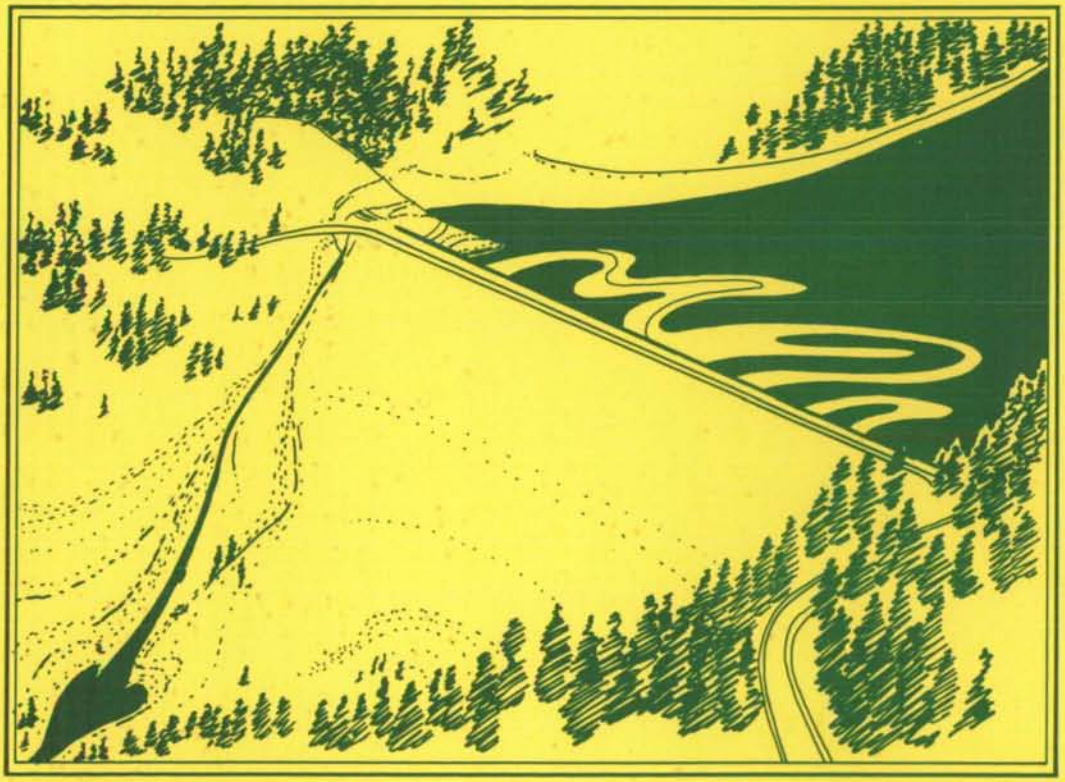
LEMON DAM PROJECT

FEASIBILITY REPORT



NOVEMBER
1985

FOR:
COLORADO
WATER RESOURCES
AND POWER
DEVELOPMENT
AUTHORITY
AND
FLORIDA
WATER CONSERVANCY
DISTRICT

BY:
HARRIS WATER ENGINEERING
DURANGO, COLORADO 81301

VOL. I - MAIN REPORT

LEMON DAM PROJECT

Feasibility Report

Volume I - Main Report

December 1985

For: Colorado Water Resources and Power Development Authority

and

Florida Water Conservancy District

By: Harris Water Engineering
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Durango, Colorado 81301
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Steven C. Harris, P.E.

November 25, 1985

Dan Law
Associate Director
Colorado Water Resources and
Power Development Authority
1580 Logan Street, Suite 620
Denver, Colorado 80203

Re: Lemon Dam Project

Dear Mr. Law:

The Authority and Harris Water Engineering (HWE) entered into an Agreement on December 12, 1984, for HWE to perform a feasibility study and prepare a report on the Lemon Dam Project. Notice to begin the study was given on February 15, 1985. The study has been completed and attached is the final Feasibility Report on the Project, with Volume I being the Report and Volume II the Appendices to the Report.

In addition to the Feasibility Report, a Federal Energy Regulatory Commission License Application has been prepared (Appendix A) and submitted on the hydropower component of the project. A special use permit application has also been submitted to the U. S. Forest Service to construct the power plant and transmission line.

Numerous State and Federal agencies were contacted during the course of the study, particularly the Bureau of Reclamation and Colorado Division of Wildlife. The ideas and concerns of all the agencies have been incorporated into the project plan.

Thank you for the opportunity to work with the Authority on the Lemon Dam Project. I look forward to further involvement with the Authority as the project progresses toward construction.

Sincerely,

Steven C Harris

Steven C. Harris, P.E.

SCH:ts

Enclosures

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CERTIFICATE OF ENGINEER

LEMON DAM PROJECT

The technical material and data contained in this report were prepared by the following persons:

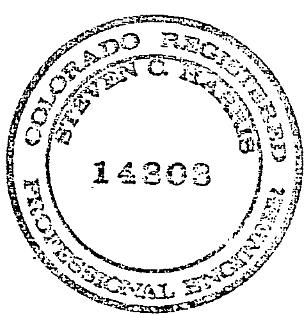
Steven C. Harris, P.E.

Dick Sittner, P.E.

Andrea Maynard

Mr. Sittner, Colorado registration number 12144, prepared the feasibility evaluations and designs on the electrical components of the Lemon Dam Project. Ms. Maynard described the environmental setting and evaluated the potential environmental impacts. Mr. Harris supervised the study and performed the engineering evaluations on project components other than electrical items.

The technical analysis, material and data developed in this study were prepared under the supervision and direction of the undersigned whose seal as a professional engineer is affixed below.



STEVEN C. HARRIS
Registered Professional Engineer
State of Colorado No. 14303

EXECUTIVE SUMMARY

The Florida Water Conservancy District (District) submitted an application for a feasibility study to the Colorado Water Resources and Power Development Authority (Authority) in August of 1984. The study was to focus on the feasibility of retrofitting a small hydroelectric power unit in the existing outlet works of Lemon Dam and to investigate the repairs required on the outlet gates. The Authority authorized the feasibility study of the Lemon Dam Project in February of 1985.

The Lemon Dam Project is located about 14 miles northeast of Durango in southwest Colorado. The dam was constructed by the Bureau of Reclamation in 1963 and is operated by the District. The dam provides irrigation water for 19,450 acres of land.

The Lemon Dam Project consists of two components which are: 1) installation of a 110 kW hydroelectric power plant and 2) repair of the seats on the main gates. The District holds a FERC preliminary permit on the power plant site which gives it exclusive rights to the site. Reclamation has stated that the gates should be repaired because of about 0.25 cfs of leakage. The feasibility report describes the technical requirements and the plan of development for each component.

The gate repair involves replacing seats on two pairs of gates which control releases from the dam. In order to repair these seats, the outlet works upstream from the gates must be dewatered to allow access to the two upstream gates. There is no simple method to dewater the outlet. A plan to block this intake was developed which requires the underwater placement of a steel plug. The plug would have an 8-inch valve so that small releases can be made to the river below the dam while the outlet is plugged.

The hydroelectric component of the project involves installation of a 110 kW turbine and generator on an existing bypass pipe in the gate chamber of the dam. The turbine had to meet very tight restrictions in the gate chamber and the elevator shaft. The turbine performance characteristics were also critical since they must maintain the historic winter releases below the dam of 9 cfs to 13 cfs. Fortunately one unit, a Worthington pump used as a turbine, met these criteria.

The power plant would generate an average of 750,000 kWh per year. The power would be marketed to Colorado Ute Electric Association at the current rate of $.035 per kWh. The facility would be interconnected to the existing power grid at a line on the crest of the dam. The District would use about 18,000 kWh per year power for their own use. The average annual revenues from the sale of this would be $25,600. In addition the District would save an additional $1,300 in electrical costs by eliminating the purchase of the 18,000 kWh from La Plata Electric Association.

A Federal Energy Regulatory Commission (FERC) License application was submitted in early December of 1985. It is expected that this application will take approximately one year to process. In light of this processing time, the earliest construction date for the project is the fall of 1987.

The potential environmental impacts of the project were discussed with appropriate agencies throughout the study process. The project plan was flexible enough so that the potential impacts were eliminated or are minimal.

The estimated project cost, based on October 1985 prices, is $323,600. The gate repairs are estimated at $150,600 and the power plant at $173,000.

In 1987 the District will have about $85,000 in cash available from a $12,500 annual contribution to a sinking fund for the project. This would require the financing of about $240,000. The most likely financing scenario is a loan from the Authority. The current rate for a tax-exempt revenue bond with a maturity of 15 years is 9 percent. Based on a 9 percent interest rate and a 15 year maturity, the annual debt service would be $29,600. In addition to the debt service, an operation, maintenance, and replacement cost of $3,000 and a falling water charge of $750 have been included. The total annual cost would be $33,350.

The annual revenues and expenses are estimated to be $25,600 and $33,350, respectively. The District is currently collecting $12,500 annually for the gate repairs, which could be used to fund the difference between the revenue and expenses. New assessments would not be required. The revenues from sales are expected to increase as power rates increase during the debt service period, and thereby reducing the District's annual contribution to the debt service cost.

Power sales are expected to produce sufficient revenues to repay the power plant costs and subsidize the gate repairs. If the District just repaired the gates, the annual debt service would be about $8,000. The power plant would not increase the District's annual repayment obligation, but it will reduce the obligation during the debt service period. After the debt is retired, the District will realize a substantial cash flow from power sales.

The project is economically and technically feasible, based upon current criteria, and should proceed to construction. The first step of construction is to begin final designs and specifications; however, before that can begin a FERC License must be issued and financing must be secured. The FERC License application was submitted in early December of 1985 and will probably be issued about one year later. It is recommended that the Authority and the District proceed with the necessary agreements to secure financing so that final designs can begin about January of 1987 followed by initiation of construction in August of 1987.

LEMON DAM PROJECT
FEASIBILITY REPORT

1.0 INTRODUCTION

This feasibility report describes the engineering, economic and environmental evaluations performed for the Lemon Dam Project which includes repair of the outlet gates and the installation of a hydroelectric turbine. This report has been prepared by Harris Water Engineering (HWE) through funding from the Colorado Water Resources and Power Development Authority (Authority) for the Florida Water Conservancy District (District).

The District operates Lemon Dam which is located in Southwestern Colorado about fourteen miles northeast of Durango, (Figure 1.1) and it holds the Federal Energy Regulatory Commission (FERC) preliminary permit on the hydropower plant.

The chapters in this report describe the technical, economic, and environmental evaluations performed for the project. Technical data, calculations and drawings are included in Volume II - Appendices. A short description of each appendix appears in the Table of Contents.

HWE would like to express special thanks to John Ey and Larry McDaniel with the District, Dan Law with the Authority, Pat Schumacher with the Durango Projects Office of the Bureau of Reclamation (Reclamation), Mike Japhet with the Colorado Division of Wildlife (CDOW), Dick Bell with the U. S. Forest Service (USFS) and Dwain Watson with the Colorado Department of Health (CDOH) for their invaluable assistance during the study.

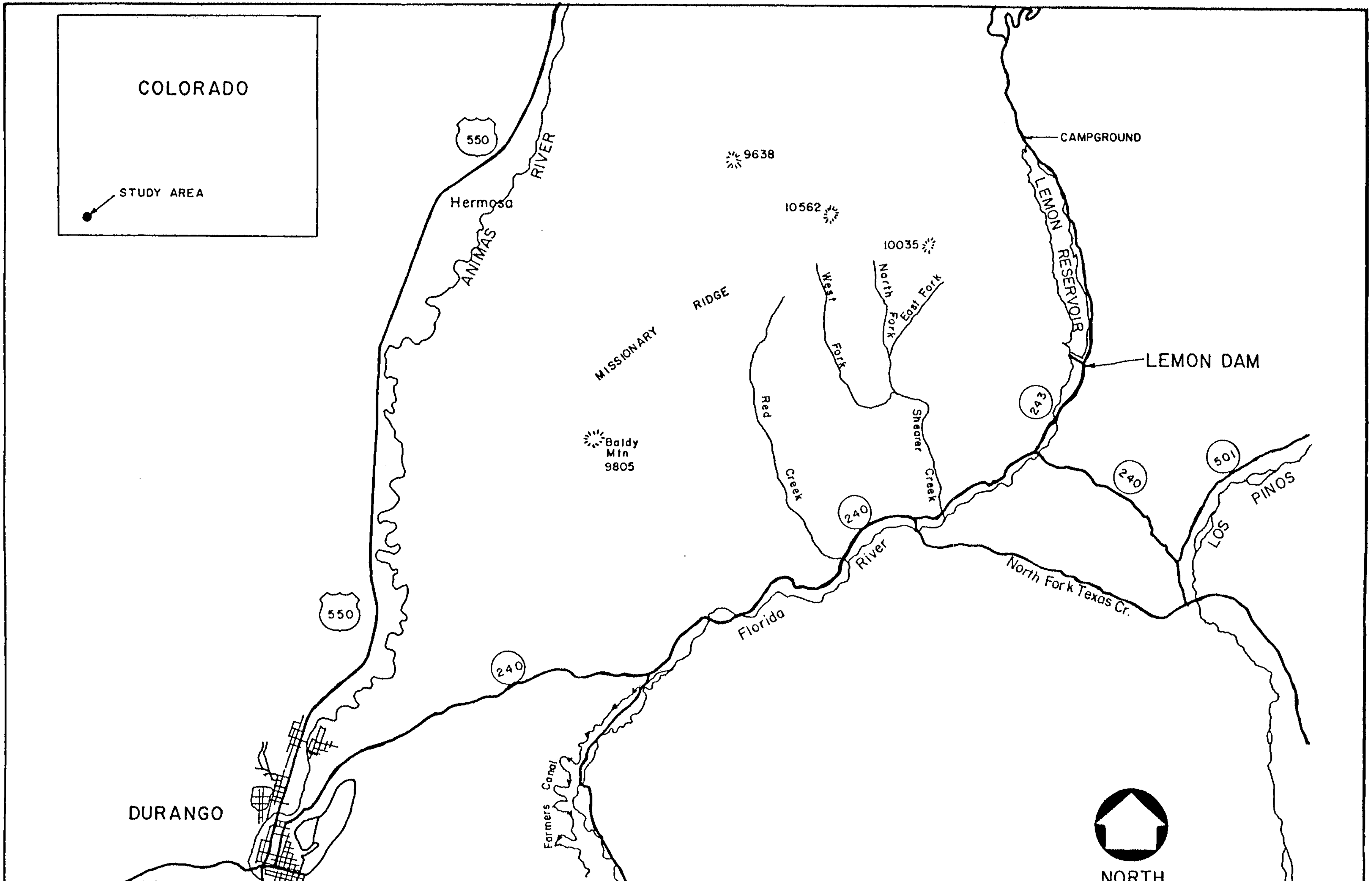


FIGURE 1-1
LEMON DAM PROJECT
LOCATION MAP

2.0 FLORIDA PROJECT HISTORY

The Florida Project was constructed by Reclamation in the early 1960's, as a participating project of the Colorado River Storage Project Act. Lemon Dam is the central feature of the project. The District contracted with the Federal Government to repay the appropriate share of the construction costs of the Florida Project. The District was formed in 1948 pursuant to provisions of Chapter 266 of the Session Laws of Colorado (37-45-101, C.R.S. 1973, as amended).

The project is located in La Plata County of Southwestern Colorado near the city of Durango. The project is in the San Juan River drainage of the Colorado River Basin. The reservoir is located on the Florida River at elevation 8000 feet.

Lemon Dam is a 215-foot high earth embankment dam on the Florida River that forms a 40,100 acre-foot (af) reservoir with a 620 acre surface area. The crest of the dam is at elevation 8167 feet. Water is released from the reservoir during the irrigation season (May-October) to irrigate 19,450 acres of land along the Florida River and on the Florida Mesa which is 15 miles downstream from the dam. The reservoir is used solely for irrigation water; municipal water use is excluded in the contract between the District and Federal Government.

Releases from the reservoir are diverted from the Florida River primarily by two canals owned and operated by two private ditch companies. The District operates the dam and coordinates with the two ditch companies to make releases. Reclamation assists the District with the operation of the facilities.

The releases from the reservoir are significantly greater during the irrigation months (May-October) than during the non-irrigation months (October-April). The irrigation releases usually peak in June and July at about 270 cubic feet per second (cfs) except in above average runoff years in which case the releases can be as high as 910 cfs. The releases begin at about 100 cfs in the spring, rise to the 270 cfs peak, and then gradually decrease to about 70 cfs in the fall.

The winter releases are in the 9 cfs to 13 cfs range and are made to provide water for the river fishery as well as for the city of Durango which diverts water from the Florida River. Durango can require that the inflow into the reservoir, up to 8.92 cfs (Durango's senior diversion right), be released from the dam. If the inflow is less than 8.92 cfs, Durango is entitled only to the amount of the inflow.

The Florida Project has operated successfully for over 20 years with only minor problems. The dam and facilities are generally in excellent condition with the exception of the outlet gates. These gates are currently leaking an aggregate of 0.25 cfs and need to be repaired.

3.0 PROJECT BACKGROUND

In 1981, the District received notice from the Bureau of Reclamation of repairs required to Lemon Dam. Accordingly, in 1982 the District began reserving $12,500 in its budget to accumulate a fund for the dam repairs.

Meanwhile, the District had been contemplating installation of a hydro power plant at Lemon Dam for a number of years. In the late 1970's a project developer filed for and received a FERC preliminary permit on Lemon Dam which was held for two years. The developer studied a large power plant which would utilize high summer releases and found the project to be infeasible.

In 1983, after the previous permit expired, the District and HWE performed an appraisal level study to investigate the possibility of installing a small turbine that utilizes a small bypass pipe in the gate chamber of the dam. This plan did not require major structural changes to the dam or any changes to the existing power distribution system. The appraisal study indicates that the project was economically justified using the relatively low market rate of $0.035 per kilowatt hour. Further, retrofitting the power plant could be combined with the required dam repairs.

At the conclusion of the appraisal study, the District received notice that another private developer had submitted an application to FERC for a preliminary permit on the site. The District filed a competing application with municipal preference and received the preliminary permit on March 15, 1984, for a period of 18 months.

The District then began exploring methods for funding a feasibility study and construction, if appropriate, of both the required dam repair and the power plant. The funding options for a feasibility study were limited to District funds, either from reserves or a bank loan, and the Colorado Water Resources and Power Development Authority ("Authority"). Funding from the Authority was particularly attractive because (1) the repayment of the feasibility study costs is forgiven if the project is not feasible, and (2) the Authority can provide a financing mechanism to fund construction.

The District submitted a Feasibility Study Application to the Authority on August 8, 1984. The Authority Board of Directors at their August 21, 1984 meeting approved a Feasibility Study for the Lemon Dam project. Contracts between the Authority and the District and HWE were required prior to the initiation of the Study. Contracts were negotiated and approved at the February 15, 1985 Authority meeting. The Study commenced on February 14, 1985.

A six month extension was requested from FERC for the preliminary permit. This extension was granted, allowing until February, 1986 for submittal of a license application. A FERC license to operate a power plant is required prior to construction.

4.0 PLAN OF DEVELOPMENT

The Lemon Dam Project would involve installation of a new hydropower plant and repair of existing facilities at Lemon Dam. The District is responsible for operation of the dam and employs a dam superintendent who lives adjacent to the dam. Reclamation provides assistance to the District and makes annual inspections of the dam.

The plan of development formulated for the project is summarized in the following paragraphs and is described in detail in the following chapters. A FERC License is required prior to construction of the power plant; the application for the license is attached as an appendix to this report.

The proposed plan of development described in the application for funding to the Authority consisted of three components:

1) Replace deteriorated riprap.
2) Repair leakage at the main outlet gates.
3) Install a 110kW hydroelectric power plant.

Items 1 and 2 were recommended in Reclamation's 1981 inspection report where "action is needed to prevent or reduce further damage or preclude operational failure." The District began reserving $12,500 per year in 1982 to perform the repairs.

Replacement of the deteriorated riprap on the dam was suggested due to what appeared to be exposed Zone 2 material on the upstream face of the dam. An examination by Reclamation in 1984 concluded that the exposed material was not Zone 2 but was road surface material from the dam crest that had washed down the embankment. For this reason, Reclamation has withdrawn the recommendation that the riprap be replaced. The riprap repair component has been deleted from the Lemon Dam Project.

Repair of the leakage at the outlet gates and installation of the power plant are the two remaining components of the project. Figure 4.1 shows the dam in relation to the project facilities.

4.1 GATE REPAIR

The irrigation releases from Lemon Dam are controlled by two pairs of outlet gates, with each pair capable of releasing 455 cfs. The non-irrigation releases are made through an existing 8-inch bypass pipe on which the turbine will be installed. Each pair of gates includes an emergency gate which is either opened or closed and a regulating gate that can be opened to various degrees to make the desired release. The seats on all four of the gates and frames have become pitted during the past 20 years of operation and no longer close tightly. While the total leakage of 0.25 cfs is not considered so great that the dam is in jeopardy, the District is still required by Reclamation to make specific plans to repair the gates in the near future.

The regulating gates can be repaired by closing the emergency gates; however, the only way the emergency gates can be repaired is to dewater the entire outlet works. The outlet works consist of an intake structure in the reservoir and a 900-foot long, 8-foot diameter pressurized tunnel between the intake and the gates, and a 900-foot unpressurized tunnel downstream of the gates to the river. The top of the intake structure is at elevation 8018 feet which means that it is normally covered by about 70 to 100 feet of water.

The following two options exist with respect to dewatering the outlet works:

(a) utilization of the 19-inch thick, 8.5-foot diameter, 14,000-pound concrete plug which was built in the intake structure. The reliability and condition of this concrete plug is

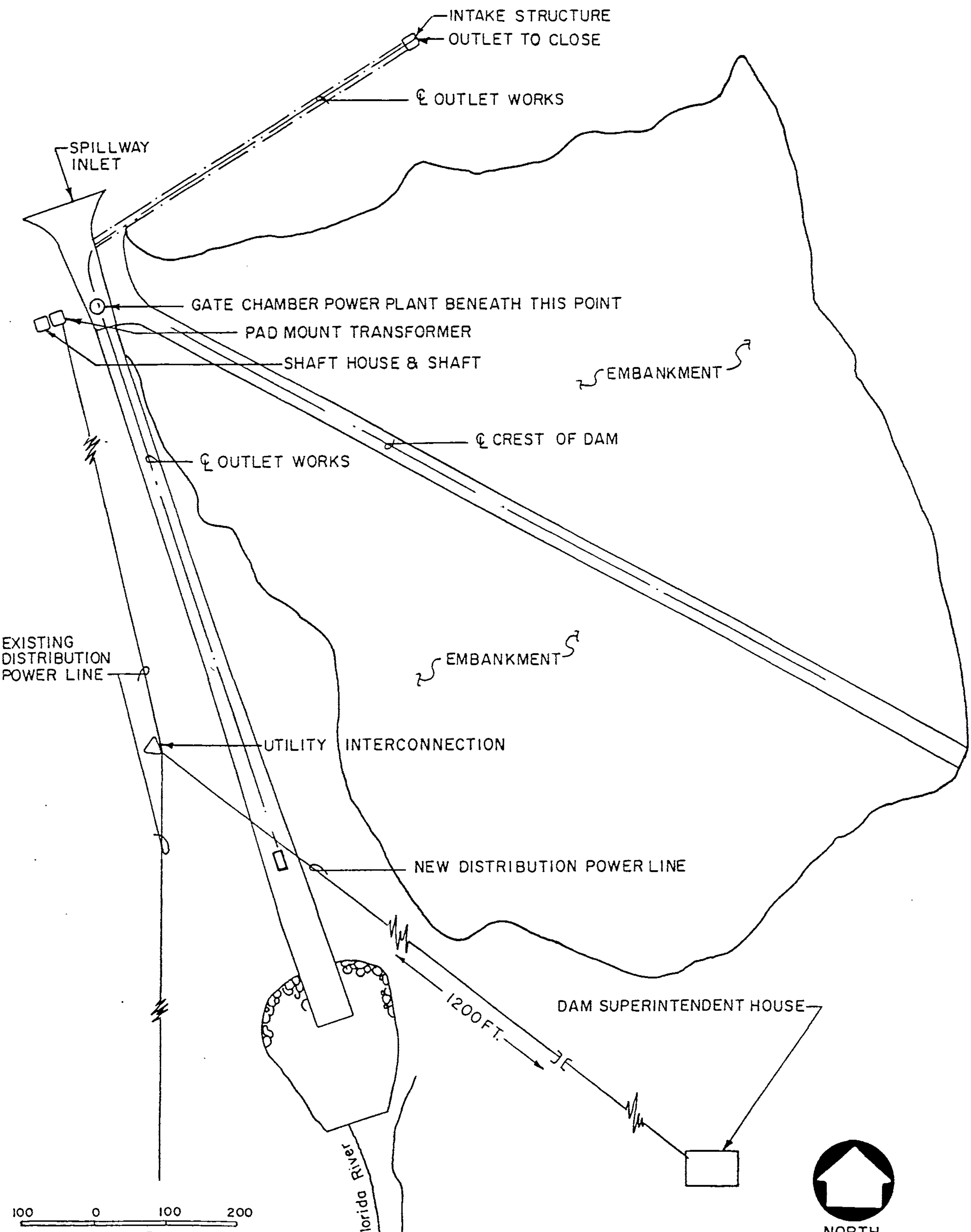


FIGURE 4.1
LEMON DAM PROJECT
LEMON DAM & PROJECT FACILITIES

unknown and there has been no precedent set for placement of this type of plug at other dams. In addition, use of this plug would require that water be pumped over the spillway to meet downstream water demands.

(b) use of a fabricated steel plug which would weigh 1,700 pounds and would be designed with a new seal to reduce leakage while in place. Also an 8-inch butterfly valve would be installed in the plug to allow releases of 11 cfs or more into the existing outlet pipe for downstream demands without pumping.

Because of the location of the intake structure, option (a) would require divers to dislodge and place the concrete plug. In order to move a plug of this weight and size, the reservoir levels would have to be lowered considerably to allow use of a winch on a barge, but the safety and reliability of moving the plug would still be questionable. This process would have both negative economic and environmental impacts. The lowering of the water levels would virtually destroy the kokanee salmon and rainbow trout populations in Lemon Reservoir. The CDOW would prefer to avoid this if at all possible. In addition, as a result of the very low levels in the reservoir, water releases downstream would have to be maintained by an elaborate and expensive pump system.

Option (b) could be implemented with minimal impacts to the fishery in the reservoir and downstream, as (1) reservoir levels could be maintained near the 14-year average for October and (2) the 8-inch valve would maintain flows in the river with no additional pumping and equipment costs. It was determined, with the assistance of the CDOW, that option (b) would be the preferred approach for this project.

Once the outlet is closed, a crew will disassemble the emergency gates, replace the seats, repair other parts as necessary, and reassemble the gates. The regulating gates will be repaired after the emergency gates so that the outlet can be opened to begin normal water releases. Releases can be made through the bypass pipe or through one pair of gates while the other regulating gate is disassembled. Reclamation approval is required if just one set of gates is used for releases.

Also, while the outlet is plugged the bypass pipe will be modified to improve the power plant output (see next section for details).

4.2 POWER PLANT

The main outlet gates are used from late April to mid-October to make large irrigation releases of over 50 cfs. During the other months the main gates are closed and releases are made through a bypass pipe, which has an inlet upstream of the main gates. The bypass pipe enters and passes through the chamber, and then daylights to the downstream tunnel 20 feet below the gates. The pipe is 8 inches in diameter through the chamber and 12 inches in diameter downstream of the chamber. Releases through the pipe are controlled by an orifice (two orifices are used at various times to make the desired releases) bolted to the exit end of the pipe. Depending upon the reservoir water surface elevation and the orifice, the releases vary from 9 to 13 cfs.

The turbine would be installed on the bypass pipe in the gate chamber, and water would then pass through the pipe all the time rather than just during the winter months. During the irrigation season, water would be released through the main gates and the pipe concurrently.

A Worthington pump-as-a-turbine was identified as being the most appropriate unit for this project. It was the only unit that met the following selection criteria: 1) maintains flow below the dam between 9 and 13 cfs, 2) fits in the space in the gate chamber, and 3) fits in the elevator so that it can be moved to the chamber. The unit will have to be dismantled to fit in the elevator.

A 110 kW induction generator would be directly connected to the turbine to produce electricity. The power would be transmitted to the crest of the dam, transformed to the proper voltage and fed into the La Plata Electric Association (LPEA) system near the crest of the dam. The District will use part of the power for its needs at the dam and at the superintendent's home. A 1200-foot distribution line to the superintendent's home will be installed.

The bypass pipe in the gate chamber will be modified to increase the power production. This modification can only be accomplished if the outlet is dewatered. The modification will significantly decrease the friction loss through the pipe and will increase the average annual production by 90,000 kWh. The estimated average output will be 750,000 kWh per year with the modifications.

A new bypass will be maintained around the turbine so that releases can be made during the winter months if the turbine becomes inoperable. Releases will be automatically routed through the bypass if the turbine shuts down; a valve on the pipe to the turbine will close and a valve on the bypass pipe will open.

The power plant will automatically shut down should problems arise, but it has to be restarted manually from the shaft house by the dam superintendent following a check for problems.

The power would probably be marketed to the Colorado Ute Electric Association (CUEA) which is the local wholesale utility.

5.0 ENVIRONMENTAL SETTING

Lemon Dam and Reservoir are located on the Florida River, about 14 miles northeast of Durango, Colorado, La Plata County, in the San Juan Basin of the Upper Colorado River Basin (Figure 1.1). The reservoir is 620 acres in area with a normal maximum water surface elevation of 8148 feet. The Florida River, which is the source of water for the reservoir, originates high in the San Juan Mountains near the Continental Divide and continues southward to its junction with the Animas River, which later joins the San Juan River (a major tributary of the Colorado River) in Farmington, New Mexico.

The Florida River flows in steep, narrow valleys until almost out of the mountains with some farms and residences located along its banks. The reservoir lies within the San Juan National Forest and has a campground, a day use area, and some private residences within the immediate vicinity, as well as a gravel road which is maintained by La Plata County.

The reservoir is surrounded by high mountains covered with conifers and aspen. In general, the area can be considered rural/ wilderness.

The mean annual temperature in the area of the reservoir is 46 degrees Fahrenheit (F) with recorded temperatures varying from 101 to -38 degrees F, fluctuating between the arid characteristics of the desert and the alpine climate of the high mountains to the north. The prevailing winds are southwesterly and the annual precipitation is approximately 25 inches.

5.1 GEOLOGY

According to page 4 of the Draft Management Plan (DMP), Lemon Reservoir, Florida Project, Colorado, 1985 prepared by Reclamation, the U. S. Forest Service (USFS) and the District, Lemon Dam and Reservoir are located along the southern edge of the San Juan Mountains near the boundary of the upturned strata that forms the outline of the San Juan Basin. The formations dip downstream about 10-15 degrees around the dam axis. There are occasional faults in the vicinity of the reservoir, but no faulting was observed during construction.

Limestones, shales, siltstones, and sandstones of the Molas, Hermosa, Rico, and Cutler Formations compose the bedrock of the dam and reservoir area. These gray, red, and maroon beds range from the Pennsylvanian through the Triassic Ages. These formations are well exposed on the valley sides, but are covered with thick deposits of glacial till and outwash in the bottom of the valleys. The valley sides are occasionally covered with landslide and other colluvial deposits of variable thicknesses.

The topography of the area is steep and rugged, formed by mountainous uplift and followed by intense glaciation. In the reservoir area, more resistant strata form high ridges and the softer beds usually form valleys tributary to the Florida River. Elevations vary from 13,147 feet at the crest of Emerson Mountain near the Florida River headwaters to 7925 feet at the base of Lemon Dam.

5.2 VEGETATIVE COVER

The steep rugged slopes surrounding the reservoir are covered with shallow soils over impervious bedrock. The typical vegetation occurring in this area includes Ponderosa Pine, Douglas Fir, and Colorado Blue Spruce associations, with the Ponderosa Pine association predominating the lower dry areas and the Douglas Fir association occurring on the higher elevation sites. It is common to find the Colorado Blue Spruce association where high water tables are prevalent and along water courses.

5.3 FISH AND WILDLIFE RESOURCES

5.3.1 Fisheries

Lemon Reservoir's storage capacity was designed to ensure that a fishery be maintained for recreational opportunities at the reservoir as well as to enhance the stream fishery below the reservoir by maintaining minimum flows in the river. To enhance the recreational and fishing value of the reservoir, a minimum of 1100 AF of storage capacity was provided. In addition, the project provides for a minimum flow of 4 cfs from October 16 through April 30 to meet minimum requirements for downstream fish habitat in the eleven mile reach of the Florida River between Lemon Dam and the Florida Farmers' Diversion Ditch. This annual release, on a cumulative basis, amounts to approximately 1600 acre feet. Releases from the reservoir continually exceed this minimum flow during the irrigation season.

The management approach for Lemon Reservoir is defined as a "put, grow and take fishery" which in essence is a stocking program implemented by the state and Federal wildlife agencies. Because the morphology of the reservoir is steep sided and narrow, there is not an abundance of shallow warm areas for fish maturation, and as a result, Lemon Reservoir does not have a productive growth rate.

Lemon Reservoir is annually stocked with 50,000 five-inch fingerling rainbow trout by the U. S. Fish and Wildlife Service (USFWS). Rainbow trout are popular with fisherman, are easy to catch and are a common commodity with fish hatcheries. They are "put" into the reservoir at five inches (size) with hopes that they will grow to be as large as 10-12 inches.

There is currently an existing brown trout population in the reservoir which probably has resulted from the 1975 stocking of 15,000 fish. The brown trout, which reside in the river below the reservoir, spawn downstream of the reservoir in the late fall-

October and November. Those residing in the reservoir spawn upstream. In addition to the brown trout, brook and cutthroat trout are also present and reproduce in the Florida River above the reservoir. The brook trout spawn during the fall months and the cutthroat spawn in the spring.

The kokanee salmon, a land-locked sockeye salmon, thrive in Lemon Reservoir and can withstand lake level fluctuations because their primary food source, the zooplankton, are least prone to the detrimental impacts from fluctuations. The kokanee have a four-year life cycle. They move upstream into the Florida River during October, November, and December, spawn and die. The CDOW voluntarily stocks the Florida River with 100,000 two-inch fry-fingerlings of kokanee salmon each year.

The production costs for the two-inch fish (kokanee or trout) are 12.8¢/fish or $128/1,000 fish or $12,800 (for 100,000 fish stocked annually). For the five-inch trout, the costs are 33.5¢ per fish or $335/1,000 fish or $16,750 for 50,000 fish. Over a four year period, replenishing of the kokanee stock would amount to $51,200. The four year period is critical to the kokanee salmon because (1) that is the amount of time it takes for kokanee to mature and spawn and (2) impacts to the fishery from historic low reservoir levels have resulted in a loss of four-year classes of kokanee salmon. The CDOW estimates that it would take two years to replenish the rainbow trout following historic low reservoir levels. This would amount to $33,500.

Prior to the construction of the Florida Project (1963), the Florida River fishery (13.5 miles from the upper end of Lemon Reservoir to the head of the Florida Farmers Ditch) was valued at $50,000 annually, according to page 53 of the <u>Florida Project, Definite Plan Report</u> (DPR, 1959) which states "but is limited by fluctuating flows which vary from more than 700 cfs during the spring runoff period to less than 30 cfs in late summer and less than 10 cfs in the winter." The DPR also estimated that the improvements to the fishery as a result of the reservoir operation would be $100,000 annually. According to Mike Japhet of the Colorado Division of Wildlife, "it is very difficult to place a monetary value on the entire worth of the fishery at Lemon Reservoir or at any other reservoir. For example if one was to try to assess the value based on the fishery alone, annual costs associated with stocking the fish could be used as a parameter, as these costs can be directly tied to the replacement costs. However, since there is no formula for calculating the monetary value of the fishery that already exists (i.e., those fish which are growing or have matured to 8 inches, 10 inches or 12 inches) the value of the fishery would be developed by using the stocking costs only. In addition, it is important to note that by determining the value based solely on the fishery, without consideration for economic indicators, the true value of the fishery is not portrayed.

On the other hand, in a recent report entitled "Sportsmen Expenditures for Hunting and Fishing in Colorado, 1981", Kenneth Nobe of Colorado State University takes the position that the value of each fish caught can be determined purely from an economic perspective. He estimates that each fish caught in Colorado is valued at $57.00. This figure incorporates the entire experience, including not only the equipment and licenses purchased but also motels, food, car expenditures, travel, etc. While this figure may be overestimated, the value based on the "fishery" alone appears to be underestimated. Possibly the true value lies somewhere between these two methodologies."

The fishery at Lemon Reservoir is currently used as a back-up egg source for the kokanee salmon in Vallecito Reservoir. It is a viable sport fishery site for both tourists and locals.

5.3.2 Wildlife

Big game animals such as deer, elk, black bear, mountain lion and big horn sheep are present in the area surrounding the reservoir. The deer and elk use the area as a summer range and both species are harvested during hunting season. Wildlife are numerous in this area and such small game species as coyote, fox, bobcat, marmot, pine squirrel, skunk, raccoon, beaver, muskrat, marten, raptorial birds, passerine birds and other small mammals, birds and a few reptiles can be found in the immediate area. Occasionally, waterfowl are observed in the reservoir area.

According to page 11 of the Draft Management Plan, "the only threatened and endangered species periodically inhabiting the reservoir area is the bald eagle, typically during the spring and fall months when fish and small game are most active. The eagle is an annual migrant from the northern portions of North America. There are no known active nests in the reservoir area."

Hunting is permitted throughout the reservoir area with the exception of the primary jurisdiction area (special management zone for the dam, spillway and outlet works) which Reclamation has restricted from hunting and the discharge of firearms. (DMP pages 17 and 18)

5.4 WATER RESOURCES

The purpose of the Lemon Dam and Reservoir project is to develop the unused flows of the Florida River for (1) the irrigation of 19,450 acres of land, (2) the control of flood waters and (3) the enhancement of the sport fishery and recreation. The project provides an average of 25,740 AF of water annually for lands in the Florida River service area.

The water is stored in the reservoir and released as needed via a natural river channel conveyance system to various diversion points where private ditch companies make use of the irrigation waters during the May to mid-October irrigation season. According to page 55 of the DPR (1959) "Future flood damages along the Florida River below the Lemon Reservoir and without the reservoir in operation are estimated at an average of $13,900 annually, including $9,100 in damage from snowmelt floods. Operation of the reservoir on the basis of runoff forecasts will reduce snowmelt flood damage by $6,700 annually but will not significantly reduce the damage from rainfall floods. The prevention of additional damages from snowmelt floods by increasing the capacity of the reservoir or the outlet works was not found to be justified economically."

In addition, a portion of the reservoir storage capacity is to provide for the recreational fishery at the reservoir and to enhance the stream fishery below the dam by maintaining flows in the river.

5.4.1 Hydrology

The primary source of precipitation over the basin occurs as snow which falls during late autumn, winter and early spring. Rain may occur during any month although it is more prevalent during the warmer seasons. The annual precipitation at the higher elevations is approximately 50 inches while at Lemon Dam the average annual precipitation is about 27 inches. At higher elevations the snowfall usually accumulates until about the first of April, after which time the runoff begins. Late March or early April mark the time for runoff at the lower elevations of the watershed, resulting in considerable melting for both areas and peak flows occurring in early May.

Normally Lemon Reservoir fills gradually during the winter and early spring, reaching maximum content in May or June. It is during the next three to four months that the reservoir level drops, with a low point being reached in October. The average annual vertical fluctuation is about 68 feet (DPR p. 54 and DPR Appendix - Bureau of Sport Fisheries and Wildlife Report, p. 8).

The drainage area for the Florida River above the Lemon Dam site is 68 square miles and varies in elevation from 7950 feet at the dam site to more than 13,000 feet at the headwaters, which originate in the Needle Mountains about ten miles southwest of the Continental Divide.

Inflow data have been derived since 1973 from measurements at a stream gage station maintained and operated by the State of Colorado "at the Florida River, above Lemon Reservoir" and indicates that the recorded inflows range from a maximum of 1140 cfs to a minimum of 3.0 cfs. The estimated annual runoff for the nine year period is 57,000 AF.

Releases recorded between mid-October and April 30 (the non-irrigation season) are relatively constant, with releases between 9-13 cfs occurring almost all of the time. Occasionally a 7 cfs or 16 cfs release occurs. During late November and early December, a week long release of 30-50 cfs is made for stock watering. During the irrigation season, the releases range from 50-1,000 cfs. Generally releases above 350 cfs result from spills when the reservoir is full.

The data related to downstream releases and reservoir capacity and elevation for 1974 and 1977 are presented in Table 5.1. Also included in this table are the reservoir elevations and capacity for the spring, following the dry year.

The reservoir's active capacity is 39,000 AF (620 acres) with 900 AF inactive capacity and 400 AF dead storage capacity. Figure 5.1 depicts the elevations, areas and capacity for pertinent parameters associated with the operation of the reservoir.

Table 5.2 identifies the historic October reservoir elevations according to year, area and capacity.

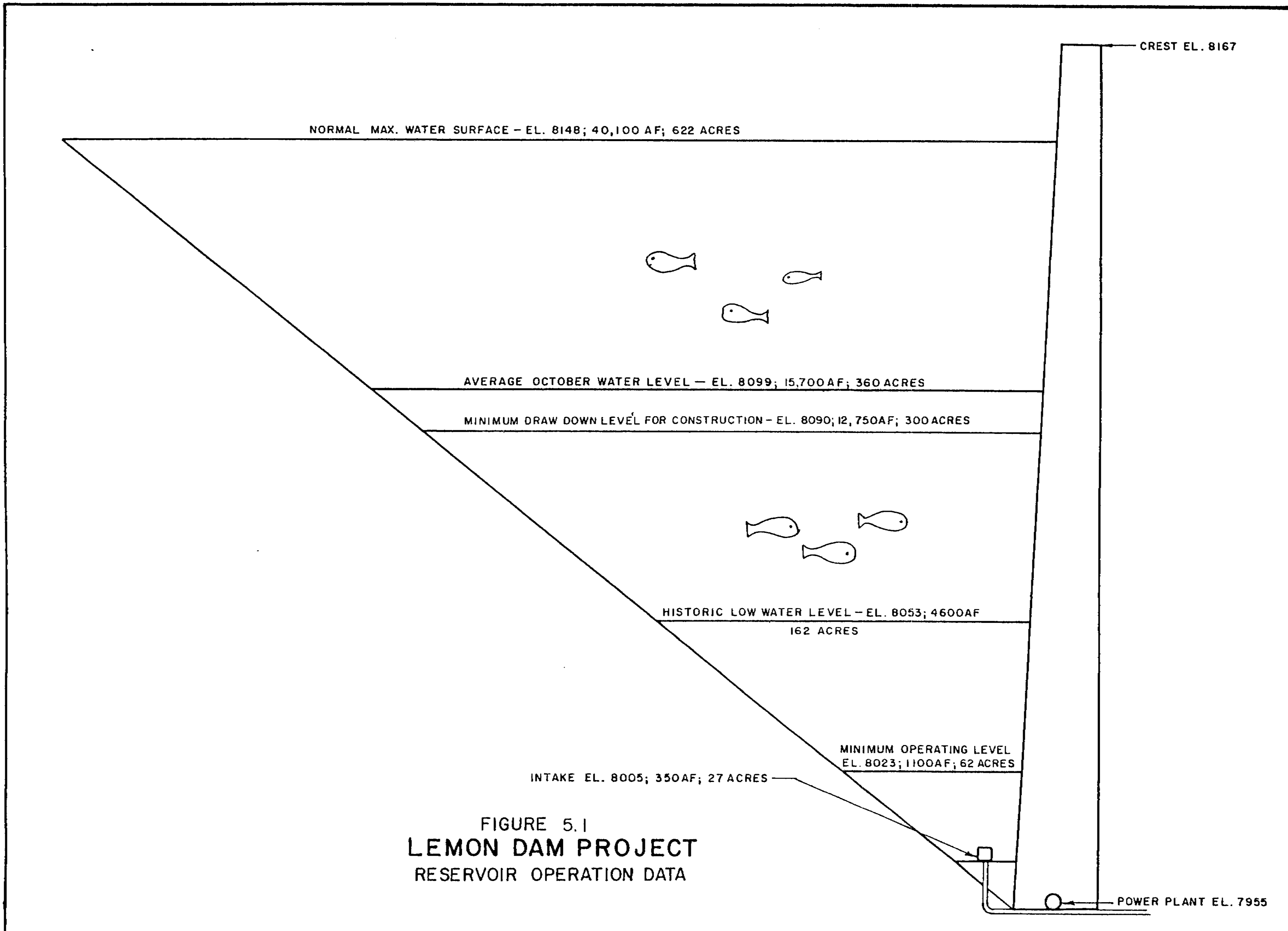


FIGURE 5.1
LEMON DAM PROJECT
RESERVOIR OPERATION DATA

TABLE 5.1
Reservoir Data

	Releases Downstream				Reservoir		
	Peak		Low		Elevation	Capacity	Month
Year	cfs	Mo.	cfs	Mo.	(Feet)	(AF)	
1974*	275	June	10	Oct.	8053	4,500	Oct.
1975**	-	-	-	-	8147	39,500	July
1977*	215	June	9	Feb./March April/Dec.	8053	4,500	June
1978***	-	-	-	-	8134	31,900	June

* Lowest recorded years.

** 1975 was an above average year for snowfall. The reservoir filled by July.

*** 1978 was a slightly below average year for snowfall. The reservoir did not fill.

TABLE 5.2
Historic October Elevations

Year	Minimum Elevation (Feet)	Surface Area (Acres)	Capacity (Acre Feet)
1971	8100	369	16,087
1972	8068	201	7,263
1973	8112	434	20,875
1974	8053	162	4,557
1975	8115	453	22,206
1976	8106	398	18,379
1977	8056	169	5,052
1978	8070	208	7,671
1979	8108	410	19,187
1980	8116	460	22,662
1981	8118	473	23,595
1982	8130	541	29,705
1983	8122	498	25,539
1984	8118	473	23,595
Oct. Ave.	8099	360	15,724

5.4.2 Water Quality

Water Quality Regulations have been established which classify stream segments and provide numeric standards for all of the streams, tributaries and standing bodies of water in Colorado. The classifications identify the actual beneficial uses for which the water is suitable and the numeric standards are assigned to determine the allowable concentrations of various parameters.

Based on the "Classifications and Numeric Standards for San Juan River and Dolores River Basins (3.4.0)", Lemon Reservoir is classified as a Recreation Class 1 (whole body contact recreation where primary contact recreation actually exists or could reasonably be expected to occur) and Aquatic Life Class 1 cold water body (a water body which provides or could provide a habitat consisting of water quality levels and other considerations such as flow or streambed characteristics which do or could protect and maintain a wide variety of cold water biota, including sensitive species). The Florida River below the dam outlet (i.e. the mainstem) has been classified as Recreation Class 2 (where primary contact recreation does not exist) and Aquatic Life Class 1 cold water body. Both water bodies have been identified as serving water supply and agricultural needs.

Out of the 27 water quality parameters (excluding organics and uranium) developed for these two bodies of water, only two differ in numeric value: fecal coliform and cadmium. The fecal coliform (f.c.) standards for the reservoir, which is classified as Recreation Class 1, is 200 f.c./100 milliliter (ml), while for the Florida River below the dam the standard is 2,000 f.c./100 ml. The cadmium standard is 0.0007 milligram per liter (mg/1) for the Florida mainstem and 0.0004 mg/1 for Lemon Reservoir. Both of these standards are more stringent for the reservoir because of the classification as Recreation Class 1. Cadmium is a heavy metal that directly affects the nervous system and fecal coliform are indicator organisms which are used to indicate the presence of pathogens.

The water quality parameters for Lemon Reservoir and the Florida mainstem fall into five categories: physical and biological, inorganic, metals, organic, and uranium, and are illustrated in Table 5.3.

The Environmental Protection Agency's data base "STORET" provided water quality data for the "Florida River Below Lemon Reservoir" sampling station, but no data was available for the reservoir itself. The data included historic and recent results of both grab and composite samples. The data were presented in two STORET files: (a) PGM-INVENT and (b) PGM=ALL PARM. The PFM=INVENT file is a summary of <u>all</u> of the statistics for <u>all</u> of the parameters and provides a composite <u>average of all of the data</u>. The PGM=PARM file describes the actual sample values for each of the parameters and contains the majority of the data upon which the PGM=INVENT file was based.

When applicable, the majority of the water quality standards were met (e.g. chlorine residual and sulfur as hydrogen sulfide did not apply). However, for three of the parameters--lead, mercury and silver--the summary data appears to exceed the water quality standards for Class 2 Recreation. After examining the actual sample values (these values are the basis for the summary data), it became evident that many of the values which were presented as being "less than" a certain value, were actually integrated into the summary table <u>as</u> <u>that</u> <u>value</u>. (Those values which were less than 5 were carried over to the summary table as 5). Table 5.4 presents an overview of the STORET data for these three parameters in question and is organized according to numeric standard, the summary data and the actual sample values.

Based on the information presented in Table 5.4, it becomes apparent that the summary data is not a true reflection of the actual samples taken.

It must also be noted that it is not unusual for many stream segments to have elevated levels of metals due to natural or unknown causes as well as mine seepage from inactive or abandoned mines.

It is unclear as to what the stream conditions truly are with respect to these three parameters, and with this in mind, it is difficult to make a decisive statement with respect to the actual exceedance of the water quality standards.

TABLE 5.3
Water Quality Standards
(Numeric Standards)

	Lemon Reservoir	Florida Mainstem
PHYSICAL AND BIOLOGICAL		
pH	6.5 - 9.0	6.5 - 9.0
DO	6.0 mg/1 - 7.0 mg/1 spawning	6.0 mg/1 - 7.0 mg/1 - spawning
Fecal Coliform	200/100 ml	2000/100 ml
INORGANIC (mg/1)		
NH_3	0.02 unionized	0.02
Residual Cl_2	0.003	0.003
Cyanide (free)	0.005	0.005
S as H_2S	0.002 undis-	0.002 undis-
Boron	0.75 solved	0.75 solved
Nitrite (NO_2)	0.05	0.05
Nitrate (NO_3)	10.0	10.0
Chloride (Cl)	250.0	250.0
Sulfate (SO_4)	250.0	250.0
METALS (mg/1)		
Arsenic (AS)	0.05	0.05
Cadmium (CD)	0.0004	0.0007
Chromium (tri)	0.05	0.05
Chromium (hex)	0.025	0.025
Copper (Cu)	0.005	0.005
Lead (Pb)	0.004	0.004
Iron (Fe, Sol)	0.3	0.3
Manganese (Mn. sol)	0.05	0.05
Mercury (Hg)	0.0005	0.0005
Nickel (Ni)	0.05	0.05
Selenium (Se)	0.01	0.01
Silver (Ag)	0.0001	0.0001
Zinc (Zn)	0.05	0.05
Iron (Fe, tot)	1.0	1.0
Manganese (Mn, tot)	1.0	1.0

URANIUM

(a) All waters of the San Juan/Dolores River Basins are subject to the following basic standard for uranium, unless otherwise specified by a water quality standard applicable to a particular segment. However, discharges of uranium regulated by permits which are within these permit limitations shall not be a basis for enforcement proceedings under this basic standard.

TABLE 5.3 (continued)

(b) Uranium level in surface waters shall be maintained at the lowest practicable level.

(c) In no case shall uranium levels in waters assigned a water supply classification be increased by any cause attributable to municipal, industrial, or agricultural discharges so as to exceed 40 picocuries per liter (pCi/1) or naturally-occurring concentrations (as determined by the State of Colorado), whichever is greater.

(d) In no case shall uranium levels in waters assigned a water supply classification be increased by a cause attributable to municipal, industrial, or agricultural discharges so as to exceed 40 pCi/1 where naturally-occurring concentrations are less than 40 pCi/1.

ORGANICS

All waters of the San Juan/Dolores River Basins are subject to the following standards for organics. (Discharges regulated by permits, which are within the permit limitations, shall not be subject to enforcement proceedings under these standards).

(a) The organic substances listed below along with concentrations listed as assigned as basic standards intended to protect all waters in the San Juan/Dolores River Basins:

Parameter	Aquatic Life mg/1	Water Supply mg/1
Aldrin	0.000003	
Dieldrin	0.000003	
DDT (DDD & DDE)	0.000001	
Endrin	0.000004	
Heptachlor	0.000001	0.0002
Lindane	0.00001	0.004
Methoxychlor	0.00003	0.1
Mirex	0.000001	
Toxaphene	0.000005	0.005
Demeton	0.0001	
Endosulfan	0.000003	
Guthion	0.0001	
Malathion		
2, 4-D PCB		
(Polychlorinated Biphenyls)	0.000001	
Chlorphenol	0.001	0.001
Monohydric phenol	0.5	0.001
Benzidine	0.0001	0.00001

TABLE 5.3 (continued)

(b) Due to their toxicity persistence, bioaccumulation potential, and carcinogenicity, these organic substances shall be maintained at the lowest practical level in both surface or groundwater. In no case shall their presence in surface or groundwater be increased by any cause attributable to municipal, industrial, or agricultural practices or discharges, so as to exceed the levels specified in paragraph (a) above.

(c) Aldrin and dieldrin in combination should not exceed 0.000003 mg/1.

(d) All organics not covered by paragraph (a) above are covered by Section 3.1.11 of the "basic regulations".

TABLE 5.4

Summary Data of Parameters in Question

(PGM=INVENT)

Parameter	Standard mg/l	Standard *ug/l	Number of Samples	Mean	Actual Sample Values: Number of Samples	Actual Sample Values: Value Found
Lead	0.004	4.00	34	0.0044 mg/l	6	0
				*(4.3824 ug)	25	5
					2	5
					1	14
Mercury	0.00005	0.05	7	0.00028 mg/l	3	0
				*(.28571 ug)	4	.5
Silver	0.0001	0.1	15	0.00026 mg	3	0
				*(.26667 ug)	11	.2
					1	2

* All actual sample values that were ** 5, .5 and .2 were recorded and averaged in as 5, .5 and .2 in this column.

* micrograms per liter

** means "less than"

5.5 LAND RESOURCES

The land in the immediate vicinity of the dam and reservoir (1/4 to 2 miles from the lake perimeter) is owned by both public and private interests. The reservoir and dam site as well as many other acres of public land are owned by the U. S. Government and are administered and managed by Reclamation, the Bureau of Land Management (BLM) and the USFS. Private properties are also adjacent to these publicly owned lands. Outside of the two mile radius and surrounding the reservoir and dam on three sides, is the San Juan National Forest.

5.5.1 Mineral Resources

Currently there are no existing mineral activities within the immediate area of the reservoir and dam. There are, however, two prospects known within the Florida River drainage basin at the extreme northern end, approximately 14 miles northeast of the dam site. There are no records of any production in the other inaccessible mine workings in the area. Production of metallic minerals within a 15 miles radius of Lemon Dam has been small.

The nearest known uranium and vanadium deposits, as reported by the Atomic Energy Commission, are in the vicinity of Durango and Lightner Creek, considerably southwest of the reservoir area. Traces of uranium have been identified near Aztec Mountain, north of Lemon Reservoir, but as with metallic minerals, the production of uranium or vanadium are not considered to be of any significance.

There are currently no prospects for oil development in the reservoir area but there is a coal belt about two miles south of the dam site that runs roughly eastward from Hesperus, Colorado and crosses the Pine River north of Bayfield, Colorado, dipping southerly away from the reservoir area.

According to the Draft Management Plan (page 10), "Ownership of mineral rights on acquired project lands has been reserved by the previous landowners. Stipulations on prospecting and extraction provide that any rights reserved shall be exercised in such a manner as will not interfere with the construction, operation, and maintenance of any works of the Lemon Dam and Reservoir of the Florida Project, as determined by the Secretary of the Interior or his duly authorized representative. Methods of extraction and removal of any such minerals shall prevent pollution and shall in no way adversely affect the water supply of Lemon Dam and Reservoir."

5.5.2 Grazing

The grazing of cattle or sheep is not permitted in the reservoir management area but is permitted on the public lands in the National Forest through a deferred rotation system which allows for the maturation of range forage plants on a portion of the grazing allotment prior to use by livestock.

Many acres of the San Juan National Forest in the area of the dam and reservoir are classified as capable and suitable livestock grazing rangeland. Grazing permits for 255 head of cattle and 500 head of sheep were issued in 1985 with ranchers paying approximately $475.00 in grazing fees. Horses are also grazed in conjunction with various types of recreation between mid-May and early November. The majority of the cattle are permitted to graze from mid-May to mid-October and sheep are permitted from early July to mid-September [San Juan National Forest - Final Environmental Impact Statement (SJNF FEIS) page III-53].

5.5.3 Timber

Timber harvests are designed (1) to improve wildlife habitat diversity, (2) to improve water yields and (3) to perpetuate or create desirable vegetation mixes for aesthetic purposes. In the

San Juan National Forest there is a total of 801,474 tentatively suitable acres for timber production (SJNF FEIS page III-56).

Since 1960, there has been a steady decrease in average annual timber harvest, primarily due to the closing of three lumber mills in Dolores (1976), Pagosa Springs (1978), and Durango (1981). Sources have indicated that the shutdowns were attributed to small trees or low quality timber and to the depressed market conditions for lumber and other wood products. The harvesting in the Lemon Dam Area has decreased in the past with occasional small sales being offered.

5.6 RECREATIONAL USE

The entire Lemon Dam and Reservoir area attracts tourists and locals alike for a variety of recreational activities. Except in the spillway chute and stilling basin below the dam where only fishing is permitted, and the primary jurisdiction area where hunting and the discharge of firearms are restricted, the area is open year round for the pleasure of people seeking both water and land related recreation.

The water-based sports that are permitted on the reservoir include fishing, boating, water skiing, swimming, sailing and wind surfing (DMP page 32). Activities that are widely experienced in and around the dam and reservoir in the land based related recreation category include camping, hiking, shoreline fishing, sightseeing, picnicking, photography, snowmobiling, snowshoeing, cross-country skiing and hunting.

An eleven unit recreation site (Miller Creek Campground) with concrete boat ramp and day use picnic facilities exists on the east side of the reservoir about two miles north of the dam. Below the dam is a parking area for stream fishermen. Approximately two miles north of the reservoir are two USFS Campgrounds; Transfer Park and Florida.

According to the DPR (page 53), annual use was estimated to be 10,000 visitor days per year, at a value of $1.60/visitor day. Recent data from the Forest Service indicates that approximately 12,000 visitors per year utilized the facilities in the area of the dam and reservoir, including the Transfer and Florida Campground areas, with the primary usage occurring during the months of June through August.

In mid-September the sanitary facilities at the Miller Creek Campground (mini-flush) and in the single unit at the north end of the lake are closed because of freezing temperatures, but there are sanitary facilities available at the Miller Creek picnic area and the Transfer and Florida Campgrounds. After Labor Day visitor usage drops dramatically to approximately 200 visitor days per month and occurs primarily in the campground areas (Personal Communication - USFS).

Data derived by the Colorado Division of Wildlife from contacts with 1,174 fishermen during the months of May-October (1982) and July-October (1983) indicates that the fishery in the reservoir supported an estimated 14,484 fishermen during that period, accounting for a total of 48,188 fisherman hours. The average overall catch per manhour, which includes both bank and boat fishermen, was 0.593 (1982) and 0.792 (1983) and the average number of fish caught per fisherman trip was 1.96 (1982) and 2.7 (1983). This information is based on a 1982 and 1983 CREEL CENSUS PROJECT report developed by the CDOW.

As the hunting season approaches, the visitor usage drops considerably for those interested in hiking/photography and the aesthetic aspects of the area, and the area becomes saturated with hunters. The estimated number of hunter days for this area of the San Juan National Forest between the October-mid November prime deer/elk hunting season is 500 hunter days (Personal Communication USFS).

5.7 SOCIO ECONOMIC ASPECTS

Because the immediate area surrounding the dam and reservoir is basically rural/wilderness in nature, the definition of the socio-economic climate will be developed utilizing a larger geographical area.

On an overall basis, the area of socio and economic influence for the 1.5 million acres of the San Juan National Forest includes five counties in southwestern Colorado--La Plata, Montezuma, Archuleta, Dolores, and San Juan. It is estimated that the activities and outputs are directly or indirectly responsible for approximately 12% of the total employment within this area of influence [Land and Resource Management Plan - San Juan National Forest (LRMP-SJNF) p. II-2]

Within the general area of influence is a population of 50,000. Projected population growth is expected to more than double over the next 30 years. Average income for the five-county area in 1973 was $3,630; and in 1978 was $5,450. The total labor force in the five-county area in April 1980 was estimated to be 23,950 of which 22,600 were employed, for an overall unemployment rate of 5.6% (LRMP SJNF p. II-3). This is slightly above the Colorado average of 3.6%. Approximately 28% of this employment or approximately 6,740 jobs were related to the activities and outputs of the San Juan National Forest. According to p. II-3 of the Land and Resource Management Plan of the San Juan National Forest, "Based on an employment to population ratio of 1 to 24 for the area, it is estimated that these jobs support about 15,000 residents of the five-county area."

The Forest Service's Rocky Mountain Region has been divided into Social Resource Units (SRU's) which serve as a foundation for assessing social, cultural, and economic interactions and are defined by natural boundaries (LRMP SJNF p. II-3). The San Juan

Forest lies within the Region's Social Resource Unit K for which the eastern boundary is the Continental Divide, the northern boundary the San Juan Mountain Range, the southern delineation the Southern Ute and Ute Mountain Ute Indian Reservations and the western perimeter, the desert of Utah. Within the SRU's are smaller units, as defined by the USFS, called Human Resource Unit's (HRU's) which are areas characterized by unique patterns of life-styles, economic conditions, institutional arrangements and topography. The HRU's vary in size, may cross political jurisdictions and are more often than not larger than individual towns and communities.

According to the USFS's "Land and Resource Management Plan, San Juan National Forest, September 1983", Lemon Dam and Reservoir lie within the Animas HRU. This unit is described below as it appears in the Land and Resource Management Plan.

5.7.1 Animas Human Resource Unit

"The Animas Human Resource Unit (HRU) is bounded on the west by a line running essentially from Red Mountain Pass southwest to the New Mexico border. This line crosses U. S. Highway 160 just west of Hesperus. The northern boundary of the HRU is the Continental Divide. The eastern border runs south from the Divide a few miles east of the Los Pinos River down to the New Mexico line.

The entire HRU is dependent on Durango as a primary trade and service center and as a recreation visitor entry point. The bulk of the unit is in La Plata and San Juan Counties.

5.7.2 Lifestyle

The Animas HRU is moderately urbanized, especially in the Durango area, but the rural mountain lifestyle still prevails. Durango is the primary trade center, and is the "gateway" to the HRU and to the San Juan National Forest. Logging, ranching and mining are directly related to National Forest activities in the HRU, and many residents spend large amounts of their leisure time in the Forest as well.

5.7.3 Attitudes, Beliefs and Values

Animas HRU residents represent a wide cross-section of attitudes, beliefs and values. The community is diverse, cosmopolitan and easily polarized on issues, including those relating to natural resource management.

5.7.4 Social Organization

The standard social services available in most small American cities are found in Durango, including a four-year college. Because of its diverse population and economic base, the Animas HRU is not as vulnerable to social disruption from projects such as mineral or ski area development as most other communities in southwest Colorado might be.

5.7.5 Population and Land Uses

Population increases of the past decade have created a problem with the conversion of agricultural lands to residential and commercial uses, particularly when converted lands are adjacent to the National Forest. Loss of access and key big game winter range are two adverse effects. Recreational use of the National Forest is growing as populations increase, with much of the increased use occurring on forest lands in the Animas HRU. Vegetation treatment is necessary to maintain the scenic views people are accustomed to and to provide for increased capacity on big game winter range to compensate for the rapid loss of private land."

5.8 HISTORICAL AND ARCHEOLOGICAL RESOURCES

According to page 13 of the Definite Plan Report (1959) and the Draft Management Plan (DMP) (1985) prepared by Reclamation, USFS and the District, the "National Park Service's cultural resources site survey...concluded that no historical, archaeological or paleontological values exist in the reservoir area".

5.9 VISUAL RESOURCES

"The Lemon Reservoir Recreation Area is defined by a unique combination of visual features. Some of these include landforms, vegetation, and water, which combine to create an enclosed landscape of inherent harmony and character. Lemon Reservoir, along with the Florida River drainage and its continuous mountain streams, provides high visual relief. Natural ponds and lakes add to this relief, and are widely scattered throughout the vicinity of the reservoir area.

The predominant visual boundaries are defined by the surrounding landforms. The mountains to the north, capped with jagged peaks and ridges, tower above the Florida Valley. The combined peaks and ridge lines contrast sharply with the sky, and form the highest boundary of enclosure. Along the sides of the valley, other boundaries are viewed as vegetation types change. These boundaries form edges or lines cutting across the natural landforms. The surface of the reservoir acts as a valley floor and forms a distinct visual boundary at the shoreline edge. Each drainage extending downward forms a terminus as it converges at the reservoir. This arrangement of landforms tends to create a definite sense of place or arrival." (DMP page 12)

5.10 ENDANGERED AND THREATENED SPECIES

"Currently, the only threatened and endangered species periodically inhabiting the reservoir area is the bald eagle, typically during the spring and fall months when fish and small game are most active. The eagle is an annual migrant from the northern portions of North America. There are no known active nests in the reservoir area. The USFS and CDOW coordinate with the USFWS to ensure proper management and protection of threatened and endangered species." (DMP page 11)

6.0 GATE REPAIR

The irrigation releases from Lemon Dam are controlled by two pairs of 2'3" x 2'3" pressure gates located in the gate chamber on the centerline of the dam about 200 feet below the crest. The location of the gates in the gate chamber is shown in Figure 6.1. The downstream gates are used to regulate water releases, while the upstream gates are either open or closed. The downstream gates can be inspected or repaired while the upstream gates are closed; however, the upstream gates cannot be inspected because there is not an easy method to dewater the outlet works upstream of the gates. Hydraulic hoists raise and lower the gates.

The seats on all four gates need to be replaced and include:

- One horizontal leaf seat on the movable portion of each gate (shown in Detail D of Drawing 519-D-36 and on Drawing 519-D-41 in Appendix B).
- Two vertical leaf seats on the movable portion of each gate (shown in Detail C of Drawing 519-D-36 and on Drawing 519-D-41 in Appendix B).
- One horizontal frame seat on the frame of the gate matching the leaf seat.
- Two vertical frame seats on the frame of the gate matching the vertical leaf seats.

In order to replace these six seats on each gate, the outlet works must be dewatered and the four gates disassembled. Each of these activities is described in detail in this chapter. Dewatering the outlet works also allows for major modifications to be made to the bypass pipe.

6.1 OPTIONS TO CLOSE OUTLET

The key activity associated with the repair of the gates is the dewatering of the outlet works. Reclamation provided a method

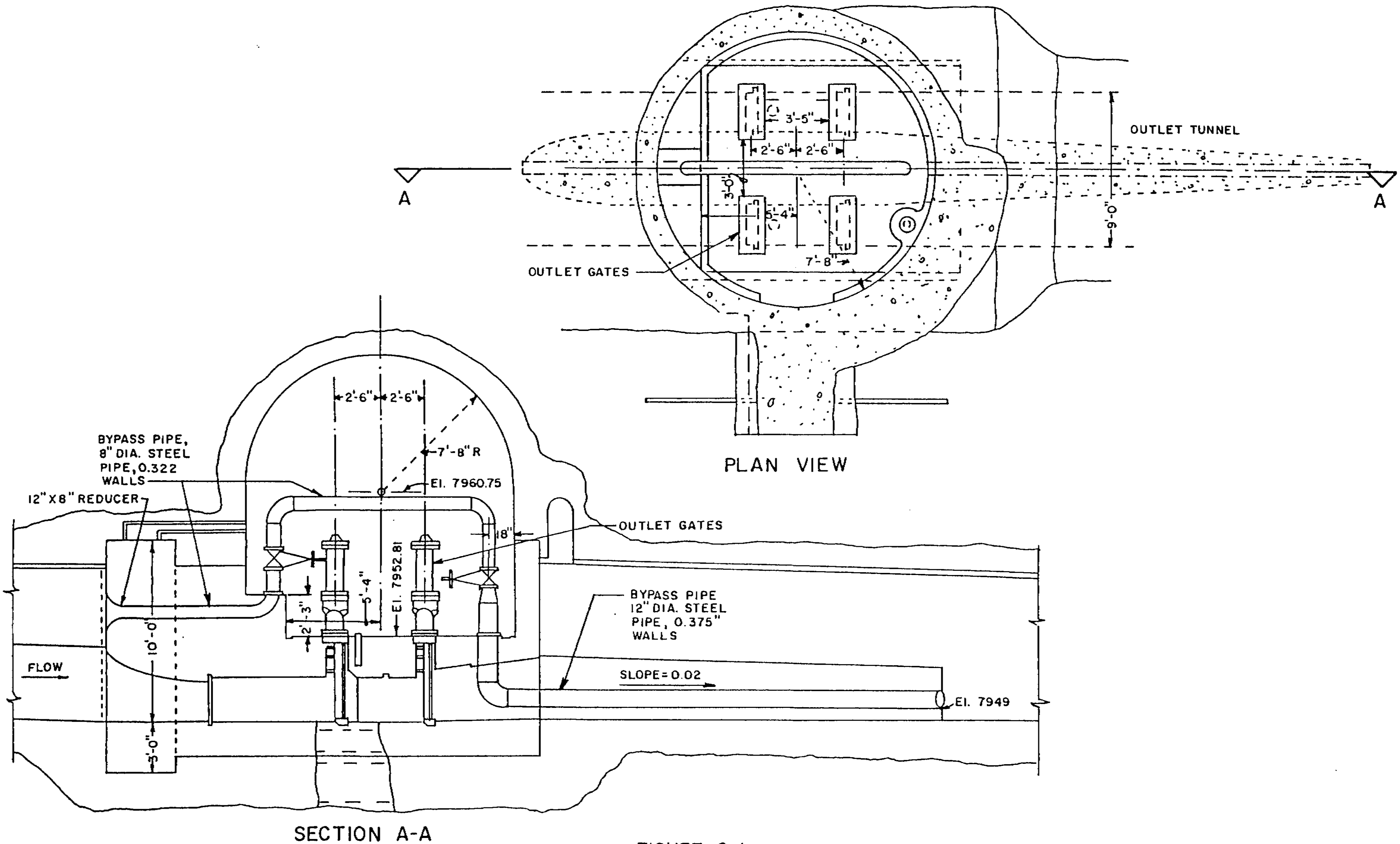


FIGURE 6.1
LEMON DAM PROJECT
HYDROELECTRIC FACILITIES
EXISTING GATE CHAMBER

NO SCALE

to close the outlet which consists of lowering the existing concrete plug in the intake structure to cover the outlet pipe. The plug or bulkhead is shown in Drawing 519-D-12 in Appendix B. The plug is an 8.5 foot diameter, 19-inch thick piece of concrete with four "flaps" at 90 degree angles to each other. The plug currently is resting on the "flaps" about ten feet above the entrance to the outlet pipe.

The plug would be lowered onto the pipe entrance by removing the four support pins and blocks, raising the plug one to two inches, and rotating it about ten degrees so that the "flaps" are away from the supports. The plug would then be lowered ten feet.

The plug weighs about 14,000 pounds in the air and 8,000 pounds submerged. (Reclamation documents incorrectly list the plug as weighing 6,500 pounds.) Several methods for lifting the plug were considered: 1) a helicopter, 2) a barge with a hoist, and 3) a frame structure which would rest on the intake structure. Reclamation has not closed an outlet of this design at any other dam so a precedent has not been set.

The nearest helicopter with the capability to lift the plug is in the northwest United States and costs $2,000 per hour; the cost for two flights to Lemon Dam and the actual lifting time have been estimated to be approximately $40,000. A barge with a hoist was suggested by Reclamation but the barge would have to be constructed specifically for the job and would have to be quite large to provide adequate buoyancy.

The frame would be constructed and placed on the intake, with a winch at the top of the frame. (Underwater winches are not commonly available for this weight and if utilized would be expensive.) Thus reservoir levels would have to be lowered to 8020 ft to allow the top of the frame to be above water. The reservoir is essentially empty at that elevation.

If existing plug were to be used, water would have to be pumped over the spillway to meet downstream water requirements. The possibility of using a siphon if the reservoir level is 8027 feet or greater appears unlikely. The releases must be able to provide about 9 cfs to Durango and 8 cfs for the river fishery. The cost of power to operate the pumps would be at least $13,000 plus the cost to install the pumps which is estimated to be approximately $13,000.

Because of the pumping costs and the potential need to substantially lower the reservoir, alternatives to the concrete plug were explored. A diving firm, Solus Ocean Systems, was contacted. This firm constructed and placed a steel plug on an outlet at Coalridge Dam in Arizona for Reclamation which operates the dam owned by the Bureau of Indian Affairs. The potential for fabricating a steel plug for Lemon Dam was discussed and it was decided that this approach would be significantly better than using the concrete plug.

The advantages of using the fabricated steel plug are cited below:

1) The condition of a new plug will be excellent and the seal can be made to fit, whereas the condition of the concrete plug, especially the seal, is unknown.
2) The steel plug will be significantly lighter than the concrete plug. It weighs about 1700 pounds in air, thus requiring considerably smaller equipment to place and remove the plug.

3) The reservoir level can be left at approximately the historic average (8099 feet) for October rather than drastically lowering it, which would have an adverse impact on the fishery.
4) The cost to construct a steel plug is about the same as the frame or barge but less than a helicopter.
5) The most important advantage of the fabricated plug is that an 8-inch butterfly valve will be constructed in the plug so that downstream releases can be made through the valve into the existing outlet pipe. While one gate is being repaired, water will be routed through the other gate. This saves at least $25,000 in pump installation and pumping costs plus it eliminates potential problems with the operation of the pumps.

The construction of the plug, and placement and removal of the plug are described in detail in the following section.

6.2 FABRICATED STEEL PLUG

The steel plug will consist of wide flanged steel beams (10 inch x 10 inch) welded together to form an 8-foot diameter plate. The plug will weigh about 1700 pounds in air. A hole will be placed in the plug in order to allow for the installation of an 8-inch butterfly valve (plug valve). The butterfly valve will be remotely operated from the surface of the reservoir to allow closing of the valve to totally dewater the outlet. About 14 cfs can pass through the valve at the estimated reservoir water surface of 8090 ft. A small, 2-inch, hole will also be included in the plug to allow a venting pipe that will extend above the water surface; this will allow air to enter and leave the tunnel.

A bulkhead will be used to divert water into one barrel of the outlet gate to allow the other gate to be disassembled. The outlet will have to be totally dewatered to allow the work crew to place the bulkhead in front of the gate being disassembled. The bulkhead will be made of rubber and steel.

6.3 DOWNSTREAM WATER RELEASES

During the time the outlet is plugged, approximately 9 cfs must be provided downstream of the dam, based on Durango's water right of 8.9 cfs. This amount will probably not be required in October because the City water demand is usually lower at this time. The CDOW recommends that 8 cfs be maintained to the Durango diversion point and 4 cfs below that point.

Tributary inflows below the dam and above the diversion point will contribute to the river flows but will vary from year to year. The available streamflow data does not allow an estimate to be made of the intervening flows. The worst possible scenario would require 9 cfs for Durango and 4 cfs for the fishery for a total of 13 cfs; this situation has not occured in actual practice. A release of 9 cfs has been the actual minimum release and is more likely during construction.

The fabricated plug would provide releases of up to 14 cfs at water elevation 8070 feet, which is 30 feet below the anticipated level. This more than satisfies the requirements. The butterfly valve can be adjusted to release about 8 cfs which is the desired release to keep the area around the gates as dry as possible while crews are repairing the gates. The releases will be increased if necessary to meet downstream requirements. Releases would be interrupted for up to one hour after the crews finish the gate on one barrel and begin work on the other. The bulkhead to divert water to the other barrel requires that the crews have access upstream of the gates and that the outlet be closed while they are moving the bulkhead.

6.4 RESERVOIR DRAWDOWN

The reservoir water level maintained while the outlet is plugged will be decided by a combination of several factors which include: 1) the spring runoff into the reservoir, 2) the amount of irrigation releases, 3) the water level preference of the divers (90 ft to 100 ft of water depth would be acceptable), 4) the higher the water level the more power produced the first year, and 5) the higher the water level the less of an impact on the fishery. At elevation 8090 ft and 13,000 af capacity, the impact is assumed to be minimal. The 14-year average water surface elevation for October has been 8099 ft.

Considering all of the above items, it presently appears that the reservoir will be drawn down to approximately 8099 ft but no lower than 8090 ft. This assumes that at the time of drawdown the reservoir level is above 8099 ft and the irrigation season has been completed. Should the year of construction be a dry year and the reservoir level below 8090 ft, no modification to the elevation will be made. The divers are capable of working in deeper water, but it requires more dives of shorter duration, to perform the work, resulting in higher costs.

6.5 GATE REPAIR

After completing the above activities the gates can be disassembled. Work on installation of the turbine and the gates would have to be coordinated because both crews cannot simultaneously work in the gate chamber. The best procedure would be to disassemble the upstream (emergency) gates and replace the seats while the outlet is closed; then repair the downstream gates after the outlet is opened. This would allow the outlet to be opened sooner and normal operation resumed.

The brass seats are very expensive and sufficient time must be available to do the work correctly. It is estimated that approximately 35 hours are needed per gate.

The turbine does not need to be fully installed while the outlet is closed. As will be explained in the next chapter, just the piping to the first valve would need to be installed while the outlet is closed.

It is expected that the outlet would be closed for about 28 working days or the entire month of October.

6.6 OUTLET CLOSING PROCEDURE

The outlet would be closed for the gate repair during the month of October so that there would be little, if any, impact on irrigation water releases, which end about mid-October. The weather in October is usually good and snow does not begin to accumulate until November.

The contracts with the divers who will close the outlet and the welder/mechanics who repair the gates and modify the turbine piping should be executed no later than mid-July so that the necessary preparations can be made. The contractors need time to make the plug, obtain the gate seats, etc.

The divers will inspect the intake structure in late August, prior to construction of the plug. This inspection is to assure that the intake is accurately depicted in the as-built drawings and to determine if 25 years of operation have affected the condition of the structure. The inspection could possibly be done by a remote controlled robot rather than a person. It is hoped that the barges would be available for the inspection. Specific plans to close the outlet will be developed once the inspection is performed.

Around September 1, a decision will be made by the engineer, the District and the divers to determine the appropriate reservoir elevation to be maintained during construction, and the approximate day that the outlet will be closed, so that irrigators can be notified. An elevation range of between 8090 ft and 8099 ft will be maintained if the year of construction is an average or wet year. Should the construction occur during a dry year and the reservoir elevation is below 8090 ft, there will be no need to lower the water level further. The elevation 8090 ft has been determined to be the limit for lowering the reservoir because of the impacts to the reservoir fishery.

The CDOW has donated the use of four flat bottomed boats (18 ft long by 6 ft wide by 2 ft deep) which are located in Durango, and are available for project use to close the outlet. This will save the District a great deal of money because renting and transporting similar boats would cost between $5,000 - $10,000. The four boats are designed to be bolted together to form a barge which the divers will use for a base. The plug would be floated on the barge as each boat is capable of carrying 3300 pounds with a 6-inch displacement. In exchange for the CDOW's assistance, an agreement has been reached, between the parties, not to lower the reservoir to a level what would impact the fishery. Cooperative agreements, such as this, are in the best interest of all concerned.

On the selected day to begin closing the outlet, the crew would assemble the boats and load the necessary equipment. The divers will require a full complement of equipment such as high intensity lights, compressors, and a decompression chamber.

The plans to close the outlet will generally include: 1) raising one trash rack by using an air bag (the intake structure cannot be entered from the top so the plug will have to be inserted from the side once the trash rack is removed), 2) setting up rigging to pull the plug into the intake structure, 3) lowering the plug by use of an air lift bag, a hoist mounted on the barge or both, 4) closing the outlet gates so that there is little or no flow into the outlet (the outlet can be closed for only one hour at a time so as not to impact the river fishery below the dam), 5) lowering the plug into place with the plug valve open to pass leakage flow , 6) closing the plug valve, opening the air vent valve and opening the gates to drain the outlet, 7) adjusting the plug valve to obtain the desired release of about 9 cfs, and 8) replacing the trash rack.

The outlet closing process is expected to take one day but may take two if problems arise. The gate repair crew will begin work the second day by first placing the bulkhead upstream of the gate to be repaired first. To place the bulkhead, the plug valve will be closed to totally dewater the outlet for about one hour. The same contractor will probably be responsible for both the gate repair and the installation of the turbine piping so the work on the gates and piping should be more easily coordinated.

Once the first emergency gate is repaired the outlet will be dewatered so that the bulkhead can be moved in front of the other gate which can then be repaired.

When the two emergency gates are repaired and the turbine piping has been modified (see next chapter for details) the gates will be tested by closing them and filling the outlet pipe. The outlet pipe upstream of the gates can be filled in one hour with 14 cfs through the plug valve. The outlet gates may have to be opened for a few minutes each half hour to keep some flow in the river below the dam. The gates and turbine piping can be checked for leaks under normal pressure once the outlet is filled. If problems arise, further work can be performed; if not the plug can be removed as soon as the divers can be recalled. The divers will not remain in Durango, so a few days notice would be required for them to return.

The plug will be removed by closing the outlet gates and filling the outlet pipe. The plug can be lifted by air lift bags and/or winches in the opposite manner of placement. The plug will be lifted to the surface and the trash rack replaced. This must be done expeditiously as the outlet cannot be closed for more than one hour at a time. The plug will be stored in the dam super-intendent's garage hopefully, not to be used again for many decades.

The downstream control gates will be repaired after the outlet is opened. The emergency gate above each control gate can be closed to allow the work. The work can be performed when there is snow because the gate chamber is the same temperature year round. Reclamation must approve the use of only one set of gates to release water if this arises. Generally, each set of gates is opened equally.

The gates should be completely repaired by mid-December.

7.0 HYDROELECTRIC FACILITIES

The hydroelectric facility design is described in this chapter, and includes the equipment selected for inclusion in the feasibility study. The equipment was selected to allow for cost estimate to be made and to assure that it is available. However, the actual equipment installed may be different. The design calculations are summarized in this chapter and the backup data is described in the appropriate appendix.

The hydroelectric power plant would be installed in the gate chamber of Lemon Dam and would utilize the existing bypass pipe through the chamber as a penstock. This chapter describes the existing facilities, installation and selection of the turbine, head and flow, electrical equipment, and cost estimates.

7.1 EXISTING FACILITIES

The Lemon Dam spillway and outlet works are located on the right hand side (looking downstream) of the embankment. The spillway is ungated with the outlet at elevation 8148 feet. The intake structure for the outlet works is also located on the right hand side of the dam and has an inlet elevation of 8005 feet. The top of the structure is at elevation 8018 ft. Water enters a five-foot diameter vertical pipe through the intake structure; the 5-ft pipe makes a 90 degree vertical to horizontal bend then expands to a 8.5-ft diameter pipe which conveys water 900 ft to the gate chamber/outlet control gates.

Releases through the outlet works are controlled by two pairs of outlet gates, each capable of releasing 455 cfs at maximum water surface. Below the gates is a nine-foot high horseshoe shaped, unpressurized tunnel which daylights to the river channel below the dam. The outlet gates are operated in the gate chamber which is on the center line of the dam.

The outlet gates are used primarily when releases are 50 cfs or greater, to provide water for irrigation which occurs from late April until mid-October. During the winter months water is released to satisfy senior water rights and for fishery flows the river below the dam. The primary senior water user below the dam is the city of Durango which can divert up to 8.9 cfs; therefore, the winter time water demand is about 9 cfs or less.

The winter releases are made through a small bypass pipe which begins upstream of the main gates and exits 26 feet below the gates. See Figure 6.1 for piping details. Depending upon the reservoir water level, uncontrolled releases through the bypass could be around 20 cfs, which is considerably greater than the demand. Thus, smaller diameter orifices are bolted to the exit end of the pipe to reduce the releases to about 9 cfs to 13 cfs. Generally, two orifices are interchanged to attain the desired release based upon the reservoir water elevation.

The gate chamber has a 23-foot horizontal diameter and is 16 feet high at the crown. See Figure 6.1. Access to the gate chamber is through a 7.5-foot diameter vertical access shaft 80 feet to the right of the gate chamber. The shaft is about 200 feet high with a gate house at the top and a chamber similar in size to the gate chamber at the bottom. The bottom of the shaft and the gate chamber are connected by a 50-foot long, 7-foot high tunnel. A ventilation system brings air from the gate house, down the shaft, to the gate chamber.

An elevator and staircase are installed in the shaft for access. The horizontal dimensions of the inside of the elevator are 1.9 ft by 3 ft. The elevator has a travel distance of 210 ft and a live load capacity of 1000 lbs.

The gate chamber can also be accessed through a two-foot diameter manhole between the chamber and the horseshoe tunnel, downstream of the gates. The manhole is for access to the gates from the chamber, but if necessary, equipment could be hauled through the 742-foot long tunnel.

7.2 PIPING CONFIGURATIONS

The piping in the gate chamber needs to be modified to obtain the best turbine location and the maximum turbine output. There are four major considerations when evaluating alternative piping configurations. They are: 1) velocity of water, 2) head loss through the piping, 3) location of the turbine in the chamber, and 4) cost of the piping. Three alternative piping plans (C, B, A) were evaluated and are shown in Figures 7.1, 7.2, and 7.3.

The piping configuration is not a major cost item compared to the turbine, generator, and electrical equipment, but it is extremely important because of potential friction loss through the pipe. For instance, piping Plan A has the least friction loss and allows an additional 90,000 kWh to be produced over piping Plan C. Each of the piping plans is described in detail beginning with Plan C which requires the fewest changes to the existing piping. Plan B provides a better position for the turbine and is an interim step to the best plan, Plan A. Plan A is the best configuration but requires that the outlet be dewatered to remove the concrete block around the first bend. Plans B or C would have to be used if the outlet were not dewatered.

Piping Plan C (Figure 7.1) would allow the existing piping to the first 8-inch gate valve to remain. After the gate valve, an 8-inch to 10-inch reducer would be needed to enlarge the pipe diameter because the inlet to the turbine is 10-inches in diameter. With a flow of 13 cfs, the maximum velocity would be reduced from 37 feet per second (fps) for the 8-inch pipe to 24 fps for the 10- inch pipe.

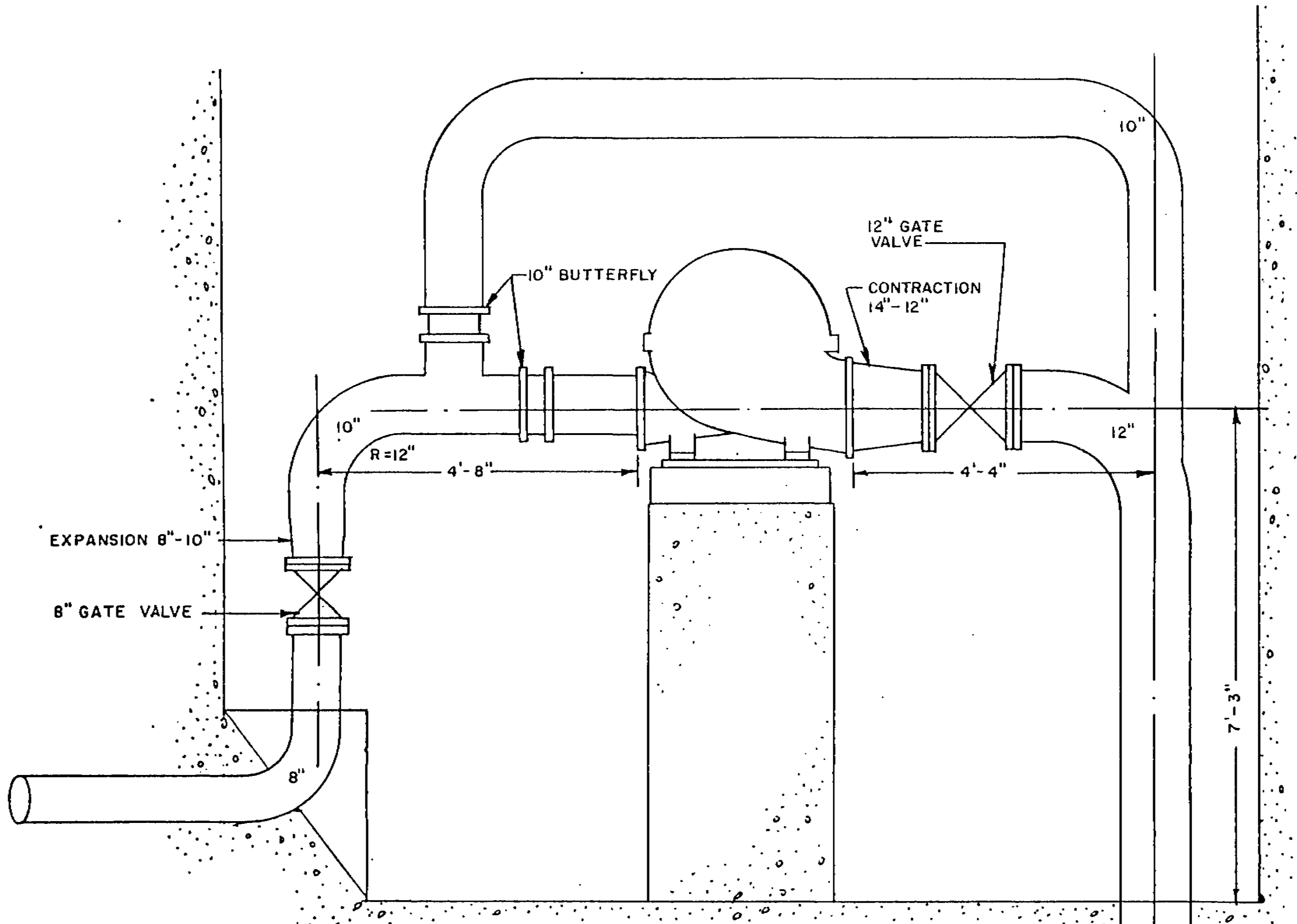


FIGURE 7.1
LEMON DAM PROJECT
HYDROELECTRIC FACILITIES
PIPING PLAN C

NO SCALE

Following the reducer would be a 90 degree vertical bend. An upward 10-inch "T" would be in the pipeline after the bend to allow a bypass around the turbine if the turbine is shut down. On each of the downstream legs of the "T" would be a butterfly valve which is automatically controlled so that the valve on the turbine leg is open when the machine is operating and the bypass leg valve is closed. If the machine stops for some reason, the turbine butterfly valve automatically closes and the butterfly valve on the bypass leg opens. The 10-inch bypass pipe loops above the turbine and "T"'s back into the pipe downstream of the turbine.

The 10-inch pipe would connect to the turbine after the butterfly valve. With this configuration the turbine and generator would be placed on concrete pedestals nearly three feet above the floor of the chamber. The turbine discharge is 14-inches in diameter which is immediately reduced by a 14-inch to 12-inch reducer to match the diameter of the outlet pipe which is 12-inches in diameter. A 12-inch gate valve is located after the reducer and before the intersection with the bypass "T" so that the turbine can be isolated from the bypass pipe. The "T" for the bypass would be incorporated in the 90 degree downward bend. From the bend the pipe would extend downward until connecting with the existing 12- inch outlet pipe. The head loss through this pipe configuration, expressed as a function of flow is $0.2116Q^2$ for the inlet and $0.0566Q^2$ for the outlet for a total loss of $0.2682Q^2$. A 15% contingency is added to the calculated loss giving $0.3084Q^2$. The result is 52 feet of head loss at 13 cfs, which is the maximum flow, and 25 feet of loss at 9 cfs, the lowest flow.

This configuration has the advantage of requiring the least change in the existing piping; however, it has two disadvantages. One disadvantage is the need for a three-foot high concrete pedestal that would be required for the turbine and generator. The other disadvantage is that 10 ft is the maximum elevation the

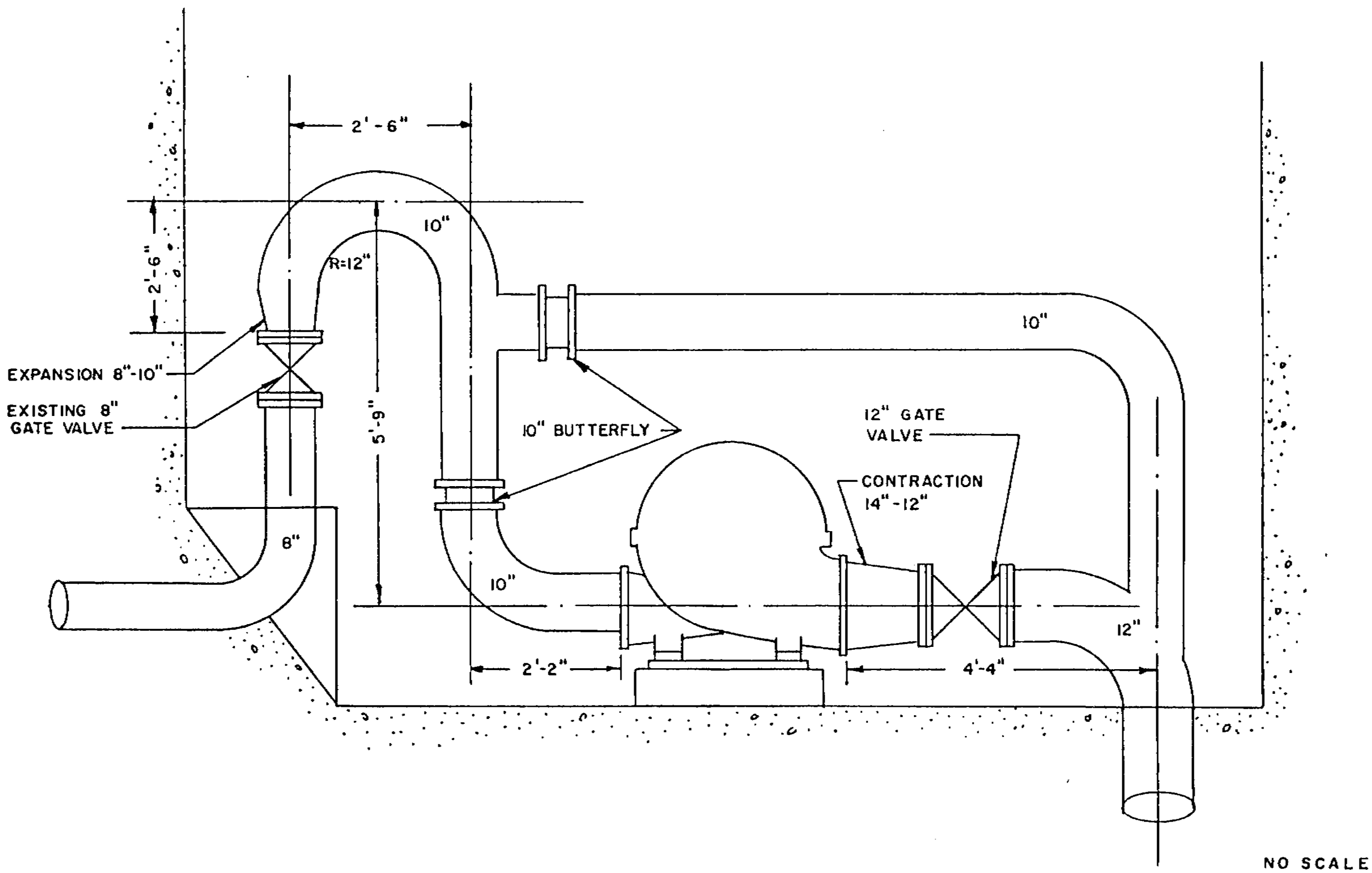


FIGURE 7.2
LEMON DAM PROJECT
HYDROELECTRIC FACILITIES
PIPING PLAN B

turbine can be above the penstock outlet to avoid cavitation. Because the elevation in this configuration is 10 feet, cavitation may occur and result in shorter impeller life.

Piping Plan B (Figure 7.2) is a modification of the first alternative, except that the turbine is placed on the floor to eliminate the pedestal and cavitation problems. The inlet piping to the turbine is more complicated. The piping has a 180 degree bend and another 90 degree bend to the turbine. The valving is the same as for Plan A. The bypass and outlet piping are simplified.

The major problem with this configuration is the friction head loss through the piping which is $0.2435Q^2$ in the inlet and $0.0508Q^2$ in the outlet, for a total of $0.3384Q^2$ including the 15% contingency. This would result in 57 feet of head loss at 13 cfs and 27 feet at 9 cfs.

Piping Plan A (Figure 7.3) is the simplest piping plan and has the least friction head loss; $0.1352Q^2$ in the inlet and $.0508Q^2$ in the outlet for a total of $0.2139Q^2$ including 15% contingency. The head loss at 13 cfs is 36 feet and at 9 cfs is 17 feet, which is significantly less than the other configurations.

The major problem with this plan is that the concrete block encasing the first 90 degree upward bend must be removed so that the bend can be removed and the pipe extended. The concrete is an approximate two-foot cube which will probably have to be jack-hammered out. Care will be required so that neither the chamber nor the pipe in the concrete is damaged. The bend will be cut off and an 8-inch to 10-inch reducer welded to the existing pipe.

A new 10-inch gate valve will be installed after the cone, followed by an upward "T" for the bypass pipe. Butterfly valves

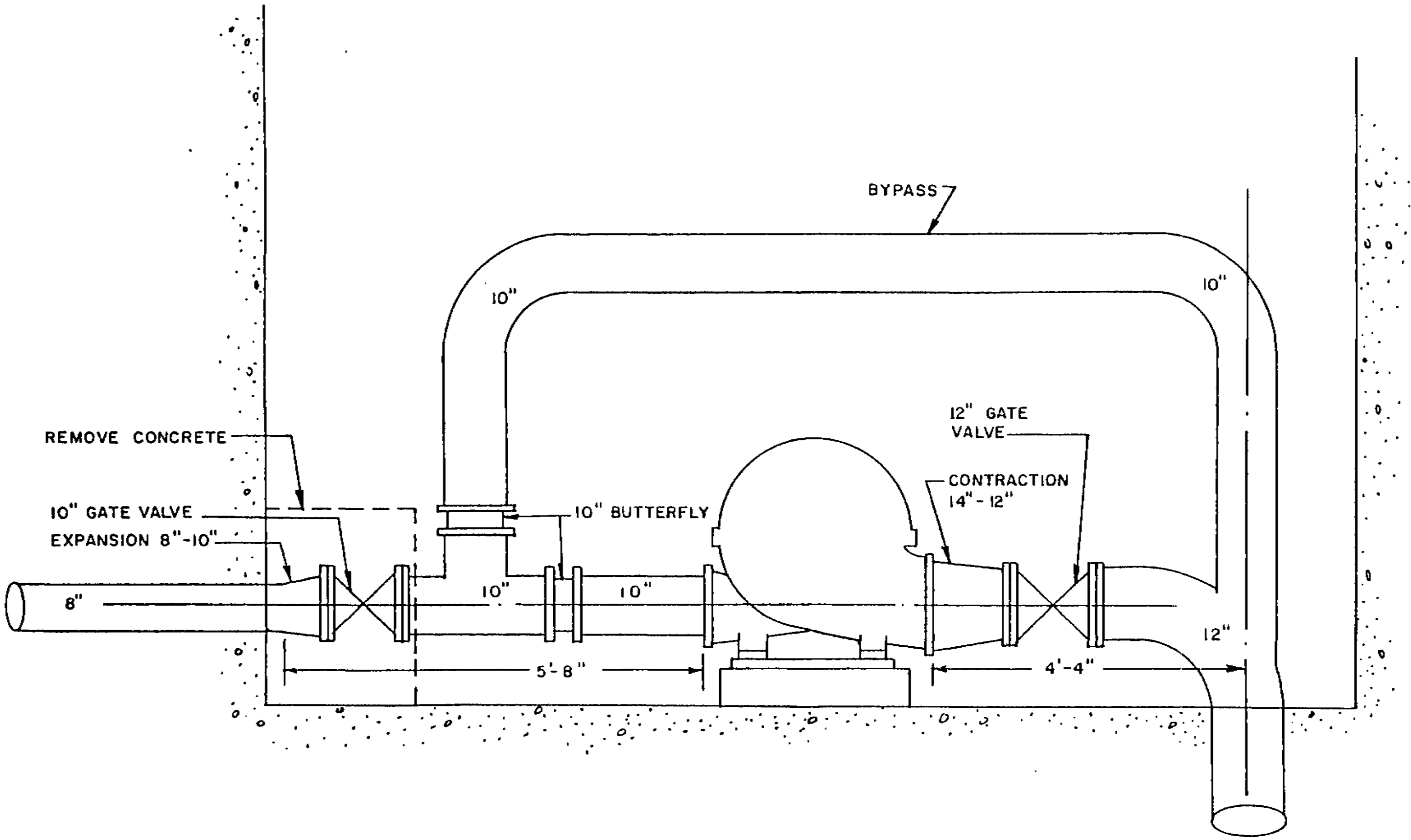


FIGURE 7.3

LEMON DAM PROJECT

HYDROELECTRIC FACILITIES

PIPING PLAN A

NO SCALE

will be on each downstream leg of the "T". The butterfly valves will be automatically operated. The bypass pipe will loop over the top of the turbine and will be used if the turbine is shut down. The automatic valves will direct water through the bypass. The bypass is included because releases must be made to downstream water users if the unit is inoperable.

This configuration will provide the best turbine output because the head loss is the least. Also the pipe system is the shortest and has the fewest bends which will reduce the turbulence as much as possible. The cost of removing the concrete from the bend will be less than constructing the pedestal in Plan C but more than the extra piping in Plan B. The most significant advantage is that about 90,000 additional kWh per year will be generated with this plan over the other configurations.

Piping Plan A is the best piping plan when considering the long term performance, and if it can be developed in conjunction with the outlet dewatering for the gate repair, would be the recommended action. If for some reason the gate repair is delayed, Plan B would be recommended. Then when the outlet is dewatered at a later time, Piping Plan A can then be incorporated without moving the turbine.

7.3 TURBINE SELECTION

The turbine for Lemon Dam must meet four specific criteria: 1) the turbine and generator must physically fit in the space available in the gate chamber, 2) the turbine and generator must fit in the elevator or through the manhole in order to be moved to the gate chamber, 3) performance curves on the turbine operation must be available to evaluate the unit output and determine if the unit would maintain releases between 9 and 13 cfs, and 4) the revolutions per minute (rpm) of the unit must be about 1200 or less to avoid cavitation at the elevation setting. (See Appendix C.)

Manufacturers of turbines and pumps-as-a-turbine were contacted to determine if they had units in the 100kW-150kW range. For small units the use of a pump-as-a-turbine is advantageous because of cost and availability. A pump-as-a-turbine is simply a pump reversed so that water moves the impeller which turns a generator to produce power.

An exhaustive search for manufacturers was not made, but nearly all of the known potential suppliers in the area were contacted. The manufacturers with small units were: Allis-Chalmers, pump-as-a-turbine; Byron Jackson, turbine; Byron Jackson, pump-as-a-turbine; Oriental Engineering and Supply, turbine; and Worthington Pump Co., pump-as-a-turbine.

The only unit which met all four criteria was the Worthington pump-as-a-turbine but the pump will have to be dismantled to fit into the elevator. The Byron Jackson turbine and the pump met all of the other criteria except they were too large to be moved to the gate chamber; both are vertical units and the barrels are larger than the elevator. The other two suppliers could not meet two of the criteria. Given the constraints of the site, it was fortunate that one manufacturer had a unit that could operate at the site.

The Byron Jackson turbine had adjustable wicket gates which made it the most efficient turbine available. However, comparison of the kWh output of the Byron Jackson turbine and the Worthington pump-as-a-turbine showed that the pump produced within 10% of what the turbine produced and the pump was about one-third the cost of the turbine. The pump would have probably been selected over the turbine based on cost and output if both had worked at the site. The Byron Jackson pump-as-a-turbine produced a little less than the Worthington pump but would have been a viable unit had it fit in the elevator.

The earliest construction date for the power plant is 1987 and by that time other units may be available and/or identified that may operate within the site limitations.

The Worthington unit that was selected is the Model 10LNT14A horizontal pump that operates at 1210 rpm. The performance curve for the unit is shown in Appendix D and explained in the following section "Head and Flow". The top of the scroll case, the bottom of the case, and the impeller would be moved to the gate chamber separately and reassembled. The unit, installed in the chamber, is shown in Figure 7.4.

The selected turbine will not change the water releases from Lemon Dam. The operation of the dam will be unchanged.

7.4 POWER PRODUCTION

The kW and kWh output of the unit is dependent upon the head and flow available at the turbine. The flow is dependent upon the water level in the reservoir, the performance curve of the unit, and the friction loss through the penstock. The friction loss reduces the head available at the power plant by nearly 20% so it is a major factor in the unit output.

A daily simulation model was made of the turbine operation from 1971 to 1982, a period of 12 years that included very wet and dry years. The model calculates the flow through the turbine based upon the daily reservoir water level, the turbine performance curve, and the friction loss. The gross head available at the turbine was calculated by subtracting the tailwater elevation, 7950 feet, from the reservoir water level.

The net head is equal to the gross head minus friction loss and is calculated by the following iterative process:

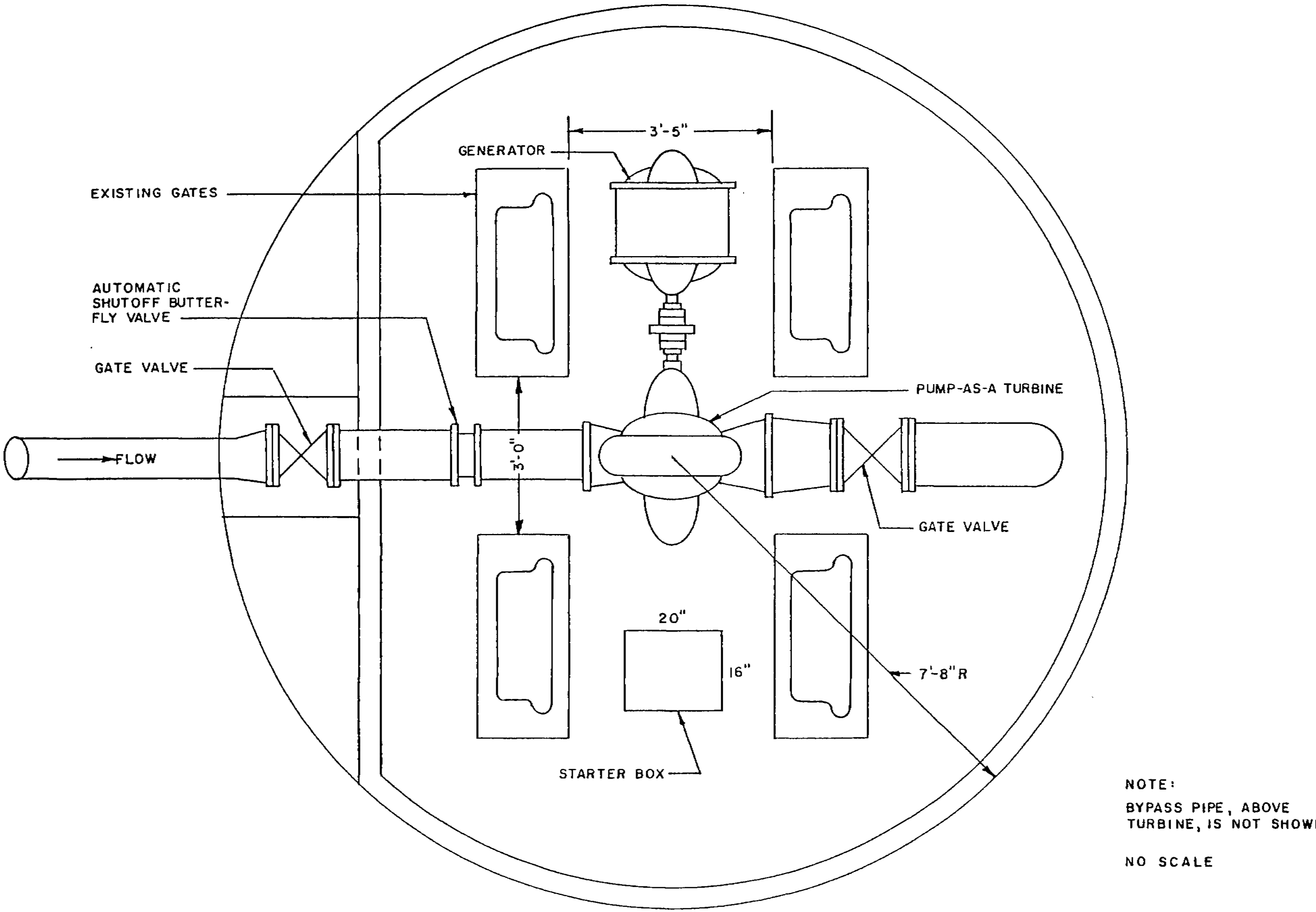


FIGURE 7.4
LEMON DAM PROJECT
HYDROELECTRIC FACILITIES
GATE CHAMBER PLAN VIEW

1) a flow is assumed and the friction loss is calculated using 0.2139 Q^2;

2) the friction loss is subtracted from the gross head to obtain the net head; and

3) the turbine performance curve is checked to see if the net head and the assumed flow match; if they don't then another flow is assumed and the net head is recalculated. This is continued until the net head and flow match. (This is why the performance curve was essential.)

Table 7.1 shows the results of the iterations for various gross head-values, for the Worthington Pump.

TABLE 7.1
Net Head

Gross Head (ft.)	Net Head (ft.)	Flow (cfs)
196	157	13.4
180	144	12.8
170	137	12.4
160	129	12.0
150	122	11.5
140	114	11.0
130	106	10.5
120	99	10.0
110	91	9.4
100	83	8.8

The flow and net head values are for the Worthington Pump model 10LNT14A, 1210 rpm. The one problem with the selected model is that it cannot utilize net head over 140 feet which is 175 feet gross head. The maximum head and flow for the model is 140 feet and 12.6 cfs, respectively; so the unit efficiency will drop or the flow will have to be throttled to reduce the head and flow when the gross head is greater than 175 feet. Alternate models, such as the 10LNT22A, would be able to utilize the full head range but when the net head is below 130 feet the flow through the turbine is 9 cfs which then decreases to 6 cfs at 90 feet. The flow below the dam should be about 9 cfs at 90 feet of head, therefore, the 6 cfs for the model 10LNT22A is unacceptable. The flow for the selected model 10LNT14A is about 8.7 cfs at the low heads which is acceptable.

The computer model calculates the net head, flow, and efficiency from the gross head based upon the data in the Net Head Table and the performance curves. These values are used to calculate the kWh production for each day of the model period. Table 7.2 shows the kWh. production and peak kW output for each year of the model period. The unit with Piping Plan A produces a yearly average of 750,000 kWh with a peak year of 910,000 kWh and a minimum year of 579,000 kWh.

TABLE 7.2
Power Plant Output

Year	Kilowatt-Hours	Maximum Kilowatt Output
1971	847,000	105
1972	752,000	103
1973	820,000	105
1974	624,000	95
1975	712,000	105
1976	823,000	105
1977	579,000	90
1978	583,000	105
1979	735,000	105
1980	832,000	105
1981	873,000	105
1982	910,000	105
Average	757,000	N/A

7.5 ELECTRIC REQUIREMENTS

Electric utilities have requirements for safe and effective parallel operation of small hydroelectric generators. This is to ensure that there will not be adverse effects on the general public, or to utility equipment and personnel. In addition, there are requirements to ensure reliable operation and protection against malfunction of the District's equipment. Both of these requirements must be met with reasonableness coupled with judgment.

This installation is relatively small and thus large expenditures for exotic equipment are not justified. Furthermore, the unit will be unattended, except for starting, stopping and maintenance, so simplicity of operation is desirable. A facility using an induction generator best fits the requirements and capabilities of this particular installation.

Furthermore, this particular installation has an economic incentive beyond selling the power. The facility can use some generated power both for station use and to supply the dam attendant's residence with electricity for domestic purposes, primarily heating.

The specific requirements of CUEA include:

1. facility isolation,
2. a circuit breaker,
3. surge arrestors,
4. a dedicated transformer, and
5. protective relaying to provide short circuit protection and isolation protection.

Additional devices for protection of the owner's facility and equipment are required. A description of how these requirements are to be met can be found in subsequent sections.

The size ratings of the turbine generator were selected on (1) the available head and water flows and, (2) compatibility with a readily available, essentially standard induction motor and pump as turbine.

7.5.1 Electrical Equipment

An induction generator is basically a standard induction motor. However, by virtue of the turbine driving the motor shaft slightly over its synchronous speed, electric power is generated back into the utility power grid. Because the electro magnetic excitation comes from the power grid, an induction generator can only produce when paralleled or connected to the grid.

The selection of an induction generator means that the ancillary equipment can be simplified both in operation, cost and maintenance.

An induction generator will be supplied in a 445 TS frame size. It will be rated for 110 kW, 1210 rpm and for use on a 480 volt system.

The sizing is based on turbine efficiency, motor efficiency, water head, and flow data. It is expected that the design ratings would be encountered about 20% of the running time. The balance of the running time is less than design rating except for extra-ordinary water conditions when throttling of the flow may be required by the inlet valve.

This is a 480 volt, 150 horsepower, 115% service factor motor. Special attention will be required by the vendor for design and balancing of the generator to run at double-rated speed and for 8100 ft elevation. The expected ambient air temperature will be less than 30°C. In addition a mechanical modification will be required to couple and mount a centrifugal speed switch device on the outboard shaft.

Surge voltage protection consisting of a MOV arrestor and capacitor will be mounted at the terminals of the induction generator.

The application of an induction generator permits the selection and use of a standard combination, full voltage, magnetic motor starter. This type of controller already contains many of the protective functions required by the utility as well as the facility.

The modified, full voltage, non-reversing, magnetic motor starter will be the stop-start power switching device using a size 5 magnetic contactor. This apparatus is in an enclosure tentatively to be located near the turbine in the gate chamber (see Figure 7.5). Short circuit protection for the induction generator is provided by an included instantaneous trip-molded case circuit breaker. This breaker will also provide sensitive ground fault protection for the generator by virtue of a zero sequence sensor and a shunt trip device. Replica-type thermal overload devices are to open the contactor in the event of overload on the generator.

The size 5 starter will also include control power transformers and necessary current transformers (CTS). Watt and var transducers will be included to transmit this data to the operator's panel with low burden on the CTS. A 250-Watt strip heater is to be included in the enclosure and energized only when the turbine/generator is not in operation. This is for the high humidity condition. This arrangement also provides the ability to switch power factor capacitors with the generator. The magnetic contactor and auxilliary relay also provides inherent undervoltage protection.

Suitable power factor correction capacitors will be switched with the induction generator to maintain 95% or less at no load. Sizing will be selected on the manufacturer's data for the generator. Mounting will be near or on the starter.

A separate custom-built wall-mounted panel will be included. It will incorporate operator control devices, indicating meters as well as the required protective devices. The protective devices, when activated, will cause the starter contactor to open and disconnect the generator and shut off the water to the turbine. Device 81 combines both over and under frequency functions and it provides a relay contact transition when the sensed frequency is under or over the adjustable set points.

A system condition that causes loss of electrical load would result in acceleration of the turbine. An example would be opening of the contactor on thermal overload or short circuit trip by the starter breaker. This disconnects the generator and shuts off the water. Another system condition might be the opening of the electrical distribution line at some remote point. With zero or low connected external load out on the system the turbine would start to overspeed. Typically under this condition the voltage would also collapse since the excitation for an induction generator comes from the line. Thus an undervoltage condition could also shut down the generator and water.

There is one unlikely system condition that could exist with remote opening of the line and low load. If the distributed capacitance of the line and capacitors on the generator are sufficient to cause self excitation, then the generated voltage does not collapse.

If the line load is low, then over frequency will occur and the generator/turbine shuts down. A back-up over-voltage relay (device 59) is also provided for this situation as well as the centrifugal speed switch. Conversely, if the separated line load is high enough to slow the turbine down then the under-frequency relay will shut down the turbine/generator.

The under voltage device also includes the function of detection of phase unbalance. A system condition such as a fuse blowing would result in unbalanced voltage which could cause high rotor heating. The turbine/generator would be shut down. This is device 47N/27.

Reverse power protection is to prevent motoring of the turbine/generator in the event of stoppage of water to the turbine. This is device 32.

The turbine valve and 10-inch bypass valves are to be hydraulically operated by the water pressure. The actuators will be controlled by electric solenoid pilot valves. When voltage is applied to the turbine solenoid pilot valve, the water pressure is directed to the actuator to open the turbine valve. Conversely, when voltage is removed from the solenoid pilot valve it has a spring return action. This then redirects the water pressure to the actuator to close the turbine valve.

The 10-inch bypass valve is to work concurrently in the opposite mode as described above. Loss of electric voltage to the pilot solenoid valve causes the bypass valve to open.

An alternate valve actuator is being considered. The alternate actuator would have spring return when the pilot solenoid valve releases the water pressure from the hydraulic actuator.

The timing of the turbine valve closing and bypass valve opening is to be adjustable to minimize water hammer, and at the same time minimize turbine generator overspeed. Water hammer should not be a problem if the valve closing time is three seconds or greater. See Appendix C for the calculations.

The operators control/protection panel will include instruments in addition to the previously described protective devices.

These will consist of a voltmeter, ampmeter, kW meter, KVAR meter and an elapsed time meter.

The voltmeter will indicate the value and presence of utility voltage before actuating the turbine generator. The ampmeter indicates a measure of the thermal loading on the generator while the kW meter will indicate the power out of the generator. The KVAR indicates the excitation flow and can be used to determine the power factor.

The elapsed time meter indicates the running time and is useful in establishing maintenance procedures.

Electrically upstream of the combination starter will be a main circuit breaker for the service entrance. This is tentatively located in the shaft house at the point where the service conductors enter. This device will be a molded case circuit breaker providing long time, short time phase-over current and short circuit protection. Furthermore, it will also provide sensitive time delayed ground fault protection as back-up to the ground fault sensing in the starter.

The existing power supply to the shaft house load is three-phase 240 volt and 120 volts single-phase supplied from a 15 KVA pole-mounted transformer bank. This source is to be abandoned. An indoor dry type transformer and primary fused switch are to be added to supply the existing load at 240/120 volts. This change is necessary since the optimum voltage for the generator and the rest of the associated apparatus is 480 volts. This equipment is also to be used in the shaft house.

The 12,470 volt distribution power line will be connected to a pad mount outdoor transformer to step down the voltage to 480 V. Three fused cutouts on the pole will serve as complete disconnection provisions for LPEA. Primary metering will be at the 12,470 volt level as well as the fused cut-out feeding a single phase 7,200 volt line to the dam keeper's home. Lightning arrestors will be located at the riser pole and also at a 25 KVA transformer for the dam keeper's home. The new line to the home is required because LPEA cannot wheel District power over its lines and then back to the District without charging the normal LPEA rate.

Metering for the power-in and power-out will be by the utility at the primary 12,470 volt level. Demand metering for plant load factor, if required, will be by the utility.

7.5.2 Operation Criteria

All generator protective functions, if actuated, result in shut down of the turbine generator system. Manual restart by the operator is required after determining the cause. Certain failures will require the operator to correct the cause and reset protective devices. A signal wire will be included on the distribution line to the dam superintendent's home to notify him if the unit is down.

Short circuit, ground fault, overload and centrifugal overspeed will require manual reset. The other protective functions will automatically reset upon re-energizing of the utility line if they were the cause of the shutdown. Note that time delay reclosing of the utility will not start up the turbine generator although the appropriate protective devices automatically reset. Detailed diagnostics will be included with the system when completed.

Normal starting will be manual. The operator will press a momentary contact start button. If all of the protective devices are enabled then a "run" relay will close and seal itself in. Contact of this relay will energize pilot solenoid valves that hydraulically allow the 10-inch turbine inlet valve to open and a

10-inch bypass valve to close. The converse will occur by pressing a stop button.

The turbine will accelerate and when it reaches approximately 100% speed, the induction generator will be connected to the power system. The operator will be advised of the connection by observing an indicating ampmeter, wattmeter and varmeter. The proper speed will be sensed by a centrifugal speed switch coupled to the shaft of the generator on the outboard end. This centrifugal speed device will also incorporate an adjustable overspeed (manual reset) set of contact for a backup protective function previously described.

7.5.3 Power Plant Installation Procedure

During the year in which construction occurs the installation of the power plant equipment would begin the first of August. The electrical wiring to connect the generator to the LPEA distribution system will be installed, including the breakers, meters, line to the District home, transformer, control panels, conduits, etc. This equipment is scheduled to be installed before October 1 in order to avoid interfering with the gate repair crew.

Also during this time, the piping on the outlet side of the turbine will be modified and as much of the new bypass pipe installed as possible. The concrete block must be removed and the piping changes made prior to completing the bypass pipe. Performing this work early will allow the bypass pipe to be connected and tested while the outlet is closed.

The outlet will be closed on about October 1 at which time work on the concrete block, etc. can begin in coordination with the gate repairs. About 40 hours will be required to remove the concrete, install the new gate valve and butterfly valves, and connect the bypass pipe.

The bypass pipe will be in place so that releases can be made prior to opening the outlet to test the piping and the repaired gates. After the outlet is opened the bypass pipe will be used to make releases while the turbine and generator are installed.

The two control gates will be repaired before installing the turbine to allow adequate work space; this will require about two weeks. Once the gate repairs are completed the turbine, generator and starter box would be installed, the piping connections will be completed and the generator connected to the power system.

There will be a few days of equipment testing and adjustments following complete installation and prior to full operation. Adjustments would have to be made intermittently during the first year's operation. The power plant should be ready for operation about the first of December.

8.0 ENVIRONMENTAL IMPACTS

Considerable care has been taken to ensure that the work associated with the repair of the outlet gates and the installation of a turbine, generator, and electrical equipment be performed in a manner that will result in the least environmental impact. Construction has been scheduled to occur between August and November (a four month period) with a possible carryover into December, should it become necessary. Table 8.1 defines the specific actions that will be taken, the months in which they will occur, the potential consequences of the actions, and the duration of the consequences.

8.1 NON-AFFECTED RESOURCES

Based on the information provided in Table 8.1, we can assume that few, if any, impacts will occur in the following categories.

- o geology
- o vegetative cover
- o wildlife resources
- o water quality
- o minerals
- o grazing
- o timber
- o recreational use
- o socio-economic aspects
- o historical and archeological resources
- o visual resources
- o endangered and threatened species

From an overall perspective, the project is short (4-5 months) with most of the inconvenience being very temporary and short-term.

The use of trucks on an intermittent basis over a period of 1-2 weeks should not result in any undue stress or hardship to the environment or to the recreational use in the Lemon Reservoir and Dam area. Personal communication with the USFS has indicated that once Labor Day approaches, usage of the area drops to approximately 200 visitor days per month and is confined primarily to the campground site. The reservoir level is usually drawn down due to irrigation releases. Water sports activities in the reservoir have been curtailed considerably by Labor Day and in October, fishing is at a minimum.

Currently there is no data to support the contention that there would be a change in the temperature of the water as it passes through the turbine, nor would there be any other water quality changes expected.

With respect to the fall hunting season, the hunting and the discharge of firearms are restricted in the primary jurisdiction area which is where most of the improvement activities will occur. Hunters utilizing other campgrounds in the area would not be affected by the project.

The placement of additional power poles and lines below the spillway would be in conformance with the above ground conditions that currently exist. The cost for the work associated with constructing above-ground power lines is approximately $8,000.00 while costs for burying the lines would be 2 to 3 times higher ($20,000-$24,000). Raptor protection measures will be incorporated. Utilization of some of the existing poles has been encouraged, and for the placement of new poles, the selection of sites will be made with visual and aesthetic considerations being a top priority. Suggestions to place the poles behind clusters of trees have been well received by LPEA.

8.2 DESCRIPTION OF AFFECTED ENVIRONMENTS/IMPACTS

8.2.1 Direct

The most important area which could be affected by the Lemon Dam Project is the fishery in the reservoir and in the river downstream from the dam. There are short term construction considerations that must be addressed with relation to the fishery as well as the potential for long term impacts due to the releases resulting from the operation of the hydropower unit.

8.2.1.1 Construction

Details related to closing the intake and the method to be employed to achieve this are described in Chapter 6.0. Quick and easy access to the intake and the expeditious plugging of the intake are the two most critical factors affecting the gate repair portion of the project. The use of divers has been determined to be the most cost effective and environmentally sound method.

Depending on the water surface elevation when the project is actually constructed, the water level may have to be lowered to 8090 feet to facilitate the dives and allow for efficient plugging of the intake. There is a reasonably good chance, however, that the reservoir elevation would be at 8100 feet (plus or minus 10 feet) which would eliminate the need to lower the reservoir more than a few feet. This is based on the historic data on October elevations from 1971-1982 which range from 8053 feet (low) to 8130 feet (high) (See Table 5.2).

The level of 8090 feet is within an acceptable range for the fishery and (1) is higher than the lowest level recorded (8053 feet), (2) is 9 feet lower than the fourteen year average elevation for October which is 8099 feet and (3) is considerably higher than the 1974 and 1977 record dry years when the reservoir remained at 8053 all winter.

Personal communication with Mike Japhet and Rick Sherman of the CDOW has resulted in their support for this water level and confirmation that, based on existing data, this elevation should have no significant impact on the fishery.

However, it was agreed that should any additional information become available which requires that the surface water be maintained at levels higher than 8090, the project will be modified.

Another factor related to diver safety and having a potential impact on the fishery, is the need for the gates to be completely shut for 60 to 80 minutes during each dive to avoid any flow through the outlet that would endanger the divers. This, of course, would result in intermittent releases to the downstream fishery during the diving period. Since the diving is to occur in the late fall which is the critical spawning period for the brown trout, the CDOW has indicated that a constant flow must be maintained in the river so that the gradient is not lost and the eggs are not left high and dry on the wetted perimeter. The CDOW has indicated that shut downs of up to one (1) hour would not result in any significant impacts to the brown trout population, but that shut downs for periods any greater than one hour would probably begin to impact the fishery. The diving schedule will be adjusted to respond to these needs.

With regard to other downstream concerns, the DPR (page 35) requires that a minimum release of 4 cfs from the reservoir be maintained at all times during the non-irrigation season for the downstream fishery habitat. The city of Durango has water rights for 8.9 cfs but requires an average of 6.1 cfs in October and 5.4 cfs in November. This demand is usually met by the releases from the reservoir coupled with the intervening flows below the dam. To maintain continuous flows of 9 cfs during construction, the fabricated plug will incorporate an 8 inch butterfly valve through which the required flows for downstream needs will pass.

During project construction, there is some potential for fish to pass through the 8 inch butterfly valve in the plug. However, as was indicated by the CDOW in recent communication, it is difficult to determine just how many fish are actually getting through the existing 8-inch pipe and it would be even more difficult to make that determination for the 8 inch butterfly valve. Thus, it is assumed that the impacts associated with this short-term action would be minimal.

With respect to the adjustment of flows during the irrigation and non-irrigation season, it is important to note that the first two weeks of October are usually transitional and the amount of irrigation water needed is dependent upon the ambient temperature and rainfall. Usually, the main gates, which are open during the irrigation season, are closed, and the 8 inch bypass pipe is used to maintain the downstream flows. The fish naturally adjust to these changing conditions.

From the irrigation standpoint, irrigators would be given advance notice that they would not be able to irrigate during the construction period in the year the improvements would be made. However, the repairs should be completed in time to provide the 30-50 cfs stock water releases in late November or December.

8.2.1.2 Hydropower Operation

The criteria used in the selection of the turbine for this project was based on the need to maintain downstream flows of between 9-13 cfs during the non-irrigation season because 9-13 cfs have been the historic releases from October to April for the last ten years (Appendix E). By releasing constant flows, with minimal fluctuations, the stability of both the spawning environment and the adult fishery habitat will be ensured.

The actual releases with the turbine will not be the same on a daily basis as those releases using the orifice (the previous mechanism). For example, on a particular day the orifice release of 13 cfs would be comparable with a turbine release of 11 cfs; or another orifice might release 9.2 cfs while the turbine would release 12.1 cfs. Factors affecting these differences are the reservoir elevation, the performance characteristics of the turbine and the size of the orifice being used (two orifices are used). Although the turbine releases will be slightly different from those of the orifice, they will ensure streamflow continuity, which is an important factor affecting the downstream fishery.

The downstream releases during hydropower generation will, as in the past, be based on the needs of the irrigators and will not, in any way, be affected by the hydropower production. There will be no impacts on downstream water requirements as a result of the installation and operation of the hydropower unit.

The potential concern with respect to the impingement of fish in the turbine has been discussed with the CDOW. It was determined that it is very difficult to screen an 8-inch opening and that if attempted, it might reduce the power output. Since the diameter of the 8 inch opening and the flow of water would not be great enough to allow for a significant amount of fish to find their way into the pipe, it was decided that a fish screen is not required. However, if under actual operating conditions, significant numbers of fish were found to be harmed, a redesign would be required and a mitigation technique would need to be developed by the District.

With respect to water temperature changes and potential fishery impacts downstream, it must be emphasized that no documentation currently exists to indicate that there are changes in water temperature once the water passes through the turbine.

8.2.2 Indirect

The only potential indirect concern associated with this project relates to the water levels in the reservoir during the year following project construction. Historic data has demonstrated that water levels in the 8090 foot range are not unusual for October and that the levels for October are the levels that generally remain in the reservoir throughout the winter. What determines whether the reservoir fills or not for the next year's irrigation program is the spring runoff. Historic data (Table 5.2) illustrates that reservoir levels of 8090 are very close to the average for the 14-year period. Based on the data presented in Table 5.1, which indicates that the reservoir easily recovered its capacity during both a "below average" and "average" year following a dry year, it is unlikely that there would be any significant impacts associated with the reservoir water level of 8090 feet during project construction.

Throughout the design of the project, extensive communication with those agencies responsible for protecting the various affected environments has taken place. Considerable caution has been exercised with regard to the planning and design of construction activities that might have potential impacts on the environment. The specific mitigative measures which will be employed include:

(1) Divers would be utilized to close the outlet to avoid excessive lowering of the reservoir elevation which could harm the fishery. (The fishery could be destroyed.)

(2) A new plug would be utilized by the divers which can be handled easily and expeditiously.

(3) Raptor mitigation techniques will be employed.

(4) Downstream flows of up to 12 cfs could be maintained during construction to ensure the stability of the fishery.

If needed, other measures will be identified and implemented.

TABLE 8.1
Consequences Related to Project Components

Action	Month During Which It Occurs	Potential Consequences	Duration of Of Consequences
1. Transport and setup of electrical wiring, transformer, power poles, distribution lines below the spillway.	Aug.-Sept.	An auger truck and electrical set-up truck would be required at the site. Construction in and around the spillway will involve La Plata Electric and electrical contractor personnel.	30 days for trucks 30 days for actual construction
2. Installation of electrical panels inside the gatehouse and placement of electrical conduits in the elevator shaft.	Aug.-Sept.	One or two pick-up trucks would be involved in the transport. The inside electrical work would be similar to wiring a house or a business.	60 days (trucks) 60 days for electrical installation (inside gatehours)
3. Installation of transformer and pouring of concrete slab for base for transformer.	Aug.-Sept.	One cement truck would be on site approximately 1-2 hours. A crew would finish the concrete work the same day.	1 day (trucks) 1 day (crew)
4. Transport of transformer	Aug.-Sept.	A 14-foot flatbed truck would be needed for transport.	1/2 day

TABLE 8.1 - continued

Action	Month During Which It Occurs	Potential Consequences	Duration of Of Consequences
5. Transport, emplacement and installment of equipment, turbine and generator (in gate chamber)	Oct.-Nov.	Welding equipment trucks would be used. All construction activity would occur 200 feet below the surface in the gate chamber (no potential consequences).	30 days (trucks) N/A
6. Transport and unloading of pontoons (18 feet long), 6 ft. diameter steel plug, decompression chamber	Aug.-Oct.	A large flatbed truck would transport the pontoons. A few pick-up trucks will be used for the transport of the other equipment.	1-3 days
7. Divers (a) reconnaisance (b) removal of trash rack/plugging of intake	Aug.-Oct.	Gates must be completely shut for 1 hour for the safety of the divers. During this period there would be no releases downstream except for what is leaking. Water levels may have to be lowered to 8090 feet to facilitate diving to plug intake.	1-2 days (Intermittent releases would result in varying downstream flows while diving occurs.) 6 months of lowered water elevations during the winter as well as construction
8. Open gates to dewater outlet; open valve on fabricated plug to begin downstream releases during gate repair	Oct.	The fabricated plug would have an 8-inch control valve so that releases could be continuously made downstream without impairing the fishery.	1 day (Intermittent flows would result while valves were being adjusted for delivery of the 9 cfs.)

TABLE 8.1 - continued

Action	Month During Which It Occurs	Potential Consequences	Duration Of Consequences
9. Repair gates	Oct.	Work would be done in gate chamber 200 feet below surface. No consequences.	N/A
10. Dive to remove plug	Oct. (late)	Gates must be shut off completely for 1 hour for the safety of the divers. During the dives there would be no releases downstream.	1-2 days (intermittent flows downstream)
11. Operation of hydropower unit	Continuous	Flows through the turbine will be nearly the same as historic releases. Present thinking is that a minimal amount of fish will be killed in the turbine and corrective action is unnecessary.	Continuous

9.0 AGENCY COORDINATION

The Florida Water Conservancy District initiated discussions to explore the feasibility of utilizing a 125 kW hydroelectric unit at the Lemon Dam in October 1983, and a preliminary permit was issued by FERC on March 15, 1984 for a period of 24 months. Since that time, much work has been accomplished including the preparation of technical documentation and the coordination with state, local and Federal entities. Throughout the process, Reclamation, which was responsible for the construction of the Florida Project, has made staff available to respond to technical concerns arising throughout the development of the feasibility study.

The CDOW, the USFS and the Colorado Department of Health have provided invaluable input into this process, particularly with respect to the environmental sections of the report. These agencies have willingly provided technical assistance and have reviewed draft portions and offered corrections and suggestions to ensure that their interests are protected and that the project proceeds in an environmentally sound manner. Table 9.1 summarizes the coordination efforts achieved by meetings, phone conversations and technical assistance sessions, and identifies the specific date, agency and participating staff person.

Prior to these interactions, considerable correspondence transpired between the consultant and appropriate state and Federal agencies. Table 9.2 summarizes these letters and presents the consultants response to the comments.

Continued coordination throughout the remaining phases of this project will be a primary concern of the consultant and the District. Participating agencies and entities that received copies of the draft feasibility report for official review and comment are listed below.

- Colorado Water Resources and Power Development Authority
- Florida Water Conservancy District
- Colorado Division of Wildlife
- Bureau of Reclamation
- U. S. Forest Service
- La Plata Electric Association
- Colorado Ute Electric Association

TABLE 9-1
Coordination

MEETINGS

Date	Agency	Personnel
February 19, 1985	Florida Water Conservancy District	Board Members
March 5, 1985	La Plata Electric Association	Larry Curtis
March 6, 1985	Colorado Ute (Montrose)	Bill Riley
March 13, 1985	Durango Public Works	Jack Rogers
April 16, 1985	Florida Water Conservancy District	Board Members
June 18, 1985	Florida Water Conservancy District	Board Members
July 23, 1985	La Plata Electric Association	Larry Curtis
July 29, 1985	Colorado Division of Wildlife	Mike Japhet
August 16, 1985	Colorado Division of Wildlife	Mike Japhet and Rick Sherman
October 7, 1985	Durango Water Commission	Commission Members
October 15, 1985	Florida Water Conservancy District	Board Members
November 12, 1985	Florida Water Conservancy District	Board Members

TABLE 9.1 (continued)

PHONE CONVERSATIONS

Date	Agency	Personnel
February 19, 1985	Colorado Ute	Bill Riley
February 19, 1985	FERC	Paul McKee
March 19, 1985	Colorado Division of Wildlife	Ann Hodgson
April 15, 1985	Colorado Historical Society	Leslie E. Wildesen
May 28, 1985	FERC	Paul McKee
August 8, 1985	U.S. Forest Service	Dick Bell
August 8, 1985	Bureau of Reclamation	Rich Gjere
August 22, 1985	San Juan Basin Health Unit/Colorado DOH (SJBHU/CO DOH)	Fred Hinman
August 22, 1985	CO DOH	Dennis Anderson
August 22	USEPA (Denver)	Dick Satiris/ Jim Zicki
September 9, 1985	Colorado Division of Wildlife	Mike Japhet
September 12, 1985	Bureau of Reclamation	Rich Gjere
September 12, 1985	U.S. Forest Service	Dick Bell
September 17, 1985	U.S. Forest Service	Dick Bell
October 1, 1985	Colorado Division of Wildlife	Bob Little
October 1, 1985	U.S. Forest Service	Dick Bell
October 1, 1985	CO DOH (Grand Junction)	Dwain Watson
October 1, 1985	USEPA	Dick Satiris
October 1, 1985	Storet, Washington, D.C.	Barbara Lamborne
October 1, 1985	USGS (Denver)	Jenny Stein

TABLE 9.1 (continued)

TECHNICAL ASSISTANCE

Date	Agency	Personnel	Assistance
August 1, 1985	BurRec	Dick Gjere	Provided DPR and Draft Management Plan
Sept. 10, 1985	SJBHU/CO DOH	Frank Singleton/ Fred Hinman	Provided copy of WQ Standards and Stream Classification
On-Going	BurRec (Durango Project Office and Engineering and Research Center)	Technical Personnel	Provided technical assistance throughout project duration.

TABLE 9.2
Written Communication

Date	Agency	Personnel	Summary of Comments	Consultant Response
4/22/85	Colorado Historical Society	Leslie Wildesen Deputy State Historic Preservation Officer	Based on present nature of project no impact on cultural resources will occur.	
3/8/85	Bureau of Reclamation	Rick Gold, Projects Manager	Indicating that it is not necessary to replace any riprap at the dam because what appeared to be thin spots was actually road surface material from the top of the dam which had been washed over the existing riprap	Modification of original work plan has been made to delete rip-rap portion
6/26/85	CO DOW	Ann B. Hodgson Wildlife Program Specialist	Based on the assumptions that (1) hydropower unit will use the existing small outlet tubes and will not increase downstream flows or affect reservoir release patterns, (2) no above ground power house construction is planned, and (3) the transmission lines are scheduled to be buried, there should be no detrimental effects on fish and wildlife resources.	The power house will be underground and the project has been designated to be as close as is technically possible to the past release patterns. Existing above ground power lines will be used to market the power and a new above ground line will be constructed for power to the dam superintendent's home. Burial of this line is cost prohibitive. Project design has been discussed with both Durango and Montrose DOW Staff.

TABLE 9.2 (continued)

7/8/85	CO DOW	Bob Clark, Habitat Res. Sect.	CO DOW recommends (1) minimum releases at dam of 8 cfs to Durango Diversion, and (2) historic flow of 4 cfs be maintained down to the Florida Diversion. Concurs with proposal to pump water during construction to maintain fishery flows.	These recommendations have been integrated into the design of the project. Releases of 9 cfs will be maintained during construction to accommodate the fishery and the City of Durango's water needs.
6/5/85	U.S. Dept. of the Interior Fish & Wildlife Service	Robert Berton Acting Field Supervisor	Identified 2 endangered species in the project area: Bald eagle Haliaeetus leucocephalus; Peregrine falcon falco peregrinus anatum and requested that mitigative measures be employed to protect raptor (hawks, owls and eagles) populations.	HWE has written for the document which outlines measures to be taken for raptor mitigation and will include these measures as part of the project.
4/24/85 8/30/84	Federal Energy Regulatory Commission	Paul McKee	Coordination required under preliminary permit authority - identification of initial activities, progress reports, request for extension of preliminary report	On schedule as required
1/19/85		Kenneth Plumb, Secretary		

10.0 COST ESTIMATES

The estimated construction cost, the annual operation, maintenance and replacement (O M & R) costs and the FERC falling water charge are presented in this chapter.

10.1 CONSTRUCTION COST

The estimate includes: the gate repairs, the power plant, the feasibility study and FERC License application, final designs and specifications, Authority administration costs, and other costs. The estimate is at an October 1985 price level. An attempt was not made to estimate the costs at the time of construction primarily because costs are currently stable. Construction costs are currently stable and future increases are assumed to be negligible.

The estimated construction costs are summarized in Table 10.1. The specific items used to determine the costs are listed in Appendix F. As can be seen in Table 10.1, 10 percent for unlisted items and 15 percent for contingencies were added to the direct expenses for the gate repairs and hydroelectric facilities. The percentages are appropriate for a feasibility level cost estimate. The gate repair estimates were established by discussions with vendors having specific expertise on the various components.

The cost to close the outlet primarily includes the construction of the temporary plug and the divers needed to place and remove the plug. Solus Ocean Systems, which was mentioned previously, prepared the estimate for the plug and the divers' time. Two estimates were obtained for the gate repair; one from a gate manufacturing firm and the other from a welding service in Durango. Both estimates were consistent for the cost of the gate seats ($60,000). The local welder's estimate for labor was about

TABLE 10.1

Construction Cost Estimate

Cost Item	Oct. 1985 Costs
Gate Repairs	
Close Outlet	$ 27,000
Repair Gates	64,400
Unlisted Items (10%)	9,100
Contingencies (15%)	15,100
Subtotal	$115,600
Hydroelectric Facilities	
Piping	$ 15,000
Turbine and Generator	22,000
Electrical Equipment	54,300
Unlisted Items (10%)	9,100
Contingencies (15%)	15,100
Subtotal	$115,500
Engineering and Design (15%)	$ 34,500
Authority Administration	$ 15,000
Bureau of Reclamation Review Fee	$ 10,000
Feasibility Report	$ 33,000
TOTAL CONSTRUCTION COSTS	$323,600

half the price of the manufacturering firm because there were no travel costs and fewer hours estimated for repairs. The local estimate was used.

The costs for the hydroelectric facilities were estimated through discussions with: 1) local welders and electricians, 2) electrical equipment suppliers, 3) LPEA, and 4) Worthington Pump Company.

Engineering and Design is generally estimated to be 15 percent of the cost for the gate repairs and construction of the hydroelectric facilities. The distribution of the costs among the various activities is shown in Appendix F.

Reclamation charges a fee to non-federal hydropower developers at federal dams to review the final plans and specifications. The review is to ensure that the power plant will not adversely affect the dam and that construction meets appropriate Reclamation standards.

Lastly, the cost of the Feasibility Report, which includes the FERC License Application, is included as part of the construction cost.

The total estimated construction cost is $323,600. Of the total, about $173,000 is for the power plant and $150,600 for the gate repair. The engineering and design and feasibility report costs are split roughly 60% for the power plant and 40% for the gate repairs. The Reclamation review fee will be used only for the power plant review. The Authority administration costs are split equally between the two components.

An item which could affect the cost estimate is any major unforeseen construction problem that may arise during construction on an existing facility. Often, there are aspects of the facility that do not operate as shown in the plans. Appropriate contingencies have been included in the cost estimate to allow for reasonable unforeseen occurences, but the potential for unforeseen costs should be recognized.

10.2 OPERATION, MAINTENANCE, AND REPLACEMENT COSTS

The O M & R costs were determined by three separate procedures, one for each component. The operation costs were assumed to be zero because the dam superintendent will incorporate these duties into his existing work schedule. It was assumed that his normal duties would complement the operation of the power plant.

The maintenance costs include the time required for a mechanic or electrician to perform scheduled or unscheduled maintenance. Scheduled maintenance would consist of periodically repacking the bearings. Personnel costs for maintenance were assumed to be $1200 (40 hrs. at $30 per hour). A company was contacted with Worthington pumps-as-turbines in operation, and confirmed that 40 hours was more than reasonable.

The replacement costs consist of contributions to a sinking/ emergency fund that would be available for unscheduled and scheduled equipment replacement. The yearly contribution to the fund was determined by assuming that the turbine, generator, valves, and half of the electrical equipment would have to be replaced in 30 years. The annual contribution would be $1800, assuming that the rate of return on the fund would be 2% greater than the inflation rate.

The annual O M & R cost was estimated to be $3000.

10.3 FERC CHARGE

FERC would charge $.001 per kWh for power generated at a Federal dam. The charge would be based upon the actual kWh generated during each calendar year and would be paid yearly. The average annual charge is estimated to be $750.

11.0 FINANCIAL EVALUATION

The general financial evaluation, including revenues, available cash, and the most likely financing scenario are presented below. A more detailed analysis, using various financing alternatives, is presented in Appendix F.

11.1 REVENUE

The District will generate revenues from the sale of their surplus power. Currently, CUEA will pay $.035/kWh for units 100 kW or less; since the Lemon Dam power plant is only 110 kW, CUEA has tentatively agreed to allow the unit to receive $.035/kWh. Also, the District currently has an annual power usage of about 18,000 kWh. The Distrcit would provide this power from the new hydro unit, and it would offset about $1,300 in power costs per year. The District is considering installing electric heat to the dam superintendent's home which could increase the annual power usage to 35,000 to 40,000 kWh.

The rate of $.035 is predicated upon a monthly plant factor of 60% or greater. The lowest monthly plant factor, excluding District usage, is 79%; the average plant factor is 97%. If the District were to use 5,000 kWh (which would be extremely high) in the lowest plant factor month, the plant factor would be reduced to 72%, which is still well above 60%. The only event which could reduce the plant factor and thus the rate received, would be if the unit were offline for a lengthy period during a month. For instance, if the unit was off-line for half of a month the plant factor would be 50%, and the rate from CUEA would be $.028/kWh. Generally, the plant factor will be greater than 60% if the unit is operational two-thirds of the month.

The power plant will produce an average of 750,000 kWh per year, of which 18,000 kWh will be used by the District, leaving

732,000 kWh to be sold. The average annual revenues will be $25,600 at $.035/kWh. The actual revenues will vary by year from $19,000 to $30,000 depending upon the water yield in the basin upstream from the dam.

Once a FERC License has been issued, the District would beging negotitating a power sales contract with CUEA. Generally, CUEA would adjust the power rate paid to the District in proporation to any increases in CUEA's wholesale rate. The wholesale power rate will increase in the future but the amount is difficult to estimate. For purposes of this analysis, a conservative 10% increase was assumed every five years, which is about 1.6% per year. Thus the rate received in the year 2000 would be $0.048/kWh, resulting in average annual revenues of about $37,000. CUEA, however, will not make any predictions on future wholesale rates. The rates have been constant since 1983 and are projected to remain stable for the 1980's. The first increase is not expected until 1990. If the market increases by more than 10%, the District's yearly cash contributions would increase accordingly.

There are two options for receiving a higher sale rate when the unit is constructed. One option is to enter into a long term contract with CUEA with a levelized rate estimated over the life of the contract. This would yield a higher market rate initially but lower at the end of the contract. CUEA is not presently interested in that type of a contract.

The second option is to sell power to another utility and pay CUEA a fee for wheeling the power over their transmission system. Other utilities which may be interested are Public Service Company of Colorado; Aztec, New Mexico; or Farmington, New Mexico. These entities have not been contacted regarding purchase of the power, but they will be after the FERC License is issued.

For this financial analysis, it was assumed that the power sales rate would be at least $0.035 per kWh.

11.2 DISTRICT ASSETS AND AVAILABLE CASH

The District has a 1985 budget of $148,000. Revenue to meet this budget is generated by an ad valorem tax of .486 mills, water charges, and assessments. About 25,740 acre-feet of water are sold each year. Repayment of project facilities requires a charge of $1.495 for each acre-foot. The District assesses an operation fee in addition which is: 1) $1.442 for water diverted directly from the Florida River, and 2) $3.30 for water delivered through the major ditches. A separate reserve fund of $15,000 is also maintained as required by Reclamation. The District has been putting $12,500 per year into a sinking fund to pay for the repairs to the gates. There is presently $56,000 in the fund. By August of 1987, there will be more than $85,000 available for construction. The District can also continue to utilize the $12,500 per year for debt service if necessary, and not increase water assessments.

The District has the authorization to sell bonds and incur debt if necessary to operate and maintain its facilities. Currently the District has no debts, other than repayment of project facilities to the Federal government.

The Lemon Dam Project will not require an increase in water assessments; therefore, an evaluation of the potential to increase the assessments was not made.

11.3 FINANCING OPTIONS

The Authority can provide financing for the project by either making a loan from cash reserves or by selling bonds. The Authority could issue and sell bonds for this project but due to the relatively small construction cost a high bond fee (7%-10%) would result. The Authority could also package this project together with other projects and issue one set of bonds. The bond fees may be lower in this case. However, at the present time there are no other projects ready for construction. The loan from cash reserves would be more advantageous to the District because it does not require a bonding fee. The loan rate would be expected to coincide with the going rate for a single A tax-exempt, revenue bond with a maturity of 15 years. The yield on a bond of this type is currently around 9 percent.

Another potential funding option is a Rehabilitation and Betterment (R & B) loan through Reclamation. The advantage is that it has a zero interest rate and a payback period of up to 40 years. Reclamation has indicated that there may be construction funds available in October 1987. Negotiations will be initiated to determine if funding could be available.

The most likely funding option would be a loan from the Authority. An interest rate of 9 percent and an amortization period of 15 years have been assumed for this financial evaluation.

11.4 FINANCIAL EVALUATION

The financial evaluation includes the comparison of the annual costs with the annual revenues. The major component of the annual costs is the debt service, which is determined below:

	Total Project	Gates Only
Construction Cost	$323,600	$150,600
Cash Available	85,000	85,000
Amount to be Financed	$238,600	$ 65,600
Debt Service (9%, 15 yrs.)	$29,600	$8,100

The total annual cost also includes annual O M & R and the FERC falling water charges which are $3,000 and $750 respectively. The total annual cost is $33,350.

The average annual revenues are expected to be $25,600 from the power plant. The District would have to contribute an additional $7,700 per year on the average. This contribution would be somewhat offset by $1,300 in benefits by not having to purchase power. The District has been setting aside $12,500 for the gate repairs and this amount could be used for debt service. This would not require any increase in water assessments.

The annual debt service, if just the gate repairs were performed would also be $8,000, so inclusion of the power plant does not increase the District's cost.

An analysis using current power sale rates and average revenues does not portray a true picture of annual expenses for the District. The actual revenue each year changes because of 1) hydrology and 2) the power sale rate. In addition the O M & R costs increase periodically due to inflation. For this reason a cash flow analysis was developed for the first 25 years of the power plant operation and is shown on Table 11.1. The cash flow analysis only gives an indication of expenses and does not predict what will happen.

The first column of the table is the model year. The next set of columns under "Income" shows the production for the model year, District kWh use, kWh sold, the market value, (increases 10% every 5 years), and the total income. The set of columns under "Expenses" shows the debt service, O M & R (increases 10% every 5 years), FERC charges based upon actual production, and the total.

The "Excess Income" column shows the yearly income, positive or negative. For instance, in 1988, there would be a $7,750 shortfall which the District would have to make up; the largest shortfall would occur in 1992, which is assumed to be a dry year, with revenues low. By 1999, the market value will have increased to the point where there are no shortfalls, and in 2002, the debt is repaid.

The right hand column shows the accumulated income. The negative income peaks in 1998 at $63,350, and then decreases until it becomes positive in 2004. In 2004, the power sales revenues will have repaid the District for the cash outlays through 1998. The District cash contributions to the project will peak at about $150,000 ($85,000 cash in 1987 plus $65,000 between 1987 and 1997), which is the cost of the gate repair.

The power plant produces revenues sufficient to repay its separable costs; the District then has to pay for the gate repairs, which it would have to do anyway. The result is that the power plant is a feasible part of the project and will yield excess revenues for use by the District after 2002.

Appendix F describes various financial evaluations using differing interest rates and amortization periods and would be useful if the interest rates change.

TABLE 11.1
CASH FLOW ANALYSIS

	INCOME					EXPENSES					
MODEL YEAR	kWh PRODUCTION	FWCD kWh USE	kWh SOLD	MARKET VALUE	TOTAL INCOME	DEBT SERVICE	O,M&R	FERC CHARGE	TOTAL	EXCESS INCOME	ACCUM INCOME
1988	750000	18000	732000	$0.035	$25,600	$29,600	$3,000	$750	$33,350	($7,750)	($7,750)
1989	846791	18000	828791	$0.035	$29,000	$29,600	$3,000	$850	$33,450	($4,450)	($12,200)
1990	752037	18000	734037	$0.038	$27,900	$29,600	$3,300	$750	$33,650	($5,750)	($17,950)
1991	819845	18000	801845	$0.038	$30,500	$29,600	$3,300	$820	$33,720	($3,220)	($21,170)
1992	623697	18000	605697	$0.038	$23,000	$29,600	$3,300	$620	$33,520	($10,520)	($31,690)
1993	712120	18000	694120	$0.038	$26,400	$29,600	$3,300	$710	$33,610	($7,210)	($38,900)
1994	822577	18000	804577	$0.038	$30,600	$29,600	$3,300	$820	$33,720	($3,120)	($42,020)
1995	579151	18000	561151	$0.043	$24,100	$29,600	$3,600	$580	$33,780	($9,680)	($51,700)
1996	582520	18000	564520	$0.043	$24,300	$29,600	$3,600	$580	$33,780	($9,480)	($61,180)
1997	735156	18000	717156	$0.043	$30,800	$29,600	$3,600	$740	$33,940	($3,140)	($64,320)
1998	831729	18000	813729	$0.043	$35,000	$29,600	$3,600	$830	$34,030	$970	($63,350)
1999	872857	18000	854857	$0.043	$36,800	$29,600	$3,600	$870	$34,070	$2,730	($60,620)
2000	910013	18000	892013	$0.048	$42,800	$29,600	$4,000	$910	$34,510	$8,290	($52,330)
2001	846791	18000	828791	$0.048	$39,800	$29,600	$4,000	$850	$34,450	$5,350	($46,980)
2002	752037	18000	734037	$0.048	$35,200	$29,600	$4,000	$750	$34,350	$850	($46,130)
2003	819845	18000	801845	$0.048	$38,500	$29,600	$4,000	$820	$34,420	$4,080	($42,050)
2004	623697	18000	605697	$0.048	$29,100		$4,000	$620	$4,620	$24,480	($17,570)
2005	712120	18000	694120	$0.053	$36,800		$4,400	$710	$5,110	$31,690	$14,120
2006	822577	18000	804577	$0.053	$42,600		$4,400	$820	$5,220	$37,380	$51,500
2007	579151	18000	561151	$0.053	$29,700		$4,400	$580	$4,980	$24,720	$76,220
2008	582520	18000	564520	$0.053	$29,900		$4,400	$580	$4,980	$24,920	$101,140
2009	735156	18000	717156	$0.053	$38,000		$4,400	$740	$5,140	$32,860	$134,000
2010	831729	18000	813729	$0.058	$47,200		$4,800	$830	$5,630	$41,570	$175,570
2011	872857	18000	854857	$0.058	$49,600		$4,800	$870	$5,670	$43,930	$219,500
2012	910013	18000	892013	$0.058	$51,700		$4,800	$910	$5,710	$45,990	$265,490

NOTES: 1) The debt service amount is for $238,600 financed at 9% for 15 years.

2) The market value and O,M&R are increased 10% every 10 years begining in 1990.

12.0 CONSTRUCTION SCHEDULE

The project construction schedule includes activities beginning when the FERC License application is submitted and continues through the final testing of the new equipment. Two time periods are critical to the schedule, and include: 1) the length of time for the FERC License to be issued and 2) the period to perform preconstruction activities which must be initiated in February prior to construction in October.

The FERC License could be issued, assuming it is submitted by January 1986, anytime between August 1986 and April 1987. At least 6 months for design will be required prior to initiation of construction and about 2 months of construction activities would be needed prior to plugging the outlet. Assuming the outlet would be plugged on or about October 1, the license must to be issued in January 1987, or earlier, for construction to be performed in 1987.

The specific activities to be accomplished and the estimated schedule are listed below. The schedule assumes construction in 1987 although the sequence of activities would still be the same if the date slipped to 1988.

Activity	Schedule
o Submit FERC License Application	1/86
o Negotiate, finalize and approve contracts between Authority-Engineer and Authority-District	2/86-8/86
o Funding mechanism is selected and funds become readily available	2/86-10/86
o Investigate power marketing options in addition to CUEA	8/86-12/86
o Receive FERC License	12/86
o Notice to proceed issued	1/87

- o Finalize power marketing plan and execute contract — 1/87-6/87

- o Officially notify Florida River water users and government agencies of construction plans — 1/87-6/87

- o Prepare final designs, specifications and drawings for: pipework, electrical, turbine and generator, outlet plug and gate repair — 2/87-4/87

- o CUEA interconnect approval — 2/87-6/87

- o Reclamation and Authority Review — 4/87-5/87

- o Prequalify potential bidders — 2/87-4/87

- o Prepare bid packages, distribute packages, select bidder for five different areas: pipework, electrical, turbine and generator, divers/outlet plug, and gate repair — 5/87-6/87

- o Prepare and execute contract with each bidder — 7/87

- o Construction activities prior to plugging outlet are: — 8/87-9/87

  1. Install electrical wiring, transformers utility interconnect, etc.

  2. Transport turbine and generator to site.

  3. Purchase pipe, valves, etc and transport to site.

  4. Modify piping on outlet side of turbine.

  5. Install turbine and generator anchor bolts.

  6. Fabricate temporary plug.

- o Activities while outlet is plugged include: — 10/87

  1. Mobilize divers and crew at site. — 3 days

  2. Plug outlet.

  3. Disassemble and repair east emergency gate. — 6 days

4. Disassemble and repair west emergency gate. — 6 days

5. Remove concrete block, weld new piping, install gate valve, "T", butterfly valves and bypass pipe around turbine. — 10 days

6. Close emergency gates, fill outlet pipe, allow water to go through bypass pipe, check gates for leaks, check bypass for leaks, check all for correct operation. (If problems arise, dewater outlet and repair.) — 3 days

7. Remove plug from outlet. — 2 days

- Disassemble and repair the two control gates; water will be released through the bypass pipe. — 10 days, 11/87
- Install turbine, generator, and accessory equipment, connect to electrical system. — 15 days, 11/87
- Test and set controls for power equipment — 3 days, 11/87
- Prepare operation manual and in-place drawings. — 12/87-2/88
- Complete project — 2/88

13.0 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions are derived from the feasibility study.

1. The Lemon Dam Project is economically feasible based upon current interest rates for tax exempt bonds. The District will not have to increase water assessments to repay the project.

2. The hydropower component of the project produces adequate revenues to meet its separable costs for debt service and O M & R. The revenues are derived from sale of power to CUEA at $.035 per kWh.

3. The hydropower component is technically feasible based upon information provided by Worthington Pump Company which had the only turbine that could operate at the site.

4. CUEA and LPEA have reviewed the interconnection plans and made appropriate comments but will not officially approve the interconnection until final designs and specifications are completed.

5. A technically feasible and economically reasonable method to close the outlet works has been identified. This would allow the gate seats to be replaced. The winter water demands below the dam can be met while the gates are repaired.

6. CDOW has reviewed the construction and operation plans that relate to the reservoir and Florida River fisheries and believe that those plans would not significantly impact the fishery.

7. The construction of 1200 ft of power distribution line could be placed and designed to minimize the visual impact and would include raptor control.

8. The project can be constructed in about four months with the outlet closed for gate repairs in October.

9. The earliest construction period is August to November of 1987.

10. The total cost of the project is $323,600 in October 1985 dollars.

Based upon the above conclusions, the following recommendations are made.

1. The project is technically and economically feasible and is recommended for construction.

2. The first step in the construction process is to file an application for a FERC License which will be accomplished as part of the feasibility study.

3. FERC should be contacted periodically to attempt to have the license issued by January 1987 so that construction can be performed in 1987.

4. Construction funding from the Authority should be requested so that the project construction activities can begin as soon as the FERC License is awarded. Included in this funding process is the necessary contracts between the Authority, the District, and the Engineer.

5. Special Use Permit applications will be submitted to the USFS as part of the feasibility study; one for the construction of the power plant and one for construction and operation of the distribution power line.

6. The project economics should be reviewed if interest rates rise substantially.

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GLOSSARY

abutment - the support at the end of a dam, arch or bridge

acre - a measure of area; equivalent to 43,560 square feet

acre-foot - the volume of water, equal to the quantity required to cover an acre of land to a depth of 1 foot or 43,560 cubic feet

afterbay - regulating reservoir that temporarily stores water below the tail race of a power generating facility

appropriation - the volume of flow of water that is legally allocated to an individual, municipality, corporation or government entity for an identified beneficial use

appraisal-level study - an investigation performed to formulate a preliminary plan for project implementation, as well as make possible selection between alternatives, and to assess the desirability for continued, more detailed analyses

average flow - the mean or mid-point of flow rates over a period of time usually one year

consumptive water use - the volume of water that is used for a process or activity that is not directly returned to the water source and results in a reduction of the water source

capacity costs - the costs are associated with providing the capital costs for the electrical generating facilities

cubic feet per second - the flow rate of water equal to 724 acre-feet per year

dependable capacity - the load carrying ability of hydropower plant under adverse hydrologic conditions for the time interval and period specified of the particular system load

depletion - the reduction in flow of a stream or the reduction in volume of a lake or reservoir due to withdrawals, evaporation or seepage

direct diversion - the diversion of water from a natural flowing stream

drawdown - the decrease in elevation of a lake or reservoir due to a release or discharge from the lake or reservoir

energy costs - the variable costs associated with the production of electrical energy, representing the cost of fuel and most O & M expenses

emphemeral stream - a stream that flows only in response to precipitation or snowmelt evaporation - the process by which water is transferred from the liquid state in a water body to vapor in the water cycle

existing reservoir - a reservoir that was created by the construction of an enbankment

hydroelectric - the production of electricity by water power

inflow design flood - the size of flood that a dam, spillway and reservoir are designed to accommodate without overtopping the dam

irrigable land - arable land for which a water supply is available

irrigation - artificial application of water to arable land for agricultural use

irrigation efficiencies - the percentage of irrigation water applied that is stored in the soil and available for consumptive use by the crops

kilowatt hour - a unit of energy production equal to 1000 watts

load - the amount of power needed to be delivered at a given point on an electric system

load factor - the ratio of the average load during a designated period to the peak or maximum load during that period

low annual flow - the lowest annual flow, generally, recorded by a stream gaging system

megawatt - a unit of energy production equal to 1000 kilowatts

orifice - a plate bolted to the outlet end of a pite with specified diameter hole smaller than the pipe diameter.

plant factor - the ratio of the average electrical load to the installed capacity of the plant, expressed as an annual percentage

riprap - rocks placed on the upstream face of a dma to protect the embankment from wave action.

water right - a legal right to use the water of a natural stream or the water beneath the surface for a specific purpose, such as irrigation, municipal or industrial use

ACRONYMS AND ABBREVIATIONS

Authority	Colorado Water Resources and Power Development Authrority
af	acre-foot
BLM	U.S. Bureau of Land Management
CDOH	Colorado Department of Health
CDOW	Colorado Division of Wildlife
cfs	Cubic feet per second
CTS	Current transformer
CUEA	Colorado Ute Electric Association
Device #	Industry designation for standard electrical equipment
District	Florida Water Conservancy District
DMP	Draft Management Plan, Lemon Reservoir
DPR	Definite Plan Report, Florida Project
F	degrees Farenheit
FERC	Federal Energy Regulatory Commission
ft	feet
HRU	Human Resource Unit
HWE	Harris Water Engineering
KV	Kilovolt
KVA	Kilovolt Amperes
KVAR	Kilovolt Amperes Reactive
kW	kilowatt
kWh	Kilowatt-hour
LPEA	La Plata Electric Association
LRMP-SJNF	Land and Resource Management Plan - San Juan National Forest
O M & R	Operation, Maintenance, and Replacement

p Ci/l	picocuries per liter
Reclamation	U. S. Bureau of Reclamation
rpm	revolutions per minute
SJNF-FEIS	San Juan National Forest - Final Environmental Impact Statement
USFS	U. S. Forest Service
USFWS	U. S. Fish and Wildlife Service