

LANDFILL PLANNING: A DESIGN PERSPECTIVE

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Introduction

The design of a modern lined landfill requires a continued relationship between the landfill owner and the design engineer. For county governments, such relationships have been common in their water treatment and waste water disposal facilities. It is, however, not true of current municipal solid waste landfill operations. As was the case in water related facilities, the counties will be faced with upgrading their technical staff to properly administer the contemporary landfill. This paper reviews design considerations that will influence the cost and operation of a liner landfill. Such considerations should therefore be understood and considered by county governments prior to beginning the conversion to a lined landfill.

General Planning Concepts

The design of a lined landfill will be based on general site development and operations concepts that are very consistent for a lined landfills. A thorough understanding of such concepts will enable a county to better plan for staff and funding requirements.

Factors Impacting Air-Space ---- The available storage capacity

of a given site is significantly limited by a number of site and regulatory considerations as follows:

Buffers: Many State are restricting the placement of waste adjacent to the property line of the landfill. the general concept being that this allows monitoring wells time to detect groundwater contamination before it moves off site. Such boundary buffers are commonly 300-feet for MSW waste and 100-feet for ash waste. Such buffer requirements result in an increased usable percentage of disposal land in those sites that are fairly square in shape. Long slender parcels will have a significant portion of their volume destroyed by the buffer requirement. Thus acreage itself is not an indicator of usable landfill acreage. Additionally, this gives land adjacent to the existing landfill a benefit since the buffer zone will not be required between the two facilities.

100-Year Flood: No waste can be placed within the 100-year flood zone of the site. Additionally, the dikes and sedimentation control structures cannot significantly impact the flow of water during a 100-year flood, nor reduce the storage capacity available for flood waters. This requirement has proven to be very limiting in the western portion of the Carolinas where much of the land is either flood prone or steep valleys that are difficult to place a liner.

Wetlands: Destruction of wetlands is prohibited by the Federal government under a program administered by the Corp of Engineers (COE). The landfill cannot intrude onto wetlands unless an equal or greater amount of new wetlands is created by the project. The site utilization must be approved by the COE prior to permitting the landfill. Such requirements can seriously limit the availability of suitable landfill sites in coastal regions. Additionally, the wetlands issue has caused problems in the mountains where wetland type features are common in the canyons.

Archaeological: Usable landfill sites may be permanently or temporarily restricted by historical sites. The restriction will be temporary if the item of historic interest can be removed in a controlled 'dig'.

Endangered Species: The presence of an endangered wildlife species on the site will limit the ability to develop the site. It may be possible to relocate the species to adjacent lands under the supervision of the State Wildlife agency.

Groundwater: Typically a minimum separation of 5-feet is required between the bottom of the liner system and the

seasonal high groundwater elevation. This will limit the depth of excavation for the landfill. This limited depth will reduce the available air-space for waste disposal and the amount of soil that is available for daily cover, etc. A high groundwater table will increase the need for available soil borrow.

Bedrock: As with groundwater, a minimum buffer is required between the bottom of the liner and the top of the bedrock surface. Excavations into the bedrock are limited due to both expense and the possibility of such excavations producing fractures in the bedrock. Such fractures make it impossible to predict the flow direction and velocity of leachate and must be avoided.

Soil Inventory: The construction, operation, and closure of a lined landfill require a significant volume of 'suitable' soil types. Clays or fine grained soils are preferred in the liner system and by many regulators in the cover system. The soils will be the most expensive component of the waste containment system. Their presence on site will significantly reduce the cost of landfill construction. Within the Carolinas it will be unusual to have sufficient clays to construct a liner having a permeability of 1×10^{-7} cm/sec.

Proper consideration of the above factors during the site selection process will significantly reduce the impact of the site on overall landfill costs.

Waste Cell Concept ---- A lined landfill is constructed incrementally to minimize initial costs, longterm liner exposure, and to reduce the amount of surface water that must be handled. Thus while a given site may have a capacity for 20+ years of waste disposal, the initial waste containment cell will have a capacity of typically 4 to 6 years. The individual waste cells will be constructed adjacent to each other and be covered by a common cap. The completed facility will therefore appear to be one large cell and not a family of smaller individual cells. This allow the operator greater control over the facility, but does not result in the loss of the airspace between the adjacent cells.

A economical landfill design will allow the leachate collection system to use common collector lines that are simply extended as new cells are added to the facility. Presently many commercial landfills use leachate collection systems that rely on submersible pumps to move the leachate from beneath the waste to the leachate collection basin. County landfills, however, are commonly designed to allow the leachate to flow by gravity to the leachate collection basin. Such a design requires the leachate collection pipe to pass through the liner and must be carefully constructed.

Leachate Considerations ---- The primary design objective in a contemporary landfill is to collect all liquids leaving the landfill to protect the underlying groundwater. Costs associated with this go beyond that initially spent in construction of the liner and leachate collection systems. The collected leachate must be treated prior to disposal. This has proven to be very costly in existing lined landfills with reported treatment costs ranging from 5 to 45 cents/gallon. These rates are significantly more expensive than typical industrial waste water rates.

To minimize the cost of leachate treatment, landfill waste containment cells must contain design provisions to allow separation of waters that have not contacted the waste from the leachate waters. The 'uncontaminated' water can be discharged as surface runoff without the need for treatment. The new Federal storm water and sedimentation control regulations do require design of the stormwater discharge system. Proper minimization of the quantity of leachate generated will produce significant economy in all cases. This program is particularly depended upon the skill of the operator to continually adjust the separation system as the waste front advances across the cell.

Leachate treatment options include 1) piping the leachate to

the nearest POTW, 2) land application of the leachate, 3) wetland treatment , and 4) recirculation into the landfill. The simplest treatment method to permit is the piping of the leachate to the nearest POTW. Unfortunately, the landfill site is frequently a great distance from the POTW. This is made more costly by the reluctance of States to permit a pump-haul and treat program. the cost of a pipeline from the landfill to the nearest sewer connect may be a significant hidden cost. In general this pipeline will have a very low volume requirement.

Land application may appear to be the most economical, but experience in the Carolinas indicates that permits for such applications will require an intensive and expensive groundwater monitoring program. Rowan County, NC, for instance was issued a land application permit for their leachate but chose to build a 6-mile pipeline to their POTW.

Wetlands treatment systems may offer significant economy of operation to coastal counties but are new and more difficult to permit. Leachate recirculation is common in Europe but has not been permitted at this point in a lined facility in the USA. Recirculation is particularly attractive if the landfill is to be commercially mined for methane.

Additional Land Demands ----- The landfill site must also provide areas for storage of recyclables such as white metals and lands for composting programs. It may be possible in many instances to utilize the buffer zones surrounding the waste containment cells for composting and special waste storage areas. In this manner it may be possible to more fully utilize the full acreage available to the owner.

Specific Construction Planning Needs

The construction of the lined landfill will require the use

of field contractor skills new to the county experience. In general, the general contractors that will bid on the construction of the landfill will be more familiar with earth moving and placement contracts for buildings or highways. The county must be aware that the landfill construction will require significant new skills from the general contractor and improved field inspection methods.

The liner of a contemporary landfill is composed of two distinct layers; an underlying compacted fine-grained soil layer, and an overlying synthetic membrane. Both liners must be placed to minimize the flow of water through the liner system. The soil component of the liner must be placed at water contents higher than typical for soil placement to obtain a minimal permeability. Additionally, the compaction equipment required for proper densification of the soil liner will be different than that required for road work. The installation of the synthetic liner must be monitored by someone responsible for the owner's interest and not the contractor. Past experiences of the author indicate that private landfill owner/operators are aware of the need for skilled contractors and independent inspection but that government owners are not. Typically government procurement limitations result in selection of a marginal general contractor and inspection by the contractor's own people.

Government owners must plan for proper construction of the new landfill and either educate their technical staff to provide proper construction quality assurance or make provisions for contracting out such services.

Specific Operational Needs

The successful operation of the completed landfill requires a comprehensive operations manual prepared by the design engineer and proper training of the landfill staff. The presence of the

landfill liner will limit the ability of the landfill staff to operate heavy equipment near the liner and forces a careful waste placement strategy. The synthetic liner may be very slick, allowing the waste to slide if the waste is improperly placed. Thus the design engineer must be very specific about the maximum depth of waste and the slope of the working face employed by the landfill operator. **No lined landfill can be designed that cannot be failed by improper landfill operation.**

The landfill staff must be educated to continually maintain the leachate/stormwater separation systems, identify potential hazardous wastes, and to work in a manner that will not damage the liner. In general this will require additional certification of and compensation for the landfill manager.