ISSUE I • 2023

ASH at work

Applications, Science, and Sustainability of Coal Ash

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6 Questions for ACPA's Laura O'Neill Kaumo

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Applications, Science, and Sustainability of Coal Ash

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ACAA

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9980 S. 300 W, Suite 200, Sandy, Utah 84070
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United We Stand

By John Halm, ACAA Chair

As I sat down to write this message, I realized that, while I had always read the feature articles, I had never really paid much attention to the editorials. After reading several Chairman's Messages, I was able to ponder the thoughts of a lot of old friends who have provided leadership and inspiration to the Association, the industry, and myself during the nearly 20 years that I've been associated with the ACAA. Most of the topics covered addressed the success of the organization, a pending environmental regulation, or a generation fleet change that would have significant impact on our industry's operations. The more things change, the more they stay the same!

As I assume the chairman's position for the next two years, I am encouraged by the dedicated professionals in our industry who have devoted their careers to the beneficial use of byproducts and environmental stewardship. Similarly, our organization is blessed with outstanding individuals who volunteer their time and effort serving on ACAA's board and standing committees to execute our organization's objectives:

- *ACAA Board Vice Chair*—Tom Kierspe, recently elected to this position, has served as Secretary/Treasurer for the past year and also chairs the Nominations Committee.
- *Government Relations Committee Chair*—John Ward brings 25 years of industry experience, as well as a unique perspective, to this critical role. He also serves on the Nominations Committee.
- *Technical Committee Chair*—Dr. Rafic Minkara has the deep knowledge base of ash data and practical application in the field needed to develop insightful standards and sustainability guidelines. He too serves on the Nominations Committee.
- *Membership & Communications Committee Chair*—Peggy Rennick has volunteered her time to ACAA for as long as I can remember and is passionate about byproduct use and the organization. She also serves on the Nominations Committee.
- *Board Members at Large*—Ann Couwenhoven, Rachel Retterath, Tara Masterson, and Hollis Walker (Utility); Matt Brownlee, Dale Diulus, and Danny Gray (Marketer/Non-Utility Producer); and Andy Hicks and Bill Petruzzi (Associate) comprise our highly capable board of directors.

In addition to our member volunteers, ACAA is fortunate to be able to rely on a seasoned full-time staff that is steeped in knowledge about the coal ash industry and our association's membership. Executive Director Tom Adams and Executive Assistant Alyssa Barto together bring more than a quarter-century of dedication to the ACAA mission.

I also want to recognize and thank outgoing ACAA Chair Steve Benza for his friendship and patience educating me about the role I have now taken on. Steve has decades of experience in the industry and leads with compassion and authority.

As for myself, I started my career in the gypsum wallboard industry and became involved with the ACAA in the mid-2000s. So much has changed during this time, with the massive industry investment in plant clean-air equipment to support long-term coal usage in the early 2000s to a sudden decline in the early 2010s and a rapid drop-off toward the end of that decade.

Where are our industry and our organization now headed? While we don't have a crystal ball to anticipate all of the issues and challenges that may emerge, many are already apparent. For example, the proposed EPA Effluent Limitations Guidelines (ELG) rule and air emission standards represent a challenge that could result in significant changes to our markets. ACAA will continue its leadership to ensure our industry's interests are protected as the agency continues on this rulemaking process. ACAA will also be supporting guideline development for safely utilizing harvested ash from legacy basins, as well as coordinating efforts with other similar organizations such as USWAG and EPRI going forward.

The Mission of the American Coal Ash Association is to "advance the management and use of coal combustion products in ways that are environmentally responsible, technically sound, commercially competitive, and supportive of a sustainable global community." And yet, while our membership and our customers agree on the economic and environmental value of our products, our adversaries will continue to attempt to undercut our industry's viability with legal and regulatory challenges.

At the end of the day, we must continue connecting with our customers, understanding their needs and the changing dynamics of the beneficial use markets, while supporting clear standards development and responsible regulation. With continuing support from our diverse membership, allied organizations, and interested stakeholders, ACAA will continue leading our industry forward to face the challenges that lie ahead.











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Predicting Can Be a Dangerous Business

By Thomas H. Adams, ACAA Executive Director

Since the beginning of history, people who believed they had special knowledge about the future of the world have been sharing that knowledge. From the date-certain for the end of the world, to floods and famines, results of elections, and even climate, there is no shortage of predictions. Predictions about dire events get the most attention. We have had "experts" warn about devastations lurking just around the corner. There has been, however, a shortage of predictions that have actually come true. The great 20th-century American philosopher Yogi Berra knew that predicting the future is difficult and said so: "It's tough to make predictions, especially about the future."

Looking back 50 years or so, we have been reacting to a variety of predictions in an effort to "save the planet" and our way of life.

In the 1970s, we were warned about global cooling. Some said there was another ice age approaching quickly. The cooling of the planet would cause a decline in agricultural production, resulting in widespread famine.

In 1989 New York City residents were alerted that the highways in that city would be underwater by 2019. That advisory was updated in 2005, with rising ocean levels inundating the roads by 2015.

The world's supply of oil, we were told, would be exhausted by 1976, 1992, 2000, 2010, 2020.

In 2000 it was reported that snowfalls were a thing of the past. Children born after that year would grow up in a world never seeing or feeling snow.

One of the more famous predictions was put forth in 1968 by Paul Ehrlich, then on the faculty of Stanford University. In his book, *The Population Bomb*, Dr. Ehrlich said the "battle to feed humanity is over." He went on to warn that "hundreds of millions of people are going to starve to death." He concluded that humanity was incapable of doing anything about this catastrophe, saying "nothing can prevent a substantial increase in the world death rate."

Of course, there have been many predictions that were partially or completely accurate. But when we are dealing with the biggest issues, I believe we need to take a cautious approach and avoid knee-jerk reactions. We are told daily that carbon is the great Satan and we need to decarbonize ASAP. Yes, there are legitimate reasons to continually work to clean up our economy and the way we do things. But we do not have to do it all at once and at any cost. Going too fast without having specific plans is reckless and potentially dangerous. Over-reacting can have serious negative impacts on our economy and homeland security. And if we cannot determine if a predicted threat truly poses an existential threat, perhaps we should just follow this age-old advice: follow the money.

* * *

One final note: On February 1, 2023, Mark Bryant retired after 30+ years of service to Ameren. During his career, Mark was very active in the American Coal Ash Association. In particular, he served two terms as Chair of the Board of Directors, 2008 to 2012, leading the Association during the most difficult years in our history. Mark's rock-solid leadership helped ACAA create a path forward as CCP rulemaking threatened to decimate the beneficial use of coal combustion products. On behalf of all ACAA members, we wish Mark a long and happy retirement!

Join ACAA in Myrtle Beach!

Photo Courtesy of Marriott Myrtle Beach Resort & Spa

2023 ACAA Fall Membership Meeting: October 10-11

Tuesday, October 10

- ACAA Committee Meetings—9AM to 4PM
- Women's Leadership Forum Luncheon—11:45AM to 1:15PM
- Welcome Reception—5 to 6:30PM

Wednesday, October 11

- Technical Presentations—8 to 11:45AM
- Group Lunch—11:45AM to 1:15PM

'Exploring the Current Opportunities in Coal Ash' (Workshop): October 11-12

Wednesday, October 11

- Workshop Presentations—1 to 5PM
- Welcome Reception—5 to 6:30PM

Thursday, October 12

- Workshop Presentations—8AM to 5PM
- Working Group Lunch—12PM to 1PM

Workshop Topics

Harvesting and Supply
Carbon Capture
Carbon Neutral Concrete
Carbon Credits
Resistivity Testing
Hot Topics in Regulation and Research

Participants must register separately for each event (Membership Meeting and/or Workshop) that they wish to attend. Both will be held at the Marriott Myrtle Beach Resort & Spa at Grande Dunes.

Sponsorship and tabletop exhibit opportunities are available. Please contact Alyssa.Barto@acaa-usa.org for more information.

ACAA
AMERICAN COAL ASH ASSOCIATION

Center for Applied Energy Research

ACAA Board Profiles

Editor's note: In this first of an ongoing series of articles, ASH at Work profiles several members of the ACAA Board of Directors.

Executive Committee

John Halm – ACAA Chair

John Halm is the Byproducts Marketing Manager for Duke Energy, responsible for developing, negotiating, and managing CCP byproduct sales strategies, studies, contracts, and customer relationships. He has over 35 years in the building construction products and byproduct use-related industries. Prior to Duke, John worked for United States Gypsum Company for 22 years in wallboard manufacturing and research roles, as well as serving as the Technical Manager for Synthetic Gypsum involved in procurement and use of FGD gypsum from utilities.

John grew up in central Texas and Jacksonville, Florida, after which he graduated from Clemson University with a bachelor of science degree in chemical engineering in 1986. He is a member of EPRI P241 Coal Combustion Product Management Committee and currently serves as co-chairman.

John lives in North Carolina with his wife and daughter, where he enjoys boating, fishing, golf, and being outside.

Tom Kierspe – ACAA Vice Chair

Tom Kierspe is the Executive Director, Business Development, for The SEFA Group. He has worked in the coal ash industry for 40 years, starting out as an Engineer at Santee Cooper's Grainger Station. His subsequent positions included Superintendent of Maintenance at Jefferies Station; Vice President Engineering and Construction Services; and Vice President Environmental, Property, and Water System Management.

Tom holds a bachelor of science degree in mechanical engineering from Clemson University and an MBA from Charleston Southern University. He lives in South Carolina with his wife and enjoys family activities, church, and outdoor sports.

Utility Members-at-Large

Ann Couwenhoven

Ann Couwenhoven is Senior Engineer Manager, Combustion Materials, at Talen Energy and has over 15 years' experience in the coal ash industry. She maintains a keen interest in fly ash material science in applications in cement, concrete, and new end products and enjoys potential business development opportunities utilizing different types of fly ashes.

Ann holds a bachelor of science degree in mechanical engineering and material science from Purdue University. In her spare time, she enjoys competitive rowing and community service.

Utility Members-at-Large *continued*

Rachel Retterath

Rachel Retterath is Director, North Dakota Affairs, at Great River Energy, where she has worked for over 15 years. In this role, she has worked to develop energy and agriculture industrial parks centered around generating assets in North Dakota, including Coal Creek Energy Park and Spiritwood Energy Park, and has managed and grown Great River Energy's community concrete donations program.

Rachel also serves as the Chair of the North Dakota Agriculture Diversification & Development Committee, Vice Chair of the North Dakota Agriculture Products Utilization Commission, and on the North Dakota Outdoor Heritage Fund Advisory Board and Bismarck State College Foundation Board.

Outside of work, Rachel farms and ranches with her husband's family in western North Dakota, where they raise corn, soybeans, edible beans, wheat, and cattle. She also enjoys supporting her children's sports activities, including football, basketball, and baseball.

She holds a bachelor of science in business and communications, as well as an MBA, from the University of Mary.

Marketer/Non-Utility Producer Member-at-Large

Dale Diulus

Dale Diulus is Senior Vice President, Pozzolan, at Salt River Materials Group, a supplier of portland and masonry cements, fly ash and other pozzolans, normal and lightweight aggregates, and natural gypsum products. He is a registered professional engineer in the State of Arizona, a Fellow of the American Concrete Institute, and earned the Southwest Association of Rail Shippers' Person of the Year Award in 2009.

Dale says that the greatest challenge the ash industry faces is the need for effective messaging of the benefits of recycling ash with the goal of eliminating ash landfills completely. Among his goals during his term on the ACAA Board are to support the Association in its efforts to educate regulators and the public.

Dale earned his bachelor of science in engineering from Arizona State University. When he is not working, he enjoys hiking, his mountain cabin, and time with his family.

Highway and Bridge Construction Market Responds to Investment Boost Under IIJA

By Dr. Alison Black

Year one of the Infrastructure Investment and Jobs Act (IIJA) is expected to boost highway bridge construction market activity in the next few years, according to analysis of leading market indicators by the American Road & Transportation Builders Association (ARTBA). The additional resources are welcome news as states continue to grapple with investment needs and a backlog of projects.

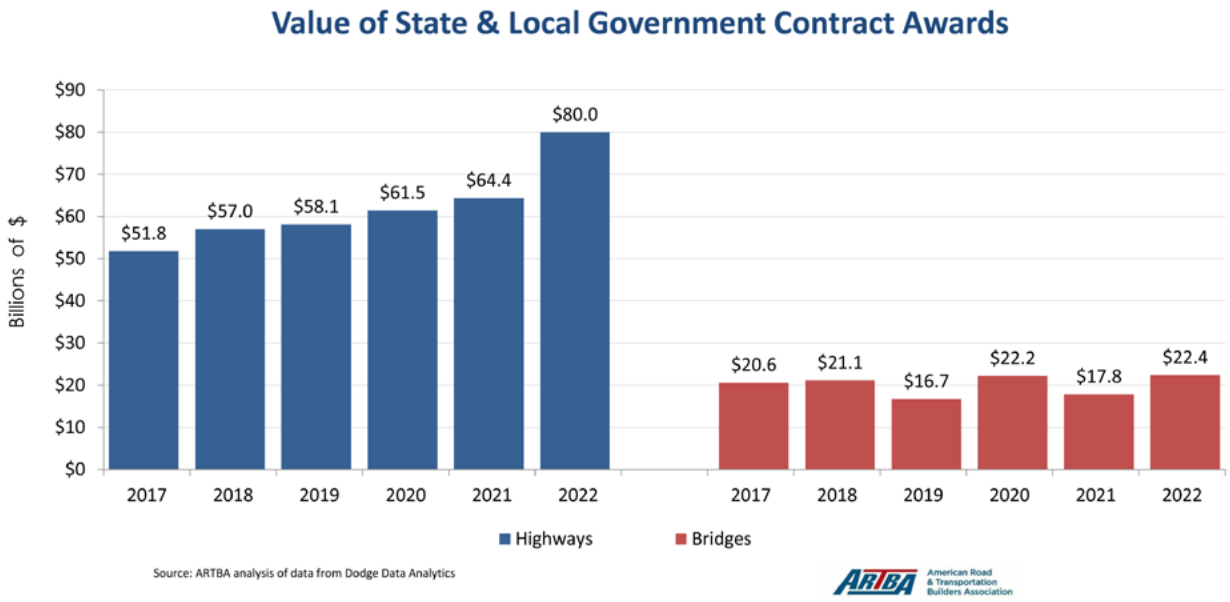
Demand for transportation construction materials, including concrete, is expected to increase as projects get underway. ARTBA estimates that more than 75 percent of the concrete used in transportation infrastructure each year incorporates fly ash as a partial replacement for cement. Major markets including California, Florida, Louisiana, New Mexico, Nevada, Utah, and Texas use fly ash in virtually all of their concrete projects.

Leading Market Indicators Are Strong

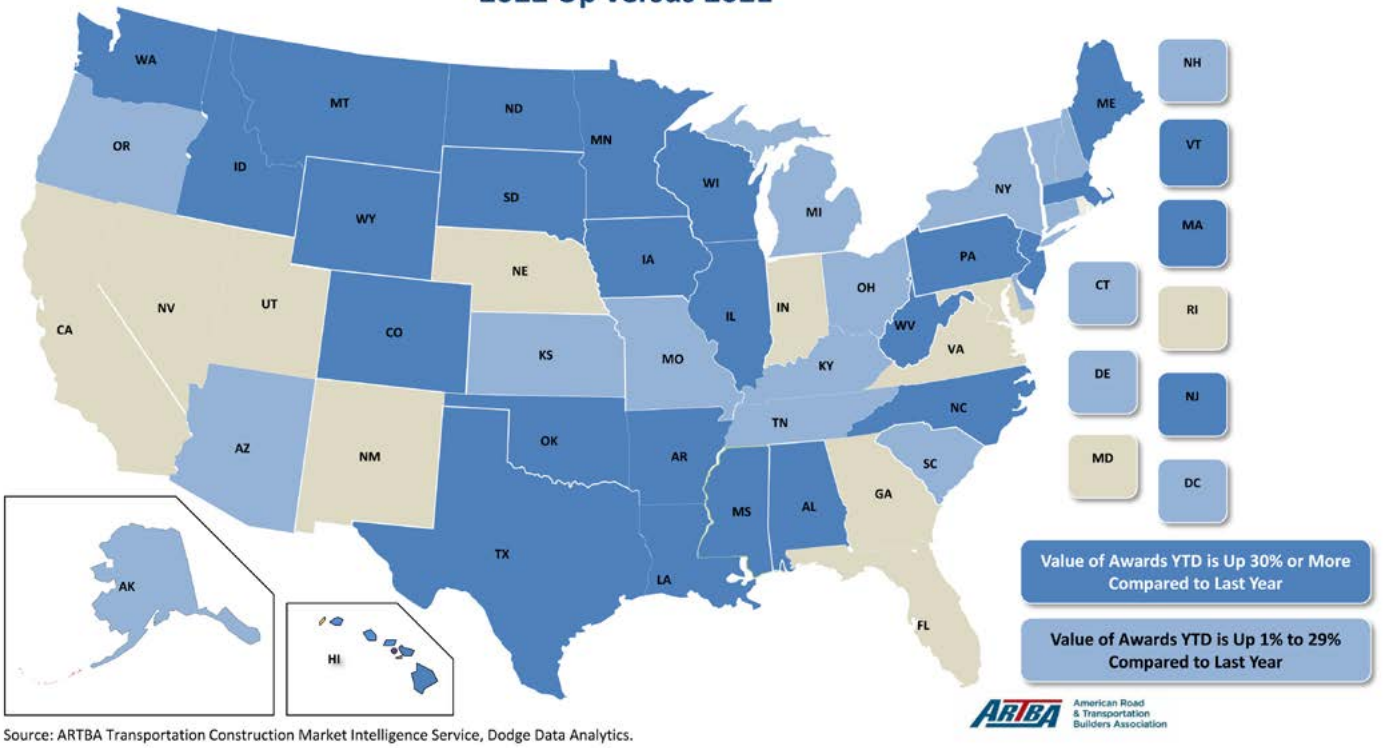
The value of state and local government contracts for highway and bridge work increased 25 percent in 2022, reaching $102.8 billion from $82.3 billion in 2021. Contract awards are a leading indicator of future highway and bridge construction activity as work gets underway. In many cases, larger projects can take several years to complete, and they support continued economic growth and jobs in a community.

The states with the largest dollar increases in the value of highway contract awards in 2022 were Texas, North Carolina, Hawaii, Pennsylvania, and Illinois. The largest percentage gains in the value of highway awards were in Hawaii, Delaware, Idaho, Rhode Island, North Carolina, and North Dakota.

States that focused on expanding their bridge work included New York, New Jersey, Texas, Illinois, Pennsylvania, Louisiana, North Carolina, and Oklahoma. Some states with a high inventory of bridges in poor condition also ranked near the top in terms of the percentage increase in the value of bridge awards. Oklahoma, West Virginia, New York, Louisiana, Illinois, and Iowa, among others, raised the value of bridge contract awards by 50 percent or more in 2022.



Value of State & Local Government Highway & Bridge Contract Awards, 2022 Up versus 2021



Source: ARTBA Transportation Construction Market Intelligence Service, Dodge Data Analytics.

States Focus Federal IIJA Funds on Reconstruction and Repair Work

Almost $9 out of every $10 in IIJA investment is for formula programs, which allow states to choose which eligible projects will receive funding. States used much of their year one IIJA funds, 46 percent, for major reconstruction and repair work, which is similar to spending in previous years. An additional 21 percent of federal funding was for projects to add capacity (either widening a roadway or adding a new lane) to an existing right of way. Only 6 percent of projects were for new highway or bridge construction.

Some of the largest projects supported by IIJA funds in FY 2022 included:

- Expanding Loop 1604 on I-10 in San Antonio, Texas
- Roadway widening on the I-17 split in Arizona
- Planning and design work in California
- Interchange improvements on the I-4 at Sand Lake Road, Florida
- Phase 1 Carolina Crossroads Corridor Improvement Project, South Carolina
- Replacement and repair of I-270 bridges over the Mississippi River, Illinois
- Replacement and repair of six bridges on I-65 over the Sepulga River, Alabama
- Gowanus Expressway Viaduct painting and steel repairs, New York

Good News: More Bridge Investment to Come

In addition to the core highway program formula funds available to states for bridge work, the IIJA included a new $5.5 billion annual bridge formula program. States have four years to commit their bridge formula funds. In FY 2022, states committed $1 billion, supporting 550 new projects. Through the first four months of FY 2023, which began October 1, 2022, states have committed $503 million in bridge formula funds for over 480 projects. Pennsylvania has committed the most funds, using $368 million to date for 199 bridge formula projects.

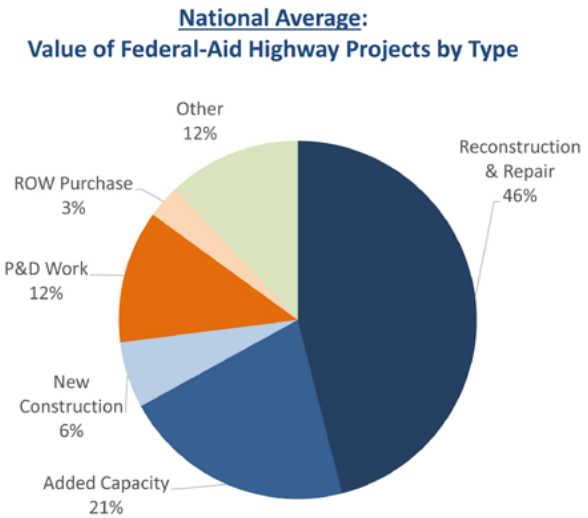
Some of the major projects including bridge formula funds are:

- Gramercy Bridge rehabilitation, Louisiana
- Major Bridge P3 Package 1, Pennsylvania
- US 64 preservation of Bridge 9 in Manns Harbor, North Carolina
- Bridge painting/metalizing along the I-395 corridor, Connecticut
- Bridge replacement at Interchange #80 on I-15, Idaho

Other eligible projects include slab and deck repairs, overlays, scour mitigation and repair, and in many cases a full bridge replacement.

The IIJA is a step in the right direction in providing states the ability to leverage federal investment for bridge improvements. As projects are completed and other improvements are made,

46% of Federal-Aid Highway Projects Are Reconstruction Work, FY 2022



Source: Data from Federal Highway Administration for FY 2022.

ARTBA American Road & Transportation Builders Association

the number of bridges in poor condition and need of repair should also begin to improve over the next decade.

Looking Ahead: Five-Year Funding Stability

Because many major projects are significant capital outlays, a multi-year federal-aid highway bill provides stability and a predictable revenue stream for state programs and investments. States are also continuing to invest their own resources in state highway and bridge programs, according to ARTBA analysis of all 50 state Department of Transportation budgets.

Total state highway and bridge capital spending is expected to increase 16 percent before the end of fiscal year 2023, which is June 30 for most states. Over 70 percent of this growth is driven by increased federal investment, including some IIJA projects. As spending increases over the next five years, this will drive demand for transportation construction materials, including cement and fly ash.

It is important to remember that we are at the beginning of this process. Many of the tangible benefits from the IIJA, including improved infrastructure conditions, jobs and economic activity, and safety improvements, are yet to come.

Alison Black *is Chief Economist for the American Road & Transportation Builders Association. She is responsible for the development of more than 100 studies examining national and state transportation funding and investment patterns, including ARTBA's landmark economic profile of the transportation construction industry, state bridge condition profiles, and annual modal forecast. She holds a Ph.D. in economics from the George Washington University and a master's in International Economics and Latin American Studies from the Johns Hopkins School of Advanced International Studies.*

2023 Transportation Construction Coalition Priorities

The American Coal Ash Association is one of 34 members of the Transportation Construction Coalition (TCC). The TCC, co-chaired by ARTBA and the Associated General Contractors, is a group of business and labor organizations advocating for increased investment in transportation infrastructure and related policy reforms. For 2023, TCC has identified three legislative policy priorities: ensuring annual appropriations authorized in the IIJA are met; pushing for full implementation of the IIJA; and supporting investment in airport construction programs through reauthorization of federal aviation programs.

The IIJA represents a historic commitment to modernize America's aging infrastructure. To ensure IIJA investments deliver intended benefits, Congress must meet the annual appropriations levels promised under the law. Securing this funding will allow core highway and transit programs to proceed without disruption.

TCC members will also push for full IIJA implementation in order to provide clarity for the transportation construction industry. This includes finalizing changes made to Buy America programs and full implementation of "One Federal Decision" to reduce permitting delays and accelerate project timelines.

Increasing support for airport construction via the Airport Improvement Program (AIP) through timely reauthorization of aviation programs will help ensure airport infrastructure can meet the increasing demands of air travel. AIP funding strengthens supply chains and supports long-term investment in sustainable infrastructure. Raising the cap on the Passenger Facility Charge (PFC) as part of a reauthorization bill will also allow airports to generate more revenue for vital infrastructure improvements. The PFC is a fee imposed by airports on passengers for the use of airport facilities and is currently capped at $4.50 per passenger per flight segment.

Concrete 2.0: Durable, Versatile... *Sustainable*

By Doug Rhodes

Concrete is here to stay. Literally.

Two millennia ago, the Romans discovered that volcanic ash, when mixed with lime and seawater, formed a mortar that could be used to make a particularly durable form of concrete. The dome of Rome's Pantheon, built in 128 A.D. from this material, still stands today as the largest unreinforced concrete dome in the world. Many Roman structures that date to antiquity and remain at least partially intact to this day—including the Colosseum—are also made from this early form of fly ash-enhanced concrete.

Little wonder, then, that early adopters of fly ash in the United States included dam and highway builders, who required the highest strength, durability, and resistance to cracking and chemical ingress from their concrete. One of the first prominent usages of fly ash was in the construction of the Hungry Horse Dam on Montana's Flathead River, where engineers specified a concrete mix incorporating 32 percent substitution of fly ash for cement. Still one of the largest concrete-arch dams in the U.S., Hungry Horse incorporated 120,000 metric tons of coal ash.

Today, concrete is the most widely used man-made material in the world. Global concrete production amounts to approximately 4.4 billion tons annually—or roughly 1,000 lbs. for every person on the planet. Moreover, its use is projected to grow rapidly in the coming years as requirements for residential construction and infrastructure expand. And with good reason. Concrete is:

- A durable and cost-effective material, whose strength increases over time
- Inert, non-toxic, and doesn't burn, mildew, or rot
- Weather- and earthquake-resistant and easy to maintain and repair
- Energy-efficient and can passively heat or cool a building's interior
- Impermeable to rodent and insect infestation
- Recyclable at the end of life

Concrete mixes incorporating supplementary cementitious materials such as fly ash boast greater performance and sustainability characteristics than portland cement concrete and thus are used widely in commercial, residential, and

infrastructure projects for their enhanced strength and durability (see "Sustainable Construction with Coal Combustion Products" brochure at the end of this article).

Benefits in Fresh Concrete—Fly ash benefits fresh concrete by reducing the amount of water required in the mix and improving its paste flow behavior. The spherical-shaped fly ash particles act as miniature ball bearings within the concrete mix, providing a lubricant effect and improving workability and pumpability. Replacing cement with fly ash reduces the heat of hydration of concrete while it cures, lessening heat gain-related problems in mass concrete placements such as cracking.

Benefits to Hardened Concrete—Fly ash reacts with available lime and alkali in concrete, producing additional cementitious compounds. The added binder produced by the fly ash/lime reaction allows fly ash concrete to continue to gain strength over time. Mixtures designed to produce equivalent strength at early ages will ultimately exceed the strength of straight cement concrete mixes. The lower water content of fly ash concrete, combined with the production of additional cementitious compounds, reduces concrete's pore interconnectivity—decreasing permeability and improving its resistance to deterioration. The decrease in free lime and the resulting increase in cementitious compounds, combined with the reduced permeability, improve concrete's resistance to alkali-silica reaction, sulfate attack, and corrosion.

Concrete Demand Will Only Increase

Because of its durability and versatility, concrete demand and production are forecast to grow rapidly in the decades ahead. In the United States, passage of the Infrastructure Investment and Jobs Act ("Bipartisan Infrastructure Bill") will see huge public investment in roads, bridges, port and water infrastructure, tunnels, airports, and other concrete-intensive infrastructure over the next decade. Globally, population growth and urbanization throughout the developing world are expected to drive explosive growth in concrete housing and infrastructure projects.

The Global Cement and Concrete Association forecasts that demand for concrete worldwide will increase 43 percent from its current level of 14 billion cubic meters (m^3) annually to 20 billion m^3 in 2050. Assuming current concrete manufacturing practices continue, the CO2 emissions associated with this growth will rise commensurately. From the perspective of mitigating human-generated atmospheric carbon emissions, these trends are unsustainable.

Of course, concrete itself is not the culprit behind these carbon emissions; they stem primarily from the production of ordinary portland cement (OPC). Cement production contributes an estimated 8 percent of all man-made CO2 emissions—2.3 gigatons in 2019 alone. Approximately 60 percent of these emissions derive from chemical reactions

related to the heating of limestone during the calcination process; 30 percent relate to burning fossil fuels to heat the cement kiln; and the remainder are indirect emissions from electricity use.

Concrete Manufacturing Is at a Tipping Point

This is a pivotal moment for the concrete construction market. As climate concerns grow more acute, governments, manufacturers, investors, builders, and customers alike are demanding lower-carbon construction materials.

Over the past several decades, substitution of portland cement with supplementary cementitious materials (SCMs), including fly ash, has played an important role not only in improving the performance characteristics of concrete, but also in reducing its carbon intensity. However, as coal plant retirements continue to reduce the availability of fresh fly ash, new sources of SCMs must be developed—particularly in light of the expected growth in the concrete sector and ongoing climate concerns—to reduce concrete's environmental footprint.

Eco Material Technologies has developed both near- and long-term solutions to address this monumental environmental challenge. Our products—which use little to no heat in their processing and thus emit virtually no carbon—currently displace 5 percent of the U.S. cement production of approximately 120 million tons per year. Working with manufacturers to further adopt our technology and materials, we expect to expand our North American leadership position in zero and near-zero-carbon concrete products by doubling the volumes sold into this market by 2030.

Eco Material is pursuing this displacement of cement in U.S. concrete manufacturing utilizing diverse materials, including:

- Fresh coal combustion products, such as fly ash and bottom ash, of which over 30 million tons per year are available;
- Landfilled coal ash products, of which 2 billion tons are available in the United States alone;
- Natural pozzolans and minerals, of which many billions of tons are available;
- Eco Material's proprietary green cements—Pozzoslag® and PozzoCEM®—which can replace a significant portion of the cement required to make high-strength, durable concrete but produce carbon emissions 99 percent lower than those associated with the manufacture of portland cement.

Eco Material currently has plants operating at scale using each of these SCMs and is actively investigating the procurement of additional zero and near-zero-carbon material resources to ensure our ability to deliver on our growth and environmental goals. Our focus is to use our market knowledge and patented technologies to increase the availability of sustainable SCMs while reducing the demand for OPC to such a level as to preclude the construction of any new cement plants. Simple economics will help drive this outcome, as Eco Material's technologies allow it to build plants at scale for roughly 10 percent of the cost to build a cement plant of similar capacity—with a significantly higher return on investment.

Decarbonizing the manufacture of concrete represents both an existential challenge for the construction industry and a profound opportunity for companies such as Eco Material that can supply low- and no-carbon materials in volume to this sector. To be sure, there is no silver bullet to shrinking concrete's carbon footprint. Delivering on this goal requires that we draw on the full range of material and technological resources at our disposal.

The challenge of building a truly sustainable concrete sector is considerable. However, Eco Material stands committed to driving change in the industry that can make this goal a reality.

Doug Rhodes *is Director of Lab Services at Eco Material Technologies. In this position, he plays a key role in planning, managing, and monitoring quality assurance and technical services activities along with overseeing all functions of Eco Material's Materials Testing and Research Facility.*

ESSENTIAL EQUIPMENT FOR FLY ASH BENEFICIATION.

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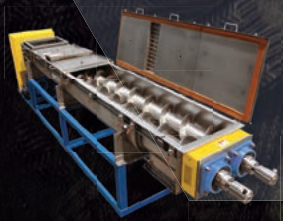

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SUSTAINABLE CONSTRUCTION
with Coal Combustion Products

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Building a Sustainable Future

Our built environment has implications for the sustainable use of natural resources, energy consumption and carbon dioxide emissions. Over half of the world's population now lives in urban areas, and by 2050 over two-thirds of the global population will be urban. Sustainable building practices are vital for protecting the natural environment while supporting livable cities and long-term economic viability.

Substituting recycled industrial materials for conventional products in construction results in tremendous environmental and economic benefits including lower construction costs; decreased water and energy use; reduced emissions; and improved technical performance and longevity. One such recycling success story is coal combustion products.

Coal combustion products (CCPs) are materials produced when coal is burned to generate electricity. Each year in the United States, coal-fueled power plants produce over 110 million tons of CCPs. Currently, about 40% of CCPs are recycled annually into concrete and a variety of green building products.

Products made with CCPs in place of mined or manufactured materials perform better, cost less, and decrease environmental impacts. Concrete made with coal fly ash is stronger and more durable than concrete made with portland cement alone.

The environmental benefits of CCP recycling are huge: for every ton of coal fly ash used as a replacement for portland cement, approximately one ton of greenhouse gas emissions are avoided. Annually, this reduces carbon emissions by 13 million tons–the equivalent to taking 2.5 million cars off the road.

Fly Ash - Improving Strength and Durability

Fly ash is a powdery material that is captured by emissions control equipment before it can "fly" up the power plant stack. Mostly comprised of silica, alumina, iron and calcium compounds, fly ash has mechanical and chemical properties that make it a valuable ingredient in concrete, providing long-term structural strength. Fly ash concrete is less permeable and more resistant to acid, sulfates and other destructive chemical reactions than concrete made with cement alone. Fly ash lowers the heat of hydration, improves workability, and reduces shrinkage and cracking. More than half of the concrete produced in the U.S. contains fly ash, used in roads, bridges, buildings and concrete blocks. Concrete mixtures routinely use 20 to 35 percent fly ash, with the optimum specification depending on ash composition, application and exposure conditions, such as freeze/thaw cycles. High volume applications for unique projects have utilized up to about 65% fly ash to extend service life and meet sustainability objectives.

Synthetic Gypsum - from Floor to Ceilings

Power plants equipped with flue gas desulfurization (FGD) emissions control systems, also known as scrubbers, create byproducts that include synthetic gypsum. Scrubbers utilize high-calcium reagents, such as lime or limestone, to capture sulfur from the flue gases. Although not technically "ash," synthetic gypsum is a type of CCP. Synthetic gypsum is used in 50% of the gypsum panel products (known as wallboard or drywall) manufactured in the U.S. Synthetic gypsum has numerous construction uses beyond walls, including ceilings and self-leveling flooring underlayments. The use of synthetic gypsum avoids the mining of virgin gypsum, yielding water, energy and emissions reductions.

Boiler Slag - Lasting Durability

Boiler slag is molten ash collected at the base of cyclone boilers that is quenched with water and shatters into black, angular pieces having a smooth, glassy appearance. Boiler slag is typically used for roofing granules, asphalt coatings and blasting grit because of its durability and resistance to wear.

Bottom Ash - Filling Many Needs

Bottom ash is a heavier, granular material that is collected from the bottom of coal-fueled boilers. Bottom ash is often used as an aggregate to replace sand and gravel, and as an ingredient in masonry products including concrete blocks. Bottom ash has also been identified as an excellent growing medium for green roofs, providing water retention benefits.

Reaching New Heights with CCPs

One World Trade Center

At 1,776 feet high, One World Trade Center in New York City is one of the greenest super-tall buildings in the U.S. The design had unique durability and sustainability requirements, including using high-strength "green concrete" utilizing fly ash and slag. The concrete mix tripled the compressive strength of conventional concrete, up to 14,000 pounds per square inch. The green concrete saved about 6000 tons of carbon dioxide emissions, 8 million kWh of energy and 30,000 gallons of fresh water. The high-strength fly ash concrete enabled the design to use smaller structural supports in columns and walls, yielding more livable floor area.

Wilshire Grand Center

The foundation for the 73-story Wilshire Grand tower in Los Angeles was designed to absorb ground movement during earthquakes and enable the building to withstand severe windstorms. The tower's foundation is a concrete slab utilizing high quality fly ash as a 25% substitution for portland cement to improve structural strength and durability. The foundation for the Wilshire Grand set a world record for the largest continuous concrete pour of 21,200 cubic yards. Fly ash was essential to the project's success because it mitigates the heat of cement hydration in such a large-scale pour.

Burj Khalifa Tower

The tallest man-made structure in the world, Burj Khalifa towers 2,722 feet above Dubai, United Arab Emirates (UAE). To achieve the structural strength needed to withstand high winds and support the building's massive weight, the tower was designed with a "Y" shaped buttressed core constructed with high performance fly ash concrete. The concrete mix was designed to provide low permeability and high durability. Two of the largest concrete pumps in the world delivered the concrete mix to heights over 2000 feet. Over 330,000 cubic yards of concrete was used in the construction of Burj Khalifa.

Beauty in Sustainable Design with CCPs

Oakland Cathedral

To create lightness and space, the Cathedral of Christ the Light in Oakland, California used architecturally-exposed reinforced concrete made with fly ash. A main design objective of the cathedral was to have the smallest environmental footprint possible, so the use of fly ash achieved both strength and sustainability objectives.

Aqua Tower

The design inspiration for the 82-story Aqua Tower in Chicago was eroded rocks found around the Great Lakes. The wave-like balconies were created by unevenly pouring different mixtures of concrete, with the gray concrete containing more fly ash while the lighter concrete contains more portland cement.

Arizona Residence

This residence designed by Arizona architect Michael Frerking was constructed using "poured earth" made with 67 percent fly ash to substantially reduce the building's carbon footprint and minimize energy use.

Shri Swaminarayan Mandir (12) by 4nitsirk/CC 4.0

BAPS Temple

The BAPS Hindu Temple in Chicago was built with high-volume (65%) fly ash concrete for the reinforced foundation, beams and shear walls to achieve a 1,000 year service life.

Milwaukee Art Museum

The Milwaukee Art Museum was constructed with high volume fly ash to achieve a variety of important design objectives. To create the unique sculptural Quadracci Pavillion, concrete was poured into one-of-a-kind wooden forms.

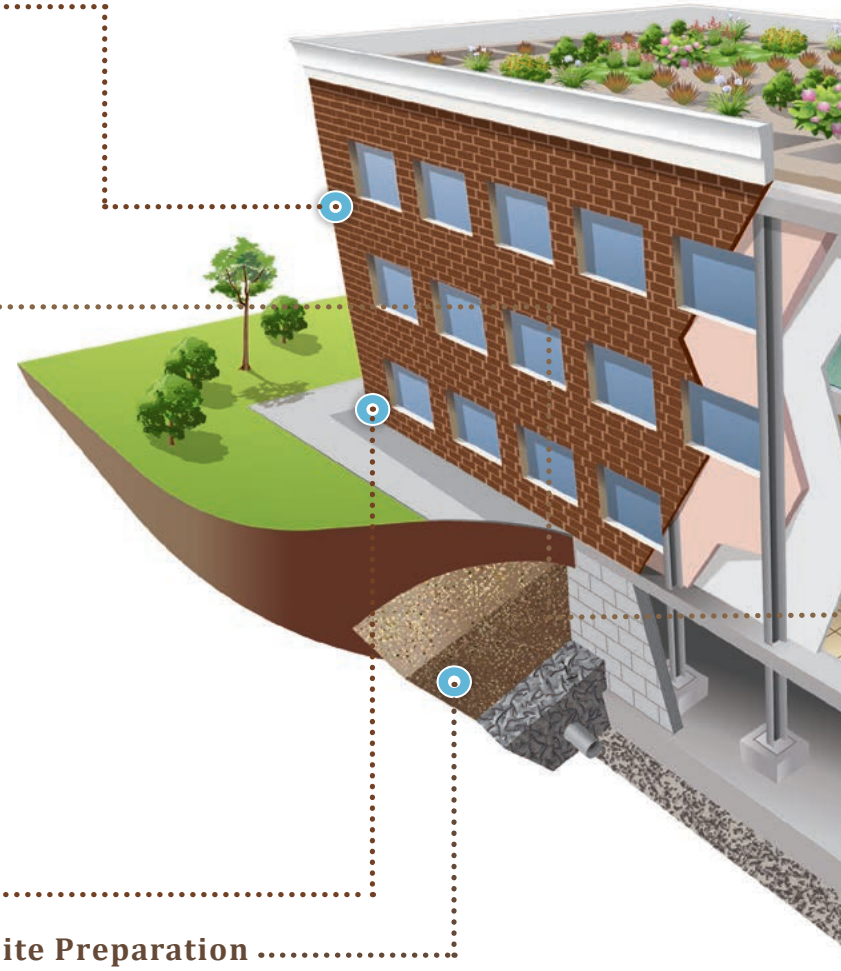
Numerous Uses for CCPs in Sustainable Construction

Wall-Form Products

Insulating concrete forms combine framing, insulation, sheeting and sheer wall strength into one building system. These wall-form products have hollow interiors and are stacked or set in place and can be filled with steel-reinforced high-volume fly ash concrete. The fly ash concrete provides structural integrity, energy conservation and sound proofing.

Flooring Applications

Many builders are using CCP-based floor underlayments in construction, to address a variety of flooring situations and challenges. Self-leveling underlayments may be placed to aid in preparation of the floor prior to installation of the finished floor systems. Overlayments are sometimes specified to correct defective flooring issues prior to installation of carpeting, tile, wood or other surfaces. These applications also can provide sound insulating features. Fly ash and synthetic gypsum are used widely in commercial applications, and can be used in single-family and multi-family homes to support credits toward LEED or Green Globes certification in the categories of indoor environmental quality, low emitting materials, recycled content, regional materials and innovation in design. For examples of these applications see www.maxxon.com/go_green.

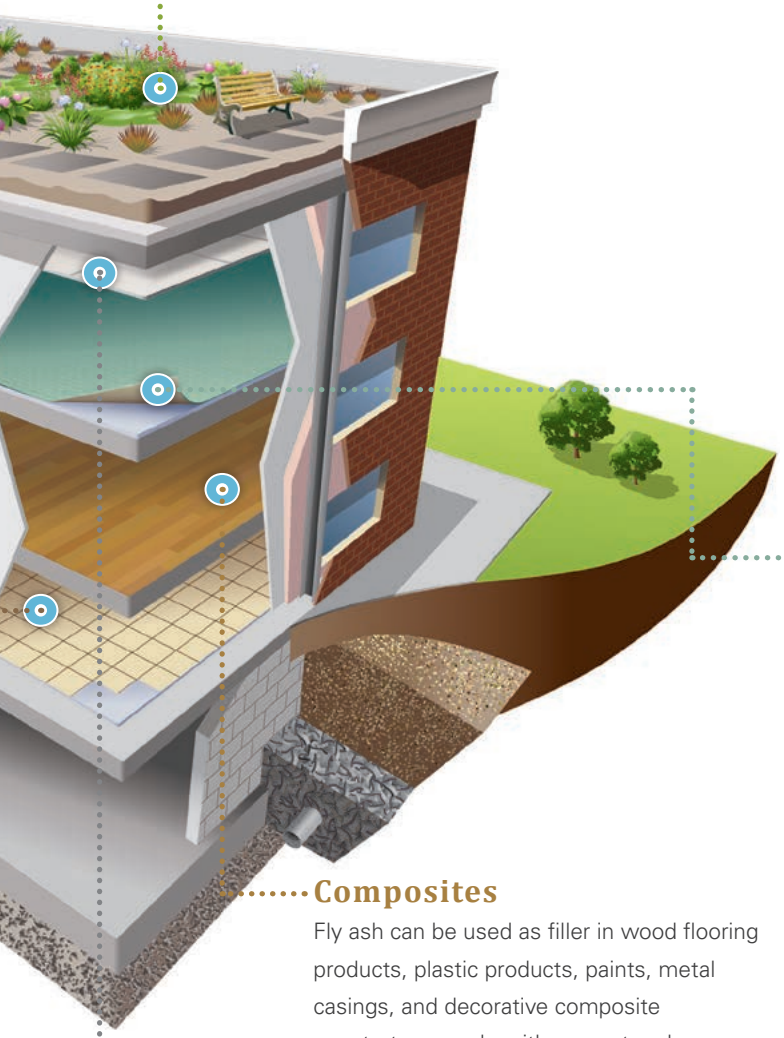


Masonry Products

Fly ash and bottom ash are used extensively in grouts and masonry products, including concrete bricks and architectural veneer stone, available in a wide range of color options.

Site Preparation

CCPs have many uses when preparing a project site for development. Fly ash can be used to stabilize and solidify soils at Brownfield sites or in construction areas. If rains have made work areas difficult to access by vehicular traffic, self-cementing fly ash or fly ash combined with portland cement, cement kiln dust or lime kiln dust can dry up these areas quickly and economically. Blending self-cementing fly ash with existing soils allows for the stabilization of roads and parking areas prior to paving. When embankments or structural fills are needed, fly ash, bottom ash and boiler slag can be combined with earthen materials to meet engineering specifications for compaction, compressive strength, grain size distribution and other geotechnical considerations.



Green Roofs

Typically green roofs are part of a normal roof system which involves green space on top of a building. Green roofs are usually modular in design, allowing plants to be planted in movable sections or containers. A waterproof barrier separates the green roof from the structural roof. The units containing plants have a drainage system, filter cloth and lightweight growing media to allow the plants to establish their roots. Green roofs can provide a wide range of benefits including aesthetic appeal, energy conservation, noise reduction, preventing water runoff, and improved air quality. Green roofs typically require less maintenance and are longer lasting than conventional roofs, and help reduce carbon emissions. Because of its lightweight, granular characteristics, bottom ash is an ideal material for part of the growing media. For more information, visit: www.greenroofs.com and www.greenroofs.org

Carpet Backing

Carpet backing comprised of recycled materials can take years of abuse without sacrificing performance. The inherent "ball-bearing" effect resulting from the spherical nature of the glass particles of fly ash contribute to better packing factors in various polymer systems. For carpet backing systems, this translates to improved flammability ratings, better tuft binds, and improved dimensional stability. As a bonus to the performance characteristics fly ash imparts to these engineered systems, carpet backings qualify for LEED and Green Globes credits for recycled content, and under NSF/ANSI 140 standards for sustainability.

Composites

Fly ash can be used as filler in wood flooring products, plastic products, paints, metal casings, and decorative composite countertops made with concrete, glass and other recycled materials.

Ceiling Tiles & Panel Products

Ceiling tiles and wall products made with fly ash and synthetic gypsum can be textured and pigmented with a wide range of colors for different architectural features.

Geotechnical

Geotechnical applications include soil stabilization, road base, engineered structural fill, and embankments. The use of CCPs in controlled low-strength materials (CLSM), sometimes called flowable fills, provides economic alternatives to many backfill situations. When utility trenches are constructed at a job site, often the dirt or earthen materials excavated are removed immediately. This necessitates importing fill materials once the trench work is completed. Rapid setting flowable fills made with fly ash, bottom ash and cement (if needed) can be used to efficiently close the exposed work areas. Workers are not needed in the trench to tamp or manually place the fill materials, as no compaction is needed. Large quantities can be placed in a matter of minutes, allowing the surface to be finished rapidly.

Certifying the Safety and Benefits of CCPs

LEED Platinum Bardessono hotel

LEED Platinum home in Mill Valley, California. Image credit: Mariko Reed Photography

LEED v4

Leadership in Energy and Environmental Design (LEED) is a green building certification program developed by the U.S. Green Building Council (USGBC) that recognizes best-in-class building strategies and practices. LEED v4 is the newest version of this global benchmark for high-performance green buildings. In order to receive LEED certification, a building must attain a specific number of credits, with Silver, Gold and Platinum levels representing advanced certification.

Using CCPs in construction can earn credits toward certification in the categories of Sustainable Sites (SS), Water Efficiency (WE), Energy and Atmosphere (EA), Materials and Resources (MR), Indoor Environmental Quality (EQ), Location and Transportation (LT), Regional Prority (RP) and Innovation (IN).

Materials that limit the extraction of virgin resources, such as synthetic gypsum wallboard as a replacement for mined gypsum products, earn credits. Concrete containing at least 25% fly ash is considered by LEED as an environmentally preferable product in the MR category. CCPs have also been used in brownfield redevelopment (SS) projects. And because CCPs are usually sourced locally, they can contribute toward RP credit. The heat island reduction from using fly ash concrete contributes toward LT credits. Using CCPs in pervious pavements, which reduces the rate and quantity of storm water runoff, can contribute to earning LEED credits in the SS, LT, WE and MR categories. Buildings constructed with fly ash concrete moderate indoor temperatures and reduce energy consumption, earning credits in EA and MR categories. Green roofs earn credits in a number of categories, including SS, WE, EA and MR.

Innovative design strategies can garner additional credits, including reducing carbon emissions through the use of high volume fly ash concrete, fly ash bricks and other recycled products made with CCPs. For information on LEED, please visit: www.usgbc.org/v4.

Standards for CCP Use

Numerous technical and engineering standards have been developed for specifying and using CCPs to ensure performance objectives. In the U.S., specifications are published by ASTM International, the American Concrete Institute (ACI), National Ready Mixed Concrete Association (NRMCA), Federal Highway Administration, Army Corps of Engineers and several other federal and state agencies. These standards specify the characteristics and technical details that must be met by CCP products and applications. Similarly, standards for demonstrating environmental attributes (called product category rules) provide a consistent approach for assessing sustainability benefits.

Demonstrating Safety

The U.S. Environmental Protection Agency (EPA) "encourages the beneficial use of coal ash in an appropriate and protective manner, because this practice can produce positive environmental, economic and product benefits" including reduced use of virgin resources, lower greenhouse gas emissions and improved strength and durability of materials. Beneficially-used CCPs are exempt from federal regulation.

In 2014, EPA conducted a scientific evaluation of the safety of using fly ash in concrete and synthetic (FGD) gypsum in wallboard, finding that releases of constituents of potential concern are comparable to or lower than those from analogous products made without CCPs, or are at or below relevant health-based benchmarks, concluding that "beneficial uses provide significant opportunities to advance Sustainable Materials Management." See: www.epa.gov/sites/default/files/2014-12/documents/ccr_bu_eval.pdf

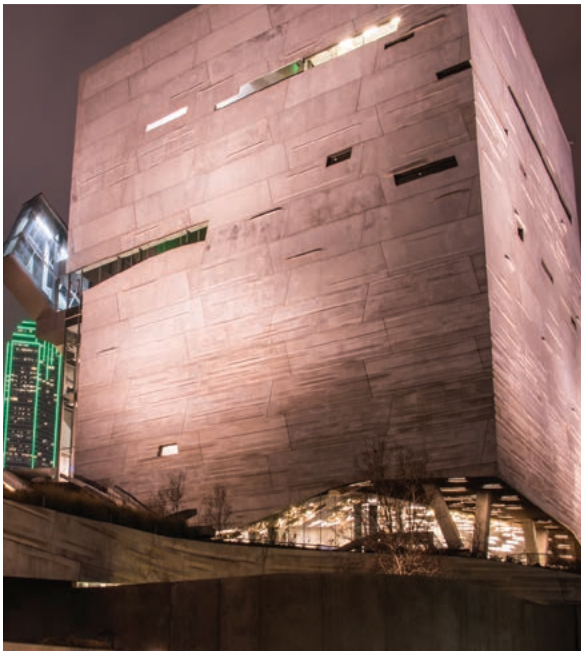
The Reagan Building in Washington D.C., headquarters for EPA, was constructed with fly ash concrete.

Green Globes

The Green Globes building rating and certification program was developed by the Green Building Initiative and is accredited by the American National Standards Institute (ANSI). Green Globes evaluates the environmental friendliness and sustainability of building projects.

As with LEED, Green Globes promotes green building practices that yield energy efficiency, emissions reductions, water savings, use of recycled and reclaimed materials, healthier indoor environments, and reduced ecological footprint. Green Globes assesses building environmental impacts on a 1,000-point scale in seven categories: Materials & Resources, Energy, Water, Emissions, Indoor Environment, Site, and Project Management. Utilization of CCPs in building construction can help score points related to materials and resources, energy consumption, water use, emissions, indoor environment and site development.

Green Globes utilizes independent, third-party assessors to rate projects. Green Globes has been recommended by the U.S. General Services Administration (GSA) as one of two certifications (with LEED being the other) for evaluating the performance of federal government agency buildings. For more information on Green Globes, please visit: www.greenglobes.com.



Perot Museum in Dallas holds the highest Green Globes certification

The Future of CCPs in Sustainable Construction

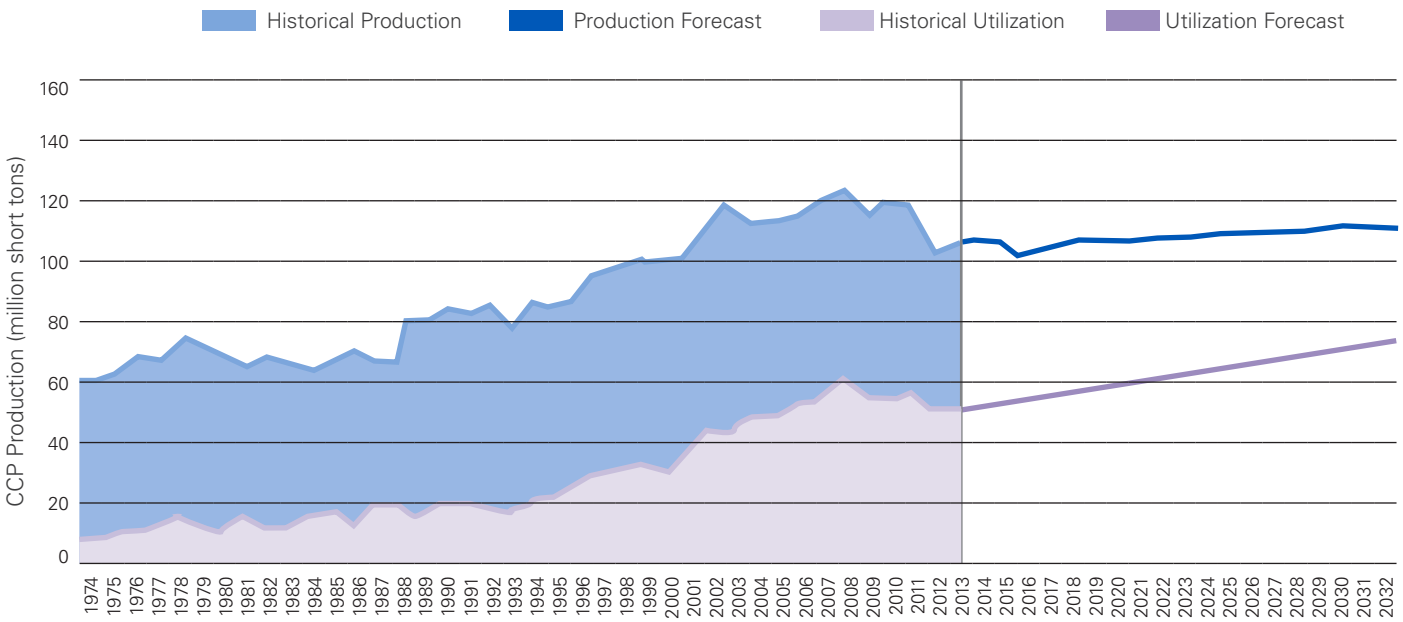
Coal combustion products are projected to continue to play a major role in sustainable construction over the next 20 years. Utilization of CCPs in major markets has grown by an average 5.1 percent annually since 1974, increasing to over 51 million tons beneficially used during 2013. CCP utilization has increased during three of the last five U.S. recessions since 1974 as markets have taken advantage of the lower cost of CCPs compared with alternative materials.

Despite retirements of coal-fueled power plants over the last few years, coal is expected to remain a primary energy source in the U.S. for decades to come, according to U.S. Energy Information Administration (EIA). As a result, overall production of CCPs are forecast to grow from 114.7 million tons in 2013 to 120.6 million tons in 2033. Fly ash production is forecast to grow from 53.4 million tons in 2013 to 54.6 million tons in 2033, and production of synthetic gypsum is projected to grow from 35.2 million tons in 2013 to 38.8 million tons in 2033. CCP utilization is forecast to increase 48 percent over the next two decades due to growth in the U.S. economy, new housing starts, and increasing demand for ready mixed concrete. Historical CCP production and utilization over the last four decades is shown in the figure below, along with forecasts for future production and use.

Ash beneficiation and other emerging technologies are expanding the use of CCPs into new markets and products. Producers and marketers are working together to ensure CCPs will continue to comply with applicable construction standards and specifications. Architects are using CCPs in new and innovative designs, leveraging the strength, durability and environmental benefits to attain green credentials under LEED and Green Globes.

More and more architects, construction firms and consumers have come to recognize the environmental, economic and sustainability benefits that CCPs deliver. Science, engineering standards and practical experience has transformed the perception of fly ash and other CCPs from waste into valuable product.

Production and Utilization of CCPs



Sustainable Building Resources

The **American Coal Ash Association (ACAA)** advances the management and use of coal combustion products in ways that are environmentally responsible, technically sound, commercially competitive, and supportive of a sustainable global environment. Visit: www.acaa-usa.org

The quality and characteristics of fly ash as a component of concrete are defined in several standards, including **ASTM C618**, **ACI 232.2** and **ACI 232.3**. Marketers of fly ash will commit to the quality specified as they supply fly ash to ready mix producers, who in turn ensure the concrete will meet the designer's needs through their own quality program. Visit: www.astm.org/Standards/C618.htm and www.concrete.org for more information on the standards.

BEES: Building for Environmental and Economic Sustainability Software developed by the National Institute of Standards and Technology (NIST) brings to your fingertips a powerful technique for selecting cost-effective, environmentally preferable building products. Visit: www.nist.gov/el/economics/BEESSoftware.cfm

Best Practices Guide for High-Volume Fly Ash Concretes: Assuring Properties and Performance is published by NIST. The best practices guide considers all aspects of high volume fly ash (HVFA) concrete production from materials characterization through curing to long-term performance.

Green Globes is an online green building rating and certification tool licensed for use in the U.S. by the Green Building Initiative. The Green Globes New Construction assessment can be used for a wide range of commercial, institutional and multi-residential building types to advance sustainability and environmental goals. Visit: www.greenglobes.com or www.thegbi.org

Specific guidance on the use of high volume fly ash can be found in a book by V.M. Malhotra and P.K. Mehta, ***High-Performance, High-Volume Fly Ash Concrete, 3rd Ed***. This book contains mix designs, recommendations, precautions and examples of high volume fly ash concrete placement and applications.

The **Industrial Resources Council (IRC)** Is a collaboration of non-profit industry associations working together to promote the appropriate use of industrial materials, including coal combustion products.

LEED green building certification program, administered by the U.S. Green Building Council (USGBC), is the premier benchmark recognizing best-in-class sustainable building strategies and practices. Building projects can earn points to achieve different levels of LEED certification. LEED v4 is the newest version of the certification program with ratings systems for Building Design and Construction, Interior Design and Construction, Building Operations and Maintenance, Neighborhood Development and Homes. Visit: www.usgbc.org/leed

The **National Association of Home Builders (NAHB)** provides a variety of resources for green building certification, construction codes and standards, and valuation of green homes. The ICC 700 National Green Building Standard is an ANSI-approved residential green building rating system that guides the construction of safe, sustainable and affordable homes. Visit: www.nahb.org/advocacy/industry-issues/sustainability-and-green-building

The **National Ready Mix Concrete Association (NRMCA)** has guidance documents available that define the quality requirements for all concrete mix designs, including those using fly ash or slag. Visit: www.nrmca.org

The **Oikos** site is an online directory for sustainable building products. The Green Building Library contains resources for various building categories. Visit: www.eerl.org/resources/oikos-green-building-source/

Sustainable Sources is an online source for green building information, including fly ash concrete related information. Visit: www.sustainablesources.com

What's in It for Coal Ash?

Accessing a Slice of the Trillions of Federal Dollars Allocated for Infrastructure and Climate Requires Persistent Engagement

By John N. Ward

Emerging from the COVID-19 pandemic, the United States Congress enacted a pair of landmark bills that promise to transform broad swaths of the nation's economy. In November 2021, the Bipartisan Infrastructure Law[1] allocated $1.2 trillion for the development of physical infrastructure in the transportation, water, energy, and broadband sectors. Just nine months later, the Inflation Reduction Act[2] allocated $1.22 trillion to address clean energy and climate change.

If those sound like big numbers, it's because they are. Compared to the nation's economy overall, they combine to total 10.5 percent of Gross Domestic Product. That's over five times the GDP equivalent of the post-World War 2 Marshall Plan. When combined with other major stimulus actions of the 2020-22 time period ($2.02 trillion CARES Act, $900 billion Phase 4 COVID relief, $1.9 trillion American Rescue Plan, $280 billion CHIPS bill, and $519 billion student loan forgiveness), the post-COVID spending spree totaled 37.1 percent of GDP—just shy of the 40.1 percent spent over eight years for the New Deal (see chart on facing page).

That much money floating around means there must be opportunities for coal combustion products beneficial use, right? With the federal government now a year or so into its planning process, the answer is a definite "maybe."

On Devils and Details

Jokes aside about how the Inflation Reduction Act must have been named on Opposites Day, it's worth remembering that Congress appropriates large blocks of money for broadly defined purposes. The details, including any devils that hitch a ride, are left to executive branch agencies to determine.

Given the extraordinary magnitude of these programs, it shouldn't be surprising that the federal government isn't exactly organized to spend this amount of money quickly. A host of federal agencies are now staffing up, either directly or through consultants, to write the rules and administer the programs that will eventually disburse the funds.

Select Stimulus Bills	Cost (2020 Dollars)	% U.S. GDP
American Rescue Plan (2021)	$1.9 Trillion	8.4%
Inflation Reduction Act (2022)	$1.22 Trillion**	5.3%
Bipartisan Infrastructure Law (2021)	$1.2 Trillion	5.2%
Student Loan Forgiveness (2022)*	$519 Billion	2.4%
CHIPS for America (2022)	$280 Billion	1.3%
Phase 4 COVID Relief (2020)	$900 Billion	4.3%
CARES Act (2020)	$2.02 Trillion	10.2%
Trump Tax Cuts (2017)	$1.46 Trillion	7.5%
ARRA (Obama Stimulus) (2009)	$1.03 Trillion	5.8%
Marshall Plan (1948-1951)	$144 Billion	~2%
New Deal (1933-1940)	$793 Billion	40.1%

*Currently blocked by court
**$790 billion new taxes; $485 billion spending + tax breaks

SOURCE: Mehlman Castagnetti Rosen & Thomas

Federal agencies have been doing their best to make their program set-up process as transparent as possible. Numerous public requests for information have been issued, and stakeholder webinars have been held to gather information and give some clues regarding what eventually may be required to qualify for a piece of the pie.

The CCP Value Proposition

Coal combustion products sit solidly at the nexus of the climate and transportation issues that the Inflation Reduction Act and infrastructure measures aspire to address. Coal ash beneficial use is already a major contributor to decarbonization of the cement and concrete industries. For instance, coal fly ash used in concrete reduces the need to manufacture cement, resulting in significant reductions in greenhouse gas emissions—about 12 million tons in 2021 alone.[3] And all of those concrete roads, bridges, airport runways, and more envisioned by the infrastructure bill can be made to last longer by incorporating coal ash. In a 2011 study[4], the American Road and Transportation Builders Association concluded that use of coal ash in concrete saves $5.2 billion per year in federally funded road and bridge construction costs, chiefly because of the increased lifespan of structures using the material.

As the transformation of energy infrastructure in the United States has led to steadily decreasing use of coal to generate electricity, users of CCP have begun developing alternative strategies for sourcing the materials they have grown to depend on. Prominent among these strategies is the practice of "harvesting" CCP that was previously disposed.

Photo courtesy of MnDOT

Harvesting previously disposed CCP for beneficial use in concrete and other applications is rapidly becoming a viable commercial activity. The consensus standards organization ASTM International in 2019 published a guide[5] for harvesting activities, and additional standards development is now under way to help guide characterization of harvested materials. Harvesting activities utilizing thermal beneficiation are now in commercial operation in South Carolina and at three facilities in North Carolina. Harvesting activities that require less capital-intensive processing of the CCP are now in commercial operation in Pennsylvania, Virginia, Kentucky, Florida, Arkansas, New Mexico, and Louisiana. A host of additional harvesting projects are under development nationwide.

Where the Funding Opportunities May Be

Numerous programs contained in the Inflation Reduction Act may provide opportunities to increase use of coal ash in already-proven applications. Examples include:

- $6 billion for a new Advanced Industrial Facilities Deployment Program, targeting hard-to-decarbonize sectors of the economy. Cement and concrete are specifically identified in the legislation.

- More than $5 billion for federal procurement of American-made clean technologies to create a stable market for clean products. Included in this program is funding to incentivize the use of low-carbon building materials in public infrastructure projects and certain government-owned buildings, specifically:

  - $2.15 billion to install low-carbon materials in General Services Administration-owned buildings.

  - $2 billion for Low-Carbon Transportation Grants to reimburse and incentivize the use of low-carbon materials for Federal Highway Administration projects.

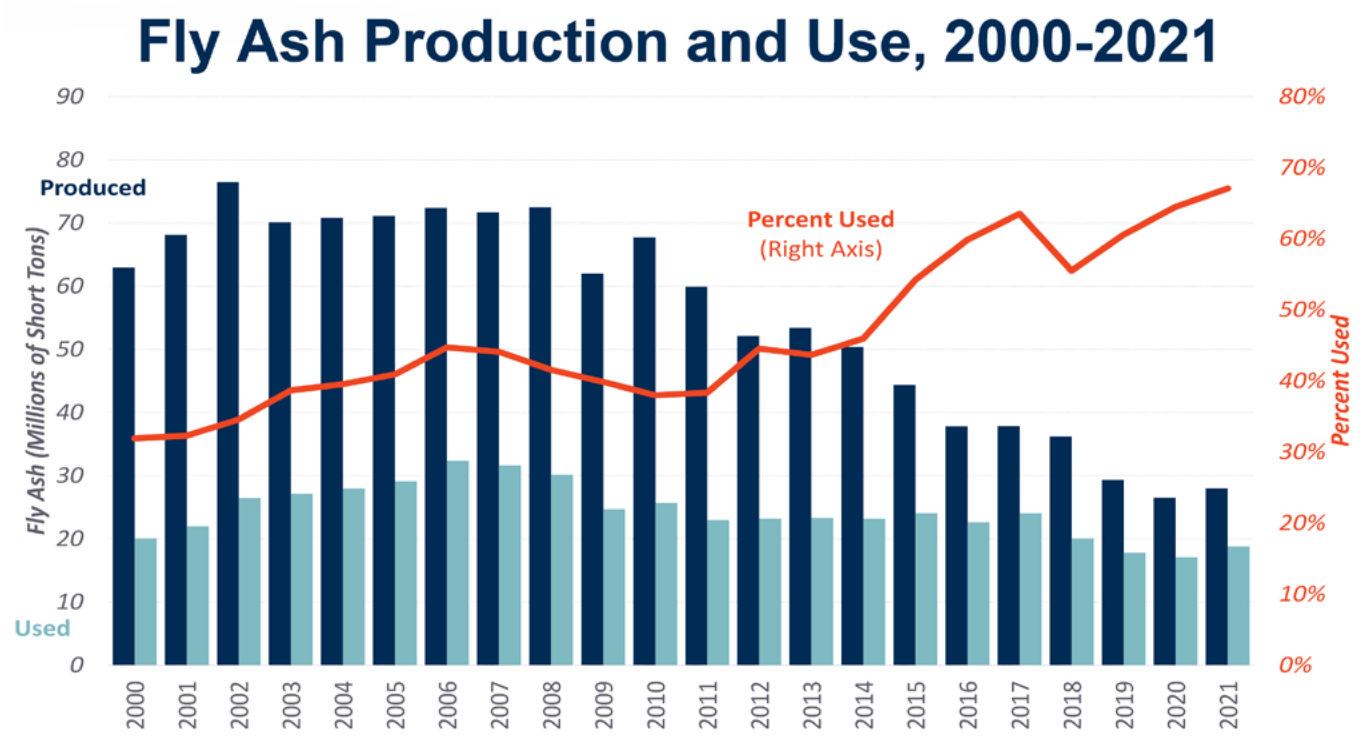
  - $250 million to develop and standardize Environmental Product Declarations for construction materials, with grants and technical assistance for manufacturers.

  - $100 million to identify and label low-carbon materials and products for federally funded transportation and building projects.

Additional Demands to Access the Funding

Like the aforementioned New Deal, a fair amount of social engineering is being incorporated in these programs as implementation details are established. Pursuant to Executive Orders issued by President Joe Biden, federal agencies are pursuing a "whole-of-government" approach to advancing climate change[6] and environmental justice.[7] Included in the climate change Executive Order is a commitment to pursue a "just transition" for workers in fossil fuel communities that are affected by the energy transition.[8]

The takeaway is simple: If you want to access federal funds from these developing programs, you are going to need to do more than just bring low-carbon building materials to the market. You're going to need to ensure that the benefits of your actions extend to environmental justice communities and probably commit to use union labor along the way. The fact that you may be creating long-term jobs in a "just transition" community could be cited as a plus.



ACAA's production and use surveys show the U.S. produces more fly ash than it consumes, leaving plenty available for infrastructure projects going forward.

Potential Barriers for CCPs

Despite the obvious, proven, significant environmental advantages of coal ash beneficial use, don't expect the practice to face an easy path through the set-up and implementation of these funding programs. Some (many?) of the federal agency employees and contractors who are writing the rules harbor deep-seated biases against anything related to coal.

Competing regulatory demands also present a significant barrier. The Environmental Protection Agency is currently pursuing an imposing regulatory agenda aimed at using its "full suite of authorities"[9] to incentivize the closure of coal-fueled power plants. Even opportunities to harvest coal ash resources and remove them from a disposal setting permanently may encounter barriers from aggressive disposal compliance timelines.

Engagement and Persistence Are Key

The American Coal Ash Association has taken an active role with federal agencies including the EPA, Federal Highway Administration, and General Services Administration as they have sought stakeholder input on program set-up.

ACAA takes every opportunity to reinforce that EPA has both statutory and long-standing policy obligations to encourage coal ash beneficial use. (For instance, "resource conservation and recovery" is right in the name of the law that enables coal ash solid waste regulations.) ACAA also routinely points out that coal ash beneficial use is highly supportive of Biden administration goals for decarbonization and just transition. Most recently, ACAA and some of its members have engaged with the EPA "Smart Sectors"[10] program to provide input on a report that is intended to describe coal ash's key role in cement and concrete decarbonization.

ACAA is also heavily engaged in industry-wide Product Category Rule development and associated relations with FHWA and its "Sustainable Pavements"[11] program. ACAA members should anticipate subsequent activity using the industry PCR to develop their own Environmental Product Declarations, because they will likely be required to qualify for any of the federal purchasing programs that are established.

Everything Old Is New Again

Fly ash utilization has a long history in federal environmental purchasing. Fly ash use in concrete was the subject of the first EPA "Comprehensive Procurement Guideline"[12] in 1983, and EPA subsequently added guidance for purchasing flowable fill containing coal fly ash. Because they were strictly voluntary, CPGs have been of limited practical benefit to the ash marketing industry up until now. But these new program developments may signal a federal policy shift to becoming more prescriptive in the use of environmentally beneficial materials.

Whether the CCP beneficial use industry will be able to receive direct funding from the federal government's historic spending spree is still an open question. Anti-coal biases or adjacent regulatory conflicts may conspire to prevent qualification. Industry participants may choose not to jump through all of the necessary hoops even if qualification is possible.

But the trend is clear: Decarbonization and "buy clean" imperatives are here to stay. And coal ash has an important role to play regardless of whether the industry takes the government's money directly.

John Ward *entered the coal ash marketing business in 1998 as Vice President, Marketing and Government Affairs, for ISG Resources (later Headwaters). Since 2008, he has served as president of John Ward Inc., a public affairs consultancy to the coal ash and energy industries. He is the longstanding chairman of American Coal Ash Association's Government Relations Committee and was the first recipient of ACAA's Champion Award. He is the author of ACAA's weekly Phoenix newsletter and introduces himself the way his son did at a seventh-grade career day many years ago—as a used coal salesman.*

Endnotes

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Building Sustainable Pavements with Fly Ash

By John Simpson

U.S. roads and highways move 72 percent, or $17 trillion annually, of the nation's goods.[1] Despite their critical importance to our country's economic well-being, 43 percent of public roadways are currently in poor or mediocre condition.[2]

The Infrastructure Investment & Jobs Act (IIJA), signed into law in November 2021, will likely go a long way towards addressing this problem. The IIJA provides approximately $350 billion for federal highway programs over a five-year period (fiscal years 2022 through 2026), representing the largest year-to-year increase in federal highway investment since the late 1950s.[3]

Just as important as the actual repair and replacement of substandard roads, however, is the manner in which this work is carried out. Specifically, care in the selection of the materials used to rebuild the nation's roads—factoring in properties such as embodied energy, durability, and recyclability—is key to ensuring that this massive infrastructure overhaul is completed as sustainably as possible.

This represents an opportunity for increased usage of fly ash in both asphalt and concrete pavement.

What Makes Pavement Sustainable?

The sustainability of pavement generally refers to its ability to:

- Achieve the engineering goals for which it was constructed
- Preserve and restore surrounding ecosystems
- Use financial, human, and environmental resources economically
- Meet basic human needs such as health, safety, and comfort[4]

Pavement sustainability is measured over its entire life-cycle and includes inputs pertaining to the material selection, design, usage phase, and end-of-life stages. That said, a paving system that is most appropriate for achieving sustainability goals in one situation might not be as suited to another.

Material Selection—A wide range of materials, including asphalt, concrete, aggregates, and supplementary cementitious materials, are used in paving applications. An established practice for improving the sustainability of pavement is the inclusion of recycled matter—such as fly ash—co-products, or waste materials.

Design—Examples of sustainable construction design include incorporating local materials to reduce transportation costs, use of techniques and materials that reduce construction time, and

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specifying inclusion of mix designs that include materials such as fly ash that can produce longer-life pavements.

Usage Phase—Certain pavements may be deemed to be more sustainable than others based on their impact on use-stage effects, such as vehicle fuel consumption, stormwater runoff, noise, safety, or contributing to urban heat islands.

End of Life—When a pavement reaches its end of life, it may be reused as a part of the supporting structure for a new pavement, recycled, or removed and landfilled. Each of these activities has economic and environmental costs that factor into the pavement's overall sustainability rating.[5]

Concrete Pavements

Virtually all rigid pavements in the U.S. are made from concrete—typically jointed-plain concrete pavement, which uses contraction joints rather than reinforcing steel to control cracking. While concrete pavements are often more costly to install, they tend to last considerably longer than asphalt pavements and suffer less rutting and cracking, as well as fewer potholes.[6]

Fly ash has been used in roadways and interstate highways since the early 1950s. In 1974, the Federal Highway Administration encouraged the use of fly ash in concrete pavement with Notice N 5080.4, which urged states to allow partial substitution of fly ash for cement whenever feasible to improve its strength and durability.[7]

The use of fly ash also conveys a range of other desirable attributes both to the concrete itself and the wider environment. Specifically, it:

- Reduces the prevalence of air voids, making concrete denser and less permeable
- Boosts concrete's resistance to sulfate attack
- Increases concrete's resistance to freeze/thaw deterioration[8]
- Decreases alkali/silica reaction in concrete and the deleterious expansion that can result from it[9]
- Saves approximately one ton of carbon dioxide from entering the Earth's atmosphere for every ton of fly ash used in replacement of portland cement in the mix
- Conserves land that would otherwise be used for ash disposal
- Reduces water usage compared with portland cement concrete[10]

Asphalt Pavements

Asphalt pavement is a flexible pavement consisting of a mix of asphalt or bituminous material and aggregates that sit on layers of compacted granular material built upon a subgrade. Flexible pavements are designed to bend on the surface and transfer the load pressure to the lower layers.[11]

While fly ash has been used for decades to produce high-performance concrete pavements, its use in asphalt pavements has been limited mostly to hot mix asphalt (HMA) paving applications. The unique spherical shape and particle size distribution of fly ash make it a highly effective mineral filler in HMA applications, where it acts to increase the stiffness of the asphalt mortar matrix, improve the pavement's rutting resistance, and enhance the durability of the mix.

The specific sustainability benefits of incorporating fly ash in asphalt pavements include:

- Reduced potential for asphalt "stripping" due to fly ash's hydrophobic properties
- Ability to use less mineral filler material by weight owing to fly ash's lower specific gravity compared with many competing fillers—saving on HMA material costs
- Fly ash is potentially a lower-cost mineral filler where it is available locally[12]

Fly Ash Asphalt: Untapped Potential

Given that the majority of roads and highways in the United States are paved with asphalt, rather than concrete, the limited use of fly ash in these applications represents a potential missed opportunity—for both the coal ash industry and those interested in sustainable road construction. With that in mind, officials at We Energies sought to demonstrate the extent to which fly ash could improve both the sustainability and performance characteristics of asphalt pavement.

In 2012, the utility paved an approximately 1.5-mile section of internal road located at its Oak Creek Power Plant with conventional asphalt as a control section together with a section of asphalt containing a 10 percent Class C fly ash replacement of the binder (which they dubbed "ASHphalt"). Although the ASHphalt section was constructed with 10 percent less binder (replaced with fly ash), WE Energies reports that mixing, placement, and compaction efforts during construction did not show any difference compared to the control mix. Field target compaction density required for optimum service quality was achieved for both control and ASHphalt sections.

"This clearly indicated that while fly ash increased binder viscosity and stiffness, it did not hamper mix workability," the authors of "Fly Ash - An Important Ingredient for use in Hot-Mix ASHphalt Concrete" wrote in a 2016 paper presented at the Fourth International Conference on Sustainable Construction Materials and Technologies. "In fact, considering the asphalt content in [the] ASHphalt section is 10 percent less than the control, this is a strong indication of the fly ash's ability to extend the volumetric effect of the binder through its unique spherical particle shape."

Nondestructive testing was performed on the completed test sections with a Falling Weight Deflectometer. After six months, the average elastic modulus was measured to be 9 percent higher for the ASHphalt section compared to the control mixture without fly ash.

According to the paper's authors, the potential benefits of using fly ash in asphalt are "significant" and include:

- Fly ash acts as an extender of asphalt bitumen volume.
- Fly ash improves the asphalt mixture workability and is easier to compact on site to targeted specified density.
- Fly ash improves the aging resistance of asphalt binder and delays aging-related cracking. Crack-arresting behavior of the spherical fly ash particles has been observed in SEM studies.
- Fly ash assists in relieving built-up thermal stresses in asphalt mixtures, thus reducing the potential for thermal cracking.[13]

***John Simpson** is editor of ASH at Work.*

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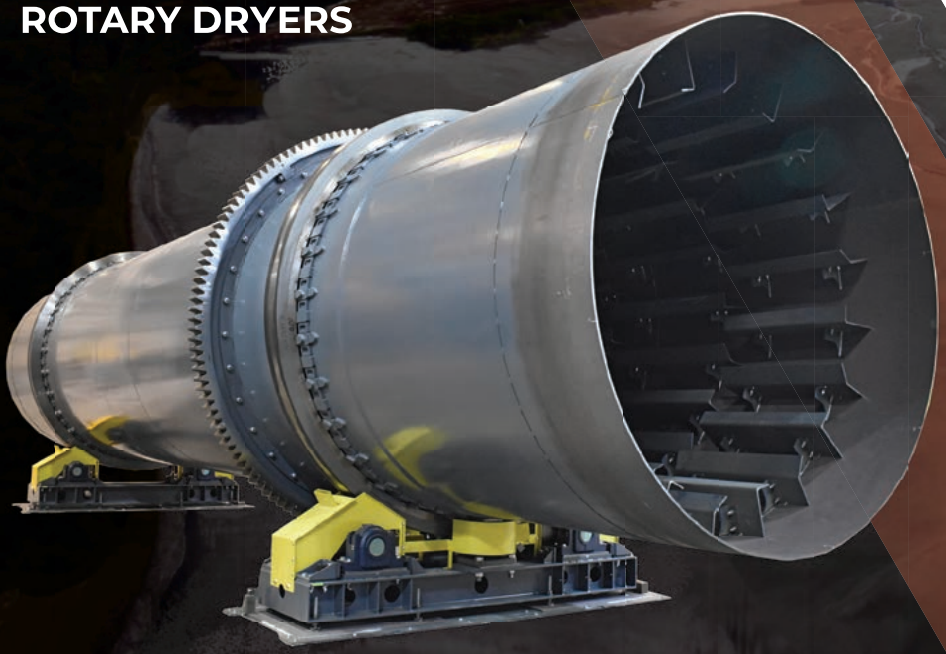

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Beneficial Use Case Study

Lake Williams Dam Rehabilitation

Coal Combustion Product Type
Class F Fly Ash

Project Name
Lake Williams Dam Rehabilitation

Project Location
York, Pennsylvania

Project Participants
Eco Material Technologies, Kinsley Construction, Gannett Fleming, York Water Company

Project Completion Date
2023

Project Summary
Lake Williams Dam has been in operation for over a century and provides water and recreational opportunities for 200,000 residents of York and Adams County, Pennsylvania. Operated by the York Water Company—the nation's oldest water utility—the original dam was built with a soil face on its back that, it was feared, could wash away during an extreme flood. To comply with Pennsylvania Department of Environmental Protection (DEP) Division of Dam Safety requirements and regulations, the dam is undergoing a major overhaul to give it adequate spillway capacity to safely pass a Spillway Design Flood equivalent to 100 percent of the Probable Maximum Flood.

Project Description
To bring the dam up to DEP specifications, plans called for replacing the existing gated concrete spillway with a new labyrinth spillway structure and armoring the dam embankment with roller compacted concrete (RCC) to provide an auxiliary spillway that could be activated during extreme flood events. The design also included construction of a new non-overflow gravity dam, outlet works, and an RCC concrete stream crossing.

Given the requirement for high-strength concrete, and the potential for excessive heat of hydration in the mass placement, use of a fly ash-heavy mix was an obvious choice. But with fresh fly ash temporarily unavailable locally, Kinsley Construction officials looked further afield for their supply—to Eco Material's Montour County monofill—which has been harvesting approximately 100,000 tons of previously disposed fly ash annually for several years now for sale into the concrete construction market.

Placement of the first 5,500 CY of RCC at Lake Williams was carried out in October thru December of 2022 utilizing 620 tons of fly ash at 50 percent substitution for cement (225 lbs. fly ash/CY) before operations went on hiatus for the winter. Thus far in 2023, approximately 1,040 tons of fly ash has been used to place a further 9,200 CY of RCC. On completion of the dam construction—expected in late 2023—a total of 46,000 CY of RCC is expected to have been placed incorporating 5,200 tons of fly ash.

Fly ash is also being used (at a rate of 125 lbs./CY) in the placement of 1,500 CY of various other concrete elements, including a bedding mix (placed on the grade prior to RCC mix placement) and self-compacting concrete and Class D concrete mixes used for miscellaneous structures and equipment-anchoring concrete. Project officials anticipated that concrete placement would again pause in the spring, as higher temperatures increase the risk of thermal cracking, with operations recommencing in the fall.

"This is a great opportunity for us to showcase the reliable, high-quality ash supply that we have at our Montour facility," says Terry Peterson, Eco Material's Vice President, East Region. "Montour holds roughly two million tons of low-moisture, low-LOI fly ash that we expect there to be great demand for as fresh production ash supplies continue to decline in the future."

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Beneficial Use Case Study

Batson Children's Hospital

Coal Combustion Product Type
Class C Fly Ash

Project Name
Batson Children's Hospital

Project Location
Jackson, Mississippi

Project Participants
Holcim US, MMC Materials

Project Completion Date
October 2020

Project Summary
Batson Children's Hospital is the only hospital in Mississippi dedicated to providing children with medical care in more than 30 specialty areas. The facility averages 10,000 patients annually from throughout the state and around the country. Opened in 1997, Batson Children's Hospital was in dire need of additional space to allow hundreds of additional children to be cared for every year. In response, the hospital developed plans for a 370,000-square-foot addition—including intensive care rooms, surgical suites, a state-of-the-art imaging center, and a children's heart center—as well as a 193,000-square-foot parking garage.

Project Description
The plan called for placing 26,600 cubic yards of concrete for the hospital addition and 8,000 cubic yards of concrete for the parking garage. With concrete a significant portion of the expansion project, the use of sustainable materials in the high-performance mixes was paramount.

Photo courtesy of Holcim US

Mixes also needed to meet specified durability requirements for moderate sulfate resistance and chloride exposure, as well as achieve compressive strengths of 4,500 psi for the foundations, 5,000 psi for the elevated decks, and 6,000 psi for the structural columns. Achieving a 75 percent early strength gain of 3,750 psi within three days for the elevated decks, especially the post-tensioned slabs of the parking garage, was also important to keep the project on schedule.

With sustainability a high priority, the project offered an ideal opportunity for using concrete mix designs incorporating Portland Limestone Cement (PLC) and Class C fly ash. Used seamlessly as a direct substitution for ordinary portland cements, PLC (Type IL) provides performance that is equivalent to or better than Type I/II cements. Because Holcim's OneCem® PLC uses less clinker than traditional portland cement, CO2 emissions are reduced by 5 to 10 percent per ton of cement. Reducing clinker content even more with fly ash further lowers a project's carbon footprint.

According to Taylor Wilson, sales and service coordinator at MMC Materials, PLC interacts with fly ash extremely well and allows higher amounts of Class C fly ash to be used in concrete mixes. "Type IL cement not only enables the use of more recycled materials to reduce clinker content, but also helps achieve better early strength gain and improved set time for concrete placement," he explained.

To develop cost-effective mix designs for various structural concrete applications on the project, the quality control team at MMC Materials evaluated 25 different recipes of OneCem PLC, Class C fly ash, various admixtures, and different aggregates. Laboratory analysis included tests on early strength, maturity of the concrete, slump, workability, set time, permeability, and durability.

Upon completion of the performance assessments, the team settled on six mixes incorporating OneCem PLC, 20 to 30 percent Class C fly ash, and various performance-enhancement admixtures. Throughout the construction process, MMC Materials supplied the sustainable concrete mixes from two of its batch plants located 15 minutes from the job site and conducted quality control tests in the laboratory and in the field during every placement. Cylinders were cast and tested every 150 yards.

The hospital expansion was completed on schedule and within budget, with a ribbon-cutting ceremony held in October 2020. The use of OneCem PLC combined with fly ash replacement levels of 20 to 30 percent reduced the embodied carbon of the concrete by as much as 35 percent. The custom-designed PLC/fly ash mixes also achieved all application-specific performance targets for durability, permeability, workability, ultimate strength, and finishing qualities.

Information adapted from materials supplied by Holcim US.

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Beneficial Use Case Study

HS2 London Euston Station

Coal Combustion Product Type
Fly Ash

Project Name
HS2 London Euston Station

Project Location
London, England

Project Participants
Capital Concrete, Wagners, John F Hunt, Mace Dragados JV, Arup, WSP, Grimshaw Architects, Haptic, LDA Design

Project Completion Date
Ongoing

Project Summary
Euston Station is a railway terminus under construction in central London that will connect Britain's capital city with Birmingham, Manchester, and Scotland as part of the High Speed 2 ("HS2") rail network. The station's ground-level concourse will be a 1,000-foot-long hall spanning over three acres that will become the largest station concourse in the UK upon its completion. It is a key part of the largest infrastructure project in Europe, which will include the construction of four new stations and 260 miles of new high-speed line, including 32 miles of tunnel, 9 miles of viaduct, and 140 bridges.

Project Description
A stated goal of HS2 Ltd, the company responsible for developing the UK's new high-speed rail network, is to achieve a 50 percent reduction in carbon emissions compared to traditional construction methods. As such, the decision to employ low-carbon concrete in the construction of Euston Station was an easy one.

In September 2022, John F Hunt, working for HS2's station Construction Partner, Mace Dragados (MD) joint venture, placed 8,200 cubic feet of Earth Friendly Concrete (EFC)—the largest single placement of this product in the UK to date. The EFC, supplied by Capital Concrete, was used for a temporary foundation slab that will support polymer silos used for future piling works at the north end of the Euston Station site.

First developed by Australian construction materials company Wagners, EFC is a cement-free concrete incorporating fly ash and ground granulated blast furnace slag that lowers the embodied carbon by 75 to 87 percent compared to standard concrete mixes. The concrete placement for the foundation used a mix of 25 percent fly ash and incorporated approximately 22 metric tons of fly ash (to date, an additional 18 metric tons have been used in other applications in the station's construction).

Capital Concrete supplied the materials for the foundation, importing the fly ash by ship from Spain. The company estimates that use of the EFC in the foundation reduced the embodied carbon by over 76 metric tons. In addition to the environmental considerations, the cement-free concrete was specified for its performance characteristics, which include its low heat generation for deep sections, low shrinkage, resistance to cracking, high durability, and increased tensile strength—the latter of which enabled thinner slab designs and thus a reduction in the volume of both concrete and reinforcement used.

Elsewhere on the Euston site, HS2 and MD have adopted a number of measures designed to reduce the environmental impact of construction, including the use of liquefied petroleum gas generators as a direct replacement for diesel generators and employing a new piling method that will provide heating for buildings above.

Photo courtesy of HS2

Photo: Experience Grand Rapids

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Beneficial Use Case Study

Fort Mandan Visitor Center

Coal Combustion Product Type
Fly Ash, Bottom Ash, Flue Gas Desulfurization Material

Project Name
Fort Mandan Visitor Center

Project Location
Washburn, North Dakota

Project Participants
Great River Energy, ISG Resources, Headwaters Resources (now part of Eco Material Technologies), Lloyd E. Platt and Associates, Rolac Contracting

Project Completion Date
2002

Project Summary
When Lewis and Clark began their historic expedition over two centuries ago, President Thomas Jefferson specifically instructed them to seek out "...mineral productions of every kind, but more particularly metals, limestone, pit coal..." In North Dakota, they found abundant lignite coal. In the lead-up to the expedition's 200-year anniversary, the North Dakota Lewis and Clark Bicentennial Foundation created at Fort Mandan—where the pair spent the winter of 1804-05—a facility that stands as a showcase for the coal combustion products that would become an important part of the regional economy.

Project Description
The Fort Mandan Visitor Center was built to accommodate the thousands of people anticipated to visit during the bicentennial anniversary of the expedition. Conveniently, the fort lies only a few miles from Great River Energy's Coal Creek Power Station, which worked with ISG and Headwaters Resources (now part of Eco Material Technologies) to provide materials and leadership for the project.

Fly ash, bottom ash, and flue gas desulfurization (FGD) material were all used in the construction of the visitor center and surrounding grounds to ensure adherence to sustainable building standards. Specifically, the complex incorporates the following coal combustion products:

- **Exterior Walls**—constructed from FlexCrete aerated concrete, which comprises nearly 70 percent fly ash by volume. FlexCrete is filled with tiny air bubbles that provide outstanding sound and thermal insulation.
- **Interior Walls**—covered with MagnaWall stucco. Fly ash replaces more than 50 percent of the cement that is typically used in stucco to improve both the durability and workability of the product.
- **Flooring, Sidewalks, Driveway, and Parking Lot**—made from fly ash concrete with a sub-base of bottom ash.
- **Walls and Ceilings**—manufactured from FGD gypsum, a byproduct of coal power plant emissions control equipment.
- **Shingles, Cultured Stone, Ceiling Tiles, Carpeting, and Fireplace**—that all contain fly ash.

- **Walking Trails**—throughout the Fort and Visitor Center area constructed with a soil cement mixture containing 50 percent fly ash.

The unique construction of the Fort Mandan visitor services center provides guests an opportunity to learn how modern technology is allowing for novel ways of utilizing coal combustion products to create useful building materials. Visitors gain an appreciation for natural resources, recycling, coal mines, power plants, their by-products, and their collective contribution to the American way of life—as well as learning about Native American life and customs and Lewis & Clark's own experience at Fort Mandan.

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Be Safe in the Water This Summer

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.

An average of 10 people die each day in the United States from accidental drowning. While drowning deaths peak among one- and two-year-olds, drownings continue to be the second-leading cause of preventable death through age 15. Take effective action to keep yourself, your family, and friends from the potential hazards associated with water.

Pools and Spas

- If you own a pool or spa, secure it with appropriate barriers to prevent unsupervised access to the water.
- Ensure every member of your family learns to swim so they achieve the skills of water competency.
- Do not rely on the use of water wings, swim rings, inflatable toys, or other items designed for water recreation to replace adult supervision over children.
- Don't let children play around drains and suction fittings.
- If a child is missing, check the water first. Seconds count in preventing death or disability.
- Keep on-hand appropriate equipment, such as reaching or throwing equipment, a cell phone, life jackets, and a first-aid kit.
- Learn cardiopulmonary resuscitation (CPR), which can make the difference in saving someone's life.

Beaches, Lakes, Rivers, and Ponds

- Be aware of weather and water conditions in advance of swimming and heed warnings.
- Swim sober and always with a buddy.
- Always enter unknown or shallow water feet first.
- In coastal areas, know the tides in advance so rising water doesn't trap you.
- At the beach, stay at least 100 feet away from piers and jetties, where permanent rip currents can exist.
- If you are caught in a rip current, stay calm and swim parallel to the shore until you are out of the current.
- Leave the water immediately if you see lightning or hear thunder; stay in a safe, enclosed area for at least 30 minutes after the last thunderclap.

Boating and Personal Watercraft

- Before going out on a boat, let somebody on land know your "float plan," including a description of the vessel, number of persons aboard, the route to be taken, and destination.
- When boating or using personal watercraft such as a jet ski, ensure that you and all other passengers are wearing a Coast Guard-approved life jacket.
- Watch out for currents, waves, and underwater obstructions.
- Be mindful of other people's activities in the same waters, such as boating and swimming.

These materials were adapted from the American Red Cross and the National Safety Council.

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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 **Bill Petruzzi**, Senior Consultant at Verdantas, who is an elected representative to the American Coal Ash Association Board of Directors. Bill's expertise is in material/waste strategic initiatives, including characterization, permitting, beneficial use, compliance, and the rulemaking process. Bill is a member of the ASTM E50.03 Subcommittee, which developed the standard for harvesting of CCP material from storage units, and is continuing as the lead author for the new ASTM standard on characterization of CCP from storage units for beneficial use.

Q. How important are consensus standards to the beneficial use of coal combustion products?

A. Exceptionally important. The coal-fired energy market is changing, resulting in the production of less coal combustion products (CCP) while our appetite for CCP for use in construction and other products is increasing. Utilities continue to work with CCP brokers and end users to divert available CCP as it is produced directly into the marketplace, but market needs cannot be met in some areas. This directly available material shortage is prompting utilities, ash brokers, and other end users to consider implementing CCP harvesting activities at operating and closed storage units (i.e., impoundments and/or landfills) for beneficial use applications.

CCP contained in storage units is recognized as an asset, and harvesting and beneficial use of CCP is a sustainable practice that needs to be promoted. The practice of harvesting and beneficially using CCP from storage units is relatively new, and the driver is primarily to harvest CCP for construction materials and other product feedstock. An additional driver for harvesting may be to achieve closure goals, environmental compliance, and/or (re)development opportunities. This is especially the case where there is limited guidance that directly addresses protocols for CCP harvesting and beneficial use.

Establishing consensus standards is essential for widespread, consistent, and socially acceptable CCP reuse. Consensus standards are a framework of guidelines in which multiple stakeholders work together to achieve consensus on a standard for use. Consensus may at times be challenging to achieve due to differing perspectives and preferences but, when there is a need and stakeholder interest, working together can yield a standard inclusive of stakeholder positions. For stakeholders, it is important to have a consensus standard that may also support or complement successful programs that may already be in place or serve as a foundation for future guidance or rule development. This consensus is not only important to stakeholders, but it provides a united front to others who may negatively perceive the concept of CCP harvesting and beneficial use without guidance.

The need for a standard related to the harvesting and beneficial use of CCP was principally identified some years ago as availability of new CCP declined and limited guidance was available on how to approach CCP harvesting and characterization studies. Stakeholders from ACAA and other interested parties charted a path to work within the ASTM organization's E50.03 Beneficial Use Subcommittee, as we have with other CCP-related standards. The goal was to build a consensus on standards to establish a framework for the responsible harvesting and effective characterization for the beneficial use of CCP. Our work within the ASTM E50.03 Subcommittee yielded two consensus standards:

1. ASTM #3183-19 Standard Guide for **Harvesting** Coal Combustion Products Stored in Active and Inactive Storage Units for Beneficial Use.

2. ASTM WK75560 Standard for **Characterization** of Coal Combustion Products in Storage Areas for Beneficial Use *(pending approval)*.

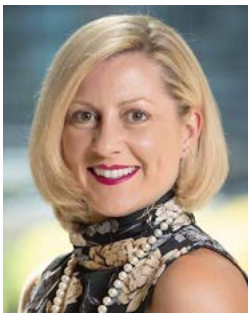
Significant stakeholder interest and participation in the drafting of these consensus standards resulted in their being fast tracked to ballot, with the harvesting standard passing on its first ballot and the characterization standard advancing rapidly.

Photo courtesy of Eco Material Technologies

As with any ASTM standard, a consensus among stakeholders is needed to achieve approval of any ballot; one negative "persuasive" vote or "valid" comment may cause a ballot fail. Therefore, the Subcommittee opens the working group to any interested party or stakeholder to present and vet the rationale and scope for any new standard so that all perspectives can be considered. With respect to the CCP harvesting and characterization standards, Subcommittee participants established some key items that needed to be integrated into the standards. Examples include that the standard must be voluntary, robust, flexible, adaptive, and non-prescriptive, and consider sound engineering, scientific, and economic principles. The Subcommittee was able to achieve integration of these key items into the standards, but only after discussing an issue's merit and alignment with the Subcommittee's goals or by addressing concerns identified in early drafts and/or failed ballots.

Key issues that were vetted included the environmental professional's role; the alignment of definitions between ASTM standards; items to include in CCP storage unit reclamation planning, design, and implementation; protocols for establishment of contingencies if harvesting activities cease early; focus on characterization of raw CCP without setting prescriptive performance standards for post-processed harvested CCP; and many others. Consensus on these items was achieved, but only after each representative was afforded an opportunity to share their preferences and perspectives. The Subcommittee achieved consensus over time and gained valuable, and sometimes alternative, perspectives from persons not working within the ASTM E50.03 Subcommittee or even in the CCP marketplace during the balloting process. This engagement from various interested parties allowed for the development of workable and fully developed consensus standards.

Now that these consensus standards are available, they may be used as a guide by a variety of stakeholders including rule makers, regulatory agencies, utilities, specific industries or end users, consultants, and/or other interested parties. While use of the standards is voluntary, the significant involvement by stakeholders as part of ASTM's consensus-based approach in adopting standards will yield flexible practices for parties interested in the harvesting and beneficial use of CCP into the future.



6 Questions for Laura O'Neill Kaumo

Editor's Note: "6 Questions" 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.

As the President and CEO of the American Concrete Pavement Association, Laura O'Neill Kaumo is responsible for strategic planning and implementation of all projects approved by the Board of Directors; managing the day-to-day activities of the professional and administrative staff; and ensuring effective administrative and operational management of the Association. In addition, overall planning, organization, development, supervision, direction, coordination of the ongoing operations of the organization, and budget management fall under her leadership. Laura holds a bachelor of science degree from Eastern Michigan University, a Juris Doctorate from the University of Miami School of Law, and is admitted to the Massachusetts Bar.

ASH at Work (AW): In July 2021, you were named President and CEO of the American Concrete Pavement Association (ACPA), succeeding Gerald Voigt, who held that post for 33 years. What attracted you to the ACPA?

Laura O'Neill Kaumo (LOK): The concrete pavement industry has a really good story to tell. ACPA's mission is to develop and protect concrete pavement markets through education, advocacy, marketing, and industry technical leadership. ACPA's vision is for concrete to be the pavement material of choice, benefitting communities and society within U.S. state and local economies. The ACPA federation is filled with passionate individuals who are ready to promote concrete pavement, and that was really inspiring for me. The Association has a lot of room to grow, and I was excited to be able to take the helm and help grow our brand.

AW: How does the ACPA lead the advocacy for the concrete paving industry? Are there local chapters? Is it a top-down process?

LOK: ACPA has chapters and partners at the state level that help lead the advocacy for pavement in 20 regions that serve 27 states. In addition to our Chapters and affiliates having active advocacy in state DOTs, ACPA National also pursues advocacy efforts at the federal level. Working together with industry partners, ACPA has deep connections with the DOT, including the Federal Highway Administration, the Federal Aviation Administration, and the Tri-Services. Our staff serve on task forces and attend meetings, which influences new policies and specifications.

AW: You have extensive experience on Capitol Hill working with Congress. The 118th Congress has been at work for about four months now. Are you hopeful there will be real progress on the transportation agenda?

LOK: I am. As we move into the second full year of this historic infrastructure funding, I think we will absolutely start to see progress on the transportation agenda. As the funding continues to go to the states and DOT for initiatives, I think we will begin to see progress on many major projects throughout the country. Many of our Chapter/State Executives are beginning to see the money flow in for this paving cycle and to see increases in 2024 and beyond. We just need to be mindful of the inflationary impacts on projects and ensure that money is making its way to paving.

AW: Like many industries, the cement and concrete industry is working to reduce its footprint. What are some of the initiatives of the ACPA to decarbonize?

LOK: ACPA released its White Paper on Sustainability earlier this year, *Concrete Pavement's Role in a Sustainable, Resilient Future*, which synthesizes research on concrete pavement's contributions to economic, environmental, and social sustainability. As part of the organization's role educating decision-makers who are involved in the placement and rehabilitation of roadway, highway, and airfield pavements, the ACPA is providing the white paper to assist those decision-makers, as they are challenged to meet ever-increasing levels of sustainability. It also addresses sustainability's relationship to resilience. Because a system cannot be sustainable if it is not also resilient, pavements should be designed with a life-cycle approach that contemplates pavement's entire life span. Designing with life cycle in mind can help ensure pavements enhance all three categories of sustainability: economic, environmental, and social. Concrete is a material well-positioned to address the planet's climate change considerations. Because millions of miles of pavements across the globe are placed or rehabilitated every year, the role of

concrete pavement in sustainability cannot be overstated. With the white paper's release, the ACPA provides valuable guidance for road owners and other decision-makers as they weigh the many considerations involved in delivering sustainable infrastructure.

AW: Tell me more about the white paper.

LOK: The report summarizes concrete pavement's role in sustainability, including:

1. The long life span of concrete pavement, which provides the greatest economic value over the long term for taxpayers and end users. Concrete can last 30 years or more before requiring a maintenance cycle.

2. Research supporting concrete pavement's many use-phase environmental and societal benefits, including improved fuel efficiency, high albedo (which improves the earth's energy balance and urban heat island effect, both of which lead to cooling impacts and CO2 reduction), and CO2 absorption.

3. Examination of how the concrete pavement industry and others across the concrete value chain are working together to implement the PCA's *Roadmap to Carbon Neutrality*, with a goal of achieving net zero carbon emissions by 2050. (Examples include reducing cement's carbon footprint using blended cements and reducing concrete's carbon footprint using performance-engineered mixtures.)

4. The importance of life-cycle thinking in addressing social sustainability, particularly concrete pavement's long life (which not only provides a smooth, safe roadway for the traveling public, but reduces the hazards associated with work zones throughout the life of the pavement); its ability to withstand, respond to, and recover rapidly after a disruptive event; and good performance with minimal traffic disruption due to maintenance.

AW: When you are not working on ACPA programs or on Capitol Hill, what kinds of activities do you enjoy away from the office?

LOK: I enjoy running, weightlifting, cooking, and watching baseball. Few things make me happier than being out at a baseball game in D.C. on a sunny summer day. I also enjoy travel, but I am on the road so much now that time at home with my husband and dog makes me very content—if we're watching baseball, of course.

AW: Thank you.

ASH Allies: The Natural Pozzolan Association

The Natural Pozzolan Association (NPA) was founded in 2017 as a producer's association to represent and promote the combined interests of natural pozzolan manufacturers as they pertain to product awareness, performance, availability, and competitiveness in concrete and cement markets worldwide, as well as to improve the quality and market presence of natural pozzolans on a continuous basis. One of our most important goals is to establish natural pozzolan as a key ingredient in concrete that is industry accepted and approved by all pertinent regulatory agencies.

Natural pozzolan producers in North America have, in just the last decade, invested heavily in the development of pozzolanic deposits and processing facilities to produce pozzolanic materials that are compliant with ASTM C618 and AASHTO M295. Natural pozzolan production capacity, in the last decade, has increased from less than 200,000 tons per year to approximately 1,500,000 tons per year. An additional 500,000 tons of capacity is currently under development. Significantly more capacity is under consideration as known natural pozzolan deposits are being tested for the appropriate properties to be commercialized. This rapid growth in the production and availability of natural pozzolans is the result of dwindling supplies of artificial pozzolans, specifically fresh fly ash.

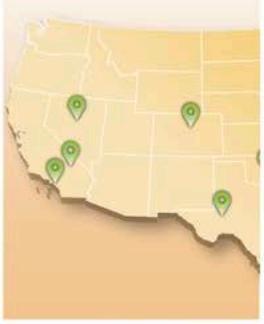
Historically speaking, natural pozzolans were used extensively by the Romans, e.g., the Pantheon, the Colosseum, aqueducts, etc. These 2,000-year-old concrete monuments are still in remarkable condition after two millennia of wear and tear. The technology of pozzolans was lost after the fall of the empire and was only rediscovered (largely) in the last 100 years or so. Most of the well-known dams constructed in the western United States (Hoover Dam, for example) incorporated natural pozzolans into the concrete mix design. The key property the engineers were looking for was reduced heat of hydration to protect the mass concrete from thermal cracking. What they also achieved, almost incidentally, was vastly improved durability by way of the pozzolans' ability to protect the concrete from alkali-silica reactions and alkali-sulfate reactions. Pozzolans also improve concrete's durability by significantly lowering its permeability—in other words, reducing or refining the pore structure.

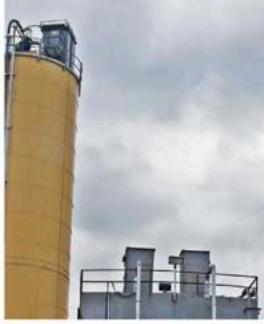
Natural pozzolans were produced in the U.S. from the early 1900s through the 1970s mostly for purposes of large concrete infrastructure. However, with the advent of coal-fueled power production—and the attendant flue gas controls—a new artificial pozzolan became popular due to its widespread availability and lower cost. These materials, known as coal combustion residuals, or more specifically fly ash, quickly captured the pozzolan market and natural pozzolan production plummeted. Only in the last two decades have natural pozzolans made a comeback, with the growth curve particularly steep in the last five to seven years.

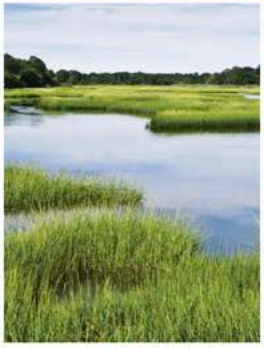
The employment of natural pozzolans in concrete has recently evolved from massive structures such as Rome's Colosseum and the Glen Canyon Dam to all concrete applications—airport runways, wind farm foundations, roads, bridges, homes, slabs, etc. In light of the diminishing supply of fresh fly ash, several companies are now blending fly ash with natural pozzolans to extend supply within traditional fly ash distribution networks, as well as remediating otherwise unusable fly ash—converting it to a fly ash/natural pozzolan blend that meets and exceeds all relevant fly ash or natural pozzolan standards and specifications. The production of these blended materials is also growing at a rapid pace, with Caltrans (the California Department of Transportation) the latest major state agency to approve blended and remediated pozzolanic materials.

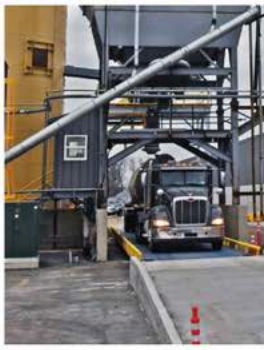
Natural pozzolans, whether alone or blended with fly ash, enhance the durability and long-term strength of concrete, making them a must for a sustainable future that requires greatly extended built life for major infrastructure projects. Perhaps even more importantly, natural pozzolans can massively reduce the carbon footprint of concrete by anywhere from 20 to 50 percent, depending on mix design and application. In a world in need of a much more durable built environment and a significantly lowered carbon footprint, natural pozzolans have come back just in time…what was old is new again!

For more information about the NPA and natural pozzolans, please visit pozzolan.org.









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Eco Material Technologies:
Decarbonizing the Materials Industry

Editor's note: In the first of an ongoing series, ASH at Work is highlighting ACAA member companies and the valuable products and services they provide.

Eco Material Technologies was formed in February 2022 via the merger of Green Cement Inc. and Boral Resources—both companies with a strong tradition of providing sustainable cement alternatives to the concrete manufacturing market. Today Eco Material is the nation's leading zero and near-zero-carbon supplementary cementitious materials provider, serving over 4,000 unique customer locations from its 100+ sites across 45 U.S. states.

Eco Material recognizes the critical point at which the concrete construction sector stands today. An estimated 8 percent of man-made carbon emissions originate from the manufacture of portland cement—the principal binder in concrete manufacturing. Given the expected growth in concrete construction in the coming decades, cement emission levels are unsustainable if we are to avoid the worst effects of climate change.

Eco Material has made its mission to decarbonize the materials industry through scalable and proven technological solutions. Our products currently displace 5 percent of the U.S. cement production of approximately 120 million tons per year. Working with manufacturers to further adopt our materials and technologies, we expect to expand our North American leadership position in zero and near-zero-carbon concrete products by doubling the volumes sold into this market by 2030.

Eco Material is pursuing displacement of cement in U.S. concrete manufacturing utilizing diverse materials and strategies, including:

- *Fresh Fly Ash and Bottom Ash*—of which 35 million tons are available annually in the U.S.

- *Landfill Harvesting*—The U.S. holds approximately two billion tons of landfilled ash. Eco Material is already harvesting 100,000 tons annually from its Pennsylvania facility and plans to ramp up production there to close to 500,000 tons per year. In January 2023, bottom ash harvesting and grinding commenced in Texas that is expected to produce 600,000 tons annually when the full commercial operations ramp is complete. Construction of harvesting infrastructure is already underway in Georgia, which could eventually add up to 1.2 million tons of production annually.

- *Natural Pozzolan Processing*—Operations continue to ramp up at our Arizona natural pozzolan operation. Once it is running at full capacity, we expect to process up to 500,000 tons annually of this high-quality material for delivery to concrete markets in the southwest U.S.

- *Manufactured Product*—Eco Material's Pozzoslag® and PozzoCEM® cements can replace a significant portion of the portland cement required to make high-strength, durable concrete. Since they are manufactured at room temperature with virtually no emissions, both are near-zero-carbon cements.

Eco Material also provides mission-critical utility services, including operations support, waste disposal, and environmental remediation. The largest coal combustion product management contractor in the United States, Eco Material's Plant Services division has over 30 years' experience and has provided services at over 100 utility sites, handling all types of CCPs as well as coal and limestone.

To learn more, please visit www.ecomaterial.com.

ECOMATERIAL TECHNOLOGIES

Concrete Solutions for the Concrete Industry

On the road to carbon neutrality, there is no single silver bullet.

Eco Material Technologies provides multiple silver bullets with our range of products and technologies to lower the carbon footprint of concrete while simultaneously improving its performance. Solutions include:

- The nation's largest supply of coal fly ash for concrete, with a coast to coast logistics network, extensive in-house laboratory capabilities, and the industry's deepest bench of fly ash experts.
- Pozzoslag® products useful in replacing high volumes of carbon-intensive portland cement.
- Kirkland Natural Pozzolan, bringing new supplementary cementitious materials supplies to markets challenged by coal plant closures.
- Micron3® refined pozzolan for high performance concrete applications.
- A full suite of beneficiation technologies enabling utilization of lower quality coal ashes and harvesting of previously disposed coal ashes.

Eco Material Technologies is the leading producer and supplier of sustainable cement alternatives in North America.

www.ecomaterial.com

Salt River Materials Group:
50 Years of Fly Ash Recycling

Editor's note: In the first of an ongoing series, ASH at Work is highlighting ACAA member companies and the valuable products and services they provide.

Salt River Materials Group (SRMG) is the commercial trade name for the marketing activities of Phoenix Cement Company and Salt River Sand and Rock Company. Headquartered at the Salt River Pima-Maricopa Indian Community's Chaparral Business Park near Scottsdale, Arizona, SRMG is the only Native American-owned producer of portland cement in the U.S. It is also a major manufacturer and marketer of sand and gravel, recycled coal combustion products, and pozzolans throughout Arizona and the southwestern United States. With 400+ employees, SRMG operates a cement plant in Clarkdale, Arizona, seven aggregate facilities in metro Phoenix, six fly ash sources in three states, and handles sales and distribution of materials in eight states.

This year, SRMG is celebrating 50 years of recycling and sustainability in the fly ash industry. Originally founded as Phoenix Cement Company (PCC) in 1959, the company began selling fly ash in 1973 and has since become one of the largest suppliers of fly ash in Arizona and the southwestern U.S.

A pioneer in the cement industry, PCC had the vision to add value by obtaining a fly ash marketing contract with a utility partner. In 1973, PCC entered into its first fly ash contract with Arizona Public Service at the Cholla Power Plant in Joseph City, Arizona. PCC brought the Cholla fly ash to its Clarkdale Cement Plant and blended it with Phoenix Cement® Type I/II/V(LA) portland cement, producing a Phoenix Cement® Portland Pozzolan Type IP cement meeting ASTM C595 specifications. This offered a convenient product for ready-mix concrete producers with limited silo space. Phoenix Cement® Portland Pozzolan Type IP continues to be a top seller in SRMG's extensive line of products. In the 50 years of PCC's contract with Cholla, PCC has processed, removed, and recycled 7 million tons of fly ash—reducing carbon impacts, beneficially using the fly ash in concrete, and avoiding the need to landfill.

The Cholla beneficiation facility in Joseph City, Arizona.

Throughout its history, SRMG has identified non-utilized fly ash sources with quality issues and invested in and implemented technologies to process non-specification fly ash into sellable products that meet ASTM standards. SRMG has continuously adapted to the changing coal power industry with additional technology and approaches including blending, natural pozzolans, harvesting, carbon removal, and partnering with utilities to achieve mutual benefits. Over five decades, SRMG has successfully recycled 21 million tons of fly ash into beneficial use in concrete.

SRMG's commitment to sustainability and innovative approaches to transform waste into valuable resources has not only reduced environmental impact, but has also contributed to the growth and prosperity of the construction industry. At a time when coal-burning power plant units are being retired, reducing fly ash availability, SRMG is focused on innovation. SRMG is a reputable and dependable major fly ash marketer that can be trusted to deliver for years to come.

SRMG IS CELEBRATING 50 YEARS OF RECYCLING & SUSTAINABILITY

In 1973, SRMG entered into its first fly ash contract at the Cholla Power Plant in Joseph City, Arizona. SRMG has since become one of the largest suppliers of fly ash and fly ash/pozzolan blends in the Southwestern U.S.

SRMG has recycled

42,000,000,000

pounds of fly ash to date

(and that number continues to grow every day!)

SRMG
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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. In this edition, we delve into the annals of the C2P2 program—a cooperative effort between the ACAA, EPA, USWAG, and DOE to promote the beneficial use of CCPs and the environmental benefits that result from their use—for a 2007 case study on the use of fly ash in a full-depth reclamation project.

By the early 2000s, many of the asphalt roadways in the United States were in poor condition and in need of repair or replacement. With this in mind, Ohio State University researchers partnered with two counties to pulverize and recycle a full-depth section of failing pavement using Class F fly ash as a cementing agent to build a new stabilized base course.

Case Study
18

Rehabilitating Asphalt Highways:
Coal Fly Ash Used on Ohio Full Depth Reclamation Projects

December
2007

Rehabilitating Asphalt Highways:
Coal Fly Ash Used on Ohio Full Depth Reclamation Projects

Much of the almost two million miles of asphalt roadways in the United States are severely distressed and in need of repair or replacement. Over the last few decades increasing traffic demands combined with decreasing funding for repairs, environmental concerns and an emphasis on safe, efficient transportation systems have stimulated research and field demonstration projects to explore methods to reuse and recycle pavement materials.

In response to this need, the Department of Civil and Environmental Engineering and Geodetic Science at Ohio State University (OSU) has partnered with the two fastest growing counties in Ohio (Delaware and Warren) to construct and monitor two pavement sections in which failing asphalt pavements were recycled in 2006 using Ohio coal-generated Class F fly ash as a cementing agent in a full depth reclamation (FDR) process.

"The value of this technology and demonstration project to the contractor is at a minimum two-fold," says Chris Anspaugh, construction manager, Base Construction. "With the price of cementitous additives continuing to rise in price due to the substantial energy costs involved in producing them it would be of value to the contractor, from a competitive standpoint, to have alternative products available that will achieve the same end results.

"Secondly, the contractor needs testing data available that can be submitted to the owner to assure them that the product will perform as we are claiming," he continues. "This research will go a long way in providing that information." This project will demonstrate that when non-concrete quality fly ash in combination with lime or lime kiln dust are properly incorporated into FDR reconstruction of a flexible pavement, the use of fly ash can be economically attractive while offering increased structural and service performance, and should not lead to a degradation of environmental quality.

On this FDR research preservation project, the complete depth of the flexible pavement section consisting of the asphalt layer, base, subbase and a pre-determined amount of the underlying existing subgrade soil were uniformly pulverized, blended with chemical additives (Class F fly ash in combination with lime or lime kiln dust), and compacted to construct a new stabilized base course.

An asphalt overlay was then placed over the stabilized base. Class F fly ash in itself is not self-cementing. It needs additional lime to undergo a cementitous reaction. It's important to note that fly ash, when used in combination with lime or lime kiln dust, performs two important functions in FDR work:

1. Fly ash provides the silica and alumina needed for cementitous reaction with lime to increase the strength, stiffness, and durability of the stabilized base layer
2. Fly ash acts as a mineral filler to fill the voids in the granular pulverized pavement mix, reducing the permeability of the FDR stabilized base layer.

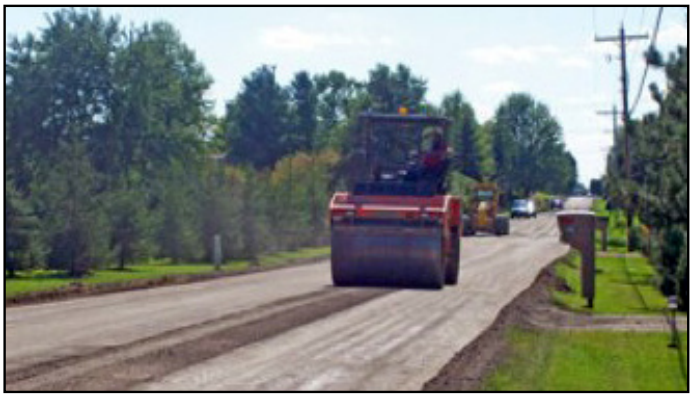
Material before mixing (left) and after mixing (right). Note the fly ash on the left side.

Case Study
18

Construction Projects

Delaware County (just north of Columbus) is the fastest growing county in Ohio. In collaboration with the Delaware County Engineer's Office, Section Line Road between State Route 42 and Home Road was selected for FDR reconstruction in 2006.

The pavement sampling and design was carried out by EDP Consultants under the supervision of OSU. A total of nine sections were constructed using the following six mixes:



Compaction of the FDR base layer in Delaware County

- 4 percent lime with 6 percent fly ash, 8-inch stabilization depth (0.7 mile)
- 5 percent lime kiln dust with 5 percent fly ash, 8-inch stabilization depth (0.6 mile)
- 3 percent lime kiln dust with 1.4 gallons per square yard emulsion, 8-inch stabilization depth (0.7 mile)
- 5 percent cement, 12-inch stabilization depth (0.8 mile)
- 2 percent cement with 1.6 gallons per square yard emulsion, 8-inch stabilization depth (0.3 mile)
- 5-inch mill and fill (two 0.1-mile sections at the north and south ends of the project, and a 0.7-mile as well as 0.1-mile sections near the middle of the project).

The FDR rehabilitation of the Section Line Road was completed in five phases. Milling removed 5 inches of the existing pavement asphalt surface, followed by pre-pulverization of the remaining pavement materials to specified depths. The third phase involved treating the pulverized pavement materials with the six admixtures outlined above. Water was then added to the mix and it was compacted immediately. The last phase involved resurfacing the pavement with 5 inches of hot mix asphalt.

In Warren County, just South of Cincinnati, failing pavement was sampled and an appropriate mix design was carried out by EDP Consultants again under the supervision of OSU. Two sections were constructed as follows:

Asphalt placed over treated pavement base materials

- 4 percent lime with 6 percent fly ash, 12-inch stabilization depth (0.32 mile)
- 5 inch mill and fill (0.08 mile)

The five-phase FDR rehabilitation included milling and removal of 4 inches of the existing pavement asphalt surface. Secondly the remaining pavement materials were pre-pulverized to a depth of 12 inches. The third phase involved treating the pulverized pavement materials with lime at an application rate of 4 percent and allowing the material to mellow for a 24-hour period.

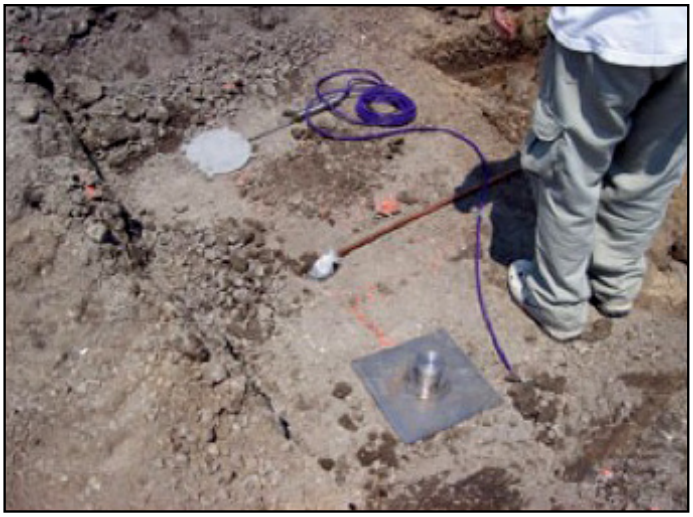
After the mellow period, 6 percent fly ash from Zimmer power plant of Duke Energy was blended into the mix to a depth of 12 inches. Water was added to the mix and it was compacted immediately. The last phase involved resurfacing the pavement with 4 inches of hot mix asphalt.

Pavement instrumentation and monitoring

During construction, the Delaware and Warren pavement sections were fitted with the following structural and environmental monitoring devices:

- Strain gauges at bottom of asphalt layer
- Pressure cells at bottom of stabilized base layer
- Pore pressure devices at bottom of stabilized base layer
- Linear Variable Displacement Transducers (LVDT) for measuring vertical deflections of pavement
- Lysimeters installed within the stabilized base to monitor leachate quality.

Data collection from the above monitoring devices is being carried out on a quarterly basis.



The OSU pavement instrumentation is installed at the bottom of the FDR layer (left to right) — pressure cell, pore pressure device and LVDT base — in Delaware County.

Falling Weight Deflectometer (FWD) tests (to measure pavement load deflection behavior, resilient modulus of pavement layers and subgrade soil, and base structural layer coefficient) are being carried out by the Ohio Department of Transportation. The FWD tests carried out on the pavement before and immediately after completion of rehabilitation show that FDR of the pavements with fly ash (and lime or lime kiln dust) increased the elastic modulus of the base layer. The fly ash sections exhibited elastic moduli of base layers similar to cement and cement plus emulsion sections. FWD tests will continue to be carried out twice a year to determine the longer term elastic moduli of the various sections constructed in this project.

Objective and Goals

The overall objective of this work is to demonstrate the effective use of Class F fly ash in combination with lime or lime kiln dust in the FDR of asphalt pavements. This is done by establishing field-verified relationships for the service performance and structural and environmental behavior of FDR pavements constructed using lime-activated fly ash.

There are four interrelated activities. In the first, laboratory studies specifically designed to investigate the physical, chemical, and engineering properties of fly ash FDR mixes were conducted. This allowed the research team to determine the optimal material mixes that were implemented in the two pavement preservation projects. In the second activity, the two highway pavements that were constructed and instrumented in 2006 will be monitored for two years. This is to obtain robust field results on the structural, service, and environmental performance of field-constructed FDR bases. In the third activity, existing flexible

pavements constructed in Ohio using FDR will be investigated to allow for evaluation of the performance of existing projects for which no performance data has been collected to date. Lastly, the existing outreach and technology transfer efforts of the Coal Combustion Products (CCP) Extension Program at OSU will be focused on county, state, and federal transportation officials and other end users of the technology.

"Class F Fly ash can be a valuable cementing ingredient when used with lime, which was first recognized by the Roman Civilization 2000 years ago and proven with time since then. The lime industry believes in the important opportunity in road construction to promote the synergisticism and pozzolanic reaction of lime and coal fly ash" said Joel Beeghly, Senior Technical Specialist with Carmeuse Lime Company.

Environmental Benefits

In addition, to demonstrating the technology itself, these projects address a very important environmental issue, says Professor William Wolfe of OSU's Department of Civil and Environmental Engineering and Geodetic Science. "Since the production of one ton of cement produces about one ton of carbon dioxide, which is then released into the atmosphere," he says, "the widespread replacement of cement with fly ash in roadway reconstruction will result in significant reductions in the generation of this greenhouse gas."

This three-year project at OSU, totaling over $2 million, is funded primarily by the Ohio Coal Development Office of the Ohio Air Quality Development Authority with additional support from the Delaware and Warren County Engineers Offices, Base Construction, Carmeuse NA, Mintek Resources, Fly Ash Direct, Headwater Resources, and others.

"Last year, two counties in Ohio used Ohio coal-generated fly ash in reclaiming failed asphalt pavements," says Mark Shanahan, executive director of the Ohio Air Quality Development Authority, which manages the Ohio Coal Development Office. "This resulted in more durable highway infrastructure and promoted the recycling of pavement materials and coal combustion byproducts, both of which would otherwise have been landfilled."

Greg Samios, project manager of EDP Consultants Inc. adds, "The unique opportunity of a comparative mix design study has enabled EDP Consultants to increase our knowledge and understanding of how different chemical additives may benefit the recycling industry."

Submitted By:

Tarunjit S. Butalia, Ph.D., P.E.
Research Scientist & Coal Combustion Products Coordinator
Department of Civil and Environmental Engineering and Geodetic Science
The Ohio State University
470 Hitchcock Hall, 2070 Neil Avenue, Columbus, Ohio 43210-1275
Tel: (614) 688-3408 (Work), Fax: (614) 292-3780
Email: butalia.1@osu.edu
CCPOhio Web Page: http://ccpohio.eng.ohio-state.edu

About the author: Dr. Tarunjit S. Butalia, P.E., is a research scientist and coal combustion products coordinator for the CCP Extension Program at the Department of Civil and Environmental Engineering and Geodetic Science at The Ohio State University.

This article (in an expanded form) appeared in the February 2007 issue of Asphalt Contractor and can be accessed from the following link http://www.forconstructionpros.com/print/Asphalt-Contractor/Features/Rehabilitating-Asphalt-Highways/2FCP4421:

ACAA 2023 Winter Meeting, Orlando, Florida

A baker's dozen turned out for the Women's Leadership Forum luncheon.

Outgoing ACAA Chair Steve Benza (HTH, LLC) hands the gavel over to incoming Chair John Halm (Duke Energy), who begins a two-year term in office.

Tiffany Duffy, Development & Partnerships Director at Carbon Upcycling, discusses "Enhanced CCP Beneficiation Utilizing CO2."

Bill Kane, Area Director, Eco Material Technologies, and wife Debbie head out to the links. The golf tournament benefitted the ACAA Educational Foundation.

EP Power Minerals

Sustainability has a new name.

What Is Your Coal Ash Industry Career?

An international company that is a leader in the recovery of power plant by-products is expanding its global businesses in the cementitious and sustainable construction materials industries.

Recruiting is under way for senior-level positions for the development of capital projects to recover legacy ash and natural pozzolan deposits for its global business expansion in Europe, Asia and the Americas, as well as to provide technical and strategic support to existing international operations and related businesses.

We are hiring senior-level executives in…

- Materials research and technology to manage all technical aspects of new projects from inception to commercialization with responsibilities that include: assessing material quality, evaluating beneficiation technologies, defining processes needed to determine the value of the deposits in addition to managing R&D initiatives, technical demonstration projects and developing IP.

- Capital project development with hands-on experience in industrial or mineral processing plant engineering design and construction. Responsibilities include the development of Capex and Opex estimates and managing EPC activities for new projects in the US, UK and the EU.

- Supply chain management for the flow of current and new materials within established and growth markets in Europe, Asia and the Americas. Responsibilities to cover the development of logistical infrastructure for new capital projects including sourcing and delivery of raw and finished products.

- Financial analysis and planning with other members of the project development team to translate technical, logistical and economic findings into a business plan with financial models and sensitivity analysis.

Other responsibilities for these new positions include designing and implementing strategic plans for multiple international business units and building a rewarding multi-national team culture.

Candidates for this international team must have relevant experience in coal combustion products and services. Candidates should have a solid business acumen and exemplary work ethic. Positions can be located in Europe or North America.

Interested candidates should reply to **info@MyCoalAshFuture.com.**

All inquiries will be kept strictly confidential.

Welcome, New ACAA Members!

DONROSS, LLC is a consultant to the heavy building materials industry based in Orlando, Florida. The company joins as an Associate Member.

Ground/Water Treatment & Technology, LLC has successfully treated more than 2 billion gallons of coal combustion residual site pond water, including bulk surface water and interstitial "pore" water. GWTT partners with clients and their engineering teams to address all aspects of the challenges posed by coal ash wastewater ponds. The company starts with source water characterization and treatability studies and then works through the design, installation, operation, and maintenance of customized treatment systems, including ongoing compliance testing and monitoring. They join as an Associate Member. For more information, please visit www.gwttllc.com.

Palmetto Wastewater Solutions, LLC is a full-service water/wastewater treatment and solids handling company. They develop and provide turnkey solutions based on process engineering and clients' site-specific needs. The company's solutions include capital equipment design and build, temporary treatment systems, and contract operations. They join as an Associate Member. For more information, please visit https://pwsllc.us.

Rainbow Energy Center, LLC is the owner of Coal Creek Station and an affiliate of Rainbow Energy Marketing Corporation, a wholesale power marketing and trading business. Headquartered in Bismarck, North Dakota, the company works to maximize efficient energy production and sound energy management to unlock the energy sector's full potential. They join as a Utility Member. For more information, please visit www.rainbowenergycenter.com.

Schnabel Engineering is a geotechnical engineering firm specializing in solid waste engineering, landfill design, ash pond closures, ash excavation plans, water treatment consulting, and dam engineering. Headquartered in Glen Allen, Virginia, the company maintains offices in 14 states and the District of Columbia. They join as an Associate Member. For more information, please visit www.schnabel-eng.com.

Slater Infrastructure Group is focused on growing within the CCP sector through ash pond wastewater treatment and dewatering, engineering design and compliance/permitting work, closure in place or closure by removal, excavation, geosynthetic liner supply, and beneficial use projects. They join as an Associate Member. For more information, please visit www.slaterinfrastructuregroup.com.

USA Materials is a manufacturer and supplier of aggregates using coal combustion products. The company is headquartered in the Richmond, Virginia area. They join as an Associate Member. For more information, please visit www.usamaterials.com.

Xylem is a leading global water technology company. They provide products and services that move, treat, analyze, and monitor water. The company has a global footprint and over 17,000 employees worldwide. They join as an Associate Member. For more information, please visit www.xylem.com.

News Roundup

ACAA Officer and Director Elections

American Coal Ash Association on January 31, 2023, conducted elections for three open Board of Directors positions and officer positions. Elected as directors for the 2023-2026 term were Hollis Walker, Southern Company (Utility seat); Danny Gray, Eco Material Technologies (Marketer seat); and William G. Petruzzi P.G., Verdantas (Associate seat). Officers elected for two-year terms were John Halm, Duke Energy, Chair; Glenn Amey, Charah Solutions, Vice Chair; and Tom Kierspe, The SEFA Group, Secretary/Treasurer. Following Glenn Amey's recent resignation from Charah Solutions and the ACAA Board, Tom Kierspe was elected to the position of Vice Chair to replace him.

EPA Completes Agricultural Gypsum Risk Evaluation

In an unexpected development, the U.S. Environmental Protection Agency on March 23, 2023, completed a "Beneficial Use Evaluation of Flue Gas Desulfurization (FGD) Gypsum in Agriculture"—concluding "that application of FGD gypsum to farm fields at the agriculturally appropriate rates considered in this evaluation can provide benefits while remaining protective of human health and the environment."

EPA's work on a risk evaluation of FGD gypsum in agriculture began around 2008 in cooperation with the U.S. Department of Agriculture's Agricultural Research Service under the Coal Combustion Products Partnership (C2P2) program. Progress stalled when EPA terminated the C2P2 program in 2010, despite repeated pleas over the years by the beneficial use community to complete the study. In the absence of EPA action, many states then moved forward with their own evaluations of the practice, which is now approved in more than 30 states.

Following termination of the C2P2 program, EPA developed a risk assessment methodology for "encapsulated" beneficial uses and applied that methodology to a 2014 validation of the safety of fly ash use in concrete and FGD gypsum use in wallboard manufacturing. (American Coal Ash Association also used the methodology in 2021 to validate fly ash use in controlled low-strength material, also known as flowable fill.) EPA's methodology was subsequently revised to cover all forms of beneficial use. In releasing the FGD in agriculture evaluation, EPA pointed out that this serves as an example for the use of the methodology on an "unencapsulated" beneficial use.

"EPA encourages the beneficial reuse of industrial non-hazardous secondary materials, including coal combustion residuals, provided it is done in a responsible and protective manner," EPA wrote in announcing the release of the evaluation. FGD gypsum, also commonly referred to as synthetic gypsum, is a byproduct of power plant emissions control devices and is used extensively in the manufacturing of wallboard. A rapidly growing use of synthetic gypsum is in agriculture, where its application to fields improves soil conditions for crops and prevents runoff of fertilizers and pesticides into waterways.

Photo courtesy of Eco Material Technologies.

Bottom Ash, Harvested Fly Ash Approved for ASTM C618

ASTM Committee C09 on Concrete and Concrete Aggregates, in a unanimous vote, has approved revision of ASTM C618, Standard Specification for Coal Ash and Raw or Calcined Natural Pozzolan for Use in Concrete, to include harvested coal ash and bottom ash. A major focus of effort by American Coal Ash Association members, the ACAA Technical Committee, and allies in the concrete industry, these revisions have been in development for more than four years.

C618 now specifically includes bottom ash and acknowledges that fly ash may come from a harvesting site rather than directly from the power plant. Changes included: 1) replacing the word "coal fly ash" with "coal ash"; 2) adding a maximum 10 percent retained on No. 100 sieve requirement to bottom ash and harvested fly ash; 3) adding definitions for coal combustion products, bottom ash, and harvested ash; 4) adding a materials and manufacture section stating that harvested ash and bottom ash require processing to meet C618; and 5) adding a requirement for disclosing the type of material being certified (harvested ash, bottom ash, etc.).

A key to building consensus for the changes was a "Literature Review on the Use of Harvested Coal Ash as a Supplementary Cementitious Material," developed by Dr. Doug Hooton, University of Toronto, and Dr. Michael Thomas, University of New Brunswick. The changes will allow expanded quantities of coal ash for use in concrete, helping to build more durable infrastructure and reduce the carbon footprint of concrete construction.

EPA Sued Over Denial of Cease-Receipts Deadline Extension

More industry lawsuits were filed February 16, 2023, against the U.S. Environmental Protection Agency over its implementation of coal ash disposal regulations. Four separate petitions were filed in the U.S. Court of Appeals for the District of Columbia Circuit challenging EPA's final decision to deny an extension of the "cease receipts" deadline for the General James M. Gavin Power Plant in Cheshire, Ohio. EPA has proposed, but not finalized, similar denials for other power plants.

In the new filings related to the final and proposed decisions, industry groups said they are moving to preserve their right to judicial review should the court conclude that it has jurisdiction to review EPA's decisions. But the industry groups indicated that they believe their suits should be heard in district courts, rather than the D.C. appeals court.

The new litigation is in addition to lawsuits filed by utilities in April 2022 challenging shifts in EPA coal ash disposal enforcement. Opening briefs filed on December 6, 2022, alleged that EPA unlawfully revised aspects of its regulation when it acted on utility requests for extensions of "cease receipts" deadlines for coal ash disposal units. The lawsuits claimed EPA's actions essentially changed the substance of the regulation without proper opportunities for public notice and comment.

EPA Coal Ash Rulemaking Timelines Slip

The U.S. Environmental Protection Agency updated its official schedule for pursuing coal ash rulemakings that remain open. In the much anticipated 2022 "Fall Unified Agenda" published on January 4, 2023, timelines for several key actions continued to slip and an issue important to beneficial use remained off the active radar.

Included within 151 regulatory actions on EPA's active list are the following coal ash-related matters:

- In EPA's Spring 2021 agenda, the Agency indicated it planned to finalize "implementation of closure" actions by July 2021. By Fall of 2021, the target completion date for that action had slipped to September 2022. The 2022 Spring Unified Agenda anticipated issuing a Final Rule in March 2023. The new 2022 Fall Unified Agenda shows Final Rule issuance slipping to August 2023.

The unified agenda does not provide insight on how the Agency intends to continue moving forward on utility requests for extensions of "cease receipts" deadlines and for alternative liner demonstrations. On January 11, 2022, the Agency marked as complete numerous utility applications that had been filed in 2020 and has since proposed decisions on a portion of those facilities. Those decisions attracted lawsuits from industry challenging EPA's approach.

- With regard to a court-mandated requirement to develop regulations for "legacy surface impoundments," EPA indicated in 2021 that it would propose a rule by November 2021 and finalize the rule by November 2022. The Agency's Spring 2022 agenda showed a Notice of Proposed Rulemaking in November 2022 and a Final Rule in November 2023. The new 2022 Fall Unified Agenda shows the Notice of Proposed Rulemaking slipping to June 2023 and the Final Rule issuance slipping to June 2024. The legacy sites rulemaking has also attracted litigation, this time by environmental groups seeking faster action and an expansion of the universe of sites subject to the regulation.
- With regard to a Congressionally mandated requirement 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, EPA indicated in 2021 that it would finalize the rule by January 2022. That schedule later slipped to October 2022. The new 2022 Fall Unified Agenda shows the Final Rule issuance slipping to July 2023.
- The 2022 Spring Unified Agenda also included a proposal to potentially strengthen Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category. EPA's plans to issue a Notice of Proposed Rulemaking in this matter have now slipped from November 2022 to January 2023. The new 2022 Fall Unified Agenda also shows EPA plans to issue a Direct Final Rule under the ELGs in January 2023 extending the date for existing coal-fueled power plants to submit a notice of planned participation for the permanent cessation of coal combustion.

Still notably absent from the active regulatory agenda is EPA's effort to revise its definition of coal ash beneficial use and regulatory treatment of "piles" staged for beneficial use. That issue remains in EPA's long-term actions list with a statement that the Agency is reviewing information obtained from public comments responding to a Notice of Data Availability "to determine the appropriate next steps." EPA is under a court mandate to address this issue, but the court imposed no deadline for EPA to act.

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 the American Coal Ash Association. Subsequently, EPA removed the issue from its regulatory agenda and indicated that it would essentially start over.

Membership Has its Privileges!

ACAA members share a common interest in fostering the use of CCPs as valuable products that enhance revenue, minimize disposal costs, reduce liability, and support environmental policies. Membership helps promote:

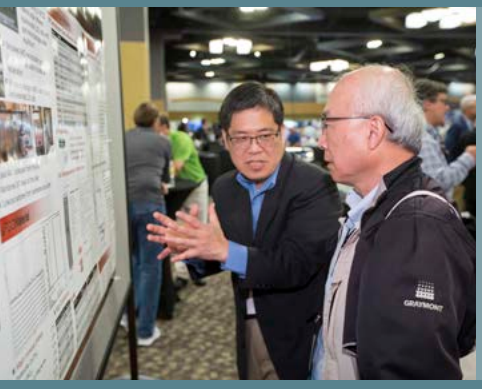
ACAA
AMERICAN COAL ASH ASSOCIATION

A Unified Industry Voice

- Promote CCPs as engineering and manufacturing materials that conserve natural resources
- Represent the CCP industry in national standards committees and industry groups
- Provide information to government, industry, and public sectors

Information Exchange and Networking

- Meet with specifiers, purchasers, and users of CCPs
- Develop consensus standards and guides for the use of CCPs
- Participate in trade shows, exhibitions, and the distribution of promotional and technical literature



Educational Opportunities and Professional Growth

- Take part in committee meetings and educational workshops
- Host international symposia and conferences on CCP management and use
- Participate in educational programs for CCP managers

Market Awareness and Development

- Coordinate the implementation of consensus standards for CCP use
- Advance technically sound, commercially competitive, and environmentally safe uses
- Remove technical, legal, and regulatory barriers to the use of CCPs

To learn more about becoming a member, visit the ACAA website or contact Alyssa.Barto@acaa-usa.org.

In addition to participating in two EPA stakeholder outreach sessions in summer 2020, ACAA filed voluminous comments on the Agency's original NODA deadline of February 22, 2021, including an 18-page summary and 11 appendices. Focusing on how coal ash beneficial use supports key Biden administration policy objectives for climate change and just transition, ACAA filed supplemental comments on the May 11, 2021, extended NODA deadline. As expected, environmental groups used the extended deadline to rebut comments made by ACAA and others on the original deadline. Environmental groups are also pushing Congress to enact a ban on all unencapsulated coal ash uses.

Copies of all ACAA comments are available on the Government Relations Committee tab of the ACAA members-only website.

EPA Proposes Denial of Alternative Liner Systems

The U.S. Environmental Protection Agency on January 25, 2023, proposed rejecting all six applications it received from utilities seeking to demonstrate that alternative liner systems used for coal ash disposal would achieve the environmental goals established by the Agency's coal combustion residuals regulations.

"With today's proposed denials, EPA is holding facilities accountable and protecting our precious water resources from harmful contamination, all while ensuring a reliable supply of electricity to our communities," said EPA Administrator Michael Regan. "We remain committed to working with our state partners to protect everyone, especially those in communities overburdened by pollution, from coal ash contamination now and into the future."

EPA's action is consistent with the Agency's recent shift toward not allowing closure in place of coal ash disposal units in contact with groundwater. That shift has attracted litigation by utilities that claim EPA has not followed required rulemaking procedures.

The affected facilities are Belle River Power Plant in China Township, Michigan; Coal Creek Station in Underwood, North Dakota; Conemaugh Generating Station in New Florence, Pennsylvania; Coronado Generating Station in St. Johns, Apache County, Arizona; Martin Lake Steam Electric Station in Tatum, Texas; and Monroe Power Plant in Monroe, Michigan.

EPA Administrator Michael Regan

EPA also continued advancing its agenda to increase regulatory pressure on coal-fueled power stations with a pair of actions affecting coal ash:

- On March 8, 2023, EPA proposed tougher wastewater discharge standards for coal-fueled power plants. The proposed revisions to Effluent Limitation Guidelines were touted as "an ambitious step toward protecting communities from harmful pollution." They included less onerous compliance paths for facilities that agree to cease operations by 2028 or 2032. Public comments will be due 60 days after the proposal is published in the *Federal Register*.

- Also on March 8, 2023, EPA submitted to the White House Office of Information and Regulatory Affairs its proposal for regulation of "Disposal of Coal Combustion Residuals From Electric Utilities; Legacy Surface Impoundments." OIRA review is the final stage of development for regulations prior to publishing a proposal for public comment.

The U.S. Environmental Protection Agency on January 12, 2023, sought public comment regarding whether coal combustion residuals regulation non-compliance should be added to the Agency's targeted list for National Enforcement and Compliance Initiatives. Comments will be accepted until March 13, 2023.

"EPA selects national initiatives every four years to focus resources on serious and widespread environmental problems where federal enforcement can make a difference," EPA's notice said. "EPA aims to align all existing and proposed NECIs with two overarching Strategic Plan goals: Goal 1: Tackle the Climate Crisis and Goal 2: Take Decisive Action to Advance Environmental Justice."

EPA is proposing to continue four of the six compliance initiatives now in place and is proposing to add two new initiatives related to climate change and PFAS contamination. Additionally, the Agency is seeking comment on two additional areas (lead exposure and CCR compliance) for "further consideration for possible development as NECIs. Both topics are significant enforcement priorities for the Agency, but resource constraints limit the number of NECIs that the Agency can pursue."

Regarding coal ash, EPA wrote: "The impact or harm to human health and environment from CCR noncompliance is significant and can occur through direct exposure to impoundment wastewater or consumption of contaminated drinking water. EPA seeks comment on the idea of a CCR-focused NECI to reduce noncompliance in this sector."

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- Nationwide operations to guarantee delivery where and when you need it

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Eco Material Technologies is your partner in a more sustainable future.

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