Reclamation Plans at Title I and II Tailings Sites[a]

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Abstract

Reclamation of uranium mill tailings impoundments in the U.S. is controlled by Federal legislation which has set forth the regulatory framework for reclamation plan approval. Title I requirements govern government owned inactive sites and Title II requirements govern active tailings impoundments or those operated by private industries. While the Title I and Title II designation may result in a slightly different regulatory process, reclamation of uranium tailings sites has the same fundamental performance goal, which is to implement reclamation plans that will be relatively maintenance free and will provide stable containment of the tailings over the long term. Differences between Title I and Title II reclamation plans are generally in the embankment and surface covers. The differences in the cover result from site-specific conditions, rather than from differences in engineering approach or the regulatory process. This paper discusses the presence or absence of an earthen embankment, which is the primary site condition that affects the selection of cover

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designs, and provides a comparative example to illustrate the effect of this condition.

Introduction

In November, 1978, Congress enacted Public Law 95-604, the "Uranium Mill Tailings Radiation Control Act of 1978" (UMTRCA). The Act authorized the U.S. Department of Energy (DOE) to enter into cooperative agreements with affected states and tribes to establish reclamation plans at inactive uranium mill tailings sites, Title I sites. The Act stipulates that the DOE will meet the applicable radiation standards promulgated by the U.S. Environmental Protection Agency (EPA). It further states that the U.S. Nuclear Regulatory Commission (NRC) is to concur in all major decisions and to license the surveillance and maintenance of the final disposal sites. The law has also set forth the requirements for remedial action programs at the active industry, Title II sites. In both cases, while the regulatory and procedural requirements are slightly different, the goals for reclamation and the standards applied are the same.

The technical standards established by the EPA that most directly affect reclamation cover design at inactive and active uranium mill tailings sites are that the reclamation:

> Be effective for up to 1000 years to the extent reasonable, and in any case, for at least 200 years, and
>
> Provide assurance that releases of radon-222 from the tailings to the atmosphere will not exceed an average release rate over the entire site of 20 picocuries per square meter per second (40 CFR 192).

In developing the standards, EPA determined that:

> A primary objective for control of the tailings should be isolation and stabilization to prevent their misuse by man and dispersal by natural forces such as wind, rain, and flood water (40 CFR 192).

The other objectives established by EPA which were important considerations were to reduce radon emanations and to eliminate significant exposure to gamma radiation from the tailings. The NRC has incorporated the EPA standards in their regulatory process as technical criteria (10 CFR 40, Appendix A) and has prepared several guidance documents which provide methods for evaluating performance (such as Nelson, et al., 1983 and 1986). These evaluations are the basis for determining if proposed reclamation plans achieve the established long-term stability goals.

Comparison of Reclamation Plans for Title I and Title II Sites

Since the technical criteria for judging acceptable reclamation plans at Title I and II sites are the same, the differences in the plans developed for different sites results principally from site-specific conditions but also to the technology available for evaluating performance.

It has been suggested that the UMTRA Project and DOE have been less concerned with the cost effectiveness of the designs for reclamation covers for Title II sites and have applied rock or soil/rock matrix covers without giving full consideration to other cover options. On the other hand, the active industry has been accused of developing cover designs which include no rock or minimal rock in an attempt to reduce the cost of reclamation as

the primary goal. Evaluation of the cover designs thus far presented to the NRC for approval indicate that neither assertion is correct. In fact the cover designs that have been developed by both the industry and DOE are based on achieving the goals of reclamation in the most cost effective and technically effective manner. The basic differences that exist in the cover designs result from differences in the site specific conditions.

An additional factor that exists is the differences in the level of the technology available to evaluate the performance of cover options. Extensive research has recently refined the design evaluation technology for rock and soil/rock matrix covers. Rock covers can now be designed with a relatively high degree of confidence that, with proper construction, will perform as well as the design evaluation predicts. In contrast, the evaluation of soil cover performance is somewhat limited by the technology available and requires extensive engineering judgement. Since an acceptable design methodology for soil covers has not yet been fully developed, the confidence level in implementing a soil cover is less than that which results from using a rock cover.

This difference in technology may be a significant part of the differences in the Title I and Title II reclamation plans. However, it must be noted that for either type of cover the analyses used to evaluate performance are based on conservative assumptions, and conservative parameter values are generally used. Therefore the designs that result from the evaluation process for either type of cover are also very conservative, making the level

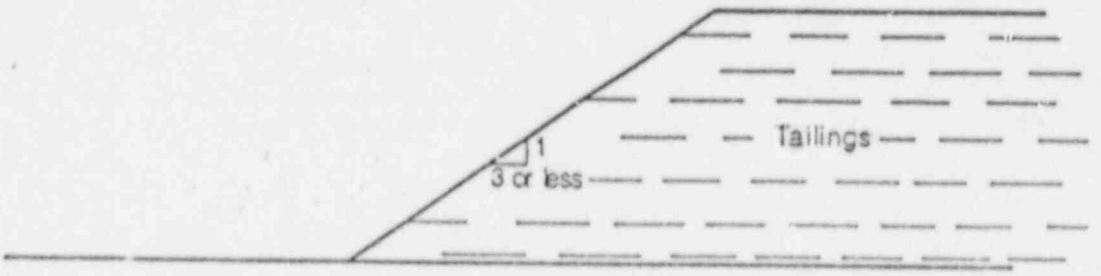
of risk involved with either type of cover an issue of relative magnitudes.

Embankment Covers

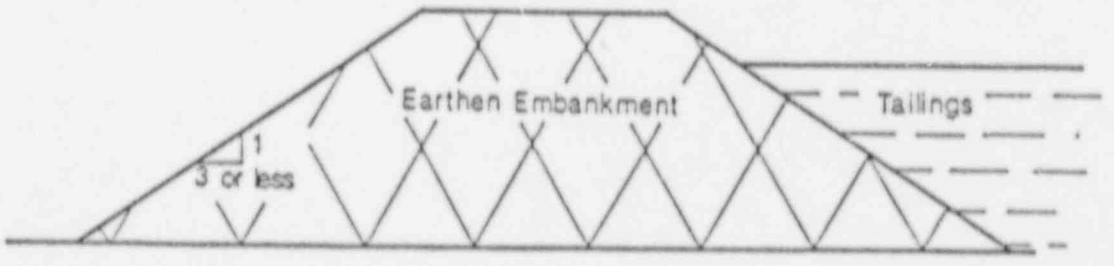
The major site condition that leads to different cover designs is the presence of earthen embankments at most Title II sites and their absence at Title I sites. This condition dramatically affects the potential for gully erosion to expose and release tailings from the site.

Gully erosion has been identified as one of the most important factors affecting reclaimed surface stability. The most important analysis to determine if a cover provides the necessary long-term stability is to estimate the potential for and maximum depth of gully intrusion on the embankment. The primary method of predicting depth of gully intrusion is outlined in Nelson et al. (1986). This method predicts the potential depth of gully incision, and therefore the potential for gully erosion to expose and release tailings. This is the key consideration in the determination of cover design acceptability.

For most Title I sites, where the embankments are constructed of tailings, a much more critical gully intrusion situation exists than at Title II sites, where embankments are constructed of earthen materials. These two embankment conditions are illustrated in Figure 1. Because of this condition, two basic cover options exist for Title I sites. One is to flatten the slopes slightly and construct the embankment cover using a relatively thin surface of non-eroding material, such as rock.



Title I Site



Title II Site

Note: Drawing Not To Scale

Fig. 1 - Typical Embankment Conditions at Title I and Title II Sites

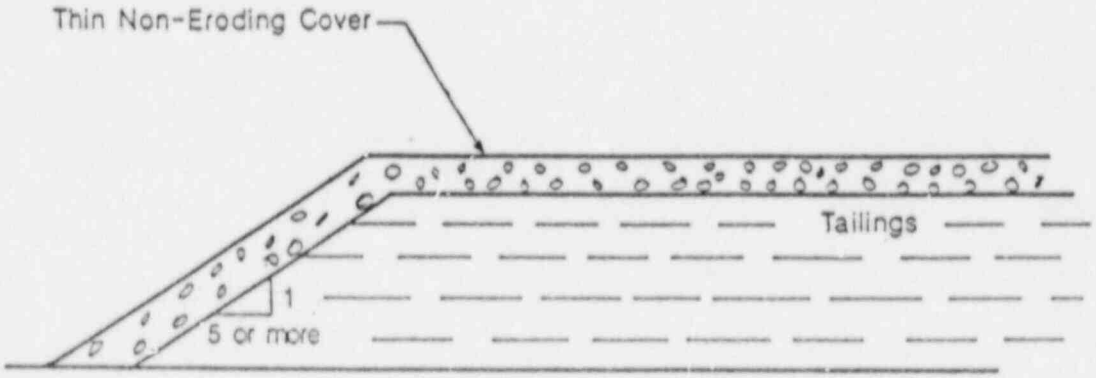
The other option is to use a soil cover thick enough to preclude potential gully intrusion into tailings. Figure 2 depicts these two options. For the first option a small amount of generally higher cost rock is required, as opposed to a larger amount of lower cost soil for the second option. In the second option, much flatter reclaimed slopes are required to minimize the cover thickness. The availability of suitable rock may be a constraint in constructing the first option embankment cover. However, the economics of that option relative to very thick earthen covers are such that acceptable rock can be brought from a significant distance and still make this the most cost effective choice.

In contrast at Title II sites, which generally have earthen embankments already in place, essentially no additional embankment thicknesses may be required to prevent predicted gully intrusion from incising into tailings. Therefore, modification of the existing embankments using relatively small amounts of soil to produce the final reclamation surface is an acceptable and economic solution.

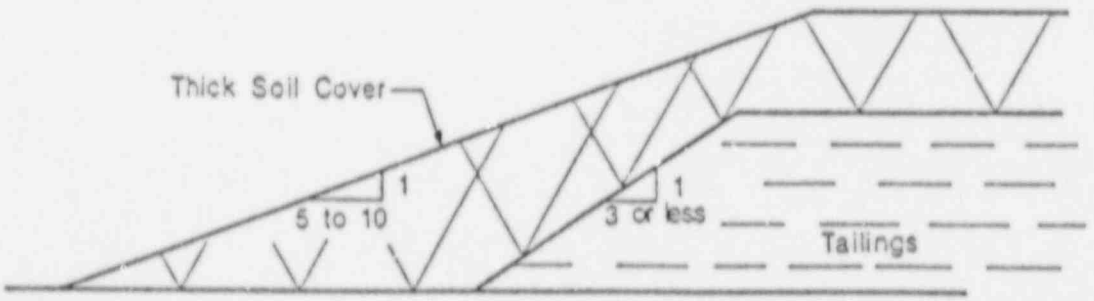
Top Surface Covers

For the top surfaces of some reclaimed sites, long-term erosional stability can be provided by vegetation-stabilized soil covers without rock surfaces. At Title II sites where this has been proposed, the top surfaces are gently sloping to aid in erosion control.

The decision to use a thinner rock surface over a clay radon barrier relates to cost. At Title I sites where the rock-clay



Option 1



Option 2

Note: Drawing Not To Scale

Fig. 2 - Basic Embankment Cover Options for Title I Sites

cover has been used, suitable cover soil material is in as short supply as clay and rock, and therefore a thicker soil cover (to achieve the same radon control performance) has been more expensive than the thinner rock-clay combination. The rock surface is used to maintain an elevated moisture content in the clay (to minimize desiccation) in addition to providing erosional stability. At Title I sites, this radon control strategy has been dictated by economics.

Case History

A useful illustration of the differences in the reclamation design of Title I and Title II sites that result from different site conditions is provided by two sites in the Falls City area of south Texas. The Title I site is the Falls City (Susquehanna) Site and will be reclaimed by the DOE's Uranium Mill Tailings Remedial Action (UMTRA) Project. The other site is the Conquista Project, an active Title II facility that will be reclaimed by the owners Conoco Inc. and Pioneer Nuclear Inc. Because of their close proximity (approximately 2 miles or 3 km apart), these two sites are essentially identical in terms of the natural environment in which stability of the reclamation plan must be demonstrated. The condition that causes the proposed reclamation for each site to be different is the presence of an earthen embankment at the Conquista Project tailings impoundment and the absence of earth embankments at the older Falls City Site.

Our understanding of the proposed reclamation plan at the Falls City Site is that the separate tailings piles will be

consolidated into one entity. The outer slopes of the consolidated tailings pile will be tailings with the steepest slopes constructed at five to one. The entire pile will be covered with a soil radon barrier over which will be placed a filter bedding layer, and covered with a soil/rock matrix surface on which vegetation may establish. The steepest reclaimed slopes will remain at five to one.

At the Conquista site, the proposed reclamation plan calls for the placement of fill material over the tailings to create a very gently sloping domed surface. The resulting soil cover and radon barrier will be stabilized with vegetation. The outer slopes are proposed to remain at the present three to one embankment slope, and will be stabilized against erosion with vegetation.

At the Falls City Site, the inclusion of the soil/rock matrix surface is proposed for the embankments because it is estimated to be less expensive than the much thicker soil cover that would be required to provide comparable erosion and gully intrusion protection. Analyses show that the existing earthen embankment that surrounds the Conquista tailings impoundment is sufficiently thick to isolate the tailings from predicted gully intrusion, and that the vegetation-stabilized soil provides acceptable erosion control.

Conclusions

While the cover options employed for Title I sites are generally quite different from those commonly proposed for Title

APPENDIX 1. - References

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Nelson, J. D., Volpe, R. L., Wardwell, R. E., Schumm, S. A., and Staub, W. P., (1983). Design Considerations for Long-Term Stabilization of Uranium Mill Tailings Impoundments, NUREG/CR-3397, Nuclear Regulatory Commission, Washington, D.C., October.

Nelson, J. D., Abt, S. R., Volpe, R. L., van Zyl, D., Hinkle, N. E., and Staub, W. P. (1986). Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments, NUREG/CR-4620, Nuclear Regulatory Commission, Washington, D.C., June.

FIGURE TITLES

Fig. 1 - Typical Embankment Conditions at Title I and Title II Sites

Fig. 2 - Basic Embankment Cover Options for Title I Sites

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