REVIEW OF NORTH DAKOTA REGULATIONS, STANDARDS, AND PRACTICES RELATED TO THE USE OF COAL COMBUSTION PRODUCTS

Final Report

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The EERC would also like to express its appreciation to the many individuals who participated voluntarily in the information-gathering process of the review. Those individuals are named in the participant list located in Appendix A of this report.

EERC DISCLAIMER

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LIST OF ACRONYMS AND ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
ASTSWMO	Association of State and Territorial Solid Waste Management Officials
AC	activated carbon
ACAA	American Coal Ash Association
AML	abandoned mine land
AMLD	Abandoned Mine Land Division
ASTM	American Society for Testing and Materials
AVS	Antelope Valley Station
C^2P^2	Coal Combustion Products Partnership
CAMR	Clean Air Mercury Rule
CARRC®	Coal Ash Resources Research Consortium®
CCP	coal combustion product
CCS	Coal Creek Station
DOE	U.S. Department of Energy
DOT	Department of Transportation
EERC	Energy & Environmental Research Center
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
FGD	flue gas desulfurization
GRE	Great River Energy
LEED®	Leadership in Energy and Environmental Design
LOI	loss-on-ignition
LOS	Leland Olds Station
MDU	Montana–Dakota Utilities Co.
MW	megawatt
NDDH	North Dakota Department of Health
NDDOT	North Dakota Department of Transportation
OTPC	Otter Tail Power Company
PSC	Public Service Commission
QA/QC	quality assurance/quality control
SDA	spray dryer absorber
SO_2	sulfur dioxide
SWOT	strengths, weaknesses, opportunities, threats
UND	University of North Dakota
USGBC	U.S. Green Building Council

REVIEW OF NORTH DAKOTA REGULATIONS, STANDARDS, AND PRACTICES RELATED TO THE USE OF COAL COMBUSTION PRODUCTS

EXECUTIVE SUMMARY

Over 54 million tons of coal combustion products (CCPs) are beneficially used in the United States each year, but over 70 million tons, or 57%, are still being disposed of in landfills or surface impoundments (American Coal Ash Association [ACAA], 2006). The U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA) set goals to increase CCP utilization to 50% by 2011. As 2011 draws near, this goal appears to be more difficult to attain, particularly as new emission regulations are implemented, resulting in larger quantities and changing qualities of CCPs produced.

To better understand the status and development of different CCP utilization profiles across the United States, the University of North Dakota Energy & Environmental Research Center (EERC) is conducting a series of state reviews. The first was conducted in Texas in 2004, the second was in Florida in 2005, and the third was in Pennsylvania in 2006. Following the series of three state reviews, a synthesis report was prepared that transfers the findings into a national perspective. These state reviews were funded in part by EPA and DOE. Both agencies encourage other states to follow a similar statement of work to conduct additional state reviews under separate funding mechanisms.

The EERC, with funding from the North Dakota Industrial Commission, Basin Electric Power Cooperative, Great River Energy, Minnkota Power Cooperative, and DOE through the Coal Ash Resources Research Consortium® (CARRC®), conducted a fourth state review in North Dakota.

CCPs are the largest solid waste stream generated in North Dakota. According to information obtained during the state review interview process, the authors estimate that North Dakota coal-based power plants produce in excess of 8000 tons per day of CCPs (or nearly 3 million tons per year). They further estimate that North Dakota coal-based power plants currently beneficially use about 40% (or 1.2–1.3 million tons) of CCPs produced per year.

Based on information obtained during the North Dakota state review process, the following items were identified as keys to successful CCP utilization in North Dakota and are discussed at greater length in this report:

1. Great River Energy (GRE) has an established CCP utilization program at Coal Creek Station (CCS) which sells nearly 500,000 tons of fly ash (~94%–95% of total production) each year. Many would agree that CCS produces perhaps the best fly ash in the country with regard to quality and consistency of supply.

2. The North Dakota Department of Transportation (NDDOT) uses fly ash in almost all concrete projects at a replacement rate of 30%. Most DOTs specify a replacement rate

between 15%–30% (if they specify fly ash use at all), making NDDOT's specification on the higher end compared to other states.

3. Fly ash is beneficially used as a key cementitious component by the North Dakota Public Service Commission Abandoned Mine Land Division for grout filling of abandoned underground mine lands. Since 1995, PSC used 32,000 tons of fly ash in 28 grout applications. Mine grout is the only preapproved beneficial use application for fly ash in North Dakota.

4. Bottom ash is classified as an inert waste by the North Dakota Department of Health (NDDH) which allows it to be used without approval. In North Dakota, bottom ash is typically used in active mines as a road base and for ice control on public and private roads.

5. Boiler slag meets the definition of an inert waste as defined by the North Dakota Solid Waste Management Rules. Slag is sold for sand blasting, ice control, manufacture of roofing shingles, and for base on mine roads or drainage media.

The following were identified as barriers that currently hinder increased CCP utilization in North Dakota. Recommended actions are provided for each barrier.

1. All North Dakota coal-based power plants have a system in place or have plans to control sulfur dioxide (SO_2) emissions (Leland Olds Station is currently installing a SO_2 control system, and Milton R. Young Station Unit 1 will install a wet scrubber in 2011). The by-products produced are either spray dryer absorber material mixed with fly ash or wet sulfite-rich material/sludge. These by-products are difficult to market because they are a low-value material, have limited use potential, and are not located within close proximity to markets. Currently, it is more cost-effective to dispose of the material; however, if high-value and high-volume applications were possible, electric generating companies may be more likely to pursue potential uses.

2. The primary objective of most electric generating companies is to produce electricity, not to make good-quality CCPs and market them. GRE CCS has successfully done both, but that is an exception in the state. Electric generating companies should also perform a cost–benefit analysis to determine what resources (i.e., staff, handling equipment) would be needed to improve CCP use and determine if it is a cost-effective ash management solution for the company.

3. NDDH's *Guideline 11 – Ash Utilization for Soil Stabilization, Fill-In Materials, and Other Engineering Purposes* summarizes the department's approach to CCP utilization. The applicant must reasonably demonstrate that the proposed use will not adversely impact the environment. NDDH believes Guideline 11 presents a flexible framework to facilitate the department's evaluation of impacts to surface water, groundwater, soils, etc. Those requesting beneficial use applications indicated the guideline is too subjective. Potential CCP users should work with NDDH in defining parameters (i.e., leaching method, pre- and postmonitoring). This collaboration could

be facilitated through a state CCP program or consortium whose primary objective was to educate government agencies about CCPs. At a federal level, EPA could provide more guidance on what a "beneficial use" is. A clear definition would be helpful to NDDH in writing new or modifying existing guidelines.

4. NDDOT representatives interviewed did not see a need to explore nonconcrete beneficial use applications such as soil stabilization or flowable fill. Conversely, the ready-mix suppliers interviewed believed flowable fill is a major untapped market in North Dakota. Industry should approach all levels of NDDOT to demonstrate the engineering, environmental, and economic benefits of using CCPs in flowable fill applications. In addition, NDDOT could take a second look at the economics associated with using flowable fills containing CCPs.

5. Many North Dakota coal-based power plants do not have a quality assurance/quality control (QA/QC) plan for their CCPs. The implementation of a strict QA/QC plan is imperative for utilization in a variety of applications, especially concrete.

6. With the exception of GRE's CCS, North Dakota coal-based power plants have transportation and distribution infrastructure issues that make it cost-prohibitive and difficult to transport CCPs to major markets outside of the state. Management at coal-based power plants should evaluate the cost–benefit ratio of improving the CCP distribution infrastructure at their plants. Local markets should also be explored.

7. Green building initiatives have not gained widespread acceptance in North Dakota from a consumer or regulatory standpoint. Since consumers are not yet pulling the green building market in North Dakota, it is recommended that approaches to push green building by government be promoted by industry. CCP industry stakeholders should work with state and national building entities to market the benefits of using CCPs in building materials. Government policy makers should also be encouraged to make green building a priority.

8. Even though NDDH supports integrated waste management, the authors believe NDDH does not have the resources (i.e., time, knowledge, budget) needed to effectively evaluate new CCP beneficial use applications. Also, once a beneficial use rule is in place, NDDH does not appear to have any mechanisms in place to encourage use. To encourage preapproved CCP beneficial use applications, NDDH should have a list of preapproved uses on its Web site and provide access to appropriate checklists. An industry-led group could be effective in assisting NDDH in education and information dissemination.

9. Ready-mix suppliers interviewed indicated the national commercial concrete market is usually the most difficult consumer group to work with to encourage CCP use. Often, the national company would give an overly prescriptive mix design that the ready-mix supplier believed would benefit from a higher percentage of replacement of fly ash, but the national company would want to stick with its design. Education is key to overcoming this barrier.

10. Fly ash use in the local concrete markets is nearly saturated, so other high-value road-building and construction applications should be explored such as flowable fill, backfill, and road base applications.

11. Some coal ashes from coal-fired industrial boilers do not have the cementitious or pozzolanic properties that coal ashes from coal-fired power plants have and, therefore, will not exhibit the same physical performance in applications such as soil stabilization or flowable fill. Anecdotal evidence has been raised indicating instances where industrial coal ashes physically failed in an application and subsequently created a public perception problem for coal ashes from coal-based power plants that are well suited for these uses.

The following potential threats were identified that could hinder CCP utilization in North Dakota in the future:

1. Most North Dakota coal-based power plants will meet 2010 mercury emission regulations (Clean Air Mercury Rule) as they currently operate but will likely need to implement new controls to meet 2018 requirements. NDDH is concerned about how new mercury emission controls will impact CCP utilization and disposal. NDDH has not evaluated by-products from plants with mercury emission controls; therefore, regulating the materials' use or disposal is new territory (as will be the case for other state health departments). This is a nationwide concern.

2. New CO_2 regulations are expected, but the potential for impact on CCPs is not clear.

REVIEW OF NORTH DAKOTA REGULATIONS, STANDARDS, AND PRACTICES RELATED TO THE USE OF COAL COMBUSTION PRODUCTS

BACKGROUND

Over 54 million tons of coal combustion products (CCPs) are beneficially used in the United States each year, but over 70 million tons, or 57%, are still being disposed of in landfills or surface impoundments. The overall CCP utilization rate is gradually rising, from 40.08% in 2004, to 40.29% in 2005, to 43.43% in 2006 (American Coal Ash Association [ACAA], 2006). The U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA) set goals to increase CCP utilization to 50% by 2011. As 2011 draws near, this goal appears to be more difficult to attain, particularly as new air emission regulations are implemented, resulting in larger quantities and changing qualities of CCPs produced. Given these challenges, both agencies are committed to reaching their utilization goals and are conducting research studies and working together to create and support programs that encourage CCP use. Such programs include EPA's Industrial Materials Recycling Program under the Resource Conservation Challenge (RCC), the Coal Combustion Products Partnership (C^2P^2), the Green Highways Partnership, and the U.S. Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED®) Program. Other programs such as the newly formed Industrial Resources Council bring together industry associations (CCPs, foundry sand, construction and demolition debris, and rubber) to achieve similar goals.

Many of the technical barriers associated with CCP utilization have been addressed, but social and knowledge barriers still exist. One of the key nontechnical barriers is the broad range of state laws, regulations, policies, and guidelines regarding the use of CCPs (American Coal Ash Association, 1998; Pflughoeft-Hassett et al., 1999; Dockter and Jagiella, 2005). Some states have worked to develop progressive and effective guidance for CCP utilization that helps to increase CCP utilization while being protective of the environment. Conversely, some states still lack the resources and information to feel comfortable with the environmental appropriateness of using CCPs in certain applications, particularly with nontraditional applications. In addition, changing state laws, regulations, policies, and guidelines can be a lengthy process, taking a number of years to come to fruition, which often frustrates CCP industry stakeholders.

To better understand the status and development of different CCP utilization profiles across the United States, the University of North Dakota (UND) Energy & Environmental Research Center (EERC) was given a grant by EPA and Headwaters Resources, LLC, to conduct a pilot review of state regulations, standards, and practices related to the use of CCPs. Texas was selected as the pilot state because of its progressive approach to CCP utilization. A subsequent grant was awarded to the EERC by EPA and DOE to conduct a second state review. Florida was selected as the second state to review, primarily because it was undergoing changes to its CCP regulations. The EERC subsequently received a grant from EPA, DOE, and ACAA to perform a review in a third state that exhibited a different CCP use scenario and geographic area than the previous two states. Pennsylvania was ultimately chosen as the third state. The final reports from the series of state reviews can be accessed online at www.undeerc.org/carrc/html/review.html. Following the completion of the series of three state reviews, a synthesis report was prepared that translates the results from the three in-depth state reviews into a national perspective. The preparation of the synthesis report was funded by EPA and DOE.

The EERC, with funding from the North Dakota Industrial Commission, Basin Electric Power Cooperative, Great River Energy (GRE), Minnkota Power Cooperative, the DOE National Energy Technology Laboratory through the Coal Ash Resources Research Consortium® (CARRC®), conducted a fourth state review in North Dakota. This report contains an in-depth analysis of how coal ash is being used in North Dakota, describes what is being done to promote coal ash utilization, lists barriers and threats that hinder use, and recommends actions that can be taken to overcome barriers.

GOAL

The primary objective of this effort is to assess activities in North Dakota that have resulted in encouraging or prohibiting the use of CCPs in an environmentally appropriate manner. The specific goals are to 1) evaluate factors related to the use of CCPs in North Dakota; 2) summarize North Dakota's successes, barriers, and threats; and 3) develop recommendations (action items) that may help North Dakota and other states increase the use of CCPs in an environmentally sound manner.

STATE REVIEW PROCESS

The following tasks outline the steps taken to conduct this review. Experience with previous state reviews showed that the most effective method for conducting the review was to conduct a multiday site visit in a central location within the state. Panels of key stakeholders were assembled and interviewed during the course of this site visit which took place August 27–29, 2007, in Bismarck, North Dakota. Information provided during the interviews was compiled and summarized in this report. The following sections describe each step of the review process in more detail. Tasks are listed in order; however, many tasks were implemented concurrently.

Task 1: Establish an Administrative Team

A project administrative team was established to perform the majority of the administrative work, including organizing the review, compiling findings, and writing reports. Ms. Tera Buckley, EERC Marketing Research Specialist, acted as team leader, with input from Ms. Debra Pflughoeft-Hassett, EERC Senior Research Advisor.

Task 2: Form an Advisory Board

A second team, the project advisory board, was formed to provide input to interviewee selection, assist in the development of a standard questionnaire, and review findings. Advisory board members included Mr. John Sager, EPA; Mr. David Goss, ACAA; and Ms. Kendra Morrison, EPA Region 8. Associated contact information is listed in the project participant list in Appendix A.

Task 3: Assemble a Review Team

A select group of individuals comprised the review team. The primary role of the review team was to administer the meetings at the review. Review team members were Ms. Tera Buckley, EERC; Ms. Debra Pflughoeft-Hassett, EERC; Mr. John Sager, EPA; and Mr. Shane Vasbinder, Basin Electric Power Cooperative. Associated contact information for review team members is listed in Appendix A.

Task 4: Create a Review Guide

A review guide was developed for North Dakota interviewees that included an agenda, background information, and targeted questionnaires for each discussion group (see Appendix B). To facilitate appropriate discussions, the following four discussion groups were formed to answer questions posed by the review team:

- Government agencies – directors and other key personnel of state transportation and health departments

- CCP generators – coal-based electric generating company environmental and ash managers

- Concrete and other engineering applications – CCP marketers and ready-mix concrete suppliers

- Mining – key personnel at the North Dakota Public Service Commission (PSC)

Task 5: Develop a List of Interviewees

With input from the advisory board, the administrative team developed a list of potential interviewees for each of the discussion groups identified in Task 4. The final participant list for the review is included in Appendix A. Those on the participant list attended a discussion session, submitted written comments, or participated in a telephone interview.

Task 6: Prepare Final Report and Disseminate Information

The primary objective of this task was to prepare a final report that could be used to encourage CCP use in North Dakota and other states. Target audiences for the final report include CCP industry representatives and users, personnel at the state government agencies, members of the American Association of State Highway and Transportation Officials (AASHTO), Association of State and Territorial Solid Waste Management Officials (ASTSWMO), and other state and federal agency groups and individuals.

The results of the report are organized into keys, barriers, threats, and actions. These sections were modeled after a SWOT (strengths, weaknesses, opportunities, threats) analysis commonly used by marketing professionals to audit an organization and the environment in which it operates. It is the first stage of planning and helps identify key issues. The SWOT terms were modified to reflect terms that the authors felt were more applicable to the CCP industry.

STATUS OF CCP PRODUCTION AND UTILIZATION IN NORTH DAKOTA

North Dakota currently has four active surface lignite mines that supply coal to all coal-based power plants in the state:

- BNI Coal Ltd. (a subsidiary of ALLETE), Center Mine
- Coteau Properties Company (a subsidiary of the North American Coal Corporation), Freedom Mine
- Dakota Westmoreland Corporation (a subsidiary of Westmoreland Mining LLC), Beulah Mine
- Falkirk Mining Company (a subsidiary of North American Coal Corporation), Falkirk Mine

North Dakota's mines produced 30.3 million short tons of lignite coal in 2006. Since 1988, North Dakota's lignite production has consistently been near the 30-million-ton-per-year range, which makes it one of 15 major coal-producing states in the United States (Lignite Energy Council, 2007a).

North Dakota has seven coal-based power plants. These plants and their megawatt (MW) capacities are listed in Table 1. The total annual generating capacity for all North Dakota coal-based power plants is over 4000 MW.

In addition to the coal-based power plants listed in Table 1, Basin Electric Power Cooperative, through its for-profit subsidiary, Dakota Gasification Company, owns and operates the Great Plains Synfuels Plant northwest of Beulah, North Dakota. The synfuels plant is the only commercial-scale coal gasification plant in the United States that manufactures natural gas.

Table 1. North Dakota Coal-Based Power Plant Annual Generation Capacity

Owner	Station	Capacity, MW
Basin Electric Power Cooperative	Antelope Valley	900
Basin Electric Power Cooperative	Leland Olds	669
Great River Energy	Coal Creek	1200
Great River Energy	Stanton	188
Minnkota Power Cooperative Inc.	Milton R. Young	744
Montana–Dakota Utilities Co.	R.M. Heskett	86
Otter Tail Power Company	Coyote*	420

* Coyote Station is owned by Montana–Dakota Utilities Co. (25%), NorthWestern Public Service (10%), Northern Municipal Power Agency (30%), and Otter Tail Power Company (35%).

The plant produces an array of by-products including ammonium sulfate, anhydrous ammonia, carbon dioxide, dephenolized cresylic acid, krypton and xenon gases, liquid nitrogen, naphtha, and phenol (Basin Electric Power Cooperative, 2007). These by-products are not considered traditional CCPs and, therefore, will not be considered in this review.

CCPs are the largest solid waste stream generated in North Dakota. The North Dakota Department of Health (NDDH) estimates that approximately 9900 tons per day of CCPs are generated compared to about 1400 tons per day of municipal solid waste, 100 tons per day of industrial waste, and about 6 tons per day of hazardous waste (Tillotson, 2007). However, according to information obtained during the state review interview process, the authors' estimate was lower than NDDH at just over 8000 tons per day of CCPs (or nearly 3 million tons per year). The authors further estimate that North Dakota coal-based power plants currently beneficially use about 40% (or 1.2–1.3 million tons) of CCPs produced each year. The basis for these production and use estimates is described by station below.

Antelope Valley Station

Antelope Valley Station (AVS) is located near Beulah, North Dakota, and is owned and operated by Basin Electric Power Cooperative. It is the newest coal-based power plant in North Dakota and is considered a minemouth facility, receiving its coal from the nearby Freedom Mine.

It is estimated that AVS produces approximately 775,250 tons of CCPs per year. About 87% (~675,250 tons) of this material is landfilled each year. AVS has one landfill for all of its CCPs.

AVS has a spray dryer absorber (SDA) system for sulfur dioxide (SO_2) control.[1] The fly ash and SDA material are collected together. About 50,000 tons of AVS fly ash/SDA material is used in area oil fields to solidify waste pits and for mine subsidence each year. An additional 50,000 tons per year is used at the Freedom Mine in soil stabilization applications and for haul roads. AVS provides the fly ash/SDA material to the mine at no charge. AVS recently began working with Headwaters Resources to market its fly ash/SDA material in geotechnical applications.

In February 2007, Basin Electric Power Cooperative approved installing an air-jigging system with a price of more than $25 million at AVS to further reduce SO_2 emissions. The air-jigging system consists of two different components. One involves pulsating air through the coal stream, and the second involves a vibrating slide. In combination, these two processes separate the heavier products in the coal which typically contain the higher percentages of sulfur, mercury, pyrites, and clay in the lignite. Construction of the air jig is expected to start in 2008, with the system becoming operational in mid-2009 (Lignite Energy Council, 2007b).

[1] SDA material is a dry powder product, which is a calcium sulfite ($CaSO_3 \cdot ½ H_2O$, or hannebachite)-rich material. SDA material and fly ash are often collected together in a particulate control device.

Coal Creek Station

Coal Creek Station (CCS) is North Dakota's largest coal-based power plant and is owned and operated by GRE. The plant is located near Underwood, North Dakota. The adjoining Falkirk Mine supplies CCS with coal.

CCS produces about 520,000 tons of fly ash per year, with an outstanding beneficial use rate of 94%–96%. CCS fly ash is used primarily as a cement replacement in concrete and is sold to ready-mix suppliers in North Dakota, South Dakota, Minnesota, Wisconsin, and Iowa and in Manitoba, and Saskatchewan, Canada, through its marketer, Headwaters Resources. GRE estimates that North Dakota uses about 120,000 tons of CCS fly ash in concrete each year. CCS is the state's only fly ash source for concrete. CCS produces 300,000 tons of bottom ash per year, and the majority is used as aggregate, sand-blasting grit, in roofing shingles, and for ice control. CCS produces 125,000 tons of wet flue gas desulfurization (FGD) material,[2] and all of that material is landfilled. CCS is considering installing a forced-oxidized FGD system that will produce a marketable by-product (FGD gypsum) and is exploring its use in agriculture applications.

Coyote Station

Coyote Station, located near Beulah, North Dakota, has multiple owners including Otter Tail Power Company (OTPC) (35%), Montana–Dakota Utilities Co. (MDU) (25%), NorthWestern Public Service (10%), and Northern Municipal Power Agency (30%). The station receives its coal from nearby Beulah Mine. Coyote Station produced approximately 106,000 tons each of dry FGD material[3] and boiler slag in 2006. All of the dry FGD material is landfilled. It sells about 20% (21,200 tons) of its boiler slag for use in roofing shingles and sand-blasting grit. In addition, 4% (4240 tons) of the boiler slag is used for ice control on mining and public roads. The remaining 76% (80,560 tons) of the boiler slag is disposed of in a landfill. The fly ash produced is mixed with lime and recycled back into the dry FGD system. All of the resulting material is landfilled because it is not reactive.

Leland Olds Station

Leland Olds Station (LOS) is located near Stanton, North Dakota, and is owned and operated by Basin Electric Power Cooperative. It receives coal from Freedom Mine.

LOS has a landfill for its fly ash and a separate sluice pond for its bottom ash. LOS produces about 150,000 tons of fly ash, and all of it is landfilled. It produces about 210,000 tons of bottom ash per year and sells ~29% (60,000 tons) for sand blasting under the brand name Black Beauty®. LOS is installing a wet FGD system which will require the landfill to double in size.

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[2] Wet FGD material is also commonly known as scrubber sludge. It is a material produced from a wet unoxidized system to control SO_2. The material is generally a mixture of calcium sulfate, calcium sulfite, and fly ash.

[3] Dry FGD material is a dry powder material that is generally a calcium sulfate-rich material.

Milton R. Young Station

Milton R. Young Station (MRYS) is a coal-based power plant located near Center, North Dakota, owned and operated by Minnkota Power Cooperative, Inc. It is a minemouth plant, receiving its coal from the nearby Center Mine. It has two units, and both are cyclone-fired. MRYS produces 180,000 tons of bottom ash per year, and it is anticipated that 80%–90% will be recycled in 2008 and continue thereafter. MRYS produces 175,000 tons of fly ash per year and uses 60% (105,000 tons) of its fly ash as a reagent in its wet FGD system. All fly ash not used as a reagent is disposed of dry. The plant also produces 240,000 tons of wet FGD material per year, and all is disposed of. In 2010, MRYS will have a new lime system, and all fly ash will be disposed of dry; in 2011, a wet scrubber will be operational for Unit 1, producing a wet FGD material/sludge.

R.M. Heskett Station

Montana–Dakota Utilities Co.'s R.M. Heskett Station (RMHS) is a bubbling fluidized-bed combustor designed to operate with river sand as its bed material. The plant is located north of Mandan, North Dakota, and receives its coal from the Beulah Mine. In 2006, RMHS produced 35,970 tons of fly ash, and all of that material was disposed of. It also produced 4782 tons of bottom ash and used 17% (800 tons) in road base/subbase applications.

Stanton Station

Stanton Station (SS), owned and operated by GRE, was named for its proximity to Stanton, North Dakota. SS has an SDA system in place for sulfur control which produces about 15,000 tons of fly ash/SDA material per year. That material is currently being marketed in the soil stabilization market. The plant also produces between 20,000 and 29,000 tons of bottom ash, which is landfilled.

KEYS TO SUCCESSFUL CCP UTILIZATION IN NORTH DAKOTA

Based on the information obtained at the North Dakota state review discussion group sessions, the authors believe the following are the keys to successful CCP utilization in North Dakota. The keys highlight "strengths" or positive aspects. The keys are listed in order of importance. The measure of importance is based on the volume of CCPs beneficially used.

Key 1: GRE CCS Has One of the Best Fly Ash Utilization Programs in the Nation

In the 1980s, GRE's CCS landfilled a vast majority of CCPs it produced. In 1995, GRE came to realize that CCP utilization is an environmentally responsible effort that could reduce landfill disposal costs and generate a significant revenue stream for the company. To make CCP utilization a priority at CCS, GRE formed an internal process improvement team representing all areas and levels of the company (i.e., upper management, plant operators, and maintenance). This multifaceted team approach gave people ownership over their areas and created a working environment focused on utilization. At the time the internal process improvements team was created, CCP utilization at CCS was 90,000 tons per year.

During the past decade, GRE's CCS established what many would agree is the premier fly ash utilization program in the country, beneficially using 94%–96% of the fly ash it produces. CCS takes great care to ensure that fly ash quality is not impaired by fuel changes, plant outages, or new emission control technologies. CCS has strict quality assurance/quality control (QA/QC) measures in place that supersede all other electric generating companies in the state and, perhaps, the nation. CCS fly ash is used primarily as a cement replacement in concrete and is sold to ready-mix suppliers in North Dakota, South Dakota, Minnesota, Colorado, Wisconsin, and Iowa and in Manitoba and Saskatchewan, Canada.

GRE's commitment to CCP utilization has taken considerable staff effort and monetary resources. GRE invests in research to explore new beneficial use applications for its CCPs and is very involved in CCP utilization programs and associations across the country. For example, GRE's ash manager is the Chairperson for ACAA. It also supports education and outreach efforts that encourage CCP utilization on a local, regional, and national scale. GRE hosted a workshop, "*CCP Beneficial Use Training*," in March 2006 to educate government representatives and end users about the use of fly ash in North Dakota. GRE has also been a long-time supporter of education and outreach activities organized through the EERC's Coal Ash Research Center including the Coal Ash Professionals Training Course. All of these activities allow GRE to remain on the forefront of CCP utilization and help pave the way for others.

As part of their commitment to CCP utilization, GRE and its ash marketer Headwaters Resources, LLC, have invested over $27 million in infrastructure at CCS. Today, CCS has two weight scales for trucks, 200 private rail cars, and an 85,000-ton fly ash storage dome. It loads/unloads 30 rail cars a day and can load up to 150 trucks per day. It also has a method for dealing with overloading trucks. GRE has fly ash terminals in Minnesota and Colorado. After seeing the positive effects of infrastructure at CCS, GRE is in the process of updating loading facilities at SS as well.

With its investment in distribution infrastructure and dedicated to quality control, the price of CCS fly ash went from $0 in 1996 to $35 FOB in 2007. Considering that CCS sold about 494,000 tons of fly ash in 2006, this represents a revenue stream of over $17 million and a significant savings in disposal costs.

Key 2: North Dakota Department of Transportation Allows 30% Fly Ash Replacement in Concrete

According to the North Dakota Department of Transportation (NDDOT) *Standard Specifications for Road and Bridge Construction* (Section 820) adopted in 2002, fly ash must meet the following specification for the specific type of work:

- Portland cement replacement in concrete – AASHTO M295

- Lime fly ash-treated subgrade – ASTM (American Society for Testing and Materials) International C593
- Econocrete – AASHTO M295
- Aggregate base – ASTM C593

The regulation also stipulates that the fly ash shall be from an electric generating plant using a single coal source. This is generally a nonissue for North Dakota coal-based power plants because they are minemouth plants or use only one coal source. However, from a functional perspective, there is no compelling reason why stations that burn more than one coal cannot produce fly ash that is perfectly suitable for use in concrete. An additional stipulation is that fly ash produced at plants where the limestone injection process is used for controlling air pollutants will be considered unacceptable for use in portland cement concrete. The maximum loss-on-ignition (LOI) of 2.0% is based on AASHTO M295.

Fly ash replacement of cement is allowed on a 1:1 ratio, up to a maximum of 30% by weight for standard concrete projects. NDDOT uses fly ash in almost all concrete projects at a replacement rate of 30%. Most DOTs specify a replacement rate between 15% and 30% (if they specify fly ash use at all), making NDDOT's specification on the higher end compared to other states. For mass pours, a replacement rate of 40% is allowed and is more typical. Fly ash is not allowed as a cement substitute when high-early-strength concrete is used. Lime or lime–fly ash mixtures may be used in the top layer of stabilized subgrade.

Fly ash suppliers, with support from contractors, drove the current fly ash regulations. As an example, prior to the specifications mentioned above, NDDOT specified that 20% of fly ash would replace 15% of cement in concrete. NDDOT was approached by fly ash suppliers to change this specification, subsequently, it performed its own research and looked at what other states were doing and modified the specification to the current 1:1 ratio. NDDOT also specified that, after September 15, a contractor would have to ask to use fly ash in a project because NDDOT was concerned about cold weather placement. NDDOT performed freeze–thaw testing with UND and determined that concern was not an issue and removed the time constraint.

Fly ash suppliers are continuing to approach NDDOT to get more fly ash used in DOT projects. Recently, fly ash suppliers requested higher fly ash percent replacement and are providing test data to NDDOT to support this request. If the data look promising, NDDOT will try a higher percentage in one or two demonstration projects before modifying the specification.

Key 3: Mine Grout to Fill Underground Mine Voids Is the Only Preapproved Beneficial Use for Fly Ash in North Dakota

The North Dakota Abandoned Mine Land Reclamation Program operates under the guidelines of the Surface Mining Control and Reclamation Act, the approved State Reclamation Plan, the Federal Assistance Manual, and associated rules, regulations, and policy decisions. The state program is administered by the Abandoned Mine Land Division (AMLD) of the PSC. Oversight of the program is conducted by the Casper Field Office of the Office of Surface Mining.

Fly ash is beneficially used as a partial replacement for cement by AMLD for grout filling of underground abandoned mine lands (AMLs). North Dakota has 600 documented underground AMLs, but the PSC estimates North Dakota actually has between 1000 and 2000 AMLs. About half of the mines are dry and the other half are wet. Since 1995, PSC used 32,000 tons of fly ash in 28 grout applications. More fly ash could be used, but the PSC has limited funding. Program funding comes from a $0.10 per ton production tax on lignite coal mined within the state. For the last 15 years, PSC operated on a budget of $1.5 million per year; however, in 2007, with the passing of Senate Bill S.2616, the budget will be raised to $3 million per year and the program extended until 2021.

In developing its grout mix design, PSC wanted a very flowable and strong material that did not segregate. PSC prefers using fly ash in the mix because it improves flowability and does not flash set like cement and will gain strength for a year or more after placement. Although PSC has no state laws or administrative rules specifying grout mix design for AML underground mine-grouting projects, the grout specifications in PSC Invitations for Bids require that the grout consist of:

- Portland cement: 100 pounds per cubic yard.
- Fly ash: 600 pounds per cubic yard.
- Aggregate: as required to achieve a yield of 27 cubic feet per cubic yard.
- Superplasticizer: (high-range water reducer) 70 ounces per cubic yard.
- Water: as required to achieve the specified slump range. Slumps will be measured 5 minutes after superplasticizer has been mixed into the grout.

This grout formulation has been reviewed and approved by NDDH for use in underground mine-grouting projects. Although quantities of aggregate and water may vary, a typical grout includes approximately 2500 lb of aggregate and 50 gallons of water (in addition to cement, fly ash and superplasticizer) per cubic yard. The grout is required to achieve a minimum unconfined compressive strength of 150 psi within 28 days. The PSC requires material testing (under separate contract) to ensure that the grout and all components meet specifications.

From an environmental standpoint, PSC and NDDH were concerned about the leachate of elements contained in fly ash. On a laboratory scale, PSC used aquariums to simulate a mine leachate scenario. PSC is not required to install groundwater-monitoring wells for all AML underground mine-grouting projects. The need for groundwater monitoring and establishment of groundwater-monitoring programs is site specific and, therefore, determined and developed on a site-by-site basis. Some circumstances that may determine the usefulness of groundwater monitoring include:

- Whether the underground mine contains water.

- Whether there are domestic wells, stock ponds, seeps, or natural water bodies that could potentially be affected by grouting. These would need to be near the project area and associated in some way with water in the mine or the mined coal seam.

Groundwater-monitoring programs for AML grouting projects may include placing monitor wells in the mined coal seam, especially downgradient from the project area. It may also include monitoring private domestic wells, screened in or near the mined coal, near the project area. Groundwater monitoring is usually conducted in consultation with a groundwater hydrologist and includes measurements of water quantity and quality regularly over a period of months or years. PSC also consults with NDDH regarding grouting projects and groundwater monitoring. Most environmental impacts are highly localized near the entry hole and are short-term (seen within 3 days of placement). Once the grout sets, it is very stable and of little environmental concern from a leachate standpoint.

Mine grout to fill underground mine voids is the only preapproved beneficial use application for fly ash in North Dakota. Once fly ash sources are approved for this application, they do not need to get consent from NDDH for each application. In order for a fly ash source to be approved, an electric generating company must request approval from PSC, which approves the physical performance of the fly ash source and works with NDDH to ensure it is an environmentally appropriate material. Approved fly ash sources include CCS, AVS, and LOS. CCS fly ash is preferred by PSC contractors because CCS has an excellent infrastructure at the plant to obtain the fly ash (i.e., ease of loading), although AVS fly ash makes a harder grout and is less costly. PSC has not used AVS fly ash since 2002. However, CCS fly ash is becoming more expensive as it is marketed outside of the state for concrete applications, and PSC suspects AVS fly ash will become a more attractive option. But, even at the higher cost for CCS fly ash, PSC is seeing an 18% reduction in grout cost by using fly ash in place of cement and believes the grout is actually leaching fewer elements because it is denser with fly ash.

When mine reclamation is conducted in North Dakota cities, it can often disrupt the citizens' lifestyles. AMLD is careful to establish relationships with city officials and holds several public meetings to keep citizens informed on the process. From a public relations standpoint, PSC believes the general public accepts the use of fly ash in mine grouts because they prefer to have the AMLs filled and stable. The general public also seems to think it is a good idea to return material back to where it came from.

Key 4: Bottom Ash Is Classified as an Inert Material by NDDH

In North Dakota, all bottom ash generated from coal-based electric generating companies is classified as an inert material by NDDH. The designation allows bottom ash to be used in beneficial use applications without seeking consent from NDDH. Bottom ash is used in active mines as a road base and for ice control on public and private roads. Inadequate information was gleaned from the discussion group sessions and supplemental materials to estimate the amount of bottom ash beneficially used.

Key 5: Boiler Slag Is a Commodity

Boiler slag meets the definition of an inert material as defined by the North Dakota Solid Waste Management Rules. Boiler slag is only produced in systems with cyclone furnaces, and since there are limited power plants with cyclone furnace designs, a relatively competitive market for boiler slag has developed in the United States. Slag is used for sand blasting, ice control, manufacture of roofing shingles, and for base on mine roads or drainage media. The market for sand blasting, in particular, has increased.

Most of the boiler slag used in North Dakota is used by Abrasives Inc., a fully integrated manufacturer, processor, and marketer of boiler slag products located in Glen Ullin, North Dakota. The company distributes product in North Dakota, Montana, Wyoming, South Dakota, New Mexico, Arizona, Colorado, and Utah as well as in Canada. Abrasives Inc. sells its product under the brand name Black Magic®, which is packaged in supersacks weighing approximately 3800 lb, 50-lb bags, or 80-lb bags. Abrasives Inc. indicated that it sold approximately 125,000 tons of boiler slag from North Dakota coal-based power plants in 2007 and expects to sell much larger quantities in coming years (Roth, 2007). The slag market for sand-blasting grit is increasing. Even with the transportation issues that had previously limited the use of North Dakota slag, another national boiler slag distributor, Reed Minerals, has been making inquiries on material availability in North Dakota.

REPORTED BARRIERS AND RECOMMENDED ACTIONS THAT COULD INCREASE CCP USE IN NORTH DAKOTA

The following barriers were identified during the North Dakota state review process. The barriers or "weaknesses" detract from a CCP stakeholder's ability to increase CCP utilization. Following each barrier is the recommended action that could be taken to overcome the barrier and, thus, increase CCP utilization. The proposed actions could be implemented by a variety of CCP stakeholders, including government at the federal, state, and local level; electric generating companies; ash marketers; ready-mix producers; academia; and industry groups. The authors believe the barriers are listed in order of significance. Significance was determined by the quantity of CCPs impacted by the barrier.

Barrier 1: North Dakota Coal-Based Power Plants Produce Large Quantities of FGD Material with Limited Market Potential

All North Dakota coal-based power plants have a system in place or have plans to control SO_2 emissions (LOS is currently installing a SO_2 control system, and MYRS Unit 1 will install a wet scrubber in 2011). The specific FGD technologies employed in North Dakota produce by--products that are difficult to market because they are a low-value material, have limited use potential, and are not located within close proximity to markets.

Two North Dakota coal-based power plants (AVS and SS) have SDA systems for SO_2 control and produce a fly ash that is mixed with SDA material. At AVS, fly ash is used as part of the SDA sorbent, while at SS, the fly ash and SDA material are combined after the SDA system. Approximately 78,000–104,000 tons of fly ash/SDA material is used per year in oil field waste sludge (drilling mud mixed with oil) solidification applications in North Dakota. The sludge is put into lined pits and mixed with about 300–500 tons of fly ash/SDA material per pit. However, horizontal drilling is decreasing the amount used because less sludge is created with this new drilling technique. AVS has successfully marketed 13% of its fly ash/SDA material to solidify oil field waste sludge and for soil stabilization in mines. AVS fly ash/SDA material is also approved for use in grout applications in mines; however, contractors prefer to use CCS fly ash because of the ease of loading the material at the plant. Stanton only produces 15,000 tons of fly ash/SDA material per year, and that material is currently being marketed into the soil stabilization market.

Other plants with dry or wet FGD systems in place also produce an FGD material that is not readily marketed because of quality issues with the material and cost issues related to transportation. Most electric generating companies appeared to favor the disposal of FGD materials in the near future. To get FGD materials beneficially used may require a research and development expense that many are not willing to spend.

CCS is considering installing a wet forced-oxidation system that would produce a usable FGD gypsum by-product. FGD gypsum is typically sold to the wallboard market; however, because there are no wallboard manufacturers in or near North Dakota, other beneficial uses must be explored. GRE funded a study conducted by the Electric Power Research Institute (EPRI), North Dakota State University, and Ohio State University to evaluate the use of FGD gypsum as a soil conditioner for agriculture applications which would soften the soil and allow water to be adsorbed more readily. The experiment involves FGD gypsum being applied at 1, 5, and 10 tons per acre to wheat fields in Dickinson, North Dakota. NDDH indicated it would need to evaluate this new proposed beneficial use.

Recommended Actions for Barrier 1

A literature review conducted by the EERC (Heebink et al., 2007) indicated that applications for fly ash/SDA material use in the United States with the highest potential included cementitious products, masonry, flowable fill, synthetic aggregate, and mining applications. Fly ash/SDA material has the most potential to be used in applications that take advantage of the fly ash component of the SDA material, can tolerate relatively high sulfur content, and have limited susceptibility to expansion or reduced expansion potential in the production process.

Agriculture applications have a moderate potential for SDA/fly ash material produced in North Dakota because there is currently no competing FGD gypsum produced in the state. The northwest part of the state has sodic soils and could benefit from the use of FGD material as a soil conditioner. It is possible that SDA material or sulfite-rich FGD material could be used for agriculture crops, especially nonfood crops such as energy crops (i.e., corn, switchgrass).

Investments in research and development will be needed to explore these potential applications. Currently, it is more cost-effective to dispose of FGD material produced in North Dakota; however, if high-value and high-volume applications were possible, electric generating companies may be more likely to research potential uses. Because North Dakota is an agriculture-rich state, the U.S. Department of Agriculture could be engaged to explore potential uses for FGD material.

Barrier 2: CCP Utilization Is Not a Priority at Many North Dakota Coal-Based Power Plants

The primary objective of most electric generating companies is to produce electricity, not to make good-quality CCPs and market them. GRE CCS has successfully done both, but that is an exception in the state. CCP utilization is not a major focus for most North Dakota electric generating companies because there is not an immediate need or clear monetary benefit for using the material. Disposal costs are relatively inexpensive (estimated cost is $15/ton), and landfills have space for more material.

Recommended Actions for Barrier 2

Electric generating companies should also perform a cost–benefit analysis to determine what resources (i.e., staff, handling equipment) would be needed to improve CCP use and determine if it is a cost-effective ash management solution for the company. It is determined that utilization could be a cost-effective solution to ash management; the electric generating company may want to consider working with an ash-marketing company to help facilitate utilization. Ash-marketing companies have expertise in ash handling, storage, and distribution as well as industry insight into what beneficial use applications would garner the greatest economic return.

Barrier 3: NDDH Has a Subjective Guideline for Beneficial Use

The NDDH Division of Waste Management Solid Waste Program administers the disposal and utilization of CCPs. The North Dakota Solid Waste Management Rules, Chapter 33–20 of the North Dakota Administrative Code, written pursuant to North Dakota Century Code Chapter 23–29, include standards for various types and sources of solid waste. CCPs are called "special waste" which is defined in the state law as follows:

> "Special waste means solid waste that is not a hazardous waste regulated under Chapter 33-20.3 and includes waste generated from energy conversion facilities; waste from crude oil and natural gas exploration and production; waste from mineral and ore mining, beneficiation, and extraction; and waste generated by surface coal-mining operations. The term does not include municipal waste or industrial waste."

North Dakota has developed modern standards and facilities for management of solid waste, including CCPs. NDDH's disposal requirements address location restrictions, operating criteria, facility design, groundwater monitoring and corrective action, closure and postclosure care, and financial assurance (Tillotson, 2007). NDDH's disposal requirements exceed EPA recommendations, and the electric generating companies generally agreed the disposal requirements are appropriate.

In addition to disposal, NDDH has worked with a number of energy companies as well as with some food processors using coal as a fuel to develop beneficial uses for CCPs. *Guideline 11 – Ash Utilization for Soil Stabilization, Fill-In Materials and Other Engineering Purposes* (see Appendix C) summarizes NDDH's approach to CCP utilization. In essence, the proposed uses for CCPs must reasonably demonstrate that the proposed use will not adversely impact the environment. The project's potential impact to surface water, groundwater, air, and soil quality should be evaluated. Background information on the source, quality, and quantity of ash as well as appropriate analysis must be provided (Tillotson, 2007).

NDDH believes Guideline 11 presents a flexible framework to facilitate the department's evaluation of potential impacts to surface water, groundwater, soils, and the environment. Guideline 11 requires proposers to work closely with NDDH as needed to assess the proposed use and how it can be assessed. Those requesting beneficial use applications indicated the guideline is too subjective. For example, what NDDH considers "reasonably demonstrate" tends to vary depending on the application and who is requesting the application. In addition, those interviewed indicated that they do not know what standard they will be measured against for each application. The leachate quality must meet water standards based on the proposed application. The state's drinking water standards and the state's surface water standards are codified in state law and rule; some of which are based on federal law. The rules and law that apply will vary based on the proposed use.

The subjectivity of Guideline 11 is a barrier to electric generating companies in the state because they are reluctant to request a beneficial use. They are not sure how much time and money it will take to reasonably demonstrate a potential beneficial use to NDDH or if it is even possible to meet NDDH's requirements. Those interviewed noted instances where they could have used CCPs in a beneficial use application but did not want to hassle with the approval process, so they disposed of the material instead.

Recommended Actions for Barrier 3

NDDH should consider revising its Guideline 11 to define what it means to reasonably demonstrate a potential use. Requestors need to know in advance what the parameters of the proposed use in order to know if they should go forward with the request. To make the guideline less subjective, a specific leachate method should be defined, the parameters the leachate must meet (i.e., ground water or drinking water standards) should be listed, and any pre- or postmonitoring should be mentioned. Making Guideline 11 more explicit would take a considerable dedicated amount of time and resources upfront on behalf of NDDH, but it is believed that the approval process would be smoother for all parties involved in the long term.

To assist NDDH in the revision or development of new guidelines and/or regulations, potential CCP users could work with NDDH to help lessen its workload (i.e., assemble existing data) and educate them about potential beneficial use applications (i.e., provide case studies on beneficial use). This collaboration could be facilitated through a state CCP program or consortium whose primary objective was to educate government agencies about CCPs. In previous state reviews, the states had an industry group whose membership consisted primarily of the state's electric generating companies – Texas was represented by the Texas Coal Ash Utilization Group; Florida by the Florida Electric Power Coordinating Group, Inc.; and Pennsylvania by the Electric Power Generation Association. These groups were extremely effective in promoting the use of CCPs and addressing barriers prohibiting utilization, such as the lack of regulations allowing the beneficial use of CCPs. Organized industry-led groups can be effective in working with government agencies and state legislators because each one represents a unified voice on behalf of its members and allows industry to pool its collective knowledge base and monetary resources to address key issues. North Dakota does not have an industry group similar to the past states reviewed. The North Dakota Industrial Commission does offer funding for research; however, its primary objective is not to educate government and influence policy.

At the federal level, EPA could provide guidance on the definition of "beneficial use." EPA has a definition for waste but not for beneficial use of CCPs. EPA's Industrial Materials Recycling Program defines industrial materials recycling, also referred to as beneficial use, as a means for reusing or recycling by-product materials generated from industrial processes. These materials can be used as substitutions for raw materials in the manufacture of consumer products, roads, bridges, buildings, and other construction projects (U.S. Environmental Protection

Agency, 2008). A clear definition for the beneficial use of CCPs would be helpful to NDDH in writing new or modifying existing guidelines. In addition, Toxic Release Inventory reporting could be modified to exempt beneficially reused material and only require reporting of material that is sent to a disposal site.

Barrier 4: NDDOT Is Not Exploring Other Beneficial Uses

Although NDDOT is comfortable with using fly ash in concrete and appeared to have a clear understanding of the benefits of using fly ash in concrete, it did not appear to be interested in exploring other beneficial use applications such as soil stabilization or flowable fill. NDDOT uses soil stabilization techniques with reactive clays to dry wet soil; however, it indicated that this practice is expensive because it takes a lot of labor to mix fly ash 6 inches into the soil or base. NDDOT indicated that flowable fill has been used in urban utility trenches and referenced an instance when the city of Fargo used flowable fill in pipes and bridge approaches. NDDOT believes existing dirt at the site is usually used instead of flowable fill so that material does not have to be hauled away and did not see a need to use an engineered fill material.

Contrary to the NDDOT representatives interviewed, the ready-mix suppliers believed flowable fill is a major untapped market in North Dakota. Just in the repair market alone, flowable fill could be used for a quick fix during winter months. Those interviewed said that oftentimes the existing dirt (i.e., clay) is not a good fill material and needs to be mixed with gravel and sand.

It is important to note that in 1996, the EERC conducted a research study to evaluate eleven CCPs produced at North Dakota coal-based power plants for use in road-building applications including concrete, flowable fill, soil stabilization, and permeable base course. All fly ashes examined were likely candidates for flowable fill applications (Pflughoeft-Hassett et al., 1996).

Although flowable fill is a large potential market, it is important to note that Montana–Dakota Utilities Co. did have a flowable fill plant that is no longer in operation because of product acceptance issues among city engineers. The MDU flowable fill was approved by NDDH. Some city engineers simply do no want to use flowable fill and, in some instances, do not want to use flowable fill material that contains CCPs. Instances were noted where city engineers believed that the use of CCPs in cementing applications, including flowable fill, could hurt product performance and cause environmental problems such as the leaching of trace metals.

Recommended Actions to Barrier 4

CCP generators should approach potential users of flowable fill material, including all levels of NDDOT, to demonstrate the engineering, environmental, and economic benefits of using CCPs in flowable fill applications. This can be accomplished by hosting a workshop and inviting industry and NDDH representatives to learn about flowable fill. NDDH, having already approved the Montana–Dakota Utilities flowable fill, could also be a good resource for NDDOT and others in the state. CCP generators could also use flowable fill containing CCPs for their own use (i.e., fill gas or water lines). It would be most effective if the workshop included visiting an in-state demonstration using CCP-containing flowable fill. North Dakota Ready Mix Association (NDRMA) has hosted lunch box seminars for private engineers on flowable fill.

NDDOT could take a second look at the economics associated with using flowable fills containing CCPs. Perhaps it may find that, in the long-term, engineered materials such as flowable fills are more cost-effective.

Barrier 5: Many Fly Ashes Are Not Managed in a Way that Produces a Consistent Quality Product

QA/QC is an important factor that greatly influences the marketability of CCPs. Quality control involves continuous measure of process and products to determine performance and consistency of supply. Quality assurance provides assurance that the customer is receiving material that meets specifications and performance expectations. Factors important to a QA/QC plan include consistency of fuel, utility plant process, stable combustion conditions, and CCP handling and storage practices. Most QA/QC plans for fly ash include testing for carbon content (LOI), fineness, moisture, color, specific gravity, and a full ASTM C 618 analysis (Majors, 2004).

Many North Dakota coal-based power plants do not have a QA/QC plan for their CCPs. Fly ash has to be more closely monitored for optimal performance in concrete. In some instances, if measures were taken to control the variability of carbon content (LOI) in fly ashes, it would be suitable for use in concrete.

In addition to QA/QC plans, fly ashes produced at plants with SDA systems are mixed with the SDA residues. The fly ash–SDA material blend has little potential for use in concrete applications. These materials could be collected separately.

Recommended Actions for Barrier 5

The implementation of a strict QA/QC plan is imperative for fly ash to be used in concrete. This could be facilitated through an ash marketer with experience in developing and executing QA/QC plans for utilities. Also, fly ash and SDA material could be collected separately so that the fly ash is not contaminated by the SDA material.

Barrier 6: Transportation and Distribution Infrastructure Can Be Cost-Prohibitive

North Dakota is a landlocked state and is not located near major metropolitan areas, so transportation is necessary to get CCPs to major markets. No plants have access to waterways and some do not have rail access, so trucking is the only mode of transportation available for some North Dakota coal-based power plants. This limits the distance the material can be shipped and still be cost-competitive. With the exception of CCS fly ash, it is cost-prohibitive to transport CCPs to major markets outside of the state.

Again with the exception of CCS, North Dakota coal-based power plants lack distribution infrastructure needed to load CCPs into trucks or rail cars. The ready-mix suppliers and NDDOT representatives indicated that they would rather pay a premium price for CCS fly ash because it is so easy to load the material.

Recommended Actions to Barrier 6

Because high-value (i.e., concrete) markets are not locally available to take significant quantities of CCPs and it is not cost-effective to transport the material to these markets, local markets for low-quality/low-value materials should be explored. Agriculture, mining, and oil field applications already use some CCPs in North Dakota, and continued evaluation and marketing in these areas may result in increased opportunity for use.

Management at coal-based power plants should evaluate the cost/benefit ratio of improving the CCP distribution infrastructure at the plants. CCS made a significant up-front investment in its infrastructure; however, it is expected to be economically beneficial through increased sales in fly ash, avoided costs for disposal, and for CO_2 credits associated with the use of fly ash as a cement replacement.

Barrier 7: Limited Green Movement in the State

There are several products that contain CCPs that could be more widely used in green construction practices (see Buyer's Guide to Coal Ash-Containing Products for more information at www.undeerc.org/carrc/BuyersGuide/default.asp), but the USGBC's LEED program and other green initiatives have not gained widespread acceptance in North Dakota. There are beginning to be more green commercial buildings in North Dakota; however, these buildings are certainly not the norm. Those interviewed indicated that, in general, North Dakotans view green building as too expensive, and the benefits of green building are not well understood.

In addition, the architectural and building industries in North Dakota are slow to accept green building practices that could incorporate CCP-containing products. As an example, the North Dakota Ready-Mix Association hosted a green concrete workshop for architects and contractors, and only four architects attended.

From a regulatory standpoint, there has been no initiative or mandate by the state legislature to encourage state government agencies to promote CCP recycling or the benefits of using CCPs. NDDH supports the green building movement; however, as a health and environmental regulatory agency, it has limited input on actual building construction or design.

Recommended Actions for Barrier 7

Since many consumers are not yet supporting the green building market in North Dakota, it is recommended that approaches to push green building by government be promoted by industry. Government policy makers in North Dakota could be encouraged by electric generating companies, green advocacy groups (i.e., Green Cities), and other entities to develop tax incentives, mandates, regulations, or policies that promote green building. The potential CO_2 savings associated with using CCPs should be a major focus of lobbying efforts. Other environmental benefits such as saving landfill space and saving virgin resources should also be considered.

Other states have been successful in getting government policy makers to encourage CCP use. For example, the California DOT requires that mineral admixtures like fly ash comprise at least 25% of the cementitious material in any concrete used in state-funded paving projects. Montana provides tax incentives for companies that install equipment to begin utilizing material like fly ash.

CCP industry stakeholders should work with state building entities such as the North Dakota Association of Builders and national entities such as the USGBC LEED program and the National Home Builders Association to market the benefits of using CCPs in building materials. This can be accomplished by speaking or exhibiting at events, working with board members to develop legislative language, serving on association boards, or providing outreach materials.

Barrier 8: NDDH Lacks Resources to Focus on Beneficial Use of CCPs

NDDH supports and promotes integrated waste management and beneficial use at all regulated facilities including CCPs. The NDDH Solid Waste Program also works with publicly and privately owned and operated landfills in the state to ensure that all land disposal operations are conducted in accordance with state regulations. However, despite NDDH's support of beneficial use, the authors believe NDDH does not have the resources (i.e., time, knowledge, budget) needed to effectively evaluate new CCP beneficial use applications. Also, once a beneficial use rule is in place, NDDH does not appear to have any mechanisms in place to encourage the use.

To illustrate the lack of resources to focus on beneficial use of CCPs, consider the following examples brought forth during the discussion group sessions. NDDH was approached by electric generating companies in the state to approve the use of CCPs in road and feedlot soil stabilization applications. After extensive reviews of each application, NDDH approved the use of preapproved CCPs in road and feedlot soil stabilization applications. For CCPs to be used in either application, one must complete a checklist, and the form must be submitted and kept on file at NDDH. NDDH does not promote these uses and leaves it up to the electric generating company to provide access to the forms and encourage the use. OTPC indicated it tried to obtain the soil stabilization checklist from NDDH, but NDDH said it would have to get the checklist from a CCP supplier. OTPC then had to identify who the CCP supplier was and the appropriate contact person. As another example, NDDH indicated that use of CCPs in surface mine reclamation would not be considered a beneficial use (although CCP use in grout mixtures used in underground abandoned mines is a preapproved beneficial use) and that disposal facilities are currently being managed in at least one North Dakota surface mine.

Recommended Actions to Barrier 8

To encourage preapproved CCP beneficial use applications, NDDH should have a list of preapproved applications and materials on its Web site and provide access to appropriate checklists. NDDH noted that it does not normally endorse or promote specific products, marketers, or manufacturers.

As previously mentioned in Recommended Actions for Barrier 3, an industry-led group could be effective in assisting NDDH in the distribution of information. It could also assist in educating NDDH about CCP utilization.

Those interested in increasing CCP beneficial use in North Dakota should make an effort to better understand the Solid Waste Management Rules, the NDDH position and integrated waste management and beneficial use, and look for opportunities to facilitate environmentally sound beneficial use and development of preapproved uses for CCPs.

Barrier 9: The National Commercial Concrete Market Has Misconceptions About CCPs

Ready-mix suppliers interviewed indicated that they classify their customers into three different classes which each perceive concrete mix designs differently:

1. National commercial market – large national companies (i.e., Menards and Wal-Mart) provide a prescriptive mix design based on company policy to the local ready-mix supplier. The prescriptive mix designs are standard and do not take into account local availability of virgin materials, climate, or fly ash quality. These designs typically do not favor a higher percentage of fly ash and, in some instances, require that no fly ash be used in the mix design.

2. Local commercial market – local commercial projects typically specify performance criteria and allow the ready-mix supplier to come up with a mix design to meet that need. This provides the opportunity for ready-mix suppliers to create a design that could potentially use up to 70% fly ash; however, 25% is most common.

3. Residential market – the residential market is driven by price, and performance is a secondary consideration. Most consumers in the residential classification do not know or care if their concrete contains CCPs.

The national commercial market is usually the most difficult consumer group for ready-mix suppliers to work with to encourage CCP use. Often the national company would give an overly prescriptive mix design that the ready-mix supplier believed would benefit from a higher percentage of replacement of fly ash, but the national company would want to stick with its design.

Recommended Actions for Barrier 9

Education is key to overcoming this barrier. Education is typically most effective if done on a case-by-case basis directly between the ready-mix supplier and/or fly ash marketer and the end user and may take several attempts. However, indirect education efforts such as workshops and online courses for engineers and specifiers are also an option for reaching larger audiences. Previous successful outreach to this audience is described below:

- ACAA, with industry stakeholders, made advances with Wal-Mart to get fly ash used in all concrete poured in the construction of new Wal-Mart stores.

- NDRMA is having lunch box seminars for private engineers.

- Colleges could be encouraged to offer more education to engineers about the benefits of using CCPs.

Barrier 10: Local Concrete Market Saturated

In 2006, about 1.2 million cubic yards of concrete was poured in North Dakota, with an average fly ash replacement rate of about 25%. The demand for concrete is expected to remain about the same in the coming years because the population of the state is not growing (population decreased 1% from 2000 to 2006 [U.S. Census, 2007]) and the building industry is stable. The fly ash percent replacement rate is also expected to remain about the same, resulting in very little increase in fly ash use in concrete in the state. However, with recent concerns about bridge safety, it is possible that North Dakota could find additional bridge replacements and repair needs that could increase concrete demand.

Recommended Actions for Barrier 10

Other high-value road-building and construction applications should be explored such as flowable fill, backfill, and road base applications. Workshops for contractors, architects, city engineers, and government agencies would be helpful to educate them on CCP use in nonconcrete applications. GRE hosted a workshop on soil stabilization in which NDDH participated, and it was successful. It may be beneficial to engage the American Public Works Association and Associated General Contractors of North Dakota in future educational efforts.

Barrier 11: Industrial Boiler By-Products Are Becoming a Public Perception Problem

Coal ashes from coal-fired industrial boilers (i.e., sugar beet plants, University boilers) have been used in soil stabilization applications in North Dakota. Some applications were approved by NDDH, but others were done without NDDH knowing they occurred and, therefore, were done without NDDH approval. The authors are unaware of an instance when NDDH has taken a corrective action toward those who conducted unapproved uses of industrial boiler coal ash in a soil stabilization application. Coal ash from industrial boilers is typically not well suited for soil stabilization because it frequently does not have the same cementitious reactivity as coal ashes from electric coal-based power plants.

Industrial boilers are typically stokers, so they do not pulverize the coal prior to combustion, and the resulting ash is generally coarser, exhibiting lower reactivity. Some industrial operators also sluice the ash which further reduces the reactivity because reactions occur before the ash is incorporated into the soil stabilization application. Stokers may also result in incomplete combustion of the coal because of the larger size of the coal going through the combustion zone.

When coal ash from an industrial boiler is used in an application and physically fails, this creates a public perception problem for utility coal ashes that may be better-suited for these uses. Often end users and NDDH do not distinguish between coal ashes from an industrial versus a utility boiler. Beneficial use of these ashes can produce very different environmental and engineering results.

Recommended Actions to Barrier 11

Industrial boilers producing coal ash may be unaware that their ash is different than ash produced from coal-fired power plants. An educational effort could be implemented by NDDH in order to inform industrial CCP generators of what testing and permissions would be needed to get their ashes used. This effort could take place in the form of sending them fact sheets on proper protocol.

POTENTIAL THREATS THAT COULD IMPACT FUTURE CCP UTILIZATION IN NORTH DAKOTA

The following potential threats could hinder the future of CCP beneficial use in North Dakota. For the purpose of this report, a threat is defined as an external challenge that could negatively impact the use of CCPs. Because threats are external, CCP stakeholders have no direct control over them but may benefit by having contingency plans to address them should they occur. The threats are based on information gathered at the discussion groups, and the authors believe the threats are listed in the order of importance.

Threat 1: Mercury Control Will Be a Concern for Utilization

At the time this state review was conducted in August 2007, the Clean Air Mercury Rule (CAMR) was calling for coal-based power plants to meet certain air emission standards for mercury. Most North Dakota coal-based power plants would have met the 2010 mercury emission regulations under CAMR as they currently operate but would have likely needed to implement new controls to meet 2018 requirements. Options for meeting those requirements include injecting activated carbon (AC), using an oxidized catalyst as a sorbent, installing a COHPAC™/TOXECON™ system (EPRI-licensed technologies), purchasing allowances, or coal drying.[4] Each of these options, with the exception of purchasing allowances, has different impacts on the CCPs.

On February 8, 2008, the courts vacated CAMR. EPA will develop a new rule regarding mercury emissions from coal-based power plants. It is unclear what EPA will do next or what the states should do regarding their own mercury rules. North Dakota does not have its own mercury rule and was planning to follow regulations set forth under CAMR.

Regardless of what rule comes to fruition and when those regulations need to be met, mercury is still expected to be regulated. NDDH and several other state and federal regulatory agencies are concerned about how new mercury emission controls will impact CCP utilization and disposal. NDDH has not evaluated by-products resulting from coal-based power plants with

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[4] Coal drying is a process that uses low-grade heat rejected from the steam condenser and waste heat from the flue gas leaving the boiler to evaporate a portion of the fuel moisture from the lignite feedstock in a fluidized-bed dryer. This process was developed in the United States by a team led by GRE, with funding from DOE (DOE Award Number: DE-CF26-04NT41763) (Bullinger and Sarunac, 2007).

mercury emission controls; therefore, regulating material use or disposal is new territory (as will be the case in other state health departments). During the NDDH discussion group session, EERC representatives indicated that NDDH should not be concerned about total mercury concentrations but should evaluate mercury mobility. The EERC further noted that mobility of mercury from CCPs generated with mercury emission controls has been shown to be very low and is not expected to impact disposal requirements (Hassett et al., 2007).

Threat 2: New CO_2 Regulations Are Expected, but the Impact to CCPs Is Not Clear

At present, there is a voluntary program for utilities to reduce the production of greenhouse gases, especially CO_2. In the future, it is anticipated that the reduction of CO_2 will be required, and coal-based electric generating power plants will need to employ CO_2 capture and sequestration technologies.

Aqueous amines are the state-of-the-art technology for pulverized-coal (pc) power plants to reduce CO_2. While this technology is not expected to directly impact CCP quantity or quality, one of the requirements for CO_2 capture using aqueous amines is that the gas stream must have very low particulate matter present. It is not currently known how the by-products from additional gas cleaning will be managed at power plants, but those particulates could either be managed with the by-products of the amine process or with other CCP streams.

Oxycombustion is another approach to producing a clean CO_2 stream for CO_2 capture. If oxycombustion is implemented at an existing power plant, it is possible that the resulting ash characteristics could be different from the materials produced using standard pc combustion.

Each coal-based power plant station will need to determine the best strategy for reducing CO_2 emissions in the future, which could include trading of CO_2 credits. At this time, it is important for coal-based power plants to keep abreast of CO_2 capture and sequestration technologies and for impacts to CCPs to be evaluated as part of the only research in this area.

CONCLUSIONS/SUMMARY

It is estimated that North Dakota coal-based power plants produce nearly 3 million tons of CCPs per year. Of that amount, 40% (or 1.2–1.3 million tons) is beneficially used. The following is a summary of highlights brought forth during the state review process and presented in this report.

Most North Dakota Coal-Based Power Plants Dispose Fly Ash – With the exception of GRE's CCS, North Dakota coal-based power plants generally dispose of the fly ash they produce. Possible reasons for disposal include the following:

1. Some fly ash is not suitable for use in concrete (i.e., high LOI, inconsistent supply, and quality).

2. Plant owners do not place a priority on utilization.

3. Two plants mix fly ash with SDA material, limiting its use potential.

4. CCS fly ash has saturated the market.

5. Plants lack the distribution infrastructure needed to supply the material.

Most Concrete Poured in North Dakota Contains CCS Fly Ash – The fly ash used in North Dakota concrete projects is predominantly supplied by GRE CCS. NDDOT uses fly ash in almost all concrete projects at a replacement rate of 30%. Ready-mix suppliers generally use a replacement rate of 25%.

Inert Classifications Allow Beneficial Use – Bottom ash and boiler slag produced by North Dakota coal-based power plants are classified as inert materials by NDDH. This allows the materials to be used without prior approval from NDDH.

Underground Mine Grout Fill Is Considered a Beneficial Use – In some states, using fly ash to fill underground AMLs is not considered a beneficial use; however, in North Dakota, it is the only preapproved beneficial use application for fly ash. North Dakota's mine reclamation program could serve as a model for other states.

Currently Produced FGD Materials Are Difficult to Utilize –All North Dakota coal-based power plants have a system in place to control SO_2 emissions (LOS is currently installing a wet FGD system) and produce a subsequent by-product. These by-products are difficult to market because they are a low-value material, have limited use potential, and are not located within close proximity to markets. Applications for fly ash/SDA material with the highest potential included cementitious products, masonry, flowable fill, synthetic aggregate, and mining applications. Agriculture applications are the most promising for other FGD materials.

Flowable Fill Is a Promising Untapped Market – Because the local concrete market is already saturated by CCS fly ash, those wishing to use fly ash will likely need to explore other markets, and flowable fill appears to be the best immediate option with the greatest demand. Barriers to overcome to enter this market include obtaining NDDH approval, getting NDDOT acceptance, and educating contractors/engineers about the use.

The Establishment of an Industry Group Focused on CCPs Would Be Beneficial – Organized industry-led groups can be effective in working with government agencies and state legislators because they represent a unified voice on behalf of their members and allow industry to pool its collective knowledge base and monetary resources to address key issues. Issues that a North Dakota industry-led group could address include working with NDDH to clarify Guideline 11, educating NDDOT on nonconcrete uses, and educating commercial concrete users (i.e., contractors, engineers, and architects) about the benefits of CCPs.

Mercury and CO_2 Emission Regulations Are of Minimal Concern – Pending mercury regulations and expected CO_2 restrictions will impact fly ash characteristics. However, because no power plants, aside from GRE CCS, are currently selling large volumes of fly ash, the impact may be minimal. Because fly ash sales are a significant revenue stream for CCS, it will take all necessary precautions to select emission control technologies that will not negatively impact the quality of the fly ash. Emission controls are not expected to impact disposal.

The Green Movement Needs a Push – Green building has not gained widespread acceptance in North Dakota from a consumer or regulatory standpoint. Opportunities exist to work with government policy makers to encourage legislation that would offer incentives for using green materials (i.e., CCP-containing materials).

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APPENDIX A

PARTICIPANT LIST

REVIEW OF NORTH DAKOTA REGULATIONS, STANDARDS, AND PRACTICES RELATED TO THE USE OF COAL COMBUSTION PRODUCTS
Bismarck, North Dakota
August 27–29, 2007

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APPENDIX B

REVIEW GUIDE

REVIEW OF NORTH DAKOTA REGULATIONS, STANDARDS, AND PRACTICES RELATED TO THE USE OF COAL COMBUSTION PRODUCTS
Review Guide
August 27–29, 2007
Bismarck, North Dakota

Background

The University of North Dakota Energy & Environmental Research Center (EERC) is conducting a review of North Dakota regulations, standards, and practices related to the use of coal combustion products (CCPs). Funding is provided by the North Dakota Lignite Research Council; Basin Electric Power Cooperative; Great River Energy; Minnkota Power Cooperative, Inc.; and the U.S. Department of Energy's Coal Ash Resources Research Consortium.

Previous reviews were conducted in Texas, Florida, and Pennsylvania. The final report from those reviews can be accessed online at **www.undeerc.org/carrc/html/review.html**. A national synthesis report from these individual state reviews is in preparation and will be published in 2007.

Objectives

- Highlight successes to CCP utilization
- Identify barriers to increased CCP utilization
- Develop recommendations that may help North Dakota and other states increase the use of CCPs

Process

A review team will pose a list of predetermined questions to key stakeholders involved in CCP utilization. The following discussion groups will be formed:

- Government agencies – directors and other key personnel of state transportation and health departments
- CCP generators – coal-fired electric generating company environmental and ash managers
- Concrete and other engineering applications – CCP marketers, ready-mix concrete suppliers
- Mining – North Dakota Public Service Commission, mining companies

Separate telephone interviews or e-mail correspondence may also take place with individuals unable to attend their scheduled session or those who have expertise outside of the major discussion groups.

Instructions

Please come to the review prepared to answer the following list of questions and assemble all applicable information prior to the review. Answer the questions as completely as is reasonably possible without stating proprietary information. Written responses to the questions are greatly appreciated but not expected. Any written documentation you can provide will ensure that exact citations are included in the final report. Please provide written comments to Tera Buckley at tbuckley@undeerc.org.

Reporting

A draft final report will be prepared and distributed to all interviewees. You will be given a 30-day review period to review the report and provide comments to the EERC. A final report will be published on or before December 31, 2007.

AGENDA

Monday, August 27, 2007

1:30 – 4:00 p.m.	North Dakota Public Service Commission

Tuesday, August 28, 2007

9:00 – 11:30 a.m.	Electric Generating Companies*
1:30 – 4:00 p.m.	North Dakota Department of Transportation

Wednesday, August 29, 2007

9:00 – 11:30 a.m.	North Dakota Department of Health
1:00 – 3:30 p.m.	Concrete and Other Engineering Applications*

*Meeting will be held at the Fort Totten meeting room in the state capitol building on the ground floor, west end.

If you are unable to attend your scheduled session, please contact Tera Buckley at (701) 777-5296 or tbuckley@undeerc.org.

GOVERNMENT AGENCIES

1. What is your agency's role in the management (use and/or disposal) of coal combustion products (CCPs)?

2. What type of infrastructure (i.e., employees, programs) has your agency dedicated to CCP management? How does the state headquarters interact with local, regional, and federal offices?

3. For which of the following CCPs does your agency have guidelines, guidance documents, material specifications, regulations, orders, or statutes? How were they developed and adopted? If applicable, provide references for, and dates of, the specific guidelines, guidance documents, material specifications, regulations, orders, or statutes related to CCPs.

   a. Fly ash

   b. Bottom ash

   c. Flue gas desulfurization material

   d. Boiler slag

   e. Other _______________

4. How would changes to the chemical or physical composition of CCPs impact your agency's role in the management of CCPs? For example, new air pollution control requirements may increase the carbon and mercury content of CCPs.

5. Are there any plans to implement any new policies, rules, or regulations regarding CCPs currently in process or expected in the near future?

6. What process does your agency undergo to make changes to its policies, rules, or regulations? Has this process ever changed over time?

7. Please list and explain any successful projects/applications using CCPs. Why were they successful?

8. Please list and explain any problematic projects/applications using CCPs. Explain the problems encountered and any instances where the use of CCPs was precluded in a project.

9. Please list and explain any cases in North Dakota where the use of CCPs has caused environmental damage or resulted in violations of environmental requirements. Describe any corrective actions, monitoring, and follow-up employed to address the issues.

10. In your opinion, what are the biggest obstacles hindering the increased use of CCPs in North Dakota? How could these obstacles be addressed?

11. Which of the following sources of information does your agency rely on in approving the use of CCPs in particular applications?

    a. Surveys of current practices (federal or state)

    b. Demonstration projects

    c. Internal (agency) testing and evaluations

    d. Technical reports submitted by qualified consultants

    e. Research projects or reports by other agencies, research institutions, or consultants

    f. Other ________________________________

12. What further research, laboratory work, or policy initiatives would be necessary to assist your agency in overcoming barriers?

13. In general, how do you perceive the position that North Dakota has taken toward CCP use in comparison to other states?

COAL COMBUSTION PRODUCT (CCP) GENERATORS

1. Please describe or provide written documentation on the type, amount, and current management practices employed for all CCPs produced at your facility.

2. Provide a general description of the CCP market in North Dakota, including supply and demand, and identify the major use applications. Are any CCPs being imported or exported?

3. How is coal ash utilization handled and perceived at your company? For example, at some electric generating companies, CCP utilization is a priority for upper management but not for plant operators.

4. What types of quality assurance/quality control procedures are employed at your company with regard to CCPs? Are efforts taken to ensure a consistent-quality product?

5. How would changes to the chemical or physical properties of CCPs impact your company's role in the generation, use, or disposal of CCPs? For example, new air pollution control requirements may increase the carbon and mercury content of CCPs. Do you foresee beneficiation technologies as a new trend to deal with these changes?

6. Please indicate your thoughts on the current CCP specifications or guidelines that you are aware of in North Dakota. Are there any environmental policies, permits, regulations, or statutes that impact the way you process and handle CCPs? What specifications or guidelines do you feel promote or restrict CCP utilization? What changes would you like to see made to the current specifications and guidelines?

7. Are you or your CCP users (marketers/contractors) provided with the flexibility to make the decision to utilize CCPs when the material meets standard specification requirements, or does the state require additional approvals and testing?

8. Please list and explain any successful projects/applications using CCPs. Why were they successful?

9. Please list and explain any problematic projects/applications using CCPs. Explain the problems encountered and any instances where the use of CCPs was precluded in a project. Describe any corrective actions, monitoring, and follow-up employed to address the issues.

10. Provide details of any ongoing or completed research and demonstration projects regarding CCPs.

11. In your opinion, what are the biggest obstacles hindering the increased use of CCPs in North Dakota? How could these obstacles be addressed? Would any changes to state or federal regulations help you address these obstacles?

12. What barriers has your company overcome to increase the use of CCPs? How?

13. What further research, laboratory work, or policy initiatives would be necessary to assist your company in overcoming barriers?

14. In general, how do you perceive the position that North Dakota has taken toward CCP use in comparison to other states?

CONCRETE AND OTHER ENGINEERING APPLICATIONS

1. Provide a general description of the coal combustion product (CCP) market in North Dakota, including supply and demand, and identify the major use applications. Are any CCPs being imported or exported? How much concrete is being used in various segments of the market (i.e., residential, commercial, highway construction)?

2. What is the general feeling toward CCPs in your industry? How would you describe the competition between fly ash and portland cement? Are there any product acceptance issues among consumers with concrete containing fly ash?

3. Please indicate your thoughts on the current specifications or guidelines that you are aware of in North Dakota related to CCPs. Are there any environmental policies, permits, regulations, or statutes that impact the way you process and handle CCPs? What specifications or guidelines do you feel promote or restrict CCP utilization? What changes would you like to see made to the current specifications and guidelines?

4. Please list and explain any successful projects/applications using CCPs. Why were they successful?

5. Please list and explain any problematic projects/applications using CCPs. Explain the problem encountered and any instances where the use of CCPs was precluded in a project. Describe any corrective actions, monitoring, and follow-up employed to address the issues.

6. What role do other alternative materials (i.e., natural aggregate) play in your business?

7. How would changes to the chemical or physical composition of CCPs impact your company's role in the use of CCPs? For example, new air pollution control requirements may increase the carbon and mercury content of CCPs. Do you foresee beneficiation technologies as a new trend to deal with these changes?

8. In your opinion, what are the biggest obstacles hindering the increased use of CCPs in North Dakota? How could these obstacles be addressed? Would any changes to state or federal regulations help you address these obstacles? Could coal-fired power plants do something to overcome these obstacles?

9. What further research or laboratory work would be necessary to overcome barriers to CCP utilization?

10. In general, how do you perceive the position North Dakota has taken toward CCPs in comparison to other states?

NORTH DAKOTA PUBLIC SERVICE COMMISSION

1. What is your agency's role in the management (use and/or disposal) of coal combustion products (CCPs)?

2. What type of infrastructure (i.e., employees, programs) has your agency dedicated to CCP use in mining applications? How does the state headquarters interact with district, regional, and federal offices?

3. For which of the following CCPs does your agency have guidelines, guidance documents, material specifications, regulations, orders, or statutes? How were they developed and adopted? If applicable, provide references for, and dates of, the specific guidelines, guidance documents, material specifications, regulations, orders, or statutes related to CCPs.

   a. Fly ash

   b. Bottom ash

   c. Flue gas desulfurization material

   d. Other _______________

4. Would changes to the chemical or physical composition of CCPs impact the requirements for CCP use in mining applications? For example, new air pollution control requirements may increase the carbon and mercury content of CCPs.

5. Are there any plans to implement any new policies, rules, or regulations regarding CCPs currently in process or expected in the near future?

6. What process does your agency undergo to make changes to its policies, rules, or regulations? Has this process ever changed over time?

7. Please list and explain any successful projects/applications using CCPs. Why were they successful?

8. Please list and explain any problematic projects/applications using CCPs. Explain the problems encountered and any instances where the use of CCPs was precluded in a project.

9. The National Academy of Sciences recently published a report entitled "Managing Coal Combustion Residues in Mines." What is your opinion of that report? Do you think the report will have an impact on the way CCPs are used in mines in North Dakota?

10. How does the general public perceive CCP use in mining applications?

11. In your opinion, what are the biggest obstacles hindering the increased use of CCPs in North Dakota? How could these obstacles be addressed?

12. Which of the following sources of information does your agency rely on in approving the use of CCPs in particular applications?

    a. Surveys of current practices (federal or state)

    b. Demonstration projects

    c. Internal (agency) testing and evaluations

    d. Technical reports submitted by qualified consultants

    e. Research projects or reports by other agencies, research institutions, or consultants

    f. Other ______________________________

13. What further research, laboratory work, or policy initiatives would be necessary to assist your agency in overcoming barriers?

14. In general, how do you perceive the position that North Dakota has taken toward CCP use in mining applications in comparison to other states?

APPENDIX C

GUIDELINE 11 – ASH UTILIZATION FOR SOIL STABILIZATION, FILL-IN MATERIALS AND OTHER ENGINEERING PURPOSES

GUIDELINE 11 - ASH UTILIZATION FOR SOIL STABILIZATION, FILLER MATERIALS AND OTHER ENGINEERING USES

North Dakota Department of Health - Division of Waste Management
Telephone 701-328-5166 ● Fax 701-328-5200 ● Website
www.health.state.nd.us
Rev: 04/01

Attachment: Parameters and Methods for Assessing Leachability* of Fly Ash and Runoff from Fly Ash Utilization Sites in North Dakota (Parameters may be reduced based upon review.)

North Dakota Department of Health is working with a number of power plants, coal-fined boiler operators, coal mines, and other entities wishing to utilize waste materials such as coal-fired fly ash and/or bottom ash for engineering purposes. Some projects such as road stabilization, underground mine stabilization, controlled strength flowable fill, and other uses have been reviewed and approved by the Department based on an evaluation of the material's engineering and environmental properties. Persons proposing use of waste materials for beneficial reuse need to demonstrate that the material will be beneficially used without adversely impacting the environment.

Beneficial reuse must be carefully considered to ensure it is not simply *"use constituting disposal"* or *"sham recycling."* Proposers should be familiar with the state's environmental laws and rules, including the North Dakota Solid Waste Law, Chapter 23-29 North Dakota Century Code (NDCC); the North Dakota Solid Waste Management Rules, Article 33-20 North Dakota Administrative Code (NDAC); as well as the state's Water Pollution laws, Chapter 61-28 NDCC, which includes Section 61-28-06 which states in part:

"It shall be unlawful for any person:

a. To cause pollution in any waters of the state or to place or cause to be placed any waters in a location where they are likely to cause pollution of any waters of the state . . . "

The Department needs to review important aspects of any proposal, including, but not limited to, the ash quality and quantity, the proposed use of the ash, site characteristics, potential receptors, how the material will be handled, contingency plans in case adverse environmental conditions arise, how the site will be monitored to ensure environmental protection, what will be done when use of the material is completed, any local health or zoning issues, site closure and reclamation, etc. At a minimum, any proposal should address the following:

1. **Background information on the source, quality, and quantity of the ash** including the generator of the ash; the type of facility, the boilers, the pollution control equipment, etc., used in generating and collecting the ash; the source and the type of fuel used in the process; the variability of the ash; whether it is a mixture of other materials or waste streams, how it is stored and handled prior to any disposal or use, and any other information necessary.

2. **Analysis of the ash,** including both existing information and, as necessary, some leach analysis. Information that might be provided would include mineralogical properties and total analysis plus an assessment of the environmental leachability of the ash materials. At a minimum, an ash leach test on one or more representative samples utilizing either: (1) a

modified EPA Synthetic Precipitation Leaching Procedure (SPLP) Method 1312, with a *solution to solid ratio 4:1*, or (2) A modified ASTM D-3987 procedure with a *solution to solid ratio of 4:1*. A list of chemical parameters is attached to this memorandum. The detection limits for analysis must be substantially below the safe drinking water standards.

3. **A discussion and details on the proposed use of the ash**, including any admixtures, fill materials, soil, etc., should be provided. Information that is essential for review includes a description of the actual beneficial use; the mix ratio and design lift thickness; type and quality of fill materials, moisture levels, compaction, and engineering properties (including the strength and durability of materials), and what the material will be covered with, assessment of weathering, material breakup, etc., should be provided.

4. **A laboratory simulation** of the environmental properties of the proposed use should be addressed. Laboratory simulation testing to replicate field conditions determine leachability of the material as-placed should be provided. Upon discussion with the Department, a field simulation test should be agreed upon that will be adequate to determine any impact on the environment from initial waste placement, and any impact through continued weathering, mechanical abrasion, erosion, field runoff, etc. Various simulation tests have been approved by the Department, including kinetic tests simulating infiltration of water through fill materials.

   One publication that has been utilized for evaluating ash utilization in a mine setting is the publication *"Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Mine Sites in British Columbia"* by Dr. William A. Price, Reclamation Section, Energy and Minerals Division, Ministry of Employment and Investment, Bag 5000, Smithers, British Columbia, V0J2N0. Other information is available in Departmental files or may be proposed by the applicant based on the conceptual field application. Laboratory simulation of the field application methods might also entail testing of the materials due to its fate in the environment through weathering, breakup, erosion, abrasion, excavation, etc.

5. **The site characteristics**, including soils, topography, geology, hydrogeology, groundwater quality, surface water conditions and flow, vegetation, etc.

6. **Potential receptors**, including nearby communities, residences, parks, natural areas, neighboring land use, waterways, site drainage, groundwater conditions and quality groundwater wells, and any other information necessary to assess potential impacts to health and the environment.

7. **Description of the material handling and conceptual construction**, including transport and storage of materials, placement of materials, equipment, construction techniques, moisture application and monitoring, mixing, testing, etc., as well as controls and monitoring of windblown dust, stormwater and/or any ponded water must be described.

8. **The proposal should address reasonable contingencies** such as discontinuance of the application methods, cleanup of the site should environmental damage occur, final disposal of placed materials after the life of the project, etc.

9. **Approval by any local health, environmental, and permitting authorities** must be obtained before the project is conducted. Any Departmental approval is contingent upon and does not supersede compliance with all local environmental, health, and building code requirements.

10. **Monitoring of surface, groundwater, air, and soil** may be required.

11. The proposer should provide routine reports on construction and operation progress, monitoring results, final construction details and, for ongoing projects, periodic re-analysis of the ash material on an annual basis or, more often, under the following circumstances:

    a. The process generating that waste changes, such as the installation of different boilers, burners, pollution control equipment, or any other process change which might influence the character of the waste being utilized;

    b. In the event that the raw material or type of fuel changes; and

    c. Any other changes or variances which may influence the characteristics of the ash/product or the mixture used in the construction project.

This outline is provided for guidance purposes only. Additional requirements or conditions may be stipulated by the Department, dependent on the particular application, site characteristics, or other regulatory requirements.

Should you have any questions regarding these matters, please feel free to contact the Department at (701) 328-5166. More information on the state's environmental laws and rules are available at our Website www.state.nd.us

North Dakota Department of Health - Division of Waste Management

Parameters and Methods for Assessing Leachability* of Fly Ash and Runoff from Fly Ash Utilization Sites in North Dakota (parameters may be reduced based upon review)

a. Basic water parameters:

(1) Appearance (including color, foaming, and odor)
(2) pH[1]
(3) Specific conductance[2]
(4) Temperature

b. General geochemical parameters:

(1) Ammonia nitrogen
(2) Total hardness
(3) Iron
(4) Calcium
(5) Magnesium
(6) Manganese
(7) Potassium
(8) Total alkalinity
(9) Bicarbonate
(10) Carbonate
(11) Chloride
(12) Fluoride
(13) Nitrate + Nitrite, as N
(14) Total phosphorus
(15) Sulfate
(16) Sodium
(17) Total dissolved solids (TDS)
(18) Total suspended solids (TSS)
(19) Cation/anion balance
(20) Sodium Adsorption Ratio SAR)

c. Heavy Metals:

Group A:

(1) Arsenic
(2) Barium
(3) Boron
(4) Cadmium
(5) Chromium
(6) Lead
(7) Mercury
(8) Selenium
(9) Silver

Group B:

(10) Antimony
(11) Beryllium
(12) Cobalt
(13) Copper
(14) Nickel
(15) Thallium
(16) Vanadium
(17) Zinc

d. For Fly Ash waste analysis, naturally occurring radionuclides:

(1) Gross Alpha Particle Radioactivity (pCi/1)
(2) Radium 226 and 228 (pCi/1)
(3) Uranium

*Ash leach test on one or more representative sample(s) using a **modified** EPA Synthetic Precipitation Leaching Procedure (SPLP) method 1312 with a **solution to solid ratio of 4:1. A modified ASTM D-3987 procedure with a solution to solid ratio of 4:1 may also be used.** Laboratory detection limits must be substantially below the level of any state or federal drinking water standard or goal.

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