ENHANCING THE USE OF EASTERN AND MIDWESTERN COALS BY GAS REBURNING-SORBENT INJECTION

ENVIRONMENTAL INFORMATION VOLUME

for

CWLP LAKESIDE STATION, BOILER NO. 7

Submitted by:

Energy and Environmental Research Corporation
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1.0 INTRODUCTION

On December 19, 1985, President Reagan signed Public Law No. 99-190, which provides funds to conduct cost-shared clean coal technology projects between industry and government. To implement this law, the Department of Energy (DOE) instituted a Clean Coal Technology Program. The goal of this program is to evaluate emerging technologies that are designed to displace oil and natural gas, or to utilize coal more cleanly, efficiently or economically than currently available technology. Individual clean coal projects are intended to demonstrate the feasibility of future commercial applications of emerging technologies. This volume is concerned with a clean coal project combining gas reburning with sorbent injection for the purpose of in-boiler control of oxides of nitrogen and sulfur.

The Energy and Environmental Research Corporation (EER) is currently making preparations to conduct a demonstration project involving cofiring pulverized coal with natural gas in combination with sorbent injection and/or coal cleaning to:

- Allow for cost effective reduction of NO_x and SO_2 emissions from coal-fired boilers constructed prior to New Source Performance Standards (NSPS) [40 CFR Part 60].

- Provide the utility industry with increased flexibility in coal purchasing.

The combination of technologies to be demonstrated, gas reburning with sorbent injection (GR-SI), involves introduction of natural gas above the main heat release zone to produce a homogeneous, slightly oxygen-deficient zone. At the downstream end of this rich zone, burnout air and calcium-based sorbent are injected into the gas duct. Gas reburning is effective in the reduction of NO_x emissions by the reaction of hydrocarbon radical species with NO to form nitrogenous intermediates which react in the oxygen-deficient atmosphere to produce N_2. The sorbent injection process can be viewed as a sequential coupling of an activation step, in which the calcium-based sorbent (limestone or hydrate) calcines to produce CaO, and a heterogeneous sulfation step, where the CaO reacts with gas phase SO_2/SO_3 to form calcium sulfate. The calcium sulfate is subsequently removed by the plant particulate control equipment. While duct injection of sorbent is a technical alternative, upper furnace injection will be used in this project.

The technology demonstration program conducted by EER will focus on three Illinois utility boilers representing the range of pre-NSPS boiler technology:

- Illinois Power Co., Hennepin Station, Unit 1; 80 MW_e tangentially fired.
- Central Illinois Light Co., Edwards Station, Unit 1; 117 MW_e front wall fired.
- Springfield CWLP, Lakeside Station, Unit 7; 40 MW_e cyclone fired.

This volume details the actions to be taken at Lakeside Station and the environmental impacts of these actions.

The purpose of this Environmental Information Volume is to facilitate DOE's preparation of the environmental documents required for compliance with the National Environmental Policy Act of 1969 (NEPA). This report has been prepared in accordance with the guidelines provided by DOE in Appendix J of the Clean Coal Technology Program Opportunity Notice (PON) and contains all relevant information requested therein. The goal of this document is to provide a project description as well as an analysis of all applicable environmental, health, safety, and socioeconomic (EHSS) issues. Current air permits and National Pollutant Discharge Elimination System (NPDES) permits are also described, as well as anticipated permit modifications.

2.0 PROJECT DESCRIPTION

This section describes the existing facility at Lakeside Station, presents a brief technical description of the GR-SI technology demonstration project, describes anticipated project activities, defines project resource requirements and discharges, and lists EHSS areas that could potentially be impacted by the project. All data requested in Appendix J of the DOE PON are addressed; however, only cursory treatment is afforded those factors for which this retrofit technology demonstration makes applicability tenuous.

2.1 Existing Facility

2.1.1 Site Description

Lakeside Station and the adjacent Dallman Station occupy a 75-acre site on the northwest shore of Lake Springfield, in the southeast section of the city of Springfield in Sangamon County, Illinois, as indicated in Figures 2-1 and 2-2. The layout of the station is illustrated in the aerial view of Figure 2-3, and specific site features are identified on the station plot plan presented in Figure 2-4.

Lakeside Station is accessible by rail and truck. The Illinois Terminal, Gulf Mobile and Ohio, Illinois Central, Norfolk and Western, and Baltimore and Ohio Railroads all have traffic lines running within 3 miles of the plant site. An Illinois Terminal Railroad spur line is in place and operational though not used. Interstate highway 55 runs adjacent to the plant site. Water supplies for Lakeside Station are taken from Lake Springfield. CWLP also operates a water treatment plant on the site which supplies potable water to the Lakeside Station and to the entire city of Springfield. A major gas pipeline currently provides natural gas to the Dallman Station on the south end of the site; a branch line will be connected to this feeder at the west boundary of the plant site to provide gas to Unit 7 for the GR-SI technology demonstration.

★ Lakeside Power Station, Sangamon County, Illinois

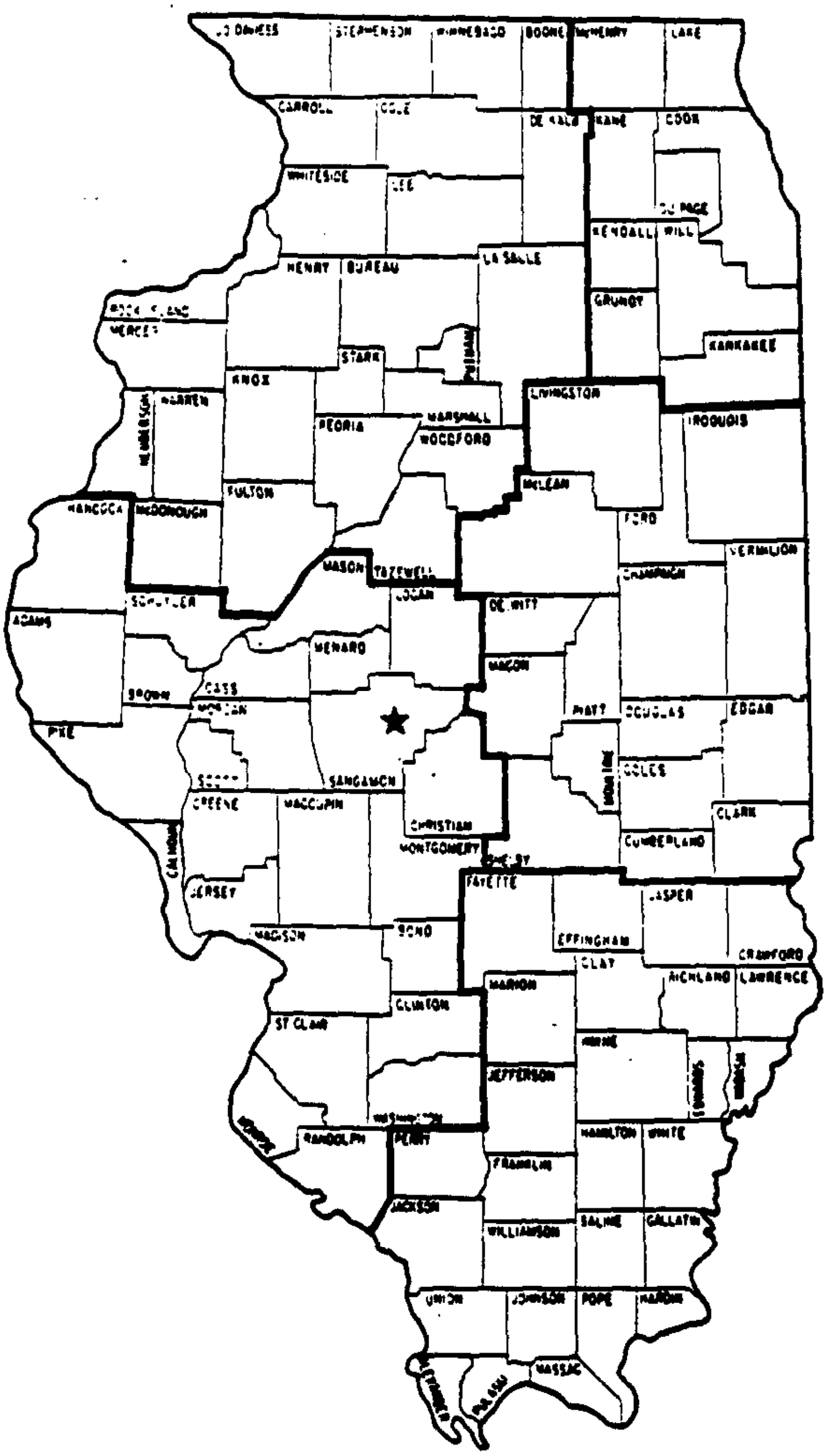


Figure 2-1. Location of CWLP Lakeside Station.

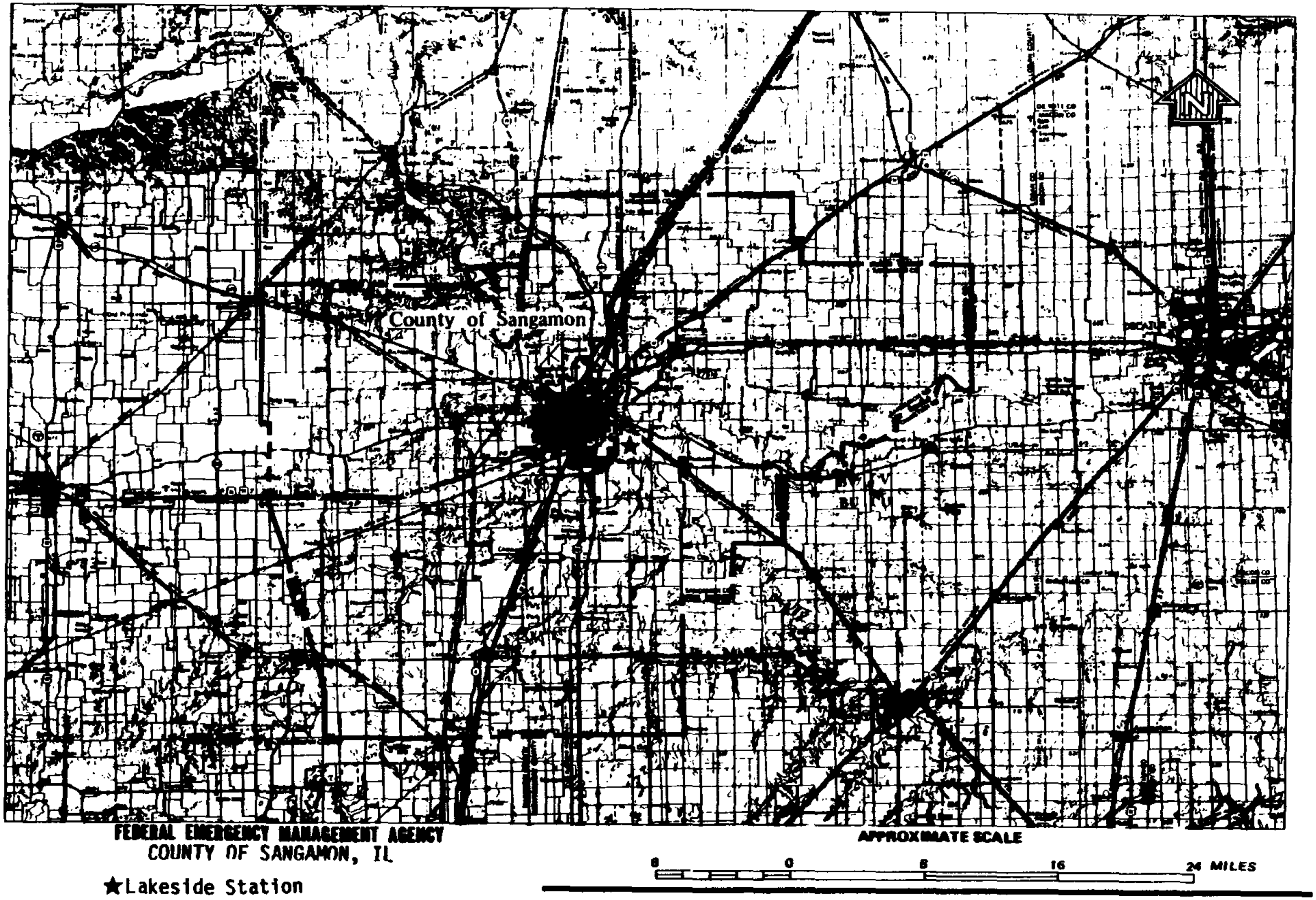
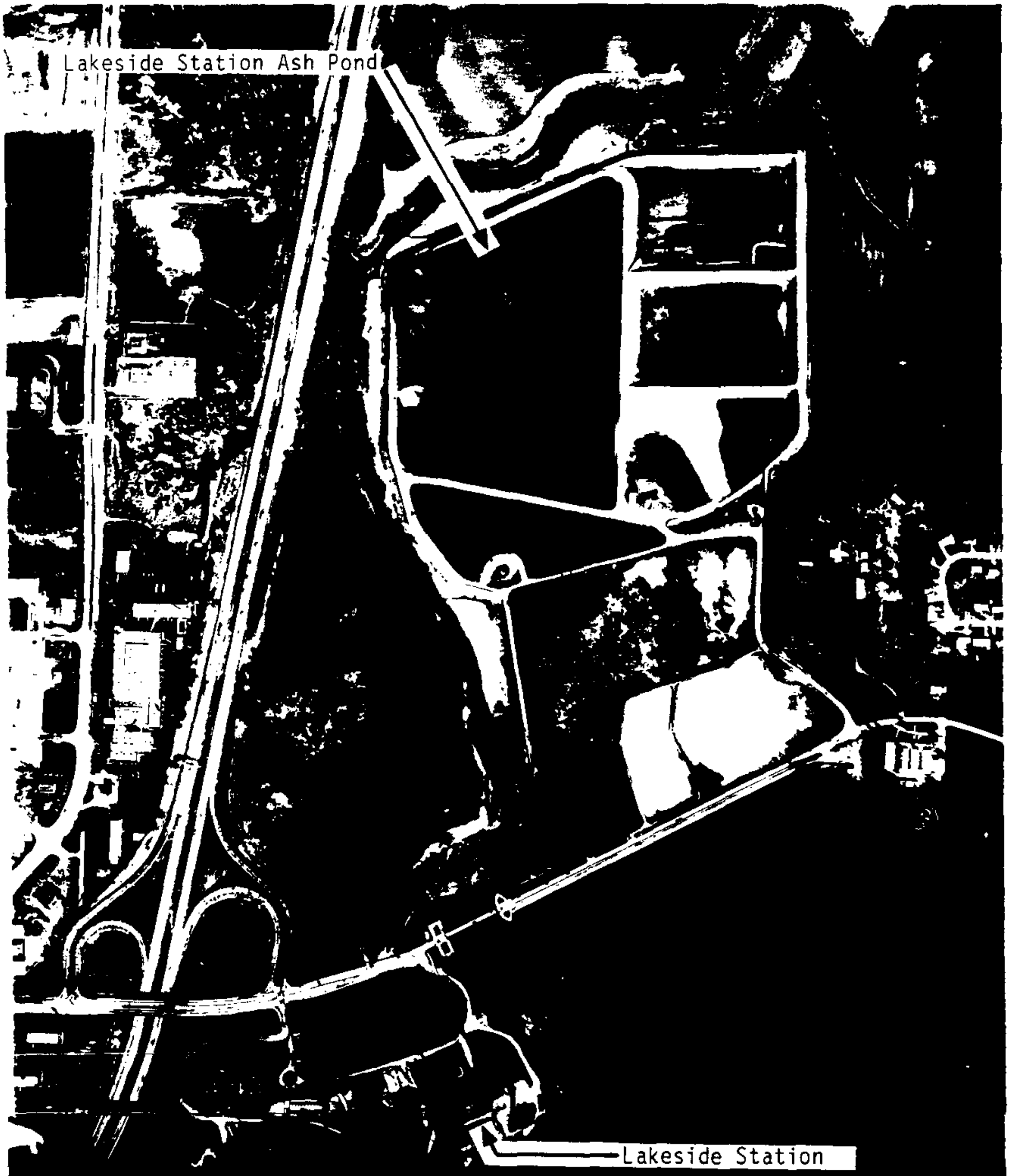


Figure 2-2. Map of Sangamon County.



Approximate Scale (miles)

1/8 0 1/8 1/4

Figure 2-3. Aerial view of Lakeside Station.

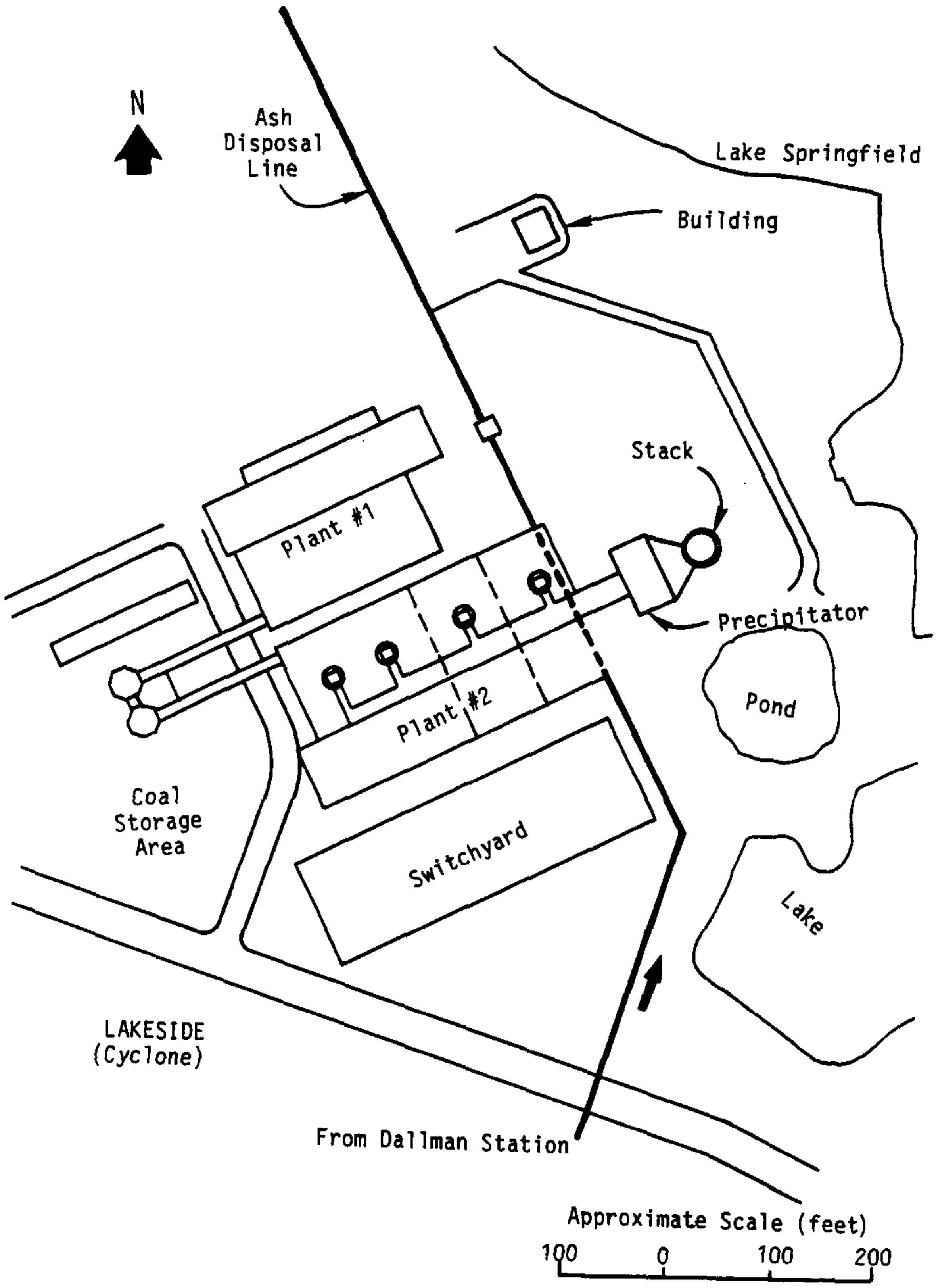


Figure 2-4. Lakeside Power Station plot plan.

Lakeside Station has three operational electrical generating units. The GR-SI technology demonstration will be conducted in Unit 7. Unit 7 fires coal from Logan County, which is about 15 miles northeast of Springfield. The coal is delivered to Lakeside Station by truck and unloaded into a storage pile which maintains a minimal reserve capacity. Coal pile runoff is intermittent and has an annualized average flow rate of 0.019 million gallons per day (MGD), based on measurements made by Lakeside personnel. Runoff is collected in a pond, and pond water is discharged into Lake Springfield.

2.1.2 Description of Existing Process

Lakeside Station contains three coal-fired steam electric generating units with a total net generating capacity of 100 MW_e. Two additional 20 MW_e units are licensed but have not been used in the past five years. The project will be conducted in Unit 7, a 40 MW_e cyclone-fired boiler, as shown in Figure 2-5. Unit 7 fires medium sulfur bituminous coal from Logan County. Coal and ash analyses are given in Table 2-1. These analyses were done for the plant by Commercial Testing and Engineering Company in 1985. During full-load operation, Unit 7 currently fires 39,480 lb/hr of coal. Plant records indicate that Unit 7 fired a total of 41,700 tons of coal in 1986. Assuming 7,392 hours per year, Unit 7 fired coal at an annualized average rate of 11,282 lb/hr in 1986. Based on boiler output of 35 MW_e, which is the Unit 7 nominal capacity, the 1986 capacity factor was 28.6 percent. The two generation stations on the CWLP site together consumed 815,000 tons of coal in 1986. Therefore, Unit 7 accounted for 5.1 percent of the total station coal usage in 1986.

An electrostatic precipitator (ESP) is used to control particulate emissions. The ESP is a cold side unit, which means that it operates downstream of the air preheater. The variable size ESP has specific collection area (SCA) ranging from 333-1000 $ft^2/(1000\ ft^3/min)$. SCA varies depending on the number of units in operation at a given time.

Solid waste streams from the boiler include the fly ash collected by the plant ESP and the furnace bottom ash. These waste streams are exempted from

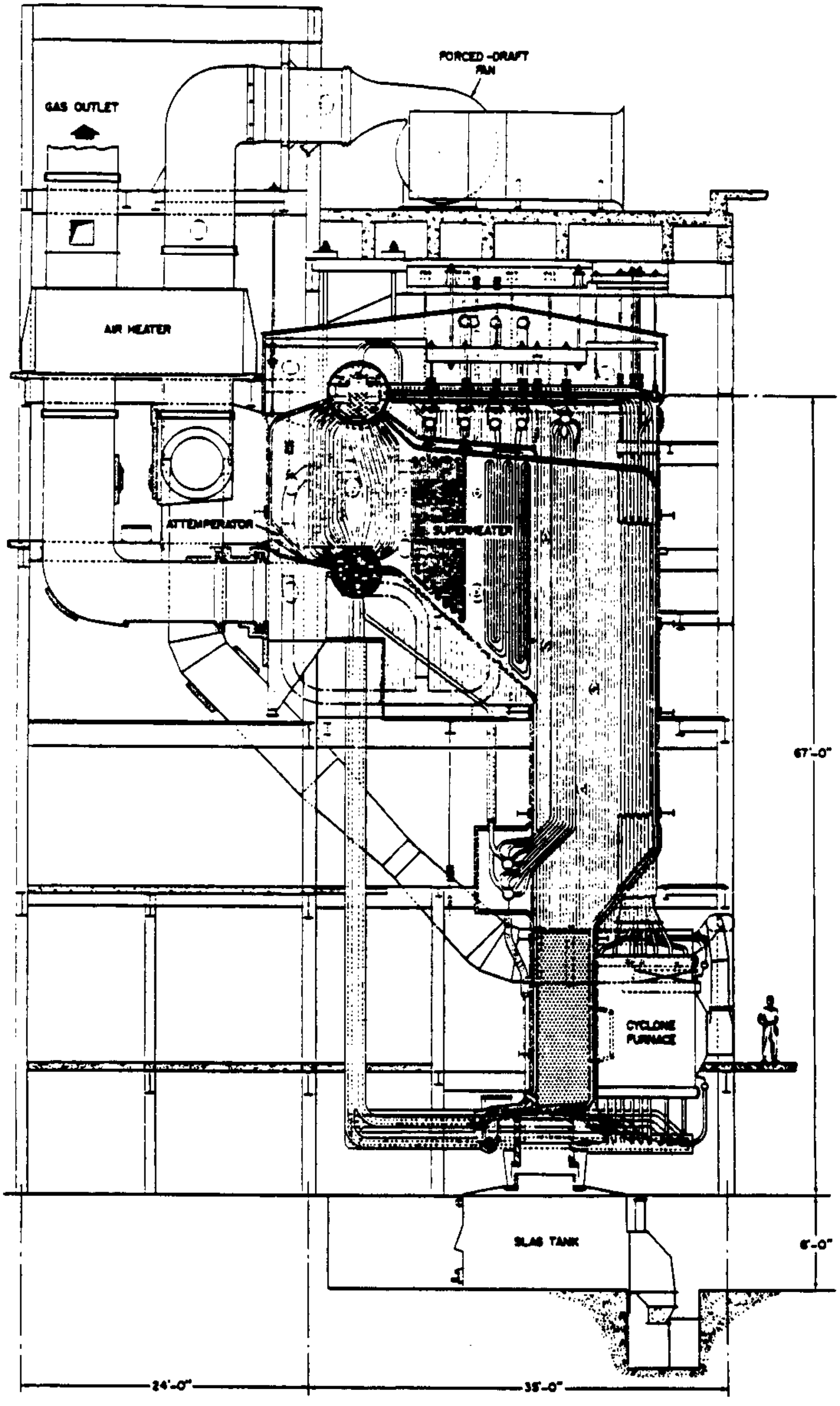


Figure 2-5. Schematic of Lakeside Station Unit No. 7 Boiler.

TABLE 2-1. COAL AND ASH ANALYSES

Fuel Property	Illinois Coal As Received	Illinois Coal Dry Basis
Proximate Analysis		
Fixed Carbon	39.70	48.23
Volatile Matter	33.72	40.96
Ash	8.90	10.81
Moisture	17.69	-
Ultimate Analysis		
Carbon	58.00	70.47
Hydrogen	4.05	4.92
Nitrogen	1.11	1.35
Chlorine	0.10	0.12
Sulfur	2.80	3.40
Ash	8.90	10.81
Oxygen	7.35	8.93
Moisture	17.69	-
Heating Value as Fired (Btu/lb)	10,460	
Ash Fusion Temp, Reducing (^{o}F)		
Initial Deformation	1945	
Softening (H = W)	1990	
Softening (H = 1/2 W)	2120	
Fluid	2280	
Ash Density (g/cm^3)	2.2	
Coal Grindability (Hardgrove)	52	

Energy and
Environmental
Research Corporation

12 January 1988

Dr. Earl Evans
Department of Energy
Pittsburgh Energy Technology Center
P.O. Box 10940
Pittsburgh, PA 15236-0940

Dear Earl:

Enclosed please find a copy of the revised Environmental Information Volume for Lakeside Station. We have addressed the comments made by you, Tom Ruppel, and Bill Willis in our conference call of December 18, 1987. Copies are being sent to you and Bill Willis. We are prepared to send, upon your notification, the additional copies you will require for distribution to DOE headquarters and/or environmental review personnel. If you have any questions or comments, please do not hesitate to call.

Sincerely,

Pete Maly for

L. P. Nelson
Program Manager
Environmental Management Division

LPN:mhh

Enclosure

cc: Mr. Harry Ritz, DOE
Dr. William Willis, SAIC
Dr. William Bartok, EER
Dr. Blair Folsom, EER
Mr. Peter Maly, EER

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RCRA Subtitle C Hazardous Waste regulations and are sluiced approximately 0.25 miles to on-site ash ponds for disposal. Based on coal flow rate and ash percentage, the flow rate of fly ash from Unit 7 to the ash pond during full-load operation is 785 lb/hr. Average flow rate of bottom ash to the ash pond is 2710 lb/hr. The process flow diagram in Figure 2-6, representing full-load conditions for Unit 7, shows these flow rates. Unit 7 generated 3711 tons of ash in 1986. The CWLP plant, which includes Lakeside and Dallman stations, generated a total of 72,535 tons of ash in 1986.

Process water from the Lake Springfield is used for once-through non-contact cooling applications and for transporting fly ash and bottom ash. Fly and bottom ash are sluiced to an ash pond. This ash pond also receives waste from other Lakeside and Dallman units. Process water flow rates as measured by the utility are summarized in Table 2-2. Unit 7 sluice water requirement averages 1.0 MGD, as measured by the utility. Effluent water from the ash pond is discharged into Sugar Creek, which runs from Lake Springfield to the Sangamon River. The plant's National Pollutant Discharge Elimination System (NPDES) permit requires the plant to file monthly effluent water monitoring reports detailing flow rate, pH, total suspended solids, and oils and greases from all Lakeside and Dallman units. Average values of these parameters for a recent year as determined from monthly reports are presented in Table 2-3. Current ash pond sulfate concentration is about 0.32 g/l.

Unit 7 currently requires air at a flow rate of 84,100 standard ft^3/min (scfm). Air emissions of concern include SO_2, NO_x and particulates. Calculations based on coal flow rate and sulfur content indicate that during full-load operation SO_2 is presently emitted at a rate of 2211 lb/hr [5.31 pounds per million Btu (lb/MBtu)]. NO_x is emitted at a rate of 603 lb/hr (1.45 lb/MBtu). This value is calculated assuming NO_x emissions of 1000 parts per million, which is a value typical of cyclone fired boilers. Utility measurements indicate that particulates are emitted at a rate of 3.3 lb/hr (0.008 lb/MBtu).

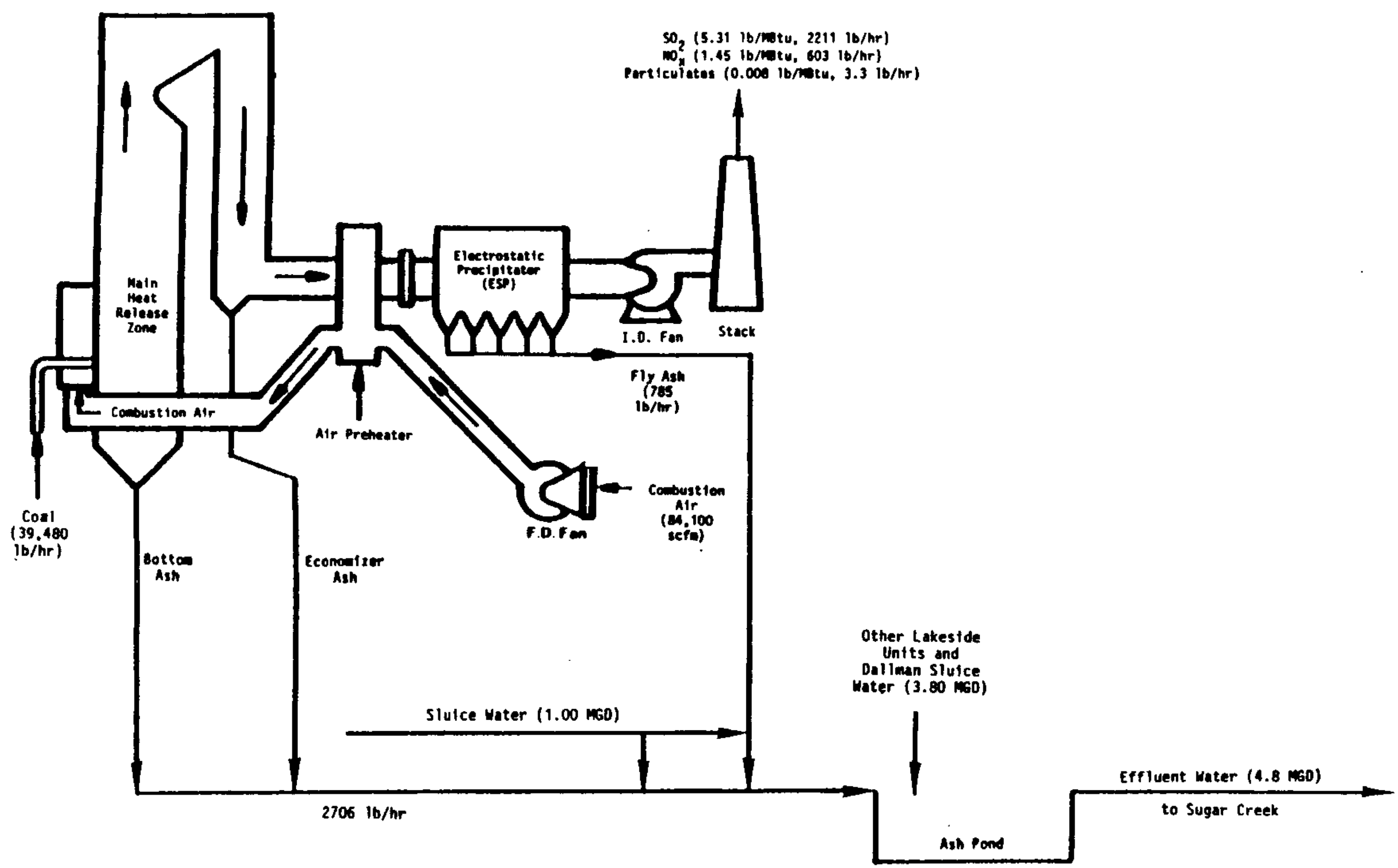


Figure 2-6. Process flow diagram for baseline operation during full load output.

TABLE 2-2. PROCESS WATER FLOW RATES

Source	Flow Rate (MGD)
Circulating Boiler Water	0.92
Cooling Water	290
Sluice Water	1.0
Coal Pile Runoff	0.019 (intermittent)

TABLE 2-3. AVERAGE ASH POND EFFLUENT WATER PARAMETERS

Parameter	High	Low	Average
Flow Rate (MGD)	7.05	2.88	4.80
pH	9.06	8.40	8.77
TSS (mg/l)	14.88	6.20	9.88
Oils/grease(mg/l)	3.30	0.05	1.10

2.2 Technical Project Description

Laboratory-scale investigations of the reburning concept were originally conducted in the United States in the early 1970's (e.g. Wendt, J. O. L., Sternling, C. V., and Matovich, M. A., "Reduction of Sulfur Trioxide and Nitrogen Oxides by Secondary Fuel Injection." Fourteenth Symposium (International) on Combustion, The Combustion Institute, Pittsburgh, 1973, p. 897). More recently it has been demonstrated at full scale in Japan, but mainly with oil fired systems. Recent extensive research and pilot scale work at EER has demonstrated potential of the reburning concept, particularly when the reburning fuel is natural gas. Sorbent injection was also originally developed in circa 1960 and 1970 and was demonstrated at full scale in Tennessee Valley Authority's (TVA) Shawnee Power Plant in the early 1970's with rather poor results. Subsequently, TVA demonstrated that significantly higher capture levels could be achieved through use of proper injection locations and advanced sorbent materials. Large scale work at several U.S. and Canadian sites has begun to confirm the potential of this technology for SO_2 control.

EER's most recent pilot scale results indicate that 60 percent NO_x reductions can be achieved from typical pre-NSPS NO_x levels. Sulfur dioxide reductions of up to 70 percent can be achieved by combining reburning with sorbent injection if a hydrated sorbent is used. These data are typical of those obtained with optimized gas reburning-sorbent injection for a wide spectrum of primary fuels and they appear to be generally achievable in full scale systems.

The objectives of the current project are to provide a comprehensive data base demonstrating the performance of GR-SI in pre-NSPS utility boiler applications and to promote commercialization of this combination of technologies. Since the design and operating characteristics of pre-NSPS utility boilers vary widely, no single demonstration could adequately address the full population. Consequently, a total of three demonstrations will be conducted using three pre-NSPS utility boilers with widely varying characteristics. The GR-SI systems will be designed for optimum performance as applied to each specific host unit.

Figure 2-7 illustrates the application of GR-SI in a tangentially fired boiler. Natural gas is injected above the main heat release zone to reburn NO that is produced in that zone. NO is reduced by a hydrocarbon radical (CH) producing HCN which allows the formation of NH via NCO. Molecular nitrogen is produced by the reaction of NO with N at high temperature and with NH_2 at lower temperatures ($<2200^{\circ}F$). The GR-SI system will provide 60 percent NO_x control, which includes reduction from the reburning process as well as from the reduction in coal usage. The pre-NSPS Lakeside unit does not have an NO_x emission constraint. Thus, this NO_x emission reduction could be useful to the plant in response to future NO_x regulations.

In Figure 2-7 four locations are shown for sorbent injection; three of these (A, B, and C) correspond to upper furnace injection. Upper furnace injection is necessary because an injection temperature of approximately $2250^{\circ}F$ is required to maximize sulfur capture. Injection location D provides for duct injection of calcium hydroxide. A humidifier is also included since humidification can help both sulfur capture and precipitator performance. For the cyclone fired Unit 7 boiler, the SO_2 strategy will be to reduce SO_2 emissions by 50 percent while firing the existing Illinois coal. This emission reduction is not required by existing regulations but could be used for compliance with any future SO_2 regulations. The preliminary plan is to inject the sorbent into the upper furnace on this unit. Sorbent injection will increase the amount of solid material in the flue gas; thus, the amount of solid waste being generated will increase.

Solid waste will be managed using the plant's current wet handling system. The solid waste from GR-SI is a blend of a calcium sorbent with fly ash which, due to the presence of unreacted lime, has similar characteristics to lime/fly ash/scrubber sludge prepared for sludge disposal or the solid product from lime-based spray dryer systems. This waste hardens after placement and produces stable landfills. Such a blend may also have commercial value for construction applications.

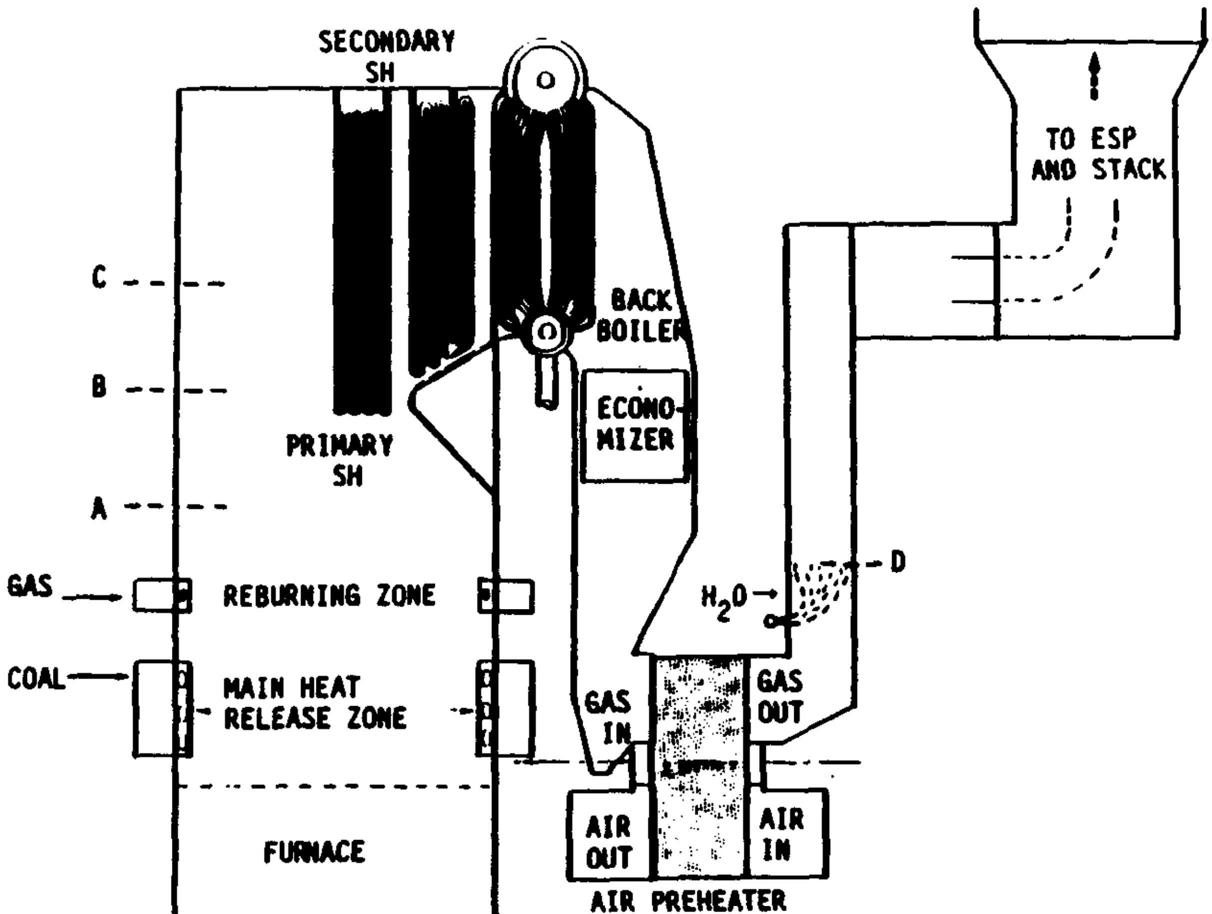


Figure 2-7. Application of gas reburning sorbent injection for NO_x/SO_x control.

2.3 Description of Activities

2.3.1 Description of Project Phases

The GR-SI project will take 53 months to complete. EER will conduct the technology demonstration project in three phases:

- Phase 1--Design and Permitting. This initial phase will culminate in the detailed design of gas reburning and sorbent injection systems for the Lakeside site. A program plan will be prepared for the equipment construction and demonstration testing. An industry panel will be established to initiate technology transfer.

- Phase 2--Construction and Startup. This phase will begin after Phase 1 is completed and will last 16 months. Following DOE approval, the gas reburning and sorbent injection equipment will be installed and checked out at Lakeside site. The process and engineering designs will be presented to the industry panel.

- Phase 3--Operation, Data Collection, Reporting, and Disposition. Phase 3 will begin concurrent with the final stages of Phase 2 and will last 29 months. Following DOE approval, the host unit will be tested for one year over a range of conditions. All data and test results will be compiled into a guideline manual which will be made available to industry. The project results will be presented to the industry panel.

The demonstration of GR-SI is not intended as a first generation of specific technology but rather it will build upon the results of several individual technology demonstrations now being conducted by the EPA and others.

2.3.2 Description of Installation Activities

The following section describes the specific installation tasks that will be undertaken as part of the GR-SI technology demonstration by EER personnel, plant personnel and local labor. Worker safety is a primary concern in any industrial project, since an employer has not only a financial liability, but an ethical responsibility to ensure that workers are not subjected to unreasonable risks. All appropriate occupational health and safety rules will be fully enforced throughout this program to minimize the risk of injury to workers.

The GR-SI equipment installation work at Lakeside Station will be conducted in a series of five steps:

1. Procurement
2. Initial installation (normal unit operation)
3. Final installation (outage)
4. Checkout
5. Correction of deficiencies

Step three, final installation, must correspond to a normally scheduled outage and this is the key element determining the installation schedule. The specific outage schedule will depend on the utility's load requirements at the time and the condition of the unit. For example, if a fall outage is scheduled but the power demand is greater than anticipated in the fall and there are no major problems, the utility may elect to delay the outage until the low load period in the spring. The program must be flexible in this regard. To maximize schedule flexibility, EER will request authorization to procure long lead time items as soon as possible following the completion of the final design specifications.

Most of the equipment will be standard items such as piping, valves, silos, etc., and will be obtained directly from vendors. A limited number of items will need to be custom-fabricated to meet site specific requirements. These include the gas and sorbent injectors, windbox modifications, etc. The general approach to the equipment procurement and installation will be to conduct the fabrication/assembly work off site to the maximum extent possible. This will limit the amount of time-consuming custom installation and fitting required during the short outage periods.

The on-site installation work will be divided into two steps: an initial installation step where all work is conducted during normal unit operation and the final installation step which requires a unit outage. The following equipment will be installed during normal unit operation:

1. Sorbent unloading and storage equipment.
2. Sorbent feeding and transport equipment.
3. Sorbent piping and injection equipment assembly.
4. Sorbent injection control assembly.
5. Gas piping and controls assembly.
6. Gas injector assembly.
7. Instrumentation installation except for final connections.

A plot plan of Lakeside Station showing the location of the sorbent storage silo is shown in Figure 2-8.

The intent is to complete the initial installation in time to provide flexibility on completing the final installation during a scheduled outage. The following equipment must be installed during an outage:

1. Windbox modifications.
2. Furnace or duct penetrations for gas injectors, overfire air ports or sorbent injectors.
3. Final connections for control equipment.
4. Final gas plumbing.
5. Final instrumentation connections.
6. ESP upgrades.

Boiler tubes are lined with asbestos to minimize heat loss, and some asbestos handling will be required. All boiler modification work will be conducted by a contractor qualified to work with asbestos materials. EER will include in the contractor's specifications a requirement that all applicable OSHA and EPA regulations be satisfied, including asbestos removal guidelines, air monitoring requirements, and proper disposal considerations.

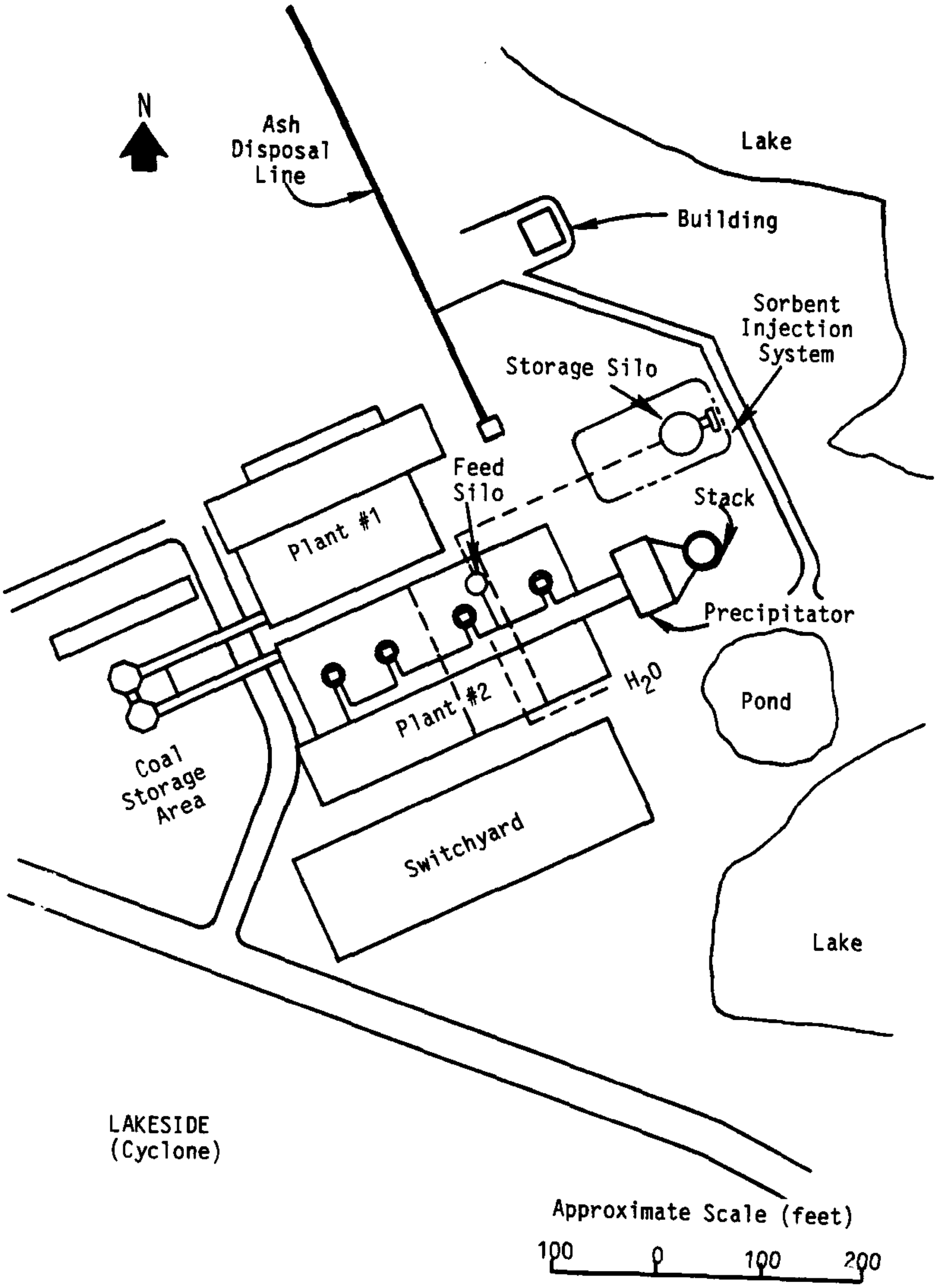


Figure 2-8. Plot plan of Lakeside Station.

It is not necessary that all final installation work be completed at a single scheduled outage following the initial installation. Consideration will be given to installing the furnace/duct penetrations, windbox modifications and ESP upgrades prior to the completion of the initial installation items if a scheduled outage becomes available. This would reduce the intensity of effort required during the final outage.

Construction of the natural gas pipeline at Lakeside Station will include the following steps:

- Final route selection
- Materials and equipment procurement
- Excavation
- Pipefitting

Each of these steps will be coordinated by CILCO, owner of the trunk pipeline. The tentative route selected for installation of the Lakeside Station natural gas pipeline is shown in Figure 2-9. This route lies entirely within the boundaries of the CWLP plant. The pipeline installation will be conducted by the Gas Division of CILCO. The materials and equipment required for the pipeline construction include piping, fittings, welding supplies, excavation equipment, and material handling equipment. All materials will meet applicable codes and common industrial practices will be matched. The pipeline will be routed to convenient termination adjacent to Unit 7. From this terminal point, the remainder of construction activity will be conducted as described previously under equipment installation.

2.4 Project Source Terms

This section characterizes all of the source terms of the GR-SI technology demonstration project. Source terms can be divided into the categories of resource requirements and project discharges.

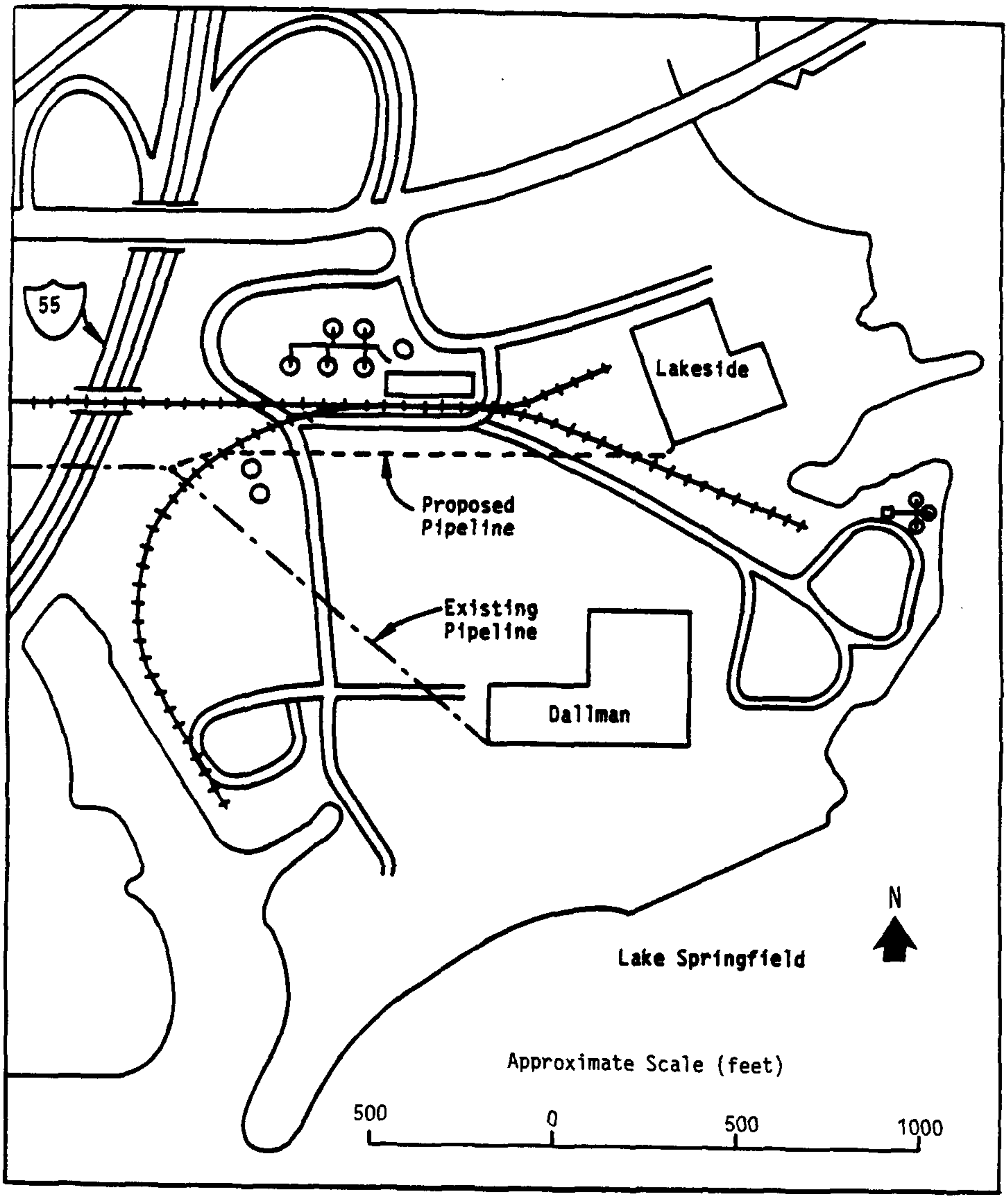


Figure 2-9. Tentative route of natural gas pipeline to Lakeside Station.

2.4.1 Project Resource Requirements

Project resource requirements include energy, land, water, labor, materials, and other resources. Figure 2-10 is a diagram detailing important process flow rates. The resource requirements associated with the GR-SI technology demonstration project are identified below.

Energy Requirements

Additional energy requirements associated with the GR-SI technology demonstration include electrical power to run sorbent equipment and natural gas required as reburning fuel. The estimated increase in electrical power consumption for the site is about 400 kW. It is estimated that the natural gas consumption rate for the host site at full operating capacity will be 1275 standard ft^3/min. Coal usage will decrease due to the added natural gas flow. Full load coal feed rate is expected to decrease by approximately 19 percent to 32,120 lb/hr. Combustion air flow rate will increase slightly to 87,384 standard ft^3/min.

Land Requirements

The GR-SI technology demonstration involves the retrofit of two emission control procedures on an existing utility boiler. The natural gas pipeline will be constructed entirely within CWLP plant boundaries. Since the technology itself is implemented within the existing boiler structure and the ancillary systems associated with GR-SI are relatively compact, there is no anticipated requirement of land outside the existing plant boundaries. The host site has been examined to ensure that adequate space is available on site for the pipeline and installation of the sorbent storage and feeding equipment. Sufficient space is available for convenient location of all required hardware.

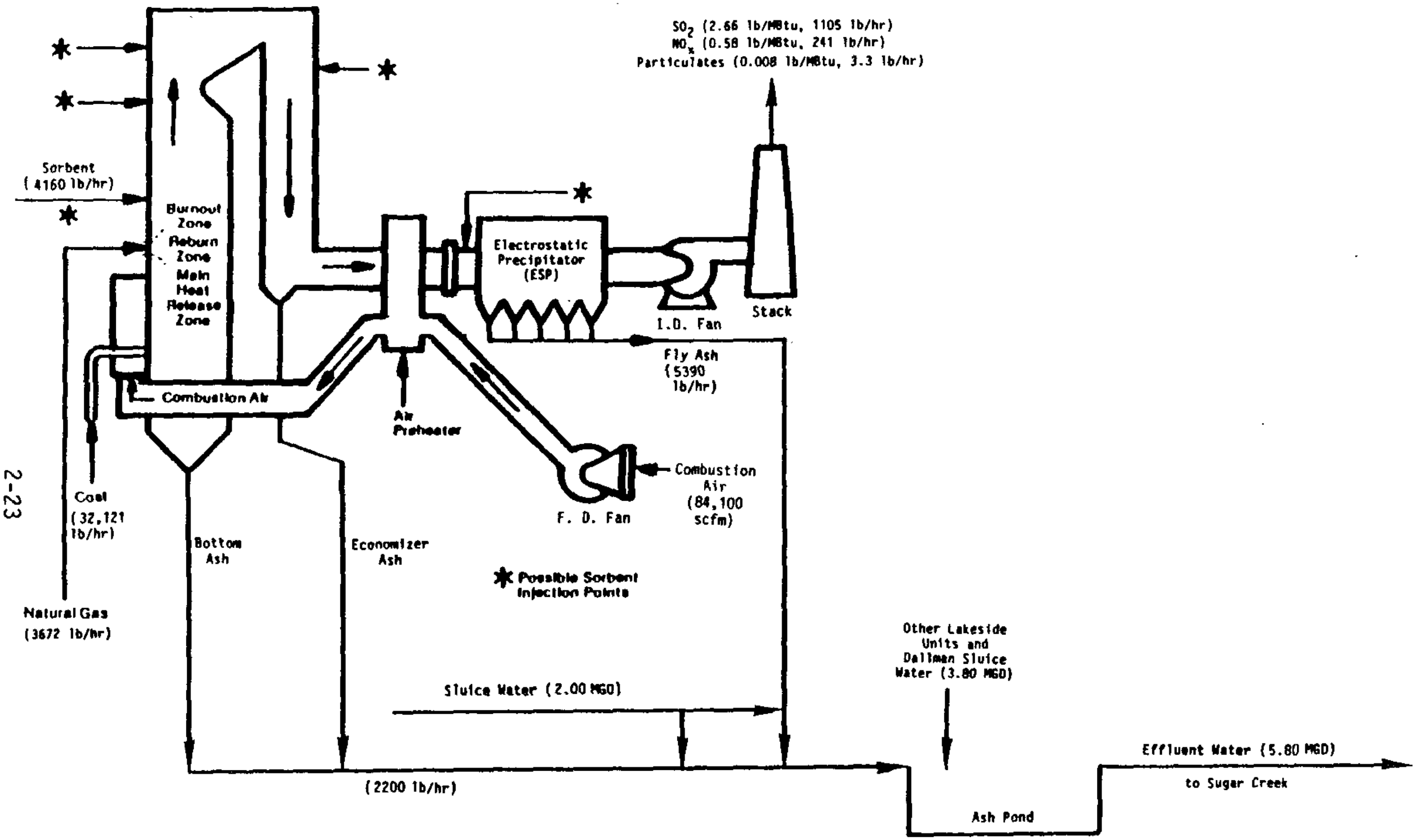


Figure 2-10. Process flow diagram for GR-S during full-load output.

Water Requirements

The GR-SI process does not require the utilization of water, per se. However, more sluice water will be required because the sorbent injection process will generate an increased amount of fly ash. Calculations by EER personnel based on amount of increase in fly ash loading indicate that the average sluice water requirement will increase from its current value of 1.0 MGD to 2.0 MGD.

Labor Requirements

Labor will be required for installation of the GR-SI equipment, operation and maintenance of the hardware, and verification of system performance. Although the equipment installation represents the largest labor requirement, it is still a relatively small effort which can be managed by EER using locally available labor to provide both general and specialized skills. A breakdown of labor requirements is presented in Table 2-4.

Operation and maintenance of the GR-SI systems requires very little additional labor; it is anticipated that these tasks may be conducted by the existing plant operations staff upon completion of a brief training program. During test periods, EER test crew personnel will also be available to oversee operation and maintenance procedures.

Performance verification tasks will be conducted by EER test crews. No additional labor will be required for these tests.

Materials Requirements

The primary material requirement for the GR-SI technology demonstration is a calcium based sorbent. During operation, 4160 lb/hr of $Ca(OH)_2$ will be required. During the course of the program, 15,000 tons of sorbent are expected to be used at the site. Approximately 150 tons of sorbent will be stored in the site's sorbent silo. The raw material for sorbent is limestone

TABLE 2-4. CONSTRUCTION LABOR REQUIREMENTS

Task	Duration (months)	Community Supplied Labor (hrs)
Phase 1: Baseline Testing	1	240
Phase 2: Construction	16	3,360
Phase 3: GR-SI Testing	12	2,000
Total	29	5,600

for which the state of Illinois is a major producer. The sorbent to be tested will be selected as part of the demonstration process.

Construction materials will be purchased from local distributors. Construction materials include sorbent silo and handling equipment, piping and small hardware items. Sulfuric acid and carbon dioxide needed for ash pond pH adjustment will also be purchased locally.

Transportation Requirements

The main factors impacting transportation will be decrease in coal usage and increase in sorbent usage. The sorbent will be trucked in and will require approximately three trucks per day for delivery. Coal is currently delivered to Lakeside by 20-ton trucks; 24 trucks per day are required by Unit 7. Because coal usage will decrease, only 20 trucks per day will be required for coal delivery after GR-SI is implemented. Therefore, the total truck traffic for Unit 7 will be 23 trucks per day.

2.4.2 Project Discharges

Significant waste discharge streams from the boilers employing the GR-SI technology include stack emissions and a solid waste consisting of fly ash and spent sorbent. At the technology demonstration site, emission reduction targets of 60 and 50 percent for NO_x and SO_2, respectively, have been established. NO_x emissions are expected to decrease to 241 lb/hr (0.58 lb/MBtu). Emissions of SO_2 are expected to decrease to 1105 lb/hr (2.66 lb/MBtu). No changes in CO, unburned hydrocarbons, or particulate emissions are anticipated.

Solid waste is expected to change in both flow rate and composition due to the addition of sorbent. Flow rate of fly ash collected by the ESP is expected to increase from its current level of 785 lb/hr to about 5390 lb/hr. The new composition of the fly ash will be 12 percent coal ash, 27 percent $CaSO_4$, and 61 percent $Ca(OH)_2$. Bottom ash flow rate, which GR-SI will not affect per se, will decrease to 2200 lb/hr during full-load operation because of reduced coal consumption.

Changes are also anticipated in liquid effluent discharge from the ash pond. More sluice water will be required because GR-SI will generate an increased amount of solid waste. Based on the expected amount of sluice water increase, calculations show that average flow rate will increase by about 21 percent to 5.80 MGD. The addition of unreacted and spent sorbent to the fly ash will cause the waste stream to become more alkaline. Calculations will be performed during Phase 1 of the project, when detailed design work will be done, to determine the method of corrective action that will be used for compliance with permit limits for pH. pH will also be monitored during project operation. Possible neutralization measures to lower the pH level in the ash pond include injection with sulfuric acid or bubbling of carbon dioxide through the alkaline water. In both of these processes, the acid addition (CO_2 reacts in water to form carbonic acid) will lower the pH to within the permit limit of 9.

Oil and grease loadings are not anticipated to change. Total suspended solids will be maintained below the regulatory limit of 15 mg/l. Options for controlling suspended solids include increasing the residence time of the water in the pond and using chemical means to enhance settling rate. Sulfate concentration is expected to increase because the sorbent reacts with SO_2 to form calcium sulfate. The amount of increase will depend on sorbent injection rate, sluice water flow rate, pond pH, and pond hydroxide concentration. The plant's discharge to Sugar Creek is required to meet Illinois general use water quality standards, which specify that sulfate concentration must be below 500 mg/l. It will be necessary to chemically treat the effluent water with precipitating agents to reduce sulfate concentration. This will be assessed during Phase 1 of the project, when detailed design work will be done. Sulfate concentration will also be monitored during project operation. Coal pile size is not expected to change and thus coal pile runoff will not change.

Coal usage will decrease as a result of the GR-SI project, and as a result coal-based metals loading will decrease. In general, metals contributions from sorbent are expected to be smaller than those from coal. In addition, pH is expected to remain at current levels or to increase slightly. Studies have shown that leachability of metals decreases with increasing pH (e.g. Cote, P. L. and Constable, T. W., "Development of Canadian Data Base on Waste Leachability, Special Technical Publication 805, ASTM, Philadelphia, 1984, p. 53). Since coal-based metals loading and leachability are both expected to decrease, there is expected to be no increase in metals levels in either effluent or groundwater as a result of the GR-SI project.

2.5 Potential EHSS Receptors

A number of environmental features could potentially be impacted by the proposed action. These include air quality, surface water quality, groundwater quality, land use, labor force, and energy resources. Section 3 focuses on characterizing the existing environment with respect to these probable impact receptors. Section 4 evaluates the probable impact of GR-SI on these receptors.

3.0 EXISTING ENVIRONMENT

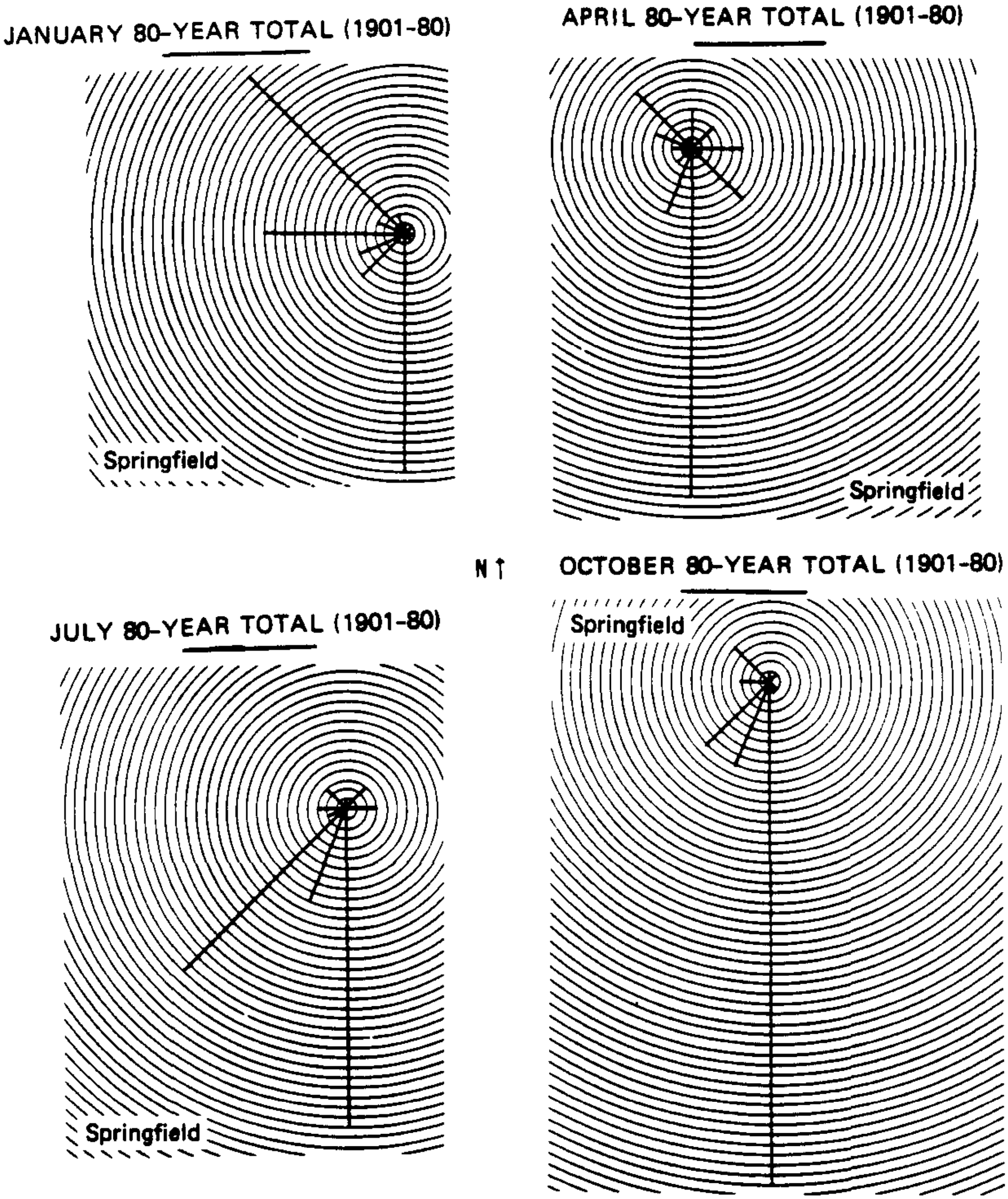
This section provides a description of the environmental setting at Lakeside Station, focusing on environmental features that might be impacted by the proposed action. The environment is divided into the six categories that were mentioned in Section 2.5. Each of these categories is characterized individually in this section.

3.1 Atmospheric Resources: Meteorology, Air Quality, and Noise

The area of central Illinois in which the demonstration site is located provides a typical continental climate with warm summers and fairly cold winters. Figure 3-1 shows wind roses for Springfield for 4 months throughout the year. According to the Illinois State Climatologist, average annual precipitation for Springfield is 33.8 inches. The climate is typical of the entire midwestern states area and not representative of a local specialized environment.

The air quality in the area of Lakeside Station is generally good. Sangamon County is in federal air quality control region 75 (West Central Illinois Intrastate), and is a primary attainment area for most U.S. EPA criteria pollutants, including SO_2 and NO_2, according to the Geographic Designations of Attainment Status of Criteria Pollutants published in February 1985 by the Illinois EPA. The region is a secondary non-attainment area for total suspended particulates. A survey of Illinois EPA's Air Emissions Inventory revealed that in Sangamon County there are 145 businesses and industrial plants that emit air pollutants, of which 86 emit particulates, 18 emit SO_2, and 24 emit NO_x.

Lakeside Station is in close proximity to the city of Springfield, as well as several railroads, highways, and other industrial plants. Current noise levels at the Lakeside plant are attributable to ongoing construction activities, normal plant operation (e.g. coal pile shaping and coal feeding), and coal delivery trucks for both Lakeside and Dallman Stations.



Key: For each concentric circle, the wind blows 1 percent of the time from the direction of the line. Thus a line directed vertically downward from the city that passed through 10 circles would indicate that the wind blew from the south 10 percent of the time.

Figure 3-1. Wind roses for Springfield, Illinois.

3.2 Land Resources

Lakeside Station is located in Sangamon County, Illinois. The power plant is situated adjacent to Lake Springfield in the Springfield Plain of the Central Lowlands Physiographic Province. The Plain is characterized by broad upland divides with mature valleys. There are no large hills in the vicinity, but rolling terrain is found near the Sangamon River. Approximately 10 feet of loess covers the Illinoian age glacial drift which is itself underlain by pre-Illinoian glacial drift and Pennsylvanian age bedrock. A flood plain map of the Lakeside Station area is given in Fig ure 3-2. From the map it can be seen that the plant itself is in a Zone C area, while the ash ponds are in a Zone A6 area. Zone C areas experience minimal flooding, while Zone A6 areas are within the 100-year flood plain. Although much of the land surrounding Lakeside Station is urbanized, there are some farmlands in the area. According to the Sangamon County Soil and Water Conservation District, most of the soil in this area is classified as Fayette silt loam, which is not considered prime or unique for farming. The Illinois Department of Conservation has indicated that wetlands maps have not yet been published for the area near Lakeside Station.

3.3 Water Resources

Lakeside plant discharges pond water to Sugar Creek. Ambient water quality data for Sugar Creek near Lakeside Station are summarized in Table 3-1, including flow rates and concentrations of contaminants. Also included are the Illinois General Use Water Quality standards for various parameters, which are standards which must be met in waters of the state for which there is no specific designation. From Table 3-1 it can be seen that dissolved oxygen, boron, iron, and silver occasionally exceed Illinois general use water quality standards. Creek flow rate depends on a number of factors, including rainfall and amount of water spilling over the Spaulding Dam from Lake Springfield. Creek flow rate generally never falls below 3 MGD (4.6 ft^3/s) due to dam spillage and pond discharge. There are no other industrial plants discharging into Sugar Creek.

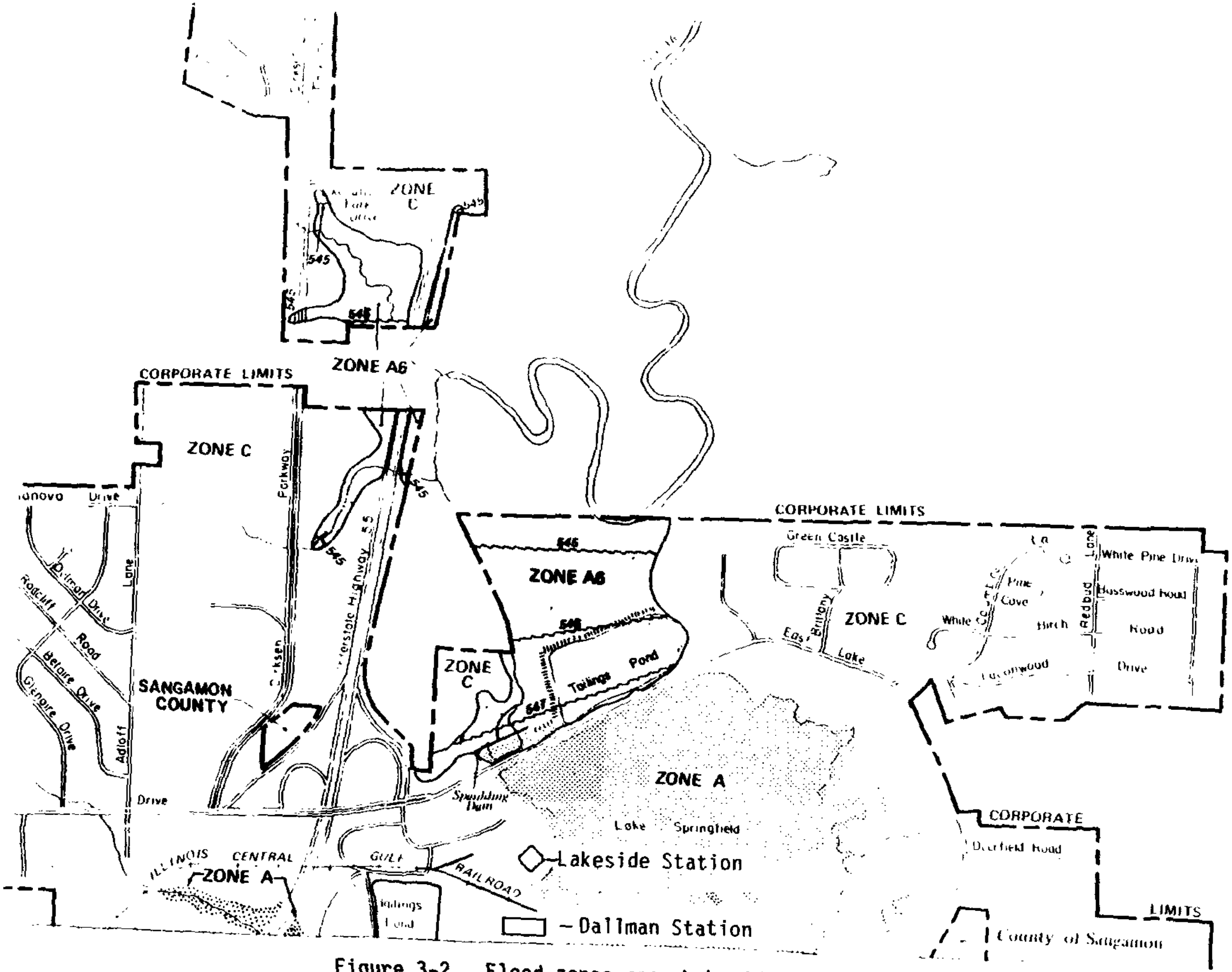


Figure 3-2. Flood zones near Lakeside Station.

TABLE 3-1. WATER QUALITY DATA FOR SUGAR CREEK NEAR SPRINGFIELD (1985).

Parameter	High	Low	Average	Illinois General Use Water Quality Standard
pH	8.0	7.1	7.7	6-9
Flow Rate (ft^3/s)	159.0	4.6	60.0	-
Dissolved Oxygen (mg/l)	13.0	5.2*	8.8	>6
Barium (mg/l)	0.071	0.045	0.059	<5
Boron (mg/l)	3.6*	0.1	1.73*	<1.0
Cadmium (mg/l)	<.003	-	<.003	<.05
Chloride (mg/l)	0.052	0.019	0.033	<500
Chromium (mg/l)	0.008	<0.005	0.005	<1.0
Copper (mg/l)	<0.005	-	<0.005	<0.02
Iron (mg/l)	2.7*	0.26	0.87	<1.0
Lead (mg/l)	<0.05	-	<0.05	<0.1
Manganese (mg/l)	o.25	0.047	0.113	<1.0
Nickel (mg/l)	0.011	0.005	0.005	<1.0
Silver (mg/l)	<0.36*	-	<0.003	<0.005
Sulfate (mg/l)	210.0	40.0	114.0	<500.0
Zinc (mg/l)	<0.05		<0.05	<1.0

*Value exceeding water quality standard.

3.4 Ecological Resources

A variety of terrestrial and aquatic plant and animal species exist in the local/regional environment of Lakeside Station. The Illinois Natural History Survey has identified approximately 1310 species of flora within 25 miles of the plant. According to the Illinois Plant Information Network, no species of flora in Sangamon County are federally listed as endangered or threatened. The Illinois Natural History Survey has also identified 476 bird, fish, mollusk, amphibian, and reptile species within 25 miles of Lakeside Station. According to the Illinois Fish and Wildlife Information System, the species Sterna antillarum (least tern) and Myotis sodalis (Indiana bat) are the only federally listed endangered species in Sangamon County. The presence of both of these species has been confirmed in the past 5 years.

A search of the Illinois Natural Areas Inventory database yielded 9 sites within a 25 mile radius of Lakeside Station. Table 3-2 lists these natural areas and their locations are indicated on the regional map of Figure 3-3. The Midwestern Regional Endangered Species Department, which is an Illinois state agency, has indicated that there are no federally designated critical habitats near Lakeside Station.

3.5 Socioeconomic Resources

Lakeside site is located immediately adjacent to the city of Springfield. Springfield and other cities in the area provide a population base of over 140,000 people within 10 miles of the plant. These cities provide an economic base of labor and materials to the Lakeside plant. Means of transportation of materials and manpower to the plant are provided by nearby railroads and Interstate highway 55.

3.6 Energy and Materials Resources

The main material resources of interest for this project are limestone, coal, and natural gas. Limestone is in abundant supply, with capacity

TABLE 3-2. NATURAL AREAS IN THE LAKESIDE STATION REGIONAL ENVIRONMENT

Reference Number	Area Name	Acreage
279	Porta School Natural Area	25.0
178	Elkhart Hill	157.0
44 *	Carpenter Park	237.0
842	Norfolk & Western Railroad Prairie	1.1
245	Sangamon State University Natural Area	40.0
801	Abraham Lincoln Memorial Garden	77.0
85	Long Point Slough (West)	89.0
84	Long Point Slough (East)	73.0
13	Berry's Woods	23.0

* Dedicated Nature Preserve

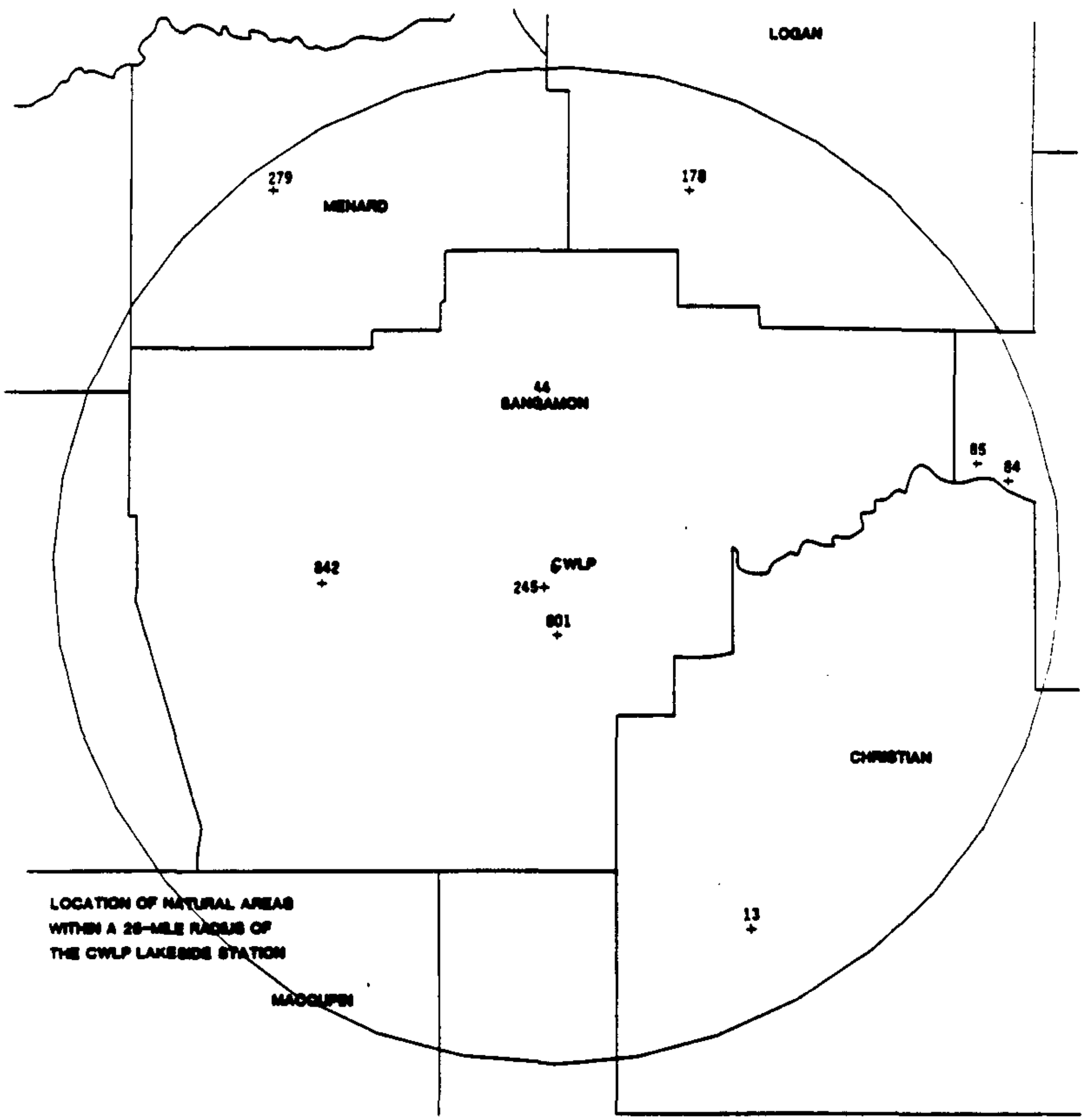


Figure 3-3. Natural areas in the Lakeside Station regional environment.

existing to deliver over 17 million tons per year to the U.S. market (Gutschick, K. A., Lime for Environmental Uses, ASTM, Philadelphia, 1987, p. 2). There are over 160 limestone quarries in Illinois and Missouri (Boynton, R. S., Chemistry and Technology of Limestone, Wiley, New York, 1980, p. 14). Coal is brought in by truck from Logan County in central Illinois. Lakeside has a contract running through 2005 with its coal supplier, and thus no problem is expected with coal availability. A natural gas pipeline will be constructed at the site. Natural gas is also in abundant supply, with capacity existing to deliver an additional 6.5 x 10^6 scfm beyond current consumption to the U.S. market (Natural Gas Production Capability-1986, American Gas Association, Arlington, VA, December 6, 1985).

4.0 CONSEQUENCES OF THE PROJECT

Demonstration of GR-SI technology in a pre-NSPS utility boiler has the potential to impact the environment in several ways. The discussion that follows considers the consequences of both construction and operation. Plans for mitigating possible detrimental impacts are also discussed. In this way it will be shown that this project will have no significant EHSS impacts.

4.1 Atmospheric Impacts

The GR-SI technology project is of insufficient scale to have an impact upon meteorology in the Lakeside Station area. During construction, the only air emissions are expected to be fugitive emissions from equipment installation and minor landscaping. These fugitive emissions should have a negligible impact upon air quality. Transportation requirements will actually decrease by a small amount, and thus transportation changes should have no impact upon air quality.

Several air quality impacts are anticipated during project operation. Emissions of NO_x and SO_2 are expected to decrease by 60 percent and 50 percent, respectively. In addition to the obvious public health benefits of these emission reductions, the utility plant could also benefit if stricter air pollution laws were passed. It is anticipated that the electrostatic precipitator will have enough specific collection area to handle the increase in particulate loading. Thus, particulate emissions from Unit 7 are expected to remain the same. Fugitive emissions may decrease slightly due to the smaller quantity of coal that will be loaded to Unit 7.

The handling and use of dry, calcium-based sorbents presents several unique problems. Sorbent handling requires special care to prevent breathing of the dust or contact with the eyes, since the sorbent is not only abrasive, but somewhat alkaline. Also, the potential exists for fugitive dust emissions during the transportation and storage of sorbents. To minimize fugitive emissions, a dustless pneumatic handling system will be used. The only exposure of the limestone to the atmosphere will be through vents in the storage silo, and these vents will be equipped with bag filters. If a need arises for workers to handle limestone, mitigating measures to minimize risks to workers will include mandatory use of protective apparatus such as enclosed safety goggles and inhalation dust filters. These protective measures have proven very effective in operations with sorbents conducted at the EER test site in El Toro, California.

Noise from the addition of the GR-SI process will be generated mainly by construction activities. Rule 208 of the State of Illinois Noise Pollution Control Regulations states that Rule 205, which regulates noise that is emitted from equipment, does not apply to equipment being used for construction. Therefore, construction activities will not violate Illinois noise regulations. Construction will be short-term and will not have a lasting effect on noise levels. Construction will also occur against a background of the ambient operational noise from other power plant activities. Incremental operational noise from the GR-SI project will be negligible in comparison to current plant noise. Because there are few residences in close proximity to the plant, no significant noise impact is expected.

4.2 Land Impacts

All construction activities will occur on-site. Thus, no impacts beyond plant boundaries on geology, farmlands, flood plains or wetlands are expected.

The rate of solids from Unit 7 entering the ash pond is expected to increase, and thus the pond will fill more rapidly due to the GR-SI process. The amount of increase will depend on the amount of sorbent injected, the amount of coal displaced by natural gas and the amount of SO_2 and NO_x removed from the flue gas stream. This will be a matter for long-term consideration at Lakeside Station, but at present the ash pond has enough capacity to span beyond the scope of the project. In addition, studies have shown that coal fly-ash/spent-sorbent mixtures have good landfilling characteristics due to their pozzolanic properties, which allow the solid waste to harden into a cement-like substance after drying. Therefore, the GR-SI solid waste will make a satisfactory landfill, if it is decided at a future date to use the waste for this purpose.

4.3 Water Quality Impacts

A negligible change in water usage is anticipated. The increase in overall water usage due to increased sluice water requirement is expected to be about 1.0 MGD. The main source of water usage at the CWLP plant is the condenser and cooling water flow, which is taken from and discharged to Lake Springfield and has a value of 290 MGD. Therefore, the increase in water usage due to GR-SI will be insignificant in comparison to the cooling water and other flows that constitute the total plant water usage.

The project is expected to have some impacts upon the water that is discharged from the ash pond to Sugar Creek. Average flow rate of pond effluent is expected to increase by about 21 percent to 5.80 MGD. The plant's current NPDES permit requires that pH be below 9.0. The lime sorbent will tend to increase the pH of the pond, and thus some pH adjustment will be needed. This will be assessed during Phase 1 of the project, when detailed design work will be done. pH will also be monitored during project operation. Suitable mitigation measures such as addition of sulfuric acid or carbon dioxide will be used as needed to maintain pH within permit limits. The process will also generate an increased amount of total suspended solids (TSS) in the pond water. To remain below the current requirement of 15 mg/l of TSS, it will be necessary to modify the pond system to increase the residence time of the water, or to use chemical means such as polymerizing agents to enhance settling rate. Oils and greases are currently well below the limit of 15 mg/l, and are expected to remain unchanged.

Concentrations of heavy metals in the effluent water are not expected to increase, as was discussed in Section 2.4.2. Coal-based metals loading will decrease as a result of the project, and pH will remain at current levels or increase slightly. Studies have shown that increasing pH decreases metals leachability. Therefore, metals levels are not expected to increase in either the effluent or groundwater.

Sulfate concentration in the pond water is expected to increase somewhat. Sulfate levels will be monitored and corrective action will be taken as necessary for compliance with regulatory limits.

4.4 Ecological Impacts

Construction activities will contribute some noise and fugitive emissions to the environment. However, noise and emissions from these activities will have a negligible impact upon the biota in the area because construction will be of a short-term nature and will be in addition to other ongoing minor construction activities. Transportation requirements will decrease and will have no ecological impact in terms of either noise or diesel engine emissions. The GR-SI project is expected to improve air quality by reducing NO_x and SO_2 emissions, which should have a minor beneficial impact upon the area's biota.

No significant changes in the effluent water stream are anticipated. Thus, change in water quality is expected to have no impact upon the area's biota. Since air quality and water quality are the only foreseeable areas of impact beyond the boundaries of the plant, the GR-SI demonstration project is not expected to have any detrimental impacts upon the ecology in the Lakeside Station area, including the least tern and the Indiana bat.

4.5 Socioeconomic Impacts

The labor requirements for the GR-SI project were detailed in Section 2.4.1. The total amount of labor required from the local community is expected to be about 5600 man-hours for construction, which will be spread over a 29-month period. Operational manpower requirements should remain at current levels. Since there are over 140,000 residents within 10 miles of Lakeside Station, the GR-SI project should have a small positive impact upon the local labor pool. Even though the construction supervisors will be non-local EER personnel, no adverse impact on housing and support facilities is anticipated since the host site is within commuting distance of metropolitan areas. In addition, miscellaneous small pieces of equipment and pH adjustment materials may be purchased locally. Thus, the GR-SI project should have a small positive impact upon the Lakeside area economy.

The GR-SI project will require three trucks per day for sorbent delivery and 20 trucks per day for coal delivery, making the total requirement 23 trucks per day. Since the current traffic volume is 24 trucks per day for coal delivery to the Lakeside Unit 7, the GR-SI project will actually decrease the transportation requirements of the plant.

The project is not expected to have any land impacts beyond plant boundaries. Therefore, there should be no archaeological, cultural or historical impacts of the project.

4.6 Energy and Materials Impacts

The estimated increase in electrical power consumption due to GR-SI is about 400 kW. Although this level of electrical consumption is not negligible, it represents only 1 percent of the total net generating capacity of the host unit. This additional energy requirement, then, will have minimal impact on the availability of electrical power beyond the plant boundaries. Also, the project will pay for the additional energy requirement, which will minimize the fiscal impact to the operating utility.

The possible areas of materials impacts are coal usage, natural gas usage, and sorbent usage. Implementation of GR-SI technology will result in direct replacement of approximately 19 percent of the baseline coal input with natural gas. Full-load coal usage will decrease from 39,480 lb/hr to 32,121 lb/hr. Because Unit 7 accounts for only 5.1 percent of the total station coal usage, a 19 percent reduction in Unit 7 coal usage will cause an overall reduction of only 0.97 percent in total station coal usage.

During operation, the project will require 1275 standard ft^3/min of natural gas. General availability of natural gas resources is not expected to present any problem; capacity exists to deliver an additional 6.5×10^6 scfm beyond current consumption to the U.S. market. This surplus represents 20 percent of the current U.S. consumption, and the increased consumption for the three GR-SI demonstrations amounts to less than 0.1 percent of the current excess capacity.

The year-long test phase of the project will require about 15,000 tons of limestone-based sorbent. Capacity exists to deliver 17 million tons per year of limestone to the U.S. market. Therefore, the project will require only 0.09 percent of the U.S. limestone supply. Local limestone availability is not a problem because there are over 160 quarries in Illinois and Missouri.

4.7 Impact Summary

In summary, no significant EHSS impacts are anticipated during the construction and operation phases of the GR-SI technology demonstration, other than the beneficial impact of the reduction in NO_x and SO_2 emissions. Disposition of the GR-SI systems at the end of the demonstrations (if required by the host utilities) would incur the same types of impacts and levels of risk associated with the on-site construction activities; i.e., minimal to negligible EHSS impacts are anticipated for the disposition activities.

5.0 REGULATORY COMPLIANCE

This section describes current permit requirements and regulations governing plant operation, and then outlines the anticipated permit modifications and the process by which they will be obtained.

5.1 Regulations and Permit Requirements

Demonstration of the GR-SI technology will be on a retrofit basis for the Lakeside boiler; therefore, the host site currently has all necessary permits for air emissions, land use, water use, and water discharges.

The Division of Air Pollution Control of the Illinois Environmental Protection Agency (IEPA) has issued a permit to CWLP for operation of Unit 7 at Lakeside Station. Particulate emissions are limited to 0.1 lb/MBtu and there is a limit of 30 percent for opacity measurements. There is also an SO_2 emissions limit of 6.0 lb/MBtu . The utility is required to submit quarterly operating reports. These reports must describe all excess opacity incidents, including date, length of occurrence and reason for occurrence.

Fly ash and bottom ash wastes from the boiler are handled by wet transport to a settling pond. The ash pond discharges to surface waters are regulated under the National Pollutant Discharge Elimination System (NPDES). The Illinois EPA Division of Water Pollution Control has issued an NPDES permit to CWLP to regulate ash pond discharge to Sugar Creek. The existing permit contains concentration limits of various species, as well as monitoring requirements. The monitoring requirements and the limits imposed are described in Table 5-1.

5.2 Anticipated Permit Modifications

5.2.1 Air Permit Modifications

The Lakeside plant is located in Sangamon County which is designated as an attainment area for NO_2, SO_2, O_3 and CO, but is a secondary non-attainment

TABLE 5-1. EFFLUENT FROM ASH POND AT LAKESIDE--
MEASUREMENT PLAN AND PERMIT LIMITS

Parameter	Measurement Method	Measurement Frequency	Permit Limit	
			30-Day Avg.	Daily max.
Flow Rate	Single Reading	Once/Week	-	-
pH	Grab Sample	Twice/Week	6-9	6-9
Total Suspended Solids	24-Hour Composite	Twice/Week	15.0 mg/l	30.0 mg/l
Oil and Grease	Grab Sample	Twice/Week	15.0 mg/l	20.0 mg/l

area for total suspended particulates (TSP). Modifications to the host boiler air emisions permit will be required since the existing system will be changed with the implementation of GR-SI technology.

After reviewing the nature of the GR-SI technology demonstration, the Illinois EPA indicated that modifications to existing air permits, rather than new permits, will be required (personal communication, Pat Dennis, September 1987). In applying for these permit modifications, it will be necessary to describe to EPA all design and operating changes, as well as emissions changes. Specifically, required information will include descriptions of boiler modifications, sorbent storage and injection equipment, projected coal input, ESP modifications and estimated efficiency, trucking changes, and fugitive dust control measures.

It may also be necessary to obtain a variance for emissions resulting from initial startup and testing of the GR-SI process. Since startup and testing will be relatively short-term, IEPA has indicated that there should be no difficulty in obtaining such a variance. In applying for a variance, it will be necessary to submit a schedule of construction and testing activities.

All preparation, including engineering calculations and design work, will be done so that permit modification applications will be ready for submittal at the end of Phase 1 of the project. Permit applications will then be submitted early in Phase 2. EPA is required to respond to permit applications within 90 days. In the experience of the utility, 60 to 90 days is usually required for permit approval. Sufficient lead time will be allocated for permit applications to allow Phase 2 construction and startup activities to begin as scheduled.

5.2.2 Solid Waste/Water Permit Modifications

Management of the fly ash/sorbent waste generated during this program will be conducted in accordance with all applicable federal, state, and local regulatory requirements. The specific waste management processes to be utilized will be defined during Phase I of the evaluation. Solid waste streams from coal firing and flue gas emission control procedures are exempt from classification as hazardous wastes under both federal (40 CFR 261.4) and Illinois (35 Ill. Adm. Code 721.104) regulations.

The current method of ash disposal by wet transport to a settling pond will be used for disposal of the GR-SI system waste. Therefore, the NPDES limits on ash pond discharge will be applicable to the generated waste. The Illinois EPA Division of Water Pollution Control has indicated that a new NPDES permit will not be required, and that modifications to the existing permit will be sufficient (personal communication, Gary Cima, IEPA, September 1987).

In applying for NPDES permit modifications, it will be necessary to describe to IEPA all projected changes in the water and solid waste entering the ash pond, and in the effluent water leaving the ash pond. Permit modification applications will be prepared at the end of Phase 1 and then submitted early in Phase 2. In the experience of the utility, 60 to 90 days is usually required for permit approval.

5.2.3 Other Required Permits

All of the GR-SI equipment will be installed within the boundaries of the plant; thus, zoning and land use issues do not apply. Construction permits for installation of the equipment will be obtained from the state and local authorities. In general, it is anticipated that demonstration of GR-SI technology can be conducted in an environmentally sound manner in complete compliance with all applicable environmental regulations without the imposition of extraordinary control measures.