Beneficial Use of Fly Ash for an Airport Safety Way Extension over a Multiple Year Project

John M. Trast, P.E.[1], Dawn M. DeJardin[2], and Gerard M. Skrzypchak[3].

[1]AECOM Technical Services, Inc, 1035 Kepler Drive, Green Bay, WI 54313; [2]Wisconsin Public Service Corporation, 700 North Adams Street, Green Bay, WI 54307; [3]Wisconsin Public Service Corporation, 2501 Morrison Avenue, Rothschild, WI 5447

KEYWORDS: ash, beneficial use, encapsulated fill

ABSTRACT

Wisconsin Public Service Corporation (WPS) actively pursues the beneficial use of the fly ash and bottom ash produced at their Wisconsin power plants. One multi-year project involved the construction of a large ash monofill at the end of Runway 8-26 at the Central Wisconsin Airport (CWA). The project allowed the airport to expand the safety way at the east end of the runway, relocate the localizer array to maximize the runway length, and improve overall site safety at the airport. WPS prepared a multi-year approach including an onsite storage pad, phased construction and filling, and the use of temporary covers to complete the projects. An innovative permitting approach and cooperative effort by WPS, CWA, and the Wisconsin Department of Natural Resources (WDNR) allowed this project to be implemented under an exempt use of solid waste in an encapsulated geotechnical fill, while being required to meet the requirements of the solid waste regulations. This paper discusses the unique aspects of the project resulting in a significant improvement to the airport. Involvement by the WDNR through the NR 500 process included approval of each phase of base and cover liner construction in addition to frequent inspections during the actual construction. The onsite storage pad was approved by the WDNR and allowed the accumulation of sufficient amount of ash to match phases of construction which improved the cost control on the project.

Submitted for consideration in the 2011 World of Coal Ash Conference, May 9-12, 2011.

Introduction

Wisconsin Public Service Corporation (WPS) actively pursues the beneficial use of the fly ash and bottom ash (coal combustion products [CCPs]) produced at their Wisconsin power plants. On June 27, 1991, the Wisconsin Department of Natural Resources (WDNR) issued a Conditional Grant of Exemption from Wisconsin's solid waste rules in accordance Wisconsin Statutes for WPS to beneficially use CCPs from the WPS Weston Power Plant Units No. 1, 2, and 3 as fill material for the construction of a large, geotechnical fill in the safety way on the east end of Runway 8-26 at the Central Wisconsin Airport (CWA). Concerns about air traffic safety motivated the management of CWA to search for a feasible, cost effective way to construct a safety way at the east end of Runway 8-26 to reduce the risk of loss of life and property in the event of an airplane accident near the end of the runway. The CWA Safety Way Project allowed CWA to relocate the aircraft localizer array, maximizing the length of the runway, and maximizing the area and length of the safety way. This was a multi-year, multi-phased project that was initially conceived in 1988, permitted for construction in 1991, and culminated with the completion in the fall of 2010. Photograph 1 shows the completed project on February 19, 2011 with the approximate limits of the fill highlighted.

Photograph 1 – CWA Beneficial Reuse Project on February 19, 2011

Project Overview

The CWA Safety Way Project consisted of the construction of a large geotechnical embankment using CCPs, at the east end of Runway 8-26 to raise the ground surface elevation in case an airplane either over ran or under shot the runway. The final embankment as constructed is approximately 500 feet (ft) (150 meters [m]) wide at the top and extends approximately 1,300 ft (400 m) east. The area is grassed and provides additional safety for take-offs and landings compared to the pre-construction 30 ft (9 m) high 25 percent slope. Overall the embankment is approximately 25 acres (10 hectares) in size, with an average thickness of about 23 ft (7 m). Although the project was exempted from the solid waste rules by the WDNR because of the size of the fill, the conditional grant of exemption requires many of the same features required by a landfill including a groundwater monitoring network, groundwater control system, liner system, leachate collection system, and final cover system.

Prior to construction of the embankment, surface waters and groundwater flowed from the northwest to the southeast across the project site to Peplin Creek. The groundwater depth was shallow, ranging from 0 to 10 feet (0 to 3 m) below the ground surface and the project site contained three small wetlands, all less than 1 acre (0.4 hectares) in size. Working with the WDNR and United States Army Corp of Engineers, the project was permitted to move forward provided the design did not impede the natural flow of ground and surface waters to the creek bed.

A groundwater monitoring network, including both up-gradient and down-gradient locations, was installed to define the hydrogeology and determine background groundwater quality conditions in the vicinity of the embankment and to detect any potential impact to groundwater from the beneficial use project. The network was monitored on a quarterly basis through 1995 and on a semi-annual basis since 1996 for the following parameters:

Table 1 – Groundwater Monitoring Parameters

Groundwater Elevation	Temperature
Field pH	Color, Odor, Turbidity
Calcium	Total Alkalinity
Sulfate	Total Hardness
Magnesium	Boron

Based on the groundwater quality data, the beneficial use project has not impacted underlying groundwater.

The project was originally permitted for the beneficial use of approximately 450,000 cubic yards (cy) (344,050 cubic meters [m^3]) CCPs over an anticipated 6.5 years. The project was divided into two phases and in each phase, 2 modules. Phase 1 Modules A and B were to be constructed in 1991 to provide sufficient capacity through the end of 1992. Phase II consisted of 6 modules, Modules A-F. Two modules were to be constructed every other year (1993, 1995, and 1997) with filling and closure of one module each year (1993-1997). Originally the design called for WPS to supply approximately 324,040 cy (247,750 m^3) and Mosinee Paper Corporation (MPC) to contribute 125,960 cy (96,300 m^3) of CCPs for the project. However, design modifications to improve constructability and meet the needs of the airport increased the beneficial use volume by 236,500 cy (180,800 m^3) to 686,500 cy (524,900 m^3).

Each phase of development started with construction of the base liner system, followed by CCP hauling and placement, and construction of temporary and permanent final covers. At the completion of the construction season, all CCPs were covered either with temporary or permanent final cover to reduce infiltration, leachate generation, and erosion, which also reduced operation and maintenance costs.

The base liner system consisted from bottom to top of the following: a prepared subgrade; a 1 ft (0.3 m) thick groundwater under drain system; a 5 ft (1.5 m) thick general fill layer; a 3 ft (0.9 m) thick compacted clay liner; and a leachate collection system consisting of perforated pipes installed on the top of the clay layer, bedded and covered in a granular filter layer. WDNR approval was required prior to the placement of CCPs in the newly constructed module. Following the construction of the base liner, a construction documentation report was prepared and submitted to the agency. Regulatory inspections frequently took place during each major phase of construction. Regulating parties were familiar with the site and frequently updated about the construction schedule and progress. Review of the construction documentation report and approval of the base liner system typically took between 2 to 3 weeks, once construction of the base liner was completed. After receiving the appropriate approvals, hauling and placement of CCPs began in the approved module.

CCPs were hauled to the project site using quad-axel dump trucks. The ash was dumped, graded, and compacted. Primary compaction was achieved using both a pad-foot compactor and a smooth-drum roller. Secondary compaction was achieved with the construction equipment and the haul truck traffic. Due to the location of the power plant in relation to the beneficial use project, the contractor was able to haul a significant volume of ash in a relatively short time period. This has both benefits and drawbacks that will be discussed below. Once the ash was placed to the design grades and documented, the final cover construction commenced.

The approved final cover system consisted from bottom to top of the following: a 1 ft (0.3 m) compacted clay layer, a 40-mil (1-mm) textured high-density polyethylene (HDPE) geomembrane, a 1 ft (0.3 m) sand drainage layer, a 2.5 ft (0.76 m) rooting zone layer, and a 0.5 ft (0.15 m) topsoil layer. For areas that had not reached final grade at the conclusion of the construction season, an exposed, temporary geomembrane cover was installed. Initially this cover was permitted as a 10-mil (0.25 mm) reinforced HDPE liner, however due to durability and longevity issues, it was changed to a 40-mil (1-mm) smooth high-density polyethylene (HDPE) geomembrane cover.

Construction of the beneficial use embankment began in 1991, and was completed in 2010. The CWA Safety Way Project was originally scheduled to be completed in 1997 based on the anticipated CCP production rates and volume of CCPs needed to construct the embankment. From CWA's perspective, this project was a long-term improvement that would provide benefit, did not impact airport operations, and did not need to be completed in a specific timeframe. Changes in CCP production, management, and development of other less costly beneficial use markets decreased the volume and frequency of CCP placement at CWA. Table 1 summarizes the year, phase and module constructed, and the ash volumes placed during the construction of the CWA Safety Way Project.

Table 1: Volume of Ash Placed in the CWA Safety Way Project (cy)				
Year	Phase Module	MPC	WPS	Total
1991	I A	66,100	35,800	101,900
1992	I B	10,700	57,300	68,000
1993	II A	8,800	24,200	33,000
1995	II A	22,900	55,900	78,800
1997	II A/B	19,700	53,700	73,400
2003	II B		72,300	72,300
2004	II C		18,300	18,300
2009	II C/D		110,300	110,300
2010	II E/F		130,500	130,500
Total		128,200	558,300	686,500

Regulatory History

Under Wisconsin Statues, CCPs are considered solid waste and their use and disposal have been regulated by the state accordingly since the early 1970's. Legislation enacted in 1985 encourages the beneficial use of industrial byproducts as a way of preserving natural resources and saving energy. The WDNR recognized that certain "high-volume" industrial waste streams such as paper mill sludge, foundry sands, CCPs, slag, and lime kiln dust have beneficial physical properties that can be safely and effectively used in a variety of different applications. From 1985 to 1998, beneficial use projects were approved by WDNR on a case-by-case basis. In 1995, the Wisconsin Legislature directed the WDNR to design a rule process to "allow and encourage to the maximum extent possible consistent with the protection of public health and the environment" the use of these industrial byproducts. This initiated a formal rule making process that produced NR 538 - Beneficial Use of Industrial Byproducts, which is a state authorized voluntary environmental program that encourages the beneficial use of industrial byproducts in order to preserve resources, conserve energy, as well as reduce the need for additional quarries, soil borrow pits, and landfills. The program is "self-implementing" and after initial project certification by the WDNR, notification and annual reporting are required.

If another project of similar size and scope to the CWA Safety Way Project were proposed for construction in Wisconsin today, the permitting process would follow NR 538 Beneficial Use of Industrial Byproducts, of the Wisconsin Administrative Code. This chapter addresses the performance criteria and public participation requirements (for projects greater than 50,000 cy [38,228 m^3]), defines the byproduct characterization and permitted uses, and outlines the required storage, transportation, and environmental monitoring requirements. The program is well thought out, allowing for the beneficial use of industrial byproducts in ways that are consistent with the protection of public health and the environment.

The United States Environmental Protection Agency (EPA) on May 4, 2010, issued a Proposed Rule for Coal Combustion Residuals (CCRs). EPA provided two co-proposals for public comment; one addressed regulation of CCRs under RCRA subtitle C and one addressed regulation under RCRA subtitle D. EPA has stated it supports and has endeavored to maintain beneficial reuse of CCRs under both proposed rules. If the EPA were to regulate CCRs under Part 258 of RCRA subtitle D, it is likely that a project such as the CWA Safety Way project would be permitted and allowed in Wisconsin if the WDNR was the regulating authority. However, under RCRA subtitle C, the options for beneficially using or reusing CCPs, even with the Bevill exemption remaining in-place, are significantly impacted and severely limited. Under federal and Wisconsin's Hazardous Waste rules, many hazardous wastes that are reused as products or that are legitimately recycled are exempt from regulations or have significantly reduced regulations. However, under both options in the EPA's proposed rules, recycling of hazardous wastes that are 'used in a manner constituting disposal' (defined as applied to or placed on the land, or used to produce products that are placed on the land) are essentially eliminated, thus these proposed rules would effectively eliminate the beneficial use of CCP embankments and geotechnical fills in Wisconsin.

Opportunities and Construction Challenges

Opportunities

Once the project started and WPS was working with its partners CWA and MPC, the project manager from WPS recognized an opportunity. MPC's boilers are not as efficient as those of WPS and the ash from MPC has a substantial percentage of unburned carbon. In 1997, WPS began taking MPC's ash as a supplemental fuel source. It solved MPC's need for a long-term disposal option for their ash, it provided WPS with an inexpensive fuel source, and it gave WPS control of the use of CCP airspace at the CWA beneficial reuse project, allowing WPS to pursue additional beneficial use options and extend the life of the project until 2010.

Weston Power Plant On-Site Air Permit

In the last two years of filling, one of the limiting issues affecting the beneficial use project was the WPS Weston Power Plant On-Site Air Permit. Since the CWA Safety Way Project was designed to move large quantities of CCPs in short periods of time, WPS was required to verify air modeling to meet the particulate matter emissions established by state and federal regulatory agencies. WPS determined the number of trucks contractors were allowed to use during the bulk hauls, and still maintain compliance with the air permits. This was especially challenging during the construction of the WPS Weston 4,500 MW coal unit, which began in 2004 and was completed in 2008.

Engineering Modifications – Temporary Geomembrane Liner and Anchors

As the initial stages of construction were coming to an end in 1991, the WDNR granted the use of a temporary geomembrane liner to cover the exposed ash slope to prevent infiltration and reduce erosion. Initially this cover was permitted as a 0.25 mm (10-mil) reinforced HDPE liner. The temporary geomembrane was to be anchored along the entire perimeter and have tire stringers or sand bags spaced at 25 feet on center, or more frequently as necessary to hold the geomembrane in place. The performance of the 0.25 mm reinforced geomembrane was not acceptable. It required substantial maintenance and proved to have limited longevity. So, due to durability and longevity issues, the design was modified to use a 1-mm (40-mil) smooth HDPE for the temporary cover. Although the cost of the geomembrane was considerably higher, its performance was substantially better, alleviating concerns that a section of ripped or torn geomembrane could potentially cause an air accident or interfere with the localizer array or airport operations.

The anchorage of the exposed geomembrane initially caused maintenance issues. During the winter, snow and ice would accumulate on the slopes. Due to the very low coefficient of friction between the smooth geomembrane and snow and ice, the latter would slide and accumulate at the toe of the slope. Unfortunately, on steeper sections of the slope, the snow and ice would hang up on the tire stringers that were used to hold the geomembrane down. This build-up of snow and ice would eventually break the cables holding the stringers. The end result was that ballast that was aiding in holding the geomembrane in place over a large portion of the exposed slope had to be continually repaired. As an alternative, HDPE pipes were constructed in lengths to match the slope face. Each tube contained a 1¼-inch diameter, 20-foot section of galvanized pipe for ballast weight and each end capped with HDPE cap. The same cabling system was used to hold the pipes in place at the top of the slope. The end result was snow and ice no longer hung up on the anchors and the anchors remained in place. In addition, the pipe anchors were easier to remove and reinstall, and caused less liner damage than was caused by the use of tires on the slope.

Engineering Modification – High Bedrock

In 2003, with the construction of Phase II, Module B, it became apparent that as construction moved further east, the thickness of the overlying soil decreased, the bedrock elevation was increasing, and the sub-base grades were decreasing. In Module B, the construction contractor spent a significant amount of time trying to rip bedrock to reach the sub-base grade of the module to install the under drain system. We also anticipated encountering significantly more bedrock in the following modules, and ripping in this area was not economically feasible. The events of September 11, 2001 virtually eliminated any chance of rock blasting at the airport. The only option was to redesign the base grades to accommodate the higher than anticipated bedrock, and allow for flexibility in dealing with rock pinnacles. The objective of the under drain system was two-fold: provide a minimum 5 ft (1.5 m) groundwater separation from the top of the under drain system to the bottom of the compacted clay liner, and to prevent any impedance of the natural flow of groundwater to Peplin Creek. The option proposed was to excavate to sub-base grades as planned, and at locations where there was high bedrock, the rock was left undisturbed as long as water in the under drain system was still discharged. This limited the areas that needed to be ripped to areas where the rock protruded through the under drain system. The WDNR agreed with the design modifications and with the revised base grades which eliminated the requirement to rip bedrock in subsequent modules.

Airport Expansion

In 2003, WPS placed approximately 72,300 cy (55,277 m^3) of CCPs in the CWA site, which completely emptied their on-site stockpile, and plans were made to suspend the project for several years. However, in 2004, CWA received federal funding allowing the airport to reconstruct Runway 8-26, reconstruct the taxi way, and relocate the localizer array to maximize the length of the runway. To accomplish this, the localizer array would need to be relocated approximately 400 ft (122 m) east of its original location and approximately 100 ft (30 m) beyond the top crest of the temporary east slope completed in 2003. This necessitated the filling that occurred in 2004, and helped to accommodate one of the objectives of the beneficial use project from its inception, to improve safety at the CWA.

WDNR Approvals

Although the regulations on how the state permits beneficial use projects have changed since this project began in 1991, this project has remained consistent with the initial grant of exemption. The site was handled much like any other landfill construction project in the state of Wisconsin. Specifically, the appropriate regulatory staff was informed about upcoming construction projects, invited to the preconstruction meetings, and invited to all regularly scheduled construction meetings. The conditional grant of exemption required WDNR approval of the base liner system prior to ash placement. Coordination and open discussion with WDNR was crucial in obtaining timely approvals and limiting delays in the CCP hauling and placement.

Project Consistency

With a project that has spanned almost 2 decades, one of the significant challenges was consistency with the project participants. None of the individuals that worked on this project from inception saw it to completion. Whether due to retirements or replacement all of the project participants changed over time. The project managers from WPS transitioned and retired; the airport general manager retired; the design engineer was replaced; and the WDNR personnel changed. Good record keeping, open and honest communication and flexibility have been key in successfully completing this project.

Summary and Conclusions

WPS viewed the project as a cost effective utilization of CCPs that created an effective partnership between CWA, MPC, and WPS. This site provided a long-term option for placement of material in a beneficial project, preserving resources, conserving energy, and saving landfill airspace. Careful planning and innovative modifications minimized expense and aided in extending the life of the project.

Airport management also viewed this as a successful partnership by allowing the airport to make cost effective improvements and meet Federal Aviation Administration safety requirements with less cost than traditional means. As a result of the project, the safety way was expanded, the runway length was maximized, and the localizer was relocated to a more suitable location, all creating a safer environment for the air traffic in Central Wisconsin.

Throughout the lengthy project, the WDNR was very cooperative in finding workable solutions for WPS, MPC, and CWA while maintaining environmental stewardship. Continual coordination and communication between WPS, CWA, and WDNR aided in addressing challenges to find solutions that did not compromise the integrity of the site. Overall, the commitment to teamwork on behalf of the WDNR, WPS, and CWA allowed for the community to benefit.