

Gilmore

MASTER

Feasibility Study for
**Boardman River
Hydroelectric Power**

Cooperative Agreement No. EW-78-F-07-1792

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1.0 COVER PAGE

FINAL REPORT

Feasibility Assessment for renovating one or more of five existing dams on the Boardman River in Grand Traverse County, Michigan, and Traverse City, Michigan to provide additional hydroelectric generation capacity.

Dated February 22, 1979

Prepared For

United States Department of Energy
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Cooperative Agreement No. EW-78-F-07-1792, between above parties, dated August 11, 1978

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1.2 SPECIAL NOTICE

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2.0 ABSTRACT

The subject report investigates the feasibility of generating additional hydroelectric power from five consecutive existing dams located on the Boardman River in Grand Traverse County and Traverse City, Michigan.

The study centered on (1) installing hydroelectric generating capacity at a non-hydropower dam (Union Street-220 KW), (2) and (3) rehabilitating and installing hydroelectric generating capacity at two abandoned hydroelectric plants (Sabin-490 KW and Boardman-970 KW), (4) rebuilding a "washed out" dam with hydroelectric generating capacity (Keystone-470 KW), and (5) upgrading an operating hydroelectric plant (Brown Bridge-830 KW).

The potential hydropower production capabilities, in terms of base load power and peak load power, the legal-institutional-environmental constraints, and the economic feasibility, including capital investment, operating costs and maintenance costs, were evaluated for each of the five dam sites individually and as a series of co-dependent facilities. The impact of installing fish passages at each site was analyzed separately.

The feasibility assessment utilized the "present worth" analytical method, considering revenue based on thirty mills/KWH for power, 4% general economy escalation rate, and a 6% net income to the municipal utility. The sensitivity of fuel costs increasing at a different rate than the general price-escalation was tested by allowing the increase in fuel costs to vary from 3% to 8% per year. Assuming fuel costs increase at the same rate as the general economy, it is feasible to update, retrofit, renovate, and install hydroelectric generating capacity at Sabin, Boardman

and Brown Bridge. Rehabilitation of Union Street and Keystone are also feasible but somewhat less attractive. Operating the dams as a co-dependent system has environmental advantages and can provide additional revenue through peak load power rates. A development plan to implement the above is outlined utilizing an ownership arrangement whereby Grand Traverse County provides easements for Sabin and Boardman Dams. The plan calls for operation of the system by Traverse City.

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3.4 GLOSSARY

AASHTO - American Association of State Highway and Transportation Officials

USGS - United States Geological Survey

KWH - Kilowatt Hours

MWH - Megawatt Hours

KW - Kilowatts

MW - Megawatts

cfs - Cubic Feet per Second

MCP - Michigan Cooperatives Pool

Cherryland R.E.C.A. - Cherryland Rural Electric Cooperative Association

DNR - Department of Natural Resources (Michigan)

MPSC - Michigan Public Service Commission

MDSH&T - Michigan Department of State Highways and Transportation

EIS - Environmental Impact Statement

MERB - Michigan Environmental Review Board

EPA - Environmental Protection Agency

WQS - Water Quality Standards

NPDES - National Pollution Discharge Elimination System

FERC - Federal Energy Regulatory Commission

TCL&P - Traverse City Light and Power Department

psi - Pounds per Square Inch

"Bottomland" means the land area of an inland lake or stream which lies below the ordinary high-water mark and which may or may not be covered by water.

"Impoundment" means water hold back by a dam, dike, flood gate or other barrier.

"Riparian Owner" means a person who has riparian rights.

"A 100 Year Flood" means a flood which has a 1% chance of occurring or being exceeded in any given year.

"Flood Plain" means that area of land adjoining a river or stream and those portions of the flood plain adjoining the channel, which are reasonably required to carry and discharge a 100 year flood.

"Watershed" means the drainage area of a stream.

"Local Governments" means cities, counties, townships and charter townships.

"River" means a flowing body of water or a portion or a tributary thereof, including streams, creeks or impoundments and small lakes thereon.

"Free flowing" means existing or flowing in natural condition without impoundment, diversion, straightening, riprapping or other modification.

"Person" means an individual, partnership, firm, corporation, association or other entity.

"Natural River" means a river which has been designated by the Commission for inclusion in the wild, scenic and recreational rivers system.

"Head of a dam" means the difference in nearest 1/20 foot between pond head water and downstream tail water.

Summary



4.0 SUMMARY

This report presents the results of a study conducted in 1978 to determine the feasibility of rehabilitating one or more of the five existing dam sites located on the 19-mile portion of the Boardman River upstream from the mouth of the river in Traverse City, Michigan.

Detailed data gathered during the study is presented and includes a description and evaluation of facilities at the sites, hydrologic analysis of the river basin, evaluation of the potential market for power which would be produced, and an appraisal of equipment that would be suitable for installation and economic and financial factors related to the potential development. Water resource needs, safety hazards, environmental concerns, and socio-institutional factors are also identified and evaluated. Federal, State of Michigan, and local government regulations were reviewed and permit requirements were identified and evaluated.

Evaluation of economic and non-economic factors indicates that hydroelectric generation at four of the sites is economically beneficial and has no significant effect on the quality of life in the Boardman River area. Rehabilitation of Keystone Dam, the fifth site, is economically beneficial but since it involves re-establishing an impoundment, significant environmental changes will occur, some of which are detrimental.

A potential major obstacle to early utilization of the power exists. Since Michigan law requires fish passages at dams, the Department of Natural Resources intends to require the installation as a condition of

any permit issued. Additional costs and impacts of fish passage installation are presented but the issue could not be resolved in the report. If the Natural Resources Commission waives the requirement for fish passages, economic benefits will accrue without significant environmental impact.

The report includes management and development recommendations. Continuation of present ownership is recommended with easements to the City of Traverse City for development and operation of all dams for hydroelectric generation. Development of hydroelectric potential is recommended in three phases. Rehabilitation of Brown Bridge, Boardman and Sabin Dams with a combined potential of 2290 KW by 1981 in the first phase. Rehabilitation of Union Street Dam with an additional 220 KW by 1982 is the second phase. Reconstruction and rehabilitation of Keystone Dam with an additional 470 KW after 1982 for a total capacity of 2980 KW.

Details of facility rehabilitation, time schedule and cost estimates are presented. The estimated cost of redevelopment is \$5,950,000. In 1978 dollars, the cost per installed KW is \$2,010, and the cost per KWH is 4.32¢. If the cost of fish passages is charged to hydroelectric generation, the initial cost increases \$3,250,000. to \$9,200,000. 1978 dollar cost per installed KW would be \$3,274, and the cost per KWH is increased 43% to 6.2¢. The return on investment without fish passages is 11 1/4%, with fish passages it is less than 5%.

Introduction



5.0 INTRODUCTION

This report presents the results of activities performed under Cooperative Agreement No. EW-78-F-07-1792 entitled "Feasibility Assessment for renovating one or more of five existing dams on the Boardman River in Grand Traverse County, Michigan and Traverse City, Michigan to provide additional hydroelectric generation capacity". The study is a result of new interest in the United States to investigate the generation of additional electric power from existing, but unused, low-head dam sites and recognition by Grand Traverse County and Traverse City officials of the ever increasing demand for electricity within their political jurisdictions. The area happens to be one of relatively high population growth.

As the title indicates, the study has as its goal to investigate and assess the feasibility of renovating, retrofitting and/or rebuilding existing dams for hydroelectric generation capacity. The study approach is threefold; namely, (1) collect additional field data and delineate existing site and facility conditions, (2) examine other factors affecting feasibility such as cost-effectiveness, power marketing potential, applicable hydro-power technology, statutory requirements, and environmental, legal and institutional implications, and (3) evaluate the individual dams and alternate co-dependent systems with the end result of selecting the most feasible arrangement. The study was further divided into ten "Major Study Tasks". The first five major tasks listed below were utilized to accomplish the two approach phases (1) and (2) of collecting additional field data and examining other factors affecting feasibility

and are found in this report in Section 6 under Background Data. These are as follows:

I. Collect additional data required to model the five existing sites, their impoundments and the connecting river reaches, individually and as a system(s).

II. Evaluate the market potential of output from the proposed facilities and identify the ultimate users.

III. Initiate assessment of environmental impact, legal and socio-institutional factors and safety aspects introduced by the project.

IV. Determine statutory permit and regulatory requirements of federal, state, and local governmental agencies.

V. Identify availability, application, performance characteristics, and cost of low-head turbines, generators, interfacing equipment, and accessories.

The third approach phase of evaluating individual dams and co-dependent systems was performed during the following three major study tasks and reported on in Section 7 under Evaluation of Alternates.

VI. Establish criteria for evaluating feasibility of generating electric power at the individual facilities as well as a system(s) of co-dependent facilities.

VII. Evaluate

- A. Maintaining existing facilities (the "do nothing" approach).
- B. Increasing the capability of existing hydropower units at Brown Bridge.
- C. Rehabilitating abandoned hydropower facilities at Boardman and Sabin.
- D. Rebuilding "washed-out" hydropower dam at Keystone and installing new facilities.
- E. Installing hydroelectric facilities at Union Street.
- F. Combinations of the above dams as a system(s) of co-dependent dams.

VIII. Evaluate cost-effectiveness of each facility and all combinations or system(s) of co-dependent facilities and select the most feasible.

After evaluating the alternate solutions, based on background data collected, the best alternate was selected and is described in detail in Section 8.2 of this report. Study Task IX is to "Prepare Outline of a Development Plan" and such a plan can be found in the report under Section 8.2.

The last major study task, Study Task X is described as "Write, Edit and Publish Final Report" and as such, is self evident. The study was completed in approximately seven months. Many functions of the major study tasks overlapped, however, it is felt that assimilating the background data for the study required approximately four months whereas the evaluation alternates were processed in approximately two months. Another month was needed to prepare the recommendations, development plan and to write the final report.

Background Data

6.0 BACKGROUND DATA

Background data for the Feasibility Study was gathered by staff engineers, technicians, and field forces during the fall of 1978.

Existing reports, records, studies, and plans were obtained from federal, state, and local governmental agencies, private industry, and non-profit organizations. Abrams Aerial Survey Corporation of Lansing, Michigan, was engaged to plot the topographic features and ground contours of all five dam sites and reservoirs from 1975 photography provided by Traverse Bay Regional Planning Commission with horizontal and vertical ground control furnished by our field staff. Stream flow monitoring devices along the entire Boardman River reach were installed by our field forces and periodically monitored. Important dam site and powerhouse features were located, measured and delineated. The structural integrity of each facility was investigated and reported upon by the staff engineers. The shoreline of all impoundments and the majority of the connecting river reaches were physically inspected by staff to locate potential problem areas arising from water level and flow variations.

Probable electricity customer service areas were identified by reviewing existing regional grid and distribution facilities. Competitive costs were determined by analyzing current cost data on operating and maintenance costs, fixed charges, load factor and availability.

Many meetings with governmental and quasi-governmental agencies at the city, township, county and state levels were initiated, scheduled, and

attended by our staff engineers and consultants to formulate initial assessments regarding the agencies concerns for the impact a project of this scope on environmental, legal, and socio-institutional matters.

Constraints of a statutory nature, largely dictated by the State of Michigan through its Department of Natural Resources, were reviewed after collecting copies of pertinent and applicable statutes and their subsequent rules and regulations. Such review necessitated personal contact with the regulatory agencies involved during which two important issues evolved, namely Boardman River minimum flow requirements and present fish passage provision requirements. Federal regulatory requirements were also secured and reviewed. Riparian, water and flowage rights were examined. Those agencies having jurisdiction or authority over licensing and/or permits required by federal, state and local agencies were identified.

Current data was solicited from foreign and domestic hydroelectric equipment manufacturers regarding the performance characteristics, purchase costs, installation costs, maintenance costs, operation costs, delivery, reliability, and expected life of such equipment as low-head turbines, generators, interfacing equipment, and accessories. The acceptability of the various types of equipment was reviewed for each dam site. However, the equipment selection for Boardman and Sabin Dams was limited due to retrofit requirements. The most appropriate equipment types were selected for each site.

6.1 BOARDMAN RIVER DAM SITES

The area of the study comprises the lower 15 miles of the Boardman River in Grand Traverse County, Michigan (see figure 6.1). Seventy percent of the entire Boardman watershed is upstream from this area. The geology and topography of the watershed results in a stable river flow with relatively small seasonal variations. Five dam sites exist in the 19 mile reach of the river considered by the study. Grand Traverse County owns and maintains two of these sites for roadway, recreational and educational purposes. Traverse City owns and maintains the other three sites. While four of these dams have supplied electric power to the Traverse City area from time to time since 1894, only one is presently generating electricity.

The annual output available at these five dams is about 17,500,000 KWH, about 13% of the net load of the Light and Power Department of Traverse City, the major power supplier in the area and one of the principals of the joint venture. The generating capacity of the five dams, depending on pond and load factors, is about 3,000 KW. The existing generating capacity of the Traverse City facilities is 33,000 KW. The renovation of the five dams would increase this capacity by 9% and could reduce consumption of high cost fossil fuel.

The unique situation of five existing contiguous hydroelectric sites of various heads in an area of growing population, a ready market for all the power available, and the willingness of the owners of these sites to work together make this a particularly attractive case for the development of an alternate energy source to the dwindling supply of fossil fuels.

The available head of these dams range from 9 ft. to 41 ft. and the potential generating capacity ranges from 220 KW to 970 KW. The site characteristics of each dam are presented separately in the following Section.

The hydroelectric characteristics of the individual sites are as follows:

(Refer to Table 6.4a for details).

<u>Dam Site</u>	<u>Average Head, (1) in feet</u>	<u>(2) Mean Flow, in cfs</u>	<u>Capacity (3) KW</u>	<u>Annual (3) Generation KWH</u>
Union Street	9.1	294	220	1,509,000
Sabin	20.5	286	490	3,315,000
Boardman	41.0	284	970	6,582,000
Keystone	20.0	282	470	3,187,000
Brown Bridge	<u>30.2</u>	<u>161</u>	<u>830</u>	<u>2,887,000</u>
Total	120.8	1290	2980	17,480,000

1 From Field Data.

2 These values are based on U.S.G.S. mean flow records from 1952 to 1973.

3 Based on 80% efficiency and exceeded by flow 15% of the time.

6.1.1 Union Street Dam is near the mouth of the Boardman River in Traverse City (Figure 6.1.1a, b and c). It was originally built in 1867 to supply power for a flour mill. The average head is 9.1 ft. with a mean flow of 294 cfs (220 KW capacity and 1,509,000 KWH annual generation).

The present function of the dam is to regulate the level of Boardman Lake (figure 6.1.1d). This dam is owned by Traverse City (recorded in Liber 271, pages 58 through 60, Grand Traverse County records).

Facilities at this dam site consist of an earth fill dike about 250 ft. long with 10 hand wheel gates and a 15 ft. long concrete dam spillway at the extreme west end with trash racks and 2 discharge tubes.

The dike, dam, rip-rap and equipment is generally in good condition.

6.1.2 Sabin Dam is about 5.0 miles upstream from the river mouth (Figure 6.1.2a, b and c). It was originally constructed in 1906 and rebuilt in 1930 for the Boardman River Light and Power Company. This dam was used by successive owners for power generation until 1969. At that time it was sold by Consumers Power Company to Grand Traverse County after removal of turbines and generators (recorded in Liber 306, pages 890 through 898, Grand Traverse County Records). The average head is 20.5 ft. with a mean flow of 286 cfs (490 KW capacity and 3,315,000 KWH annual generation). The Sabin Pond is shown in figure 6.1.2d.

Facilities at this dam site consist of a 20 ft. x 60 ft. rectangular brick powerhouse, a concrete dam 110 ft. long with two concrete spillways. One spillway has an 18 foot long tainter gate and the other has three 10 ft. wood lift gates. Turbine flumes have been closed off with stop logs.

An inspection report (Appendix B) issued January, 1978, indicated dam stability is good with adequate freeboard and minimal erosion of the concrete spillways.

6.1.3 Boardman Dam is 5.6 miles upstream from Traverse City (Figure 6.1.3a, b and c). Originally constructed in 1894 for the Boardman River Light and Power Company and rebuilt in 1940, this dam site was used by successive owners for power generation until 1969 when it was sold by Consumers Power Company to Grand Traverse County, after removal turbines and generators (recorded in Liber 306, pages 890 through 898, Grand Traverse County Records). The average head is 41.0 ft. with a mean flow of 284 cfs (970 KW capacity and 6,582,000 KWH annual generation). Boardman Pond is shown in figure 6.1.2d.

Facilities at this site consist of a 700 ft. long earth dike across the original river channel and an 18 ft. wide by 200 ft. long concrete bridge-dam structure. An 18 ft. wide concrete spillway includes 2 stoney spillway gates and energy dissipation blocks at the lower end. The brick and concrete powerhouse is 18 ft. by 60 ft. Two exposed steel penstocks feed the turbine bays which includes the scroll case, wicket gates and draft tubes.

An 18 ft. wide County Road crosses along the crest of the concrete dam. The adjacent forebay provides gate control for the two penstocks beneath the road.

An inspection report (Appendix B) submitted in January, 1978, indicates minimal concrete deterioration, an inoperable wicket gate, and slight seepage at the northeast abutment since construction.

6.1.4 Keystone Dam is about 7 miles upstream from Traverse City (Figure 6.1.4a, b and c). The dam was constructed about 1908 for the Queen City Light and Power Company. In 1912 the facility was purchased by Traverse City and generated power until 1961 when the intake structure at the powerhouse overtopped and washed out part of the dam. The impoundment site is shown in figure 6.1.2d.

This site had an average head of 20.0 ft. and a mean flow of 282 cfs (470 KW capacity and 3,187,000 KWH annual generation).

As a result of the washout in September, 1961, an opening was excavated in the west end of the earth dike to permit the river to follow its original course. About 1969, all remnants of the powerhouse were leveled and the spillway was demolished to eliminate public hazards at the site.

6.1.5 Brown Bridge Dam is about 19 miles upstream from Traverse City (Figure 6.1.5a, b and c). Constructed in 1921 for the Traverse City Light and Power Department, (TCL&P) it has generated power continuously since that time. The site has an average head of 30.2 ft. and a mean flow of 161 cfs (830 KW capacity and 2887 MWH annual generation). Brown Bridge Pond is shown on figure 6.1.5d).

Facilities at this site include a 2400 ft. long earth embankment with a concrete cutoff wall, concrete spillway with two 12 ft. wide steel tainter gates. The powerhouse is located over the concrete spillway and contains one Leffel 375 BHP Turbine (1941) and one Leffel 690 BHP Turbine (1921). These turbines are operating in a "run-of-the river" mode and generated 2,345,000 KWH of electricity in 1977. Step-up transformers and a 13.8 KV wood pole transmission line traversing overland near Keystone, Boardman, and Sabin Dam enroute to Traverse City are in satisfactory condition (Figure 6.1). Inspection of this dam in September, 1977 (See Appendix C), concluded that the facility is in safe condition and required only minor repairs and recommended routine operating procedures and inspections for continued use.

6.2 BOARDMAN RIVER HYDROLOGY

The Boardman River system contains approximately 130 linear miles of streams, draining 276 square miles above Union St. dam, which is located 0.9 miles from the outlet into Grand Traverse Bay (Figure 6.2a and b).

Much of the river flow, particularly during low flow conditions, is sustained by groundwater discharges from the permeable glacial outwash soils. A region of numerous water table lakes exist north of Mayfield consisting of 12 lakes ranging in size from a few acres to 60 acres

draining into the Boardman River. Warmer outflows from these lakes are soon cooled by spring seepage to support cold water fish species.

Stream flow in the river is fairly stable, particularly during low flow as it is sustained by groundwater flow from the permeable glacial soils. About 65% of the basin is forested which along with the many lakes and glacial soils accounts for flow stability.

Water discharge records from the U.S.G.S. gauge on the Boardman River near Mayfield indicate that the average flow based on 25 years of record is 194 cfs. The extremes for the period of record are a maximum discharge of 1,220 cfs on September 14, 1961 and a minimum discharge of 47 cfs on November 2 and 3, 1963. An average minimum flow for the summer months is about 130 cfs. Spring flows normally raise the stage heights from 2 to 4 ft. in the upper and lower reaches, respectively.

Refer to Figures 6.2c, d, and e, respectively for Monthly Mean Flow, Duration of Flow, and Extreme Flow Probability curves for the Boardman River.

The distance from Grand Traverse Bay, elevations, drainage area, impoundment area and minimum flow for each site are shown in figure 6.2f.

Tailwater stage-discharge curves for the various dams are shown in figure 6.2g. There is no curve for Boardman Dam since the tailwater at this site is Sabin Dam's headwater.

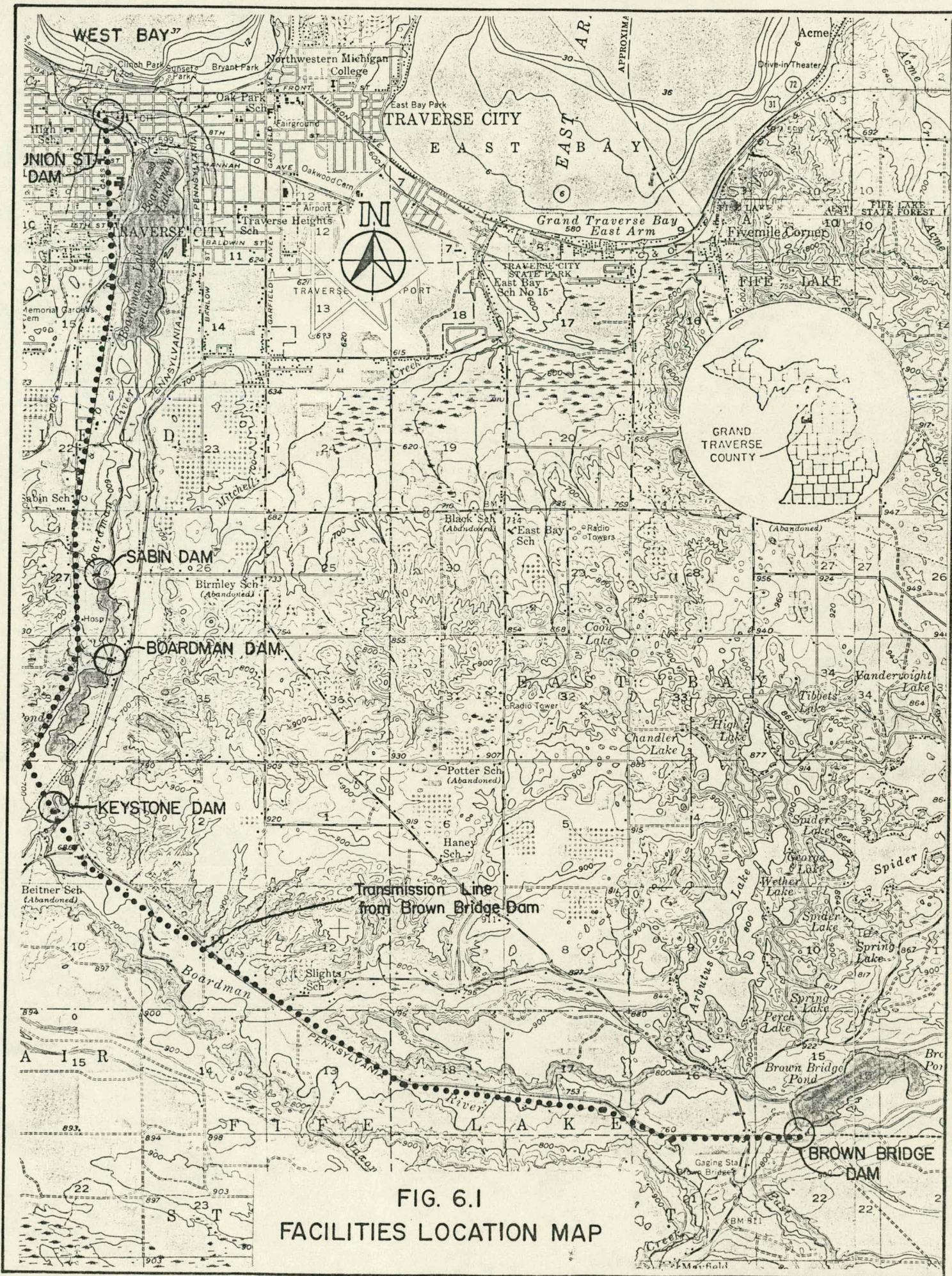


FIG. 6.1
FACILITIES LOCATION MAP



SCALE: 1" = 100'

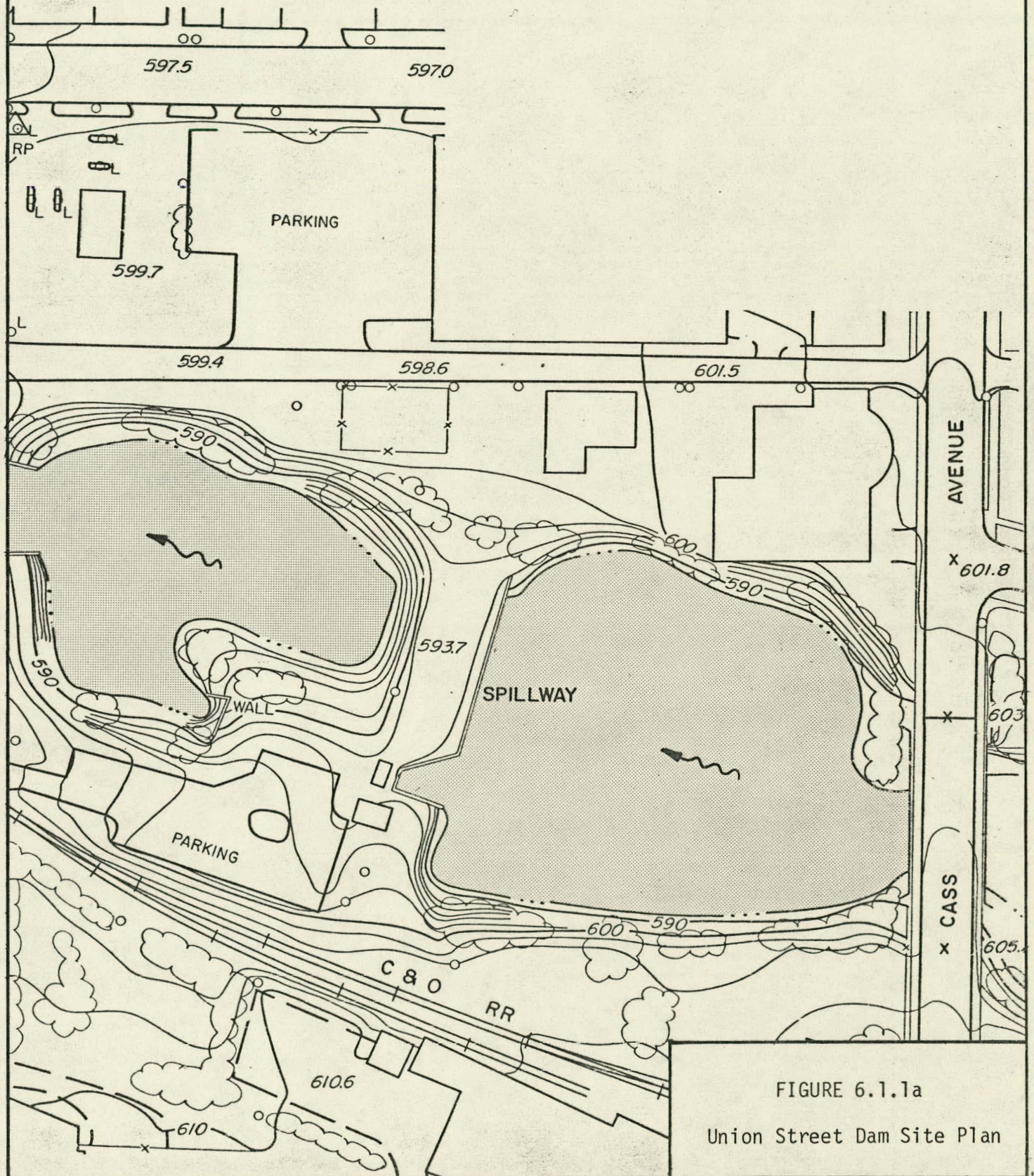
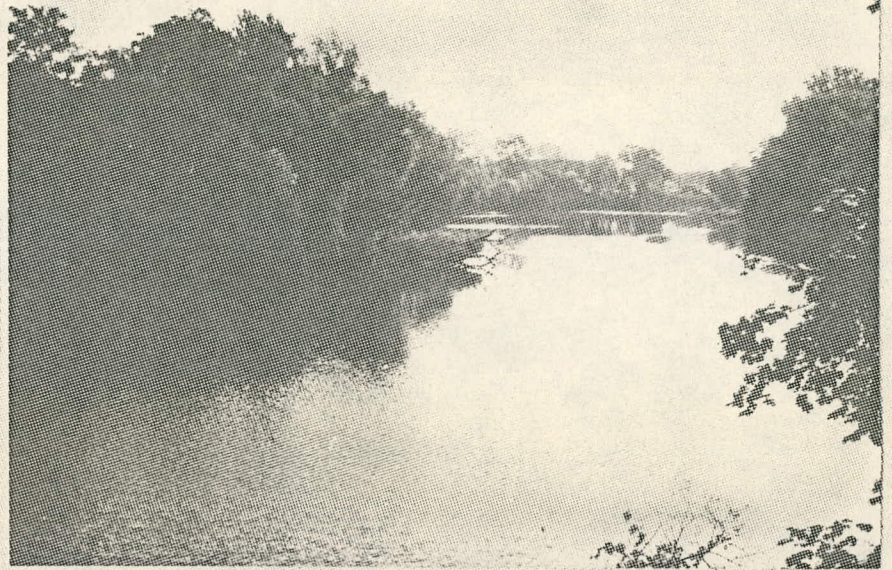


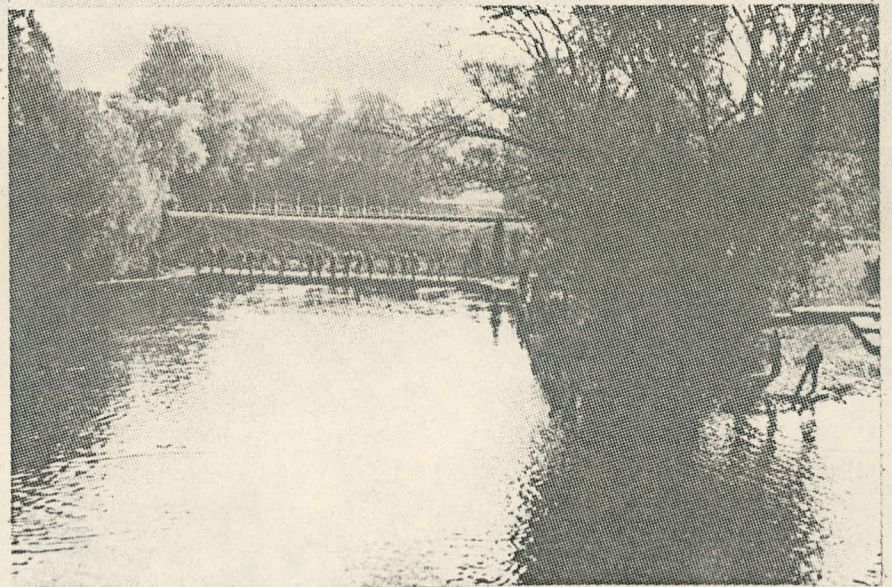
FIGURE 6.1.1a
Union Street Dam Site Plan

Boardman River looking
upstream at Union St.
Dam.

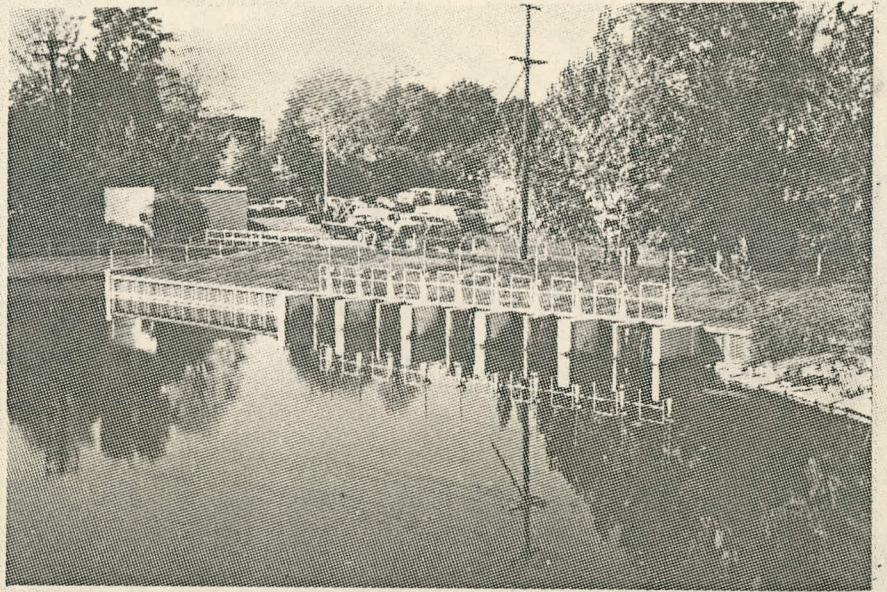


Tailwater at Union St.
Dam looking upstream.

Boardman River looking
upstream, to Union St.
Dam.

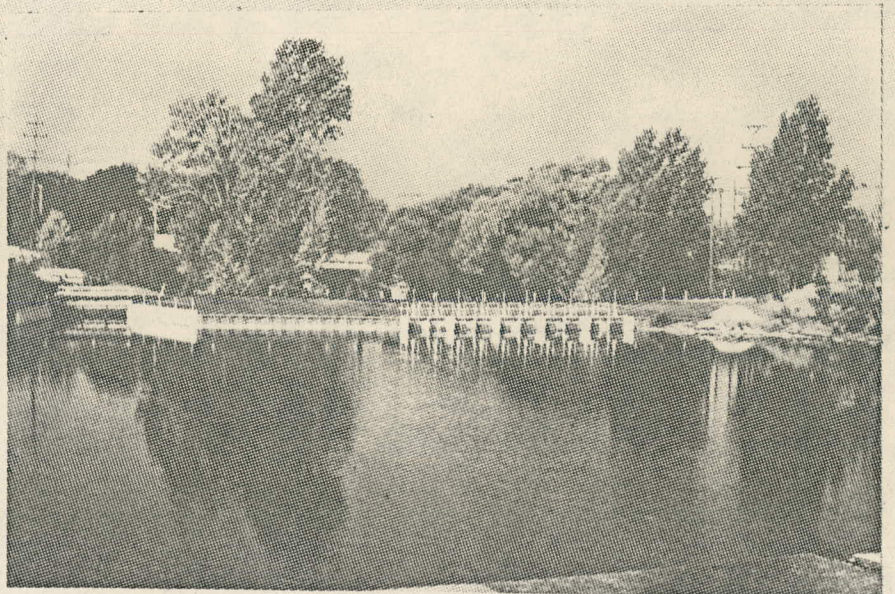


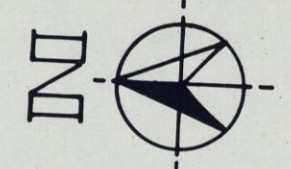
Boardman River, intake and
Spillway at Union St. Dam.



Boardman River, intake and
spillway at Union St. Dam.

Boardman River looking
downstream, intake and
spillway at Union St. Dam.





Scale: 1" = 400'



FIGURE 6.1.1d
UNION STREET DAM
RESERVOIR PLAN

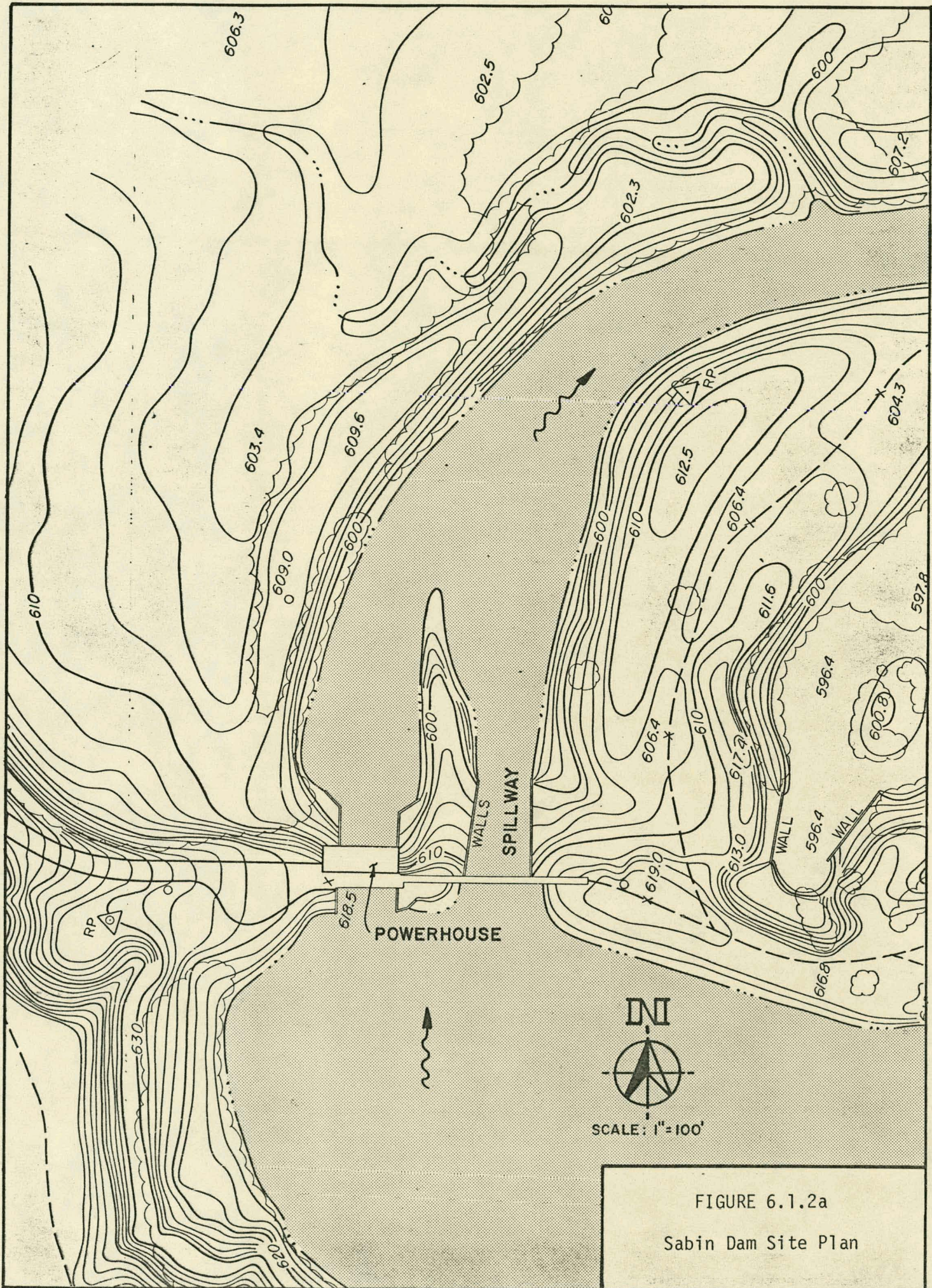
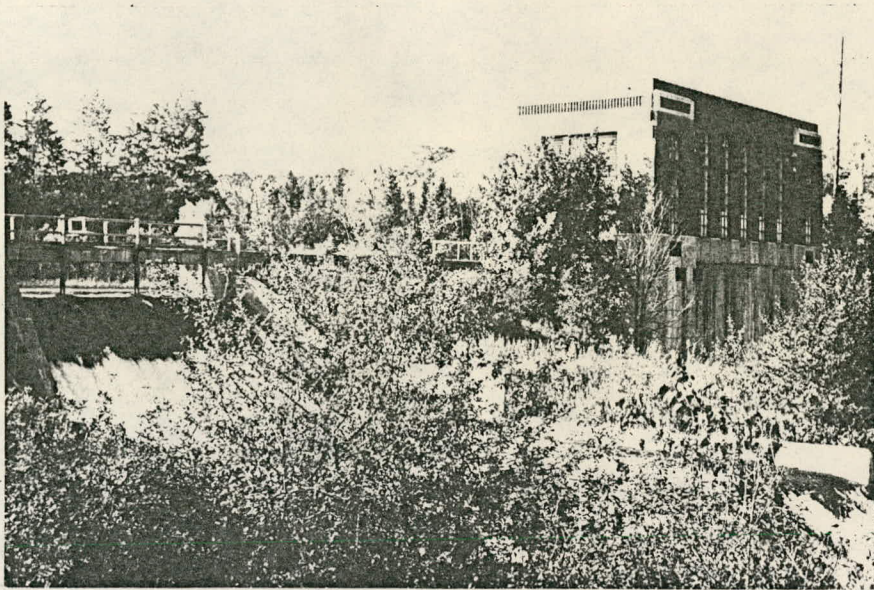
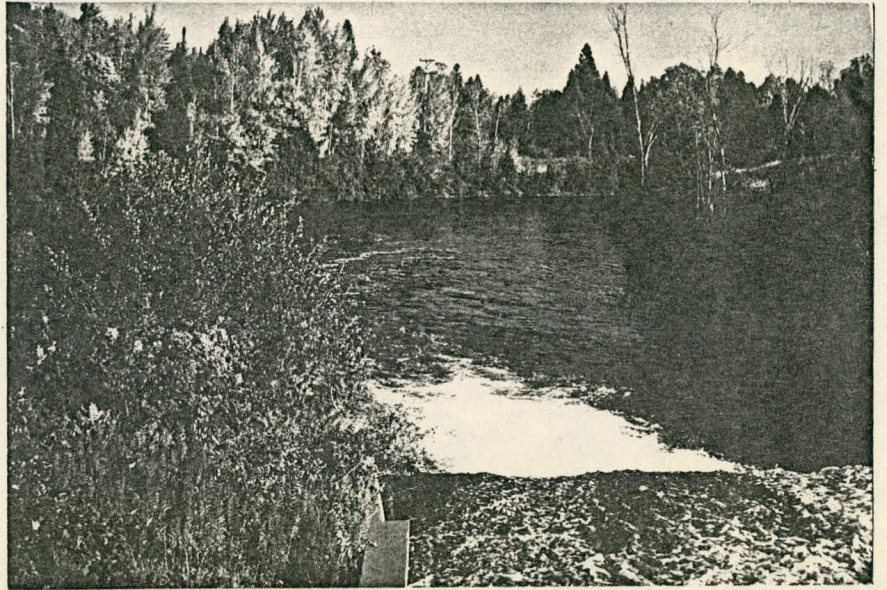


FIGURE 6.1.2a
Sabin Dam Site Plan

Boardman River looking
downstream at Sabin Dam.



Spillway and Powerhouse
looking upstream at Sabin
Dam.

Spillway and Powerhouse
looking West at Sabin Dam.

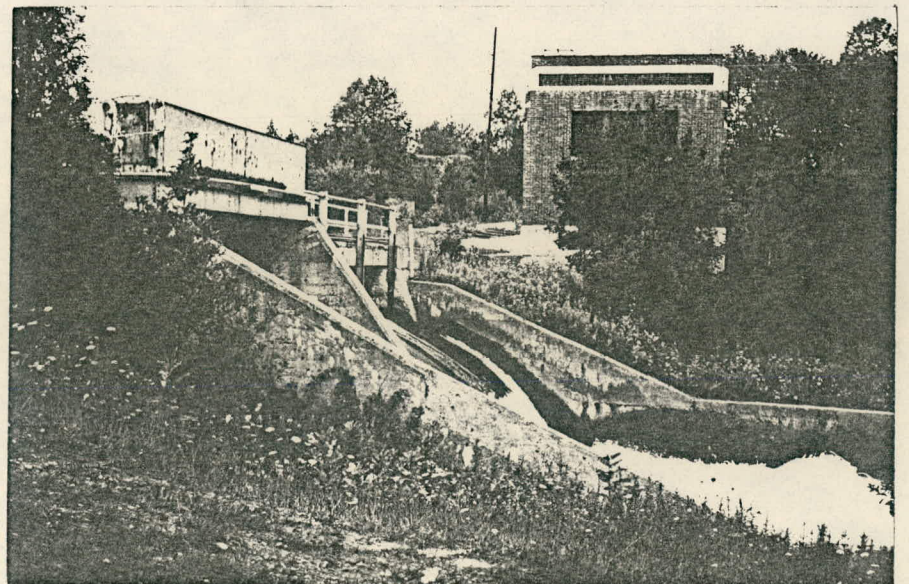
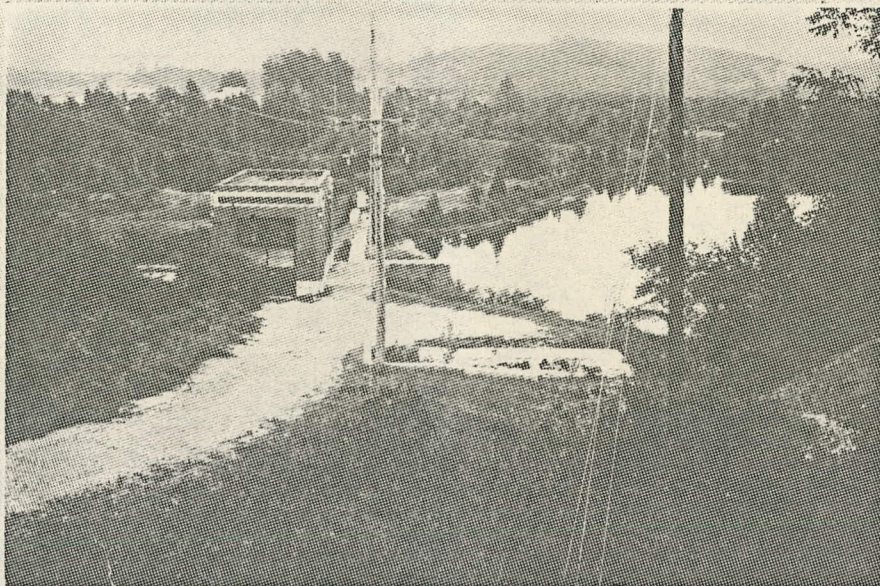
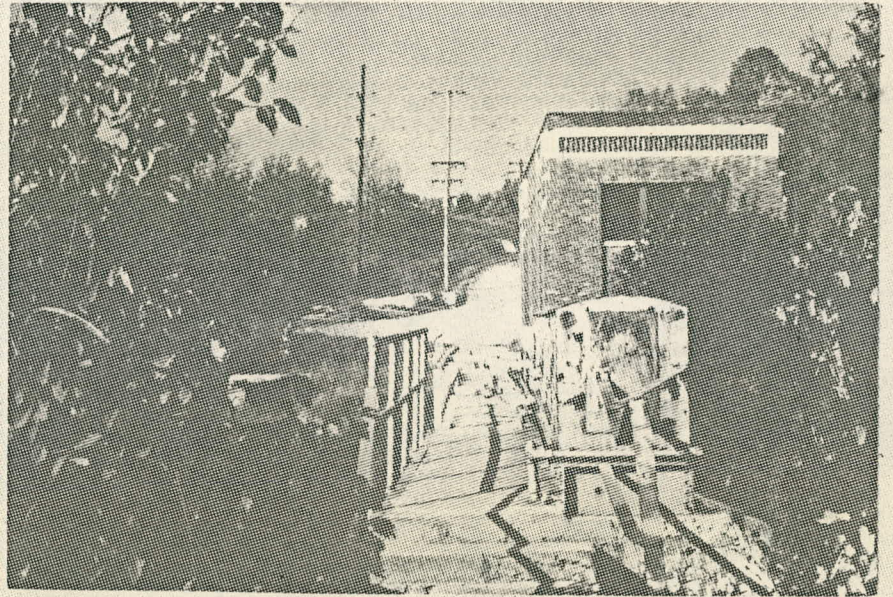


Figure 6.1.2 b



Spillway Head, Gate Control Mechanism and Powerhouse looking West at Sabin Dam.



Access Road, Powerhouse and Sabin Reservoir looking East at Sabin Dam.

Powerhouse and Spillway looking downstream at Sabin Dam.

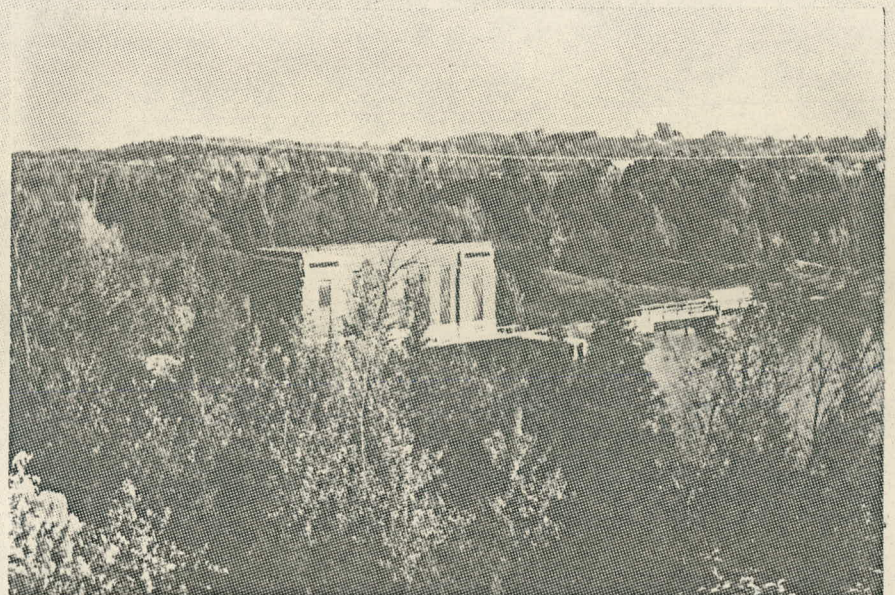


Figure 6.1.2 c

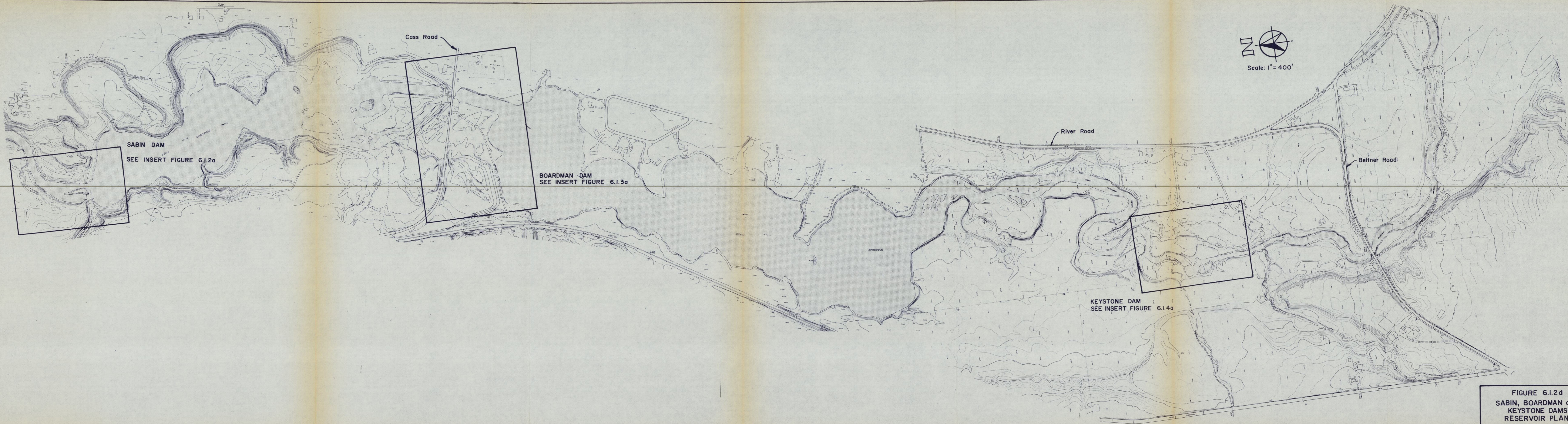


FIGURE 6.1.2d
SABIN, BOARDMAN and
KEYSTONE DAMS
RESERVOIR PLANS

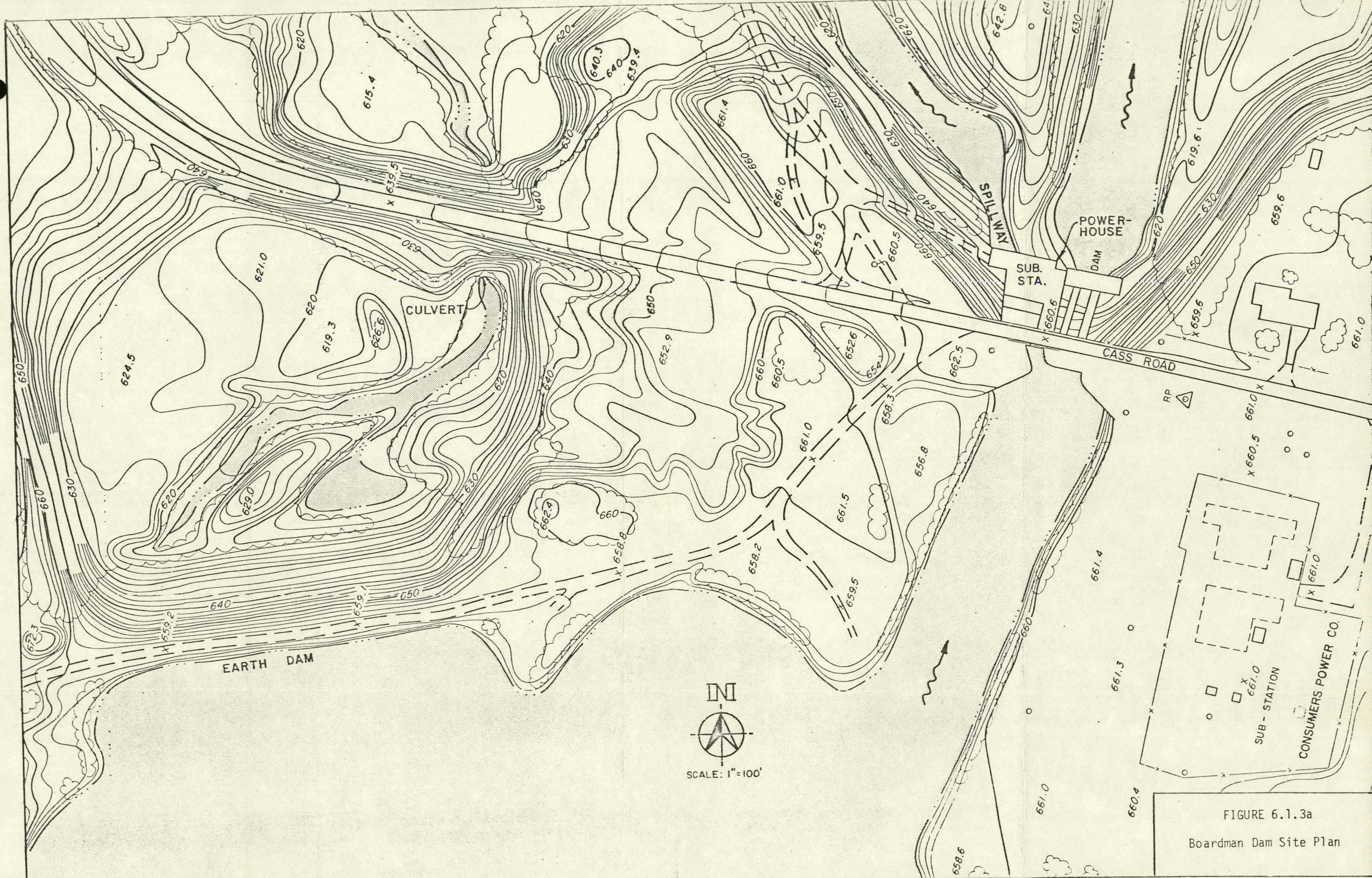
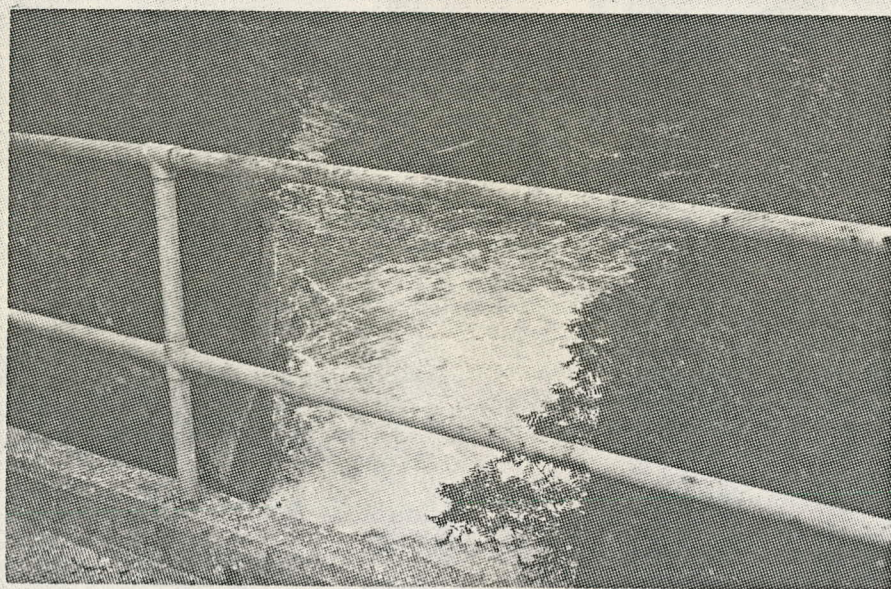
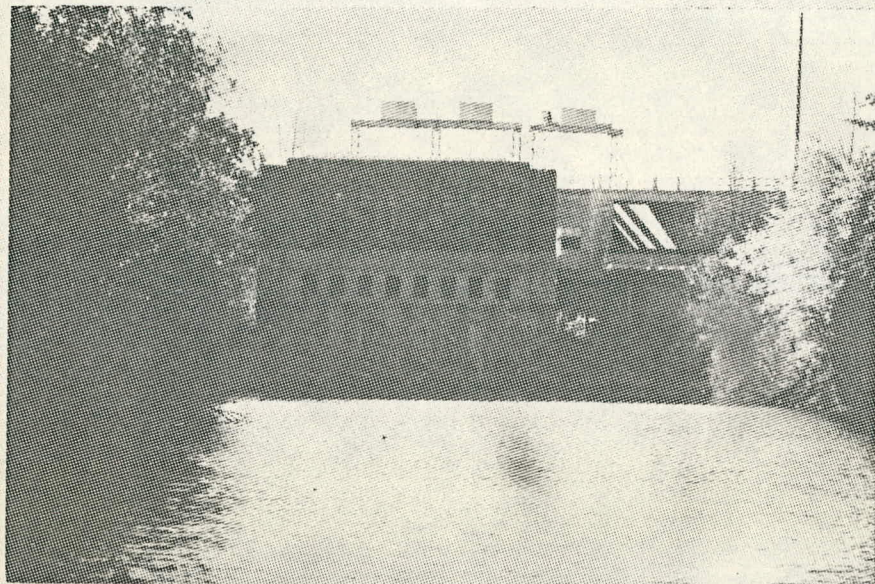


FIGURE 6.1.3a
Boardman Dam Site Plan

Boardman River looking upstream, Powerhouse and tailrace at Boardman Dam.



Boardman River looking downstream, Spillway outlet at Boardman Dam.

Penstocks, Powerhouse and Substation Slab looking West at Boardman Dam.

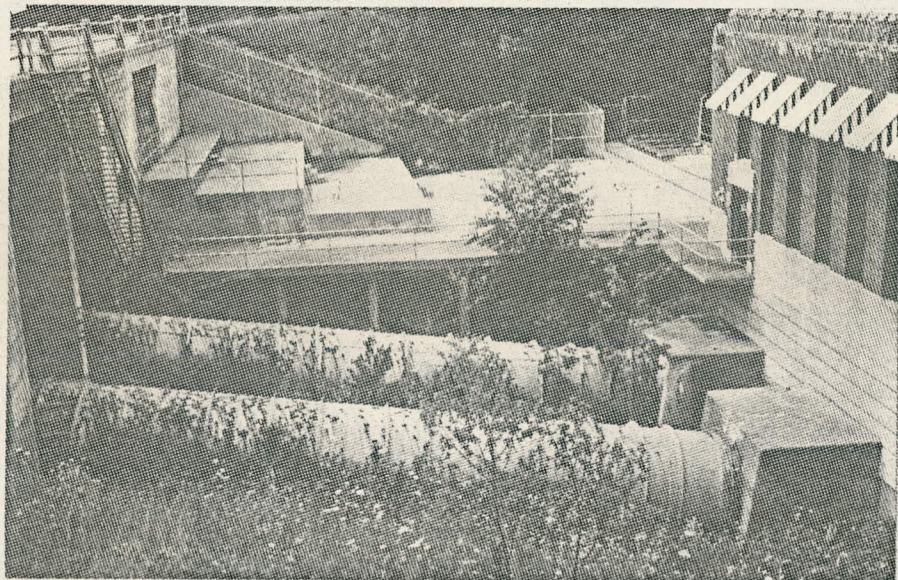
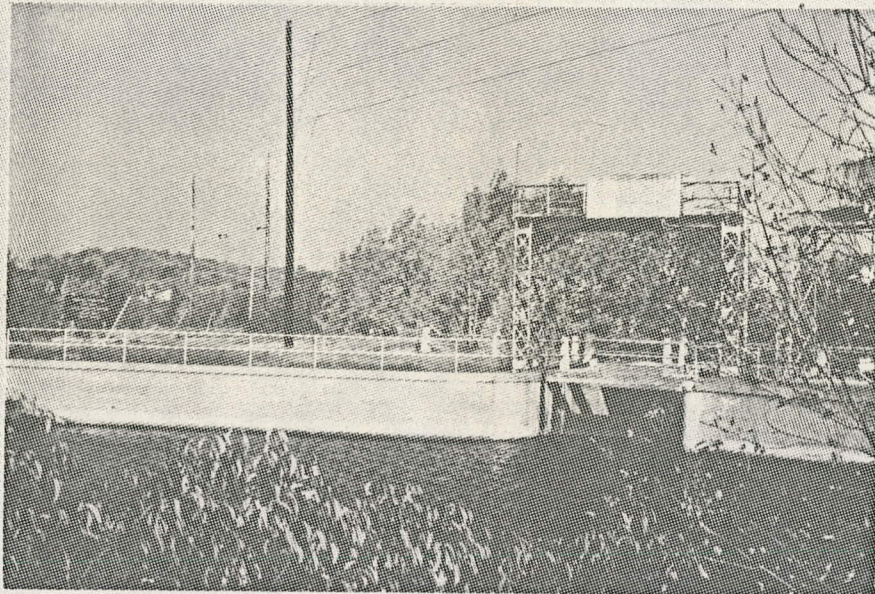
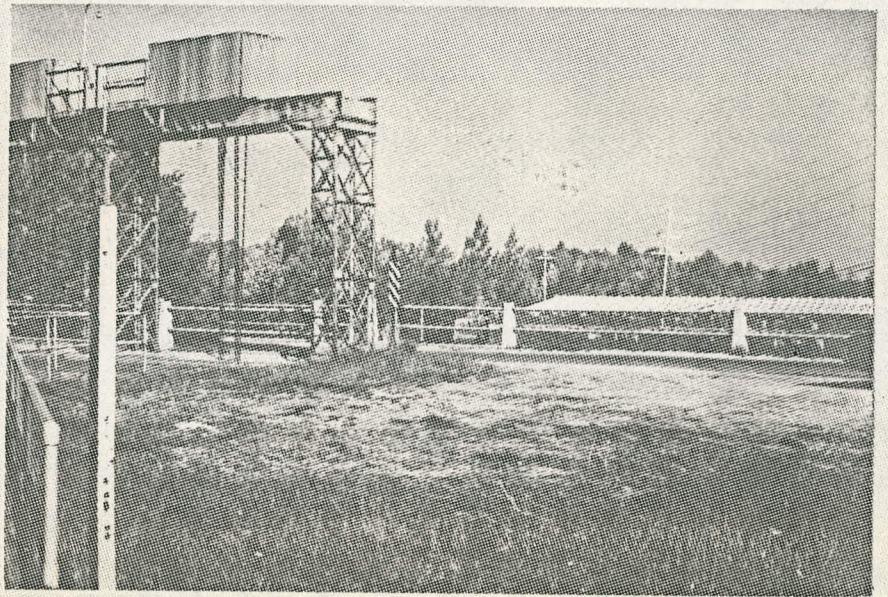


Figure 6.1.3 b

Intake Gates Control
Mechanisms, Roadway over
Dam and Powerhouse Roof
Looking North at Boardman
Dam.



Boardman River looking
downstream, Spillway Head-
Gate and Control Mechanism
at Boardman Dam.

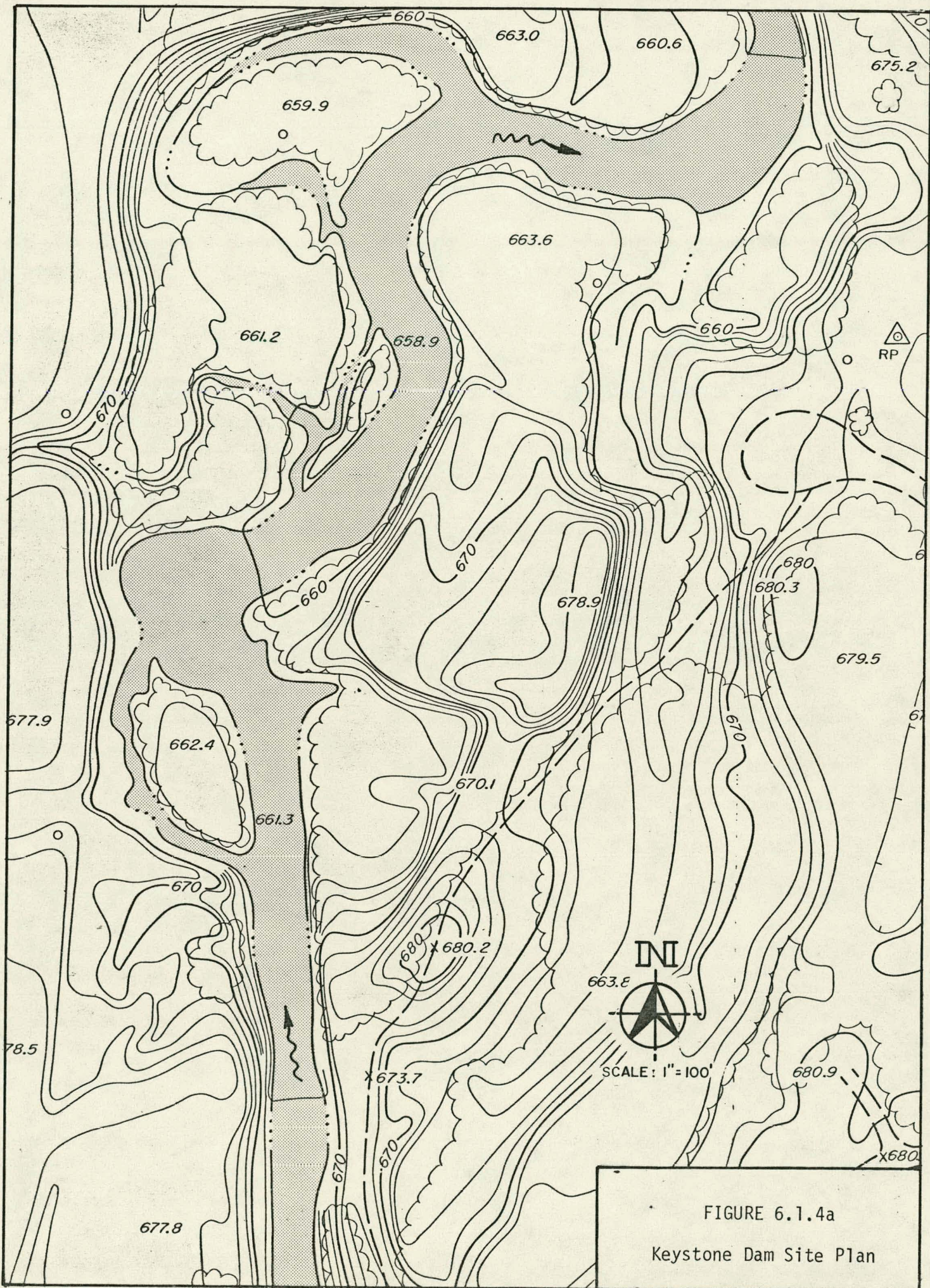
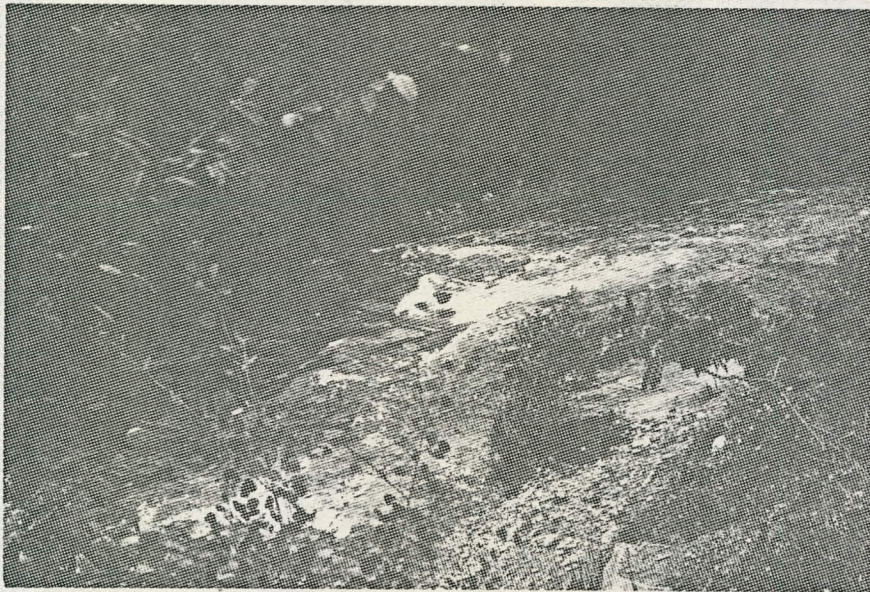
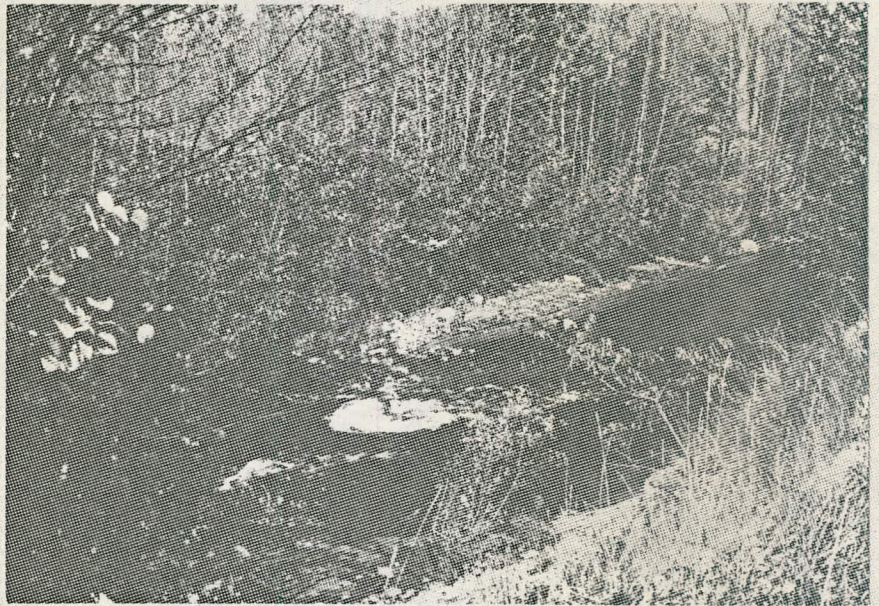


FIGURE 6.1.4a
Keystone Dam Site Plan

Boardman River looking
downstream at former
Keystone Dam.

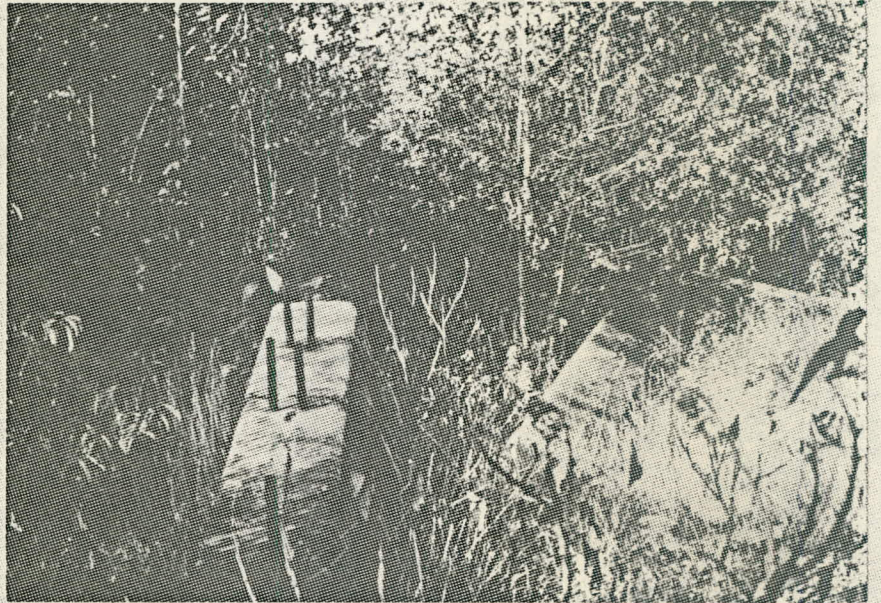


Boardman River looking
downstream at former
Keystone Dam.

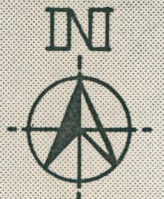
Remains of Keystone Dam
looking East.



Remains of Keystone Dam.



Access Road to Remains of
Keystone Dam.



SCALE: 1" = 100'

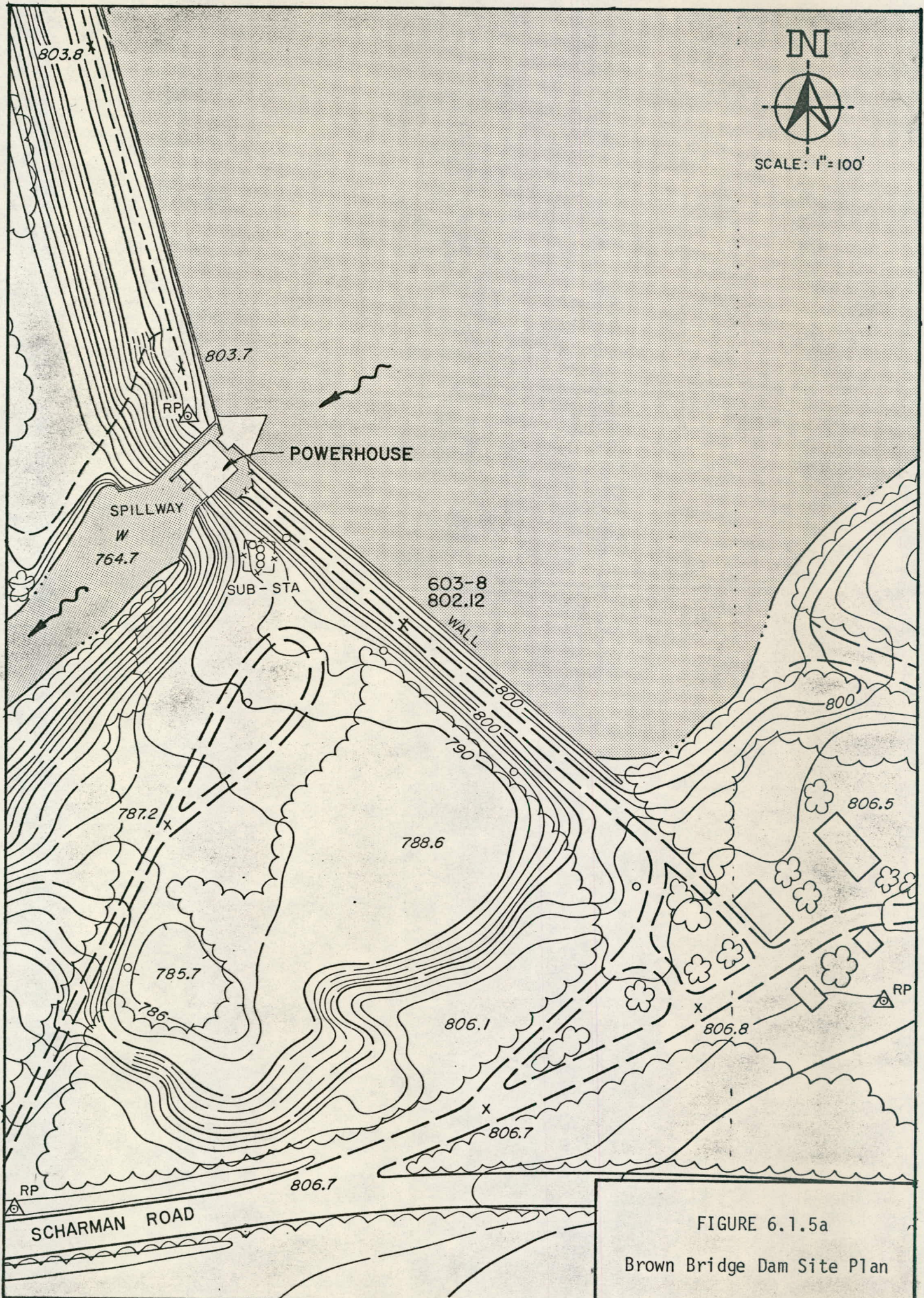
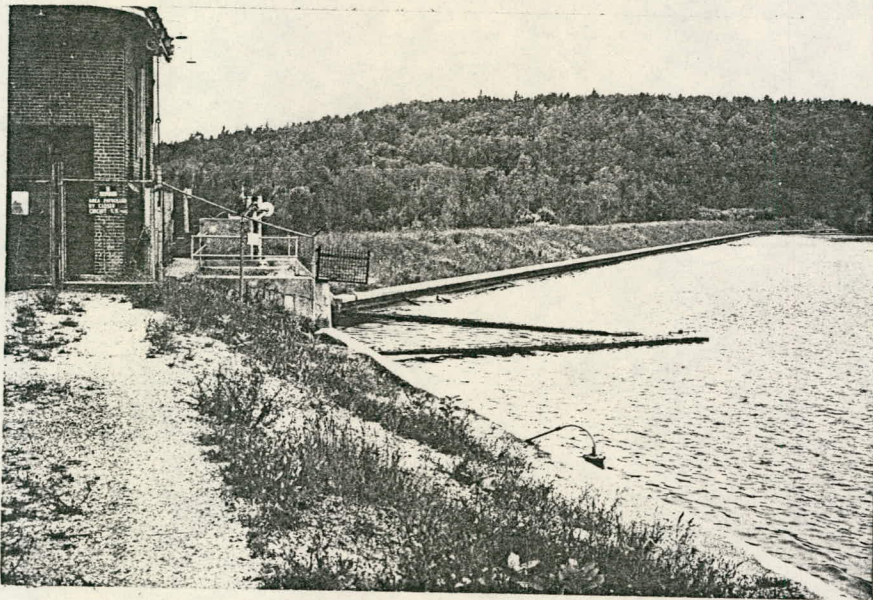
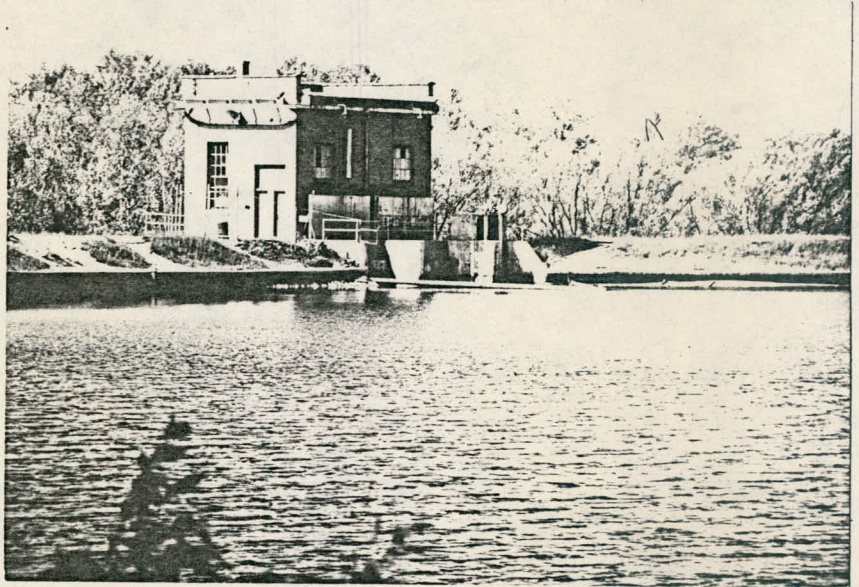


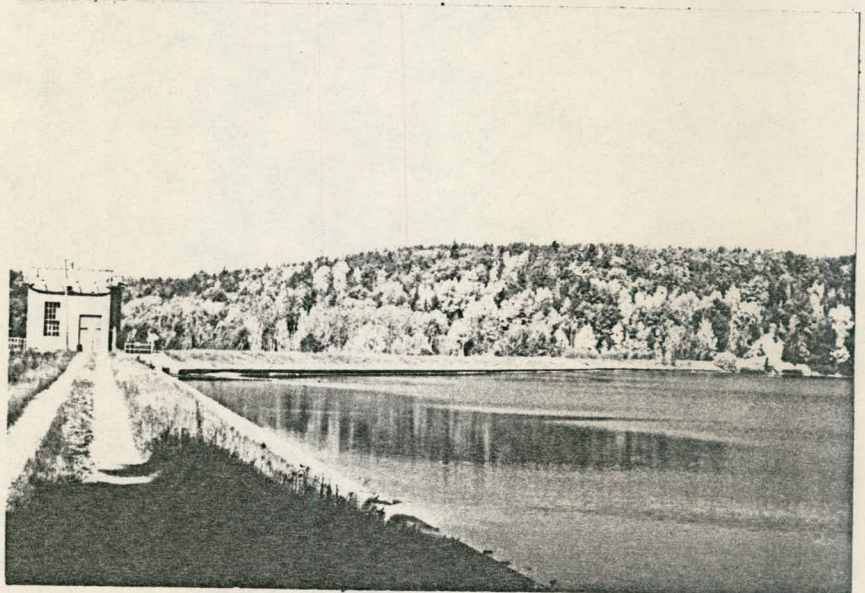
FIGURE 6.1.5a
Brown Bridge Dam Site Plan

Boardman River looking downstream, Powerhouse, Spillway and intake at Brown Bridge Dam.

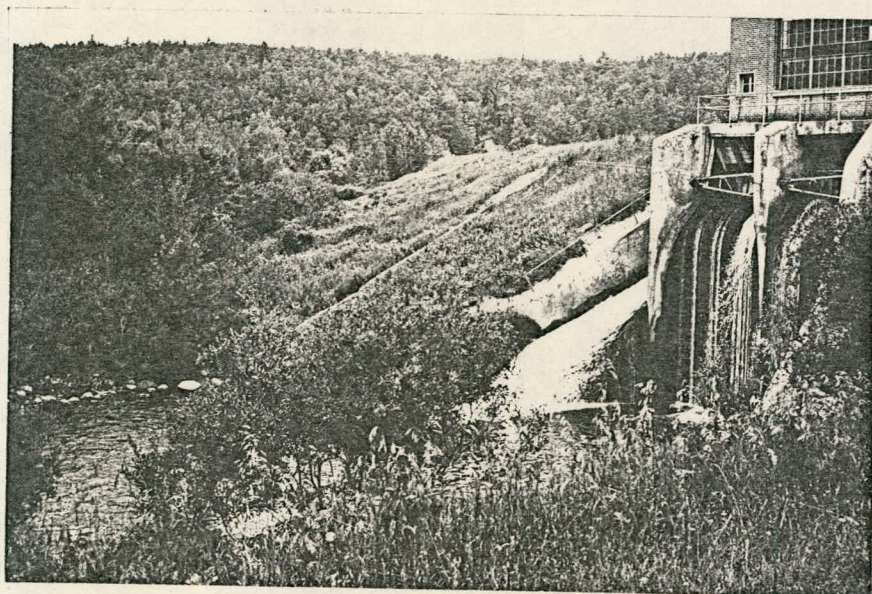


Powerhouse and Brown Bridge Reservoir looking North at Brown Bridge Dam.

Powerhouse and Brown Bridge Reservoir looking North at Brown Bridge Dam.

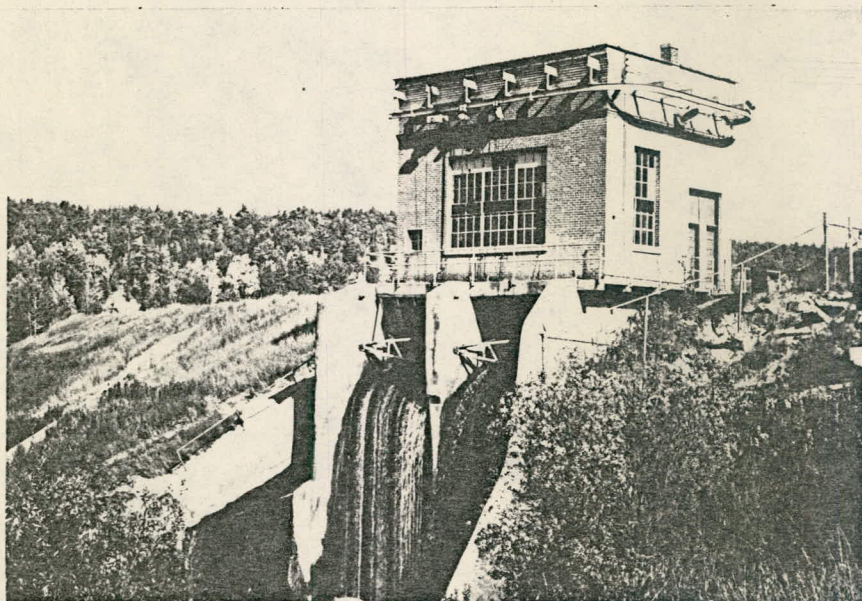


Boardman River looking
downstream at Brown Bridge
Dam.



Spillway outlet, tailrace
and Powerhouse looking North
at Brown Bridge Dam.

Powerhouse looking upstream
at Brown Bridge Dam.





Scale: 1" = 400'

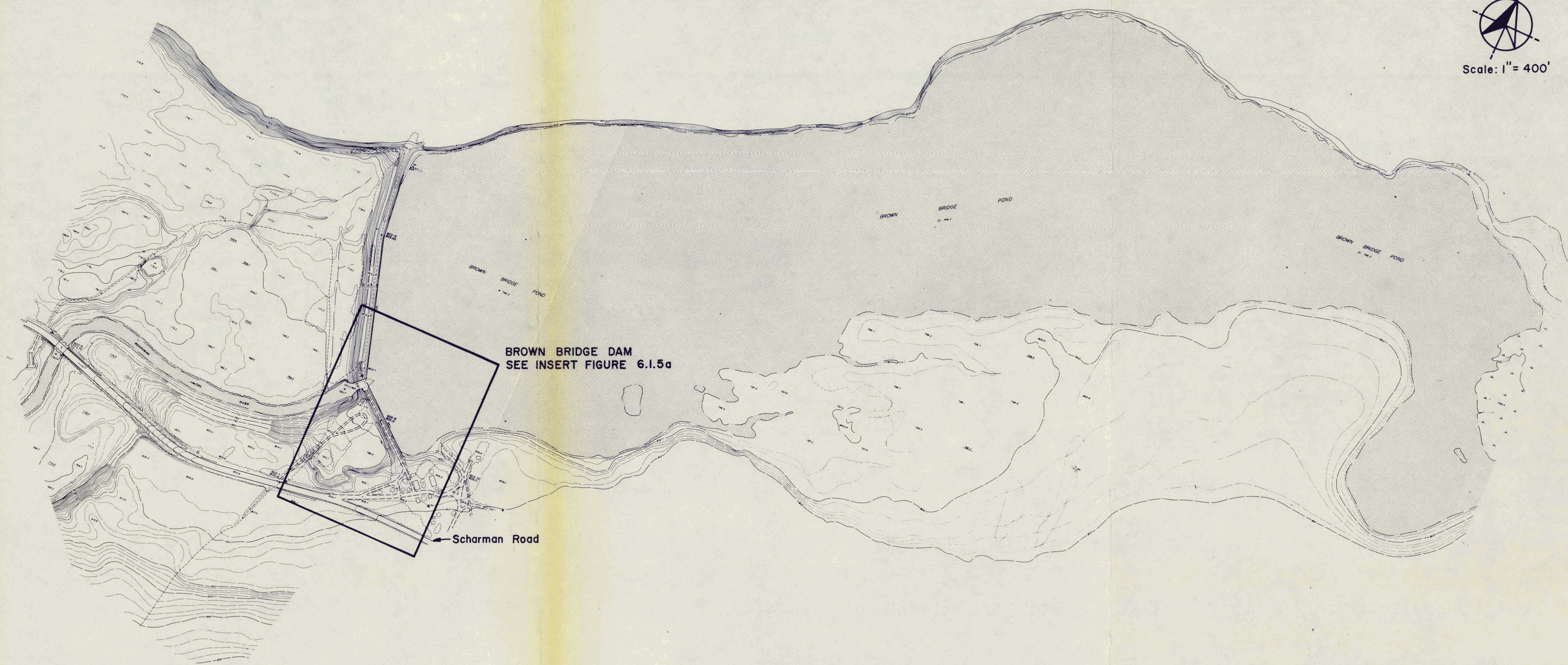
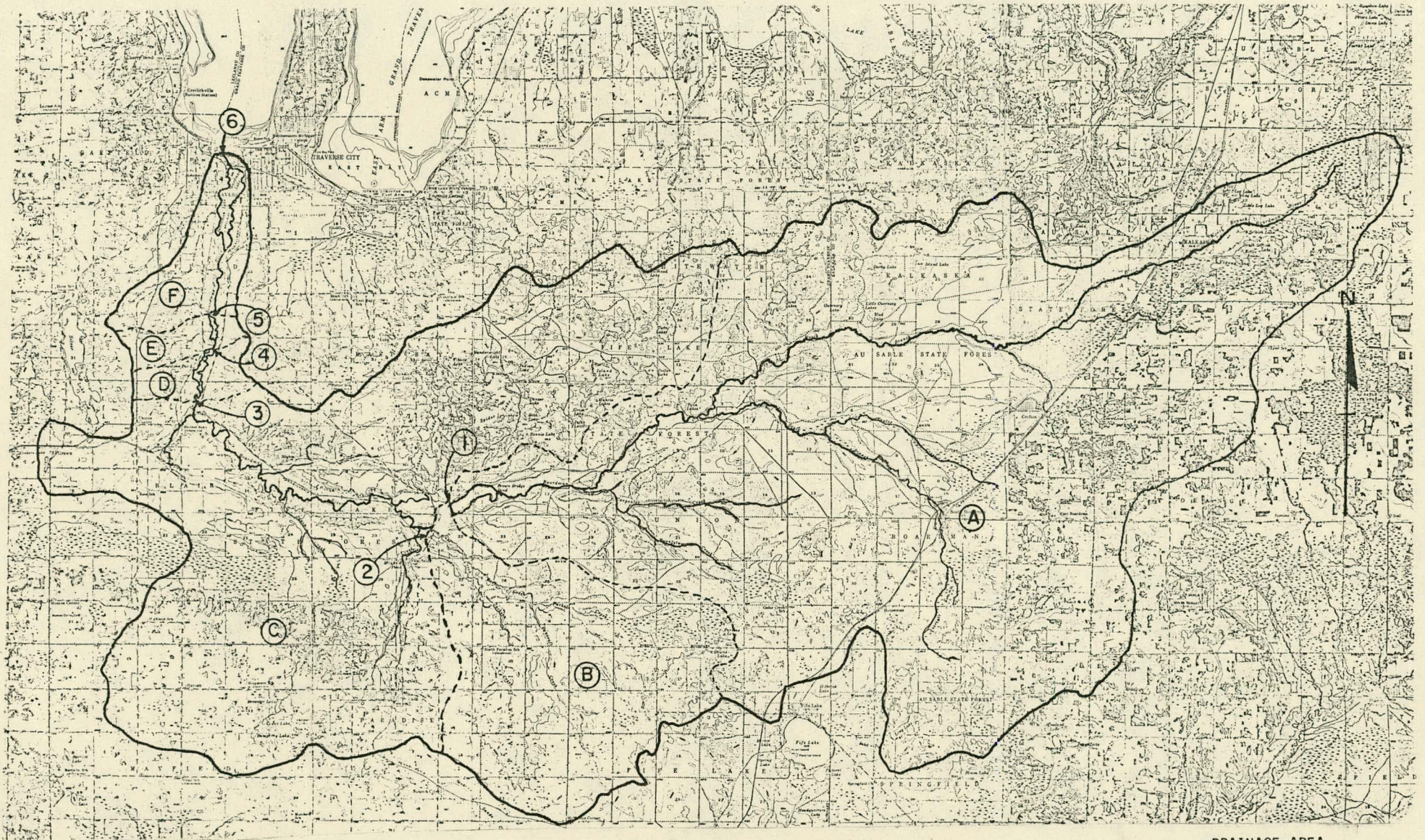
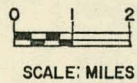


FIGURE 6.1.5d
BROWN BRIDGE DAM
RESERVOIR PLANS



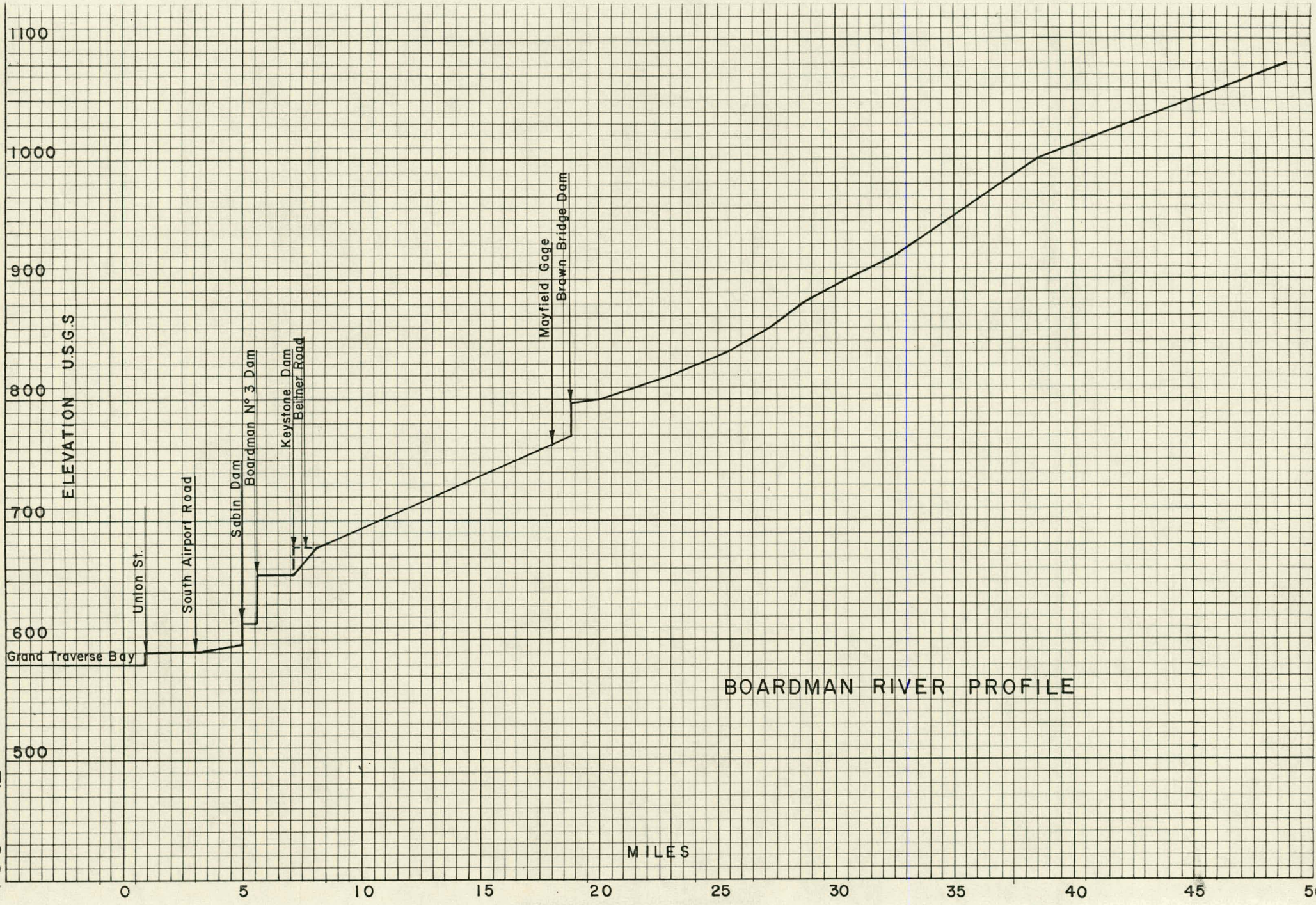
BOARDMAN RIVER
DRAINAGE AREA



SITE

DRAINAGE AREA
SQ. MILE

① Brown Bridge Dam	151	(A)
	+ 30	(B)
② Mayfield Gage	181	
	+ 84	(C)
③ Keystone Dam	265	
	+ 2	(D)
④ Boardman Dam	267	
	+ 2	(E)
⑤ Sab-n, Dam	269	
	+ 7	(F)
⑥ Union Street Dam	276	



BOARDMAN RIVER PROFILE

Figure 6.2 b

BOARDMAN RIVER
MAYFIELD, GRAND TRAVERSE COUNTY
MICHIGAN
FROM FLOW RECORDS 1953-1973

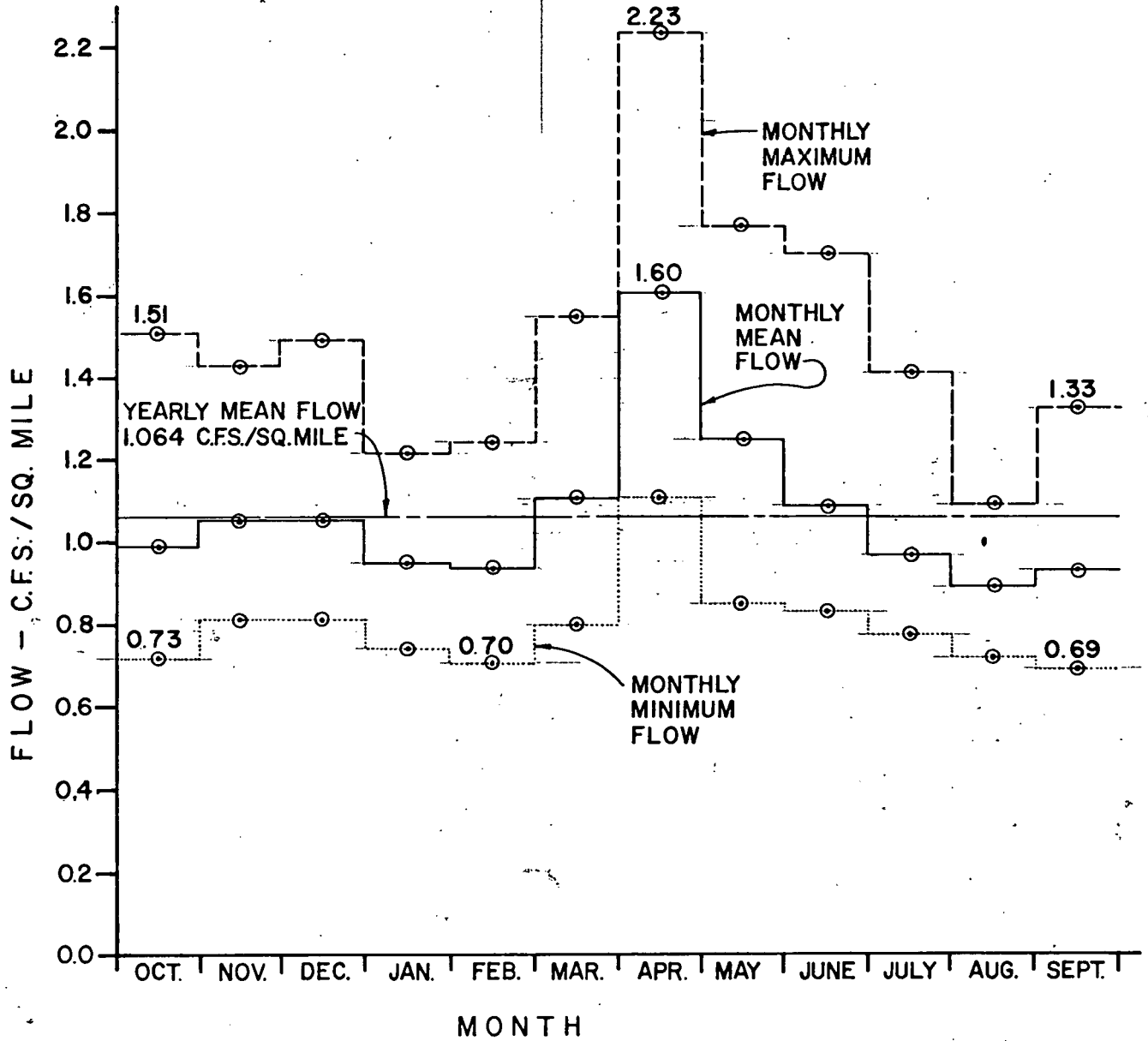


Figure 6.2c
MONTHLY MEAN FLOW

DURATION OF FLOW
BOARDMAN RIVER
AT
MAYFIELD, GRAND TRAVERSE COUNTY
MICHIGAN
FROM FLOW RECORDS 1953—1973

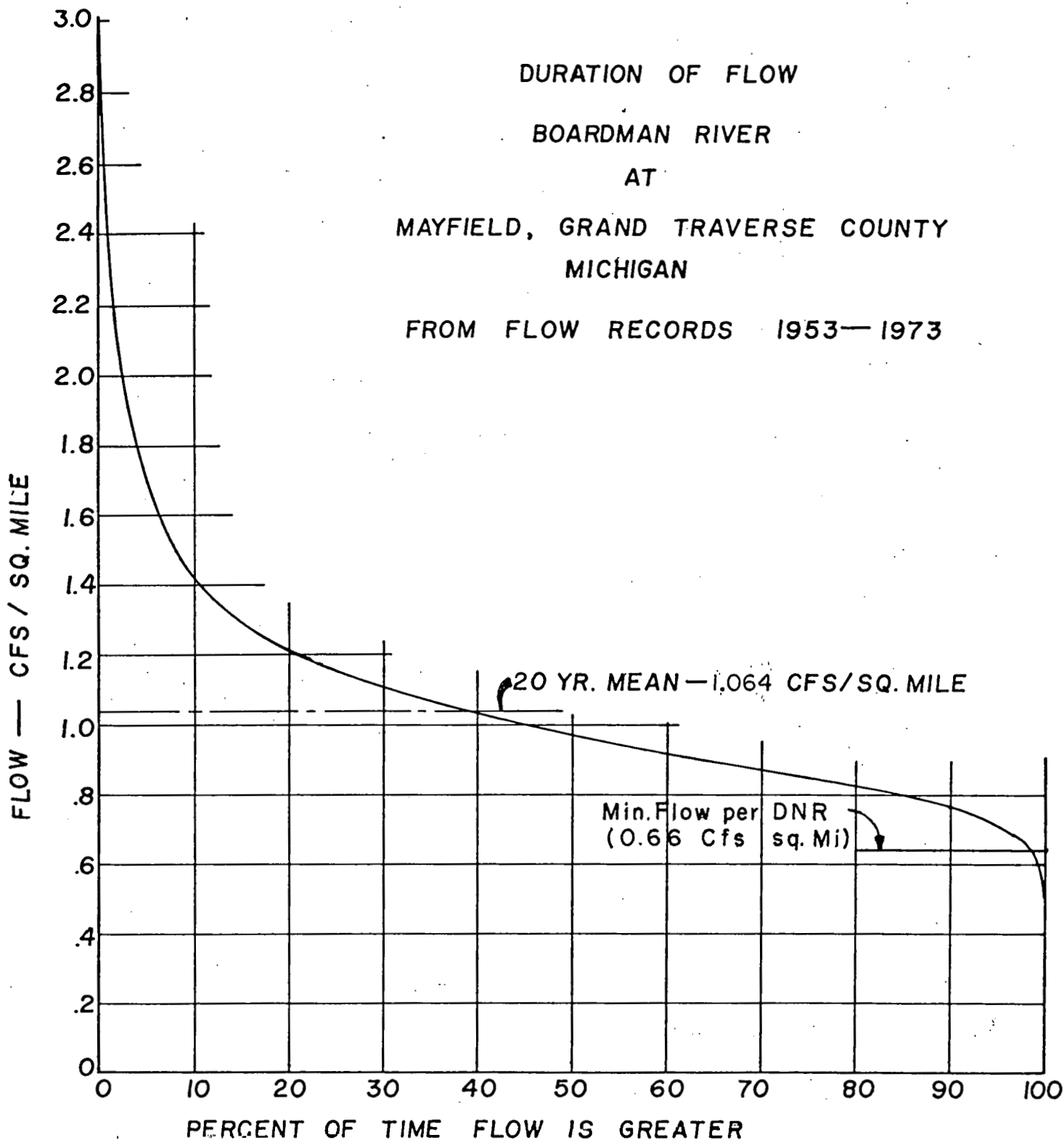


Figure 6.2 d

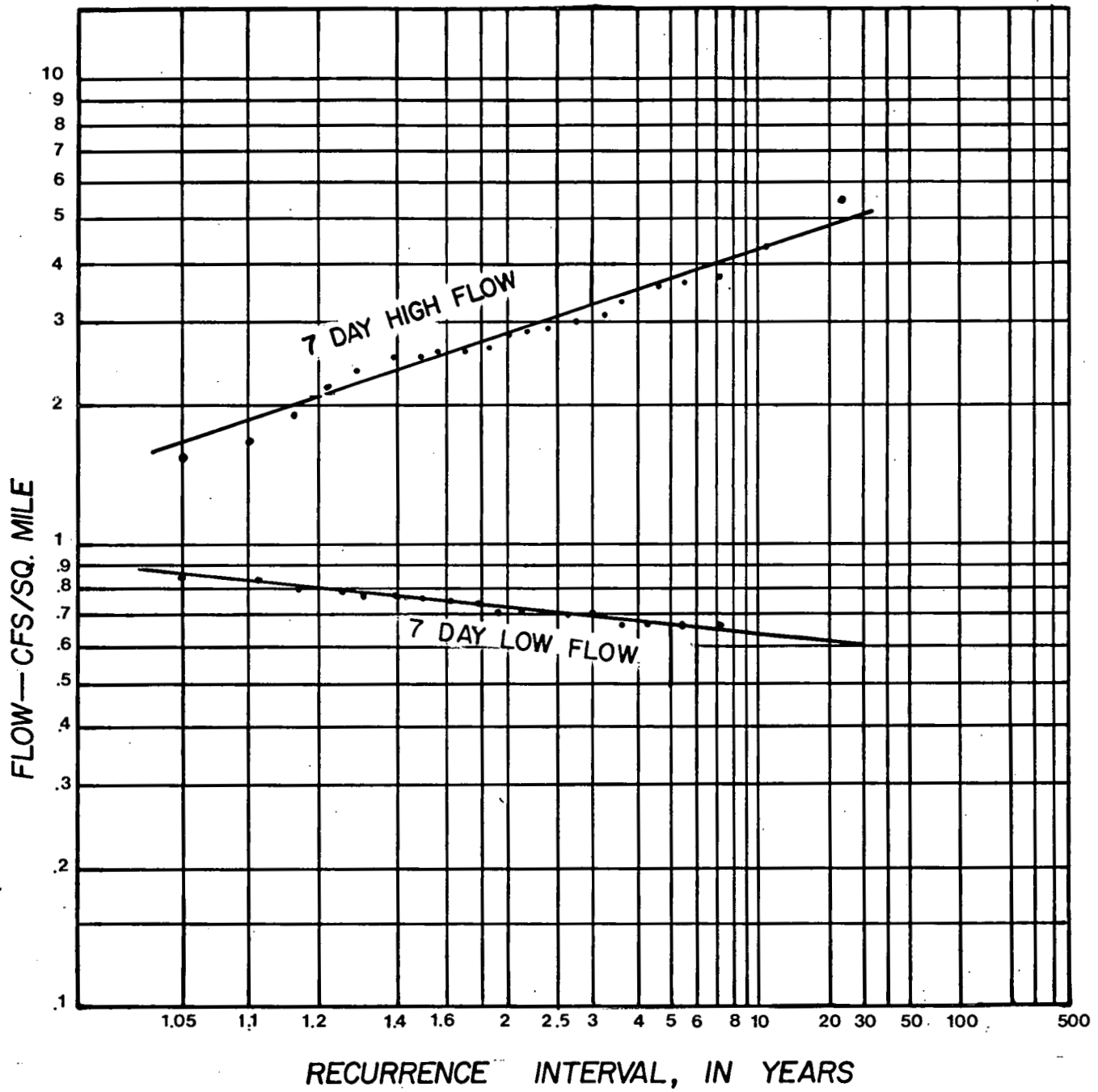
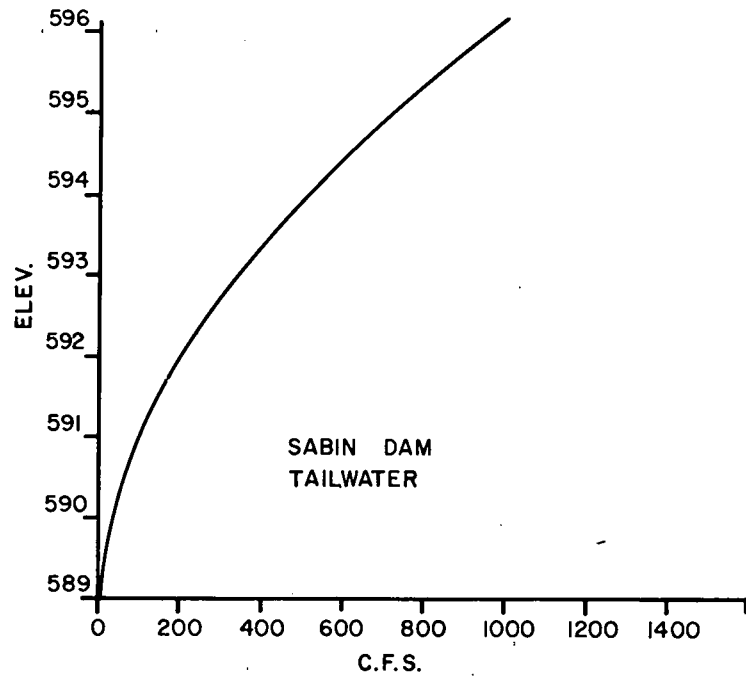
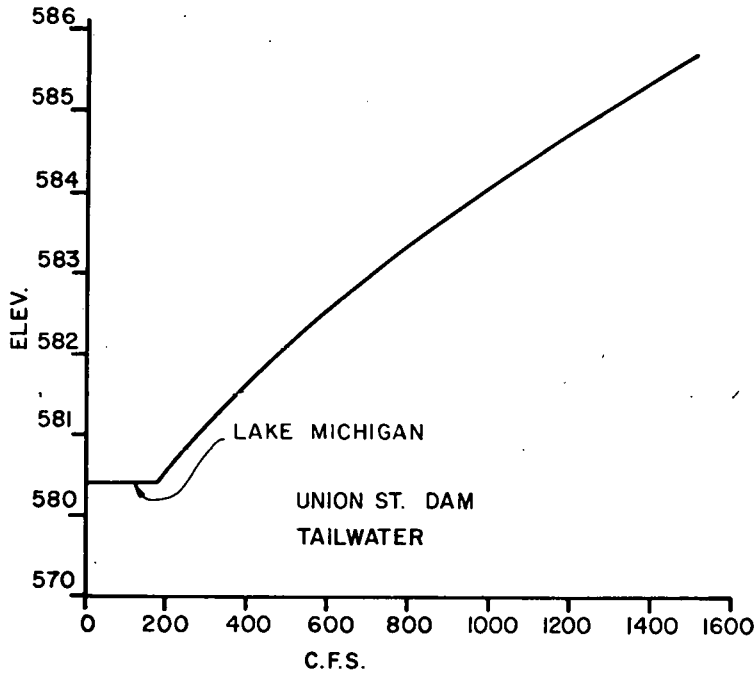


Figure 62e

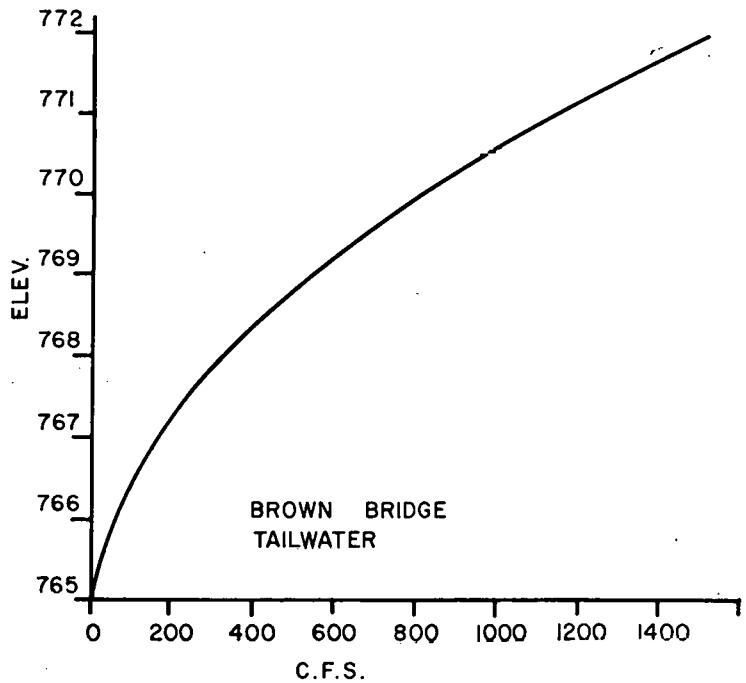
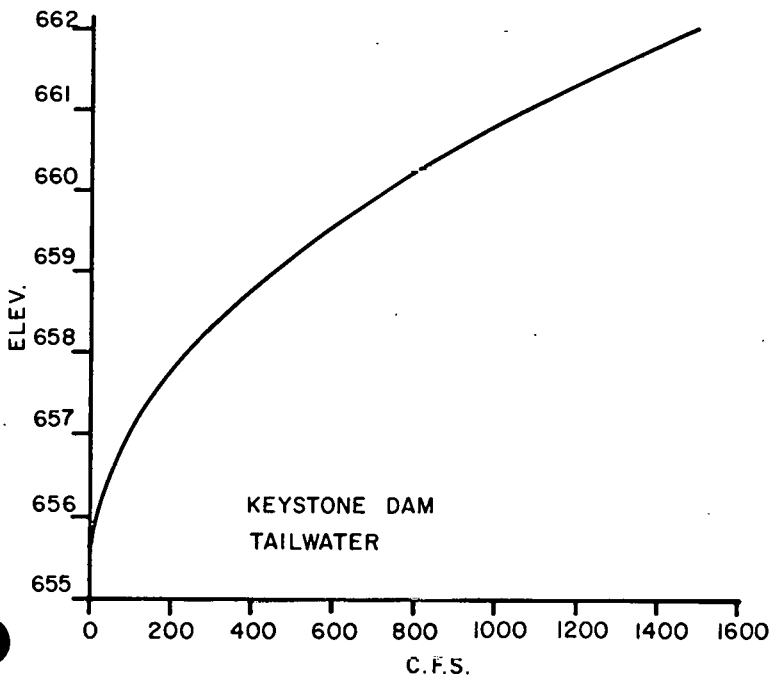
BOARDMAN RIVER HYDROELECTRIC SYSTEM PERTINENT DATA

SITE	STATION Grand Traverse Bay = Sta. 0 + 00	DISTANCE FROM OUTLET MILES	TAILWATER ELEVATION U.S.G.S.	HEADWATER ELEVATION U.S.G.S.	HEAD (ft.)	DRAINAGE AREA SQ. MILES	IMPOUNDMENT AREA ACRES	REQUIRED MINIMUM FLOW-cfs
UNION STREET DAM	48 + 75	0.9	Max. 581.4 Min. 580.4	590.0	Max. 9.6' Min. 8.6'	276	350	183
SOUTH AIRPORT ROAD LOGANS LANDING	164 + 50	3.1	589.0	589.2	—	—	—	—
SABIN DAM	263 + 85	5.0	Max. 593.8 Min. 592.8	613.8	Max. 21.0' Min. 20.0'	269	37	180
BOARDMAN DAM	294 + 70	5.6	Max. 613.8 Min. 613.8	654.8	Max. 41.0' Min. 41.0'	267	81	177
KEYSTONE DAM (WASHED OUT)	385 + 00	7.3	Max. 658.5 Min. 657.5	678.0	Max. 20.5' Min. 19.5'	265	20	176
MAYFIELD GAGE (U.S.G.S.)	946 + 80	17.9	761.3	—	—	181	—	120
BROWN BRIDGE DAM	992 + 45	18.8	Max. 768.2 Min. 766.5	797.5	Max. 31.0' Min. 29.3'	151	191	100

Figure 6.2 f



NOTE: BOARDMAN DAM TAILWATER NOT SHOWN SINCE IT IS EQUAL TO SABIN DAM HEADWATER



BOARDMAN RIVER - STAGE DISCHARGE CURVES

FIGURE 6.2g

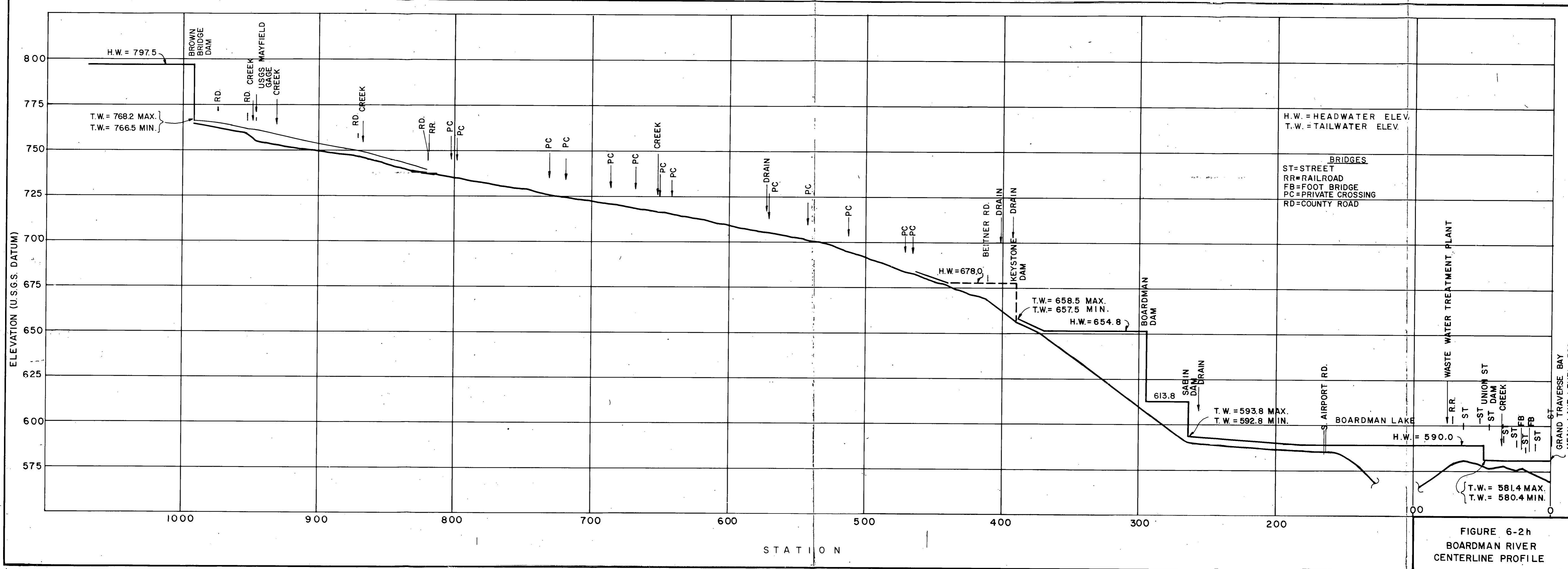


FIGURE 6-2h
 BOARDMAN RIVER
 CENTERLINE PROFILE

6.3 MARKET POTENTIAL

The TCL&P is the most probable user of power generated at the proposed sites. Present generating capacity is 32,300 KW coal and gas fired and 800 KW hydroelectric. Consumption by TCL&P's customers increased at the annual rate of 6.2% from 1974 to 1977. Estimated growth (4% per year) indicates supply capacity must be increased 35,000 KW by 1993. If it is feasible to develop additional hydropower on the Boardman River, development should be undertaken in stages as soon as possible to match load and to defer additional steam generation or bulk purchase until 1982. This would somewhat depend on the peaking capacity available from pondage and controlled flow routing between dams.

6.3.1 PRESENT POWER MARKET

The TCL&P is a principal producer and distributor of electricity in the Traverse City Area (figure 6.3b). In the year ended June 30, 1978, net load was 140,407,000 KWH. 92.47% of this load was generated from steam (coal and gas fired), 1.7% from hydro and 5.83% was purchased from MCP. Peak demand for 1978 was 25,980 KW. Power distribution for 1977 and 1978 was as follows:

Year	% KWH		Number of Customers	
	1977	1978	1977	1978
Residential Customers	21.9%	21.3%	4,951	5,041
Small Commercial Customers	45.4%	44.3%	1,506	1,558
Large Commercial Customers	23.9%	27.8%	9	9
Public Street & Highway Lights	0.8%	0.8%	1	1
Other	3.8%	3.9%	8	8
Sale for Resale	4.2%	1.9%	4	4
	<u>100.0%</u>	<u>100.0%</u>	<u>6,479</u>	<u>6,621</u>

Cherryland R.E.C.A. is also a distributor of electricity in this general area. About 60% of their load is within 12 miles of Traverse City. In 1977, net sales was 106,800,000 KWH. Since Cherryland R.E.C.A. has no generating facilities, all of this power was purchased from Northern Michigan Electric Cooperative, (a member of MCP). Peak demand during 1977 was 22,300 KW.

Consumers Power Company serves a limited area in the vicinity of Traverse City. Specific data on load, demand, and customers in this area is not available. Consumers Power Company generates power in Michigan and distributes throughout the state. The several systems in northern Michigan are interconnected. In 1977, a 138/69 KV - 50,000 KVA interconnection with TCL&P and Northern Michigan Electric Cooperative was installed.

6.3.2 LOAD GROWTH

From 1974 through 1977, annual power send-out of TCL&P and of Cherryland R.E.C.A. increased at an annual rate of 6.4% as follows:

	ANNUAL KWH		
	<u>1974</u>	<u>1977</u>	<u>Annual % Growth</u>
TCL&P	111,285,000	133,300,000	6.2
Cherryland R.E.C.A.	88,100,000	106,800,000	6.6
Total KWH per year	<u>199,385,000</u>	<u>240,100,000</u>	<u>6.4</u>

Load growth prior to 1974 was actually greater (figure 6.3a). The lower rate of 1974 to 1977 is believed to be a result of energy conservation.

Population projections by the Population Studies Center, University of Michigan, in Ann Arbor, indicate a growth rate from 1970 to 2000 of 2.65% per year for Grand Traverse County, of which the service area is a part. Preliminary review of customer growth rate and load growth rate indicate that consumption per customer in Traverse City is increasing at about 5% per year. Since population growth in Traverse City is estimated at less than 1% per year, the adjacent area must be increasing at a rate above 2.65% per year.

Estimates of load growth from 5 to 7% per year are therefore conservative for long term projections. If energy conservation practices are not effective, a 7% rate is more probable.

Peak demand of the study area is estimated as follows:

PEAK DEMAND KW

	<u>1974</u>	<u>1977</u>	<u>Annual % GROWTH</u>
TCL&P	20,340	25,700	8.11
Cherryland R.E.C.A.	<u>18,400</u>	<u>22,600</u>	<u>7.09</u>
Combined	38,740	48,300	7.62

For unknown reasons peak demand appears to be increasing at a faster rate than annual consumption.

6.3.3 PRESENT POWER SOURCES

The power sources for the general area are TCL&P generating facilities, generating facilities of the members of the Michigan Cooperative Pool (MCP) and Consumers Power Company. The principal source for the study area is the TCL&P facilities. Capacity of these facilities is as follows:

Nameplate Capacity	32,300 KW
Practical Maximum Capacity	26,250 KW
Normal Operating Capacity	19,650 KW
Firm Capacity (Largest Unit Inoperable)	12,750 KW

Under the MCP agreement nameplate capacity must provide 17.5% reserve. Based upon present nameplate capacity, TCL&P with this reserve has capacity for a peak demand of 26,650 KW. Unless the growth in peak demand slows, the peak demand capacity of TCL&P will be exceeded before

1980. The need for expanded or alternate power sources for Traverse City is urgent. The power source study, near completion, projects a 35,000 KW deficiency in 1993 (4% Load Growth). Presently, coal for power generation is transported in over long distances, purchased power must be wheeled over several hundred miles, and natural-gas costs are increasing. The no fuel power potential is particularly attractive.

Full development of hydroelectric power at the five sites will result in fuel savings estimated as follows:

	<u>Per Year*</u>
Union Street	\$ 33,745
Sabin	74,131
Boardman	147,190
Keystone	71,270
Brown Bridge	<u>64,561</u>
TOTAL	\$390,898

*Based on 1978 fuel cost.

6.3.4 FUTURE SOURCES

The power source study nearing completion is evaluating all reasonable sources of power to satisfy projected load growth. Among those considered were power purchase, additional steam generation (coal, wood chip, oil, gas), cooperative generation with other municipal and private power companies, purchases of blocks of capacity of major plants in Michigan which are under development.

The best alternate without hydro-power appears to be acquiring shares of large plants. The estimated cost for KW is \$1,152.00 with an average cost per KWH of 44.6 mils in 1990.

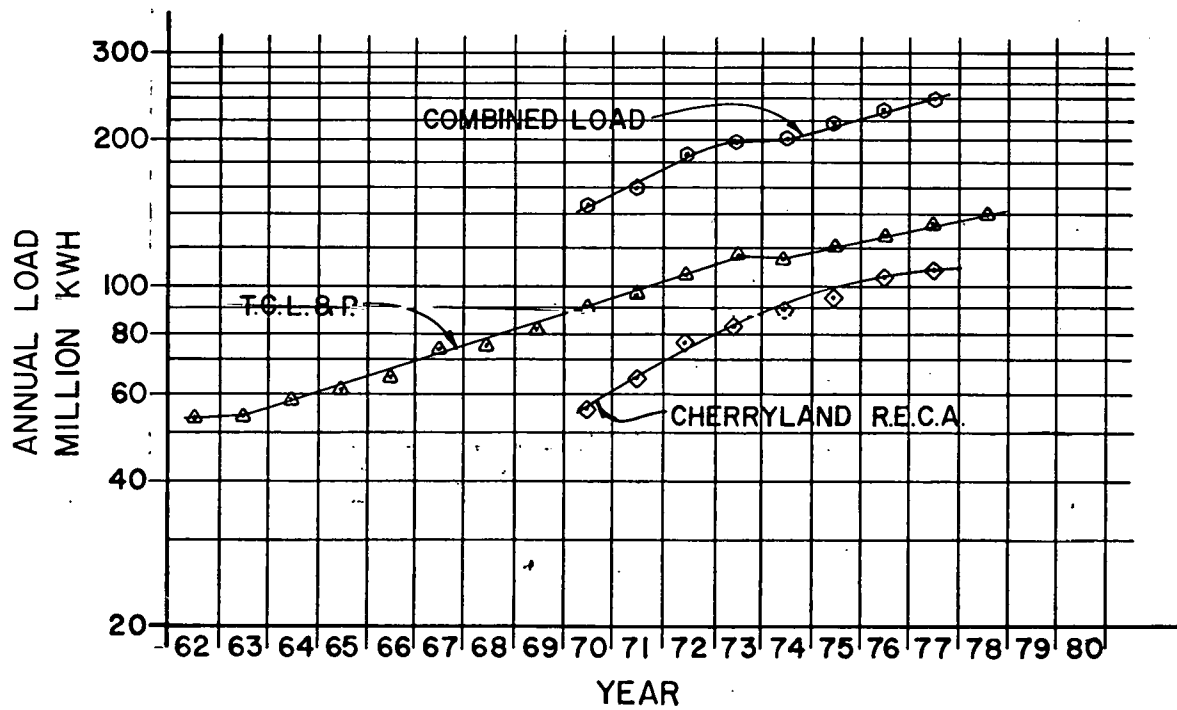
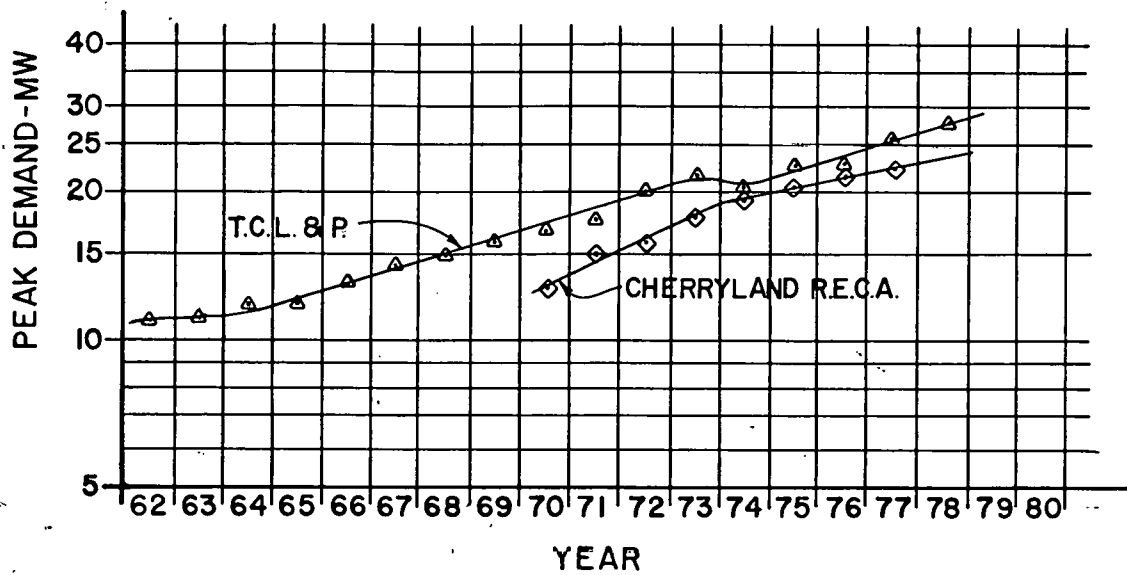


Figure 6.3a
 DEMAND & LOAD GROWTH
 IN
 TRAVERSE CITY AREA

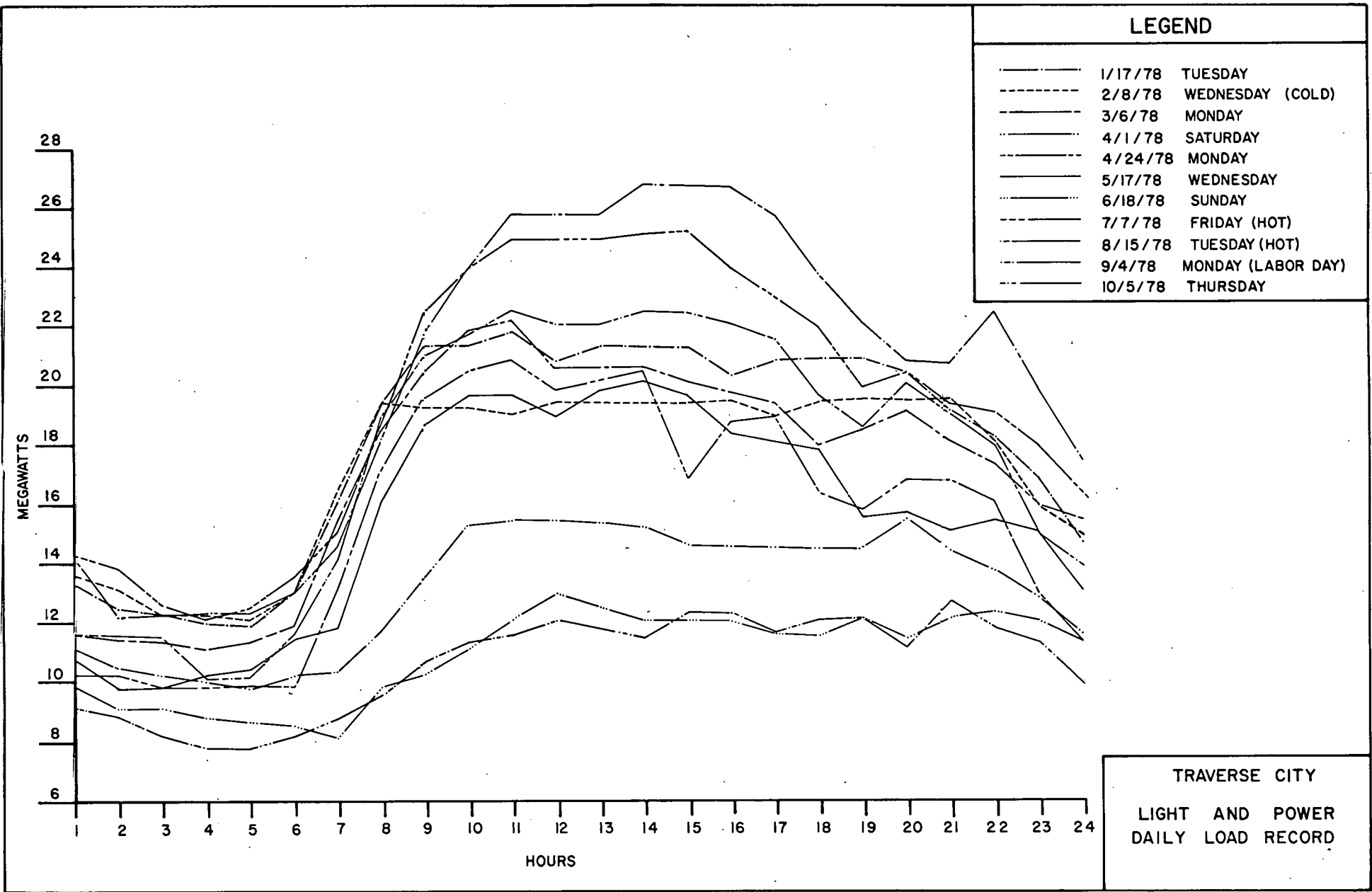


Figure 6.3 b

6.4 HYDROELECTRIC EQUIPMENT

Analysis of equipment data and costs furnished by manufacturers indicates that maximum economic turbine capacity at the five sites is about 1.3 cfs per square mile of drainage area at each of the dams. Equipment cost per KW depends greatly on head at the dam and the maximum flow. Installed cost depends greatly on the amount of powerhouse reconstruction necessary.

At Boardman and Sabin Dams, minimum installed cost is obtained by using two vertical fixed blade propeller type units at each dam. This is most feasible because a minimum of powerhouse reconstruction is required since the existing waterways are suitable for equipment installation. Union Street and Keystone Dams have no existing powerhouse structure. A single unit with variable pitch propeller blades results in a minimum of powerhouse construction and provides good efficiency over the range of flow indicated by economics and environmental concerns.

Brown Bridge turbines are operating satisfactorily and no significant benefit could be determined by replacing the units in the foreseeable future.

Hydroelectric characteristics are summarized in Figure 6.4a. The power potential at the five dams exceeds 17,500,000 KWH per year. About 78% of this is base load and about 22% is peak load energy. The potential capacity is in excess of 2,970 KW. About 45% of this is base load

capacity and about 55% is peak load capacity. If fish passages are installed and used, 1,365,700 KWH per year of power is lost and a value of \$40,971. per year at 3¢/KWH. In the final equipment selection, the fish passage water consumption should be considered and may reduce the sizing of turbines.

6.4.1 INVESTIGATION OF EQUIPMENT SOURCES

Correspondence with ten manufacturers of hydroelectric turbines and generators were conducted. This resulted in preliminary discussions with seven of the manufacturers of equipment and detailed discussion with five of the original ten. Final evaluation study was conducted on two turbine types because of the configuration of the five different dams. Characteristics of the sites indicate that fixed blade propeller type turbines would be suitable and most economical at Boardman and Sabin Dams. Variable pitch propeller type turbines appear to be most suitable for Keystone and Union Street Dam sites. Detailed inspections of all of the dam sites resulted in a conclusion that Brown Bridge turbines and generators were in satisfactory condition showing no evidence of cavitation or significant wear.

6.4.2 RESULTS OF THE INVESTIGATION

While comparative cost data between different manufacturers of similar equipment was unobtainable, costs of different types of equipment could

be compared as well as performance characteristics and cost of installation. The following criteria were used are indicated for the selection of equipment.

(1) Install the least number of units within constraints of minimum flow and peaking possibility.

(2) Avoid significant changes in powerhouse configuration because of the high cost of structural modification when compared to reasonable costs of different equipment sizes and types.

(3) Avoid a high cost for generators by using higher turbine speeds or speed increasers. (This results in a preference for propeller type turbines rather than reaction wheels.)

(4) When the cost of on site construction is high, some economy from package or standardized units is attainable.

6.4.3 EQUIPMENT SELECTION

The hydroelectric characteristics of each dam site were determined from flow duration curves reduced to a cfs per square mile based upon hydrologic data from Mayfield Gauging Station (Figure 6.2d). Specific constraints on turbine flow due to environmental factors (see Section 6.8) are as follows:

(1) Fish passage when provided at a dam require a 25 cfs diversion through the fish passage at all times.

(2) Flow in the river must be maintained in proportion to 120 cfs at Mayfield (.66 cfs per square mile) when natural flow in the stream exceeds this amount.

(3) Variations in pond level must be kept to a minimum to prevent conflict with other established uses on the ponds including recreation, and wildlife, the wastewater treatment plant in Traverse City and bank erosion. No specific limit or range was established by the DNR, however, a range of one foot seems to be tolerable.

(4) Maximum turbine flow at each individual dam is established by economics. However, because of the close proximity of Keystone, Boardman and Sabin, flows through any one of them must be passed through the other or wasted over the spillway. Each additional KW of capacity, while costing less per KW, produces fewer KWH per year, and therefore has less economic value. Economic analysis based on current turbine cost information, flow duration curve data, a revenue of 3¢/KWH, and a turbine capacity at all dams of 1.3 cfs per square mile, will provide a 6 1/2% rate of return.

(5) Stored power is of some significance when the 5 dams are operated in conjunction with each other. The large reservoir at Brown Bridge and the large reservoirs at Boardman and Union Street permit the discharge

of water through all of the dams during the peaking period using the storage at Brown Bridge and Boardman to provide peaking capacity at Keystone and Sabin. The total pond area of the system is 679 acres. Stored power per foot of draw on all reservoirs is 8,550 KWH per ft.

(6) Analysis of the load curve for TCL&P indicates the maximum duration that peaking is needed or usable is about 16 hours.

BROWN BRIDGE

At Brown Bridge Dam the two Francis turbines, in place, are in satisfactory condition and have excellent performance characteristics in terms of efficiency. The larger turbine rated at 690 horsepower (515 KW) at a flow of 252 cfs and a head of 29 ft. was originally installed in 1921. This turbine is quite suitable for handling peaking loads and high flows. The second turbine installed in 1941 to replace the original turbine is of smaller capacity, 375 horsepower (280 KW) at 135 cfs and 29 ft. This turbine would perform satisfactorily at the minimum flow of 100 cfs required.

KEYSTONE

At Keystone Dam, if it is reconstructed, the minimum turbine flow would be 176 cfs. When handling 1.3 cfs per square mile, the maximum flow to the turbine would be 344 cfs. This would require the turbine to operate over the range of 241 to 466 KW. With a single turbine installed

at this installation tentative selection is a 1250 millimeter horizontal, adjustable blade propeller, standard tube turbine. Such a unit, as manufactured by Allis Chalmers, is rated at 445 KW under a net head of 21 ft. and would discharge 287 cfs. The unit would be coupled to the generator with a speed increaser providing a generator speed of 900 rpm. An air operated clutch would disconnect the generator at 25% overspeed. Approximate efficiency is 81% (turbine 87%, gear box 98%, generator 95%).

BOARDMAN

At Boardman, the minimum flow is 177 cfs and maximum flow is 347 cfs. At a head of 41 ft. the minimum capacity would be 489 KW, maximum capacity would be 963 KW. The structure at this installation is suitable for the installation of two turbines, one to handle the minimum flow and the second, in conjunction with the first, to handle the maximum flow. Both units would be vertical propeller type turbine units installed in the existing concrete pressure flume. At a flow of 175 cfs and a head of 41 ft. each unit would operate at a speed of 600 RPM and a rating of 610 KW. Since these units are fixed blade propeller units they should be operated near their rated capacity for maximum efficiency. Overall efficiency should be about 81% (turbine 85%, generator 95%).

SABIN

At Sabin Dam the minimum turbine flow is 180 cfs, maximum turbine flow is 349 cfs. At a head of 20 ft. this will produce a minimum capacity of 250 KW and maximum 484 KW. Tentative selection is two vertical propeller type turbines installed in the open flumes. The first turbine with a rating of 335 KW and a discharge of 175 cfs will operate at a speed of 300 rpm. The second unit would have a similar rating. The two together would discharge the maximum turbine flow of 350 cfs. Overall efficiency should be about 81% (turbine 85%, generator 95%).

UNION STREET

At Union Street, the minimum flow is 183 cfs, and the maximum flow is 359 cfs at a head of 9.1 ft. Tentative selection is a single 1750 mm horizontal, adjustable blade, propeller, standard tube turbine as manufactured by Allis Chalmers. This unit would be rated at 195 KW with a flow of 312 cfs and at a head of 9 ft. Overall efficiency is estimated at 81% (turbine 87%, gear box 98%, generator 95%).

Specific data on hydroelectric equipment selected as well as a summary of hydroelectric characteristic is tabulated in Figure 6.4a.

SUMMARY OF HYDROELECTRIC CHARACTERISTICS

	Unit	Union Street Dam	Sabin Dam	Boardman Dam	Keystone Dam	Brown Bridge Dam	Total
Drainage Area	Sq.Mile	276	269	267	265	151	
Max. Flow (4)	Cfs	359	350	347	345	403	
Min. Flow	Cfs	183	180	177	176	100	
Max. Head Water	Elev.	590.0	613.8	654.8	678.0	797.5	---
Max. Tail Water	Elev.	581.4	593.8	613.8	658.5	768.2	---
Min. Tail Water	Elev.	580.4	592.8	613.8	657.5	766.5	---
Max. Head (at Base Load) (1)	ft. (1)	9.6	21.0	41.0	20.5	31.0	123.1
Min. Head (at Peak Load) (2)	ft. (2)	8.6	20.0	41.0	19.5	29.3	118.4
Pond Area	Acres	350	37	81	20	191	679
Power Potential	(@ 80% eff.)						
Min. Capacity	KW	120	255	490	240	210	1,315
Max. Capacity (5)	KW	220	490	970	470	830	2,980
Base Power	KWH/yr.	1,220,000	2,680,000	5,322,000	2,577,000	1,875,000	13,674,000
Peak Power	KWH/yr.	289,000	635,000	1,260,000	610,000	1,012,000	3,806,000
Annual Power	KWH/yr.	1,509,000	3,315,000	6,582,000	3,187,000	2,887,000	17,480,000
Stored Power (3)	KWH/ft (3)	2,610	620	2,720	330	4,720	8,550
Fish Passage	KW	16	36	69	35	---	156
Losses	KWH/yr.	142,350	311,400	607,950	304,000	---	1,365,700

- (1) Max. H.W. El - Min. T.W.El.
- (2) Max. H.W. El - Max. T.W.El.
- (3) Pond Area x Aver. Head x 0.8193.
- (4) At 15% of Time Exceeded except Brown Bridge which is existing capacity.
- (5) At Average Head & Max. Flow.

6.5 ECONOMIC AND FINANCIAL CONSIDERATIONS

Historic trends in inflation indicate the general economy can be expected to inflate at 4% per year over the life of the project. Bond rates will range from 6¼% to 7% depending on the bond term, from 15 to 25 years. Of particular concern, however, is the inflation rate in energy costs. During the life of the project, the price of gas can be expected to inflate 10% per year, coal 8% per year, and electricity costs 5% per year. Evaluation of the feasibility of hydroelectric generation on the Boardman River must be made considering these inflation trends. The 8% rate is likely since coal is the major fuel at TCL&P. However, proper planning and acquisition of low fuel cost power sources may make the 5% rate realistic. Consideration of inflation in the comparison of alternates by Present Worth Net Cash Flow & Rate of Return is essential for proper judgement. Other economic considerations such as market potential, are treated in Section 6.3, indicating a steady increase in demand for electricity in the area adjacent to the river (TCL&P Service Area). The need for future bond issues to provide new power sources suggest that rate increases should be given early consideration.

6.5.1 ECONOMIC CONSIDERATION

An evaluation of alternate ways of generating power should consider inflation rates in costs of operation, fuel and also provide some measure of net income to be applied against future major capital improvements. Such net income over and above inflation should reasonably be expected to be from 5% to 6%. For comparison, the alternates in this study should be based upon 6% net income.

In order to compare alternate ways of providing power which involve

different initial investment and operating costs, the "Present Worth of the Net Cash Flow" at some discount rate is the most relevant measure of financial feasibility. If the present worth of all cash expenditures is subtracted from the present worth of revenue during the life of the project, the balance remaining is the equivalent amount of money invested today at the designated discount rate such that it will produce the same cash balance as the project at the end of the project. Therefore, the project with the largest positive "Present Worth Net Cash Flow" is the most attractive economic alternate. Since hydroelectric generation involves a large initial investment, little operating cost and no fuel cost, the hydro alternate is being compared with lesser investment in a high fuel cost alternate with fuel cost escalating at a rate greater than the general economy, special consideration must be given to the escalation rate of energy cost relative to the general price level. Tabulated below is an analysis of inflation rates. Rates have been selected to apply to the revenue to give the present worth of the net cash revenue flow in terms of inflating energy costs.

During the past 20 years, costs have inflated at the rate of 4 to 10%, per year. This inflation rate should be considered in projecting the long term cost of the hydroelectric alternates. Tabulated below is a derivation of the rates to be applied to the present costs of anticipated work as it related to expected net income, general and energy inflation rates, and life of the project.

RATE OF INFLATION

(From U.S. Department of Labor Statistics)

1943 - 1978

Year:	1943	'48	'53	'58	'63	'68	'73	'78	10 Year Rate	20 Year Rate	Rate to be Used
Wholesale Price Index	53.3	82.8	87.4	94.6	94.5	102.5	134.7	212.3	7.5	4.1	4.0
Coal	49.3	83.3	88.5	96.5	93.8	103.7	218.1	442.7	15.6	7.9	8.0
Gas	--	--	--	76.1	91.8	92.7	126.7	431.5	16.6	9.1	10.0
Elect.	--	--	--	99.7	101.3	100.9	129.3	252.7	9.6	4.8	5.0

If gas was the major fuel used in power generation electric rates would rise at about 10% per year. Since coal is the major fuel at TCL&P, rates can be expected to rise at 8% per year. However, power purchased from major generation sources using nuclear, hydroelectric, and other lower cost sources in conjunction with coal will have an inflation approaching 5%.

Another parameter used in evaluating alternate investments is called the "Rate of Return". Using the principles of "Present Worth Net Cash Flow" of all the expenditures and revenues involved in a project, if the net income rate is increased such that the present worth of the net cash flow becomes zero, the increased rate is called the "Rate of Return". The value of Rate of Return is the interest rate necessary to equal the net income provided by the project. The project with the greatest Rate of Return, therefore, is the best from an economic point of view.

A third parameter is used to evaluate projects which have an element of risk which is called the "Payout Period". It is the number of years required to return the initial investment plus annual expenses including interest. This parameter is used when a project may have a relatively

short life or an indeterminate life. This approach is not considered relevant to hydroelectric installations, since the demand for the electricity can be expected to exist many years.

Since load projections for the Traverse City area indicate a constantly increasing demand for power, consideration of possible overbuilding is unnecessary. All of the power to be generated by the proposed hydroelectric facilities is a small fraction of the TCL&P load (See Section 6.3).

Other economic benefits of the hydroelectric facilities on the Boardman River are as follows:

1. Stabilization of electricity costs by isolating them from fuel cost.
2. Pondage provides some peaking capacity (8,550 KWH per day est.)
3. Conversion of the dams to hydroelectric generation and transferring dam maintenance cost to hydro expense reduces the General Fund expenses of Grand Traverse County (maintenance of Boardman and Sabin) and Traverse City (maintenance of Union Street).

6.5.2 FINANCIAL CONSIDERATION

Consultations with the bonding consultants for the City of Traverse City has indicated that bonding for hydroelectric up to \$9,000,000 is not unreasonable. The following is a table of interest rates and bond terms for the various levels of bonding that might be used:

<u>Bond Amount</u>	<u>Term</u>	<u>Interest Rate</u>
\$0 - \$3,000,000	15 years	6 1/4%
\$3,000,000 - \$5,000,000	20 years	6 3/4%
\$5,000,000 - \$9,000,000	25 years	7%

The above rates should be used to determine the annual bond payment in

the economic analysis of the various alternates.

The operation and maintenance of hydroelectric facility involves certain periodic major expenditures including equipment replacement, regular and thorough inspections of the dams and turbines, and major repairs to the dam and the impoundment or reservoir. These should be considered as occurring at 5 and 10 year intervals. Funds should be set aside annually accruing as a cash reserve for these expenditures. Annual deposits to this reserve account should accrue interest at the rate of 5%, the probable interest rate at the bank. In addition, an allowance of money in the reserve at the termination of the project (called decommissioning costs) should be available. This should also be handled as an annual payment into a reserve account bearing interest at 5%.

While a \$9,000,000 bond issue is not considered unreasonable, the need for additional bond issues for long term power source purchases is indicated in the power source study nearing completion. Consideration of rate increases must be made in the near future.

6.6 WATER RESOURCES NEEDS AND RESERVOIR USES

The Boardman River water uses are outlined in the Boardman River plan:

"The Michigan Water Resources Commission has established by administrative rule intrastate water quality standards and use designation for the Boardman River. It is to be protected for recreation-total body contact (i.e., swimming); intolerant-cold water species; industrial water supply; agricultural and commercial water supply and other uses. The water is to be protected for more than one use under these standards, the most restrictive individual standard of designated water use applies. Also, if existing water quality is superior to the designated use requirements, it must be maintained at that level until it has been adequately demonstrated to the Michigan Water Resources Commission that the change in quality does not or will not become injurious to the public health, safety or welfare, or become injurious to any other uses being made of such waters."

Studies conducted on the Boardman River by the Bureau of Water Management Staff, DNR, indicate that the quality of waters within the Boardman River basin meet or exceed all standards, as mentioned above, established for the river. The villages of South Boardman and Mayfield are on septic-drainfield systems and the Village of Kalkaska disposes of its waste by land disposal methods. Traverse City operates a modern wastewater treatment plant. Secondary treatment of waste removes more than 80% of the phosphorous before the effluent is discharged into the Boardman River just below Boardman Lake.

Except for the impoundments on the main stream (classed as top quality warm water), the river above Boardman Pond to "the forks" is classified as top quality trout water. The north and south branches and most of the tributaries are classified as top quality trout tributaries.

The most extensive land uses in the watershed are forestry and recreation. The glaciated topography and sandy soils of the Boardman River watershed limit agricultural activities. Where soils are more productive and slopes are more gentle as in the southern portion of the watershed, a fair degree of success has been obtained with dairy farming. Abandonment of non-competitive farms in the northern part of the state has been a trend of long standing. Some farms, especially in Kalkaska County, have been re-established as tree farms supplying a substantial share of the nation's Christmas trees.

Only one public access site is located on the river. Additionally, access is provided at the three campgrounds from Brown Bridge Pond up to the Forks. Access to the stream is also provided for fishermen over state lands in the upper reaches of the river and at several county road bridges.

Fishery and Wildlife Uses

As a trout stream, the Boardman ranks among Michigan's top ten. Above Brown Bridge Dam, the Boardman River is a top quality, moderate size

trout stream flowing through the Fife Lake State Forest. It contains excellent populations of small to moderate size brook and brown trout. Brown trout in the 10 to 13 inch size-range are abundant. Considerable public ownership and scenic terrain make the stream a pleasant one to fish. The bottom is firm sand and gravel and the stream is relatively swift.

Below Brown Bridge Dam, the stream widens but it still has a rapid flow over a gravel and sand bottom. Brown trout dominate the fish population. Their numbers are somewhat less than their food supply will support as natural reproduction is impaired by Brown Bridge Dam. The Boardman is still a fine trout stream, however, all the way down to the Boardman Hydro Pond.

The lower part of the river within the confines of Traverse City receives substantial runs of steelhead, lake trout and salmon seasonally migrating upstream to the Union Street Dam. The impoundments on the river, particularly Brown Bridge Pond and Boardman Lake (actually a natural lake), support typical warmwater fish populations.

Nearly all of the Boardman's numerous tributaries are top quality trout waters and important nursery streams, with the more sizeable ones supporting considerable trout fishing of their own.

Major game species in the area include white-tail deer, squirrels (black and gray and fox squirrels), cottontail rabbits, snowshoe hare,

ruffed grouse, many species of waterfowl and shorebirds. The mute swans found in the Traverse Bay area are a particular attraction for bird watchers. The bay area and Boardman River are the only major wintering areas in Michigan for the non-native swan.

The river is not large or consistently deep enough for boating. Therefore, boating is restricted to the three impoundments, Boardman Lake, and the extreme lower reach of the river at Traverse City.

The Boardman River is used extensively by canoeists.

Operating the five dams on the Boardman River as a co-dependent hydroelectric system provides benefits to the river of an environmental nature. Water resource management such as impoundment level stabilization and flood control can be realized in a managed system, whereas the present conditions make such benefits difficult to achieve.

6.7 ENVIRONMENTAL CONCERNS

The Boardman River, like most rivers, especially those in the northern regions, is environmentally sensitive and therefore subject to social controls and public acceptance of alterations in river use; therefore, environmental concerns are an important part of this feasibility study. A complete Environmental Impact Statement (EIS) is not within the scope of this report. However, environmental concerns which could directly affect the feasibility of this project are carefully examined.

Operating the five dams on the Boardman River as a co-dependent hydroelectric system provides benefits to the river of an environmental nature. Water resource management such as impoundment level stabilization and flood control can be realized in a managed system, whereas the present conditions make such benefits difficult to achieve.

6.7.1 ENVIRONMENTAL IMPACT STATEMENT

If rehabilitating the dams on the Boardman River is undertaken, a complete EIS should be prepared for review by the DNR and Michigan Environmental Review Board (MERB). Discussion of environmental issues in this feasibility study is intended to identify possible problem areas. The cost of preparing an environmental impact statement and the amount of time anticipated to gain approval is considered in the economic feasibility assessment.

6.7.2 WILDLIFE

The wildlife species found in the area of the Boardman River are the same as those found in other areas of northern Michigan. There is no record of any threatened or endangered plant or animal species in the area and no eagle or osprey nests are known to exist in the area.

Generating hydroelectric power on the Boardman River should have no significant impact on wildlife, with the exception of the upper end of the Boardman Lake (at Logan's Landing) where the main concern is a colony of mute swans and other waterfowl.

In the event of hydroelectric power generation, the following precautions should be implemented.

- a. Sufficient flow must be maintained to keep the estuary at the upper end of Boardman Lake free of ice to provide wintering habitat for the waterfowl in the area.

- b. Lake level fluctuation at Boardman Lake must be controlled such that waterfowl food resources at the upper end of the lake are not impaired. Of note is that there is a lot of feeding by people visiting the area, utilizing the park and boat launch facilities.

6.7.3 FISHERIES

A list of fish species in the Boardman River was furnished by the DNR

during correspondence with that department. No threatened or endangered species are currently known to exist in the Boardman River.

Salmon fishing is an important, but controversial, asset to the community the short reach of the river downstream from Union Street Dam to Grand Traverse Bay. It is not expected that the flow characteristics in this reach would be materially altered to have an impact on sport fishing.

Fisheries is a major consideration in establishing minimum flow for Boardman River. Minimum flow has been established by agreement with the DNR at 120 cfs at the Mayfield U.S.G.S. gage. At the individual dam sites it is to be proportional to the respective drainage areas.

Turbine mortality, according to the DNR, has not been a problem at other hydroelectric sites, but the effect on migrant fish would have to be addressed in the EIS.

According to the DNR, fish passages will be required at all dam sites except Brown Bridge Dam and is discussed in Section 6.7.9 of this report.

6.7.4 WATER QUALITY

The Boardman River has always had very high stream and water quality, and this high quality was verified during stream bottom sampling undertaken by the DNR Water Quality Division in November, 1978.

Elwin D. Evans, Ph.D., aquatic biologist with the DNR observed the sampling. His letter of January 10, 1979, (see Appendix E(11)), states "I do not foresee any significant changes in river quality or water quality should power once again be generated with these hydro plants".

Water quality standards applying to this project are also addressed by Robert Basch, biology section, DNR, in his letter to Dale Granger, Water Management Division, on October 18, 1978: "these dams/hydro generators were operated in the past and a brown trout fishery was maintained in the river and the impoundments had good warm water fisheries. It is therefore unlikely that reactivating these dams will significantly alter the existing water quality of this river."

6.7.5 MINIMUM FLOW

Minimum flow for the portion of the Boardman River involved in this study has been jointly determined with the DNR as a result of low flow studies conducted in the field.

Three reaches of the river are seen as important for maintaining minimum flow:

- a. The outlet from Boardman Lake in order to maintain sufficient flow to assimilate the discharge from the municipal wastewater treatment plant;
- b. The inlet to Boardman Lake (Logan's Landing) must have sufficient flow to maintain the open-water wildfowl habitat;

c. The reach of river from Brown Bridge Dam downstream to the confluence of East Creek, primarily to maintain trout fisheries.

A low flow study was conducted in November of 1978. Controlled discharges from Brown Bridge Dam were used to stabilize the flow at the U.S.G.S. Mayfield gage. As a result of the above study, it has been determined by the DNR that minimum flow allowed at the Mayfield gage should be 120 cfs and the flow at the individual dam sites to be proportional to their respective drainage areas as follows:

<u>Site</u>	<u>Drainage Area Sq. Mi.</u>	<u>Minimum Flow cfs</u>
Brown Bridge Dam	151	100
Mayfield Gage	181	120
Keystone Dam	265	176
Boardman Dam	267	177
Sabin Dam	269	180
Union Street Dam	276	183

During extreme conditions when the flow in the Boardman River is less than the above minimums, the flow at the dam sites would be "run-of-the-river". A gage located at the inlet to Brown Bridge Pond could be used to monitor that extreme condition.

6.7.6 POND FLUCTUATIONS

Due to the constraints at the existing dam sites, such as spillway elevations, existing buildings, etc., the pond elevations are not anticipated to be raised above the levels experienced during present and past operations.

Boardman Lake, being the largest of the impoundments, will fluctuate less than 1 ft. due to hydro-operations at Union Street Dam.

There are currently no legal lake levels-established for any of the impoundments. Pond level fluctuations as a result of hydro-operation would have to be carefully analyzed as a part of an EIS if the project proceeds.

All of the existing impoundments were checked by boat for the possible need of bank protection. Photographs were obtained for identification of various suspect shore-areas on each impoundment. No significant problem areas were discovered.

The south bank of the Brown Bridge Pond is relatively low, 3 to 4 ft. in height, except for the boat launch area which is considerably higher. Banks appear stable and vegetation along the slopes provides protection from erosion. The inlet area (east end) of the pond has somewhat lower banks with less vegetation along the shore and normal fluctuation (as in past years) inundates only a narrow band at the water's edge. The north bank of the pond is steep and as much as 40 ft. high. Along the foot of this steep slope is a shelf 20 to 45 ft. wide which discourages erosion. Although the banks are steep, they are well timbered, principally with conifers. A less than 1 ft. fluctuation in level because of hydro-operation appears to present insignificant erosion problems.

Boardman Pond was examined by boat on September 19, 1978. A berm beach exists along the length of the concrete cutoff wall across the old river channel west of the dam. A minor shelf at the water's edge protects the 10 ft. to 12 ft. bank east of the railroad. Some swamp on the west side of the river between Boardman and the Keystone Dam site exist as a natural nature study area. Some silting exists as a result of the Keystone Dam failure in 1961. The swift current through the cut area and for some distance downstream from the Keystone site silting is evident.

Banks on the east side of the pond are somewhat steeper and higher, but are less well protected with vegetation, yet evidence of sloughing has been minimal. Further downstream, the few residences have lower banks and are well protected both as to slope and to vegetative cover. No significant problems are expected to develop from the proposed operation.

Sabin Pond was also checked by boat. Fairly steep banks on both sides of the pond were well protected with vegetation and with a narrow earth shelf along the toe of the slopes. A low swampy area exists downstream from the Boardman Dam concrete spillway discharge channel. The east bank for the most part is well wooded and the proposed operation of fluctuation of 2 ft. or less would cause little if any erosion. This is the largest proposed level fluctuation and the banks of this pond should be inspected annually if this procedure is followed in the future.

6.7.7 CANOE PORTAGES

The Boardman River is used extensively by canoeists and canoe portage should be provided at all the dam sites. It is thought that one of the most economical and still satisfactory portages could be built incorporating a bark or sawdust trail with some type of handrail on one side, and it would prove desirable to bench at intervals on some of the steeper portages. Posts along the portage to assist in landing canoes may also be required.

6.7.8 SILT REMOVAL

Silt removal is not being considered in the scope of this feasibility study. The existing dams, if retrofitted for hydropower, would function hydraulically the same as in the present operations and silt disturbance is not anticipated.

If de-silting the impoundments at a later date as a maintenance item is proposed, the dredging would be subject to DNR and U.S. Army Corps of Engineers' review and analysis.

Sediments would have to be analyzed prior to dredging using EPA polluted dredge spoil criteria. Control measures and permit limits would be such as to assure compliance with Michigan Water Quality Standards (WQS). DNR and Corps of Engineers' permit requirements would have to be met.

6.7.9 FISH PASSAGE

The question of fish passage requirements has been discussed thoroughly during meetings with DNR representatives. They maintain that fish passage will be required as a condition to permit approval for the rehabilitation of all dams, excluding Brown Bridge Dam. Any fish passage structure would require a manual sorting operation during the salmon runs in order to keep these species out of the impoundments, if found necessary by the DNR.

Fish passages would require 25 cfs of flow continuously in order to operate properly. Construction cost is estimated at \$31,000 per ft. of head or a total amount of \$2,790,000.00 (Appendix F) and an energy loss of \$39,000.00 per year (figure 7.2.1a).

The statutory authority for the fish passage requirement is Act 123, PA 1929 conferring to the Natural Resources Commission the authority "to provide for the erection and maintenance of means for the free passage of fish through and over dams erected across rivers, streams, or creeks and to prohibit obstruction of rivers, streams and creeks such as to prevent the free passage of fish up and downstream".

The stated general policy of the DNR is: "Fish passage will be required to be provided at all dams and other obstructions to fish movement unless it is determined by the Department that long range fisheries

management programs will or may be adversely affected if such passage provisions are exercised. If such determination is made, a waiver of this requirement may be authorized. Since even long range management programs are subject to change, and since the capability for passage provides management flexibility, waivers of passage requirements shall be reviewed and approved by the Commission" (Natural Resources Commission).

It was pointed out by DNR staff that funds for 50% of the cost of fish passages may be available from federal or state sources under the Anadromous Fisheries Conservation Act and others.

6.7.10 FLOWAGE RIGHTS

Flowage rights currently exist for the owners of Brown Bridge Dam, the washed-out Keystone Dam, Boardman Dam and Sabin Dam. Our investigation has not disclosed any existing or past flowage rights for Boardman Lake and Union St. Dam although flowage rights are referred to in a quit claim deed which transfers Union St. Dam to Traverse City. Union St. Dam has been used to power a grist mill, therefore, hydro-mechanical power has been produced at that site, but not hydroelectric power. More recently, the dam has been operated as a lake control structure for Boardman Lake, although it is a natural lake. Inasmuch as the City of Traverse City owns the dam, it may be possible to have a legal lake level or levels established in circuit court. These levels could be established within parameters suitable for hydropower production. Flowage rights appear to be in order to proceed with a rehabilitation project.

6.8 SOCIO-INSTITUTIONAL FACTORS

The Boardman is a popular trout and salmon stream, between Union Street and Lake Michigan (about one mile), there are several runs of salmonidae which attract large numbers of fishermen. At the four other dams upstream, there are no effective fish passages. Therefore, river reaches between dams are isolated and fish migration is limited.

River use by boaters is primarily by canoeists and they are a formidable factor; therefore safe portage must be provided. At the Keystone site, canoe transit is made difficult by the fast current where the Keystone Dam has been washed out. Other boats are limited by river characteristics to the impoundments and motor boats are not allowed.

There are no known historic or archaeological sites in or along the river.

6.8.1 MEETINGS WITH LOCAL AGENCIES

Following is a listing of agencies with whom investigators met during the study. The minutes of each meeting are included in Appendix E.

1. Traverse Bay Regional Planning Commission - Feasibility study staff met with Commission staff on various occasions for assistance and consultation.
2. Northwest Michigan Regional Planning and Development Commission Staff (11-9-78) - No apparent serious negatives.
3. Traverse City Planning Commission (11-14-78) - Generally favorable.
4. Garfield Township Board (11-9-78) - No objections.
5. East Bay Township Board (11-13-78) - No objections.

6. Blair Township Board (11-14-78) - Favorable comments.

6.8.2 MEETINGS WITH DNR TO EXPLORE IMPACT QUESTIONS

During the course of investigation, study investigators met on several occasions with DNR staff and received information regarding state requirements, statutory authority and environmental standards. More detail follows:

1. (9-26-78) Study Investigators, Donald Emery, Hat Hanes, and David Starr met with Dr. Howard Tanner, Director of the DNR, and Dale Granger, Chief, Water Management Division, to establish procedures for exchanging information.
2. (10-3-78) Letter sent to Dr. Tanner, Director of DNR, addressing areas of major concern. (See Appendix E (6)).
3. (10-20-78) Reply from Dale Granger with responses from various Divisions of DNR, summarized below: (See Appendix E (7)).

John R. Scott, Chief, Fisheries Division:

- minimum flow determinations required at each site
- impoundment level control
- fish passage provisions
- retrofitting hydropower dams impact on sport fishing
- possibility of recovering free-flowing stream

Robert Basch, Biology Section:

DNR requirements for silt removal

- analysis required prior to removal
- EPA polluted dredge spoil criteria
- restrictions and requirements vary according to method of removal

Water quality standards

- total body contact recreation and coldwater fish (trout)
- impoundments - warmwater fish
- discharges such as sump water, bearing cooling water, floor drains or any other low volume wastes, could require an NPDES (National Pollution Discharge Elimination System) permit.
- a minimum flow required to assure that the municipal waste assimilation does not cause downstream water quality problems.
- unlikely that reactivating dams will significantly alter water quality.

Edward Mikula, Wildlife Division:

From a wildlife standpoint, the impacts of the reactivation of a multi-dam hydrosystem will have minimal impact on wildlife, except in the upper portion of Boardman Lake (Logans Landing Area).

- mute swan flock uses this area for wintering habitat
- considerable number of ducks, geese and other water birds use same area
- maintain flow so upper portion of lake does not freeze
- minimize lake fluctuations to preserve flora and fauna in upper portion of lake
- Audobon Society has "nature area" on upper impoundment (same area as Natural Education Reserve) (See Figure 6.8a).

Henry H. Webster, Forest Management Division:

- No concern with Union Street Pond or flowage
- Some concern with Sabin Pond, Boardman Pond, and Keystone Pond
- State forest campground at Brown Bridge Dam has been abandoned, County now has charge

Dennis J. Hall, In Charge, Special Lands Program Section:

Specific programs involved

Natural Rivers Program
Michigan Coastal Management Program
Inland Lakes and Stream Program
Soil Erosion and Sedimentation Control Program

- free flowing condition
- impoundment fluctuations
- impact on recreation

"prior to any approvals for such a project, a complete environmental impact statement should be prepared for review by this Department and by the Michigan Environmental Review Board."

4. (10-24-78) Meeting with DNR staff, notes of meeting included in Appendix E (9).

Questions and discussion listed below:

- a. minimum flow requirements
- b. impoundment level variations
- c. boundary between "country-scenic" and "wild-scenic"
- d. silt removal from impoundments
- e. canoe portage provisions
- f. fish passage provisions
- g. permit requirements

5. (11-7-78) Staff met with DNR representatives at Traverse City to conduct minimum flow studies.

Staff Investigators: Donald Emery, David Starr, Hathaway Hanes.

DNR Representatives: Leon Cook - Water Management, Thomas Doyle - Fisheries, Gary Croskey - Water Management, Bruce Vollmer - Land Resources.

- conditions were observed with 100 cfs and 122 cfs at Mayfield gage

6. (11-28-78) Meeting with DNR staff to discuss findings of minimum flow study. (Appendix E(10)).

- Minimum flow determined to be 120 cfs at Mayfield Gage (USGS) and minimum flow at dam sites to be proportional to respective drainage areas.
- Fish passage will be required at all sites except Brown Bridge.
- Pond level fluctuations will be much reduced from those originally discussed.

7. (Nov. 1978) Biological sampling of river bottom conducted by Elwin D. Evans, Ph.D. Aquatic Biologist (DNR) - (Appendix E(11)).

- significant erosion will not result from fluctuating flows

- no significant detectable negative impacts on stream life would result from elevating flows over the minimum flows in a fluctuating manner
- no significant changes in river quality or water quality should power once again be generated with these hydroplants.

6.8.3 COMMENTS FROM OTHER AGENCIES

1. United States Coast Guard - no objections (Appendix E(12)).
2. West Michigan Tourist Association - concerned with recreational impact (Appendix E(13)).
3. Grand Traverse Natural Education Reserve - concerned about structures within reserve boundaries (Figure 6.8a) (Appendix E(14)).
4. Boardman River Advisory Council (Appendix E(15)).
5. Grand Traverse County Drain Commissioner (Appendix E(16)).
6. Department of Army - Corps of Engineers - no adverse comments (Appendix E(17)).
7. Grand Traverse Soil Conservation District - favorable comments (Appendix E(18)).
8. Garfield Township Planner (Appendix E(19)).
9. Garfield Township Supervisor (Appendix E(20)).
10. East Bay Township Planning Commission (Appendix E(21)).

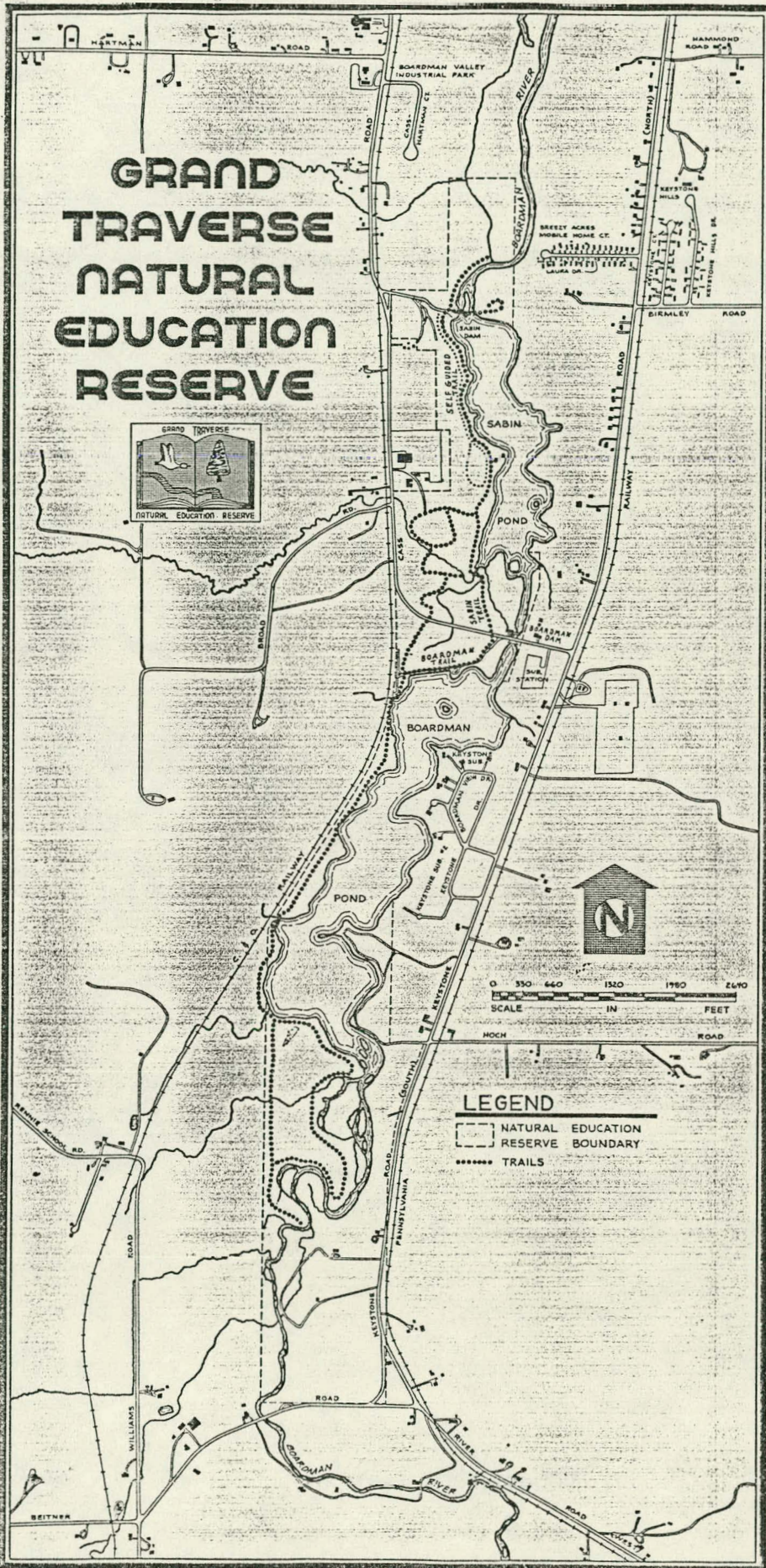


Figure 6.8 a

6.9 LEGAL CONSIDERATIONS AND PERMIT REQUIREMENTS

Following are federal, state and local statutory and regulatory authority applicable to hydroelectric generation on the Boardman River. Included are required permits and recommendations regarding ownership and operation.

6.9.1 FEDERAL REGULATIONS

Operating the dams on the Boardman River falls under the General Rules and Regulations of the Federal Power Act (administered by the Federal Energy Regulatory Commission FERC) subchapters A, B and D, and Chapter I, Title 18, code of Federal Regulations. (See Appendix A). Section 404 of Federal Water Pollution Act.

6.9.2 STATE OF MICHIGAN CONSTRAINTS

1. State Constitution

Natural resources; conservation, pollution, impairment, destruction.

Act IV, Sec. 52. "The conservation and development of the natural resources of the state are hereby declared to be of paramount public concern in the interest of the health, safety and general welfare of the people. The legislature shall provide for the protection of the air, water and other natural resources of the state from pollution, impairment and destruction."

This section of the constitution provides for the protection of natural resources and is the basis for legislation more directly affecting this feasibility study.

2. Act 17, PA of 1921 creates State Conservation Department and Commission (Now the Department of Natural Resources or DNR).

3. Act 231, PA of 1970 Natural Rivers Act.

a. An Act to authorize the establishment of a system of designated wild, scenic and recreational rivers; to prescribe the powers and duties of the Natural Resources Commission with respect thereto; to fund necessary study and comprehensive planning for the establishment of the system; to provide for planning, zoning and cooperation with local units of government; to authorize the protection of designated river frontage by acquisition, lease, easement or other means; to authorize local units of government and the commission to establish zoning districts in which certain uses of rivers and related lands may be encouraged, regulated or prohibited; to provide for limitations on uses of land and their natural resources, and on the platting of land; and to provide that assessing officers shall take cognizance of zoning on true cash value.

b. Section 3 of Act 231, PA of 1970. The Commission in the interest of the people of the state and future generations, may designate a river or portion thereof, as a natural river area for the purpose of preserving and enhancing its value for water conservation, its free flowing condition and its fish, wildlife, boating, scenic, aesthetic, flood plain, ecologic, historic and recreational values and uses. The commission shall prepare and accept a long-range comprehensive plan for a designated natural river area which shall set forth the purpose of the designation, proposed

uses of lands and waters, and management measures designed to accomplish the purposes.

c. Act 231, PA of 1970 Natural River Act of 1970 provides for control of zoning in designated reaches of the river. Zoning covers subdivisions and most if not all of the other items currently covered in zoning laws.

4. Natural River Plan - Boardman River (Grand Traverse & Kalkaska Counties)

Prepared by Boardman River Management Plan Committee under the auspices of the Boardman River Advisory Council and the DNR office of Planning Services and sponsored by the Grand Traverse Bay Regional Planning Commission.

Objectives: Maintain and improve water quality consistent with the DNR designated classification of the river, discourage development or activity which may damage the ecologic, aesthetic values of the river, encourage any future development to be done in an orderly manner consistent with natural environment and maintain the existing free-flowing conditions and seek to stabilize or improve the purpose of preserving the natural environment.

Provides for designation of the following portions of the Boardman River system be classified and managed as a natural river under Act 231, PA of 1970 (approximate mileage - mainstream 21 miles, tributaries 67 miles).

- a. Country scenic - Mainstream of Boardman River from North boundary of Grand Traverse County property in Section 27, T27N, R11W, Garfield Township to Brown Bridge Dam, section 15, T26N, R10W, East Bay Township (13 miles).

- b. Wild Scenic - Mainstream of Boardman River above Brown Bridge Dam to "forks" (8 miles).

It is obvious that the Natural River Act 231, PA of 1970 and the Natural River Plan Boardman River (Grand Traverse and Kalkaska Counties) Boardman River Management Plan Committee cooperating with DNR Office of Planning Service Rev. December 22, 1975, constitutes the essence of control desired by the Department. Necessary permits will be required prior to any construction, but the constraints in the Boardman River Plan will very probably govern.

Comments: Provisions in the plan to maintain the existing free-flowing conditions, etc. are important.

Minimum flow issue has been resolved by DNR flow test by the investigators and is set at 120 cfs at the Mayfield Gage and proportional to respective drainage area at dam sites.

Required building setbacks will limit development within 100 ft. of river bank thus could affect location of substations, interfacing equipment, power transmission lines, etc.



Any new transmission lines will require approval of the DNR. The existing corridors can be used.

Canoe portage will have to be provided at all dam sites.

Water quality is of concern in this act (see Inland Lakes and Streams Act cited later in this section).

5. "Act 123, PA of 1929 confers authority and duty upon the Natural Resources Commission to provide for the erection and maintenance of means for the free passage of fish through and over dams erected across rivers, streams, creeks, etc."

Comments: As a result of meetings with DNR, fish passage will be required at Union Street, Sabin, Boardman and Keystone Dams as a condition to permit approval. The estimated 1981 construction cost for such passages is \$31,000 per ft. of head. This item is seen as a major feasibility constraint. Fifty percent federal, through state, funding may be available to finance construction.

6. Act 156, PA of 1851.

a. An act to define the powers and duties of the Boards of Supervisors of all the counties and to confer upon them certain local, administrative and legislative powers and responsibilities.

b. Sections 21-24 of this Act give the Boards the power within their respective counties, to permit or prohibit the construction or maintenance of any dam or bridge, over or across any navigable stream.

Comments: This Act as pertaining to county dam construction permits has seldom been enforced but should be followed.

7. Act 184, PA of 1963 as amended, Dam Construction Approval Act.

It calls for approval and permits for construction of a dam impounding more than five acres or with a head of more than five ft. or a drainage area more than one square mile.

Comment: Permit for reconstruction of Keystone Dam (fee \$600) would be required from DNR under this Act.

8. Act 245 PA of 1929 as amended by Act 167, P A of 1968.

Act 245, PA of 1929 creates Stream Control Commission and establishes Pollution Standards.

Act 167, PA of 1968 prohibits obstructions of floodways of rivers of the stream (Control of flood Plain Construction).

a. An application must be made to the Department of Natural Resources for a permit to occupy, fill, or grade lands in a flood plain, streambed, or channel of a stream.

b. This Act would effect reconstruction of Keystone Dam, the modifying of Union Street Dam and possibly the three remaining sites if modifications to spillways or control structures is undertaken.

c. Act 245 is statutory authority for water quality standards addressed in Natural River Plan for Boardman River.

9. Act 347, PA of 1972 as amended by Act 197, PA of 1974, the Soil Erosion and Sedimentation Control Act.

a. A soil erosion and sedimentation control plan would be required under this act for any earth change which disturbs one or more acres of land, or if the earth change is within 500 feet of a lake or stream of this state.

b. A State prescribed permit is required from the local enforcing agency.

10. Act 346, PA of 1972 the Inland Lakes & Stream Act.

a. "An Act to regulate inland lakes and streams, to protect riparian rights and the public trust in inland lakes and streams; to prescribe powers and duties; to provide remedies and penalties; and to repeal certain acts and parts of acts.

Comments: Act 346, PA of 1972 Inland Lakes & Streams Act does not apply to the installation of generating equipment at the Union Street Dam, Sabin Dam, Boardman Dam, or possible changes to the Brown Bridge Dam unless paragraph E under Section 3 "Structurally interfere with the natural flow of an inland lake or stream" is so interpreted.

However, such an application would place the DNR on record and in turn other interested state agencies. Section 4 of Act 346, PA of 1972 states no permit shall be required for "(a) Any fill or structure existing before April 1, 1966, etc." (This is covered under Act 184, PA of 1963 and Act 231, PA of 1972.

11. Act 253, PA of 1964 Local River Management Act.

Definition: Council, District, Board, Commission, Watershed. Local Government, Local Agencies, River Management, Level of Stream Flow. To enable local units of government to cooperate in planning and carrying out a coordinated water management program in the watershed they share.

Comment: This Act is not applicable, particularly with Act 231, PA of 1972 in force.

12. Act 127, PA of 1970 Environmental Protection Act.

An Act to provide for actions for declaratory and equitable relief for protection of the air, water and other natural resources and the public trust therein.

Comment: Doubtful if any effect on feasibility, but note: provides for any citizen to sue, if pollution exists.

13. Act 150, PA of 1970.

"An Act to designate certain roads as Michigan natural beauty roads; to provide certain powers and duties; and to provide for the development of guidelines and procedures."

Comment: Not applicable with respect to feasibility.

14. Act 200, PA of 1957.

An Act to provide for the creation by two or more municipalities of an intermunicipality committee for the purpose of studying area problems; and to provide authority for the committee to receive gifts and grants.

Comment: Not applicable in view of Natural River Plan.

6.9.3 LOCAL GOVERNMENT REGULATIONS

A. Zoning Ordinances and land uses of City of Traverse City, East Bay Township, Blair Township, and Garfield Township were reviewed and apply as follows:

Boardman Lake

- a. West Shore zoned industrial (uses - industrial and institutional)
- b. East Shore zoned multi-family (uses - industrial and moderate density multi-family housing)
- c. South End Community center - Logans Landing Shopping Center, Restaurant and Park

- d. Land area immediately adjacent to Lake used for parks, recreation and open space.

Sabin Pond

- a. East Shore zoned single and multi-family residential
- b. Within boundaries of Natural River District
- c. Uses - forestry, recreational and rural residential

Boardman Pond

- a. East Shore zoned single family residential and single family rural residential
- b. Within limits of Natural River District
- c. Uses - forestry, recreational and rural residential

Keystone Pond (presently not existant)

- a. Zoned country residential
- b. Within boundaries of Natural River District
- c. Uses - forestry, open land, general farming

Brown Bridge Pond

- a. Zoned S-1 Lake and River Environment (Residential only)
- b. Within boundaries of Natural River District
- c. Uses - forestry and recreational

The major park facilities in the Traverse City urban area include the West Bay Waterfront Park, the Boardman River Park and the Grand Traverse Natural Education Reserve.

The Boardman River Park extending from the Bay to and around Boardman Lake is entirely passive in character and is intended primarily to serve

Traverse City community residents. South of Front Street it is to be a quiet park with a minimum amount of shoreline development. Primary activities include walking, picnicing, fishing and nature and historical interpretation.

The Grand Traverse County Natural Education Reserve is a large passive recreation facility lying along the Boardman River Valley south of Traverse City. It is a nature interpretation center which should be expanded over time as a means to protect the river environment from urban encroachment.

6.9.4 OWNERSHIP AND OPERATION

Union St. Dam, Keystone Dam site, and Brown Bridge Dam are owned by the City of Traverse City. Boardman Dam and Sabin Dam are owned by Grand Traverse County.

TCL&P currently operates Brown Bridge Dam for hydroelectric power.

There are three basic alternate schemes for operation of a hydroelectric system utilizing the five dam sites on the Boardman River.

- a. The County could sell Boardman and Sabin Dam to the City and in turn the Light and Power Department would operate these facilities along with Union St., Keystone and Brown Bridge Dams.

b. The County could lease Boardman and Sabin Dams to the city for power generation.

c. The County could transfer an easement to the city to operate and maintain Boardman and Sabin Dams and any necessary and appurtenant facilities and land. A long term lease or an intergovernmental contract could be used to accomplish the same purpose.

W. Peter Doren, Traverse City city attorney in his letter of January 29, 1979 to Ross Childs, Grand Traverse County, County Coordinator, states that an easement arrangement would be the most preferable from his viewpoint. A copy of this letter is included in Appendix E (22).

The Grand Traverse County Board of Commissioners formally moved at their regular meeting on Tuesday, February 13, 1979, that their intention is to enter into a legal agreement with the City of Traverse City to provide for the production of power at County owned dams (see Appendix E (24)).

The easement arrangement appears to be the most advantageous at this point. The county would retain ownership of Boardman and Sabin Dam and the City would obtain an easement from the county for monetary considerations to be agreed upon mutually.

Operation of the facilities would be the responsibility of the TCL&P.

6.9.5 PERMIT REQUIREMENTS

- a. Federal Short Form Licence (minor), docket No. RN78-9. Order No. 11.

Simplified procedures for certain water power licenses
(issued September 5, 1978) (See Appendix G)

The Federal Energy Regulatory Commission has given notice that it is amending the general rules and regulations under the Federal Power Act, sub-chapters a, b, and d, Chapter 1, title 18, Code of Federal Regulations. These amendments established a short form water power license (minor) and a new application form with accompanying instructions for completing the application for a short form license (minor).

Comments were solicited from many power companies throughout the United States and these were written into the following.

A proposed rule-making would have imposed three eligibility criteria for a project to obtain a short form license. These were: "1. A project dam or diversion structure could be no more than 25 ft. in height above stream bed; 2. a project could not impound a reservoir having a surface area of 10 acres or more; and 3. a project generating capacity could not exceed 2,000 horsepower (1500 kilowatts). After examining the comments, re-evaluating the criteria, and considering the legal and policy questions involved, the Commission has decided to eliminate the first and second limiting criteria to widen acceptability of a short

form license (minor) procedure to all projects having a generating capacity of 2000 horsepower (1500 kilowatts) or less, that is, all "minor" projects.

The Commission is making these amendments effective immediately.

The application in docket No. RN78-9 issued September 5, 1978, is covered in pages 8 - 11 for completing the application is covered pages 11 to 18 and the appendix shows the short form for license including four pages.

b. State Act 184, Public Acts of 1963 - known as the Dam Construction Approval Act.

An act to require approval of the DNR before erection of dams; to provide fees for approval; and to provide a penalty for failure to comply with the provisions of this act and the rules adopted thereunder. Approximately 4 weeks will be required for permit after submission of plans, specifications, and the amount of the fee. A fee permit for Keystone Dam construction will be \$600 and will take about the time mentioned.

Act 346 (Public Acts of 1972) - An act to regulate inland lakes and streams; to protect riparian rights and a public trust in inland lakes and streams; to prescribe powers and duties; to provide remedies and penalties and to repeal certain acts and parts of acts.

An application should be made under Act 346 (Public Acts 1972) which will place the DNR on record and in turn other interested state agencies. This Act is known as the Inland Lakes and Streams Act of 1972. Processing of an application under Act 346 Lakes and Streams Act may take two months as it has to go to the U.S. Army Corps of Engineers. No fee is required.

Act 347 (Public Acts of 1972) - The Soil Erosion and Sedimentation Control Act of 1972. Control of soil erosion for the identified land uses of an area to prevent sedimentation of the waters of this state.

Act 347 (Public Acts of 1972) as amended will probably require 30 days as the DNR (Department of Natural Resources) furnishes information to the county or counties and in the case of construction crossing a county line, rights the permit. However, the county or counties involved charge for the permit. The amount varies from county to county.

The Michigan Public Service Commission (MPSC) has no authority or concerns regarding licensing hydroelectric dam site construction or operation. The only involvement MPSC would have would be in the area of rate regulation once the plants are on line (none if system is operated by the City of Traverse City).

Section 404 of Federal Water Pollution Control Act - A permit from the U.S. Army Corps of Engineers would be required under this Act. Application for this permit would have been made in conjunction with the Act 346 (Inland Lakes and Streams) permit and the processing time would be comparable.

6.10 SAFETY ASPECTS

General required safety measures will be incorporated at each of the generating plants along with those required for distribution. Access and trespass measures will be required to prevent unauthorized persons entry into hazardous areas.

6.10.1 BROWN BRIDGE DAM

Brown Bridge Dam was inspected September 29, 1978 (Appendix C). Considerable gravel has been placed on the downstream slope of the dike. This needs addition of granular fines and fertilizer to promote adequate vegetation, such as reed canary grass.

The dike needs some fill just north of the power house to bring it up to grade. This is near the old concrete fish passage which has been filled with gravel.

Seepage along the downstream slope is spotty and in no case is material being carried away. Total amount of seepage is estimated at about 2 cfs.

The dike south of the powerhouse is in good shape throughout. The concrete cutoff wall provides adequate slope protection from erosion on the pond side. The downstream slopes are well covered with vegetation.

The existing spillway is capable of safely passing even an unusually large flood. The free board between normal level (below top of cut-off wall and top of dike) is adequate for considerable storage and the discharge capacity increases with the rise in pond level.

6.10.2 BOARDMAN DAM

A. INSPECTION AND TESTING RESULTS

Concrete compressive strength tests were conducted over various areas of the existing concrete structures of both the Boardman and Sabin Dams by our inspection team between September 27 and September 30, 1977, with a Testlab Corporation Rebound Hammer.

On November 8, 1977, the concrete bridge slab at Boardman Dam was cored by SOILS AND STRUCTURES, INC. to determine the exact compressive strength of the concrete deck.

By comparing the compressive strength test results of the two corings with tests A3 through A9 taken by the Rebound Hammer in the same area of the bridge deck, a close correlation was observed. The average of the above Rebound Hammer tests equal approximately 7,700 psi which compared quite favorably to the average core test results of approximately 7,300 psi and indicated the relative accuracy of the rebound hammer results.

Some more serious spalling had occurred at the walkway slab entrance to the Boardman Dam Powerhouse. This did not present a problem and was repaired (Appendix D).

A large vertical crack extended from the roof of the Boardman Dam Powerhouse to its foundation at the southeast corner. The crack may have been caused by frozen impounded water from plugged roof drains.

The west wingwall from the construction joint in the tail race of the Boardman Dam Powerhouse had moved approximately 6 inches forward. The wall has stabilized since the installation of a tie back to the top of the wall by Consumers Power Company personnel. A large volume of water seepage behind the wall probably caused the original movement.

It was learned through Mr. Perry Ericksen, head maintenance personnel for Consumers Power Company at the project dams, that undermining of the soil material beneath the spillway floor slab at Boardman Dam was detected in the late 1950's. Two holes about 2 ft. by 3 ft. were cut in the

spillway's concrete floor slab and approximately 90 cubic yards of sand and gravel was replaced through the holes at that time. Metal plates were placed over the holes and bolted to the slab with the use of concrete inserts.

On November 8, 1977, our inspectors closed the spillway head gate, descended to the spillway floor slab, removed the metal plate and found that the replaced sand and gravel was at the same level as originally placed, and that no additional displacement or erosion had occurred. We recommended that such observations be conducted at least once a year.

B. STRUCTURAL ANALYSIS

Results of the structural analysis performed on the Boardman Dam Bridge, based on criteria established in the "Michigan Bridge Analysis Guide" prepared by the Michigan Department of State Highways and Transportation indicated the deck slab is the critical element for restricting vehicular traffic loads. The encased steel beams, which support the deck slab, offer only a minor increase in allowable load capacity. The deck slab is restricted to axle loads of 4.7 tons per axle allowing a gross vehicular load restriction of 52 tons. These restrictions can be compared to the allowable maximum legal loads of the State of Michigan by referring to the following extract from the "Michigan Bridge Analysis Guide".

The reinforced concrete and steel sheet piling cutoff wall for the Boardman Dam intake structure has, to all appearances, been effective in

controlling seepage except possibly in the northeast sector near the end of the east tail race wall. Some seepage has existed here since the pond was originally filled and has not increased materially according to Consumers Power Company people. We feel pressure grouting along the cutoff wall should be done to reduce or eliminate this seepage. This would also reduce cost of maintenance in this area.

Stability of the Boardman Dam appeared excellent as no sloughing of the fill and very little erosion had developed. Considerable foot traffic up and down the north backslope of the fill section had resulted in a potential erosion problem. Heavier soil mixed with the sand fill is needed, so that fertilizer and seeding will successfully develop a good vegetative cover for protection from the effects of precipitation.

The long fill and reinforced concrete topped steel sheet piling dike in the old river channel west of the Boardman Dam appeared to be in good condition. There were two or three places where repairs to the top of the concrete wall are required. Some seepage had developed near the east end of the fill but the seepage water was not carrying any material away and was not considered to be serious. The fill was ample in width and height and had a good vegetative cover. The upstream and downstream slopes were adequate as is the freeboard. Care should be taken to prevent tree growth on earth dike fills as the roots from such trees can provide "paths" for water and eroded material through the fills (Appendix D).

C. CAPACITY

The Boardman Dam can easily pass a 100 year flood discharge through its existing spillway. However, if the steel beam (Appendix D) and lower spillway head gate were not raised, the water surface elevation would continue to rise until the emergency spillway plug elevation of 146.0 ft. (dam datum) was reached and the emergency spillway would become operational. The plug would washout and the additional 100 year flood discharge would be dissipated through the emergency spillway. By raising the lower spillway head gate, the spillway would have a capacity of 3700 cfs below elevation 143.0 which is well above the 100 year flow discharge of 1760 cfs. The use of the emergency spillway at any time does not appear to be a viable alternative since the plug elevation of 146.0 would cause property damage to residents on the Boardman Pond, as shown on the area topography maps (figure 6.1.2d).

6.10.3 SABIN DAM

The Sabin Dam has been in operation since 1930 as a hydro unit and for the last eight years for maintaining the Sabin Pond in connection with the environmental education program. The capacity of the Sabin Dam has been adequate during this period and the dam's stability appears to be unquestioned. Freeboard provides adequate safety from over topping.

There are no sags in the crest and vegetative cover is adequate. Both upstream and downstream slopes are good. No serious erosion could be found either in the vicinity of the powerhouse or the discharge spillways.

6.10.4 UNION STREET DAM

Union Street dike is well grassed throughout despite much traffic by fishermen. The 10 tubes through this dam are gate controlled. Additional spillway capacity is provided by the 15 ft. weir, trash racks and two large discharge tubes. Boardman Lake area of 350 acres provides adequate storage as an added safety factor. Some leakage is evident in the corner between the left river bank and the dam but does not appear serious.

Evaluation of Alternates



7.0 EVALUATION OF ALTERNATES

All viable alternate modes of operation of the five existing dams on the Boardman River within the reach of Brown Bridge Dam to Grand Traverse Bay were defined and listed in Section 7.1.

In order to determine the feasibility of any project, it is first necessary to establish the criteria on which such an evaluation is to be based.

The essential criteria for all economic comparisons was the "present worth net cash flow" technique described in Section 7.2.1. All present and future revenue and cost items are considered as to their present dollar value considering interest rates on capital investments and the inflationary rate of energy and the general economy. The present worth of each alternate was established based on a 4% annual inflation rate in the general economy and a 6% yearly net income to the public utility. Three sets of numbers for each alternate were generated by considering the annual increase in energy costs at 3%, 5%, and 8%.

The major non-economic items of comparison are environmental, recreational, aesthetics, socio-institutional, legal-permit, and safety. The effect of each viable alternate on the above non-economic criteria was assessed, and ranked as to its effect on the total community, and listed for comparison.

In order to establish a criteria for selection of the best alternate, it was necessary to assess the relative importance of the most acceptable alternates regarding non-economic factors for comparison with the alternate providing the greatest economic advantage. The importance of economic factors and relative ranking of non-economic factors within each comparison area is based on the best judgment of the combined Feasibility Study Investigation Team.

7.1 DEFINITION OF ALTERNATES

Alternate A is the present operation. Costs of the operation of the Traverse City Light and Power for the period July 1, 1977 to June 30, 1978 were analyzed to determine present investment and present operating cost (figure 7.1a & b).

Alternate Category B is the rehabilitation of the existing dam sites through the installation of generation equipment, interfacing equipment and upgrading of the reservoir and dam without any consideration of fish passage.

Alternate Category C involves the rehabilitation of the existing dam sites with the provision of fish passage as indicated by the Michigan Department of Natural Resources.

**DETERMINATION OF PRESENT
UNIT POWER COSTS**

	Direct Expense	Payroll Taxes & Benefits	Propty. Taxes & Insur. (1)	Deprec. (2)	Dir.Exp. plus overhd.	Mils per KWH
<u>Production - MWH</u>						
Purchase 8,187	\$ 231,366		\$12,415	\$ 7,145	\$ 250,926	30.65
Steam						
Fuel	2,901,624					
Labor	349,449	100,550				
M & R	216,490					
Other	61,540					
Subtotal 129,833	<u>3,529,103</u>	<u>100,550</u>	84,311	190,320	3,904,284	30.07
Hydro						
Labor	3,176	913				
M & R	2,743					
Other	---					
Subtotal 2,387	<u>5,919</u>	<u>913</u>	930	2,663	10,425	4.37
Total 140,407	<u>3,766,388</u>	<u>101,463</u>	97,656	200,128	4,165,635	29.67
<u>Transmiss & Dist.</u>						
Labor	71,329	20,524				
M & R	263,964					
Other	13,399					
Total	<u>348,692</u>	<u>20,524</u>	57,397	87,484	514,097	3.66
<u>Cost of Sales</u>						
Labor	26,020	7,487				
Meter Read.	19,691					
Postage & Sup.	6,881					
Promotion	6,769					
Uncollect	32,071					
Other	11,374					
Total	<u>102,806</u>	<u>7,487</u>	-0-	-0-	110,293	.79
<u>Admin & Gen</u>						
Labor	56,373	16,221				
Prof.Serv.	66,831					
Merch. & Inter	24,771					
Other	34,541					
Pay Taxes & Bene.	145,695	(145,695)	20,794			
Insurance	31,391		(31,391)			
Total	<u>359,602</u>	<u>(129,474)</u>	<u>(10,597)</u>	9,370	250,095	1.78
Total MRO	\$4,577,488	-0-	144,456	296,982	5,018,926	35.75

1. Equivalent property taxes and insurance expense is apportioned according to to book value of TCL&P buildings and equipment.
2. Depreciation is apportioned according to depreciation schedule in the annual report.

Alternate Category D involves the rehabilitation of the existing dam sites with fish passage and the abandonment of dams that are not used for power generation.

The alternate modes of operating the Boardman River System within the confines of the study area are further and more concisely defined as follows:

A - "Do Nothing" approach - Maintain the existing hydroelectric facility at Brown Bridge at its present operating capacity, and maintain the existing facilities at Boardman, Sabin, and Union Street at a safety level consistent with good engineering judgment.

B 1. - Excluding fish passage update the existing hydroelectric facilities at Brown Bridge by installing new interface equipment, and maintain the existing facilities at Boardman, Sabin, Union Street at a safety level consistent with good engineering judgment.

B 2. - Excluding fish passage, update the existing hydroelectric facility at Brown Bridge by installing new interface equipment, retrofit and install hydroelectric equipment at Boardman, and maintain existing facilities at Sabin and Union Street at a safety level consistent with good engineering judgment.

B 3. - Excluding fish passage, update the existing hydroelectric facility at Brown Bridge by installing new interface equipment, retrofit

and install new hydroelectric equipment at Boardman and Sabin, and maintain the existing facility at Union Street at a safety level consistent with good engineering judgment.

B 4. - Excluding fish passage update the existing hydroelectric facility at Brown Bridge by installing new interface equipment, retrofit and install new hydroelectric equipment at Brown Bridge and Sabin Dams, and renovate and install new hydroelectric equipment at Union Street.

B 5. - Excluding fish passage, update the existing hydroelectric facility at Brown Bridge by installing new interface equipment, retrofit and install new hydroelectric equipment at Boardman and Sabin Dams, renovate and install new hydroelectric equipment at Union Street, and rebuild and install new hydroelectric equipment at Keystone.

C 1. - Same arrangement as B 1. except to install fish passage at Boardman, Sabin, and Union Street.

C 2. - Same arrangement as B 2. except to install fish passage at Boardman, Sabin, and Union Street.

C 3. - Same arrangement as B 3. except to install fish passages at Boardman, Sabin, and Union Street.

C 4. - Same arrangement as B 4. except to install fish passage at Boardman, Sabin, and Union Street.

C 5. - Same arrangement as B 5. except to install fish passage at Boardman, Sabin, Union Street, and Keystone.

D 1. - Update existing hydroelectric facilities at Brown Bridge by installing new interface equipment, and decommission and remove the existing dam and facilities at Boardman, Sabin, and Union Street.

D 2. - Update existing hydroelectric facilities at Brown Bridge by installing new interfacing equipment, retrofit and install new hydroelectric equipment at Boardman, install fish passage at Boardman, and decommission and remove the existing dam and facilities at Sabin and Union Street.

D 3. - Update existing hydroelectric facility at Brown Bridge by installing new interface equipment, retrofit and install new hydroelectric equipment at Boardman and Sabin, install fish passage at Boardman and Sabin, and decommission and remove existing dam and facilities at Union Street.

7.2 COMPARISON OF ALTERNATES

Economic considerations can be expressed in absolute numbers. The economic advantages of various alternates can be displayed readily and studied from several different vantage points.

Non-economic concerns deal with matters that do not easily lend themselves to be analyzed and compared in a relative fashion. The individual non-economic items are rated as either "No Change", "Minor Effect", or "Major Effect" on the total community or the study area.

The alternate modes of operation as defined in Section 7.1 were compared economically, as shown in Section 7.2.1, and non-economically, as shown in Section 7.2.2.

7.2.1 ECONOMIC COMPARISON

Computation of economic parameters of the various hydroelectric alternates are tabulated in Figure 7.2.1a.

All alternates listed under C and D have an initial cost per KWH in excess of the present cost of power to Traverse City Light and Power (Alternate A). Alternates B1, B2, and B3 have initial cost per MWH competitive with the present operation of Traverse City Light and Power (Alternate A).

Considering inflation trends, B3 is the best if energy costs inflate 3% and general inflation rate is 4%, B3 is still the best alternate if energy inflates 5% and general inflation rate is 4%. However, if energy costs inflate 8% and the general inflation rate is 4%, then B5 is the best course of action.

In the event fish passages are required (Alternate C), subalternate C3 is the only alternate that can absorb the high cost of fish passage at reasonable inflation rates. If energy costs inflate at 8% then Alternate D-4 is most attractive. However, since the adverse consequences of abandoning Union Street are severe and probably unacceptable, Alternate C-4 is the best alternate if fish passages are mandatory. If all, or a significant part of the cost

Alternate	FINANCIAL DATA		LIFE CYCLE COST --- 1978 DOLLARS					REVENUE	PRESENT WORTH NET CASH FLOW (Note 1)			CURRENT COSTS		
	Capital Cost	Bond Bond	Bond	Annual	5 Yr. Major	10 Yr. Major	Decomm.	\$/year (MWH/yr.)	g=4% (General Inflation Rate) P=6% (Real Net Income) e=Energy Inflation Rate			\$/KW	Mils KWH	Rate of Return ³ %
	Proj. Life	Term Inter.	Payment	Cost	Maint. Cost	Repair Cost	Costs		3%	5%	8%			
Ci&n	m & b	C _b	C _a	C ₅	C ₁₀	C ₄₀	R							
A - Do Nothing - Purchase Power Above Capacity	\$6,699,699 (Book Value)	25@ 7%	574,904	4,165,635	---	---	400,000	4,212,210 (140,407)	(7,317,742) ²	(1,595,550) ²	8,153,632 ²		29.7	
B - Rehabilitate Dams w/o Fish Passage														
1. Brown Bridge 830	36,270 40	15@6 1/4%	3,790	4,250	12,900	30,000	90,000	86,600 (2,887)	1,011,400	1,364,700	2,260,700	44	5.3	>12
2. Add 970 KW @ Boardman 1300	1,550,000 40	15@6 1/4%	162,209	8,900	17,800	60,000	180,000	284,070 (9,469)	2,375,600	3,535,500	6,473,700	866	21.3	>12
3. Add 490 KW @ Sabin 2290	2,250,000 40	15@6 1/4%	235,500	13,500	22,700	90,000	270,000	383,500 (12,784)	3,238,300*	4,802,900*	8,771,000	991	23.0	>12
4. Add 220 KW @ Union St. 2510	3,450,000 40	20@6 3/4%	319,400	18,200	27,600	120,000	360,000	428,820 (14,294)	2,612,800	4,362,300	8,799,000	1385	30.9	>12
5. Add 470 KW @ Keystone 2980	5,950,000 40	25@7 %	510,570	27,600	32,500	150,000	450,000	524,400 (17,480)	1,801,500	3,940,900	9,366,000*	2010	43.2	11 1/4%
C - Rehabilitate Dams Including Fish Passage														
1. Brown Bridge w/ Fish Ladders @ 3 Ex. Dams 830	2,600,000 40	15@6 1/4%	272,100	4,250	12,900	30,000	100,000	86,600 (2,887)	(1,030,300)	(677,000)	219,000	3171	93.7	<5
2. Add 900 KW @ Boardman 1730	4,100,000 40	20@6 3/4%		8,900	17,800	60,000	200,000	266,550 (8,885)	137,000	1,224,400	3,982,000	2343	48.2	<5
3. Add 455 KW @ Sabin 2185	4,800,000 40	20@6 3/4%	444,320	13,500	22,700	90,000	300,000	357,200 (11,906)	695,700*	2,153,000*	5,848,700	2211	42.9	5 1/2%
4. Add 205 KW @ Union St. 2390	5,950,000 40	25@7 %	510,570	18,200	27,600	120,000	400,000	398,430 (13,281)	277,990	1,903,500	6,025,800*	2521	48.7	<5
5. Add 435 KW @ Keystone include Fish Ladder 2825	9,200,000 40	25@7 %	789,460	27,600	32,500	150,000	500,000	485,550 (16,185)	(1,266,000)	715,200	5,739,000	3274	62.0	<5
D - Rehab. Dams w/ Fish Passage Decommission Others														
1. Brown Bridge w/ All Others Removed 830	340,000 40	15@6 1/4%	35,580	4,250	12,900	30,000	100,000	86,600 (2,887)	658,700	1,012,040	1,908,000	415		
2. Add 900 KW @ Boardman Aband. Sabin & Union 1730	3,100,000 40	20@6 3/4%	286,960	8,900	17,800	60,000	200,000	266,550 (8,885)	925,100	2,012,500	4,770,400	1771		
3. Add 455 KW @ Sabin Aban. Union St. 2185	4,250,000 40	20@6 3/4%	393,400	13,500	22,700	90,000	300,000	357,200 (11,906)	1,129,134*	2,586,400*	6,282,100*	1958		

$$(1) \text{PWNCF} = R \times A_{n|e} - C_2 \times A_{n|g} - C_5 \times A_{n|g}^5 - C_{10} \times A_{n|g}^{10} - C_{40} \times N_g^n - C_i \times \frac{A_{m|i}}{A_{m|b}}$$

$$A_{n|e} = \frac{(1+e)}{i-e} \left[1 - \left(\frac{1+e}{1+i} \right)^n \right]$$

$$A_{n|g}^5 = \left[\frac{1 - \left(\frac{1+g}{1+i} \right)^n}{1 - \left(\frac{1+g}{1+i} \right)^5} \right] - 1$$

$$A_{n|g} = \left(\frac{1+g}{i-g} \right) \left[1 + \left(\frac{1+g}{1+i} \right)^n \right]$$

$$A_{n|g}^{10} = \left[\frac{1 - \left(\frac{1+g}{1+i} \right)^n}{1 - \left(\frac{1+g}{1+i} \right)^{10}} \right] - 1$$

$$N_g^n = \left(\frac{1+g}{1+i} \right)^n$$

$$A_{m|i} = \frac{1 - (1+i)^{-m}}{i}$$

$$A_{m|b} = \frac{1 - (1+b)^{-m}}{b}$$

$$(2) g = .3037 \times .04 + .6963e$$

* Best Alternate

(3) Without Inflation

SUMMARY OF ECONOMIC COMPARISONS

FIGURE 7.2.1a

C 5. - Same arrangement as B 5. except to install fish passage at Boardman, Sabin, Union Street, and Keystone.

D 1. - Update existing hydroelectric facilities at Brown Bridge by installing new interface equipment, and decommission and remove the existing dam and facilities at Boardman, Sabin, and Union Street.

D 2. - Update existing hydroelectric facilities at Brown Bridge by installing new interfacing equipment, retrofit and install new hydroelectric equipment at Boardman, install fish passage at Boardman, and decommission and remove the existing dam and facilities at Sabin and Union Street.

D 3. - Update existing hydroelectric facility at Brown Bridge by installing new interface equipment, retrofit and install new hydroelectric equipment at Boardman and Sabin, install fish passage at Boardman and Sabin, and decommission and remove existing dam and facilities at Union Street.

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In the event fish passages are required (Alternate C), subalternate C3 is the only alternate that can absorb the high cost of fish passage at reasonable inflation rates. If energy costs inflate at 8% then Alternate D-4 is most attractive. However, since the adverse consequences of abandoning Union Street are severe and probably unacceptable, Alternate C-4 is the best alternate if fish passages are mandatory. If all, or a significant part of the cost

of fish passages is removed (paid for by some other source of revenue such as general taxes or assessment to other beneficiaries of the impoundment) then C-4 is acceptable. If all of the cost of fish passage is obtained from other sources of revenue, Alternate C-5 becomes essentially B-5 and the best alternate.

From economic considerations, the rehabilitation of Brown Bridge, Boardman and Sabin (B-3), is the best alternate. In addition, the rehabilitation of Union Street (B-4) is an acceptable alternate if energy costs rise at a rate of 8% (the inflation rate of coal). Since coal is the major fuel at TCL&P, this is an acceptable alternate. In addition, reconstruction of Keystone is a good alternate (B-5) for TCL&P if fish passage is omitted or the cost charged to some other account.

7.2.2 NON-ECONOMIC COMPARISON

The non-economic aspects of this project are basically site specific, therefore the comparison is for the most part by individual dam sites and not by combined schemes of operation.

7.2.2.1 ENVIRONMENTAL CONCERNS

BROWN BRIDGE DAM

Since this site is currently producing hydroelectric power, upgrading the equipment would have minimal environmental impact, especially considering that minimum flow criteria have been established.

KEYSTONE DAM

Keystone Dam is the most environmentally sensitive site since the impoundment area has returned to a natural state following the dam failure in 1961 therefore, this site is a complete reconstruction.

BOARDMAN AND SABIN DAM

Retrofitting these two dam sites to hydroelectric power production has minimal environmental impact since the work would involve mainly equipment replacement. Proper impoundment level control and minimum flow will help minimize environmental impact.

UNION STREET DAM

This dam site and impoundment is the most environmentally sensitive one of the existing facilities due to the wildlife habitat at the upper end of Boardman Lake (Logans Landing) and salmon fishery downstream. However, hydro-operation can be managed not to materially interfere with either.

7.2.2.2 RECREATIONAL

BROWN BRIDGE DAM

No alteration to recreational uses would be encountered in updating equipment at Brown Bridge Dam.

KEYSTONE DAM

Rebuilding Keystone Dam would require canoe portage and a short reach of trout stream would be converted to impoundment use. Therefore this site probably has the largest impact on recreational uses.

BOARDMAN AND SABIN DAMS

Retrofitting Boardman and Sabin Dams for hydroelectric power will have minimal impact on recreational uses since the work on these sites would primarily involve replacement of equipment. Proper low flow and impoundment level management also would contribute to lessening impact.

UNION STREET DAM

Installing hydroelectric capacity at Union Street Dam will have little adverse recreation effect if proper regulation of minimum flow and Boardman Lake level is observed. Some disruption of the sport fishing immediately downstream of the dam during construction is anticipated.

7.2.2.3 AESTHETICS

Brown Bridge Dam and pond aesthetics would be unaffected by the minor power house switching changes.

Reconstruction of the Keystone Dam (if this is done) would have more effect on aesthetics than the proposed retrofitting at any of the other dam sites. There would be no crowding even with installation of fish passage.

Boardman Dam with the construction of a fish passage would certainly create physical changes in this area. It is not thought that they would necessarily adversely affect the overall picture.

A fish passage could be constructed at Sabin Dam with less effect on the surrounding area than at Boardman Dam. Otherwise, there would be no effect.

The low head (9 feet) at Union St. would make the installation of generation equipment (bulb turbines) easier than increasing the head. The latter is not contemplated. It is believed that adequate fish passage could also be worked in at the stated economic cost.

7.2.2.4 SOCIO-INSTITUTIONAL FACTORS

Comments by concerned agencies or organizations have been favorable to producing hydroelectric power at all dam sites.

Some objection by canoeists and trout fishermen may be raised to reconstructing Keystone Dam as a portion of stream would be converted to an impoundment.

7.2.2.5 LEGAL-PERMIT FACTORS

BROWN BRIDGE DAM

Since this dam is currently producing power, no regulatory or legal problems are anticipated in updating equipment.

KEYSTONE DAM

Rebuilding Keystone Dam would involve the greatest amount of construction permit applications, cost and processing time.

BOARDMAN, SABIN AND UNION ST. DAMS

No major legal or institutional problems are anticipated at these sites although some construction permits would be required.

7.2.2.6 SAFETY

Risk - rated in the order of possible damage in the event of dam failure:

1. Boardman
2. Sabin
3. Union St.
4. Brown Bridge
5. Keystone

Due to the head of 41 feet and the road crossing the dam, Boardman Dam is judged to head the list. Failure of Boardman Dam would cause Sabin Dam to fail with resulting damage downstream, although Boardman Lake, because of its size, would be a "shock-absorber".

Failure of Union St. Dam due to its location would likely effect more than any of the others with more possible property damage within Traverse City. However, the outflow from Boardman Lake is quite restricted in the river channel. Also, as has been mentioned, Boardman Lake is really a natural lake.

A Brown Bridge Dam failure with the second highest head (31 feet) might damage one or two bridges. Traffic and population density is lowered with little floodplain involvement, there would be less likely damage than at the previously discussed dams.

The 1961 failure of Keystone raised the Boardman pond level but with negligible damage. It would hold true for a future Keystone Dam failure.

7.2.2.7 RELATIVE COMPARISON

Figure 7.2.2a shows the relative rating of the alternate schemes of operation based on the previous comparison of dam sites. Each item is rated either "No Change", "Minor Effect" or "Major Effect".

The relative rating does not necessarily designate negative impact on the various item considered but serves as an indication of the effect of the project on the Boardman River area in general.

NON-ECONOMIC ITEMS	ALTERNATES (See Section 7.1 for Descriptions)													
	A	B ₁	B ₂	B ₃	B ₄	B ₅	C ₁	C ₂	C ₃	C ₄	C ₅	D ₁	D ₂	D ₃
ENVIRONMENTAL	O	O	L	L	L	H	L	L	L	L	H	H	H	H
RECREATIONAL	O	O	O	O	L	H	O	O	O	L	H	H	H	H
AESTHETICS	O	O	O	O	L	H	L	L	L	H	H	H	H	H
SOCIO - INSTITUTIONAL	O	O	O	O	L	H	H	H	H	H	H	H	H	H
LEGAL - PERMIT	O	O	L	L	L	H	L	L	L	L	H	H	H	H
SAFETY	O	L	L	L	H	H	L	L	L	H	H	L	L	L

O = NO CHANGE
L = MINOR EFFECT
H = MAJOR EFFECT

SUMMARY OF NON-ECONOMIC COMPARISONS

Environmental, recreational and aesthetic ratings generally indicate the degree of negative impact.

Socio-Institutional and Legal-Permit ratings indicate the degree of difficulty in obtaining governmental approvals, construction permits, licensing and public acceptance of the project.

7.3 SELECTION OF THE BEST ALTERNATE

The best alternate based on economic and non-economic considerations is to rehabilitate all five dam sites without fish passages. The rehabilitation of Brown Bridge, Boardman and Sabin should be carried out as soon as practical. Steps should be taken to plan for the rehabilitation of Union Street and Keystone a little later.

The following is recommended with respect to the fish passage issue. In light of the constitutional question whether the DNR can in fact require the owner of an existing dam to install fish passage and pay for all or part of the installation, and in light of the effect on economic feasibility and hydroelectric production cost, what is at issue deserves the attention of the Michigan Natural Resources Commission. The Commission has substantial control over sources of funds for fish passage construction which no doubt will affect the Commission's stance. Therefore, it is recommended that a final copy of this report be submitted for a ruling to the Michigan Natural

Resources Commission by Traverse City or the Joint Venture. Because of the anticipated activities in small hydro rehabilitation, the Commission will have to face the issue sooner or later anyway.

Within the scope of this feasibility study it was not possible to make such a formal approach to the Commission, nor was it possible to obtain a legal opinion regarding the constitutional question. In any event, the latter legal approach should wait a ruling by the Commission. The ruling may be such that the constitutional question does not have to be explored.

If it turns out in the end that fish ladders are mandated, then the following would apply: if sources of power are available which cost less than 49 mills per KWH, rehabilitation of Union Street only should be implemented. If alternate sources of power cost in excess of 62 mills per KWH it would pay to rehabilitate Keystone.

Recommendations

8.0 RECOMMENDATIONS

The principal recommendation of this report is that Grand Traverse County and Traverse City take action to implement a program of hydroelectric generation at all five Boardman River dam sites as described in section 8.1, according to the development plan presented in section 8.2. The recommendation is predicated on the belief that the cost of providing fish passages at the existing dam sites is unrelated to hydroelectric power generation. A mandate by the State of Michigan to install a fish passage at an existing dam appears to be without due process. However, the desirability of providing fish passages is not an issue of this report, and therefore, will not be further addressed herein. Possible locations for fish passages at each facility, as shown on topographic plans included in this report, are substantially removed from any rehabilitation work, and therefore, could be constructed independently.

Implementation of the program is recommended in three phases.

Phase 1. Renovate Brown Bridge Dam and rehabilitate Boardman and Sabin Dams by fall of 1981.

Phase 2. Rehabilitate Union Street Dam by the fall of 1982.

Phase 3. Reconstruct Keystone Dam by the fall of 1983 subject to conditions in section 7.3.

To carry out the program, a management plan as outlined in section 8.1 is recommended. Since TCL&P has the experience in hydro operation, and has the need for the power, it would be prudent that management, operation and control be vested in the City of Traverse City.

8.1 DESCRIPTION OF SELECTED ALTERNATE

Implementation of the selected alternate is accomplished in three phases:

Phase 1 is the rehabilitation of Boardman and Sabin Dams by installing two new turbine-generators at each dam, the installation of transformers and switch gear and governors to operate these facilities and renovation at Brown Bridge Dam including a new switchboard, repairs and replacements. Telemetering and remote control will be provided to all three of these dams with controls suitably located in a Traverse City control center.

Phase 2 is the rehabilitation or installation of hydroelectric generating equipment at Union St., consisting of one standardized tube-type turbine-generator with switchgear, transformers, and telemetering link into the control center.

Phase 3 is the reconstruction of Keystone Dam and the installation of a single standardized tube turbine-generator unit at Keystone.

Implementation of this program requires the establishment of a management plan. Our recommendation is that the management plan include the following features:

1. Ownership of the dams remain titled as they presently are, that is, Boardman and Sabin continue to be owned by Grand Traverse County and Union, Keystone and Brown Bridge remain in the ownership of Traverse City.
2. Grand Traverse County grant an easement to the City of Traverse City to install hydroelectric generation equipment on Boardman and Sabin and operate that equipment for the benefit of TCL&P customers.
3. TCL&P through its easement will be the operator and beneficiary of the power generated at the two dam sites.
4. In the event that fish passages are mandated, the construction of the fish passage shall be the responsibility of the owners of the dams.
5. In the event of decommissioning of the dams or termination of the easement on the part of Traverse City, the costs of decommissioning shall be borne or be the responsibility of the owners of the dam, including the rights of salvage of hydro-generation equipment.

The time schedule should allow for on line timing for Phase 1, to be fall of 1981. This would require or allow for negotiation of the management plan by September, 1979.

Phase 2 should provide for Union St. Dam being on line by fall of 1982.

Phase 3 should provide for Keystone Dam being on line by fall of 1983.

8.2 DEVELOPMENT PLAN

The physical facilities required are described and presented in Section 8.2.2, Facilities Rehabilitation Plan. The schedule for the implementation of this program is presented in Section 8.2.1. Pertinent data, including initial costs, bond schedule, annual operating costs and annual revenues along with the installed capacities and projected power generation are summarized in Figure 7.2.1a.

8.2.1 DEVELOPMENT SCHEDULE

The overall Development Plan described in Section 8.2 and detailed in Section 8.2.2, Facilities Rehabilitation Plan, should be implemented according to the schedule listed below. A second schedule was established based on anticipated delays, through adverse public opinion and reception, and expanded engineering and construction time requirements, caused by the necessity of providing fish passages.

	<u>ITEM</u>	<u>DATES</u>	
		<u>Without Fish Passages</u>	<u>With Fish Passages</u>
PHASE 1	1. Accept feasibility assessment recommendations.	Feb., 1979	Feb., 1979
	2. Form operating management organization by resolution between City of Traverse City and Grand Traverse County.	April, 1979	April, 1979
	3. Award contracts for engineering and environmental impact statement (E.I.S.) on Phase 1, rehabilitating Brown Bridge, Boardman and Sabin Dams.	May, 1979	May, 1979
	4. Complete E.I.S. on Phase 1	November, 1979	May, 1980
	5. Award construction contract on Phase 1	February, 1980	December, 1980
	6. Complete Brown Bridge Dam updating and put on line.	January, 1981	November, 1981
	7. Complete Boardman and Sabin Dam renovation and put on line.	August, 1981	June, 1982
PHASE 2	8. Award contract for engineering and E.I.S. for Phase 2, Union St. Dam.	February, 1980	July, 1980
	9. Complete E.I.S. on Phase 2	November, 1980	April, 1981
	10. Award construction contract on Phase 2.	February, 1981	August, 1981
	11. Complete Union St. Dam rehabilitation and put on line.	August, 1982	February, 1983
PHASE 3	12. Award contract for engineering and E.I.S. on Phase 3, Keystone Dam	October, 1980	July, 1981
	13. Complete E.I.S. on Phase 3	October, 1981	July, 1982
	14. Award construction contract on Phase 3.	February, 1982	December, 1982
	15. Complete Keystone Dam rebuilding put on line.	August, 1983	June, 1984

8.2.2 FACILITIES REHABILITATION PLAN

The facilities rehabilitation plan shall proceed according to the overall development plan stated in Section 8.2 and the development schedule outlined in Section 8.2.1. A description of each site is followed by a dam site map that represents the proposed topography at each site after the development plan has been completed. Each map shows direction of flow, maximum head water elevation and maximum tail water elevation, fish passage locations and miscellaneous topographic features unique to the particular site.

BOARDMAN

The development plan requires the retro-fitting of existing physical features to accept new hydroelectrical equipment in the Boardman Dam powerhouse. (Figure 8.2c Boardman Dam Site Development Plan). The roadway which currently crosses the Boardman Dam will be removed from the dam structure and relocated to the south where a new bridge constructed over the intake channel. The purpose of the relocation is two-fold. First, the existing roadway width of the bridge over the Boardman Dam is inadequate by current AASHTO standards, and consequently, the new structure will allow current safety and loading standards to prevail. Secondly, the penstocks leading to the powerhouse will be protected from vehicular accidents by relocating the roadway.

The fish passage located on Figure 8.2c need not be built during the retro-fitting construction. The fish passage at this site might not be required, or at least not constructed until the renovation at the Union Street Dam Site is complete or its fish passage is constructed. The fish passage location

shown was chosen to separate, as much as possible, the hydro plant from the fish passage and allow construction on a pleasingly visual contour of the land near the current park location. The proximity of the fish passage with respect to the hydro plant will allow for the least disruption of fish travel due to the workings of the hydro plant.

SABIN

The Sabin Dam renovation will coincide with the renovation at the Boardman Dam site. (Figure 8.2b Sabin Dam Site Development Plan). Here, as with the Boardman Dam Site, the fish passages will be constructed, if required, a considerable distance away from the workings of the powerhouse and dam spillway. The location will give the fish passage a pleasing visual appeal and allow for the uninterrupted migration of fish. Here, also, the fish passage would not be constructed until the completion and renovation of the Union Street Dam Site and/or construction of its fish passage.

BROWN BRIDGE

Little physical site alteration will need to occur at the Brown Bridge Dam Site. (Figure 8.2e Brown Bridge Dam Site Development Plan). Minor concrete repair and updating or replacing interfacing equipment will be required at the Brown Bridge Dam. Slope protection will be needed in certain areas of the Brown Bridge Dam Reservoir to ensure slope stability.

UNION STREET

Renovation of the Union Street Dam Site is predicated on events previously noted. (Figure 8.2a Union Street Dam Site Development Plan.) A new powerhouse will be constructed on the Union Street Dam Site and will use the two southerly most spillway tubes as an intake structure, thus, minimizing the amount of excavation and total civil construction work required in the area. A fish passage, if required, will be constructed on the northern edge of the dam to separate the powerhouse and fish passage by the greatest distance. The fish passage will be constructed concurrently with the powerhouse.

KEYSTONE

In the event conditions previously stated prevail, a total rebuilding effort at the Keystone Dam Site will be initiated. (Figure 8.2d Keystone Dam Site Development Plan.) An entirely new powerhouse will need to be constructed near or at the old powerhouse site. A new spillway will be constructed near the old spillway site. The locations are chosen to create a pond reservoir which will closely approximate the shape of the "washed-out" dam's reservoir and the configuration will minimize the amount of excavation and fill required to create the reservoir, thereby reducing environmental concerns.

The fish passage location shown was chosen to closely approximate the current river flow location and to separate the fish passage from the powerhouse workings. The fish passage will be constructed concurrently with the dam reconstruction.



SCALE: 1" = 100'

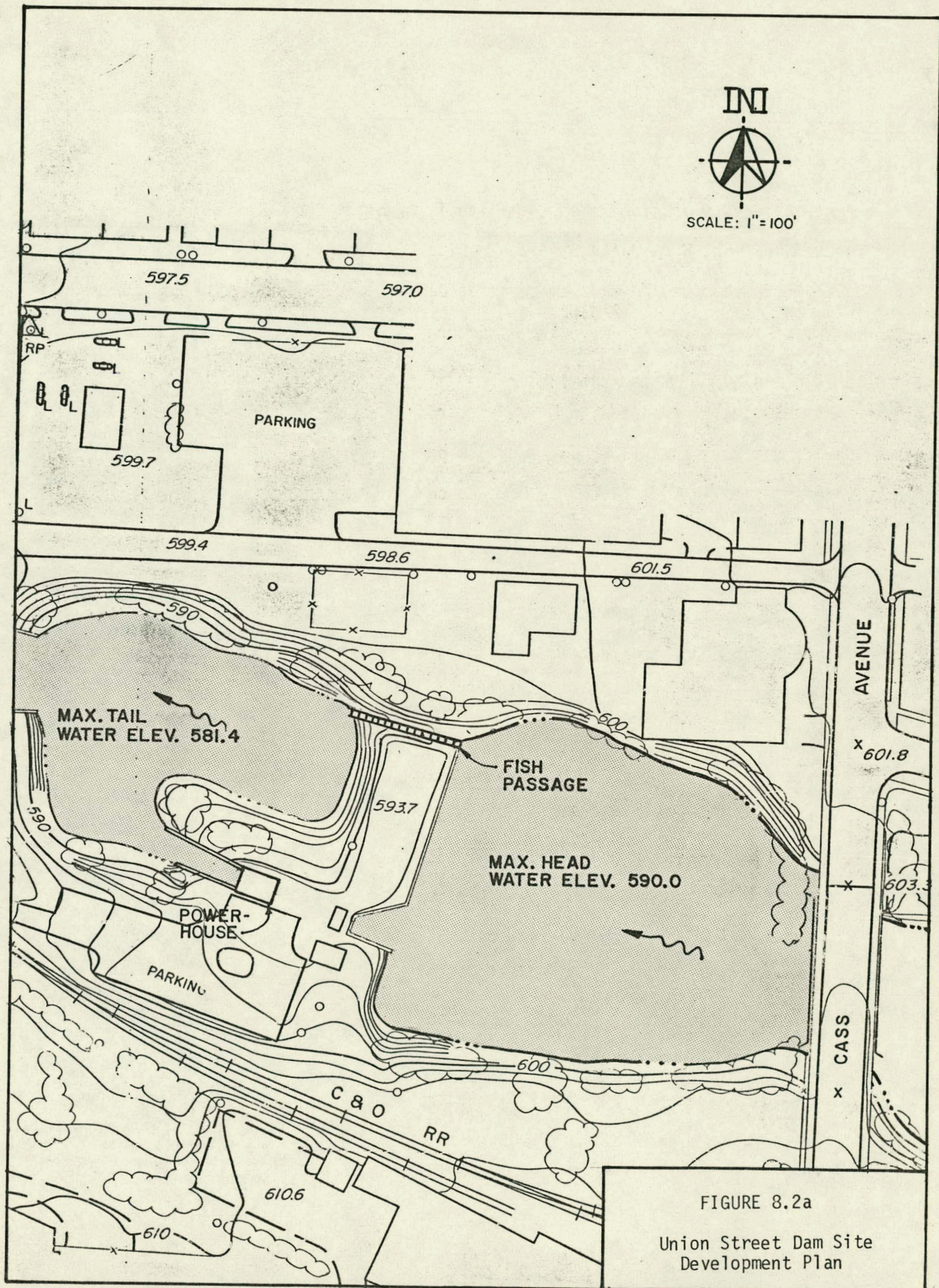
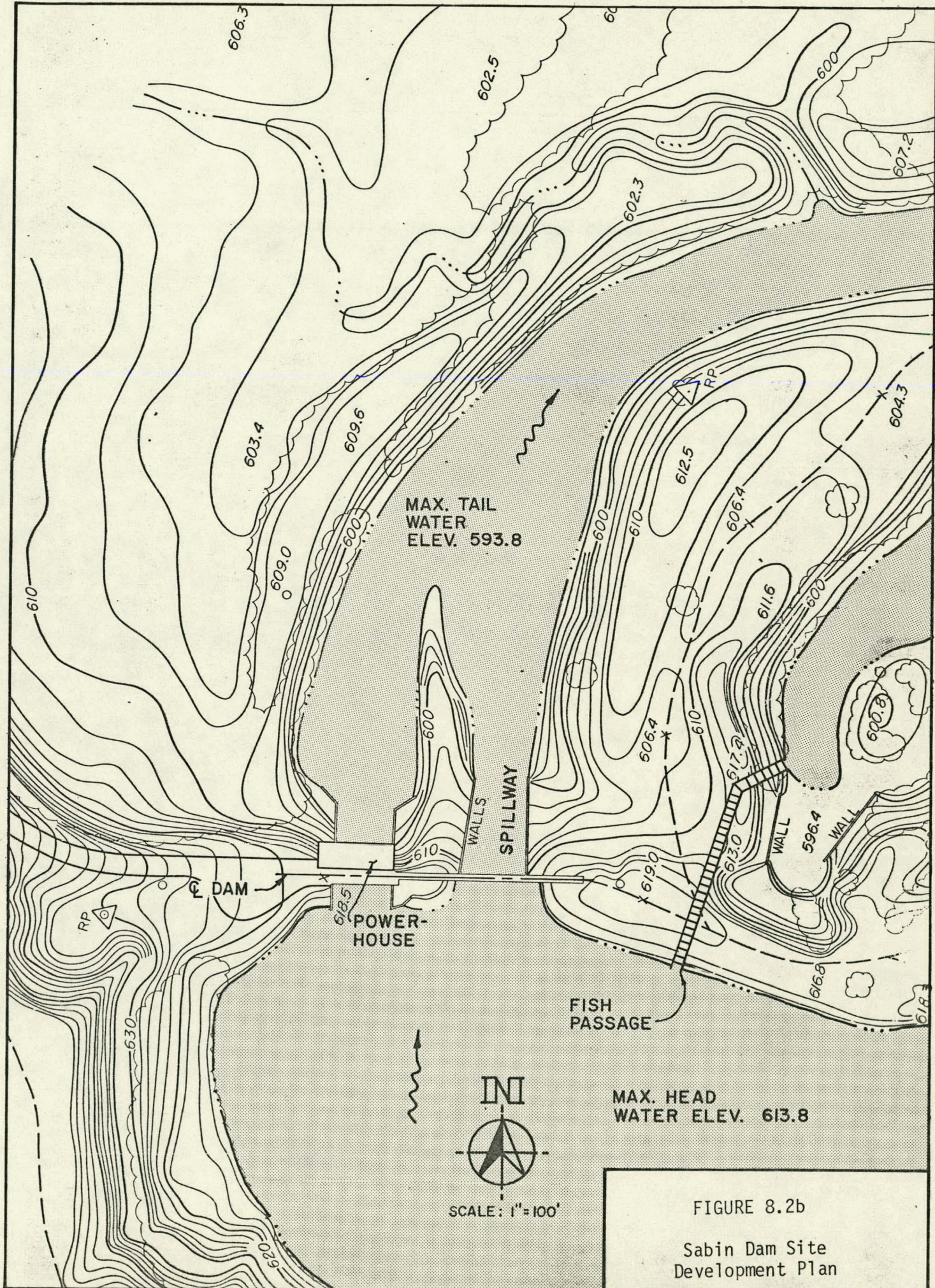


FIGURE 8.2a
Union Street Dam Site
Development Plan



MAX. HEAD WATER ELEV. 613.8

MAX. TAIL WATER ELEV. 593.8

FIGURE 8.2b

Sabin Dam Site Development Plan

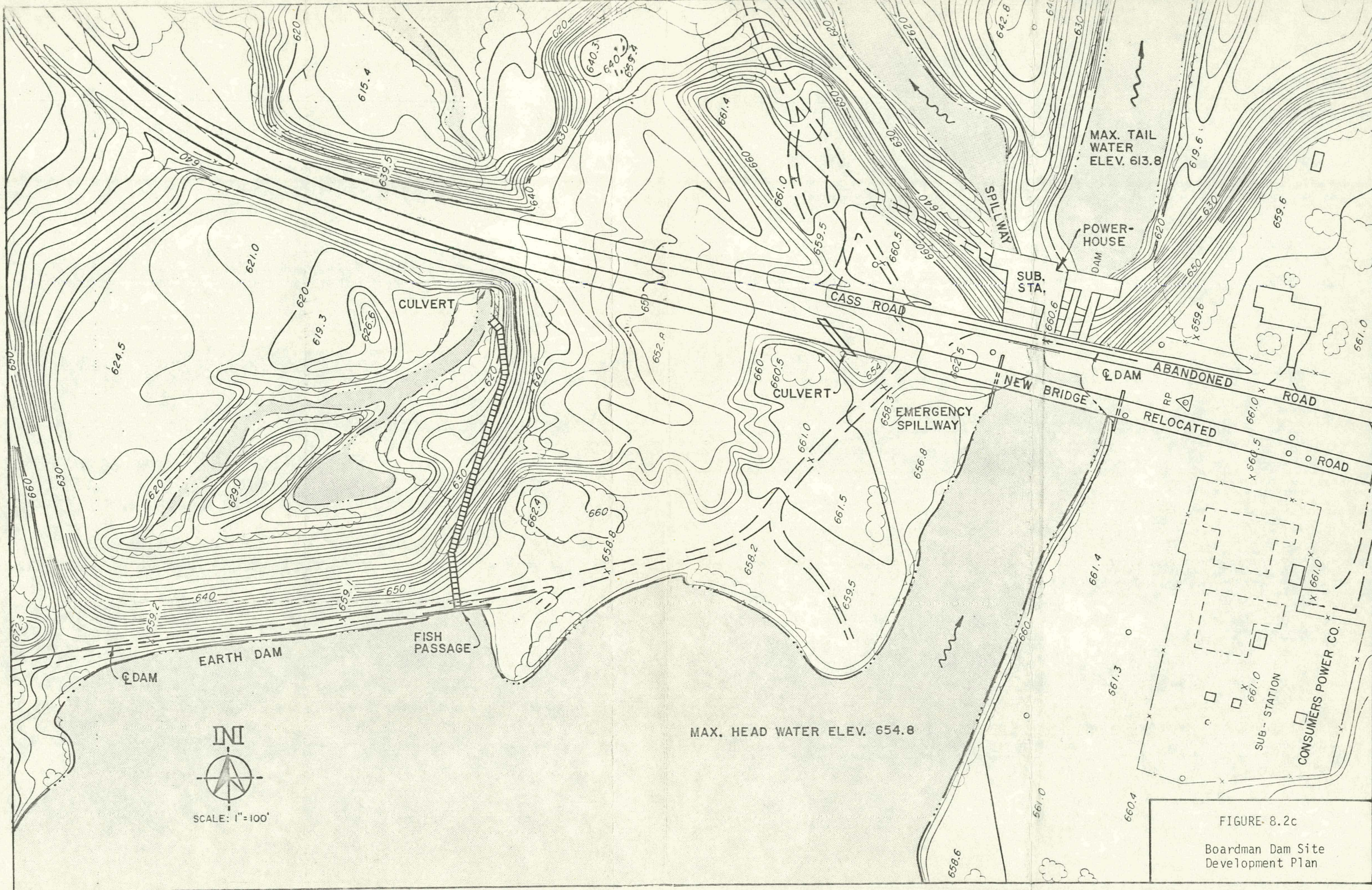


FIGURE 8.2c

Boardman Dam Site Development Plan

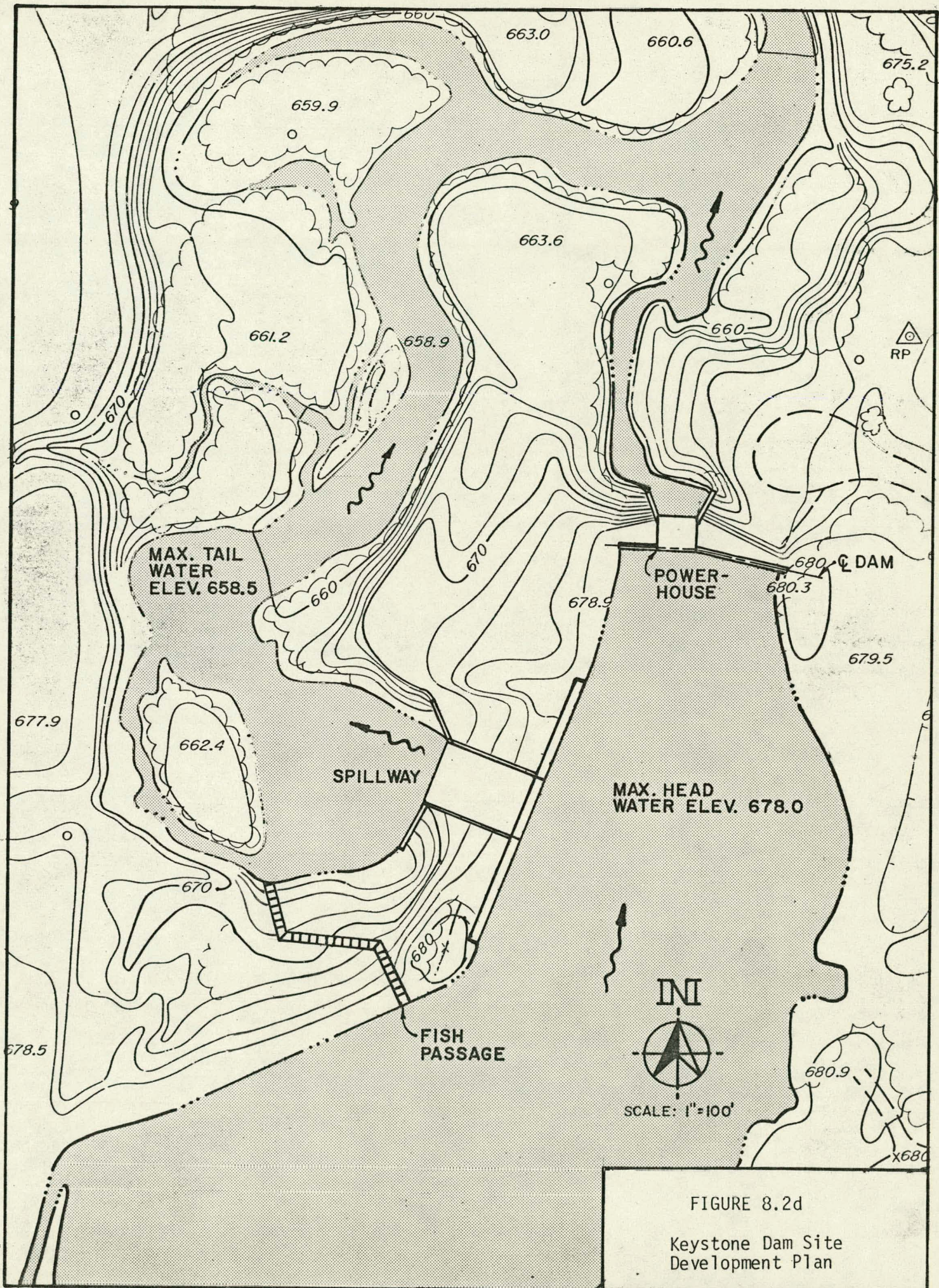
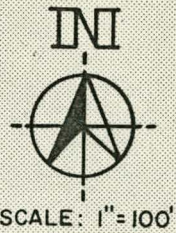


FIGURE 8.2d

Keystone Dam Site
Development Plan



MAX. HEAD WATER ELEV. 797.5
MAX. TAIL WATER ELEV. 768.2

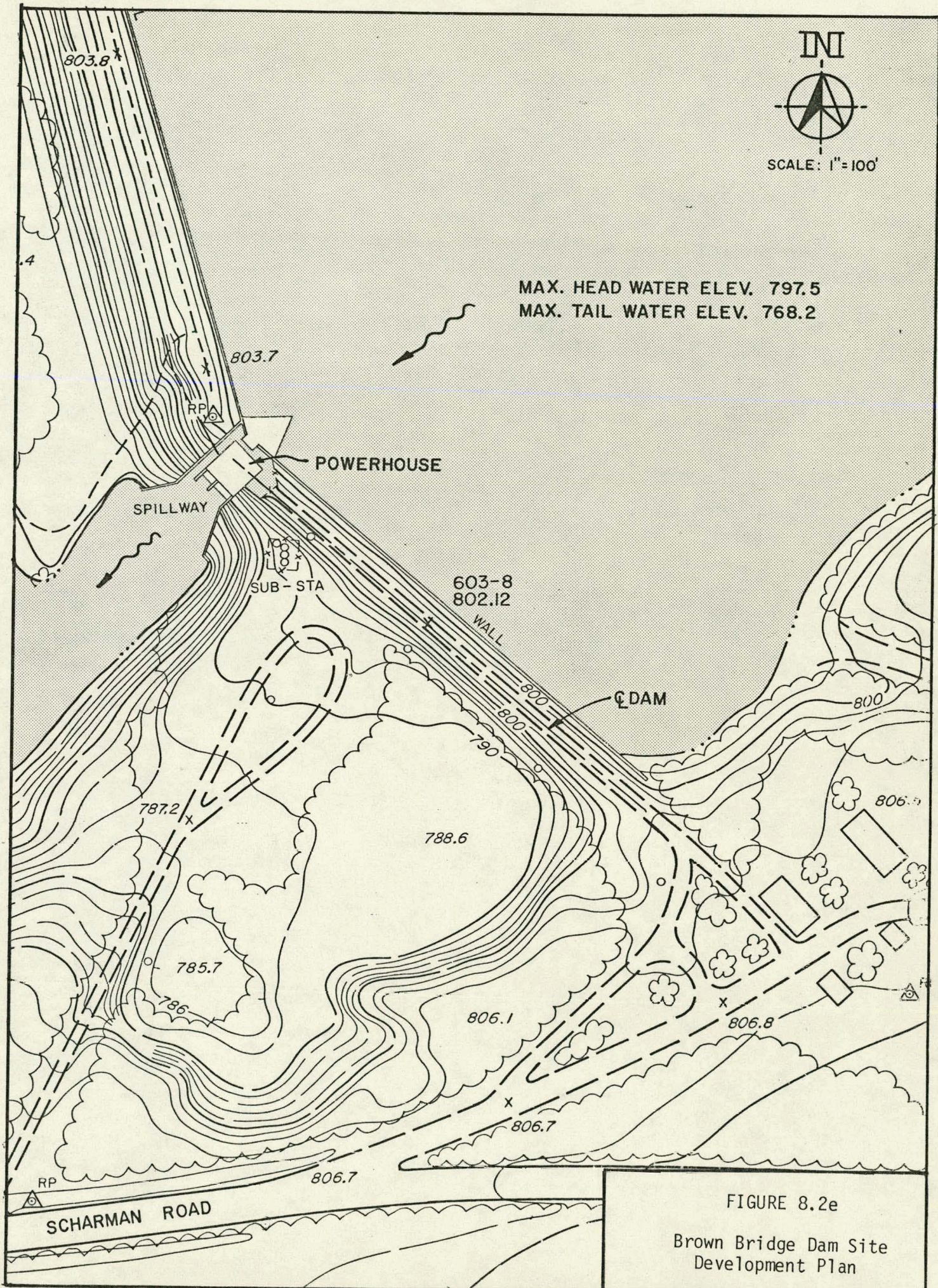


FIGURE 8.2e
Brown Bridge Dam Site
Development Plan

Appendix A

FEDERAL ENERGY REGULATORY COMMISSION

~~WASHINGTON, D.C. 20428~~

Federal Building - Room 3130
230 South Dearborn Street
Chicago, Illinois 60604

February 1, 1979

Mr. Hathaway J. Hanes
1712 Wood Street
Lansing, Michigan 48912

Dear Mr. Hanes:

Enclosed is a copy of Order No. 11 "Simplified Procedures for Certain Water Power Licenses" that you requested by January 17, 1979 letter.

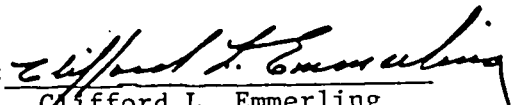
Subchapters A, B, and D are part of Chapter I of Title 18. We are sending you Parts 1 to Part 149 and Part 150 to End of CFR 18 (Revised as of April 1, 1977).

If you wish a copy of the current 1978 Edition, it is available for \$5.00 per copy from:

Superintendent of Documents
Government Printing Office
Washington, D.C. 20402

Sincerely,

Bernard D. Murphy
Regional Engineer

By: 
Clifford L. Emmerling

Enclosure:
as above

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

(18 CFR §§3.114(b), 4.60, 16.12, 131.6)

Short-Form License (Minor)

) Docket No. RM78-9

ERRATA NOTICE

(September 11, 1978)

Order No. 11

Simplified Procedures for
Certain Water Power Licenses

(Issued September 5, 1978)



Page 5, change the last word on the page from "notice" to "order."

Page 9, add to the fourth line from the bottom the word "association" in parenthesis so that the line will read: "state (municipality)(corporation)(association)."

Kenneth F. Plumb,
Secretary.

FEDERAL ENERGY REGULATORY COMMISSION

WASHINGTON, D. C. 20426
EQUAL OPPORTUNITY EMPLOYER

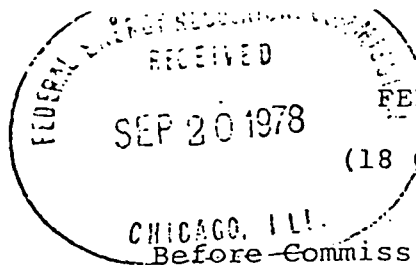
POSTAGE AND FEES PAID
FEDERAL ENERGY REGULATORY COMMISSION

FERC 22

FIRST CLASS MAIL



ROUTING		
TO	ACTION	Date
Murphy		9/27
Emmons		9/22
Simon		9/27
HWC		9/27



UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

(18 CFR §§3.114(b), 4.60, 16.12, 131.6)

Before-Commissioners: Don S. Smith, Acting Chairman;
Georgiana Sheldon, and George R. Hall.

Short-Form License (Minor)) Docket No. RM78-9

ORDER NO. 11

SIMPLIFIED PROCEDURES FOR
CERTAIN WATER POWER LICENSES

(Issued September 5, 1978)

The Federal Energy Regulatory Commission (Commission) gives notice that it is amending the General Rules and Regulations under the Federal Power Act, Subchapters A, B, and D, Chapter I, Title 18, Code of Federal Regulations. These amendments establish a short-form water power license (minor) and a new application form with accompanying instructions for completing the application for a short-form license (minor).

As stated in the Notice of Proposed Rulemaking, 43 F.R. 18196 (April 28, 1978), the purpose of these amendments is to provide a simplified procedure and format for processing applications for small-scale water power projects. This procedure should save time for the applicant and the Commission Staff, as well as to eliminate unnecessary obstacles to the development of small capacity water power projects, in furtherance of national policies for conservation of fossil fuels. 1/

The number of inquiries received by Commission staff in recent months concerning the installation of additional generating capacity at existing water power projects, the

1/ For example, the National Energy Act proposals now under consideration by a Joint Conference Committee of the United States Senate and House of Representatives include a program for loans, encouragement, and expeditious licensing for certain hydroelectric projects with no more than 20,000 HP (15 megawatts) installed capacity.

Docket No. RM78-9

redevelopment of existing projects to provide additional power, and the installation of power generating facilities at existing non-power dams has increased sharply. This interest has been accompanied by a substantial increase in the number of applications filed with the Commission.

The proposed rulemaking would have imposed three eligibility criteria for a project to obtain a short-form license (minor). These were: (1) the project dam or diversion structure could be no more than 25 feet in height above stream bed; (2) the project could not impound a reservoir having a surface area of 10 acres or more; and (3) the project generating capacity could not exceed 2,000 horsepower (1,500 kilowatts). After examining the comments, reevaluating the criteria, and considering the legal and policy questions involved, the Commission has decided to eliminate the first and second limiting criteria to widen the applicability of the short-form license (minor) procedure to all projects having a generating capacity of 2,000 HP (1,500 kW) or less (that is, all "minor" projects).

In response to the notice, 18 entities and 1 individual submitted comments for Commission consideration. 2/ The

2/ Letters of comments were received from: Southern California Edison Company; the Salt River Project; the New England Energy Task Force; the New England Regional Energy Advisory Board; the New England States Commissions; the National Rural Electric Cooperative Association; the Straflo Group; American Public Power Association; Central Vermont Public Service Corporation; LeBoeuf, Lamb, Leiby & MacRae; Power Authority of the State of New York; Robert J. Taylor; the U. S. Department of the Interior, Heritage Conservation and Recreation Service; Central Maine Power Company; Duke Power Company; Maine Hydroelectric Development Corporation; the Mead Corporation; Allegheny Power Service Corporation; and Linton, Miels, Reisler & Cotton, Ltd.

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comments were generally favorable to the proposal, but most also expressed the view that the criteria used were far too restrictive, and should be expanded so that more applications could be processed under the streamlined procedure.

One common suggestion was that the generation limit be raised from 1,500 kW (1.5 MW) to 15 MW. The latter figure is the upper limit selected for the small hydroelectric project incentive program included in the National Energy Act now pending in Congress. These short-form license (minor) procedures are specifically intended to apply only to minor projects, those with installed capacity of 2,000 HP or less (i.e., 1.5 MW), for which the Commission may waive certain provisions of the Federal Power Act, as authorized in Section 10(i), 16 U.S.C. §803(i). But the Commission intends to simplify its hydroelectric licensing procedures for major projects as well. Its staff is currently reviewing these procedures and developing recommendations for the Commission's consideration. Thus, future rulemakings will propose additional simplified licensing procedures for major projects between 2,000 HP and 20,000 HP (15 MW), as well as for major projects larger than 20,000 HP, in generating capacity.

Another suggestion common to many of the comments was that the height limitation be increased from 25 feet to 66 feet (20 meters). The higher figure is used by the Department of Energy in its Program Research and Development Announcement (PRDA), ET-78-D-07-1706. The 25-foot limitation was originally selected because it corresponded to the dam height set by Congress in the National Dam Inspection Act, 33 U.S.C. §467a-467e, as the upper limit for dams to be considered in a "low hazard" category. Comments generally pointed out that any size limitation based on safety reasons was irrelevant because at the time of licensing the Commission must find all dams

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safe and adequate, or capable of being made safe by taking appropriate action as spelled out in the licensing order and instrument. The Commission agrees and also notes that, for an existing but unlicensed project which is subject to our jurisdiction, the public health, safety, and welfare are better served by procedures which allow the swift issuance of a license for that project, but requiring the owner to take actions to make the project safe under penalty of law, than by a more cumbersome and lengthy licensing process required by a dam height limit. Thus, the Commission is eliminating the dam height criterion.

The final suggestion common to many of the comments was that the 10-acre reservoir size limitation was too restrictive. This limitation was based upon Section 2 of the Fish and Wildlife Coordination Act (FWCA). 3/ Upon further review, the Commission concludes that the consultation requirements of the FWCA will be satisfied by its solicitation of the relevant federal and state agencies' comments by means of forwarding to those agencies a copy of the public notice of the application for license. The public notices, which are issued pursuant to the Federal Power Act, 4/ will explicitly solicit comments. The Commission also notes that these federal and state agencies are given a prior opportunity for comment and input on the proposed project very early in the process, because the short-form procedures require the applicant to consult with these agencies and include evidence of such consultation as part of the application submitted to the Commission. Furthermore, the agencies may obtain copies of the application from the Commission or the applicant upon request. Therefore, the Commission has decided to eliminate

3/ 16 U.S.C. §662.

4/ 16 U.S.C. §797(e) and (f).

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the criterion relating to reservoir size for projects that would otherwise be eligible for a short-form license (minor).

Finally, some comments suggested certain other changes in the new procedures -- such as making them applicable to applications for relicensing and requiring only that a water quality certificate be applied for at the time of license application to this Commission, rather than be included with the short-form application. Those and other minor suggested changes have been made. In addition, the Commission is extending the new procedure to qualifying existing license applications already on file, as well as to future filings.

As a result of the changes discussed above, all existing "minor" license applications will be processed under the new short-form license (minor) procedures. Thus, the amendments to Commission regulations made below generally delete the existing sections dealing with "minor" licenses and substitute new sections for short-form licenses (minor). While some section numbers may thus be different from those in the notice of proposed rulemaking, the sections themselves are essentially the same.

The short-form license (minor) procedures in the notice of proposed rulemaking also contained proposed new Forms L-22 and L-23, which were license order formats containing, inter alia, standard license articles. The expansion of the short-form license (minor) procedures to cover all minor projects obviates the need for any new forms. For standard license articles for short-form licenses (minor), the Commission will select the appropriate form from the current Forms L-9, L-12, and L-14 through L-19 (revised October, 1975) applicable to minor projects. See 18 CFR §2.9 and Order No. 540, 40 F.R. 51998 (November 7, 1975). For information, a typical format for a short-form license (minor) is attached as Appendix A to this ~~notice.~~ order.

ERRATA
NOTICE
9-11-78

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The Commission is making these amendments effective immediately. Because the amendments reduce the filing requirements in a certain type of application, they involve a substantive rule which relieves a restriction and are not required to be published thirty days prior to their effective date.

(Federal Power Act, as amended, 16 U.S.C. §792 et seq., Department of Energy Organization Act, Pub. L. 95-91, E.O. 12009, 42 F.R. 46267.)

For the reasons stated above, Parts 3, 4, 16, and 131 of Chapter I, Title 18, Code of Federal Regulations, are amended as set forth below, effective immediately.

By the Commission.

(S E A L)

Kenneth F. Plumb,
Secretary.

Docket No. RM78-9

1. Section 3.114 is amended by revising paragraph (b) to read:

§3.114 Licenses

* * * * *

(b) Applications under the Federal Power Act for license authorizing construction of projects; for license for constructed projects; and for renewal of licenses for projects are processed in the manner stated in §3.113.

* * * * *

2. Part 4 is amended by revising §4.60 to read:

§4.60 Contents

Each application for a short-form license (minor) for a water power project having installed capacity of 2,000 horsepower (1,500 kW) or less, whether constructed or to be constructed, shall conform to §131.6 of this chapter and shall be filed in accordance with §4.31 of this chapter.

3. Part 16 is amended by revising §16.12 to read:

§16.12 Renewal of minor or minor part license or short-form license (minor) not subject to sections 14 and 15

A licensee whose minor or minor part license or short-form license (minor) is not subject to sections 14 and 15 of the Act and who wishes to continue operation of the project after the end of the license term shall file an application for a "new license" 1 year prior to the expiration of the original license in accordance with applicable provisions of Part 4 of this chapter. Each application for new license under this section shall conform to §131.6 of this chapter, and shall set forth all information and exhibits prescribed in §4.60 of this chapter.

4. Part 131 is amended by revising §131.6 to read:

§131.6 Application for Short-Form License (Minor)
(See Section 4.60 of this chapter.)

Docket No. RM78-9

APPLICATION FOR SHORT-FORM LICENSE (MINOR)

1. Applicant's full name and address: _____

(Zip Code)

2. Location of Project:
State: _____ County: _____
Nearest town: _____ Water body: _____

3. Project description and proposed mode of operation
(reference to Exhibits K and L, as appropriate):

(continue on separate sheet, if necessary)

4. Lands of the United States affected (shown on Exhibit K)
(Name) (Acres)

- a. National Forest _____
- b. Indian Reservation _____
- c. Public Lands Under
Jurisdiction of _____
- d. Other _____
- e. Total U.S. Lands _____

f. Check appropriate box:

Surveyed Unsurveyed land in public-land
state:

(1) If surveyed land in public-land state provide the
following:

Sections and subdivisions: _____
Range _____ Township: _____
Principal base and meridian: _____

(2) If unsurveyed or not in public-land state, see
Item 7 of instructions: _____

5. Purposes of project (use of power output, etc.)

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- 6. Construction of the project is planned to start _____ it will be completed within _____ months from the date of issuance of license.
- 7. List here and attach copies of State water permits or other permits obtained authorizing the use or diversion of water, or authorizing (check appropriate box):
 - the construction, operation, and maintenance
 - the operation and maintenance
 of the proposed project.
- 8. Attach an environmental report prepared in accordance with the requirements set forth in the Instructions for Completing Application for Short-Form License (Minor), below.
- 9. Attach Exhibits K and L drawings.
- 10. State of _____
County of _____ ss:

being duly sworn, depose(s) and say(s) that the contents of this application are true to the best of _____ knowledge or belief and that (check appropriate box)

- _____ is (are) a citizen(s) of the United States
- all members of the association are citizens of the United States

_____ is (are) the duly appointed agent(s) of the state (municipality)(corporation)(association)

and has (have) signed this application this _____ day of _____, 19____.

ERRATA
NOTICE
9-11 '71

(Applicant(s))

Docket No. RM78-9

By _____
Subscribed and sworn to before me, a Notary Public of the
State of _____, this ___ day of _____,

/SEAL/

(Notary Public)

Docket No. RM78-9

INSTRUCTIONS FOR COMPLETING APPLICATION
FOR SHORT-FORM LICENSE (MINOR)

GENERAL

1. This application may be used if the proposed or existing project will have or has a total generating capacity of not more than 1,500 kW (2,000 horsepower). Advice regarding the proper procedure for filing should be requested from the Federal Energy Regulatory Commission in Washington, D. C.; or from one of the Commission's Regional Offices in Atlanta, Chicago, Fort Worth, New York, or San Francisco.

2. This application is to be completed and filed in an original and nine copies with the Federal Energy Regulatory Commission, 825 N. Capitol Street, N.E., Washington, D. C. 20426. Each of the original and the nine copies of the application is to be accompanied by:

- a. One copy each of Exhibits K and L described below.
- b. One copy each of a state water quality certificate pursuant to Section 401 of the Federal Water Pollution Control Act (or evidence that this certificate is not needed), and any water rights certificate or similar evidence required by state law relating to use or diversion of water. In lieu of submitting a copy of a Section 401 certificate (or other certificate), evidence that applications for these certificates have been filed with appropriate agencies, or that such certificates are not necessary, will be adequate to begin FERC processing of the application.
- c. One copy each of any other state approvals necessary. (Applicant should contact the state natural resources department or equivalent to ascertain whether any such approvals are necessary.)

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- d. One copy of Applicant's environmental report, described below.

3. Applicant is required to consult with appropriate Federal, State, and local resources agencies during the preparation of the application and provide interested agencies with the opportunity to comment on the proposal prior to its filing with the Commission. The comments of such agencies must be attached to the application when filed. A list of agencies to be consulted can be obtained from the Commission's main office or the appropriate regional office.

4. No work may be started on the project until receipt of a signed license from the Commission. The application itself does not authorize entry upon Federal land for any purpose. If the project is located in part or in whole upon Federal land, the Applicant should contact the appropriate land management agency regarding the need to obtain a right-of-way permit. As noted above, other state or Federal permits may be required.

5. An applicant must be: a citizen or association of citizens of the United States; a corporation organized under the laws of the United States or a State; a State; or a municipality.

- (a) If the applicant is a natural person, include an affidavit of United States citizenship.
- (b) If the applicant is an association, include one verified copy of its articles of association. If there are no articles of association, that fact shall be stated over the signature of each member of the association. Also include a complete list of members and a statement of the citizenship of each in an affidavit by one of them.

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- (c) If the applicant is a corporation, include one copy of the charter or certificate and articles of incorporation, with all the amendments, duly certified by the secretary of state of the State where organized, and one copy of the by-laws. If the project is located in a state other than that in which the corporation is organized, include a certificate from the secretary of state of the State in which the project is located showing compliance with the laws relating to foreign corporations.
- (d) If the applicant is a state, include a copy of the laws under the authority of which the application is made.
- (e) If the applicant is a municipality as defined in the Federal Power Act, include one copy of its charter or other organization papers, duly certified by the secretary of state of the State in which it is located, or other proper authority. Also include a copy of the State laws authorizing the operations contemplated by the application.

Include a copy of all minutes, resolutions of stockholders or directors, or other representatives of the applicant, properly attested, authorizing the filing of the application. This information can be provided by a letter attached to the application.

6. If the stream or water body is unnamed, give the name of the nearest named stream or water body to which it is tributary.

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7. The project description (application item 4) shall include, as appropriate: the number of generating units, including auxiliary units, the capacity of each unit, and provisions, if any, for future units; type of hydraulic turbine(s); a description of how the plant is to be operated, manual or automatic, and whether the plant is to be used for peaking; estimated average annual generation in kilowatt-hours or mechanical energy equivalent; estimated average head on the plant; reservoir surface area in acres and, if known, the net and gross storage capacity; estimated hydraulic capacity of the plant (flow through the plant) in cubic feet per second; estimated average flow of the stream or water body at the plant or point of diversion; sizes, capacities, and construction materials, as appropriate, of pipelines, ditches, flumes, canals, intake facilities, powerhouses, dams, transmission lines, etc.; and estimated cost of the project.

8. In the case of unsurveyed public land, or land not in a public-lands state, give the best legal description available. Include the distance and general direction from the nearest city or town, fixed monument, physical features, etc.

9. Exhibits K and L shall be submitted on separate drawings. Drawings for Exhibits K and L shall have identifying title blocks and bear the following certification: "This drawing is a part of the application for license made by the undersigned this ____ day of _____, 19____.

"_____
(Name of Applicant)

Docket No. RM78-9

10. The Commission reserves the right to require additional information, or another filing procedure, if data provided indicate such action to be appropriate.

EXHIBIT K-PROJECT LANDS AND BOUNDARIES

1. The Exhibit K is a planimetric map showing the portion of the stream developed, the location of all project works, and other important features, such as: the dam or diversion structure, reservoir pipeline, powerplant, access roads, transmission lines, project boundary, private land ownerships (clearly differentiate between fee ownership and land over which applicant only owns an easement), and Federal land boundaries and identifications.

2. The map shall be an ink drawing or drawing of similar quality on a sheet not smaller than 8 inches by 10-1/2 inches, drawn to a scale no smaller than one inch equals 1,000 feet. Ten legible prints shall be submitted with the application. Upon request after review of the application, the tracing must be submitted.

3. The project boundary shall be drawn on the map so that the relationship of each project facility and reservoir to other property lines can be determined. The boundary shall enclose all project works, such as the dam, reservoir, pipelines, roads, powerhouse, and transmission lines. The boundary shall be set at the minimum feasible distance from project works necessary to allow operation and maintenance of the project and control of the shoreline and reservoir. The distance in feet from each principle facility to the boundary shall be shown. The project boundary should be a surveyed line with stated courses and distances. A tape-compass survey is acceptable. True north shall be indicated on the map.

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The area of Federal land in acres within the project boundary shall be shown. The appropriate Federal agency should be contacted for assistance in determining the Federal land acreage. For clarity, use inset sketches to a larger scale than that used for the overall map to show relationships of project works, natural features, and property lines.

4. Show one or more ties by distance and bearing from a definite, identifiable point or points on project works or the project boundary to established corners of the public land survey or other survey monuments, if available.

5. If the project affects unsurveyed Federal lands, the protraction of township and section lines shall be shown. Such protractions, whenever available, shall be those recognized by the agency of the United States having jurisdiction over the lands. On unsurveyed lands, show ties by distance and bearing to fixed recognizable objects.

6. If the project uses both Federal and private lands, the detailed survey descriptions discussed above for the project boundary apply only to Federal lands. General location data and an approximate project boundary will normally suffice for project works on private lands.

EXHIBIT L-PROJECT STRUCTURES AND EQUIPMENT

1. The exhibit shall be a simple ink drawing or drawing of similar quality on a sheet no smaller than 8 inches by 10-1/2 inches, drawn to a scale no smaller than one inch equals 50 feet for plans and profiles, and one inch equals 10 feet for sections. Ten legible prints shall be submitted with the application. Upon request after initial review of the application, tracings must be submitted.

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2. The drawing shall show a plan, elevation, and section of the diversion structure and powerplant. Generating and auxiliary equipment proposed should be clearly and simply depicted and described. Include a north arrow on the plan view.

ENVIRONMENTAL REPORT

The environmental report should be consistent with the scope of the project and the environmental impacts of the proposed action; e.g., authorization to operate and maintain an existing project, or a project using an existing dam or other facility, would require less detailed information than authorization to construct a new project. The environmental report shall set forth in a clear and concise manner:

- (1) A brief description of the project and the mode of operation, i.e., run-of-river, peaking or other specific mode.
- (2) A description of the environmental setting in and near the project area, to include vegetative cover, fish and wildlife resources, water quality and quantity, land and water uses, recreational use, socio-economic aspects, historical and archeological resources, and visual resources. Special attention shall be provided endangered and threatened plant and animal species, critical habitats, and sites eligible for or included on the National Register of Historic Places. Assistance in the preparation of this information may be obtained from state natural resources departments and from local offices of Federal natural resources agencies.

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- (3) A description of the expected environmental impacts resulting from the continued operation of an existing project, or from the construction and operation of a new project or a project using an existing dam or other existing facility. Include a discussion of specific measures proposed by the Applicant and others to protect and enhance environmental resources and to mitigate adverse impacts of the project on the environmental resources and values, the cost of those measures, and the party undertaking to implement those measures if other than the Applicant.
- (4) A description of alternative means of obtaining an amount of power equivalent to that provided by the project in the event that construction or continued operation of the project is not authorized.
- (5) A description of the steps taken by the Applicant in consulting with Federal, state, and local agencies during the preparation of the environmental report. Indicate which agencies have received the final report and provide copies of letters containing the comments of those agencies.

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

SHORT-FORM LICENSE (MINOR)

Before Commissioners:

/Applicant/) Project No. _____

ORDER ISSUING SHORT-FORM LICENSE
()

An application was filed on _____ and
supplemented on _____ by _____
_____ for a short-form license (minor)
for a water power project.

/discussion, if any/

Issuance of a license for the project is in the public
interest and in conformance with all applicable provisions of
the Federal Power Act.

The Commission orders:

(A) This license is issued to _____
_____ (Licensee) of _____,
for a period effective the first day of the month in which
this order is issued, and terminating _____
for /"construction, operation, and maintenance" or "operation
and maintenance", as suitable/ of Project No. _____
located on _____, /a tributary
of the _____, / subject to the
terms and conditions of the Federal Power Act, insofar as not
expressly waived here, which Act is incorporated by reference
as part of this license, and subject to such rules and
regulations as the Commission issues or prescribes under the
provisions of the Act.

RM78-9

(B) This project consists of:

(i) All lands constituting the project area and enclosed by the project boundary, to the extent of the Licensee's interests in those lands. The project area and the project boundary are shown and described by certain Exhibit K drawing(s), FERC No(s). _____, which also form part of the application for license.

(ii) Project works consisting of: works listed
The location, nature, and character of these project works are more specifically shown and described by the exhibit cited above and by Exhibit L drawing(s), FERC No(s). _____, which also form part of the application for license.

(iii) All of the structures, fixtures, equipment, or facilities used or useful in the maintenance and operation of the project and located in the project area, and any other property used or useful in connection with the project or any part of it; together with all riparian or other rights, the use or possession of which is necessary or appropriate in the maintenance or operation of the project.

The exhibits designated and described above in this paragraph (B) are approved and made a part of the license.

(C) Pursuant to Section 10(i) of the Federal Power Act, it is in the public interest to waive the following Sections of Part I of the Act, and they are excluded from the license:

4(b), except the second sentence relating to free access by the Commission or its agents to the project works and project records; 4(e), insofar as it relates to approval of plans by the Chief of Engineers and the Secretary of the Army; 10(c), insofar as it

Docket No. RM78-9

relates to depreciation reserves; 10(d); 10(f); 11; 12; 14, except insofar as the power of condemnation is reserved; 15; 16; 18, except as it relates to fishways; 19, 20; 21; 22; and 23(a), insofar as it relates to the determination of fair value.

(D) This license is also subject to the terms and conditions designated Articles 1 through _____ in Form L- _____, entitled _____, attached to and made a part of this license. This license is also subject to these additional special terms and conditions:

/any special articles/

(E) This order shall become final 30 days from the date of its issuance unless an application for rehearing shall be filed as provided in Section 313(a) of the Federal Power Act, and failure to file such an application shall constitute acceptance of this license. The acknowledgement of acceptance attached to this license shall be signed for the Licensee and returned to the Commission within 60 days from the date of issuance of this order.

By the Commission.

(S E A L)

Secretary

Docket No. RM78-9

IN TESTIMONY of (its) acknowledgement of acceptance of
all of the terms and conditions of the foregoing order,

_____, this ____ day of _____,
(Name)

19__, has caused his (its corporate) name to be signed hereto
(by _____

_____ its President, and its corporate seal
to be affixed hereto and attested by _____,

its _____ Secretary, pursuant
to a resolution of its Board of Directors duly adopted on the
_____ day of _____, 19__, a certified
copy of the record of which is attached hereto).

(By _____)

(Attest:

Secretary)

Note:

Execute in quadruplicate. Statements within brackets apply
only to corporations, municipalities and associations of
citizens.

Appendix B

Engineering Report

For

Boardman Dam - Boardman Dam and FAS Route 2837 (Cass Road)
over the Boardman River in Section 34, T27N, R11W, Grand Traverse County, Michigan

Sabin Dam - Sabin Dam over the Boardman River
in Section 27, T27N, R11W, Grand Traverse County, Michigan

Prepared For

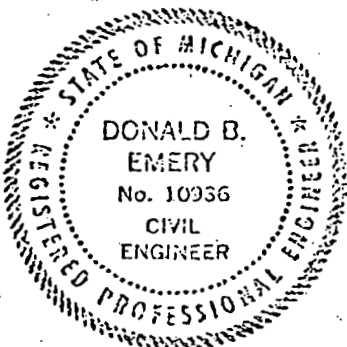
The Grand Traverse County Board of Commissioners

Prepared By

Emery and Porter, Inc.

3750 Wood Street

Lansing, Michigan 48906



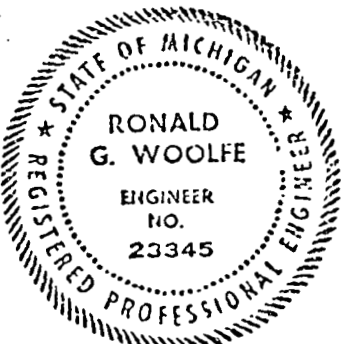
A handwritten signature in black ink that reads "Donald B. Emery".

Donald B. Emery, P.E.
Michigan Registration No. 10936



A handwritten signature in black ink that reads "Hathaway J. Hanes".

Hathaway Hanes, P.E.
Michigan Registration No. 5260



A handwritten signature in black ink that reads "Ronald G. Woolfe".

Ronald G. Woolfe, P.E.
Michigan Registration No. 23345

I N D E X

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Attachments

1. Initial Inspection Report, Dated October 6, 1977
2. Results of Concrete Core Tests
3. River Flow Data
4. Photographs of Existing Conditions
5. Topographic Maps, Drawings 1 thru 3
6. Plans of Existing Structures, Drawings 4 thru 12
7. Proposed Alternate Schemes, Drawings 13 thru 15

I. INTRODUCTION

On September 13, 1977, the Grand Traverse County Board of Commissioners, hereinafter referred as the "COUNTY," engaged the professional services of the consulting engineering firm of Emery and Porter, Inc., 3750 Wood St., Lansing, Michigan, hereinafter referred to as the "CONSULTANT."

The engineering services desired consists of performing all work necessary to develop a preliminary study and engineering report for the "PROJECT," being described and located as:

Boardman Dam - Boardman Dam and FAS Route 2837 (Cass Road) over the Boardman River in Section 34, T27N, R11W, Grand Traverse County, Michigan.

Sabin Dam - Sabin Dam over the Boardman River in Section 27, T27N, R11W, Grand Traverse County, Michigan.

II. SCOPE OF SERVICES

The engineering services to be rendered by the CONSULTANT as set forth in the agreement for this PROJECT, are itemized as follows:

1. Obtain all existing plans, maintenance records, operating records and other data that is available from all logical sources such as the Grand Traverse County Road Commission and Consumers Power Company.

2. Collect sufficient field survey data to enable plotting the existing dams, buildings and utilities on reproducible sheets to a workable scale of at least $1/8" = 1':0"$. All elevations will be related to United States Geological Survey Datum, and at least two permanent bench marks will be established to the same datum at each site for future use.

3. Inspect the dams, bridge, spillways, and adjacent buildings for structural adequacy to support present loadings, and bring any items requiring immediate action to the COUNTY'S attention at once in the form of an inspection report outlining the unsafe items along with cost estimates to correct such conditions.

4. Plot and record all field data collected.

5. Structurally analyze each dam, bridge and building to determine their ability to sustain present loadings, as well as those loading conditions that may be applied by alternate usages to be studied in this report. Determine the possibility and extent of renovation necessary to ensure structural integrity for the above loadings.

6. Study the advantages and disadvantages of discontinuing or removing the present structures and constructing new facilities at the present or alternate locations.

7. Evaluate increasing the operational efficiency of the existing water level control structures and mechanisms and investigate alternate methods of controlling the desired water levels within each body of water.

8. Determine, in coordination with the Grand Traverse County Road Commission, the ability of the County Primary Roadway, FAS Route 2837 (Cass Road), to safely and adequately accommodate present and future vehicular traffic over the Boardman Dam. The financial responsibility of any maintenance or renovation to the dam structure to handle the above traffic will be discussed with the Grand Traverse Road Commission.

9. Explore the possibility of utilizing either or both sites as a potential electrical generating power source.

10. Prepare a Preliminary Study, Preliminary Plans and Estimates of Cost to perform the maintenance, renovation or new construction required by any of the above activities. Itemize and summarize such cost estimates for each alternate solution.

11. Investigate availability of possible governmental funding assistance for all or any portion of the Project.

12. Prepare an Engineering Report to include all aforementioned items along with our firms detailed recommendations and alternate courses of action for the COUNTY'S consideration.

13. Submit above Engineering Report to the COUNTY within 75 working days from acceptance of this Agreement or within 60 working days of receipt of the contour maps to be supplied by the COUNTY, whichever is later.

The body of this report addresses itself to each of the above items.

Section VIII-Recommendations

The following recommendations and alternate courses of action are hereby offered to the Grand Traverse County Board of Commissioners.

1. The COUNTY should authorize the CONSULTANT, by resolution, to prepare and submit a proposal to the U.S. Department of Energy for feasibility assessments for adding hydroelectric generation capacity to the existing dams on the Boardman River system. The proposal is entitled "Feasibility Determination of Low-Head Hydroelectric Power Development at Existing Sites" and must be submitted no later than February 22, 1978. No fee will be charged to the COUNTY for preparing the proposal. The dams to be considered are the Brown Bridge Dam, the Keystone Dam, the Boardman Dam, the Sabin Dam and the Union Street Dam. Since the Brown Bridge, Keystone and Union Street Dams are owned by Traverse City, a similar resolution should be requested of the City Council of Traverse City. The resolution, in essence, states that the owners of the dams desire to have the proposed study performed and are willing and able to implement the conclusions and recommendation of the study. The exact verbage of the resolution can be worked out when the proposal is prepared. In the event the Federal Government does not fund the above proposed feasibility study within a reasonable length of time, we recommend that the COUNTY contact Traverse City for the purpose of joint funding a similar type feasibility study for The Boardman River System or that the COUNTY fund a feasibility study for the Boardman and Sabin Dams only.

2. In our opinion, the COUNTY should immediately authorize the installation and operation of a high water alarm at the Boardman Dam. We feel the high water alarm at the Mayfield Gaging Station would be required if the ultimate solution leaves the Boardman impoundment intact, as recommended, however, a decision regarding the Mayfield Gaging Station alarm can be deferred until that time.

3. We recommend that Schemes 1 and 8, that is operating both Dams in their present condition at the Boardman impoundment lowered lake level of elevation 138.4, be continued until early summer of 1978. We feel that added storage capacity of the lowered pond is adequate, with close surveillance, to accommodate the spring runoff.

4. Schemes 3 and 8, that is operating the Sabin Dam the same as present and operating the Boardman Dam at normal lake level with the Spillway, Wicket Gate control on the East Penstock and Stoplog control on the West Penstock,

are recommended to be implemented during the early summer of 1978 and utilized until the results of the feasibility study from recommendation 1 is known. We feel that the extra lake level control capabilities and automation of Scheme 3 over Schemes 1 or 2 at Boardman Dam is worth the additional costs. We feel the costs involved with Scheme 4 are not worth the added benefits.

5. In the event the feasibility study indicates that it is feasible to generate electrical power at both the Boardman Dam and Sabin Dam, we would recommend that the conclusions of that study be followed, essentially Schemes 7 and 10.

6. In the event the feasibility study does not recommend rehabilitation of the Sabin Dam for electrical power generation, we feel that Scheme 9, which utilizes the existing spillways and reworks the existing Powerhouse area for additional spillway, as an ultimate long-term solution, would be preferred over Scheme 11, reverting to natural river status by total elimination of the spillway, Powerhouse and impoundment. We do not believe that the Boardman River in its natural state would have the esthetic quality or recreational advantages equal to the existing impoundment. The existing Powerhouse building should be left in its present condition until it is no longer needed as a maintenance or storage area.

7. In the event the feasibility study does not recommend rehabilitation of the Boardman Dam for electrical power generation, we recommend Scheme 5, which is construction of a new spillway at the original channel location, removing the existing Boardman Dam, filling the intake channel and realignment of FAS Route 2837 (Cass Road). Although the initial construction costs of this scheme are high, the COUNTY will have rid itself of a potential hazardous liability with continually increasing maintenance costs, while still retaining all the beauty and recreational benefits of the Boardman pond. In our opinion, eliminating the Boardman impoundment, as in Scheme 6, would be contrary to the COUNTY'S original involvement in the PROJECT areas.

Appendix C



EBASCO ENGINEERING CORPORATION

7221 KENNEDY BOULEVARD
NORTH BERGEN, NEW JERSEY 07047

September 26, 1977

Mr Lawrence C Savage
City Manager
City Hall
Traverse City, Michigan 49684

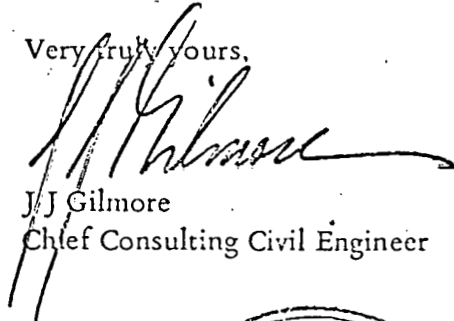
Dear Mr Savage:

Re: BROWN BRIDGE DAM
SAFETY INSPECTION

We are pleased to submit herewith our certified report entitled "Safety Inspection of Project Works, Brown Bridge Dam Project for the City of Traverse City."

We appreciate this opportunity to have been of service to you, and wish to acknowledge the gracious and able assistance and cooperation of your staff in this matter.

Very truly yours,



J.J. Gilmore
Chief Consulting Civil Engineer

JJG/ACG:dm

Encl.



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EXHIBITS

FIGURE 1 - Site Location

FIGURE 2 - General Layout and Typical Embankment Section

FIGURE 3 - Power Plant-Spillway Structure Typical Cross Section

PHOTOGRAPHS - General Views of Structures

I - SUMMARY

A. PURPOSE AND SCOPE

In May 1977, the City of Traverse City requested Ebasco Engineering Corporation to perform a safety inspection of the Brown Bridge Hydroelectric Project in Grand Traverse County, Michigan. The purpose of the inspection is to allow the City of Traverse City to obtain an assessment of the safety of the structures by an independent consultant. The last such inspection was carried out in 1962. The present inspection was performed solely for the City of Traverse City and not as a result of the requirements of any regulatory organization.

The scope of the work, which excludes generating equipment and transmission lines, mandated Ebasco to conduct an engineering inspection of the Brown Bridge Dam Project, to the extent deemed necessary by Ebasco, to permit them to express an opinion as to whether there are any deficiencies in the condition of the project structures, quality and adequacy of maintenance, or methods of operation which might present a safety hazard. The inspection covered settlement, movement, erosion, seepage, leakage, cracking, internal conditions of stress, and hydrostatic pressures in structures and their foundations and abutments, functioning of foundation drains and relief wells, stability of critical sections of reservoir shorelines and backslopes above structures, and any other project conditions which might endanger safety. Additionally, Ebasco included an evaluation relative to the possible effects on the structures resulting from operations normally conducted in the exploration for, and extraction of, oil or gas, on or under the City owned property on which the Brown Bridge Dam Project is located.

B. CONCLUSIONS

Based upon the information discussed in this report and such other matters as in our opinion are pertinent, it is the opinion of Ebasco that:

- 1) At the time of this inspection, which did not include generating equipment or transmission lines, there were only minor deficiencies in the adequacy of maintenance, i.e., unrepaired erosion causing low spots in the crest of the dam immediately adjacent to the power plant as a result of foot traffic of fishermen, and some gate leakage which could be economically significant.
- 2) The method of operation of the project appears to be satisfactory; however, it is noted that incorrect operation of the spillway gates could create an artificially high minor flood peak downstream of the dam. Also, during major floods, spillway gate operation would be dependent on road access to the powerhouse being passable.
- 3) The structures at the Brown Bridge Dam Project do not at this time indicate a need for a formal surveillance program to detect, measure and monitor settlement and displacement.

- 4) Interior water passages in the power plant spillway structure were not inspected due to operation of the turbine units during the inspection visit. As soon as plant operation permits a scheduled outage, interior water passages and the tailbay floor should be inspected to determine if cavitation or erosion has affected the concrete surfaces so that any potential impact on the powerhouse structure may be properly assessed.
- 5) Foreshore slopes of the reservoir present no hazard to the safety of the project.
- 6) Exploration for oil and gas below the property presents negligible hazard provided detonation of explosives is limited to the size of charge (i.e., under 5 pounds) normally associated with such work and is kept at least 400 feet from any structure. Extraction will also not present a hazard as long as such extraction is from the presently anticipated depth which would be in the order of 6000 feet.
- 7) Check computations on the stability of the dam indicate a satisfactory factor of safety against sliding failure under normal conditions and earthquake conditions.
- 8) Check computations on the stability of the power plant spillway structure indicate that factors of safety for overturning, flotation and sliding, under normal, maintenance and earthquake conditions, are acceptable. Foundation bearing pressure was found to be satisfactory under all conditions with a maximum computed value of 4.6 kips per square foot.
- 9) At normal reservoir water level of 117.5 feet the existing spillway is capable of safely passing a flood of 2000 - 2500 cfs depending on operating conditions; has a maximum capacity of 2900 cfs under ideal conditions and would be able to safely pass a flood having a recurrence interval of 10,000 years (i.e., a probability of occurring in any given year of 0.01 percent).
- 10) Should the capacity of the spillway at normal reservoir water level be exceeded, the pond water level would commence to rise. This surcharge would increase the spillway capacity thus allowing the dam to safely pass a flood having a recurrence interval in excess of 10,000 years.
- 11) Should a flood approaching the theoretical probable maximum flood of approximately 18,000 cfs occur the water level in the pond would rise until overtopping, or a sliding type failure, occurred and the dam would fail. The probability of the probable maximum flood occurring is very small.
- 12) Seepage through the dam was not measured. However, visual observations indicate that the flow in the drainage ditch is in the range of previous readings which indicated minimal seepage.

C. RECOMMENDATIONS

Based upon the information discussed in this report and such other matters as in our judgement are pertinent, it is the further opinion of Ebasco that:

- 1) The eroded low spots in the crest of the dam in the vicinity of the powerhouse spillway structure should be refilled and repaired.
- 2) The interior concrete surfaces of the spillway duct and the floor of the tailbay area should be inspected for cavitation and erosion of the concrete surfaces.
- 3) The seepage through the dam should be measured periodically for comparative purposes and records kept of such measurements. Also, regular routine visual inspections should be made for signs of any unusual increase in flow.
- 4) An annual operational check and inspection of the spillway gates should be performed and any malfunction or damage repaired immediately. The lower spillway gates should be checked with the intake gate in position, or the reservoir drawn down, to avoid the possibility of creating an artificial flood downstream.
- 5) An operational sequence for the spillway gates, under major flood conditions, should be established and posted at the plant and at the control center, to avoid the possibility of creating an artificial floodpeak downstream. This operation procedure plan should also include detailed descriptions of all possible alternate access roads between Traverse City and the dam in case normal routes are closed by flooding. In hurricane warning periods, consideration should be given to drawing the pond down prior to arrival of the storm.
- 6) Consideration should be given to repairing the spillway gates to eliminate the present leakage.
- 7) Regular routine inspections of the concrete in the tailrace area of the powerhouse spillway structure should be made as further deterioration of the concrete may require some repair work.

Appendix D

BOARDMAN AND SABIN DAM IMPROVEMENTS

The following improvements were conducted on the Boardman and Sabin Dams in 1978 based upon the recommendations made by Emery & Porter, Inc. in an inspection report to the Grand Traverse County. The improvements were executed under three general contract divisions. The following are the improvements made under the separate contract divisions:

GENERAL CONTRACT DIVISION 1

Item 1, BRIDGE RAILING REPLACEMENT - The bridge railing, railing posts, curb, and portions of the concrete slab were removed on the bridge over the Boardman Dam. A portable type concrete barrier railing was replaced.

Item 2, REINFORCED CONCRETE SURFACE REPAIR - Deteriorated concrete at locations indicated on the plans and to limits determined by the Engineer were removed. The deteriorated concrete was replaced by new concrete to the structure's original dimension.

Item 3, STRUCTURAL STEEL PAINTING - This work consisted of cleaning and painting metal surfaces of structures designated on the plans which included areas so designated by the Engineer.

Item 4, EMBANKMENT TREE CUTTING - This work consisted of cutting all the trees on the core wall embankment shown on the drawings. The trees were

cut within one foot of the natural ground of the immediate surrounding area. They were left at or near the location they fell to provide ground cover as directed by the engineer. Exact limits were determined by the Engineer in the field.

MECHANICAL CONTRACT DIVISION 2

Item 1, HEAD GATE HOISTING MECHANISM REPAIR - The head gate hoisting mechanisms at the east and west penstocks and the spillway gate hoisting mechanism was repaired.

Item 2, EAST PENSTOCK WICKET GATE REPAIR - This work consisted of replacing missing and worn shear pins in the wicket gate closing ring, adjusting the wicket gates for fit after repair of the shear pins and repairing or replacing wicket gate controlling mechanism to insure proper wicket gate control both manually and automatically.

Item 3, PENSTOCK HEAD GATE STEEL AND WOOD STOP LOG FABRICATION AND INSTALLATION Steel and wood stop logs at the west penstock intake structure were furnished and placed by the contractor.

Item 4, WEST PENSTOCK WICKET GATE REPAIR - This work consisted of fixing all the gates of the west wicket gate assembly in an open position.

Item 5, SPECIAL SPILLWAY HEADGATE FABRICATION AND INSTALLATION - A steel beam and watertight seals in the spillway headgate were furnished and placed by the contractor.

Item 6, LAKE LEVEL CONTROL ADJUSTMENTS - The contractor adjusted the top elevation of the stop logs at the west penstock intake structure, set the automatic controls on the east penstock wicket gate and the high water alarm and established a lake level elevation of 140.7 existing dam data.

Item 7, SPILLWAY BOOM LOG FABRICATION AND INSTALLATION - Steel brackets and an oak timber at the intake to the spillway was furnished and placed by the contractor.

ELECTRICAL CONTRACT DIVISION 3

Item 1, HIGH WATER ALARM FURNISHING AND INSTALLATION - A high water alarm system at the Boardman impoundment was furnished and installed by the contractor. The contractor also furnished a sending and receiving network for the system.

Item 2, BURGLAR ALARM FURNISHING AND INSTALLATION - A burglar alarm system at the Boardman Dam powerhouse and blower room was furnished and installed by the contractor. The contractor also furnished a sending and receiving network for the system.

Item 3, POWERHOUSE ELECTRICAL CIRCUIT REPAIR AT BOARDMAN AND SABIN DAMS

This work consisted of repairing the east penstock head gate hoist wiring, replacing the lighting panel in the powerhouse, and wiring a new 100 amp switch all at the Boardman Dam. Retainer gate operating mechanism at the Sabin Dam was inspected and repaired as deemed necessary by the engineer.

Item 4, POWERHOUSE VALVE ROOM SUMP PUMP REPLACEMENT - The existing valve room sump pump was removed and replaced by the contractor.

**Appendix
E**

BOARDMAN RIVER PROJECT

November 9, 1978

Meeting with Northwest Michigan Regional Planning and Development Commission staff:

Charles Grant
Tom Weaver
David Warner (involved in energy planning and NOAA Coastal Zone Management Program, under DNR)

Feasibility Study Staff

Don Emery
Otto Krauss

Nature and purpose of Feasibility Study was explained.

Comments:

Section # 208 (PL 92-500) is now State certified. EPA draft comments have been solicited.

There is nothing in plan which would preclude rehabilitation (or building new) hydroelectric plant.

If Boardman Lake is held back, there may be a sewage-plant-effluent dilution problem (?)

Boardman River water quality is now high. Plan was adopted by the Commission to maintain the high water quality.

No apparent serious negatives.

From notes taken, by Otto Krauss

E(1)

BOARDMAN RIVER PROJECT

November 14, 1978

Meeting with Traverse City Planning Commission (regular meeting)

James Franklin
Robert Sipple
Ted Okerstrom
Carol J. Hale
Dick Whiting

Fred Hoisington (Chief Planner)

Feasibility Study Staff

Don Emery
Otto Krauss

Bill Strom, Traverse City L & P

Representing the Michigan Department of Natural Resources

Ralph Hay

Nature and purpose of Feasibility Study was explained and questions solicited. Such questions and comments concerned

- (1) Fly-fishermen's concern about disturbing the impoundment level at Brown Bridge. A = the pond-level variation problem was explained including the economic and natural limitations
- (2) Cost of energy versus hydropower, will it pay? A = Feasibility Study will determine as well as the Power Source Study now being done for Traverse City by another engineering firm. Brown Bridge is now operating at very small costs
- (3) Disturbance of natural river flow and environmental effects? A = explained what is being done to establish minimum flow criteria together with DNR, based on 7-day lowest flow for the last 10 years
- (4) Ralph Hay explained purpose and rationale of fish passages as a result of a related question
- (5) Hoisington pointed out that the Union St. dam site is a city park and suggested that it be disturbed as little as possible
- (6) Level of Boardman Lake was discussed. A 12" variation was indicated to Commission as a possibility
- (7) Discussion concerning Nature Reserve at Sabin and Boardman

Summary: Generally favorable

From notes taken by Otto Krauss

E(2)

BOARDMAN RIVER PROJECT

November 9, 1978

Meeting with Garfield Township Board

Lee Wilson, Supervisor
Irvin Zimmerman, Clerk
Anna Feiger, Treasurer
Jim Harvey, Trustee
Leo Strait, Trustee

and approx. 30 people in the audience.

Feasibility Study Staff

Don Emery
Otto Krauss

Representing the Michigan Department of Natural Resources

Leon Guzinski

Nature and purpose of Feasibility Study was explained and questions solicited. Such questions and comments concerned

- (1) Siltation and silt removal? A = follow rules and statutes
- (2) Fish passages? Negative comment, mention of dead fish etc. nuisance. A = under statutes Natural Resources Commission will make decision, if necessary, hold hearings
- (3) Financing? A = to be determined by Feasibility Study
- (4) How much power? A = gave the estimate for each dam
- (5) Who gets the power? Is it shared? A = Traverse City L & P
- (6) Cost of power? A = Feasibility Study will determine

Summary: No red flags.

From notes taken by Otto Krauss

BOARDMAN RIVER PROJECT

November 13, 1978

Meeting with East Bay Township Board (their regular meeting)

George J. Shimek, Supervisor
Florence Herold, Clerk (the new Clerk is Frances Ferguson)
Donna Finnila, Treasurer
Tom Strait, Trustee
Jerome Korb, Trustee

Richard Ford, Township Attorney

and approx. 25 people in the audience

Feasibility Study Staff

Don Emery
Otto Krauss

Bill Strom, Traverse City L & P

Representing the Michigan Department of Natural Resources

Ralph Hay

Nature and purpose of Feasibility Study was explained and questions solicited. Such questions and comments concerned

- (1) Who operates? A = part of Feasibility Study
- (2) Fish passages? A = explained Dam Act of 1929 Board wants to be kept posted
- (3) General expression favoring "putting water power back to work"

Summary: No objections

From notes taken by Otto Krauss

BOARDMAN RIVER PROJECT

November 14, 1978

Meeting with Blair Township Board (their regular meeting)

John P. Coyne, Supervisor
Virginia E. Durocher, Clerk
Matilda Fashbaugh, Treasurer
Clara Schneider, Trustee (absent)
John Herrington, Trustee

and approx. 15 people in the audience

Feasibility Study Staff

Don Emery
Otto Krauss

Bill Strom, Traverse City L & P
Paul Hazelton, Grand Traverse County

Representing the Michigan Department of Natural Resources

Ralph Hay

Nature and purpose of Feasibility Study was explained and questions solicited. Such questions and comments concerned

- (1) Change River? A = little except for the changes due to putting Keystone back into operation
- (2) Fish ladders, who empowers DNR to demand? A = 1929 Dam Act. Some discussion on subject
- (3) Variation in impoundment levels? A = explained run-of-the-river generation versus higher value of peak power
- (4) Natural Resource Committee and similar groups informed? A = yes, through County Commission (answer given and explained by Paul Hazelton)
- (5) What about property taxes? A = none, joint venture by City and County. Benefits explained

Summary: Favorable comments

From notes taken by Otto Krauss

ROAD AND BRIDGE DESIGN
SEWER AND WATER SYSTEMS
STRUCTURAL DESIGN
INSPECTIONS
DRAINAGE PROJECTS

SUBDIVISIONS
CONDOMINIUMS
CERTIFIED SURVEYS
CONSTRUCTION SUPERVISION
RECREATIONAL DEVELOPMENT

Emery and Porter
Consulting Engineers and Land Surveyors

3750 WOOD STREET • LANSING, MICHIGAN 48906
TELEPHONE 517 487-3789

DONALD B. EMERY
PE 10936
PHONE: 655-1155

JAMES A. PORTER
RLS 19003
PHONE: 487-0235

October 3, 1978

Dr. Howard A. Tanner, Director
Michigan Department of Natural Resources
Stevens T. Mason Building
Lansing, Michigan 48926

RE: Feasibility assessment for renovating and/or rehabilitating one or more of five existing dams on the Boardman River in Grand Traverse County, Michigan and Traverse City, Michigan, to provide additional hydroelectric generation capacity. Cooperative Agreement No. E-W-78F-07-1792 between the U.S. Department of Energy and the Joint Venture of Grand Traverse County and the City of Traverse City.

Dear Dr. Tanner:

We wish to express our appreciation for the consideration given by you and Dale Granger during the September 26, 1978 meeting with the referenced study team members Donald Emery, Hathaway Hanes, and David Starr.

The study covers the five dams shown on the attached "Facilities Location Map" and the plan is, subject to the study findings, to operate any combination of these established sites on the Boardman River as an integrated hydroelectric system. The study is unique in that it deals with a river system rather than individual dams and sites. The river system approach has been used in Europe for many years to maximize beneficial uses, i.e., river system management. As you know, large river systems in the U.S. are similarly managed.

There is little question regarding technical feasibility. Economic feasibility depends on a number of technical, operational and financing factors. We also realized that total feasibility depends to a large extent on a series of environmental and social impact

Dr. Howard A. Tanner, Director
October 3, 1978
Page Two

questions. It is these environmental and social questions which we wish to discuss with you and your staff. In a sense, we would like to look to you as representing the public interest in the feasibility determination.

As requested during the aforementioned meeting, we have prepared the following questions addressed to some ten areas of general concern.

The Natural Rivers Act

The five sites under consideration antedate the act.

- . Does the country scenic classification include the entire Brown Bridge impoundment or does the country scenic classification end at the Brown Bridge Dam?
- . What effect does the act have on retrofitting existing dams?

Minimum Flow Requirement

There is at this time no minimum flow agreement nor has there been one in the past. The lowest daily flow of record seems to be 83 cfs in September 1959, although there have been other periods with flows below 100 cfs.

- . What are the procedures and criteria used to determine minimum flow?

Impoundment Level Control

Hydroelectric operation becomes more practical if some impoundment level variation is acceptable.

- . What are reasonable and acceptable limits from the DNR and public point of view?
- . As a part of the feasibility study peaking will be considered, therefore, what is the DNR reaction to peaking.

Fish and Wildlife

- . What are requirements regarding fish ladders?
- . Has turbine mortality been a problem at current hydro sites?
- . What are current species of game fish and wildlife in Boardman River system?
- . Are any threatened or endangered species involved?
- . Does retrofitting hydro dams have any effect on current sport fishing?

Dr. Howard A. Tanner, Director
October 3, 1978
Page Four

Since rehabilitation of abandoned hydros and generation of power at non-power dams are on the national agenda, perhaps you might wish to assign someone to coordinate the various elements.

Please do not hesitate to contact this office if you have any questions regarding this request.

Very truly yours,

EMERY AND PORTER, INC.

Donald B. Emery

Donald B. Emery, P.E.
Principal

DBE/sm



WILLIAM G. MILLIKEN, Governor

DEPARTMENT OF NATURAL RESOURCES

STEVENS T. MASON BUILDING, BOX 30028, LANSING, MICHIGAN 48909
HOWARD A. TANNER, Director

October 20, 1978

MICHIGAN DEPARTMENT OF NATURAL RESOURCES

INTEROFFICE COMMUNICATION

Refer to 6500
Grand Traverse Co.

October 19, 1978

Mr. Donald B. Emery, P.E.
Emery and Porter
Consulting Engineers and Land Surveyors
3750 Wood Street
Lansing, Michigan 48906

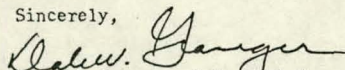
Dear Mr. Emery:

Consistent with the wishes of our Director, certain members of the department staff have been provided copies of your communication dated October 3, which announced your firm's involvement in a feasibility assessment for renovating and/or rehabilitating one or more of five existing dams on the Boardman River. This "working committee" has had opportunity to meet together and review your proposal.

Staff members representing Fisheries, Wildlife, Forest Management, Water Quality, Land Resource Programs, and Water Management divisions have submitted memorandums to the writer expressing their concerns and views. In order to provide you with an early departmental reaction to your inquiry, we are taking the liberty of providing you with copies of these documents containing background information on the department's interests in such a proposal.

In accordance with my telephone contact of October 19, we are establishing a date and time for a joint meeting of your staff with department staff to further review this feasibility study proposal for 1:30 p.m. on Tuesday, October 24. This meeting will be held in the 2nd Floor Conference Room in the east wing (Purchasing Section) of the Stevens T. Mason Building.

Sincerely,


Dale W. Granger, P.E., Chief
Water Management Division

DWG:cjs

cc: S. Milstein; C. Harris;
J. Scott; D. Jenkins;
H. Webster; R. Courchaine;
K. Fosford

R1026 10/78

TO: Dale W. Granger, Chief, Water Management Division
FROM: John A. Scctt, Chief, Fisheries Division
SUBJECT: Feasibility Study - Boardman River Hydro Electric Generation

The following are responses which Fisheries Division requests be incorporated in the answers to Emery and Porter's October 3rd letter relative to renovating dams on the Boardman River for power generation.

Minimum Flow Requirements

Studies are required to assure regulated releases are adequate to protect fish and other aquatic life, wildlife and recreational resources.

At existing facilities, the Department has participated in low flow investigations to the extent of providing biologists and hydrologists to inspect a series of flow releases designed to bracket and establish what minimum flow is required to protect the previously mentioned resources.

At new or newly activated facilities, it is the responsibility of the developer to perform the studies and provide recommendations for a minimum flow. The Department will review such studies to assure that fish food producing areas are not adversely impacted, fish spawning areas are protected, sufficient water is released to assure attraction of and transportation for anadromous species. Flow release requirements may also be geared to prevent compaction and sedimentation in gravels and to assure proper water temperatures for resident or anadromous species. Minimum flow determinations would be required at each site and flows will typically increase at each site in relation to accretions and increased drainage area. Standard wetted perimeter/water depth cross-section analyses for important fish habitats will be required.

Impoundment Level Control

Fluctuations of reservoir levels will naturally depend upon what uses are to be made and what resources need to be protected in the impoundment and downstream. Generally speaking, if recreation is a major use, as little fluctuation as possible during the summer period is desired. Consideration

Dr. Howard A. Tanner, Director
October 3, 1978
Page Three

River and Impoundment Bank Management

- . What are the DNR concerns regarding bank stabilization?

Recreational Uses and Public Access

- . Responsibilities for accommodating canoe traffic and portage provisions.
- . Requirements for public access and liabilities for public use of impoundments.
- . Any potential problems regarding future use of Boardman River System?

Water Quality

- . What are DNR requirements regarding initial and periodic silt removal from impoundments?
- . What are standards involving water quality?

Dam Safety and Security at the Hydroelectric Plants

- . What state public acts and regulations involve dam safety and security?
- . What agencies are responsible for enforcement?

Construction Permits and Licensing

- . What specific construction permits or approvals are needed for a project of this nature?
- . Is DNR involved in licensing of hydroelectric dams?

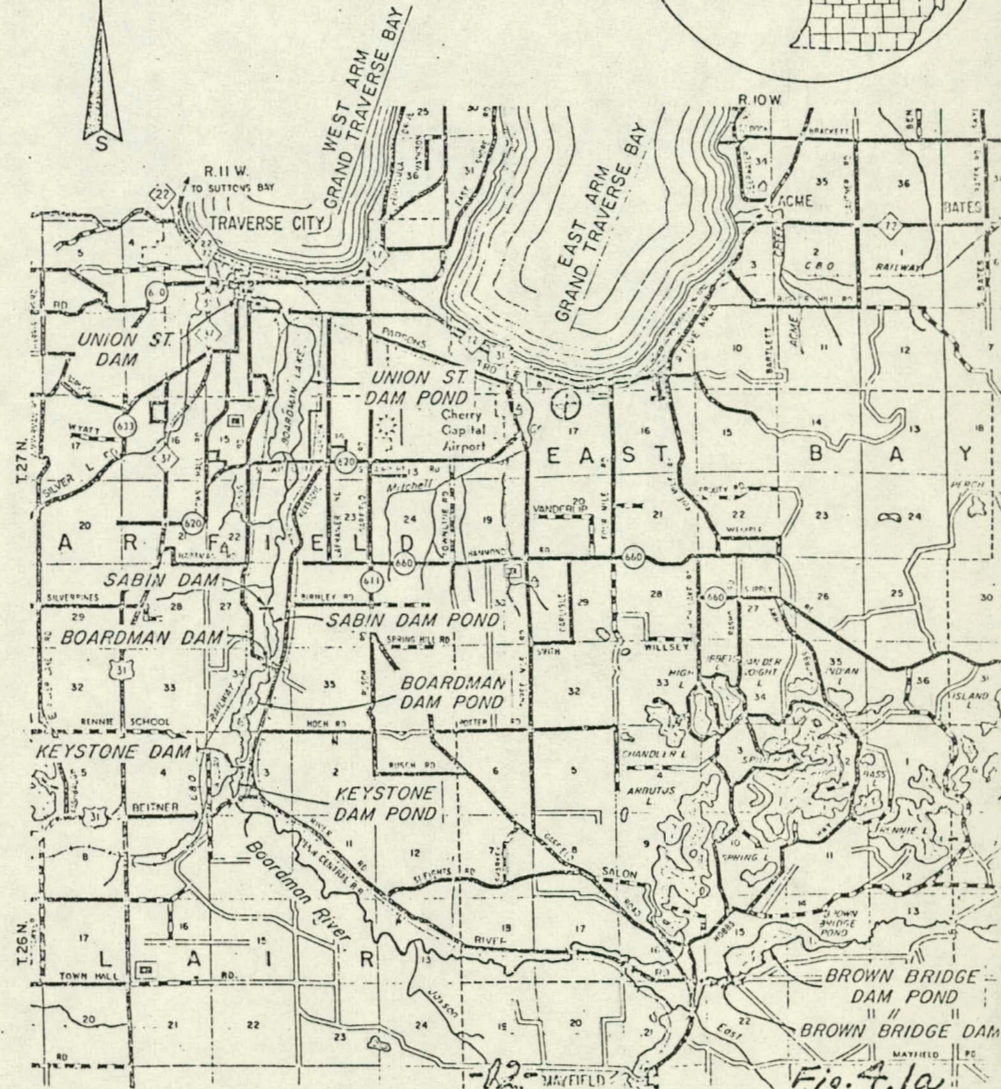
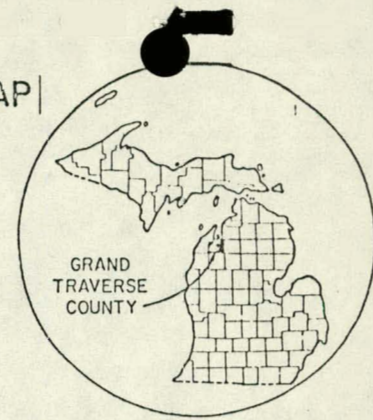
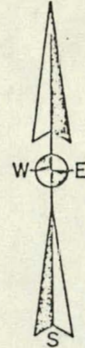
Environmental

- . Will an environmental impact statement be required and at what stage?
- . Are there any critical environmental issues the DNR feels should be addressed at this point?

Your input regarding environmental issues in areas inadvertently omitted from the above list is hereby solicited.

It is understood that your staff will review and respond to the above questions at a seminar type meeting to be arranged by your office. Convening such a meeting at the earliest possible date would be greatly appreciated since the time frame of our study requires completion of this study task by the middle of November, 1978.

FACILITIES LOCATION MAP



will have to be given to the impact of fluctuations on spawning of resident fish species within the impoundment. The degree of variation acceptable is site specific, e.g., in a steep sided reservoir a great deal more change in elevation would be tolerated compared with one which was gradually sloped. Obviously soil types are important too, i.e., will fluctuations cause bank erosion and/or slumping?

With respect to peaking operations, they are in general inimical to fisheries interests both as to protection of the fish and utilization by anglers. That is not to say that no mode of peaking operation (with proper minimum flows) is possible.

Fish and Wildlife

Attached is a copy of draft Department policy regarding fish passage requirements. If water development is to be practiced on a basin-wide or "river system approach" we could hardly do otherwise with respect to the Boardman River's fishery resources; therefore, we do not envision waivers of fish passage requirements at any structures involved in the study area.

Turbine mortality has not, to our knowledge, been a problem at existing hydropower sites; that may be because such losses are not readily apparent, however, and the subject needs evaluation. Studies to assess the potential loss of emigrant fish would probably be required at any new hydropower facility.

Fish species present in the Boardman include:

- | | |
|-----------------|-------------------|
| Brown Trout | Johnny Darter |
| Brook Trout | Longnose Dace |
| Rainbow Trout | Blacknose Dace |
| Coho Salmon | Common Shiner |
| Northern Pike | Bluntnose Minnow |
| Yellow Perch | Mimic Shiner |
| Smallmouth Bass | Central Mudminnow |
| Largemouth Bass | Creek Chub |
| Rock Bass | Banded Killifish |
| White Sucker | Iowa Darter |
| Sculpins | Walleye |

This list is not exhaustive, but comes from fish sampling collections conducted by department personnel. There are no threatened or endangered fish species listed, but lake sturgeon undoubtedly used the river for spawning prior to dam construction.

Retrofitting hydropower dams will in general have an adverse impact on current sport fishing. This is particularly true on a cold water river like the Boardman.

River and Impoundment Bank Management

Impoundment fluctuations and effects on shoreline were mentioned earlier.

Fluctuations in the stream on an hourly or daily basis will have an adverse impact on the stability of river banks. This is in part due to the type of soils involved and also in part to the flooding and dessication of them. Water releases or power generation are significantly different from natural stream variations due to snow melt and rainfall.

Finally, one adverse impact on the river has not previously been addressed. If hydropower generation of these old dams is re-instated, our ability to recover the free-flowing stream fades into the far distant future.

JAS:TRD:bjw
Attachment

PASSAGE OF FISH OVER DAMS
Act 123, P.A. of 1929

AN ACT to confer power and authority upon the conservation commission to provide for the erection and maintenance of proper means for the free passage of fish through and over dams now in existence or which shall hereafter be erected across rivers, streams or creeks, and to prohibit the obstruction of rivers, streams and creeks in such manner as to prevent the free passage of fish up and down; and to repeal Act No. 295 of the Public Acts of 1909, as amended by Act No. 26 of the Public Acts of 1921.

The People of the State of Michigan enact:

307.1 Free passage of fish, rules; fish ladders.

Sec. 1. It is hereby made the duty of the conservation commission to prescribe means and to lay down rules and regulations to admit of the free passage and uninterrupted passage of fish over or through dams now in existence or which shall hereafter be erected over rivers, streams or creeks: Provided, That the director of conservation is authorized to abrogate the provisions of this act requiring the erection of fish ladders whenever, in the opinion of the commissioner, the height of the dam or the condition of the river or stream makes the installation of such ladders impracticable or unnecessary.

307.2 Inspector of dams; duties; plan, contents, copies.

Sec. 2. The director of conservation is hereby made inspector of dams across rivers, streams and creeks of this state and it shall be his duty to prepare a draft of a general plan that will, in his opinion, best permit of the free passage of large and small fish up and down a stream at the dam. Each such plan shall set forth such details and specifications in respect to material and construction and connection with the dam as will enable the owner of such dam to properly construct and place the means designated and it shall be the duty of the director of conservation to furnish a copy of such plans and specifications to each owner or occupant of a dam, on request.

307.3. Same; compliance with order, time.

Sec. 3. Any person, firm or corporation owning or using any dam now existing, or which may hereafter be constructed across any river, stream or creek in this state, when ordered to do so by the director of conservation, shall, within 90 days after the issuance of said order, erect and maintain in good repair sufficient and permanent means to admit of the free and uninterrupted passage of fish over or through such dam. Such means providing for the free passage of fish shall be of such kind and shall be placed in such manner as shall be prescribed by the director of conservation.

307.4. Prosecutions; mandamus

Sec. 4. It shall be the duty of the director of conservation to prosecute in the name of the people of the state in all cases where the provisions of this act are not complied with and it shall be the duty of

Act 123, P.A. 1929 (cont.)

-2-

the prosecuting attorney of the county in which a prosecution is commenced under this act to aid in said prosecution when requested to do so by the director of conservation or any of his deputies or such officer or department as shall accede to the powers and duties of this office: Provided, That the attorney general may institute mandamus proceedings in the circuit court for Ingham county to compel any person, firm or corporation to comply with the provisions of this act.

307.5. Violations of act.

Sec. 5. If any person, firm or corporation owning, using or employing the use of any dam across any of the rivers, streams or creeks of this state shall refuse or fail to erect and maintain in proper repair the means or equipment, when ordered by the director of conservation so to do, such person, firm or corporation shall be deemed guilty of a violation of the provisions of this act and every period of 30 days during which any person, firm or corporation owning or using a dam shall fail to erect or maintain in proper repair such means for the free passage of fish or equipment shall render such person or corporation guilty of a distinct and separate offense of the provisions of this act.

307.6. Construction by director; expenses, payment; tax assessment.

Sec. 6. In case the owner or user of any dam shall refuse or fail to construct and maintain the means or equipment for the free passage of fish when ordered by the director of conservation so to do, said director may cause the same to be constructed over or through said dam at such place in the dam as will cause least injury to the water power, and the expense of the construction of such means for the free passage of fish shall be by him certified to the board of supervisors of the county in which such dam is located and such expense shall be audited by the board of supervisors and shall be paid from the general fund of said county. The board of supervisors of any county, upon auditing and allowing such expense, shall, by resolution order the supervisor of the township or ward in which said dam is situated to spread the amount of such expense upon the assessment roll of such township or ward as a tax against the property to which said dam is appurtenant and against the owners of such property to be collected in the same manner as other township taxes and paid over to the county treasurer or returned as delinquent in accordance with law.

307.7. Passage of fish through and over dams; unlawful apparatus in rivers, streams or creeks; authority of director of conservation.

Sec. 7. It shall be unlawful for any person, firm or corporation to obstruct the channel or course of any river, stream or creek in this state by placing or causing to be placed therein any net, wire screen or any other apparatus or material of any kind whatever, which will tend to prevent the free passage of fish up and down such river, stream or creek, except as authorized by law, and any person or corporation so offending shall be deemed guilty of a violation of the provisions of this act: Provided, That the director of conservation may, when deemed to be in the public interest, authorize the placing of screens in any river, stream, creek or in the inlet or outlet of any lake.

STATE OF MICHIGAN
DAM CONSTRUCTION APPROVAL ACT
Act No. 184, Public Acts of 1963
as amended by
Act No. 68, Public Acts of 1970
and
Act No. 204, Public Acts of 1971

An act to require approval of the department of natural resources before erection of dams; to provide fees for granting approval; and to provide a penalty for failure to comply with the provisions of this act and the rules adopted thereunder.

The People of the State of Michigan enact:

Sec. 1. No person shall construct or permit construction of any dam on land owned by him impounding more than 5 acres or with a head of 5 or more feet without first obtaining a permit approving the plans for such construction from the department of natural resources, except that ponds impounding less than 5 surface acres of water with a contributing drainage area of less than 1 square mile, designed and constructed under the provisions of federal or state soil conservation programs shall not require a permit or inspection fee.

Sec. 2. (1) The department shall require the submission of detailed plans prepared by a registered professional engineer, the proper clearing of the land to be flooded and provisions for an adequate water supply and water depths before issuing a permit approving construction of a dam. The department may inspect the dam during construction and after completion, and may inspect a dam constructed or enlarged after the effective date of the 1969 amendatory act at any time and require the owner either to make the necessary repairs or to remove the dam if the public safety is endangered.

(2) Any person making application for a permit shall pay to the department the following fees: No fee for dams with a head less than 5 feet; \$200.00 for a dam with a head of 5 feet but less than 8 feet in height; \$400.00 for a dam with a head of 8 feet but less than 20 feet in height; and \$600.00 for a dam with a head of 20 feet or more in height. The fees shall be deposited to the credit of the fish and game protection fund to defray the cost of reviewing plans and specifications and field inspections during and after construction. "Head of a dam" means the difference in nearest 1/20 foot between pond head waters and downstream tail water.

(3) The director of the department of natural resources may require that a dam with a head of 10 feet or more shall be equipped with an underspill device that will discharge water from the lake bottom.

(4) A permit shall be required for repair or reconstruction where the previously existing dam failed for whatever reason.

(5) A delay of 1 year or more in commencing construction after issuance of a permit shall require application for formal extension of the permit.

Sec. 2a. Prior to 60 days following construction of any impoundment created by a dam authorized by this act with a head of 5 feet or over, or impounding 5 or more acres, the permittee, subject to the provisions of Act No. 146, of the Public Acts of 1961, as amended, being sections 281.61 to 281.86 of the Compiled Laws of 1948, shall petition the county board of supervisors for a court-established lake level and establishment of a special assessment district for future maintenance of the lake level. The permittee shall record the court order establishing the lake level with the register of deeds, and advise the department of natural resources in writing of such compliance.

Sec. 2b. A permit may be issued if, in the opinion of the director of the department of natural resources, the presence of an impoundment will not have a significant adverse effect on fish, wildlife or recreational values in the watershed or infringe on the public rights in the waters of the state.

Sec. 2c. When, in the opinion of the department, a hazardous condition may exist in the structure of an existing dam, the department may require the owner of the dam to submit a report prepared by a registered professional engineer to the department on the condition of the dam. The report shall include statements as to whether leakage is present, whether there are any signs of disintegration or erosion of the material of the dam or the abutments or the foundation, and shall also include statements of any other changes in the condition of the dam that relate to its safety. After an inspection, the department may require the owner to make necessary repairs or to remove the dam if the public safety is endangered.

Sec. 3. The department of natural resources is authorized to promulgate rules in accordance with the provisions of Act No. 38 of the Public Acts of 1943 as amended, being sections 24.71 to 24.80 of the Compiled Laws of 1948, and subject to Act No. 197 of the Public Acts of 1952, as amended, being sections 24.101 to 24.110 of the Compiled Laws of 1948, governing standards and methods of construction and materials used so as to insure the structural soundness of any dam. The department may cancel any permit issued by it upon failure of the permittee to comply with its conditions or with the approved plan of construction.

Sec. 4. Nothing contained in this act shall abridge the rights of the boards of supervisors of the several counties to approve the construction of any dam as is provided in Act No. 156 of the Public Acts of 1951, as amended, being sections 46.21 and 46.22 of the Compiled Laws of 1948, and in Act No. 146 of the Public Acts of 1961, as amended, being sections 281.61 and 281.86 of the Compiled Laws of 1948, or under such other restrictions as any board of supervisors may lawfully impose.

Sec. 5. Any person who constructs, or permits to be constructed upon his land, a dam without first obtaining a permit as provided in this act, or violates any provision of this act or lawful rule adopted thereunder, is guilty of a misdemeanor.

MICHIGAN DEPARTMENT OF NATURAL RESOURCES

INTEROFFICE COMMUNICATION

October 18, 1978

RECEIVED

OCT 18 1978

WATER MANAGEMENT

TO: Dale Granger, Water Management Division

FROM: Robert Basch, Biology Section *R.Basch*

SUBJECT: Feasibility Study: Re: Reactivating Five Dams on Boardman River

This is in response to questions regarding water quality impacts raised in the October 3, 1978, request from Mr. Donald Emery concerning the subject proposal. He requested information relative to:

1. MDNR requirements regarding initial and periodic silt removal from the impoundments.
2. Water quality standards.

With regard to point 1, we would have to know more specific information regarding the project before definitive answers could be given. We can, however, suggest areas of concern and approaches we would use to protect the resource. For example, we would request an analysis of the sediments in each impoundment prior to any dredging operation to determine pollution potential. In this analysis we would, as a minimum, require that the EPA polluted dredge spoil criteria be analyzed for.

Depending on the method of silt removal and subsequent handling of the spoils, we could impose additional measures and/or request other information. If the silt is removed mechanically, we would need to know more specific information such as the volume of silt, the method of dredging, river flows and when dredging would be done so that we could evaluate the probable impact of this operation. If the silt were removed hydraulically, a settling basin would likely be needed and we could issue an NPDES permit or an order to assure that the overflow from the basin did not adversely affect the river. In such a permit or order, we could limit suspended solids, biological oxygen demand and/or other appropriate parameters. The control measures and permit limits would assure that the dredging aspect of the project complies with the Michigan Water Quality Standards (WQS).

In regard to point 2 (WQS) the dams would have to protect the river for total body contact recreation and coldwater fish (trout). The impoundments, however, would have to be protected for warmwater fish such as bass, pike, walleye and panfish. The specific WQS which would be of immediate concern are temperature and dissolved oxygen. Specifically, the temperature limits applicable downstream of the dam in the river and upstream in the impoundments are prescribed in Rule 75 and 74, respectively, (attached) with dissolved oxygen limits given in Rules 65 and 64 (also attached). Since dams have not been treated as industries have in the past, it would be unlikely they would be given a mixing zone, and thus the WQS should apply at the base of the dam.

D. Granger

-2-

October 18, 1978

We have other concerns in regard to this project as follows:

1. If the dams/hydrogenerators have discharges such as sump water, bearing cooling water, floor drains or any other low volume wastes, they could be required to have an NPDES permit limiting these wastes.
2. Since the City of Traverse City discharges municipal waste to the Boardman River, we would require a minimum flow at all times to assure that the municipal waste assimilation does not cause downstream water quality problems.

In summary, our Division has various concerns as outlined above. These dams/hydrogenerators were operated in the past and a brown trout fishery was maintained in the river and the impoundments had good warmwater fisheries. It is therefore unlikely that reactivating these dams will significantly alter the existing water quality of this river. Of course, the management plans of Fisheries Division will dictate the required water quality which the project will have to provide for. In closing, I would like to repeat my request for a detailed discussion on the amount of electricity to be generated in this project so that the Department, if the project goes beyond the feasibility stage, can balance the increased electric generating capacity against the value of the lost resources. I suspect that these dams will not generate a great deal of electricity.

If you need any clarification or further information, please feel free to contact me.

clp

promulgated pursuant to section 1412 of the public health service act, as amended by the safe drinking water act, P.L. 93-523.

R 323.1058. Radioactive substances.

Rule 58. The control and regulation of radioactive substances discharges into the waters of the state shall be pursuant to the criteria, standards, or requirements prescribed by the U.S. nuclear regulatory commission, 10 C.F.R. §20.1 et seq. and by the U.S. environmental protection agency, 40 C.F.R. §141.1 et seq.

R 323.1060. Plant nutrients.

Rule 60. Nutrients originating from controllable sources shall be limited to the extent necessary to prevent stimulation of growths of aquatic rooted, attached, and floating plants, fungi, or bacteria which are, or may become, injurious to the designated uses of the waters of the state. Phosphorus which is, or may readily become, available as a plant nutrient shall be controlled from point source discharges by the application of methods utilizing best practicable waste treatment technology for control of total phosphorus, with the goal of achieving a monthly average effluent concentration of 1 milligram per liter as P.

R 323.1062. Fecal coliform.

Rule 62. (1) Waters of the state protected for total body contact recreation shall contain not more than 200 fecal coliform per 100 milliliters; high risk areas adjacent to, or downstream from, urban areas identified by the commission shall contain not more than 1,000 fecal coliform per 100 milliliters. These concentrations may be exceeded if due to uncontrollable non-point sources.

(2) Compliance with the fecal coliform standards prescribed by subrule (1) shall be determined on the basis of the geometric average of any series of 5 or more consecutive samples taken over not more than a 30-day period.

R 323.1064. Dissolved oxygen in Great Lakes, connecting waters, and inland streams.

Rule 64. (1) A minimum of 7 milligrams per liter of dissolved oxygen shall be maintained in all Great Lakes and connecting waters and inland streams designated by the rules to be protected for coldwater fish. In all other waters, 5 milligrams per liter of dissolved oxygen shall be maintained as a minimum.

(2) The commission may grant a variance in accordance with rule 90. Such variance shall not permit dissolved oxygen levels less than 6 milligrams per liter for coldwater streams and 4 milligrams per liter for warmwater streams.

R 323.1065. Dissolved oxygen in inland lakes.

Rule 65. (1) The following standards for dissolved oxygen shall apply to inland lakes capable of supporting coldwater fish:

(a) In warmwater inland lakes with little water exchange, which are capable of sustaining a cold stratum of well-oxygenated water throughout the summer above a hypolimnion with very little oxygen, a minimum of 7 milligrams per liter of dissolved oxygen shall be maintained throughout the epilimnion and the upper 1/3 of the thermocline during the entire summer stagnation period. At all other times, the dissolved oxygen concentration shall be maintained at natural levels.

(b) In inland lakes capable of sustaining high oxygen values throughout the hypolimnion during periods of stagnation, dissolved oxygen concentrations greater than 7 milligrams per liter shall be maintained throughout the entire lake.

(c) In shallow, unstratified, coldwater inland lakes, dissolved oxygen concentrations greater than 7 milligrams per liter shall be maintained throughout the entire lake.

(2) The following standards for dissolved oxygen shall apply to inland lakes capable of supporting warmwater fish.

(a) In warmwater lakes with little water exchange, dissolved oxygen concentrations greater than 5 milligrams per liter shall be maintained throughout the epilimnion and the upper 1/3 of the thermocline during the entire summer stagnation period. At all other times, dissolved oxygen concentrations shall be maintained at natural levels.

(b) In warmwater lakes with a high rate of water exchange, dissolved oxygen concentrations greater than 5 milligrams per liter shall be maintained throughout the epilimnion and the upper 1/3 of the thermocline during the summer stagnation period. At all other times, dissolved oxygen concentrations greater than 5 milligrams per liter shall be maintained except in areas where natural oxygen depressions occur.

R 323.1069. Water temperature.

Rule 69. (1) In all waters of the state, the points of temperature measurement normally shall be in the surface 1 meter; however, where turbulence, sinking plumes, discharge inertia, or other phenomena upset the natural thermal distribution patterns of receiving waters, temperature measurements shall be required to identify the spatial characteristics of the thermal profile.

(2) Monthly maximum temperatures are standards based on the ninetieth percentile occurrence of natural water temperatures, plus the increase allowed at the edge of the mixing zone which is, in part, based on long-term physiological needs of fish. These standards may be exceeded for periods when natural water temperatures exceed the ninetieth percentile occurrence. Temperature increases during these periods may be permitted by the commission, but in all cases shall not be greater than the natural water temperature, plus the increase allowed at the edge of the mixing zone.

(3) Natural daily and seasonal temperature fluctuations of the receiving waters shall be preserved.

R 323.1070. Temperature of Great Lakes and connecting waters.

Rule 70. (1) The Great Lakes and connecting waters shall not receive a heat load which would warm the receiving water at the edge of the mixing zone more than 3 degrees Fahrenheit (1.7 degrees Centigrade) above the existing natural water temperature.

(2) The entire Keweenaw waterway including Portage lake, Houghton county, shall be protected for warmwater fish.

(3) The Great Lakes and connecting waters shall not receive a heat load which would warm the receiving water at the edge of the mixing zone to temperatures in degrees Fahrenheit (or Centigrade) higher than the following monthly maximum temperatures:

(a) Lake Michigan, north of a line due west from the city of Pentwater:

	J	F	M	A	M	J	J	A	S	O	N	D
Fahrenheit	40	40	40	50	55	70	75	75	75	65	60	45
Centigrade	4.4	4.4	4.4	10.0	12.8	21.1	23.9	23.9	23.0	18.3	15.6	7.7

(b) Lake Michigan, south of a line due west from the city of Pentwater:

	J	F	M	A	M	J	J	A	S	O	N	D
Fahrenheit	45	45	45	55	60	70	80	80	80	65	60	50
Centigrade	7.7	7.7	7.7	12.8	15.6	21.1	26.7	26.7	26.7	18.3	15.6	10.0

R 323.1074. Temperature in impoundments.

Rule 74. (1) River and stream standards, as prescribed by rule 75, shall apply to all impoundments.

(2) The commission shall determine, when necessary, whether a body of water shall be considered as an inland lake or an impoundment for the purpose of these rules. This determination shall be made partially on the basis of aquatic life resources to be protected.

R 323.1075. Temperature of rivers and streams.

Rule 75. (1) Rivers and streams naturally capable of supporting coldwater fish shall not receive a heat load which would:

(a) Increase the temperature of the receiving waters at the edge of the mixing zone more than 2 degrees Fahrenheit (or 1.1 degrees Centigrade) above the existing natural water temperature.

(b) Increase the temperature of the receiving waters at the edge of the mixing zone to temperatures greater than the following monthly maximum temperatures:

	J	F	M	A	M	J	J	A	S	O	N	D
Fahrenheit	38	38	43	54	65	68	68	68	63	56	48	40
Centigrade	3.3	3.3	6.1	12.2	18.3	20.0	20.0	20.0	17.2	13.3	8.9	4.4

(2) Rivers and streams naturally capable of supporting warmwater fish shall not receive a heat load which would warm the receiving waters of the edge of the mixing zone more than 5 degrees Fahrenheit (or 2.8 degrees Centigrade) above the existing natural water temperature.

(3) Rivers and streams naturally capable of supporting warmwater fish shall not receive a heat load which would warm the receiving water at the edge of the mixing zone to temperatures greater than the following monthly maximum temperatures:

(a) Rivers and streams north of a line between Bay City, Midland, Alma, and North Muskegon:

	J	F	M	A	M	J	J	A	S	O	N	D
Fahrenheit	38	38	41	56	70	80	83	81	74	64	49	39
Centigrade	3.3	3.3	5.0	13.3	21.1	26.7	28.3	27.2	23.3	17.8	9.4	3.9

(b) Rivers and streams south of a line between Bay City, Midland, Alma, and North Muskegon, except the St. Joseph river:

	J	F	M	A	M	J	J	A	S	O	N	D
Fahrenheit	41	40	50	63	76	84	85	85	79	68	55	43
Centigrade	5.0	4.4	10.0	17.2	24.4	28.9	29.4	29.4	26.1	20.0	12.8	6.1

(c) St. Joseph river:

	J	F	M	A	M	J	J	A	S	O	N	D
Fahrenheit	50	50	55	65	75	85	85	85	85	70	60	50
Centigrade	10.0	10.0	12.8	18.3	23.9	29.4	29.4	29.4	29.4	21.1	15.6	10.0

(4) Non-trout rivers and streams that serve as principal migratory routes for anadromous salmonids shall not receive a heat load during periods of migration at such locations and in a manner which may adversely affect salmonid migration or raise the receiving water temperature at the edge of the mixing zone more than 5 degrees Fahrenheit (or 2.8 degrees Centigrade) above the existing natural water temperature.

R 323.1080. Special conditions; United States - Canadian agreement.

Rule 80. To be consistent with the agreement between the United States of America and Canada on Great Lakes water quality, effective April 15, 1972, the following conditions shall apply to the Michigan waters of the Great Lakes and their connecting waters:

(a) Values of pH shall not be outside the range of 6.7 to 8.5.

(b) In Lake Erie, the level of total dissolved solids shall not be greater than 200 milligrams per liter.

(c) Filtrable iron shall not be greater than 0.3 milligrams per liter.

MICHIGAN DEPARTMENT OF NATURAL RESOURCES

INTEROFFICE COMMUNICATION

October 18, 1978

RECEIVED

OCT 18 1978

WATER MANAGEMENT

TO: Dale Granger - Chief, Water Management Division
FROM: Edward Mikula - Senior Wildlife Executive, Wildlife Division
SUBJECT: Reactivation of 5-Dam Hydro System on Boardman River, Grand Traverse County

I have read the letter to Dr. Tanner from consulting engineers, Emery and Porter, regarding the proposed reactivation of an active Hydro electric generating system on the Boardman River. We have discussed their questions among our staff and with our District personnel in the area.

As a former resident of Traverse City, born and reared in the area, I have spent many hundreds of hours fishing the Boardman River and impoundments from Brown Bridge down to Union Street Dam. During the 1940's and early 1950's when I did much of my fishing on the river, all four of the upper dams were generating hydro-power. So I think that I have some feel for what such a system would do if reactivated.

From the wildlife standpoint, the impacts of the reactivation of a multi-dam hydro system will be minimal. Waterfowl fluctuation in any of the four upper ponds will not have more than a minimal impact. However, any wide variation in water levels on Boardman Lake would have significant impacts on the aquatic flora and fauna on the upper portion of the lake by Logans Landing just north of Airport Road, where the river enters Boardman Lake. This area of the lake is used by a large part of the mute swan flock in the Grand Traverse region as wintering habitat and during their molt. Considerable numbers of ducks, geese and other water birds use the same area. Any daily wide fluctuation of water levels would degrade the abundant available food resources presently found in the shallows of the immediate area.

I know that Boardman Lake has a large surface area and that power generation might not seriously impact the upper region of the lake. If we do permit a hydro plant to be sited on the Union Street dam site, we should be sure their flow patterns do not seriously impact the upper part of the lake so important to waterfowl.

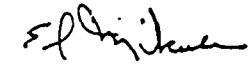
Minimum downstream flow must be maintained throughout the system to be sure that the inflow pattern into Boardman Lake is not diminished to permit the upper part of the lake to freeze over in the winter, thus impacting the wintering waterfowl that use the area.

-2-

Ducks, geese and swans are the important wildlife species associated with the Boardman River system. Other wildlife species do occur but in lower numbers. Species that occur are similar to those in other areas of northern Michigan. You should also be aware that the local Audubon Society has gotten a "nature area" established on one of the upper impoundments. Our endangered species people tell me there are no eagle or osprey nests in the area, and they have no records of any threatened or endangered plant or animal species. There is a low probability of any endangered or threatened species involved with the project.

In summary the Wildlife Division feels there should be no significant impacts on wildlife by implementing the project, with the exception of the upper portion of Boardman Lake. I am sure that the program can be designed and regulated to minimize any impacts on that part of Boardman Lake of importance to waterfowl near Logans Landing.

EJM/sam
cc: Huff
Martz



MICHIGAN DEPARTMENT OF NATURAL RESOURCES

INTEROFFICE COMMUNICATION

October 19, 1978

TO: Dale W. Granger, Chief, Water Management Division
FROM: Henry H. Webster, Chief, Forest Management Division
SUBJECT: Dams on the Boardman River

This is in answer to your memo of October 4, 1978.

The Forest Management Division has no concerns with Union St. Dam Pond or flowage; some with Sabin Dam Pond, Boardman Dam Pond and Keystone Dam Pond. At Brown's Bridge Dam, the state forest campground has been abandoned and closed this summer (1978); the County is now in charge.

We do have Sheeks and Forks Campgrounds upstream that could be effected if low or high water resulted.

MDM:bjc

MICHIGAN DEPARTMENT OF NATURAL RESOURCES

INTEROFFICE COMMUNICATION

October 19, 1978

RECEIVED

OCT 19 1978

WATER MANAGEMENT

TO: Dale Granger, Chief, Water Management Division

FROM: Dennis J. Hall, In Charge, Special Land Programs Section,
Division of Land Resource Programs

SUBJECT: REVIEW AND COMMENTS REGARDING THE FEASIBILITY STUDY FOR THE
REACTIVATION OF FIVE DAMS LOCATED ON THE BOARDMAN RIVER,
GRAND TRAVERSE COUNTY

The letter to Dr. Tanner from Emery and Porter outlining a feasibility study to reactivate one or more of five dams located on the Boardman River in Grand Traverse County has been reviewed and discussed by Division staff in those areas where impacts on our programs could be affected. Those specific program areas involved in this review include: the Natural Rivers Program, Act No. 231 of the Public Acts of 1970; the Michigan Coastal Management Program, Federal Coastal Zone Management Act, P.L. 92-583 of 1972; the Inland Lakes and Streams Program, Act No. 346 of the Public Acts of 1972; and the Soil Erosion and Sedimentation Control Program, Act No. 347 of the Public Acts of 1972.

The first concern regarding this proposal is the lack of sufficient information provided by the consultant firm to permit adequate responses to the issues raised in this proposal. Further information, perhaps in the form of an environmental impact statement, may be warranted should this proposal proceed.

We do offer the following specific comments by program area to this proposal based upon the limited information at hand.

Natural Rivers Program. A review of the feasibility study indicates the possibility of resumption and the use of 3 of the 5 dam sites. Staff wishes to point out that one dam site no longer exists (Keystone Dam) and would require total reconstruction prior to utilization. The second dam site (Union Street Dam) is outside of the portions of the Boardman River designated, but any change in the water levels and other river characteristics could impact upon upper reaches of the Boardman River which have been designated by the Natural Resources Commission.

Staff recognizes that the dams were in existence prior to designation of the Boardman River as a state natural river under the categories of wild-scenic and country-scenic. The upper reaches of the Boardman River and its tributaries from Brown Dam were designated as wild-scenic, with the portions between Brown Dam and below Sabin Dam designated as country-scenic. At the time of the river's designation by the Natural Resources

Dale Granger

-2-

October 19, 1978

Commission in February 1976, none of the dams were being utilized for the operation of electrical power, with the exception that it was understood that Brown Dam would be used by Traverse City in emergency situations.

Designation of this river system received wide support from the citizens, property owners and local governmental units for the protection of a unique resource. Local governmental agencies have implemented zoning ordinances to protect the numerous resource values found along the river system. It should be understood by the agencies making such a proposal that local zoning ordinances may have to be complied with prior to such an undertaking. It should also be pointed out that the Department of Natural Resources is in the process of implementing an administrative rule covering "Utility and Publicly Provided Facilities in Natural River Areas", which will require final approval from the Natural Resources Commission for projects impacting upon a designated natural river system.

Staff does not wish to comment further upon the concern regarding jurisdictional legal authority of the Natural River Act and its impact over the utilization of the dams in question. If the project is pursued, it is recommended that the Department request a legal opinion from the Department of Attorney General in this matter to clarify jurisdictional authority.

It is clear that the intent of the Natural River Act of 1970 was to preserve and enhance numerous river resource values to ensure that present and future generations could enjoy those resources. In identifying those values to be protected, the Act specifically mentions the free-flowing condition of a river system. This value was also highlighted in the Boardman River Natural River Plan adopted by the Natural Resources Commission at the time of designation when it stated: "Maintain the existing free-flowing conditions and seek to stabilize or improve the water flow characteristics for the purpose of preserving the natural environment."

In working with the local citizens and governmental units in the development of this plan, many were concerned over fluctuating water levels due simply to natural causes. It is certain that there would be additional concern if hydroelectric power operation was of the type which required periodic impounding and draw downs.

Recreational use of the Boardman River system, and the Brown Bridge impoundment, may be adversely affected by this proposal. However, without additional information as to water flow, operation of the dams, and the identification of the amount of use made of the river system by recreationalists of all types, it is impossible to determine the exact impact which could occur.

Staff is highly concerned about the impact the fluctuating water levels would have on the aquatic environment and the possible erosion problems which may be created on the river, particularly if an impoundment and draw down system is utilized in dam operation.

Dale Granger

-3-

October 19, 1978

A question also needs to be raised regarding the impacts such a proposal would have on the rights of the riparian property owners along the Boardman River. The legal implications and ramifications of such action upon their property must be clearly addressed.

Without additional information from the proposing agencies involved, the Natural Rivers Program staff cannot further address the impacts and implications of such a proposal.

Coastal Management Program. Pursuant to Section 307 of the Coastal Zone Management Act of 1972 (P.L. 92-583), as amended, federal agency activities, including funding programs, must be consistent with the provisions of an approved Coastal Management Program. Federal activities, which would result in a direct and significant impact on the coastal areas, may be required by the Michigan Coastal Management Program to be modified or suspended in order to be consistent with Michigan's program. Michigan's program has cited the Natural River Act of 1970 as an important state management authority--which federal agencies are required to be consistent with--especially those designated natural rivers tributary to Michigan's coastal waters.

However, in order to assert federal consistency under the Coastal Management Program, a clear relationship must exist between the proposed federal activity and impacts in or on Michigan's designated coastal management area. Only a portion of the proposed dam-related activities fall within the state's defined coastal area, which extends along Boardman Lake and River approximately 3.5 miles South of the Traverse City city limits. It appears that the state's coastal boundary encompasses a portion of the Boardman River, presently designated country-scenic, and clearly includes the Union Street Dam site. If, based upon findings of the feasibility study and Department review, staff can determine that the proposed project will degrade either the portion of the designated country-scenic reach in the Coastal Management Program boundary, or Boardman Lake, federal consistency can be ascertained to modify or suspend the proposed dam project accordingly.

Based upon the consultant's communication to the Director, it appears that such factors as increased stream erosion from fluctuating water levels, impacts on aquatic habitat--especially fish spawning areas and migration, invertebrate species of fish food, creation of barriers to salmonoid migration, and water quality impacts including alteration of the thermal regime of the river and water quality of Boardman Lake, e.g., phosphorus release to the system, should definitely be thoroughly studied and addressed.

It should be noted that the Coastal Management Program is providing funds to the Traverse Bay Regional Planning Commission during 1978-79 to conduct an environmental design to plan for Boardman Lake and a small segment of Boardman River. The purpose of the study is to assess development constraints and recreational potential in order to formulate a development plan for the area. This study should be coordinated with Emery and Porter's efforts.

Dale Granger

-4-

October 19, 1978

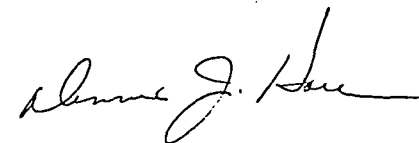
Inland Lakes and Streams Program. The proposal as submitted is very vague. Should the proposal continue, review and permits will be required under the Inland Lakes and Streams Act of 1972 for any dam reconstruction, elimination, draw down, or increase in impoundment area. Review and permits would also be required for additions to existing dams, such as generating equipment. It should also be noted that thought must be given to possibilities of lengthy court actions filed by various environmental groups in Michigan. A final determination could take years to conclude.

Soil Erosion and Sedimentation Control Program. Should the proposal continue, the agencies would be required to obtain permits for any earth changing activities within 500 feet of the river system from the appropriate county Soil Erosion and Sedimentation Control enforcing agency. Assessments and studies should be made to determine the impact of the fluctuation of water levels on the river banks and stream beds for a possible need for the installation of erosion control and bank protection devices.

Staff review of the proposal clearly indicates that prior to any approvals for such a project, a complete environmental impact statement should be prepared for review by this Department and by the Michigan Environmental Review Board.

DJH:pt

c.c: Karl R. Hosford



Emery and Porter, Inc.
Consulting Engineers and Land Surveyors
3750 WOOD STREET • LANSING, MICHIGAN 48906
TELEPHONE 517 487-3789

November 3, 1978

Mr. Dale W. Granger, P.E., Chief
Water Management Division
Department of Natural Resources
Stevens T. Mason Building
Box 30028
Lansing, Michigan 48909

RE: Feasibility Study for the Reactivation of Five Dams located on
the Boardman River, Grand Traverse County, Michigan.

Dear Dale:

Please be advised that team members of the referenced Study will be conducting presentations at regular meetings of the following organizations on the dates shown:

Garfield Township Board, November 9, 1978 at 7:30 P.M.
East Bay Township Board, November 13, 1978 at 7:30 P.M.
Blair Township Board, November 14, 1978 at 8:00 P.M.
Traverse City Planning Commission, November 14, 1978 at 7:30 P.M.

The presentations are intended to inform the study area residents of the nature of the Feasibility Study and its current status. A major task of the Study is to become aware of and address the concerns that people living in the area may have regarding a proposed project of this type and we feel that Township Boards and Planning Commission meetings are ideal vehicles to accomplish same.

Our staff attended, by invitation, the September 27, 1978, meeting of the Boardman River Advisory Council held in Kingsley, Michigan. The audience was genuinely interested and receptive to our description of the Study and the report of its current status. The question and answer period that followed indicated their concerns were primarily centered on the environmental effects of such a project.

Department of Natural Resources

-2-

November 3, 1978

The same interest will undoubtedly be generated at the aforementioned meetings since public notice of our participation was placed with the local news media. We feel that representation from the Department of Natural Resources would be extremely valuable in responding to specific questions regarding your Department's regulations and requirements for the project.

Please do not hesitate to contact this office if you have any questions or if we can be of assistance in making any arrangements or accommodations.

Very truly yours,

EMERY AND PORTER, INC.

Donald B. Emery, P.E.
Principal

DBE/ys

BOARDMAN RIVER PROJECT

Pursuant to the Emery & Porter letter to DNR Director Tanner dated October 3, 1978 and the DNR response by Dale Granger dated October 20, a meeting was held October 24, 1978, 1:30 PM at the DNR offices.

Present: Emery & Porter

Don Emery

Roger Slykhouse

Hathaway Hanes

David Starr

Otto Krauss

DNR

Ed Mikula - Wildlife

John Scott - Fisheries

Charles Harris - Renewable Resources Management

Dennis Hall - Land Resource Program

Leon Cook - Water Management

Robert Bosch - Water Quality

Dale Granger - Water Management, Chief

Mike Moore - Forestry

DNR staff comments attached to the Dale Granger letter were reviewed.

Questions and discussion centered on:

- * Minimum flow requirements
- * Impoundment level variation due to hydro operation
- * Boundary line between "country-scenic" and "wild-scenic"
- * Silt removal from impoundments
- * Canoe portages
- * Fish passage
- * Permit requirements

2

Minimum flow requirements

Data from the Mayfield Gaging Station is reference. Drainage areas are basis for other points. DNR staff present and Roger Slykhouse estimated that about 100 ft³/sec or "run-of-the-river" could be used as a minimum; it is based on 7-day low-flow frequency every 10 years.

DNR staff will validate by means of controlled releases at Brown Bridge (reach between Brown Bridge and Keystone site) and Sabin (reach between Sabin and Logans Landing) early November. Arrangements to be made by Don Emery with Strom and Erickson.

Impoundment levels

Traverse City P & L electric load profile was passed around.

Impoundment level variations proposed are:

Brown Bridge	2 ft
Keystone	4 ft
Boardman #3	3 ft
Sabin	4 ft
Boardman Lake	1 ft

DNR staff will inspect shoreline conditions and respond to the suggested level fluctuations. 2 ft interval contour maps have been loaned to DNR staff for this purpose.

Boundary line

Boundary line for "country-scenic" and "wild-scenic" is Brown Bridge dam

Comment: The Act does not specify?

Silt removal

If silt removal from impoundments is undertaken it would require a determination of chemistry and make-up of silt. It was suggested this might be handled by following a procedure similar to one for dredging permits.

Canoe transit

Provisions for canoe portaging at the dams have to be made. Soil erosion problems have to be prevented. It is not necessary to provide for any time of vehicle access.

Fish passage

DNR staff feels any work on dams would require the installation of fish passages, see Public Act 123 of 1929, copy attached.

Mention of local objections as evidenced at Boardman River Basin Council meeting in Kingsley are not likely to deter DNR from insisting on fish passages.

Comment: Fish passages would absorb several years' revenue from hydroelectric production.

Permit requirements

Any hydroelectric development in Michigan is subject to DNR permit requirements under Acts 184 of 1963, 68 of 1970 and 204 of 1971, copy attached.

After completion of flow-tests and impoundment-shoreline inspection, a similar meeting is to be held to finalize on the above questions. Don Emery is to make arrangements with Dale Granger for such a meeting.

Meeting adjourned 3:45 PM

The above was transcribed from notes taken by Otto Krauss.

BOARDMAN RIVER PROJECT - HYDROELECTRIC FEASIBILITY STUDY

Meeting held on October 24 at the Michigan Department of Natural Resources (MDNR) was continued on November 28 in the office of the DNR Chief of the Fisheries Division.

Present: Emery & Porter

Don Emery
Otto Krauss
David Starr
Hat Hanes

MDNR

John A. Scott, Chief of the Fisheries Division
Thomas R. Doyle, Fisheries Division
Chuck Harris, Renewable Resources Mgt.
Chris Duncan, Coastal Mgt.
Dennis Hall, Land Resource Programs
Edward Mikula, Wildlife Division
Leon Cook, Water Mgt.

Meeting had to do with investigations carried out during the October 24- November 28 period which were concerned with

- (1) Minimum flow standard
- (2) Impoundment level variations
- (3) Fish passages

Results were discussed. Additionally, the MDNR staff suggested that different drainage basin areas should be used, i.e., different from U.S. Geological Survey and Cliff Humphry's figures. The MDNR figures follow:

Brown Bridge	151 mi ²
Mayfield Ga. Sta.	181 (U.S. Geol. Survey = 223 mi ²)
Keystone	265
Boardman #3	267
Sabin	269
Union Street	276

The recommended minimum flow standard at Mayfield is 120 ft³/sec and at Sabin 180 ft³/sec. This means a min. flow at Brown Bridge of about 100 ft³/sec. or run-of-the-river if less.

For river-flow control purposes, Leon Cook recommends that a gage

be installed upstream from the headwaters of Brown Bridge pond. Leon Cool could advise as to where such a gage should be located exactly.

There was considerable discussion about the proposed impoundment-level variations. Concerns expressed centered on public access at Boardman #3, shoreline stability, the water-fowl sanctuary at the upper end of Boardman Lake (Airport Rd.) and impact on fisheries. In order to arrive at definitive statements it would be necessary to make detailed studies which are not in the scope of the present feasibility study. Cost estimates to be shown in the feasibility study should provide for some contingencies such as geotechnical assessment of a few shoreline situations.

On the fish passage questions, the MDNR staff will insist that they be included in any dam rehabilitation. However, it was mentioned that fish-passages installed would still require a manual sorting operation during salmon runs in order to eliminate them. (A trade-off might be a trap and transfer operation.) Of note is that nothing is being done now. The exception is Brown Bridge. MDNR staff would recommend not to include Brown Bridge in any fish passage program. It was pointed out that funds for fish passages might come from federal-state programs under the Anadromous Fisheries Conservation Act and others. It was felt by the staff that the owners of the dams should pay $\frac{1}{2}$ of the fish-passage cost. This means that economic costs shown in the feasibility study should reflect this (no fish passage as an alternate). It was also pointed out by MDNR staff that the entire question would be subject to review by the NR Commission and the Michigan Environmental Review Board (MERB).

Transcribed from notes taken by Otto Krauss.

STATE OF MICHIGAN



WILLIAM G. MILLIKEN, Governor

DEPARTMENT OF NATURAL RESOURCES

STEVENS T. MASON BUILDING, BOX 30028, LANSING, MICHIGAN 48909
HOWARD A. TANNER, Director

NATURAL RESOURCES COMMISSION

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DEAN PRIDGEON
HILARY F. SNELL
HARRY H. WHITELEY
JOAN L. WOLFE
CHARLES G. YOUNGLOVE

January 10, 1979

16475
5 December 1978

Mr. Don Emery
3750 Wood Street
Lansing, Michigan 48906

Dear Mr. Emery:

Mr. Hanes talked to me by telephone yesterday and requested the results of my November 1978 biological sampling of the Boardman River bottom fauna in the vicinity of the dams above Boardman Lake. This study will not be completed until late spring, at best. However, I can give you the general conclusions as a result of my observations during sampling.

The river channel is well incised into the surrounding land and the banks are covered with grasses, brush or trees and are therefore well stabilized and significant erosion will not result from fluctuating flows.

The stream bottom is relatively flat as opposed to V-shaped. As long as some level of minimum flows are maintained, the bottom will be covered with water and no significant detectable negative impacts on stream life would result from elevating flows over the minimum flows in a fluctuating manner.

As we are all well aware, very high stream and water quality exists in the river and has for a very long time. The bottom fauna reflected this at all sampling sites. Below the impoundments high densities of filter feeding organisms existed and this will not change much should the dams become operational as long as some flow is continuously discharged downstream. In essence, I do not foresee any significant changes in river quality or water quality should power once again be generated with these hydro plants.

Sincerely,

WATER QUALITY DIVISION

Elwin D. Evans, PhD.
Aquatic Biologist

The Aids to Navigation Branch (0ar) has reviewed referenced letter and response, and has no comments or objections to offer at this time.

Sincerely,

J. A. WILSON
Captain, U. S. Coast Guard
Chief, Marine Safety Division
By direction of the Commander,
Ninth Coast Guard District



EDE/pls
cc: Mr. Hat Hanes



**DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD**

Address reply to:
COMMANDER (mep)
Ninth Coast Guard District
1240 East 9th St.
Cleveland, Ohio 44199
Phone: 216-522-3919

16475
5 December 1978

Emery and Porter, Inc.
Consulting Engineers and Land Surveyors
Attn: Mr. Donald B. Emery
3750 Wood Street
Lansing, MI 48906

Re: Your ltr dtd 16 October 1978
concerning Boardman River dams
renovation/rehabilitation


Dear Mr. Emery:

This office has reviewed the referenced letter and suggests that future studies include correspondence with the State Boating Law Administrator. Correspondence should include plans and a request of education and enforcement assistance commensurate with anticipated increases in boating activity on the Boardman River as a result of the project.

Over the last three years, the Coast Guard has analyzed the relationship between boating accidents and the percentage of boat operators who have participated in boating classes and of boat operators who have complied with safe boating laws. Results have indicated that boating accidents decreased even when boating activity or boating density increased where active boating education and enforcement programs existed. Consequently, the Coast Guard considers it imperative that any organization or governmental body planning an expanded boating activity forecast the resource requirements necessary to reduce the potential for boating accidents.

The State Boating Law Administrator for the State of Michigan is:

Mr. Robert W. Dyke, Program Administrator
Marine & Recreation Vehicles
Law Enforcement Division
Department of Natural Resources
4th floor, Steven T. Masons Bldg.
Lansing, MI 48926
Tele: (517) 373-1650

WEST MICHIGAN  TOURIST ASSOCIATION

HOSPITALITY HOUSE • 138 FULTON EAST • GRAND RAPIDS, MICHIGAN 49503 PHONE 616/456-8557

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WEST MICHIGAN...100

October 19, 1978

Mr. Donald B. Emery, P.E.
Emery and Porter, Inc.
3750 Wood Street
Lansing, Michigan 48906

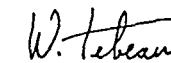
Dear Mr. Emery:

Thank you for informing us of the study of the Boardman river you are doing. We have no technical expertise in this field.

However, we are concerned with the recreational quality of the river and hope that it can be maintained. We are also concerned about canoeing activity and I hope you will bear this aspect of tourism in mind when making your request.

The obvious need for the fishing fraternity is, of course, extremely important. Thank you for touching base with us.

Sincerely,



Wesley B. Tebeau,
President

WBT:hcs



Grand Traverse
Natural Education Reserve

1125 WEST CIVIC CENTER DRIVE, TRAVERSE CITY, MICHIGAN 49684, PHONE: 946-0250

946-2298

111 Monroe
Traverse City, Mi. 49684
24 Oct 78

Mr. Donald B. Emery
3750 Wood Street
Lansing, Michigan 48906

Dear Mr. Emery:

Thank you for sending the letter describing the feasibility assessment for renovating and/or rehabilitating dams on the Boardman River in Grand Traverse County. Your letter was read during the Natural Education Reserve Commission meeting held on October 19th.

Members of the Reserve Commission do have some questions and concerns relating to the dam situation, particularly as it pertains to structures within the bounds of the Education Reserve. We would like to set up a meeting in early December, if such is possible with you. We would also like to make the meeting open to interested persons who may not be members of the Reserve Commission.

An alternative to our setting up a meeting in early December would be our attendance at a similar meeting which you may already have scheduled with another group in this area.

Please let me know if we can make plans for an early December meeting (evening) or if there is presently a meeting scheduled which we may attend.

Sincerely,

Dick Parks
Ch. NER

BOARDMAN RIVER ADVISORY COUNCIL

Box 482
Mayfield, Mich. 94666

October 11, 1978

Mr. Don Emery
Emery & Porter, Inc.
375C Wood Street
Lansing, Michigan 48906

Dear Mr. Emery,

On behalf of the Boardman River Advisory Council, I would like to thank you, Mr. Slykehouse, and Dr. Krause for attending the Council meeting September 27th and explaining the hydro-electric feasibility study for the Boardman River. A great deal of information was presented and the Council is most interested in following the study to completion.

I hope you realize that the limited input you received that evening in no way indicated the Council's lack of interest in the study, and we hope to have the opportunity to review the study findings.

Thank you, again, for the fine presentation, and we hope you will be able to return for a presentation of the study findings.

Sincerely yours,

Louanna French,
Chairman

LF/vw



**GRAND TRAVERSE COUNTY
DRAIN COMMISSIONER**

GOVERNMENTAL CENTER • 400 BOARDMAN AVE.
TRAVERSE CITY, MICHIGAN 49684 • (616) 941-2292

WARREN VERHAGE
DRAIN COMMISSIONER



DEPARTMENT OF THE ARMY
DETROIT DISTRICT, CORPS OF ENGINEERS
BOX 1027
DETROIT, MICHIGAN 48231

NCEED-L

Mr. Donald B. Emery
Emery and Porter Inc.
Consulting Engineers and Land Surveyors
3750 Wood St.
Lansing, MI 48906

October 31, 1978

Emery and Porter, Inc.
3750 Wood Street
Lansing, MI 48906

Dear Sir:

Thank you for your letter of October 16, 1978, on the feasibility study for the five dams on the Boardman River.

I am interested in your study and your findings as to cost to restore, what K.W. they will produce, cost of operation and what effect the repaired dams will have on the ponding areas.

I am looking forward to reading your reports and studying your findings.

Sincerely,


Warren Verhage
Drain Commissioner

WV:mf

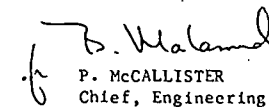
Dear Mr. Emery:

This is in response to your letter regarding your feasibility assessment for renovating or rehabilitating of five existing dams on the Boardman River basin in the Grand Traverse County, Michigan.

At this time, the Corps of Engineers has no flood control or navigation projects on the Boardman River basin and none are anticipated in the near future. However, flood problems have occasionally been experienced in the Boardman River basin. Accordingly, the feasibility assessment should discuss adverse and beneficial impact of five hydroelectric reservoir sites on the potential flood levels and should include a comprehensive reservoir regulation plan beneficial to the flood control. In addition the feasibility assessment report should also consider a water-oriented outdoor recreation, improvement of fish and wildlife resources and other related aspects that would meet the existing and projected needs and objectives.

I trust that the above remarks will serve your needs. Should you require any other data, please feel free to contact us.

Sincerely yours,


P. McCALLISTER
Chief, Engineering Division

Grand Traverse Soil Conservation District

1222 Rennie Street

Telephone ~~XXXXXXXXXX~~
941-0960

Traverse City, Michigan 49684

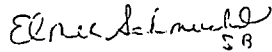
November 17, 1978

Donald B. Emery, P.E.
Emery and Porter, Inc.
Consulting Engineers and Land Surveyors
3750 Wood Street
Lansing, MI. 48906

Dear Mr. Emery:

In reference to your letter of October 16, 1978, on additional production of hydroelectric power from the Boardman River. The Grand Traverse Soil Conservation District Board of Directors feel the study is a good idea, but would like to be informed of any changes.

Respectfully,



Elmer Schmuckal, Chairman
Grand Traverse Soil Conservation District

Charter Township of Garfield Grand Traverse County

3848 TOWN HALL ROAD
TRAVERSE CITY, MICHIGAN 49684

October 25, 1978

Donald B. Emery, P.E.
Emery and Porter, Inc.
3750 Wood Street
Lansing, MI 48906

Dear Mr. Emery:

Re: Feasibility assessment for renovating and/or rehabilitating one or more of five existing dams on the Boardman River in Grand Traverse County, Michigan and Traverse City, Michigan to provide additional hydroelectric generation capacity. Cooperative Agreement No. E-W-78F-07-1792 between the U.S. Department of Energy and the Joint Venture of Grand Traverse County and the City of Traverse City

Your letter to Mr. Frank Tezak, Garfield Township Planning Commission Chairman was handed to me for reply as Garfield Township Planner.

I believe the Township will be vitally interested in the potential implications of this project, particularly with regard to the recreational capabilities of the water bodies, as well as the safety factors involved with hydroelectric generation facilities.

Your letter makes no mention of public hearings regarding this matter. We would, therefore, be happy to hold a public hearing for Garfield Township residents should you wish. The most likely time would be at our December Planning Commission Meeting on December 6, 1978. Should you desire such a hearing, we would like to hear from you as soon as possible so that we may make suitable arrangements.

Should you wish to informally discuss the matter with our Planning Commission, we could make allowances for it either at our November 1, 1978 meeting or again at the December 6, 1978 meeting. We would be glad to include it as an agenda item should you wish to contact us in that regard.

Charter Township of Garfield
Grand Traverse County

3848 TOWN HALL ROAD
TRAVERSE CITY, MICHIGAN 49684

October 27, 1978

Donald B. Emery, P.E.
Emery and Porter, Inc.
3750 Wood Street
Lansing, MI. 48906

Dear Mr. Emery:

Re: Feasibility assessment for renovating and/or
rehabilitating one or more of five existing
dams on the Boardman River in Grand Traverse
County, Michigan and Traverse City, Michigan
to provide additional hydroelectric generation
capacity. Cooperative Agreement No.
E-W-78F-07-1792 between the U.S. Department
of Energy and the Joint Venture of Grand Traverse
County and the City of Traverse City

This letter is in reference to a telephone conversation of
Thursday, October 26, 1978 between yourself and Gerry Harsch,
Planner regarding the above captioned matter.

The Town Board has a meeting scheduled for Thursday, November 9,
1978, at 7:30 p.m. at the Garfield Townhall, Traverse City
Michigan, and we would be happy to place this matter on the
agenda and have you speak to the Board at that time.

Very truly yours,



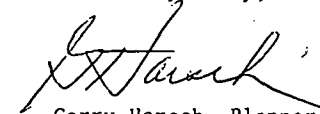
Lee F. Wilson, Supervisor
Charter Township of Garfield

nej

Donald B. Emery, P.E.
Emery and Porter, Inc.
October 26, 1978
Page Two

In any event we would like to discuss your findings at a
preliminary stage before your final publication, and would
be grateful if you could keep us apprised of your progress
so that we may give you input as we may deem desirable.

Yours very truly,



Gerry Harsch, Planner
Charter Township of Garfield

mej

cc: Mr. Frank Tezak, Chairman
Planning Commission

EAST BAY TOWNSHIP

1965 3 Mile Road
Traverse City, Michigan 49684
Phone (616) 947-8647

Supervisor - George J. Shimek
Clerk - Florence M. Herald
Treasurer - Donna J. Finnilla

Trustee - Jerome F. Koeb
Trustee - Thomas Strail

November 2, 1978

Emery & Porter Inc.
3750 Wood Street
Lansing, Michigan 48906

Dear Sirs:

Re: Feasibility assessment for renovating and/or
rehabilitating existing dams on Beardman River,
in Grand Traverse County.

It is the opinion of this commission that the restoration of the hydro-electric plants in the river system, would be to a distinct advantage to the entire area involved. As this has been designated a natural river area, the maintenance of the ponds and existing dams would provide possible flood control, excellent fish and wild life habitat, and provide a source of electrical energy to supply on estimated 8 to 10 percent of the current usage of The City Of Traverse City.

This would result in energy savings of thousands of tons of coal each year, thus reducing the cost to produce extra peak load needs.

If possible it would be greatly appreciated if a representative could attend our Planning Commission meeting, on December 11, 1978. We would plan publicity for our area and invite open public to this meeting.

Sincerely,



Duane M. Corpe
Chairman
East Bay Planning Commission

DMC/bjs
CC: File



City of Traverse City • Michigan

49684

Commission • Manager Form of Government

January 29, 1979

Ross Childs,
County Coordinator
Grand Traverse County
Courthouse
Traverse City, MI 49684

Re: Hydro Feasibility Study

Dear Ross:

As we discussed January 26, 1979, by telephone, Dave Starr of the Snell Environmental Group (working under the direction of Don Emery) has requested that the City and County correspond to him listing alternate methods of ownership and operation authority for electricity-producing dams owned by the County.

It is my assumption that a County in Michigan does not have authority to operate an electric utility and that irregardless of the question of authority, you feel it does not appear in the best interests of the County at this time, to become involved in the electric utility business. Therefore, I will assume that the operation of the hydro-electric facilities on the Boardman River will be the responsibility of the Traverse City Light and Power Department.

For County-owned dams operated by the City to produce electricity at least three legal options would be available. The County could transfer an easement to the City to operate and maintain the dam and any necessary and appurtenant facilities and land. A long term lease or an intergovernmental contract could be used to accomplish the same purpose.

Ross Childs, County Coordinator
Page Two
January 29, 1979

At the present I see the easements arrangement to be the most preferable. Since there is a transfer of effective control of real estate, an intergovernmental contract would in reality be a lease or grant of easement to certain real property. Also, if I am correct about the County's lack of authority to engage in the electric utility business, an intergovernmental contract for that very activity may create difficulties in receiving a clean bond opinion should a bond issue be authorized. A lease may pose similar difficulties with bonding and has the disadvantage of being for a finite period and is subject to cancellation, re-entry rights, and other similar landlord - tenant obligations.

The easement arrangement would convey a definite asset that creditors could look to and that could be conveniently valued. The easement arrangement would only have to be acted upon once by the County and the City and would automatically cease upon termination of light and power activities on the property.

Please let me know if you agree or disagree with my preference for an easement arrangement, and, of course, feel free to contact me if you have any questions.

Sincerely,

W. Peter Doren
City Attorney

WPD/eth

cc: Dennis LaBelle
Bill Strom
Buck Williams
Wes Reincke
Dave Starr ✓

STATE OF MICHIGAN



WILLIAM G. MILLIKEN, Governor

DEPARTMENT OF NATURAL RESOURCES

STEVENS T. MASON BUILDING, BOX 30028, LANSING, MICHIGAN 48906
HOWARD A. TANNER, Director

February 6, 1979

NATURAL RESOURCES COMMISSION

CARL T. JOHNSON
E. M. LAITALA
DEAN PRIDGEON
HILARY F. SNELL
HARRY M. WHITLEY
JOAN L. WOLFE
CHARLES G. YOUNGLOVE

Mr. Donald P. Emery, P. E.
Emery & Porter
Consulting Engineers and
Land Surveyors
3750 Wood St.
Lansing, MI 48906

Dear Mr. Emery:

Mr. Hanes of your office has requested that we provide formal verification of the minimum flows required on the Boardman River as was discussed with you in my office on November 28, 1978.

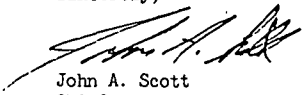
In accordance with provisions of the Federal Power Act, the Federal Fish and Wildlife Coordination Act, and other pertinent state statutes for the protection of fish and wildlife resources, the Department will request the following minimum flows be released from the hydropower generating facilities on the Boardman River:

- | | |
|---------------------|---------------------|
| 1. Brown Bridge Dam | 120CFS ¹ |
| 2. Sabin Dam | 180CFS |

It would be a nice gesture on the part of the city and county if that minimum flow regimen were implemented at this time rather than waiting until formal submittals are made to the Federal Energy Regulatory Commission.

You may wish to communicate our interest in this regard to your clients.

Sincerely,


John A. Scott
Chief
FISHERIES DIVISION

1. As measured at the Mayfield gauge.

JAS:TD:km

cc: D. Tierney
L. Cook



81026 10/76



GRAND TRAVERSE COUNTY
COUNTY COORDINATOR

GOVERNMENTAL CENTER • 400 BOARDMAN AVE.
TRAVERSE CITY, MICHIGAN 49684 • (616) 941-2200

February 14, 1979

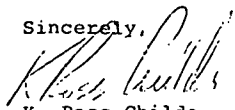
Mr. Donald B. Emery
Emery & Porter, Inc.
Consulting Engineers and Land Surveyors
3750 Wood Street
Lansing, Michigan 48906

Dear Don:

The County Board of Commissioners formally moved at their regular meeting on Tuesday, February 13, 1979, that their intention is to enter into a legal agreement with the City of Traverse City to provide for the production of power at county owned dams. This matter has been voiced by the City Attorney, Mr. Doren, and reviewed by the Chief Assistant Prosecuting Attorney, Mr. LaBelle. Several alternatives appear to be available by which the county could give full and legal authorization to the City of Traverse City for the production of power.

It is therefore determined that the County of Grand Traverse does not intend to enter the business of producing power but will enter into such an agreement which will provide for the production of power by the City of Traverse City. This should respond to the recent question raised in reference to completion of the project.

Should there be any further questions, please do not hesitate to contact my office.

Sincerely,

K. Ross Childs
County Coordinator

KRC/aay

copies: Peter Doren, City Attorney
Dennis LaBelle, Chief Ass't. Prosecuting Atty.

RECEIVED
FEB - 8 1979
SNELL ENVIRONMENTAL
GROUP, INC.

RECEIVED
FEB 16 1979
SNELL ENVIRONMENTAL
GROUP, INC.

Appendix F

DESCRIPTION: UNION STREET DAM

Earliest Date in Service: Fall, 1981

Nameplate Rating	<u>N/A</u> KW		
Capacity	<u>221</u> KW		
Transmission Losses	<u>6</u> KW		
Capacity for System Load		Without	With
		Fish Ladder	Fish Ladder
Base Load	<u>118</u> KW	<u>1220</u> MWH/YR	1086
Peak Load	<u>103</u> KW	<u>289</u> MWH/YR	289
Total	<u>221</u> KW	<u>1509</u> MWH/YR	1375
Capital Costs			
Plant		<u>477,540</u>	
Equipment		<u>488,000</u>	
Interfacing		<u>35,000</u>	
Other (Fish Passage)		<u>*(279,000)</u>	
Int. During Construction		<u>10,000</u>	
Engineering & Conting.		<u>150,000</u>	
Total Capital			<u>1,160,540</u>
Annual Expense			
Maintenance - Labor	<u> </u>		
Other	<u> </u>	<u>4,900</u> every 5 years	
Repair - Labor	<u> </u>		
Other	<u> </u>	<u>30,000</u> every 10 years	
Operation - Labor	<u> </u>		
Other	<u> </u>	<u>4,235</u>	
Admin. & General		<u>430</u>	
Insurance		<u>3,000</u>	
Taxes		<u>No Add</u>	
Other		<u> </u>	
Total Annual Expense			<u>11,645</u>
Depreciation		<u>*(6,975)</u>	<u>29,014</u>
Dept. Retirement		<u>*(25,827)</u>	<u>107,431</u>
Total Annual Cost		<u>*(32,802)</u>	<u>148,090</u>
Cost per KWH (Mils)		<u>≠(131.6)</u>	<u>98.1</u>

* (Added Cost for Fish Passage) ≠ (Including Fish Passage)

ESTIMATING FORM -

Hydro-Electric Power Developments

UNION STREET DAM

Item	Description	Cost
		1,440+
1.	Preliminary Expenses (Feasibility Study)	11,600
2.	Clearing Site	9,000
3.	Highways and Bridges	
4.	Railroads and Bridges	
5.	Wharves	
6.	Ferries	
7.	Taking Care of Water	
8.	Reservoirs and Pond	
9.	Dams	
10.	Intakes	
11.	Conduits	
12.	Power House Substructure	365,000
13.	Power House Superstructure	90,500
14.	Hydraulic Equipment	448,000
15.	Electrical Equipment	20,000
16.	Miscellaneous Equipment	20,000
17.	Testing and Starting	
18.	Tail Race	
19.	Outdoor Transformer Station Structure	34,000
20.	Indicat. & Record Devices - Hydraulic Purposes	1,000
21.	Transmission Line & Telephone Line	
22.	Substations	
23.	Permanent Quarters	
24.	Construction Overhead	
25.	Local General Charges	
26.	Engineering & Miscellaneous 15%	150,000
27.	Allowance for Contingencies & Omissions	
28.	Real Estate, R/W, Flow & Water Rights	
29.	Interest during Construction 1%	10,000
30.	Taxes during Construction	
31.	Interest & Taxes on Cost of Real Estate R/W, Flowage & Water Rights Prior to Construction	
32.	Working Capital	
	TOTAL PROJECT COST	1,160,540

UNION STREET DAM CONSTRUCTION COST DATA

ITEM	UNIT	AMOUNT	UNIT COST	SUB-TOTAL	TOTAL
(1) <u>PRELIMINARY EXPENSES</u>					
a) Surveys	Lump Sum		\$ 4,000.00	\$ 4,000.00	
b) Reports	Lump Sum		800.00	800.00	
c) Borings and Test Pits	Lump Sum		5,000.00	5,000.00	
d) Miscellaneous	Lump Sum		1,000.00	1,000.00	
e) Office			500.00	500.00	
f) Power for Construction	Lump Sum		300.00	300.00	
					<u>\$ 11,600.00</u>
(2) <u>CLEARING SITE</u>					
a) Clearing	Lump Sum		\$ 9,000.00	\$ 9,000.00	<u>\$ 9,000.00</u>
(12) <u>POWERHOUSE SUBSTRUCTURE</u>					
a) Earth Excavation	C.Y.	1000	\$ 5.00	\$ 5,000.00	
b) Bearing Piles	Lin.Ft.	1000	15.00	15,000.00	
c) Embankment	C.Y.	2000	4.50	9,000.00	
d) Structure Concrete	C.Y.	385	260.00	100,000.00	
e) Slope Protection	C.Y.	5000	45.50	227,500.00	
					<u>\$365,000.00</u>
(13) <u>POWERHOUSE SUPERSTRUCTURE</u>					
a) Structural Steel	LBS.	8000	\$ 1.95	\$ 16,000.00	
b) Miscellaneous Steel	LBS.	2500	2.00	5,000.00	
c) Miscellaneous Finish Construction	Lump Sum		\$ 56,000.00	\$ 56,000.00	
d) Plumbing	Lump Sum		4,000.00	4,000.00	
e) Lighting	Lump Sum		3,000.00	3,000.00	
f) Heating	Lump Sum		5,000.00	5,000.00	
g) Office	Lump Sum		1,500.00	1,500.00	
					<u>\$ 90,500.00</u>
(14) <u>HYDRAULIC EQUIPMENT</u>					
a) Shipping Turbines	Lump Sum		\$ 4,000.00	\$ 4,000.00	
b) Hydraulic Equipment	Lump Sum		324,000.00	324,000.00	
c) Hydraulic Equipment Installation	Lump Sum		120,000.00	120,000.00	
					<u>\$ 448,000.00</u>
(15) <u>ELECTRICAL EQUIPMENT</u>					
a) Switchboard	Lump Sum		\$ 10,000.00	\$ 10,000.00	
b) Electrical Installation	Lump Sum		\$ 10,000.00	\$ 10,000.00	
					<u>\$ 20,000.00</u>

UNION STREET DAM CONSTRUCTION COST DATA -- Continued

	ITEM	UNIT	AMOUNT	UNIT COST	SUB-TOTAL	TOTAL
(16)	<u>MISCELLANEOUS EQUIPMENT</u>					
	a) Crane and Motor	Lump Sum		\$ 20,000.00	\$ 20,000.00	<u>\$ 20,000 70</u>
(19)	<u>OUTDOOR TRANSFORMER STATION STRUCTURE</u>					
	a) Transformer Footings	C.Y.	27	\$ 260.00	\$ 7,000.00	
	b) Transformer Equipment	Lump Sum		27,000.00	<u>27,000.00</u>	<u>\$ 34,000.00</u>
(20)	<u>INDICATING AND RECORDING DEVICES FOR HYDRAULIC EQUIPMENT</u>					
	a) Alarms	Lump Sum		\$ 1,000.00	<u>\$ 1,000.00</u>	<u>\$ 1,000 0</u>

DESCRIPTION: SABIN DAM

Earliest Date in Service:		<u>September, 1980</u>	
Nameplate Rating	<u>N/A</u>	KW	
Capacity	<u>484</u>	KW	
Transmission Losses	<u>15</u>	KW	
Capacity for System Load		Without Fish Ladder	With Fish Ladder
Base Load	<u>253</u> KW	<u>2680</u> MWH/YR	2386
Peak Load	<u>231</u> KW	<u>635</u> MWH/YR	635
Total	<u>484</u> KW	<u>3315</u> MWH/YR	3021
Capital Costs			
Plant		<u>32,440</u>	
Equipment		<u>557,000</u>	
Interfacing		<u>21,500</u>	
Other (Fish Passage)		<u>*(620,000)</u>	
Int. During Construction		<u>6,100</u>	
Engineering & Conting.		<u>91,600</u>	
Total Capital			<u>708,640</u>
Annual Expense			
Maintenance - Labor	<u> </u>		
Other	<u> </u>	<u>4,900</u>	Every 5 years
Repair - Labor	<u> </u>		
Other	<u> </u>	<u>30,000</u>	Every 10 years
Operation - Labor	<u> </u>		
Other	<u> </u>	<u>1,635</u>	
Admin. & General		<u>294</u>	
Insurance		<u>3,000</u>	
Taxes		<u>No Add</u>	
Other	<u> </u>		
Total Annual Expense			<u>8,909</u>
Depreciation		<u>*(15,500)</u>	<u>17,716</u>
Dept. Retirement		<u>*(57,393)</u>	<u>65,599</u>
Total Annual Cost		<u>*(72,893)</u>	<u>92,224</u>
Cost per KWH (Mils)		<u>\$(54.7)</u>	<u>27.8</u>

* (Added Cost for Fish Passage) ≠ (Including Fish Passage)

ESTIMATING FORM -

Hydro-Electric Power Developments

SABIN DAM

Item	Description	Cost
1.	Preliminary Expenses (Feasibility Study)	\$ 3,440
2.	Clearing Site	
3.	Highways and Bridges	2,000
4.	Railroads and Bridges	
5.	Wharves	
6.	Ferries	
7.	Taking Care of Water	
8.	Reservoirs and Pond	2,000
9.	Dams	
10.	Intakes	
11.	Conduits	
12.	Power House Substructure	
13.	Power House Superstructure	25,000
14.	Hydraulic Equipment	537,000
15.	Electrical Equipment	20,000
16.	Miscellaneous Equipment	
17.	Testing and Starting	
18.	Tail Race	
19.	Outdoor Transformer Station Structure	20,500
20.	Indicat. & Record Devices - Hydraulic Purposes	1,000
21.	Transmission Line & Telephone Line	
22.	Substations	
23.	Permanent Quarters	
24.	Construction Overhead	
25.	Local General Charges	
26.	Engineering & Miscellaneous 15%	91,600
27.	Allowance for Contingencies & Omissions	
28.	Real Estate, R/W, Flow & Water Rights	
29.	Interest During Construction	
30.	Taxes During Construction 1%	6,100
31.	Interest & Taxes on Cost of Real Estate, R/W, Flowage & Water Rights Prior to Construction	
32.	Working Capital	
	TOTAL PROJECT COST	\$708,640

SABIN DAM CONSTRUCTION COST DATA

	ITEM	UNIT	AMOUNT	UNIT COST	TOTAL
(3)	<u>HIGHWAYS AND BRIDGES</u>				
	a) Canoe Portage	Lump Sum		\$ 2,000.00	<u>\$ 2,000.00</u>
(8)	<u>RESERVOIRS AND PONDS</u>				
	a) Reservoir Bank Protection	Sq.Yds.	67	\$ 30.00	<u>\$ 2,000.00</u>
(13)	<u>POWERHOUSE SUPERSTRUCTURE</u>				
	a) Structural Steel	LBS.	500	\$ 2.00	\$ 1,000.00
	b) Miscellaneous Finish Construction	Lump Sum		\$ 15,000.00	\$ 15,000.00
	c) Plumbing	Lump Sum		2,500.00	2,500.00
	d) Lighting	Lump Sum		1,500.00	1,500.00
	e) Heating	Lump Sum		3,500.00	3,500.00
	f) Office	Lump Sum		1,500.00	1,500.00
					<u>\$ 25,000.00</u>
(14)	<u>HYDRAULIC EQUIPMENT</u>				
	a) Shipping Turbines	Lump Sum		\$ 10,000.00	\$ 10,000.00
	b) Hydraulic Equipment	Lump Sum		367,000.00	367,000.00
	c) Hydraulic Equipment Installation	Lump Sum		160,000.00	160,000.00
					<u>\$537,000.00</u>
(15)	<u>ELECTRICAL EQUIPMENT</u>				
	a) Switchboard	Lump Sum		\$ 10,000.00	\$ 10,000.00
	b) Electrical Installation	Lump Sum		10,000.00	10,000.00
					<u>\$ 20,000.00</u>
(19)	<u>OUTDOOR TRANSFORMER STATION STRUCTURE</u>				
	a) Transformer Footings	C.Y.	27	\$ 260.00	\$ 7,000.00
	b) Transformer Equipment	Lump Sum		13,500.00	13,500.00
					<u>\$ 20,500.00</u>
(20)	<u>INDICATING AND RECORDING DEVICES FOR HYDRAULIC PURPOSES</u>				
	a) Alarms	Lump Sum		\$ 1,000.00	<u>\$ 1,000.00</u>

DESCRIPTION: BOARDMAN DAM

EARLIEST DATE IN SERVICE: September, 1980

NAMEPLATE RATING	<u>N/A</u> KW		
CAPACITY	<u>963</u> KW		
TRANSMISSION LOSSES	<u>25</u> KW		
CAPACITY FOR SYSTEM LOAD		Without Fish Ladder	With Fish Ladder
Base Load	<u>489</u> KW	<u>5,322</u> MWH/YR	4,738
Peak Load	<u>474</u> KW	<u>1,260</u> MWH/YR	1,260
Total	<u>963</u> KW	<u>6,582</u> MWH/YR	5,998

CAPITAL COSTS

Plant		<u>542,700</u>	
Equipment		<u>727,000</u>	
Interfacing		<u>28,000</u>	
Other (Fish Passage)		<u>*(1,271,000)</u>	
Int. During Construction		<u>13,000</u>	
Engineering & Conting.		<u>194,700</u>	
Total Capital			<u>1,505,400</u>

ANNUAL EXPENSE

Maintenance - Labor	<u> </u>		
Other	<u> </u>	<u>4,900</u> Every 5 years	
Repair - Labor	<u> </u>		
Other	<u> </u>	<u>30,000</u> Every 10 years	
Operation - Labor	<u> </u>		
Other	<u> </u>	<u>1,635</u>	
Admin. & General		<u>294</u>	
Insurance		<u>3,000</u>	
Taxes		<u>No Add</u>	
Other	<u> </u>		

TOTAL ANNUAL EXPENSE 8,909

DEPRECIATION *(31,775) 37,635

DEPT. RETIREMENT *(117,656) 139,355

TOTAL ANNUAL COST *(149,431) 185,899

COST PER KWH (Mils) *(55.9) 28.2

*(Additional Cost for Fish Passage) ≠ (Including Fish Passage)

ESTIMATING FORM -

Hydro-Electric Power Developments

BOARDMAN DAM

Item	Description	Cost
1.	Preliminary Expenses (Feasibility Study)	\$ 7,240
2.	Clearing Site	
3.	Highways and Bridges	503,460
4.	Railroads and Bridges	
5.	Wharves	
6.	Ferries	
7.	Taking Care of Water	
8.	Reservoirs and Pond	2,000
9.	Dams	
10.	Intakes	
11.	Conduits	2,000
12.	Power House Substructure	
13.	Power House Superstructure	28,000
14.	Hydraulic Equipment	707,000
15.	Electrical Equipment	20,000
16.	Miscellaneous Equipment	
17.	Testing and Starting	
18.	Tail Race	
19.	Outdoor Transformer Station Structure	27,000
20.	Indict. & Record Devices - Hydraulic Purposes	1,000
21.	Transmission Line & Telephone Line	
22.	Substations	
23.	Permanent Quarters	
24.	Construction Overhead	
25.	Local General Charges	
26.	Engineering & Miscellaneous 15%	194,700
27.	Allowance for Contingencies & Omissions	
28.	Real Estate, R/W, Flow & Water Rights	
29.	Interest During Construction	
30.	Taxes During Construction 1%	13,000
31.	Interest & Taxes on Cost of REal Estate, R/W, Flowage & Water Rights Prior to Construction	
32.	Working Capital	
	TOTAL PROJECT COST	\$1,505,400

BOARDMAN DAM CONSTRUCTION COST DATA

	ITEM	UNIT	AMOUNT	UNIT COST	TOTAL
(3)	<u>HIGHWAYS AND BRIDGES</u>				
	a) New Bridge	Sq.Ft.	4074	\$ 78.00	\$317,770.00
	b) New Approaches	Mi.	0.3	612,300.00	183,690.00
	c) Canoe Portages	Lump Sum		2,000.00	2,000.00
					<u>\$503,460.00</u>
(8)	<u>RESERVOIRS AND PONDS</u>				
	a) Reservoir Bank Protection	Lump Sum		\$ 2,000.00	<u>\$ 2,000.00</u>
(11)	<u>CONDUITS</u>				
	a) Painting Penstocks	Lump Sum		\$ 2,000.00	<u>\$ 2,000.00</u>
(13)	<u>POWERHOUSE SUPERSTRUCTURE</u>				
	a) Structural Steel	LBS.	500	\$ 2.00	\$ 1,000.00
	b) Miscellaneous Finish Construction	Lump Sum		16,500.00	16,500.00
	c) Plumbing	Lump Sum		3,000.00	3,000.00
	d) Lighting	Lump Sum		2,000.00	2,000.00
	e) Heating	Lump Sum		4,000.00	4,000.00
	f) Office	Lump Sum		1,500.00	1,500.00
					<u>\$ 28,000.00</u>
(14)	<u>HYDRAULIC EQUIPMENT</u>				
	a) Shipping Turbines	Lump Sum		\$ 10,000.00	\$ 10,000.00
	b) Hydraulic Equipment	Lump Sum		\$495,000.00	\$495,000.00
	c) Hydraulic Equipment Installation	Lump Sum		\$202,000.00	\$202,000.00
					<u>\$707,000.00</u>
(15)	<u>ELECTRICAL EQUIPMENT</u>				
	a) Switchboard	Lump Sum		\$ 10,000.00	\$ 10,000.00
	b) Electrical Installation	Lump Sum		10,000.00	10,000.00
					<u>\$ 20,000.00</u>
(19)	<u>OUTDOOR TRANSFORMER STATION STRUCTURE</u>				
	a) Transformer Equipment	Lump Sum		\$ 27,000.00	<u>\$ 27,000.00</u>
(20)	<u>INDICATING AND RECORDING DEVICES FOR HYDRAULIC PURPOSES</u>				
	a) Alarms	Lump Sum		\$ 1,000.00	<u>\$ 1,000.00</u>

DESCRIPTION: KEYSTONE DAM

EARLIEST DATE IN SERVICE: Fall, 1982

NAMEPLATE RATING	<u>N/A</u> KW		
CAPACITY	<u>466</u> KW		
TRANSMISSION LOSSES	<u>14</u> KW		
CAPACITY FOR SYSTEM LOAD		Without	With
		Fish Ladder	Fish Ladder
Base Load	<u>241</u> KW	<u>2,577</u> MWH/YR	2,294
Peak Load	<u>225</u> KW	<u>610</u> MWH/YR	610
Total	<u>466</u> KW	<u>3,187</u> MWH/YR	2,904
CAPITAL COSTS			
Plant		<u>1,739,400</u>	
Equipment		<u>414,000</u>	
Interfacing		<u>20,250</u>	
Other (Fish Passage)		<u>* (620,000)</u>	
Int. During Construction		<u>27,700</u>	
Engineering & Conting.		<u>326,000</u>	
Total Capital			<u>2,527,350</u>
ANNUAL EXPENSE			
Maintenance - Labor	<u> </u>		
Other	<u> </u>	<u>4,900</u> Every 5 Years	
Repair - Labor	<u> </u>		
Other	<u> </u>	<u>30,000</u> Every 10 Years	
Operation - Labor	<u> </u>		
Other	<u> </u>	<u>4,235</u>	
Admin. & General		<u>430</u>	
Insurance		<u>6,750</u>	
Taxes		<u>No Add</u>	
Other	<u> </u>		
TOTAL ANNUAL EXPENSE			<u>15,395</u>
DEPRECIATION		<u>*(15,500)</u>	<u>65,013</u>
DEPT. RETIREMENT		<u>*(57,393)</u>	<u>233,957</u>
TOTAL ANNUAL COST		<u>*(72,893)</u>	<u>314,365</u>
COST PER KWH (Mils)		<u>*(133.4)</u>	<u>98.6</u>

* (Added Cost for Fish Passage) ≠ (Including Fish Passage)

ESTIMATING FORM -

Hydro-Electric Power Developments

KEYSTONE DAM

Item	Description	Cost
1.	Preliminary Expenses (Feasibility Study)	2,900+
2.	Clearing Site	17,000
3.	Highways and Bridges	15,000
4.	Railroads and Bridges	25,000
5.	Wharves	
6.	Ferries	
7.	Taking Care of Water	
8.	Reservoirs and Pond	
9.	Dams	1,285,000
10.	Intakes	
11.	Conduits	70,000
12.	Power House Substructure	222,000
13.	Power House Superstructure	102,500
14.	Hydraulic Equipment	378,000
15.	Electrical Equipment	16,000
16.	Miscellaneous Equipment	20,000
17.	Testing and Starting	
18.	Tail Race	
19.	Outdoor Transformer Station Structure	18,250
20.	Indicat. & Record Devices - Hydraulic Purposes	1,000
21.	Transmission Line & Telephone Line	1,000
22.	Substations	
23.	Permanent Quarters	
24.	Construction Overhead	
25.	Local General Charges	
26.	Engineering & Miscellaneous 15%	326,000
27.	Allowance for Contingencies & Omissions	
28.	Real Estate, R/W, Flow & Water Rights	
29.	Interest During Construction 1%	27,700
30.	Taxes During Construction	
31.	Interest & Taxes on Cost of Real Estate, R/W, Flowage & Water Rights Prior to Construction	
32.	Working Capital	
	TOTAL PROJECT COST	\$2,527,350

KEYSTONE DAM CONSTRUCTION COST DATA

ITEM	UNIT	AMOUNT	UNIT COST	SUB-TOTAL	TOTAL
(1) <u>PRELIMINARY EXPENSES</u>					
a) Surveys	Lump Sum		\$ 6,000.00	\$ 6,000.00	
b) Reports	Lump Sum		1,000.00	1,000.00	
c) Borings and Test Pits	Lump Sum		8,000.00	8,000.00	
d) Miscellaneous	Lump Sum		1,000.00	1,000.00	
e) Office	Lump Sum		500.00	500.00	
f) Power for Construction	Lump Sum		500.00	500.00	
				<u>500.00</u>	<u>\$ 17,000.00</u>
(2) <u>CLEARING SITE</u>					
a) Clearing	Lump Sum		\$ 15,000.00	\$ 15,000.00	
				<u>15,000.00</u>	<u>\$ 15,000.00</u>
(3) <u>HIGHWAYS AND BRIDGES</u>					
a) Access Road	Lump Sum		\$ 25,000.00	\$ 25,000.00	
				<u>25,000.00</u>	<u>\$ 25,000.00</u>
(9) <u>DAMS</u>					
a) Earth Excavation	C.Y.	2,000	\$ 5.00	\$ 10,000.00	
b) Embankment	C.Y.	40,000	4.55	182,000.00	
c) Structural Concrete	C.Y.	1,900	260.00	494,000.00	
d) Sheet Piling	Ton	450	975.00	438,700.00	
e) Slope Protection	C.Y.	3,500	45.50	159,000.00	
f) Structural Steel	LBS.	10,000	2.00	20,000.00	
				<u>20,000.00</u>	<u>\$1,285,000.00</u>
(11) <u>CONDUITS</u>					
a) Earth Excavation	C.Y.	6,000	\$ 5.00	\$ 30,000.00	
b) Lining and Slope Protection	S.Y.	2,000	20.00	40,000.00	
				<u>40,000.00</u>	<u>\$ 70,000.00</u>
(12) <u>POWERHOUSE SUBSTRUCTURE</u>					
a) Earth Excavation	C.Y.	2,000	\$ 5.00	\$ 10,000.00	
b) Bearing Piles	L.F.	1,667	15.00	25,000.00	
c) Embankment	C.Y.	7,100	4.50	32,000.00	
d) Structural Concrete	C.Y.	385	260.00	100,000.00	
e) Slope Protection	C.Y.	1,200	45.50	55,000.00	
				<u>55,000.00</u>	<u>\$222,000.00</u>

KEYSTONE DAM CONSTRUCTION COST DATA -- Continued

	ITEM	UNIT	AMOUNT	UNIT COST	SUB-TOTAL	TOTAL
(13)	<u>POWERHOUSE SUPERSTRUCTURE</u>					
	a) Structural Steel	LBS.	19,500	\$ 2.00	\$ 39,000.00	
	b) Miscellaneous					
	Finish Construction	Lump Sum		47,000.00	47,000.00	
	c) Plumbing	Lump Sum		5,000.00	5,000.00	
	d) Lighting	Lump Sum		4,000.00	4,000.00	
	e) Heating	Lump Sum		6,000.00	6,000.00	
	f) Office	Lump Sum		1,500.00	1,500.00	
						<u>\$102,500.00</u>
(14)	<u>HYDRAULIC EQUIPMENT</u>					
	a) Shipping Turbines	Lump Sum		\$ 4,000.00	\$ 4,000.00	
	b) Hydraulic Equipment	Lump Sum		304,000.00	304,000.00	
	c) Hydraulic Equipment					
	Installation	Lump Sum		70,000.00	70,000.00	
						<u>\$378,000.00</u>
(15)	<u>ELECTRICAL EQUIPMENT</u>					
	a) Switchboard	Lump Sum		\$ 6,000.00	\$ 6,000.00	
	b) Electrical Installation	Lump Sum		10,000.00	10,000.00	
						<u>\$ 16,000.00</u>
(16)	<u>MISCELLANEOUS EQUIPMENT</u>					
	a) Crane and Motor	Lump Sum		\$ 20,000.00	\$ 20,000.00	
						<u>\$ 20,000.00</u>
(19)	<u>OUTDOOR TRANSFORMER STATION STRUCTURE</u>					
	a) Transformer Footings	C.Y.	27	\$ 260.00	\$ 7,000.00	
	b) Transformer Equipment	Lump Sum		11,250.00	11,250.00	
						<u>\$ 18,250.00</u>
(20)	<u>INDICATING AND RECORDING DEVICES FOR HYDRAULIC EQUIPMENT</u>					
	a) Alarms	Lump Sum		\$ 1,000.00	\$ 1,000.00	
						<u>\$ 1,000.00</u>
(21)	<u>TRANSMISSION LINE AND TELEPHONE LINE</u>					
	a) Telephone Line	Lump Sum		\$ 1,000.00	\$ 1,000.00	
						<u>\$ 1,000.00</u>

DESCRIPTION: BROWN BRIDGE DAM W/O FISH LADDERS

EARLIEST DATE IN SERVICE: N/A on Stream

NAMEPLATE RATING	<u>800</u> KW			
CAPACITY	<u>823</u> KW			
TRANSMISSION LOSSES	<u>25</u> KW			
CAPACITY FOR SYSTEM LOAD				
Base Load	<u>210</u> KW	<u>1,875</u> MWH/YR		1,429
Peak Load	<u>613</u> KW	<u>1,012</u> MWH/YR		1,012
Total	<u>823</u> KW	<u>2,887</u> MWH/YR		2,441

CAPITAL COSTS

Plant		<u>20,000</u>		
Equipment		<u>10,000</u>		
Interfacing		<u>2,000</u>		
Other		<u> </u>		
Int. During Construction		<u>270</u>		
Engineering & Conting		<u>4,000</u>		
Total Capital				<u>36,270</u>

ANNUAL EXPENSE

Maintenance - Labor	<u> </u>			
Other	<u> </u>	<u>12,900</u> Every 5 Years		
Repair - Labor	<u> </u>			
Other	<u> </u>	<u>30,000</u> Every 10 Years		
Operation - Labor	<u> </u>			
Other	<u> </u>	<u>4,235</u>		
Admin. & General		<u>515</u>		
Insurance		<u>No Add</u>		
Taxes		<u>No Add</u>		
Other	<u> </u>			

TOTAL ANNUAL EXPENSE 10,330

DEPRECIATION 1,741

DEPT. RETIREMENT 3,358

TOTAL ANNUAL COST 15,428

COST PER KWH (Mil's) 5.3

ESTIMATING FORM -

Hydro-Electric Power Developments

BROWN BRIDGE DAM

Item	Description	Cost
1.	Preliminary Expenses (Feasibility Study)	\$ 5,000
2.	Clearing Site	
3.	Highways and Bridges	2,000
4.	Railroads and Bridges	
5.	Wharves	
6.	Ferries	
7.	Taking Care of Water	
8.	Reservoirs and Pond	10,000
9.	Dams	1,500
10.	Intakes	
11.	Conduits	
12.	Power House Substructure	
13.	Power House Superstructure	1,500
14.	Hydraulic Equipment	
15.	Electrical Equipment	10,000
16.	Miscellaneous Equipment	
17.	Testing and Starting	
18.	Tail Race	
19.	Outdoor Transformer Station Structure	
20.	Indicat. & Record Devices - Hydraulic Purposes	1,000
21.	Transmission Line & Telephone Line	1,000
22.	Substations	
23.	Permanent Quarters	
24.	Construction Overhead	
25.	Local General Charges	
26.	Engineering & Miscellaneous 15%	4,000
27.	Allowance for Contingencies & Omissions	
28.	Real Estate, R/W, Flow & Water Rights	
29.	Interest During Construction 1%	270
30.	Taxes During Construction	
31.	Interest & Taxes on Cost of Real Estate, R/W, Flowage & Water Rights Prior to Construction	
32.	Working Capital	
	TOTAL PROJECT COST	\$ 36,270

BROWN BRIDGE DAM CONSTRUCTION COST DATA

	ITEM	UNIT	AMOUNT	UNIT COST	TOTAL
(3)	<u>HIGHWAY AND BRIDGES</u>				
	a) Canoe Portage	Lump Sum		\$ 2,000.00	<u>\$ 2,000.00</u>
(8)	<u>RESERVOIRS AND PONDS</u>				
	a) Reservoir Bank Protection	Sq.Yds.	333	\$ 30.00	<u>\$ 10,000.00</u>
(13)	<u>POWERHOUSE SUPERSTRUCTURE</u>				
	a) Miscellaneous Steel	Lump Sum		\$ 200.00	\$ 200.00
	b) Walls and Partitions	Lump Sum		700.00	700.00
	c) Gutters, Leaders, and Flashing	Lump Sum		200.00	200.00
	d) Hardware	Lump Sum		100.00	100.00
	e) Painting and Finishing	Lump Sum		300.00	300.00
					<u>\$ 1,500.00</u>
(15)	<u>ELECTRICAL EQUIPMENT</u>				
	a) Switchboard	Lump Sum		\$ 10,000.00	<u>\$ 10,000.00</u>
(20)	<u>INDICATING AND RECORDING DEVICES FOR HYDRAULIC PURPOSES</u>				
	a) Alarms	Lump Sum		\$ 1,000.00	<u>\$ 1,000.00</u>
(21)	<u>TRANSMISSION LINE AND TELEPHONE LINE</u>				
	a) Telephone Lines	Lump Sum		\$ 1,000.00	<u>\$ 1,000.00</u>

(9) FISH PASSAGE CONSTRUCTION COST DATA

LOCATION	HEAD (FEET)	\$/FOOT OF HEAD*	COST
Union Street Dam	9	\$ 31,000.00	\$ 279,000.00
Sabin Dam	20	\$ 31,000.00	\$ 620,000.00
Boardman Dam	41	\$ 31,000.00	\$ 1,271,000.00
Keystone Dam	20	\$ 31,000.00	\$ 620,000.00
Brown Bridge Dam	30	N/A	N/A

Total Construction Cost of Union Street Dam, Sabin Dam and Boardman Dam ==
\$ 2,170,000.00

Total Construction Cost of Union Street Dam, Sabin Dam, Boardman Dam and
Keystone Dam ==
\$ 2,790,000.00

* Construction Cost Estimate Supplied by the Michigan Department of Natural Resource
(1981 Cost Estimate)

Emery and Porter, Inc.
Consulting Engineers and Land Surveyors

