United States
Environmental Protection
Agency

Environmental Research
Laboratory
Duluth MN 55804

Research and Development

EPA-600/S3-84-014 Mar. 1984

EPA

Project Summary

Documentation of the Data Base Wisconsin Power Plant Impact Study

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This report describes the data collected by investigators at the University of Wisconsin-Madison from 1971 to 1978 during a study of the Columbia Generating Station near Portage, Wisconsin. It gives a history of the project and describes the site and the operation of the power plant. Information is presented on methods, access procedure, data samples, quality assurance, supporting documents, and qualifications of the investigators for the data set or sets associated with each subproject. Related data sets collected by the Wisconsin Power and Light Company or their contractors are also included.

This Project Summary was developed by EPA's Environmental Research Laboratory, Duluth, MN, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

In 1969, three Wisconsin electric power companies applied to the Wisconsin Public Service Commission for permission to construct a large coal-burning power plant near Portage in south-central Wisconsin. At the time, little was known about the environmental impacts of large projects such as this. In recognition of the need for this kind of information, researchers at the University of Wisconsin-Madison suggested a study to measure the impact of the proposed power plant. In 1971 they began preconstruction studies of the site. These studies, supported by the three utility companies, continued during the construction and early operational phases of the plant from January 1971 until July 1975.

In 1975, the U.S. Environmental Protection Agency recognized the unique research opportunity that existed at this site, as well as the potential nationwide application of the findings. The agency awarded the project a three-year grant to continue and expand the research funded by the power companies. This project, known as "The Impact of Coal-Fired Power Plants on the Environment," has involved more than 100 investigators in 24 areas of research.

One of the goals of the large study was to integrate the various subprojects so that questions that might be neglected in separately funded projects could be examined. The Columbia study was conceived and developed as a unit. This approach demonstrated the need for a center to coordinate central collection, transfer, storage, and documentation of all data. In June 1976, the Data Center for the Columbia Site Impact Study was established to:

1. Eliminate unnecessary duplication of data gathering.
2. Facilitate the transfer of data and other information from one subproject to another.
3. Organize the data so that maximum use could be made of it by investigators internal and external to the project.

The Columbia Generating Station

The Columbia Generating Station is a two-unit, 1054-MW facility burning low sulfur subbituminous western coal. It is located in the eastern floodplain of the Wisconsin River, approximately 6.4 km south of Portage, Wisconsin (Figure 1). It is owned and

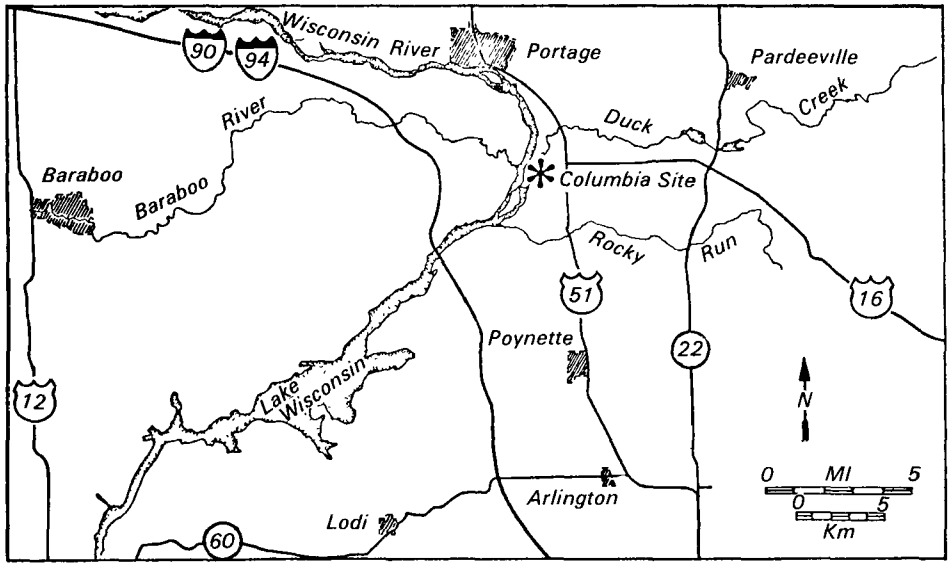

Figure 1. *Location of the Columbia Generating Station.*

operated by a consortium of three utilities: Wisconsin Power and Light Company, Wisconsin Public Service Corporation, and Madison Gas and Electric Company.

The power plant was built in a 1900-ha wetland (Figure 2). Of this total area, 445.5 ha have been permanently altered by construction of a 202.5-ha diked cooling lake, a 28.4-ha ash basin, a coal storage area, coal train tracks, coal handling facilities, a boiler and turbine-generator building, a parking lot, and access roads.

The higher areas are well drained, but most of the site is <239 m above sea level and these low areas are usually wet throughout the year because of groundwater discharge. The groundwater discharge area includes the wetlands of the site, the wetlands to the east, which are used for mint farming, and extensive wetlands along the lower reaches of Rocky Run Creek. The low areas also receive groundwater recharge from upland areas located on and adjacent to the site.

The site supports a range of plant and animal communities including marsh/sedge meadow, wet forest, and dry forest. The region around the site is rich agricultural land producing a variety of crops. Six of these are considered especially vulnerable to impacts from the power plant: alfalfa, oats, soybeans, barley, rye, and wheat.

The power plant is in an area of relatively low population. The combined population of the 13 towns within a 16-km radius of the station was 18,995 in 1970, and was estimated at 21,105 in 1980. The entire service area for the three utilities that built the plant encompasses about 40% of the land area of Wisconsin.

Construction began at the Columbia site in 1971 and was completed in 1978. Table 1 shows the major events during development of the site.

Several aspects of plant operation are especially relevant to the environmental impacts addressed by the various subprojects. These include disposal of fly ash and the effects of the power plant on the water regime at the site.

High energy electrostatic precipitators collect more than 99% of the fly ash residue. Residue from Unit II is collected dry, but that from Unit I, along with bottom ash, is slurried with water from the cooling lake and discharged to the ashpit. Water entering the ash basin flows through a series of lagoons where ash particles settle. The water is pumped to the ashpit drain and eventually joins Rocky Run Creek (Figure 2).

The chemistry of the ashpit is complex. The metal oxides, which constitute the major reactive portions of the ash, result in a pH of 10 to 11 in the water. The pH must be lowered to 8 or less before the ash effluent is discharged, but the addition of acid causes elements such as Ba, Al, and Cr to precipitate in a floc that coats the bottom of the ashpit drain and is carried with the current into Rocky Run Creek and the Wisconsin River.

Water from the Wisconsin River is pumped into the cooling lake at a rate which averages 0.30% of the river's flow, or 50,000 m^3/day. Of this, 20% is discharged to the ashpit, 40% is lost by groundwater seepage, and 40% is lost by evaporation. Hot water is discharged at the north end of the lake at temperatures averaging 10° to 15°C higher than at the intake. Although cooling towers dissipate some of the waste heat from Unit II, the cooling lake still receives 80% of the annual heat load. The discharge of waste heat increases the overall temperature of the lake by about 8°C when the cooling towers are not operating.

The cooling lake has a 2.47-m hydrostatic head above the surrounding wetlands. Seepage through the bottom of the lake has changed the character of the wetlands in the study area adjacent to the west dike.

The Data Center

The data center was organized to provide a range of services. It standardized, adjusted, and organized the data into forms suited to modern procedures for storage and retrieval. It prepared information about the data and quality assurance. By this means, the center facilitated interdisciplinary evaluation of the data, enhancing its usefulness to other investigators and helping to minimize duplica-

Table 1. *Chronology of Events in Construction of Columbia Generating Station*

Date	*Event*
April 1971	*Construction of west dike begun*
October 1972	*Main building frame topped off*
March 1973	*Unit I stack begun*
September 1973	*Ashpit, drainage ditch begun*
January 1974	*Intake channel started*
April 1974	*Cooling lake completed*
June 1974	*Filling of cooling lake started*
July 1974	*Transmission line right-of-way started*
October 1974	*First coal received*
December 1974	*Unit I stack completed*
January 1975	*Cooling lake sealed and refilled, boiler testing started*
May 1975	*Unit I on line*
August 1975	*Unit II building started*
December 1975	*Unit II stack construction started*
November 1976	*Cooling tower construction begun*
October 1977	*Unit II stack completed*
April 1978	*Cooling tower completed, Unit II on line*

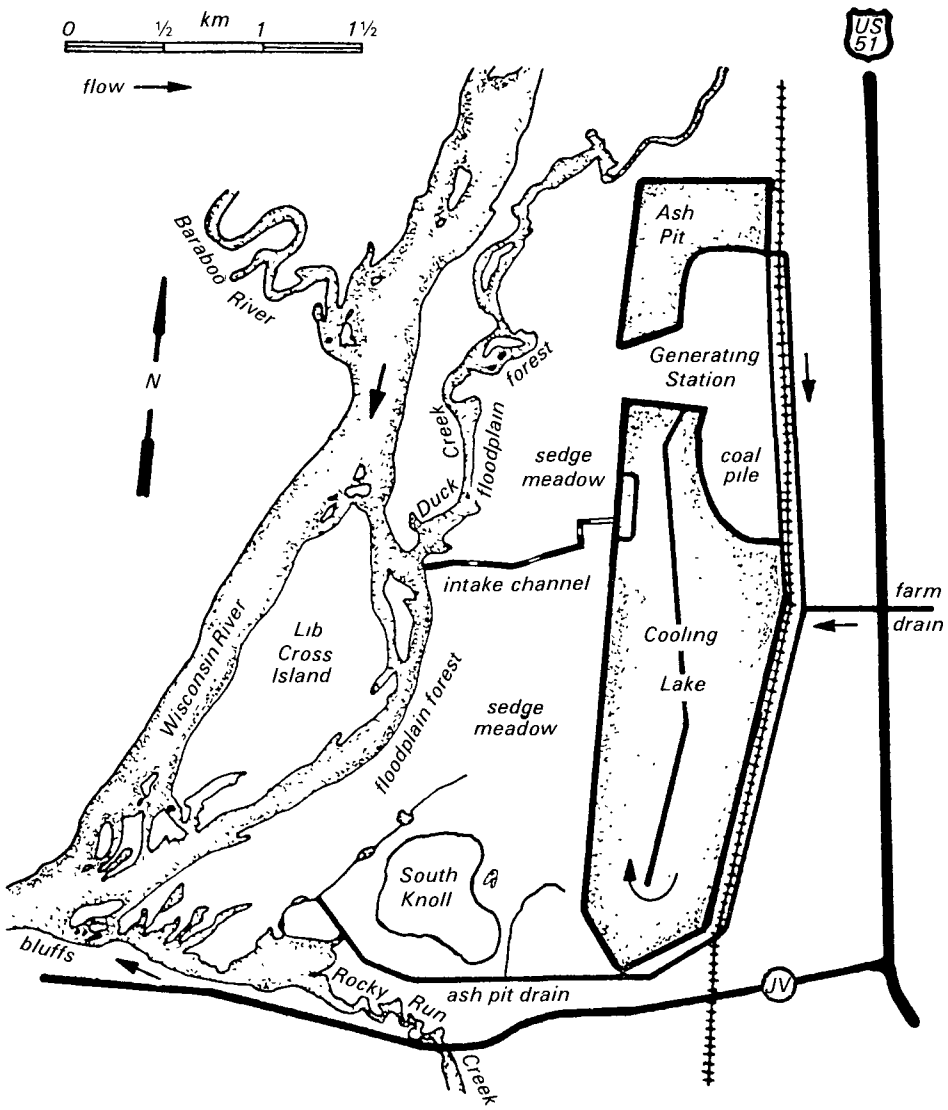

Figure 2. Columbia Generating Station site and study area.

tion in data collection. It also provided investigators with assistance in computer services and statistical analyses. The center could disseminate data from its large base of information, manipulating and processing the data as user requirements dictated.

During the first 18 months after it was established, the data center developed standardized procedures for putting information into computer-compatible form. It listed all data available with information about the form of the data, the parameters measured, and the dates and location of acquisition. It made the data and documentation of the data accessible to users and provided statistical analysis and summary output to the various subprojects in the study.

In 1978 the data center began to compile a data book for the entire study. The purposes of the data book were to make data available to secondary scientific users for reanalysis, synthesis, or theoretical studies and to provide a means for transferring ecosystem and environmental data to policy makers and nonscientific users. Four categories of potential users were considered in compiling the data book: investigators who would conduct longitudinal studies at the site, investigators who depend on analysis and synthesis of large amounts of data on many parameters for the development of models, investigators looking for tools for impact assessment, and the nonscientific user community. The rapidly increasing costs of data collection put an even greater value on existing data for use in policy analysis, environmental assessment, and the calibration of models. Such secondary uses enhance the value of the data consolidated in the data base of the Columbia power plant impact study.

Two major forms of data, computer-readable and visual, were identified for purposes of storage and retrieval. Computerized data are stored on tape in the tape utility system of the Univac 1110 computer at the Madison Academic Computing Center (MACC), University of Wisconsin-Madison. Users with access to MACC can retrieve data directly. Other users may request data in the form of cards, printouts, or tapes. Visual data including maps, graphs, slides, and pictures are stored in the data center of the Columbia impact study. Reproductions of all available data can be obtained from the data center with permission of the principal investigator involved. There is a charge to defray certain expenses.

The basic need of a secondary user of data is adequate documentation. To meet this need, the full report summarized here documents each data set in six sections: a data abstract, an explanation of data access, a data sample, a quality assurance analysis, supporting documents, and qualifications of the investigators. Data abstracts include the names of the investigators, a data summary, a short description of the experimental method, and dates. Data access tells how to access the data and, for computerized data, gives the number of records, a field description, indication of missing data, percent recovery, and underlying corrections. For long data sets, a representative sample is given. The entire data set is reproduced for small data sets.

The quality assurance report provides the necessary information for an assessment of the validity and reliability of the measurements in that set. Although the topics vary according to the specific requirements of each data set, most quality assurance reports give the objectives of the data set, describe the system studied and the methods, equipment, and procedures used in the study, and evaluate the performance of the equipment. The supporting documents either describe the data or present the results of the studies. These documents include internal documents such as the semiannual progress reports of the Columbia study.

The data sets fall into four categories: numeric data base, noncomputerized data, integrated hardware/software system, and model. Most of the data are in the form of numerical data bases. The integrated hardware/software systems contain programs that were developed in the Columbia project. A model is considered to be a mathematical function that has been developed for and applied to an ecosystem problem to arrive at

condensed results that can be used for prediction and simulation. Models emerging from the Columbia study are documented and published elsewhere.

The Data

The data sets are grouped according to the 14 subprojects of the overall study plus data from the Wisconsin Power and Light Company and other outside sources.

1. Aquatic chemistry. Five data sets are related to the aquatic chemistry subproject. They contain data on a variety of water quality parameters and on experiments to determine the concentrations of elements in fly ash and the rates at which they are leached out.

2. Trace elements. Four data sets document the concentrations of trace elements in Columbia County soil, in oak leaves near the power plant, and in a variety of aquatic animals, including amphibians, collected near the generating station.

3. Organic contaminants. Two data sets give measurements of polycyclic aromatic hydrocarbons in soils and snow surrounding the generating station.

4. Air pollution modeling. This data set contains measurements of dry deposition of sulfur in the plume of the generating station.

5. Meteorology. Six data sets give information on wind speed and direction, air temperature gradients at one monitoring station, and the monitoring of solar radiation, rainfall, and inversion layers.

6. Hydrogeology. Seven data sets document groundwater levels and temperatures at sampling points in the vicinity of the power plant. They also include results of a five-year survey of 12 water quality parameters and background information on the wells that were installed to monitor the effects of the power plant on groundwater.

7. Plant damage. Eleven data sets address questions of the effects of air pollution on alfalfa grown in the vicinity of the power plant, the effects of the power plant on lichen communities, tipburn injury to needles of Eastern white pine, and levels of ozone, nitrogen oxides, and oxidants in the ambient air near the generating station.

8. Aquatic invertebrates. Eight data sets measure changes in communities of aquatic invertebrates, effects of temperature on the life histories of *Ephemeroptera,* distribution of aquatic invertebrates colonizing artificial substrates upstream and downstream from the ash effluent, effects of short-term exposures of *Gammarus* to the ash effluent, effects of food contaminated by ash effluent on *Asellus racovitzai,* oxygen consumption of crayfish exposed to ashpit effluent, metal concentrations in tissues of crayfish caged in field locations near the power plant, and supporting water quality data for all of these studies.

9. Fish. Four data sets record information on the ecology and distribution of fish at sampling stations near the power plant, with special studies of northern pike. Data on water temperature are included.

10. Cooling lake ecosystem assessment. Seven data sets document currents and temperatures in the cooling lake, populations of selected species of fish and invertebrates, light extinction, and chlorophyll.

11. Wetland birds. Nine data sets record the abundance and distribution of wetland birds and relate these results to characteristics of the vegetative cover and water regime at the site of the power plant.

12. Wetland plants. Three data sets identify changes in the wetlands west of the cooling lake, relate various vegetation parameters to the water regime, and document the condition of the wetlands photographically.

13. Remote sensing. Five data sets include a survey of vegetation counts and cover, aerial photographs of the wetland west of the cooling lake, scanned data from selected color and color infrared aerial photographs taken at the study site and at four similar central Wisconsin wetlands, and documentation of image processing software for digitizing scanned air photos.

14. Citizen concerns and attitudes. Two data sets record results of a workshop and a survey on attitudes of citizens on land use and power plant siting.

15. Wisconsin Power and Light Company data. Thirteen data sets monitor levels of several air pollutants, air temperature, wind speed and direction, atmospheric pressure, precipitation, net solar radiation, and daily coal consumption and gross megawatt load of the power plant.

16. Data from other sources. Two data sets provide evaporation data from the Arlington Experimental Farm of the University of Wisconsin-Madison and meteorological data obtained by the National Weather Service at Truax Field, Madison, Wisconsin.

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***Gary E. Glass** is the EPA Project Officer (see below).*
The complete report, entitled "Documentation of the Data Base: Wisconsin Power Plant Impact Study," (Order No. PB 84-140 268; Cost: $29.50, subject to change) will be available only from:
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☆ U.S GOVERNMENT PRINTING OFFICE: 1984-759-102/884