

**FY94-XVI-54
SURVEY & DEMONSTRATION OF UTILIZATION POTENTIAL
OF ND LIGNITE ASH RESOURCES**

CONTRACTOR: Energy & Environmental Research Center

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PARTICIPANTS

<u>Sponsor</u>	<u>Cost Share</u>
Coal Ash Resources Research Consortium ¹	\$40,000
Cooperative Power ²	40,000
Department of Energy	70,000
ND Industrial Commission	<u>80,000</u>
Total	\$230,000

Project Schedule - 1 Year

Contract Date - 6/29/94
Start Date - 6/17/94
Completion Date - 3/31/96

Project Deliverables

Status Report - 11/15/94 ✓
Status Report - 2/15/95 ✓
Final Report - 12/31/96 ✓

OBJECTIVE / STATEMENT OF WORK

The goal of the project is: 1) to provide the information beneficial for the use of North Dakota lignite (NDL) combustion residues and 2) to demonstrate the potential economic and environmental benefits of their use. The primary objectives of this program are: 1) to identify beneficial uses of NDL fly ash and bottom ash, 2) to develop information useful in the marketing and use of NDL fly ash and bottom ash, and 3) to demonstrate improved technologies and uses of NDL combustion byproducts. The information from this study will be included in the Coal Ash Resources Research Consortium (CARRC) database system to allow easy and efficient access for potential technical and marketing users.

1 Cooperative Power Association, the Industrial Commission of North Dakota, and the U.S. Department of Energy provided funding for this research project. Houston Engineering, Braun Intertec, Falkirk Mine, Manz Associates, the North Dakota Department of Transportation (NDDOT), the North Dakota State Department of Health (NDS DH), and several additional North Dakota utilities participated in the project by providing in-kind services and materials to the Energy & Environmental Research Center's (EERC) Coal Ash Resources Research Consortium (CARRC).

2 Not included as cost share is the relocation of ND Highway 200 at Cooperative Power estimated to cost \$4,295,000.

STATUS

Information provided by this project was originally intended for use in relocation of ND Highway 200 near Underwood, North Dakota. The road was planned for relocation in 1995 to accommodate lignite mining at the Falkirk Mine. A change in the mining plan postponed this highway relocation project until 2009. The characterization and mix design information on concrete, controlled low-strength materials (CLSM), soil stabilization, and permeable base course presented in this report is applicable to general road-building projects and other public works and commercial projects.

Eleven NDL combustion byproducts shown in Table ES-1, were evaluated for use in the following road-building applications: concrete, CLSM, soil stabilization, and permeable base course.

TABLE ES-1
North Dakota Lignite Combustion Byproduct Samples Evaluated

Utility Owner or Operator	Unit Name	Byproduct Type		
		FGD ¹	FA ²	BA ³
Basin Electric Power Cooperative	Antelope Valley	X		X
	Leland Olds		X	X
Cooperative Power Association	Coal Creek Station		X	X
	Minnkota Power Cooperative, Inc.		X	X
Montana Dakota Utilities Co.	Coyote			X
	Heskett (FBC ⁴)		X	X

1 Flue gas desulfurization

2 Fly ash

3 Bottom ash

4 Fluid-bed combustor

The Coal Creek Station fly ash met the American Society for Testing and Materials (ASTM) specification for use as a mineral admixture in concrete. All the NDL byproducts showed high potential for successful use in all the remaining applications.

Characterization of the NDL combustion byproducts included chemical, environmental, mineralogical, and physical components. The NDL byproducts contained extremely low concentrations of most regulated trace elements, as summarized in Table ES-2. The elements present leached at levels well below Resource Conservation and Recovery Act (RCRA) limits, and most of these elements were below Primary Drinking Water Standard (PDWS). These results indicate that the materials evaluated are environmentally benign.

TABLE ES-2
Summary of Regulated Elemental Concentrations in NDL Combustion Byproduct Samples

Sample ID:	Coal Creek		Leland Olds		M.R. Young		Antelope Valley		Coyote Station		Heskett No.2
	FA	BA	FA	BA	FA	Slag	SA	BA	Slag	FA	BA
Ba, %	0.51	0.38	1.33	1.18	0.72	0.56	0.76	0.78	0.82	0.76	0.18
Ag, µg/g	0.34	0.11	0.29	0.096	0.52	<0.08	0.20	0.092	<0.08	0.36	0.14
As, µg/g	74	17.6	67.0	10.0	22.4	5.62	28.7	13.0	9.42	50.3	36.8
Cd, µg/g	0.92	0.52	0.89	0.72	1.60	0.68	0.88	0.89	0.73	1.40	0.60
Cr, µg/g	31	8.7	29	14	39	21	14	<5	20	19	<5
Hg, µg/g	0.019	0.034	0.039	0.30	0.27	0.060	0.631	0.21	0.048	0.91	0.035
Pb, µg/g	31.9	7.91	38.7	4.23	54.4	1.30	16.3	7.04	5.06	48.4	9.74
Se, µg/g	5.5	<1	11	<1	14	<1	5.4	<1	<1	13	<1

FA = fly ash; SA = scrubber ash; BA = bottom ash.

Physical and engineering tests show excellent potential for use in road-building applications such as concrete, controlled low-strength materials, soil stabilization, and permeable base course. A summary of ASTM C618 results of physical and engineering tests for the five fly ash and scrubber ash samples evaluated is given in the following table.

Results of ASTM C618 Physical and Engineering Tests

Physical Test	Coal Creek Fly Ash	Leland Olds Fly Ash	M.R. Young Fly Ash	Antelope Valley Station Scrubber Ash	Heskett FBC Fly Ash	ASTM C618 Specification	
						Class F	Class C
Fineness, % retained on No. 325 sieve	23.29	14.31	62.25	5.14	25.03	34 max.	34 max.
Strength on Activity Index with Portland Cement, % ratio to control						75 min.	75 min.
@ 7 days	77	88	69	85	72	75 min.	75 min.
@ 28 days	87	83	67	90	76	min.	min.
Water Required, % of control	97	97	97	98	112	105 max.	105 max.
Soundness, autoclave expansion, %	0.10	0.18	0.20	0.12	0.16	0.8 max.	0.8 max.
Specific Gravity	2.44	2.86	2.31	2.67	2.51		

Conclusions and Recommendations

- NDL combustion byproducts are environmentally benign.
- NDL combustion byproduct use and recycling is economically beneficial and environmentally friendly.
- Road building is a key opportunity for use and recycling of NDL combustion byproducts.
- It is recommended that near-term demonstration projects be pursued through the NDDOT and other governmental agencies.
- It is recommended that the NDDOH encourage the recycling of NDL combustion by-products by developing pre-approved uses.
- It is recommended that road building applications be designated a pre-approved use.
- It is recommended that the Lignite Research Council facilitate the use of NDL combustion byproducts in road building applications working with utilities, the NDDOH, NDDOT, and other agencies.

The Falkirk Mine is constructing a bridge to demonstrate the use of NDL combustion byproducts. The project will demonstrate use at substantially higher concentrations of NDL combustion byproducts in the mix (See Project FY98-XXIX-82).

On December 12, 1997, Cooperative Power received notification from the North Dakota Department of Health pre-approving the use of Coal Creek Station bottom ash for unsurfaced roads, road construction materials, de-icing and blasting grit.