

# MULTI-FACETED BENEFITS OF COMPREHENSIVE LANDFILL PHASING PLANS

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## EXECUTIVE SUMMARY

State regulatory requirements associated with landfill permitting vary from state to state in the level of detail required for landfill phasing plans. Nevertheless, comprehensive landfill phasing plans are essential for planning landfill operations and optimization of capital expenditures at today's MSW landfills. Landfill phasing plans provide the following benefits for landfill operators:

- Achieving a common understanding among landfill manager, controller, environmental manager, and engineer of the airspace and operating life for each phase of landfill development, thereby avoiding the development of new cells on an urgent basis to avoid running out of airspace.
- Improved planning for the associated capital budgets for cell construction, final cover construction, and other landfill features.
- Planning for the construction of on-site roads, including temporary and permanent internal and perimeter roads. Integrating the ongoing expansion of landfill gas collection systems into the phased development of the landfill.
- Integrating surface water drainage system components with phases of landfill development.
- Planning for location of stockpiles for cover material in a manner that avoids double handling.

Inadequate planning can result in not only unnecessary capital expenditures but also possible impacts on operations resulting in lost revenue. Experienced landfill managers know that an integrated approach to planning for these expenditures form the basis of reliable budgets for capital, as well as operating expenditures for each fiscal year. This paper presents not only the principles and advantages of integrated airspace and operations planning, but also a case history which has resulted in notable cost savings.

## BACKGROUND

With the evolution of modern-day landfills, which include capital-intensive components (liners, leachate collection systems, final cover systems, landfill gas control systems, surface water management systems, etc.), the need for phasing and the related airspace management plans has increased notably. The absence of such planning can give rise to various concerns including the following:

- Running out of constructed airspace.
- Stockpiles or other operations located in non-optimal locations.
- Inadequate drainage features and controls.
- Short-term use of on-site haul roads.
- LFG collection system components that need to be replaced or upgraded pre-maturely.

Proper planning for the ongoing development of modern-day landfills entails many components of landfill operations with notable and diverse benefits, as will be addressed in this paper.

## REGULATORY PERSPECTIVE

As is commonly known, consistent with Subtitle D of the Resource Conservation and Recovery Act (RCRA), in 1991, the U.S. Environmental Protection Agency (EPA) promulgated new federal regulations found at 40 CFR 258 that require MSW landfills to address a broad range of new requirements, which were designed to protect human health and the environment. These rules address various aspects of landfills including location restrictions, various operational standards, the control of explosive gases, stormwater management, groundwater monitoring and protection, closure and post-closure, etc. However, the EPA's Subtitle D rules are silent with regard to landfill phasing plans. Since the federal rules were established as minimum standards to be implemented by the states, in turn, each state has developed its own rules governing MSW landfills. Our review of state agency programs indicated a range of state practices for requiring and encouraging the development of landfill phasing plans.

Table 1 summarizes the regulatory programs of 16 states as related to landfill phasing plans. As indicated in this table, whereas some states require or encourage the development of landfill phasing plans, many states do not require the submittal of such plans to the state agencies. As such, the need for phasing plans and the associated level of detail of such plans is left to the discretion of the regulated community. Whereas phasing plans are not necessarily required by state regulations, as noted in the discussion of the associated benefits, phasing plans can contribute to cost-effective regulatory compliance in various ways.

## **COMPONENTS OF A COMPREHENSIVE PHASING PLAN**

Phasing plans can vary from a simplistic two-dimensional diagram depicting the general fill progression of the landfill to a more complex three-dimensional series of contour plans that provide guidance for the development of the landfill over the site life, including consideration of not only landfilling but also related aspects of an integrated solid waste management system (e.g., wood waste management, composting, separate management of construction and demolition waste, citizen drop-off areas, equipment maintenance areas, etc.). This comprehensive approach to phasing entails the following:

- Defining phases of the development of a landfill.
- Development of topographic surfaces (contours) for each phase. These contours define achievable fill heights for each phase. The fill heights for each phase are determined by operating logistics. Whereas the overall objective of the landfill development will be to achieve the permitted final contours, it is understood that reaching final grades will not be achievable within each individual phase, as noted in drawings for the example landfill at the end of this paper.
- The associated landfill volume is calculated for each phase of the landfill, thereby enabling the calculation of the associated life of each phase based on an assumed monthly waste intake. As indicated in the next section, these estimates of the operating life of each phase provide the basis for planning the associated capital expenditures for each phase, most notably the cost for the development of each successive landfill cell, including excavation, liner and leachate collection system.
- Planning for the optimal location (and sometimes relocation) of ancillary facilities and other facilities associated with integrated solid waste

management systems (e.g., wood waste management, composting, separate management of construction and demolition waste and scrap tires, citizen drop-off areas, equipment maintenance areas, etc.).

## **BENEFITS OF COMPREHENSIVE LANDFILL PHASING PLANS**

The notable benefits of comprehensive phasing plans include the following:

- Improving airspace utilization (including avoiding running out of airspace) and financial management.
- Optimizing capital improvements.
- Promoting integrated solid waste management at the landfill.
- Enhancing landfill operations, especially earthwork.
- Maintaining regulatory compliance.
- Cost-effective expansions of landfill gas control systems.

## **OPTIMIZING AIRSPACE UTILIZATION AND IMPROVING FINANCIAL MANAGEMENT**

As noted above, each new cell that is constructed at a landfill has an associated constructed airspace, which, in turn, has an associated operating life. By calculating these values (volume of constructed airspace and operating life of each cell), and estimating the related cost of cell development, landfill managers and their controllers can enhance their financial management tools for forecasting future capital expenditures. As can be seen in Figure 1, the timeframe for the successive development of landfill cells and the related capital cost can be predicted. Further, by incorporating the tipping fees and waste compaction ratios into the financial models, these values can be utilized in estimating the airspace value associated with each phase, and developing associated amortization schedules. In any event, such phasing plans can be used to promote an improved understanding of the value of landfill airspace for accountants and business managers, as well as landfill managers.

## **OPTIMIZING CAPITAL IMPROVEMENTS**

Through advanced planning, cell construction projects can serve as the cornerstone for constructing other improvements at the landfill. In particular, excavated soil from cell development can be utilized in constructing roads, drainage improvements, embankments, and final cover, thereby minimizing double-handling and lowering construction costs.

## **PROMOTING INTEGRATED SOLID WASTE MANAGEMENT**

Many landfills today serve as the center of integrated waste management processing facilities. Such facilities may include various operations, including citizens convenience centers, material recovery facilities, processing areas for construction and demolition waste, wood waste / mulching areas, waste tire shredders, landfill-gas-to-energy plants, household hazardous waste facilities, leachate management facilities, etc. In addition, as technology in the waste industry continues to evolve, some landfill locations are being considered for locating waste conversion facilities and learning centers for environmental studies and related research. As such, optimizing the use of the real estate for such a diverse combination of operations requires significant planning.

## **ENHANCING LANDFILL OPERATIONS**

Landfills require not only significant capital expense, but also significant expense on an annual basis for such activities as earthmoving for grade control and cover soil, as well as for drainage control. Comprehensive phasing plans serve as a management tool to assist landfill managers in many aspects of managing a landfill, including the following:

- Grading plans for each phase of the development of the landfill, depicting maximum achievable grades for each stage of the landfill, including areas with intermediate grades and areas of the landfill where final grades can be achieved in an orderly manner.
- Having such plans identified, therefore enables the landfill manager to plan for intermediate cover and final cover construction.
- Optimizing soil utilization.
- Strategically located soil stockpiles.
- Planning for use of on-site materials (cover soil, clay liner material, roads, embankments, drainage features, and aggregate).
- Confirming the soil balance for the entire life of the site, and, therefore, assessing the need to plan for importing soil from off-site.
- Constructing drainage features, including letdown structures, side-slope swales, and detention basins.

## **MAINTAINING REGULATORY COMPLIANCE**

Permitted designs reflect the knowledge of the site, state regulations, and the state-of-the-art of cell design (including liners, leachate collection systems, etc.) at the time that the site received its initial permit, which may have been many years earlier. Comprehensive phasing

plans provide landfill managers with an opportunity to assess the currently permitted design as related to cell construction and to make a timely determination of the need for changes in the design in advance of construction. Since many changes may have transpired since the time of permit issuance, it may be cost-effective to modify the permitted design prior to cell construction. Common permit modifications related to cell design include the following: alternate liner design demonstrations, revisions to the leachate collection system, improving the excavation plan (e.g., to address new information on depth to rock or groundwater), and addressing or modifying the groundwater controls.

In addition to permit modifications related to cell design, other potential permit modifications might include: revisions to drainage controls; revisions to final grading plans; and changes in permitted cell sequence plans. Comprehensive phasing plans enable landfill managers to proactively address necessary modifications in site permits in a timely, cost-effective manner.

## **COST-EFFECTIVE EXPANSIONS OF GAS CONTROL SYSTEMS**

EPA regulations (40 CFR, Section 60.755(b)) specify that an NSPS-applicable MSW landfill must expand the gas collection and control system (GCCS) to collect landfill gas from areas where solid waste has been in place (1) for five years or more if the area is active or (2) two years or more if the area is closed or at final grade. Complying with this “two-year/five-year rule” requires careful planning, and can be addressed in the context of developing a landfill’s comprehensive phasing plan. This planning will not only contribute to regulatory compliance but also will result in optimizing the installation of extraction wells at interim and final grades for both NSPS-applicable landfills and landfills for which the NSPS rules do not yet apply. In addition to enhanced compliance with the NSPS rules, comprehensive GCCS plans can create the following benefits for landfill operators:

- Optimize landfill gas (LFG) collection thereby increasing the revenue for LFG-to-energy plants.
- Allow planning for the capital expenditures associated with GCCS expansions.
- Minimize re-drilling of gas wells.
- Proper integration of the GCCS expansions with the phased development of the landfill (especially achieving interim and final grades) as well as the overall development of the landfill.

## **UPDATING PHASING PLANS**

In view of the dynamic nature of landfills with variations in the quantity and type of waste received on an annual basis, the need for flexibility and frequent updates becomes readily apparent. As such, many landfill managers find that it is appropriate to review the phasing plans on at least an annual basis – usually in advance of their budget season. This review may entail updating the topographic map of current landfill conditions (either with aerial mapping or ground surveying). Such a review enables the landfill manager to plan for available capacity and avoid running out of constructed airspace. In the course of this annual review, the landfill manager, working in tandem with accountants and financial management team, can provide estimates of the capital expenditures that will be needed in the next fiscal year.

## **SUMMARY**

Landfill phasing plans are an effective tool, not only for enhancing day-to-day operations, but also for planning significant capital expenditures. As described above, the benefits are extensive and multi-dimensional. These plans can be an effective management tool, which enhances communications among landfill operations and controllers, as well as upper management – particularly during the annual budget process. These plans serve to organize the capital and annual operating budgets and, when routinely updated, provide a roadmap for maintaining and optimizing budgets and the resources of the solid waste management department.

**TABLE 1**

State	Regulatory Reference for MSW Landfills	Regulatory Reference for Landfill Phasing Plans	General Level of Detail Required for Landfill Phasing Plans
Texas	30 TAC, Chap. 330	30 TAC §330.63(b)(2)	Schematic view drawings showing the various phases of disposal.
Oklahoma	252 Chapter 515		No specific reference in state solid waste rules.
Georgia			No specific reference in state solid waste rules.
South Carolina	61-107.19: SWM	61-107.19; Part V – Class 3 Landfills	Fill Progression Drawings and Report that addresses phasing and daily, intermediate and final cover.
North Carolina	15A NCAC 13B	15A NCAC 13B Section 1625(b)	Drawings showing fill progression, including waste placement, daily operations, and contours for five year timeframe.
Florida	FAC 62-701	701.500	Requires sequence plan as a component of the Operation Plan for the landfill.
Maryland	COMAR 26 04 07	COMAR 26 04 07 08	Location and depth of solid waste cells, sequence of filling, implementation schedule, and related information.
Virginia	9VAC20-81-10, etc.	9VAC20-81-470.A.1.f	Phasing plan sheets showing the progression of site development with a list of construction items & quantities per phase.
Pennsylvania	Title 25 Chapter 273		Plans showing progressive construction, filling and restoration with consideration for development during the appropriate season.
New Jersey	NJAC 7:26 Subchapters 2 & 2A		None required
Wisconsin	NR 500 Series	NR 514.05(5)	Detailed phasing plan sheet for each phase of development, including grading, stormwater management, soil stockpiles, and quantities.
Iowa	567 IAC 113		No specific phasing plan requirements for permitting in rule. Limited operating requirements for fill sequencing related to surface water mgt.
Idaho	IDAPA 58.01.06		No specific reference in state solid waste rules.
Oregon	OR Admin. Rules (OAR) 340-094	340-094-040(11)(b) Operations Plan	Detailed operations plan describing the proposed method of operation and progressive development of trenches and/or landfill lifts or cells.
Washington	Washington Admin. Code Chap. 173-351		No specific reference in state solid waste rules.
California	27 CCR Chapter 4	27 CCR §21600(b)(4)(C)	Permit level text & drawings describing sequencing plans showing the anticipated phases of site development and topographic map.

FIGURE 1

