

FINAL TECHNICAL REPORT  
September 1, 1997, through August 31, 1998

Project Title: **ILLINOIS BASIN COAL SAMPLE PROGRAM**

ICCI Project Number: 97-1/7.1A-1  
Principal Investigator: William R. Roy, ISGS  
Other Investigators: Kathleen M. Henry, John M. Lytle, ISGS  
Project Manager: Dr. Ken Ho, ICCI

ABSTRACT

Coal is inherently a heterogenous material. Reproducible results between researchers can be difficult because of the variability in the chemical, mineralogical, and physical composition between coal samples. The costs of characterizing new samples for a given project can also be a potential barrier to research. Moreover, chemical composition of coal samples may change as a function of storage time. The purpose of the Illinois Basin Coal Sample Program (IBCSP) is to acquire, preserve, and distribute well-characterized coal samples to researchers. The IBCSP was established in 1983, and has been supported continuously by the Center for Research on Sulfur in Coal, and then later by the Illinois Clean Coal Institute. During the contract year, the requests for coal samples were less than the previous year. There were seven requests for samples. A total of 133 pounds was provided to users at no cost. Two pounds of IBC-111 were requested by an out-of-state private company doing gasification research. Twenty pounds of IBC-102 were requested for an ICCI-funded research project in Illinois. Twenty pounds of IBC-101 were requested by an out-of-state investigator performing coal cleaning research.

The bibliographic database was updated via the results of input provided by IBCSP users and by an on-line literature search. Thirty publications were found that mentioned the use of IBCSP samples, during a literature search done by ISGS librarians. A mass mailing was initiated to obtain more information for the database. About 113 letters were sent out, but we received only four responses. There are now 64 outside (non-ICCI) publications in the database. The Home Page was also completed and may be accessed at <http://denr1.isgs.uiuc.edu/isgsroot/ibcsp/intro.htm>. This home page includes the goals of the IBCSP, detailed descriptions of each lot, information on coal cleaning and sampling, and information on how to request samples. Results of the annual QA/QC analyses conducted with eight of the coal samples indicated that they have not oxidized or deteriorated in any way while in storage since last year. The IBCSP serves a valuable function in coal research and warrants support for the coming year to continue to meet the goals of the program.

## EXECUTIVE SUMMARY

The Illinois Basin Coal Sample Program, in its fifteenth year, continues to maintain, deliver, and publicize the twelve lots of coals in its program to researchers worldwide. This program enables researchers to compare the results from their basic and applied research with colleagues who use the same coals. The program benefits not only Illinois researchers, but also leverage Illinois dollars by encouraging outside researchers who are funded by other sources to include Illinois Basin coals in their investigations. The IBCSP remains the primary source of reproducible coal samples to ICCI-funded projects. The value of a given coal increases as more information about the use and/or research done on that coal becomes available. This information, when included in the continually updated bibliographic database, becomes a beneficial tool for researchers worldwide.

The objectives of the IBCSP project from September 1, 1997, to August 31, 1998 were to:

- maintain and continue to enforce quality control on the twelve samples in the program
- deliver coal samples monthly to requesters, both domestic and international, based on their need;
- update and distribute the bibliographic information on the coals in the program to requesters;
- publicize the program at various professional meetings by distribution of IBCSP brochures and the Users Handbook, display of posters, and by maintaining a Home Page on the Internet.

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way while in storage since last year. The analytical results for C, H, and N were not available at the time of writing because of instrument failure.

## OBJECTIVES

The primary objectives of the Illinois Basin Coal Sample Program (IBCSP) are to acquire, preserve and distribute well-characterized coal samples to researchers. Sample availability is not limited to those currently sponsored by the ICCI. Samples are also provided to those who wish to include Illinois coals in their research. In addition to providing samples to researchers, the IBCSP also archives, maintains and distributes abstracts of all ICCI-sponsored research conducted on Illinois coal in general or on its IBCSP samples. Specific objectives of the project for the 12 months starting September 1, 1997 are:

- to maintain the twelve samples in an inert atmosphere to minimize weathering;
- to deliver monthly coal samples to requesters;
- to update and distribute the bibliographic information on the coals in the program to requesters;
- to publicize the program by distribution of brochures, the Users Handbook, exhibition of posters at professional meetings, and by maintaining a Home Page on the Internet.

## INTRODUCTION AND BACKGROUND

Meaningful and well thought of coal research begins with samples that are consistent and well characterized. Without these well-characterized samples, researchers would have to repeatedly collect and characterize their own coals. Research findings are also more difficult to duplicate and confirm without reproducible samples. It is apparent that reproducibility and standardization are vital issues for the coal research and development community. The IBCSP addresses these issues well. The program has responded to the needs of the research community for the past fifteen years. This has been done with prompt service and well-characterized samples that have remained uniform over a long period of time. The samples have exhibited little chemical and physical change. Quality assurance and quality control protocol is routinely imposed on the samples in the program. Furthermore, the IBC samples are gaining acceptance by the coal research community from those funded by ICCI, and also by those in other states and foreign countries. Thus, the IBCSP leverages Illinois resources by encouraging researchers with outside funding sources to include Illinois coal in their studies.

At present, there are twelve lots of coal in the program. These are stored in 55 gallon drums under slight positive nitrogen pressure. The samples are stored in a temperature and security monitored building. Each barrel is checked weekly for any abnormal change in nitrogen pressure. At the first full week of each month, all pending sample requests are prepared and filled. To comply with our quality control protocol, twice yearly, complete coal analyses are

performed on randomly selected barrels of larger lots. All of the abstracts of the ICCI sponsored research are archived and distributed freely, either by fax, hard copies or by e-mail. A Home Page for the IBCSP is currently available on the world wide web. All new chemical and physical data for the coals in the program, together with associated mineral composition, will be updated periodically via this web page.

## EXPERIMENTAL PROCEDURES

### **Task 1. Maintenance**

The IBC samples are housed in a temperature controlled building with temperature and electrical outage remote sensors. The 55-gallon barrels are monitored weekly for N<sub>2</sub> pressure, which is kept at or slightly below 3 psig. Periodically, complete coal analysis is done for representative samples of the twelve lots. Inventories of the sample and records of the requests are maintained. Each barrel in the system is numbered and documented such that record keeping of each coal is easily retrieved.

### **Task 2. Processing and shipping samples**

Coal samples in each lot are stored in plastic bags each with nominal weight of twenty pounds, which in turn are stored in 55-gallon barrels. Samples less than the 20-pound size are first crushed to less than 2.38 mm, riffled, and split into individual one-pound bags for mailing. Orders received by the last day of each month are processed by the first full work week of the next month.

### **Task 3. Responses to requests for information and updating records**

Responses to requests for information are done using fax, telephone, written request forms, e-mail and a Users Handbook.

## RESULTS AND DISCUSSION

There were seven requests for samples (Table 1). A total of 133 pounds was provided to users at no cost. Two pounds of IBC-111 were requested by an out-of-state private company doing gasification research. Twenty pounds of IBC-102 were requested for an ICCI-funded research project in Illinois. Twenty pounds of IBC-101 were requested by an out-of-state investigator performing coal cleaning research.

Table 1. Coal Samples delivered from September 1, 1997 through, August 31, 1998.

<u>Name</u>	<u>Organization</u>	<u>IBC number</u>	<u>Weight (lbs.)</u>
Jeremy B. Cole	Global Reclamation Co.	102, 110	20 lbs. each
Michael Schwartz	Eltron Research Inc.	111	2
Jian Sun	ISGS	102	20
Frank Leidendeker	Private researcher	101	20
Kathy Henry	ISGS	101, 102, 105, 106 109, 110, 111, 112	1 lb. each
Latif Khan	ISGS	102	40
Chris Lehman	ISGS	102	5
			Total 133 lbs.

The bibliographic database was updated via the results of input provided by IBCSP users and by an on-line literature search. Thirty publications were found that mentioned the use of IBCSP samples during a literature search done by ISGS librarians. A mass mailing was initiated to obtain more information for the database. About 113 letters were sent out, but we received only four responses. There are now 64 outside (non-ICCI) publications in the database. The Home Page was also completed and may be accessed at <http://denr1.isgs.uiuc.edu/isgsroot/ibcsp/intro.htm>. This home page includes the goals of the IBCSP, detailed descriptions of each lot, information on coal cleaning and sampling, and information on how to request samples. Results of the annual QA/QC analyses conducted with eight of the coal samples (Table 2) indicated that they have not oxidized or deteriorated in any way while in storage under N<sub>2</sub> since the last year when compared with previous analyses (Table 3). Analytical data for C, H, and N were not available at the time of writing because of an instrument failure. These determinations will be reported when available in a forthcoming monthly report.

Table 2. QA/QC analyses of some IBCSP samples, moisture free basis (concentrations are as weight percent unless otherwise noted).

Analysis	IBC-101	IBC-102	IBC-105	IBC-106	IBC-109	IBC-110	IBC-111	IBC-112
Btu/lb	12714-	13727	11571	13158	13427	13084	12770	12999
FSI	3.5	3.5	4.0	4.0	4.5	4.0	4.0	5.5
Moisture	14.8	14.6	10.0	10.3	9.0	10.7	13.7	5.4
H-T Ash	10.4	6.9	18.9	8.9	8.2	9.6	11.0	10.9
Vol .Mat.	41.3	40.1	36.8	39.9	35.5	39.7	37.2	35.4
Fixed C	48.3	53.1	44.4	51.2	56.3	50.8	51.8	53.7
Carbon <sup>1</sup>	-	-	-	-	-	-	-	-
Hydrogen <sup>1</sup>	-	-	-	-	-	-	-	-
Nitrogen <sup>1</sup>	-	-	-	-	-	-	-	-
SO <sub>4</sub> -S	0.1	0	0	0	0	0.1	0.1	0.1
Pyritic-S	1.0	2.0	2.2	1.6	0.5	1.9	0.8	1.1
Organic-S	3.6	1.5	2.8	2.4	0.7	2.8	1.1	1.8
Total S	4.7	3.6	5.0	4.1	1.2	4.7	2.0	3.0
Total Cl	0.1	0	0.1	0	0.5	0	0	-0.2

<sup>1</sup> The missing values are due to the instrument failure.

Table 3. Analyses of Twelve IBCSP Lots (Moisture Free values)

	IBC-101	IBC-102	IBC-103	IBC-104	IBC-105	IBC-106	IBC-107	IBC-108	IBC-109	IBC-110	IBC-111	IBC-112
	mean	mean	mean	mean	mean	mean	mean	mean	mean	mean	mean	mean
	of 22	of 22	of 19	of 19	of 23	of 23	of 18	of 11	of 22	of 22	of 22	of 19
	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD
Btu/lb	66 13641	91 13442	86 8532	85 11551	66 13187	66 12227	23 13733	67 13332	57 13069	51 12936	79 13032	35
FSI	3.8 0.55	3.7 0.52	5.0 0.63	3.2 0.38	4.2 0.47	2.2 0.26	3.0 0.82	4.4 0.46	4.4 0.53	3.7 0.60	5.9 0.66	
Percent												
Moisture	15.1 0.45	14.5 0.31	5.7 0.17	10.7 0.30	9.8 0.24	10.6 0.31	9.3 0.15	1	9.2 0.30	10.6 0.23	14.6 0.71	4.8 0.24
Volatiles Matter	41.1 0.50	40.1 0.48	36.3 0.42	28.5 0.49	37.0 0.36	40.0 0.40	40.0 0.32	41.5 0.54	35.4 0.49	39.7 0.43	37.4 0.57	35.9 0.41
Fixed Carbon	48.5 0.44	53.2 0.42	55.0 0.65	33.2 0.46	44.3 0.45	51.0 0.42	48.4 0.38	54.7 0.55	56.2 0.60	50.6 0.35	51.5 0.53	53.2 0.39
H-T Ash	10.4 0.27	6.8 0.32	8.6 0.60	38.2 0.62	18.7 0.25	9.0 0.23	11.5 0.13	3.6 0.20	8.3 0.20	9.7 0.21	11.1 0.21	10.9 0.21
Carbon	69.4 0.54	74.5 0.66	74.5 0.41	46.8 0.47	63.8 0.46	72.4 0.55	68.1 0.15	76.0 0.35	75.0 0.44	71.3 0.67	71.8 0.53	72.8 0.41
Hydrogen	5.1 0.13	5.3 0.30	4.9 0.24	3.4 0.27	4.5 0.12	5.1 0.17	4.8 0.22	5.2 0.29	4.9 0.15	5.2 0.09	5.0 0.06	4.9 0.06
Nitrogen	1.2 0.14	1.5 0.11	1.7 0.14	0.8 0.14	1.2 0.09	1.5 0.10	1.2 0.04	1.4 0.10	1.6 0.08	1.5 0.07	1.5 0.08	1.6 0.06
Oxygen	9.4 0.61	8.7 0.67	7.6 0.47	6.3 0.51	7.2 0.64	8.2 0.54	10.5 0.06	10.8 0.56	8.4 0.47	7.8 0.50	8.5 0.51	6.9 0.63
Sulfatic S	0.0 0.05	0.1 0.05	0.0 0.03	0.0 0.02	0.0 0.01	0.0 0.04	0.2 0.02	0.0 0.02	0.0 0.01	0.0 0.04	0.1 0.04	0.0 0.01
Pyritic S	1.1 0.11	2.1 0.15	1.0 0.07	2.3 0.24	2.3 0.19	1.7 0.18	0.4 0.05	0.4 0.07	0.4 0.06	2.0 0.13	0.9 0.16	1.2 0.09
Organic S	3.2 0.22	1.1 0.21	1.1 0.10	1.7 0.23	2.2 0.28	2.0 0.19	2.9 0.08	2.3 0.09	0.7 0.11	2.4 0.22	0.9 0.10	1.6 0.14
Total Sulfur	4.4 0.14	3.3 0.12	2.2 0.07	4.1 0.14	4.5 0.16	3.8 0.10	3.7 0.11	2.7 0.07	1.2 0.10	4.5 0.21	2.0 0.05	2.8 0.09
Total Chlorine	0.1 0.02	0.0 0.01	0.1 0.01	0.0 0.02	0.1 0.03	0.0 0.01	0.0 0.01	0.0 0.03	0.4 0.03	0.0 0.05	0.0 0.00	0.2 0.06
mg/kg												
As	2	32	16	5	2.6	4.1	0.6	0.1	6.9	4.7	6.1	3.3
B	193	109	71	317	79	96	102	105	64	80	104	40
Ba	32.0	14.0	28	135	73	30	55	15	35	43	49	49
Cd	1.1	0.8	0.1	<0.4	<0.1	0.2	<0.4	<0.1	<0.3	<0.4	<0.4	<0.3
Co	3	6	5	9	3.8	3.7	2.8	2.3	3.6	3.6	6.6	3.6
Cr	31	7	16	44	19	10.4	12	14	13	11	14	14
F	106	49	79	638	151	67	85	59	85	68	86	108
Hg <sup>1</sup>	0.043	0.105	0.12	0.059	0.12	1.14	0.07	0.12	0.11	1.78	2.13	0.07
Mn	31	16	13	112	71	20	42	13	15	27	31	34
Ni	11	22	14	23	15	15	5	9	11	12	27	14
Pb	8	149	57	28	6	6	11	5	18	10	18	27
Sb	0.2	3.4	1.1	0.3	0.3	0.8	0.1	0.2	0.7	0.7	1.9	0.5
Se	1.5	1.3	2.2	2.2	2.4	2.0	1.2	1.5	1.5	2.5	1.5	1.6
V	25	22	26	50	23	30	16	34	22	22	30	24

September, 1998

<sup>1</sup> The moisture in the filter cake is 45% ±5 as supplied. <sup>2</sup> By Pyrohydrolysis and Ion Chromatography - ASTM approval pending. <sup>3</sup> Coincidentally, the Indiana coals are higher in Hg than the Illinois coals. The Hg content of other Indiana coal has been found to be typical of the Illinois Basin coals and similar to the Illinois coals in the IBCSP. (See IGS Circular 499, 1977)



## CONCLUSIONS AND RECOMMENDATIONS

The Illinois Basin Coal Sample Program has provided samples, free of charge in most cases, to researchers world wide. Because of the belief and the farsightedness of the Illinois Coal Development Board in supporting the formation and funding of this program, Illinois research resources are leveraged when non-Illinois dollars are spent for research on Illinois coals. The benefit of the comparison of data obtained by research groups working on representative splits of the same coal is a significant contribution by the IBCSP to coal research. In addition to the regular archiving and distribution of the abstracts of all ICCI-funded projects to researchers, this year a home page has been created and is available for Internet users. Thus, by this means, together with the distribution of the brochures and the Users' handbook, the activities of the program will be more extensively advertised. The IBCSP serves a valuable function in coal research and warrants support for the coming year to continue to meet the goals of the program.

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PROJECT MANAGEMENT REPORT  
March 1, 1998, through August 31, 1998

Project Title: **ILLINOIS BASIN COAL SAMPLE PROGRAM**

ICCI Project Number: 97-1/7.1A-1  
Principal Investigator: William R. Roy, Illinois State Geological Survey  
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COMMENTS

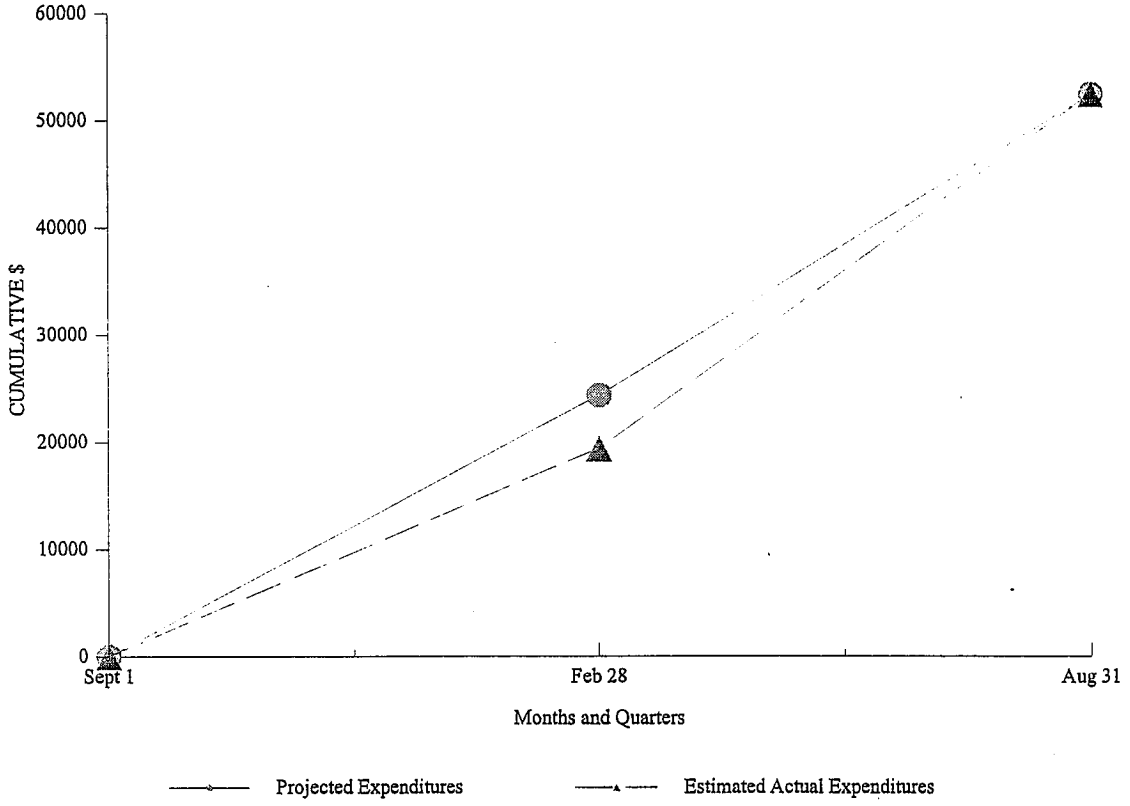
The projected expenditures were about 99.9% of the estimated costs.

**Projected and Estimated Expenditures**

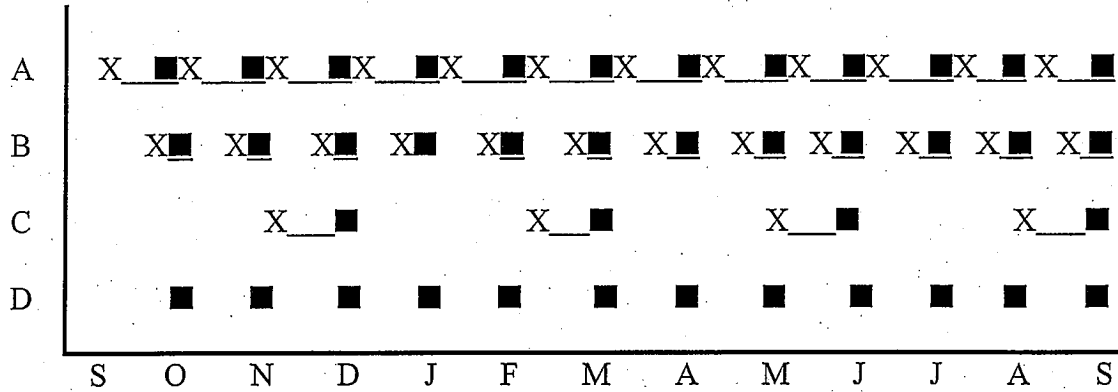
Report Period*	Types of Cost	Direct Labor	Fringe Benefits	Material & Supplies	Travel	Major Equipment	Other Direct Costs	Indirect Cost	Total
Sept. 1, 1997 to Feb. 28, 1998	Projected	11,300	2,340	125	0	0	2,900	1,666	19,331
	Estimated	14,000	2,900	200	0	0	5,000	2,210	24,310
Sept. 1, 1997 to Aug. 31, 1998	Projected	30,386	5,889	132	0	0	11,159	4,757	52,324
	Estimated	29,643	5,900	574	400	0	11,053	4,757	52,327

\*Cumulative by Report Period

**COSTS BY QUARTER**  
ILLINOIS BASIN COAL SAMPLE PROGRAM



### SCHEDULE OF PROJECT MILESTONES



Begin  
Sept. 1  
1997

Milestones:

- A. Maintenance
- B. Processing orders for coal
- C. Responses to requests for information and updating records
- D. Reporting (Semi-Annual and monthly), publicity and planning .

