Considerations in the Development of a Coal Combustion Products Landfill

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INTRODUCTION

As some coal-based Electric Utilities convert from wet to dry ash handling operations, construction of permitted, lined landfills for long-term storage of coal combustion products (CCP) is becoming more prevalent. Successful development and operation of a CCP landfill requires both the owner and the engineer to consider many factors throughout the landfill siting, permitting, design, construction and operations phases. This paper focuses on the key considerations that were taken into account during the development of a new landfill site in the Eastern US. The landfill was a necessity due to facility enhancements that required the onsite disposal of generated residuals, including fly ash, bottom ash, boiler slag, mill rejects and flue gas desulfurization sludge and gypsum.

Key topics to be discussed in this paper include the following:

- The site selection and suitability process to evaluate potential properties. Many factors were considered in this initial evaluation including property proximity to the power station, size of property, ease of access and potential landfill volumes. Once the most appropriate site was identified, a more detailed suitability study was conducted. The site suitability study evaluated all pertinent criteria including assessment of unique site historic/archeological/biological and drainage features, wetlands, geologic considerations (including depth to groundwater and bedrock) and property buffers.

- Following site suitability approval, the design of the Phase I landfill area was completed. The unique physical characteristics of the CCP required special consideration during the design of the leachate conveyance and collection system. A few of the key permits that were required included a Permit to Construct, Permit to Operate, and Erosion and Sedimentation Control Permit.

- Quality Assurance/ Quality Control and construction oversight procedures that were utilized to verify and document that the landfill was properly constructed. This documentation was, in turn, used to obtain the Permit to Operate.

- Operations and maintenance practices that were developed to maximize landfill volume and control storm water during landfilling operations.

SITE SELECTION AND SUITABILITY

Initially, an extensive site selection evaluation was performed to determine the most appropriate site or sites for long-term landfilling options. Fortunately, the facility is located in a relatively rural area and there was flexibility to evaluate many different sites located relatively close to the power station. Once the various candidate sites were identified, a rigorous analysis of the characteristics of each site was conducted through desktop studies, site reconnaissance, and exploratory investigations. A comparison of each of the options was then developed. The analysis included an estimate of the lined area for disposal, estimated disposal volume, estimated disposal life and the approximate construction cost. This data as well as information related to site access, constructability, and constraints (i.e., regulatory established buffers, geologic conditions, roads, railroads, wetlands, endangered or threatened species, etc.) were evaluated to determine the viability of the various sites. A siting matrix table was developed to identify the disadvantages and advantages of each option to assist in final selection.

A 182-acre tract of land adjacent to and owned by the Station was ultimately selected. Taking into consideration, the buffer criteria as required by state regulations and the construction of landfill infrastructure and support features (i.e., access roads, stormwater conveyance ditches and retention basins, leachate holding ponds, etc.), the available space to dispose and contain the CCPs was approximately 86 acres. CDM Smith subsequently submitted a Site Suitability Application to the State for approval of the entire landfill site. To meet State permitting restrictions relating to the maximum allowable disposal life that could be permitted at one time and based on distributed construction capital expenditures, it was determined that the landfill would be developed in five phases. In accordance with State regulations, the application addressed various application and siting requirements including:

- Determination of existing land use and zoning
- Identification of potential sources of water pollution
- Identification of potable wells and public supplies
- Determination of surface water drainage patterns and features
- Description of the conceptual design, operation and closure approaches

In addition, the application included a geologic and hydrogeologic study to determine subsurface conditions and the depth to groundwater. The application also contained a discussion regarding compliance with the State siting standards related to potential impacts from floodplains, threatened and endangered species, historic sites, nature and historic preserves and airports. This evaluation did identify an endangered plant species

in the project area. To avoid additional permitting and mitigation issues, the landfill was designed to avoid a wooded area where this species was present.

LANDFILL DESIGN – PHASE I

Following site suitability approval from the State, preparation began on the construction plan application. In compliance with State requirements, a more detailed hydrogeologic study for the Phase I area was completed. This investigation evaluated site soil characteristics, depth to bedrock and the depth to the seasonal high groundwater table. The bedrock and groundwater data was utilized to support the final subgrade design, ensure that regulatory requirements for vertical separation from the waste were maintained, and support development of the groundwater well system to be monitored during landfill operation.

Design drawings and specifications for construction were also developed based on input from the Station and CDM Smith's experience with similar projects and site conditions. Sections of the permit application included a Facility Plan describing the overall development of the landfill, Engineering Plan presenting and discussing the analyses regarding the design and construction of the facility permit drawings, Operation Plan presenting the guidelines for operation and monitoring, and Closure/Post-Closure Plan describing how the landfill will be capped and monitored after completion of disposal activities. Engineering calculations and drawings were also included in the State permit application. Key design considerations included the following:

- The landfill configuration and base grading plan was established based on buffer criteria, site topography and geology, seasonal high groundwater levels, earthwork volumes, and stormwater controls. Interior landfill grades were developed by considering the optimization of landfill storage capacity with the economic costs of earthwork volumes. Outside of the landfill, essential infrastructure items, such as access roads, stormwater basins, and leachate storage and management areas, were integrated into the design.

- Geotechnical analyses necessary for the landfill design were conducted based upon the subsurface data, geotechnical laboratory testing, and the proposed finished grades of the new landfill. Analyses consisted of static and seismic global stability analyses, foundation and waste settlement analyses, liner and cover deformation evaluations, and veneer stability analyses of liner and cover systems.

- Stormwater conveyance and management structures were designed to control runoff from the landfill area. The structures were evaluated for operating and post closure conditions so that the design meets or exceeds the regulatory requirements. The bottom liner and leachate collection systems for the landfill were designed in accordance with specific criteria identified in the State Rules. Engineering evaluations were performed to assess the bottom liner system performance and integrity in regards to barrier performance, settlement, bearing capacity, and

stability. The leachate collection and removal systems were designed with leachate-compatible materials and analyzed so that sufficient structural and hydraulic capacity is available for the anticipated loading conditions and leachate volumes. A pump station and pipeline were designed to convey the collected leachate to the Station for incorporation into the Station's wastewater treatment system.

- Post-closure grading plans were developed for the landfill that address stability considerations, stormwater drainage requirements, vegetative cover, and the final cover system design. The Facility Plans show the site development and progression of operation.

The landfill design incorporates a composite liner system and a leachate collection and removal system located directly above the liner. The leachate system consists of a geonet composite layer that directs leachate to perforated collector/header pipes that discharge into a collection sump. A separate storm water collection and conveyance system was also designed to accommodate cell areas of the landfill that were exposed to rainfall prior to receiving waste.

CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL

As is the case in most construction projects, design and successful implementation of a quality assurance/ quality control (QA/QC) program is critically important to verify and document that construction is performed in accordance with the design so that the landfill system performs properly. The CQA plan submitted with the construction permit application detailed the procedures that the contractor was required to follow to ensure proper construction of the various landfill components. Critical aspects of the QA/QC program included the following:

- Full time onsite inspection on all of the contractor's activities – A CDM Smith representative was onsite during the duration of construction. The onsite representative provided contract administration assistance to the client, including review of contractor pay requests, coordinating site meetings and managing overall project communication between contractor and the client.

  The onsite inspection included oversight during the installation of the liner and leachate collections systems. Visual observations were performed for installation of the geosynthetic components (GCL, HDPE liner, geocomposite, and filter fabric), seaming and non-destructive in-field seam testing, liner destructive sampling for the testing of "seam strength" and "peel adhesion", repairs to liner defects and non-compliant seams, and installation of the leachate collection system, including placement of the filter fabric, gravel, and piping. The design plans and specifications required the construction contractor to provide sampling and laboratory testing services for conformance testing of the synthetic materials. CDM Smith reviewed the test results and included them in the final Construction Quality Assurance (CQA) summary report.

- Monitoring of Construction Quality Assurance and Quality Control – The technical specifications also required the Contractor provide construction quality control soils testing and oversight. CDM Smith reviewed the results of soils testing as performed by the Contractor. CDM Smith also "spot checked" the contractor's quality control results by independently collecting and analyzing soil samples to verify compaction results.

- CQA Reporting – CDM Smith began preparation of the CQA Report as each component of the landfill was completed. To expedite the regulatory review process, CDM Smith prepared and submitted individual sections of the CQA Report as they were completed. This summary report included the following:

    - Results of all CQA testing including documentation of any failed test results, descriptions of procedures used to correct the improperly installed material, and results of all re-testing performed

    - As-built drawings

    - Daily field reports and construction progress photographs

OPERATIONS AND MAINTENANCE PRACTICES

Following construction completion, CDM Smith was asked to support the client in developing detailed operational filling drawings. A general landfill operations plan was provided to the State as required for permitting. This general plan, however, was not required to have a detailed filling plan for the landfill operator. CDM Smith evaluated several different options that considered Phase I landfill access points, topography, and desired access points to subsequent phases. Filling drawings were prepared displaying the location of the haul road during Phases I and II filling operations, storm water controls, proposed waste contours, and the access point for Phase II filling.

CONCLUSION

The successful permitting and development of a CCP landfill requires the owner and engineer to evaluate many factors throughout the various phases of the project. Performing a thorough site selection and suitability study is a critical first step to ensure that the most appropriate site is selected. This initial study must evaluate a wide range of issues including proximity to station, regulatory constraints/issues, constructability and site specific hydro-geologic conditions. During design, key landfill component parameters must be determined/assessed to optimize landfill storage capacity while considering economic costs. Construction oversight and implementation of the QA/QC program is essential to verify that the construction is performed in accordance with the design so that the landfill components perform properly. The operations plan should provide sufficient detail to guide the operator on the most efficient approach to operating the landfill while maintaining control of storm water and maximizing volume.