UNITED STATES DEPARTMENT OF ENERGY
Albuquerque, New Mexico

Uranium Mill Tailings Remedial Action Project (UMTRAP)

Belfield & Bowman, North Dakota

BEL/BOW

Information for Reviewers

Final Design for Construction

November 1990

MORRISON-KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES GROUP

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5025-B/B-R-01-00796-02
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PREFACE

This volume, Information for Reviewers, is intended as a guide for person(s) reviewing the final design documents for the Uranium Mill Tailings Remedial Action Project (UMTRAP) at Belfield and Bowman, North Dakota.

It provides an overview of the Design and Supporting Documents, intended to serve as a "roadmap" for the reviewers. It summarizes the conceptual design plan as envisioned in the draft Remedial Action Plan (dRAP), including any changes or modifications thereto and identifies open issues that are being resolved or need to be resolved prior to the implementation of the Remedial Action Plan.

Comments made by the State of North Dakota and the Nuclear Regulatory Commission (NRC) on various issues of the Project and responses to these comments are included in another section of this volume.

CONTENTS

*Roadmap" to design and supporting documents.

SECTION A

OVERVIEW OF FINAL DESIGN AND SUPPORTING DOCUMENTS

A. OVERVIEW OF DESIGN AND SUPPORTING DOCUMENTS

INTRODUCTION

This volume, Information for Reviewers, is the first of a series of volumes, listed in attached Table A.1. The final design proper is presented in "Subcontract Documents", which includes the bid schedule (quantities), special conditions (contractual requirements), specifications (technical requirements) and drawings. The remaining volumes in this submittal are: Information for Bidders (4 volumes), which presents the "fact documents"; i.e., data which form the basis for design, and which will be provided to the prospective bidders for their use; Supporting Calculations (4 volumes), which include the design analyses, computations and studies leading to the final design presented; and Cost Estimate, which is an estimate of construction costs for completion of the remedial action.

BACKGROUND AND DESIGN APPROACH

Soil contamination and groundwater contamination have occurred at two inactive lignite ashing sites near Belfield and Bowman, North Dakota. The Belfield processing site is located one mile southeast of the town of Belfield in Stark County, North Dakota, and the Bowman processing site is located seven miles west of the town of Bowman and near the former Griffin town site. The project location and vicinity maps are shown in Figure A-1.

Contamination has resulted from burning of uraniferous lignite and subsequent incomplete recovery of ash during burning, ash cooling and loading operations. Part of the radioactive and non-radioactive contamination can also be attributed to lignite or ash storage, spilling of ash during loading in railroad cars, or disposal of sludge from the rotary kiln scrubbers. No chemical, metallurgical, or nuclear processes were involved at the site, hence no residual material called tailings is present at these sites. Soil contamination that exceeds a Radium-226 concentration of 5 picoCuries/gm (absolute) will be cleaned up. This criteria for clean up is more stringent than that specified in 40 CFR 192, to include removal of the non-radioactive toxics, such as molybdenum. Soils with Ra-226 concentration greater than 5 pCi/g range in depth from 0.5 foot to 4.0 feet over areal extents of about 30 acres at Belfield site and about 70 acres at Bowman site. The total estimated contaminated material and soil volumes, including debris resulting from demolition of building, buried foundations plus assorted metal piles, membrane liners, decontamination pads, and other materials, are:

Belfield Site	= 60,000 cy
Bowman Site	= 100,000 cy
Total	= 160,000 cy

Under the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978, Congress has authorized remedial actions for cleanup of 24 inactive processing sites including the Belfield/Bowman sites. The proposed remedial actions at the Belfield/Bowman sites are summarized as follows:

- o Excavate the contaminated materials from the Belfield Site and relocate these materials in an embankment, which is to be constructed over part of the contaminated materials at the Bowman site.

- o Excavate the remaining contaminated and windblown materials from the Bowman site and consolidate these materials in the embankment.

The contaminated material embankment will be constructed above grade. Its overall dimensions are 740 ft x 575 ft at the base, including 15 ft rock apron, and height is approximately 35 feet above the surrounding ground with a top slope of five percent and side slope of 20 percent

(5H:1V). A 7.5 ft cover thickness is proposed consisting (from bottom to top of 1.5 ft of radon barrier, 0.5 ft of filter, 4.0 ft of compacted select fill, 0.5 ft of bedding and 1.0 ft of riprap erosion protection.

The relocation of the Belfield site contaminated material should effectively remove the contamination source for Heart river and ground water in the shallow aquifer system and make the area suitable for unrestricted public use. At the Bowman site consolidation of all the contaminated material in the embankment and provision of a multi-layered infiltration/radon barrier will essentially permit no infiltration through the barrier, eliminating long-term leachate flow from the embankment to the ground water. It is intended that the design will meet the requirements of the revised EPA Groundwater Standards (proposed). The contoured embankment slopes provide for efficient drainage of the embankment surface. A riprap apron has been designed to prevent long-term gully encroachment and undermining of the perimeter of the embankment.

The design does not address restoration and clean up of existing contamination of the groundwater which will be done at a later date.

CONCEPTUAL DESIGN IN DRAFT RAP - COMMENTS AND RESPONSES

A conceptual design was presented in "Draft Remedial Action Plan and Conceptual Design of Stabilization of the Inactive Uraniferous Lignite Processing Sites at Belfield and Bowman, North Dakota," dated February, 1988, and submitted previously. Comments on this document by NRC and the State of North Dakota are presented in B. below, together with DOE responses.

PRELIMINARY DESIGN - COMMENTS AND RESPONSES

A preliminary design for review was prepared in October 1988. Comments on these documents by MKF and DOE were incorporated in the final design for review. Open issues described in the Information for Reviewers, and Preliminary Design for Review were addressed in the Final Design for Review.

FINAL DESIGN DETAILS AND CRITERIA

A final design for review was prepared in March 1989. Comments on these documents by MK-F and DOE were incorporated in the final design for construction.

The general features of the design are presented above briefly in the "Background and Design Approach". The key final design details and the governing detailed criteria are in Section C, "Revised Chapter 4 of final Remedial Action Plan (fRAP)". The relationship between the design details and criteria and the supporting calculations and reports is shown in Attached Table A.2.

TABLE A.1

LIST OF DOCUMENTS IN

FINAL DESIGN CONSTRUCTION

I. Information for Reviewers (1 Volume)
   - A. Overview of Final Design and Supporting Documents*
   - B. Responses to NRC and State of North Dakota Comments on Draft Remedial Action Plan
   - C. Revised Chapter 4 of Final Remedial Action Plan
   - D. Analysis of Changes from dRAP Design and final design
   - E. Open Issues

II. Subcontract Documents (1 Volume)
   - A. Bid Schedule
   - B. Special Conditions
   - C. Specifications
   - D. Drawings

III. Information for Bidders (4 Volumes)
   - A. Vol. I - Belfield Geotechnical and Climatic Data
   - B. Vol. II - Bowman Geotechnical and Climatic Data
   - C. Vol. III - Prospective Soil Borrow Materials, Groundwater and Miscellaneous Data
   - D. Vol. IV - Erosion Protection Material

IV. Supporting Calculations and Reports (4 volumes)
   - A. Vol. I - Embankment Design+
   - B. Vol. II - Embankment Design+
   - C. Vol. III - Surface Water Hydrology and Erosion Protection
   - C. Vol. IV - Temporary Facilities Design and Quantity Estimates

V. Cost Estimate (1 Volume)

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*"Roadmap" to design and supporting documents.
+Critical to meeting EPA Standards

TABLE 4.2
RELATIONSHIP BETWEEN DESIGN DETAILS AND
CRITERIA AND SUPPORTING CALCULATIONS AND REPORTS
(Sheet 1 of 6)

Design Detail or Criteria	Calculation No. +	Title	Remarks
4.3.3* Embankment Location	-	Draft RAP	Embankment to be located at Bowman site at the approximate location shown in the draft RAP. Contaminated materials from both Belfield and Bowman sites to be consolidated and stabilized in this embankment.
4.3.4 Embankment Layout	B/B-815-01-01	Contaminated Material Excavation - Belfield, Excavation Plan and Quantities	Total volume of contaminated materials is estimted to be more than than reported in draft RAP.
	B/B-915-01-01	Contaminated Material Excavation - Bowman, Excavation Plan and Quantities	Total volume of contaminated materials is estimated to be more than reported in dRAP.
	B/B-943-01-00	Demolition/Debris Disposal - Quantity Estimates	Estimates volume quantities of demolition debris.
	B/B-929-01-01	Embankment Design - Layout and Capacity Estimate	Accordingly embankment "foot-print" revised to accommodate additional materials. Foot print is approximately 10 acres. Embankment height is approximately 35'.

* Subsection number in Chapter 4 of Draft Remedial Action Plan.

TABLE A.2
RELATIONSHIP BETWEEN DESIGN DETAILS AND
CRITERIA AND SUPPORTING CALCULATIONS AND REPORTS
(Sheet 2 of 6)

Design Detail or Criteria	Calculation No. +	Title	Remarks
4.3.5 Geomorphology	--	"Geomorphology" in Appendix D of dRAP	Embankment set back at least 100 feet from the top of the existing west side tributary drainage channel slope. Site is graded to allow positive drainage away from toe.
	B/B-920-03-01	Contaminated Material Embankment - Riprap Toe Protection	Riprap toe is set below estimated limit of erosion.
	B/B-950-05-00	Cover Design - Frost Penetration Depth Determination	Infiltration/radon barrier is below depth of frost. Use of frost cover to prevent degradation of infiltration/radon barrier is conservative, since cover will be unsaturated.
4.3.6 Seismicity	B/B-918-01-00	Embankment Design - Review of Site Seismicity for the Bowman Site	dRAP seismic parameters appear to be overly conservative. Reanalysis yielded the following data: $a_{max} = 0.13g$ $K_H = 0.09$
	B/B-919-01-00	Embankment Design - Evaluation of Earthquake - Induced Liquefaction Potential	Concludes that earthquake - induced liquefaction will not occur at the site.

TABLE A.2
RELATIONSHIP BETWEEN DESIGN DETAILS AND
CRITERIA AND SUPPORTING CALCULATIONS AND REPORTS
(Sheet 3 of 6)

Design Detail or Criteria	Calculation No. +	Title	Remarks
4.3.7 Hydrogeology	B/B-920-01-01	Erosion Protection - Embankment	Embankment is sloped to promote runoff. Riprap bedding layer is graded to provide drainage.
	B/B-961-01-00	Groundwater - Infiltration During Construction	Surface water infiltration during construction will not adversely affect the groundwater.
	B/B-950-02-00	Radon Barrier Design - RAECOM Input Data	Permeability of infiltration/radon barrier is less than 10^{-7} cm/sec.
	----	Specifications	Material selection, compaction and moisture conditioning requirements ensure that no more water than necessary is introduced onto the contaminated materials.
	B/B-950-04-00	Radon Barrier Design - Moisture Content Required to Attain Minimum Permeability.	Radon barrier material should be compacted wet of optimum.
4.3.8 Surface Water	B/B-916-01-00	Site Hydrology - PMP	Establishes design parameters.
	B/B-916-02-00	Site Hydrology - Time Distribution of 6-hour PMP	(See above.)

TABLE A.2
RELATIONSHIP BETWEEN DESIGN DETAILS AND
CRITERIA AND SUPPORTING CALCULATIONS AND REPORTS
(Sheet 4 of 6)

Design Detail or Criteria	Calculation No. +	Title	Remarks
4.3.8 Surface Water (Continued)	B/B-916-04-01	Site Drainage, Bowman - Off-Site PMF	Off-site flood waters may temporarily flood against the embankment, primarily along the west or north sides.
	B/B-916-05-00	Flooding Limits Due to PMF - West Side of Bowman Site	(See above.)
	B/B-948-01-00	Tailings Embankment - Toe Drain	Provides drainage for below-grade toe protection.
	B/B-847-01-00	Site Hydrology, Belfield - Flooding Potential	Belfield site is unlikely to flood during construction, therefore no flood protection berm is required.
	B/B-945-01-00	Site Hydrology, Bowman - 10 Year, 24 Hour Storm Event, West Side Drainage Area	Temporary dike is required along west side to protect against flooding during construction.
4.3.9 Geotechnical	B/B-929-04-01	Embankment Desgin - Slope Stability Analysis	Embankment is stable under static and earthquake loadings.

TABLE A.2
RELATIONSHIP BETWEEN DESIGN DETAILS AND
CRITERIA AND SUPPORTING CALCULATIONS AND REPORTS
(Sheet 5 of 6)

Design Detail or Criteria	Calculation No. +	Title	Remarks
4.3.9 Geotechnical (Continued)	B/B-919-01-00	Embankment Design - Evaluation of Earthquake - Induced Liquefaction Potential	There is no liquefaction potential at the Bowman disposal site. Since the soils are highly plastic and clayey.
	B/B-947-01-00	Embankment Design - Settlement/Cover Cracking Analysis	Total and differential settlements are relatively small and will not adversely impact the embankment cover performance.
	B/B-929-02-01	Embankment Design - Materials Properties (Contaminated Materials and Foundation Soils In-Place)	Establishes design parameters for contaminated materials and foundation soils.
4.3.10 Radon Control	B/B-955-02-00	Radon Barrier Borrow Material - Griffin Borrow Site Quantities	Establishes that there is adequate quantities of acceptable material at the Griffin Borrow Site.
	B/B-950-01-00	Radon Barrier Design - Statistical Analysis of Ra-226 Concentrations	Estimates Ra-226 concentrations of contaminated materials including SEM to be used in RAECOM runs.
	B/B-950-02-00	Radon Barrier Design - RAECOM Input Data	Establishes radon barrier material design parameters to be used in RAECOM runs, plus other parameters.

TABLE A.2
RELATIONSHIP BETWEEN DESIGN DETAILS AND
CRITERIA AND SUPPORTING CALCULATIONS AND REPORTS
(Sheet 6 of 6)

Design Detail or Criteria	Calculation No. +	Title	Remarks
4.3.10 Radon Control (Continued)	B/B-950-03-00	Radon Barrier Design - Design Thickness (Based on RAECOM Program)	Less than 6-inch thickness is required to limit the radon flux. Design provides for 18-inch thick cover.
4.3.11 Erosion Protection	B/B-920-01-01	Erosion Protection - Embankment	Rock sizes and erosion protection layer thicknesses are shown in Table A.3.
	B/B-920-03-01	Contaminated Material Embankment - Riprap Toe Protection	(See above.)
	B/B-955-01-00	Erosion Protection - Rock Quality Evaluation	Rock Quality score used for design = 65%, rock and bedding material, oversized by 15%.
4.4 Construction	--	Draft RAP	Changes to construction aspects of the design are discussed in Section D.
4.4.11 Construction Schedule	--	--	Construction schedule is shown in Figure 4.5 of Revised Chapter 4 of RAP.
4.4.12 Cost Estimate	--	--	Final Design Cost Estimate is presented in a separate volume.

TABLE A.3

EMBANKMENT EROSION PROTECTION REQUIREMENTS

Location	Design Flow	Rock Size Requirements[d] (inches)		Layer[a] Thickness (feet)
Topslopes		D_{50}	1.5	1.5
(5 percent)	0.35 cfs/ft[b]	D_{100}	4.0	
Sideslopes	0.66 cfs/ft[b]	D_{50}	4.5	1.5
(20 percent)	13,600 cfs[c]	D_{100}	8.0	
Riprap Toe	0.70 cfs/ft[b]	D_{50}	9.2	2.5 - 3.5
Protection		D_{100}	16.0	

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a/ Includes bedding and filter layer.
b/ Cubic feet per second per foot width (down slope flow).
c/ Cubic feet per second.
d/ Includes oversizing for rock quality.

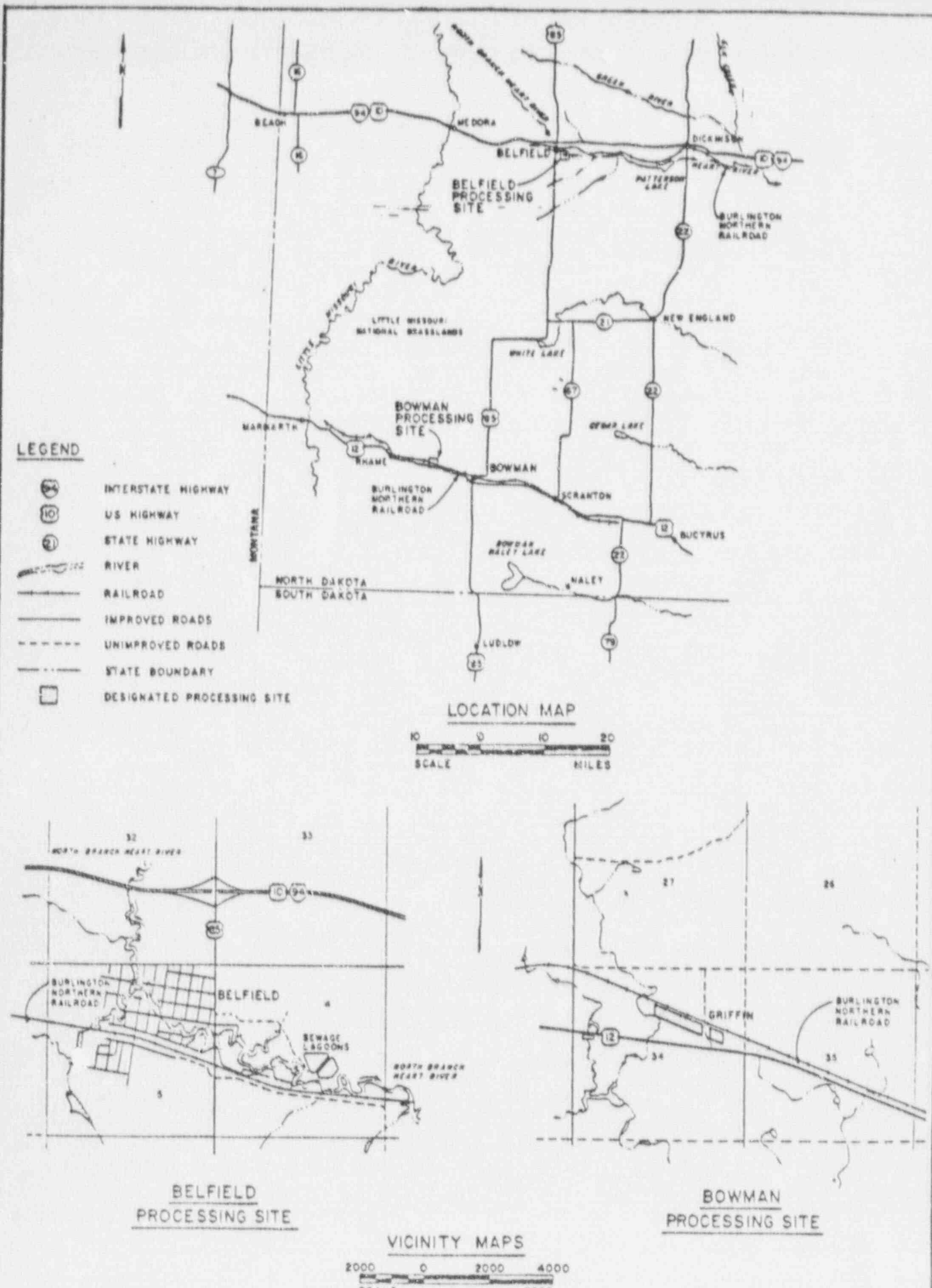

FIGURE A-1. UMTRA: BELFIELD/BOWMAN PROJECT

LOCATION MAP

SECTION B

RESPONSE TO NRC AND STATE OF NORTH DAKOTA COMMENTS ON 00796 REMEDIAL ACTION PLAN (dRAP)

B. RESPONSE TO NRC AND STATE OF NORTH DAKOTA COMMENTS ON DRAFT REMEDIAL ACTION PLAN (dRAP)

(To Be Provided by DOE)

SECTION C

REVISED CHAPTER 4 OF REMEDIAL ACTION PLAN

FINAL DESIGN

REVISED CHAPTER 4

FOR REMEDIAL ACTION PLAN

4.0 SITE FINAL DESIGN

4.1 INTRODUCTION

This chapter discusses remedial action objectives, permanent design features and construction features associated with the Belfield and Bowman designated sites in North Dakota. Maps, drawings, and tables relevant to the design are provided here and more detailed data are included elsewhere. The site final design is described to demonstrate compliance with EPA standards. The following are the major objectives of this chapter:

- o Provide concurring parties with a description of the remedial action plan.

- o Demonstrate that the final design will be able to meet the applicable EPA standards. (Groundwater/aquifer restoration is not included in this remedial action plan and will be evaluated at a later date).

- o Provide the criteria, basis, and instructions for development of the final design.

The main objective of the site final design is to meet the requirements for PL95-604 and current EPA standards applicable to the UMTRA project. These standards require restrictions on release of contaminated materials into the environment; and limits on the release of radon gas and gamma radiation from radium in the contaminated materials. The design objectives are as follow:

- Reduce the radon flux from the contaminated materials to the atmosphere to levels not greater than 20 picoCuries per square meter per second.

- Design controls to be effective for up to 1000 years to the extent reasonably achievable, and for at least 200 years.

- Prevent inadvertent human or animal intrusion into or disturbance of the contaminated materials.

- Ensure that existing or anticipated uses of ground and surface waters are not adversely affected by the contaminated materials.

- Minimize the size of the restricted final disposal site.

- Prevent release of contaminants from the sites during construction.

- Minimize the areas disturbed during construction.

- Minimize exposure of workers and the general public to contaminated materials.

This section of the report is divided into four subsections: (1) this introduction; (2) a design summary; (3) a more detailed description of the various aspects of the remedial work that will be undertaken to permanently stabilize the contaminated materials; and (4) a description of the construction requirements of the remedial action. The third section is divided into subsections that describe the final design, the rationale for the design, alternatives considered, and design criteria.

The site final design section is to be read in conjunction with Appendix D, Site Characterization and related updated addendums. The final RAP will include the final design drawings and specifications of the subcontract documents.

The final design presented in this report demonstrates a remedial action that meets the requirements of PL95-604. The final design and criteria developed represent all the data required for the design of the remedial work. Although the numerous final design details are elaborated in calculation volumes, the basic concept presented in this document represents the final remedial action. Some elements of the remedial design, such as aquifer clean-up and restoration, have not been fully developed and are intended for completion at a later date.

4.2 SUMMARY OF THE PROPOSED REMEDIAL ACTION

The principal feature of final design is the stabilization of the contaminated materials from the Belfield and Bowman sites in a location on and adjacent to the Bowman designated site (Figure 4.1).

Disposal will be almost entirely above existing grade, except for some contaminated materials to be left in-place beneath the embankment. A disposal embankment will be constructed with sideslopes of 20 percent (five horizontal to one vertical) and topslopes of five percent. The contaminated materials will be covered with a multilayered cover consisting of the following five succeeding layers, starting at the bottom: (1) a 1.5-foot-thick infiltration/radon barrier layer that will inhibit radon emanation and water infiltration; (2) a six-inch-thick layer of bedding material (sand and gravel) to act as a drain; (3) a 4.0-foot-thick layer of compacted select soil; (4) a six-inch-thick layer of bedding material (sand and gravel); and (5) a one-foot-thick layer of erosion protection material (rock). The cover materials above the infiltration/radon barrier, totaling 6.0 feet thick, will serve to protect this barrier from potential effects of freeze/thaw cycles.

The stabilized rectangular embankment (including apron) will cover about 10.0 acres, and will measure 740 feet by 575 feet. The embankment will be no more than a maximum height of 53 feet above the surrounding terrain (if the 5:1 sideslopes are extended to the crest), with an average height of 19 feet. The base perimeter of the embankment will be protected with a below grade riprap toe protection 15 feet wide (from the base of the 5(H):1(V) embankment side slopes to the outermost edge of the apron), 3.5 feet deep, and constructed with a 2.5 percent surface slope. To avoid standing water in the toe trench, drainage features have been provided in the southwest corner of the embankment.

Embankment erosion protection, consisting of rock riprap layers, are designed to withstand the Probable Maximum Precipitation (PMP) on the embankment and Probable Maximum Flood (PMF) flows around the embankment. A bedding layer will be placed between the riprap layer and the underlying select fill layer to protect against erosion as migration of material at bedding interfaces. Another filter layer will be placed between the select fill and the radon barrier which will be designed to act as a non-clogging filter. This will further reduce the infiltration of any water through the barrier.

The embankment configuration, cross section, and cover detail are illustrated in Figures 4.2, 4.3, and 4.4 respectively. The infiltration/radon barrier will be placed over the contaminated materials in the embankment to reduce radon flux to 20 pCi/m^2S or less and to inhibit infiltration so that the MCLs for hazardous constituents in the groundwater are not exceeded at the point of compliance.

After embankment construction and stabilization, areas near the embankment will be backfilled, as necessary, and graded to prevent ponding at or near the toe. Excavated areas at the Belfield and Bowman sites will be restor... with clean backfill, graded as necessary and revegetated. Areas used for cultivation will not be reseeded. The final restricted (fenced) area will cover 12.0 acres. The remainder of the designated site, except possibly some land outside the final fence that will serve as a buffer zone, will be released for any use consistent with existing land use controls following completion of remedial action.

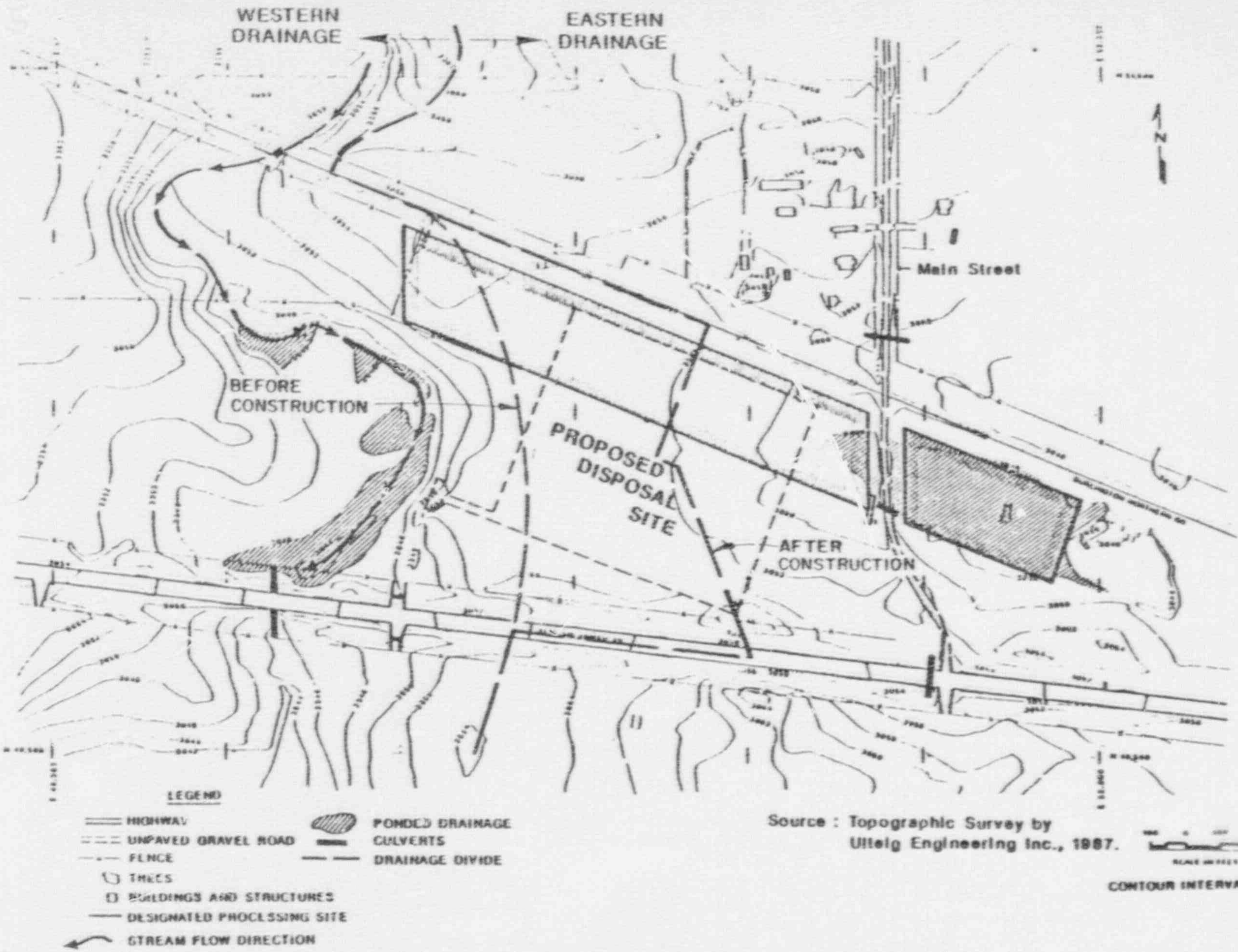

FIGURE 4.1
DRAINAGE FEATURES
BOWMAN PROCESSING SITE - GRIFFIN, NORTH DAKOTA

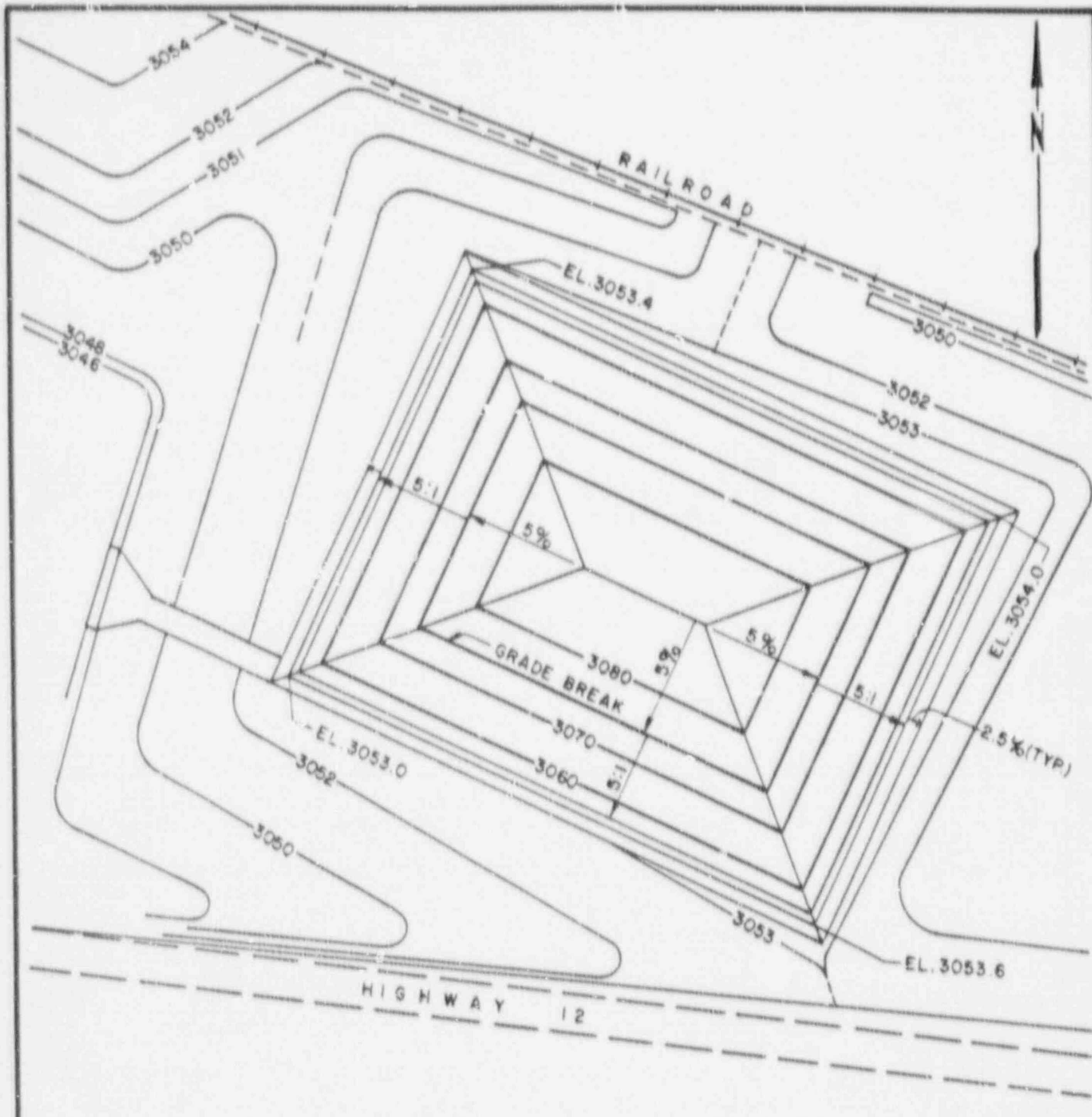

FIGURE 4.2
CONFIGURATION OF THE PROPOSED EMBANKMENT
FOR THE PROPOSED ACTION
BOWMAN PROCESSING SITE - GRIFFIN, NORTH DAKOTA

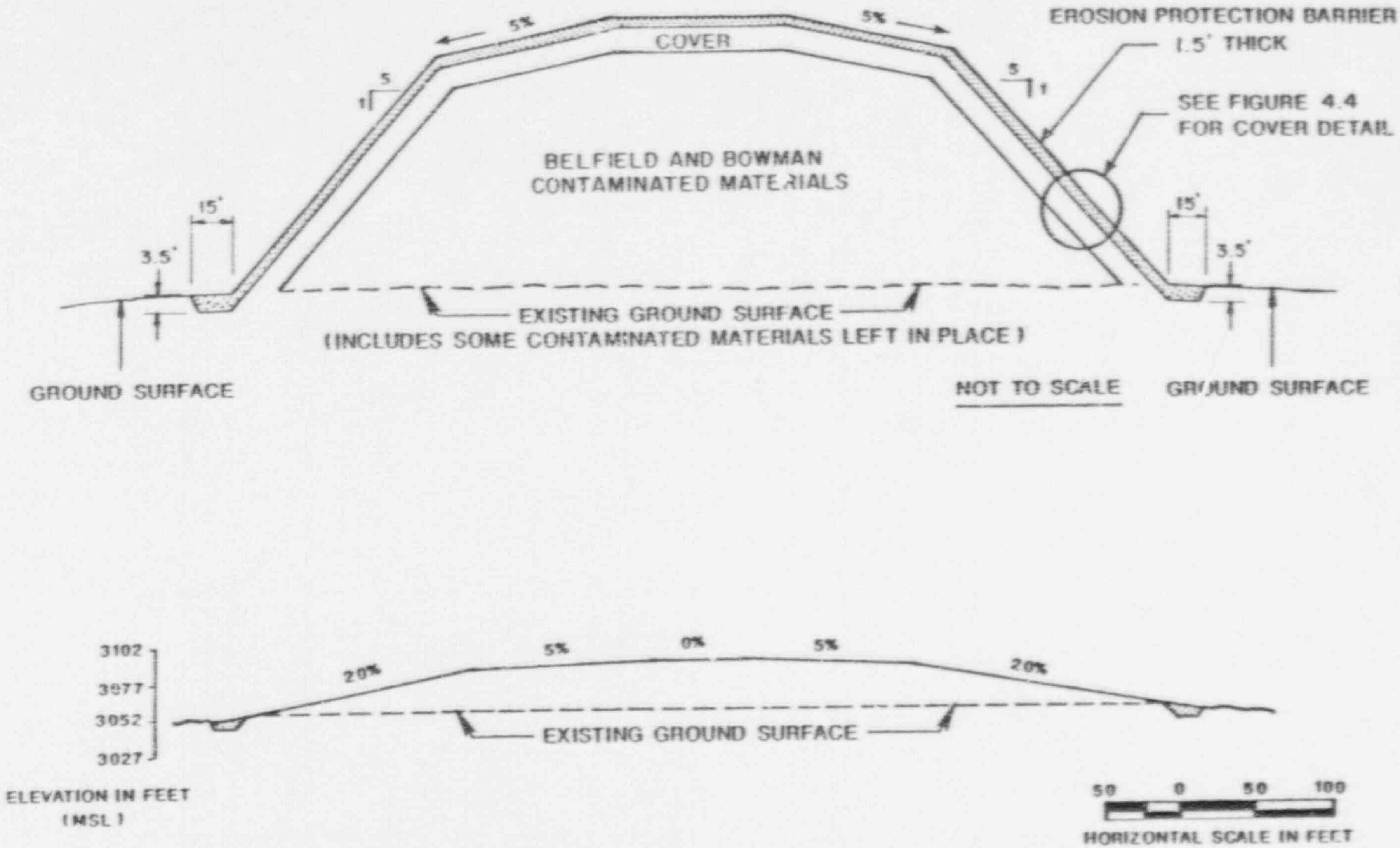

FIGURE 4.3
TYPICAL CROSS SECTION FOR THE PROPOSED EMBANKMENT
BOWMAN PROCESSING SITE – GRIFFIN, NORTH DAKOTA

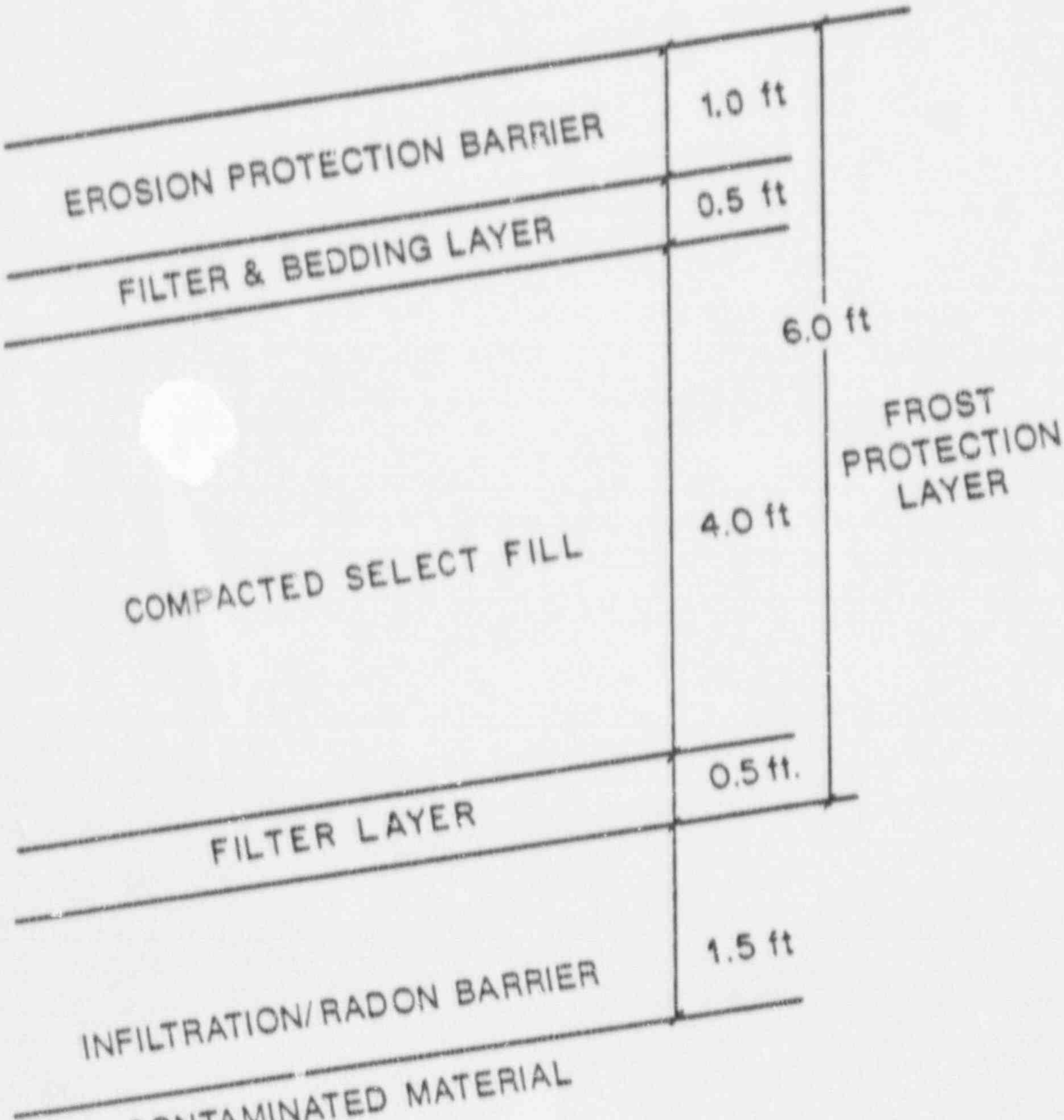

FIGURE 4.4
CROSS SECTION OF COVER LAYER FOR THE PROPOSED EMBANKMENT
BOWMAN PROCESSING SITE – GRIFFIN, NORTH DAKOTA

4.3 DESIGN DETAILS - PERMANENT DESIGN FEATURES

4.3.1 Introduction

This section provides details of the major components of the final design. Factors considered in the design, such as surface and subsurface site conditions, the nature of the contaminated materials, and requirements for erosion and radon control, are described as they affect the layout and construction of the contaminated materials embankment. All design approaches, unless otherwise discussed in the following sections, are outlined in the Technical Approach Document (TAD) (DOE, 1986b). Where applicable, possible alternatives are discussed as justification for the selected design.

4.3.2 General Requirements

This section remains essentially the same as in dRAP of February, 1988 with the following minor changes as follows: "In addition, the detailed design should comply with all criteria, methods, and approaches set out in the TAD (DOE, 1986b) and the Standard Review Plan (NRC, 1985) and Standard Format and Content Guide (NRC, September, 1988*).

4.3.3 Embankment Location

The remedial action calls for the relocation of contaminated material from the Belfield site and consolidation and stabilization of all contaminated materials in a disposal embankment at the Bowman site.

Stabilization in place (SIP) disposal at the Bowman site was selected based on technical performance, constructibility, and cost effectiveness. The proposed location removes the contaminated materials

* "Standard Format and Content Guide for Documentation of Remedial Action Selection at Title 1 Uranium Mill Tailings Sites", prepared by the U.S. NRC, September, 1988 (Draft).

at the Belfield site from the 100-year floodplain of the Heart River and onto a flat surface at the Bowman site. Advantages of this location are: (1) the contaminated materials already in place at the disposal site will not have to be moved; (2) the disposal site can be accessed via an existing road; and (3) the embankment will lie on a drainage divide, and will be protected from surface flows during normal precipitation events on the north and south by railroad and highway embankments.

Several alternatives were considered for locating the disposal embankment for the Belfield and Bowman contaminated materials. An alternate disposal site, the Bull Creek site, was selected by applying the UMTRA Project alternate site selection process. The concept considered for the Bull Creek site was transporting the contaminated materials from both the Belfield and Bowman sites and stabilizing them at Bull Creek. The Bull Creek alternative was evaluated and compared to two other options: (1) stabilize the Belfield materials at the existing Belfield site and the Bowman materials at the existing Bowman site; and (2) the selected remedial action of relocating the Belfield materials to the Bowman site, and stabilizing the materials from both sites into one embankment at the Bowman site. Details of the comparisons are provided in the Belfield and Bowman environmental assessment (EA) (DOE, 1988). The selected remedial action is considered the best choice based on the following:

- o It is the least costly action
- o It would require minimum surveillance and maintenance because there would be only one disposal site instead of two
- o It would require fewer haul trips and therefore fewer trucks since about two-third most of the contaminated materials are at the Bowman site
- o It removes the contaminated material at Belfield from the 100-year floodplain of the Heart River.

Placement of the embankment to use more of the Bowman designated site was also considered. However, that concept was dropped because it would necessitate realignment of the Griffin access road, (including possibly construction of a new rail crossing), cover costs per unit volume of contaminated material would increase for the elongated shape of the designated site, and the surface drainage could be more susceptible to flood impacts.

4.3.4 Embankment Layout

All contaminated materials from both sites will be consolidated at the Bowman site. The stabilized embankment (including apron) will be rectangular and may rise a maximum of 53 feet above the surrounding terrain. Final design estimates indicate that the embankment will rise 35 feet above the surrounding terrain, averaging 19 feet, with 20 percent sideslopes and five percent top slopes. The embankment will have dimensions of 740 feet by 575 feet and will cover about 10.0 acres. The top of the embankment will form a ridge running from the northwest to the southeast.

The perimeter of the embankment will be protected with riprap toe protection 15 feet wide (at the surface), and 4 feet deep to prevent erosion from undercutting the embankment. The embankment configuration, typical cross section, and cover detail are shown in Figures 4.2, 4.3, and 4.4, respectively.

Above-grade disposal of relocated contaminated materials is used because of the shallow ground water table at the Bowman site which may be as shallow as 6 feet deep in some areas on occasion. The rectangular shape of the embankment is relatively easy to construct and takes advantage of the flat terrain in the disposal area. However sharp edges will be rounded during construction as indicated in notes on construction drawings.

The final design provides an embankment layout in the selected area while meeting EPA standards. All significant aspects of the final layout will be, to the extent reasonable, the same as described for the final design.

A 5 percent topslope is used to allow adjustments in the height of the embankment if quantities of contaminated materials found during construction differ from design quantity estimates. The topslope of the embankment could be made steeper than five percent without significantly affecting construction procedures, and costs, or size of the erosion protection rock. However, steepening the topslope would permit less adjustment in capacity for an established perimeter.

Alternative embankment layouts that differ significantly from the selected layout are not considered feasible due to site constraints. These constraints include maintaining clearances from the existing railroad to the north, gravel road to the east, highway to the south, and drainage to the west.

4.3.5 Geomorphology

[Note: TAC reportedly has accomplished additional evaluation, of geomorphology, e.g., in response to NRC comments. Results of those evaluations should be used to revise this section as appropriate]

Geomorphic processes are evaluated to determine potential impacts on the remedial action over the design life. Details of the geomorphology of the Bowman site are given in Appendix D. The site appears to be very stable from a geomorphic standpoint. One process to which the site is susceptible is wind erosion which has resulted in depressions called blowouts. These are old features that have been preserved in the present landscape and are not active at present. Drought conditions or fire could affect the well-established grass cover and thus lead to increased wind erosion.

Increased lateral erosion due to headward erosion of the west side drainage is unlikely in the present drainage system as a consequence of ponded drainage in the western watershed. The soil is susceptible to erosion but the gentle slope and low site relief will inhibit a tendency for gullying in the event manmade berms are removed. In order to protect the embankment from potential impact by on-site erosional processes, riprap toe protection extending below and away from the embankment toe, and positive surface drainage are included in the design. Protection against wind erosion and other geomorphic processes such as rain splash, sheet wash, frost heave, solifluction, and creep of unconsolidated materials will be afforded by the cover design.

The final design includes the following to provide protection from off-pile erosion.

- o The embankment should be set back at least 100 feet from the top of the nearest channel slope along the existing west side tributary drainage (approximate location of contour elevation 3051 near the southwest corner of the embankment).

- o Following removal of contaminated soil, the site will be graded to allow drainage away from the toe of the embankment.

- o Sheet flow is provided as much as possible by site grading around the embankment to minimize flow concentrations that could initiate increased erosion relative to existing erosion conditions.

The approach used in geomorphic studies is outlined in the TAD (DOE, 1986b).

4.3.6 Seismicity

Historically the site is known to have low seismic risks (largest event recorded closest to the site: m_b = 3.6 miles at 76 miles from the site). Considering the long life (1000-year) of the UMTRA Project the design earthquake for this site was, however, conservatively determined to be a 6.0 m_b or 6.1 M_L event occurring at a distance of 36 km from the site on a suspected structure. The peak horizontal acceleration at the site is estimated to be 0.17g. Due to the shallow depth to bedrock, this is also considered to be the site ground-surface acceleration. Bedrock at the Bowman site consists of poorly consolidated sedimentary units of teriary age. Seismic design parameters were determined using procedures presented in Section D.3 of Appendix D. These procedures depart from the TAD (DOE, 1986b), which is considered more appropriate for the western United States than for the central U.S. where seismic data and relationships to known structures are unknown or little-known. The acceleration attenuation relationship of Nuttli (1982) is applied in lieu of Campbell (1981) to reflect the low attenuation predicted for this region.

As discussed in the TAD (DOE, 1986b) the following values were used for slope stability and liquefaction potential studies:

- o Long-term slope stability seismic coefficient, $k_h = 0.11$.
- o Short-term slope stability seismic coefficient, $k_h = 0.09$.
- o Liquefaction analysis embankment crest horizontal acceleration, $a_{max} = 0.17g$.

4.3.7 Hydrogeology [To be Revised and Completed by DOE/TAC]

This section summarizes features and requirements used in the final design as they apply to groundwater protection. A more detailed discussion of the hydrogeology including water resources protection of the Belfield and Bowman sites is provided in Appendix D.

The principal design features for groundwater protection are:

- o Relocation of the Belfield contaminated material to the Bowman site, and stabilization of all contaminated material at the Bowman site.

- o Placement of a compacted, low hydraulic conductivity infiltration/radon barrier over the contaminated materials to reduce the rate of infiltration the long-term flux of seepage from the embankment.

- o Conservatively placing the infiltration/radon barrier under a 6-foot thick layer of select fill even though the frost effect may be much less severe for the unsaturated barrier located way above the groundwater table.

- o Design a stabilized cover system to promote surface runoff and adequate drainage away from the embankment.

Relocation of the contaminated material away from the Belfield site will remove the source of leachate, thereby preventing further contamination of the Heart River and groundwater in the shallow aquifer system. Design of the embankment at the Bowman site will include a 1.5-foot-thick, low hydraulic conductivity infiltration/radon barrier placed below a 6-foot thick cover, that will reduce the infiltration rate and therefore minimize the long-term flux of seepage from the embankment. The contoured barrier will also promote surface runoff and drainage of water water away from the embankment. After stabilization of the contaminated materials, groundwater quality at the Bowman site is expected to eventually return to background by natural processes. Thus the 4-foot thick select fill and the infiltration/radon barrier layer will perform like a two-layered system to inhibit infiltration. Essentially this will allow the infiltration/radon barrier to remain unsaturated with no flow through the barrier to the contaminated soil.

The final design incorporates the following detailed requirements in the remedial action:

- o The embankment cover is sloped to promote surface runoff and adequate drainage away from the pile.

- o The low hydraulic conductivity infiltration/radon barrier will be uniformly sloped with no depressions that would hold water and promote infiltration.

- This low hydraulic conductivity infiltration/radon barrier will have a saturated hydraulic conductivity lower than $K_{sat} = 1 \times 10^{-7}$ cm/s. If the barrier remains unsaturated which is predicted from theoretical considerations as well as verified from observed performance at several UMTRA sites, the field unsaturated permeability of the barrier will be even lower.

- Placement of the infiltration/radon barrier beneath a select fill layer to inhibit potential effects of freezing. The select fill layer will perform as the primary infiltration/radon barrier with added protection against infiltration.

- Bedding layer permeability (saturated hydraulic conductivity) is greater than 1×10^{-1} cm/sec minimum to promote drainage of surface runoff. The bedding filter layers will prevent erosion and migration of the compacted select fill layer and the infiltration/radon barrier.

- During construction of the embankment, low hydraulic conductivity infiltration/radon barrier, the select fill layer, bedding layers, and the erosion protection layer, precautions will be taken to ensure that no more water than necessary is introduced onto or into the contaminated material.

- In the semiarid climatic conditions of Bowman, with potential evaporation several times higher than the mean annual precipitation and high wind, the multi-layered cover design provides an effective infiltration barrier.

4.3.8 Surface Water

Existing Conditions

The disposal site lies on a low drainage divide between two upland watershed tributaries to Spring Creek. Spring Creek is an intermittent stream flowing in a southeastward direction in the site vicinity and is in the headwaters of the north fork of the Grand River, a tributary ofthe Missouri River. Twenty-one miles downstream, Spring Creek enters the Bowman-Haley reservoir created by a dam on the north fork of the Grand River (FBDU, 1981b). From there the drainage continues southeast into South Dakota, joining the Grand River and continuing eastward 100 miles, where it flows into the Missouri River.

A flood analysis of Spring Creek was not performed to determine major flood flows. Potential flooding of Spring Creek is not a hazard from the south because it is over 0.5 mile away and 30 feet below the general elevation of the disposal site. Also, the maximum recorded peak discharge during a six-year period of record for a U.S. Geological Survey gaging station 21 miles downstream of the site for a 170-square-mile subbasin area was only 40 cfs (USGS, 1987b). Flooding in the drainage immediately west of the embankment may encroach on the embankment side slopes.

Other surface-water features in the vicinity of the disposal area include numerous small impoundments and ephemeral streams that flow into Spring Creek upstream and downstream of the disposal site.

The two upland watersheds drain the east and west sides of the site. Drainage from the western watershed enters Spring Creek 0.5 mile southwest of the disposal site. Drainage from the eastern watershed enters a small ephemeral stream 0.5 mile southeast of the site, and eventually converges with Spring Creek another 1.5 miles downstream.

The western upland watershed consists of 1225 acres of relatively flat terrain. Elevations in the upland watershed range from 3200 feet above mean sea level (MSL) at the headwaters down to 3044 feet above MSL 300 feet west of the disposal site. Runoff drains southward through a constricted area underneath a railroad bridge about 1000 feet northwest of the disposal site and into a broad channel that forms the western boundary of the contaminated area. The channel is entrenched three to eight feet below the general elevation of the site (3050 to 3053 feet above MSL) where it meanders on a narrow valley bottom 20 to 30 feet wide. Before placement of the highway, drainage from the western watershed continued southward to Spring Creek 0.5 mile downstream. Currently, however, the highway crosses the original channel and ponding tends to occur in several low spots in the channel reach between the railroad tracks and highway during normal flow events.

The eastern upland watershed tributary to the disposal area under extreme runoff conditions consists of 10 acres of relatively flat terrain with no well-defined streams or channels. Elevations in the upland watershed range from 3220 feet above MSL at the headwaters to 3052 feet above MSL at the railroad embankment north of the disposal site. During normal flow events runoff from the 10-acre area drains south and southeast towards the site; however, it is diverted away from the disposal area by a shallow ditch along the north side of the railroad embankment.

On-site runoff on the west side of the site flows to the broad channel draining the western upland watershed; however, rainfall over most of the site tends to pond in low-lying areas on either side of Griffin's Main Street as a result of the elevated road bed.

Site Conditions After Remedial Action

After remedial action, surface flows will be directed away from the embankment by backfilling and grading around and near the embankment to prevent ponding at or near the toe. Under extreme runoff conditions approaching discharges associated with a Probable Maximum Precipitation (PMP), flood waters from the western watershed could overtop the low drainage divide, spread across the eastern watershed, overtop the railroad embankment north of the disposal area, and finally flow alongside the stabilized embankment. The erosion protection on the embankment side slope and in the toe is sized to prevent any erosion under expected flood flow conditions along the north side of the embankment.

An alternative was considered to reduce potential effects of off-site flows on the embankment. A diversion channel on the north side of the existing railroad embankment was considered to divert runoff from the upland watershed areas tributary to the site during a PMP event. However, this concept was found to be impractical because the channel would have to be extremely wide and shallow to avoid the high water table and yet carry the maximum peak discharge.

The final design creates a hydraulic condition in which runoff within adjacent drainage features and from sheet flow off the eastern watershed will not adversely affect the integrity of the embankment.

Contaminated Material Embankment

The final design uses a planar surface on the top and sides, so sheet flow will occur over the entire embankment surface. Because of the relatively close proximity of the highway and railroad embankments to the embankment location, flow concentrations along the toe of the embankment in these areas are avoided to the maximum extent practical. The site around the embankment will be graded to promote positive drainage away from the embankment.

While a below-grade disposal design could reduce potential impacts of surface waters, an above-grade disposal is used because of the shallow water table at the Bowman site.

The following are incorporated in the embankment design to reduce surface water erosion potential:

- Gentle sideslopes (20 percent) to allow economic rock sizing and still contain the required material volumes within the disposal area.
- Five-percent topslopes to minimize rock size yet promote drainage.

- Alignment of northern side of embankment parallel to railroad to avoid flow concentration of runoff.

- Alignment of west side of embankment parallel to existing drainage to reduce turbulence if flood waters reach embankment.

- A toe drain is provided at the southwest corner to avoid occasional standing water in the toe trench.

4.3.9 Geotechnical

Slope stability, liquefaction, and settlement were analyzed in order to demonstrate adequate embankment stability and performance for the 1000 year design life. Material properties determined from laboratory testing of the soils were used as needed for these analyses.

Stability analyses were performed for the slopes using parameters from laboratory tests (shown in Appendix D). The factors of safety for the slope for each design condition are shown on Table 4.1. Comparison of calculated factors of safety with minimum required factors of safety indicates that the slopes will remain stable under all design conditions.

TABLE 4.1

SLOPE STABILITY FACTORS OF SAFETY

Stability Condition	Minimum Required Factor of Safety	Calculated Factor of Safety
Short term stability (static)	1.30	3.23
Short term stability (dynamic)	1.10*	2.15
Long term stability (static)	1.50	2.82
Long term stability (dynamic)	1.10*	1.76

* $(F.S.)_{min}$ = 1.0 is acceptable to the NRC. (Ref. SRP, NRC,1985).

There is no potential for seismic induced liquefaction at the disposal site since the groundwater is within bedrock (poorly consolidated sediments of Tertiary age) and the materials to be used in the stabilized embankment are predominantly compacted clays, which are not susceptible to liquefaction. There will also be no perched or raised water table in the embankment during the design life, since the embankment location and cover will prevent introduction of water from the top or sides. The contaminated materials will be placed as a compacted and engineered fill having densities and other characteristics well above the threshold values below which liquefaction occurs. Analysis also shows the few layers and lenses of silty material present at significant depths in the foundation are finite and dense and have large liquefaction resistance, hence safe.

A final evaluation of settlement using available data has been completed for the final RAP. The maximum total calculated settlement was conservatively estimated to be about 2.6 feet. Tensile strains in the low-permeability cover layer as a result of this settlement will be below those that could cause cover cracking.

Primary considerations regarding embankment configuration resulted from constraints other than those of geotechnical origin. Analyses were performed in order to verify the feasibility of the final design and to aid in specifying required design criteria. Procedures used in these analyses conform with the TAD (DOE, 1986b).

The final design includes the following to ensure geotechnical-related stability of the embankment.

- o The maximum percentage of organics contained within the reshaped embankment will not exceed five percent by volume, and the material should be distributed in a manner that will prevent nesting and pockets or layers of organic matter.

- All uncontaminated vegetation and organic material in areas subject to excavation and placement of contaminated materials will be removed and either burned to ash or otherwise disposed of in accordance with local regulations.

- Contaminated demolition debris will be reduced to manageable pieces and carefully placed in the embankment to avoid nesting and to ensure that no voids remain around the debris. The adjacent contaminated materials will be compacted to at least 90 percent of the standard Proctor density (ASTM D698).

- Excavation of all contaminated materials should be carefully monitored to prevent inclusion of unnecessary, uncontaminated materials in the embankment.

- The surface of all areas where fill materials are to be placed will be proof-rolled prior to placement of contaminated materials. Soft zones should be excavated and replaced with compacted fill.

- Contaminated materials will be compacted to a minimum of 90 percent of the standard Proctor density (ASTM D698). Water will not be added prior to compaction except as needed to bring materials drier than 5 percent below optimum moisture content to within 5 percent below optimum to optimum moisture content.

- The infiltration/radon barrier will be compacted to a minimum of 100 percent of the standard Proctor density (ASTM D698), at a moisture content ranging from optimum to three percent above optimum moisture content, and compacted by kneading (i.e., by tamping-foot rollers).

- The select fill layer will comprise of materials similar to the infiltration/radon barrier and will be placed at the same density and moisture conditions as the infiltration/radon barrier materials.

- As far as practicable moisture conditioning, will be done for the contaminated and the uncontaminated materials at the source before hauling and placement on the embankment.

4.3.10 Infiltration/Radon Barrier (To be Provided by TAC)

NOTE: With promulgation of the Revised EPA Groundwater Standards, the soil barrier provided over the contaminated materials embankment will have a dual function, as the name implies, for the protection of the groundwater and air.

4.3.11 Erosion protection

The rock layer on the embankment top and sideslopes will be designed to prevent erosion due to runoff resulting from the PMP on the pile. The rock layer on the embankment sideslopes will also resist erosion from flow off the embankment from the upland area. Erosion protection requirements and layer thicknesses for the final design are summarized in Table 4.2. Design requirements and thicknesses were determined using the methods and criteria presented in the TAD (DOE, 1986b). A six-inch bedding layer is used beneath the rock layers on the topslopes and sideslopes. A six-inch thick bedding layer plus a six-inch thick filter layer (of topslope riprap type) will be beneath the riprap toe protection.

TABLE 4.2

EMBANKMENT EROSION PROTECTION REQUIREMENTS

Location	Design Flow	Rock Size requirements[d/] (in)		Layer[a/] thickness (ft)
Topslopes (5 percent)	0.35 cfs/ft [b/]	D_{50} D_{100}	1.5 4.0	1.5
Sideslopes (20 percent)	0.66 cfs/ft [b/] 13,600 cfs [c/]	D_{50} D_{100}	4.5 8.0	1.5
Riprap Toe Protection	0.70 cfs/ft [b/]	D_{50} D_{100}	9.2 16.7	2.5-3.5

a/ Includes bedding and filter layer
b/ Cubic feet per second per foot width
c/ Cubic feet per second
d/ Includes 15% oversizing.

Riprap toe protection will be placed along the toe of the embankment sideslopes for protection from embankment undercutting by erosion. The surface portion of the toe protection (apron) will prevent scour due to sheet flow off of the embankment. The riprap toe protection will be 4 feet deep with a 15-foot apron. A minimum mean rock diameter (D_{50}) of 9.2 inches will be used for the toe protection riprap. Since the disposal site is geomorphically stable and the terrain is relatively flat, deep scour will not be expected along the embankment toe during a PMP or PMF from off-site. Therefore, scour depth was not a consideration in the design of the riprap toe protection. The 4-foot riprap thickness provides protection against average long-term sheet and rill erosion and includes consideration that some minor uneven erosion (relative to the average depth) will occur. The erosion protection material was oversized by 15% to optimize the potential sources of material.

4.3.10 Radon Control

EPA standards limit allowable radon emanation from the contaminated material. An uncontaminated clayey soil infiltration/radon barrier is provided over the entire pile in order to meet the applicable standards.

Contaminated materials from Belfield and Bowman may be placed in the embankment in any order, as a specific layering sequence will impose construction constraints but will not significantly affect the cover thickness conservatively provided to meet radon attenuation. A minimum of 1.5-foot-thick radon barrier of low-hydraulic conductivity material (K_{sat} less than 1×10^{-7} cm/sec) will be provided. Thus the actual flux through the barrier will be way below the required limit. A sensitivity analysis, using statistical methods, shows that the required barrier thickness is less than 6 inches, to meet the allowable emanation limits. The 1.5-foot-thickness assures the infiltration characteristics of the barrier will remain unchanged.

4.4 CONSTRUCTION FEATURES

4.4.1 Introduction

This section describes construction facilities and procedures to be used for the remedial action. The construction facilities and procedures are briefly described here to show that adequate public and worker safety will be achieved during construction.

4.4.2 Overview

Construction features include, decontamination facilities, access roads, temporary drainage ditches, wastewater collection and retention systems, staging areas and construction offices and other facilities. A planned layout is described below to provide an overview of the implementation of remedial action. The exact location and size of construction features may be changed to facilitate construction activities.

The access control and decontamination area at Bowman will be constructed near the southeast corner of the contaminated material embankment, north of Highway 12. The office area will be on the east side of the old Griffin Main street and the decontamination pad will be on the west side. The Griffin Main Street will be closed to the public during construction.

The access control and decontamination area at Belfield is proposed to be south of the railroad tracks, and southwest of the L.P. Anderson building. Final design has incorporated a temporary railroad crossing to reduce problems with site access during construction via the existing access road.

Site security will be accomplished by erecting a woven wire perimeter fence with an entrance gate at the access control and decontamination area at both sites. The perimeter fence will provide control of traffic entering and leaving the sites and prevent unauthorized traffic from entering the areas. Equipment will be decontaminated prior to leaving the controlled areas. Only the major portion of each site will be fenced. Outlying areas can be excavated and backfilled quickly following initial ground disturbance at both sites due to the shallow depth and limited extent of those area. This sequenced approach will significantly reduce the volume of contaminated water by reducing the size of contributory contaminated areas.

Collection ditches will be used to collect runoff from the major contaminated area at the Belfield site. Sumps, pumps, and pipelines will be used in addition to ditches at the Bowman site to collect runoff, due to the relative flat area situated near a drainage divide at that site. Runoff from the major contaminated areas at each site will be collected in a membrane lined wastewater retention basin. Water will either evaporate or be treated and discharged.

Site utilities in areas of excavation will be relocated, protected, temporarily removed and rebuilt, or abandoned as required.

The exact location and sizes of all planned construction features are shown on the subcontract drawings.

4.4.3 Drainage, Erosion Control, and Wastewater Retention Basin

Surface-water runoff from the major contaminated areas at each site will be collected and drained to a lined retention basin. Uncontaminated water from clean areas will be diverted to off-site areas. Collecting and rerouting of runoff from isolated areas is not cost effective and will not pose a major health risk, provided they are, excavated and backfilled in a continuous operation. Such areas will be filled to meet land clean-up standards.

Runoff collected from contaminated areas will either be retained in the retention basin and evaporated, or treated as necessary and discharged. Contaminated water will to the extent practicable be evaporated and used for construction. Treatment and discharge may be necessary if runoff during the construction period exceeds the basin capacity, or if the water cannot be evaporated before completing infiltration/radon barrier construction. Controlled discharges from the retention basin will meet effluent limits established by a National Pollution Discharge (NPDES) permit. Emergency uncontrolled discharge will be used only as necessary to prevent failure of the retention basins.

Wastewater ditches are designed to carry the peak flow resulting from a 10-year storm event. Diversion ditches are not anticipated to be required at either site due to blockage of off-site flows by existing features. Thus, each retention basin capacity was sized only for inflow from contaminated areas.

The retention basins will receive waters from:

- o Runoff from major contaminated areas.
- o Decontamination activities including equipment and truck washdown.
- o Laundry, shower, and washbasin facilities.

The retention basins at the sites are sized to retain, as a minimum, runoff resulting from a 10-year 24-hour storm event, wastewater generated from remedial action activities, net accumulation of average runoff (inflow minus evaporation/construction use) and sediment load for the construction period. A large surface area of each basin is provided to promote evaporation. The retention basins will have sufficient capacity to hold the total estimated sediment inflow during the project life without need for removal during the construction period. Wastewater retention basins will be membrane lined to reduce potential for subgrade contamination or discharge to ground water.

The emergency outlet from the Bowman retention basin is designed to discharge the peak 25-year storm runoff with at least six inches of freeboard with the spillway flowing at maximum depth. Six inches minimum freeboard is considered adequate because there is no gravity (uncontrolled) flow into the basin. The spillway at the Belfield site is also designed for 6 inches to reduce excavation to preclude the Heart river from backing up into the basin.

4.4.4 Wastewater Treatment

Wastewater will be directed to retention basins, which will provide primary settling as well as flow and contaminant equalization. Some of this water will be used for dust control at contaminated areas primarily on the embankment area at the Bowman site during construction.

If required a wastewater treatment plant will be mobilized during or at the end of the remedial action. The volumes of contaminated water expected to be generated during construction were estimated and some water may remain at the end of construction. Water remaining at the end of construction may need to be treated.

All discharged water must meet acceptable Federal and state of North Dakota water-quality standards prior to discharge.

4.4.5 Equipment Decontamination Pad

To prevent contaminated materials from being carried out of either construction area by vehicles and equipment, a decontamination pad with a holding pond and pump will be provided at both sites to wash contaminated equipment, as required. Decontamination pads will be constructed and maintained to collect wastewater and to prevent uncontrolled discharge into the subgrade or adjacent areas.

4.4.6 Belfield Contaminated Material Transport

Belfield contaminated material will be transported to the disposal area by truck. The trucks will be equipped with gate seals covered with tarpaulins to prevent leakage. All trucks will be monitored and decontaminated as necessary prior to leaving the Belfield site. The exact transportation route will be determined during final design. The following description is presented as a possible transportation route that could be used in accomplishing the remedial action.

The trucks will exit the Belfield site from the access road, and enter U.S. Highway 85. Trucks will proceed south on Highway 85 through the town of Bowman, then proceed west on U.S. Highway 12 to the former town of Griffin. Trucks will drive north on the north-south main street and enter the disposal area on the west side of Main Street.

4.4.7 Dust Control

Dust generated by excavation, earth movement, vehicle use, temporary materials stockpiling, associated with strong wind and similar activities will be controlled and minimized by the use of water and water-based surfactants sprayed from hoses or trucks. Special care will be taken to control dust created by building decontamination and the temporary stockpiling or mixing of contaminated materials. Use of water for dust suppression will be controlled to limit soil infiltration of contaminated water.

The sources for dust suppression water may include recycled water from the wastewater retention basins. Uncontaminated water will be used to control dust in clean areas.

The schedules for spraying the roads and pile areas will vary daily and will be evaluated on an hourly basis. The frequency of spraying will increase when combinations of low soil moistures and high wind speed are encountered.

4.4.8 Borrow Sites

Two borrow sites have been identified for the final design. The Griffin borrow site is 0.3 road mile south of the Bowman site. Earthen material for the infiltration/radon barrier and select fill layers will be obtained from this site.

Erosion protection material including riprap and bedding material may be obtained from a commercial quarry or quarries near Rapid City, South Dakota, which is about 165 road miles south of the Bowman site.

The subcontractor may use alternate sources of erosion protection material providing the specified material requirements are met.

Restoration material will be obtained from required excavations and from outside sources supplied by the Subcontractor.

Further information on the borrow sites is provided in Appendix D, Site Characterization and in the Information for Bidders documents.

4.4.10 Construction Sequence

The following is proposed as a possible construction sequence for the remedial action. The construction subcontractor will be allowed some flexibility in executing the work, but subject to overview and approval of the contractor. Therefore, the actual construction sequence may differ from the following.

Initially, a site security system will be established at both sites and coordinated with staging and vehicle decontamination areas to provide control of traffic entering and leaving the sites and prevent unauthorized traffic from entering the sites.

Site preparation will continue, including construction wastewater retention basins and collection ditches at both sites. Uncontaminated materials excavated during construction of these facilities will be stockpiled for later use as backfill or used as fill in construction of retention basins, sumps, and ditches. Uncontaminated topsoil will be stockpiled separately at each location for later use in site restoration.

Concurrent with these activities, borrow area development will begin.

Once initial site preparation is completed, earthwork at both sites will begin. The embankment area at the Bowman site will be prepared for placement of contaminated materials. Contaminated materials from the Belfield and Bowman sites will be excavated, moved, and placed in the embankment at the disposal site. This will also include contaminated materials from the wastewater retention basins and any miscellaneous contaminated debris found during construction.

Isolated areas of contaminated materials will be excavated, verified, and backfilled/graded in as continuous an operation as practical, following initial disturbance of any such area. These areas are relatively small, with shallow depth of contamination. The intent of this requirement is to minimize the risk of runoff discharge from disturbed contaminated areas, but without providing facilities to transport runoff to the retention basins that are not cost-effective.

The final stages of remedial action will involve placement of the infiltration/radon barrier, bedding layers, select fill layer and erosion protection layers over the contaminated material and complete overall site grading. Restoration in all areas of both sites involve grading and backfilling as required. Revegetation and replacement of scoria surfacing will be accomplished as necessary.

Demobilization will consist of the removal of the wastewater retention basins and temporary drainage ditches. The water will be treated and discharged if it has not evaporated and the bottom sludges and dike materials will be placed in the embankment. All decontamination areas will be removed and the equipment cleaned for salvage. The staging areas will be dismantled with the contaminated items either cleaned and salvaged or buried. All construction equipment will be decontaminated and inspected prior to release from the contaminated areas.

4.4.11 Construction Schedule

Remedial action for the stabilization of the Belfield and Bowman contaminated materials is planned to commence in April, 1992. Figure 4.5 shows the remedial action schedule.

4.4.12 Cost Estimate

A cost estimate based upon the final design will be included in Table 4.3 of the final RAP.

TABLE 4.3

SITE COST ESTIMATE SUMMARY

(FY 1988 constant dollars; dollars in thousands)

Item	Cost
Site acquisition	
Remedial action	
Site preparation	
Embankment construction	
Radon cover	
Erosion protection	
Decontamination	
Restoration	
Fencing and monuments	
Subtotal subcontractor's remedial action costs[a]	
Field management	
Construction contingency (25%)	
Total processing site remedial action	
Processing site engineering[a/]	
TOTAL PROCESSING SITE COST ESTIMATE	

a/ These costs include the subcontractor's overhead, profit, and five -percent contingency.

[EDITOR'S NOTE: This table will be completed prior to issuance of the final RAP.]

4.5 REPROCESSING ASSESSMENT

[This section remains the same as in dRAP of February, 1988]

4.6 SITE ACQUISITION

[This section remains the same as in dRAP of February, 1988]

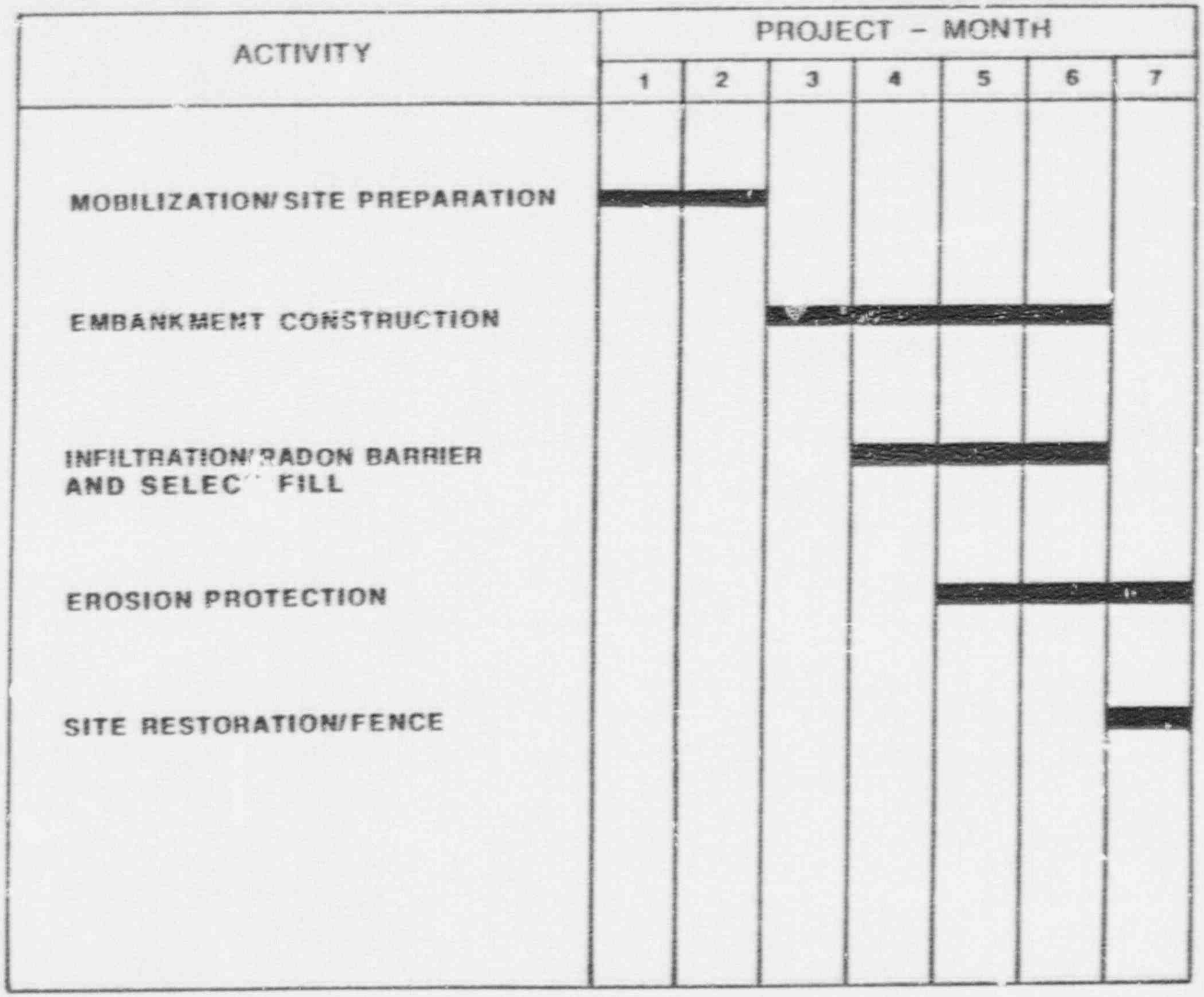

FIGURE 4.5 REMEDIAL ACTION SCHEDULE FOR THE PROPOSED ACTION, BELFIELD AND BOWMAN, NORTH DAKOTA, PROCESSING SITES

SECTION D

ANALYSIS OF CHANGES FROM dRAP AND PRELIMINARY DESIGN MADE IN FINAL DESIGN

ANALYSIS OF CHANGES FROM dRAP AND PRELIMINARY DESIGN
(Sheet 1 of 18)

Permanent Design Features	dRAP Design	Preliminary Design	Final Design	Remarks
Location	Located between U.S. Highway 12, Griffin Main Street, Burlington Northern R.R., and west side drainage.	Same location.	Same location.	No change.
Embankment layout	Above-grade, 700' x 585' (rectangular), 36-ft maximum height, 5% top slopes, 20% side slopes, below-grade rock apron 23-ft wide by 7-ft deep.	Above-grade, 740' x 575' (rectangular), 34-ft maximum height, 5% top slopes, 20% side slopes, below grade rock apron 15-ft wide by 4-ft deep.	Above grade 740'x575' (rectangular), 35-ft height 5% top slopes, 20% side slopes, below-grade rock apron 15-ft wide by 3.5' maximum depth including the 6" riprap bedding.	Embankment was enlarged slightly to accommodate final design estimates of contaminated materials.(Design allows for 20% reserve capacity [illegible] 20% side slopes are extended to the crest.) Below-grade rock apron is used to dissipate energy of sheet flow from embankment to minimize scour of adjacent vegetated grades. Depth of protection was changed to 3 ft to reflect potential long-term erosion of vegetated grades. Rock in apron can self-adjust to provide protection greater than 3 feet, if necessary.
Geomorphology	Embankment set back 150 ft from west side tributary drainage.	Embankment set back 100 ft from contour Elev. 3052 ft at top of bank slope of west side tributary drainage.	No change from preliminary design.	Embankment setback criteria clarified by TAC in telephone conversation with MKE 8-1-88.

ANALYSIS OF CHANGES FROM dRAP AND PRELIMINARY DESIGN
(Sheet 2 of 18)

Permanent Design Features	dRAP Design	Preliminary Design	Final Design	Remarks
	Found base of cover 6 inches below frost penetration depth of 6.5 feet.	Base of riprap toe protection bedding layer 5 ft deep.	Base of riprap toe protetion bedding layer 3.5-ft deep.	Frost heave should not cause failure of reasonably-sized key trench. Minimum depth of protection is estimated depth of long-term erosion in grades adjacent to riprap toe protection.
	Grade for drainage away from toe of embankment.	Graded for drainage away from toe of embankment.	Graded for drainage away from toe of embankment.	No change in grading requirement. Grades have also been designed to promote sheet flow and to minimize flow concentrations in grades adjacent to the embankment to the extent practicable.
Seismicity	k_h = 0.09 for short-term slope stability. k_h = 0.11 for long-term slope stability.	Same k_h values as in the dRAP for short- and long-term stability. Values in dRAP are considered conservative.	No change from dRAP and preliminary design.	Reanalysis of slope stability results in following factors of safety: Short Term (static) = 3.2 Short Term (dynamic) = 2.2 Long Term (static) = 2.8 Long Term (dynamic) = 1.8
Hydrogeology	Slope embankment surface to promote runoff drainage away from embankment.	Embankment surface is sloped to promote runoff drainage away from embankment.	No change from dRAP or preliminary design.	No change in embankment slope requirements.
	Slope infiltration/radon barrier uniformly to avoid depressions.	Earthwork specifications require 0.1-ft accuracy of top surface of infiltration/radon barrier.	See Preliminary Design.	Practical tolerance for earthwork is specified to avoid depressions in top of infiltration/radon barrier.

ANALYSIS OF CHANGES FROM dRAP AND PRELIMINARY DESIGN
(Sheet 3 of 18)

Permanent Design Features	dRAP Design	Preliminary Design	Final Design	Remarks
Hydrogeology (Contd)	Saturated hydraulic conductivity of infiltration/radon barrier of 1×10^{-7} cm/sec.	Borrow materials give saturated hydraulic conductivity less than 1×10^{-7} cm/sec after compaction.	No change from dRAP or Preliminary Design.	No change in saturated hydraulic conductivity criterion for infiltration/radon barrier. Specified materials will provide $k_{sat} = 10^{-8}$ cm/sec. k_{unsat} will be even lower.
	Provide a bedding with as coarse a gradation and as large a permeability as possible that complies with filter criteria in TAD.	Bedding is designed using alternate "allowable velocity" approach to enhance drainage without significant erosion of infiltration/radon barrier.	See Preliminary Design.	Alternate "allowable velocity" approach is used to protect infiltration/radon barrier from erosion while providing much greater permeability for drainage that can be achieved by using well established filter criteria.
	Take precautions to ensure that unnecessary water is not introduced into the contaminated materials during construction.	Specifications prohibit unnecessary water from being applied to embankment materials.	See Preliminary Design.	Unnecessary water is unlikely to be used in embankment construction. In any case specifications require moisture conditioning prior to placement in the embankment.
Surface Water	Direct surface flows away from embankment.	Surface flows are directed away from embankment.	See Preliminary Design.	No significant changes in treatment of surface water issues from dRAP.
	Grade area adjacent to embankment to prevent ponding at the toe.	Area adjacent to embankment is graded to minimize ponding at the toe.	See Preliminary Design.	No significant change.

ANALYSIS OF CHANGES FROM dRAP AND PRELIMINARY DESIGN

Permanent Design Features	dRAP Design	Preliminary Design	Final Design	Remarks
Surface Water (Continued)	Check erosion protection requirements with estimated surface flows that could impinge upon the embankment.	Erosion protection requirements are adequate for protection against estimated off-site flows that imp' ᴞe on the embankment.	See Preliminary Design.	
	Avoid low-lying areas as much as possible.	Low-lying areas are avoided as much as possible, which includes requirements for determining toe elevations of embankment side slopes (particularly northeast corner).	See Preliminary Design.	
Contaminated Material Embankment	Planar surfaces on top and side slopes to promote sheet flow.	Planar surfaces used on top and side slopes.	No change from dRAP and pre' ainary design.	No change.
	"Above-grade" disposal design.	"Above-grade" disposal design.	No change.	No change. (Note: Some contaminated materials under the embankment will remain in place.)
	Avoid flow concentrations at toe of embankment.		Site is graded to avoid flow concentrations and to promote drainage away from the embankment.	No change.

ANALYSIS OF CHANGES FROM dRAP AND PRELIMINARY DESIGN

Permanent Design Features	dRAP Design	Preliminary Design	Final Design	Remarks
Contaminated Material Embankment (Continued)	Elevation of embankment along west side 3 ft higher than east side to promote northwest to southeast drainage.		Site is graded to promote drainage away from the embankment.	No significant change.
	Maximum height 36 ft above surrounding terrain (avg. 18 ft).	Maximum height: 34 ft, which will increase to 55 ft if full reserve capacity is used.	Maximum height is approximately 35 ft.	Minor change (dictated by contaminated material volume).
	20% side slopes.	No change.	No change.	No change.
	2% to 5% top slopes.	Top slope is 5%.	See Preliminary Design.	No change.
Geotechnical	Stability analyses performed using dRAP configuration and material properties.	Stability analyses performed using preliminary design configuration and material properties (with maximumh height at full reserve capacity).	Stability analyses performed using final design configuration and material properties (with maximum height at full reserve capacity.	Minor revisions to embankment layout and shape were incorporated. Material properties were revised to include additional results. Slopes will be stable for all conditions. (See remarks on Sheet 1.)
	Determination was made that there is no liquefaction potential at the site or within the embankment.	Potential for liquefaction was checked and a determination of no potential for liquefaction was made.	See Preliminary Design.	No change in conclusion. Moderate to highly plastic soils are not susceptable to liquefaction.

ANALYSIS OF CHANGES FROM dRAP AND PRELIMINARY DESIGN
(Sheet 6 of 18)

Permanent Design Features	dRAP Design	Preliminary Design	Final Design	Remarks
Geotechnical (Continued)	Maximum total post-construction settlement of less than 0.4 ft was estimated. Resulting tensile strains in the cover were considered well below strains that could cause cracking.	Maximum total post-construction settlement of 0.34 to 0.5 ft estimated. Based on uniform and favorable properties of foundation and embankment, potential effects of differential settlement (e.g., cracking and flow concentrations) are unlikely.	Maximum settlement is conservately estimated to be 2.6'. Resulting tensile strains are considered below strains than can cause cracking.	No change in conclusion.
	Maximum percentage of organics should not exceed 5%. Organic materials should be distributed in a manner that will prevent pockets or layers of organic matter.	Organic materials will be distributed so as not to exceed 5% by volume in any area of the embankment.	No change from preliminary design.	No significant change.
	Burn to ash all uncontaminated vegetation and organic material from areas subject to contaminated material excavation and placement.	All organic material from stripping and clearing of contaminated material areas will be placed in the embankment.	No change from preliminary design.	Organic material in contaminated areas is considered to be contaminated itself, due to lack of data confirming lack of any contamination (both radioactive and non-radioactive contamination).
	Place contaminated debris in embankment to ensure against voids and nesting, and compact adjacent materials to at least 90% of standard Proctor density (ASTM D698).	No change.	No change from dRAP.	No change.

ANALYSIS OF CHANGES FROM dRAP AND PRELIMINARY DESIGN
(Sheet 7 of 18)

Permanent Design Features	dRAP Design	Preliminary Design	Final Design	Remarks
Geotechnical (Contd)	Monitor all contaminated materials excavation to prevent inclusion of unnecessary contaminated materials.	Excavation plans are based on site characterization data.	No change from dRAP and preliminary design.	The contaminated material excavation will be monitored to minimize inclusion of uncontaminated materials.
	Proof-roll areas of contaminated material placement and replace soft zones with competent material.	Areas of contaminated material will be stripped and proof-rolled/compacted. Any soft zones will be excavated and replaced with compacted fill.	No change from preliminary design.	No change, except that stripping is required to remove existing live vegetation.
	Compact contaminated materials to at least 90% of standard Proctor density, at 5% below up to optimum moisture content.	Contaminated materials will be compacted to at least 90% of standard Proctor density (ASTM D698). Moisture conditioning will not be permitted to raise moisture content above optimum. Minimum compaction moisture content is 5% below optimum.	No change from preliminary design.	Contractor may allow materials with in situ moisture contents above optimum to be compacted at in situ moisture content, provided required density is achieved. This would avoid delays in embankment construction due to drying clayey soils.

ANALYSIS OF CHANGES FROM dRAP AND PRELIMINARY DESIGN

Permanent Design Features	dRAP Design	Preliminary Design	Final Design	Remarks
Geotechnical (Contd)	Place infiltration/radon barrier at a minimum of 95% of standard Proctor density (ASTM D698) at a moisture content 0-3% above optimum, and compact by kneading.	Infiltration/radon barrier will be compacted to a minimum of 95% of standard Proctor density (ASTM D698), at a moisture content 0-3% above optimum, and will be compactedby tamping-foot rollers.	Infiltration/radon barrier will be compacted to a minimum of 100% of Standard Proctor density (ASTM D698) at a moisture content 0-3% above optimum.	Compaction requirements revised to reduce permeability of the barrier.
	Place random fill layer at same density and moisture conditions as the infiltration/radon barrier.	A select fill layer will be placed using material from the infiltration/radon barrier borrow area. Placement density and moisture requirements are the same as the infiltration/radon barrier.	Select fill will be compacted to the same requirements as the infiltration/radon barrier.	The term "select fill" is used in lieu of radon fill. This term reflects the benefits that can be obtained by using a relatively impervious soil in this layer, particularly by promoting runoff and reducing infiltration into the cover system. The Griffin borrow can provide all the necessary materials.
Infiltration/Radon Barrier	Minimize required cover thickness by sequencing contaminated material placement in embankment as follows (from bottom to top). layering sequence. 1) Belfield contaminated material. 2) Bowman contaminated material from designated site and "Tract 2". 3) Remainder of Bowman contaminated material (primarily wind-blown).	Minimum cover thickness of 1 ft is probably adequate, using averages of data obtained to date, regardless of the Therefore, no layering sequence is required in plans and specifications.	No sequencing of material placement is required.	Specifying a required layering thickness may result in significant cost and/or schedule impacts. The cover thickness of 1.5 ft is adequate for all layering sequences.

ANALYSIS OF CHANGES FROM dRAP AND PRELIMINARY DESIGN
(Sheet 9 of 18)

Permanent Design Features	dRAP Design	Preliminary Design	Final Design	Remarks
Infiltration/Radon Barrier (Contd)	Minimum cover thickness is 1 ft.	Thickness of infiltration/ radon barrier is 1 ft.	Minimum cover thickness is 1.5 ft.	Cover thickness was increased to improve water infiltration resistance.
	During final design, determine required cover thickness using procedures outlined in TAD.	Analysis to date made using simplified procedure to assess need for layering sequence and to include protection given by select fill layer.	Less than 6" thickness is required to limit radon flux to acceptable limits.	Procedures developed by joint TAC/RAC working group were used in final design to determine required infiltration/radon barrier thickness. See remark above for increased thickness.
Erosion Protection	Prevent erosion of top and side slopes resulting from the 1-hour PMP.	Prevents erosion due to peak flow rate resulting from PMP.	Same as preliminary design.	No change in requirements to provide protection from PMP on embankment and off-site PMF.
	Prevent erosion due to PMF flows from off the embankment.	Prevents erosion due to PMF flows from off of the embankment.	Same as preliminary design.	Minor changes in design flow rates due to reanalysis to confirm critical design conditions and incorporate minor changes in embankment layout.
Erosion Protection (Cont'd.)	Top slope requirements: design flow = 0.57 cfs/ft D_{50} 1.5" D_{100} 5.0" layer thickness including bedding = 1.5'	Top slope requirements: design flow = 0.48 cfs/ft D_{50} 1.5" D_{100} 4.0" layer thickness including bedding = 1.5'	Top slope requirements design flow = 0.35 cfs/ft Same size and thickness as dRAP and Preliminary design.	No change in rock size or layer thickness.

ANALYSIS OF CHANGES FROM dRAP AND PRELIMINARY DESIGN

Permanent Design Features	dRAP Design	Preliminary Design	Final Design	Remarks
Erosion Protection (Contd)	Side slope requirements: design flow = 0.65 cfs/ft (sheet flow) = 13,100 cfs (lateral flow) D_{50} 4.0" D_{100} 9.0" layer thickness including bedding = 1.5'	Side slope requirements: design flow = 0.66 cfs/ft (sheet flow) = 14,100 cfs (lateral flow) D_{50} 3.2" D_{100} 6.0" layer thickness including bedding = 1.5'	Side slope requirements: design flow = 0.66 cfs/ft (sheet flow) = 13,600 cfs (lateral flow) D_{50} 4.5" D_{100} 8" No change in layer thickness.	No change in layer thickness. Rock size increased due to oversizing for rock quality.
		Riprap toe protection extends 10 ft up side slope from toe.	No change from preliminary design.	
	Rock will be durable, according to NUREG/CR-4620 and TAD requirements.	Rock assumed durable according to NUREG/CR-4620 and TAD requirements.	Rock quality determined using UMTRA design procedures, which incorporate NUREG/CR-4620 and TAD requirements as well as NRC guidelines.	Acceptable Rock quality score is 65% to allow flexibility in sources of material. Rock size will be oversized by 15%. Average rock score of prospective sources is 80%.
Riprap Toe Protection	Provides protection from sheet flow and upland watershed (off-site) flow caused by 1-hour PMP.	Provides protection from peak sheet flow and peak off-site flow caused by PMP.	No change from preliminary design.	No change.

Permanent Design Features	dRAP Design	Preliminary Design	Final Design	Remarks
Riprap Toe Protection (Contd.)	Riprap wall keyed in bedrock.	Riprap wall extends into poorly-indurated sediments (silty clays) of Tertiary age or older.	No change from preliminary design.	Extension of riprap toe protection into bedrock, by itself, is not considered necessary. Instead, depth of toe protection is greater than estimated average depth of long-term erosion. The geomorphic stability of the site provides protection against deep gullying adjacent to the embankment, not the existence of a "non-erodible" bedrock surface.
	Below-grade slope of 2(H):1(V) and above-grade slope of 5(H):1(V).	Above-grade apron slope of 2.5%. Stable below-grade slope not constructed.	Same as preliminary design.	Above-grade slope of 2.5% is provided to dissipate energy of sheet flow from embankment. This protects against scour of grades adjacent to embankment and potential flow concentrations that could be formed by scour.
	Depth of toe protection is 6" below regional frost penetration depth of 6.5 ft.	Depth of toe protection is 4 ft; greater than estimated average long-term erosion of grades adjacent to toe protection.	Depth of toe protection is 3.5 ft, which is greater than estimated average long term erosion of adjacent grades.	Frost heave or other frost effects are not expected to disrupt riprap toe protection. Constructed depth of 3.5 ft actually provides depth of protection greater than 3.5 ft, since riprap mass can adjust if erosion attempts to undercut toe protection. Toe drain will drain water that collects in embankment toe.

ANALYSIS OF CHANGES FROM dRAP AND PRELIMINARY DESIGN
(Sheet 12 of 18)

Permanent Design Features	dRAP Design	Preliminary Design	Final Design	Remarks
Riprap Toe Protection (Contd.)	Deep scour not expected adjacent to embankment due to PMP runoff (on-site or off-site).	Deep scour adjacent to toe protection due to PMF is not anticipted.	Same as preliminary design.	No change in assumption of low potential for deep scour due to PMF in areas adjacent to embankment.
	Rock size D_{50} 4"	Rock size D_{50} 9.2"	Rock size $D_{50} \geq 9.2"$	Rock size increased to provide stability due to energy dissipation at toe of side slope. Rock oversized by 15%.
	Rock durability requirements are the same as embankment riprap.	Rock assumed durable, the same as rock for embankment riprap.	Rock quality of 65% was used in final design.	Rock oversized by 15% to agree with minimum quality score of 65%.
Drain, Erosion Control and Evaporation Ponds	Drain runoff from disturbed contaminated areas to evaporation ponds.	Runoff from most disturbed contaminated areas will be collected and directed to retention basins. Isolated areas of shallow excavation are not drained to retention basins. Instead, continuous excavation, verification and backfilling are required in isolated areas to minimize risk of off-site discharge of contaminated runoff.	Same as preliminary design.	Collection of runoff and diversion of off-site flows from isolated areas is not cost-effective, and the risk of off-site discharge of contaminated runoff during short excavation period (for any given area) is small. Instead, alternate construction sequence requirements are proposed for continuous excavation, verification and backfilling of any area once a portion of that area is disturbed.

ANALYSIS OF CHANGES FROM dRAP AND PRELIMINARY DESIGN
(Sheet 13 of 18)

Permanent Design Features	dRAP Design	Preliminary Design	Final Design	Remarks
Drainage, Erosion Control (Contd.)	Watershed ditches should carry peak flow from a 10-year, 1-hour storm.	Wastewater collection ditches designed for peak flow due to 10-year storm.	Wastewater collection ditches design for 10 year, 24 hour flows.	Minor revision from dRAP.
	Diversion ditches for uncontaminated runoff should carry peak flow from a 10-year, 1-hour storm.	Diversion ditches unnecessary.	Same as preliminary design.	Diversion ditches unnecessary due to existing features and treatment of isolated areas discussed above.
	Evaporation pond capacity based on: 1. Runoff from 10-year, 24-hour storm. 2. Wastewater from remedial action activities and snowmelt runoff. 3. Sediment inflow for construction period.	Retention basins designed for maximum practical surface area to promote evaporation. Basin capacities are based on the following: 1. Runoff from 10-year, 24-hour storm. 2. Maximum monthly accumulation (inflow minus outflow/evaporation) using mean monthly runoffs (decon pad wash water to be recycled, may need makeup water from basins). 3. Sediment inflow for construction period.	Same as preliminary design.	No significant change in retention basin capacity requirements. Liner thickness is thinner that what is used at other UMTRA sites, because of short construction season.

Permanent Design Features	dRAP Design	Preliminary Design	Final Design	Remarks
Drain, Erosion Control and Evaporation Ponds (Contd.)	Emergency outlet from ponds to safely discharge peak 25-year, 1-hour storm runoff, with 2 ft of freeboard from top of embankment with outlet flowing at design depth.	Spillways: 1. Bowman Site - Spillway provided capacity for peak flow 25-year storm falling ing directly on the basin with 6 inches minimum freeboard above design water level.	Spillways at both sites designed for 25-year, 24 hour storm runoff. Freeboard is 6 inches above design storm. Flood control berm was eliminated at Belfield site.	Free board reduced to 6" because of flat terrain and short construction season.
		2. Belfield Site - Spillway was not necessary. Any overflow was contained by flood control berm.	See above.	Deeper spillway may cause overflow of Heart River flooding into retention basin.
Wastewater Treatment	Wastewater treatment plant not anticipated. During final design, decide on need for and method(s) of wastewater treatment.	Wastewater treatment plant may be needed, either during construction or at end of construction. Net remaining runoff in basins at end of construction, based on average monthly runoff, are as follows: Bowman site: 3.7 ac-ft Belfield site: 2.4 ac-ft	See preliminary design. Net remaining runoff in basins are as follows: Bowman Site: 1.6 ac-ft Belfield Site: 2.4 - ac-ft	Evaporation from basins is less than estimated inflow for the construction period. Site constraints and results of net accumulation calculations appear to preclude exclusive treatment of wastewater by evaporation. A mobile wastewater treatment plant will be available if required at time of Bowman and Belfield construction.

ANALYSIS OF CHANGES FROM dRAP AND PRELIMINARY DESIGN
(Sheet 15 of 18)

Permanent Design Features	dRAP Design	Preliminary Design	Final Design	Remarks
Equipment Decontamination Pad	Provide decontamination pad at both sites with holding pond and pump to wash contaminated equipment, as required.	Decontamination pad provided at Bowman site, and a pad will be provided at Belfield site once site access facilities are determined.	Decontamination facilities provided at both sites. Decontamination pad is 20'x100'.	Size of decontamination pad reduced to 20'x100' because of low traffic volume.
Belfield Contaminated Material Transport	Monitor and decontaminate (if necessary) haul trucks prior to leaving Belfield site. Cover trucks with tarpaulins and provide trucks with gate seals to reduce risk of off-site spillage.	Trucks will be monitored and decontaminated (if necessary) prior to leaving Belfield site. Trucks will be equipped as necessary to prevent off-site leakage and covered with tarpaulins.	Same as preliminary design.	No significant change.
	Haul route from Belfield site will comprise, in order, U.S. Highway 85 south through town of Bowman, then west on U.S. Highway 12 to Bowman site.	Haul route anticipated from Belfield site will comprise, in order, U.S. Highway 85 south through town of Bowman, then west on U.S. Highway 12 to Bowman site.	Same as preliminary design.	No change.
Dust Control	Control dust generated by construction activities by spraying water and water-based surfactants.	Dust generated by construction activities will be controlled by spraying water, including water-based surfactants at the subcontractor's option.	Specifications require that water for dust control will be use sparingly to reduced water infiltration during construction.	No significant change. Water use is controlled to minimize potential for infiltration during construction.

ANALYSIS OF CHANGES FROM dRAP AND PRELIMINARY DESIGN
(Sheet 16 of 18)

Permanent Design Features	dRAP Design	Preliminary Design	Final Design	Remarks
Dust Control	Use uncontaminated water in uncontaminated areas.	Uncontaminated water will be used in uncontaminated areas.	See preliminary design.	No change.
	Contaminated water may be used in contaminated areas.	If available in retention basin, contaminated water will be used for dust control and moisture conditioning in contaminated areas.	See preliminary design.	Contaminated water should be used if available to reduce potential requirements for wastewater treatment.
	Evaluate spraying schedule on an hourly basis.	Dust control will be provided according to specification Section 15600.	See preliminary design.	Specification requirements are considered adequate. Requiring evaluation on an hourly basis may be ambiguous with respect to what an "evaluation" requires.
Utilities	Utilities in areas of excavation will be either relocated or abandoned.	Utilities will be protected during construction. Options include protection, relocation, or removal and replacement.	Demolition plan specifies what utilities will be abandoned. Specations state requirements for protecting remaining utilities.	Active utilities will be protected.
Borrow Sites	Griffin borrow site for infiltration/radon barrier and random fill.	Griffin borrow site for infiltration/radon barrier and select fill.	See preliminary design.	No change. In the specifications the random fill is renamed as "select fill", as explained above under "Geotechnical". Aereal extent of borrow area expanded to provided adequate reserves.

ANALYSIS OF CHANGES FROM dRAP AND PRELIMINARY DESIGN
(Sheet 17 of 18)

Permanent Design Features	dRAP Design	Preliminary Design	Final Design	Remarks
Borrow Sites (Contd.)	Erosion protection (riprap) from Rhame area.	Prospective sources are listed in Information for Bidders, Vol. III.	Designated source for riprap and bedding materials is the Blackhawk quarry near Rapid City South Dakota. Rock is "Minnekahta" limestone. Other prospective sources are in included in Information for Bidder.	Rhame area does not contain adequate quantities to be used as a source for erosion protection materials. "Pseudoquartzite" seems to be the only rock type within a 50-mile radius with adequate quality, but the following potential problems are associated with using "pseudoquartzite" field boulders: 1. Adequate quantities are not available on land owned by a single owner. 2. Disturbance of extensive areas of hilltops and ridgetops will be needed to obtain adequate quantities. Restoration may be difficult and expensive. 3. Permanent environmental drainage may result. Blackhawk commercial quarry has sufficient quantity of suitable materials.

ANALYSIS OF CHANGES FROM dRAP AND PRELIMINARY DESIGN
(Sheet 18 of 18)

Permanent Design Features	dRAP Design	Preliminary Design	Final Design	Remarks
Borrow Sites (Contd.)	Filter and bedding material from Bowman sand and gravel source.	Obtain bedding material from riprap source.	Filter and bedding material from Blackhawk quarry. Subcontract or may select aiernate sources.	See remarks above. Test results quality of Bowman sand and gravel show that material is unsuitable.
	Obtain site restoration materials from excavation of rock apron along toe of	Site restoration material from Griffin borrow area.	Site restoration materials from onsite uncontaminaed excavated materials and from outside sources selected by the subcontractor.	Increased quantities of site restoration materals are required to promote drainage around embankment, avoid changing existing grades drastically (to reduce potential adverse effects on geomorphic stability), and backfill areas to be released for unrestricted use. Griffin borrow area may be used as well as other sources.
	Belfield restoration - no requirements.	Subcontractor will furnish restoration materials from his own sources.	See preliminary design.	Preliminary design requires substantial increase in estimated site restoration quantities. Increased quantities are primarily required to avoid increased risk of on-site flooding and potential impact on use of land to be released for unrestricted use. Potential sources near Belfield are described in the Information for Bidders.

SECTION E

OPEN ISSUES

SECTION E
OPEN ISSUES

The following items are not complete or are in progress at the time of this final design submittal for construction (November 1990). Items are listed according to permanent design features and temporary facilities.

PERMANENT DESIGN FEATURES

1. This final design for construction does not include confirmation that design will meet all the requirements of revised EPA groundwater standards for disposal facilities. The analysis and supportive data required for this confirmation will be done by TAC and reviewed by RAC/MKE.

2. Final design does not address cleanup and restoration of existing contaminated groundwater stipulated in the revised EPA groundwater standards (proposed).

3. The design is based on the assumption that all required sites will be obtained. Site acquisition for disposal site and Griffin Borrow site have not yet been obtained.

4. Supplemental standards have been developed to protect the trees in the riparian habitat along the Heart River at the Belfield site. Excavation in this area will be done by the vicinity properties subcontractor.

5. Except for the construction of the railroad crossing at the Belfield site, no construction or removal of contamination is shown along the railroad tracks. Supplemental standards will be developed to exclude the areas along the Railroad tracks. If removal of contaminated materials is required, the extent will be defined and included in the vicinity properties subcontracts.

6. The reseeding specifications are based on preliminary seed requirements obtained from the U.S. Soil Conservation Service (USSCS) and on North Dakota State Highway Department standard specifications. A request for specific seeding recommendations was sent to the USSCS. Their response is held up pending a service agreement with the DOE. The final seeding specifications will be revised, if required, to conform with specific seeding recommendations from the USSCS.

TEMPORARY DESIGN FEATURES

1. Application will be made to Burlington Northern Railroad for temporary railroad crossing to provide access to Belfield site via county road south of site. The subcontract includes the construction and removal of a temporary railroad crossing. The type of railroad crossing including safety provisions may be revised depending upon the response from the Burlington Northern Railroad.

2. The subcontract documents show a detour and restoration of the county road at the Belfield site. Permits for this work will be applied for and, if required, the design will be modified to conform to permit stipulations.