FEASIBILITY ASSESSMENT

LAKE FRANCES POWER GENERATION FACILITIES
FOR THE
CITY OF SILOAM SPRINGS, ARKANSAS

Project No. EW-78-F-07-1794

April 1979

MASTER

Prepared by

McGOODWIN, WILLIAMS AND YATES, INC.
CONSULTING ENGINEERS — FAYETTEVILLE, ARKANSAS

The following pages are an exact representation of what is in the original document folder.

FEASIBILITY ASSESSMENT

LAKE FRANCES POWER GENERATION FACILITIES

FOR THE

CITY OF SILOAM SPRINGS, ARKANSAS

Project No. EW-78-F-07-1794

April 1979

Prepared by

951 0044

McGOODWIN, WILLIAMS AND YATES, INC.
CONSULTING ENGINEERS — FAYETTEVILLE, ARKANSAS

HLO

TABLE OF CONTENTS

MCGOODWIN, WILLIAMS AND YATES, INC.
CONSULTING ENGINEERS
FAYETTEVILLE, ARKANSAS

O. T. WILLIAMS, JR.
L. CARL YATES

909 ROLLING HILLS DRIVE
FAYETTEVILLE, ARK. 72701
TELEPHONE 443-3404

May 4, 1979

Re: Feasibility Assessment
Lake Frances Power Generation Facilities
Cooperative Agreement EW-78-F-07-1794

Mr. Charles E. Gilmore
Advanced Technology Branch
Idaho Operations Office, DOE
550 Second Street
Idaho Falls, Idaho 83401

Dear Mr. Gilmore:

In accordance with the terms of the cooperative agreement referred to above, we are enclosing eight copies and one photo-ready copy of the final Feasibility Assessment report on power generation facilities for the city of Siloam Springs, Arkansas.

As noted in the section "Summary and Conclusions," the development of the hydropower potential on the Illinois River at Lake Frances is not feasible at the present wholesale rate the city pays for power. With increasing energy costs, and assuming that the capital investment can be fixed, the project will likely become feasible in the near future.

We sincerely appreciate the opportunity of conducting this assessment and trust that this report meets with your approval.

We are looking forward to working with the city of Siloam Springs on the dam safety aspect and the hydropower development at Lake Frances.

Sincerely,

Brian L.

Brian L. Gartside, Project Manager

BLG:jr

Enclosures

cc: City of Siloam Springs

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOGRAPHS

SECTION I
SUMMARY and CONCLUSIONS

SECTION I. SUMMARY AND CONCLUSIONS

A. Summary

The purpose of this study is to analyze the feasibility of developing the power potential of the Illinois River at the Lake Frances Dam for utilization by the city of Siloam Springs, Arkansas. Our study finds that:

1. The actual average power potential of the river at this location is 1,200 horsepower, or 894 kilowatts. With a utilization factor of 51 percent, the average annual power production is 3.8 megawatt hours.
2. The cost saving produced by the proposed hydropower project will not support any remedial rehabilitation costs of the entire dam structure.
3. Power generated can be readily utilized on the city of Siloam Springs' electrical distribution system.
4. The cost of an 850 kilowatt hydro-generating facility is estimated to be $740,000.
5. The annual total kilowatt-hour cost to produce the power available will vary from 22 mills to 18 mills per kilowatt hour, depending on the financing costs for development.
6. The project is not self-liquidating at the present wholesale rate that the city pays for power.
7. Development and operation of this hydropower project would save nonrenewal types of energy, and, if the capital cost can be fixed at present day prices, the development will become economically feasible when electric costs increase by 43 percent.

B. Conclusions

1. Construction and operation of a hydropower facility in the Lake Frances Dam are feasible if the following problems can be solved:
    - a. Additional studies will be required into the dam safety aspect of the project. These studies will determine the requirements necessary to make the dam safe during high flow conditions. Based on the findings, cost estimates on the required remedial measures will be formulated. As the hydropower project cannot support any dam safety corrective measures, alternate sources of funding will be required for construction to insure dam safety.
    - b. Sources of funding can be made available so that the annual costs will not exceed the annual savings.
2. The hydropower facilities should be constructed, owned and operated by the city of Siloam Springs, which has an immediate use for the power generated and means to finance at least a portion of the project.
3. There will be no significant adverse environmental impact resulting from either the construction or operation of the hydropower facilities.

SECTION II
INTRODUCTION

SECTION II. INTRODUCTION

Water power has been used for centuries to accomplish many functions. Only during the last century, however, has water power been utilized to generate electricity. During the early part of this century, generation of electricity using water power was introduced to provide power for isolated areas.

Such has been the case with Lake Frances. During the early period after construction, the generator installed into the dam was used to provide power for a resort area near the lake. The Lake Frances generator failed because of an overload, but many power stations similar to the Lake Frances installation were abandoned because of high maintenance costs.

Increasing concern of the availability of energy and its costs has once again made the small hydropower facility an attractive alternate source of energy. While power from small hydropower facilities is too small to solve the nation's energy porblems, such installations can substantially supplement fossil fuel power plants and save nonrenewable types of energy.

The U. S. Department of Energy is presently concentrating its efforts on reactivating existing hydropower facilities and incorporating new hydropower facilities into existing impoundments. By utilizing existing impoundments many development problems have already been solved. For example, the land that such impoundments cover has previously been acquired, and the major portion of the civil structures has been constructed.

This Feasibility Assessment will address: the structural integrity of the dam, the impact on water needs of the area, the marketing potential of the power produced, an analysis of the flows present in the river, the system configuration, the estimated development costs and operating expenses, and possible project financing programs.

SECTION III
DESCRIPTION and HISTORY

SECTION III. DESCRIPTION AND HISTORY

The Lake Frances Dam is located on the Illinois River approximately three miles south of Siloam Springs, Arkansas, at latitude 36 degrees 7.7 minutes, longitude 94 degrees 33.8 minutes. The dam and most of the lake are in the extreme northeast corner of Adair County, Oklahoma. Figures 1 and 2 show location.

Lake Frances has approximately 517 acres of surface area with an estimated volume capacity in excess of 2,000 acre-feet. Figure 3 shows the general layout of the existing structure.

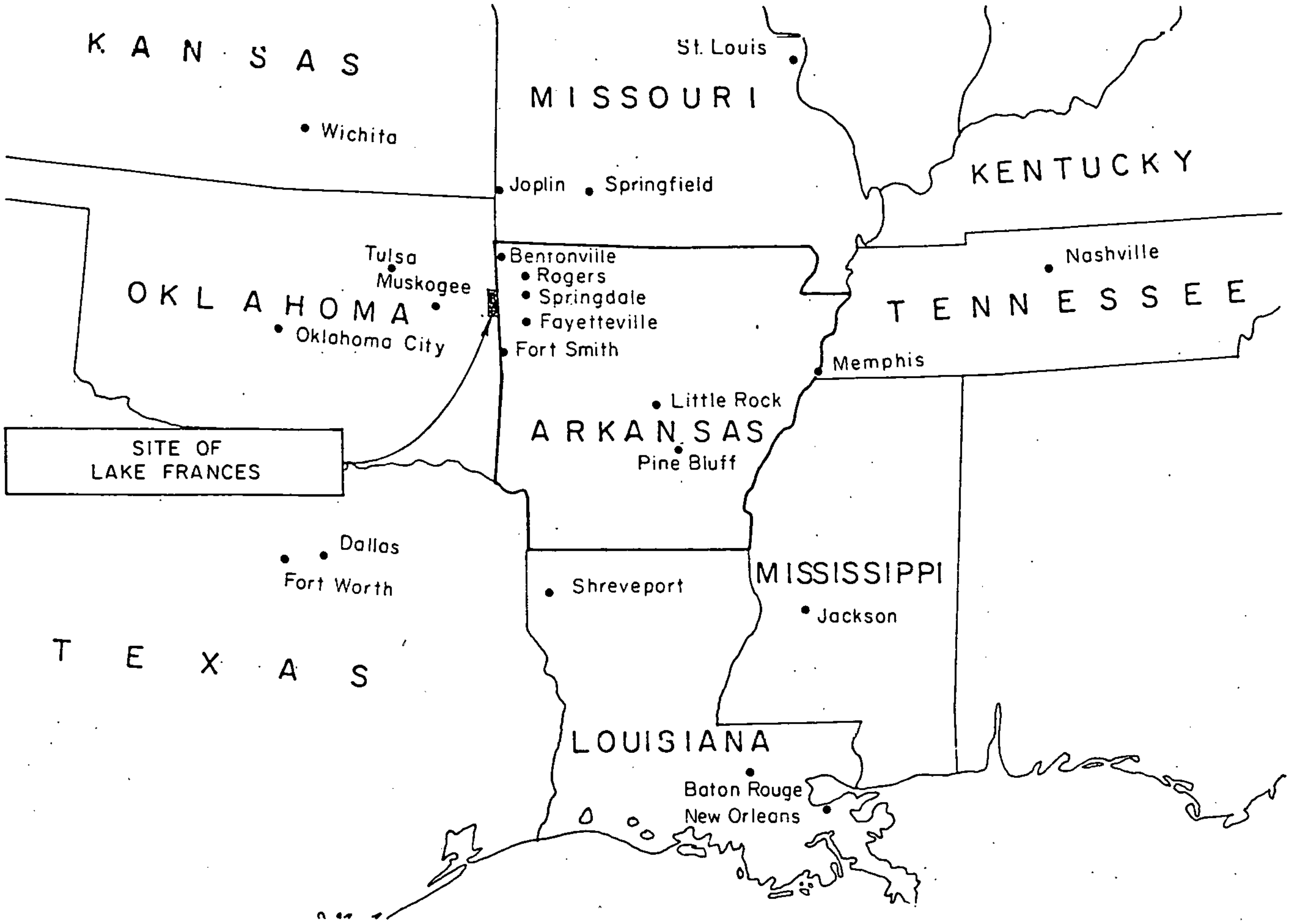
The dam consists of an earthfill section that is approximately 6,000 feet long, a concrete arch section 68 feet wide, a main spillway 162 feet wide, and an auxiliary spillway 518 feet wide. The elevation of the top of the earth embankment is 948.5*, and the top of the arch section is 949, while the top of the main spillway is 936.5. (See photo No. 1.)

The powerhouse structure, which is located to the left of the main spillway between the main spillway and the concrete arch section of the dam, still has old generating equipment in place. However, the equipment is not serviceable and has been abandoned. (See photos No. 2 and 3.)

There is a low flow outlet structure located on the right side of the main spillway. A motor operated 54 inch square sluice gate controls the flow through the outlet. Since this outlet structure is inaccessible during high flows, a control device was installed on the right bank of the downstream channel

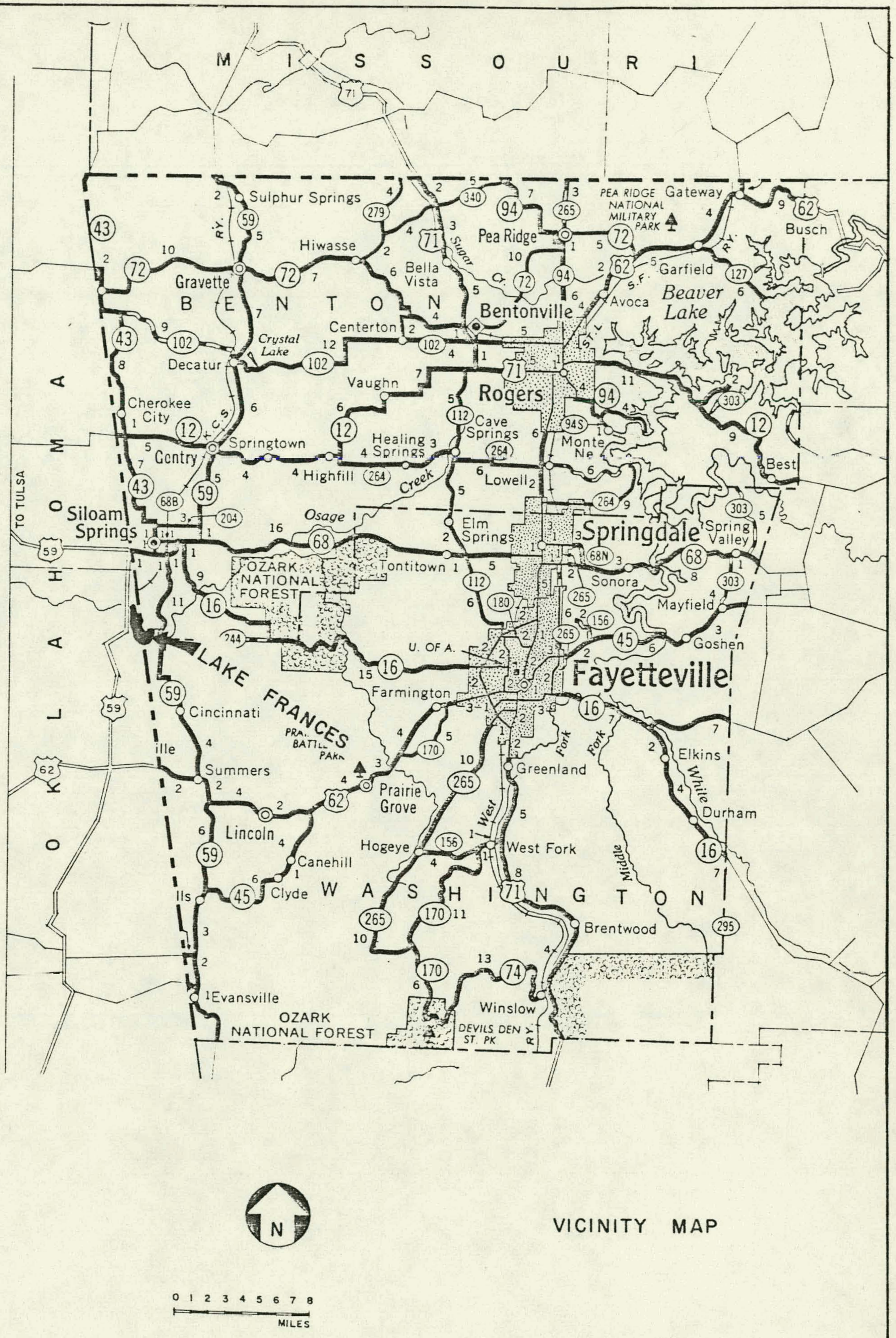
---

* All elevations are referenced to U.S.G.S. datum.



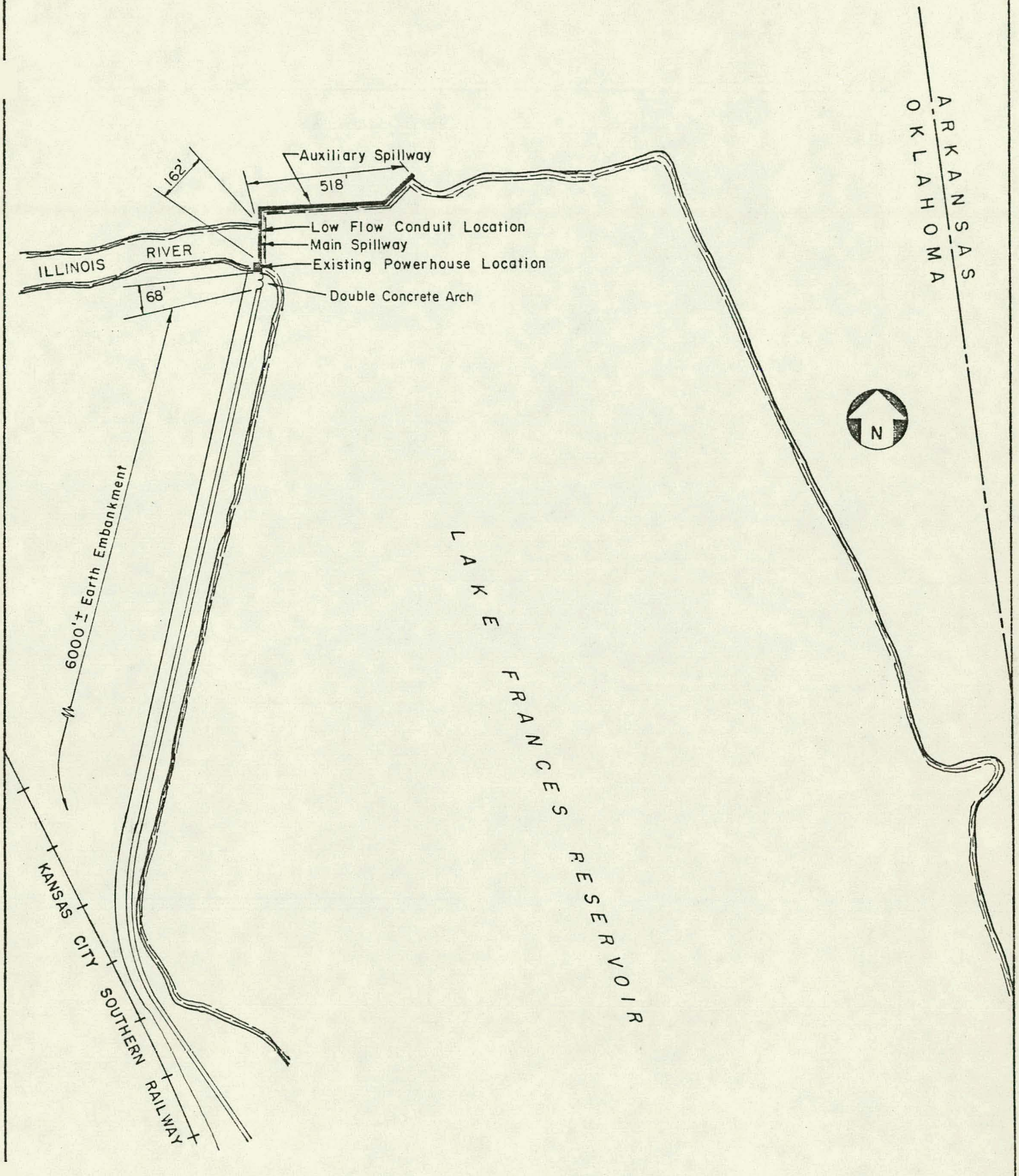
vicinity relations map

FIGURE NO. 1



VICINITY MAP

FIGURE NO. 2



SITE PLAN

SCALE : 1" = 400'

FIGURE NO. 3

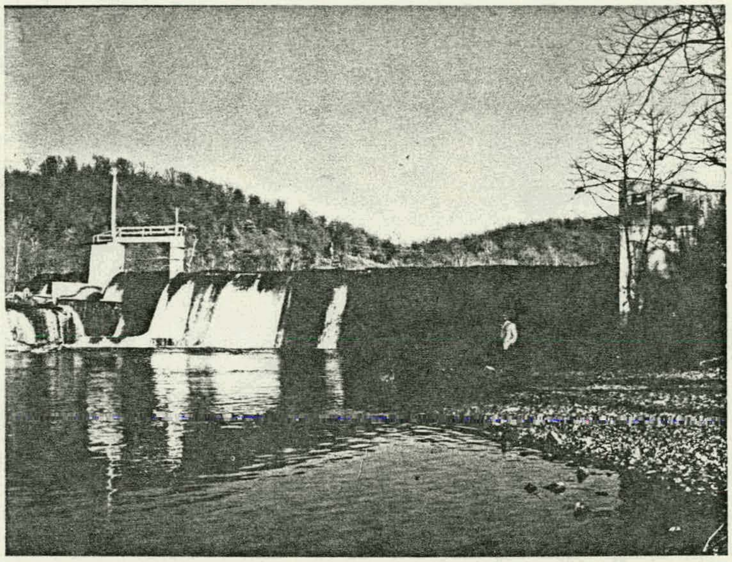


PHOTO NO. 1

DOWNSTREAM VIEW

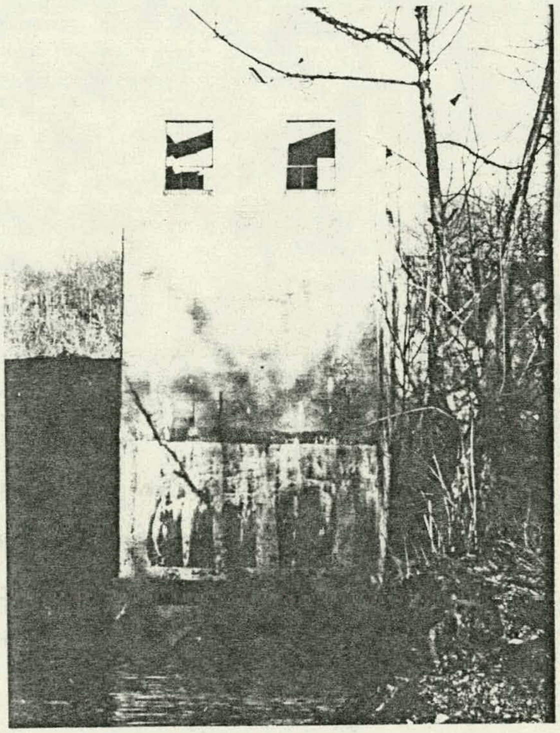


PHOTO NO. 2

OLD POWERHOUSE

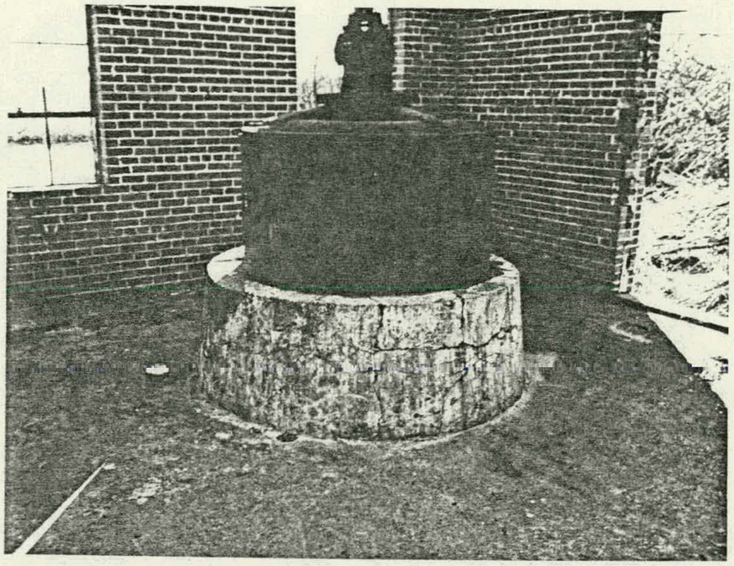


PHOTO NO. 3

OLD GENERATOR INSIDE POWERHOUSE

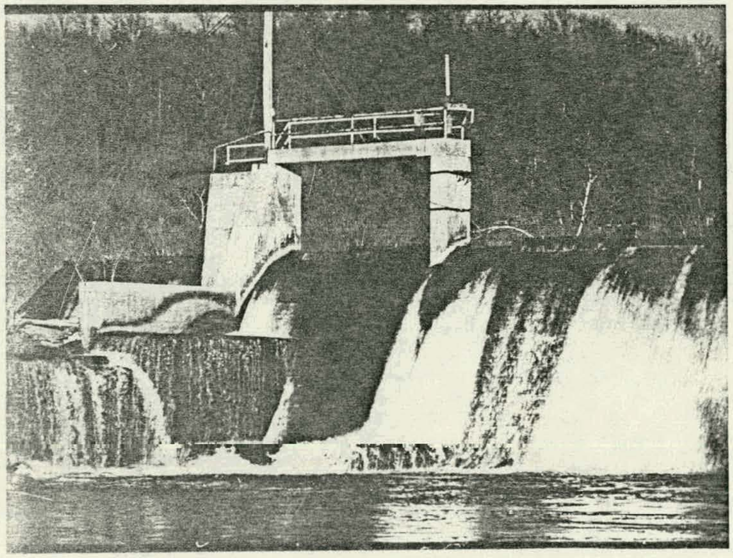


PHOTO NO. 4

LOW FLOW OUTLET STRUCTURE

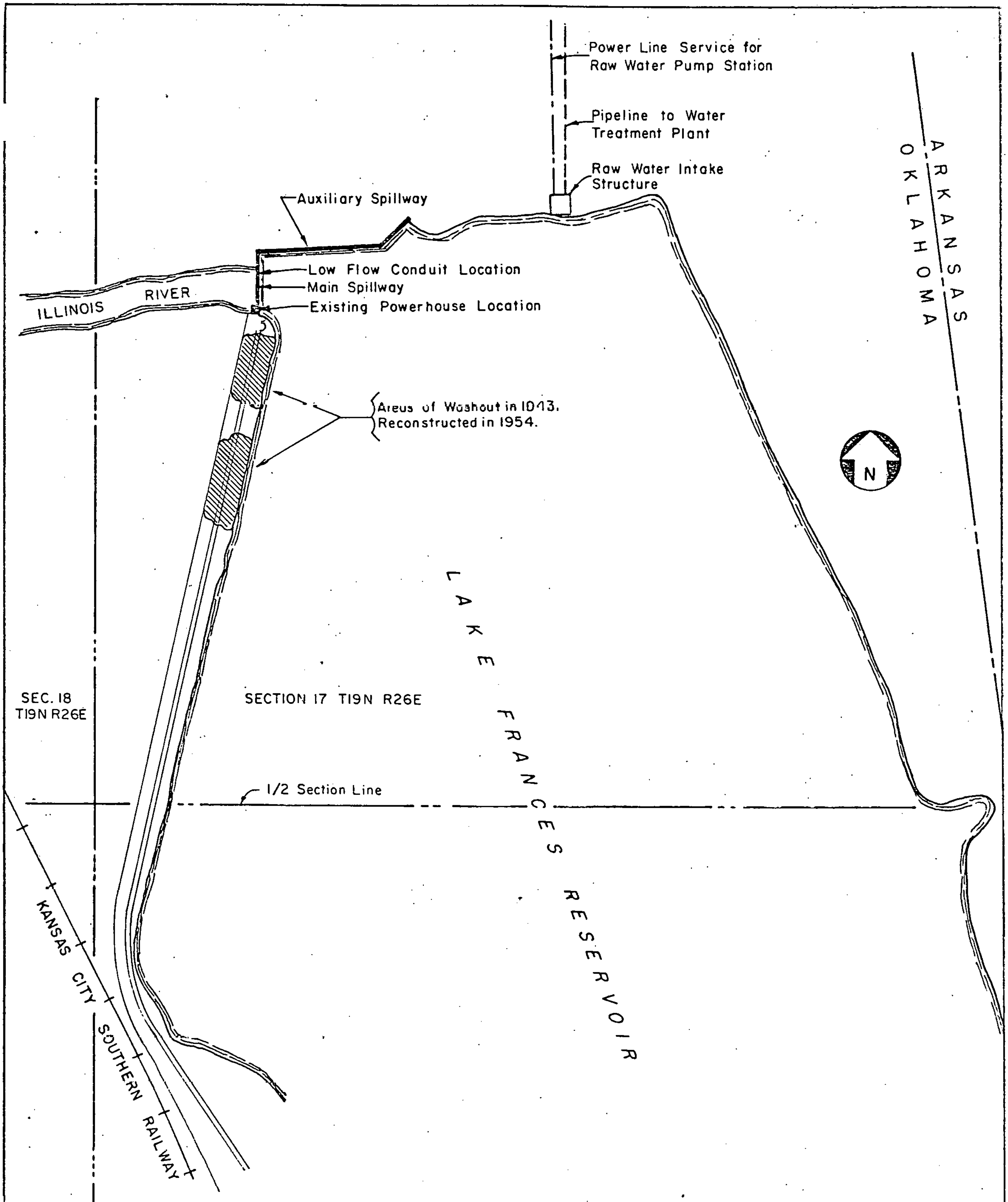
to make it possible to open and close the outlet remotely. (See photo No. 4.)

The dam was originally planned and designed by Victor H. Cochrane, Consulting Engineer, Tulsa, Oklahoma. The structure, with some modifications, was completed in 1931. The generating equipment that was included in the structure was put on line and operated for only about four years, as an overload caused the equipment to fail in 1935. The generating equipment was abandoned at that time.

In May 1943, the earth embankment section of the dam failed due to high flows which apparently exceeded the capacity of the spillway. Approximately 700 feet of the earth embankment washed out. The U.S.G.S. gaging station now located immediately downstream was not activated until 1955. Therefore, there is no record of the magnitude of this flood. Details of the failure are inconclusive.

In 1954, the city of Siloam Springs purchased the dam and the adjacent land so that the dam could be rebuilt for use as a water supply for the city. The plans for the reconstruction project were prepared by Fell & Wheeler Consulting Engineers, Tulsa, Oklahoma. The earth embankment was raised two and one-half feet and a 200 foot section of sheet piling with a small concrete cutoff wall was included to reduce the possibility of the failure occurring again. The earth embankment was also extended approximately 700 feet south, and the turbine hole in the powerhouse was plugged with concrete. Figure 4 shows the areas that were reconstructed.

With the exception of the powerhouse, the dam has been



SITE PLAN

SCALE: 1"-400'

FIGURE NO. 4

operated as rebuilt since 1955.

The normal operational procedure keeps the pool level at or near the top elevation of the main spillway by means of wooden flashboards that have been installed and periodically maintained by the city. With the flashboards in place, the pool elevation is 937.4. During low flow periods the sluice gate is opened to maintain a downstream flow. During high flows, however, the sluice gate is closed and the spillways discharge the water downstream. The city's raw water intake structure is located on the right bank of the stream and diverts a varying amount of water each day for the city's potable water needs.

SECTION IV
STRUCTURAL SOUNDNESS

SECTION IV. STRUCTURAL SOUNDNESS OF THE DAM

Since the existing dam and powerhouse are 48 years old, the structural soundness of the facility is of prime importance. Hydropower projects generally cannot support major remedial rehabilitation of existing structures; however, the existing structure will be required to meet dam safety standards before power facilities can be constructed.

The Lake Frances Dam has been classified by the Oklahoma Water Resources Board (OWRB) as an intermediate size dam with a high hazard potential. The size classification is due to the storage capacity of 2,000+ acre-feet and a height of 48 feet. A high hazard classification, according to the OWRB, is defined as that in the event of failure, more than a few people could be killed and economic loss could be excessive.

The performance standards set by the rules and regulations of the OWRB for an intermediate size, high hazard dam require that the spillway have the capacity to pass the Probable Maximum Flood (PMF) with a freeboard of three feet.

The dam was inspected by the OWRB and the Corps of Engineers on February 15, 1978, under the authority of the National Dam Inspection Act. A report entitled "Phase I-Inspection Report, National Dam Safety Program, Lake Frances Dam and Spillway" sets out their findings, conclusions and recommendations. Sections 3, 4, 6 and 7 of this report are included herein as Appendix A.

The Corps of Engineers estimates the PMF to be approximately 555,000 cubic feet per second. At this flow the dam would overtop

8.1 feet, which would cause a failure of the earth embankment. The Corps of Engineers also estimates the spillway can safely pass approximately 20 percent of the PMF without overtopping the earth embankment. The maximum flood at the dam site reportedly occurred in 1892 and was estimated at 84,000 cubic feet per second.

The conclusions reached in this Phase I-Inspection Report are summarized as follows:

1. Preliminary computations indicate the spillway can pass only approximately 20 percent of the PMF without overtopping the embankment.
2. Under PMF and one-half PMF conditions, the embankment would be overtopped by 8.1 feet and 4.3 feet of water, respectively. Overtopping of such magnitude would result in failure of the dam.
3. Remedial measures would be required to assure the spillway can safely pass the design flood.

Recommendations set out in the report are as follows:

1. Determine the source and possible consequences of seepage downstream of the embankment on the safety of the structures.
2. Evaluate the potential for and possible effects of differential settlement, cracking, and piping within the reconstructed portion of the earth embankment adjacent to the concrete arch section.
3. Determine the remedial measures necessary to insure that the spillways can safely pass the design flood.
4. Evaluate the structural stability of the cyclopean rock

filled spillways.

5. A routine inspection and maintenance program needs to be developed and implemented.
6. Trees and heavy vegetation should be removed from the slopes of the earth embankment.
7. The riprap on the upstream slope of the earth embankment should be repaired and supplemented.
8. After an investigation of any evidence of differential settlement or cracking, all of the low areas on the crest of the dam should be restored with compacted fill to the original elevation.
9. The marsh area near the downstream toe should be cleared and graded to drain to allow measurement and observation of possible seepage.

The reported safety hazards associated with the dam are present whether or not the dam is utilized for the generation of electric power. Therefore, the power project does not include costs for a major renovation of the entire structure.

For the hydropower project to be feasible, remedial measures necessary to insure dam safety during flooding would have to be funded from alternate sources.

SECTION V
PROJECT IMPACT on WATER NEEDS

SECTION V. PROJECT IMPACT ON WATER NEEDS

A. Uses of Lake Frances

The city of Siloam Springs purchased the dam and the adjacent land to provide a source of potable water. The current uses of the lake are a city water supply and a recreational facility.

B. Present and Projected Population and Usage

According to a special census taken in 1975, the population of Siloam Springs at that time was 6,454. The city's population has been projected to be 17,000 by the year 2000.

The present average daily water usage by the city is 2.03 million gallons. Of this amount, three industries use approximately 1.2 million gallons per day. With industrial usage subtracted from total usage, the per capita average daily domestic usage is therefore 130 gallons per day. Based upon the projected population, the average daily domestic water usage in the year 2000 can be projected to be 2.20 million gallons.

Assuming an industrial growth factor of 25 percent, the industrial average daily water consumption in the year 2000 would be 1.50 million gallons. These two figures added together give a total average daily water consumption of 3.70 million gallons. The peak water demand factor has proven to be 1.5 times the average daily consumption rate. Therefore, the peak day in the year 2000 is projected to be 5.60 million gallons.

The projected 20 year peak day of 5.60 million gallons is only 8.70 cubic feet per second (cfs). The projected peak water usage by the city is only 1.5 percent of the flow required to operate the generator (i.e., 590 cfs).

C. Effects of Generator Operation

As the control scheme for operating the generator will be based on an on-level and an off-level that will be only six inches apart, the generator will not affect any benefits that are derived from the lake.

Since the generator will use the top six inches of the lake for control functions, the generator system will regulate the stream flow more than the present operation does. A downstream flow will have to be maintained at all times; therefore, any time the facility is not generating power and there is no flow over the main spillway, the gate on the low flow conduit will be opened automatically. This procedure will assure a downstream flow at all times.

D. Conclusion

Compared to the amount of stream flow required to generate electricity, the water usage amounts diverted from the stream are insignificant to the proposed development of hydropower in Lake Frances.

The installation of a hydropower generating system into the Lake Frances Dam will create no adverse impact on the water needs of the area, nor will it affect the recreational uses of the facility.

SECTION VI
ENVIRONMENTAL ASSESSMENT

SECTION VI. ENVIRONMENTAL ASSESSMENT

A. General

A significant element of planning any project is an assessment of the environmental aspects. The purpose of this assessment is to insure that the advantages of the hydropower development at the Lake Frances Dam will not be negated by ecological damage. To help insure that environmental factors are not overlooked, Federal law requires that prior to initiation of the proposed development, a document will be prepared covering these factors. The document will address (1) the environmental impact of the proposed development, (2) any adverse environmental effects which cannot be avoided, (3) alternatives to the proposed development, (4) the relationship between local short-term uses of man's environment and the maintenance and enhancement of the long-term productivity, and (5) any irreversible and irretrievable commitments of resources which would be required in the proposed development.

The initial step in studying the effects that hydropower development will have on the quality of the environment is to make a generalized and subjective evaluation, using guidelines developed from experience as criteria. This subjective evaluation, which is summarized in Table 1, assists in determining problem areas that may result from the proposed hydropower development.

Based on a "none-slight-moderate-severe" rating scale, there are no areas which indicate any significant change in the environment.

B. Displacement of Residences

Since Lake Frances has existed since 1931, and since the

TABLE 1

SUMMARY OF EVALUATION OF ENVIRONMENTAL EFFECTS

ENVIRONMENTAL CRITERIA	EFFECTS	
	Hydropower Development (Short-Term)	Hydropower Operation (Long-Term)
Controversial?	Slightly adverse	Slightly adverse
Have a significant aesthetic or visual effect?	Slightly adverse	None
Affect areas of unique interest or scenic beauty?	None	None
Destroy or derogate from important recreational areas?	None	None
Substantially alter the pattern of behavior of a species?	None	None
Interfere with important wildlife breeding, nesting, or feeding grounds?	None	None
Interfere with known historical or archeological sites?	None	None
Adversely affect the water table of the area?	None	None
Displace a significant number of people?	None	None
Divide or disrupt an established community or divide existing uses?	None	None
Cause excessive congestion on existing ground transportation facilities?	None	None
Adversely affect the land-use plan for the community?	None	None
Significantly increase water pollution?	None	None
Significantly increase air pollution?	None	None
Noticeably increase the ambient noise level for a significant number of people?	Slightly adverse	None

city of Siloam Springs now owns the lake, the dam, and the adjacent land, the hydropower development at the Lake Frances Dam would result in no displacement of residences or persons. Also, no significant disruption of an established community or division of existing uses would be expected to result from the proposed development.

C. Water Pollution

No significant water pollution is expected to result from the proposed hydropower development. Pollution of the stream is possible if environmental protection, restoration, and enhancement actions are not carefully followed during the construction of the development.

The three sources of possible water pollution are domestic sewage, industrial waste, and storm drainage.

1. Domestic Sewage. There will be no source of domestic sewage after the hydropower development is constructed. During construction, however, provisions will have to be made for the disposal of wastes from temporary toilet facilities.
2. Industrial Waste. The proposed hydropower development does have some possible sources of industrial waste. The possible sources during the construction would be from maintenance of construction machinery, metal working, and painting. Provisions would have to be made to keep possible sources from becoming ecological problems. Since the occurrence of accidental liquid spills is infrequent, the most effective means of controlling

water pollution from this source is to enforce a strict policy of immediate cleanup using absorbent sweeping compounds.

3. Storm Drainage. The existing natural and man-made storm drainage around the structure flows generally west as does the river at this point. The natural drainage would not be altered significantly as a result of the proposed hydropower development. All areas that were disturbed during the course of construction would be revegetated with native grasses to hold the soil erosion to a minimum.

D. Noise

Noise created during the construction of the facilities would be very similar to the noise created in the construction of a large building. While the noise created might be annoying to nearby residents, it would not be of long duration.

E. Dust

The rehabilitation of the existing gravel access road might create a dust problem. Therefore provisions would be made to keep the roadway well watered during dusty periods.

F. Safety

Contractors are required by Federal law to comply with the regulations imposed by the Occupational Safety and Health Act of 1970.

G. Conclusion

There will be no adverse environmental impact from either the construction or operation of the hydropower development at the Lake Frances Dam.

SECTION VII
MARKETING POTENTIAL

SECTION VII. MARKETING POTENTIAL

The marketing aspect of this hydropower facility is one of its best benefits. This benefit is the ease of utilization of the power produced.

Since the city owns and operates the electrical distribution system, the city can be characterized as an electric utility. The city has a contract with Southwestern Electric Power Company (SWEPCO) for purchase of wholesale power. Specifically, the present demand charge is $1.50 per kilowatt for the actual measured monthly peak demand. The energy charge on the first 1 million kilowatt hours is 5 mills per kilowatt hour. The next energy charge bracket is 4 mills per kilowatt hour. The fuel adjustment varies, but the average cost is approximately 10 mills per kilowatt hour. The present average cost of power is 14 mills per kilowatt hour, not including the demand charge.

Because the power from the Lake Frances generator would be utilized in lieu of purchased wholesale power, the city would actually have a marketing arrangement best described as savings per kilowatt hour. With a savings-per-kilowatt-hour marketing arrangement, the present day savings to the city by utilizing the power generated at Lake Frances would average 14 mills per kilowatt hour.

The most economical generator could produce only approximately 5 percent of the city's power needs. Consequently, any time there is sufficient stream flow, all of the power that the generator can produce would be used immediately.

SECTION VIII
STREAM FLOW ANALYSIS

SECTION VIII. STREAM FLOW ANALYSIS

A. Location and Flows

Lake Frances is on the Illinois River, which is in the Arkansas River Basin. The lake has a drainage area of 635 square miles. Discharge measurements are generally made twice a month with the computations of daily flow furnished by the Corps of Engineers.

At the Lake Frances location, the stream flow records are good. The flow data utilized in the analysis were taken from the Oklahoma Water-Data Reports that are published by the U. S. Geological Survey. The data used were gathered at gaging station 07195500, which is at the U. S. Highway 59 bridge near Watts, Oklahoma. This gaging station, activated in October, 1955, is only 0.8 mile downstream from the Lake Frances Dam.

For the twenty years of record, from Water Year 1956 through Water Year 1975, the average flow is 622 cubic feet per second. Table 2 is a statistical summary of the stream flow for the twenty years of record. The table shows the flow duration of the daily discharges for different class flow rates.

B. Generating Capacity of the River

The city of Siloam Springs uses Lake Frances as a source of raw water. Since 1957 the city has been diverting a small, varying amount of water for the city's daily water needs. As pointed out in Section V, the city's water needs will not adversely affect the hydropower development at the lake.

As noted, the twenty year average flow of the Illinois River at the gaging station just downstream from the dam is 622

TABLE 2

Duration Table of Daily Discharge

Illinois River Near Watts, Oklahoma

Class	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	
Year	Number of Days in Class																																			CFS-Days
1956		12	15	24	8	10	5	24	79	27	16	37	23	17	15	19	13	11	4	2	3				1	1										63604.0
1957		3	9	4	11	1	4	12	16	19	21	7	38	11	22	24	24	16	22	22	16	8	13	16	8	5	4	1	3	1		2	2			373138.0
1953												2	30	51	57	43	30	32	30	25	19	15	11	6	5	4	2	1		1	1					282752.0
1959									4	14	19	49	93	39	27	42	16	17	13	13	6	3	5	1	1	1	1		1							139755.0
1960							1	1		2	13	19	18	37	65	63	25	34	26	16	15	10	7	3		3	3	1		1	2		1			271640.0
1961											43	46	19	23	42	52	34	24	22	16	11	8	5	4	5	2	1	1	2	2	2				1	285807.0
1962											1	7	29	29	35	30	58	84	29	28	14	9	3	5	2	1	1									219627.0
1963							2	15	16	43	46	26	65	40	45	24	16	11	7	6	1	1		1												82878.0
1964						2	40	47	58	60	44	21	24	20	14	12	7	5	4	4	2	1		1												55253.0
1965						4	4		16	40	50	42	23	27	45	28	28	22	9	10	5	1	3	3	3		1	1								132112.0
1966									38	52	47	46	36	26	18	27	23	15	8	9	6	6	1	1	3			1	1		1					137245.0
1967								9	57	97	73	35	21	19	19	13	9	3	2	2	2	3		1												60175.0
1968								4	10	1	8	17	45	37	38	26	25	35	31	26	14	10	14	5	5	10		3	2							285188.0
1969										3	45	11	38	35	4	22	39	48	42	30	12	7	9	7		6	3	1		1	1	1				283993.0
1970										6	26	23	45	42	33	22	46	35	26	23	12	2	8	7	3	2	3				1					217813.0
1971										4	51	34	9	28	9	48	58	39	22	19	14	10	5	7	4	1	1	1				1				223701.0
1972								2	3	38	47	69	57	43	24	14	11	17	9	7	6	5	3	1	3	2	2	3								146083.0
1973									1	1	5	7	6	30	28	28	47	24	25	37	28	21	26	16	12	8	8	2	2	2	1					454684.0
1974								1	1	1	1	1	1	33	29	34	56	58	39	25	26	15	10	10	8	4		3	2		3	2	1		1	450129.0
1975														21	51	22	59	48	41	43	25	13	13	11	6	2	1	2	4	2			1			378953.0

Class	CFS	Class	CFS	Class	CFS	Class	CFS	Class	CFS	Class	CFS
0	0.00	6	34.00	12	150.00	18	650.0	24	2900.0	30	12000
1	10.00	7	44.00	13	190.00	19	840.0	25	3700.0	31	16000
2	13.00	8	56.00	14	240.00	20	1100.0	26	4700.0	32	20000
3	16.00	9	71.00	15	310.00	21	1400.0	27	6000	33	26000
4	21.00	10	91.00	16	400.00	22	1700.0	28	7600	34	33000
5	27.00	11	120.00	17	510.00	23	2200.0	29	9800		

cubic feet per second. With an effective constant head of 20 feet, the basic generating capacity the river is capable of supporting is 1200 horsepower, or 894 kilowatts.

If the generating facilities were arranged to operate only when the flow exceeds 622 cubic feet per second, the energy production with an 894 kilowatt system would be approximately 1.8 million kilowatt hours per year. The flow of 622 cfs has an exceedance factor of only 23 percent. If a system is installed to take advantage of a small portion of the storage capacity of the lake, the energy production can be substantially increased.

C. Operation and Controls with Fixed Blade Turbine

An operation utilizing 6 inches of lake storage would require a fully automatic system that would start operating at an on-elevation of 935.75 and stop operating at an off-elevation of 935.25. The conservation pool, which is based on elevation of the main spillway of 935.75, covers approximately 517 acres. The top 6 inches of the lake between elevations 935.75 and 935.25 have a volume of almost 11.3 million cubic feet.

The most economical size generator (i.e., 850 kilowatts, as will be shown in Section IX) requires a flow of 590 cubic feet per second at its rated output. Therefore, the top 6 inches of the lake would be capable of running the generator at full capacity for 5.3 hours without any inflow to the lake. The utilization of even this small amount of storage substantially increases the power production of a system.

The automatic generating system would also require automatic control of the sluice gate that controls the flow in the low-flow conduit. While the facility is generating power, 590 cubic feet of water per second would be released from the lake. During generating periods, the low-flow conduit would close. On the other hand, after the generating facility shutdown at the low-level point, the low-flow conduit would be partially opened to assure a downstream flow at all times. A generating facility shutdown because of a low lake level would indicate a relatively low lake inflow rate.

For example, according to the Flow Duration Table, Table 2, a flow of 150 cubic feet per second is exceeded 72 percent of the time. The 72 percent figure is a 20 year average, which means the 20 year average year has 262 days in which the flow exceeds 150 cubic feet per second. If there were an extended period of 150 cubic feet per second flows and the partial opening of the sluice gate could maintain a downstream flow of 100 cubic feet per second, the lake would have a net inflow of 50 cubic feet per second. At a rate of 50 cubic feet per second, it would take almost 63 hours to refill the 6 inch storage so that the generating facility could generate another 5.3 hours. Consequently, during a period of sustained low flows, even as low as 150 cubic feet per second, the storage can greatly improve the productivity of the generator facility.

The stream flow analysis presented here utilizes the 6 inches of storage, with the generator cycling on and off during periods when the stream flow is less than 590 cubic feet per second. A flow of 590 cubic feet per second has an exceedance factor of only 24 percent, but combining the flow with the small amount of storage, the facility will be on line 51 percent of the time.

D. Flow Duration Tables

The flow duration tables included in this section have been used to calculate 20 year average flow exceedance factors. The second columns of Table 3 through Table 7 show the average exceedance factors for the same flow classes that are used in Table 2. The third column is the percent of the time the flow rate stays between the bracketed flow classes. The fourth column is the number of days during the 20 year average year that the flow rate stays within the bracketed flow classes. For example, as shown in Table 3, the percent of the time the flow is between 120 cubic feet per second and 150 cubic feet per second is 6.83 percent (i.e., 78.71%-71.88%). The number of days that the flow is within these two limits is 24.93 days (i.e., 6.83% x 365).

The fifth column is cubic-feet-per-second days, which is calculated by multiplying the number of days in column four and the correponding flow (i.e., 24.93 x 120). The sixth column in the flow duration tables is the equivalent flow cubic-feet-per-second days which is determined by dividing the flow required to run the generator at full capacity into the cubic-feet-per-second days in column five (i.e., 2992/347).

Table 3 through Table 7 show the total cubic-feet-per-second days and the total number of equivalent cubic-feet-per-second days for five different flows that would be required to run various sizes of generators. Table 8 is a summarization showing the required flows, the corresponding generator size, the

TABLE 3

Flow Duration - Equivalent Days at 347 Cubic Feet Per Second

Flows cfs	% Time Flow Exceeded	Δ %	Days	cfs-Days	Equivalent 347 cfs-Days
120	78.71			2,992	8.62
		6.83	24.93		
150	71.88			4,653	13.41
		8.50	31.02		
190	63.38			5,770	16.62
		8.32	30.37		
240	55.06			7,445	21.45
		8.50	31.02		
310	46.56			52,682	151.82
		46.56	169.94		
TOTALS				73,536	211.92

TABLE 4

Flow Duration - Equivalent Days
at 451 Cubic Feet Per Second

Flows cfs	% Time Flow Exceeded	Δ %	Days	cfs-Days	Equivalent 451 cfs-Days
120	78.71			2,992	6.63
		6.83	24.93		
150	71.88			4,653	10.31
		8.50	31.02		
190	63.38			5,770	12.79
		8.32	30.37		
240	55.06			7,445	16.50
		8.50	31.02		
310	46.56			9,188	20.37
		8.12	29.64		
400	38.44			56,120	124.43
		38.44	140.30		
TOTALS				86,154	191.03

TABLE 5

Flow Duration - Equivalent Days at 520 Cubic Feet Per Second

Flows cfs	% Time Flow Exceeded	Δ %	Days	cfs-Days	Equivalent 520 cfs-Days
120	78.71	▨	▨	2,992	5.75
		6.83	24.93		
150	71.88			4,653	8.95
		8.50	31.02		
190	63.38			5,770	11.10
		8.32	30.37		
240	55.06			7,445	14.32
		8.50	31.02		
310	46.56			9,188	17.67
		8.12	29.64		
400	38.44			12,484	24.01
		8.55	31.21		
510	29.89			55,640	107.00
▨	▨	29.89	109.10	▨	▨
TOTALS				98,172	188.79

TABLE 6

Flow Duration - Equivalent Days at 590 Cubic Feet Per Second

Flows cfs	% Time Flow Exceeded	△ %	Days	cfs-Days	Equivalent 590 cfs-Days
120	78.71	▨	▨	2,992	5.07
		6.83	24.93		
150	71.88			4,653	7.89
		8.50	31.02		
190	63.38			5,770	9.78
		8.32	30.37		
240	55.06			7,445	12.62
		8.50	31.02		
310	46.56			9,188	15.57
		8.12	29.64		
400	38.44			12,484	21.16
		8.55	31.21		
510	29.89			14,744	24.99
		7.92	28.91		
650	21.97			52,123	88.34
▨	▨	21.97	80.19	▨	▨
TOTALS				109,399	185.42

TABLE 7

Flow Duration - Equivalent Days at 690 Cubic Feet Per Second

Flows cfs	% Time Flow Exceeded	Δ %	Days	cfs-Days	Equivalent 690 cfs-Days
120	78.71			2,992	4.34
		6.83	24.93		
150	71.88			4,653	6.74
		8.50	31.02		
190	63.38			5,770	8.36
		8.32	30.37		
240	55.06			7,445	10.79
		8.50	31.02		
310	46.56			9,188	13.32
		8.12	29.64		
400	38.44			12,484	18.09
		8.55	31.21		
510	29.89			14,744	21.37
		7.92	28.91		
650	21.97			52,123	75.54
		21.97	80.19		
TOTALS				109,399	158.55

TABLE 8

Fixed Blade Summarization and Annual Production

Flows cfs	Generator Size KW	Equivalent cfs-Days	Utilization Factors	20-Year Average Annual Production KWh
347	500	211.92	58%	2,543,040
451	650	191.03	52%	2,980,068
520	750	188.79	52%	3,398,220
590	850	185.34	51%	3,780,936
690	1,000	158.55	43%	3,805,200

corresponding equivalent cubic-feet-per-second days, the corresponding utilization factor of the system, and finally, the expected energy production of each of the various size systems.

E. Operation and Controls with Adjustable Blade Turbine

The adjustable blade turbine is furnished with the necessary control equipment to change the pitch on the blades of the turbine, which enables the turbine to maintain a high efficiency factor regardless of the flow. These turbines are sized at an optimum flow rate, but they can actually generate power at flow rates of between about 40 percent and 100 percent of the optimum design flow. In other words, the adjustable blade system can generate all the power that the prevailing flow can possibly produce.

A sequential calculation of production for each day's flow was the method used to figure the total production for the 20 years of record.

The sequential calculations were done for each of the four different size adjustable blade systems. For example, the 500 kilowatt size requires a design flow of 350 cubic feet per second to operate the generator at full capacity. The system will actually produce power with flows of from 140 cubic feet per second to 350 cubic feet per second. If a daily flow rate was less than 140 cubic feet per second, the generator was assumed off. For flows in excess of 350 cubic feet per second, the generator was assumed to be operating at its rated capacity. But at flows greater than 140 and less than 350, the actual flow rate was used to figure that particular day's production. The following formula was used.

KWh = Q x H x E x K x 24 hours

Where: Q = Flow in cubic feet per second
H = Head (i.e., 20 feet at Lake Frances)
E = Efficiency of generator system (i.e., 85% used)
K = Constant derived from (449/3960)x.746 = .08458

Each of the 20 years of record were figured sequentially separately, then added together to produce a 20 year grand total, and finally divided by 20 to obtain the 20 year average yearly production. Table 9 summarizes the calculations for each size adjustable blade system.

F. Conclusion

As can be seen from Tables 8 and 9, either type hydropower system can produce a rather large amount of power and either type of facility will have an ample utilization factor. The water needs of the area will have no adverse effect on the power potential of the river.

TABLE 9

Adjustable Blade Summarization and Annual Production

Flow Range cfs	Generator Size KW	Days on Line	Utilization Factor	20-Year Average Annual Production KWh
148 to 370	500	202	55%	2,434,964
192 to 480	650	170	47%	2,656,964
252 to 630	850	167	46%	3,430,182
296 to 740	1,000	137	38%	3,299,811

SECTION IX
SYSTEM CONFIGURATION and ESTIMATED DEVELOPMENT COSTS

SECTION IX. SYSTEM CONFIGURATION AND ESTIMATED DEVELOPMENT COSTS

A. Introduction

This Feasibility Assessment for installing a hydropower unit or units into the Lake Frances Dam was to address three alternate installations: (1) installation of generating equipment in the existing low-flow conduit, (2) installation of generating equipment in both the existing low-flow conduit and the rehabilitated powerhouse, and (3) the rehabilitation of the existing powerhouse.

Alternate 1, the installation of equipment into the low-flow conduit, is not feasible for the following reasons.

1. The low-flow conduit is only 54 inches square. Modification would have to be extensive to accomodate any kind of in-line equipment to the existing low-flow conduit.
2. Even if the equipment could be installed easily into the conduit, this portion of the dam is not accessible most of the time which would make maintenance extremely difficult.

Alternate 2, the utilization of both sites, is also not feasible because of the problems associated with Alternate 1.

Alternate 3, the rehabilitation of the existing powerhouse, is the only alternative that has a possibility of being feasible. Therefore, this Feasibility Assessment of the Lake Frances power development will be limited principally to the rehabilitation of the existing powerhouse.

In rehabilitating the existing powerhouse there are two hydropower system configurations that were investigated. The first configuration is the incorporation of a horizontal unit into the existing structure. Figures 5 and 6 show a plan view and a sectional view of the horizontal installation. The second configuration is the incorporation of a vertical open-flume unit into the existing structure. Figure 7 shows a plan and sectional view of the vertical installation.

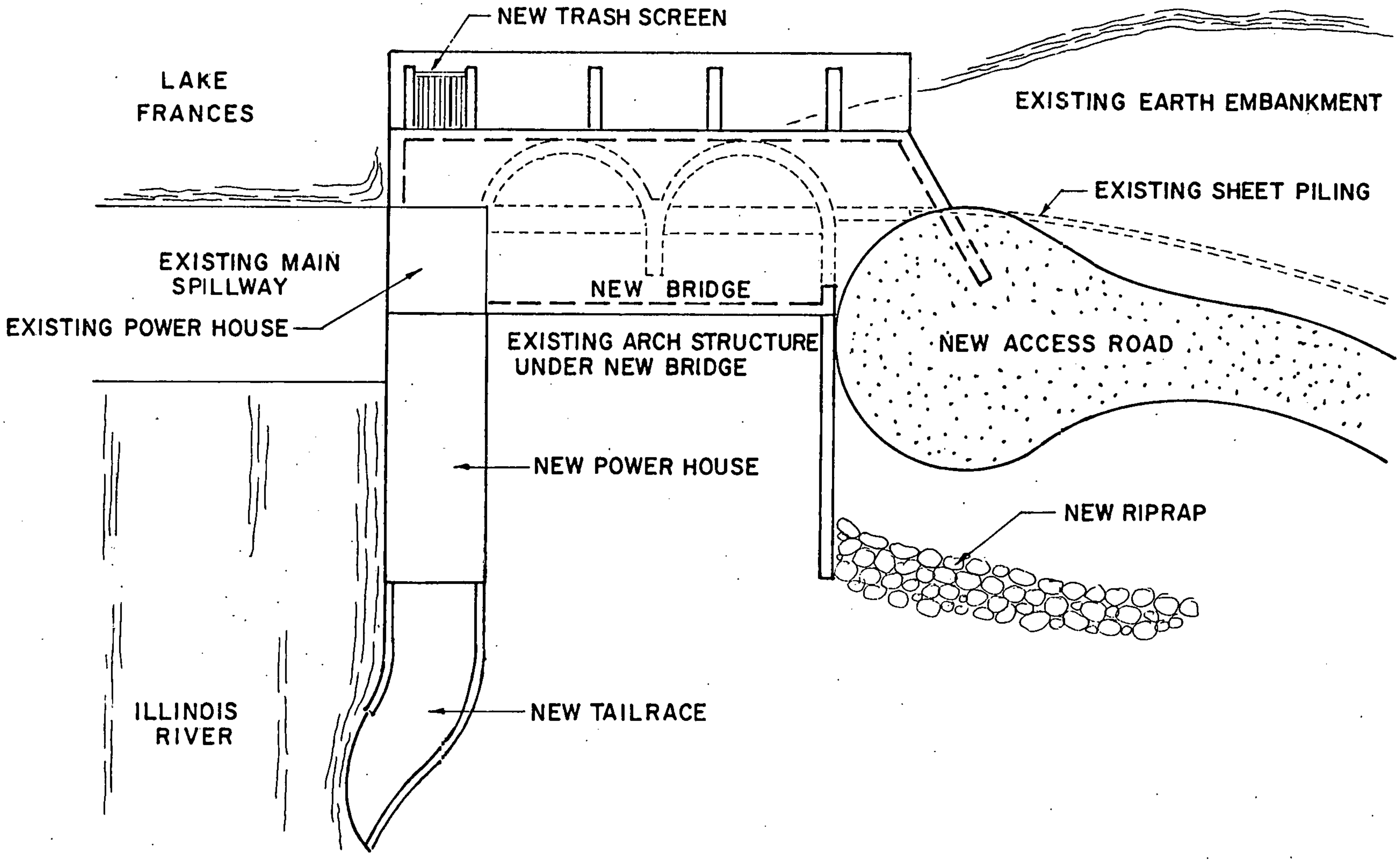
B. Horizontal Installation

The horizontal installation requires the construction of a new powerhouse immediately downstream from the existing powerhouse. Minor modifications would be made to the existing powerhouse structure, and the structure would then be utilized as an intake facility for the inlet tube.

The modifications required would include the construction of an abutment wall to reinforce the existing concrete arch section of the dam; an access bridge across the top of the existing arch section of the dam; an access road up to the bridge; a new trash screen; a new maintenance gate; a new powerhouse; and a new tailrace.

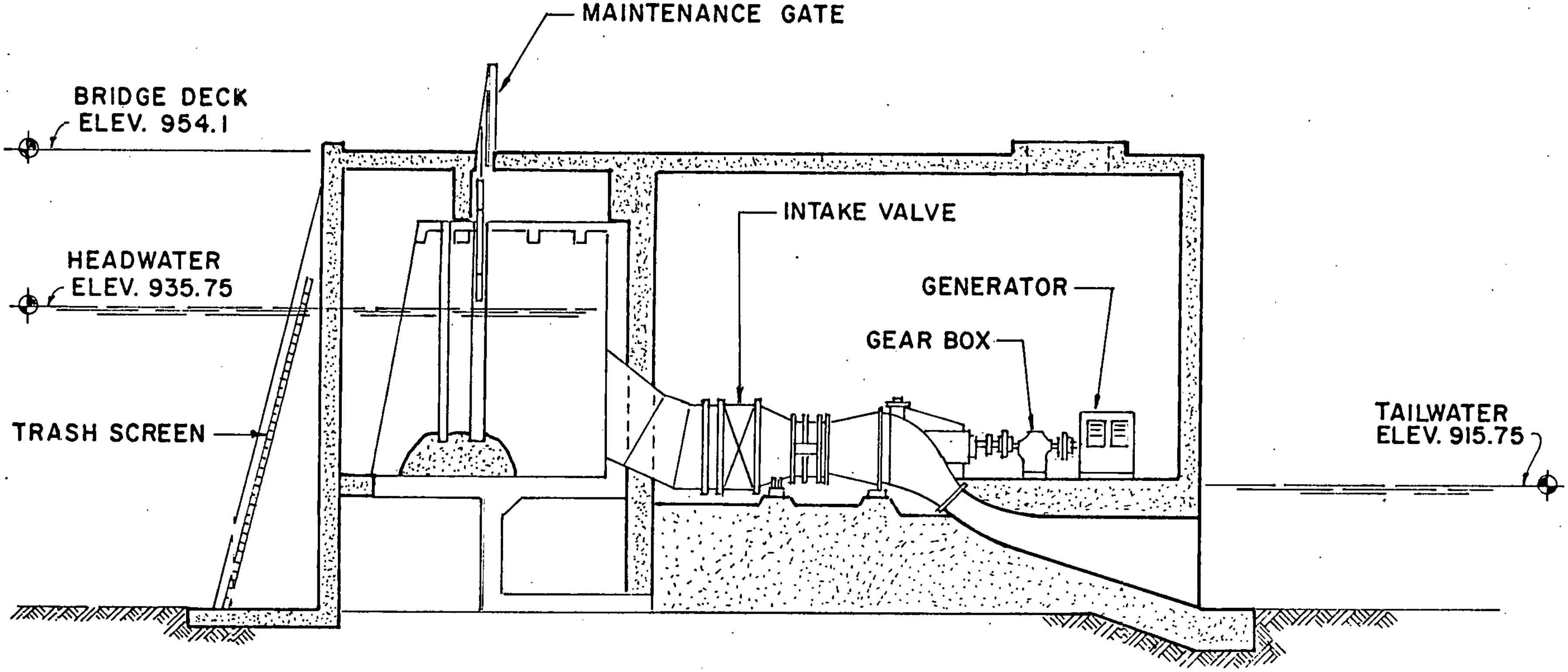
The present day (March 1979) estimated development cost of the required modifications and structural additions to the existing powerhouse, using the horizontal configuration, is $665,876.

The breakdown of the structural cost estimate is given on page IX-6.



PLAN
HORIZONTAL INSTALLATION

FIGURE NO. 5



SECTION THROUGH HORIZONTAL INSTALLATION

FIGURE NO. 6

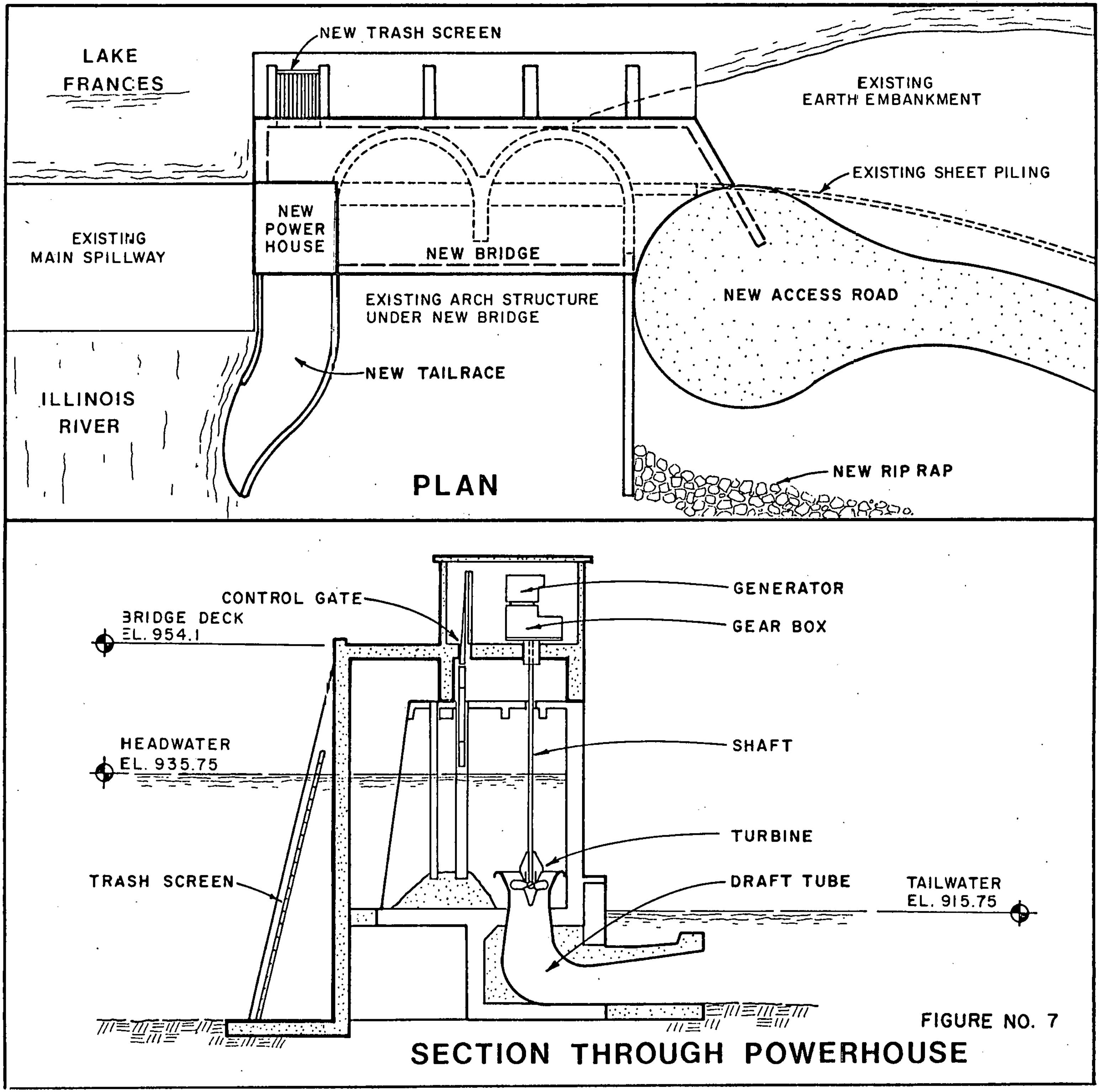

NEW TRASH SCREEN
LAKE FRANCES
EXISTING EARTH EMBANKMENT
EXISTING SHEET PILING
NEW POWER HOUSE
EXISTING MAIN SPILLWAY
NEW BRIDGE
NEW ACCESS ROAD
EXISTING ARCH STRUCTURE UNDER NEW BRIDGE
NEW TAILRACE
ILLINOIS RIVER
NEW RIP RAP
PLAN
CONTROL GATE
GENERATOR
BRIDGE DECK EL. 954.1
GEAR BOX
SHAFT
HEADWATER EL. 935.75
TURBINE
TRASH SCREEN
DRAFT TUBE
TAILWATER EL. 915.75
SECTION THROUGH POWERHOUSE

FIGURE NO. 7

Estimated Cost - Horizontal Configuration

2,280	Cu. Yds. Class A Concrete @ $135.00	$307,800
228,000	Pounds Reinforcing Steel @ $0.30	68,400
667	Sq. Yds. Concrete Slab Roadway @ $28.00	18,676
4,000	Pounds Steel for Trash Screen @ $3.00	12,000
Lump Sum	Installation and Painting	259,000
Total Estimated Construction Cost		$665,876

The structural costs will be associated with any size horizontal system; therefore, the equipment costs and the engineering costs are added to the structural costs, as shown in Table 10, which gives a summary of the estimated project development costs. The equipment costs shown in the table were obtained from Allis-Chalmers, York, Pennsylvania.

C. Vertical Installation

The vertical open-flume installation also requires the construction of a new powerhouse, but it can be built on top of the existing structure. As the existing structure once housed a vertical hydropower unit, only minor modifications would be required.

As shown in Figure 7, some of the same modifications would be required for the vertical unit as set out for the horizontal unit. The modifications would include the construction of an abutment wall to reinforce the existing concrete arch section of the dam; an access bridge across the top of the arches; an access

TABLE 10

Summary of Estimated Project Costs
for Horizontal Adjustable Blade System

Size	Equipment Cost	Structural Costs	Engineering Costs	Total Project Cost	Cost per KW
500	$495,000	$665,876	$116,087	$1,276,963	$2,553
650	582,000	665,876	124,787	1,372,663	2,111
850	627,000	665,876	129,287	1,422,163	1,673
1,000	640,000	665,876	130,587	1,436,463	1,436

road up to the bridge; a new trash screen; a control gate; a new powerhouse; and a new tailrace.

Again, the present day (March 1979) estimated development cost of the required modifications and structural additions to the existing powerhouse, using the vertical open-flume configuration, is $342,776.

The breakdown of the structural cost estimate is as follows.

Estimated Cost - Vertical Configuration

1,020	Cu. Yds. Class A Concrete @ $135.00	$137,700
102,000	Pounds Reinforcing Steel @ $0.30	30,600
667	Sq. Yds. Concrete Slab Roadway @ $28.00	18,676
4,000	Pounds Steel for Trash Screen @ $3.00	12,000
Lump Sum	Installation and Painting	133,000
400	Sq. Ft. Masonry Building @ $27.00	10,800
Total Estimated Construction Costs	. . . . . .	$342,776

The structural costs will be associated with any size vertical system; therefore, the costs for equipment, installation, and engineering are summarized in Table 11. The equipment prices for the different sizes of generators were received from BOFORS-NOHAB, Ind., Trollhättan, Sweden, with offices in the World Trade Center, New York City, New York.

Both Allis-Chalmers and BOFORS-NOHAB quoted total equipment prices for each size of generator. The quotations included the generator, transformer, circuit breaker, control equipment, gearbox, turbine, intake gate, servomotors, oil pressure unit, and the float control equipment.

TABLE 11

Summary of Estimated Project Costs
for Vertical Open Flume System

Size	Equipment Cost	Structural Costs	Engineering Costs	Total Project Cost	Cost per KW
500	$246,000	$342,776	$58,877	$647,653	$1,295
650	315,000	342,776	65,777	723,553	1,113
750	325,000	342,776	66,777	734,553	979
850	330,000	342,776	67,277	740,053	870
1,000	392,782	342,776	73,556	809,114	809

D. System Selection

Development costs for the horizontal and the vertical configurations have been discussed for several different sizes of generator systems. In Section VIII of this assessment, the production capabilities of each different size system were given in detail. The system selection is based on the comparison of production capabilities versus capital investment required.

Because of the extensive civil works that would be required for the horizontal configuration and the cost of the horizontal equipment, the horizontal system configuration is not feasible for the Lake Frances Dam hydropower development. Therefore, the horizontal configuration has been eliminated on the basis of its high total project cost.

A comparison of the different vertical open-flume systems is presented in Table 12. This table shows comparative power production capabilities and the increase in power production as generator size increases. The table also shows the comparative total system costs and the increased costs resulting from use of successively larger systems. Turbine sizes required for each different size generator are also set out. The turbine sizes are significant because the cost of the turbine is a large portion of the total cost.

As can be seen from the table, the increases in power production are substantial from a generator size of 500 kilowatt size to the 850 kilowatt generator size; but the power production increase from the 850 kilowatt to the 1,000 kilowatt size system is minimal.

TABLE 12

Production/Capital Cost Comparison Table

Generator Size KW	Turbine Size mm	System 20-year Average Yearly Production KWh	Increase in Production KWh	Total Project Cost	Increase in Cost
500	1,400	2,543,040	▨	$647,653	▨
650	1,700	2,980,068	437,028	723,553	$75,900
750	1,700	3,398,220	418,152	734,553	11,000
850	1,700	3,780,936	382,716	740,053	5,500
1,000	2,000	3,805,200	24,264	809,114	69,060

Development costs, because of increased turbine sizes, are also shown on the table. There is a large cost increase from the 500 kilowatt size to the 650 kilowatt size due to increased turbine size. When increasing the system size from the 650 kilowatt size through the 850 kilowatt size, however, there are only small cost increases because each of these systems utilize the same turbine size. But there is another large cost increase when increasing the system size from 850 kilowatts to 1,000 kilowatts, which again is due to an increase in turbine size.

The 1,000 kilowatt system has the highest yearly production; however, the system production is only 24,000 kilowatt hours more than the 850 kilowatt system. The small additional production does not warrant the additional $69,000 capital investment. Therefore, the most cost-effective system is an 850 kilowatt hydropower system.

E. Conclusion

The adjustable blade horizontal-type turbine could utilize a wide range of flows without using any of the lake storage. The control of this type turbine, however, is somewhat complicated and costs considerably more than the vertical type. Also, the horizontal unit would require the construction of extensive quite costly civil works downstream.

Consequently, the most feasible approach to the hydropower development in the Lake Frances Dam is the vertical open-flume system. The system equipment is less costly; the civil structural construction requirements are far less costly; and finally, the control scheme, which would be based on the level of the headwater, makes the system much easier to operate and maintain.

The most cost-effective size open-flume system is 850 kilowatts.

SECTION X
ESTIMATED OPERATING EXPENSE

SECTION X. ESTIMATED OPERATING EXPENSES

According to manufacturers of hydropower generating equipment, the typical life span of a low-head hydropower plant is 50 years. There are operating and maintenance expenses associated with any mechanical installation. If the unit is to remain in good operating condition for 50 years, routine maintenance is a necessity.

Operating and maintenance for the 850 kilowatt system is estimated to be $11,700 annually. These costs are broken down as follows.

Operations and Maintenance Estimate

Items and Unit Costs	Annual Cost
Station Logging and Supplies @ $200 per month	$ 2,400
Telephone and Leased Telemetering Lines @ $50 per month	600
Daily Trash Screen Cleaning @ $10 a day	3,650
Equipment and Supplies @ $250 per year	250
Preventative Maintenance and Materials @ $100 per month	1,200
Supervision @ $200 per month	2,400
Trouble Calls @ $100 per month	1,200
Total Annual Costs	$11,700

Although the dam will have to be maintained, with resultant maintenance costs, these costs have not been included in the power system operation and maintenance costs. As such costs will be incurred whether or not the hydropower system is installed, dam maintenance costs have been omitted from the estimated operating and maintenance expenses of the hydropower plant.

SECTION XI
PROJECT FINANCING

SECTION XI. PROJECT FINANCING

A. Introduction

Financing will be needed for initial construction, equipment acquisition and operating expenses during the development period of the project. The major portion of the funds will be required for construction and equipment.

As set out in Table 11, Section IX, the total cost for the 850 kilowatt hydropower system at present day (March 1979) prices is $740,053.

B. Financing Programs

There are several possible funding sources that may be, or may become, available for the financing of the construction of the hydropower generation facility.

1. Revenue Bonds

The city of Siloam Springs could issue revenue bonds on its power system. These revenue bonds can be issued with varying terms. The longest term the city could obtain on the commercial bond market, however, probably would not exceed 25 years.

Under Title IV of Public Law 95-617, the Department of Energy is authorized to make loans of up to 75 percent of the total project costs of a small hydroelectric power facility. The term of these loans is 30 years.

2. Grants

In the past, the Department of Energy has requested proposals for low-head hydroelectric power demonstration projects with up to 50 percent DOE participation. If DOE issues another Program Opportunity Notice, grant funds might be made available for a demonstration project at Lake Frances.

3. General Obligation Bonds

   Amendment 13 to the Arkansas Constitution authorizes the city to issue general obligation bonds up to 10 mills for electrical system construction. However, this type of bond does require a vote of the people.

Even though grant funds may become available, this Feasibility Assessment addresses the use of revenue bonds only as the source of funding the hydropower development at Lake Frances.

Table 13 shows four theoretical revenue bond issues, with the principal and the interest rate remaining constant for each bond. The term of each bond is the varying factor.

C. Conclusion

Since the city has appropriate collateral and owns and operates its own power distribution system, the project could be financed.

TABLE 13

Theoretical Financing Programs

Program	Principal	Interest Rate	Term (Years)	Annual Payment	Total Amortization Cost
A Revenue Bonds 100% Loan	$740,053	7%	20	$69,855	$1,397,116
B Revenue Bonds 100% Loan	740,053	7%	25	63,504	1,587,609
C Revenue Bonds 100% Loan	740,053	7%	30	59,638	1,789,143
D Revenue Bonds 100% Loan	740,053	7%	40	55,510	2,220,433

SECTION XII
ESTIMATED ANNUAL BUDGET

SECTION XII. ESTIMATED ANNUAL BUDGET

A. Introduction

This section will discuss the total annual budget factors relating to the hydropower development at the Lake Frances Dam.

B. Budget

The annual payment will vary depending on the type financing that is obtained. As set out in Section X, the operating and maintenance expenses are estimated to be $11,700 annually.

In Table 14, the annual loan payment is combined with the operations and maintenance costs for the total annual costs. The production capability of the 850 kilowatt system is shown to be the most cost-effective in Section IX. The production cost per kilowatt hour can be calculated by dividing the total annual cost by the annual production rate.

As can be seen from Table 14, the cost to produce the power ranges from a high of 22 mills per kilowatt hour to a low of 18 mills per kilowatt hour.

C. Conclusion

Regardless of the financing program utilized to construct the hydropower generating facility, the production cost exceeds the average 14 mill wholesale rate that that the city now pays.

Since there is no saving to the city over the current wholesale price, the hydropower facility is not at present economically feasible.

TABLE 14

Cost of Production Summarization

Term of Loan	Annual Payment	Annual O & M	Total Annual Costs	20-Year Average Yearly Production	Production Cost per KWh
20 years	$69,855	$11,700	$81,555	3,780,936	22 mills
25 years	63,504	11,700	75,204	3,780,936	20 mills
30 years	59,638	11,700	71,338	3,780,936	19 mills
40 years	55,510	11,700	67,210	3,780,936	18 mills

SECTION XIII
PROJECT FEASIBILITY

SECTION XIII. PROJECT FEASIBILITY

A. Introduction

There are two factors that greatly influence the feasibility of hydropower development in the Lake Frances Dam. The first factor is the dam safety requirements, and the second is the wholesale power rate.

B. Dam Safety Requirements

According to the Corps of Engineers, the existing spillways can pass only 20 percent of the probable maximum flood. The size and hazard classification dictate that the spillways be able to pass 100 percent of the probable maximum flood. Therefore, remedial measures will be required to insure that the dam will be safe during periods of extremely high flows.

Additional spillway capacity is indicated, which will be quite expensive. The hydropower development will not generate enough savings to defray expenses incurred from any construction required to insure dam safety.

The safety hazards associated with the dam are present whether or not the dam is utilized for the generation of electric power. The safety problems associated with the structure will have to be corrected, but remedial construction will have to be funded from other sources.

C. Wholesale Power Rate

The city's present wholesale power rate averages 14 mills. The most cost-effective generator system (i.e., 850 kilowatts) will generate approximately 3.8 megawatt hours annually. At the present 14 mill wholesale rate the hydropower facility will generate $52,933 of power annually. This amount is less than the total annual costs with any of the financing programs given.

The city's contract for power was executed on May 28, 1972, with the initial period of the contract being five years. After this five year period, the contract may be terminated at the option of either the city or SWEPCO. If the contract is not terminated it is automatically renewed for another year.

As prices of all types of energy are increasing frequently, the city's existing contract for power is certain to be renegotiated. With the inevitability of higher wholesale electric rates, the hydropower development in the Lake Frances Dam becomes more attractive.

Table 15 shows the impact of the electric rates on the hydropower project as electric rates increase. As can be seen from the table, the project is not feasible at the present wholesale electric rate of 14 mills. The hydropower project does become feasible, however, at about 20 mills. And as the rates continue to rise, the hydropower facilities would generate substantial savings for the city.

D. Conclusion

It is inevitable that energy rates will increase. If the Lake Frances Dam can be improved so that it can safely pass high flows, and if the hydropower potential is developed, the city of Siloam Springs has available a practical supplemental energy source as its electric rates increase.

TABLE 15

Electric Rate Impact on Project Feasibility

Rate[1] Mills	20-year Average Annual Yearly Production	Annual Gross Savings	Total Annual Cost[3]	Annual Net Savings
14[2]	3,780,936	$52,933	$75,204	$ -22,270
18	3,780,936	68,056	75,204	- 7,147
20	3,780,936	75,618	75,204	+ 414
22	3,780,936	83,180	75,204	+ 7,976
24	3,780,936	90,742	75,204	+15,538

[1] Rate is base energy charge plus fuel adjustment charge.

[2] Fourteen mills is the city's present wholesale power rate.

[3] Total annual cost is based on 25-year financing.

SECTION XIV
DEVELOPMENT PLAN

SECTION XIV. DEVELOPMENT PLAN

A. Plan

This feasibility study recommends that the city of Siloam Springs should sponsor the development of hydropower generation in the Lake Frances Dam. Briefly, the major steps in the plan are as follows:

1. The city should be the sponsoring agency, with the city electrical department responsible for the operation and maintenance of the facility.
2. The city should continue its studies further of the dam safety program so the remedial measures required to make the dam safe can be formulated.
3. The city should investigate alternate funding for the dam safety requirements once these requirements have been determined.
4. Once the structural integrity of the dam is assured, the city should retain financial consultants and initiate financial planning for the hydropower project.
5. Concurrently with the financial planning, applications should be filed with the Federal Energy Regulatory Commission so that the appropriate licenses can be issued.
6. When financing has been secured, consulting engineers should be retained to do the field surveys, subsurface investigation, and the engineering design for the hydropower facilities.
7. After the plans and specifications have been prepared by the engineers, construction bids would be received on the

project.

8. The equipment could then be ordered and manufactured. The civil works could be constructed and the equipment installed into the structure.
9. Concurrently with the contracted portion of the work, the city electrical department would build the power line from the new powerhouse to the city's raw water pump station where the generator system will be tied into the city's power grid. Only a short distance of new power line would be required to connect the generator to the power system.
10. After most of the construction work has been completed, representatives of the equipment manufacturer would be called in to test the unit, make the final adjustments, and instruct the operating personnel on the proper operation of the equipment.
11. After all tests and adjustments have been completed, the unit would then be put into operation.

It is estimated that the project would take about three years to complete.

B. Key Decision Points

The three key decision points on whether to proceed with the plan are implementation, dam safety, and financing.

1. Implementation. The decision to implement the hydropower project will be based on the findings of the Feasibility Assessment. This Feasibility Assessment concludes that if certain problems are remedied, then hydropower development

is a possible alternate source of supplemental energy for the city of Siloam Springs.

2. Dam Safety. Investigations by the city are now under way to determine the dam safety aspect of the development. If the safety problems can be remedied, then the hydropower development should proceed. On the other hand, if alternate funding cannot be secured for the dam safety, it will not be wise to incorporate generating equipment.
3. Financing. Adequate financing will be necessary for construction of this hydropower project. The city can issue revenue bonds, and seek supplemental grant funds, for construction of the facilities.

C. Conclusion

The conclusion of this Feasibility Assessment is that, with dam safety and financing assured, the hydropower development in the Lake Frances Dam should be seriously considered.

APPENDIX - A
PHASE I INSPECTION REPORT

Excerpts from

PHASE I
INSPECTION REPORT
NATIONAL DAM
SAFETY PROGRAM

Lake Frances — Dam and Spillway

Section 3.	Visual Inspection
Section 4.	Operational Procedures
Section 6.	Structural Stability
Section 7.	Assessment/Remedial Measures

SECTION 3: VISUAL INSPECTION

3.1 FINDINGS

a. General - On 15 February 1978, Engineers from the Oklahoma Water Resources Board and the Corps of Engineers met the water plant superintendent for Siloam Springs, Arkansas, and made a visual inspection of the Siloam Springs Dam (Lake Frances) and appurtenant structures. The people present for the inspection were:

(1) Dennis Daniels, Water Plant Superintendent, Siloam Springs, Arkansas.

(2) Terry Thurman, Chief, Engineering Division, OWRB.

(3) Cecil Bearden, Engineer, OWRB.

(4) Joe Glenn, Foundations and Materials Branch, Corps of Engineers, Tulsa

(5) Tom Horner, Chief, Hydraulic Design, Corps of Engineers, Tulsa

(6) Reggie Kikugawa, Design Branch, Corps of Engineers, Tulsa

(7) Larry Dearing, Construction Division, Corps of Engineers, Tulsa

(8) Gary Ditty, Foundations & Materials Branch, Corps of Engineers, Tulsa

Results of the visual inspection are summarized below:

Photographs taken during the inspection are included in Appendix "B".

b. Earth Dam - The earth embankment is approximately 6,000 feet long and varies from approximately 10 feet to 40 feet in height. The major portion of the earth embankment is on the left side of the spillway with a short section (250± feet) connecting the auxiliary spillway with the right abutment.

The crest is seven feet wide according to available construction plans. It was not possible to obtain a centerline profile or to determine the exact crest width during the inspection because of extremely heavy vegetation and snowy weather. Some areas of minor erosion and possible settlement were noticed on the crest near the junction of the earthfill and double concrete arch, but no evidence of overtopping or unusual settlement was noticed. The material observed on the crest appeared to be predominantly lean clay with possibly some sandy and silty clay.

The upstream slope on the left earth embankment was generally 1V and 2H and 1V on 2-1/2H. The upstream slope seemed to vary somewhat along the length and in some areas the slope appeared to be steeper than 1V on 2H. The upstream slope had riprap extending to the crest for a distance of about 2,000 feet south from the spillway. For the next 2,000± feet the riprap extended about halfway up the slope above the water surface. The remaining portion of the embankment did not have slope protection. The condition of the existing limestone riprap was generally good; the rock was intact and well graded with no sign of breakup or deterioration. A two to three foot vertical slough existed throughout the extent of the riprap near pool level. The slough had exposed the embankment material and no bedding material was observed. The upstream slope had many small to medium trees growing near the waterline and on other areas.

The downstream slope of the left embankment was generally 1V on 2H with no major variations. Heavy vegetation in the form of small to medium trees and grass was present along the first 4,000± feet. The downstream as well as the upstream slope was generally free of trees and brush for the last 2,000± feet. Evidence of surface erosion was observed in several locations in the form of small ditches. The snow covering and vegetation prevented a thorough inspection of the slope.

Evidence of seepage was noted along the downstream toe. There was a small ditch running almost parallel to the embankment for the entire length of the embankment. Flow in the ditch was estimated to vary from 25-50 gpm at different locations. It was not possible to determine the origin of this water because of the heavy vegetation and snow covering, however, it is believed that part of this water was surface runoff from a recent rainfall and snowmelt. A heavily vegetated marsh area exists near the downstream toe about 3,000± feet south of the double concrete arch.

The junction of the earth embankment and double concrete arch showed evidence of erosion and possible settlement. A 100± foot section adjacent to the concrete structure was about 3 feet lower than the top of concrete. The downstream slope in this area was quite rough but there was no evidence of slides.

The left abutment of the earth embankment was inspected and no sign of leakage or erosion was observed. A five-foot-diameter pipe which extends through the embankment was observed near the left abutment. This pipe has a flap gate on the reservoir side and the water level was approximately one foot below the top of the pipe. On the downstream end a small pool of water was observed. Apparently the pipe is a drainage pipe for an adjacent railroad fill and surrounding area but only when the reservoir is low would drainage occur. It appears that the pipe may have been improperly installed and actually drains in the opposite direction due to leakage around the flap gate. This may explain the ponded area downstream.

There was no indication of any type of instrumentation present in either the earthfill or concrete portion of the structure.

The right earth embankment was inspected and appeared to be in good condition with no problems or deficiencies noted.

c. Arch Dam - Two, 15-foot radius, concrete arch dams exist between the main spillway and the earth embankment. There were several cracks noted in both sections on the downstream face. Seepage thru vertical construction joints was estimated at 20-25 gpm in the section adjacent to the main spillway and powerhouse. The section adjacent to the earth embankment had a two-foot section added to it at some time and was higher than the other section.

d. Spillways - The spillway structures consist of a 162-foot uncontrolled ogee weir main spillway and a 518-foot uncontrolled ogee weir auxiliary spillway. Wooden flashboards have been added to both spillways to raise the crest elevation 14 inches. On the day of the inspection water was flowing over the auxiliary spillway crest approximately 4 inches deep. Therefore only a cursory inspection of the spillway structures was possible. The wooden flashboards were quite irregular and probably in bad condition. The condition of the concrete in the spillways was not determined.

e. Appurtenant Structures - The appurtenant structures consist of a powerhouse located on the left side of the main spillway and a sluice gate outlet structure on the right side of the main spillway. The powerhouse has remnants of a single turbine which is inoperable and appeared to have been abandoned for some time. Part of the trash rack is missing and the draft tube has been plugged. Although the powerhouse has been abandoned no severe structural deficiencies were noted that might affect the safety of the structure. A possibility of approximately 6 inches of differential settlement between the powerhouse and the adjacent concrete arch dam was noted. This is not supported by other observations and it is felt that it may have been a construction error.

The sluice gate outlet structure was not accessible for inspection because of the flow over the spillways. A 2-1/2-foot by 5-foot pier which supports a personnel bridge and houses the stem of the sluice gate was cracked. Two steel straps around the perimeter of the pier to prevent further deterioration were noted.

f. Downstream Channel - The channel immediately downstream of the dam appeared to be about 200 feet - 300 feet wide and relatively free from restrictions. A highway bridge and a railroad bridge crosses the channel about one-half mile downstream.

3.2 EVALUATION

Results of the visual inspection were somewhat inconclusive for the following reasons: (1) The main structural portions of the spillways could not be inspected for deficiencies due to high flows. It was not possible to detect any cracks or leakage which could indicate severe structural defects; (2) The inspection was conducted on a day when moderate snowfall was occurring continually. This reduced the ability to detect problems which may have been present with the earthfill embankment; (3) the heavy vegetation also restricted the ability to make a thorough inspection of the embankment; and (4) The adverse weather made it impossible to reevaluate the downstream hazard potential. Roads were impassable and only one dwelling located near the main highway was observed which may be endangered should the dam fail.

SECTION 4: OPERATIONAL PROCEDURES

4.1 PROCEDURES

Procedures for maintaining reservoir levels are described in Section 1, paragraph 1.2 h. No other information concerning routine operational procedures was available.

4.2 MAINTENANCE OF DAM

Most deficiencies noted during the visual inspection were due to a lack of proper and timely maintenance. These included such items as heavy vegetation and trees growing on the dam, poorly drained areas at the downstream toe of dam, condition of riprap on upstream slope, etc.

4.3 MAINTENANCE OF APPURTENANT STRUCTURES

The double concrete arch dam had several large cracks with leakage coming through them. The powerhouse and equipment were inoperable and did not appear to have been used for some time. The spillways were impossible to inspect because of the high flow, however, the flashboards appeared to be quite irregular. Based on conversation with the water plant superintendent and other information, it appears that the majority of the maintenance has been to repair and replace the wooden flashboards used to raise the crest of the spillways.

4.4 WARNING SYSTEM

To our knowledge there are no emergency action plans or warning systems currently in effect for the project.

4.5 EVALUATION

The maintenance on Siloam Springs Dam and appurtenant structures has essentially been nonexistant. A routine and proper maintenance program is important on a structure of this size and should be incorporated immediately.

SECTION 6: STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations - As indicated in paragraph 3.2, results of the visual inspection were somewhat inconclusive due to flows over the spillways, snow cover, and heavy vegetation on the embankment. The majority of deficiencies that were observed were due to a lack of proper and timely maintenance.

Evidence of seepage was observed along the downstream toe of the embankment. The source and possible consequences of this seepage could not be determined during the visual inspection. Additional investigations will be necessary to evaluate this condition.

b. Original Project - Design, Construction and Operating Data - Data for the original project consisted of four (4) sheets of plans as shown in Appendix "D". The original project, completed in 1931, failed in 1943 when the earth dike washed out adjacent to the arch dam portion of the structure. According to available data, 18-inch flashboards were in place atop the spillway prior to the failure. The flashboards reduced the spillway capacity from 64,000 cfs to 51,000 cfs. Flow during the time of failure was estimated at 62,000 cfs. A twenty-five-foot high steel sheet pile wall was connected to the arch dam and extended through the lower portion of the embankment for a distance of 200 feet. Whether the dam actually failed as a result of overtopping or as a result of seepage and piping along the arch dam - embankment contact is unknown. The project apparently was not repaired or utilized between 1943 and 1954.

The spillways consist of cyclopean masonry cores with outer facings of concrete. The cyclopean core consists of large hand placed stone (12 inches or more). This type of construction was evidently used during the depression years to save money but would not be used today because of the possibility of voids in the concrete. Stability analyses of the spillways were not available for review.

c. Post Construction Changes - In 1954, the city of Siloam Springs repaired the dam to provide a water supply reservoir. Plans of the repairs, shown in Appendix "E", consisted of raising the embankment 2.5 feet and providing a small 200-foot-long concrete cutoff wall across the existing channel. The embankment was raised so the spillway capacity would be increased to 85,000 cfs (maximum flood of record 84,000 cfs) without overtopping the embankment. Apparently, the small concrete wall was installed to intercept seepage along the embankment-foundation contact.

As shown on sheet 1, Appendix "E", the area eroded or washed out in 1943 covered several areas within a 700-foot distance of the arch dam. If the embankment was reconstructed between the peaks of the eroded areas, differential settlement and cracks could develop within the embankment. The concrete cutoff wall installed into rock could also result in differential settlement and cracking of the embankment. For a discussion on development of such cracks, see Appendix "I". Information was not available to evaluate these conditions or to determine design or construction techniques used to control seepage and settlement throughout this reach. Apparent settlement was observed in this area of the reconstructed embankment crest during our visual inspection. Additional investigations will be required to evaluate the structural stability of the embankment within this area.

Preliminary computations indicate the project, as reconstructed in 1954, will not meet the hydraulic considerations included in the "Guidelines" or required by Rules and Regulations of the OWRB. These computations indicate the embankment would be overtopped by 8.1 feet of water under PMF conditions and 4.3 feet under 1/2 PMF conditions. An earth embankment the size and configuration of the Lake Frances Dam cannot withstand such overtopping without failure. Additional investigations will be required to develop remedial measures necessary to modify the project to safely pass the design flood.

d. Seismic Stability - Detailed investigations were not made to determine the seismic activity in the area or the response of the structures to past earthquakes. The project is located within an area which has a Zone 1 seismic probability classification. It is assumed that projects located in Zone 1 present no hazard from earthquakes provided static stability conditions are satisfactory.

SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

Based upon results of the visual inspection; a review of the history of the project and available design, construction or operational data; and preliminary computations, the following is an assessment of Siloam Springs (Lake Frances) dam and spillway.

a. Safety - In 1943, the project failed by "washing out" the embankment adjacent to the concrete arch dam. The exact cause of this failure is unknown. Information available on reconstruction of the embankment in the failure area was not sufficient to assess the safety of the project. The plans do indicate conditions which could possibly result in differential settlement, cracking and subsequent piping through the embankment adjacent to the arch dam. Additional information and investigations will be necessary to properly assess these conditions.

Apparent seepage was observed at several locations downstream of the earth dam. Additional investigations will also be required to determine the source and possible consequences of this seepage on the safety of the project.

Preliminary computations indicate the embankment will be overtopped by 8.1 feet of water under PMF conditions. To our knowledge, an earth dam of the size and configuration of the Lake Frances embankment could not withstand such overtopping without failure. Additional investigations would be necessary to determine remedial measures necessary to insure the project can safely pass the design flood.

b. Adequacy of Information - As indicated in paragraph 6.1 a, results of the visual inspection were somewhat inconclusive due to snow cover, heavy growth of trees and vegetation on the embankment, and flows over the spillways. In addition, available design, construction or operations data was not sufficient to properly evaluate and assess the safety of the project.

c. Necessity for Phase II - Phase II investigations, by the owner, are required to:

(1) Determine the source and possible consequences of seepage downstream of the embankment on the safety of the project.

(2) Evaluate the potential for and possible effects of differential settlement, cracking, and piping within the

reconstructed portion of the earth embankment adjacent to the concrete arch dam.

(3) Determine remedial measures necessary to insure the project can safely pass the appropriate design flood.

(4) Determine the structural soundness of the cyclopean masonry core spillway sections.

7.2 REMEDIAL MEASURES

To minimize the possibility of loss of life and property and to assure continued operation of the project, the following actions are necessary. These actions fall into three basic categories: (1) Additional investigations necessary to further evaluate and assure the safety and operational adequacy of the project, (2) additions to current operating procedures, and (3) routine operation and maintenance measures to remedy and/or prevent deterioration of the project.

a. Additional Investigations

(1) Investigate and evaluate the potential for and possible effects of differential settlement, cracking and piping within the reconstructed 700-foot portion of the embankment adjacent to the arch dam. It is recommended that the initial investigation consist of another visual inspection under more favorable conditions so that the existence of any differential settlement or cracking could more readily be determined. A search and evaluation of any additional design and construction data for the area may also provide information regarding the possibility of cracking. Should transverse cracks be observed in the embankment, the pool should be lowered and remedial measures provided to prevent piping.

(2) Determine the source and possible consequences of seepage observed downstream of the embankment.

(3) Determine remedial measures necessary to insure the project can safely pass the appropriate design flood.

(4) A seepage and stability analysis for the earth embankment and a stability analysis for the cyclopean masonry core spillways should be a part of the record for the project.

b. Additions to Operating Procedures

(1) A warning system and emergency action plan should be developed for the project. Discussion of such a plan is

presented in ASCE publication, "The Evaluation of Dam Safety," page 463. See Appendix "J".

(2) A routine inspection and maintenance program should be developed and implemented.

(3) Any future modification to the structure such as flashboards which does not reduce the potential for overtopping or embankment failure should not be permitted.

c. Operation and Maintenance Measures

(1) To prevent the development of potential seepage paths along root systems and to provide areas that can be adequately inspected for evidence of distress, trees and heavy vegetation should be removed from the slopes and crest of the earth embankments.

(2) To provide protection against erosion of the upstream slope, the sloughed area should be repaired and adequate slope protection provided.

(3) After the embankment has been carefully inspected and evaluated for evidence of differential settlement or cracking, all low areas on the crest of the dam should be restored to original grade with compacted fill.

(4) The marsh area near the downstream toe should be cleared and graded to drain to allow measurement and observation of seepage.

APPENDIX - B
PROOF of OWNERSHIP

#A 35448

INSTRUMENT: DEED

GRANTOR: Illinois Water Development Company
an Oklahoma Corporation

GRANTEE: The City of Siloam Springs, Arkansas
a municipal corporation

DATED: December 1st, 1954

FILED: January 8th, 1955 at 10:00 A.M.
Book 92 page 457-8

CONSIDERATION: $35,000.00

DESCRIPTION:

QUITCLAIM, GRANT, BARGAIN, SELL AND CONVEY all its right, title, interest and estate, both at law and in equity, in the following described real estate, to-wit:

See Next Page

To Have and to Hold..
Rev. $38.50 - stamps affixed

Attest: (SEAL)
A. T. Bourne

ILLINOIS WATER DEVELOPMENT COMPANY

By: Mrs. James W. Sloan,
President

ACKNOWLEDGED: Before Vera Nichols, Notary Public in and for Tulsa County, Oklahoma, by Mrs. James W. Sloan, as President of said corporation, December 1st, 1954. SEAL
Commission expires September 7th, 1957.

All of Lots 3 and 4 Section 8, and the N½ of Section 17; and S½ of Section 17 lying andbeing situated East of the right-of-way of the Kansas City Southern Railway, in Township 19 North, Range 26 East; And

All that part of N½ of NE¼ of NE¼ of Section 18, Township 19 North, Range 26 East, in Adair County, Oklahoma, lying East of Oklahoma State Highway 17, it being a strip about twelve feet wide; and

All the land lying South and East of the right-of-way of the Kansas City Southern Railway Company in Section 19, and North of the North bank of Ballard Creek and West of the West Section line of Section 20, being more particularly described as follows: Beginning at a point on the West Section line of Section 20, Township 19 North, Range 26 East of the Indian Meridian, where the right-of-way of the Kansas City So thern Railroad intersects said West Section line; thence Southwesterly along the East line of said right-of-way to a point where said Kansas City Southern Railway right-of-way intersects the North bank of Ballard Creek in the Southwest corner of the SW¼ of SE¼ of SE¼ of Section 19; thence in a gneral Southeasterly and Northeasterly direction along the bank of said Ballard Creek to the West line of Section 20, Township 19 North, Range 26 East of the Indian Meridian; thence North along said West Section line of Section 20 to the point or place of beginning, and N½ of N½ and (S½ of NW¼) and North 11.58 acres of Lot 2 of Section 20, Township 19 North, Range 26 East; AND

Beginning at a point on the West line of Section 20, Township 19 North Range 26 East, 376.8 feet North of the Northwest corner of the SW¼ of SW¼ of SW¼ of said Section 20; thence South 31° 30' East a distance of 243.5 feet; thence South 77° East, a distance of 207.4 feet; thence North 53° 33' East, a distance of 265.6 feet; thence North 66° 37' East a distance of 635.2 fect; thence South 46° 04' East, a distance of 106.1 feet; thence South 19° 28' East, a distance of 209.1 feet; thence South 24° East a distance of 518 feet; thence South 41° 11' East, a distance ~~of [illegible] feet; thence South 41° 11' East, a distance~~ of 461 feet; thence South 45° 40' East, a distance of about 230 feet to intersection with the South line of said Section 20; thence continuing on the same course a distance of about 760 feet to an intersection with the North and South center line of Section 29; thence North along said North and South center line a distance of about 400 feet to an intersection with the South line of Section 20 (including 3 acres, more or less in the NE¼ of NE¼ of NW¼ of Section 29); thence East about 558' along the South line of Section 20 to the Illinois River; thence Northwesterly along said river to point of intersection with the East and West center line of Section 20; thence West along East and West center line of Section 20 to intersection with the Easterly right-of-way line of the Kansas City Southern Railroad; thence Southwesterlyalong said right-of-way line to intersection of said Easterly right-of-way line with the West line of Section 20; thence South along the West line of Section 20 to point of beginning; AND

All of Lot 1 in Section 29, lying North of bluff road, starting on Arkansas line at Section 20 and 29, going West 1300 feet; South 865 feet, running with the bluff road in a Southeasterly direction 1293 feet to where road intersects Arkansas line; thence North 1293 feet on Arkansas line; AND

All that part of Lots 2, 3 and 4 lying South and West of the Illinois River in Section 20, Township 19 North, Range 26 East.

Filed: Oct. 14, 1955 at 9:45 a.m.
Book 92 pages 622 - 3 - 4
Adair County Clerk, Stillwell, Okla.

DEED

THIS INDENTURE, Made this 6 day of ~~September~~ October, 1955, between THE CITY OF SILOAM SPRINGS, ARKANSAS, a municipal corporation, Party of the First Part, and ILLINOIS WATER DEVELOPMENT COMPANY, INC., an Oklahoma corporation, Party of the Second Part.

WITNESSETH:

That said Party of the First Part, in consideration of the sum of One Dollar ($1.00), and other good and valuable considerations, to it duly paid, receipt whereof is hereby acknowledged, does hereby quit claim, grant, bargain, sell and convey unto the said Party of the Second Part and its assigns, all its right, title, interest and estate, both at law and in equity, of, in and to, the following described real estate situate in the County of Adair, State of Oklahoma, to-wit:

All of Lots 3 and 4 Section 8, and the N½ of Section 17; and S½ of Section 17, lying and being situated East of the right-of-way of the Kansas City Southern Railway, in Township 19 North, Range 26 East,

AND

All that part of N½ of NE¼ of NE¼ of Section 18, Township 19 North, Range 26 East, in Adair County, Oklahoma, lying East of Oklahoma State Highway 17, it being a strip about twelve feet wide,

AND

All the land lying South and East of the right-of-way of the Kansas City Southern Railway Company in Section 19, and North of the North bank of Ballard Creek and West of the West Section line of Section 20, being more particularly described as follows: Beginning at a point on the West Section line of Section 20, Township 19 North, Range 26 East of the Indian Meridian, where the right-of-way of the Kansas City Southern Railroad intersects said West Section line; thence Southwesterly along the East line of said right-of-way to a point where said Kansas City Southern Railway right-of-way intersects the North bank of Ballard Creek in the Southwest corner of the SW¼ of SE¼ of SE¼ of Section 19; thence in a general Southeasterly and Northeasterly direction along the bank of said Ballard Creek to the West line of Section 20, Township 19 North, Range 26 East of the Indian Meridian; thence North along said West Section line of Section 20 to the point or place of beginning, and N½ of N½ and S½ of NW¼ and North 11.58 acres of Lot 2 of Section 20, Township 19 North, Range 26 East.

AND

Beginning at a point on the West line of Section 20, Township 19 North, Range 23 East, 376.8 feet North of the Northwest corner of the SW¼ of SW¼ of SW¼ of said Section 20; thence South 31° 30' East, a distance of 243.5 feet; thence South 77° East, a distance of 207.4 feet; thence North 53° 33' East, a distance of 265.8 feet; thence North 66° 37' East a distance of 635.2 feet; thence South 46° 04' East, a distance of 105.1 feet; thence South 19° 28' East, a distance of 209.1 feet; thence South 24° East, a distance of 518 feet; thence South 41° 11' East, a distance of 461 feet; thence South 45° 40' East, a distance of about 230 feet to intersection with the South line of said Section 20; thence continuing on the same course a distance of about 760 feet to an intersection with the North and South center line of Section 29; thence North along said North and South center line a distance of about 400 feet to an intersection with the South line of Section 20. (including 3 acres, more or less in the NE¼ of NE¼ of NW¼ of Section 29); thence East about 558' along the South line of Section 20 to the Illinois River; thence Northwesterly along said river to point of intersection with the East and West center line of Section 20; thence West along East and West center line of Section 20 to intersection with the Easterly right-of-way line of the Kansas City Southern Railroad; thence Southwesterly along said right-of-way line to intersection of said Easterly right-of-way line with the West line of Section 20; thence South along the West line of Section 20 to point of beginning.

AND

All of Lot 1 in Section 29, lying North of Bluff Road, starting on Arkansas line at Section 20 and 29, going West 1300 feet; South 865 feet, running with the bluff road in a southeasterly direction 1293 feet to where road intersects Arkansas line; thence North 1293 feet on Arkansas line.

It being the intention to transfer to Party of the Second Part all of the property owned by Party of the First Part in Adair County, Oklahoma, whether herein specifically described or not, except that a vendor's lien for $35,000.00, balance of the purchase price of said real estate, is hereby reserved by vendor; said debt being evidenced by a note dated ______________________, due ____________________, without interest, payable to grantor and signed by grantee.

Together with all and singular the hereditaments and appurtenances thereunto belonging. To have and to hold the above granted premises unto the said Party of the Second Part and its assigns.

IN WITNESS WHEREOF The City of Siloam Springs, Arkansas, a municipal corporation, has hereunto caused its name to be signed by its Mayor, attested by its Recorder, and its seal to be affixed this 6 day of September, 1955.

THE CITY OF SILOAM SPRINGS,
ARKANSAS, a Municipal Corporation,

By J. W. Hogg
Mayor

ATTEST:

Recorder

STATE OF ARKANSAS)
) SS.
COUNTY OF BENTON)

Before me, a Notary Public in and for said County and State, on this 6th day of September, 1955, personally appeared J. W. HOGG, to me known to be the identical person who subscribed the name of the maker to the foregoing instrument as its Mayor, and acknowledged to me that he executed the same as his free and voluntary act and deed and as the free and voluntary act and deed of such corporation, for the uses and purposes therein set forth.

WITNESS my hand and official seal the day and year last above written.

Notary Public

My commission expires
July 11th [illegible]

MORTGAGE OF REAL ESTATE

THIS INDENTURE made this 13th day of [illegible] A. D. 1955, between ILLINOIS WATER DEVELOPMENT COMPANY, INC., a corporation organized and existing under the laws of the Stat of Oklahoma, with its office at Stilwell, Oklahoma, Party of the First Part, and AUSTIN FEENSTER, N. P. NEELY and EARL PHILLIPS, as Trustees for the City of Siloam Springs, Benton County, Arkansas, Parties of the Second Part.

WITNESSETH:

That Party of the First Part, in consideration of the sum of One and no/100 Dollars ($1.00), the receipt of which is hereby acknowledged, does by these presents grant, bargain, sell and convey unto said Parties of the Second Part, their successors and assigns, all the following described real estate situate in Adair County, State of Oklahoma, to-wit:

> All that part of the S½ of the NW¼ of Section 20, Township 19 North, Range 25 East, lying and being situated East of the right-of-way of the Kansas City Southern Railway, containing about 51½ acres, more or less.
>
> Beginning at a point on the West Line of Section 20, Township 19 North, Range 26 East, 375.8 feet North of the Northwest corner of the SW¼ of SW¼ of said Section 20; thence South 31° 30' East a distance of 243.5 feet; thence South 77° East, a distance of 207.4 feet; thence North 55° 33' East, a distance of 265.6 feet; thence North 66° 37' East, a distance of 635.2 feet; thence South 46° 04' East, a distance of 106.1 feet; thence South 19° 28' East, a distance of 209.1 feet; thence South 24° East, a distance of 513 feet; thence South 41° 11' East, a distance of 461 feet; thence South 45° 40' East, a distance of about 230 feet to intersection with the South line of said Section 20; thence continuing on the same course a distance of about 760 feet to an intersection with the North and South center line of Section 29; thence North along said North and South center line a distance of about 400 feet to an intersection with the South line of Section 20, (including 3 acres, more or less in the NE¼ of NE¼ of NW¼ of Section 29); thence East about 553' along the South line of Section 20 to the Illinois River; thence Northwesterly along said river to point of intersection with the North and South center line of Section 20 at the Northeast corner of the SE¼ of SE¼ of SW¼ of said Section 20; thence North along said center line to center of Section 20, excepting 12 acres, more or less, lying East of the Illinois River, thence West along East and West center line of Section 20 to intersection with the Easterly

right-of-way line of the Kansas City Southern Railroad; thence Southwesterly along said right-of-way line to intersection of said Easterly right-of-way line with the West line of Section 20; thence South along the West line of Section 20 to point of beginning, all in Township 19 North, Range 26 East, containing 121.05 acres, more or less.

All the land lying South and East of the right-of-way of the Kansas City Southern Railway Company in Section 19, and North of the North bank of Ballard Creek and West of the West Section line of Section 20, being more particularly described as follows: Beginning at a point on the West Section line of Section 20, Township 19 North, Range 26 East of the Indian Meridian, where the right-of-way of the Kansas City Southern Railroad intersects said West Section line; thence Southwesterly along the East line of said right-of-way to a point where said Kansas City Southern Railway right-of-way intersects the North bank of Ballard Creek in the Southwest corner of the SW¼ of SE¼ of Section 19; thence in a general Southeasterly and Northeasterly direction along the bank of said Ballard Creek to the West line of Section 20, Township 19 North, Range 26 East of the Indian Meridian; thence North along said West Section - line of Section 20 to the point or place of beginning, said tract containing in all 28 acres, more or less.

All of Lot 1 in Section 29, Township 19 North, lying North of bluff road, starting on Arkansas line at Section 20 and 29, going west 1300 feet; South 865 feet, running with the bluff road in a Southeasterly direction 1293 feet to where road intersects Arkansas line; thence North 1293 feet on Arkansas line containing 34.45 acres situated in Adair County, Oklahoma.

All that part of the E½ of SE¼ of Section 7, Township 19 North, Range 26 East, Adair County, Oklahoma, lying within the following described lands, to-wit: Beginning at an iron pin which is 1134 feet more or less West and 729 feet, more or less North of the SE corner of said tract; thence North 43° 10' East 219 feet to an iron pin; thence North 25° 22' East 237 feet to an iron pin; thence South 64° 32' East 100 feet to an iron pin; thence South 25° 22' West 237 feet to an iron pin; thence South 43° 10' West 219 feet to an iron pin; thence North 64° 32' West 100 feet, more or less to point of beginning, containing 1.14 acres, more or less.

All that part of N½ of NE¼ of NE¼ of Section 18, Township 19 North, Range 26 East, in Adair County, Oklahoma, lying East of Oklahoma State Highway 17, it being a strip about twelve feet wide, and also the following described land, the North eleven and 59/100 acres of Lot 2, Section 20, Township 19 North, Range 26 East.

All of Lot 3 and 4 of Section 8, and all of the N½ of Section 17, and all of the S½ of Section 17, lying East of K.C.S.Ry. right-of-way, and all of N½ of Section 20, lying East of K.C.S.Ry. right-of-way, and the North 11.59 Acres of Lot 2, Section 20, Township 19 North, Range 26 East.

TO HAVE AND TO HOLD the same unto the Parties of the Second Part, their successors and assigns, together with all and singular the tenements, hereditaments and appurtenances thereunto belonging or in any wise appertaining, forever:

PROVIDED ALWAYS, and these presents are upon this express condition, that whereas, said Illinois Water Development Company, Inc., has this day executed and delivered to the Parties of the Second Part one certain promissory note in writing, payable to the Parties of the Second Part in the sum of $35,000.00, due five years after date, without interest, and the Party of the First Part agrees that in case of default in the payment of said note and a suit to foreclose this mortgage is brought, then the Party of the First Part shall pay as part of the costs of said proceeding, an attorney's fee of $2,000.00.

Now, if the Party of the First Part shall cause to be paid to the Parties of the Second Part, their successors or assigns, said sum of money in the above described note mentioned, according to the terms and tenor of the same, then this mortgage shall be wholly discharged and void; and otherwise shall remain in full force and effect. But if said sum of money, or any part thereof, is not paid when the same is due, or if the taxes and assessments of every nature which are or may be assessed and levied against said lands, or any part thereof, are not paid when the same are by law made due and payable, the whole of said indebtedness evidenced by said note shall then become due and payable and said Parties of the Second Part, their successors or assigns, shall be entitled to the possession of said premises. And said Party of the First Part, for said consideration, does hereby waive appraisement of said real estate and of benefit of the homestead exemption and stay laws of the State of Oklahoma.

IN WITNESS WHEREOF said Party of the First Part has hereunto caused its name to be signed by its President and its corporate seal to be affixed, attested by its Secretary on this 13th day of October, 1955.

ILLINOIS WATER DEVELOPMENT COMPANY, INC.

ATTEST:

Secretary

By

President

STATE OF ARKANSAS)
) SS.
COUNTY OF BENTON)

Before me, [illegible], a Notary Public in and for said County and State, on this [illegible] day of October, 1955, personally appeared HOMER BYNUM, to me known to be the identical person who subscribed the name of the maker thereof to the foregoing instrument as its President, and T. P. STAHL, as Secretary, and each for himself acknowledged to me that they executed the same as their free and voluntary act and deed and as the free and voluntary act and deed of such corporation for the uses and purposes therein set forth.

WITNESS my hand and official seal the day and year first above written.

Notary Public

My commission expires
July 11th 1956

82798

RELEASE OF MORTGAGE

KNOW ALL MEN BY THESE PRESENTS:

WHEREAS, on the 13th day of October, 1955, a certain mortgage was executed by Homer Bynum, President, Illinois Water Development Company, Inc., Mortgagor, to Austin Feemster, W. P. Neely and Earl Phillips as Trustees for the City of Siloam Springs, Benton County, Arkansas, Mortgagee, for the sum of $35,000.00 on lands in Adair County, Oklahoma, located in:

Sections 7, 17, 18, 19, 20 and 29, all in Township 19 North, Range 26 East,

which was filed for record on October 14, 1955, in Book 85 at Pages 501-2 of the Mortgage Records of Adair County, State of Oklahoma; and

WHEREAS, the note secured by said mortgage has been paid in full.

NOW, THEREFORE, we, Robert E. Knight, Mayor, and Helen Allum, City Clerk, of the City of Siloam Springs, Benton County, Arkansas, do hereby remise, release and forever quit-claim all right, title and interest in and to the above mentioned property that the City of Siloam Springs may have acquired by virtue of the above named mortgage.

WITNESS our hand and seal this 15th day of December, 1977.

CITY OF SILOAM SPRINGS, ARKANSAS

By: Robert E. Knight
Robert E. Knight, Mayor

Attest:
Helen Allum
Helen Allum, City Clerk

(SEAL)

FILED
ADAIR COUNTY, STILWELL, OKLA.
DEC 24 1977
2 HOUR 00 MINUTE
IN BOOK [illegible] AT PAGE [illegible]
MAE JEAN JOHNSON, County Clerk
By [illegible] Deputy

* *

STATE OF ARKANSAS)
) ss ACKNOWLEDGMENT
County of Benton)

Before me, the undersigned, a Notary Public, in and for said County and State on this 21 day of December, 1977, personally appeared ROBERT E. KNIGHT and HELEN ALLUM, to me well known, respectively, as the Mayor and City Clerk of the City of Siloam Springs, Benton County, Arkansas, duly authorized to execute the foregoing Release of Mortgage and acknowledged to me they executed the same as their free and voluntary act and deed for the uses and purposes therein mentioned and set forth.

Given under my hand and seal of office the day and year last above written.

My Commission expires:
11-24-80

Betty Knapp
Notary Public

Return to
Liberty Savings & Loan Assn.
Box 540
Siloam Springs, AR 72761