PLANNING AT SELECTED UMTRA PROJECT SITES

Victoria A. Dery, Jack A. Caldwell
Jacobs Engineering Group Inc.
Albuquerque, New Mexico 87108

Mark Matthews
U.S. Department of Energy
Albuquerque, New Mexico 87108

ABSTRACT

The Uranium Mill Tailings Remedial Action (UMTRA) Project involves remedial work at 24 mill processing sites in ten states. To date remedial work is complete at two sites, in progress at five others, and the planning for the remaining sites is well advanced. Previous papers have described the construction work and remedial action designs at some of these sites. This paper documents the status of the planning of the remedial action work at four of the lower priority sites; namely, Spook, in Wyoming, Belfield and Bowman, in North Dakota, and Falls City, in Texas.

While these sites are of relatively low priority in the UMTRA Project, the engineering work required to bring the sites to a level where they comply with the U.S. Environmental Protection Agency (EPA) standards involves many interesting and unique approaches. This paper describes the different engineering plans and approaches being adopted for remedial work at the sites listed.

INTRODUCTION

In 1978, Congress passed the Uranium Mill Tailings Radiation Control Act (UMTRCA) charging the EPA with the responsibility for promulgating remedial action standards for inactive mill sites. The primary objective of the EPA standards was the isolation and stabilization of tailings and contaminated materials to prevent dispersal by natural forces and misuse by man. A long-term stability design objective of 1000 years was established to be satisfied whenever reasonably achievable, with a minimum performance period of 200 years.

THE BELFIELD AND BOWMAN SITES

Location and Description

The inactive Belfield and Bowman lignite ashing sites are in southwestern North Dakota in Stark and Bowman Counties, respectively. A large portion of the Belfield site is in the 100- and 500-year floodplains of the North Branch of the Heart River. There are no ash piles at either site; contamination is presumed to be a result of incomplete recovery of lignite ash during the combustion, cooling and loading of the processed materials. Topography at both sites is generally level. The total estimated volume of contaminated materials from both sites is 123,500 cubic yards (cy).

The Bowman site is on the Tongue River Formation on a low drainage divide between two unnamed tributaries of Spring Creek. Soils are stiff, silty clays of low permeability. The shallow groundwater table 6 to 20 feet beneath the site has been contaminated by infiltration of water through the ash-contaminated soils.

The Bowman site is bordered by a railroad embankment to the north, an elevated road bed to the east, a highway embankment to the south and a small ephemeral channel to the west. The channel is restricted by a culvert in the highway embankment south of the site. This causes water to pond in the area and inhibits erosion. Bowman is one of the most geomorphologically stable of the UMTRA sites; the only erosion in the site area is from sheet flow that results in minor-deposition within the nearby drainage channels.

Remedial Action Design

The proposed action is to relocate the ash-contaminated soils and materials from the Belfield site to the Bowman site and codispose and stabilize all material into an embankment at the Bowman site. Contaminated soils already within the disposal area will remain in place. The Belfield materials will be placed on top of the in-place contaminated soils, followed by the excavated Bowman contaminated soils and windblown material. The proposed action is preferred for the following reasons:

- The flat terrain at the Bowman disposal site makes it possible to construct a rectangular embankment; an efficient and economical configuration.
- The remedial action objectives and cleanup standards can be achieved in the most cost-effective manner, as compared to the other options.
- Long-term surveillance and maintenance costs are equal to or lower than other alternatives.
- Contaminated materials at the Belfield site are removed from the 100- and 500-year floodplains of the Heart River.

The ash-contaminated materials will be consolidated in an above-grade embankment covered with a radon barrier and an erosion protection layer. The embankment will have 20 percent sideslopes and two to five percent topslopes. The embankment will be surrounded by a below- and above-grade rock apron to protect it from erosion by on-pile and off-pile runoff. The configuration of the embankment and a typical cross-section are shown in Fig. 1 and 2.

The configuration of the embankment is controlled by three factors: 1) a high water table that precludes below-grade disposal; 2) the proximity of the existing highway and railroad embankments; and 3) the low relief of the disposal area.

Interesting Aspects

Transportation of the contaminated materials from the Belfield site to the Bowman site is one of the interesting aspects of this site. The method of transport will probably be by trucks and an estimated 3000 round trips through the towns of Bowman and Belfield will be necessary to haul this material. Transportation by truck is considered the only feasible means of moving the small quantity of material 60 miles between the sites. Rail transport would be more expensive because of the need to build a new rail siding at the Bowman site. Construction firms bidding on the work will be given the option of selecting the transportation method. The lowest cost proposal by a qualified bidder will be selected.

Another interesting aspect of this site is the presence of man-made interferences at the Bowman site, such as, railroad and highway embankments, culverts, and impoundments. These present a challenge in evaluating flooding potential and geomorphic stability at the site, particularly in view of the 1000-year design life. Drainage characteristics and flow patterns had to be analyzed with and without these interferences because of the uncertainty in predicting whether the interferences would remain in place for a thousand years, and to ensure that the proposed embankment could withstand the erosive forces of a Probable Maximum Flood under all drainage conditions. Also, the lack of large-size rocks within a reasonable distance from the site area limits the maximum rock size. Therefore optimization of the embankment design (i.e., maximum flow length, sideslopes, topslope and bedslope) and erosion protection features are critical in keeping the rock sizes down.

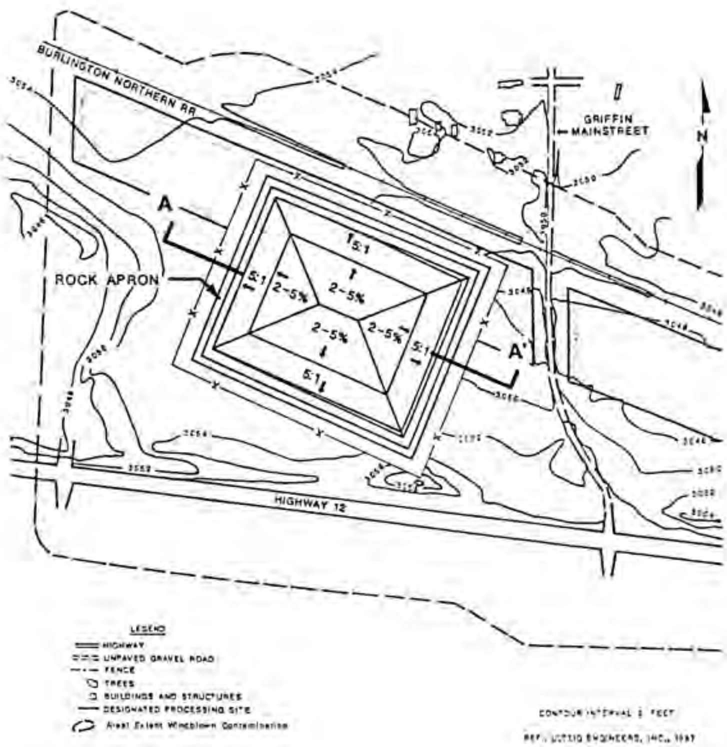

Fig. 1. Proposed Stabilized Enhancement Configuration Bowman Processing Site-Griffin, North Dakota.

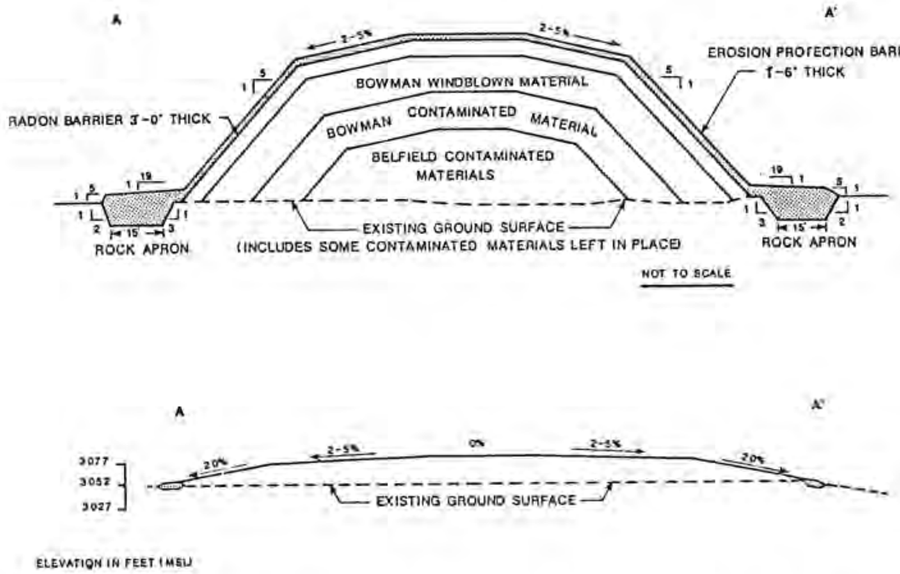

Fig. 2. Typical Cross Section A-A' for the Proposed Stabilized Embankment Bowman Processing Site-Griffin, North

THE FALLS CITY SITE

Location and Description

The Falls City mill site and tailings piles are in a sparsely populated farming area in Karnes County, Texas approximately 46 miles southeast of San Antonio, Texas, and eight miles southwest of Falls City, Texas. The site is within the West Gulf section of the Coastal Plain Physiographic Province and is 93 miles northwest of the Gulf of Mexico shoreline. Low rolling hills are the characteristic landform of the inner coastal plains and site region. Broad valleys between the hills are occupied by shallow meandering stream channels incised into clayey sediments and sandstone bedrock. In the region is an abundance of vegetation, which impedes erosion. Most of this area has been disturbed by farming or mining. The tailings site is on a drainage divide between the San Antonio and Atasoca Rivers, at an average elevation of 450 feet above mean sea level, and is not affected by floodwaters from either river system.

Depths to groundwater in the shallow aquifer beneath the site range from five to 30 feet below grade. A deeper aquifer contains groundwater 20 to 100 feet below grade. Seepage of acidic fluids from the tailings to the groundwater and the migration of contaminants has substantially affected water quality in the shallow aquifer.

Three of the tailings piles are at grade and the other three - including the pond - are in open pits from which the ore was removed. The tailings are generally loose sands and wet due to a perched water table. The total estimated volume of tailings and contaminated materials is 5.56 million cy.

The main concerns at this site that affect design are the ongoing geomorphic processes of fluvial erosion and gullying, potential localized flooding from a small drainage area, continued groundwater contamination, and potential liquefaction of the tailings.

Remedial Action Design

The principal feature of the remedial action design is the consolidation and stabilization of all tailings and contaminated materials into a single embankment, and placement of a radon barrier and an erosion protection layer. The location and geometric configuration of the embankment minimize the impacts on land use, surface water, and groundwater. To reduce contamination of groundwater, tailings from the pits will be excavated and placed on and around the three piles. Consolidation of piles at-grade reduces the area of cover and the acreage permanently withdrawn from use. Placement of the tailings on the drainage divide minimizes the need for extensive erosion protection.

The embankment will have 20 percent sideslopes and 3.5 percent topslopes. Surface water flows from the southwest face of the embankment and the area west will be channeled to existing drainage features south of the embankment by a diversion ditch along the southwest perimeter. The remainder of the embankment is surrounded by a rock apron to prevent undercutting and gully intrusion. The configuration of the embankment and a typical cross-section are shown in Fig. 3 and 4.

Interesting Aspects

Data was obtained from the site to calculate settlements across the final embankment because of the concerns associated with placing remolded tailings over 40 feet of undisturbed tailings in some areas, on foundation materials and adjacent to the tailings in others. The piezocone was chosen as the prime characterization tool and was supplemented with boreholes and laboratory data in order to evaluate the tailings in their in-situ state (1).

The results showed that use of the piezocone effectively and economically characterized the material type and behavior of the hydraulically-placed tailings. The piezocone enabled significant amounts of data to be collected quickly while still maintaining reasonable exploration and laboratory testing costs. In addition, other parameters such as friction angle, blow counts, undrained sheer strength and over-consolidated ratios were determined from the piezocone data.

THE SPOOK SITE

Location and Description

The Spook mill site and tailings pile are in Converse County, Wyoming, 48 miles northeast of Casper.

The site consists of an abandoned open pit uranium mine, a mill site, and several miscellaneous contaminated areas. A portion of the tailings are adjacent to the large open pit from which the ore was mined. The remainder of the tailings are along the southeast pit wall where they were dumped over the edge. The estimated volume of tailings and contaminated material is 230,000 cy. Overburden materials (1.5 million cy) from the pit are in nine piles. The open pit exposes flat lying Eocene age Wasatch Formation bedrock of medium- to coarse-grained buff, arkosic sandstone with grayish-blue claystone and siltstone, and black carbonaceous shale.

There are two mine tunnels in the southern portion of the pit and one in the northern end; the largest of these tunnels is 370 feet long. Portions of two tunnels have partially collapsed; future collapse of the tunnels could disrupt or concentrate surface flows. Collapse of the tunnels and

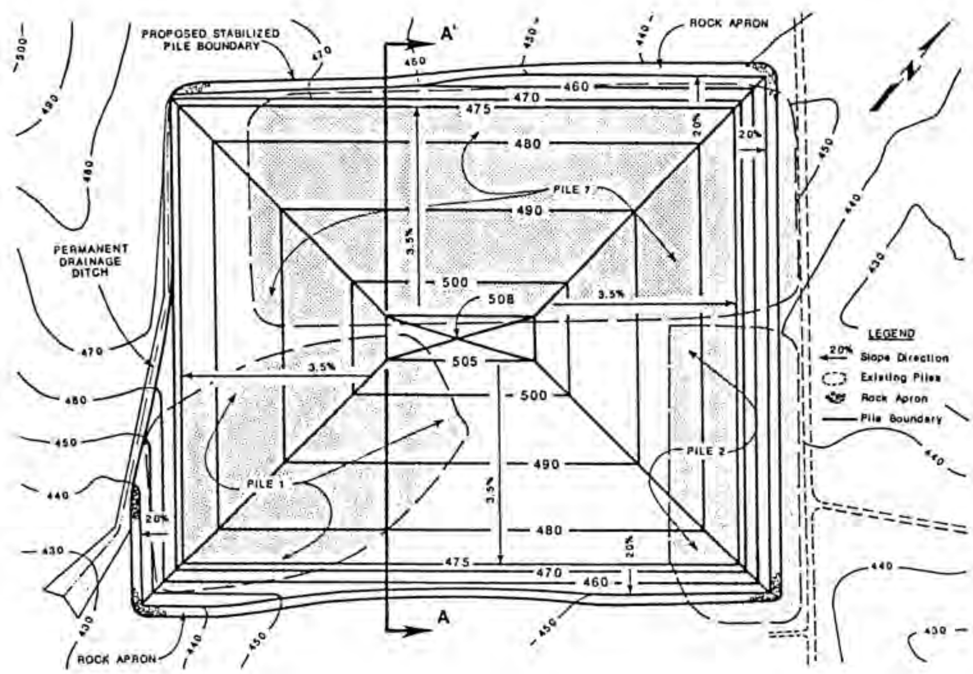

Fig. 3. Typical Cross Section.

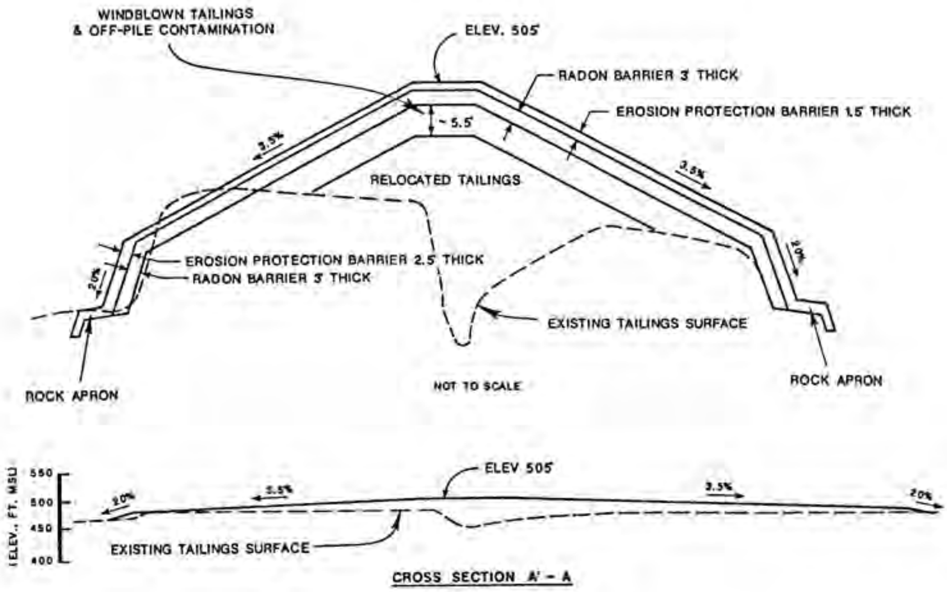

Fig. 4. Typical Cross Section for the Proposed Stabilized Embankment Falls City Tailings Site, Near Falls City, Texas.

fluvial erosion in an ephemeral stream drainage adjacent to the open pit are the two most important processes of concern to stabilize the tailings and contaminated materials.

Groundwater occurs in the upper and lower sandstone units of the Wasatch Formation with water levels ranging from 20 feet below the bottom of the excavated pit to over 100 feet below the surrounding land surface. Background water quality in the site vicinity has been difficult to characterize because the site is underlain by uranium mineralization in parts of the upper sandstone. The area downgradient of the site is influenced by elevated concentrations of metals and radioactive contaminants which occur under natural conditions and from other mining-related processes in the site vicinity. Some of the contamination is probably derived from the milling process and the tailings.

Remedial Action Design

The principal feature of this design is the stabilization of all materials in the pit. The embankment will have 50 percent sideslopes and two to four percent topslopes. The tailings will be covered with a low-permeability layer to inhibit water infiltration. The upper surface will be crowned to encourage runoff of water and reduce infiltration. A configuration of the stabilized embankment and a typical cross-section are shown in Fig. 5 and 6.

Following construction of the embankment, the State of Wyoming will proceed with reclamation of the Spook pit under the State Abandoned Mine Lands (AML) program. The restoration will involve placing and compacting the stockpiled overburden material in the pit, then bringing the surface of the backfill up to the original and surrounding ground surface. The backfill averages 48 feet thick above the tailings and serves as a radon barrier. Stabilization in the pit, as opposed to other options, was selected for the following reasons:

- AML reclamation eliminates the need for erosion protection on the embankment.
- Below-grade disposal is more geomorphologically stable than above-grade disposal.
- It presents the fewest potential negative impacts to the surrounding environment.
- It is the least costly alternative.
- Interesting Aspects

Aspects of this remedial action that are unique to the UMTRA Project are: 1) the construction of 50 percent sideslopes of the tailings embankment in the pit; 2) reclamation of the three adjoining mine tunnels, and 3) coordination of the UMTRA remedial action and AML reclamation programs.

Fifty percent sideslopes were proposed because of the limited relatively level area at the base of the pit, and because long-term stability is not a concern since the embankment will be completely covered with overburden material soon or immediately after stabilization. Steep sideslopes minimize the surface area; thus reducing the amount of low-permeability layer material.

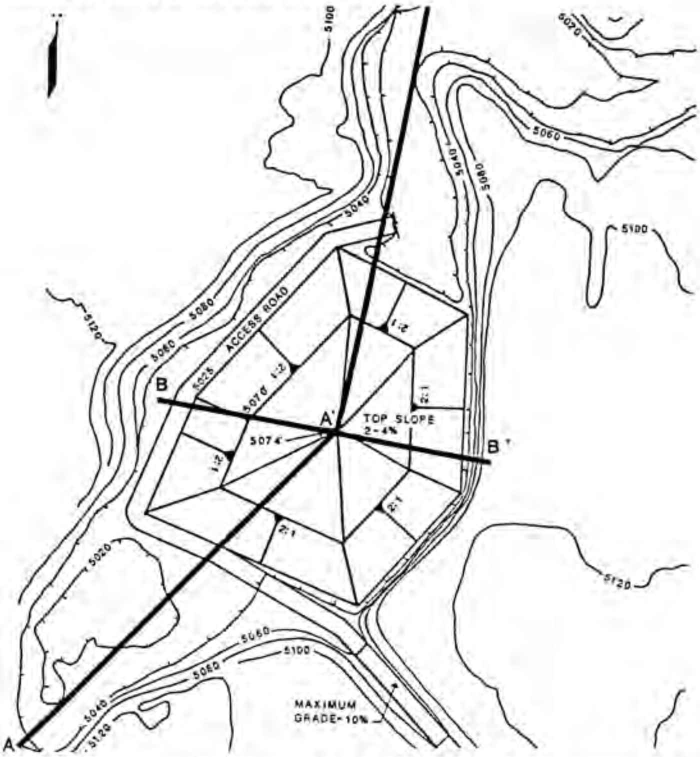

Fig. 5. Proposed Embankment Configuration in the Spook Pit Converse County, Wyoming.

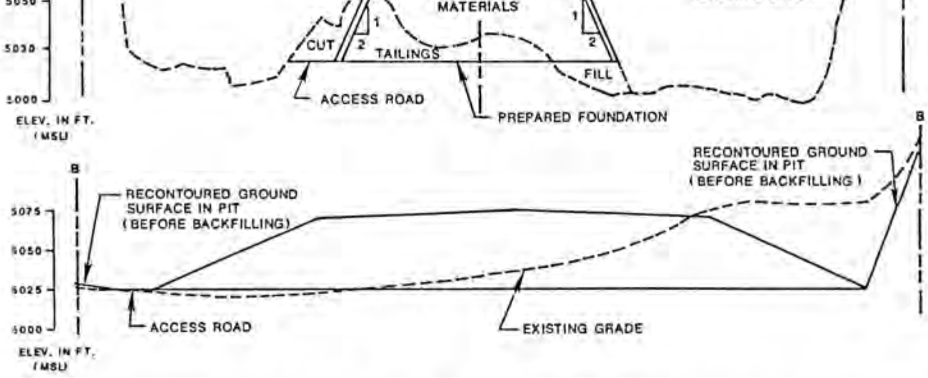

Fig. 6. Typical Cross Sections A-A' and B-B' of the Proposed Embankment in the Spook Pit Converse County,

Reclamation of the three adjoining mine tunnels is important in ensuring design performance of the embankment. The chimneying effects of tunnel collapse could disrupt or concentrate surface-flows, thus providing a means of rapid infiltration. One method of safely backfilling the tunnels is pneumatic loading of granular materials into the tunnels. Construction firms bidding on the work will be given the option of selecting the most cost-effective method.

Efforts to coordinate and combine the schedule, site characterization, and design and construction of the UMTRA and AML projects have been challenging, particularly in obtaining cost efficiencies and avoiding duplication of work. Combining two separate projects with different design objectives (i.e., longevity requirements) has raised many issues that are in the process of being resolved. One such issue is how and where the UMTRA surveillance and maintenance program can be implemented since the embankment lies under 48 feet of overburden material which is part of another project that has a maximum design life of only three years. Work is currently being done to coordinate both projects under one construction contract. This would allow more flexibility in the schedule and construction sequence; both projects could be done concurrently rather than waiting for remedial action to be completed before commencing with reclamation.

CONCLUSION

The rationale for locations and layouts of the designs of the four low priority sites, as well as all other UMTRA sites, are developed through effective use of site area and topography in order to minimize the:

- amounts of contaminated materials to be relocated
- amount of cover material
- erosion protection requirements
- effects on groundwater and surface water, and
- the final restricted area.

Also a cost-effective balance has to be found between the volume of contaminated material to be handled and the cover material requirements.

This paper has described a few of the approaches and engineering solutions to dealing with the unique requirements and constraints of these sites, as well as to report on the current status of the designs.

ACKNOWLEDGEMENTS

The U.S. Department of Energy's (DOE) Uranium Mill Tailings Remedial Action (UMTRA) Project is headquartered in Albuquerque, New Mexico. The Technical Assistance Contractor (TAC) is a team of Jacobs Engineering Group Inc., Roy F. Weston Inc., and Sergent, Hauskins, & Beckwith Geotechnical Engineers. Staff of the TAC and DOE have formulated and contributed to the designs described in this paper. The input of the many people who have been involved in the work is acknowledged.

LIST OF REFERENCES

1. N. Larson, and B. Keshian, Jr., "Prediction of Strains in Earthen Covers", Hydraulic Fill Structure '88, Geotechnical Engineering Division, ASCE, August, 1988, Ft. Collins, Colorado (1988).