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SUMMARY OF CCP REGULATIONS AND SPECIFICATIONS OF FOUR EPA REGION 8 STATES: MONTANA, NORTH DAKOTA, SOUTH DAKOTA, AND WYOMING

Revised Task 1 Report

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NOMENCLATURE

AASHTO	American Association of State Highway and Transportation Officials
ARM	Administrative Rules of Montana
ASTM	ASTM International
CCP	coal combustion product
DEQ	Department of Environmental Quality
DOE	U.S. Department of Energy
DOT	Department of Transportation
EERC	Energy & Environmental Research Center
EPA	U.S. Environmental Protection Agency
MDT	Montana Department of Transportation
NDAC	North Dakota Administrative Code
NDDH	North Dakota Department of Health
NDDOT	North Dakota Department of Transportation
SDDOT	South Dakota Department of Transportation
WYDOT	Wyoming Department of Transportation

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INTRODUCTION

This project was made possible by funding from the U.S. Environmental Protection Agency (EPA) Region 8. Current regulations, standards, and practices related to the use of fly ash for soil stabilization applications were reviewed in Montana, North Dakota, South Dakota, and Wyoming. This effort built on a broader effort completed in 2005 under a contract with the U.S. Department of Energy (DOE)-funded Combustion Byproducts Recycling Consortium. An Energy & Environmental Research Center (EERC) report entitled "Engineering and Environmental Specifications of State Agencies for Utilization and Disposal of Coal Combustion Products" lists state transportation and environmental specifications pertaining to coal combustion products (CCPs) in two volumes (Dockter and Jagiella, 2005a,b). Preliminary information related to CCPs was taken from that report, and more detailed information, with an emphasis on soil stabilization, was sought from state Department of Transportation (DOT) offices and state environmental departments.

Following a series of three state reviews funded by EPA and DOE, with a goal to better understand the status and development of different CCP utilization profiles across the United States, a fourth state review was conducted by the EERC in North Dakota (Buckley and Pflughoeft-Hassett, 2008). The report identified keys to the successful utilization of CCPs, barriers that currently hinder increased CCP utilization, and potential threats that could hinder CCP utilization in North Dakota. The report was used to provide additional information on the use of CCPs in the state of North Dakota for this project.

The information is presented in two categories for each state. The first category presents existing DOT engineering specifications as they pertain to the use of CCPs. The second category details the environmental statutes and regulations for each state as they pertain to utilization, handling, and disposal of CCPs. Specifications for the utilization and disposal of CCPs are continuously being updated and modified to express the trends for a particular state. Associated contact information for the state agencies is provided. The results here are but a summary of current specifications for four EPA Region 8 states at the time of publication of this report.

MONTANA

Montana Department of Transportation

The Standard Specifications for Road and Bridge Construction, 2006 Edition, adopted by the Montana Department of Transportation (MDT) and the Montana Transportation Commission, provides information on the requirements related to the use of fly ash and other cementitious materials in MDT applications. The document and supplemental information are

available on the MDT Web site. Fly ash is indicated for use as a partial replacement for portland cement, as a mineral filler, and in flowable fill.

The following cementitious materials may be used as partial replacement for portland cement in the mix design:

- Fly ash may be included in the mix design for up to 20% by weight of the total cementitious material. Portland cement meeting American Association of State Highway and Transportation Officials (AASHTO) M85, Table 1, may be used in place of moderate heat-of-hydration cement where fly ash is substituted.

- Microsilica may be included in the mix design for up to 5% by weight of the total cementitious material when a minimum of 15% fly ash is also included in the mix design or when the mix design uses Type IP blended cement.

- Metakaolin may be included in the mix design for up to 20% by weight of the total cementitious material.

- Ground granulated blast furnace slag may be included in the mix design for up to 20% by weight of the total cementitious material.

Fly ash must meet the AASHTO M295 mineral admixture Class C or Class F chemical requirements of Table 1 and physical requirements of Table 3. It must also be from a source on DOT's approved source list. Microsilica must meet AASHTO M307 specifications. Metakaolin must meet the AASHTO M295 mineral admixture Class N chemical requirements of Table 1 and physical requirements of Table 3.

Fly ash is allowed to be used as mineral filler as well as are portland cement, ground limestone dust, or graded fines free of silt or clay produced from crushing stone, gravel, slag, or other nonplastic mineral matter. These are subject to approval. The mineral filler materials must meet the following criteria as determined by AASHTO T165, AASHTO T167, Montana Test Method MT-306, or other tests:

- Dry and free from fine-particle lumps

- Free carbon less than or equal to 5% by weight as measured by the loss-on-ignition test

- Silica content less than or equal to 10% for uncalcined materials

Fly ash is used in flowable fill in a mixture with portland cement, fine aggregate, air-entraining admixture, and water. Mix guidelines for excavatable and nonexcavatable flowable fill are provided in the standard specifications. Fly ash is not suggested in the design for excavatable flowable fill.

District representatives of MDT were contacted to discuss the regional soil stabilization practices. Only one of the representatives contacted indicated that fly ash has been used for soil

stabilization applications, although it is not a routine practice. In that same district, lime has also been used for soil stabilization purposes. Other districts have not used stabilizing agents but have considered lime, cement, or fly ash. The district departments have not performed soil stabilization for parking lots and other construction projects. Design considerations vary by project, so the MDT does not have a standard practice for soil stabilization. Mitigation efforts are determined by the soil type and cost-effectiveness of potential stabilizing agents. Example soil stabilization practices include removing the surface or milling the aggregates with a stabilizing agent such as cement.

Montana Department of Environmental Quality

Montana law exempts electrical generation facilities from the solid waste licensure for disposal of coal ash waste on-site under 75-10-214(1)(b), Montana Code Annotated (MCA). Further, in accordance with the Administrative Rules of Montana (ARM) 17.54.307(2) (b), fly ash, bottom ash, slag, and flue gas emission control wastes generated primarily from the combustion of coal or other fossil fuels are exempt from regulation as hazardous waste. However, ARM 17.50.502(22) identifies these materials as industrial solid waste – a Group II waste in accordance with ARM 17.50.503(1)(a)(1). ARM 17.50.502(52) exempts by-products or materials that have economic value and may be used by the person producing the material or sold to another person for resource recovery or use in a beneficial manner as wastes. However, the user must demonstrate the proposed use is beneficial and that it will not negatively impact human health or the environment before the exemption from regulation as a waste is approved.

The reuse of CCPs is not specifically authorized under Montana law or regulations although fly ash may be substituted for up to 25% of portland cement in connection with monitoring well construction (ARM 36.21.801[39][h]). The Montana Department of Environmental Quality (DEQ) currently has guidelines for beneficial use and is in the process of developing rules pertaining to the beneficial use of by-products or materials. At the present time, beneficial use is reviewed on a case-by-case basis. DEQ encourages the reuse of CCPs, especially in construction projects, and provides referrals to companies wishing to reuse CCPs.

Class C fly ash and Class F lime blends can be used in numerous geotechnical applications to improve soil strength, control shrink–swell in native soils, and as a drying agent to reduce soil moisture content and increase soil density and compaction. Because of these characteristics, fly ash meeting minimum AASHTO M240 criteria may be used in Montana in road construction projects.

According to a Montana DEQ representative, of the 1.3 million tons of CCPs generated annually in Montana, all but 30,000 tons are landfilled. The 30,000 tons that are not disposed of are reused in the manufacture of cement and concrete products, for the stabilization of soils prior to road and commercial site construction, and as a drying agent in coal-processing waste to reduce the moisture content prior to disposal.

NORTH DAKOTA

North Dakota Department of Transportation

The Standard Specifications for Road and Bridge Construction was adopted by the North Dakota Department of Transportation (NDDOT) in 2008 and provides information on the requirements related to the use of fly ash in NDDOT applications. The document and supplemental information are available on the NDDOT Web site. Fly ash is indicated for use as a partial replacement for portland cement, in lime–fly ash-treated subgrade, in Econocrete, and as an aggregate base.

Fly ash must meet the following specifications for the specific types of work:

- Portland cement concrete – AASHTO M295
- Lime–fly ash-treated subgrade – ASTM International (ASTM) C593
- Econocrete – AASHTO M295
- Aggregate base – ASTM C593

Sampling and testing all fly ash is at the contractor's expense, except as described below. The chemical composition of fly ash required to meet AASHTO M295 must be Class F (as described in Table 1 of AASHTO M295) with the following modifications:

A. The total of silicone dioxide (SiO_2) plus aluminum oxide (Al_2O_3) plus iron oxide (Fe_2O_3) will be at least 66.0% by dry weight of the total fly ash composition.

B. The SiO_2 will be at least 40.0% by dry weight of the total fly ash composition.

C. Loss on ignition will be no more than 2.0% maximum.

D. The optional requirements of Table 2 will be required.

Fly ash will be from an electrical generating plant using a single coal source. 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.

Fly ash replacement of cement is allowed on a 1:1 ratio, up to a maximum of 29% by weight. Fly ash will not be 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.

NDDOT district representatives contacted to discuss the regional soil stabilization practices indicated that fly ash has been used for soil stabilization applications on a limited basis. Lime has also been used for soil stabilization purposes. The regional departments have performed soil stabilization primarily for roads. A common soil stabilization practice is to dry the area requiring mitigation. Geotextiles have commonly been used, and lime was mentioned as another material.

North Dakota Department of Health

Under North Dakota law and regulations, fly ash, bottom ash, slag, and flue gas emission control waste generated primarily from the combustion of coal or other fossil fuels are regulated as nonhazardous solid waste (special waste) under North Dakota Century Code (NDCC) Chapter 23-29 and North Dakota Administrative Code (NDAC) Article 33-20 Solid Waste Management and Land Protection rules.

The North Dakota Department of Health (NDDH) has approved the use of fly ash as a replacement for cement in concrete and has approved demonstration projects using fly ash as an admixture in controlled low-strength grout for stabilizing and reclaiming high-hazard dry underground mines as administered by the state Public Service Commission Abandoned Mine Land Reclamation Program. NDDH has worked with a number of energy companies as well as with some food processors utilizing coal as a fuel to develop beneficial uses for CCPs or ash. The NDDH Guideline 11, "Ash Utilization for Soil Stabilization, Fill-In Materials and Other Engineering Purposes," provides guidelines for ash reuse. Proposed reuse projects are evaluated on a case-by-case and site-specific basis by NDDH, contingent upon protection of surface water, groundwater, and air resources. Proposed uses must demonstrate that constituents of concern do not exceed drinking water maximum contaminant levels, surface water quality standards, or soil ingestion guidelines. Proper management and handling of materials is required to minimize potential for ingestion, skin contact, and inhalation and to minimize spillage, wind-blown dust, etc.

The review of projects looks at site soils, geology, groundwater and surface water conditions, and proximity to receptors.

Bottom ash is classified as an inert waste by NDDH as long as it is not mixed with other wastes. In North Dakota, clean bottom ash is typically used in active mines as a road base and for ice control on public and private roads. Boiler slag meets the definition of an inert waste as defined by the North Dakota Solid Waste Management Rules as long as it is not mixed with other wastes. Clean slag is sold for sand blasting, ice control, manufacture of roofing shingles, and for base on mine roads or drainage media (Buckley and Pflughoeft-Hassett, 2008; Tillotson, 2011).

A demonstration project conducted by EERC researchers led to an approval process for the use of fly ash for feedlot and livestock pen stabilization in NDDH-approved feedlots. A manual was developed by the research project team, consisting of the North Dakota State University Carrington Research Extension Center; the EERC; and Power Products Engineering, Inc., for feedlot operators with guidance on the appropriate use of fly ash to stabilize soil in livestock facilities in the state of North Dakota (Anderson et al., 2004). The manual is to be used in accordance with the NDDH criteria for siting feedlots outlined in NDAC Section 33-16-03-04.

North Dakota State Review Findings

The North Dakota state review process identified strengths, barriers, and potential threats to the utilization of CCPs in North Dakota. The coal-based power plants in the state produce a range of CCPs and, therefore, employ a range of utilization and disposal scenarios. CCP utilization applications include the following:

- Cement replacement in concrete
- Solidification of waste pits in area oil fields
- Mine subsidence
- Soil stabilization
- Haul roads in a mine
- Road base/subbase applications (bottom ash)
- As aggregate, sand-blasting grit, in roofing shingles, and for ice control (bottom ash and slag)

NDDOT uses fly ash in almost all concrete projects at a replacement rate of 30%. A replacement rate between 15% and 30% is specified by most state DOTs (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. NDDOT representatives interviewed during the North Dakota state review process 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. The authors concluded that industry should approach all levels of NDDOT to demonstrate the engineering, environmental, and economic benefits of using CCPs in flowable fill applications.

NDDH Guideline 11 is intended to present a flexible framework to facilitate the department's evaluation of potential impacts to surface water, groundwater, soils, and the environment. The state review team concluded, and NDDH concurs, that the NDDH does not have sufficient resources available to encourage the use once a beneficial use rule is in place (Buckley and Pflughoeft-Hassett, 2008). The NDDH recognizes the guideline is not all encompassing and is willing to work on additional scientific and engineering studies if the NDDH is factored into the initial project setup and investigation (Tillotson, 2011).

The state review team suggested that to overcome the barrier of local concrete market saturation, other high-value road-building and construction applications such as flowable fill, backfill, and road base applications should be explored. They noted that workshops for contractors, architects, city engineers, and government agencies would be helpful to educate them on CCP use in nonconcrete applications. Great River Energy hosted a workshop on soil stabilization in which NDDH participated, and it was successful (Buckley and Pflughoeft-Hassett, 2008).

SOUTH DAKOTA

South Dakota Department of Transportation

The 2004 Standard Specifications for Road and Bridge Construction, adopted by the South Dakota Department of Transportation (SDDOT), provides information on the requirements related to the use of fly ash in SDDOT applications. The document and supplemental information are available on the SDDOT Web site. Fly ash is indicated for use as a partial replacement for portland cement, as a mineral filler, in flowable fill, and as a grout in certain applications.

Class C fly ash conforming to AASHTO M295 will be allowed in grout for pavement jacking, undersealing, or when specified. All other fly ash shall conform to AASHTO M295 Class F including the optional requirements in the referenced AASHTO specification except as modified by the following:

- Loss on ignition, 2.0% maximum
- Moisture content, 2.0% maximum
- Available alkali as Na_2O, 1.5% maximum

Available alkalies up to 2% may be used, provided mortar expansion test results at 14 days are less than or equal to that of the control sample. The expansion test will be run in accordance with modified ASTM C441.

Fly ash will be from approved base-loaded electric generating plants using a single coal source. Using a limestone injection process for controlling air pollutants is not acceptable. Fly ash from the start-up and shutdown of the plant will not be used. The total of SiO_2 plus Al_2O_3 plus Fe_2O_3 will be at least 66.0% by dry weight of the total fly ash composition. The SiO_2 will be at least 40.0% by dry weight of the total fly ash composition.

For normal pavement concrete, the maximum replacement limit of fly ash for cement is 20%, and it is replaced on a 1:1 rate per pound. Class C fly ash is only allowed for pavement jacking, undersealing, flowable fill, etc. Class F modified fly ash is required for normal concrete applications.

Fly ash will not be permitted when Type III cement is used. Pozzolan-modified (PM) cement, if used, will conform to AASHTO M240. Fly ash may not be substituted for a portion of PM portland cement. If fly ash is substituted for cement in concrete, the minimum amount of cement to be replaced is 15% and the maximum amount is 20% at a 1:1 ratio by weight. For concrete pavement, the 28-day compressive strengths of concrete with fly ash will be at least 95% of the 28-day compressive strength obtained using the design mix with cement only.

Fly ash is allowed in structural concrete, which is used in bridges, box culverts, and miscellaneous structures. Grout mixtures, for pavement jacking, are proportioned as one part portland cement with three parts fly ash. Mineral filler, for mineral aggregates in asphalt

concrete, will consist of finely ground particles of stone, fly ash, lime, or portland cement. The asphalt concrete aggregate can be used for haul roads.

SDDOT region representatives were contacted to discuss the regional soil stabilization practices. The representatives indicated that fly ash has been used for soil stabilization applications, although it is not a routine practice. Lime has also been used for soil stabilization purposes. The regional departments have performed soil stabilization for parking lots and other construction projects. SDDOT does not have a standard practice for soil stabilization as each site or problem area is evaluated individually based on soil type and reason for requiring mitigation. Excavation and replacement of an unsuitable material is typical. When excavation is not suitable, stabilization techniques such as geogrid/geosynthetics, fly ash, lime, pit run, additional granular base material, or other methods may be used. Estimated quantities of fly ash used for soil stabilization applications by different regional departments included 1000 tons over the past 5 years, 300–500 tons over the past 5 years, and 110 tons 10 years ago.

South Dakota Department of Environment and Natural Resources

South Dakota regulations adopt by reference the federal regulations that exempt CCPs from classification as hazardous waste. Exempt from hazardous waste regulation are fly ash, bottom ash, slag, and flue gas emission control waste generated primarily from the combustion of coal, South Dakota Administrative Rule 74:28:22; 40 Code of Federal Regulations (CFR) 261.4. CCPs are considered solid waste and are regulated under the Solid Waste Management Program. Currently, reuse of CCPs is not specifically authorized under South Dakota law or regulations. The South Dakota Department of Environment and Natural Resources (DENR) will consider reuse projects on a case-by-case basis. Approval for reuse will depend on the type of ash (bottom, fly, or both) and the proposed use.

Upon further contact, a South Dakota DENR representative indicated that fly ash is primarily used for feedlot stabilization. There is an approval process in place for this purpose.

WYOMING

Wyoming Department of Transportation

The State of Wyoming Department of Transportation (WYDOT) Standard Specifications for Road and Bridge Construction, 2010 Edition, adopted by the Transportation Commission of Wyoming, provides information on the requirements related to the use of fly ash in WYDOT applications. The document and supplemental information are available on the WYDOT Web site. Fly ash is indicated for use as a partial replacement for portland cement, in flowable fill, as a backfill, and as an aggregate replacement as a blotter material for plant mix pavement crack sealing.

Fly ash will conform to the requirements of ASTM C311 and ASTM C618 for either Class C or Class F. Approval of the source must be obtained from the Materials Program. For

aggregate sources that are determined to be reactive by the Materials Program, the requirements of ASTM C618, Table 4, will also apply. A list of approved fly ashes is maintained by WYDOT.

Approval is required from the Materials Program if fly ash is to be used in a blended hydraulic cement in accordance with ASTM C595 for Type I PM portland cement. The pozzolan must be in accordance with ASTM C618 and ASTM C311.

Only preapproved fly ash as listed in the Materials Testing Manual may be incorporated into portland cement concrete pavement. Class C fly ash is not approved. A Class F fly ash substitution rate of 20% to 25% by mass is allowed for concrete pavement mixes and is required for a Level of Control I, which requires the strictest level of quality assurance and quality control testing. Fly ash is listed as a material in numerous other concrete applications, including precast concrete; concrete barriers; drilled shaft foundations; reinforced bridge approach fills and reinforced concrete approach slabs; reinforced concrete slope paving; structural concrete; culverts and storm drains; underdrains; guardrail and median barriers; fences; minor paving (sidewalks, bike paths, median paving, ditch paving, and other minor paving); curb and gutter; highway monuments; inverted pipe siphons; erosion control concrete; cattle guards; cutoff walls and head walls; precast reinforced concrete stock passes; adjustment of valve boxes, fire hydrants, and associated waterlines; slotted drains; and electrical devices.

For structural concrete, fly ash may be substituted up to a maximum of 20% by weight (mass) for portland cement when approved by the department's Materials Program, based on a satisfactory trial mix. A fly ash-to-cement replacement ratio of 1.33:1 is to be used for fly ash with a calcium oxide content of less than 20%. The total combined weight (mass) of portland cement and fly ash is not allowed to vary more than 1% from the approved trial mix.

Reinforced concrete pipe using Type V cement with fly ash requires 20%–30% Class F fly ash by weight (mass). When fly ash is used in a flowable fill, a minimum of 50 lb cement/yd^3 and 80 lb fly ash/yd^3 are required. Flowable fill is specified as a backfill for culvert excavations and as a fill for voids in reinforced concrete slope paving repair/modification, may be specified as a backfill for new culverts and storm drains or for adjustments of valve boxes and fire hydrants, and is an option for fill around bearing piles.

Materials other than aggregate that may be used as blotter material for sealing cracks in plant mix pavement include portland cement, fly ash, sawdust, blotter paper, or biodegradable, nontoxic, nonhazardous compounds designed to form a temporary protective barrier over the sealant to prevent tracking.

ASTM C1567, Standard Test Method for Determining the Potential Alkali–Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method), is the test required when fly ash is to be used in concrete. Approved Class F fly ash and/or lithium nitrate additive are used to mitigate reactive sources of alkali–silica reactions.

One district representative indicated that fly ash has not been used in soil stabilization applications through that location. Lime has been used a limited number of times to dry wet soil

and make it less susceptible to moisture. The regional department had not performed soil stabilization for parking lots and other construction projects.

Wyoming Department of Environmental Quality

Wyoming regulations adopt by reference the federal regulation that exempts CCPs from classification as hazardous waste. Exempt from hazardous waste regulation are fly ash, bottom ash, slag, and flue gas emission control waste generated primarily from the combustion of coal, Wyoming Administrative Code HWM Ch. 2 §1; 40 CFR 261.4. Wyoming law regulates CCPs as an industrial solid waste, Wyoming Administrative Code SWM Ch. 1, §1(e)(i).

Currently, reuse of CCPs is not specifically authorized under Wyoming law or regulations. Wyoming's beneficial use program currently considers beneficial use proposals for CCP reuse on a case-by-case basis. Encapsulated uses of CCPs are well-researched and, therefore, generally supported. Unencapsulated uses are evaluated on a case-by-case/site-specific basis to account for variables such as the characteristics of the CCP and conditions at the proposed reuse site that could threaten human health and the environment. In general, CCP generators must demonstrate that constituents of concern do not exceed precalculated levels based on 1) direct contact with the CCP (which includes ingestion, skin contact, and inhalation) and 2) the potential for contaminants in the CCP to migrate to groundwater. According to the Wyoming DEQ, the agency is in the process of developing regulatory guidelines for beneficial reuse of solid waste, including CCPs.

SUMMARY OF DOT SPECIFICATIONS

The DOT specifications for Montana, North Dakota, South Dakota, and Wyoming indicate the use of fly ash in several applications within the Standard Specifications for Road and Bridge Construction. The primary use is as a partial replacement for portland cement for use in various concrete applications. Other applications include as a mineral filler, in flowable fill, in lime–fly ash-treated subgrade, in Econocrete, as an aggregate base, as a grout in certain applications, and as blotter material for sealing cracks in plant mix pavement.

Soil stabilization applications are generally limited in the four states. Stabilizing agents have included geosynthetic materials, lime, cement, and fly ash. A variety of techniques have been employed when soil stabilization is required for DOT projects and are site-specific based primarily on the soil type.

SUMMARY OF ENVIRONMENTAL AGENCY REGULATIONS

Montana, North Dakota, South Dakota, and Wyoming have exempted CCPs from regulation as hazardous waste. The reuse of CCPs is not specifically authorized under law or regulation in Montana, South Dakota, and Wyoming. Beneficial use of CCPs is reviewed on a case-by-case basis in each of the four states. NDDH's Guideline 11 – Ash Utilization for Soil Stabilization, Fill-In Materials, and Other Engineering Purposes summarizes the department's

approach to CCP utilization. NDDH has approved the use of fly ash in concrete and has approved demonstration projects using fly ash as an admixture in controlled low-strength grout for stabilizing and reclaiming high-hazard dry underground mines as administered by the state Public Service Commission Abandoned Mine Land Reclamation Program. The Montana DEQ encourages the reuse of CCPs, especially in construction projects.

A number of CCP reuse applications that have not been specifically authorized by the state environmental agencies are commonly practiced with agency approval. In each of the states, CCPs are used in the manufacture of cement and concrete products. CCPs are used for soil stabilization and as a drying agent in coal-processing waste in Montana. Feedlot stabilization using CCPs has been approved on a case-by-case basis in North Dakota and South Dakota. Encapsulated uses are generally supported in Wyoming.

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