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On the Cover

CCPs are used in geotechnical applications ranging from backfill for earthen berms to structural fill for mine reclamation.

Adapting to an Evolving Marketplace

By Steve Benza, ACAA Chair

Scarcely a decade ago, coal accounted for roughly half of the fuel used to generate electricity in the U.S. Today, coal's share of the power market is less than 20 percent—the result of price competition from natural gas and governmental incentives encouraging the use of renewable energy. The ramifications are many and include economic dislocation in coal-producing regions and reduced availability of coal combustion products for ash marketers and their varied customers.

The good news is that coal retirements have slowed greatly in 2021, and ash supply from plant production is projected to be steady for much of the next two decades. On the other hand, demand for CCPs is forecast to continue to rise over this same period. Meeting this demand will require our industry to continue developing strategies to ensure the continued supply of ash products to our downstream customers where and when they need them, including:

- Technologies that remove excess carbon from coal ash, passivate the carbon that remains in ash, and mitigate the effects of particulate emissions control devices on ash;
- Beneficiation methodologies that allow for utilization of previously disposed CCPs;
- Expanding the use of natural pozzolans and blending of ashes to help increase supply;
- Updating specifications to allow for the use of products such as ground bottom ash that can be used as supplementary cementitious materials;
- Investment in storage and distribution infrastructure to address seasonal and geographical disconnects between ash production and use; and
- Augmenting terminal and logistics capacity to allow for imports where economically feasible.

The to-do list is extensive. But the stakes couldn't be higher—for our industry, our customers, and our country. Core infrastructure—from bridges to dams, roads, pipelines, ports, and runways—are in desperate need of upgrading. Much of that infrastructure will be built from concrete. A reliable, robust supply of coal combustion products must be available to ensure that this infrastructure is built to the highest safety and environmental standards.

Fortunately, our industry is not alone in recognizing the need for cost-effective, sustainable construction materials and solutions going forward. Since large quantities of CCPs find their way into infrastructure projects, we can and will continue to work with like-minded groups such as the National Ready Mixed Concrete Association, the American Road and Transportation Builders Association, the National Stone, Sand, and Gravel Association, and the Portland Cement Association to advocate for federal support of green infrastructure buildout. Similarly, we are working with standards bodies including AASHTO, ACI, and ASTM International to update specifications that would encourage the use of materials to increase the supply of CCPs—such as blending of in-spec and out-of-spec fly ashes, fly ash and natural pozzolans, and ground bottom ash with fly ash.

As the marketplace continues evolving, so too does our industry. Like many ACAA colleagues, I am nearing retirement age. So, in looking toward the future, I believe we must also focus on educating the next generation of industry professionals and leaders. What new skills will our rising generation need to ensure the industry's continued success in this changing marketplace? How best can the ACAA assist its member companies in managing this industry transformation? What tools, training, and programs are worthy of our time and investment? I look forward to discussing these and related issues in the months ahead with our members.

In closing, I'd like to thank former chair Kenny Tapp for his hard work in leading the ACAA through some turbulent times. I look forward to my term as his successor and to helping guide our industry on a path to sustainable success in the future.


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Almost Normal

By Thomas H. Adams, ACAA Executive Director

As we reach the midpoint of 2021, we find many activities returning to a semblance of familiarity to what was "normal" when the COVID-19 pandemic struck in full force in early 2020. Workers are returning to their places of employment, in-person meetings and events are resuming, and many of the COVID-19 precautions and restrictions are being eased or eliminated. The widespread availability of vaccines has made a huge difference. But make no mistake: there are still many concerns about the health risks posed by exposure to the coronavirus, especially for the elderly and those with underlying conditions that increase risk for serious illness or even death.

For the American Coal Ash Association (ACAA), our challenges did not take a break during the COVID lockdown. With the election of President Biden, new management at the U.S. Environmental Protection Agency (EPA), and one-party control of Congress, anti-coal advocates have resumed their efforts to increase regulation of coal combustion products (CCPs). Efforts to redefine "beneficial use" of CCPs, regulations for CCP stockpiles intended for beneficial use, and an outright ban on "unencapsulated" beneficial uses are the most immediate examples of the assault on uses with decades of demonstrated safe application—and are based on no legitimate damage cases or new research to support new limitations.

In this issue, we have a guest editorial by Richard Kinch. Mr. Kinch retired from a long career at the EPA. Oversight of coal combustion residuals (CCRs) was one of his primary responsibilities. I recommend you read his editorial closely and share it with your colleagues. It is a revealing insight into the crooked path of EPA rulemaking for CCRs.

As we get the opportunity to resume meeting with Congressional offices and EPA, Government Relations Committee Chair John Ward and I will be working to inform members of Congress of the real story behind beneficial use.

* * * * * * * * * * * * * * *

The ACAA is returning to in-person meetings starting this coming October with our fall membership meeting. To make this event even more special, we are adding a CCP workshop. With our partners at the Center for Applied Energy Research at the University of Kentucky, we will offer sessions on recent developments in ASTM documents, rare earth element extraction, ponded ash, research in-progress, harvesting activities, and regulatory discussions. The event will be held at the French Lick Resort, French Lick, Indiana, October 19 to 21. This unique resort offers a wide array of high-quality options, including two excellent golf courses, a spa, fine dining, casino gambling, and much more. To learn more about this facility, please visit www.frenchlick.com.

We look forward to seeing you this October for our "coming out" party. It will be interesting to see what "almost normal" looks like this fall.

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Sustainable Use of FGD Structural Fills in Mine Reclamation: Geotechnical Properties and Environmental Response

By Tarunjit Singh Butalia, Ph.D., P.E., Chin-Min Cheng, Ph.D., P.E., and Mehedy Amin

Introduction

The Bureau of Land Management estimates that there are as many as 500,000 abandoned mine lands (AMLs) in the United States.[1] These AMLs discharge highly mineralized acidic mine drainages, disrupt flows of surface water streams and lakes with sediments, contain highwalls that are potential threats to public safety, and degrade the ecosystems and habitats of the impacted watersheds. Reclaiming these AMLs is needed in order to improve the quality of the environment and eliminate the hazards within impacted regions.

Using structural fills made of coal combustion residues (CCRs), especially flue gas desulfurization (FGD) materials such as stabilized sulfite-rich FGD (sFGD) material (a mixture of lime, fly ash, and FGD filter cake) and sulfate-rich FGD gypsum, can be an effective and economically viable approach to reclaim AMLs. However, the use of CCRs for remediating abandoned mine lands has also been questioned.[2] Upon the request of the U.S. Congress, the National Research Council (NRC) conducted a study evaluating the health, safety, and environmental risks associated with the practice of using CCRs in reclaiming active and abandoned coal mines.[3] The study concluded that the practice is a viable option as long as CCR placement is properly planned and is carried out in a manner that avoids significant adverse environmental and health impact. The state of Ohio considers CCRs as a beneficial use if regulations (e.g., Surface Mining Control and Reclamation Act [SMCRA]) and other special requirements are met.[3] The adequacy of safeguards in permits authorizing CCRs' placement in coal mines is important.[4]

In a three-phase study supported by Ohio Development Services Agency (ODSA), American Electric Power, the American Coal Ash Association, and the Midwest Coal Ash Association, we investigated the feasibility of using high-volume FGD materials to reclaim AMLs that are close to coal-fueled power plants (e.g., within a 5-mile radius). In the Phase I study, we characterized the engineering and chemical/leaching properties of FGD materials, evaluated potential project sites for full-scale demonstration, and gathered input from public and industrial stakeholders. In the second phase, two full-scale demonstration projects were carried out at highwall pit complexes near the Conesville and Cardinal coal-fueled power plants located in eastern Ohio. Currently, the reclamation at both demonstration sites has been completed and the study has progressed from the research/demonstration phases to the commercialization phase. Two additional highwall complexes near the Conesville demonstration site are being reclaimed using CCRs freshly produced from the power plant and harvested from a nearby ash pond and landfills by a local land development company.

In this article, we summarize the geotechnical properties of CCR structural fill used to reclaim the highwall complex at the Conesville demonstration site and the observed environmental response after five years since the reclamation was completed.

Geotechnical Characterization of CCRs

The CCRs used for this project include sFGD, gypsum FGD, and some fly ash. The sFGD encapsulates the core filling materials created from the blending CCRs (including sFGD, FGD gypsum, and fly ash). The shear and drainage performance of the CCRs are discussed in the following sections, as both are important aspects for the backfill material to be used as a structural fill in mine land reclamation.

Shear Performance

Shear strength is the resistance to applied shearing forces, which includes gravity in a sloping surface and is featured in this project. Consolidated undrained (CU) triaxial testing was used to determine the engineering shear strength parameters of the material. The test involves the monotonic application of axial strain to a cylindrical specimen consolidated and confined under constant hydrostatic pressure. Shear strength parameters include internal friction angle and cohesion. Internal friction angle is a measure of shear strength from friction. Cohesion is also a measure of resistance that occurs from intermolecular forces.

Table 1 summarizes strength results from the CU testing. A test fill pad at Conesville landfill was the primary source for the test materials. In addition, the Cardinal power plant was also a source for gypsum FGD. The CU testing shows that in general the CCR specimens tend to expand with loading

Table 1: Engineering Properties

Material	Internal Friction Angle (Deg)	Horizontal Hydraulic Conductivity (cm/sec)	Permeability / Drainage
Stabilized FGD + Gypsum FGD + Fly Ash Blend	37.5-38.6	$2X10^{-5}$-$9X10^{-5}$	Low / Poor
Gypsum FGD	40.4-40.5	$2X10^{-4}$-$9X10^{-4}$	Low / Poor
Stabilized FGD	38.0	($1.8X10^{-5}$)	Low/ Poor

volumetrically (dilate), which reduces pore water pressure. This dilative characteristic has a stabilizing effect on short-term loading conditions by increasing the effective stress and shear strength. The dilative tendency also showcases the tendency of these CCRs to resist static liquefaction, since liquefaction occurs due to volumetric contraction.

Drainage Performance

Table 1 also shows the horizontal hydraulic conductivity values of the CCRs from the project obtained from permeability tests. The permeability values of all CCRs are low (10^{-3} to 10^{-5} cm/s) and create poor drainage conditions when used as backfill material. Hydraulic conductivity values show CCR blend and stabilized FGD have comparable hydraulic conductivity, and both materials have slightly lower permeability than gypsum FGD. Using a low-permeable material has the added benefit of shielding the exposed coal seam from the environment. Exposure limitation reduces the quantity of acid mine drainage from the mine pit by limiting infiltration. Furthermore, low permeability and low infiltration improve the quality of seepage water from the area.

Impact on Underlying Aquifer

Groundwater Monitoring

The Conesville site, located approximately two miles east of the decommissioned Conesville plant, comprises three phases. The reclamation at Phases 1 and 2 started in 2009 and was completed in 2016 as one of the two full-scale demonstration projects in the ODSA study. The demonstration project eliminated over 4 miles of highwall and reclaimed about 109 acres of abandoned mine land. Approximately 1.7 million tons of sFGD, FGD gypsum, and fly ash were placed. Progress throughout the period from September 2009 to May 2021 can be seen in Figure 1. Phase 3, which is currently ongoing, is expected to use about an additional 2 million tons of CCRs to reclaim approximately 1.1 miles of highwalls. The Ohio State University was recently selected by the U.S. Department of Energy for completing this work using CCRs harvested from a nearby ash pond and a closed-out FGD landfill.

The associated environmental impacts of the CCR structural fill were evaluated by regularly characterizing the leaching properties of the backfilling CCRs and monitoring the water quality in the uppermost aquifers underlying the reclamation site. Because Phase 3 is still ongoing, this discussion focuses on Phases 1 and 2 completed in the OSU demonstration study. The water quality monitoring network comprises eight groundwater monitoring wells and four surface water locations.[4] MW-0901 serves as a hydraulically up-gradient well. MW-0902, MW-1001, and MW-0904 are installed at the edge of the backfilling area to capture the water quality change in the down-gradient shallow aquifer. MW-0905, MW-0906, and a well cluster (MW-1101s/MW-11-1d) are further down-gradient locations representing approximately 5-year groundwater travel time from the backfilling area (Figure 2). MW-1101s and MW-1101d monitor the water quality in the shallow mine spoils and deep sandstone layers, respectively. OSU began collecting monthly water samples approximately 15 months prior to the beginning of reclamation. The sampling frequency remained as monthly during site preparation and structural backfilling periods before it was reduced to quarterly and later semi-annually after the reclamation was completed.

Groundwater Quality

We used the water quality data collected before the site underwent preparation to establish two-sided background levels, i.e., upper prediction limits (UPLs) and lower prediction limits (LPLs). If any of the field observations recorded after site preparation exceeded a UPL or dropped below an LPL, we noted that the observed water quality had possibly deviated from its background levels and the change was statistically significant with 99 percent confidence. According to Cheng, et al.,[4] at least one monitored constituent in one or more of the groundwater monitoring wells deviated from the background range once reclamation began. For example, the concentrations of 25 monitored constituents in the minespoil layer on the east edge of the area (i.e., MW-0904 [Figure 2]) were found to be higher than their respective UPLs at least once in the samples collected during the period from 2012 to 2016.[4] However, there were also constituents in the same well whose concentrations decreased and became lower than their respective LPLs.[3] Some water quality changes did occur after reclamation began. OSU then focused its efforts on evaluating what was causing the change in water quality during the construction of the CCR structural fill.

Figure 1. Progression of reclamation at the Conesville Five Points site. (1) and (4) are adapted from Cheng, et al.[4]

(1) Phase 1 project area before reclamation.

(2) Phase 2 project area (East Pond) before reclamation.

(3) Site preparation in February 2012.

(4) First batch of sFGD in January 2012.

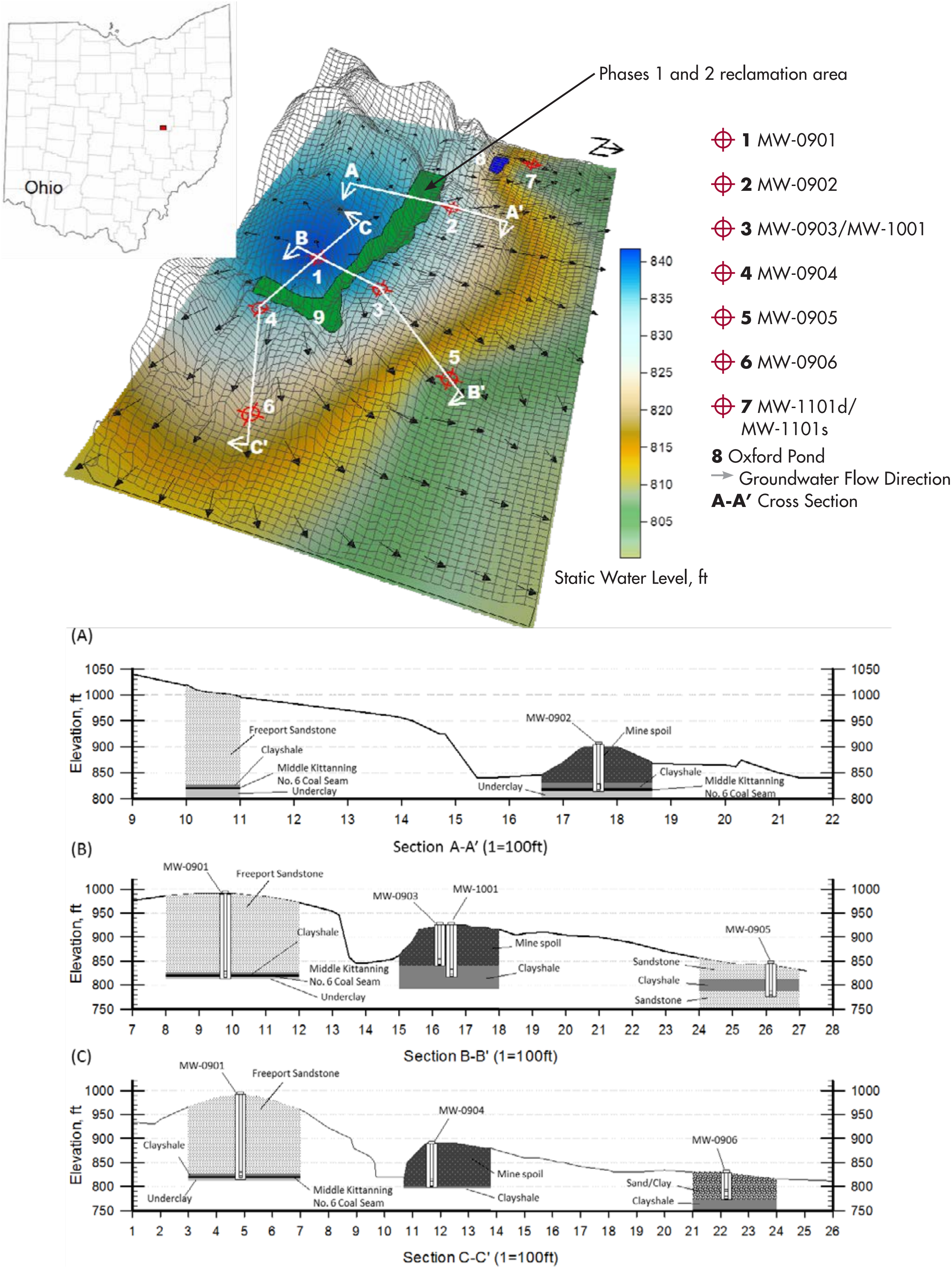
(5) Placement of sFGD and FGD gypsum in August 2013.

(6) Backfilling of highwall in December 2014.

(7) Capping and vegetation in July 2016.

(8) Vegetation in May 2021 (five years after reclamation was completed).

Figure 2. Hydrogeological condition and cross-sections at Conesville Five Points site (adapted from Cheng, et al.[4]).



Impact from Backfilled CCRs

To determine if the backfilled CCRs play a significant role in changing the water quality of the underlying aquifer, we compared the hydrogeochemical characteristics of the water samples collected from the shallow aquifer that is immediately down-gradient of the backfilled area, i.e., MW-0904 and MW-0906, to those of the CCR leachates from laboratory leaching tests.[5] By using a linear discriminant analysis (LDA) method, we identified "sulfate signature" and "boron signature" to distinguish the hydrogeochemical differences of these water groups. Details of the analysis have been described by Cheng, et al.[5] A sulfate-boron signature biplot (Figure 3) created from the LDA analysis illustrates the changes in the hydrogeochemical characteristics at MW-0902 and MW-0904 after reclamation began.

By comparing the relative locations of different water groups in the sulfate-boron signature biplot (Figure 3), it appears the water samples collected during site construction (black hollow circles) have similar but distinguishable sulfate and boron signatures to those of the backgrounds (grey hollow circles). No significant changes were observed during the early stage of the backfilling period. As the backfilling of CCRs continued, boron signatures (grey dots) started deviating further away from the background/construction clusters. After the reclamation was completed (black dots), both boron and sulfate signatures of the water samples are outside of the background ranges.

Although the hydrogeochemical signatures of the aquifer in the minespoil layers on the edge of the backfilled area have become different from the background, the data points do not migrate toward the CCR leachates cluster. The impact of backfilled CCRs on the water quality of the underlying shallow aquifer is not apparent. Instead, the water quality changes are likely associated with (a) saturation of mine spoil areas that experience a rise in water level in the underground mine due to the placement of the structural fill, and (b) the Appalachian Regional Reforestation Initiative (ARRI) approach used to cap the backfilled CCRs. Local spoil was end dumped in an interlocking manner to encourage saturation and limit offsite erosion to promote tree survival and growth.

Environmental Implications

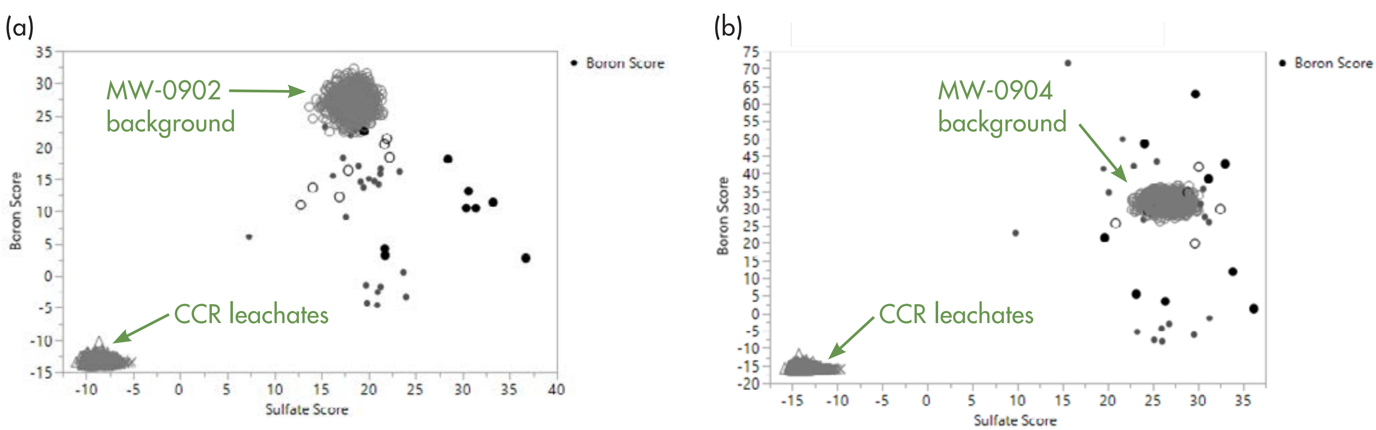
The water quality at the site was compared with the primary drinking water standards, i.e., maximum contaminant levels (MCLs), or action levels, and Ohio ambient groundwater quality.[6] Except for As, Be, Sb, and Tl, none of the water samples collected after the reclamation began exceeded the drinking water standards, including Ba, Cd, Cr, Cu, Hg, Pb, Se, and F. Please note that the shallow aquifer underlying the project site is not designated as a source of drinking water.

All detectable As and Sb were within the range measured in local groundwater and/or background levels. The naturally occurring Sb is likely associated with As contained in iron oxide and pyrite[7] in this region. Higher Be, Cd, and Tl concentrations were observed in a number of down-gradient sallow wells shortly (within 3-5 months) after site preparation began but before backfilling,[4] which all decreased to the levels similar to or lower than the detection limits after the reclamation was completed.

Conclusions

Results from engineering property analysis show that these CCRs (sFGD, FGD gypsum, and CCR blend) are suitable materials for use as structural fills and are resistant to liquefaction. While statistically significant water quality changes were observed, the cause of these water quality changes is not the CCR materials used in the construction of the structural fill. After five years of site monitoring since the reclamation was completed, there is no indication suggesting the backfilled CCR structural fill has posed any significant adverse impacts to the uppermost aquifers underlying the demonstration site. It appears the impact of reclamation on the eleven selected constituents of concern (i.e., F, Hg, B, Be, As, Ba, Cd, Cr, Sb, Se, and Tl) was insignificant and temporary.

Figure 3. Sulfate-boron signature biplots of (a) MW-0902 and (b) MW-0904. Grey hollow circles, grey hollow triangle, and grey crosses represent the groundwater background, sFGD leachate, and FGD gypsum leachate, respectively. Black hollow circles represent water samples collected during site construction. Small grey dots are water samples collected during CCR backfilling. Big black dots are water samples collected after reclamation was completed (adapted from Cheng, et al.[5]).



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A Unique Solution to a Challenging Scenario: Placement of an Ash Buttress by Dredging Within an Ash Basin

By R. Kula Kulasingam, Ph.D., P.E., Gabe Lang, P.E., and John Priebe, P.E.

Introduction

Historically, ash basins have been constructed either within or adjacent to fossil plant support infrastructure. Features such as power pole foundations, facilities, parking and roadway systems, landfills, and dry stacking operations (temporary or permanent) have often been constructed within the basins and were commonly constructed on historical ash within the basin. While these features are stable throughout the operation of the ash basin, as closure construction approaches and is initiated, potential stability concerns arise associated with either the decanting and/or movement of ash within the basin in support of closure. Decanting of the large open pool areas within the basins commonly lowers factors of safety in ash slopes surrounding the pool as higher pore pressures remain in the ash and the buttressing effect of the pool is removed. Addressing these potential stability concerns can be difficult due to the presence of sluiced ash in the pond and the ability for safe access. This article presents a case study on a creative solution involving the dredging of ash within an ash basin for placement as an ash buttress to provide stability to an adjacent landfill during ash basin decanting. While not directly a scenario involving beneficial use of ash, the use of ponded ash to achieve project stability goals resulted in many benefits as compared with alternative and more costly approaches.

Decanting of an ash basin finger—a narrow portion of the basin that extends outside of the main basin footprint—was planned in support of the basin closure, and this finger was located adjacent to a closed ash landfill as shown in Figure 1. However, the decanting operation within the ash basin finger was considered to involve some risk associated with slope instability for the landfill. Historical information for the ash basin indicated that it was likely that a small section of the ash basin finger extended under a portion of the closed landfill. As a result, it also appeared that the perimeter soil berm for the landfill was built over the sluiced ash from the finger. Additionally, the landfill was located immediately adjacent to a pooled water area of the ash basin finger, and it was believed that the removal of this water during decanting could lower slope stability factors to unsafe levels.

Figure 1. Pre-decanting conditions

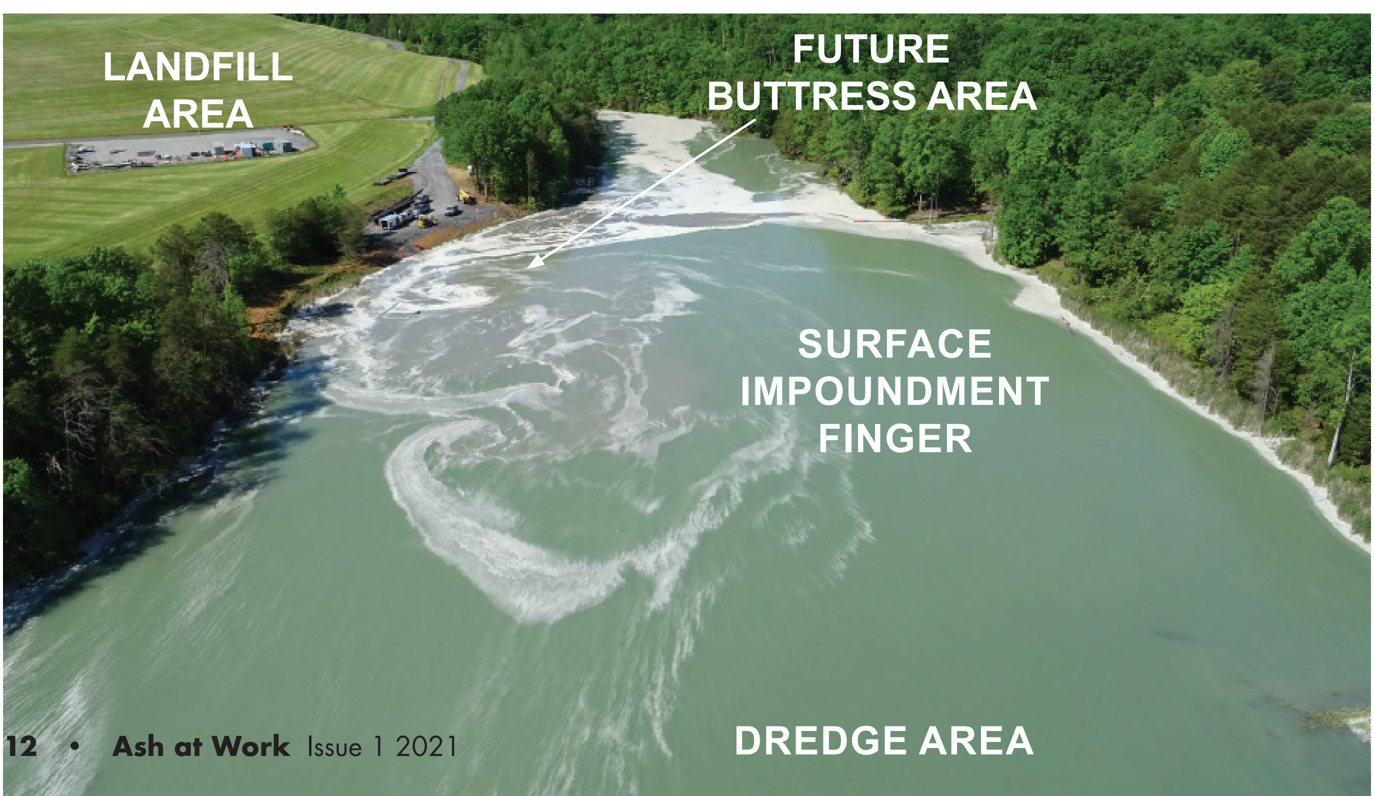


Table 1. Ash Slope Slough Potential Screening Table

Slope Range	Potential for Decanting or Seepage Face Trigger Sloughs
> 4H:1V	Very High to Extremely High
6H:1V to 4H:1V	High to Very High
8H:1V to 6H:1V	Moderate to High
10H:1V to 8H:1V	Low (if Bottom Ash) to Moderate (Fly Ash)
12H:1V to 10H:1V	Low
< 12H:1V	Very Low

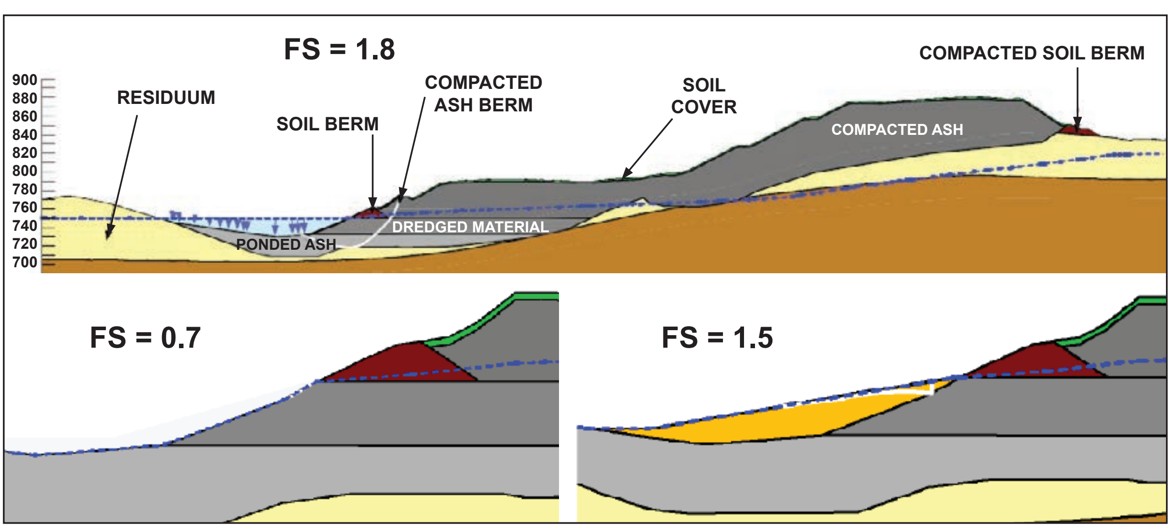
Permanent stabilization measures were being designed for the landfill as part of the ultimate closure of the ash basin by excavation. However, project drivers necessitated the decanting of the ash basin finger in advance of the closure of the basin and construction of these permanent measures, therefore requiring interim stability to be addressed. As with many ash basins, the site conditions within the basin were challenging and included shallow depths to sluiced ash, ponded water, extensive surface water drainage into the basin, and other features that make certain stabilization options not feasible. As a result of the above site conditions and challenges, dredging of bottom ash from a pooled area of the ash basin and placement against the landfill perimeter berm at a maximum slope of 12H:1V was chosen as the interim stabilization option in support of the decanting. This alternative mitigated the need for costly and time-consuming dewatering and fill material import, and enabled the transfer (via hydraulic dredge) of approximately 75,000 cubic yards of ponded ash within a period of approximately three months. Since the construction was entirely within the ash basin, which is secluded from the surrounding area, regulatory and community-related concerns were eliminated as significant factors (another benefit of this approach).

Investigation and Design

Based on available historical topographic and construction information, a conceptual model for the geometry of the landfill perimeter berm area over the ash basin finger was developed. The available geotechnical boring information was supplemented with several Cone Penetration Tests (CPTs) along the landfill soil perimeter berm. This work facilitated the refinement of the subsurface valley shape of the ash below the landfill soil berm and provided strength and permeability parameters for slope stability and seepage analyses.

Based upon prior experience with ash sloughs that develop during ash basin decanting, it is believed that they are triggered by smaller wedge-type slides that initiate at the slope face and under certain conditions develop into a larger cascading failure. Therefore, the goal of the slope protection for decanting stability of an ash slope, and for this project, was to reduce the risk of ash slope slough triggers. Global failure surfaces that extended directly to the landfill were found to result in acceptable safety factors even during or after decanting. However, slope stability analyses indicated that the risk of

Figure 2. Factors of safety of 1.8 for pre-decanting (top), 0.7 for post-decanting without buttress (bottom left), and 1.5 for post-decanting with ash buttress (bottom right – ash buttress in orange).



ash slough triggers decreases significantly when ash slopes are reduced to 8H:1V to 12H:1V or flatter, depending on parameters such as the unit weight of the ash and shear strengths. In addition, ash internal angle-of-friction values on the order of 24 to 28 degrees were found to be more appropriate for transient or construction stability of sluiced ash even though laboratory measured values often may indicate 30 degrees or more. These conclusions were made on the basis of our observations and analyses of prior ash sloughs that developed during decanting on other projects.

Slope stability analyses were performed for the original conditions (pre-decanting), post-decanting (without a buttress), and with an ash buttress constructed at a slope of 12H:1V. The results of the analyses are summarized in Figure 2.

Based on the site considerations and our analyses, a 12H:1V ash buttress slope was selected for construction in the vicinity of the landfill soil berm. The pre-decanting ash slopes at the landfill soil berm were originally on the order of 4H:1V to 6H:1V or steeper, and the slope was located below a pool of water in the ash basin finger. As a result, the construction of the flatter buttress would be challenging to complete in advance of decanting.

Selection of Ash as the Buttress Material

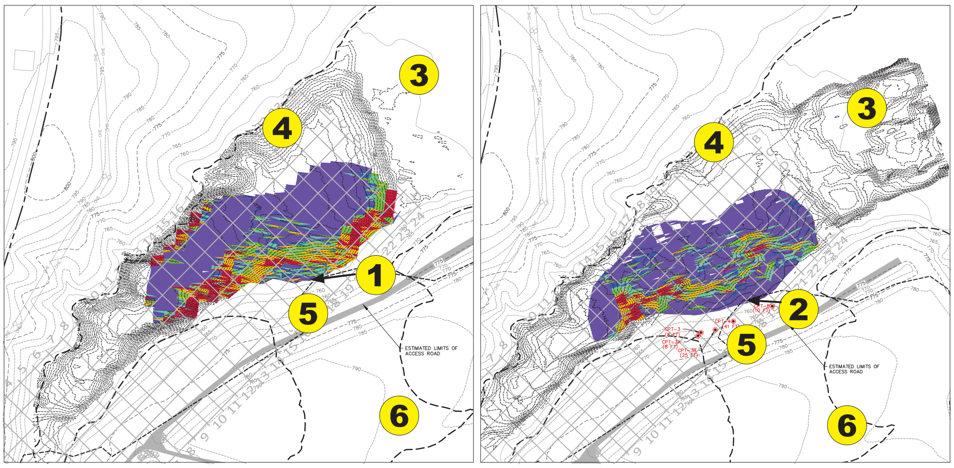
An options analysis was conducted to select material types for the buttress and associated placement method. As noted above, the landfill is located adjacent to a finger of the much larger ash basin, and as a result there is an ash delta near the finger that consists predominantly of bottom ash. While several options were considered, the option of using a dredge to remove bottom ash from the delta, transport via dredge pipe, and place in the buttress area to fill in the valley and reshape the slopes to meet the target design slopes was selected as the preferred option. This reuse of bottom ash within the ash basin would eliminate the need to bring in fill material from outside, construct access roads within the basin, and place the material subaqueous along the landfill berm slope. Key construction considerations included the ability to place the ash subaqueous, settling and self-weight consolidation characteristics of the bottom ash, limited waiting time prior to commencement of decanting operations, and increased post-decanting stability of the placed bottom ash and landfill berm slope. The location and availability of bottom ash was also a key consideration in the selection of ash as the construction material for the buttress.

Buttress Construction

Figure 3 shows photographs taken during buttress construction work. The ash buttress construction involved dredging and hydraulically placing approximately 75,000 cubic yards of bottom ash. Use of the dredge was a safe way to access the ash delta and remove ash for placement. An excavator was used in limited areas to clear vegetation from the ash delta. The dredged bottom ash was transferred via a dredge pipeline to the buttress location for hydraulic placement. Field observations indicated the dredged bottom ash was flowing under pressure and ash was moving in the pooled water after leaving the pipe and being deposited. The dredge pipe discharge location was moved a few times a day, using boats, to build the buttress. The placement of ash was confirmed on the basis of weekly field bathymetry surveys conducted by the contractor. The hydraulic placement of the ash created some challenges in achieving the target design slopes in a uniform manner across the buttress area. However, as demonstrated previously, this project allowed for some variance in final slope configuration and that accuracy of this method was deemed acceptable. However, if more stringent requirements are needed during subaqueous slope construction, a tremie placement method such as the ones used for constructing sediment capping projects may have to be considered.

Figure 3. Dredging and depositing ash. Left photo: dredge near the cut area in the ash delta. Right photo: discharge pipe in the ash basin finger adjacent to the landfill.

Figure 4. Bathymetric slope scan comparison.



(a) Pre-construction slopes

(b) As-built slopes

Slopes Table

Number	Minimum Slope (H: V)	Maximum Slope (H: V)	Color
1	4.00: 1	2.00: 1	Red
2	6.00: 1	4.00: 1	Orange
3	8.00: 1	6.00: 1	Green
4	10.00: 1	8.00: 1	Teal
5	12.00: 1	10.00: 1	Blue
6	Horizontal	12.00: 1	Purple

(c) Slope legend

1 FUTURE Buttress Area
2 COMPLETED Buttress Area
3 Dredge Area
4 Surface Impoundment Finger
5 Landfill Soil Berm
6 Landfill Area

Ash buttress slopes were compared with design slopes to determine target placement areas during construction, as shown in Figure 4. The survey frequencies were increased to daily near the end of the project as the specific placement locations were identified and modified. While there were deviations from the design slope, the as-built buttress achieved the target objectives through reducing the slopes in most of the areas to the target ranges. In addition, where steeper slopes than the target were identified, they were located away from the critical section of the landfill soil berm (see Figure 4[b]). This steeper slope area (i.e., approximately 4H:1V) is generally located in the abutment of the ash fingers, with limited areas near the mouth of the ash basin finger. Design and construction of the interim buttress also required a post-construction monitoring program (visual and instrumentation) during decanting to verify that adequate stability was maintained.

Decanting

The decanting progressed well and successfully completed the drawdown of water level in the ash basin finger safely by approximately 10 feet within a period of approximately eight months. Figure 5 shows a view of the decanted ash basin finger and buttress area. Severe storm events have been observed to increase the water level occasionally by a few feet, necessitating drawing down the water level again. Storm events also result in run-on that is observed to cause erosion and selective scouring of certain ash buttress areas. However, the magnitude of these impacts is not significant compared to the shape and mass of the buttress material. The manual and automated instruments have indicated acceptable factors of safety, and the phreatic surface levels are observed to be going down slowly toward an equilibrium condition.

Figure 5. View of the decanted ash basin finger and ash buttress area.

Conclusions

The buttress was built successfully using dredge placement of bottom ash, and the associated decanting operations were able to be completed safely without impacting the stability of the landfill. During this interim period between decanting and closure construction, the ash buttress and associated landfill berm are being inspected weekly and monitored using a combination of manual and automated instruments until phreatic surface levels are observed to reach equilibrium conditions. The placement and utilization of the dredged bottom ash buttress is not intended to serve as a permanent stabilization feature and as a result must be managed carefully, especially during changing loading conditions associated with decanting. Some of the additional measures that were incorporated into this project and should be considered on future projects include: (1) use of a drawdown rate of 0.5 feet per week or less; (2) avoiding cycling of water levels within the basin finger; (3) three layers of documented inspections including daily by operating staff, weekly by an engineer from the owner's staff, and monthly by a design engineer; (4) use of instrumentation to monitor pore pressures and movements; and (5) developing an emergency response plan.

Permanent stabilization measures are still planned to be implemented as part of the closure of the ash basin by excavation. However, in the interim, the dredged ash buttress continues to meet the functional and stability requirements and demonstrates that this approach is feasible and effective for achieving goals for interim stability measures at ash basins. Redistribution of ash materials within a CCR unit to increase stability is an elegant solution that can (and should) be recreated where appropriate.

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Gabe Lang *is a Vice President at AECOM and serves as the Program Manager for AECOM's power sector clients in the southeast. In this role, he has been responsible for overseeing local and national teams of civil and geotechnical design engineers and geologists, and developing and implementing a variety of civil/geotechnical work scopes related to dam safety and the disposal of coal combustion products at over 30 coal plants. Mr. Lang received his Bachelor of Science degree in Civil Engineering from the University of South Florida and performed graduate studies at the University of Pittsburgh.*

John Priebe *is Associate Vice President at AECOM and Co-Leader of its CCR Management Practice. In this capacity, he provides leadership and support to AECOM's CCR projects and programs throughout the U.S. Mr. Priebe earned his Bachelor of Science degree in Civil Engineering from Valparaiso University.*

Functional Value of Coal Combustion Products for eMSE Structures

By John P. Swenson

Over 2 billion cubic yards of coal combustion products (CCPs) currently are stored in more than 700 impoundments and landfills under regulations set forth in the U.S. Environmental Protection Agency's Disposal of Coal Combustion Residuals (CCRs) from Electric Utilities final rule and subsequent revisions.[1]

Compliance with the rule—which establishes minimum national standards regulating the location, design, and operation of existing and new CCR landfills and surface impoundments—would pose significant logistical challenges for power plant owner/operators under even the best of circumstances. Compounding the challenge is that the regulatory compliance schedule of EPA's rule, which is likely to result in the closure and removal of CCRs from many such facilities, is too tight to allow current beneficiation markets to absorb and utilize these materials.[2] Utilities must fix an environmental issue in a little over a decade that has been created over half a century. This disparity requires innovation. Service providers, including engineering, consulting, and construction firms, are looking for solutions to address the challenge in the most environmentally responsible and cost-effective manner.

One problem each faces is that the properties' existing boundaries and permits, as well as the activities planned for them before and after their closure, often limit the space available to manage the CCPs they contain. In such cases, encapsulated mechanically stabilized earthen (eMSE) structures can be an excellent tool for safe, long-term CCP storage, potentially making even more sense than traditional mechanically stabilized earthen (MSE) berms.

The EnCAP-IT Solution

A patented eMSE system developed by EnCAP-IT, a Richmond, Virginia, company, offers an additional benefit: it can repurpose the CCPs as the backfill material in its berms, thus enabling the owners/operators of proposed and existing impoundments and landfills that will or already contain CCPs to utilize the materials to construct or expand their facilities.

EnCAP-IT has successfully completed a deployment of its green safeBERM® system that uses CCPs as the backfill material at a municipal solid waste (MSW) landfill in Chester, Virginia. In addition to permitting the use of CCPs as backfill material, EnCAP-IT's safeBERM® system can more easily attain approval by stakeholders (regulators, local jurisdictions, etc.) than traditional MSE berm systems because of its safety features. Plus, it can be less expensive.

A traditional MSE berm is constructed by compacting fill materials in layers, each of which is underlain by a reinforcing medium, typically a geosynthetic geogrid. Preventing water from getting into the fill material can minimize the risk of the berm failing. An eMSE berm has a geomembrane liner that fully encapsulates it, preventing stormwater run-on or run-off from migrating into the fill. It also has a toe drain at its bottom to collect, transport, and dispose of water that enters the fill during construction.[3]

Using traditional MSE berms to expand landfills can be expensive if doing so requires buying natural soil fill material. With eMSE berms, non-traditional construction materials such as CCPs can be used, making them less-costly alternatives for landfill expansion.

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1 *Cox, David. "Using Business Intelligence to Gauge the U.S. Coal Ash Market," Ash at Work, Issue 2, 2019.*
2 *Laubenstein, Joe. "Closure-by-Removal Strategies Facilitating Beneficial Use," Ash at Work, Issue 1, 2019.*
3 *Warwick, Katherine, et al. "The Benefits of an Encapsulated Mechanically Stabilized Earthen (eMSE) Berm," Waste Advantage Magazine, September 30, 2019.*

eMSE berms also can be less costly than traditional MSE berms for landfill expansion because they can be used to expand a landfill on its existing footprint rather than laterally. That allows the landfill operator to use the landfill's existing operations infrastructure and environmental management controls. It also increases the landfill's capacity without increasing its closure cost—and with only negligible impact on its post-closure costs—and avoids potentially long and costly facility-siting processes.

Shoosmith Landfill

EnCAP-IT was able to demonstrate the effectiveness of its safeBERM® eMSE system at a MSW landfill in Chester, Virginia. Shoosmith Bros. Inc. needed to expand the landfill in a way that would increase its airspace while addressing the concerns of the community in which the landfill was located. After Shoosmith reached out to us, EnCAP-IT began designing a solution package for the landfill, gathering such site characteristics as hydrogeologic conditions, pre-existing environmental resources, permitting pathways, constructability, and the market availability of repurposed backfill material.

Shoosmith originally planned to use impacted soils as the repurposed material in the landfill's new berms. But its plan changed after winning a contract for the landfill to take in roughly 175,000 to 200,000 tons of fly ash a year from a local cogeneration plant, more than enough to use in EnCAP-IT's safeBERM® system. Despite concerns about then-pending EPA regulations on CCRs and how the Commonwealth of Virginia would adapt them to its waste and beneficial-use rules, EnCAP-IT determined that the design parameters of its safeBERM® system and the safeguards embedded within the system would enable it to use the fly ash as repurposed material for the solution it planned to deploy at the landfill in a way that would comply with potential future regulations.

Having determined that it would use the fly ash that the landfill was scheduled to take in as the repurposed material in the berms it planned to deploy there, EnCAP-IT was faced with another challenge: Shoosmith wanted to use all the fly ash coming to the landfill in the berms and asked EnCAP-IT to change the system's design parameters from an internal bladder encapsulation to a full encapsulation by moving the geomembrane to the outer face of the berms. Fortunately, EnCAP-IT was in the process of enabling its safeBERM® system to be designed in that manner, and its updated safeBERM® system was able to accommodate Shoosmith's request.

The public perception of CCRs presented yet another challenge to Shoosmith's and EnCAP-IT's plan for the landfill's expansion, but the companies were able to show that the safeBERM® system renders its repurposed backfill inert and that CCRs make good fill material because they are homogeneous, their primary decomposition is complete, and there is plenty of supply.

Also working in their favor was the fact that regulators with the EPA and even the Commonwealth of Virginia have been indicating that they think repurposing CCRs by using them as backfill in landfill berms is a practice that needs to be encouraged. Perhaps they're starting to realize that dealing with the tremendous amount of CCRs in existence today requires innovation, not regulatory obstinacy.[4]

When fully constructed, EnCAP-IT's eMSE berm at Shoosmith's landfill will be 3,532 feet long, range from 52 feet to 65 feet high, give the landfill an additional 2.6 million cubic yards of MSW capacity, and incorporate more than 800,000 cubic yards of CCRs. Additionally, the first phase of it was completed in five months.

Advantages of the safeBERM® System

Although a traditional berm system would have added the same amount of capacity to the landfill, the initial phase of its construction could have taken longer to complete as crews waited for natural soils to be procured. On top of that, EnCAP-IT estimates that by using its safeBERM® system instead of a traditional MSE berm system, Shoosmith realized savings in the mid-eight-figure range.

The fact that EnCAP-IT's safeBERM® system can use CCPs as fill material was helpful for Shoosmith, which was taking them in at its landfill, but it can be even more beneficial to the owners of current and former coal-fueled power plants that have tons of CCPs already located on their premises. If a property owner wants to implement a closure-by-removal strategy and build a landfill on their property to hold the CCPs being removed, EnCAP-IT's safeBERM® system can enable the use of a portion of those CCPs to construct the landfill. If a property owner already has a landfill for CCPs and is contemplating building another one, the safeBERM® system may allow the use of some of its CCPs to expand its existing landfill instead.

The safeBERM® system also may allow entities responsible for dealing with CCPs to have them treated more favorably

4 *Ward, John. "Structural Fill: Conserving Natural Resources Through Projects Featuring Rigorous Engineering Standards," Ash at Work, Issue 2, 2019.*

from a regulatory standpoint. The EPA's final rule for disposal of CCRs distinguishes between disposal and beneficial use of CCRs and contains four criteria that unencapsulated uses of CCRs, such as in structural fills, must comply with. An unencapsulated use of a CCR that doesn't comply with all four criteria will be considered a disposal and subject to all the requirements in the regulation governing CCRs' disposal. Since berms in the safeBERM® system are fully encapsulated by a geomembrane liner system, using CCRs in an eMSE structure may be considered an encapsulated use of CCRs, thus allowing it to be treated as a beneficial use rather than disposal.

To sum up, eMSE systems offer advantages over traditional MSE systems for landfill construction and expansion in multiple areas, including cost, safety, efficiency of land use, and regulatory risk. And, because it can utilize CCPs as fill material in its berms, EnCAP-IT's safeBERM® system offers owners of sites containing large quantities of CCPs another advantage: it makes them part of its containment solution.

__John P. Swenson__ is the Founder, Inventor, and Managing Partner of EnCAP-IT, an environmental consulting company headquartered in Glen Allen, Virgina. During his 26+-year career in the waste industry—at Republic Services, Laidlaw Waste Systems, Capital Environmental Services, Casella Waste Systems, Winter Bros. Waste Systems, Enviro Solutions, and Waste Associates—he has learned all facets of nonhazardous solid waste management. Over twelve years ago, he put his broad knowledge of waste and business management to work to become a leader in responsible environmental stewardship by promoting EnCAP-IT's patented innovations to help the waste, power, and other industries adopt methods for more efficient, environmentally friendly, cost-effective nonhazardous waste disposal and responsible reuse.

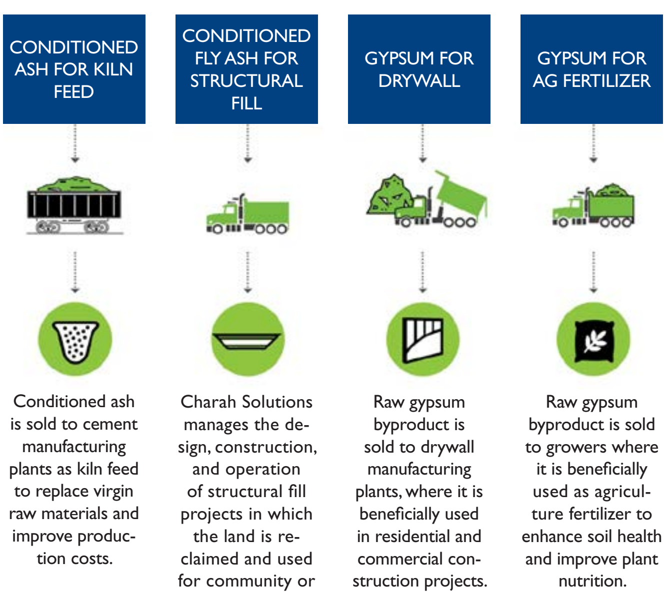
There's More to CCPs Than Fly Ash

By Eric Effinger

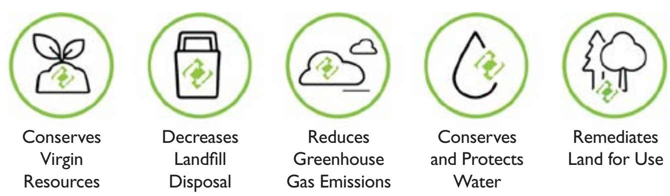
According to the American Coal Ash Association, approximately 41 million tons of coal combustion products (CCPs), or 52 percent of those generated, were beneficially used in 2019. The most commonly used CCP is fly ash, which is a more affordable substitute for cement in the production of concrete. Approximately 12.6 million tons of fly ash was used in concrete production in 2019.

While fly ash concrete represents the largest use of recycled CCPs, it is just one part of the CCP equation, with other beneficial uses including:

- Conditioned ash for structural fill and land reclamation;
- Conditioned ash for cement kiln feed used in the production of cement;
- Gypsum for drywall; and
- Gypsum for agricultural fertilizer.



Charah Solutions recycles CCPs for use in all of these applications. In 2020 alone, we recycled more than 2.58 million tons of CCPs, saving 2.24 million tons of CO_2 from entering the atmosphere. In addition to reducing greenhouse gas emissions, these beneficial uses help to conserve water and virgin resources, as well as reduce the amount of waste sent to landfills. Since the Environmental Protection Agency's 2015 Coal Combustion Residuals (CCR) Rule took effect, the company has also reclaimed approximately 300 acres of land and committed to remediate and return 90 percent of land owned to its natural habitat or redevelop the land in a sustainable manner.



Conditioned Ash for Structural Fill and Land Reclamation

A major application of recycled CCPs is the beneficial use of conditioned ash as structural fill, in which ash is utilized as fill material to help reclaim unusable land for community, residential, or business use rather than being disposed of in a surface impoundment or landfill. Charah Solutions manages the design, construction, and operation of these fully lined structural fill projects, which recycle the ash and return hundreds of acres of land back to the community. This includes the beneficial use of over 10 million tons of ash in structural fill projects and approximately 300 acres of reclaimed land.

Conditioned ash as a structural fill material is placed and compacted in accordance with approved design criteria in order to improve land for an intended use. Conditioned ash is a useful fill material due to its low unit weight, relatively high shear strength, and ease of handling and compaction. In a fully lined structural fill, the ash is placed in a series of liners, with the top and bottom impermeable liners heat welded together to encapsulate the ash covered by soil—meeting state and federal standards for a structural fill including strict groundwater monitoring standards and reporting.

The use of conditioned ash as structural fill material not only eliminates the need to dispose of ash in landfills, but it is also a cheaper alternative than using traditional structural fill materials such as soil and natural aggregates. This conserves resources by substituting recycled materials for virgin ones that would typically be mined and also reduces greenhouse gas emissions as less equipment is used in the process.

Conditioned Ash for Kiln Feed in Cement Production

Tightening federal, state, and local guidelines are forcing many utilities to think beyond the ready-mix concrete industry for their byproduct sales and marketing efforts. For example, recent state legislation gave a large utility 15 years to remove approximately 15 million cubic yards of coal ash currently stored in its ponds. The material must be recycled or placed in a lined landfill that meets federal and state guidelines for CCRs. To meet the standards mandated, the utility has contracted with Charah Solutions for the beneficiation of a portion of this ash through 2032.

As part of the beneficiation and marketing contract, Charah Solutions will load conditioned ash and ship it directly to cement kilns, where it is used as raw feed to replace virgin materials and improve production costs for the customer. This supply of ash will also be a long-term, consistent sourcing solution for the cement producers, allowing them to be confident in the supply volume and quality for years to come. To support the volume of ponded ash, Charah will develop a new high-volume enclosed rail loadout facility, deploy processing and material handling equipment, and use our rail transportation infrastructure to transfer the reclaimed material to cement plants in the eastern U.S.—leveraging more than a decade of our ash kiln supply experience. The beneficiated ash product can replace other currently utilized virgin raw materials in the production of portland cement at multiple cement kiln locations for the next 10+ years and help supply the growing demand for concrete in the construction industry. In addition, every ton of coal ash used to replace traditional virgin raw materials in the production of cement reduces carbon dioxide emissions entering the atmosphere.

There are several factors that guide decisions regarding what materials a cement kiln can use. Quality, economics, and handling characteristics are all important; however, economics tend to be the major driver. Raw materials bring multiple mineral components to the mix and are evaluated as such. Handling characteristics of each material determine its compatibility with existing equipment. Extremely fine or high-moisture materials can be challenging to handle, as well as materials that are not uniform in size or are oversized and thus require more energy to process. Quality and environmental factors are extremely critical, as the amount of heavy metals, primarily mercury, as well as elevated levels of carbon, sulfur, and chlorides, can preclude a certain ash, or portion of a ponded deposit, as a cement kiln feed candidate. Additionally, the presence of organic materials can be problematic, as higher levels can result in air emission exceedances in measured parameters such as total hydrocarbons or volatile organic compounds. Each cement plant is guided by its own individual plant Operating Permit (generally known as a Title V Permit [Clean Air Act]). Cement plants are highly regulated by the EPA and state government agencies to control for air emissions, water discharges, and safety.

Substituting dried, graded CCPs for virgin aluminum-, iron- and silica-bearing materials may equate to a lower carbon dioxide emissions factor per ton of cement mill output—a metric cement producers increasingly prioritize for their environmental profiles. The contract and infrastructure outlay are indicative of a changing regulatory and supply chain landscape for power utilities and cement producers alike. The site's scale of viable material, coupled with the utility's incentives to pursue ponded ash recycling vs. permanent disposal measures, allows cement producers the opportunity to improve production economics as well as environmental performance.

Gypsum for Drywall and Agricultural Fertilizer

While natural gypsum is mined, synthetic gypsum is a routine product of flue gas desulfurization (FGD) and sulfur dioxide compliance operations at coal-fueled power plants. Charah Solutions provides marketing and management services, including operations support, for onsite management or implementation of loading, transportation, and marketing solutions to deliver cost savings to customers and recycle gypsum for the manufacture of drywall and agricultural fertilizer.

Raw gypsum byproduct is sold to drywall manufacturing plants, where it is beneficially used in residential and commercial construction projects. Charah Solutions has years of experience marketing wallboard-grade quality gypsum. The beneficial use of gypsum in drywall offers product benefits, including fire resistance, sound control, versatility, quality, convenience, and cost-effectiveness. In addition, it eliminates the need for utilities to dispose of FGD material in landfills or ponds, while reducing water and energy consumption and preserving natural resources.

Raw gypsum byproduct is also sold to growers, where it is beneficially used as agricultural fertilizer to enhance soil health and improve plant nutrition. Farmers have used gypsum (calcium sulfate dihydrate) for centuries as a soil amendment because of its many benefits. It is an excellent source of calcium sulfur for plant nutrition and improving crop yield. It also improves acid soils and treats aluminum toxicity, resulting in increased root growth. Additionally, gypsum enhances soil structure for root growth, improves water infiltration, and helps reduce runoff and erosion.

Efficient Distribution Network

In recent years, Charah Solutions has increased the efficient distribution of ASTM C618 fly ash, cement kiln feed ash, gypsum, and other CCPs through development of our MultiSource® terminal network. The MultiSource materials network is a unique distribution system of more than 40 locations nationwide, with international sourcing and distribution and a national network of barge, rail, and truck services that provide a continuous and reliable supply of CCPs for structural fill projects, cement manufacturing, ready-mix concrete production, and other uses throughout the U.S.

The MultiSource® materials network provides CCPs to markets where they are needed, as well as sufficient storage to level out seasonal supply and demand fluctuations. With terminals and distribution hubs in place nationwide, customers are able to reliably purchase CCPs, including ash and gypsum, through the network across the country. In addition, Charah Solutions continues to strategically expand this network to meet growing customer demand.

Sustainability is central to everything we do at Charah Solutions. Our core business is centered on coal ash byproduct management, the beneficial recycling of ash products, and environmental remediation and compliance. While fly ash used in the production of concrete is the most commonly recycled CCP, there are many other applications—conditioned ash for structural fill, land reclamation, and cement kiln feed, as well as gypsum for drywall and agricultural fertilizer—for which ash and other CCPs can be responsibly recycled. These options not only provide a lower-cost and better-performing product for customers, but reduce greenhouse gas emissions, conserve water and virgin resources, and reduce the amount of waste sent to landfills. We are proud to develop innovative sustainable solutions to complex environmental issues for the betterment of the planet and to benefit our customers who use these recycled products.

***Eric Effinger** is Vice President of Operations at Charah Solutions Inc. A registered professional engineer and certified project management professional, he has over 15 years of experience executing and managing large-scale heavy civil construction and utility-related projects throughout the United States. Effinger earned a Bachelor of Science in Civil Engineering Technology from the University of Southern Indiana.*

Full-Depth Reclamation and Subgrade Modification

By Darryl Neapolitano

Full-depth reclamation (FDR) and subgrade modification are processes of transforming native substandard soils and/or existing asphalt roadway into high-performing and economically feasible base material.

Base failure, low bearing capacity, and expansive soils are all issues that can impact new road construction. Utilizing large specialized rototiller-like machines (reclaimers), existing pavement or substandard soils are pulverized/mixed in place (in-situ) with cementitious binders and water to produce ready-to-use road base. This process works well for the stabilization of existing soils containing high organic materials or soils that include expansive fatty clays. LafargeHolcim utilizes a broad portfolio of products and expertise to evaluate and design solutions for various types of scenarios.

Applications

FDR and soil modification processes can be used to enhance a variety of roadway projects with different degrees of failure or varying types of native soils. LafargeHolcim has supplied products for an assortment of different roadway and driving surface projects. Some of the more common types of sites for each process include:

Full Depth Reclamation

- Reconstruction of existing asphalt parking lots.
- Low-volume asphalt roadways.
- Any existing hot mix asphalt road that has surface distresses and obvious base failure.
- Federal Aviation Administration runway projects are using FDR as an alternative to conventional removal/replacement of asphalt runways.

Soil Modification

- Building pad construction where the in-situ soils are wet of optimum and require modification. The use of portland cement as a reagent will eliminate the need for removal and replacement with virgin material.
- Wind farm and solar field access roads with high organic nature content of native soils.

Material Features

Full depth reclamation combines the existing asphalt roadway, base, cement, and water to create a structural foundation for the application of hot mixed asphalt or concrete pavements. It reduces the number of trucks and equipment needed due to utilizing the existing materials in-situ.

Soil modification uses the existing native soils in combination with cementitious binders (portland cements, Class C fly ash, and slag) and water to increase the strength of the soil prior to placement of the crushed aggregate base course and/or the hot mix asphalt layers.

Benefits

Most projects have the goals of being completed on time, meeting or coming in under budget, and maximizing the ability to be environmentally friendly (sustainable) and durable. The benefits of utilizing FDR and stabilization over conventional removal/replacement methods are as follows:

- Reuses existing assets.
- Requires less import/export of materials.
- Cost-effective.

This building pad in Channahon, Illinois, uses a 50:50 blend of Class C fly ash and Type 1 cement.

- More predictable results.
- Faster construction.
- More durable.
- Subgrade modification may be the only option for late-season start-ups when wet soil conditions prevail.
- Reduces trucking and labor vs. removal/replacement (undercutting), achieving savings of up to 40 percent or more.
- Expansion mitigation of fatty clay soils.
- Reduces the carbon footprint of any project by minimizing the number of trucks used to import/export virgin materi-als, thereby increasing the project's sustainability.

Darryl Neapolitano *is Manager, Major Construction Projects at LafargeHolcim. He has served in a variety of roles at Larfarge over the past 19 years, including Laboratory Manager; Technical Service Manager, Logistics; Market Manager; and Area Sales Manager. He received Bachelor of Science degrees in both Interdisciplinary Engineering and Management and Civil and Environmental Engineering from Clarkson University and his Master of Business Administration degree from Rensselaer Polytechnic Institute.*

Subgrade modification of an access road at Invenergy's Bishop Hill Wind Center Phase 3 Windfarm, in Woodhull, Illinois.

Risk Evaluation Finds Fly Ash-Based CLSM Safe in Common Applications

By Rafic Minkara, Ph.D., P.E.

A risk evaluation of the beneficial use of fly ash-based controlled low-strength material (CLSM) has concluded that it is safe to humans and the environment in its most common applications.

While CLSM, or flowable fill, is used in a variety of construction applications, *Risk Evaluation of Fly Ash-based Controlled Low Strength Material*, prepared for ACAA by Gradient Corporation, focused on two key uses: conduit trenches and roadway embankments. Both applications involve CLSM used in the subsurface, which is then covered by a permeable cover such as soil, thus allowing the potential for rainwater to infiltrate, interact with the CLSM, and produce leachate that can subsequently migrate downward and impact groundwater. These applications were selected because they provide the opportunity to examine a wide range of potential human health and ecological risks and represent applications that have the greatest potential for exposure. The potential for worker risks from CLSM excavation and disposal activities was also evaluated.

The study focused on determining the concentrations of constituents of potential concern (COPC) in bulk CLSM and CLSM leachate that would *not* be expected to pose a human health or environmental risk for specific CLSM application scenarios. According to the study's authors, such an approach allows for a more practical understanding of CLSM uses that have a low potential to pose a risk versus those uses that may require more project- or product-specific analyses.

Risk modeling was conducted using EPA's Composite Model for Leachate Migration with Transformation Products (EPACMTP), which relies on a probabilistic approach that accounts for potential climatic, hydrogeologic, and source conditions in a statistical manner. (This same model was used by EPA in the 2014 Coal Combustion Residual (CCR) Risk Assessment, while a closely related model—the Industrial Waste Evaluation Model—was used in the agency's 2014 fly ash concrete beneficial use evaluation.)

Conduit Trenches

One of the most common uses of CLSM is as a stabilization material for trenches, particularly long, narrow spaces that are more difficult to properly backfill with traditional materials such as soil or gravel. Specific uses include bedding for water pipes and electrical conduits.

The risk evaluation examined potential exposures for the use of CLSM in a conduit trench 20 feet wide and one mile long. This is a significantly wider channel than that used for most conduit trenches in residential settings for fiber optic and cable lines, which are typically less than 30 inches. Larger trenches, such as those used for oil and gas pipelines, would not typically be located near residential areas.

Nonetheless, because conduit trenches may be close to residential areas, it was assumed that a drinking water well could be located as close as 25 feet from the edge of the trench. For completeness, the risk evaluation also assessed a drinking water receptor using wells located 100 and 1,000 feet downgradient of the edge of the trench. Consistent with use specifications, it was assumed that the trench was constructed above the water table.

Roadway Embankments

A second common application of CLSM is as a stabilizer for roadway embankments and, particularly, as a bridge abutment to help mitigate settlement or erosion concerns. For this application, two embankment/abutment project sizes were evaluated: a small 100-foot-by-100-foot embankment and a larger 300-foot-by-300-foot embankment.

To account for different receptors and exposure pathways, two embankment scenarios were considered:

1. Embankment with no nearby surface water body: In this scenario, it was assumed that the potential exists for CLSM leachate from a highway embankment to migrate toward a downgradient drinking water well. It was also assumed that a drinking water well could be located either 100 or 1,000 feet downgradient of the edge of the embankment.

2. Embankment with a nearby surface water body: In this scenario, residential receptors were evaluated using the surface water adjacent to a CLSM embankment as a drinking water source. It was assumed that the surface water was located 25 feet downgradient from the embankment.

CLSM Excavation

Workers are primarily exposed to CLSM in the form of particulates or dust generated from activities that involve excavating CLSM from a trench with a backhoe and dumping the material into a truck. Because the activities associated with excavation and disposal would be similar among different CLSM project types, an exposure scenario was developed that would be applicable to any construction project involving the excavation and disposal of CLSM. For this scenario, a worker was assumed to be exposed for 20 days a year (5 days a week for 4 weeks) for 10 years.

The results of these evaluations are summarized in Table 1, and the study's conclusions are as follows:

- The use of CLSM in conduit trenches does not pose a drinking water risk, even for a well as close as 25 feet downgradient from the edge of a conduit trench. This conclusion is based on a conduit trench 20 feet wide and 1 mile long. It is noteworthy that longer trenches are also unlikely to be associated with a risk concern. For trenches significantly wider than 20 feet and less than 100 feet from a potential drinking water well, it is advisable to conduct a project- and/or CLSM-specific evaluation to assess risk potential.

- The use of CLSM in embankments 100 feet by 100 feet without a nearby surface water body has the potential to pose a drinking water risk (for arsenic and molybdenum) if a drinking water well is as close as 100 feet. Based on this, it is advisable to confirm CLSM leachates are below the health-protective levels or conduct project/site-specific modeling. If a well is as close as 1,000 feet from the downgradient end of the impoundment, the risk concern is lower (approximately 10-fold less). It is advisable to conduct a project and/or CLSM-specific leachate assessment for larger embankments (300 feet by 300 feet or more) that will be located within 1,000 feet of a drinking water well.

- The use of CLSM in embankments (up to 300 feet by 300 feet) with a nearby surface water body does not pose a drinking water risk, even for a surface water body as close as 25 feet downgradient from the edge of the embankment. This is applicable to embankments near medium and large surface water bodies.

- The use of CLSM in embankments (up to 300 feet by 300 feet) with a nearby surface water body does not pose a risk to aquatic ecological receptors, even for a surface water body as close as 25 feet downgradient from the edge of the embankment. This is applicable to embankments near small, medium, and large surface water bodies. The one exception is for selenium and cadmium in high-end leachate concentrations (e.g., those consistent with measured 90th percentile pore water leachate concentrations), which can exceed health-protective benchmarks when discharging to a small water body 25 feet from the edge of the embankment. It is noteworthy, however, that more typical (50th percentile) leachate concentrations of selenium and cadmium do not pose a risk.

- The excavation and disposal of post-use CLSM do not pose a risk concern to workers. This conclusion is based on a worker excavating and disposing of CLSM 20 days a year (i.e., 4 weeks a year). While—based on typical COPC concentration in fly ash (e.g., 50th percentile)—it is unlikely that longer work periods would pose a risk concern, it is advisable to conduct a project and/or CLSM-specific evaluation to assess risk potential for CLSM excavation work conducted for >20 days a year for 10 years.

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Table I. Summary of CLSM Application Risk Potential for Evaluated Exposure Scenarios

Worker Risk – Applicable to Excavating CLSM under Multiple Applications		
Exposure Duration	**Measured Bulk Fly Ash – 50th Percentile**	**Measured Bulk Fly Ash – 90th Percentile**
20 days/year for 10 years	No Risk Concerns[a]	No Risk Concerns[a]
Drinking Water Risk – Conduit Trench		
Well Distance	**Measured Fly Ash Leachate – 50th Percentile**	**Measured Pore Water Leachate – 90th Percentile**
25 ft.	No Risk Concerns[a]	No Risk Concerns[a]
100 ft.	No Risk Concerns[a]	No Risk Concerns[a]
1,000 ft.	No Risk Concerns[a]	No Risk Concerns[a]
Drinking Water Risk – Embankment – No Nearby Surface Water Body – 100 Ft. x 100 Ft.		
Well Distance	**Measured Fly Ash Leachate – 50th Percentile**	**Measured Pore Water Leachate – 90th Percentile**
100 ft.	No Risk Concerns[a]	Consider Additional Evaluation[b]
1,000 ft.	No Risk Concerns[a]	Minimal Risk Concerns[c]
Drinking Water Risk – Embankment – No Nearby Surface Water Body – 300 Ft. x 300 Ft.		
Well Distance	**Measured Fly Ash Leachate – 50th Percentile**	**Measured Pore Water Leachate – 90th Percentile**
100 ft.	Minimal Risk Concerns[c]	Consider Additional Evaluation[b]
1,000 ft.	No Risk Concerns[a]	Consider Additional Evaluation[b]
Drinking Water Risk – Embankment – Nearby Surface Water Body – 300 Ft. x 300 Ft.		
Surface Water Size	**Measured Fly Ash Leachate – 50th Percentile**	**Measured Pore Water Leachate – 90th Percentile**
Medium	No Risk Concerns[a]	No Risk Concerns[a]
Large	No Risk Concerns[a]	No Risk Concerns[a]
Ecological Risk – Embankment – Nearby Surface Water Body – 300 Ft. x 300 Ft.		
Surface Water Size	**Measured Fly Ash Leachate – 50th Percentile**	**Measured Pore Water Leachate – 90th Percentile**
Small	No Risk Concerns[a]	Minimal Risk Concerns[c]
Medium	No Risk Concerns[a]	No Risk Concerns[a]
Large	No Risk Concerns[a]	No Risk Concerns[a]

Notes:

CLSM = Controlled Low Strength Material.

(a) "No risk concerns" indicate that measured fly ash leachates (used as proxies for CLSM leachates) were below the application-specific health-protective leachate levels.

(b) "Consider Additional Evaluation" indicates that measured 50th percentile fly ash leachate (used as a proxy for CLSM leachate) was below the application-specific health-protective leachate level, but there was an exceedance at the 90th percentile. To address the potential risk concern, CLSM leaching tests and/or project-specific fate and transport modeling should be considered.

(c) "Minimal Risk Concerns" indicates that measured 50th percent Fly ash leachate (used as a proxy for CLSM leachate) was below the application-specific health-protective leachate level, but there was a small (<3-fold) exceedance at the 90th percentile.

The risk evaluation report is now available for download from the ACAA website.

Guide to Existing CCP Standards

By Ivan Diaz, Ph.D.

ASTM Standards

Committee C09 on Concrete and Aggregates

C311/C311M-18 Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
This standard contains relevant test methods for fly ash and natural pozzolans. ASTM C618 and other specifications reference the test methods contained in this document.

C618-19 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
This document lays out composition, performance, and other requirements fly ash must meet for its use in concrete. It is the most widely used fly ash specification in the U.S. AASHTO makes available virtually the same fly ash specification of use in concrete under the name M295.

C1697-18 Standard Specification for Blended Supplementary Cementitious Materials
This document lays out composition, blending tolerances, performance, and other requirements that blended supplementary cementitious materials must meet for their use in concrete.

C1709-18 Standard Guide for Evaluation of Alternative Supplementary Cementitious Materials (ASCM) for Use in Concrete
This guide identifies relevant parameters that should be evaluated when introducing an SCM lacking a significant record of performance in concrete and the appropriate test methods that should be employed. ASCM typically refers to materials such as pozzolans and hydraulic materials that fall outside the scope of Specifications C618, C989, and C1240.

C1897-20 Standard Test Methods for Measuring the Reactivity of Supplementary Cementitious Materials by Isothermal Calorimetry and Bound Water Measurements
This document provides two test methods for evaluating the reactivity (hydraulic or pozzolanic) of fly ash and other SCMs.

C1827-20 Standard Test Method for Determination of the Air-Entraining Admixture Demand of a Cementitious Mixture
This test measures the impact fly ash and other SCMs have on the ability of admixtures to entrain air in concrete. This test is also known as the foam index, a fly ash test that has been used for many years, although it was not standardized until C1827 was published in 2020.

C1567-13 Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
This is one of the most widely used tests to determine deleterious expansion caused by ASR. This test is intended to be used while following the guide for reducing the risk of ASR in concrete C1778. The test can determine aggregate reactivity, the effectiveness of fly ash and other SCMs in mitigating ASR, and the replacement level of cement by fly ash required to mitigate ASR.

C1293-20a Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction
This is one of the most reliable test methods for determining potential deleterious expansion due to ASR. Like C1567, this test is intended to be used while following the guide for reducing the risk of ASR in concrete C1778 and can be used to determine aggregate reactivity, the effectiveness of fly ash

and other SCMs in mitigating ASR, and the replacement level of cement by fly ash required to mitigate ASR. However, although a reliable test, its 2-year duration typically makes C1567 (a 14-day test) specifiers' test of choice.

C1778-20 Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete
This document is a comprehensive guide for reducing the risk of deleterious expansion caused by alkali-silica and alkali-carbonate reactions. The use of fly ash is one of the most widely used approaches provided in this guide.

C441/C441M-17 Standard Test Method for Effectiveness of Pozzolans or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction
This test method can be useful to evaluate the relative effectiveness in mitigating ASR of fly ash and other SCMs. Although it is still available in the ASTM library, it has been gradually replaced in specifications by C1567 and C1293.

Committee C01 on Cement

C595/C595M-20 Standard Specification for Blended Hydraulic Cements
This document lays out composition, blending tolerances, performance, and other requirements that blended cements must meet for their use in concrete. Type IP cement, a uniform blend of cement and fly ash, is included in this specification.

C1157/C1157M-20a Standard Performance Specification for Hydraulic Cement
This specification provides performance requirements for cement. Unlike C150, Standard Specification for portland cement, and C595, this specification contains no prescriptive requirements. Some cements containing high volumes of fly ash have been specified using this document.

Committee E50 on Environmental Assessment, Risk Management, and Corrective Action

E2060-06(2014) Standard Guide for Use of Coal Combustion Products for Solidification/Stabilization of Inorganic Wastes
This guide provides a framework for selecting fly ash and other CCPs for stabilization/solidification of solid waste or wastewater that may contain trace elements.

E2201-13(2020) Standard Terminology for Coal Combustion Products
This document defines terms related to CCPs used in E50 standards.

E2243-13(2019) Standard Guide for Use of Coal Combustion Products (CCPs) for Surface Mine Reclamation: Re-Contouring and Highwall Reclamation
This document provides guidance in selecting CCPs with adequate properties for use in surface mine reclamation activities, which may include structural fill, road construction, soil modification or amendment for vegetation, isolation of acid-forming materials, reduction of acid mine drainage, and highwall mining.

E2277-14(2019) Standard Guide for Design and Construction of Coal Ash Structural Fills
This guide describes the requirements CCPs should meet for use in structural fills. It also covers procedures for the design and construction of structural fills using CCPs.

E2278-13(2019) Standard Guide for Use of Coal Combustion Products (CCPs) for Surface Mine Reclamation: Revegetation and Mitigation of Acid Mine Drainage
This document provides guidance on the use of CCPs for abatement of acid mine drainage and revegetation for surface mine reclamation.

E3183-19 Standard Guide for Harvesting Coal Combustion Products Stored in Active and Inactive Storage Areas for Beneficial Use
This guide identifies and describes in stepwise form critical aspects related to harvesting fly ash and other CCPs for beneficial use in concrete and other applications.

AASHTO Standards

M 295, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
A counterpart to ASTM C618, AASHTO M295 lays out composition, performance, and other requirements fly ash must meet for its use in concrete.

M 240M/M 240, Standard Specification for Blended Hydraulic Cement
This document lays out composition, blending tolerances, performance, and other requirements blended cements must meet for their use in concrete. Type IP cement, a uniform blend of cement and fly ash, is included in this specification. The ASTM counterpart of this document is C595.

R 80, Standard Practice for Determining the Reactivity of Concrete Aggregates and Selecting Appropriate Measures for Preventing Deleterious Expansion in New Concrete Construction
A counterpart to ASTM C1778, AASHTO R80 is a comprehensive guide for reducing the risk of deleterious expansion caused by alkali-silica and alkali-carbonate reactions. The use of fly ash is one of the most widely used approaches provided in this guide.

M 321, Standard Specification for High-Reactivity Pozzolans for Use in Hydraulic-Cement Concrete, Mortar, and Grout
This document provides composition and performance requirements for high-reactivity pozzolans for use in concrete. Ultrafine fly ash and silica fume are examples of high-reactivity pozzolans.

ACI Documents

ACI PRC-232.2-18: Report on the Use of Fly Ash in Concrete
This document provides comprehensive information on the use of fly ash and natural pozzolans in concrete. It includes historical uses and describes chemical and physical properties, their effect on fresh and hardened concrete, and aspects related to sustainability.

ACI PRC-232.3-14: Report on High-Volume Fly Ash Concrete for Structural Applications
This document provides supporting technical information for the use of high-volume fly ash in concrete for structural applications. Among other information, the document discusses advantages and limitations, fresh and hardened characteristics, and durability of high-volume fly ash concrete.

ACI PRC-232.4-20: TechNotes: Limits on the Proportions of Fly Ash in Concrete
This TechNote discusses the implications of limits on the proportions of fly ash in project specifications. It notes that specifying limits for use of fly ash in concrete is unnecessary if relevant fresh and hardened concrete performance requirements are specified and goes on to say that limiting the proportion of fly ash in concrete can adversely impact workability/pumpability of fresh concrete.

Important Updates and New and Proposed Standards Related to CCPs

ASTM Work Item 67338

This is a proposed revision to ASTM C618 that aims to include compositional, physical characteristics, and performance requirements for bottom ash for use in concrete. The rationale for this change includes a summary of several studies showing that bottom ash, when ground to a fineness comparable to that of a typical fly ash, performs in similar manner, and in some cases it performs better than fly ash.

Fly ash and bottom ash are generated from the same coal in a given power plant; hence, they have very similar chemical compositions. However, some elements in bottom ash, such as silicon and iron, are generally slightly higher than in fly ash, while others, such as sodium, potassium, and calcium, are generally slightly lower.

Bottom ash has also been shown to contain the same crystalline constituents found in fly ash. However, since bottom ash cools at a slower rate than fly ash, it has a higher degree of crystallinity and consequently lower amorphous content.

Several studies have shown ground bottom ash has pozzolanic properties, one of the most desirable features of fly ash. As with other materials with pozzolanic properties, when proportioned in concrete, ground bottom ash has been shown to improve the durability of concrete by reducing permeability and the risk of deleterious reactions, such as ASR and sulfate attack.

Ground bottom ash offers a common-sense approach to expand the availability of SCMs for use in concrete. This proposed change to C618 to include the material will provide the necessary framework for specifiers to allow or prescribe the use of ground bottom ash in concrete projects, facilitating its beneficial use.

ASTM Work Item 70466

This is a proposed new performance-based specification for supplementary cementitious materials. Unlike other SCM specifications, this proposed document contains no prescription of origin and includes limited compositional requirements. Instead, it focuses on performance requirements that SCMs must meet for use in concrete.

The prevalent types of SCMs currently used today—coal fly ash and to a lesser extent slag cement—play an important role in improving concrete durability and sustainability, while also providing an important avenue for the beneficial use of materials that otherwise would have been disposed. Other types, such as silica fume and ground glass, provide similar benefits. There has also been an increased interest in natural pozzolans, which can play an important role in improving concrete durability and can improve concrete's sustainability, as their embodied energy is much lower than that of portland cement. However, there are other untapped sources and types of SCM, some of them CCPs, that can provide similar benefits to concrete but are not covered by current specifications.

The rationale for this new proposed specification states that a performance-based specification will provide the framework to establish critical quality characteristics that are readily measurable and clearly tied to product performance such that suppliers, specifiers, and purchasers of an SCM can confidently introduce new sources and types of SCMs for use in concrete. This focus on performance rather than prescriptive requirements will open the door to innovative developments, beneficial use of currently disposed SCMs, a much-needed expansion in supply of SCMs, and improved concrete sustainability and durability.

ASTM Work Item on the Autoclave Expansion Requirement of C618

This is a proposed change to C618 to remove the autoclave expansion requirement from C618. The rationale for this proposed change states that numerous studies on autoclave expansion testing have concluded that there are several factors that make this test irrelevant in determining the suitability of fly ash for use in concrete. A literature review summary included in the rationale delineates the following arguments that support the change:

- The autoclave expansion method was originally developed as a test for expansion of cement paste; however, it is still specified in ASTM C618 as a method for soundness of fly ash in concrete.
- Expansion caused by MgO and C3A as measured according to ASTM C151 does not correlate to expansion in concrete cured under normal conditions.
- ASTM C151 testing allows for the determination of expansion due to the hydration of free lime and periclase. Due to a lower temperature of testing, the Le Chatelier test is more suitable to access expansion related to the hydration of free lime only.
- Pozzolanic reaction associated with the addition of fly ash leads to formation of a stronger microstructure of calcium silicate hydrate (C-S-H) and a better containment of forces associated with the hydration of MgO. Specifically, the addition of fly ash "leads to a denser, homogeneous morphology and higher strength, resulting in lower expansion."
- The testing of portland cement-fly ash-standard system according to ASTM C151 can sometimes result in excessive expansion due to alkali-silica reaction (ASR). Some studies have concluded that ASTM C151 is not a suitable test to assess cement-fly ash systems due to the prospect of ASR, and "such an application can misidentify the beneficial functions of alkali to promote the pozzolanic reaction" of fly ash.

ACI TechNote on Harvested Fly Ash

ACI Committee 232 on fly ash for use in concrete has undertaken the development of this TechNote. The document provides background on the factors that have made the concept of harvesting fly ash an attractive option for expanding supply of SCMs, such as changes in energy infrastructure in the U.S. and the enactment of emission standards by EPA.

The TechNote also provides references supporting that harvested fly ash has been shown to retain its pozzolanic properties and thus its ability to improve concrete durability by lowering permeability and mitigating ASR and other deleterious reactions in concrete. Also included in the TechNote is information related to the processes that are available to beneficiate harvested fly ash and the types of processing that may be required to produce ASTM C618-compliant fly ash for use in concrete.

Once published, this document is expected to be an important source of information related to harvested fly ash for the concrete industry.

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Comments on the EPA Coal Ash Beneficial Use Rulemaking

Editor's Note: On March 12, 2021, the Environmental Protection Agency (EPA) reopened the comment period on the notice of data availability for its reconsideration of the beneficial use criteria and provisions for piles of coal combustion residuals. Richard Kinch, formerly the Chief of the Industrial Materials Reuse Branch at EPA, submitted the following comments, which he has permitted ASH at Work to publish as a guest editorial.

By Richard Kinch

As a retired EPA employee of 41 years, I worked extensively on regulatory matters, including coal ash. I, therefore, have a particularly strong view of EPA's regulatory process. My focus in these comments will be on the fundamental principles that should be followed in all regulatory efforts, including this one. Some flaws in addressing beneficial use of coal ash may be difficult for EPA to acknowledge, but the underlying principles behind the comments are sensible, broadly understood, and accepted by those engaged in regulatory development.

To issue regulations, EPA must do the tough work; there should be sound environmental support for regulation; and the stringency and structure of a regulation needs to reflect the data, not a personal or public desire.

Background

Where we are today is an outgrowth of earlier actions while I was at EPA. As we were developing coal ash regulations, there was no plan to include beneficial use. Thus, there were no targeted regulatory efforts associated with site visits, environmental data gathering, risk analysis, and damage case assessments associated with beneficial use. There were, however, some significant associated studies in 3 beneficial use areas: coal ash used in concrete and wallboard, and FGD gypsum (a form of coal ash) used in agriculture. These 3 areas had the kind of work that a sound regulatory effort should undertake. Coal ash used in concrete and wallboard was found not to be needing Federal regulations. FGD gypsum used in agriculture is included in the beneficial use regulations, but there is little to no connection between the extensive work done in a joint effort by EPA and the Department of Agriculture and the structure of EPA's regulation. At essentially the closing few months, we were directed to come up with regulations for beneficial use as part of the original coal ash rule. My prime comment was that we simply had not done the regulatory work, and if regulations are to be developed, EPA needs to put beneficial use on a separate, much longer schedule so the appropriate studies could be done. My immediate management rejected that notion, and we tossed together some general principles with little need for new studies. The result corresponded to the first 3 beneficial use criteria:

(1) The CCR must provide a functional benefit;

(2) The CCR must substitute for the use of a virgin material, conserving natural resources that would otherwise need to be obtained through practices such as extraction;

(3) The use of the CCR must meet relevant product specifications, regulatory standards, or design standards when available and, when such standards are not available, the CCR is not used in excess quantities.

But my immediate management wanted more—so in a few days we came up with a 4th criterion. This included options for a size cut-off. The option that produced the most stringent criteria was selected by my immediate management. That option was selected despite my warning that the criteria, 12,400 tons, was based on the single lowest data point for disposal units (not beneficial use) out of hundreds of values. As such, the basis was extremely vulnerable because the very extreme in databases is where reporting errors are more likely to be found. There is no joy in "I told you so" or that, 6 years

later, EPA has not made the correction. In a principled process, if EPA believed the single lowest data point for disposal units was the right process, the correction could have been made 6 years ago. Instead, there seems to be a search for some way to justify some method to maintain or increase stringency. Given that the selection of the most weakly supported, most technically vulnerable option simply imposed the most stringent value, there is reason to believe that if the error was in the other direction, a rapid regulatory correction would have been made. Such a bias leaking into the regulatory process is without principle.

A Principled Path Forward

With regard to the 12,400-ton criteria, there is, of course, the minimal principled action of just going to the corrected value for the process EPA used to set the criteria. From a broader perspective, the whole process was corrupt—the appropriate regulatory work was not done previously—and this current effort where some scheme is made up and then parties are asked to send in comments and data is a sad regulatory commentary. The commentary isn't a substitute for EPA doing their regulatory job: there will be gaps because EPA was not precise regarding needs; in many cases the data may not exist and EPA still has the responsibility to develop it; all of these uses will need beneficial use specific risk assessment and other work by EPA—and that work will need to be incorporated in a proposed rule and subject to notice and comment. Considering the lack of thorough supporting studies by EPA, legitimately this process is closer to the beginning of an appropriate regulatory development than the end. Also, it should be embarrassing for the Agency to be calling for comments and data when, in the one area where there are substantial studies—FGD gypsum used in agriculture—EPA never tailored that information into the regulatory structure.

For beneficial use, we know there are the following uses:

- Concrete/Concrete Products/Grout
- Blended Cement Feed for Clinker
- Flowable Fill
- Structural Fills/Embankments
- Road Base/Sub-base
- Soil Modification/Stabilization
- Mineral Filler in Asphalt
- Snow and Ice Control
- Blasting Grit/Roofing Granules
- Mining Applications
- Gypsum Panel Products
- Waste Stabilization/Solidification
- Agriculture
- Aggregate
- Oil/Gas Field Services
- CCR Pond Closure Activities
- Miscellaneous/Other

Each of these pose different conditions, yet the old and new regulatory work is largely barren in addressing the environmental data, risk analyses, or damage cases associated with each of these areas being regulated. In not regulating coal ash in concrete or FGD gypsum in wallboard, EPA acknowledges that uses can be environmentally different. Yet the regulated collection of beneficial uses is simply lumped together without beneficial use specific data or analyses, under a structure that makes no attempt to conform to the differences. At one point, EPA raised the option of eliminating a size cutoff. This simply highlighted how far EPA personnel are from doing the proper regulatory work—a bag of soil conditioner from a home improvement store may contain some coal ash and subject a homeowner to ridiculous burdens. These kinds of grossly flawed ideas do not occur when personnel have engaged in proper regulatory development. EPA should address in the rulemaking, separately, how all of the above regulated uses are supported by damage cases, environmental data, and direct risk analysis for the use. It would also be helpful to document for each type of beneficial use visits by EPA personnel, sampling efforts, survey information, etc. The problem for EPA is that such work was not done in the past and continues to be absent. The solution is not for EPA to wholly neglect doing their work and believe the substitute is asking for comments.

One last point: the development of Federal regulations should be driven by an environmental need—often some evidence of damage cases helps drive EPA's selection of regulatory priorities. For coal ash, there was a collection of damage cases for landfills and surface impoundments (as well as associated risk assessments) that drove the regulatory effort. In the beneficial use area, there were a half dozen damage cases associated with structural fills where placement was reported to be into or very close to the groundwater table. EPA's rule swept all structural fills into disposal; thus, those damage cases are not even associated with the beneficial use component of the rule. (I would have preferred a more appropriately studied and targeted regulatory action for structural fills.) The remaining sites of concern with regard to damage were a few actions that no one views as beneficial use—dumping tons of coal ash in depressions throughout the Town of Pines, IN (a much earlier beneficial use guidance by EPA specifically identified that situation as not being beneficial use). I also recall two situations of dumping large quantities of coal ash on top of a road and another on a beach. Those situations never needed beneficial use regulations because they clearly were recognized as not being beneficial use. Maybe things have changed slightly, but as far as I know there have been no practices that the beneficial use rule is addressing that are associated with identified damage cases. Other than the public outcry regarding all things associated with coal ash, the available information never supported the regulatory effort. That said, when EPA wants to investigate and regulate areas without significant identified environmental damage, there are still fundamental and substantive work efforts that need to be undertaken.

Maybe there is some reasonable, face-saving option for EPA to exercise. Note, the first 3 beneficial use criteria were my initial attempt to come up with something that responsibly addressed reasonably accepted conditions for what is beneficial use without the need for major studies. When that was not deemed adequate by my immediate management, we crossed the line and developed criteria 4:

(4) When unencapsulated use of CCR [involves] placement on the land of 12,400 tons or more in non-roadway applications, the user must demonstrate and keep records, and provide such documentation upon request, that environmental releases to groundwater, surface water, soil, and air are comparable to or lower than those from analogous products made without CCR, or that environmental releases to groundwater, surface water, soil, and air will be at or below relevant regulatory and health-based benchmarks for human and ecological receptors during use.

This criterion necessitated the actual and significant work that had not been done and still hasn't been done. Structurally, the soundest approach would be to withdraw the 4th criterion of the beneficial use rule and commit to doing work on each of the use types. Such work would include trying to identify damage cases, gathering basic process and site information, conducting environmental sampling and analyses, conducting risk analyses, etc. to effectively determine the need and appropriate structure of any beneficial use regulations. As EPA experienced dealing with disposal of coal ash, and in the studies of coal ash in concrete and FGD gypsum in wallboard, doing such work is a significant resource commitment, which EPA has thus far inappropriately avoided. (Again, there was also significant work by EPA and the Department of Agriculture on FGD gypsum used in agriculture, but that information wasn't even used in any meaningful way. It should also be noted that FGD gypsum has different properties than the types of coal ash that dominated the landfill and surface impoundment risk analyses. In an analogous vein, bottom ash also has different properties—EPA just proceeded without the appropriate work in my time and continues that error now.) Without basic supporting damage cases or risk assessments for the specific uses, it isn't clear why the beneficial use criterion 4 is in place or whether the regulatory structure is appropriate.

(There is a portrayal that the rule is not regulating beneficial use, but rather it is an exemption. One could recraft every EPA regulation to make a similar claim—the coal ash rule, within criterion 4, is inherently regulating beneficial use.)

Thank you for your consideration of these comments. My underlying principles continue to be consistent and simple. To issue regulations, EPA must do the tough work; there should be sound environmental support for regulation; and the stringency and structure of a regulation needs to reflect the data, not a personal or public desire. While I am skeptical regarding the environmental need for the beneficial use regulations, my past and current concern is that EPA do the appropriate work to justify a rule. Absent that work, calls to issue requirements or have commenters substitute for wholly inadequate work by EPA makes no justifiable sense. If EPA senior managers just ask staff simple questions about the various uses, such as "tell me what you know about coal ash use in oil/gas field operations" (sites visited, use, number of sites, environmental data, damage cases, risk analyses, etc.), the whole process will ring hollow—and that part bothers me. While some may believe industry and citizen groups are most pleased if they get their way, I believe they appreciate when the EPA process is thorough and technically sound. If those at EPA and in the judicial system take an objective look at the lack of study associated with beneficial use rulemaking, they too should be bothered by the process.

My past and current concern is that EPA do the appropriate work to justify a rule. Absent that work, calls to issue requirements or have commenters substitute for wholly inadequate work by EPA makes no justifiable sense.

Richard Kinch *is an independent environmental consultant principally involved in addressing Environmental Protection Agency (EPA) requirements regarding coal ash management and beneficial use. He formerly served as Chief of the Industrial Materials Reuse Branch at EPA in Washington, D.C.*

I'm Glad You Asked

Editor's Note: "I'm Glad You Asked" is a recurring feature that invites a different expert each issue to answer a commonly asked question about coal combustion products. If you would like to submit a question and/or volunteer to provide a written answer to one, please contact the editor at johnfsimpson@gmail.com.

This issue's guest columnist is Sheryl Smith, Business Development Manager at ATC Group Services LLC, an Atlas Company—a leading provider of environmental, testing, inspection & certification (TIC); engineering & design (E&D); and program, construction, and quality management (PCQM) services for government and commercial clients. Sheryl is responsible for growth opportunities for professional engineering design, environmental, and construction materials testing and inspection services in the power, solid waste, water resources, and transportation markets in Atlas' Central Region. Her areas of expertise are in strategic planning, beneficial use benchmark evaluations for coal combustion products, and market evaluations for technology or consulting services opportunities. She has a Bachelor of Science degree in Civil Engineering from the University of Illinois and a Masters of Engineering (Civil) degree from Cornell University. She is a member of the Solid Waste Association of North America, the National Waste and Recycling Association, and the Board of Directors of the Women's Energy Network of Ohio.

Q. Are unencapsulated uses of fly ash safe?

A. According to the United States Environmental Protection Agency (EPA), "unencapsulated" beneficial uses of secondary materials generated by manufacturing and other industrial processes, including coal combustion residuals (CCRs), are uses in which the secondary material is used in a loose or unbound particulate or sludge form and the material is placed on land.[1] Typical examples of unencapsulated uses for fly ash include flowable fill; structural fill; road base/subbase; soil modification/stabilization; waste stabilization/solidification; aggregate; and mining applications.[2]

According to the 2019 ACAA "Production and Use Survey" (2019 survey), 41 million tons of coal combustion products (CCPs) were beneficially used, a recycling rate of 52 percent, although this is 18.4 million tons less than in 2018. The reduction in the amount of CCPs beneficially used is attributable to decreased coal consumption, for the sixth year in a row, due to closure of coal-fueled power plants. Natural gas production has replaced electricity generation from the retired coal plants.[3] The 2019 survey also showed that approximately 1,676,669 tons of fly ash were used in unencapsulated applications.[4] Since 1980, through its production and use survey data, ACAA found that more than 188.7 million tons of coal combustion products (CCPs) have been placed as structural fill, providing a long history of beneficial use.[5]

As discussed below, the beneficial use of fly ash in "unencapsulated" applications is safe due to the adherence to longstanding technical engineering standards, state regulations, and agency specifications; EPA's prescribed methodology for evaluating beneficial use; and other technical reports addressing risk related to "unencapsulated" uses of fly ash.

1 *US EPA, Office of Resource Conservation and Recovery, Office of Solid Waste and Emergency Response, Methodology for Evaluating Beneficial Uses of Industrial Non-Hazardous Secondary Materials, (EPA 530-R-16-011), April 2016, p 2.*
2 *American Coal Ash Association, Beneficial Use of Coal Combustion Residuals Regulatory Guide, undated.*
3 *Energy Information Administration, U.S. renewable energy consumption surpasses coal for the first time in over 130 years, May 28, 2020.*
4 *The CCP categories used in this calculation included: flowable fill, structural fill/embankments, road base/sub-base, soil modification/stabilization, mineral fill, mining applications, waste stabilization/solidification, aggregates, and oil/gas field service. American Coal Ash Association, 2019 Coal Combustion Byproduct & Use Survey Report, December 15, 2020.*
5 *Ward, John, Structural Fill: Conserving Natural Resources Through Projects Featuring Rigorous Engineering Standards, Ash at Work, Issue 2, 2019.*

"Unencapsulated" Beneficial Uses Are Governed by Engineering Standards

"Unencapsulated" coal ash beneficial use applications have been widespread since the 1970s and are conducted in compliance with numerous engineering and consensus-based standards. The following engineering documents were developed for the "unencapsulated" use of fly ash, including structural fill, and other CCPs:[6]

- In 1979, the Electric Power Research Institute (EPRI) issued a "Fly Ash Structural Fill Handbook" (Report EA-1281).

- In 1988, EPRI published "High Volume Fly Ash Utilization Projects in the United States and Canada" (Report CS-4446, Second Edition) and "Fly Ash Construction Manual for Road and Site Applications" (CS-5981, Volumes 1 and 2).

- In 1995, ASTM International issued "Provisional Standard Guide for the Use of Coal Combustion Fly Ash in Structural Fills" (PS23-95).

- In 1997, ASTM International adopted E1861-97 "Standard Guide for Use of Coal Combustion By-Products in Structural Fills."

- In 2001, EPRI and the U.S. Department of Energy (DOE) National Energy Technology Laboratory worked with utilities and state agencies to demonstrate that the use of fly ash in soil stabilization was environmentally viable and did not present a public health or environmental threat.[7]

- ASTM E1861 was superseded in 2003 with the publication of ASTM E2277-03, "Standard Guide for Design and Construction of Coal Ash Structural Fills." ASTM E2277 has been continually updated through a consensus process in order to address improved methods of engineering and placement of coal ash materials, with the current version at ASTM E2277-14.

- In 2005, EPA published "Engineering and Environmental Specifications of State Agencies of Utilization and Disposal of Coal Combustion Products."[8]

- ASTM C593 for Soil Stabilization and ASTM C143 and ASTM C934 for Controlled Low Strength Materials (CLSM) are testing procedures and specifications.

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6 *American Coal Ash Association, Docket ID No. EPA-HQ-OLEM-2020-0463, Disposal of Coal Combustion Residuals From Electric Utilities; Reconsideration of Beneficial Use Criteria and Piles; Notification of Data Availability; Reopening of Comment Period. May 11, 2021.*

7 *U.S. Department of Energy, Co-Sponsor and EPRI, Environmental Evaluation for Use of Ash in Soil Stabilization Applications, Final Report, September 2001.*

8 *University of North Dakota Energy & Environmental Research Center, Engineering and Environmental Specifications of State Agencies for Utilization and Disposal of Coal Combustion Products: Volume 1 – DOT Specifications; Volume 2 – Environmental Regulations, 2005.*

"Unencapsulated" Uses Have Been Regulated by State Rules or Departments of Transportation Specifications

In 2005, the University of North Dakota Energy & Environmental Research Center published a study that presented a state-by-state comparison of Departments of Transportation (DOT) standards and specifications governing the use of CCPs and identifying which beneficial uses were allowed. The document also summarized which states enacted laws or adopted regulations governing the use and disposal of CCPs. The findings of the report demonstrated that many of the state DOTs had adopted other "unencapsulated" uses such as aggregate, mineral filler in asphalt, CLSM, and flowable fill.[9]

In 2012, the Association of State and Territorial Solid Waste Management Officials (ASTSWMO) conducted a survey of states on their policies related to the beneficial use of coal combustion residuals (CCRs). This was a follow-up to the 2006 ASTSWMO survey regarding the beneficial use of various waste streams. Forty-six states responded to the 2012 survey, with 24 of these states noting that large-scale CCR fill operations ("unencapsulated") were allowed for beneficial use. State-specific applications of the unencapsulated uses based on the survey responses are shown in Figure 1.[10] Structural/engineered fill and road/road base construction represent the largest number of beneficial uses based on the number of states that allow these applications. (The "other" category includes filling in underground coal mines, allowing beneficial use in a landfill, and use for stabilization in road/highway construction.)

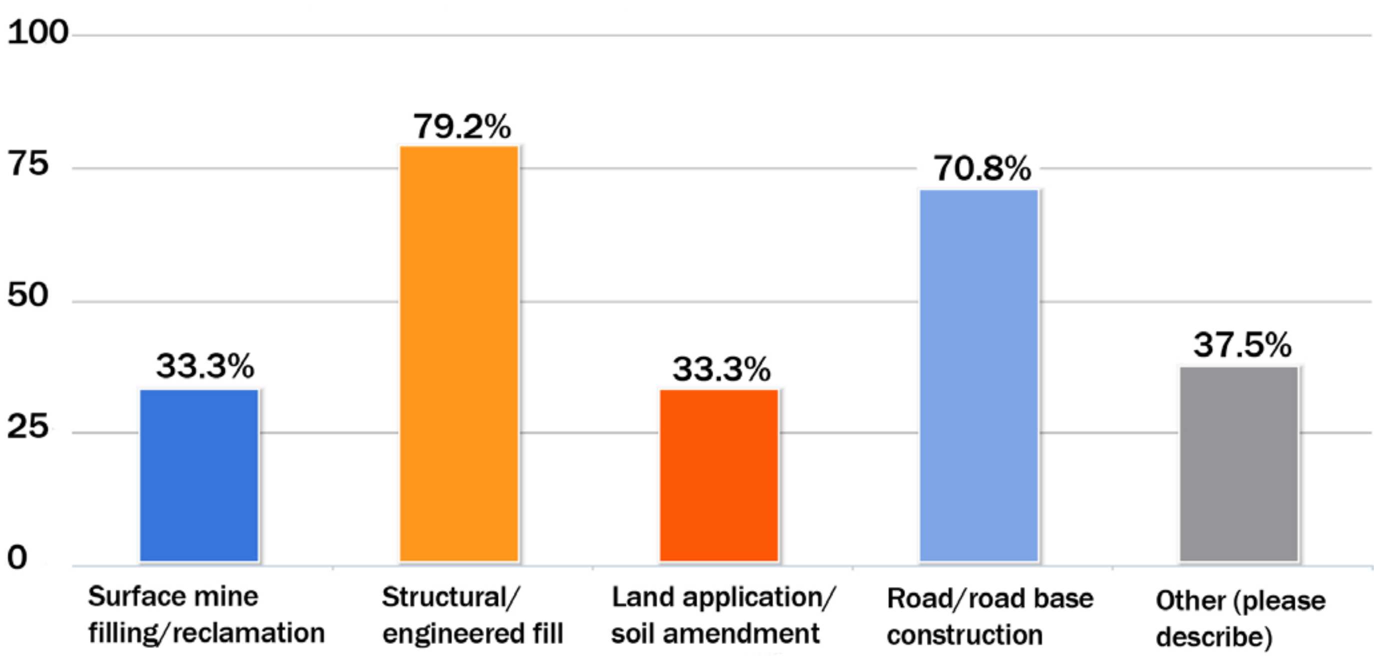
Seventy-six percent of the responding states restrict beneficial use of CCRs either by statute, regulation, policy, or local ordinances. These standards and regulations provide the framework to obtain approvals for beneficial use application, demonstrating that the "unencapsulated" use of these materials is safe.

EPA Has a Prescribed Methodology for Evaluating Beneficial Uses of Non-Hazardous Secondary Materials in "Unencapsulated" Applications

In 2013, EPA published a guidance document that outlined procedures to be followed related to the use of CCPs for encapsulated uses, such as in wallboard or cement production, where the materials are contained in a solid matrix that minimizes their mobilization into the surrounding environment. The methodology included a five-step procedure including:

- Literature review and data collection;
- Comparison of available data from analogous products;
- Creation of a conceptual exposure pathway model;
- Benchmarking of the estimated concentrations; and

Figure 1. Types of large-scale fill operations considered beneficial use



9 *The state DOTs also reported the approved specifications for Class F and Class C for fly ash use in concrete. University of North Dakota Energy & Environmental Research Center, Engineering and Environmental Specifications of State Agencies for Utilization and Disposal of Coal Combustion Products: Volume 1 – DOT Specifications (2005-ERC-07-04), Table 3, p 37.*

10 *Association of State and Territorial Solid Waste Management Officials, Beneficial Use of Coal Combustion Residuals Survey Report, September 2012, pp. 8-9.*

- Quantitative and qualitative risk assessment and comparison to benchmarks to determine if the CCP results were comparable or lower than analogous non-CCP products.[11]

The CCPs were deemed appropriate for beneficial use if they met these steps.

In 2016, EPA published a second manual that expanded application of the methodology to other industrial non-hazardous secondary materials and incorporated the methodology to "unencapsulated" uses. This methodology can be applied to determine whether the proposed beneficial use is safe by demonstrating that the potential for adverse effects to human health or the environment from the secondary material is comparable to or lower than human health risks from the use of an analogous product.[12] Once a demonstration is made, then no additional evaluation is needed and the use is appropriate as proposed.[13]

ACAA-Commissioned Report Shows Low Risk from Fly Ash CLSM

In 2021, Gradient Corporation released a risk evaluation of controlled low strength material (CLSM), also known as flowable fill, which is considered by EPA to be an "unencapsulated" use. The study followed the April 2016 methodology discussed above and determined the constituents of potential concern in the bulk CLSM and leachate samples for both conduit trenches and roadway embankment applications. According to the study, these applications represent the most common uses of CLSM, but also allowed comparison based on subsurface use. In one evaluation, the CLSM was covered with permeable soils and in the other it was used as a road stabilizer and covered by concrete or asphalt.

The key conclusions for the study were:[14]

- The use of CLSM in conduit trenches does not pose a drinking water risk, even for a well as close as 25 feet down-gradient from the edge of the trench.

- For certain embankment sizes, it may be advisable to confirm CLSM leachates are below the health-protective levels or conduct project/site-specific modeling if a groundwater drinking water well is located within 1,000 feet.

- The use of CLSM in larger embankments with a nearby surface water body does not pose a drinking water risk for surface waters located as close as 25 feet down-gradient of the embankment.

- For larger embankments with a nearby surface water body, CLSM does not pose an ecological risk for surface waters located as close as 25 feet down-gradient from the embankment, except for selenium and cadmium in high-end leachate concentration, when discharging to a small water body 25 feet down-gradient from the embankment.

Conclusion

In summary, the "unencapsulated" use of fly ash as structural fill, mineral filler, CLSM, road base, waste stabilization, and other applications discussed above is safe for the following reasons:

- The "unencapsulated" uses have been part of a historical framework governed by engineering design documents, state DOT specifications, state regulations, and ASTM International standards governing safe placement of these materials.

- ASTSWMO has documented through several state surveys (2006 and 2012) that a majority of states allow large-scale fill operations for "unencapsulated" use, applying statutes, regulations, policies, and local ordinances to regulate the safe placement of these materials.

- EPA has a prescribed voluntary phased procedure for evaluating the risks of using secondary waste materials when compared to using analogous products. If the risk evaluations deem a proposed beneficial use to be comparable or lower than the risk from an analogous product, then the application is considered safe.

- The ACAA retained Gradient Corporation to apply the EPA's 2016 methodology for evaluating the risk from using CLSM in conduit trenches and roadway embankments. Gradient's study concluded for most scenarios they evaluated that there were no risk concerns and the application would be safe. In a few scenarios, additional testing of the site-specific leachate was recommended to ensure the health protective levels are met.

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11 *US EPA, Office of Resource Conservation and Recovery, Office of Solid Waste and Emergency Response, Methodology for Evaluating Encapsulated Beneficial Uses of Coal Combustion Residuals, (EPA 530-R-13-005), September 2013, p 1-1.*

12 *US EPA, Office of Resource Conservation and Recovery, Office of Solid Waste and Emergency Response, Methodology for Evaluating Beneficial Uses of Industrial Non-Hazardous Secondary Materials, (EPA 530-R-16-011), April 2016, p 1 (April 2016 methodology).*

13 *Ibid. p 3.*

14 *Gradient Corporation, Risk Evaluation of Fly Ash-Based Controlled Low Strength Material, pp. 31-32, February 19, 2021.*

Preventing a Dryer Fire in Your Home

Editor's Note: As a service to our readers, ASH at Work publishes a recurring series on everyday health and safety topics. We welcome contributions from readers with expertise in health-related issues. Article length should be approximately 500 words. Please submit topic suggestions in advance to John Simpson at johnfsimpson@gmail.com.

Photo designed by Freepik

According to the U.S. Fire Administration, approximately 2,900 residential clothes dryer fires are reported each year, causing an average of 5 deaths, 100 injuries, and $35 million in property loss. Failure to clean the dryer, which can lead to lint accumulation around hot motor components, is the leading cause of dryer fires—but not the only one. Fire prevention experts offer the following safety tips to lower your chances of becoming a casualty to this all-too-common occurrence.

Installation

- Have your dryer installed and serviced by a professional. Dryers should be properly grounded.
- Make sure the correct plug and outlet are used and that the machine is connected properly.
- Only rigid or flexible metal venting material should be used to help sustain proper air flow and drying time.
- Replace flexible plastic or foil type ducting, which more easily traps lint and is more susceptible to kinks or crushing that can impair airflow.

Operation

- Do not use the dryer without a lint filter.
- Follow the manufacturer's operating instructions and don't overload your dryer.
- Keep the area around your dryer clear of things that can burn, such as boxes, cleaning supplies, and clothing.
- Make sure the air exhaust vent pipe is not restricted and that the outdoor vent flap will open when the dryer is operating. Check the outdoor vent flap to ensure that it is not covered by snow and has a proper cap on it to prevent animals from entering.
- If clothing is still damp at the end of a typical drying cycle, or drying requires longer times than normal, it may be a sign that the lint screen or the exhaust duct is blocked.
- Take extra care when drying clothes that are soiled with volatile chemicals (gasoline, cooking oils, cleaning agents, finishing oils, stains, etc.). If possible, wash the clothing more than once or hang the clothes to dry. If drying the clothes

in a machine, use the lowest heat setting and a drying cycle with a cool-down period at the end. To prevent clothes from igniting after drying, don't leave them in the dryer or piled in a laundry basket.

- Turn your dryer off if you leave home or when you go to bed.

Maintenance

- Clean the lint filter before or after each load of laundry. Remove lint that has collected around the drum. Don't forget to clean the back of the dryer, where lint can also build up.
- Have a qualified service person clean the interior of the dryer chassis periodically to minimize the amount of lint accumulation.
- Once a year, or more often if you notice that it is taking longer than normal for your clothes to dry, clean lint out of the vent pipe or have a dryer lint removal service do it for you.
- Keep dryers in good working order. Gas dryers should be inspected by a qualified professional to ensure that the gas line and connection are intact and free of leaks.

In the Event of Fire

- Call your local fire department immediately.
- Do not open the dryer door to try to put the fire out, as this will provide more oxygen and could make it worse.
- If possible, turn off and unplug the dryer.
- Evacuate your home.

This was adapted from materials published by the U.S. Fire Administration ("Clothes Dryer Fire Safety Outreach Materials") and the National Fire Protection Association ("Clothes Dryer Safety Tip Sheet").

ACAA

Beneficial Use Case Study

Correcting Sulfur Deficiency with FGD Gypsum to Boost Alfalfa Yield

Coal Combustion Product Type
FGD Gypsum

Project Name
Correcting Sulfur Deficiency with FGD Gypsum to Boost Alfalfa Yield

Project Location
Onaway, Michigan

Project Participants
Presque Isle County Michigan State University Extension, Charah Solutions

Project Completion Date
2017

Project Summary
Sulfur and boron are essential to alfalfa's quality, yield, and regrowth. Alfalfa utilizes approximately five to six pounds of sulfur per harvested ton. A 2015 survey of tissue sulfur levels in Michigan alfalfa fields found that 58 percent of those sampled in the northern regions of the state were deficient, likely the result of lower atmospheric sulfur deposition resulting from regulatory efforts to minimize power plants' sulfur emissions. Boron is commonly deficient in alfalfa grown in high-pH, sandy loam soils, such as those found in northeast lower Michigan. To address these deficiencies, Presque Isle County Michigan State University Extension tested the use of two Sul4R PLUS gypsum products from Charah Solutions on alfalfa hay quality and yield.

Project Description
A two-year-old alfalfa stand near Onaway, Michigan, was selected for testing based on soil analysis that revealed sulfur and boron deficiencies. Approximately 300 pounds per acre of 3-14-42 dry fertilizer was applied to all fields to control for potential nitrogen, phosphorous, and/or potassium deficiencies. Two different treatments were then applied to the alfalfa fields at a rate of 147 pounds per acre—the first SUL4R-PLUS gypsum, comprising 21% Ca and 17% S, and the second SUL4R-PLUS B+Z, comprising 18% Ca, 16% S, 0.50% B, and 1.5% Zn. The other plots were left untreated to act as a control group. Each treatment was replicated four times in a randomized pattern.

Alfalfa yield varied significantly between the gypsum and control treatments at first cutting (P=0.008), second cutting (P=0.05), and overall (P=0.02), with the SUL4R-PLUS and SUL4R-PLUS B+Z treatments out-yielding the control treatment by 1,321 and 1,537 pounds dry matter per acre, respectively. Yield was higher for the SUL4R-PLUS treated fields at first cutting, and in the SUL4R-PLUS B+Z treated fields at second cutting.

Further, alfalfa yield was significantly correlated with tissue sulfur concentration (R2=0.26, P=0.10). Alfalfa tissue sulfur concentrations varied significantly between the SUL4R-PLUS treatment and the control treatment (P=0.10). However, the SUL4R-PLUS B+Z treatment produced intermediate tissue sulfur concentrations not significantly different from the SUL4R-PLUS treatment or the control. Tissue boron levels, however, were significantly higher in both the SUL4R-PLUS B+Z and control treatments

Photo: GNU FDL/Gary D. Robson

relative to the SUL4R-PLUS treatment, although all treatments produced sufficient tissue boron levels.

These differences in nutrition status between treatments did not translate into significant differences in forage quality at first cutting—likely the result of the alfalfa being over-mature and damaged by alfalfa weevil prior to first cutting, making quality poor overall. However, crude protein and relative feed value were both higher in the SUL4R-PLUS B+Z treatment at second cutting.

Collectively, the data suggest SUL4R-PLUS products are capable of addressing sulfur, and possibly boron, deficiency in alfalfa to significantly increase both forage yield and net economic return. The addition of boron to gypsum (i.e., the SUL4R-PLUS B+Z treatment) produced somewhat unexpected results, apparently counteracting the negative effect of added calcium on boron uptake by the alfalfa in the SUL4R-PLUS treatment.

The addition of boron to SUL4R-PLUS also appears to have a possible effect on the rate of sulfur uptake and utilization by alfalfa. Tissue sulfur and first cutting yields were less in forage treated with SUL4R-PLUS B+Z compared to SUL4R-PLUS. Yet regrowth after first cutting in the boron-treated fields outpaced even the standard SUL4R-PLUS treatment, and forage quality was also better at second cutting where boron was added.

The researchers hypothesize that the addition of boron as a coating to the gypsum pellets may physically limit the availability of sulfur initially. However, the additional boron appears to be important eventually in counteracting reduced boron uptake caused by the large amount of calcium in gypsum—and may also interact synergistically with added sulfur to improve forage yield and quality by mid-season.

This case study was adapted from "Increase alfalfa hay yields by addressing sulfur deficiency," published January 15, 2018, by James DeDecker and Christian Tollini of Michigan State University Extension. To read the full synopsis of their research, please visit: https://www.canr.msu.edu/news/increase_alfalfa_hay_yields_by_addressing_sulfur_deficiency

Beneficial Use Case Study

Calgary International Airport Runway and Tunnel

Coal Combustion Product Type
Fly Ash

Project Name
Calgary International Airport Runway and Tunnel

Project Location
Calgary, Alberta

Project Participants
TransAlta, LaFarge Canada, PCL Construction, CH2M HILL, AECOM, Hatch Mott MacDonald, Dufferin Construction

Project Completion Date
2014

Project Summary
With roughly 18 million passengers and 240,000 aircraft landings and takeoffs in 2019, Calgary International is the fourth-busiest airport in Canada. At just over 3,600 feet in elevation, it is also one of Canada's highest airports. Owing to the thinner air, airplanes—particularly large aircraft or those carrying a heavy payload—require longer runways for take-off and landing. In 2011, the airport set about building a new runway that could accommodate the largest planes in the world. At the same time, it built a concrete traffic tunnel under the new runway, extending the existing Airport Trail both to provide a new access point to the airport and to link with one of Calgary's primary east-west connectors through the city.

Project Description
Prior to construction of the new runway, aircraft landing at Calgary International used one of two other runways that ran at angles toward each other—a less than optimal situation depending on prevailing wind conditions. The new runway was designed to run parallel to the longer of the existing runways to help facilitate the flow of air traffic.

Although the need for an additional runway had been recognized up to 40 years earlier, construction only began in 2011. A life-cycle analysis had already been undertaken that concluded the durability and maintenance costs of concrete were more favorable than asphalt—and so concrete was selected as the surfacing material.

To increase the airport's capacity to accommodate international and other larger aircraft (including the Boeing 747-800 and Airbus A380), a runway length of 14,000 feet (2.65) miles was specified. The Calgary Airport Runway Development project consisted of one million square meters of concrete paving, or 400,000 cubic meters of concrete. TransAlta supplied fly ash for the concrete mix, which used a 15 percent replacement of portland cement. The resulting runway, 17L/35R, is now Canada's longest, and its placement represents one of the largest ever undertaken in Alberta.

Concurrent with its construction, the six-lane, 2000+-foot-long Airport Trail Tunnel was built underneath the runway to provide better traffic circulation around the airport. Engineers chose a cast-in-place concrete rigid frame design using a cut-and-cover construction method (rather than boring a tunnel under the runway). Here again, the structure's life-cycle costs and durability were major considerations in the design.

Owing to the relatively short time period—three days—between the placement of the concrete and the removal of the formwork during casting of the tunnel's concrete segments, an initial rapid rise of concrete strength was required. A mix design that maximized the use of fly ash was used to temper the subsequent heat of hydration. Additional cooling measures, including the use of ice and a liquid nitrogen injection system, were also used during batching.

Beneficial Use Case Study

Use of Green Concrete to Pave U.S. Route 287

Coal Combustion Product Type
Class F Fly Ash

Project Name
Use of Green Concrete to Pave U.S. Route 287

Project Location
Lamar, Colorado

Project Participants
Castle Rock Concrete Construction Company, Holcim (US) Inc., Colorado Department of Transportation

Project Completion Date
2008

Project Summary
In 2007 Holcim (US) Inc. and Castle Rock Construction Company joined in a collaborative partnership to provide the Colorado Department of Transportation (CDOT) with a sustainable concrete pavement solution to help with the governor's initiative to lower the environmental impact of construction. An industry task force helped develop the "green concrete" specification allowing carbon-reducing alternatives to ordinary portland cement (OPC), such as portland-limestone cement (PLC) and fly ash, to be used in concrete paving projects. In 2008, CDOT became the first state department of transportation to approve the use of PLC containing up to 10 percent limestone and to allow blending with fly ash at the ready-mix plant.

Colorado Department of Transportation

Roughly 1.2 million square yards of fly ash-rich "green concrete" was placed during the construction of 12.5 miles of new express lanes on Colorado State Highway 470.

Project Description
An early usage and test of the lime/fly ash mix came in May 2008 with the replacement of a seven-mile segment, together with shoulder widening, of U.S. Highway 287. The road is a major U.S. - Mexico shipping highway that accommodates heavy truck traffic. When the time came to replace a section of this highway—a jointed plain concrete pavement near Lamar, Colorado—CDOT selected its Class P mixture, which is designed to have a 28-day flexural strength of at least 650 psi. Together with PLC sourced from Holcim (which replaced the more typical Type I/II portland cement), the concrete mix incorporated 20% Class F fly ash and a carefully selected blend of aggregate to facilitate the production of a consistent concrete batch and a solid platform for the concrete paver.

Most of the paving work took place during the summer months, and contractor Castle Rock Construction dealt with frequent placement conditions of 100° Fahrenheit. Thus, the project provided a good opportunity to gauge the effect of hot weather on the PLC/fly ash mix. Site workers, however, reported no difference in performance or placement with the new mix. Ultimately, the green concrete satisfied all the requirements for batching, mixing, and placing—and the contractor earned a quality performance incentive by attaining a 28-day flexural strength of 695 psi.

Since this first project, Castle Rock Construction has used green concrete in most of its infrastructure paving work (over 600 lane miles). This includes the resurfacing of Pena Boulevard, the thoroughfare that leads to Denver International Airport, which was recognized with a Triad Award from *Public Works* magazine for outstanding innovation and sustainability in using PLC. Other notable projects include 1.5 million square yards of concrete for 12 miles of express lanes on U.S. Route 36 (which earned a National Award for Excellence from the American Concrete Pavement Association) and 1.2 million square yards of concrete for 12.5 miles of new express lanes on Colorado State Highway 470.

Beneficial Use Case Study

St. Croix Crossing Bridge

Coal Combustion Product Type
Fly Ash

Project Name
St. Croix Crossing Bridge

Project Location
St. Croix River crossing on the Minnesota/Wisconsin border

Project Participants
MnDOT, WisDOT, Lunda/Ames Joint Venture, Beton Consulting Engineers, Cemstone, Aggregate Industries, HDR, Holcim Technical Services Group

Project Completion Date
2017

Project Summary
The Stillwater Lift Bridge was constructed in 1931 as a two-lane overpass crossing the St. Croix River between Stillwater, Minnesota, and Houlton, Wisconsin. With only one lane in each direction, the crossing was a frequent traffic bottleneck, a situation compounded by the fact that the bridge's main span had to be lifted to allow boats to pass underneath. In 2008, after more than three-quarters of a century in service, the bridge was deemed structurally deficient and in need of replacement.


Photo: MnDot


Photo: MnDot

Project Description
The existing bridge's location on the St. Croix National Scenic Riverway, a federally protected system of waterways, meant that the design and construction of its replacement would face particular environmental scrutiny—pertaining to such factors as the volume and sustainability of the materials used as well as the bridge's physical profile within the surrounding landscape.

Ultimately, an extradosed bridge design was settled upon—a hybrid configuration combining box girders and cable stays. Compared to a more traditional cable-stayed span of similar length, the design allowed for the use of fewer piers; shorter towers; less concrete, steel, and cable; and lower environmental impact. The specifications called for a minimum 100-year service life—making concrete fortified with supplementary cementitious materials (SCMs) the obvious choice of material over structural steel.

In spite of its streamlined design, the St. Croix Crossing Bridge—at almost one mile in length and 140 feet above the river—required the casting and shipment of massive precast concrete girders, some as large as 180 tons. The girders' size and relatively intricate form required very specific concrete mixes combining workability with both early strength gain (4,000 psi in 24 hours) and durability. Rigorous testing produced almost 20 mixes for the concrete elements used, each featuring liberal use of SCMs—ranging from a 10 percent fly ash mix for the bridge-approach segments (variously requiring 6,000 or 8,000 psi strength) to a 30 percent fly ash mix for the main span segments (requiring 8,000 psi strength). In total, 6,000 tons of fly ash were incorporated into the main span's 650 concrete girders.

Completed in 2017, the St. Croix Crossing Bridge represents only the fifth time an extradosed design has been employed in bridge construction in the U.S.—and stands as proof of the feasibility of using fly ash concrete in such designs to help achieve both environmental and aesthetic objectives. Since its opening, the bridge has earned a raft of awards, including a Public Works Project of the Year Award in 2018 from the American Public Works Association and Best Project (2018) in *Engineering News-Record Midwest*'s Highway/Bridges category.

6 Questions for Rich Nolan

Editor's Note: "Six Questions for…" is a regular ASH at Work feature in which leaders with unique insight affecting the coal ash beneficial use industry are asked to answer six questions.

Rich Nolan is President and Chief Executive Officer of the National Mining Association (NMA). NMA is the national trade association for the U.S. mining industry and represents coal, metal, and industrial mineral producers, mineral processors, equipment manufacturers, and other suppliers of goods and services to the domestic mining industry. As President and CEO, he directs the association's public policy efforts before Congress, regulatory agencies, and the White House and sets the association's strategic agenda for media relations, grassroots communications, and political involvement.

With more than 20 years of experience advocating on many natural resources-sector issues, Mr. Nolan most recently served NMA for 13 years as Senior Vice President of Government and Political Affairs. His three decades in government affairs and political advocacy have spanned a number of industries, including mining, forestry, paper, chemicals, and agriculture. His career began on Capitol Hill, where he served as an aide to several members of Congress and worked as an advisor on multiple campaign committees. After his time on the Hill, he held leadership roles at associations and firms focusing on natural resources and environmental issues, including the American Forest & Paper Association, CropLife America, and the U.S. Chamber of Commerce, among others.

Mr. Nolan is a member of the Board of the U.S. Energy Association and serves on the National Coal Council, a Federal Advisory Committee to the U.S. Secretary of Energy.

ASH at Work (AW): Last year saw a steep drop in U.S. coal production, principally as a result of lower power sector demand. Does 2021 offer an improved outlook for U.S. coal producers?

Rich Nolan (RN): There are definitely positive economic signs on the horizon. Rebounding U.S. and global economic growth should drive demand for coal as well as other commodities for the rest of 2021. With LNG terminals near full capacity and prices in Asia skyrocketing, coal's competitive position has improved. Combined with the ongoing China-Australia trade dispute and labor issues in Colombia, it points to improving markets for U.S. coal.

AW: Where do you see the market for metallurgical coal heading?

RN: As a key input in the steelmaking process, met coal demand is expected to increase as economic stimulus plans take effect and infrastructure spending picks up globally. New blast furnaces are coming online in India, Vietnam, and Indonesia that will help drive future demand and U.S. met coal exports. Global met prices are expected to rise—and U.S. producers will compete in these markets.

AW: Given the closely divided House and Senate, do you see opportunities to forge bipartisan consensus on coal and mining issues in the upcoming congressional session?

RN: The historically narrow margins in Congress will require compromise. We expect that the West Virginia congressional delegation, which understands the importance and value of the coal industry, will play a key role in seeing that coal and coal communities continue to have a place in the nation's energy picture.

Working with these and other allies across the country, the NMA expects to be able to effectively engage not just on coal technology and on DOE's CoalFirst program, but on coal-to-products as well as met coal in producing the steel for the upcoming infrastructure stimulus.

AW: What specific legislative items does NMA intend to push for in the months ahead?

RN: We look forward to helping build bipartisan support on a number of issues, including:

- Opportunities to advance coal-based energy technologies to address climate and coal-to-products research;
- Crafting an infrastructure recovery package that includes met coal-based steel;
- New fair-trade deals for coal exports; and
- Continuing to advocate for balance and fairness in the electricity markets.

AW: How real a threat are policy proposals such as the "Green New Deal" to the future of coal as a baseload generating fuel?

RN: The NMA continues to advocate for an all-of-the-above energy strategy that includes coal, nuclear, renewables, and natural gas. The baseload retirement crisis is real, and it's only growing more acute. The fact is U.S. coal capacity continues to be undervalued by policymakers, public service commissions, and utilities who fail to grasp the reliability coal brings to our transitioning grid as well as the larger economic value that plants, and the coal mines that support them, provide to the states and communities they serve.

AW: What can be done to reverse those trends and the economic damage that they are visiting on coal and mining communities?

RN: The industry has to come together to tell its story to both the public and policymakers that fuel targeting is not the answer to the world's climate challenge. Coal remains absolutely critical to providing balance on the grid and underpinning affordability and reliability in many states. Jeopardizing affordability is the last thing consumers need with millions out of work and our focus on economic recovery.

This administration has already articulated a need for focus on carbon capture, and we would like to see action there. There's widespread, bipartisan support for carbon capture, utilization, and storage, and we need to double down. Producing globally replicable solutions requires focusing on technology for the fuels and infrastructure the world uses and will continue to use well into the future.

ASH Allies: Portland Cement Association A Roadmap for Carbon Neutrality

By Mike Ireland

For more than 100 years, the Portland Cement Association (PCA) has represented manufacturers of a truly necessary and incredible product—one that is literally the foundation of civilization and will continue to play a key role in society for decades to come.

PCA has over 30 staff, with offices in Illinois and Washington, D.C. Our association provides a plethora of benefits to our member companies and the entire industry—benefits they request and efforts that they direct. Last fall, the CEOs of PCA member companies identified three key areas of strategic focus: sustainability, infrastructure, and market development. PCA also recognized the necessity of weaving communication and coordination throughout our efforts to ensure we are successful, aligning with the American Concrete Paving Association and the National Ready Mixed Concrete Association where it makes sense to amplify our collective voice.

The renewed national focus on sustainability and action on infrastructure shines a spotlight on the opportunities and benefits of building with concrete. The cement and concrete industry is taking significant steps toward addressing climate change and emissions. Building on the November 2020 announcement that PCA is developing a roadmap to achieve carbon neutrality across the concrete value chain by 2050, we shared additional details about our roadmap and the opportunities for collaboration on environmental goals during the 2021 World of Concrete in Las Vegas, Nevada.

To truly measure a material's environmental impact, it is critical to consider its full lifecycle—starting at production and looking across the value chain to availability, use, and recycling opportunities. Taking this holistic view, the entire value chain of clinker, cement, concrete, construction, and carbonation is integral to tomorrow's circular economy, and each link has its own part to play in the roadmap. The roadmap addresses five major areas:

- Clinker: Optimizing its composition and manufacturing are the starting point of the value chain.
- Cement: Optimizing the ingredients in cement to reduce carbon intensity.
- Concrete: Exploring the infinite number of concrete mixture combinations, all of which can help reduce overall emissions.
- Construction: Outlining the opportunities to reduce emissions in the design, construction, use, and end-of-life phases.
- Carbonation: Using concrete as a carbon sink—measuring the benefits from the natural process of concrete absorbing CO2 over its lifetime.

This roadmap will guide us on what may be the most ambitious journey to carbon neutrality ever attempted by any industry. The cement and concrete industry will be a leading voice in enabling the construction sector to step up and meet this goal. Collaboration with industry and private partners will be key to unlocking a spectrum of solutions that our roadmap outlines. After all, the best success stories happen while working together, cooperatively, to solve society's challenges.

Partnership with legislators and government decision-makers will also be critical in achieving solutions that go beyond the next Congress and Administration. Many of the actions and opportunities identified in the roadmap are relatively "low-hanging" solutions already developed and proven and only require federal or local assistance. Looking ahead, we continue to be heavily involved in research and development of emerging and innovative technologies such as carbon capture, utilization, and storage. However, collaboration from government is needed to scale up these technologies as well as create a national system of transport, utilization, and/or sequestration.

Cement and concrete are pivotal in building resilient communities that enable people to live safe, productive, and healthy lives relying on structures that can withstand natural and man-made disasters. PCA's members are committed to delivering essential products to meet those needs while continually driving down emissions and achieving ever more stringent environmental goals.

Equally, we are committed to addressing climate change and reaching the ambitious, yet achievable, goal of carbon neutrality by 2050. This roadmap enables our member companies and partners along the value chain to continue building a better future.

For additional information, please visit www.cement.org or www.shapedbyconcrete.com.

***Mike Ireland** is President and CEO of the Portland Cement Association.*

ASH Classics

A Look Back at the Beginnings of the U.S. Coal Ash Industry

"ASH Classics" is a recurring feature of ASH at Work that examines the early years of the American Coal Ash Association and its predecessor, the National Ash Association, focusing on issues and events that were part of the beneficial use industry's defining years.

The 1970s saw increasing use of coal ash in road base course applications to conserve dwindling aggregate resources. This ASH Classic, from 1972, showcases the use of bottom ash and boiler slag in the base course of a major road construction project in West Virginia's Northern Panhandle.

ASH AT WORK
PUBLISHED BY NATIONAL ASH ASSOCIATION, 1819 H STREET NW, WASHINGTON, D.C. 20006
Vol IV, No. 3 1972

Bottom Ashes In Major Road Construction

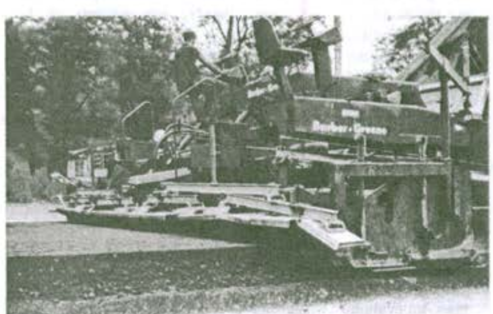
¼ Million Tons Used In West Virginia Route 2

A major road construction project currently underway in the upper Ohio Basin in West Virginia's Northern Panhandle will utilize approximately ¼ million tons of bottom ash and boiler slag from nearby power plants in both Ohio and West Virginia plus blast furnace slag from Pennsylvania in the widening and relocation of a portion of that state's Route 2. This job is one of the few in the country constructed almost entirely of by-product materials. No natural aggregates were used.

The bottom, cement-treated base course in the 4-mile long project is now being constructed and consists of 45% cyclone slag from the nearby Kammer Plant (Ohio Power Co.) and 42% dry bottom boiler ash from Appalachian Power's new Mitchell Plant. These two materials are mixed with 5% Type I Portland cement and 8% water to form the final mix. The cement-treated material is placed in one lift and compacted to a final thickness of 6". Density measurements have met or exceeded the state requirement of 97% of Proctor.

The overlying course, an aggregate base course, is placed in two lifts to a final thickness of 9". The mix is composed of 80-85% bottom ash and 15-20% AASHO #3 blast furnace slag.

The surface course, a bituminous concrete, is 2" thick and contains both boiler slag and blast furnace slag as aggregate.



All courses in the road construction project contain ash to fulfill several functions.

The Route 2 project demonstrates the versatility of bottom ashes when quality control and performance engineering are emphasized.

50,000 tons of boiler slag from Ohio Power's Cardinal Plant, 40 miles up-river at Brilliant, Ohio, will be used to produce the shoulders and base for lightweight "feeder" or access roads. Preliminary tests show the material will compact to 98-99% of Proctor density, well exceeding the state's 95% requirement. The shoulders will be covered with consecutive layers of AASHO #3, #7, and #8 blast furnace slags, with oil treatment between aggregate layers.

Ash is effectively being used in a number of areas in the country to conserve dwindling aggregate resources. State inspectors have expressed their pleasure in the quality of this job and the performance of the material. The Route 2 project is expected to result in considerable savings to the state as well as produce a good road.

Credits:
General Contractor .... S. J. Groves & Sons, Inc.
Paving Contractor .... Tri-State Asphalt, Inc.
Ash Supplier .... Highway Materials, Inc.
Ash Sources .... Appalachian Power Company
Ohio Power Company

(continued on page 3)

Personal Profiles – Allegheny Power Ash Representatives

The Allegheny Power System, Inc., has begun a program designed to take advantage of the potential use of fly ash and bottom ashes.

Allan W. Babcock and Bernard G. Hawkins have been assigned the responsibility for the promotion of ash sales throughout the utility's service area.

Babcock, who is located in Fairmont, West Virginia, will handle the output from APS stations located in the Monongahela Power Company and The Potomac Edison Company service areas, and Hawkins will direct sales from West Penn Power Company headquarters in Greensburg, Pennsylvania.

Al Babcock

Bernie Hawkins has been meeting with Pa. state highway officials and reclamation officers to promote the use of ash materials in roadbuilding and land reclamation. Preliminary work is underway on three landfill and subsidence projects.

Bernie Hawkins

Since taking his new responsibility, Al Babcock has worked with federal, state and local officials, and diverse private industry people—all of whom play a potentially important role in reaching the Allegheny Power System's goal.

Babcock and Hawkins are establishing and promoting uses for ash that will be of benefit to all concerned—citizens, industry and utility—in the APS service area.

IN MEMORIAL

Paul G. Viall – Paul passed away Friday, August 25, 1972 of a heart attack. He had been confined in the hospital for several weeks. The fly ash community has lost a diligent ash promoter, family man and friend.

Mr. Viall founded Viall-Ohio Fly Ash Company Incorporated a number of years ago in the Akron area. Through his efforts, the company has expanded operations, working with several utilities on ash disposal and utilization in Ohio and neighboring states. Paul Viall, Jr. will continue to operate the business from the Akron offices:

2101 N. Cleveland-Massillon Rd.
Akron, Ohio 44313

Alex Wilson – News of the death of Alexander Wilson on Wednesday, August 30, 1972 has been received from his office in London, England. Alex had suffered a stroke in 1969. However, he had recovered to resume his professional activities. He had undergone an emergency appendectomy just prior to his passing.

For many years, Mr. Wilson served as Chief Marketing Officer, Central Electricity Generating Board, England. As an introduction to CEGB's new book, *PFA Utilization*, Mr. Wilson wrote, "The fact that over six million tonnes (sic) of ash . . . are now being sold annually, by the CEGB, amply demonstrates the commercial viability of the methods of utilization. . . ." This fact amply demonstrates, to a great degree, the success of the dedication and leadership of a world leader in ash utilization and dear friend, Alex Wilson.

Ash-Based Aggregate In Roadbuilding

Highway officials in West Virginia recently heard presentations by several experts on the value of using synthetic aggregate in roadbuilding. Dr. L. John Minnick, G. & W. H. Corson, Inc., explained the process developed by the Corson Co. which uses fly ash, sulfate sludges and lime as ingredients in a quality roadbuilding aggregate.

The success of the material at TRANSPO '72, coupled with previous extensive research and testing by Corson researchers, has prompted the Federal Highway Administration (FHWA) to encourage expanded use of the fly ash-sludge-lime mixture on regular highway projects. This encouragement by FHWA is a part of the broad-based goal of demonstrating the use of several specified waste products.

The importance of such demonstrations and ultimate utilization is magnified in view of such real problems as mounting pollution in some areas and the shortages of natural materials for such applications as, in this case, aggregate in roadbuilding. At the West Virginia Highway Dept. meeting, Dr. David Maneval, Science Advisor, Appalachian Regional Commission (ARC), emphasized that southern West Virginia is, indeed, aggregate-short at this time. To further clarify the specific needs for using such materials, the ARC is sponsoring a consultant evaluation of the factors relating to the process.

After hearing the presentations and discussions, West Virginia highway representatives decided on a plan to evaluate the technical and economic feasibility of the fly ash-sludge-lime aggregate in local service roads and repair jobs within the state highway system.

Based on the findings of the ARC-sponsored evaluation, the performance of the fly ash-sludge-lime material will be advanced to the West Virginia Department of Highways and others in the Appalachian Region. FHWA resources will be solicited to assist in the evaluation. Following this, a coordinated development plan will be proposed to the states, FHWA, ARC, utility and private industry representatives, to provide for the use of the fly ash based aggregate in primary roads and interstate construction in the Appalachian Region.

Illinois Interstate Uses Boiler Slag

Recently, Central Illinois Public Service Company, the Illinois Dept. of Highways and Litchfield Bituminous Corp. took a major step toward making constructive use of a valuable by-product—boiler slag.

Boiler slag is a quality engineering material for many applications, including base material for roads. Boiler slag will be used as a base material in the construction of two overpasses on Illinois Interstate 55, where engineers determined that a material was required that was superior to the in situ material.

Boiler slag from CIPS's Coffeen Station was approved as the substitute base material after meeting all gradation specifications in tests conducted by both Litchfield Bituminous and the Illinois Dept. of Highways. Illinois, as well as the Highway Depts. in Indiana and Ohio, has specifications for boiler slag as aggregate. A number of other states have also used the material as base course aggregate, fill and wear-course anti-skid aggregate.

Approximately 125,000 to 150,000 tons of material will be required to complete the construction of the twin bridges spanning the tracks of the Chicago, Burlington and Quincy Railroad near Litchfield, Ill. Litchfield Bituminous has been hauling over 2,000 tons each day—using up to 24 tandem and dump trucks—to move the 150,000 tons of material from the storage pile at Coffeen Station to four large excavations on the construction site.

Engineering applications for boiler slag have been increasing throughout the country. Interest among state and federal officials and commercial enterprises is high. But a major project on an interstate highway is certain to stimulate even further activity across the country.

The successful completion of this project is certain to expand markets in the midwest, particularly in Illinois, for bottom ash and boiler slag in future road-building projects.

Seaboard Fly Ash Builds Bagging Plant

Seaboard Fly Ash Company has recently begun operations at a new bagging plant in Baltimore, Maryland.

Ash from the Potomac Electric Power Company is bagged as pozzolan which meets ASTM requirements. The ash is presently being hauled to the plant in Seaboard's aluminum tankers from unit #4 of PEPCO's Potomac River Station. Two other PEPCO stations are future sources of pozzolan ash, according to Seaboard president Harvey Greenwell.

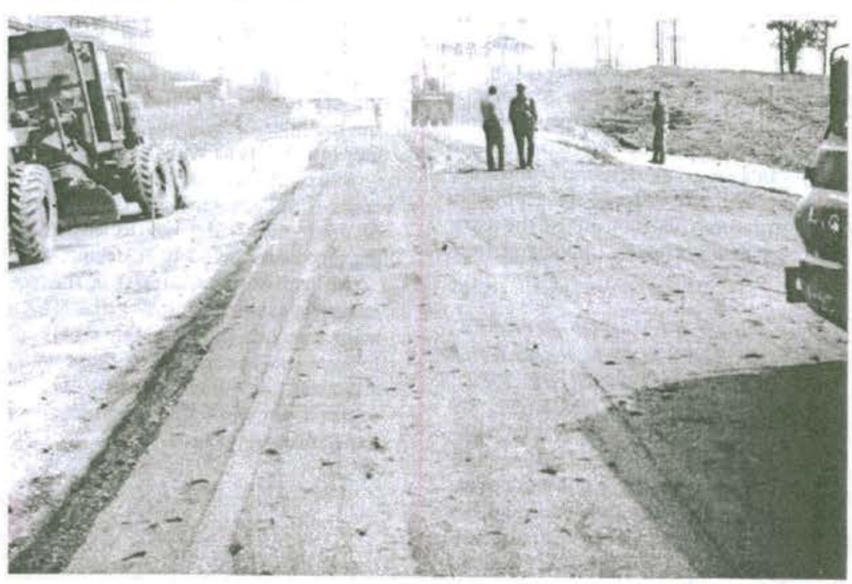
The new operation, with an 80-ton-per-day capacity, is set to produce 50 and 75 lb. bags of pozzolan. The company plans to expand operations to bag grouting mixes and ferro-cement. The material is normally palletized and covered with plastic, ready to haul. Private truckers, as well as Seaboard's own flatbed trucks, haul from the plant.

Seaboard's new testing laboratory provides support for the organization's ash marketing and construction inspection activities. The lab, located at company headquarters in Rockville, Md., is equipped to perform complete analyses and testing of fly ash and other materials as required by ASTM, AASHO and others.

Bottom Ashes In Road Construction In W.Va.

(continued from page 1)

West Virginia State highway officials and a number of interested roadbuilders viewed the Rt. 2 project with a great deal of interest.



The roadbuilder finds boiler slag a welcome sight, especially in view of natural aggregate shortages which are becoming increasingly more acute.

Ultra-Modern Plant Uses Fly Ash To Produce Quality Concrete Block

Fly ash has been an important and profitable ingredient in the manufacture of concrete block for the past 16 years at Hagerstown Block Company. The Maryland company's experience reflects that of many concrete products producers throughout the country.

To Hagerstown Block president Jim Myers, the most important advantage resulting from using ash is the increased life of the working parts—reducing costly down time for repairs.

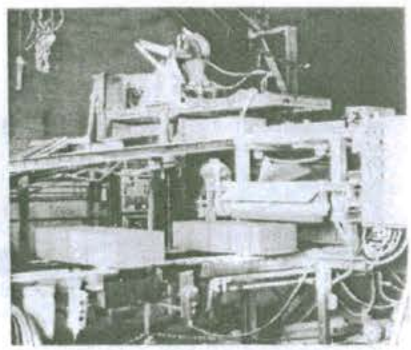
And this is extremely vital to the Maryland firm whose totally automated system, according to Mr. Myers, probably produces more units per machine than any other in the country. Each day, 33 thousand eight-inch equivalents (that's seven cycles per minute) are turned out.

Since coming into full production in August, 1971, Hagerstown's $700,000 system has operated 20 hours per day and has produced over 5 million concrete blocks. To keep up this rate, the system must maintain constant equipment efficiency and unscheduled repairs must be minimized. Here, fly ash is a key factor. The spherical ash particles decrease abrasion and, therefore, extend the life of working parts. Mr. Myers says many items such as mixer liners and molds last about twice as long when ash is an ingredient.

Other benefits found in a fly ash block are color consistency, smoothness, increased strength, lower permeability and decreased production cost reflecting reduced raw materials cost.

Hagerstown Block started using fly ash from Potomac Edison Company's R. Paul Smith Station at nearby Williamsport (six miles from the plant) in 1956.

The typical mix for light weight units, is: 150 lb. of fly ash, 475 lb. of cement, 2700 lb. of limestone fine aggregate, and 1300 lb. of expanded shale coarse aggregate. In their stone units, Hagerstown Block uses 150 lb. of fly ash, 450 lb. of cement, and 4600 lb. of limestone. Both Type I and block cement are used. The automated system uses a 12 Hr., 225° gas kiln cycle.



Mixer liners and molds last up to twice as long when ash is an ingredient in the block mix.

Fly ash concrete blocks are delivered to a variety of jobs near Hagerstown, Md.

Four manufacturers provided equipment for the new operation—a unique layout engineered by Theodore M. Myers, Jim's dad. Aside from clean-up crews the new system is operated by two men.

The original block plant, started in 1946, also uses fly ash. The older facility, utilizing a standard block plant layout that is less automated, produces about 18 thousand eight-inch equivalents daily. This unit uses a 25-hour steam cure.

Fly ash enables Hagerstown Block to turn out a superior product economically since replacements are fewer and costly down time is reduced.

Reprints Available

"FLY ASH AS A STRUCTURAL FILL," by A. M. DiGioia and W. L. Nuzzo, General Analytics, Inc. The paper summarizes some of the field and laboratory research conducted in the Western Pennsylvania area to determine the engineering properties of fly ash used in structural fill. Reprints of the paper are being offered at no charge from the NAA.

"HOW FLY ASH IMPROVES CONCRETE BLOCK, READY-MIX CONCRETE, CONCRETE PIPE." Reprinted from CONCRETE INDUSTRIES YEARBOOK, 1971-1972. This useful pamphlet provides descriptions of and designs for using fly ash to produce quality concrete block, ready-mix, and concrete pipe. Available on request from the Association.

New Text Describes British Utilization

A new, highly attractive book has been published by England's Central Electricity Generating Board. The text describes the applications for fly ash and explains the methods of commercialization of the uses in the United Kingdom.

Since British ash utilization now exceeds 6 million tons annually (over 60% of production), the key to their marketing success is obviously valuable.

Anticipating the interest in this useful reference (shown at right), the NAA has made arrangements to obtain a bulk order to expedite handling. For those who are interested in obtaining one or more copies from the CEGB, contact the National Ash Association.

NAA
NATIONAL ASH ASSOCIATION, INC.
1819 H Street, N. W.
Washington, D. C. 20006

Meet the 'New' Association Management Services Team!

As most members are now aware, the ACAA has transitioned to a new association management services company. As of March 2021, John Ward Inc. (JWI) has taken over the functions formerly provided by Advancing Organzational Excellence. In addition to the transfer of back-office operations, such as web-hosting and financial accounting services, ACAA has a new official business address in downtown Denver, Colorado, at 1616 17th Street, Suite 266, Denver, CO 80202. This new office receives correspondence and payments that are not transmitted electronically and also has (limited) space for meetings as required.

Additionally, JWI brings together a new team of professionals to support ACAA's operations and activities whose biographies are included below. One thing that will not change is that Tom Adams and Alyssa Barto will continue in their dedicated ACAA roles, although they are now JWI employees. Similarly, communications activities—including editorial services for *The Phoenix* and *ASH at Work*, as well as media relations support—will continue to be provided, as before, by JWI.

Hereafter are thumbnail profiles of the JWI staff and network:

JWI Staff

***John Ward**, Principal*—Wardo's colorful career has touched a wide variety of industries ranging from industrial and radioactive waste management to medical device manufacturing, with a healthy dose of counseling for local, state, and national political candidates along the way. Starting out in the coal ash industry as Vice President, Marketing and Government Affairs, for Headwaters Inc., he has worked at every level of the coal value chain, including in mining, transportation, utilities, and coal ash recycling. Currently serving as the Chairman of both the ACAA's Government Relations Committee and Citizens for Recycling First—and Vice Chairman of the National Coal Council—he participates in numerous industry groups related to the manufacturing and use of construction materials containing recycled content. Since 2019, he has also served as Executive Director of the National Coal Transportation Association.

***Jenny Maxwell**, Vice President, Events*—For the past 20 years, Jenny has pursued a diverse career in the marketing, advertising, and event planning industries. After several years as an advertising account executive, the Colorado native's career took her to the Gulf Coast, where she spent her days working in tourism marketing, publishing, and event planning. Since her return to the Rocky Mountain State, she earned her MBA in marketing and now focuses on planning private events, corporate functions, and fundraisers for non-profit organizations of all sizes nationally and internationally. She prides herself on meticulously planning and executing events to ensure successful meetings for her clients. She currently also serves as Vice President of the Denver Chapter of the International Live Events Association, where she leads the Communications Committee and develops social media, website, and newsletter content.

***John Simpson**, Vice President, Editorial Services*—John has over 30 years' experience as a writer, reporter, and public relations professional in the energy and manufacturing sectors. Opinion/thought leadership pieces, magazine/newsletter editing, and website development/social media are among his specialties—and his work has appeared in national publications including *Industry Week, Crain's Business*, and *Public Utilities Fortnightly*. Currently, he serves as editor of both *ASH at Work* and the National Coal Transportation Association publication *Coal Transporter*. When he's not formulating communications for corporate or association clients, he writes for personal pleasure—and has authored more than 1,000 freelance articles over the past decade.

***Thomas H. Adams**, ACAA Executive Director*—Tom has been the Executive Director of the American Coal Ash Association since February 2009. Prior to joining the ACAA, he was employed by the American Concrete Institute (ACI). Tom has over 30 years of experience in the ready mixed concrete industry in a variety of management positions. Currently, he is active in a variety of technical and trade organizations, including ASTM International, ACI, the Electric Power Research Institute, and the National Ready Mixed Concrete Association (NRMCA). Tom is a Fellow of the ACI and a recipient of the NRMCA's Richard D. Gaynor Award. A native of Detroit, he attended Wayne State University and Aquinas College, where he studied business administration and strategic management.

***Alyssa Barto**, ACAA Executive Assistant*—Alyssa has served as Executive Assistant and Member Liaison for the American Coal Ash Association since 2012. A graduate of Northern Michigan University, she previously spent many years working in state and city government. Alyssa is a proud Michigander who grew up as a Troll (i.e., "below" the Mackinac Bridge) but was lucky enough to live for seven years as a Yooper (in the Upper Peninsula). She's settled in Fenton, Michigan, now with her husband and four adorable (no bias here) sons. Her favorite part of her job, other than the work itself, is catching up with the ACAA membership whenever she gets the chance.

JWI Network

***Mark Summers**, Print and Digital Design*—The owner of Revolver Design, Mark has over 20 years' experience as a professional graphic designer. While in college, he worked in prepress and has a solid working knowledge of the printing process. He has also designed high-profile projects for companies such as Adobe, Sportsman's Warehouse, Intermountain Healthcare, Energy Solutions, and the University of Utah. He has now taken over design duties for *ASH at Work*.

***Celeste Royal**, Accounting*—Celeste has had an impressive career spanning two decades as a financial business consultant. As CFO/COO at Angel Heart LLC, she offers in-house services for business plans, financial projections, budgets, contracts, business process setup, executive support, and legal services.

***Terri Woodin**, **CMP**, Meeting Planning*—Terri is Vice President, Marketing and Global Meeting Services, at Meeting Sites Resource (MSR). She has been with MSR since 2012 and is responsible for strategically partnering with MSR customers on all facets of global site research, custom hotel contract negotiations, meeting support services, and strategic meetings management solutions. Terri is also the MSR Marketing Team leader responsible for coordinating all marketing activities, including publications, presentations, and related marketing materials.

***Allen Crist**, Information Technologies*—For over 10 years, Allen has been CEO and owner of CCW Technology I.T. Services, a complete information technology services company providing onsite support for local customers as well as remote, virtual, and digital support for clients outside of its geographical area. With over a dozen support specialists, his company provides managed (monitored/preventive) services as well as ad hoc (break/fix) help. Allen's company provides reliable service and maintenance of servers, networks, PCs, laptops, network storage, VOIP telephony, data recovery, and much more.

***Paul Linton**, Legal Services*—Paul has worked as an attorney in private practice in the Denver metropolitan area and throughout Colorado since May 1976. He is licensed to practice in Colorado, Pennsylvania, and before the Tenth Circuit, U.S. Court of Appeals, Denver. A graduate of Brown University and the University of Denver College of Law, Paul has served as legal counsel to the National Coal Transportation Association for over 25 years. He also boasts extensive experience in a number of varied fields of practice, including establishment and counsel of small business entities, non-profit organizations, and charitable, educational, and religious organizations; as well as in real estate; administrative law; employment and contract law; and general civil litigation.

Charles Price Receives the ACAA Champion Award

Charles E. Price, retired founder of Charah Solutions and former chairman of the American Coal Ash Association, was selected as the seventh recipient of the ACAA Champion Award. The award was announced March 4, 2021, by outgoing ACAA Chairman Kenny Tapp at the Association's Winter Virtual Meeting.

Charles Price founded Charah in his Louisville, Kentucky, home with his wife Janet in 1987. He came up with the name Charah by using the first letters of his son's name (Charles) and the last letters of his daughter's name (Sarah). Using his grandfather's and father's previous business models, Charah started out completing public bid general contracting work and then eventually civil construction jobs for local surface coal mines. In 1992, Charah performed its first coal ash project, completing a pond excavation project for Big Rivers Electric Cooperative in western Kentucky. Charah primarily focused on coal ash pond and landfill projects throughout the 1990s, expanding outside of Kentucky with projects in the Carolinas, Pennsylvania, and Florida. Charah moved into fly ash and bottom ash marketing in the early 2000s.

Charles was always focused on new and inventive ideas for performing work, which resulted in three patents related to processing coal ash for beneficial use. In 2012, he directly oversaw research and development of the first synthetic gypsum pelletizing plant in the United States to allow for easier and more efficient use of synthetic gypsum in agricultural applications. At the time of his retirement in 2019, Charles had overseen the growth of Charah from a ground-zero startup to a publicly traded company on the New York Stock Exchange that employed over 1,000 people.

ACAA established the Champion Award in 2012 to recognize extraordinary contributions to the beneficial use of coal combustion products. The recipient is selected exclusively by the Chair of the ACAA Board of Directors and is known only to the Chair until the moment the presentation is made. The recipient may be an individual or individuals; an institution, private or public; or a member or non-member of the ACAA, living or deceased.

ACAA Champion Award Honorees

2020
Charles Price, Charah Solutions

2018
Bruce W. Ramme, WEC Energies Group

2017
University of Kentucky Center for Applied Energy Research

2015
USDA Agricultural Research Service

2014
U.S. Representative David B. McKinley

2013
David Goss, former ACAA Executive Director

2012
John Ward, ACAA Government Relations Committee Chairman

Since 1990, CBP Environmental has completed some of the Southeast's largest heavy civil construction & power generation projects safely and on schedule. Visit our website to learn more about our time-tested, proven track record of moving projects in **THE RIGHT DIRECTION.**

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Welcome, New ACAA Members!

ATC Group Services, an Atlas Company, provides professional environmental, testing, inspection, engineering, and consulting services from more than 100 locations nationwide. ATC delivers solutions to both public- and private-sector clients in the transportation, commercial, water, government, education, and industrial markets. The company has 3,200 professional staff nationwide and in 2020 was ranked #13 on *ENR*'s top 100 list. The company's Coal Combustion Residuals (CCR) team has provided services for CCR landfills, leachate storage ponds, and ash ponds. Over the past three decades, its engineers and geologists have designed and permitted over 1,600 acres of solid waste disposal areas. For more information, please visit www.atcgroupservices.com.

Gray Energy Tech is a consulting company focused on technologies, research and development, and policies that improve the economics of electric energy production and the sustainability of each facet of the production process. Danny Gray serves as the primary contact with ACAA.

Seneca Engineering is a civil/environmental engineering consulting firm located in Akron, Ohio. Its team of professionals has collaborated to provide industry-leading expertise in cost-effective, environmentally responsible operations, stormwater management, and environmental compliance. Seneca has a number of clients that work with coal combustion residual (CCR) materials and a senior staff with several years of experience in this area. For more information, please visit www.senecaengr.com.

SMBC Rail Services provides net and full-service railcar operating leases and financing to suit a diverse range of customers, including coal-fired electric utilities and coal combustion products (CCP) shippers. SMBC has a fleet of approximately 56,000 railcars, including aluminum and steel open-top hoppers, and small cube gravity and pressure differential covered hoppers to address the growing needs of the CCP market. For more information, please visit www.smbcrail.com.

ACAA Fall Meeting & CCP Workshop

October 19-21, 2021

French Lick Resort • French Lick, Indiana

CCP Workshop Topics:

- Rare Earth Element Extraction State of the Art
- ASTM Action: Specifications, Standards, and Best Practices
- Academic Research Roundtable
- Ponded Ash Update
- Current CCP Harvesting Projects
- EPA/Government Regulation Developments

Sponsorship/exhibitor deadline is **October 1, 2021.**

Contact Alyssa Barto at **Alyssa.Barto@acaa-usa.org** for more information.

UK Center for Applied Energy Research

News Roundup

ACAA Directors and Officers Elected

The American Coal Ash Association concluded officer and director elections in January 2021, selecting the following:

- Chair (term ending 2023) – Steve Benza, Boral Resources
- Vice Chair (term ending 2023) – Julie Olivier, Duke Energy
- Secretary/Treasurer (term ending 2023) – Dr. Lisa JN Bradley, Haley & Aldrich
- At-Large Utility Member Director (term ending 2024) – Rachel Retterath, Great River Energy
- At-Large Utility Member Director (term ending 2024) – Ann Couwenhoven, Talen Energy
- At-Large Marketer/Non-Utility Producer Member Director (term ending 2024) – Dale Diulus, Salt River Materials Group

Subsequent to the election, ACAA's Board of Directors appointed members to fill Board seats for two unexpired terms. Hollis Walker, Southern Company, was selected to complete the term of Julie Olivier, Duke Energy, who vacated her Board position when she became ACAA's vice chair. Hollis previously served as a director, vice chair, and chair of the ACAA Board of Directors. Andy Hicks, ASH Mineral Solutions, was selected to complete the term of Mike Schantz, Lhoist, who retired at the end of March.

ACAA Addresses EPA's Beneficial Use Definition

Focusing on how coal ash beneficial use can help accomplish key Biden Administration policy objectives, the American Coal Ash Association on May 11, 2021, filed supplemental comments on the U.S. Environmental Protection Agency's notification of data availability (NODA) for "Reconsideration of Beneficial Use Criteria and Piles." The filing was in addition to voluminous comments, including an 18-page summary and 11 appendices, that were submitted on the original deadline of February 22, 2021. After that deadline passed, EPA reopened the comment period in response to a request by Earthjustice.

In August 2019, EPA proposed revisions to its definition of beneficial use and regulatory treatment of "piles" of coal combustion products destined for beneficial use. EPA's proposals were roundly criticized by commenters on all sides, including ACAA. In 2020, EPA essentially decided not to decide the issue and went back to the drawing board. Stakeholder meetings were held last summer, and this NODA represented another step in EPA's information gathering process prior to coming up with another proposal.

EPA's 2015 Final Rule created controversy over its definition of beneficial use by requiring environmental evaluations of "unencapsulated" uses involving more than 12,400 tons in non-roadway applications that are in direct contact with the ground

"CCP beneficial use will help achieve the Biden Administration's goals for addressing climate change and a just transition for fossil fuel workers. In beneficial use settings, CCP is a valuable mineral resource that conserves natural resources, saves energy, reduces greenhouse gas emissions, and in many cases improves durability and performance of finished products. Moreover, beneficial use creates jobs in the areas hard-hit by the closing of coal-fueled power plants," ACAA wrote in its May 11 submission.

"CCP beneficial use is also an important component of EPA's longstanding objective for encouraging Sustainable Materials Management," ACAA continued. "EPA policies regarding the definition of beneficial use and regulatory treatment of materials staged for beneficial use should actively encourage the accomplishment of these objectives and avoid erecting unwarranted barriers to environmentally beneficial practices guided by engineering standards and decades of experience."

Coal ash beneficial use is exempt from federal solid waste regulations. But EPA's 2015 Final Rule created controversy over its definition of beneficial use by requiring environmental evaluations of "unencapsulated" uses involving more than 12,400 tons in non-roadway applications that are in direct contact with the ground, as well as setting up inconsistent regulatory treatment of piles staged for beneficial use. These controversies were remanded to EPA for further rulemaking in a 2018 federal court decision. In August 2019, EPA proposed revisions that were roundly criticized by commenters on all sides, including ACAA. Subsequently, EPA removed the issue from its regulatory agenda and indicated that it would essentially start over.

The beneficial use definition matter was notably absent from EPA's Spring 2021 regulatory agenda. The issue remained on EPA's "long-term actions list" with a statement that the agency will weigh additional information obtained from recent comments responding to a Notice of Data Availability "to determine appropriate next steps."

ACAA Comments on Multiple EPA Rulemakings

In addition to engaging on the beneficial use definition matter, the American Coal Ash Association filed comments on three other Environmental Protection Agency rulemakings in early 2021:

- On February 8, 2021, ACAA commented on EPA's proposed approval of a Coal Combustion Residuals Permit Program for the State of Texas. "Although CCR beneficial use… is exempt from federal regulation, the consistent application of CCR disposal standards creates regulatory certainty that is helpful to increasing beneficial use and achieving the associated environmental benefits," ACAA wrote. "EPA has correctly found that the proposed Texas CCR permit program includes all the elements of an adequate state CCR permit program, as well as includes all of the technical and public participation criteria contained in EPA's federal standards… ACAA thanks EPA for its thorough analysis of the proposed Texas permit program and urges its final approval as soon as possible."

- On February 12, 2021, ACAA commented on EPA's advance notice of proposed rulemaking for disposal of coal combustion residuals from electric utilities at "legacy" CCR surface impoundments. "As EPA considers potential regulation of legacy disposal units, ACAA encourages the agency to view the materials within those units as a potential resource," ACAA wrote. "ACAA urges EPA to develop a clear regulatory pathway that allows for CCR storage that supports harvesting and beneficial use. Specifically, EPA should consider allowing temporary closure in place for CCR units that can demonstrate viable beneficial use opportunities. This type of approach would eliminate double-handling and separate-landfill storage of CCR, since it would only be excavated as needed for beneficial use. Additionally, this type of approach would help ensure final 'closure by removal' without imposing on a different community the need to host a disposal facility."

- On March 8, 2021, ACAA commented on EPA's inquiry into whether other resources should be added to the agency's methodology for calculating national recycling rates. (Coal combustion products are currently not included in these calculations.) Echoing recent comments in other EPA proceedings, ACAA encouraged EPA to adopt a "resource perspective" that actively encourages the beneficial use of coal combustion products. "Measurement of CCP beneficial use rates is already well established, with decades of historical data available. ACAA has conducted a survey quantifying the production and use of CCP in the United States annually for more than five decades," ACAA wrote. "Beneficial use rates increased dramatically during periods when EPA established goals for the practice and actively encouraged CCP utilization. ACAA strongly encourages EPA to adopt a 'resource conservation' paradigm and add CCP utilization to its recycling rate measurement."

ACI Tech Note Refutes Fly Ash Limits

American Concrete Institute (ACI) published a "tech note" advising that limits on the proportion of fly ash used in concrete meeting ASTM C618 are generally unnecessary "if relevant fresh and hardened concrete performance requirements are specified."

"Prescriptive specifications for concrete construction projects often include a clause that limits the proportion of supplementary cementitious materials (SCMs)," ACI Committee 232 wrote in "Limits on the Proportions of Fly Ash in Concrete," issued November 1, 2020. As an example, the Committee cites a clause incorporated in Section 033000 of the American Institute of Architects' MasterSpec (2014) pertaining to cast-in-place concrete that specifies a limit of 25 percent fly ash or 25 percent combined fly ash and pozzolan.

Although MasterSpec's notes inform the designer that this clause pertains specifically to concrete exposed to freezing-and-thawing cycles and the application of deicing salts, these limitations are routinely cited in cast-in-place concrete projects that will not be subject to these environmental conditions. According to the tech note, a review by the National Ready Mixed Concrete Association (NRMCA) of more than 100 specifications (Obla and Lobo, 2015) for projects funded by private agencies found the aforementioned limits were referenced in fully 85 percent of the specifications "without consideration of the anticipated exposure condition for concrete members. Some specifications specifically prohibited the use of SCMs."

The tech note goes on to say that limiting the proportion of fly ash in concrete can adversely impact workability/pumpability of fresh concrete. In addition, temperature control in mass concrete may be difficult to achieve if fly ash quantities are limited. Finally, concrete durability may be affected, as fly ash is commonly used to reduce the risk of deleterious expansion and cracking due to alkali-silica reaction, sulfate attack, and also to reduce permeability, which reduces the risk of corrosion of reinforcing steel.

ACI and NRMCA continue to work on the development of performance-based rather than prescriptive specifications, the latter of which in some instances have had the effect of unnecessarily limiting the use of fly ash and other supplementary cementitious materials in concrete.

ACI Committee Expands to Address Bottom Ash

American Concrete Institute's Technical Activities Committee approved a name and mission change for ACI Committee 232 on Fly Ash in Concrete, expanding the committee's focus to include bottom ash. The new title of the committee will be "Use of Fly Ash and Bottom Ash in Concrete." The committee's new mission is to "develop and report on the use of fly ash and bottom ash as a supplementary cementitious material."

Biden Administration Sets Coal Ash Regulation Priorities

The U.S. Environmental Protection Agency completed a Biden Administration mandated review of coal ash disposal regulations and laid out a schedule for pursuing rulemakings that remain open.

On January 20, 2021, President Biden issued Executive Order 13990 instructing federal agencies to review a laundry list of regulations enacted by the previous administration. EPA's list included 48 items, three of which were directly related to coal combustion residuals. With no public fanfare in June, EPA posted the following statement to its "coal ash rule" website: "EPA determined that the most environmentally protective course is to implement the rules. EPA will be addressing the remaining issues remanded back to the Agency regarding the July 2018 rule through the rulemaking process."

EPA also published its "Spring Unified Agenda," updating its timeline for completing several open rulemakings related to coal ash disposal and leaving an issue important to beneficial use with an uncertain future. Although federal agencies frequently fail to meet the deadlines expressed in the Unified Agenda, they serve as a helpful benchmark of priorities.

EPA indicated it plans to finalize "Implementation of Closure" actions by July 2021. Presumably this relates to overdue agency responses to utility requests for extensions of "cease receipts" deadlines and for alternative liner demonstrations.

With regard to a court-mandated requirement to develop regulations for "legacy" coal ash disposal impoundments, EPA indicated it would propose a rule by November 2021 and finalize the rule by November 2022.

With regard to EPA's proposal to create a federal permit program for use in states that don't seek EPA approval of their own permit programs and in Indian Country, the agency indicated it would finalize the rule by January 2022.

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