# CONSIDERATIONS FOR CREATING A FREE-STANDING MONOLITH

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## ABSTRACT

The Texas Low-Level Radioactive Waste Disposal Authority is investigating alternatives to shallow-land burial for low-level radioactive waste. This alternative proposes a standard shallow-land burial trench with a reinforced concrete floor over a sand bottom, backfilling the trench voids with concrete instead of sand and using a concrete cap covered with clay and top soil. The use of concrete backfilled trenches in a geologically stable, semi-arid area can provide an additional degree of safety, but their use in a geologically unfavorable area could actually create problems. Three reasons for using concrete backfill are: better intruder barriers, creation of a concrete monolith, and lower susceptibility to subsidence. A fourth nontechnical reason is that the public seems to be infatuated with concrete, which may prove to be the best reason for a concrete backfilled trench. The additional cost of using concrete is approximately $7.78/ft$^3$ of waste buried if the concrete is commercially purchased; however, if a batch plant is utilized, the cost is reduced to $1.43/ft$^3$.

## INTRODUCTION

The disposal of low-level radioactive waste is not only a technical problem, but also a socio-political issue. Several former disposal sites have experienced problems with radionuclide migration. In light of these problems, several new and improved disposal technologies and waste management approaches have been suggested. These include aboveground storage, plastic liners, Surpak-type systems, wick caps, and cradle-to-grave waste tracking systems, to name a few. The Authority believes that an additional degree of safety can be achieved through the use of concrete as the backfill material in a low-level waste disposal trench. If this additional safety factor is available at a reasonable cost, then it behooves the design engineer to use it; especially if it also brings a high degree of public acceptance.

The use of concrete backfill does not preclude the selection of a disposal site that is environmentally sound. Too many self-appointed experts feel that concrete can mitigate the effects of poor site characteristics (1). Before addressing the particular design that the Authority is studying, I must point out that the geology and hydrology of the site must drive the design of the disposal facility (2). The use of concrete at a site with poor characteristics could actually decrease the ability of the site to prevent radionuclide migration.

## TRENCH DESIGN

The construction of our proposed trench is basically the same as shallow-land burial trenches being used at Barnwell, South Carolina and Hanford, Washington. The dimensions of the trench are 210 feet long, 80 feet wide, and 40 feet deep (Fig. 1). The width of the trench at the bottom is 40 feet, but if the area in which the disposal facility is built has tight clay soils, then the bottom width can be increased. The trench bottom has a 1% slope along its length and width to help remove water from the trench. A 3-foot thick sand layer is placed in the trench bottom. Standpipes will be placed along the sides of the trench and extend from ground level to the bottom of the sand. The sand acts as a french drain system for sampling and removal of water. A 2-foot thick reinforced concrete slab (also sloped) is then poured on top of the sand. The slab will contain 4 layers of rebar mesh for structural integrity and to facilitate the pouring of the slab. Next, waste is placed in the trench and all the void spaces are backfilled with concrete. This concrete will contain a very small size aggregate in order to promote the filling of all void spaces. When the trench is filled to 12 feet below ground level, a 2-foot thick reinforced concrete slab is poored on top. After the cement cures, a low permeability clay, gravel, and top soil is placed on top of the cement to act as a wick cap (3).

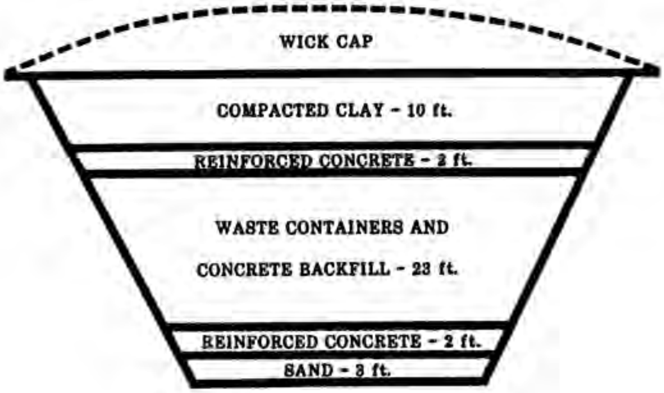


Fig. 1. Trench profile.

In order to facilitate the most expedient waste emplacement operations and to cover the waste as quickly as possible, the trench is divided into three sections. Each section is then divided into three layers (Fig. 2). When the first layer of a section is filled with waste, it is backfilled with concrete. Then another section is filled with waste. If an intensive rainstorm is approaching the site, a partially-filled section could be covered with tarps or immediately backfilled with concrete and covered.

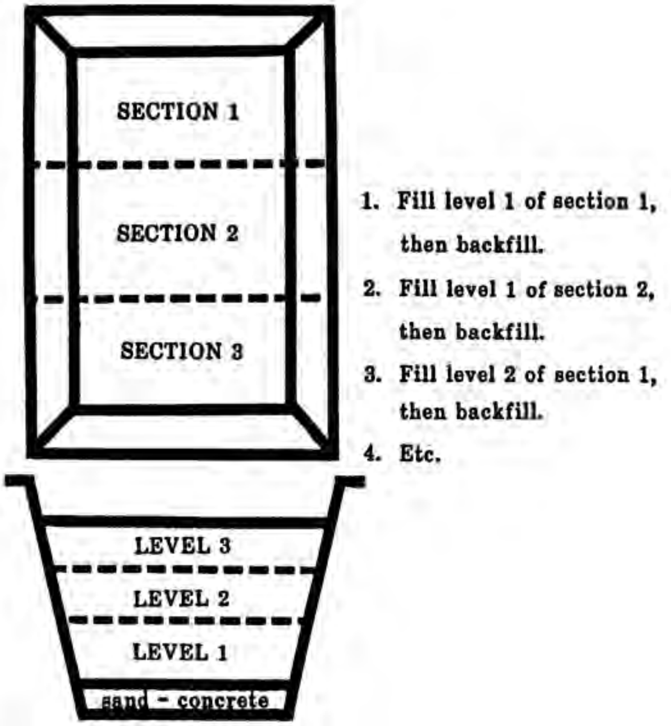


Fig. 2. Waste emplacement and concrete backfilling procedure.

SAFETY FACTORS

The addition of concrete as a backfill material can only be justified through a gain in the degree of safety within the design. According to 10 CFR 61, if Class B/C waste is not buried with at least five meters of cover on top, additional intruder barriers must be provided (2). This design not only creates a solid concrete monolith, but the concrete slab on top also provides another barrier in addition to the 10-foot clay cap. The concrete clab could be embossed with warning symbols and labels explaining the type of hazard to be found below. The concrete structure should also provide excellent protection from the problems associated with burrowing animals and deep-rooting plants.

The concrete monolith should prevent water from intermingling with waste containers and carrying radionuclides from the trench area. This is the major problem that the public associates with shallow-land burial techniques. Instead of creating a bath tub effect, the monolith will act somewhat like a "rock" in the ground. The concrete will have lower permeabilities than the surrounding soil and any water that flows downward will flow around the monolith rather than through it.

The concrete will also add structural stability to the waste containers. This should prevent subsidence for a longer period of time. The concrete should slow down the corrosion process that otherwise may act very quickly on the waste containers. With this type of trench, Class A, B, and C waste can be buried in the same trench. This should not only provide a cost savings through only having to excavate one trench, but also should create less operational problems. In addition, because there are fewer trenches, less potential trench problems, such as subsidence or radionuclide migration should exist.

The last point--infatuation that the public has developed with the use of concrete--adds no degree of safety, but may actually be the force driving the use of concrete in trenches. The public feels that concrete is impermeable and will last forever, but engineers know that there is no way to prevent concrete from eventually developing cracks as it ages. Recent discussions indicate that buried concrete does have a finite lifetime. In either case, it may be expedient to use concrete in the development of a low-level radioactive waste disposal facility, not only for technical reasons, but also because of the enhanced public acceptance during the siting and licensing of a facility.

CONCRETE AND COST CONSIDERATIONS

The total trench volume in this discussion is approximately 456,000 $ft^3$ and the usable disposal volume is 242,357 $ft^3$. If one assumes a 60% usage factor for the trench, then the actual disposal volume will be 145,414 $ft^3$. The predicted annual waste volume to be received at the disposal facility is 133,000 $ft^3$, or about 10% less. This allows for a margin of error in the trench usage factor and the waste volume received. The concrete backfill volume will be about 96,943 $ft^3$. The upper and lower concrete slabs will amount to a total of 42,774 $ft^3$. This brings the total amount of concrete needed for a trench to 139,717 $ft^3$.

If a private contractor was employed to provide the concrete, the cost would be approximately \$200/$yd^3$, including all delivery and rebar charges. This results in an additional cost of \$7.78/$ft^3$ of waste buried, at an annual waste volume of 133,000 $ft^3$. If a concrete batch plant was purchased, the cost could be decreased to \$1.43/$ft^3$ of waste buried. This cost includes the necessary batch plants, cement mixers, rebar, cement, sand, aggregate, concrete slab for the plant, and the additional personnel to run the plant for a 30-year lifetime.

NEGATIVE ASPECTS

As with any proposed design, the negative aspects must be analyzed. The geology and hydrology of a particular site will determine whether this proposed design is applicable. In a seismically active setting, the concrete monolith could develop large cracks. This could increase the likelihood of radionuclide migration. In areas containing shallow aquifers, the concrete could be in a moist environment. This would likely decrease the time it takes for the concrete to degrade.

The trench may need to be backfilled more quickly because of the weather. This could decrease the trench utilization and slightly increase the cost. The prevention of voids is also associated with backfilling the trench. It may be necessary to use a "soupy" concrete misture to ensure that all void spaces are filled.

The disposal facility will most likely be located in a clay formation. This could present some problems because of the shrink/swell and water-absorbing properties of clay. Calcic and sodic type clays can absorb up to 4 and 12 times their weight in water, respectively (4). Precautions must be taken to ensure that the clay does not absorb so much of the water that the concrete does not cure properly. The shrink/swell potential of the clay can be minimized by not allowing water to pond on the surface.

## CONCLUSION

The following points can be made about the use of concrete backfill in a disposal trench. Concrete does not take the place of a good, environmentally sound site, and could actually cause problems if used in improper situations. Construction of a concrete backfilled trench is no more difficult than a conventional trench. Additional cost is probably about 4% of the total disposal cost. Concrete backfill should aid in the prevention of subsidence, radionuclide migration, and plant and animal intrusion. Concrete should also provide better intruder barriers, hence the degree of safety is increased. Finally, the public feels that concrete can help to solve the waste disposal problem.

## REFERENCES


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