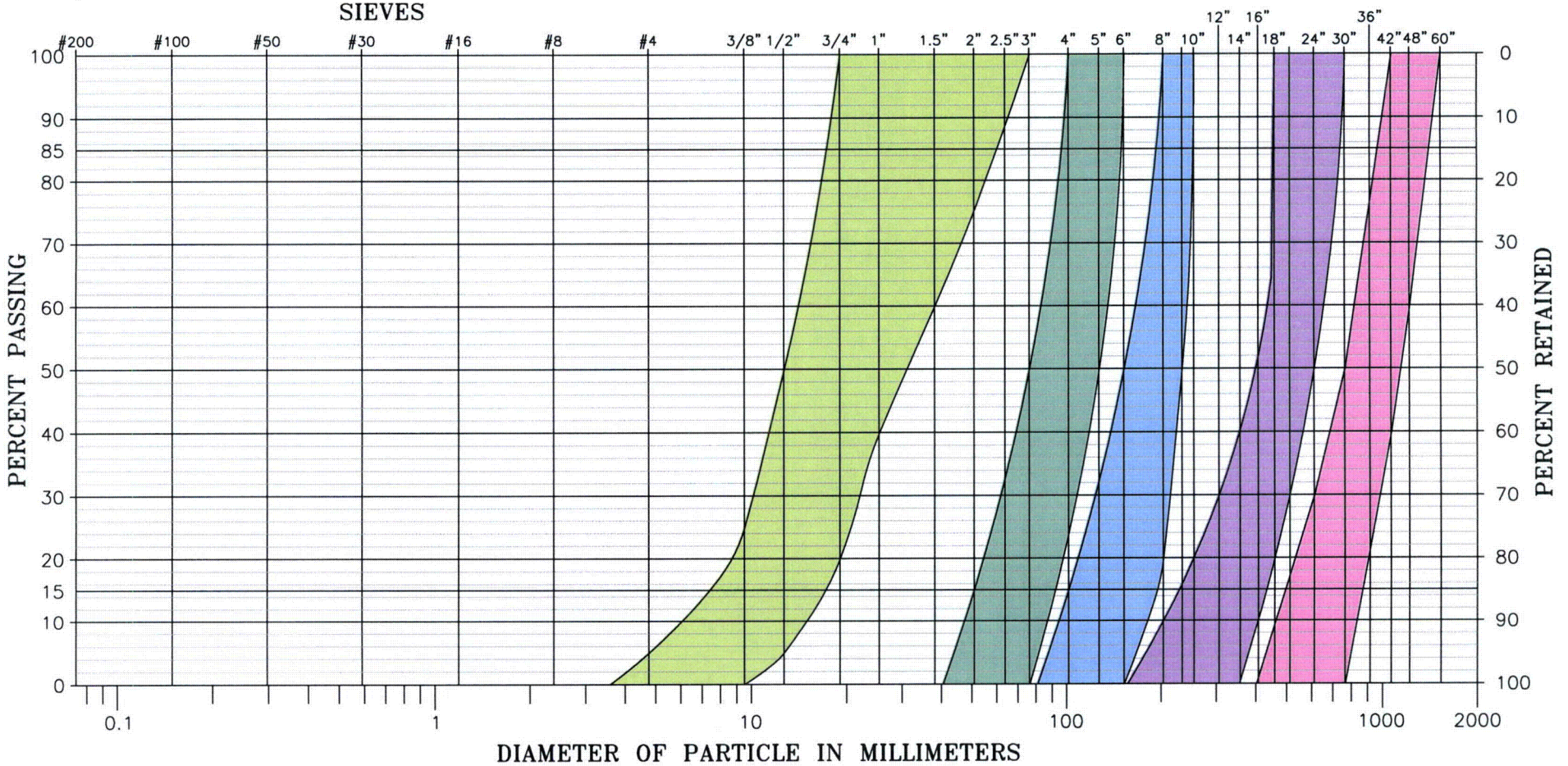
The modifications to the East Canyon Creek realignment design are summarized below:

- The previously approved channel alignment from Sta. 4+00 to –2+00 was straightened to minimize disturbance of cultural resource areas.
- A launched stone design replaced the below-grade scour apron design to minimize disturbance of cultural resources and excavation of saturated streambed soils.
- The graded channel side-slopes were flattened to a 5:1 slope instead of the originally approved 3:1 slope to widen the channel prism and to provide a stable slope for re-vegetation.
- A 2-feet deep, 40-feet wide low flow channel was provided along the eastern channel bed. The low flow channel was included in the design to replace jurisdictional wetlands.
- The width of the downstream grade control structure was revised to 20 feet to provide a conservative design, yet minimize disturbance of cultural resources in the streambed.

Also, using a scour depth of 9.4 feet (vs. the previously-approved scour depth of 7.4 feet), a median particle size (D_{50} rock size) of 30 inches (Type E) was specified (vs. the previously specified Type E). These modifications were approved by the NRC by License Amendment 44 in April 2001 (provided as Attachment 2). NRC review of the analyses and supporting assumptions indicated that the proposed design was in accordance with the design procedures suggested in NUREG-1623 and was therefore acceptable.

Additional details regarding the design and underlying assumptions are documented in detail in the 1997 enhanced reclamation plan, the 2000 modification submittal, and in the technical evaluation reports accompanying the NRC's approval of those designs (Attachments 1 and 2). Corresponding gradation curves are shown on Figure 6.1.

GH\RIPRAP-REV2002.DWG



Type A Specification (D_{50} = 0.5")

SIEVE	PERCENT PASSING
3"	100
1.5"	60 – 100
1"	40 – 100
3/4"	20 – 100
1/2"	5 – 50
3/8"	0 – 25
#4	0 – 5

Type B Specification (D_{50} = 3")

SIEVE	PERCENT PASSING
6"	100
5"	50 – 100
4"	30 – 100
3"	0 – 50
2"	0 – 15

Type C Specification (D_{50} = 6")

SIEVE	PERCENT PASSING
10"	100
9"	50 – 100
8"	20 – 100
6"	0 – 50
4"	0 – 15

Type D Specification (D_{50} = 16")

SIEVE	PERCENT PASSING
30"	100
24"	50 – 100
18"	20 – 100
12"	0 – 30
8"	0 – 10

Type E Specification ($D_{50\ MIN}$ = 30")

SIEVE	PERCENT PASSING
60"	100
48"	60 – 100
42"	40 – 100
30"	0 – 50
24"	0 – 30

LEGEND:

- TYPE A RIPRAP
- TYPE B RIPRAP
- TYPE C RIPRAP
- TYPE D RIPRAP
- TYPE E RIPRAP

FIGURE 6.1
RIPRAP GRADATIONS
UMETCO GAS HILLS SITE
JUNE, 2002

6.3 Rock Placement and Quality Control Test Results

Between 2000 and 2002, the volume of rock placed as erosion protection material on the AGTI is summarized below:

- Type A – 16,826 CY
- Type B – 63,302 CY
- Type C – 117,736 CY
- Type E – 18,639 CY

In accordance with the enhanced reclamation plan, the following requirements were met:

- The riprap met or exceeded the size requirements presented in the Construction Drawings and design report.
- When necessary, riprap was oversized in accordance with the NRC *Final Staff Technical Position – Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites*, Appendix D. [As discussed in Volume I, Section 5, this guidance ultimately evolved into what is now NUREG-1623 (NRC 2002).
- Riprap material was placed to the lines and grades shown on Drawing 14, consistent with the design plan and subsequent modifications.
- Placement of all riprap materials was accomplished in a manner providing well-keyed, densely placed layers of the specified thickness.

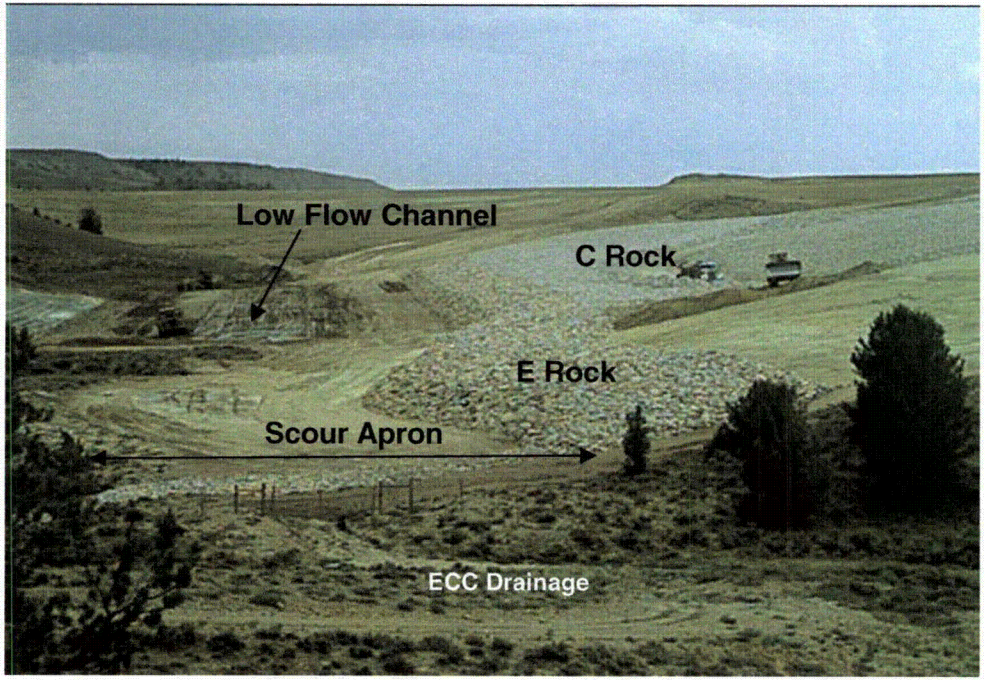
As indicated in the introduction to this section, the reader is referred to Section 5 of Volume 1 for detailed information regarding rock quality, gradation test results, and in-place visual depth checks. Gradation and depth check locations are shown on Drawing 15.

Key aspects of AGTI rock placement are shown on Figures 6.2 and 6.3. Figure 6.2 shows photographs of the 2002 East Canyon Creek rock placement and scour apron. Figure 6.3 shows photographs of visual depth check testing conducted in 2001.

6.4 Carbide Draw Rock Placement

In Appendix G (Hydrology Analysis, Carbide Draw) of the October 1997 design plan, a gullying and headcutting analysis was presented to calculate the maximum expected scour at the toe of the AGTI on the north side in the vicinity of Carbide Draw. This analysis was later updated by SMI in September 1998 in response to NRC comments (Tables 3.2 and 3.3). Based on the results of this updated analysis, SMI concluded that any future headcutting in Carbide Draw would follow the historic path and location of the draw and therefore, placing a buried rock layer (Type C) to a depth equal to the maximum historic depth of the draw would effectively prevent any future headcutting from affecting the stability of the reclaimed impoundment.

Figure 6.2. Photographs of 2002 East Canyon Creek (ECC) Rock Placement and Scour Apron Above-Grade Tailings Impoundment Design Enhancement



August 23, 2002, showing scour apron and low flow channel.

Placing Rock in Scour Apron (22 ft x 6 ft)

Type E Rock Depth Verification (6 feet)

On December 20, 2000, Umetco submitted a request to modify the erosion protection design for the AGTI entitled *Proposal for Erosion Protection Modification for the Above-Grade Tailings Impoundment and Heap Leach* (December 18, 2000). The re-design for the AGTI included riprap armoring of the East Canyon Creek (ECC) slope adjacent to the tailings embankment on the east side. These changes resulted from discovery of historic artifacts in that area and the need to minimize impacts to these resources. In the April 5, 2001 Technical Evaluation Report, NRC review of the analyses and supporting assumptions indicated that the proposed designs (for the launch rock and scour apron) were in accordance with the design procedures suggested in NUREG-1623 and are therefore acceptable.

Figure 6.3. Photographs of 2001 Surface Visual and Depth Check Testing: Above-Grade Tailings Impoundment Design Enhancement

A Rock: Required Thickness ≥ 0.45 ft

B Rock: Required Thickness ≥ 0.45 ft

C Rock: Required Thickness ≥ 0.90 ft

Type E rock depth verification shown on Figure 6.2 (previous)

While this buried rock layer was placed in accordance with the 1998 submittal (revised Appendix G), as shown in Drawing 13, Umetco ultimately had to deviate from normal quality control testing procedures because of the depth of the draw and associated safety concerns. Essentially, in building the toe apron on Carbide Draw, the gully was too deep (approximately 25 feet) for site crew to safely enter and test. This deviation was documented in detail and is not considered to have any adverse affect on rock quality.

6.5 Summary

As demonstrated in these tables and in Drawings 13 through 15, placement of erosion protection materials for the AGTI cover construction was conducted in accordance with plan requirements and satisfies the criteria set forth in 10 CFR Part 40, Appendix A for the following criteria:

Criterion 4(c) – provides requirements for the long-term stability of the embankment and cover slopes for tailings;

Criterion 4(d) – requires establishment of a self-sustaining vegetative cover or employment of a rock cover to reduce wind and water erosion to negligible levels, that individual rock fragments are suited for the job, and that the impoundment surfaces are contoured to avoid concentrated surface runoff or abrupt changes in slope gradient.

7.0 FINAL RADIOLOGICAL STATUS

To verify that the completed Above-Grade Tailings Impoundment cover meets the criteria set forth in 10 CFR 40, Appendix A, Criterion 6(1) and Criterion 6(2), this section summarizes: 1) verification data documenting the Ra-226 content of frost protection materials placed on the heap; 2) radon emission rate measurements; and 3) the results of the AGTI gamma exposure rate survey. The latter information is already documented in the *Final Status Survey Report* (Umetco 2003), which was approved by the NRC on September 27, 2004.

7.1 Cover Radium Content (Frost Protection)

During construction of the AGTI cover extension, frost protection materials were continuously gamma surveyed and the upper two feet sampled and analyzed for Ra-226 content to ensure that reclamation plan requirements were met. Table 7.1 summarizes these results, which indicate an average Ra-226 content of 5.6 pCi/g for the 0-1 foot depth profile and 4.0 pCi/g for the 1-2 foot profile, well below the 10 pCi/g requirement.

Table 7.1 AGTI Frost Protection Verification Sampling Results

	0-1 ft Results (pCi/g)			**1-2 ft Results** (pCi/g)		
Grid	Sample Date	Ra-226	Error Term	Sample Date	Ra-226	Error Term
1	4/24/01	2.81	±0.49	4/24/01	2.96	±0.51
2	4/24/01	3.42	±0.65	4/24/01	3.7	±0.66
3	4/24/01	2.44	±0.44	4/24/01	3.77	±0.61
4	4/24/01	3.21	±0.61	4/24/01	3.45	±0.69
5	4/24/01	2.79	±0.56	4/24/01	3.0	±0.56
6	4/24/01	5.86	±0.85	4/24/01	4.7	±0.71
7	4/24/01	5.14	±0.90	4/24/01	4.24	±0.8
8	4/24/01	7.16	±1.4	5/24/01	3.78	±0.6
9	4/24/01	8.96	±1.6	5/24/01	4.68	±0.8
10	4/24/01	8.27	±1.4	5/24/01	5.57	±0.94
11	4/24/01	8.52	±1.5	5/24/01	2.91	±0.55
12	4/24/01	9.0	±1.6	5/24/01	5.23	±0.76
13	4/24/01	5.27	±1.2	5/24/01	3.89	±0.77
AVERAGE		**5.6**			**4.0**	

7.2 Radon Emanation (NESHAPS)

Radon emission rates were measured from the AGTI in 2000 for comparison with the regulatory limit in 10 CFR 40, Appendix A, Criterion 6(2) of 20 pCi/m^{2}s (NESHAPs report submitted January 8, 2001). The radon emission rate measured for the AGTI Repository cover was 1.4 pCi/m^{2}s, well within the regulatory limit of 20 pCi/m^{2}s in 10 CFR 40 and consistent with the radon emission rate measurements from the adjacent Heap Leach repositories (1.1 pCi/m^{2}s).

7.2 Direct Gamma Exposure Rates

10 CFR 40, Appendix A, Criterion 6(1) requires demonstrating that direct gamma exposure from tailings or wastes be reduced to background levels. To demonstrate compliance with this requirement, direct gamma exposure surveys of the AGTI were made over the completed earthen cover between April and July 2001, upon completion of the frost protection layer and prior to placement of erosion protection. One-meter high bare gamma exposure readings were collected and then averaged over the entire area in the manner described below. The results of this survey are documented in the Final Status Survey Report (Umetco 2004) and summarized below.

The average exposure rate measured over the AGTI was 27 μR/hr, satisfying the 30 μR/hr criterion. This was approved by the NRC in the September 27, 2004 TER, which states the following: "The average exposure rate measured on the earthen covers of the AGTI and the Heap Leach was 27 μR/hr, therefore, the gamma levels comply with the approved limit of 30 μR/hr, demonstrating compliance with Part 40, Appendix A, Criterion 6(1). The potential dose is very low and the radiation levels on the Umetco site are comparable to the surrounding area."

8.0 SUMMARY AND CONCLUSIONS

In summary, this volume of the Construction Completion Report demonstrates that all work documented herein was performed in accordance with the design and procedures in the *Design for Enhancement of the Previously Approved Reclamation Plan for the Above-Grade Inactive Tailings Impoundment Design Report* (SMI 1997) and subsequent modifications. Additionally, it verifies that the completed cover meets the requirements established in 10 CFR 40, Appendix A, Criteria 4 (c), (d), (e), 6(1), and 6(2) with regard to reasonable assurance of stability and control of the contaminated material, and limitation of the radon flux from the disposal area to the atmosphere to 20 pCi/m^2s.

Completed AGTI cover – July 2002.

9.0 REFERENCES

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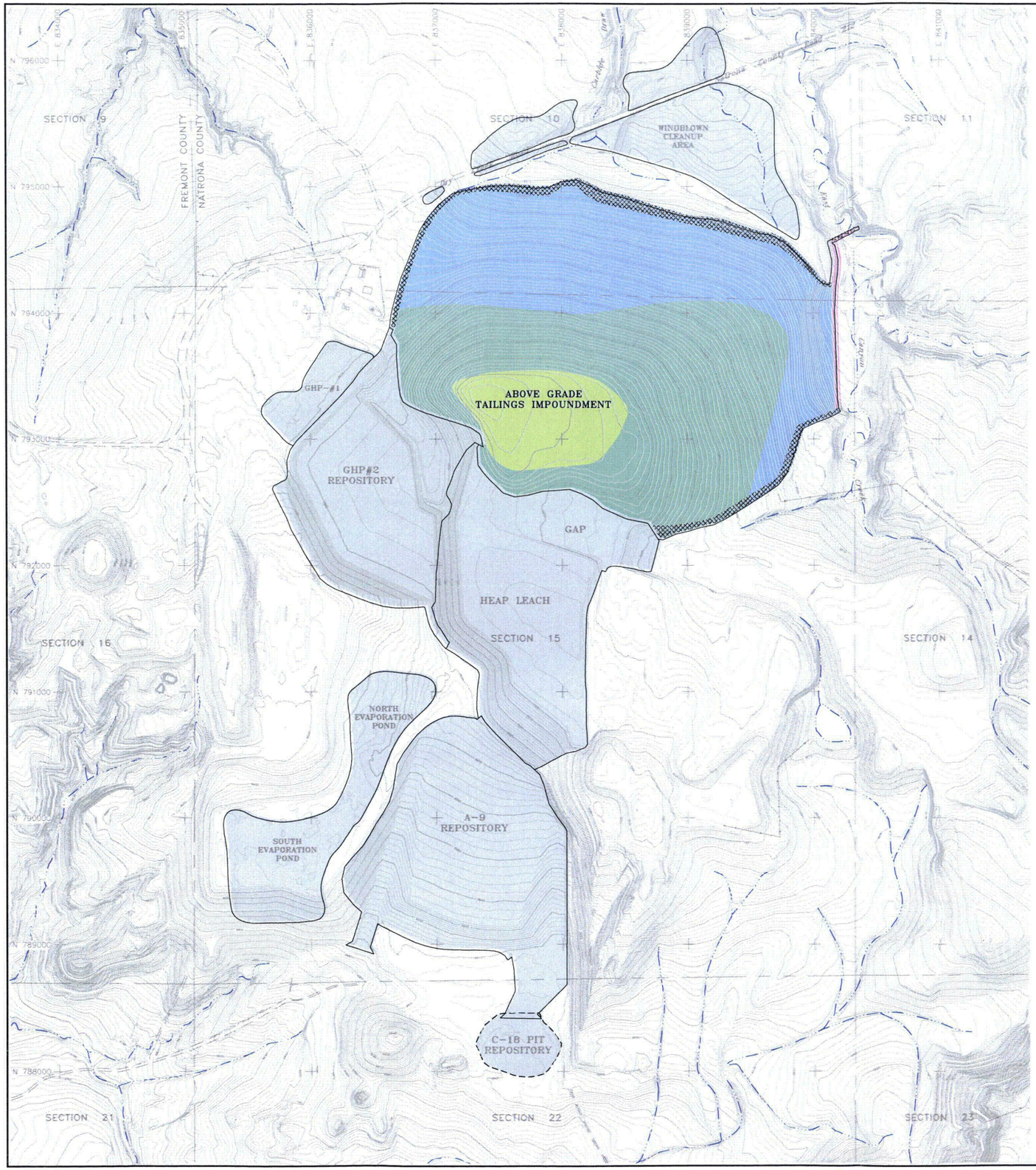
DRAWINGS



SHEET NO.	TITLE
1 OF 15	ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT FINAL SITE PLAN REFLECTING POST-RECLAMATION CONSTRUCTION FINAL GRADES
2 OF 15	FINAL ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT AND PREVIOUSLY APPROVED RECLAMATION
3 OF 15	ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT FINAL CONTOURS AND SURVEY VERIFICATION POINTS CONTAMINATED FILL AREA
4 OF 15	ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT COMPACTION TEST LOCATIONS CONTAMINATED FILL AREA
5 OF 15	ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT FINAL CONTOURS AND SURVEY VERIFICATION POINTS RADON BARRIER
6 OF 15	ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT COMPACTION TEST AND VISUAL DEPTH CHECK LOCATIONS RADON BARRIER
7 OF 15	ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT FINAL CONTOURS AND SURVEY VERIFICATION POINTS FROST PROTECTION LAYER
8 OF 15	ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT 1999 COMPACTION TEST LOCATIONS FROST PROTECTION LAYER
9 OF 15	ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT 2000 COMPACTION TEST LOCATIONS FROST PROTECTION LAYER
10 OF 15	ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT FINAL CONTOURS AND SURVEY VERIFICATION POINTS TOE PROTECTION EXCAVATION AND EAST CANYON CREEK REALIGNMENT
11 OF 15	ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT SUBGRADE COMPACTION TEST LOCATIONS TOE PROTECTION EXCAVATION AND EAST CANYON CREEK REALIGNMENT
12 OF 15	ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT FINAL CONTOURS AND SURVEY VERIFICATION POINTS REGRADING OF PREVIOUSLY RECLAIMED IMPOUNDMENT AND EAST CANYON CREEK REALIGNMENT FILL AREA
13 OF 15	ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT COMPACTION TEST LOCATIONS REGRADING OF PREVIOUSLY RECLAIMED IMPOUNDMENT AND EAST CANYON CREEK REALIGNMENT FILL AREA
14 OF 15	ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT FINAL CONTOURS AND SURVEY VERIFICATION POINTS EROSION PROTECTION PLACEMENT
15 OF 15	ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT IN-PLACE GRADATION AND VISUAL DEPTH CHECK TEST LOCATIONS EROSION PROTECTION PLACEMENT

LEGEND

- 7000 — 2006 FINISHED GRADE TOPOGRAPHY
- DRAINAGE PATH/PONDED WATER
- UN-PAVED ROADS
- N 794,000 — UMETCO 1000' SITE GRID
- 6-INCHES OF RIPRAP TYPE "A" D_{50} = 0.5 INCH
- 6-INCHES OF RIPRAP TYPE "B" D_{50} = 3.0 INCH
- 12-INCHES OF RIPRAP TYPE "C" D_{50} = 6.0 INCH
- LAUNCHED STONE EMBANKMENT TYPE "E" D_{50} = 30.0 INCH
- BELOW-GRADE APRON

N

400' 0 400'

SCALE IN FEET

CONTOUR INTERVAL : 2'

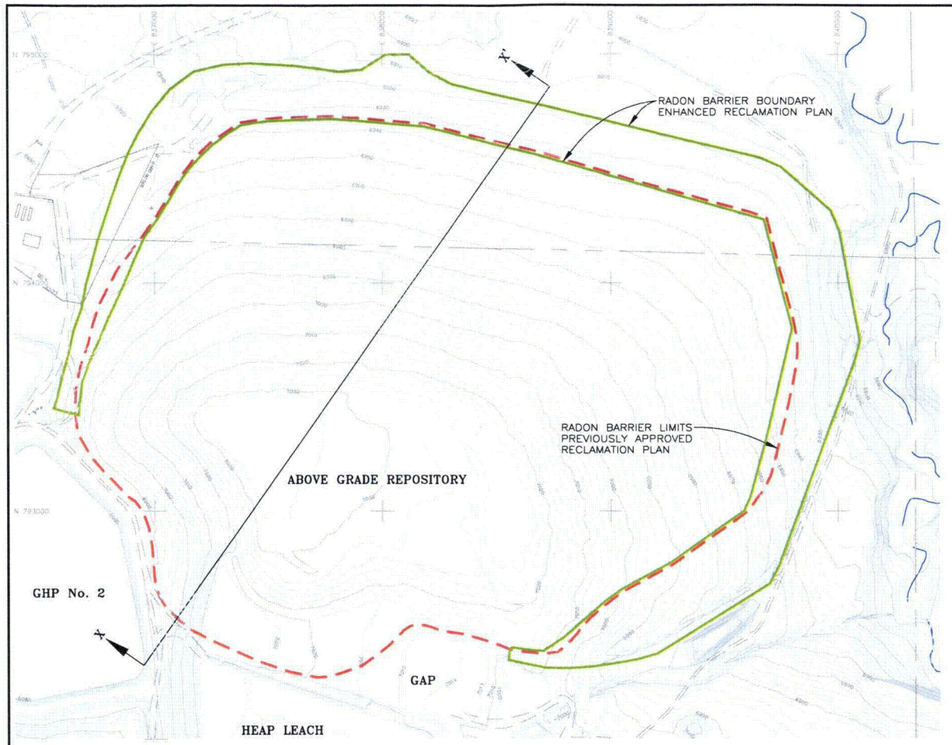
Umetco Minerals Corporation
2754 COMPASS DRIVE, SUITE 280, GRAND JUNCTION, CO 81506

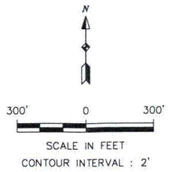
AS BUILT

ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT FINAL SITE PLAN REFLECTING POST-RECLAMATION CONSTRUCTION FINAL GRADES

GAS HILLS, WYOMING

DATE: JUNE 2007 DWG. GH-AG-01-AB SHEET 1 OF 15

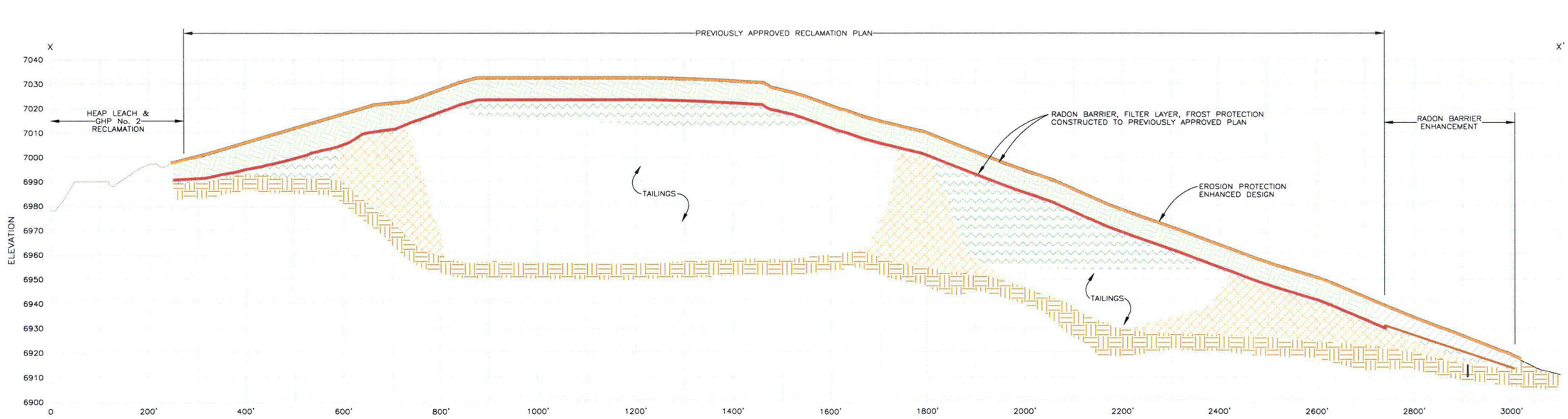




LEGEND:

- 7000 — 1997 AERIAL TOPOGRAPHY UPDATED WITH 1998 SURVEYS
- DRAINAGE PATH/PONDED WATER
- UN-PAVED ROADS
- N 794,000 — UMETCO 1000' SITE GRID
- RADON BARRIER LIMITS PREVIOUSLY APPROVED PLAN
- RADON BARRIER BOUNDARY ENHANCED RECLAMATION PLAN

THE ENHANCED RECLAMATION DESIGN INCLUDED (WITH SUBSEQUENT NRC APPROVAL) EVALUATION OF EXISTING RECLAMATION COVER CONSTRUCTION COMPLETED IN ACCORDANCE WITH THE PREVIOUSLY APPROVED RECLAMATION DESIGN, i.e., SEISMIC DESIGN, SLOPE STABILITY, LIQUEFACTION POTENTIAL, SETTLEMENT, RADON BARRIER COVER CRACKING POTENTIAL, AND RADON ATTENUATION. (REFER TO LICENSE AMENDMENT 41, TER DATED JUNE 21, 1999, TRANSMITTED BY LETTER FROM NRC DATED JULY 16, 1999)



SECTION X-X'
SCALE: HORIZ. 1" = 100'
VERT. 1' = 20'

LEGEND PREVIOUSLY APPROVED RECLAMATION PLAN

- EXISTING COVER
- EXISTING EMBANKMENT FILL
- EXISTING RECLAMATION FILL
- FOUNDATION SOIL
- EXISTING TAILINGS
- EXISTING RADON BARRIER

LEGEND ENHANCEMENT RECLAMATION PLAN

- FROST PROTECTION LAYER
- ENHANCED RADON BARRIER
- RIPRAP

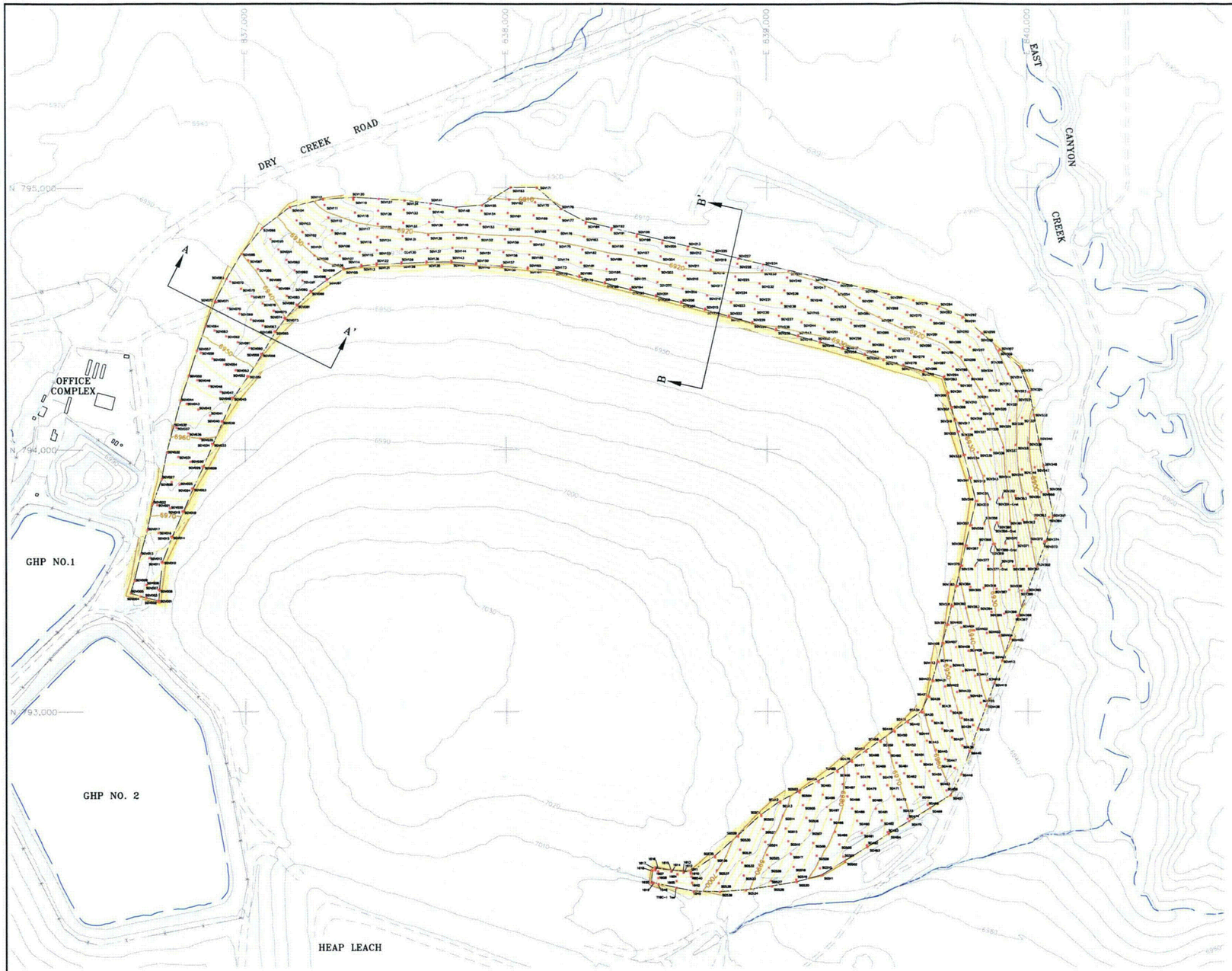
Umetco Minerals Corporation
2754 COMPASS DRIVE, SUITE 280, GRAND JUNCTION, CO 81506

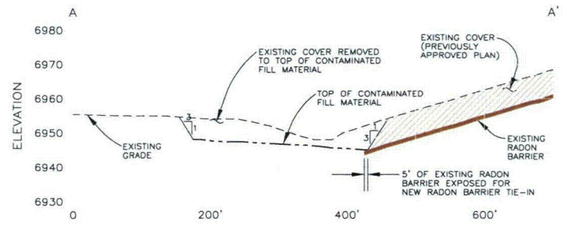
AS BUILT

ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT AND PREVIOUSLY APPROVED RECLAMATION

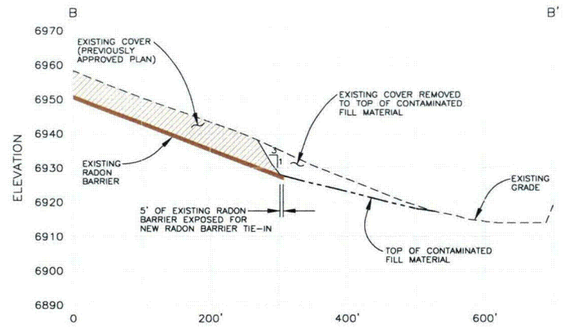
GAS HILLS, WYOMING

DATE: JUNE 2007 DWG: GH-AG-02-AB





SECTION A-A'
SCALE: HORIZ. 1" = 100'
VERT. 1' = 20'



SECTION B-B'
SCALE: HORIZ. 1" = 100'
VERT. 1' = 20'

PROFILE LEGEND:

- EXISTING GRADE 1997 AERIAL TOPOGRAPHY
- EXISTING RADON BARRIER
- TOP OF THE CONTAMINATED FILL

N

200' 0 200'

SCALE IN FEET
CONTOUR INTERVAL : 2'

LEGEND:

- EXISTING 1997 AERIAL TOPOGRAPHY
- DRAINAGE PATH/PONDED WATER
- UN-PAVED ROADS
- UMETCO 1000' SITE GRID
- FINISH GRADE TOPOGRAPHY CONTAMINATED FILL AREA
- CONTAMINATED FILL SURVEY VERIFICATION POINT

Umetco Minerals Corporation
2754 COMPASS DRIVE, SUITE 280, GRAND JUNCTION, CO 81506

AS BUILT

ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT FINAL CONTOURS AND SURVEY VERIFICATION POINTS CONTAMINATED FILL AREA

GAS HILLS, WYOMING

DATE: JUNE 2007 DWG: GH-AG-03-AB SHEET 3 OF 15

LEGEND:

- EXISTING 1997 AERIAL TOPOGRAPHY
- DRAINAGE PATH/PONDED WATER
- UN-PAVED ROADS
- UMETCO 1000' SITE GRID
- FINISH GRADE TOPOGRAPHY CONTAMINATED FILL AREA
- CONTAMINATED FILL COMPACTION TEST LOCATION – FINISHED GRADE
- CONTAMINATED FILL COMPACTION TEST LOCATION – FILL AREAS TESTED IN 1-FOOT LIFTS

N

200' 0 200'

SCALE IN FEET
CONTOUR INTERVAL : 2'

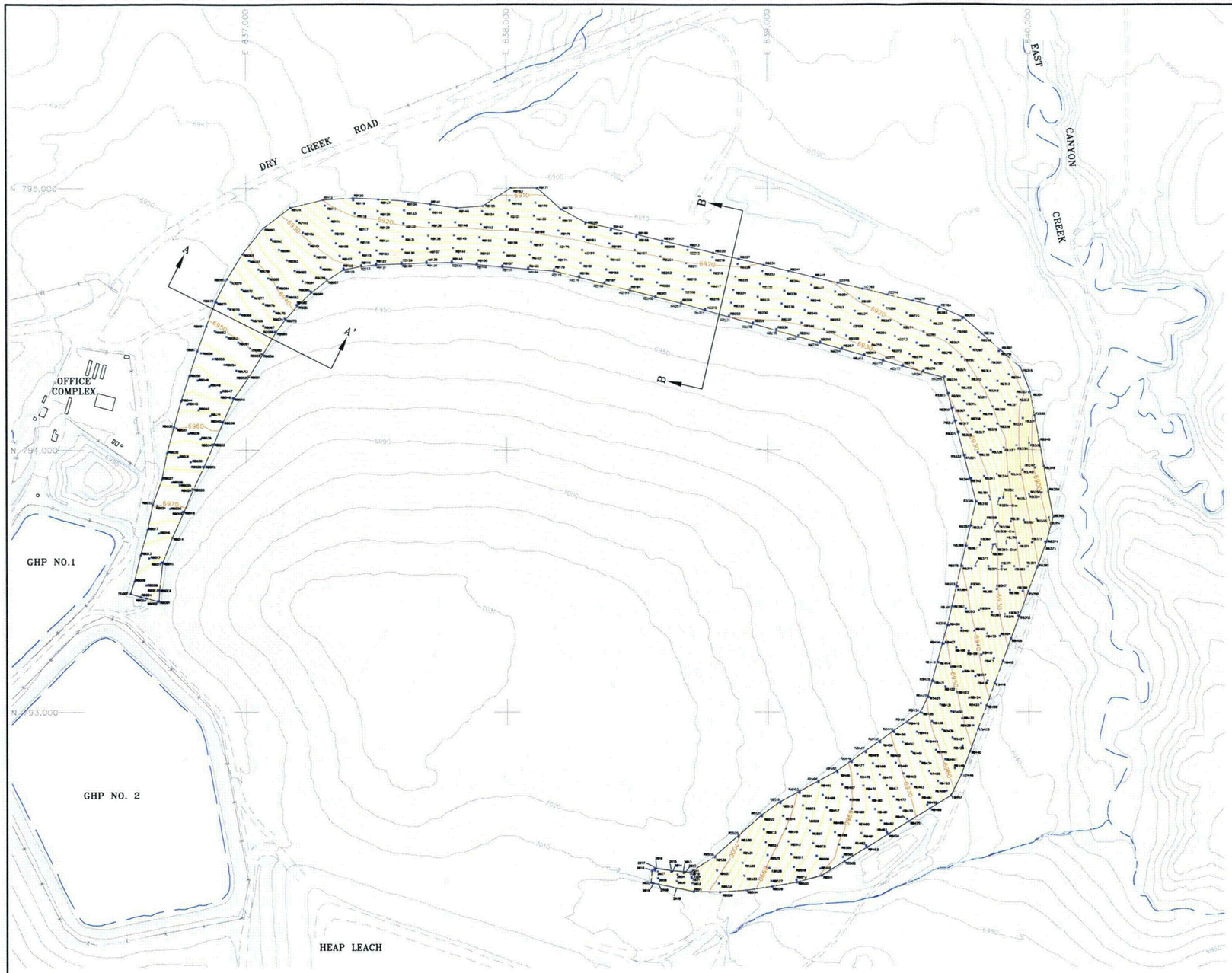
Umetco Minerals Corporation
2754 COMPASS DRIVE, SUITE 280, GRAND JUNCTION, CO 81506

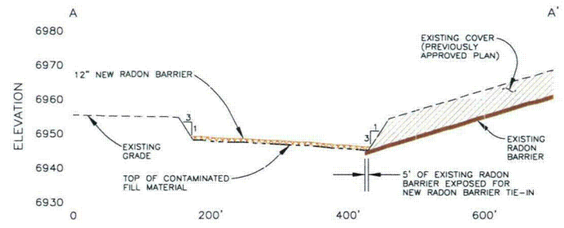
AS BUILT

ABOVE-GRADE TAILINGS IMPOUNDMENT
DESIGN ENHANCEMENT
COMPACTION TEST LOCATION
CONTAMINATED FILL AREA

GAS HILLS, WYOMING

DATE: JUNE 2007 DWG: GH-AG-04-AB SHEET 4 OF 15





SECTION A-A'
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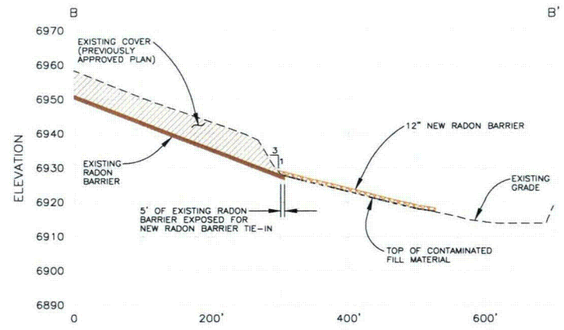
VERT. 1" = 20'



SECTION B-B'
SCALE: HORIZ. 1" = 100'
VERT. 1" = 20'

PROFILE LEGEND:

- EXISTING GRADE 1997 AERIAL TOPOGRAPHY
- EXISTING RADON BARRIER
- TOP OF THE CONTAMINATED FILL
- 12" NEW RADON BARRIER

LEGEND:

- EXISTING 1997 AERIAL TOPOGRAPHY
- DRAINAGE PATH/PONDED WATER
- UN-PAVED ROADS
- UMETCO 1000' SITE GRID
- FINISH GRADE TOPOGRAPHY RADON BARRIER FILL AREA
- RADON BARRIER FILL SURVEY VERIFICATION POINT

Umetco Minerals Corporation
2754 COMPASS DRIVE, SUITE 280, GRAND JUNCTION, CO 81506

AS BUILT

ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT FINAL CONTOURS AND SURVEY VERIFICATION POINTS RADON BARRIER

GAS HILLS, WYOMING

DATE: JUNE 2007 DWG: GH-AG-05-AB

LEGEND:

- EXISTING 1997 AERIAL TOPOGRAPHY
- DRAINAGE PATH/PONDED WATER
- UN-PAVED ROADS
- UMETCO 1000' SITE GRID
- FINISH GRADE TOPOGRAPHY RADON BARRIER FILL AREA
- RADON BARRIER FILL COMPACTION TEST LOCATION – FIRST LIFT
- RADON BARRIER FILL COMPACTION TEST LOCATION – SECOND LIFT
- RADON BARRIER FILL VISUAL DEPTH VERIFICATION TEST LOCATION
  #46 INDICATES VISUAL DEPTH CHECK I.D.
  1.10 INDICATES DEPTH MEASURED IN FEET

N

200' 0 200'

SCALE IN FEET
CONTOUR INTERVAL : 2'

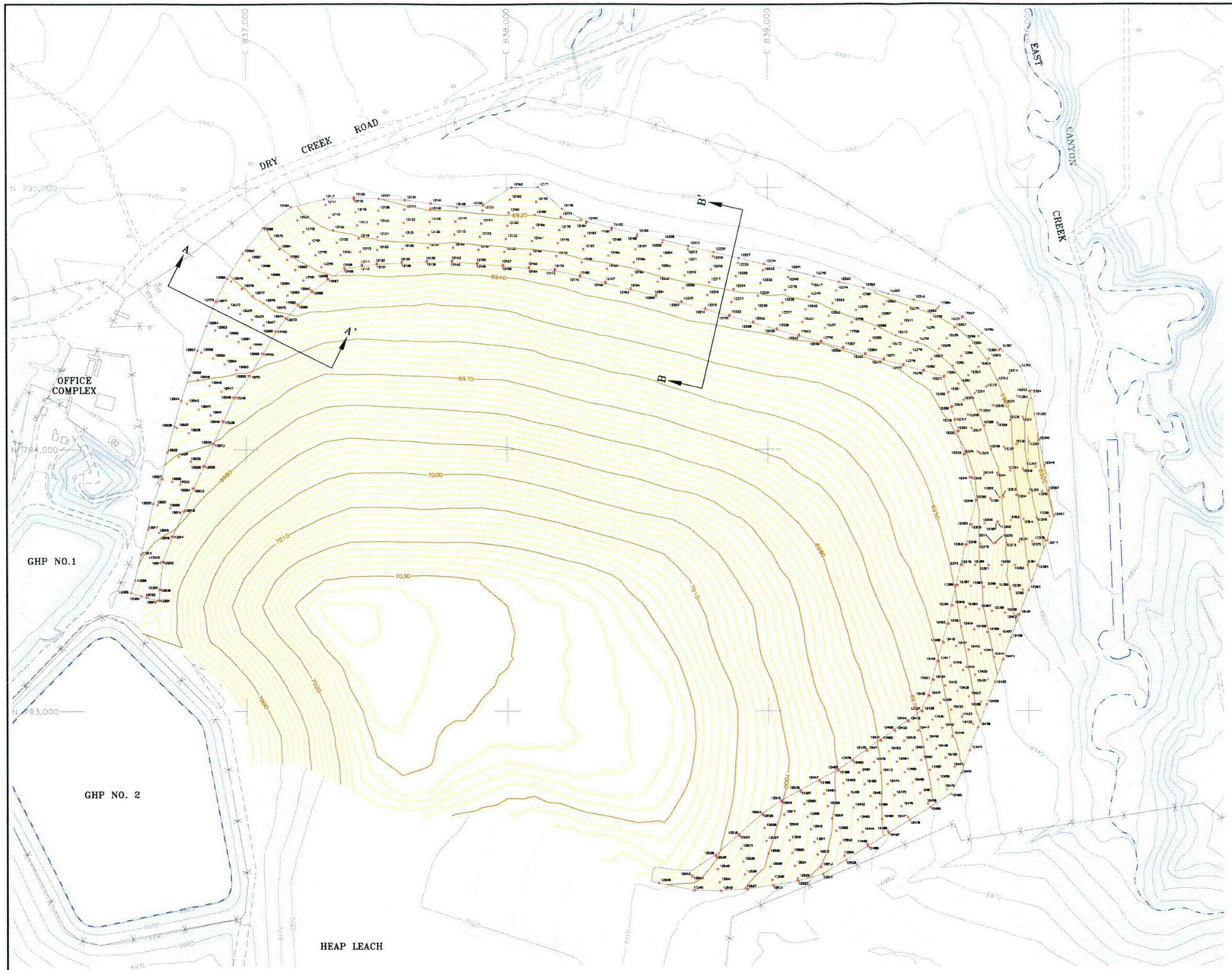
Umetco Minerals Corporation
2754 COMPASS DRIVE, SUITE 280, GRAND JUNCTION, CO 81506

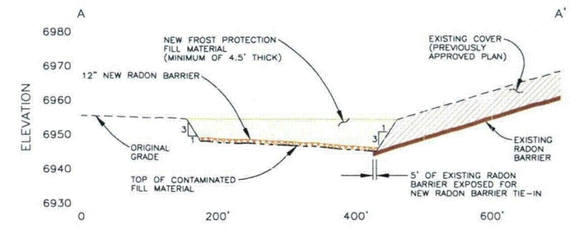
AS BUILT

ABOVE-GRADE TAILINGS IMPOUNDMENT
DESIGN ENHANCEMENT
COMPACTION TEST AND
VISUAL DEPTH CHECK LOCATIONS
RADON BARRIER

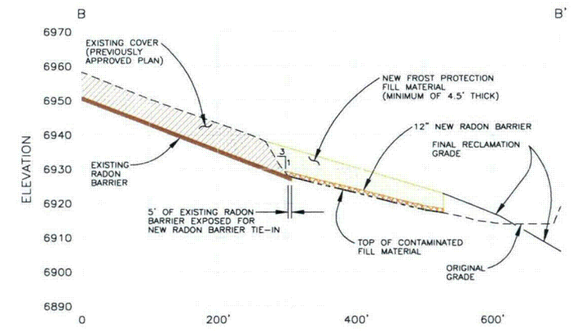
GAS HILLS, WYOMING

DATE: JUNE 2007 DWG: GH-AG-06-AB SHEET 6 OF 15





SECTION A-A'
SCALE: HORIZ. 1" = 100'
VERT. 1' = 20'



SECTION B-B'
SCALE: HORIZ. 1" = 100'
VERT. 1' = 20'

PROFILE LEGEND:

- EXISTING GRADE 2002 TOPOGRAPHY
- EXISTING RADON BARRIER
- TOP OF THE CONTAMINATED FILL
- 12" NEW RADON BARRIER
- NEW FROST PROTECTION MATERIAL

N

200' 0 200'
SCALE IN FEET
CONTOUR INTERVAL : 2'

LEGEND:

- 2000 AERIAL TOPOGRAPHY UPDATED WITH 2002 SURVEYS
- DRAINAGE PATH/PONDED WATER
- UN-PAVED ROADS
- UMETCO 1000' SITE GRID
- FINISH GRADE TOPOGRAPHY FROST PROTECTION FILL AREA
- FROST PROTECTION FILL SURVEY VERIFICATION POINT

Umetco Minerals Corporation
2754 COMPASS DRIVE, SUITE 280, GRAND JUNCTION, CO 81506

AS BUILT

ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT FINAL CONTOURS AND SURVEY VERIFICATION POINTS FROST PROTECTION LAYER

GAS HILLS, WYOMING

DATE: JUNE 2007 DWG. GH-AG-07-AB SHEET 7 OF 15

LEGEND:

- 7000 — 2000 AERIAL TOPOGRAPHY UPDATED WITH 2002 SURVEYS
- DRAINAGE PATH/PONDED WATER
- UN-PAVED ROADS
- N 794,000 — UMETCO 1000' SITE GRID
- 6960 — FINISH GRADE TOPOGRAPHY ABOVE GRADE REGRADE AND TOE APRON BACKFILL
- FROST PROTECTION FILL COMPACTION TEST LOCATION – FIRST LIFT
- FROST PROTECTION FILL COMPACTION TEST LOCATION – SECOND LIFT
- FROST PROTECTION FILL COMPACTION TEST LOCATION – THIRD LIFT
- FROST PROTECTION FILL COMPACTION TEST LOCATION – FOURTH LIFT
- FROST PROTECTION FILL COMPACTION TEST LOCATION – FIFTH LIFT

N

200' 0 200'

SCALE IN FEET

CONTOUR INTERVAL : 2'

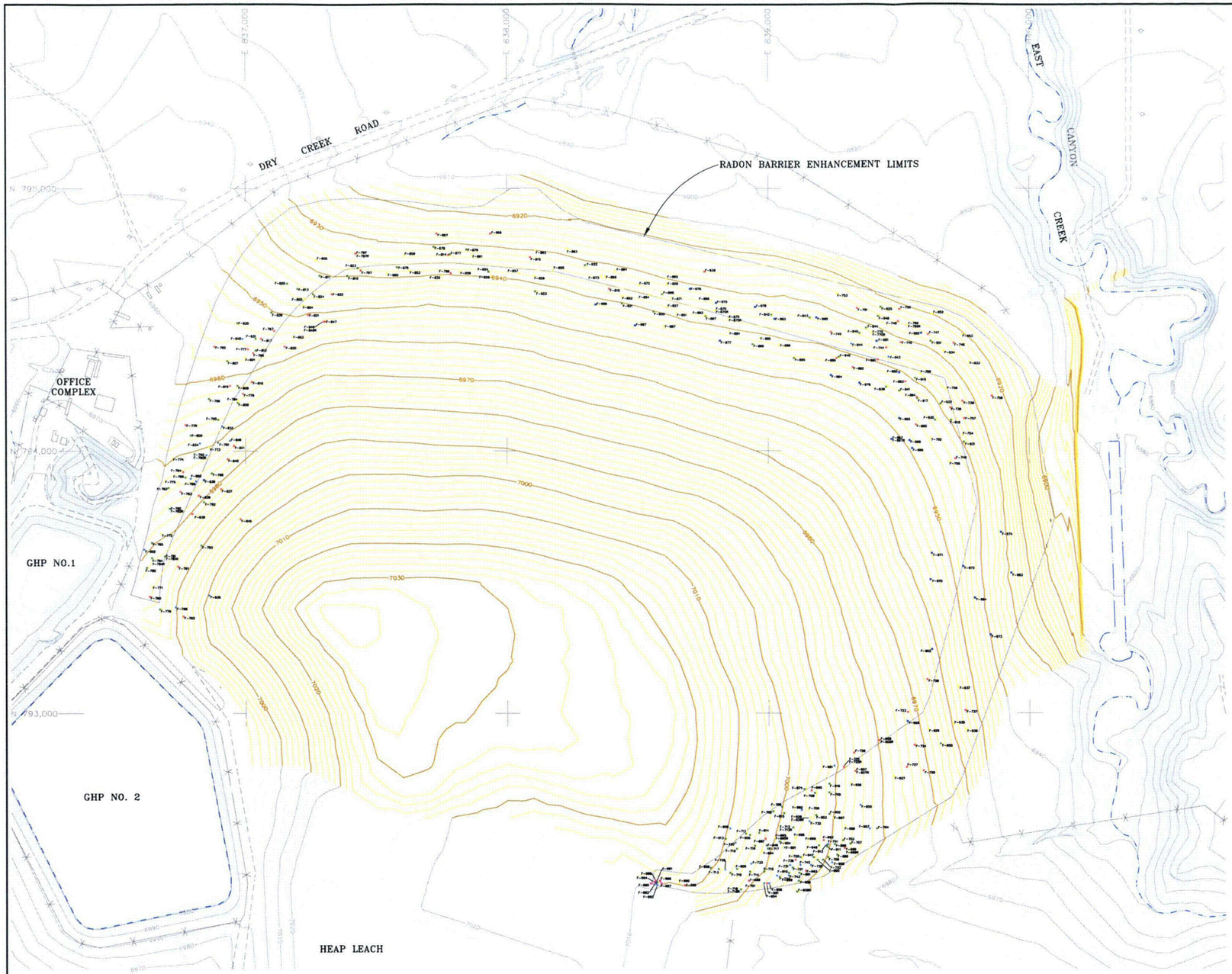
Umetco Minerals Corporation
2754 COMPASS DRIVE, SUITE 280, GRAND JUNCTION, CO 81506

AS BUILT

ABOVE-GRADE TAILINGS IMPOUNDMENT
DESIGN ENHANCEMENT
1999 COMPACTION TEST LOCATIONS
FROST PROTECTION LAYER

GAS HILLS, WYOMING

DATE: JUNE 2007 DWG: GH-AG-08-AB SHEET 8 OF 15



LEGEND:

- 7000 — 2000 AERIAL TOPOGRAPHY UPDATED WITH 2002 SURVEYS
- DRAINAGE PATH/PONDED WATER
- UN-PAVED ROADS
- N 794,000 — UMETCO 1000' SITE GRID
- 6960 — FINISH GRADE TOPOGRAPHY ABOVE GRADE REGRADE AND TOE APRON BACKFILL
- F-781 — FROST PROTECTION FILL COMPACTION TEST LOCATION – FIRST LIFT
- F-772 — FROST PROTECTION FILL COMPACTION TEST LOCATION – SECOND LIFT
- F-784 — FROST PROTECTION FILL COMPACTION TEST LOCATION – THIRD LIFT
- F-838 — FROST PROTECTION FILL COMPACTION TEST LOCATION – FOURTH LIFT
- F-873 — FROST PROTECTION FILL COMPACTION TEST LOCATION – FIFTH LIFT
- F-964 — FROST PROTECTION FILL COMPACTION TEST LOCATION – LIFTS 6 THRU 9

N

200' 0 200'

SCALE IN FEET
CONTOUR INTERVAL : 2'

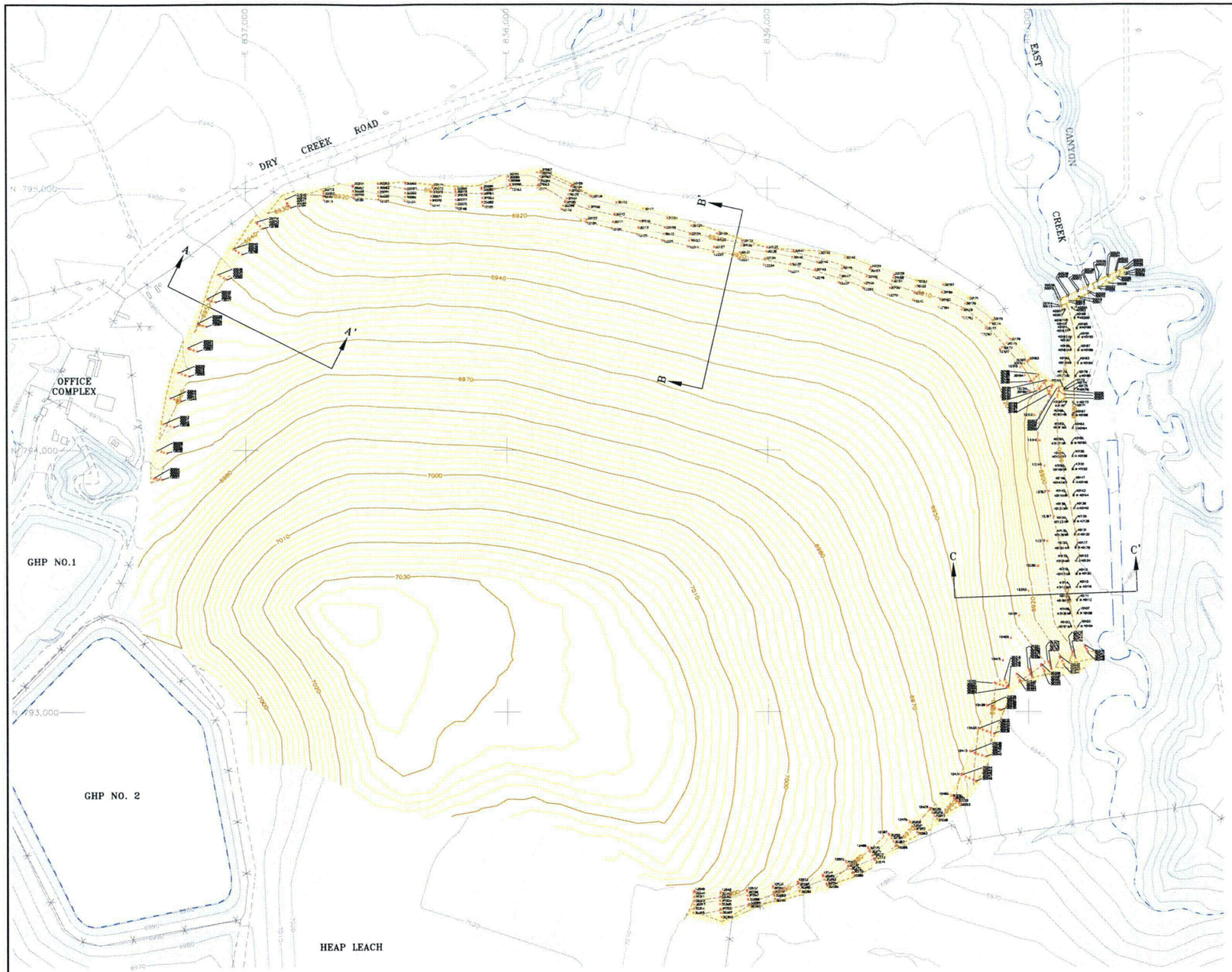
Umetco Minerals Corporation
2754 COMPASS DRIVE, SUITE 280, GRAND JUNCTION, CO 81506

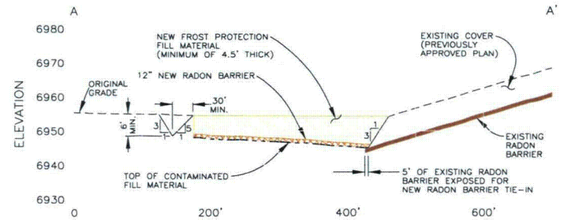
AS BUILT

ABOVE-GRADE TAILINGS IMPOUNDMENT
DESIGN ENHANCEMENT
2000 COMPACTION TEST LOCATIONS
FROST PROTECTION LAYER

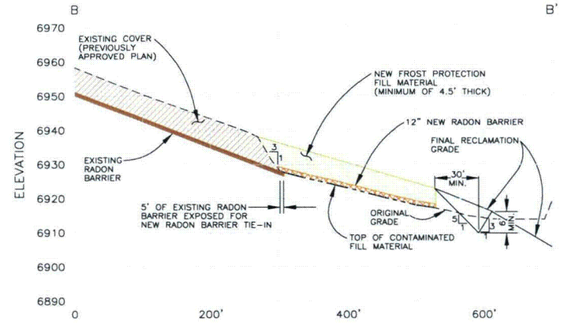
GAS HILLS, WYOMING

DATE: JUNE 2007 DWG: GH-AC-09-AB SHEET 9 OF 15

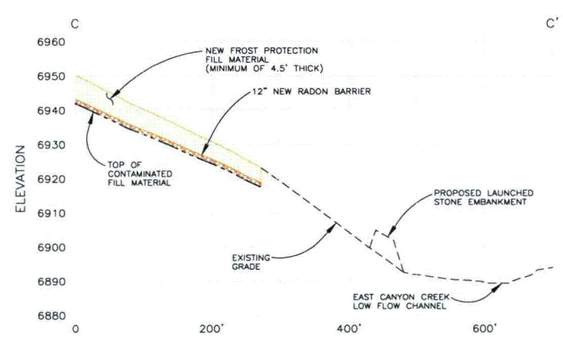




SECTION A–A'
SCALE: HORIZ. 1" = 100'
VERT. 1' = 20'



SECTION B–B'
SCALE: HORIZ. 1" = 100'
VERT. 1' = 20'



SECTION C–C'
SCALE: HORIZ. 1" = 100'
VERT. 1' = 20'

PROFILE LEGEND:

- EXISTING GRADE 2002 TOPOGRAPHY
- EXISTING RADON BARRIER
- TOP OF THE CONTAMINATED FILL
- 12" NEW RADON BARRIER
- NEW FROST PROTECTION MATERIAL

N

200' 0 200'
SCALE IN FEET
CONTOUR INTERVAL : 2'

LEGEND:

- 7000 — 2000 AERIAL TOPOGRAPHY UPDATED WITH 2002 SURVEYS
- DRAINAGE PATH/PONDED WATER
- UN–PAVED ROADS
- N 794,000 — UMETCO 1000' SITE GRID
- 6960 — FINISH GRADE TOPOGRAPHY FROST PROTECTION FILL AREA
- 6960 — FINISH SUBGRADE TOPOGRAPHY TOE APRON EXCAVATION AND EAST CANYON CREEK RE–ALIGNMENT
- TOE APRON EXCAVATION AND EAST CANYON CREEK RE–ALIGNMENT VERIFICATION POINT

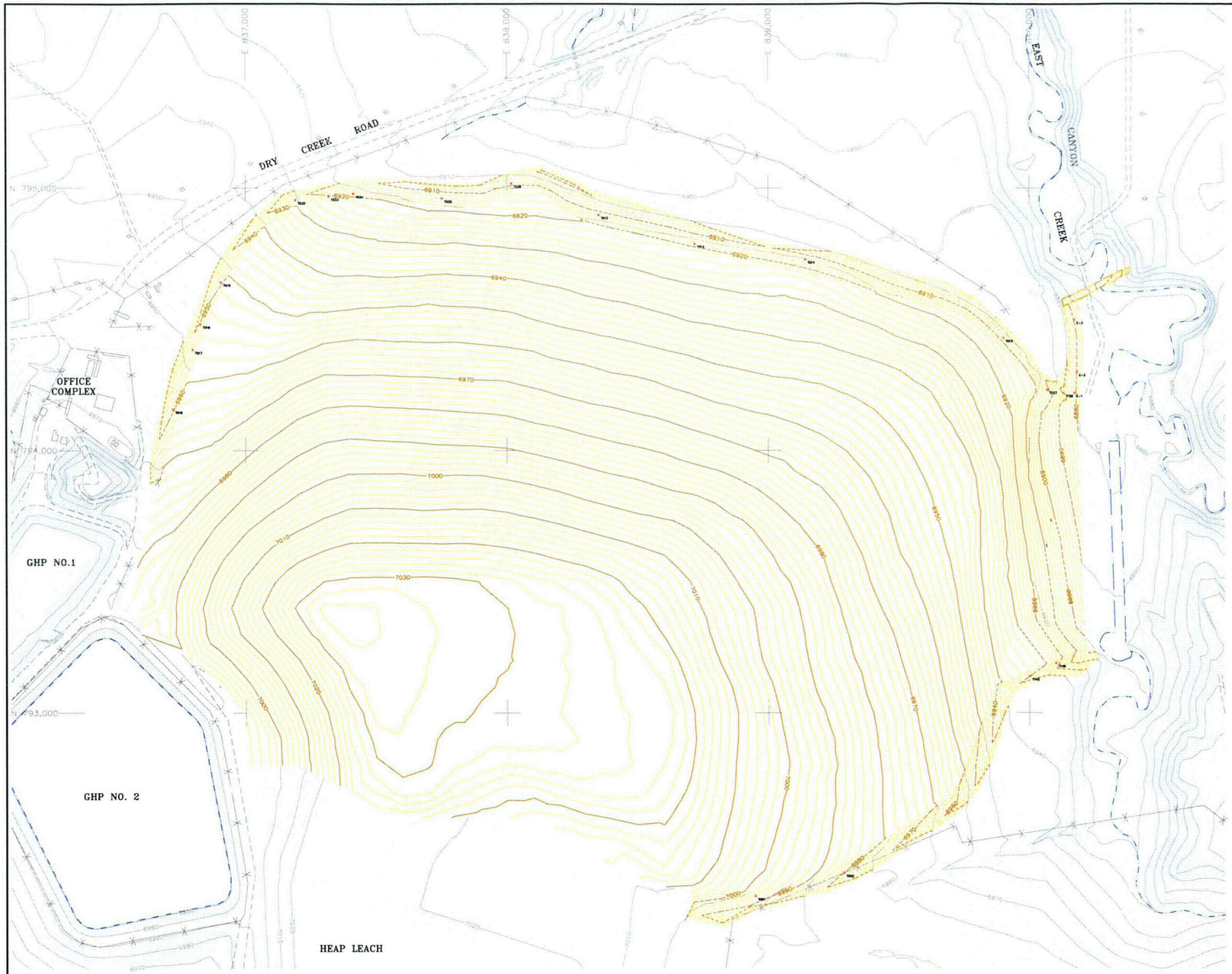
Umetco Minerals Corporation
2754 COMPASS DRIVE, SUITE 280, GRAND JUNCTION, CO 81506

AS BUILT

ABOVE–GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT FINAL CONTOURS AND SURVEY VERIFICATION POINTS TOE PROTECTION EXCAVATION AND EAST CANYON CREEK REALIGNMENT

GAS HILLS, WYOMING

DATE: JUNE 2007 DWG: GH–AG–10–AB SHEET 10 OF 15



LEGEND:

- 2000 AERIAL TOPOGRAPHY UPDATED WITH 2002 SURVEYS
- DRAINAGE PATH/PONDED WATER
- UN-PAVED ROADS
- UMETCO 1000' SITE GRID
- FINISH GRADE TOPOGRAPHY FROST PROTECTION FILL AREA
- FINISHED SUBGRADE TOPOGRAPHY TOE APRON EXCAVATION AND EAST CANYON CREEK RE-ALIGNMENT
- COMPACTION TEST LOCATION TOE APRON SUBGRADE AND EAST CANYON CREEK SUBGRADE FILL AREA

N

200' 0 200'

SCALE IN FEET

CONTOUR INTERVAL : 2'

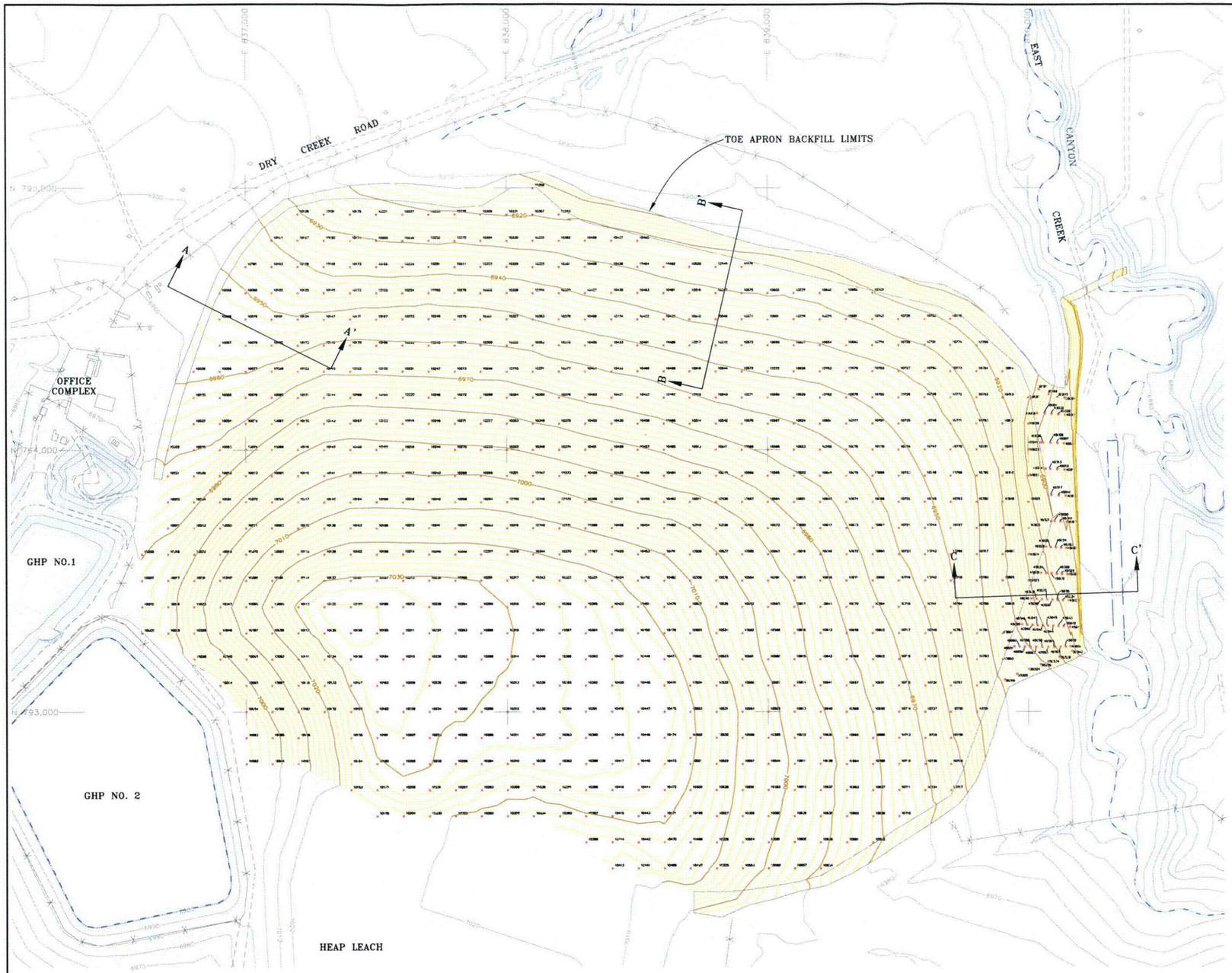
Umetco Minerals Corporation
2754 COMPASS DRIVE, SUITE 280, GRAND JUNCTION, CO 81506

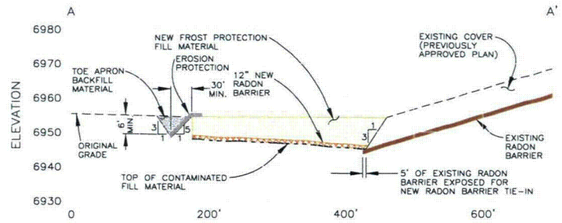
AS BUILT

ABOVE-GRADE TAILINGS IMPOUNDMENT
DESIGN ENHANCEMENT
SUBGRADE COMPACTION TEST LOCATIONS
TOE PROTECTION EXCAVATION AND
EAST CANYON CREEK REALIGNMENT

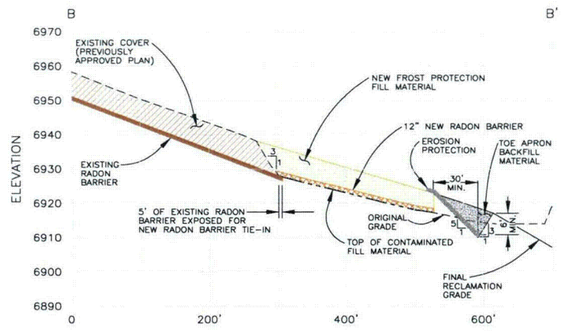
GAS HILLS, WYOMING

DATE: JUNE 2007 DWG: GH-AG-11-AB SHEET 11 OF 15

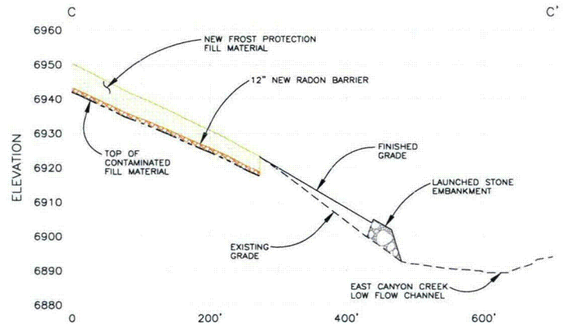




SECTION A-A'
SCALE: HORIZ. 1" = 100'
VERT. 1' = 20'



SECTION B-B'
SCALE: HORIZ. 1" = 100'
VERT. 1' = 20'



SECTION C-C'
SCALE: HORIZ. 1" = 100'
VERT. 1' = 20'

N

200' 0 200'

SCALE IN FEET
CONTOUR INTERVAL : 2'

LEGEND:

- 2000 AERIAL TOPOGRAPHY UPDATED WITH 2002 SURVEYS
- DRAINAGE PATH/PONDED WATER
- UN-PAVED ROADS
- UMETCO 1000' SITE GRID
- FINISH GRADE TOPOGRAPHY ABOVE GRADE REGRADE AND TOE APRON BACKFILL
- ABOVE GRADE REGRADE VERIFICATION POINT

PROFILE LEGEND:

- EXISTING GRADE 2002 TOPOGRAPHY
- EXISTING RADON BARRIER
- TOP OF THE CONTAMINATED FILL
- 12" NEW RADON BARRIER
- NEW FROST PROTECTION MATERIAL
- TOE APRON BACKFILL MATERIAL
- EROSION PROTECTION

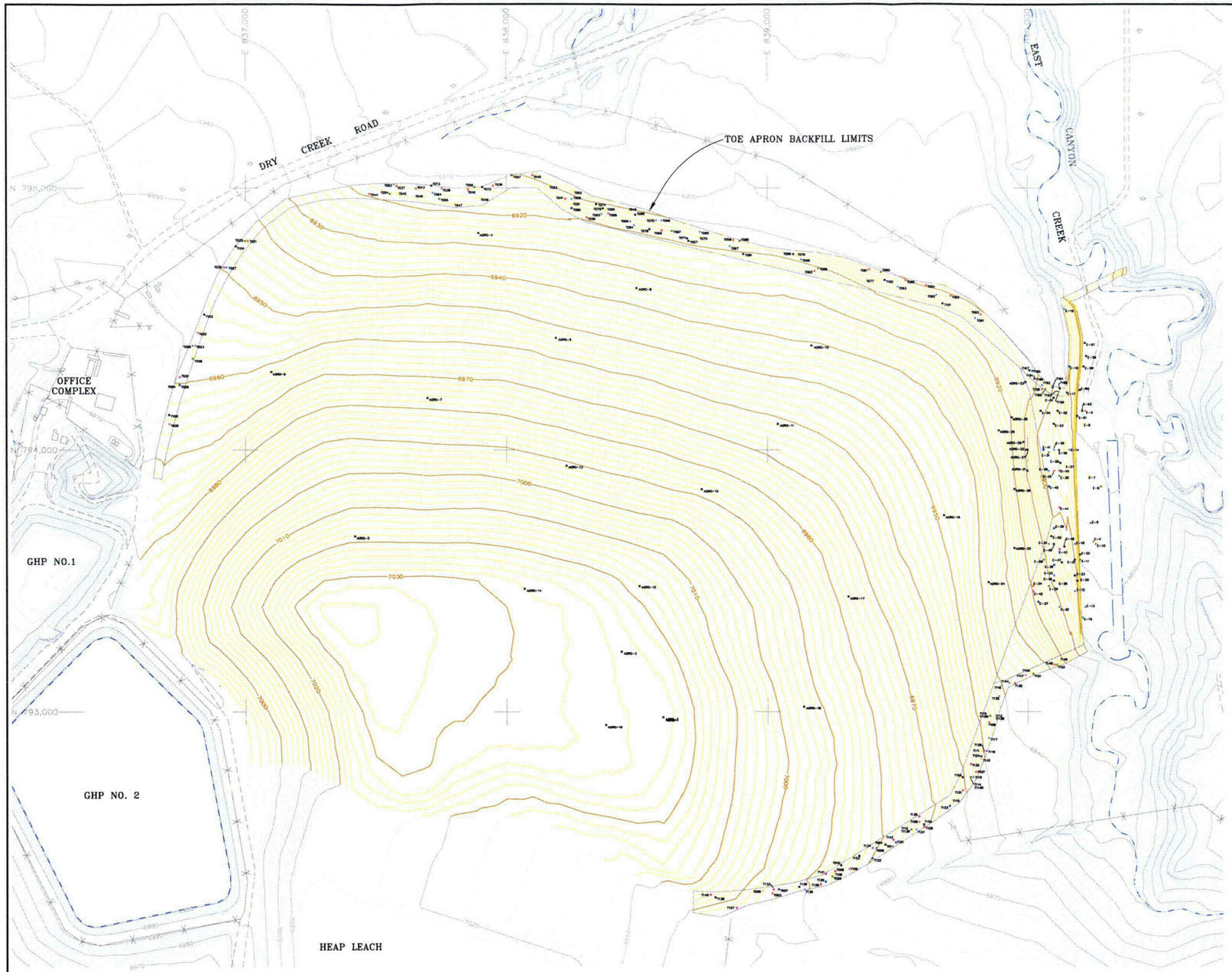
Umetco Minerals Corporation
2754 COMPASS DRIVE, SUITE 280, GRAND JUNCTION, CO 81506

AS BUILT

ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT
FINAL CONTOURS AND SURVEY VERIFICATION POINTS
REGRADING OF PREVIOUSLY RECLAIMED IMPOUNDMENT AND EAST CANYON CREEK REALIGNMENT FILL AREA

GAS HILLS, WYOMING

DATE: JUNE 2007 DWG: GH-AG-12-AB



LEGEND:

- 7000 — 2000 AERIAL TOPOGRAPHY UPDATED WITH 2002 SURVEYS
- DRAINAGE PATH/PONDED WATER
- UN-PAVED ROADS
- N 794,000 — UMETCO 1000' SITE GRID
- 6960 — FINISH GRADE TOPOGRAPHY ABOVE GRADE REGRADE AND TOE APRON BACKFILL
- AGRC-17 — COMPACTION TEST LOCATIONS REGRADING OF THE PREVIOUSLY RECLAIMED IMPOUNDMENT
- T100 — COMPACTION TEST LOCATIONS TOE APRON BACKFILL
- C-39 — COMPACTION TEST LOCATIONS EAST CANYON CREEK REALIGNMENT FILL AREA
- FIRST LIFT – COMPACTION TEST LOCATIONS
- SECOND LIFT – COMPACTION TEST LOCATIONS
- THIRD LIFT – COMPACTION TEST LOCATIONS
- FOURTH LIFT – COMPACTION TEST LOCATIONS
- FIFTH LIFT – COMPACTION TEST LOCATIONS
- SIXTH LIFT – COMPACTION TEST LOCATIONS
- SEVENTH LIFT – COMPACTION TEST LOCATIONS
- FINISHED GRADE – COMPACTION TEST LOCATIONS

N

200' 0 200'

SCALE IN FEET

CONTOUR INTERVAL : 2'

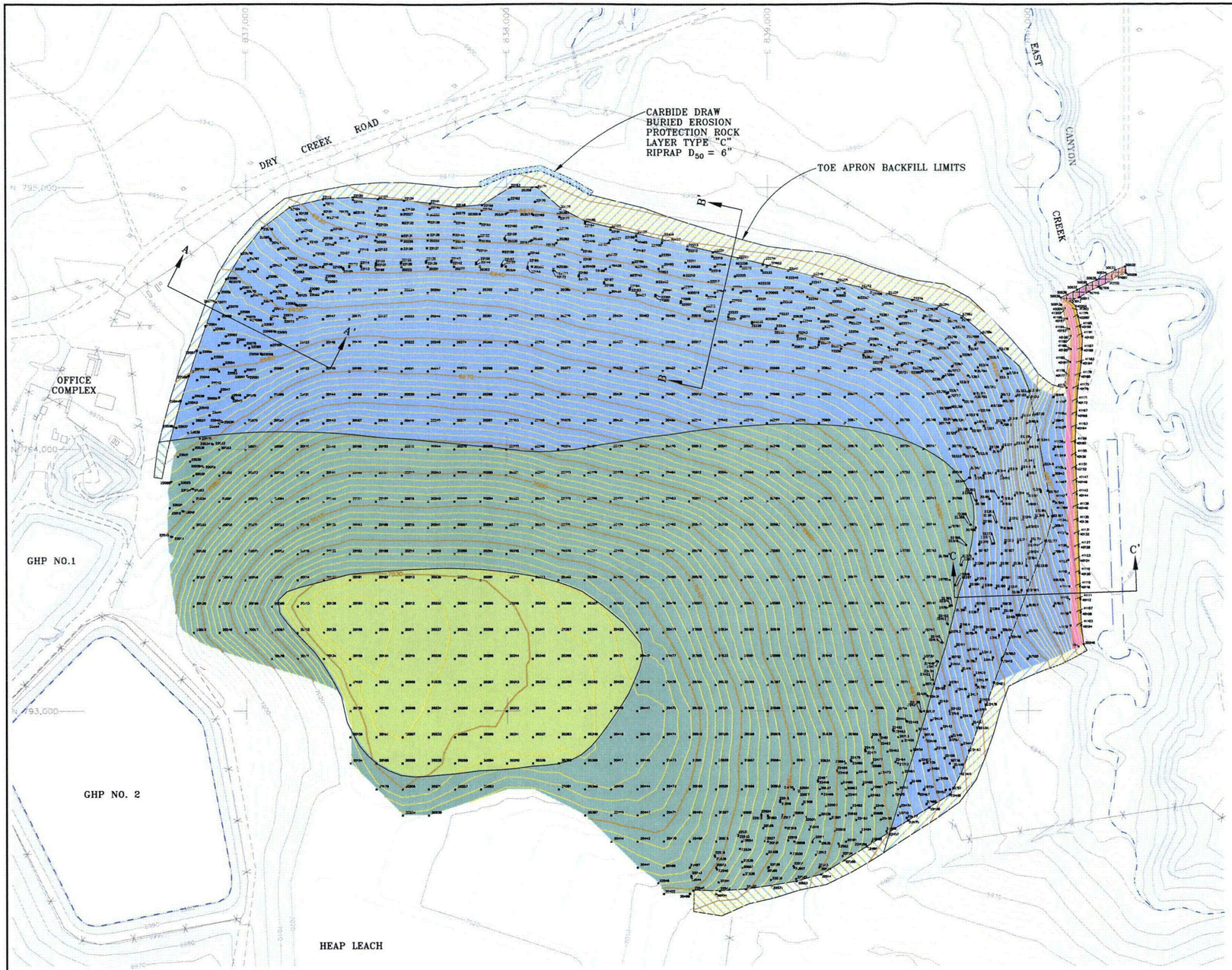
Umetco Minerals Corporation
2754 COMPASS DRIVE, SUITE 280, GRAND JUNCTION, CO 81506

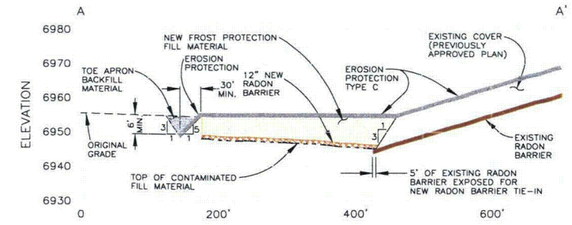
AS BUILT

ABOVE-GRADE TAILINGS IMPOUNDMENT
DESIGN ENHANCEMENT
COMPACTION TEST LOCATIONS TOE APRON BACKFILL
REGRADING OF PREVIOUSLY RECLAIMED IMPOUNDMENT
AND EAST CANYON CREEK REALIGNMENT FILL AREA

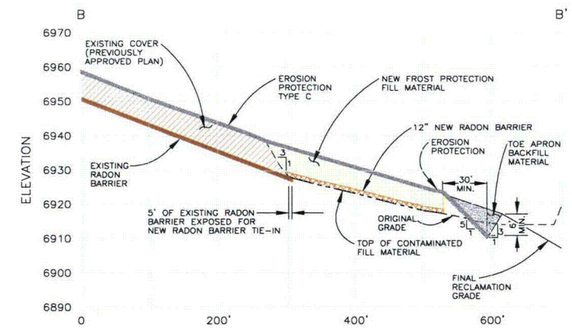
GAS HILLS, WYOMING

DATE: JUNE 2007 DWG: GH-AC-13-AB SHEET 13 OF 15

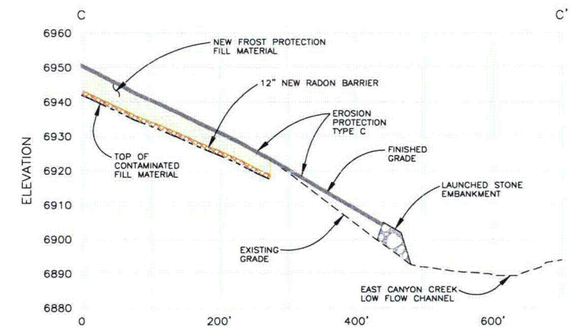




SECTION A-A'
SCALE: HORIZ. 1" = 100'
VERT. 1' = 20'



SECTION B-B'
SCALE: HORIZ. 1" = 100'
VERT. 1' = 20'



SECTION C-C'
SCALE: HORIZ. 1" = 100'
VERT. 1' = 20'

PROFILE LEGEND:

- EXISTING GRADE 2002 TOPOGRAPHY
- EXISTING RADON BARRIER
- TOP OF THE CONTAMINATED FILL
- 12" NEW RADON BARRIER
- NEW FROST PROTECTION MATERIAL
- TOE APRON BACKFILL MATERIAL
- EROSION PROTECTION

N

200' 0 200'

SCALE IN FEET
CONTOUR INTERVAL : 2'

LEGEND:

- 2000 AERIAL TOPOGRAPHY UPDATED WITH 2002 SURVEYS
- DRAINAGE PATH/PONDED WATER
- UN-PAVED ROADS
- UMETCO 1000' SITE GRID
- FINISH GRADE TOPOGRAPHY ABOVE GRADE RIPRAP AND TOE APRON BACKFILL
- ABOVE GRADE RIPRAP PLACEMENT VERIFICATION POINT
- CARBIDE DRAW BURIED EROSION PROTECTION ROCK LAYER 12-INCHES OF TYPE "C" RIPRAP D_{50} = 6.0 INCH
- 6-INCHES OF TYPE "A" RIPRAP D_{50} = 0.5 INCH
- 6-INCHES OF TYPE "B" RIPRAP D_{50} = 3.0 INCH
- 6-INCHES OF TYPE "B" RIPRAP BELOW GRADE TOE APRON
- 12-INCHES OF TYPE "C" RIPRAP D_{50} = 6.0 INCH
- 12-INCHES OF TYPE "C" RIPRAP BELOW GRADE TOE APRON
- LAUNCHED STONE EMBANKMENT TYPE "E" D_{50} = 30.0 INCH
- SCOUR APRON (22' WIDE & 6' DEEP) TYPE "E" D_{50} = 30.0 INCH

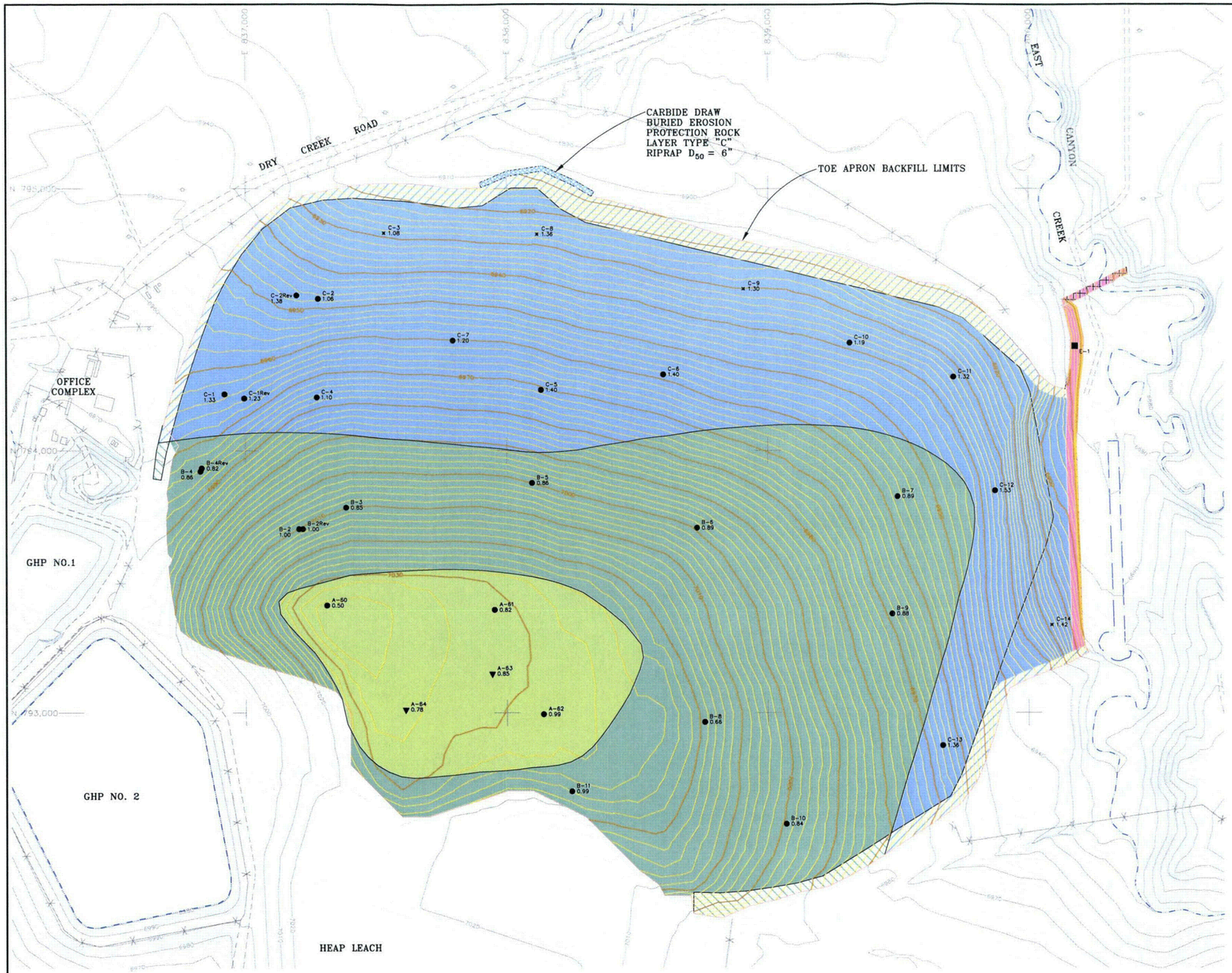
Umetco Minerals Corporation
2754 COMPASS DRIVE, SUITE 280, GRAND JUNCTION, CO 81506

AS BUILT

ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT FINAL CONTOURS AND SURVEY VERIFICATION POINTS EROSION PROTECTION PLACEMENT

GAS HILLS, WYOMING

DATE: JUNE 2007 DWG: GH-AG-14-AB SHEET 14 OF 15



LEGEND:

- 2000 AERIAL TOPOGRAPHY UPDATED WITH 2002 SURVEYS
- DRAINAGE PATH/PONDED WATER
- UN-PAVED ROADS
- UMETCO 1000' SITE GRID
- FINISH GRADE TOPOGRAPHY ABOVE GRADE RIPRAP AND TOE APRON BACKFILL
- C-6 1.40 — IN-PLACE VISUAL DEPTH CHECK AND IN-PLACE GRADATION SAMPLE C-6 = FIELD IDENTIFICATION NUMBER 1.40 = DEPTH MEASURED IN FEET
- A-64 0.78 — IN-PLACE VISUAL DEPTH CHECK A-64 = FIELD IDENTIFICATION NUMBER 0.78 = DEPTH MEASURED IN FEET
- E-1 — IN-PLACE GRADATION SAMPLE E-1 = FIELD IDENTIFICATION NUMBER
- CARBIDE DRAW BURIED EROSION PROTECTION ROCK LAYER 12-INCHES OF TYPE "C" RIPRAP D_{50} = 6.0 INCH
- 6-INCHES OF TYPE "A" RIPRAP D_{50} = 0.5 INCH
- 6-INCHES OF TYPE "B" RIPRAP D_{50} = 3.0 INCH
- 6-INCHES OF TYPE "B" RIPRAP BELOW GRADE TOE APRON
- 12-INCHES OF TYPE "C" RIPRAP D_{50} = 6.0 INCH
- 12-INCHES OF TYPE "C" RIPRAP BELOW GRADE TOE APRON
- LAUNCHED STONE EMBANKMENT TYPE "E" D_{50} = 30.0 INCH
- SCOUR APRON (22' WIDE & 6' DEEP) TYPE "E" D_{50} = 30.0 INCH

N

200' 0 200'

SCALE IN FEET

CONTOUR INTERVAL : 2'

Umetco Minerals Corporation
2754 COMPASS DRIVE, SUITE 280, GRAND JUNCTION, CO 81506

AS BUILT

ABOVE-GRADE TAILINGS IMPOUNDMENT DESIGN ENHANCEMENT IN-PLACE GRADATION AND VISUAL DEPTH CHECK TEST LOCATIONS EROSION PROTECTION PLACEMENT

GAS HILLS, WYOMING

DATE: JUNE 2007 DWG: GH-AG-15-AB SHEET 15 OF 15