Water Resources Development

Saint John River Basin

Lincoln School Hydroelectric Project, Maine Economic And Financial Feasibility Study

JUNE 1983

US Army Corps
of Engineers
New England Division

WATER RESOURCES DEVELOPMENT

SAINT JOHN RIVER BASIN

LINCOLN SCHOOL HYDROELECTRIC PROJECT, MAINE

ECONOMIC AND FINANCIAL FEASIBILITY STUDY

US ARMY ENGINEER DIVISION

NEW ENGLAND DIVISION

WALTHAM, MASSACHUSETTS

JUNE 1983

ECONOMIC & FINANCIAL FEASIBILITY STUDY

LINCOLN SCHOOL HYDROELECTRIC PROJECT

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LINCOLN SCHOOL HYDROELECTRIC PROJECT

ECONOMIC AND FINANCIAL FEASIBILITY STUDY

SUMMARY

This report addresses the economic and financial feasibility of constructing a hydroelectric project at the Lincoln School damsite on the St. John River in the Town of St. Francis, Maine. The study effort was directed by Congressional language contained in Senate and Conference reports relative to the FY 1982 Energy and Water Development Appropriations Act.

Twenty-seven alternative plans of development, consisting of nine power plant configurations for three alternative power pool levels were studied. Comparative analyses determined that a 110 MW power plant installation with a power pool elevation of 620 feet NGVD, capable of producing 272 million KWH annually, best utilized the resource for the production of power and was selected for further study. In view of State of Maine initiatives addressing preservation and restricted utilization of upstream reaches of the St. John River, alternative plans having pool elevations of 600 and 610 feet NGVD were also retained for further study.

All three plans were found to be economically feasible when evaluated as a source of electrical energy which would intermittently displace the operation of existing high cost oil-fired generating units in the New England system (Displaced Energy Method of Analysis). However, it was recognized that the economic feasibility would be severely jeopardized should Hydro-Quebec power be imported into the New England Region as currently being contemplated.

Marketability and financial feasibility studies performed by the Department of Energy determined that sufficient power revenue could not be obtained from the sale of project generated power to repay all costs associated with the production and distribution of the project's power. Accordingly, the project was found to be not financially feasible based on current Federal criteria for financial justification.

In addition to the economic and financial aspects of the project, the real estate requirements - relocations (i.e., residences, roads and cemeteries) and the impacts on historical and natural resources were also identified.

WATER RESOURCES DEVELOPMENT
SAINT JOHN RIVER BASIN
LINCOLN SCHOOL HYDROELECTRIC PROJECT
MAINE

ECONOMIC AND FINANCIAL FEASIBILITY STUDY

SECTION 1. GENERAL

1.01. PURPOSE

This report presents documentation and findings addressing the economic and financial feasibility of constructing a hydroelectric project at the Lincoln School damsite on the Saint John River in the town of St. Francis, Maine. The study effort is in response to Congressional direction - "to determine the economic and financial feasibility of constructing a project at Lincoln School" - contained in Senate and Conference Reports relative to the FY 1982 Energy and Water Development Appropriations Act.

This document is structured to serve as a decision document for Congressional use in its deliberation on the project's future and as such has been tailored to address the issues and intent expressed in the above-referenced language.

1.02. AUTHORIZATION

Dickey-Lincoln School Lakes was authorized by Section 204 of the Flood Control Act of 1965, Public Law 89-298, 89th Congress, 27 October 1965.

The Energy and Water Development Appropriations Act for FY 1982 Public Law 97-88 dated 4 December 1981 and related Conference Reports (Nos. 97-345 and 97-352) and Senate Report (No. 97-256) contained language directing the Corps to determine the economic and financial feasibility of constructing a project at Lincoln School without the large upstream Dickey Dam.

Public Law 97-128, 97th Congress, 29 December 1981, amended Section 204 of the Flood Control Act of 1965 (P.L. 89-298) as follows: "The Dickey Lincoln School Lakes Project, Saint John River, Maine is hereby modified to deauthorize that component of the project known and referred to as the Dickey Dam and its associated transmission facilities." Authorization of the Lincoln School feature of the project was retained.

1.03. SCOPE OF REPORT

This report presents the results of study efforts addressing the following tasks:

Hydrologic - Spillway design flood and spillway requirements for Lincoln School without the upstream storage and control provided by the Dickey Dam.

- Seasonal high flow frequency analyses to determine diversion requirements and construction sequence for Lincoln School.

Hydropower Scoping & Economic Evaluation - Determination of the optimum development of the river resource considering various pool elevations, layouts and installed capacities, and the associated costs in comparison with the hydroelectric benefits. An economic evaluation of the optimum development to demonstrate the project's economic feasibility.

Financial Evaluation - An analysis of the project's ability to recover all costs associated with the production and distribution of the power produced to establish the financial feasibility of the project.

Environmental - Presents environmental, social and economic data necessary to identify, but not necessarily quantify, the major impacts of project implementation. Data was developed using extensive resource information available for the area from earlier studies conducted for the Dickey-Lincoln School Lakes Project.

1.04. PROJECT HISTORY

The origins of the Lincoln School Hydroelectric Project evolved over the years from engineering and scientific interest in harnessing northern Maine and Canadian tidal waters to produce electrical energy and the related feasibility studies conducted during the period of 1956 through 1965.

Attention was focused on the Saint John River as a source of auxiliary power to augment generation from a proposed international tidal power project at Passamaquoddy Bay on the Maine-New Brunswick coast. Auxiliary generation was needed because the lunar tidal cycle does not coincide with daily and seasonal demands for electricity. Efficient operation of a tidal power plant would therefore require a complementary energy source to stabilize output when the tides and demands for electricty were out of phase.

Construction of conventional hydroelectric facilities on the upper Saint John River was considered to be the best solution to firm up the tidal generation. Initially, a site at Rankin Rapids, approximately eight miles downstream of the Allagash River confluence, was selected as the most favorable location. Development of the Rankin Rapids site, however, would have flooded the Allagash River. This was found to be environmentally unacceptable and resulted in moving the proposed dam nine miles upstream to the Dickey damsite just above the confluence of the Saint John and Allagash Rivers. At the same time, a reregulatory dam was proposed at the Lincoln School damsite located ten miles downstream of the

Allagash River confluence. These two proposed dams and power facilities became known as the Dickey-Lincoln School Lakes Project. The Allagash River was subsequently designated a "Wild and Scenic River" and protected under the Wild and Scenic River Act.

The tidal power studies culminated in a 1965 report which concluded that the tidal project was not economically justified but that the Dickey-Lincoln School Lakes Project alone was economically sound and recommended its authorization and construction. The Dickey-Lincoln School Lakes Project was authorized in October 1965 and funds were appropriated to initiate preconstruction planning which continued until late 1967 when all work ceased due to lack of continued funding by Congress.

The advent of the energy crisis in 1973/74 prompted a search for alternative electrical energy sources and interest was renewed in Dickey-Lincoln School. Congress appropriated funds and planning resumed in the Fall of 1974, after a seven year interruption. Planning, in compliance with rapidly changing water resource policies and procedures and extensive environmental legislation recently enacted, was essentially completed with the filing of a final environmental impact statement in August 1981 and the completion of designs for early construction features later that year.

By this time, Congressional support for the Dickey-Lincoln School Lakes Project had waned. This along with controversy and concern for the environmental impacts of the project resulted in the passage of legislation (P.L. 97-128) on 29 December 1981 to deauthorize the Dickey Dam component of the project. Authorization of the Lincoln School feature, however, was retained. Almost simultaneous with passage of the Dickey Dam deauthorization, Congress, through language related to the FY 1982 Appropriations Act, directed the Corps to determine the economic and financial feasibility of constructing a project at Lincoln School without the Dickey Dam.

1.05. LOCATION OF PROJECT AND TRIBUTARY AREA

The Lincoln School Project is located on the upper Saint John River in Aroostook County, northern Maine adjacent to the Canadian border. The project is located approximately 17 miles upstream of the town of Fort Kent, Maine. (See Plate No. 1)

The Saint John River rises in Little Saint John Lake in the extreme southwestern corner of the basin on the international boundary between Quebec, Canada and Maine. As the Southwest Branch, it flows in a generally northerly direction along the boundary for about 38 miles and then through Maine for about 12 miles to its confluence with Baker Branch. From this point, as the main Saint John River, the river flows in a general northeasterly direction through Maine for a distance of about 95 miles to the mouth of the Saint Francis River, then easterly forming the international boundary for about 70 miles to Hamlin, Maine where it enters New Brunswick, Canada and flows for about 200 miles in a general south-

easterly direction past Fredericton, New Brunswick to its mouth at Saint John, New Brunswick on the Bay of Fundy. Its total length is 415 miles. The total fall in the river between its source at Little Saint John Lake and Fort Kent is about 1,110 feet. The Lincoln School damsite is located 10 miles below the mouth of the Allagash River and 1 mile above the mouth of the Saint Francis River in the town of Saint Francis, Maine.

The Saint John River basin has a total drainage area of 21,600 square miles, located in northern Maine and in the adjacent Canadian Provinces of Quebec and New Brunswick, between the watersheds of the Saint Lawrence River to the north and the Penobscot River to the south. Approximately 7,400 square miles are located in Maine. The upper Saint John watershed above Fort Kent, Maine has a drainage area of 5,960 square miles and above the Lincoln School damsite, a drainage area of 4,086 square miles.

SECTION 2. COORDINATION

2.01 GENERAL

Coordination between the New England Division and applicable Federal agencies with specific expertise has been continuous and extensive during the preparation of this report. The State of Maine through the Governor's office has been kept informed and a draft report was furnished to the State Planning Office for review and comment. A compilation of correspondence is included as Appendix D entitled "Coordination Correspondence."

2.02 FEDERAL AGENCIES

The following paragraphs summarize the coordination activites with other Federal agencies:

a. Department of Energy - Power Agencies

- Bonneville Power Administration, Portland, Oregon. (BPA) furnished cost data and preliminary information on substation and transmission requirements for the study effort. This agency had previously accomplished the extensive transmission studies for the Dickey-Lincoln School Lakes project.

- Federal Energy Regulatory Commission, New York Regional Office, N.Y. (FERC) furnished information on the regional electric utility system, the most feasible alternatives to the project, costs of these alternatives, and costs of existing energy produced in the system. These costs formed the basis of determining project benefits for the scoping and economic evaluations of the project.

- Southeastern Power Administration, Elberton, Georgia (SEPA) prepared the financial feasibility and power marketing aspects of the project evaluation. This agency had previously accomplished the indepth studies of financial feasibility and marketability for the Dickey-Lincoln School Lakes project.

b. Department of Interior - U.S. Fish and Wildlife Service, Concord N.H. (USF&WS) provided a planning aid letter report addressing the impacts of project implementation on the natural environment. Their letter report also presents recommendations for measures to mitigate losses attributed to project implementation.

c. North Pacific Division, Corps of Engineers, Portland Oregon (NPD) being the Design Center for hydroelectric power plant design of the U.S. Army Corps of Engineers furnished cost data and preliminary power plant layouts for the various plant configurations studied.

2.03 STATE OF MAINE

a. Draft copies of the report were furnished the State Planning Office for review and comment by the various State agencies. Letters of comment have been received from Governor Joseph E. Brennan and the following State Agencies:

Office of Energy Resources
Department of Inland Fisheries and Wildlife
Department of Environmental Protection
Department of Transportation
Department of Conservation

These letters of comment are included in Appendix D.

b. Many of the issues raised by the State comments relate to future power supplies in the NEPOOL system, the type and value of the energy displaced by the Lincoln School power, and the procedures and methodologies used to evaluate financial feasibility and marketability of Federal power projects. These matters are in the Department of Energy's (DOE) area of expertise. The Southeastern Power Administration and the Federal Energy Regulatory Commission of the DOE have addressed these issues and provided responses to the State's comments. These and other responses to the State's comments are included in Appendix D following the appropriate letter of comment.

SECTION 3 HYDROLOGY

3.01 CLIMATOLOGY AND STREAMFLOW

The upper Saint John River basin, located near 47°N, Latitude, has a cool, semi-humid climate, characterized by short, cool summers and long, cold winters. The mean temperature in the basin approximates 40° Fahrenheit, and the area is subject to wide temperature extremes with minimums of about -40° and maximums near 100° Fahrenheit. Annual precipitation approximates 36 inches and is distributed fairly uniformly throughout the year. However, about one-third of the precipitation occurs as snow with an annual snowfall of about 100 inches. Average depth of snow ranges between 20 and 40 inches over the upper basin by early spring, frequently exceeding 10 inches of water content. Average monthly precipitation for the period of record at Fort Kent, 17 miles east of Lincoln School, is listed in Table 3-1.

TABLE 3-1
MONTHLY PRECIPITATION

FORT KENT, MAINE
ELEVATION 530 FEET NGVD
(1931-1981) 46 YEARS

	Mean	Maximum	Minimum
January	2.26	5.10	.38
February	2.03	4.09	.30
March	2.37	5.86	.55
April	2.32	4.90	.74
May	2.89	5.87	.81
June	3.52	6.86	.47
July	4.02	10.51	1.42
August	4.05	9.97	.85
September	3.45	7.28	.41
October	3.27	5.87	.48
November	2.79	7.00	.21
December	2.81	8.38	.07
Annual	35.78	51.32	25.49

Total annual streamflow in the upper St. John basin is equivalent to about 23 inches of runoff or about 65 percent of annual precipitation. The average annual flow at Lincoln School, with a drainage area of 4,086 square miles, is 6,900 cfs. However, the St. John River is subject to wide variations in seasonal discharge. Winter snows provide reduced runoff from December through March, but the snowpack melt produces high riverflows during April, May and June, amounting to about two-thirds of the total annual runoff. Streamflow is recorded on the St. John River at Dickey, Maine (D.A. = 2,700 square miles) upstream of the Allagash River and on the Allagash River at Allagash, Maine (D.A. = 1,250 square miles)

by the US Geological Survey. Average monthly flows, as recorded at the two gage sites, and computed flows at Lincoln School (D.A. = 4,086 square miles) are listed in Table 3-2. A flow duration curve developed for the Lincoln School site is shown on Figure 3-1.

3.02 SPILLWAY DESIGN FLOOD

The spillway of the Lincoln School hydroelectric plant would be designed to safely discharge the "probable maximum flood". The flood has a peak flow of 613,000 cfs, resulting from a storm rainfall of about 10 inches plus snowmelt. It is noted that without the surcharge storage at the upstream Dickey project the probable maximum flood discharge at Lincoln School is increased from the former 318,500 cfs to the present design discharge of 613,000 cfs. The hydrologic development of the spillway design flood for the Lincoln School project is presented in Appendix A of this report.

3.03 DIVERSION REQUIREMENTS

The Lincoln School project would be built in two phases to facilitate passage of riverflows during construction. (See Plates B-1 and B-2 of Appendix B). Initially the left side (looking downstream) of the river would be cofferdammed off, a distance of 450 feet into the river, or nearly one-half the width, permitting riverflows to pass through the remaining right side. The spillway bays would then be built on the left side, but the invert of the bays would be raised only to elevation 540 feet NGVD, initially. The first cofferdam would then be removed allowing the passage of flows through the partially completed spillway.

Secondly the right side of the river would be cofferdammed to permit completion of the dam and powerhouse. Once completed, all cofferdams would be removed and then the spillway gate bays would be bulkheaded, one at a time, and the gate sills raised from elevation 540 to final design grade. Cofferdams built for summer season construction (June-November) would be built to protect against the summer season record flood flow of about 88,000 cfs. Cofferdams would be in the order of 21 to 26 feet in height with required top elevations ranging from 553 at the downstream end to 559 at the upstream end.

Cofferdams built for all season construction would be built to protect against the all season flood of record flow of about 118,000 cfs. Cofferdams would be in the order of 24 to 30 feet in height with required top elevations ranging from 555 at the downstream end to 562 feet NGVD at the upstream end.

The two phase plan of diversion will permit passage of flood flows during construction with minimal restriction. In the event of high flows during construction, river levels upstream of the site would be about 5 to 6 feet higher than natural unrestricted high flow levels. Velocities through the restricted river section, in the event of a flood flow, would be increased from about 5 ft/sec to 13 ft/second.

TABLE 3-2

MONTHLY FLOWS

	St. John River at Dickey, Maine D.A. = 2,700 Sq. Mi. 1947-1981			Allagash River near Allagash, Maine D.A. = 1,250 Sq. Mi. 1932-1981			St. John River at Lincoln School D.A. = 4,086 Sq. Mi. 1947-1981
	Mean (cfs)	Maximum (cfs)	Minimum (cfs)	Mean (cfs)	Maximum (cfs)	Minimum (cfs)	Mean (cfs)
January	1,301	3,059	341	671	1,865	192	2,080
February	1,105	3,902	201	554	2,224	119	1,793
March	1,611	9,249	378	720	3,610	181	2,450
April	12,740	27,790	3,989	4,141	10,100	623	17,562
May	17,200	35,100	5,660	7,032	13,550	2,631	25,082
June	4,548	10,840	1,152	2,315	4,554	719	6,968
July	2,677	9,041	904	1,426	4,053	365	4,060
August	2,846	11,740	265	1,182	5,292	165	4,235
September	2,772	7,655	397	1,097	3,133	122	4,050
October	3,435	11,280	690	1,229	4,121	149	4,734
November	3,955	10,180	605	1,513	4,628	235	5,609
December	2,589	9,781	624	1,137	4,549	215	3,930
Annual	4,745	7,193	2,843	1,925	2,899	989	6,900

Further details and discussion on the diversion requirements at the Lincoln School site are presented in Appendix B of this report.

3.04 HYDROPOWER POTENTIAL

a. General

Hydropower is a function of rate of flow times the net hydraulic head available at the site. Hydropower in kilowatts (KW) is equal to the flow in cubic feet per second (Q) times the head in feet (H) times the combined generator-turbine efficiency (e), all divided by the constant 11.8:

$$KW = \frac{(Q)(H)(e)}{11.8}$$

Hydropower potential at Lincoln School was computed using an assumed average generator-turbine efficiency, throughout the range of operating flows and heads, of 0.88.

The Lincoln School project alone, without the upstream Dickey storage project, would operate basically as a run-of-river plant, that is the magnitude and timing of generation would be dependent on the magnitude and timing of the natural streamflow. The upper 10 feet of the power pool would be available for some occasional daily or weekly load fitting but there would be inadequate storage for any seasonal flow regulation and project operation would be basically run-of-river. Also, because there would be no seasonal flow regulation, there would be no benefits realized at existing downstream Canadian hydropower plants, as there was with the originally proposed combined Dickey-Lincoln School project. An area-capacity curve for the Lincoln School project is shown on Figure 3-2.

The Saint John River is subject to wide variations in streamflow, both yearly and seasonally. Winter snows provide little runoff from December through March, but the snowpack melt resulting from spring rains and rising temperatures, produces large riverflows during April, May and June, amounting to about two-thirds of the total annual runoff. Average monthly streamflow computed for the Lincoln School site using upstream flow records are listed in Table 3-2. Average monthly flows are also shown graphically on Figure 3-3. Monthly flows have ranged from a high of about 50,000 cfs to a low of about 300 cfs . Daily flows have ranged from 118,000 to 220 cfs. With extreme variations in streamflow, and minimal regulating capability, it would not be practical to install equipment capable of generating throughout all ranges of flow. Therefore, the average annual hydropower potential of the site is a function of the average annual streamflow, within the limits of generating capability, times the net average annual hydraulic head.

b. Flow Duration

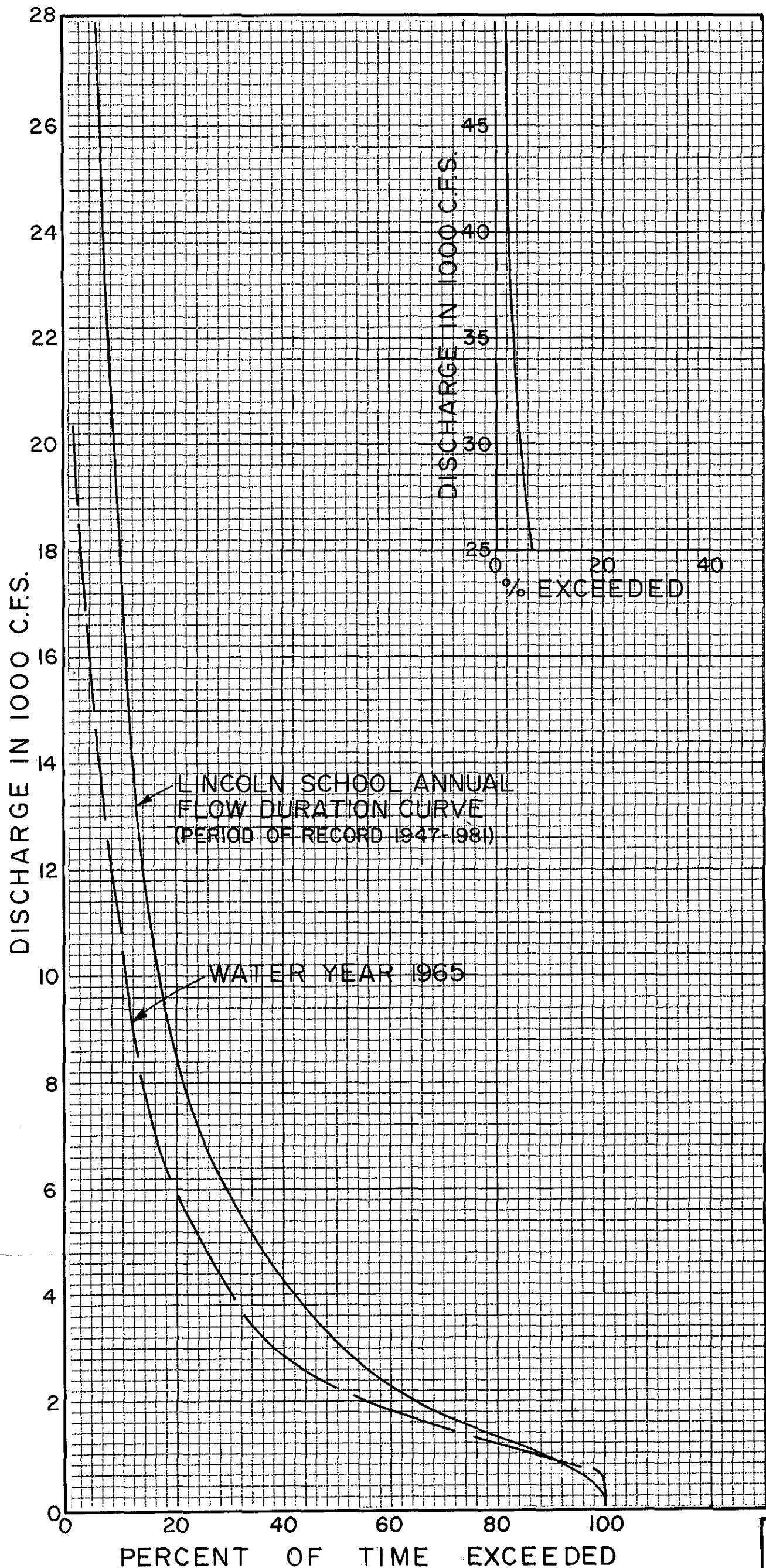
The flow duration curve for the Lincoln School site, shown on Figure 3-1, was computed using period of record daily flows as derived from WATSTORE for the two upstream gaging stations: St. John River at Dickey (2,700 sq. mi.) and Allagash River at Allagash (1,250 sq. mi.). The Lincoln School curve was computed by multiplying the Dickey values by 1.05 to adjust for intervening drainage area and then adding the values for the Allagash. Adding the two flow duration curves together did not allow for any seasonal desynchronization of flows from the two upstream sources. However, a comparative test was made, using 2 years of flow data, in which flows were added daily versus simply adding flow duration curves. The error induced by adding the two flow duration curves was found to be minimal, therefore, the method of adding curves was adopted.

c. Average Net Hydraulic Head

Average annual hydropower potential was computed using an average net hydraulic head equal to the difference between average head pool and tailwater elevations. The average tailwater elevation for an average annual streamflow of 6,900 cfs is 539 feet NGVD. Average annual pool level was assumed at 70 percent of full power pool or 3 feet below full pool. Hydraulic losses in the entrance and exit to the hydraulic turbines were assumed negligible.

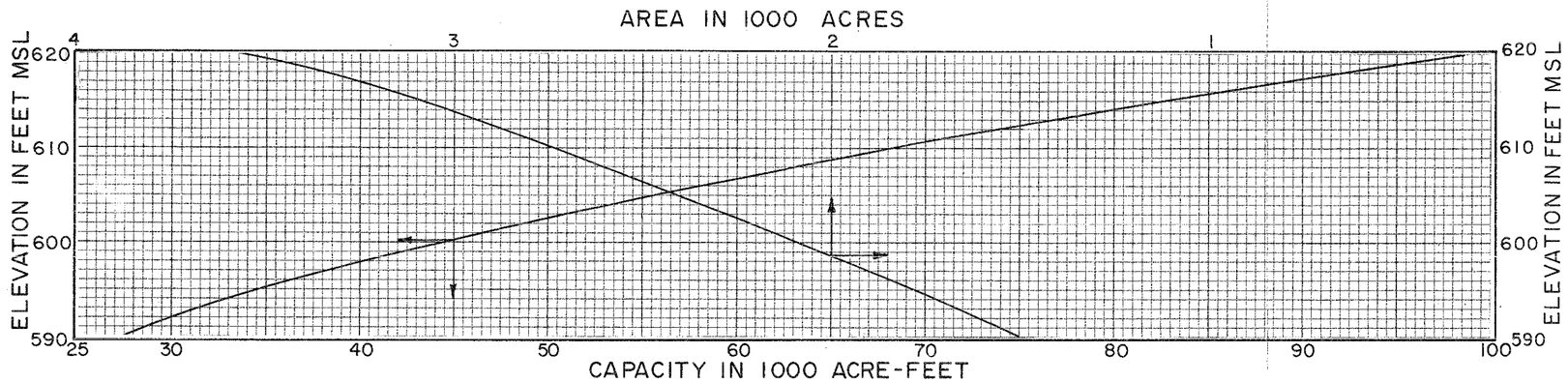
d. Annual Energy versus Installed Capacity

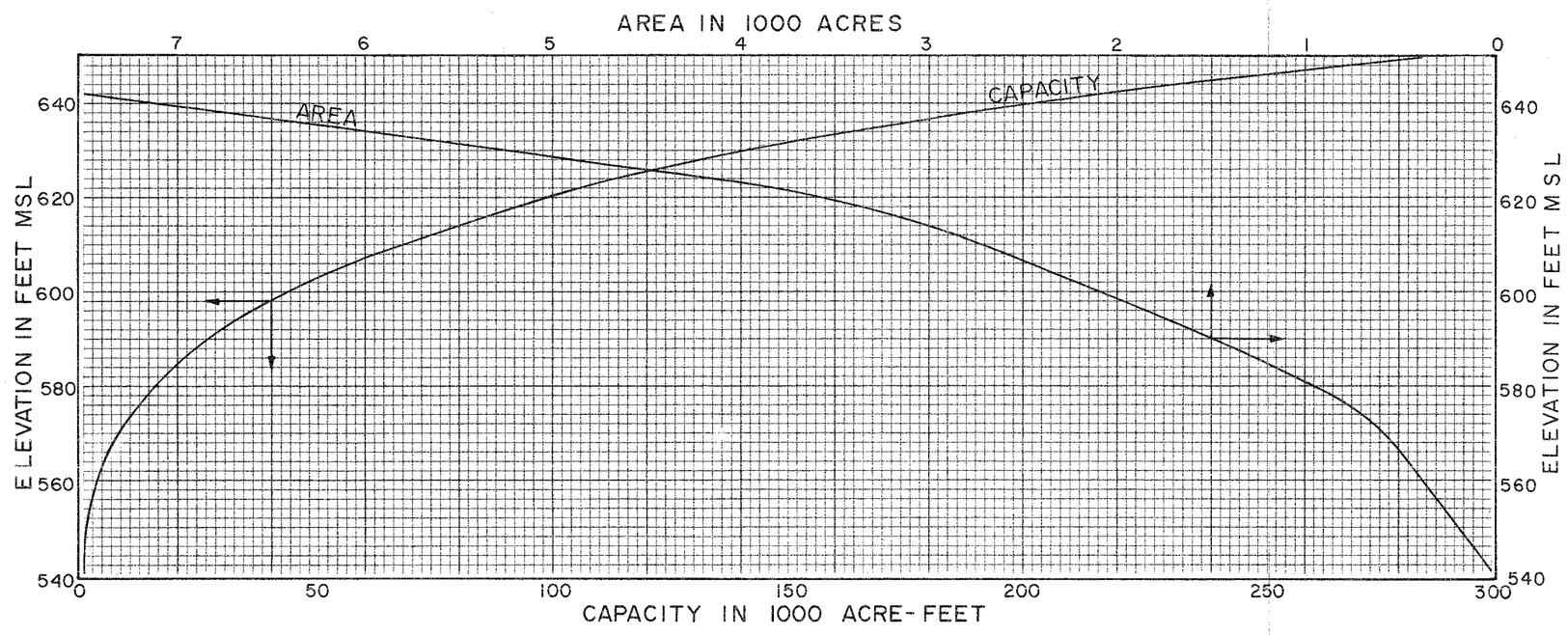
Average annual energy potential was determined for alternative power pool elevations and installed hydraulic capacities by assuming a run-of-river operation and scaling the inclosed area under the flow duration curve within the maximum and minimum capacity limits. Individual units were assumed capable of operating at flows ranging from 40 percent to 105 percent of rated hydraulic capacity. It was further assumed that at least one unit would be installed capable of generating at flows as low as 1,000 cfs. Generation would cease when flows are less than 1,000 cfs and natural streamflows would be released during such low flow periods with no low flow augmentation or deprivation by storage regulation. The resulting average annual energy versus installed hydraulic capacity curves for the three alternative power pool elevations evaluated are shown on Figure 3-4.



LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY
ST. JOHN RIVER BASIN, MAINE
AVERAGE ANNUAL FLOW DURATION CURVE
NOVEMBER 1982

FIGURE 3-1



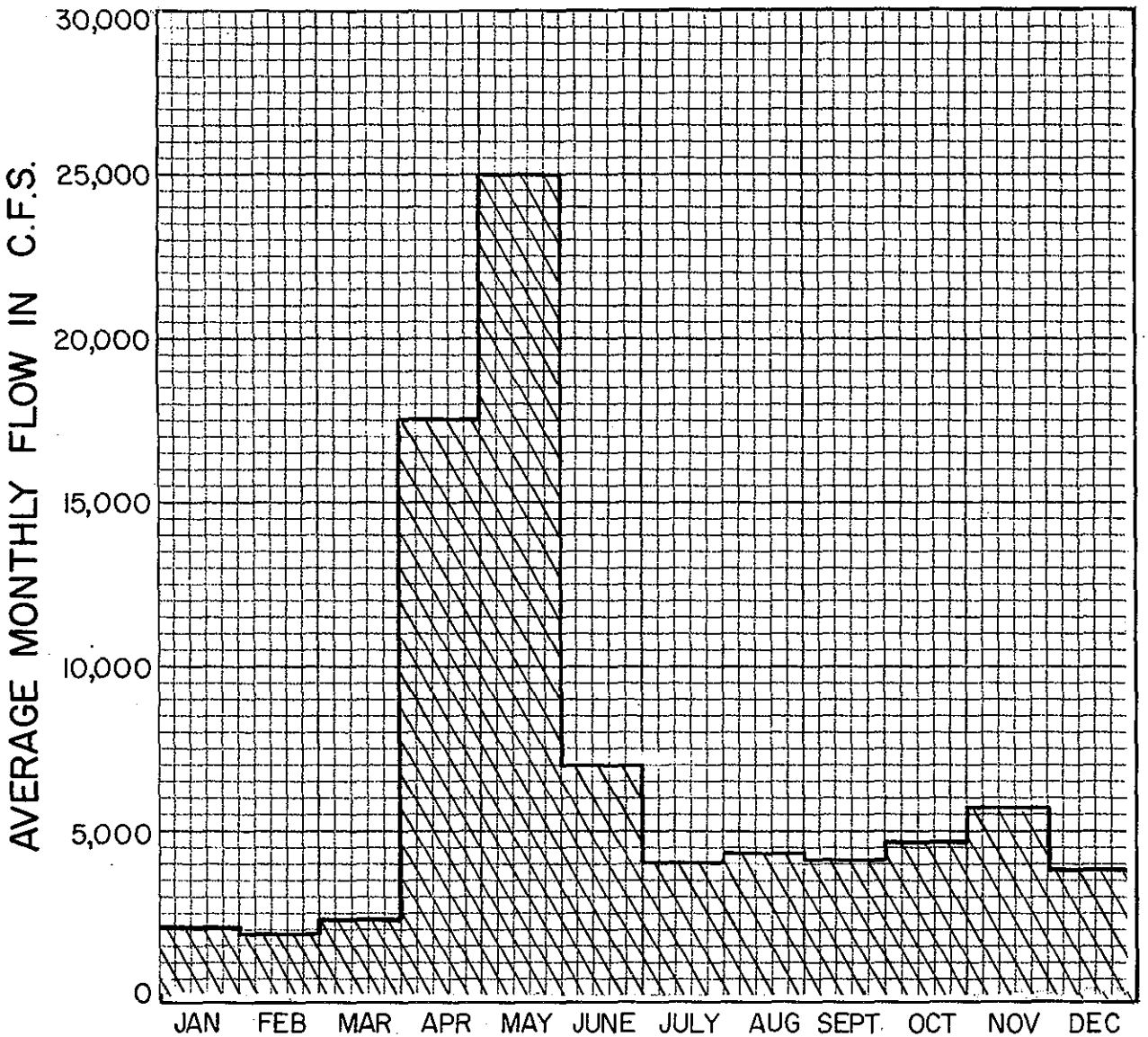


LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY
ST. JOHN RIVER BASIN, MAINE

RESERVOIR AREA-CAPACITY (WITHOUT DICKEY)

NOVEMBER 1982

FIGURE 3-2

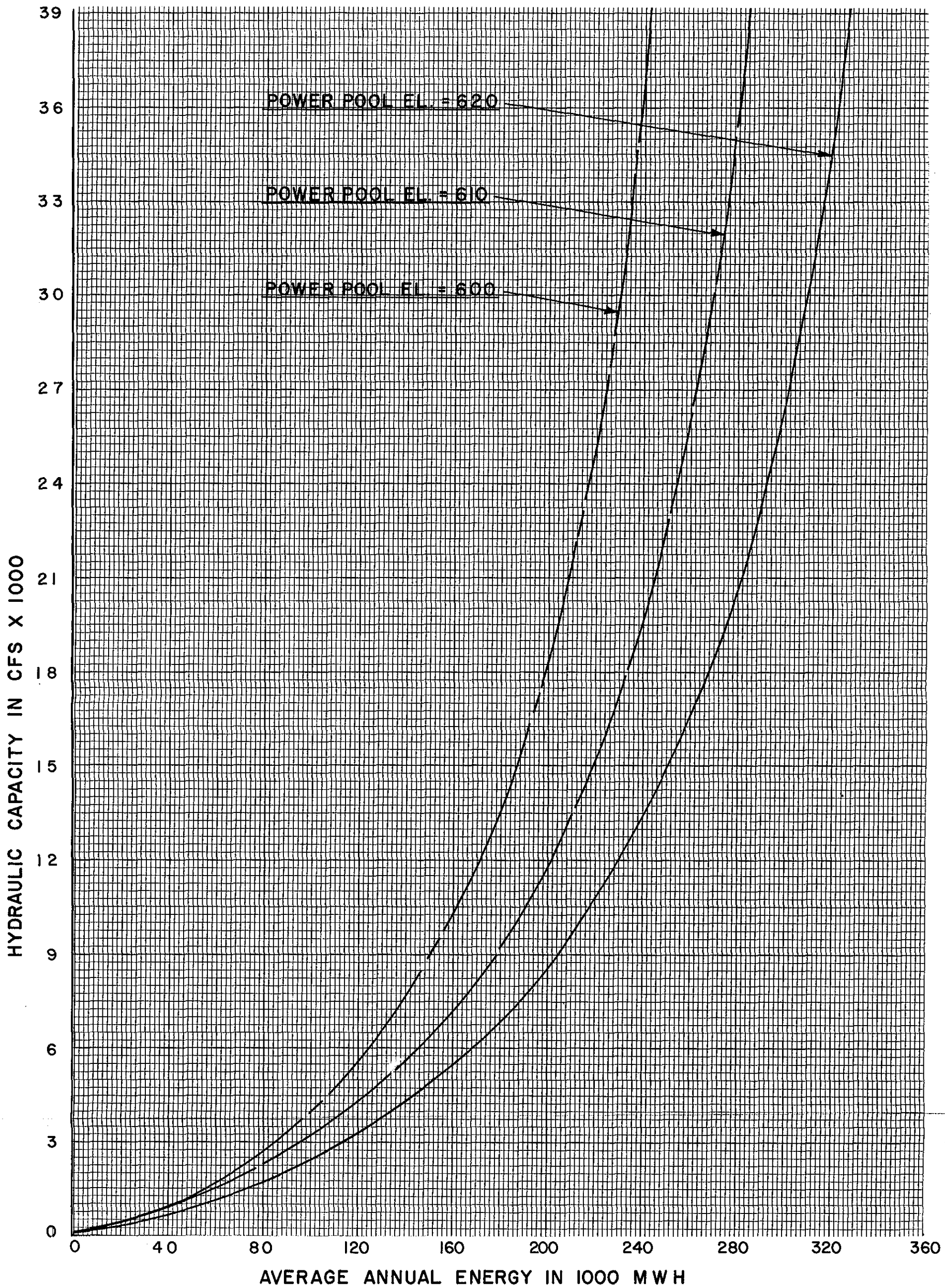


LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY
ST. JOHN RIVER BASIN, MAINE

AVERAGE MONTHLY FLOWS

NOVEMBER 1982

FIGURE 3-3



LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY
ST. JOHN RIVER BASIN, MAINE

AVERAGE ANNUAL ENERGY V.S. HYDRAULIC CAPACITY

NOVEMBER 1982

FIGURE 3-4

SECTION 4 HYDROPOWER SCOPING

4.01 GENERAL

Hydropower scoping studies were performed for three alternative power pool levels to arrive at an appropriate level of development with respect to unit numbers and sizes. The scoping studies involved developing project costs and hydropower benefits for a range of power development.

4.02 ALTERNATIVES CONSIDERED

a. Alternative Power Pool Levels

Three alternative power pool levels were considered namely elevations 600, 610 and 620 feet NGVD. Elevation 620 was the maximum selected due to environmental constraints, as any pool elevation above this would encroach upon the Allagash Wilderness Waterway protected under the Wild and Scenic River Act. Elevation 600 was the minimum considered as it would result in a minimum net head of about 60 feet and would produce no encroachment on the toe of Big Rapids, an upstream White Water Canoeing attraction on the Saint John River. Alternative elevation 610 was selected as an intermediate level with only minimal impact at the toe of Big Rapids.

b. Alternative Number and Sizes of Units

For each of the 3 power pool levels, 9 alternative power unit configurations comprised of various combinations and sizes of units were studied and compared. Turbines were of the Kaplan type and numbers ranged from 3 to 5 units. Each alternate included one small unit capable of generating relatively efficiently at flows down to 1,000 cfs. The smaller and larger units were comparatively sized so as to provide efficient operating capability for all flows from the 1,000 cfs to total installed project capacity. The unit sizes and numbers studied are listed in table 4-1.

4.03 ANNUAL GENERATION

Average annual generation potential of the various alternatives was determined by analyzing the areas under the flow duration curve within the limits of operating capability. No generation was assumed for periods of flow less than 1,000 cfs and maximum generating capacity was assumed equal to total rated hydraulic capacity at rated head with generators at 15 percent overload. Average annual energy was computed using an overall turbine-generator efficiency of 0.88 and average net heads of 78, 68, and 58 feet for power pools of 620, 610 and 600 feet NGVD, respectively. Average annual energy in thousands of megawatt hours, and average annual plant factors for the 27 alternatives studied are listed in Table 4-1.

TABLE 4-1
LINCOLN SCHOOL

ALTERNATIVE UNIT SIZES
AND NUMBERS

Alt Scheme	Top Power Pool (ft. NGVD)	Net Head (ft)	Gen. Cap. (MW @ 115%)	No. & Diameter of Units (in.-ea.)	Approx. Hyd. Cap. (cfs)	Avg. Ann.[1/] Energy (MWH x 10³)	Avg. Ann. Plnt Fac. (%)
1	620	76	85.26	2 large - 195.3 1 small - 108.4	14,520	251	33.6
2	620	76	98.37	2 large - 208.1 1 small - 121.1	16,680	262	30.4
3	620	76	110.87	2 large - 220.1 1 small - 132.7	18,840	272	28.0
1A	620	76	122.13	3 large - 195.3 1 small - 108.4	20,800	281	26.3
2A	620	76	140.01	3 large - 208.1 1 small - 121.1	23,800	292	23.8
3A	620	76	157.79	3 large - 220.1 1 small - 132.7	26,800	301	21.8
1B	620	76	159.04	4 large - 195.3 1 small - 108.4	27,080	302	21.7
2B	620	76	181.95	4 large - 208.1 1 small - 121.1	30,920	312	19.6
3B	620	76	204.7	4 large - 220.1 1 small - 132.7	34,760	320	17.9
4	610	66	69.0	2 large - 195.3 1 small - 108.4	13,540	209	34.6
5	610	66	79.35	2 large - 208.1 1 small - 121.1	15,570	220	31.6
6	610	66	89.7	2 large - 220.1 1 small - 132.7	17,560	230	29.2
4A	610	66	98.87	3 large - 195.3 1 small - 108.4	19,400	239	27.6
5A	610	66	113.28	3 large - 208.1 1 small - 121.1	22,220	249	25.1
6A	610	66	127.64	3 large - 220.1 1 small - 132.7	24,980	257	23.0
4B	610	66	128.76	4 large - 195.3 1 small - 108.4	25,260	258	22.9
5B	610	66	150.21	4 large - 208.1 1 small - 121.1	28,870	267	20.3
6B	610	66	165.85	4 large - 220.1 1 small - 132.7	32,400	275	18.9
7	600	56	53.92	2 large - 195.3 1 small - 108.4	12,460	174	36.8
8	600	56	62.04	2 large - 208.1 1 small - 121.1	14,310	183	33.6
9	600	56	70.13	2 large - 220.1 1 small - 132.7	16,190	191	31.0
7A	600	56	77.28	3 large - 195.3 1 small - 108.4	17,850	199	29.4
8A	600	56	88.57	3 large - 208.1 1 small - 121.1	20,420	207	26.7
9A	600	56	99.8	3 large - 220.1 1 small - 132.7	23,030	215	24.6
7B	600	56	100.65	4 large - 195.3 1 small - 108.4	23,240	216	24.5
8B	600	56	115.10	4 large - 208.1 1 small - 121.1	26,530	224	22.2
9B	600	56	129.46	4 large - 220.1 1 small - 132.7	29,870	230	20.3

1/ Average Annual Energy Computations based on average tailwater; capacity based on block loaded tailwater

4.04 DEPENDABLE CAPACITY AND HYDROLOGIC AVAILABILITY

Two different methods are presently employed in deriving the power value or benefits of a hydropower project. The first evaluation method (conventional) determines the power value as equal to the cost of power from the most likely alternative source that would be developed in the absence of the project. This method uses a dependable capacity value based on the capital cost of the alternative and an energy value based on the operating costs of the alternative.

The second evaluation method establishes the power value based on the cost of the "fuel displaced" by the project in the overall integrated power system. In using this second method the project does not constitute any new capacity added to the electric power system. Consequently no value is assigned for capacity, only to the energy representing savings in fuel costs by reducing operating time of oil-fired units existing in the New England electric system.

Historically, in employing the conventional "alternative source" method of analysis, benefits were assigned only to that capacity considered dependable. Dependable capacity is defined as that capacity that could be produced during periods of maximum power demand with a high degree of dependability under severe hydrologic drought conditions. According to this conventional definition, Lincoln School operating alone would have little or no dependable capacity due to the wide variations in streamflow.

More recently, in evaluating the value of intermittent hydropower capacity in large integrated power systems, dependable capacity has been computed as the product of installed capacity times its hydrologic availability.[1/2/]

The hydrologic availability factor is the ratio of the average generating capability, at a specified minimum plant factor during the critical load period, to the total installed capacity.

The critical demand period in New England is the winter season and the critical winter month at Lincoln School, hydrologically, would be January. It was considered that generating capability, to be creditable for peaking in the New England system, would have to be available at a plant factor of not less than 15 percent. Average generating capability

References:

1/ US Corps of Engineers, North Pacific Division, "Hydropower at F.E. Walter Project", Technical Report, September 1981.

2/ US Water Resources Council Water and Energy Task Force, "Evaluating Hydropower Benefits", December 1981.

was therefore determined for a plant factor of 15 percent (5 hours per day, 5 days per week), with a minimum release of 1,000 cfs, i.e.:

$$(Q_{peak})(15\%) + (Q_{min})(85\%) = Q_{avg}$$

The resulting dependable capacities, with intermittent capacity adjustment, for the 27 alternative levels of development are listed in Table 4-2.

TABLE 4-2

LINCOLN SCHOOL
HYDROLOGIC AVAILABILITY
AND ADJUSTED DEPENDABLE CAPACITIES

Alt.	115% Cap. (MW)	Hydra. Cap. (cfs)	Hydro Avail. (%)	Dep/Inter. Cap (MW) 1/
1	85.26	14,520	48	41
2	98.37	16,680	44	43
3	110.87	18,840	41	45
1A	122.13	20,800	38	46
2A	140.01	23,800	34	48
3A	157.79	26,800	31	49
1B	149.04	27,080	31	49
2B	181.95	30,920	28	51
3B	204.70	34,760	25	51
4	69.0	13,540	50	35
5	79.35	15,570	46	36
6	89.70	17,660	43	38
4A	98.87	19,400	40	40
5A	113.28	22,220	36	41
6A	127.64	24,980	33	42
4B	128.76	25,260	33	43
5B	150.21	28,870	30	45
6B	165.85	32,400	27	45
7	53.192	12,460	53	29
8	62.04	14,310	49	30
9	70.13	16,190	45	32
7A	77.28	17,850	42	32
8A	88.57	20,420	39	35
9A	99.80	23,030	35	35
7B	100.65	23,240	35	35
8B	115.10	26,530	32	37
9B	129.48	29,870	29	38

1/ Rounded to nearest MW.

4.05 ESTIMATED COSTS

a. Cost Estimates

Initially cost estimates were prepared for the twenty-seven alternative levels of development. The power plant costs were developed by the North Pacific Division (NPD). Transmission requirements and costs were furnished by the Department of Energy, Bonneville Power Administration (BPA). Costs for all other components were developed by the New England Division (NED). The estimated construction costs, including transmission, for the various schemes range from $145,000,000 to $203,000,000 for the 600 ft. pool elevation, $163,000,000 to $226,000,000 for the 610 ft. pool elevation and $181,000,000 to $248,000,000 for the 620 ft. pool elevation. The cost estimates are summarized in Table 4-3.

In all cases, project developments are based on a powerhouse facility in the south (right) river bank, a spillway structure in the north (left) river bank and an earth-filled dam extending across the river between the powerhouse and spillway structures. Other materials consisting of formed concrete and roller compacted concrete were considered for the dam structure. However, preliminary investigations indicated that an earth-filled embankment would be the least costly and is therefore utilized as the basis for this evaluation effort. More refined evaluations would be a part of any more detailed design studies.

b. Annual Costs.

The period of analysis for the project is 100 years. Interest and amortization on the total investment consisting of first construction costs and interest during construction was computed at 7-7/8%, the interest rate for water resources in Fiscal Year 1983. Operation and maintenance costs were derived by scaling down or tailoring the requirements previously determined for the Dickey-Lincoln project, to the smaller Lincoln School Only concept. These O&M costs were further evaluated using the Corps of Engineers Hydropower Cost Estimating Manual, revision date July 1981. Replacement cost estimates were based upon the referenced estimating manual. Annual costs data pertaining to the transmission facilities were furnished by the Bonneville Power Administration and adjusted for more costly transmission requirements of capacities higher than 100 MW. All costs were adjusted to reflect October 1982 price levels. The annual costs for the alternative developments are summarized in Table 4-3.

TABLE NO. 4-3
LINCOLN SCHOOL PROJECT
FIRST COSTS/ANNUAL COSTS
ALTERNATIVE SCHEMES

Alt. Scheme		Capacity (MW)	First Costs ($) Dam & Res.	Transmission	Total	Annual Costs ($)
1	620' Pool	85.26	172,000,000	9,150,000	181,150,000	18,963,000
2	"	98.37	178,000,000	9,150,000	187,150,000	19,603,000
3	"	110.87	183,000,000	12,745,000	195,745,000	20,547,000
1A	"	122.13	193,000,000	12,745,000	205,745,000	21,627,000
2A	"	140.01	201,000,000	12,745,000	213,745,000	22,497,000
3A	"	157.79	207,000,000	16,340,000	223,340,000	23,550,000
1B	"	149.04	214,000,000	16,340,000	230,340,000	24,300,000
2B	"	181.95	223,000,000	16,340,000	239,340,000	25,270,000
3B	"	204.70	232,000,000	16,340,000	248,340,000	26,240,000
4	610' Pool	69.0	154,000,000	9,150,000	163,150,000	17,193,000
5	"	79.35	158,000,000	9,150,000	167,150,000	18,273,000
6	"	89.70	164,000,000	9,150,000	173,150,000	18,273,000
4A	"	98.87	174,000,000	9,150,000	183,150,000	19,353,000
5A	"	113.28	179,000,000	12,745,000	191,745,000	20,297,000
6A	"	127.64	187,000,000	12,745,000	199,745,000	21,147,000
4B	"	128.76	194,000,000	12,745,000	206,745,000	21,907,000
5B	"	150.21	201,000,000	12,745,000	213,745,000	22,667,000
6B	"	165.85	210,000,000	16,340,000	226,340,000	24,040,000
7	600' Pool	53.19	136,000,000	9,150,000	145,150,000	15,403,000
8	"	62.04	142,000,000	9,150,000	151,150,000	16,053,000
9	"	70.13	146,000,000	9,150,000	155,150,000	16,483,000
7A	"	77.28	156,000,000	9,150,000	165,150,000	17,563,000
8A	"	88.57	163,000,000	9,150,000	172,150,000	18,313,000
9A	"	99.80	168,000,000	12,745,000	180,745,000	19,257,000
7B	"	100.65	174,000,000	12,745,000	186,745,000	19,917,000
8B	"	115.10	183,000,000	12,745,000	195,745,000	20,867,000
9B	"	129.48	190,000,000	12,745,000	202,745,000	21,627,000

4.06 POWER BENEFITS

a. General

Annual power benefits were developed for each alternative and were based on generalized power values furnished by the New York Regional Office of the Federal Energy Regulatory Commission (FERC) for a range of annual energy producing potentials and available generating capacities. Comparison of the annual benefits with the annual costs provides a measure of the economic feasibility and also provides appropriate net benefit values necessary to determine the optimum project development.

Power values were developed for benefit analysis using two methodologies. One method, the more traditional, is based on the cost of the alternative thermal generation most likely to evolve in the absence of the project and is expressed as a capacity value component ($/Kw/Year) and an energy value component (mills/Kwh). This procedure implies that project implementation will preclude or defer the need for some other form of generation expansion in the system. The capacity value reflects the annual investment and fixed costs of the generation expansion most likely to be eliminated or deferred and the energy value reflects its variable operating costs, predominantly fuel costs.

The other method utilized to evaluate benefits is based on the cost of generating electrical energy in the system that would be avoided or displaced by project implementation and is expressed as an energy value component only (mills/Kwh). This procedure recognizes that the project would not eliminate any of the need for system expansion but would displace energy produced by more costly forms of generation existing in the system. The energy value reflects the variable operating costs, predominantly fuel costs, of existing and planned plants in the system which would be avoided by project operation.

b. Evaluation by "Most Likely Alternative" Method

Annual power benefits are computed using generalized at-market power values provided by the FERC and reflect applicable data pertaining to hydropower potential and power characteristics of the specific resource. FERC's current policy is to consider generation with annual plant factors up to and including 17 percent (corresponding to 1500 hours annual operation) as the peaking band on the New England load curves; plant factors over 17 percent and up to 40 percent (corresponding to 3500 hours annual operation), as the intermediate range; and 40 percent and over as baseload. The least costly thermal alternatives most likely to evolve or be constructed in New England to meet these ranges of demand on the load curve, are oil-fired combustion turbines for peaking loads; cycling coal for intermediate loads; and conventional coal-fired units for baseload operation. The twenty-seven alternative schemes considered in this study have average annual plant factors ranging from 17.9 percent up to 36.8 percent. Accordingly, the power values used to estimate the power

benefits for all schemes are based on a cycling coal plant thermal alternative with a capacity value component of $138.00 per kw/year and an energy value component of 40 or 41 mills/kwh depending on the plant factor. The energy values reflect projected inflation rates for future fuel costs which are above the general inflation rates over the same period. The power values are computed using the same discount or interest rates and procedures as those used in developing the annual costs of the Federal project being evaluated. For a more detailed discussion of the at-market power values used, see FERC letter dated 22 July 1982 contained in Appendix D, COORDINATION CORRESPONDENCE.

Capacity Benefits - The capacity component of the annual power benefit is the product of the above mentioned capacity value times the dependable capacity. The dependable capacity is that portion of the installed capacity which could reasonably be expected to be available for a substantial part of critical load periods, and is the product of the installed capacity times the hydrologic availability factor - (see 4.04, DEPENDABLE CAPACITY AND HYDROLOGIC AVAILABILITY).

Capacity Benefit = (Capacity Value) x (Installed Capacity x Hydrologic Availability)

or

Capacity Benefit = (Capacity Value) x (Dependable Capacity)

The dependable capacities for the alternative schemes are in all cases considerably less than the installed capacities. This is due to three resource characteristics; 1 - the wide variations in streamflow; 2 - Low flow periods coincide with critical load periods, and 3 - limited storage capability.

The resulting capacity benefits for the twenty-seven alternative developments are listed in Table No. 4-4. These benefits are basically the costs of constructing and owning the thermal alternative, a cycling coal-fired plant, in the system that would be eliminated or deferred if the hydroelectric project was implemented. As such the capacity benefits represent the value of the hydroelectric capacity in the system.

Energy Benefits - The energy component of the annual power benefits is the product of the energy value, mentioned above, times the average annual energy (kwh) output of the hydroelectric project. The annual generating potential is discussed in paragraph 4.03, ANNUAL GENERATION.

Energy Benefit = (Energy Value) x (Ave. Annual Generation)

The resulting energy benefits for the twenty-seven alternative developments are listed in Table No. 4-4. These energy benefits represent the variable costs of operating the cycling coal-fired plant, alternative. As such the energy benefits are the value of the hydroelectric generated energy in the system.

Total Annual Power Benefits - The total annual power benefit is the sum of the capacity and energy benefit components and is listed for the various alternative developments considered in Table No. 4-4.

TABLE NO. 4-4
LINCOLN SCHOOL PROJECT
ALTERNATIVE SCHEMES
ANNUAL POWER BENEFITS - MOST LIKELY ALT. METHOD

Act. Scheme	Dep/Inter Capacity (MW) 1/	Ave.Ann. Energy (Millon Kwh)	Annual Capacity Ben. ($)	Annual Energy Ben. ($)	Total Annual Benefit ($)
1 620' Pool	41	251	5,650,000	10,000,000	15,650,000
2 "	43	262	5,970,000	10,480,000	16,450,000
3 "	45	272	6,270,000	10,880,000	17,150,000
1A "	46	281	6,400,000	11,240,000	17,640,000
2A "	48	292	6,570,000	11,680,000	18,250,000
3A "	49	301	6,750,000	12,040,000	18,790,000
1B "	49	302	6,800,000	12,080,000	18,880,000
2B "	51	312	7,030,000	12,480,000	19,510,000
3B "	51	320	7,060,000	12,800,000	19,860,000
4 610' Pool	35	209	4,760,000	8,570,000	13,330,000
5 "	36	220	5,040,000	8,800,000	13,840,000
6 "	38	230	5,320,000	9,200,000	14,520,000
4A "	40	239	5,460,000	9,560,000	15,020,000
5A "	41	249	5,630,000	9,960,000	15,590,000
6A "	42	257	5,810,000	10,280,000	16,090,000
4B "	43	258	5,860,000	10,320,000	16,180,000
5B "	45	267	6,220,000	10,680,000	16,900,000
6B "	45	275	6,180,000	11,000,000	17,180,000
7 600' Pool	29	174	3,940,000	7,130,000	11,070,000
8 "	30	183	4,200,000	7,320,000	11,520,000
9 "	32	191	4,360,000	7,640,000	12,000,000
7A "	32	199	4,480,000	7,960,000	12,440,000
8A "	35	207	4,770,000	8,280,000	13,050,000
9A "	35	215	4,820,000	8,600,000	13,420,000
7B "	35	216	4,860,000	8,640,000	13,500,000
8B "	37	224	5,080,000	8,960,000	14,040,000
9B "	38	230	5,180,000	9,200,000	14,380,000

1/ Rounded to nearest MW.

c. Evaluation By "Displaced Energy" Method

Annual power benefits using the "Displaced Energy" method of analysis are computed based on at-market energy values within the system provided by the FERC for the range of energy generation potentials (kwh) of the hydroelectric developments being considered. As discussed in 4.06a. above, this energy value represents the variable operating costs, predominantly fuel costs, of existing and planned generating plants in the system which could be avoided by operating the proposed hydroelectric project. The FERC analysis of the market areas and the system generation mixes indicates that the chief value of Lincoln School hydroelectric generation would be as displacement of oil-fired generation in the New England Power Pool (NEPOOL). The value of the displaced generating costs is considered to be 115 mills per kwh and is applicable to all the alternative developments. This displaced energy value reflects projected inflation rates for fuel costs which are above the general inflation rates over the study period. For a more detailed discussion of the displaced energy value see FERC letter dated 22 July 1982 in Appendix D, COORDINATION CORRESPONDENCE.

The total annual power benefit based on the "Displaced Energy" methodology consists of an energy benefit only and is the product of the energy value times the average annual energy output (kwh) of the proposed hydroelectric project. Table No. 4-5 lists the annual power benefits for the twenty-seven alternative developments evaluated.

4.07 NET BENEFITS AND BENEFIT/COST RATIO

The net benefits and benefit to cost ratios for the various Lincoln School alternatives were determined using the annual costs and annual benefits data presented earlier in this section and are listed in Table No. 4-6 for both the "Most Likely Alternative" and "Displaced Energy" methods of analysis. The net benefit is the Total Annual Benefit minus the Total Annual Costs and the benefit to cost ratio is the Total Annual Benefit divided by the Total Annual Costs. An alternative must have a benefit to cost ratio of 1.0 or greater to be considered economically justified.

a. Most Likely Alternative Method

In all cases, the net benefits developed using this method of analysis are found to be negative and the benefit to cost ratios are accordingly less than unity. This finding indicates that the Lincoln School hydroelectric development is not economically justified when evaluated as an alternative to thermal expansion, i.e. cycling coal-fired generation, in the electrical utility system.

TABLE 4-5
LINCOLN SCHOOL PROJECT
ALTERNATIVE SCHEMES
ANNUAL POWER BENEFITS - DISPLACED ENERGY METHOD

Alt. Scheme	Ave. Annual Energy (Million Kwh)	Total Annual Benefits (Displaced Energy Value) ($)
1 620' Pool	251	28,870,000
2 "	262	30,130,000
3 "	272	31,280,000
1A "	281	32,315,000
2A "	292	33,580,000
3A "	301	34,615,000
1B "	302	34,740,000
2B "	312	35,880,000
3B "	320	36,800,000
4 610' Pool	209	24,040,000
5 "	220	25,300,000
6 "	230	26,450,000
4A "	239	27,485,000
5A "	249	28,635,000
6A "	257	29,555,000
4B "	258	29,670,000
5B "	267	30,705,000
6B "	275	31,625,000
7 600' Pool	174	20,010,000
8 "	183	21,050,000
9 "	191	21,970,000
7A "	199	22,885,000
8A "	207	23,805,000
9A "	215	24,725,000
7B "	216	24,840,000
8B "	224	25,760,000
9B "	230	26,450,000

TABLE NO 4-6
LINCOLN SCHOOL PROJECT
ALTERNATIVE SCHEMES
NET BENEFITS - BENEFIT/COST RATIOS

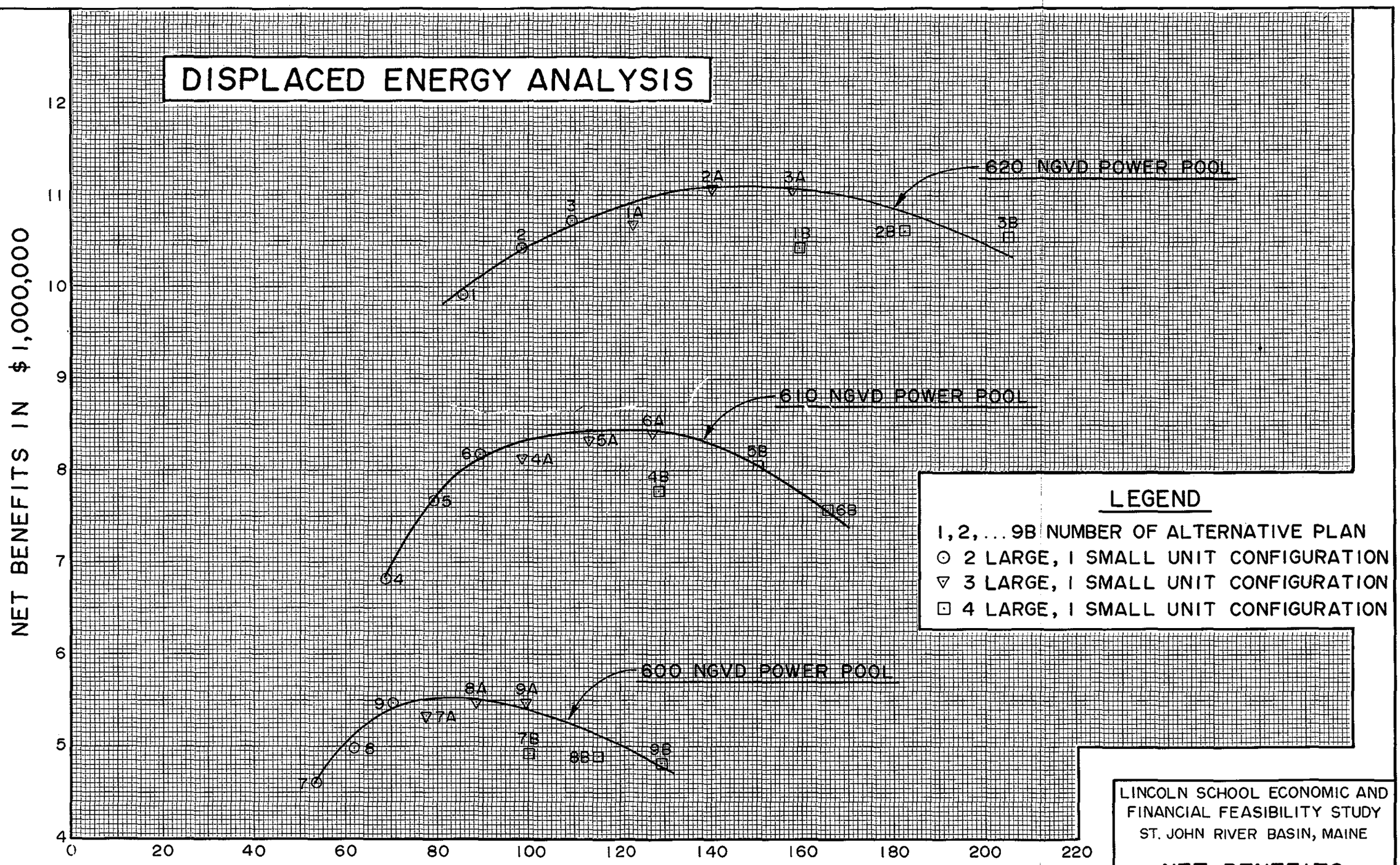
Alt. Scheme No.	Installed Capacity (MW)	Annual Costs ($)	Most Likely Alt. Method			Displaced Energy Method		
			Annual Benefits ($)	Net Annual Benefits ($)	Ben/ Cost	Annual Benefits ($)	Net Annual Benefits ($)	Ben/ Cost
1	85.26	18,963,000	15,650,000	-3,313,000	0.83	28,870,000	9,97,000	1.52
2	98.37	19,603,000	16,450,000	-3,153,000	0.84	30,130,000	10,527,000	1.54
3	110.87	20,547,000	17,150,000	-3,397,000	0.83	31,280,000	10,733,000	1.52
1A	122.13	21,627,000	17,640,000	-3,987,000	0.82	32,315,000	10,688,000	1.49
2A	140.01	22,497,000	18,250,000	-4,247,000	0.81	33,580,000	11,083,000	1.49
3A	157.79	23,550,000	18,790,000	-4,760,000	0.80	34,615,000	11,065,000	1.47
1B	149.04	24,300,000	18,880,000	-5,420,000	0.78	34,740,000	10,430,000	1.43
2B	181.95	25,270,000	19,510,000	-5,760,000	0.77	35,880,000	10,610,000	1.42
3B	204.70	26,240,000	19,860,000	-6,380,000	0.76	36,800,000	10,560,000	1.40
4	69.0	17,193,000	13,330,000	-3,863,000	0.78	24,040,000	6,847,000	1.40
5	79.35	17,633,000	13,840,000	-3,793,000	0.78	25,300,000	7,667,000	1.43
6	89.70	18,273,000	14,520,000	-3,753,000	0.79	26,450,000	8,177,000	1.45
4A	98.87	19,353,000	15,020,000	-4,333,000	0.78	27,485,000	8,132,000	1.42
5A	113.28	20,297,000	15,590,000	-4,707,000	0.77	28,635,000	8,338,000	1.41
6A	127.64	21,147,000	16,090,000	-5,057,000	0.76	29,555,000	8,408,000	1.40
4B	128.76	21,907,000	16,180,000	-5,727,000	0.74	29,670,000	7,763,000	1.35
5B	150.21	22,667,000	16,900,000	-5,767,000	0.75	30,705,000	8,038,000	1.35
6B	165.85	24,040,000	17,180,000	-6,860,000	0.71	31,625,000	7,585,000	1.32
7	53.19	15,403,000	11,070,000	-4,333,000	0.72	20,010,000	4,607,000	1.30
8	62.04	16,053,000	11,520,000	-4,533,000	0.72	21,050,000	4,997,000	1.31
9	70.13	16,483,000	12,000,000	-4,483,000	0.73	21,970,000	5,487,000	1.33
7A	77.28	17,563,000	12,440,000	-5,123,000	0.71	22,885,000	5,322,000	1.30
8A	88.57	18,313,000	13,050,000	-5,263.000	0.71	23,805,000	5,492,000	1.30
9A	99.80	19,257,000	13,420,000	-5,837,000	0.70	24,725,000	5,468,000	1.28
7B	100.65	19,917,000	13,500,000	-6,417,000	0.68	24,840,000	4,923,000	1.25
8B	115.10	20,867,000	14,040,000	-6,827,000	0.67	25,760,000	4,893,000	1.23
9B	129.48	21,627,000	14,380,000	-7,247,000	0.66	26,450,000	4,823,000	1.22

b. Displaced Energy Method

Unlike the "Most Likely Alternative" method, the net benefits developed using the "Displaced Energy" method of analysis were positive for all case studies and benefit to cost ratios are all greater than unity. These results indicate that Lincoln School hydroelectric development is economically viable as a source of electrical energy to intermittently displace the operation of existing high cost, oil-fired generating units in the NEPOOL system.

Curves for Net Annual Benefits vs. Installed Capacity are presented on Figure No. 4-1 for the three power pool levels considered. From these curves, it is apparent that an installed capacity of 150 MW with one small and three large unit configuration and a 620 ft. elevation power pool is the project development which maximizes the net annual benefits.

Curves showing the Benefit to Cost Ratio vs. Installed capacity are presented on Figure No. 4-2 for the three power pool levels considered. These curves show that a three unit configuration (one small and two large units) with an installed capacity of approximately 100 MW and a 620 ft. elevation power pool is the project development which exhibits the highest Benefit to Cost Ratio.



LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY
ST. JOHN RIVER BASIN, MAINE

NET BENEFITS VS. INSTALLED CAPACITY

NOVEMBER 1982

FIGURE 4-1

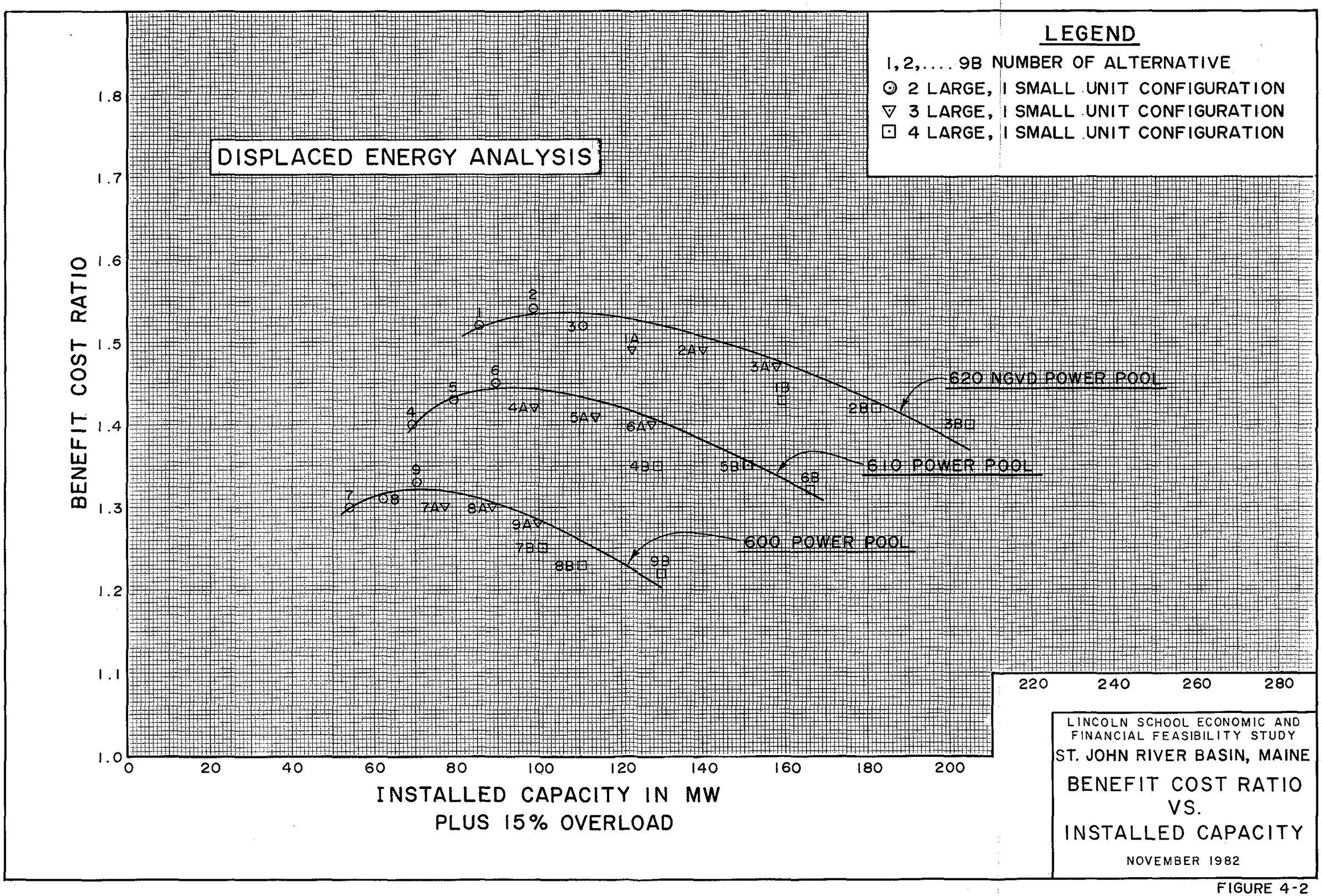

DISPLACED ENERGY ANALYSIS
LEGEND
1, 2, ... 9B NUMBER OF ALTERNATIVE
2 LARGE, 1 SMALL UNIT CONFIGURATION
3 LARGE, 1 SMALL UNIT CONFIGURATION
4 LARGE, 1 SMALL UNIT CONFIGURATION
620 NGVD POWER POOL
610 POWER POOL
600 POWER POOL
BENEFIT COST RATIO
INSTALLED CAPACITY IN MW
PLUS 15% OVERLOAD
LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY
ST. JOHN RIVER BASIN, MAINE
BENEFIT COST RATIO
VS.
INSTALLED CAPACITY
NOVEMBER 1982

FIGURE 4-2

SECTION 5 PLANS SELECTED FOR FURTHER STUDY

5.01 GENERAL

The Corps of Engineers' normal plan formulation policy is to assess the economic feasibility of each alternative development by means of the benefit-to-cost ratio. When more than one alternative has a positive benefit-to-cost ratio, the criteria for selection on the basis of economic efficiency, is the plan that maximizes net benefits. While this method attempts to insure the fullest utilization of the resource and the selection of the most economical alternative, it does not necessarily result in selecting a plan with the best financial advantage (competitive repayment rate) for projects with a vendible end product. Congressional direction for accomplishing this study effort placed emphasis on both the economic and financial feasibility of the project. Therefore, selection of a plan or plans for further study involves consideration of many factors in addition to net benefit maximization.

5.02 FACTORS CONSIDERED

Based on the Congressional directive, the following factors are considered in the plan selection process: benefit-to-cost ratio; net benefits; internal rate of return; operational characteristics and marketability.

a. Benefit-to-Cost Ratio's

Reference to Table No. 4-6 and Figure 4-2 indicates that, under the "Displaced Energy" method of analysis, all twenty-seven alternatives have benefit/cost ratios greater than unity. The range of benefit/cost ratios from 1.23 to 1.0 to 1.54 to 1.0 dictates that additional criteria be applied to aid in the selection process. The highest benefit/cost ratio is that of Alternative #2 (1.54 to 1.0). This alternative has three units, 98.37 MW installed capacity and utilizes the 620 ft. power pool.

b. Net Benefits

As mentioned earlier, when more than one plan under consideration has a positive benefit/cost ratio, the usual criteria for selection on the basis of economic efficiency is the plan that maximizes net benefits. Reference to Table 4-6 and Figure 4-1 shows a range of annual net benefits from $4,823,000 to $11,083,000. A development level approximately midway between Alternatives #2A and #3A with four units, an installed capacity of 150 MW and the 620 ft. power pool, maximizes net benefits.

c. Internal Rate of Return

In economic terms the rate of return represents the percentage or rate of interest earned on the unrecovered balance of an investment. For purposes of this study the rate of return is the rate of interest at which

benefits equal costs over the period of analysis (i.e., the benefit/cost ratio equals 1.0). The benefits and costs for the Lincoln School Project were estimated at the current water resources interest rate of 7 7/8 percent and a 100 year project life. Rates were estimated for the 9 plans which utilized the 620 ft. power pool. These 9 plans (1 through 3B) also displayed the largest amounts of net benefits of the 27 plans considered. The rates of return ranked by magnitude are:

Plan	Rate of Return (%)
2	16.1
3	16.
1	15.9
2A	15.7
1A	15.7
3A	15.5
1B	15.1
2B	15.
3B	14.2

d. Operating Characteristics

The Lincoln School project would be operated basically as a run-of-river plant with only limited daily and weekly load fitting by storage regulation. Within the range of hydraulic capacities which appear most beneficial, the project would operate to full capacity continuously, 24-hours a day, for only about 5-10 percent of the time or 18-36 days per year. This type of continuous operations would generally occur during the Spring snowmelt season. Due to inadequate natural streamflows there would be no generating capabilility for about 15 percent of the time or an average of 55 days per year, occurring generally during the winter months. Conversely to the above characteristics, the New England peak electrical demands occur during the winter and the period of least demand is in the Spring. Given these characteristic extremes and their non-conformance with power demand periods it is important to exercise caution in choosing the appropriate level of development.

e. Marketability of the Projects Power

Electrical power from a Federal power project must be sold or marketed at a rate sufficient to repay the entire Federal investment associated with the production and distribution of the power over a 50-year period with interest. As Lincoln School would be strictly for electrical power production, all project costs would have to be recovered by power revenues.

The higher range of installed capacities required to fully utilize or optimize the resources based on maximum net benefits would result in higher annual costs. As discussed in (d) above the higher increments of capacity would generally be used only during the high streamflow periods

or 5-10 percent of the time. Therefore, the incremental energy (Kwh) derived from the higher increments of installed capacity would be less than that derived from the lower ranges of installed capacity because the lower capacity increments would be operated for longer periods of time. The increase in annual costs for higher increments of installed capacity and the reduced energy derived per increment of added capacity results in increased rates (mills/Kwh) that must be charged to recover the Federal investment. These repayment rates necessary for the higher levels of development would penalize the marketability of the projects' power. This is particularly applicable when considered in conjunction with the non-dispatchable nature of the projects' power and the fact that approximately two-thirds of the annual energy would be available during low electrical demand periods when competitive rates would be low. In view of these marketing considerations, the selection of the level of development to be studied further should be conservative.

5.03 NATIONAL ECONOMIC DEVELOPMENT (NED) PLAN

Given the above considerations it seems prudent for this study to select a project development which is slightly less ambitious than that found to provide the maximum net benefits and slightly larger than that having the highest benefit-to-cost ratio. This approach will result in selecting a plan which is more favorable both economically and financially. A development plan between alternative #2A and 3A with four units and installed capacity of about 150 MW and a 620 ft. power pool would maximize net benefits. The highest benefit to cost ratio for the twenty-seven alternatives was that of alternative #2 with three units, 98.7 MW installed capacity and a 620 ft. power pool. Therefore, for this effort a project development consisting of a three-unit configuration (one small and two large units) of approximately 110 MW capacity and a power pool elevation of 620 feet NGVD was determined to best meet the objectives of National Economic Development (NED). This plan will provide 96 percent of the maximum net benefits at 22 million dollars less initial cost and is comparable to alternative scheme number three (3) addressed in the scoping studies. Should a decision be made to proceed with the project, the project development would be reformulated based on conditions prevailing at that time.

5.04 ALTERNATIVE PLANS RETAINED

An Executive Order was issued on 7 July 1982 by the Governor of Maine and a Resource Protection Plan was recently implemented by the State of Maine which address preservation and restricted utilization of upstream reaches of the St. John River. In view of these State of Maine initiatives, alternative project development plans with power pool elevations of 600 and 610 Feet NGVD are retained for further study and presentation. The plan with a 620 ft. elevation power pool would inundate a significant portion of Big Rapids, an upstream white water canoeing attraction. The 610 ft. pool would inundate riffles at the toe of these rapids and the 600 ft. pool option would not impact the rapids at all.

The development plan at the 610 ft. elevation power pool would consist of a three-unit configuration (one small and two large units) of approximately 90 MW capacity, comparable to alternative scheme number six (6) identified in the scoping studies.

The development plan at a 600 ft. elevation power pool would consist of a three-unit configuration (one small and two large units) of approximately 70 MW capacity, comparable to alternative scheme number nine (9) identified in the scoping studies.

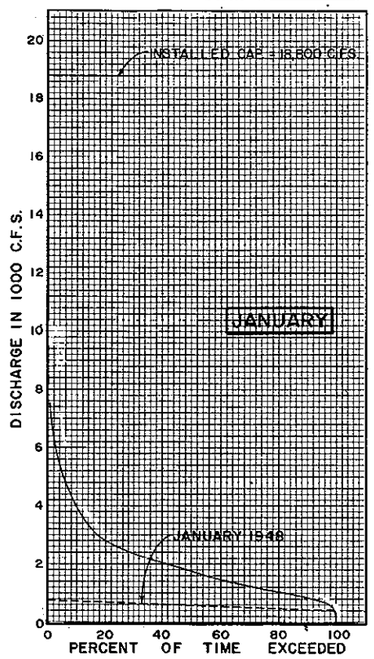
Both these alternative plans represent the same relative level of development as the NED plan except that they would have lower power pools and associated hydraulic heads.

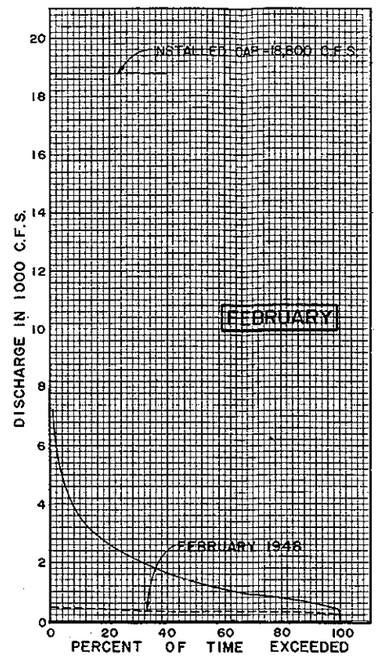
5.05 MONTHLY GENERATION

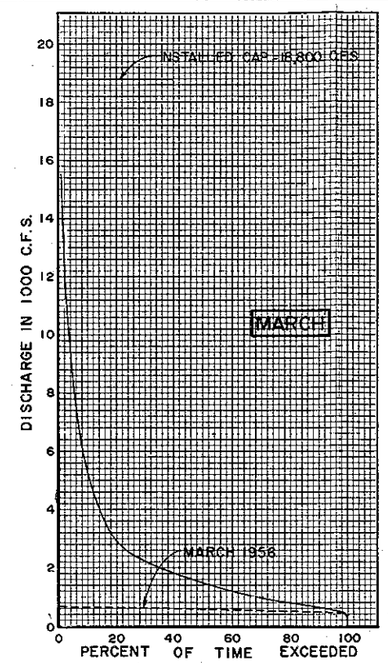
Average monthly generation at Lincoln School with an elevation 620 feet NGVD power pool and the adopted 3 unit, 110.9 MW installation, would vary from a maximum of 66,650 MWH in May to a minimum average of 5,590 MWH in February. Average monthly generation was computed from average monthly flow duration curves developed from 35 years of daily flow records. Resulting average monthly generation for the 620 power pool level as well as for the 600 and 610 power pool levels are listed in Table No. 5-1. Monthly flow duration curves at the site are shown on Figures No. 5-1 and 5-2.

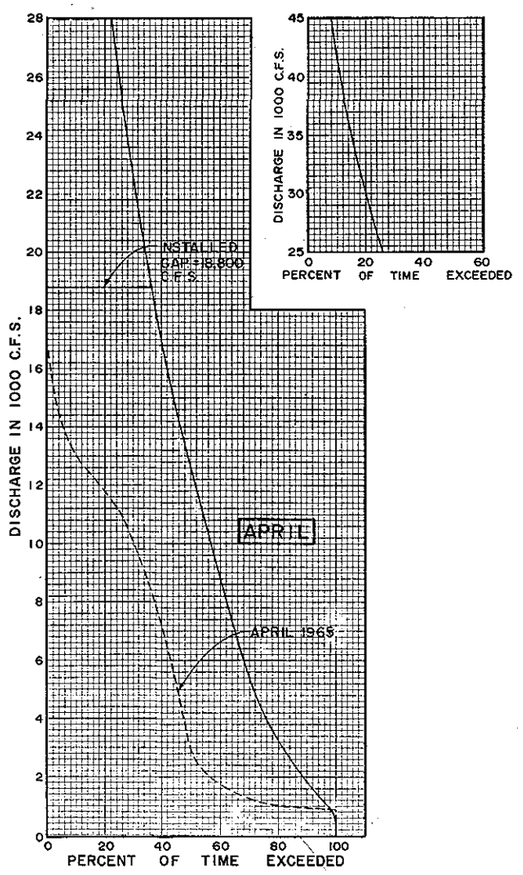
TABLE 5-1
LINCOLN SCHOOL
MONTHLY GENERATION
(MWH)

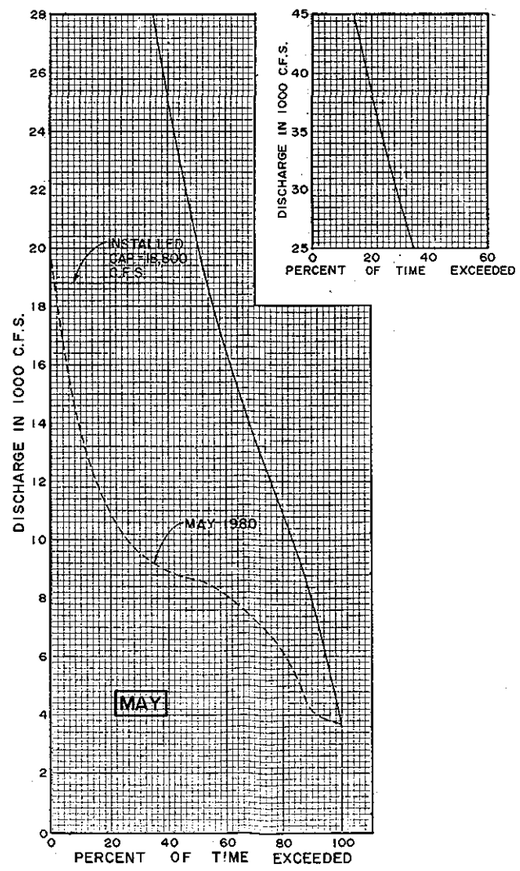
Month	Avg. Flow (cfs)	620 Ft. Plan Alt. 3 (MWH)	610 Ft. Plan Alt. 6 (MWH)	610 Ft. Plan Alt. 9 (MWH)
January	2,080	8,180	7,130	6,100
February	1,790	5,590	4,900	4,200
March	2,450	9,950	8,600	7,270
April	17,560	47,800	39,400	31,800
May	25,080	66,650	55,100	45,100
June	6,970	27,900	24,000	20,100
July	4,060	16,700	14,400	12,200
August	4,235	16,100	13,700	11,400
September	4,050	15,900	13,500	11,200
October	4,730	19,800	16,900	14,200
November	5,610	21,500	18,600	15,500
December	3,930	16,400	14,100	11,900
Annual	6,900	272,000	230,000	191,000

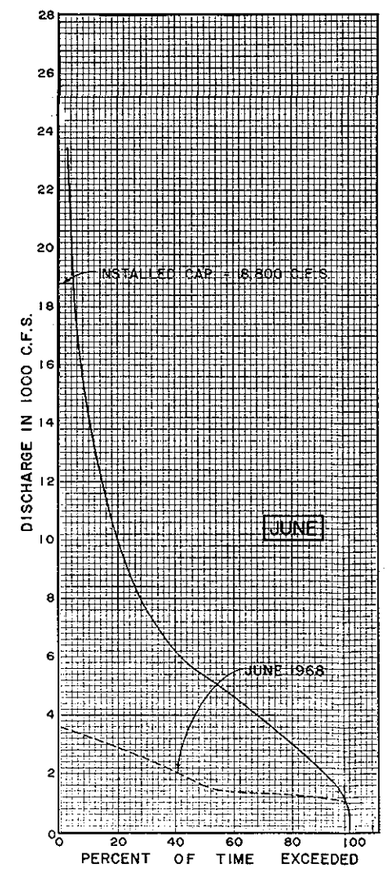












LONG TERM AVERAGE FLOW DURATION: ————

RECORD LOW FLOW DURATION: — — — —

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

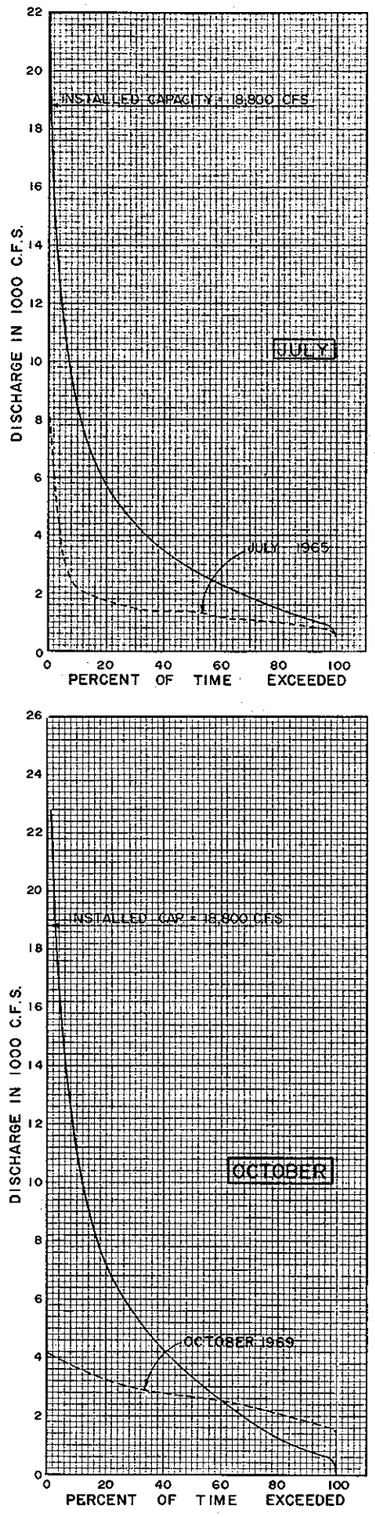
LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY

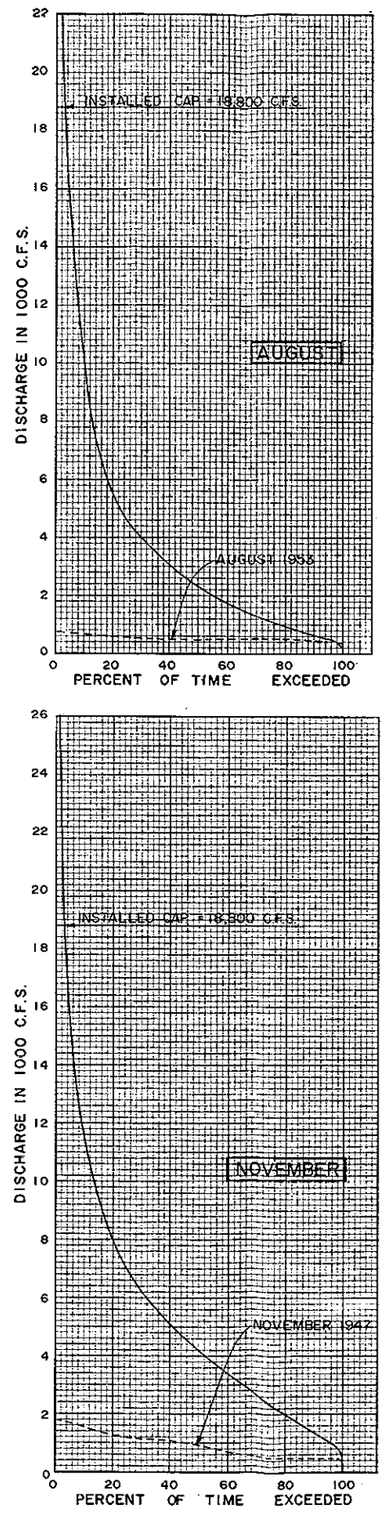
ST. JOHN RIVER BASIN, MAINE

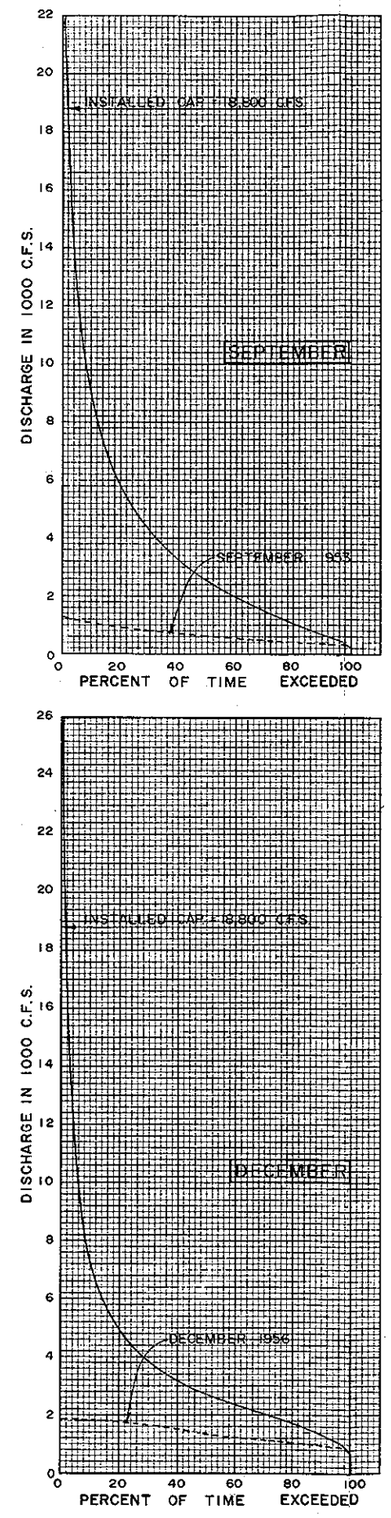
MONTHLY FLOW DURATION CURVES NO. 1

NOVEMBER 1982

FIGURE 5-1







LONG TERM AVERAGE FLOW DURATION: ————

RECORD LOW FLOW DURATION: — — — —

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY

ST. JOHN RIVER BASIN, MAINE

MONTHLY FLOW DURATION CURVES NO. 2

NOVEMBER 1982

FIGURE 5-2

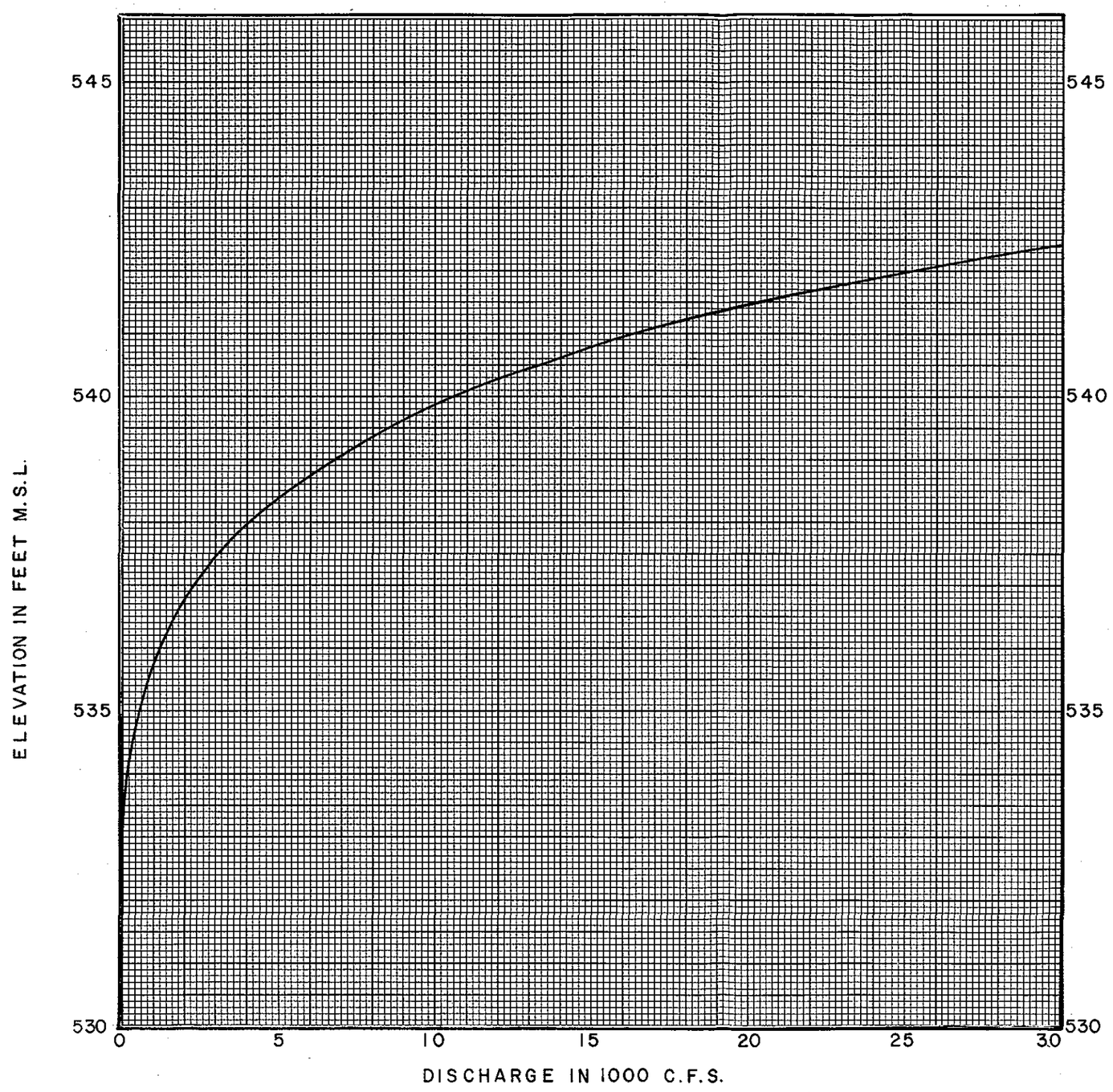
5.06 OPERATIONAL CHARACTERISTICS

It is expected that the Lincoln School project would be operated basically as a run-of-river plant with only limited daily and weekly load fitting by storage regulation. With the selected hydraulic capacity of about 18,800 cfs, the project would operate to capacity continuously 24 hours per day only about 10 percent of the time or about 36 days per year. This period of operation would occur generally during the high flow months of April and May. During such high flow operation the pool would remain full and there would be no fluctuation in pool level or downstream flows as a result of hydropower generation.

The project would not generate when natural streamflows are less than 1,000 cfs, and flows would be passed through the project with neither augmentation or deprivation by storage regulation. Natural streamflows of less than 1,000 cfs occur about 15 percent of the time or an average of about 55 days per year. The low flow period is generally during the winter months of January, February and early March. During no generation low flow periods, there would obviously be no fluctuation in pool levels or downstream flows due to hydropower generation. When the natural streamflows are less than 18,000 but greater than 1,000 cfs, there might be some storage regulation for limited daily and weekly load fitting operations.

The overall optimum mode of operation is not presently known and would be subject to change with changing load and marketing conditions. In New England the electrical demand during the daytime peak load hours is typically in the order of 50 percent greater than base load demand. Therefore, if the Lincoln School loading was patterned after the New England load: i.e. meeting a certain percentage of total load, then generating flows might fluctuate by about 50 percent. For example, if the average streamflow was 15,000 cfs, generating flows might range from about 12,000 to 18,000 cfs. With such an operation, the pool level might fluctuate generally from 1 to 2 feet per day and 3 to 4 feet per week. Downstream tailwater levels with such an operation would be expected to fluctuate in the order of 1 to 2 feet. A tailwater rating curve for the Lincoln School project is shown on Figure No. 5-3.

It is not expected, or would it likely be environmentally acceptable except under emergency conditions, that the project loading would be rapidly fluctuated from near zero to maximum capacity. However, under such a peaking operation the pool level would fluctuate at a maximum rate of about 1/2-foot per hour and downstream tailwater levels would fluctuate about five feet.



LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY

ST. JOHN RIVER BASIN, MAINE
LINCOLN SCHOOL DAM
TAILWATER RATING CURVE
NOVEMBER 1982

FIGURE 5-3

SECTION 6.
DESCRIPTION OF MAJOR CONSTRUCTION FEATURES

6.01 GENERAL

The Lincoln School Dam would include an earthfill embankment structure across the St. John River, a gated spillway in the north (left) abutment and a hydroelectric power plant in the south (right) abutment (See Plate No. 4).

6.02 EMBANKMENT

The embankment would consist of a rolled earth and rockfill embankment constructed across the St. John River. The crest width would be 30 feet with an 18-foot wide bituminous surfacing to serve as a maintenance access road. The top elevation of the dam would be 630 feet NGVD, 10 feet above the maximum power pool, providing 5 feet of spillway surcharge and 5 feet of freeboard. The embankment would be approximately 534 feet long with a maximum height above streambed of 90 feet and consist of a central impervious core section flanked by relatively pervious zones. The impervious section would be extended down to impervious strata. A downstream rock toe and relief wells would provide for control of underseepage. Rock slope protection would be placed on the upper portion of the dam's upstream face. The lower portion would be protected by processed gravel and cobbles extending to a rockfill cofferdam. Processed gravel and cobbles would also be placed on the downstream face ending at a rockfill berm (See Plate No. 7).

6.03 SPILLWAY

The spillway would consist of eight 60-foot wide by 50-foot high tainter gates on a concrete overflow weir. The crest elevation of the weir would be elevation 570 ft. NGVD. Intermediate and end piers forming the gate bays would be 9 feet thick and would carry a bridge deck for the maintenance access road at elevation 630 ft. NGVD (See Plate No. 6.) Concrete retaining walls would be constructed at each end of the spillway structure abutting the earth embankment section and the north (left) river bank.

6.04 POWER PLANT

The powerhouse would be concrete measuring approximately 292 ft. long by 173 ft. wide and arranged to house two 47.87 MW and one 17.40 MW Kaplan generating units (See Plate No. 8). The small unit would be capable of providing reasonably high efficiency generation during periods of lower river flows. The two larger units would provide high capacity plus operating flexibility, reliability and maintenance practicality. The powerhouse would have three operating bays and one erection bay and would be equipped with a bridge crane, intake gantry crane and a tailrace gantry crane. The generated power would be stepped-up by 13.8kv - 69 kv power

transformers located on the tailrace deck and transmitted underground to the substation located on the south (right) bank of the river.

Auxiliary electrical and mechanical equipment would be located in galleries below the tailrace deck. Each turbine would have suitable governing equipment actuating the Kaplan runner and each unit would have an adjacent control board located on the generator floor for local control of generator and auxiliaries.

Floors below the erection floor in the erection bay at one end of the powerhouse would accommodate the main control room, offices and facilities for plant operating personnel, maintenance shop and tool room, and oil storage facilities and equipment. An elevator operating between all floors would permit handling of heavy equipment.

6.05 DIVERSION AND CONSTRUCTION SEQUENCE

The construction sequence for the major project features are interrelated and substantially influenced by diversion requirements of the St. John River during the construction period. It is estimated that construction of the project will take five years to accomplish. The construction season for many work efforts will be limited to six months (mid-May through mid-November) due to the severe winter conditions in this northern most area of Maine and the ice flows and high river flows associated with the spring snowmelt runoff period. The hydrologic considerations relative to the construction procedure and diversion plan were previously discussed in paragraph 3.03 and in Appendix B hereof.

The sequence of construction and real estate activities as currently envisioned are as follows:

1st Year -
- .Construct a cofferdam along the north (left) river bank to isolate construction areas for the spillway and spillway approach and discharge channels from the riverway.
- .Initiate road relocations
- .Initiate excavation of spillway channels
- .Initiate construction of spillway structure
- .Initiate land acquisition

2nd Year -
- .Complete excavation of spillway channels
- .Complete spillway structure excluding gates and weir crests
- .Continue land acquisition
- .Initiate relocation of residences

3rd Year -

- Remove cofferdams for spillway channels permitting river flows through spillway structure
- Construct upstream and downstream cofferdams from spillway structure to the south (right) river bank to isolate construction areas for the embankment, powerhouse and powerhouse approach and discharge channels from the riverway.
- Excavate for the powerhouse and power channels
- Initiate construction of powerhouse and embankment
- Initiate cemetery relocations
- Continue relocation of residences
- Complete land acquisition
- Complete road relocations

4th Year -

- Initiate reservoir clearing
- Continue powerhouse construction
- Complete embankment construction
- Complete cemetery relocations
- Complete relocation of residences

5th Year -

- Remove upstream and downstream cofferdams
- Construct spillway weir crests and install spillway gates, one gate bay at a time
- Complete powerhouse
- Complete reservoir clearing
- Fill reservoir
- Power on line

6.06 TRANSMISSION FACILITIES

a. General

The substation and transmission facilities would be constructed by the Department of Energy (DOE) under its statutory responsibility for the transmission of power from Federal projects. The Bonneville Power Administration (BPA) of DOE furnished the preliminary information on the substation and transmission requirements for this study effort. Two transmission line routes and points of interconnection were considered to intergrate the project power into the regional system. These consisted of a line from Lincoln School to the Flo's Inn substation near Presque Isle, Maine, a distance of 60 miles; and to the substation at Edmundston, New Brunswick, Canada, a distance of 40 miles. For this study, the interconnection at Edmundston, N.B. was selected due to the shorter distance and lower cost.

b. Substations

The substation located on the right bank downstream of the powerhouse would include transformation rated at 120 mva, 69 kv/138 kv. Underground cables from the generators in the powerhouse would feed into the substation at 69 kv. The substation would also include the necessary structures and switching for the 69 kv line interconnection to Fort Kent and the 138 kv line interconnection to Edmundston.

c. Transmission

Transmission facilities to intergrate the project power into the existing grid system would consist of a 69 kv line to the Fish River substation at Fort Kent and a 138 kv line to the Edmundston, N.B. substation. The Lincoln School - Fort Kent line would be of wood pole construction 18 miles long. The Lincoln School - Edmundston line would be of wood H-frame construction 40 miles long.

6.07 ALTERNATIVE PLANS RETAINED

The alternative plans being retained for further evaluation have the same general arrangement of construction features as the NED plan. The top elevations of water control structures and reservoir levels, however, would be 10 and 20 feet lower for the 610 ft. pool and 600 ft. pool plans, respectively. For details on the plan with a 610 ft. power pool see Plates No. 11 thru 15 and Plates No. 18 thru 22 for the plan with a 600-foot power pool.

SECTION 7
REAL ESTATE REQUIREMENTS

7.01 GENERAL

The guide acquisition line for hydroelectric development of the Lincoln School project would be based on the maximum power pool elevation of 620 ft. NGVD plus five (5) feet or to elevation 625 ft. NGVD. Accordingly, the guide acquisition line for the alternative plans would be to elevations 615 ft. NGVD and 605 ft. NGVD.

7.02 NED PLAN

The NED plan with a maximum power pool elevation of 620 ft. NGVD requires acquisition in fee of approximately 4,400 acres. Much of the area required for the project consists of existing riverways accounting for approximately 1530 acres. The remaining acreage is made up of approximately 1835 acres of improved parcels and approximately 1035 acres of commercial timberlands.

The project would require the acquisition of approximately 90 residential parcels in the Town of Allagash and 50 residential parcels in the Town of St. Francis. Re-establishment of these residences would be a project requirement. Other improved parcels to be acquired would include 16 commercial units, two churches and one bible camp.

The cost summary of Real Estate is estimated as follows:

Cost Summary

Land and Improvements	$6,549,000
Contingencies 20%	1,310,000
Total Cost of Lands & Improvements	$7,859,000
Project Boundary Marking	192,000
Acquisition Costs	1,132,000
Relocation Assistance Costs	2,875,000
Total Estimated Real Estate Costs	$12,058,000
Rounded to	$12,000,000

7.03 ALTERNATIVE PLANS RETAINED

The alternative plans with maximum power pool elevations of 610 and 600 ft. NGVD would require acquisition in fee of approximately 2980 acres and 2330 acres, respectively.

The following tabulation indicates the breakdown of areas to be acquired, improved properties involved and total estimated real estate costs of the alternative plans:

	Alternative Plan 610 Ft. Pool	Alternative Plan 600 Ft. Pool
Riverways	1450 Acres	1400 Acres
Improved Parcels	1155 "	630 "
Commercial Timberlands	375 "	300 "
Total Area Required	2980 Acres	2330 Acres
Residential Parcels (Improved)		
Allagash	37	16
St. Francis	45	44
Commercial Parcels (Improved)	14	9
Other Improved Parcels	0	0
Total Estimated Real Estate Costs	$7,700,000	$4,900,000

Section 8
RELOCATION REQUIREMENTS

8.01 HIGHWAYS AND ROADS

State Highway Route No. 161 is the only public highway providing access to the project area and points west. In general, Route 161 approaches the area from the east and proceeds upstream along the south (right) bank of the St. John River in the reach between the Lincoln School damsite and the confluence with the Allagash River.

A state-owned highway bridge crossing the Allagash River constitutes the westerly terminus of Route 161 and links the state road with town-owned roads providing access to points further upstream along both the Allagash and St. John Rivers.

A second state-owned highway bridge carriers Route 161 over Pelletier Brook in the project area.

Approximately 11 miles of state highway Route No. 161 are located in or adjacent to the project area, extending from a point just downstream of the Lincoln School damsite upstream to the state highway terminus at the Allagash River bridge. About 5 miles of the state highway are below the guide acquisition elevation of 625 ft. NGVD based on a maximum power pool development of 620 ft. elevation and would require relocation. New bridges would also be provided to carry Route 161 over the Pelletier Brook and to provide a crossing of the Allagash River. The total length of highway required to replace the 5 miles of existing highway would be 10 miles. The increased length is due primarily to the additional length of highway to relocate the Allagash River crossing and reconstruction of existing highway sections to provide proper transition and continuity of design.

About 3 miles of state-aid and town-owned roads maintained by the Town of Allagash which are located upstream of the Route No. 161 terminus would require relocation. Two state-owned bridges which carry state-aid roads over the St. John River (Dickey Bridge) and the Little Black River would be replaced to maintain access to areas north of the project.

Highway and road relocations required for the NED plan with a 620 ft. elevation NGVD powerpool are shown on Plate No. 3.

8.02 UTILITIES

a. Electric lines owned by Maine Public Service Company supplies electric power of rural type construction, 7,200v, single phase 2-#6CW on wooden poles used jointly with the telephone company. The pole line is located along state Route No. 161 and along town and state-aid roads in the project area. About 5 miles of poleline located along the affected sections of Route 161 and 3 miles of town and state-aid roads would

require relocation. The alignment of the relocated polelines would in general follow that of the relocated highway and roads and would accordingly have a length of about 11 miles.

b. The Continental Telephone Company of Maine provides telephone service to the project area over cables on wooden poles used jointly with the electric company. Consequently, the length of telephone lines involved and their location would be the same as described for the electric lines.

8.03 CEMETERIES

Preliminary investigations indicate that four existing cemeteries could be affected by the NED plan. Locations of these cemeteries are shown on Plate No. 3. The Town, Baptist and Catholic cemeteries would be relocated and clustered into a cemetery complex. The concept of clustering these three cemeteries into a relocated cemetery complex has previously been approved, in connection with earlier study efforts on the Dickey-Lincoln School concept. Information on the cemeteries is as follows:

Allagash Town Cemetery - The Allagash Town Cemetery is under the jurisdiction of the Town of Allagash. The cemetery is located on the northerly side of a state-aid road, about 0.3 mile northwesterly of the Allagash River bridge. The cemetery property has an area of about 40,900 square feet and contains at least 117 graves. The earliest known burial date is 1846.

St. Paul's Catholic Cemetery - St. Paul's Catholic Cemetery is under the jurisdiction of the Pastor of St. Charles Catholic Church, which is located in the Town of St. Francis. The cemetery is on the northerly side of the same state-aid road as the Allagash Town Cemetery, and is located about 1.3 miles downstream of the bridge over the St. John River in the village of Dickey. The cemetery property has an area of about 16,560 square ft. and contains at least 81 graves. The earliest known burial date is 1930.

Baptist Cemetery - The Baptist Cemetery is under the jurisdiction of the Pastor of the First Baptist Church in the village of Dickey. The cemetery is located in the village of Dickey, on the southerly side of the same state-aid road as the Catholic and town cemeteries, and about 0.3 mile downstream of the bridge over the St. John River at Dickey. The cemetery property has an area of about 9,108 square ft. and contains at least 73 graves. The earliest known burial date is 1932.

Gardner Cemetery - Gardner Cemetery is a small family burial ground located on the left bank of the St. John River, approximately opposite the mouth of the Allagash River. The burial ground contains about 5 graves and has an area of about 4,674 square ft. Earlier investigations indicated that the Gardner family heirs may elect not to have this burial

ground relocated. However, should the family elect to relocate this cemetery, it would be relocated to the cemetery complex mentioned above.

8.04 ALTERNATIVE PLANS RETAINED

The alternative plans with maximum power pool elevations of 610 and 600 ft. NGVD would have relocation requirement similar to the selected plan, except to a lesser extent.

The following tabulation indicates the various relocation requirements for the alternative plans:

	Alternative Plan 610 Ft. Pool	Alternative Plan 600 Ft. Pool
Highway161	10 miles to replace 5 miles	8 miles to replace 4.5 miles
State-aid & Town Rds	1.5 miles	0
Bridge Replacement	Allagash River Bridge Pelletier Brook Bridge Dickey Bridge	Pelletier Brook Bridge
Utilities (Elect.&Tel)	Same as Hwy & Rds	Same as Hwy & Rds
Cemeteries	Baptist Town Gardner	None

Proposed Highway and cemetery relocations for alternative plans are shown on Plate Nos. 10 and 17.

SECTION 9
ECONOMIC ANALYSIS

9.01 GENERAL

This section addresses the economic feasibility of the Lincoln School project at the appropriate scales of development determined in Sections 5 and 6 and described in preceding sections. To accomplish this, the project costs and benefits for the NED and two alternative plans of development are presented. The analytical procedures are similar to those used in evaluating the alternatives to scope the project. The data however is more specific for this level of study.

9.02 PROJECT COSTS

a. First Costs - The following cost estimates represent the cost for the NED plan of development along with costs for the alternative plans with 610 ft. and 600 ft. pool developments.

Cost estimates for the dams and appurtenant facilities were prepared by the Corps of Engineers. The power plant costs were developed by the North Pacific Division and all other costs were prepared by the New England Division. The cost of transmission facilities was estimated by the Department of Energy (DOE), Bonneville Power Administration (BPA). A summary of costs by major features of work is presented in Table No. 9-1.

Dams and Appurtenances - The estimated first cost for the dams and appurtenant facilities, including required real estate acquisition is $183 million for the NED plan and $164 million and $146 million for the alernative 610 ft. and 600 ft. pool developments respectively. Unit prices used in estimating the construction costs are based on October 1982 price levels. The unit prices include all labor, equipment and materials required for project construction including contractors' overhead and profit. A contingency allowance of 15 percent has been added to all construction costs. A detailed breakdown of estimated first costs are included in Appendix C.

An item has been included for cultural resources preservation to reflect the cost for excavation and associated research activities for prehistoric and historic site identified within the respective impoundments.

Valuations of real estate are based on gross appraisals reflecting October 1982 conditions and include all costs for resettlement and acquisition as required by P.L. 91-646.

Costs associated with mitigation of fish and wildlife losses resulting from project implementation are not identified or included. However, mitigation requirements are addressed in Section 11.

TABLE NO. 9-1

LINCOLN SCHOOL HYDRO PROJECT
SUMMARY OF COSTS

Acct. No.	Feature	NED Plan 620 Ft. Pool	Alternative Plan 610 Ft. Pool	Alternative Plan 600 Ft. Pool
02.	Relocations	$14,910,000	$10,440,000	$6,110,000
03.	Reservoir	2,790,000	1,900,000	940,000
04.	Dam & Spillway	60,480,000	56,420,000	52,180,000
07.	Power Facilities	69,150,000	65,590,000	62,200,000
08.	Roads & Bridges	320,000	320,000	320,000
18.	Cultural Resources	210,000	100,000	100,000
19.	Bldg., Grounds & Utilities	640,000	640,000	640,000
20.	Perm. Oper. Equip.	260,000	260,000	260,000
	Sub-Total/Dir. Constr. Cost	$148,760,000	$135,670,000	$122,750,000
01.	Lands & Damages	12,000,000	7,700,000	4,900,000
30.	E&D (8% ± DCC)	11,850,000	11,000,000	9,800,000
31.	S&A (7% ± DCC)	10,390,000	9,630,000	8,550,000
	Total First Cost (COE)	$183,000,000	$164,000,000	$146,000,000
	Total First Cost (DOE) Transmission	12,700,000	9,200,000	9,200,000
	TOTAL PROJECT COST	$195,700,000	$173,200,000	$155,200,000

Note:
October 1982 Price Levels

Transmission Facilities - The estimated first cost for transmission facilities, including all lines and supporting electrical equipment and systems is $12.7 million for the NED plan and $9.2 million for each of the alternative plans. A listing of transmission components and respective estimated costs, based on October 1982 price levels is included in Appendix C.

b. Annual Costs

Dams and Appurtenances - Average annual costs reflect all direct annual economic costs that would be incurred through the construction and future operation and maintenance of the project. Estimated annual costs include: interest and amortization of the total project investment, including interest during construction; annual operation and maintenance costs; and the annual equivalent for periodic replacement of major operating equipment having an estimated life less than the project life. The derivation of the annual costs for operation and maintenance is included in Appendix E. Annual costs for major replacements are based on a factor of .0125 times the power plant cost as presented in the Corps of Engineers Hydropower Cost Estimating Manual, revision date July 1981.

The analysis is based on: a 5-year construction period; the prevailing (FY 1983) water resources interest rate of 7-7/8 percent; and a project economic life of 100 years.

Transmission Facilities - The average annual costs for transmission facilities have been computed by the DOE and include the annual interest and amortization on the initial investment, including interest during construction; and all operation and maintenance expenses. In their analysis, DOE used the prevailing 7-7/8 percent interest rate; 38-years project life for transmission lines; and 28 years life for substations.

Table No. 9-2 summarizes the annual costs of the dams and appurtenances and transmission facilities for the NED plan and the two alternative plans.

9.03 PROJECT BENEFITS

a. Power Benefits

Power would be the principal benefit realized through implementation of the Lincoln School project. On-site annual power generation of 272 million kilowatt-hours (kwh) would result from the installed capacity of 110,870 kilowatts (kw). The annual power generation and installed capacities for the alternative plans are 230 million kwh and 89,700 kw for the 610 ft. pool elevation plan and 191 million kwh and 70,130 kw for the 600-ft pool elevation plan. The facility on an annual basis would generate intermediate range power with average annual plant factors of 28.0%; 29.3% and 31.1% for the NED plan and the alternative plans, respectively.

TABLE NO. 9-2

LINCOLN SCHOOL HYDROELECTRIC PROJECT
ANNUAL COSTS

(Oct 82 Price Level, 7-7/8% Interest Rate/100-Year Life)

Dam & Appurtenances	NED Plan 110.87 MW 620 Ft. Pool	Alternative Plan 89.70 MW 610 Ft. Pool	Alternative Plan 70.13 MW 600 Ft. Pool
Investment			
Construction Costs	$183,000,000	$164,000,000	$146,000,000
Int. During Constr. (5 yrs)	41,700,000	37,400,000	33,300,000
Total Investment	$224,700,000	$201,400,000	$179,300,000
Capital Recovery Factor	.07879	.07879	.07879
Annual Costs			
Interest & Amortization	$17,700,000	$15,870,000	$14,130,000
Operation & Maintenance	560,000	560,000	560,000
Major Replacements	860,000	820,000	770,000
Total Annual Costs	$19,120,000	$17,250,000	$15,460,000
Transmission Facilities			
Investment			
Construction Costs	$12,700,000	$9,200,000	$9,200,000
Int, During Constr.	2,300,000	1,600,000	1,600,000
Total Investment	$15,000,000	$10,800,000	$10,800,000
Annual Costs			
Interest & Amortization	$1,260,000	$905,000	$905,000
Operation & Maintenance	190,000	115,000	115,000
Total Annual Costs	$1,450,000	$1,020,000	$1,020,000
Total Project Cost			
Total Investment Costs	$239,700,000	$212,200,000	$190,100,000
Total Annual Costs	20,570,000	18,270,000	16,480,000

The power benefits for the project have been computed using two methodologies. These methodologies are "The Most Likely Thermal Alternative" method and the "Displaced Energy" method and are discussed in detail in SECTION 4 - HYDROPOWER SCOPING. Power values for the capacity and energy components of the power benefits are furnished by FERC based on the two methodologies. A Cycling coal-fired plant would be the thermal alternative and existing oil-generated energy in NEPOOL was considered to be the type of energy that would be displaced. The power values furnished by FERC for this analysis differ from those used in the HYDROPOWER SCOPING - SECTION 4 evaluation due to further refinement by FERC based on the selected and optional plans and on a more current survey of fuel costs. (See FERC letter dated 3 Nov. 1982 in Appendix D.)

Computations of annual power benefits are shown on Table 9-3. It is noted that a computation using the Displaced Energy method without reflecting projected fuel cost increases is also presented. This permits determination of the extent to which the project power benefits are sensitive to or dependent on projected fuel cost increases.

b. Employment Benefits

The Lincoln School Project is located on the upper Saint John River, approximately 17 miles upstream of the town of Fort Kent, in Aroostook County, Maine. Aroostook County is an area eligible for National Economic Development (NED) benefits from the employment of previously unemployed labor resources based on its designation as an area of "substantial and persistent unemployment." This designation, determined by the Bureau of Labor Statistics, fulfills the eligibility criterion for evaluating employment benefits based on Water Resources Council Standards.

For this study, it was considered appropriate to base the employment benefits for Lincoln School on the extensive work previously performed for this benefit category for the larger Dickey-Lincoln School Lakes Project. The relationships between direct construction cost, total wages and total local wages were derived and applied to the Lincoln School direct construction cost. A capital recovery factor for the 7-7/8 percent interest rate and 100-year project life was applied to place the benefits on a uniform annual basis.

EMPLOYMENT BENEFITS
LINCOLN SCHOOL PROJECT

	NED Plan 620 Ft. Pool	Alternative Plan 610 Ft. Pool	Alternative Plan 600 Ft. Pool
Employment Benefit	$1,000,000	$910,000	$820,000

TABLE NO. 9-3
LINCOLN SCHOOL HYDROELECTRIC PROJECT
ANNUAL POWER BENEFITS

	NED Plan 110.87 MW 620 Ft. Pool	Alternative Plan 89.7 MW 610 Ft. Pool	Alternative Plan 70.13 MW 600 Ft. Pool
DISPLACED ENERGY METHOD			
Energy Benefits			
272 x 10^6 KWH x $0.150/KWH	$40,800,000	-	-
230 x 10^6 KWH x $0.150/KWH	-	$34,500,000	-
191 x 10^6 KWH x $0.149/KWH	-	-	$28,460,000
Total Annual Power Benefits	$40,800,000	$34,500,000	$28,460,000
DISPLACED ENERGY METHOD (w/o Projected Fuel Cost Increases)			
Energy Benefits			
272 x 10^6 KWH x $0.059/KWH	$16,050,000	-	-
230 x 10^6 KWH x $0.059/KWH	-	$13,570,000	-
191 x 10^6 KWH x $0.059/KWH	-	-	$11,270,000
Total Annual Benefits	$16,050,000	$13,570,000	$11,270,000
MOST LIKELY ALTERNATIVE METHOD			
Capacity Benefits			
110,870 KW x .41 1/ x $136.00/KW	$6,180,000	-	-
89,700 KW x .43 x 136.00/KW	-	$5,250,000	-
70,130 KW x .45 x 136.00/KW	-	-	$4,290,000
Energy Benefits			
272 x 10^6 KWH x $0.021/KWH	$5,710,000	-	-
230 x 10^6 KWH x 0.023/KWH	-	$5,290,000	-
191 x 10^6 KWH x 0.026/KWH	-	-	$4,970,000
Total Annual Power Benefits	$11,890,000	$10,540,000	$9,260,000

1/ Hydrologic Availability Factor.

9.04 ECONOMIC FEASIBILITY

a. A summary of annual costs, annual benefits and resulting benefit-to-cost ratios for the NED and two alternative plans is presented in Table No. 9-4. This data is prepared to include results developed by the "Displaced Energy" method of evaluating power benefits both with and without projected fuel cost increases and by the "Most Likely Alternative method of evaluating power benefits.

Power is overwhelmingly the major benefit attributable to the plans evaluated, approximately 98 percent, and is subject to significant variation in value depending on evaluation procedures used. Annual costs and employment benefits on the other hand remain constant for each of the three development plans addressed. For these reasons the following discussions pertaining to economic feasibility deal only with the power aspects of the project.

b. Using the "Most Likely Alternative" method of evaluating power benefits, all three development plans considered are found to be uneconomical with benefit-to-cost ratios less than unity. This is due to several factors. The least costly thermal alternative which would produce power of a type and magnitude similar to the project was identified by FERC to be a cycling coal-fired plant. This alternative has a relatively high capacity value or investment cost and a low energy value or operating cost. These component costs of the alternative are used with the hydroelectric projects capacity and energy characteristics to measure the value or power benefits of the hydroelectric project. Due to the erratic stream flows of the St. John River, the full generating capability or capacity of the Lincoln School plans would not be available much of the time. Therefore, the project's generating capacity, which can qualify for capacity benefits is significantly reduced to reflect the lack of dependability based on hydrologic availability. The reduced capacity benefits plus the low energy benefits, based on the low operating costs of the thermal alternative, result in total power benefits less than the annual cost of the hydroelectric project. This analysis demonstrate that a Lincoln School hydroelectric development is not economically feasible as an addition to the electrical utility system to meet load demands in lieu of other alternative forms of generation expansion, namely cycling coal-fired generators.

c. Using the "Displaced-Energy" method of evaluating power benefits, all three development plans considered are found to be economically feasible with benefit-to-cost ratios greater than unity. The results of this analysis in conjunction with the uneconomic finding of the "Most Likely Alternative" method of analysis, clearly demonstrates that the highest value and best use of Lincoln School hydroelectric development in the regional electric system is to displace the high operating costs of existing oil-fired generating facilities. When the St. John River flows permit, the Lincoln School project would produce electricity for integration into the system and exisiting oil-fired generation units in the system which are more costly to operate would be shutdown.

TABLE NO. 9-4
LINCOLN SCHOOL HYDROELECTRIC PROJECT
ECONOMIC FEASIBILITY
BENEFIT/COST RATIO

	NED PLAN 110.87 MW 620 Ft. Pool	ALTERNATIVE PLAN 89.70 MW 610 Ft. Pool	ALTERNATIVE PLAN 70.13 MW 600 Ft. Pool
DISPLACED ENERGY METHOD			
Annual Benefits			
Power Benefits	$40,800,000	$34,500,000	$28,460,000
Employment Benefits	1,000,000	910,000	820,000
Total Annual Benefits	$41,800,000	$35,410,000	$29,280,000
Annual Costs	$20,570,000	$18,270,000	$16,480,000
Benefit Cost Ratio	2.0 to 1.0 (2.03)	1.9 to 1.0 (1.94)	1.8 to 1.0 (1.78))
DISPLACED ENERGY METHOD (w/o Projected Fuel Cost Increases)			
Annual Benefits			
Power Benefits	$16,050,000	$13,570,000	$11,270,000
Employment Benefits	1,000,000	910,000	820,000
Total Annual Benefits	$17,050,000	$14,480,000	$12,090,000
Annual Costs	$20,570,000	$18,270,000	$16,480,000
Benefit/Cost Ratio	0.83 to 1.0 (0.829)	0.79 to 1.0 (0.793)	0.73 to 1.0 (0.734))
MOST LIKELY ALTERNATIVE METHOD			
Annual Benefits			
Power Benefits	$11,890,000	$10,540,000	$9,260,000
Employment Benefits	1,000,000	910,000	820,000
Total Annual Benefits	$12,890,000	$11,450,000	$10,080,000
Annual Costs	$20,570,000	$18,270,000	$16,480,000
Benefit/Cost Ratio	0.63 to 1.0 (0.627)	0.63 to 1.0 (0.627)	0.61 to 1.0 (0.612)

The results of the analysis, using the "Displaced Energy" method without reflecting projected fuel cost increases, indicate that all plans are not economically feasibile. The benefit-to-cost ratios developed without fuel cost increases are about 40 percent of those developed with fuel cost increases, and in all cases the benefit-to-cost ratios (B/CR) are less than unity. The difference in B/CR between these two evaluations indicates a measure of sensitivity to fuel costs and the degree to which economic feasibility is dependent on fuel cost projections.

SECTION 10
FINANCIAL FEASIBILITY/MARKETABILITY

10.1 GENERAL

In addition to the economic tests, which define the economic worth of the project, a financial feasibility analysis has been conducted by the Department of Energy (DOE). This analysis determines the financial value of the project power through a repayment analysis. All annual costs allocated to power should be recovered with interest within a reasonable period of time. Marketing of electric power from Federal projects, as authorized by Section 5 of the 1944 Flood Control Act, is the responsibility of the DOE. Administratively, DOE has set the repayment period at 50-years and the interest rate at 9-1/2 percent for Fiscal Year 1983 (Oct 82-Sept 83). Repayment rates at which bulk power must be marketed are established to recover the costs of power production and transmission including annual operation and maintenance expenses.

10.01 FINANCIAL FEASIBILITY

The DOE financial feasibility analysis prepared by the Southeastern Power Administration (SEPA) is presented in their letter dated 17 November 1982 included in Appendix D. A summary of the analysis follows.

Marketing analyses by SEPA confirm that the chief value of the power produced by a hydroelectric development at Lincoln School would be as displacement energy and as such would be most valuable in New England as a whole through the New England Power Pool (NEPOOL) rather than in Maine alone.

The rate required to repay all costs allocated to power, which in this case is all project costs, at the current interest rate of 9-1/2 percent over a 50-year repayment period was determined to be 97.8 mills per kilowatt-hour for the 272 million kilowatts-hours of annual energy produced by the plan with a 620 ft. power pool. For the plans with 610 and 600 ft. power pools the repayment rates were calculated to be 102.4 and 110.5 mills per kilowatt-hour respectively for the annual energy produced.

Rates presently being charged to preference customer were found to vary substantially in the New England area, but a rate of 57 mills per kilowatt-hour appeared to be among the higher overall rates currently being paid by wholesale customers. Further evaluation indicated that if the current wholesale rate of 57 mills is escalated to reflect cost increases of non-hydro plants, which exceed cost increase of hydro plants, to the year 1990 (Power-on-line date) the escalated rate would still be only 72 mills per kilowatt hour.

Therefore the Southeastern Power Administration concluded that sufficient power revenues could not be obtained from the sale of power to

repay all costs associated with the production and distribution of project power. Accordingly, all three plans studied are not financially feasible under existing Federal criteria.

While the above conclusion is SEPA's official position they further noted that if the current wholesale rate of 57 mills is escalated to year 2040 or 50-years into the project life, the rate would average out to 140 mills for the 50-year period. On this basis the plan with a 600 ft. power pool could start repaying total annual costs between the 14th and 15th year of operation.

SECTION 11
PROJECT IMPACTS

11.01 GENERAL

The proposed project would impact socioeconomic, historical/ archaeological and natural resources in the project area. The degree of impact on these resources is mainly a function of power pool elevations. The three pool elevations investigated are 600 ft., 610 ft., and 620 ft. National Geodetic Vertical Datum (NGVD). Impacts for each pool elevation are summarized in Table 11-1. These values are preliminary in nature and are subject to refinement if further study is undertaken.

11.02 SOCIOECONOMIC CONSIDERATIONS

a. Baseline

Population in St. Francis and Allagash in 1980 was 839 and 448 respectively. While Aroostook County population declined between 1970 and 1980, populations in these communities showed small increases. The county is sparsely settled, having 13.4 persons per square mile.

Farming and forestry are the major economic sectors in Aroostook County. The seasonality associated with these sectors results in high unemployment rates in excess of national averages. Principal jobs of men in the project area include woods work, machine operation and skilled crafts. Women in the labor force hold service work jobs, clerical and sales jobs, and professional-technical positions, specifically teaching.

Local services are of various quality and quantity within communities surrounding the project site. Public water systems available in some communities have ability to accommodate growth. Most communities rely on septic tanks for sewage waste disposal and open burning dumps for solid waste disposal. Public works functions are split between the county, state and the local communities. Education facilities are shared in School Administrative Districts. A shortage of housing units as well as rental units is perceived in several communities.

b. Impacts

Major construction related impacts would result from the influx of the construction workforce, expected to peak at 300. Many workers would bring spouses and children further increasing the demand on local services and housing. Many workers can be expected to bring mobile homes because of limited housing availability.

TABLE 11-1
SUMMARY OF PROJECT CHARACTERISTICS AND
IMPACTS OF THE PROPOSED POOL ELEVATIONS

Project Characteristics			
Target Power Pool Elevation (ft, NGVD)	600	610	620
Reservoir Surface Area (acres)	2000	2700	3600
Reservoir Depth (ft)	60	70	80
Annual Pool Fluctuation (ft)	4	4	4
Socioeconomic Concerns			
Year-Round Households Relocated	60	82	140
Other Properties Relocated (Commercial, Institutional)	9	14	19
Active Agricultural land Inundated (acres)	99	143	193
Commercial Timber Lands Taken (acres)	300	375	1035
Historic/Archaeological Concerns			
Archaeological Sites Inundated	1	1	2
Natural Resource Concerns			
Total Stream Habitat Inundated (miles)	16.4	22.4	28.8
St. John River Mainstem	12.1	14.7	14.9
Little Black River	0	1.4	5.1
Allagash River*	2.3	3.5	4.9
Other Tributaries	2.0	2.8	3.9
Periodically Inundated Zone (acres)	160	220	440
Total Forest Habitat Inundated (acres)	560	824	1368
Softwoods	279	381	707
Hardwoods	36	45	67
Mixed forest	245	398	594
Wetlands Inunadated (acres)	119	149	172
Shrubland/Abandoned Fields Inundated (acres)	176	252	314
Deer Wintering Habitat Inundated (acres)	0	4	126
Recreational Concerns			
Whitewater Stream Inundated (feet)	0	2000	3000

*Below Allagash Wilderness Waterway

The dispersion of workers throughout the local communities would determine the extent of local service impacts. Existing limitations in solid waste disposal capabilities, educational facilities and health and medical services would be further burdened by the project induced population increase. Volume of traffic on local routes would increase safety risks and decrease road surface quality.

Local businesses would experience an increase in business and new retail and service establishments may be attracted to the area. Workers may leave other jobs for higher salaries of project related jobs.

Most workers are expected to leave the area at the end of construction. Business volumes and demands on municipal services would decline with the phase down of construction activities.

The creation of the impoundment however would result in land use changes, the most significant of which would be the relocation of Allagash and St. Francis residents. Residents would be relocated within the communities in which they currently reside. The number of residents relocated would depend on the pool heights selected. These numbers are displayed in Table 11-1 with the numbers of forest acres and agricultural acres that would be lost with each pool.

11.03 HISTORICAL/ARCHAEOLOGICAL CONSIDERATIONS

The proposed Lincoln School project would affect a maximum of two prehistoric archaeological sites located during a 1976 survey. These sites have been declared eligible for inclusion in the National Register of Historic Places. As with other sites located during the survey, these appear to have been camping areas for prehistoric groups travelling along the river, hunting and foraging in the vicinity, and appear to date from the period between 1000 BC and European contact.

At flow line elevation 600 ft. and 610 ft. NGVD, one prehistoric site located during the archaeological surveys undertaken in 1976 would be destroyed or heavily damaged by inundation and pool fluctuations. At flow line El. 620 ft. NGVD a second site would also be impacted. As both sites have been declared eligible for inclusion in the National Register of Historic Places, mitigation of impacts upon them would be required prior to project construction.

11.04 NATURAL RESOURCES CONSIDERATIONS

a. Aquatic Ecosystem

The aquatic habitat in the St. John River Basin upstream of the proposed Lincoln School dam consists of approximately 3450 miles of continuously flowing and intermittent streams as well as a number of lakes, ponds and beaver impoundments. Construction of the proposed dam would inundate a total 16.4 miles of stream habitat at the 600 ft. pool

elevation, 22.4 miles at the 610 ft. pool elevation and 28.8 miles at the 620 ft. elevation (Table 11-1). Table 11-1 indicates that the St. John River mainstem and its two large tributaries, the Little Black and Allagash Rivers, comprise approximately 86-87% of these mileage values. The proposed impoundment would not inundate the Allagash River above West Twin Brook which is protected by the Federal Wild and Scenic Rivers Act of 1968 (16 U.S.C. 1271-1287). Only the lower portion of the tributaries to the large streams would be inundated. A 1976 survey of the Negro, Wiggins and Aegan Brooks indicated that the lower portion of these streams contained fair to good adult holding habitat for brook trout as well as other species. The vast majority of the good and excellent spawning, nursery, amd adult holding habitats occur well above all three power pool elevations and would not be affected by the proposed project. No ponds or lakes would be inundated by any of the proposed pool elevations.

The proposed dam would create a standing water habitat of 2000 acres at the 600 ft. pool, 2700 acres at the 610 ft. pool and 3600 acres at the 620 ft. pool. Reservoir depths would be 60, 70 or 80 ft. for each pool respectively.

Lincoln School Lake would tend to be a warm water body during summer and would probably be weakly to moderately stratified by surface heat exchange processes. The lake is expected to be well oxygenated throughout its depth and would have other water quality characteristics reflecting the quality of the influent streams which presently meet State water quality standards. Future water quality studies would be accomplished to assess the potential development of the reservoir as a seasonal coldwater and/or year round warmwater fishery.

Creation of the reservoir would shift the present stream-associated plant and animal species to those associated with standing water habitat. The facility would be operated as run-of-the-river during most operating times. However, depending upon available flows, some storage regulation for limited daily and weekly load fitting would likely fluctuate the power pool elevations 1-2 feet on a daily basis and up to 3-4 feet in a weekly basis. Such fluctuations would create a periodically inundated zone (PIZ) around the perimeter of the proposed reservoir. This fluctuation combined with wave action and ice scour during winter would cause instability or erosion along more exposed shoreline areas. Such instability would limit the establishment of shoreline plants and animals which could provide habitat and forage for fish. The area of the PIZ is dependent upon the pool elevation. Assuming a maximum fluctuation of 4 ft., a 160 acre area would be expected with the 600 feet power pool, a 220 acre area with 610 ft. pool and 440 acre area with 620 ft. pool.

The quality of the downstream riverine environment would be dictated by releases from the dam. Temperatures and dissolved oxygen levels would be similar to the reservoir inflows except during the summer. Bottom withdrawal of the mildly stratified lake during summer would release slightly cooler and less oxygenated waters than those of the inflows.

Daily downstream fluctuations would alter the species composition and reduce the diversity of plants and animals associated with the St. John River mainstem and its banks. This impact would be most marked near the dam site and decrease further downstream. The U.S. Fish and Wildlife Service has recommended a minimum release of 2562 cubic feet per second (cfs) (See Appendix D). Future water quality studies would incorporate an instream flow analysis to determine if operational modes can accommodate this recommendation or what minimum downstream releases would be to remain consistent with project purposes.

The U.S. Fish and Wildlife Service has indicated that private clubs in Canada may introduce Atlantic salmon above the downstream historical barrier of Grand Falls, New Brunswick. The Corps would investigate the need and feasibility of providing passage ways should this occur.

b. Terrestrial Ecosystem

The St. John River Basin upstream of the Lincoln School site is covered with nearly 2.5 million acres of second growth forest interspersed with wetlands, agricultural land and shrub land.

Table 11-1 indicates the reservoir would inundate 560 acres of forests at the 600 ft. elevation, 824 acres at 610 ft. elevation and 1368 acres at the 620 ft. elevation, NGVD. Softwood and softwood-hardwood mixed stands comprise the largest portions of those acreages. Inundation would be generally limited by the steepness of the valley walls on the lower portion of the impoundments. The 620 ft. impoundment would inundate wetland habitats along the lower five miles of the Little Black River where the topography is very gradual. About one and a half miles would be inundated under the 610 ft. pool.

Riparian habitat which supports Federal and State designated rare plants would also be inundated upstream and downstream of the dam site. These areas support populations of the Federally listed endangered species, the Furbish Lousewort. Formal consultation with the U.S. Fish and Wildlife Service would be required under Section 7 of the Endangered Species Act. Mitigation measures similar to that generated for the Dickey Lincoln School Lakes Project would be developed.

Impacts to wildlife generally would be proportional with the acreages of inundated terrestrial habitat shown in Table 11-1. Upon inundation, wildlife would perish or move to adjacent lands. This displacement of survivors would put increased pressure on existing populations which are already fully utilizing the available habitat.

The U.S. Fish and Wildlife Service has evaluated the lost habitat using its Habitat Evaluation Procedures for each pool elevation. The annual loss or gains are indicated in Tables 2-4 of their 29 October 1982 letter exhibited in Appendix D. According to their analysis total annualized habitat losses aggregate to 4509 acres for the 600 ft. pool,

6525 acres for the 610 ft. pool and 9977 acres for the 620 ft., NGVD. These figures are preliminary and further study is required to determine acceptable levels of mitigation.

Of particular concern is the deer wintering habitat which is critical for over winter survival. Based on available information provided by the State of Maine, no deer yards would be inundated by the 600 ft. pool, about 4 acres by the 610 ft. pool and about 126 acres by the 620 ft. pool. These areas occur on either side of the lower portion of the Little Black River. Mitigation of these losses would also require acquisition of lands for enhancement of deer carrying capacity through timber management practices. Again, detailed analyses would be conducted at a later stage of planning in cooperation with State and Federal resource agencies if further study is authorized.

c. Recreational Resources

The upper St. John river is one of the largest lengthy segments of free flowing, near wilderness rivers in the northeastern United States. Significant recreational opportunities in the area include canoeing, fishing, hunting and wilderness camping.

Creation of the reservoir would eliminate stream canoeing and stream fishing along the impounded portion of the St. John River mainstem. The degree of impact would be relative to the inundated stream miles listed in Table 11-1 for each pool elevation. The 620 ft. pool would inundate approximately 3000 feet of the Big Rapids, a two mile long white-water canoeing reach of the St. John River mainstem. The 610 ft. pool would inundate approximately 2000 ft. of the reach whereas the 600 ft. pool would not encroach upon the rapids. The loss of the stream fishery is not replaceable but may be partially offset by the potential creation of the lake fishery. Stream brook trout fishing above the impoundment would remain popular and would not be affected by the project.

Hunting opportunities would be reduced by the loss of habitat. However, the hunting "supply" would continue to exceed demand and therefore no significant changes in utilization of project land would be expected.

The maximum pool elevation would inundate about three primitive camp sites along the impoundment shoreline. This loss would not have a significant effect on the camping use of the project area.

d. Transmission Facilities

A new Lincoln School power substation would be connected with two existing substations by construction of above-the-ground transmission lines. An 18 mile long 69 kilovolt (kv) line would be connected at Fort Kent, Maine and a 40 mile long 138 kv line connected at Edmunston, New Brunswick. Impacts associated with the lines would ultimately depend upon

the corridors chosen. Although use of existing rights of way would be pursued as much as possible, there could be crossings of sensitive aquatic, wetland and terrestrial habitats. Specific impacts would be identified and assessed when the corridors are chosen. Appropriate mitigation measures, if necessary, would be developed at that time.

SECTION 12

FINDINGS/CONCLUSIONS

12.01 ECONOMIC FEASIBILITY

a. The economic feasibility of a project is measured by the benefit-to-cost ratio. A project with a benefit-to-cost ratio of unity or greater is economically justified and with less than unity is not economically justified. When evaluated as an alternative to thermal expansion in the New England electrical system (most likely Alternative Method of Analysis), the benefit-to-cost ratios are 0.63 for the NED plan and 0.63 and 0.61 for the alternative plans. However, when evaluated as a source of electrical energy which would intermittently displace the operation of existing high cost, oil-fired generating units in the system (Displaced Energy Method of Analysis), the benefit-to-cost ratios are found to be 2.0 for the NED plan and 1.9 and 1.8 for the alternative plans. Therefore, based on its use as energy displacement, the construction of a hydro-electric project at Lincoln School is found to be economically feasible.

b. A supplemental analysis conducted to determine the degree to which economic feasibility is sensitive to fuel (oil) cost projections indicates that without allowances for fuel cost increases the benefit-to-cost ratios would decrease to less than unity, ranging from 0.73 to 0.83.

c. It should also be noted that import of Hydro-Quebec power into the NEPOOL system could greatly affect the economic feasibility of the project. Reference is made to the following paragraph extracted from FERC letter dated November 3, 1982.

"A large scale purchase of capacity and associated energy from Canada (several thousand megawatts are now contemplated) would push New England's high cost oil-fired generation upwards - or even off - the load curve. This could move lower cost oil, coal generation, or the Canadian purchases into the capacity factor band occupied by Lincoln School. This would sharply lower the value of Lincoln School energy based on displaced energy costs. Hence, if the contracts for Canadian imports are formally announced by New England, it will be necessary to recalculate the power values for the Lincoln School project."

Note: A contract was formally signed by NEPOOL and Hydro-Quebec on March 21, 1983 for 33 billion kilowatt hours of energy from Hydro-Quebec over a period of eleven years, starting in 1986. The Hydro-Quebec energy will be priced at 80 percent of the weighted average fossil fuel cost for NEPOOL.

The agreement further provides for the sale of additional surplus hydro energy from Hydro-Quebec to NEPOOL at 80 percent of NEPOOL's replacement fuel costs.

An Energy Banking Agreement is also specified, whereby Hydro-Quebec and NEPOOL will share the savings created on the NEPOOL system by using Hydro-Quebec reservoirs to "bank" energy. NEPOOL will deliver energy to Hydro-Quebec at times when NEPOOL's incremental costs are low and Hydro-Quebec will return this energy, less losses, at times when NEPOOL's incremental costs are high.

12.02 FINANCIAL FEASIBILITY

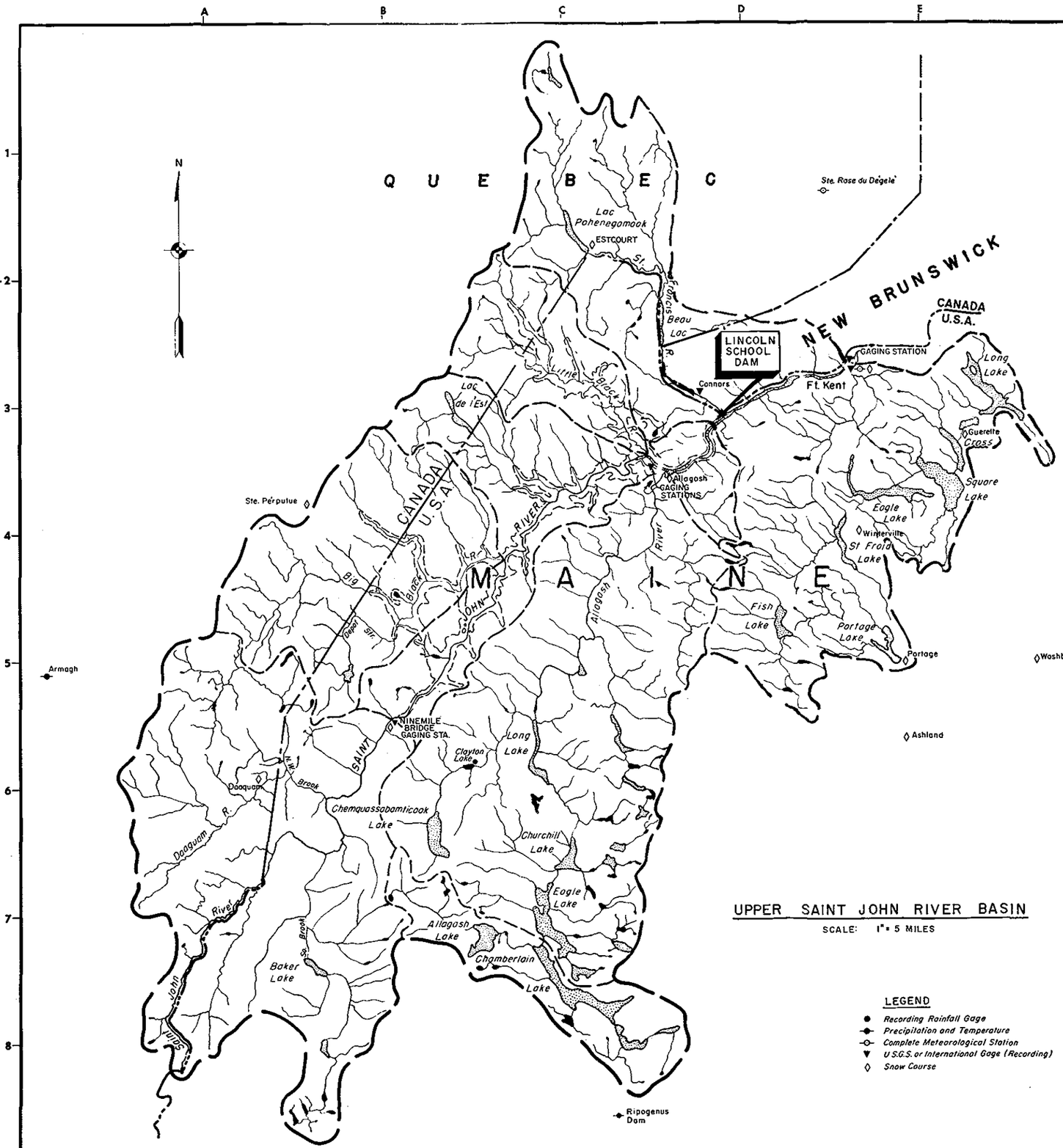
The Southeastern Power Administration found that sufficient power revenues could not be obtained from the sale of project generated power to repay all costs associated with the production and distribution of the project's power. Accordingly the project is not financially feasible based on existing Federal criteria.

12.03 CONCLUSION

Given the above findings and considerations, it is concluded that:

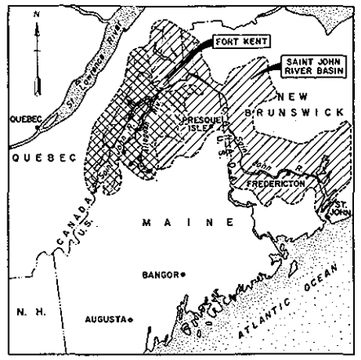
1. Hydroelectric development of Lincoln School is currently economically feasible, however, its feasibility would be severely jeopardize by introduction of Canadian Hydro-Quebec power into the NEPOOL system.

2. Hydroelectric power generated by Lincoln School could not be marketed at a rate sufficient to repay production and distribution costs. The project, therefore, does not meet the Federal prerequisite requirements for financial feasibililty.



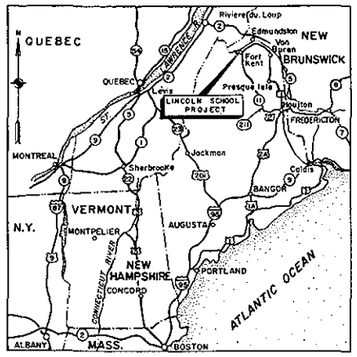
UPPER SAINT JOHN RIVER BASIN

SCALE: 1" = 5 MILES



VICINITY MAP

SCALE: 1" = 50 MI.



LOCATION MAP

SCALE IN MILES

50 0 50 100 150

LEGEND

- Recording Rainfall Gage
- Precipitation and Temperature
- Complete Meteorological Station
- U.S.G.S. or International Gage (Recording)
- Snow Course

GRAPHIC SCALES

1" = 5 MI. 5 0 5 10 MI

1" = 50 MI. 50 0 50 100

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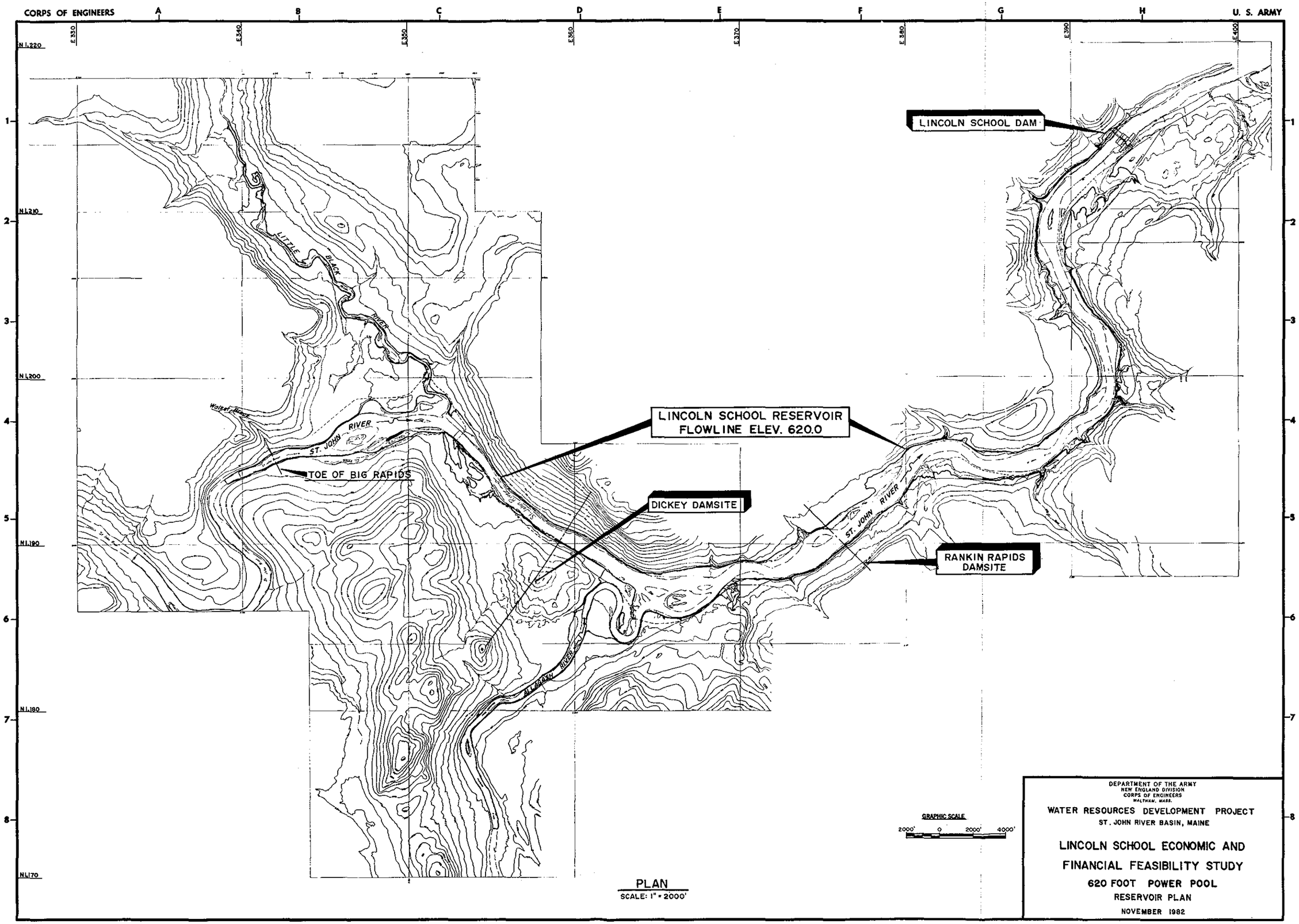
LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY

BASIN MAP

NOVEMBER 1982

PLATE 1


CORPS OF ENGINEERS
U. S. ARMY
LINCOLN SCHOOL DAM
LINCOLN SCHOOL RESERVOIR
FLOWLINE ELEV. 620.0
TOE OF BIG RAPIDS
DICKEY DAMSITE
RANKIN RAPIDS
DAMSITE
LITTLE BLACK RIVER
ST. JOHN RIVER
ALLAGASH RIVER
GRAPHIC SCALE
2000' 0 2000' 4000'
PLAN
SCALE: 1" = 2000'
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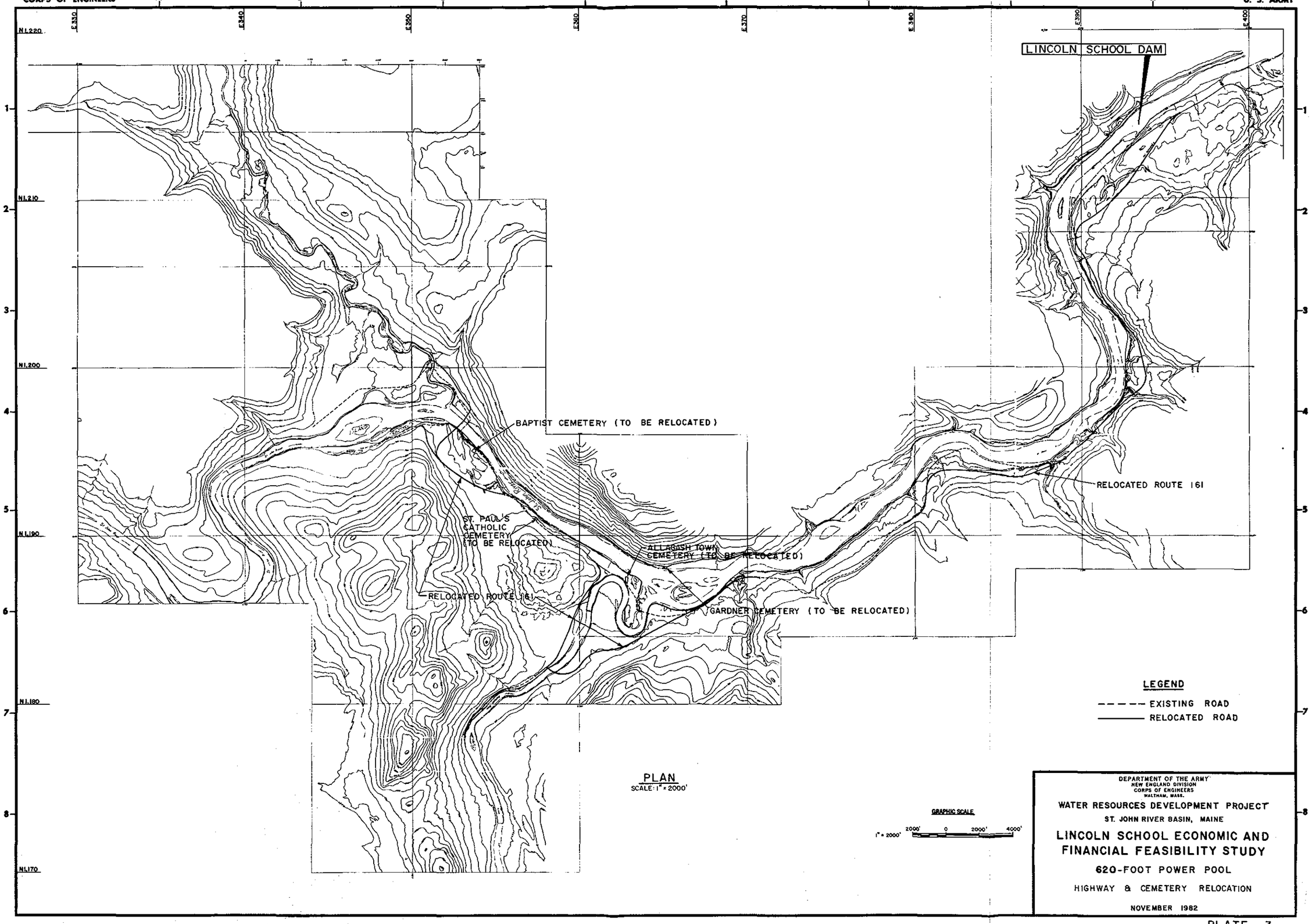
ST. JOHN RIVER BASIN, MAINE
LINCOLN SCHOOL ECONOMIC AND
FINANCIAL FEASIBILITY STUDY
620 FOOT POWER POOL
RESERVOIR PLAN
NOVEMBER 1982

PLATE 2

CORPS OF ENGINEERS U. S. ARMY



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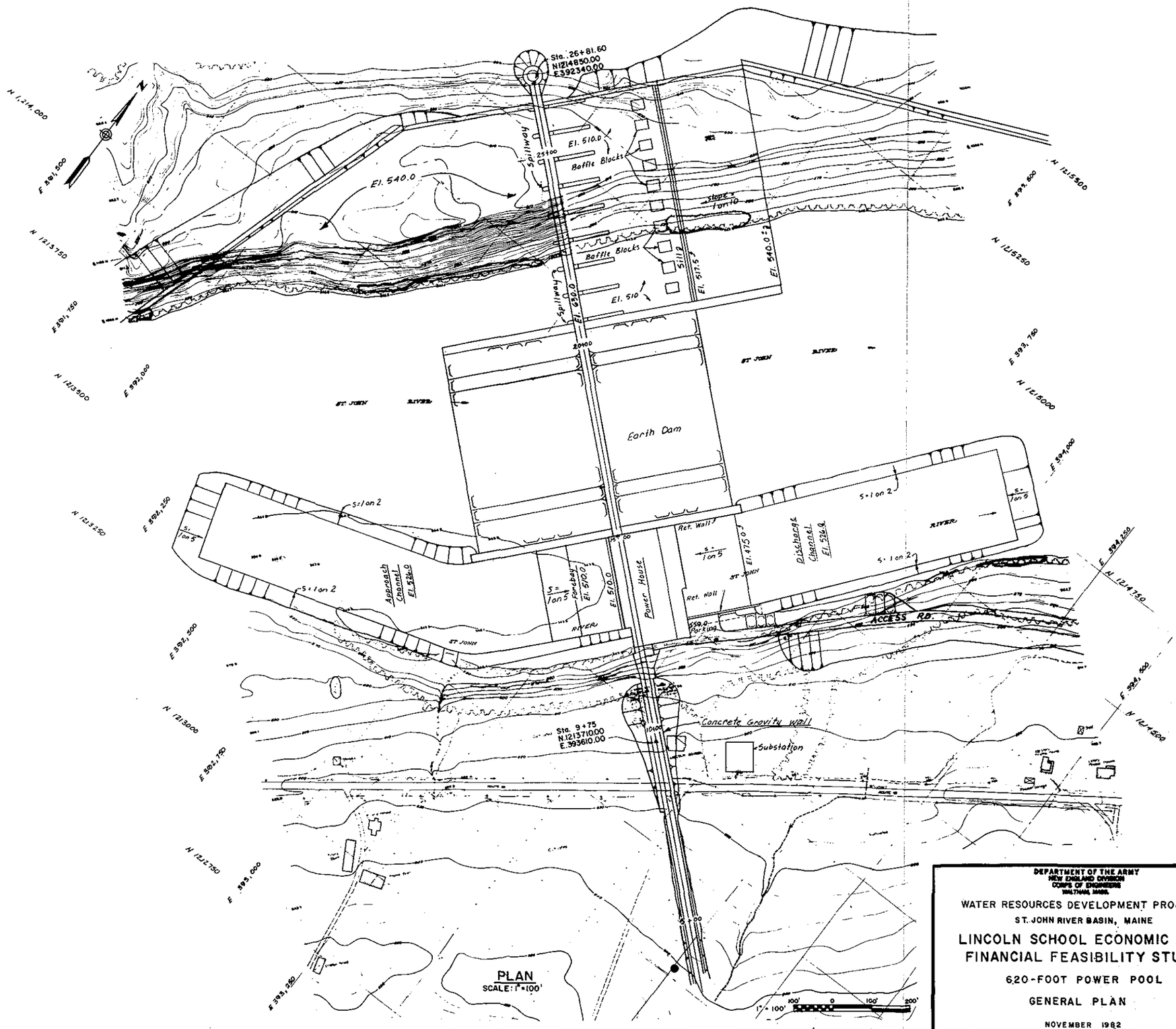
LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY

620-FOOT POWER POOL

HIGHWAY & CEMETERY RELOCATION

NOVEMBER 1982



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LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY

620-FOOT POWER POOL

GENERAL PLAN

NOVEMBER 1982

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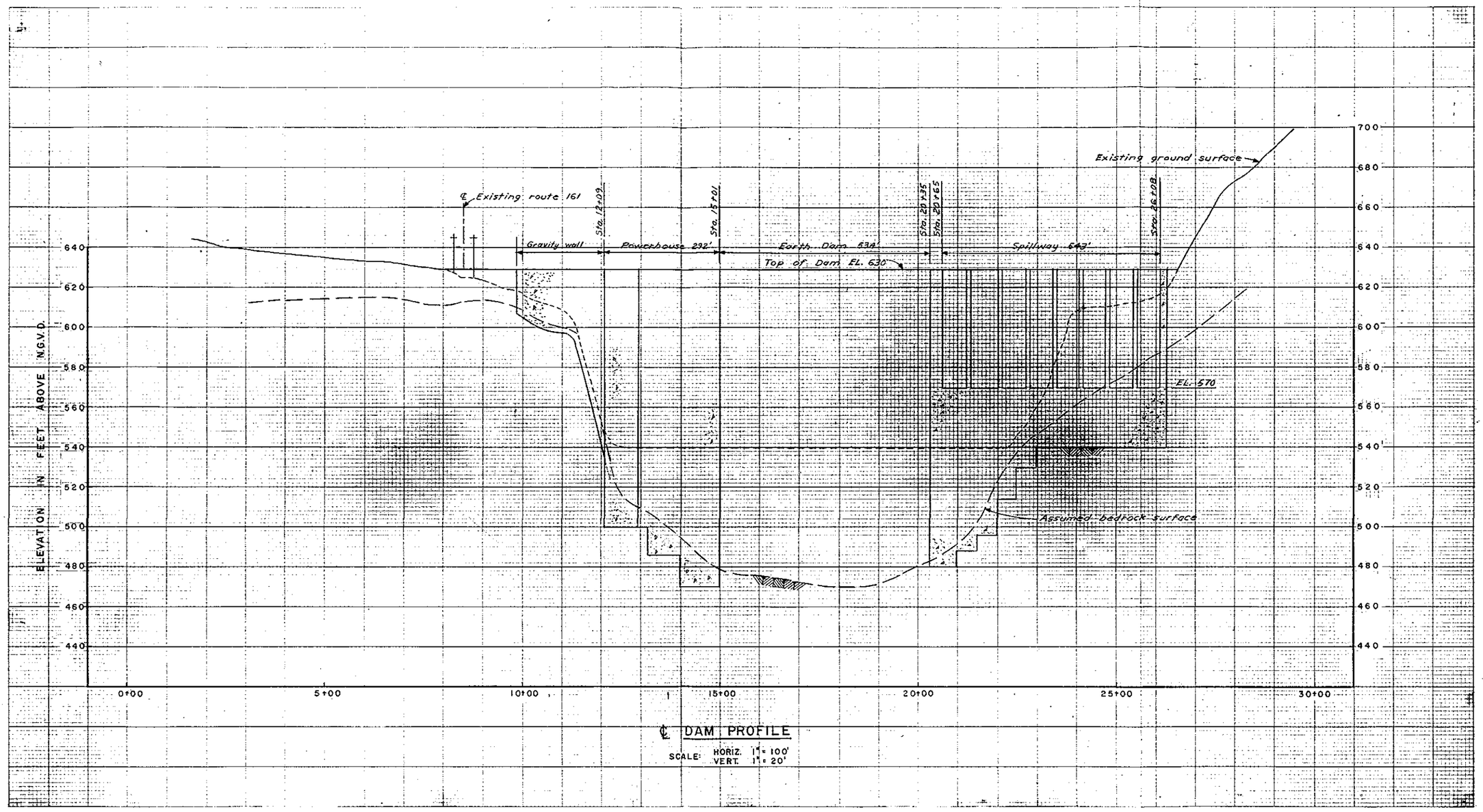

℄ DAM PROFILE

SCALE: HORIZ. 1" = 100'
VERT. 1" = 20'

GRAPHIC SCALES

1" = 100' 100' 0 100' 200'

1" = 20' 20' 0 20' 40'

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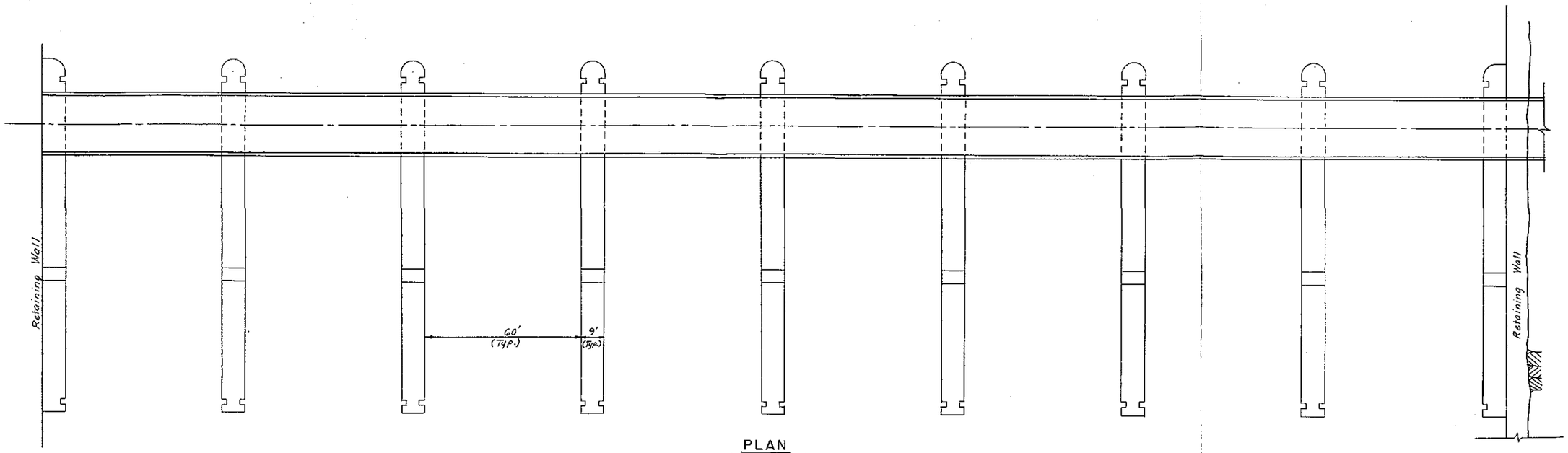
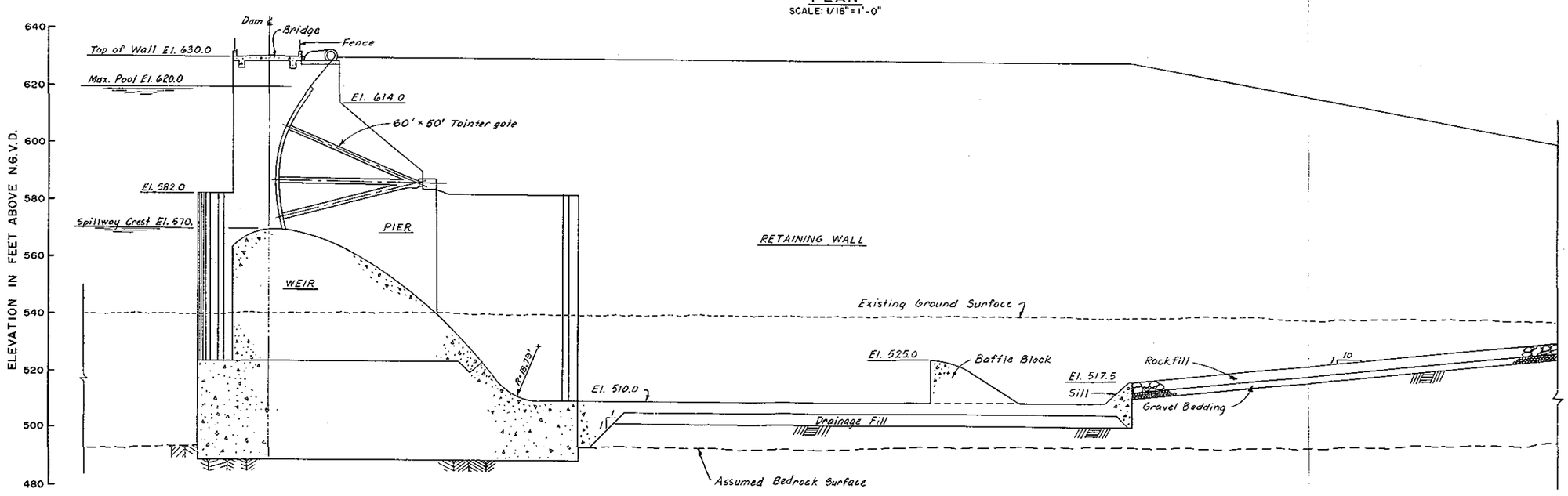
620 FOOT POWER POOL

PROFILE ALONG ℄ OF DAM

NOVEMBER 1982



PLAN
SCALE: 1/16" = 1'-0"



TYPICAL SPILLWAY SECTION
SCALE: 1/16" = 1'-0"

GRAPHIC SCALE
1/16" = 1'-0" 8' 0 8' 16' 24' 32' 40'

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620-FOOT POWER POOL

SPILLWAY PLAN AND SECTION

NOVEMBER 1982

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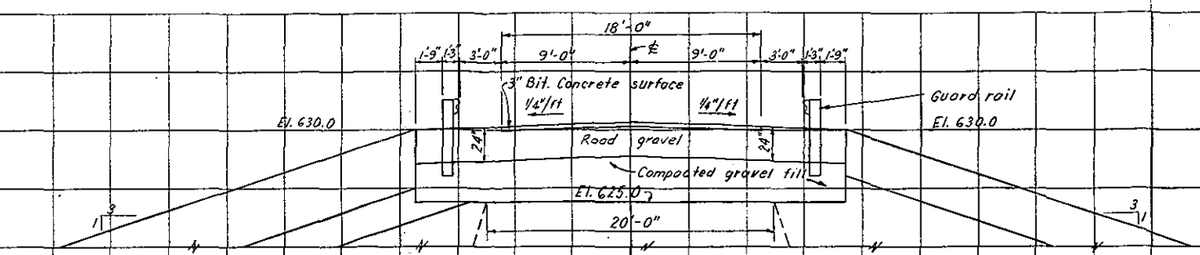
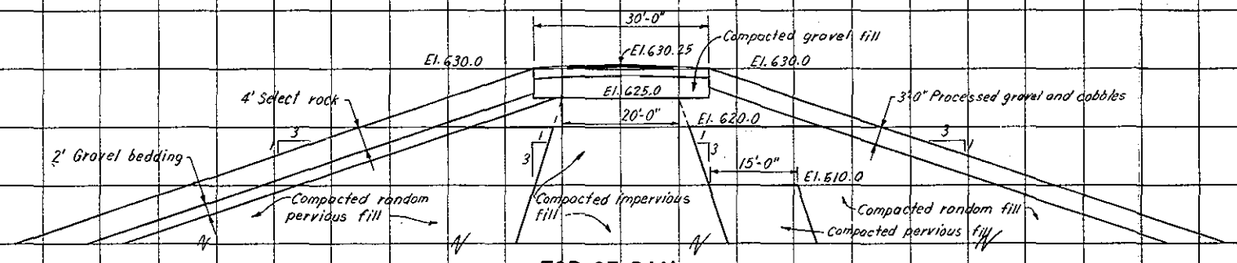
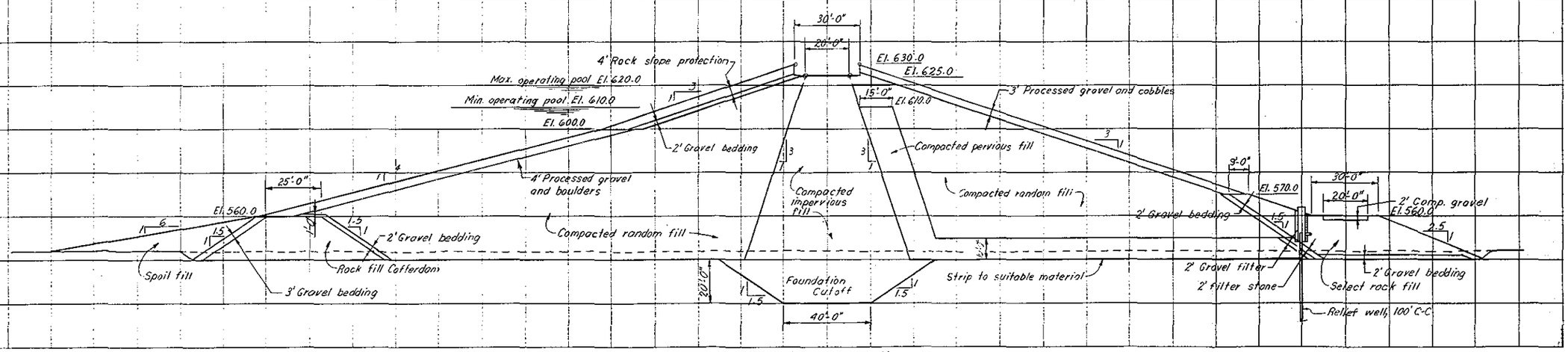


TYPICAL ROAD SECTION
SCALE 1" = 4'



TOP OF DAM
SCALE 1" = 10'



TYPICAL SECTION
SCALE 1" = 20'

GRAPHIC SCALES
1" = 4' 4' 0 4' 8'
1" = 10' 10' 0 10' 20'
1" = 20' 20' 0 20' 40'

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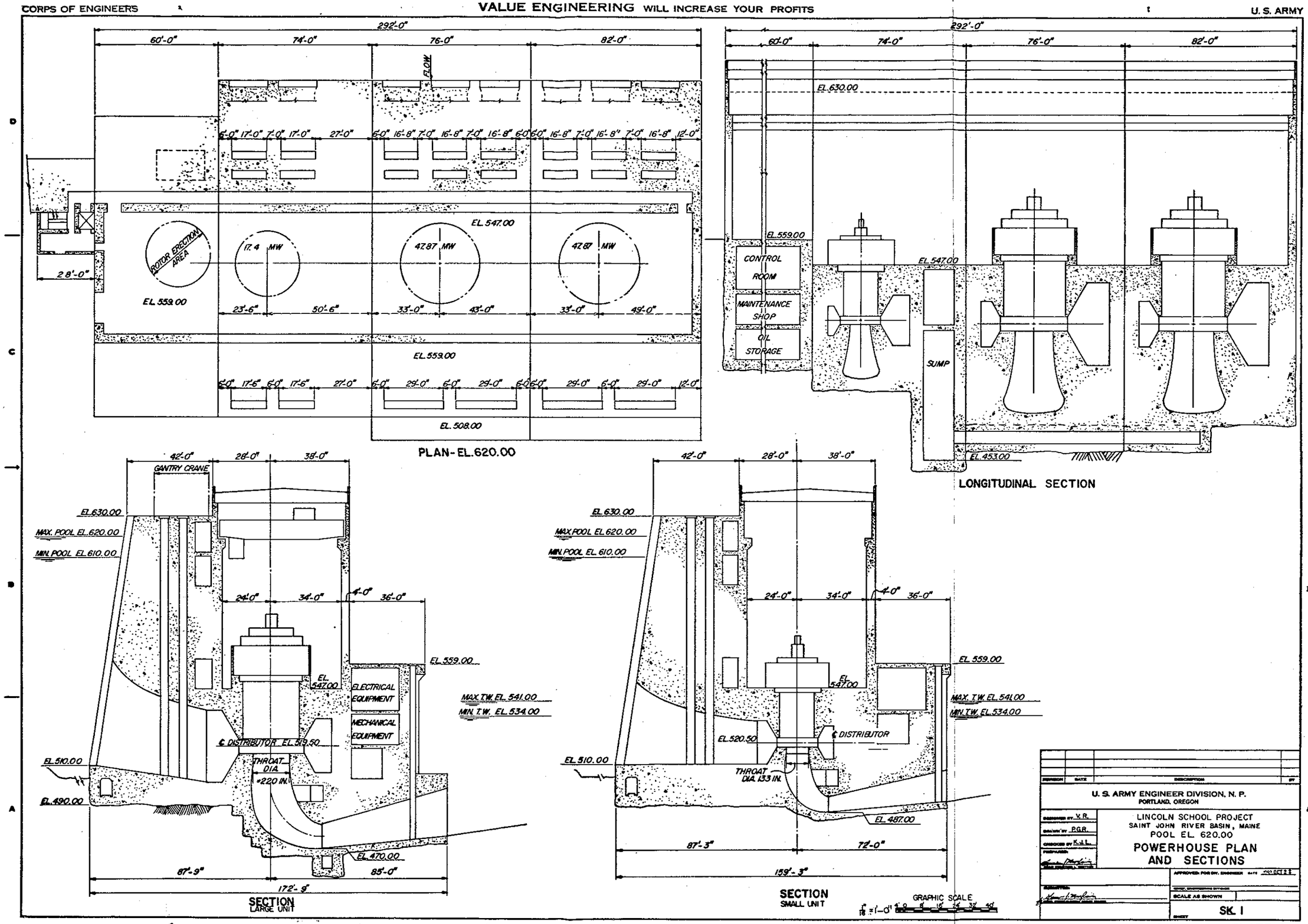
ST. JOHN RIVER BASIN, MAINE

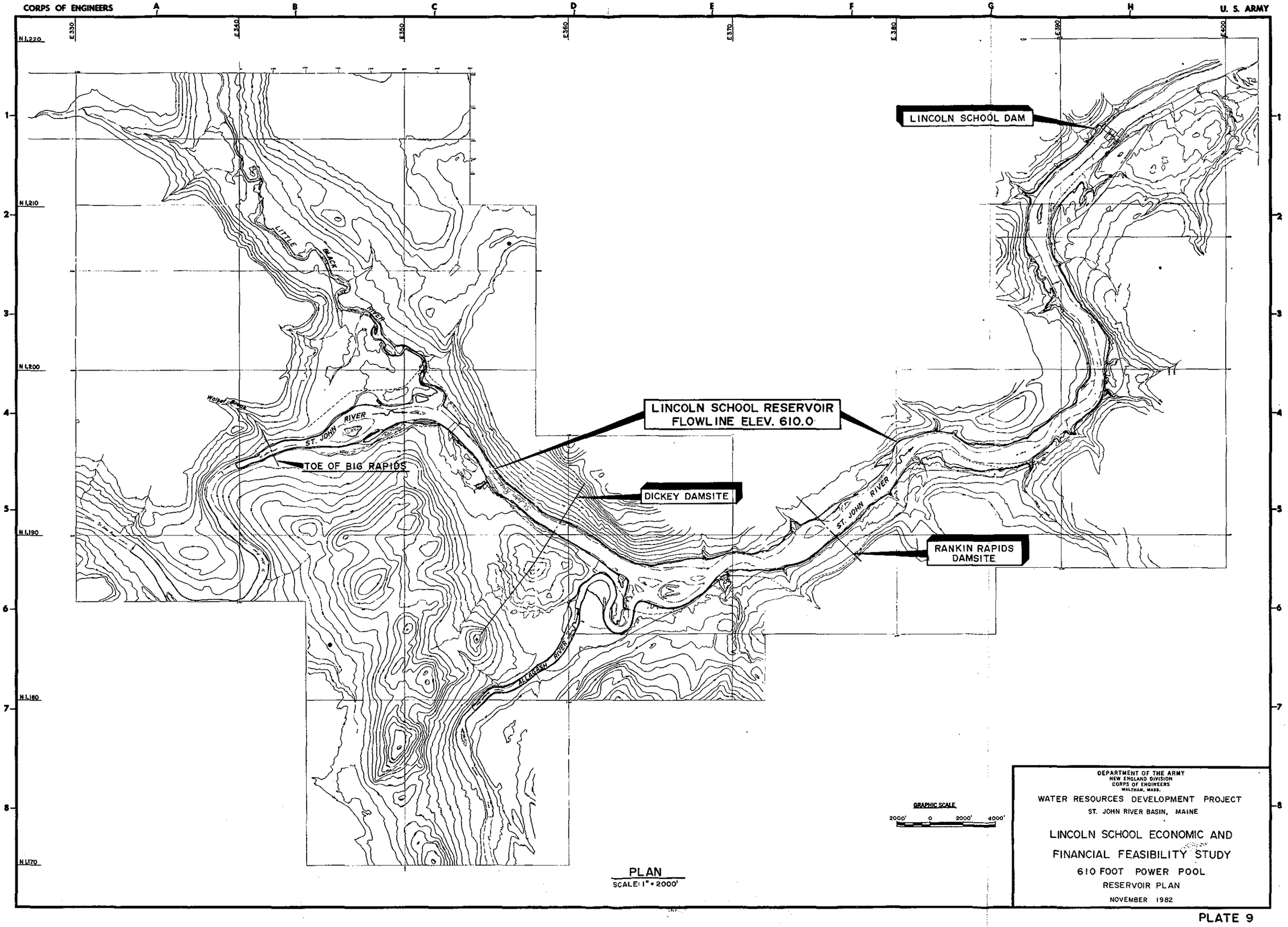
LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY

620 FOOT POWER POOL
TYPICAL DAM SECTIONS

NOVEMBER 1982


292'-0"
60'-0"
74'-0"
76'-0"
82'-0"
FLOW
EL. 547.00
ROTOR ERECTION AREA
17.4 MW
47.87 MW
47.87 MW
EL. 559.00
28'-0"
23'-6"
50'-6"
33'-0"
43'-0"
33'-0"
49'-0"
EL. 559.00
EL. 508.00
PLAN-EL.620.00
EL. 630.00
EL. 559.00
CONTROL ROOM
MAINTENANCE SHOP
OIL STORAGE
EL. 547.00
SUMP
EL. 453.00
LONGITUDINAL SECTION
42'-0"
28'-0"
38'-0"
GANTRY CRANE
EL. 630.00
MAX. POOL EL. 620.00
MIN. POOL EL. 610.00
24'-0"
34'-0"
4'-0"
36'-0"
EL. 559.00
EL. 547.00
ELECTRICAL EQUIPMENT
MECHANICAL EQUIPMENT
MAX. T.W. EL. 541.00
MIN. T.W. EL. 534.00
℄ DISTRIBUTOR EL. 519.50
EL. 510.00
THROAT DIA. =220 IN.
EL. 490.00
EL. 470.00
87'-9"
85'-0"
172'-9"
SECTION
LARGE UNIT
EL. 630.00
MAX. POOL EL. 620.00
MIN. POOL EL. 610.00
EL. 559.00
EL. 547.00
MAX. T.W. EL. 541.00
MIN. T.W. EL. 534.00
EL. 520.50
℄ DISTRIBUTOR
EL. 510.00
THROAT DIA. 133 IN.
EL. 487.00
87'-3"
72'-0"
159'-3"
SECTION
SMALL UNIT
GRAPHIC SCALE
1/16" = 1'-0"
U. S. ARMY ENGINEER DIVISION, N. P.
PORTLAND, OREGON
LINCOLN SCHOOL PROJECT
SAINT JOHN RIVER BASIN, MAINE
POOL EL. 620.00
POWERHOUSE PLAN AND SECTIONS
SCALE AS SHOWN
SK. 1

CORPS OF ENGINEERS U. S. ARMY



PLAN
SCALE: 1" = 2000'

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ST. JOHN RIVER BASIN, MAINE

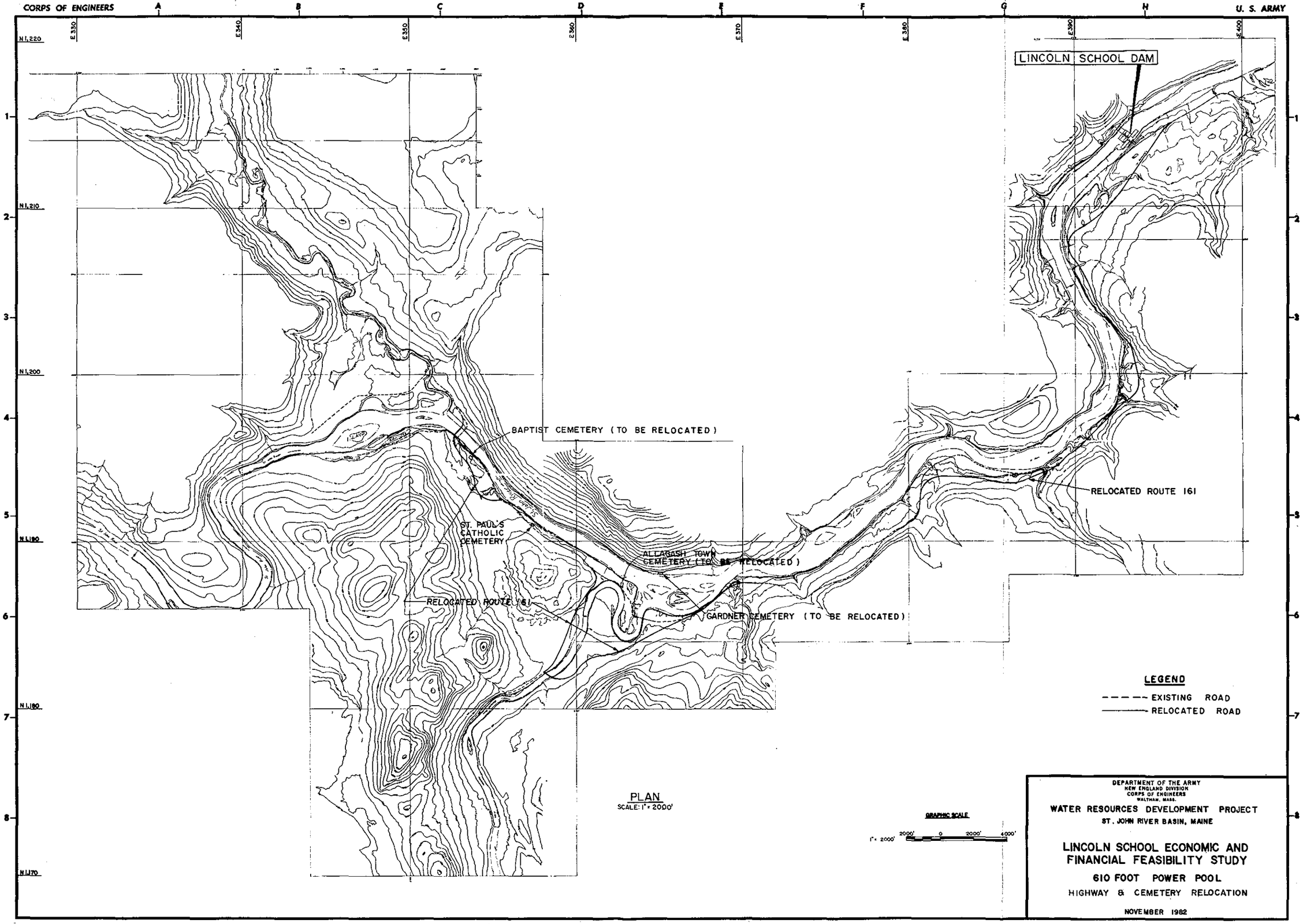
LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY

610 FOOT POWER POOL

RESERVOIR PLAN

NOVEMBER 1982

CORPS OF ENGINEERS U. S. ARMY



PLAN
SCALE: 1" = 2000'

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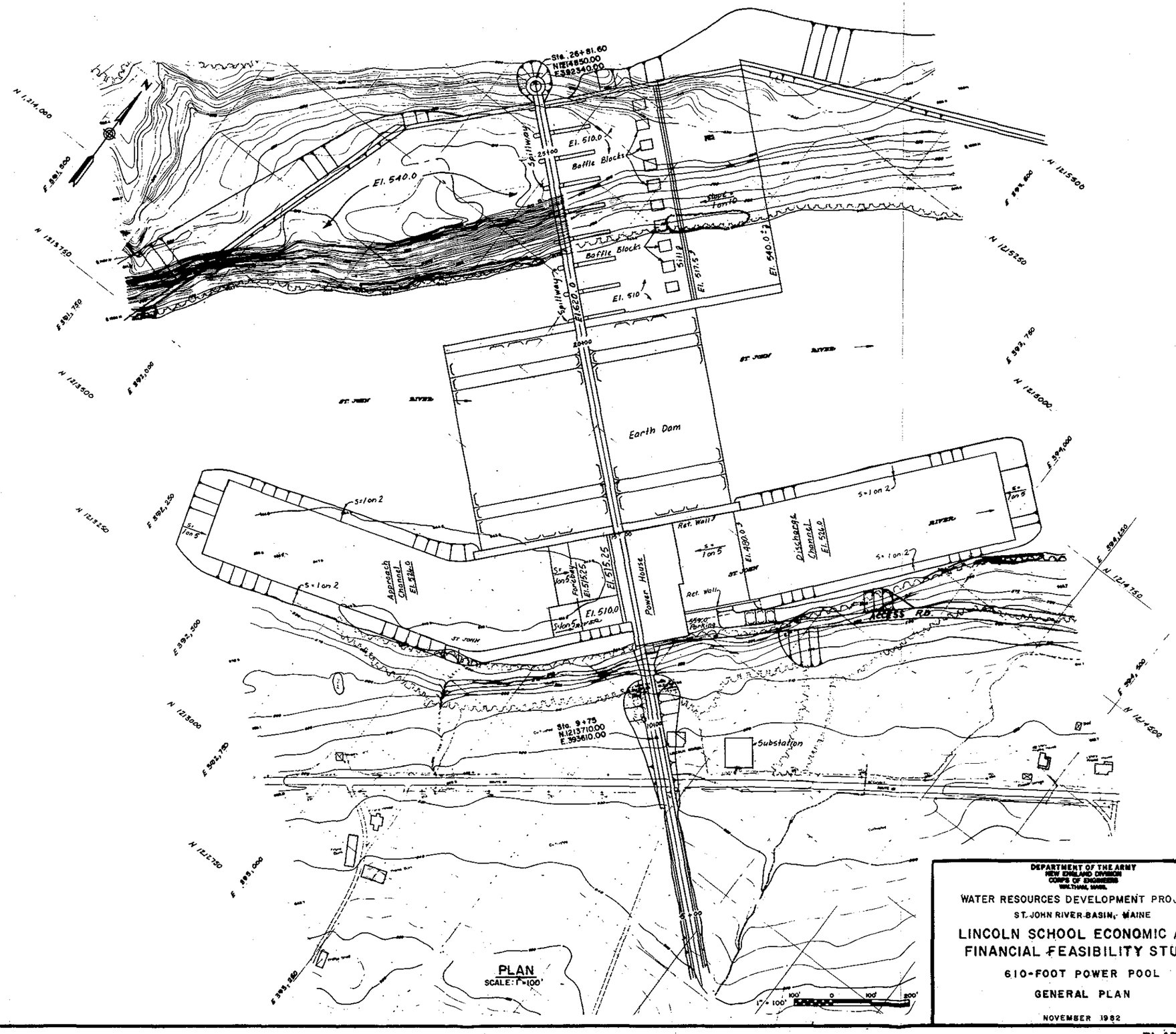
LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY

610 FOOT POWER POOL

HIGHWAY & CEMETERY RELOCATION

NOVEMBER 1982

PLATE 10



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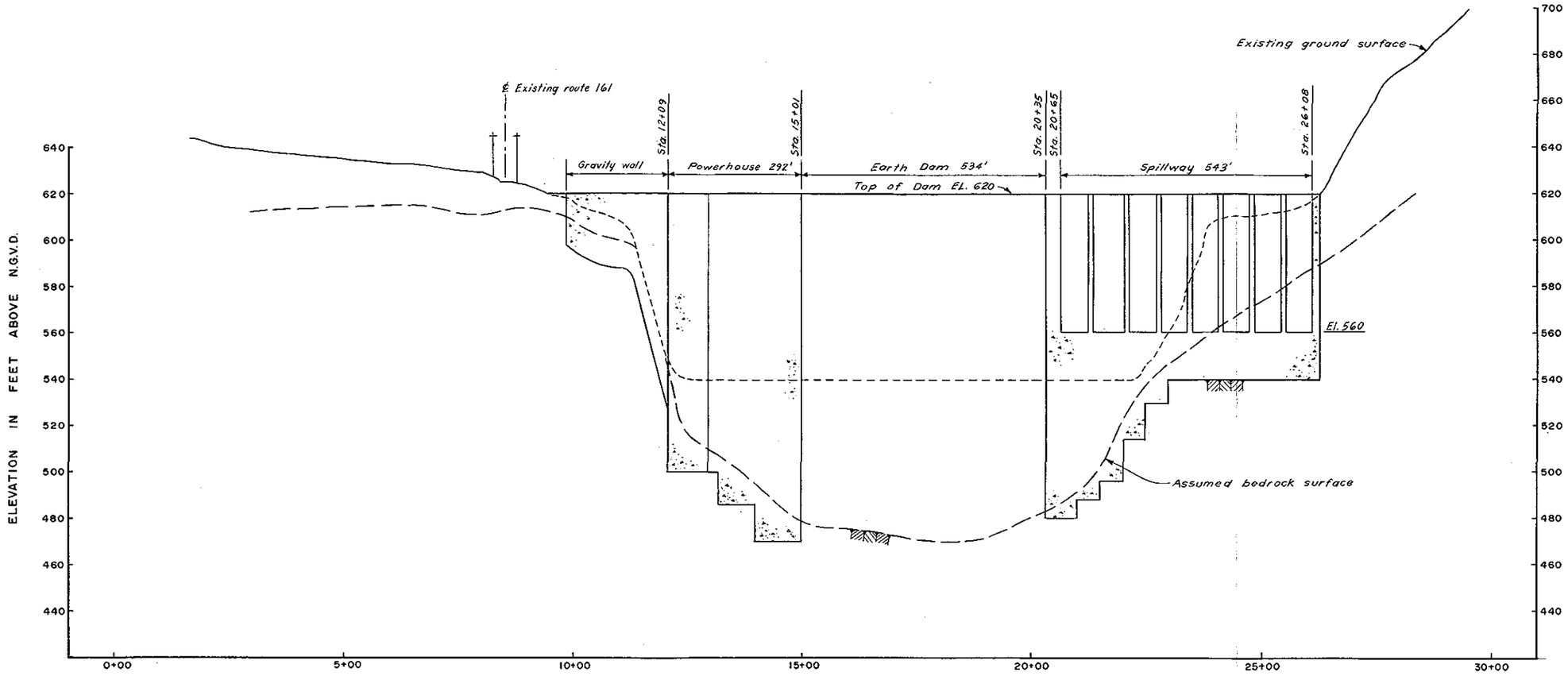
LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY

610-FOOT POWER POOL

GENERAL PLAN

NOVEMBER 1982



℄ DAM PROFILE

SCALE: HORIZ. 1" = 100'
VERT. 1" = 20'

GRAPHIC SCALES

1" = 100' 100' 0 100' 200'

1" = 20' 20' 0 20' 40'

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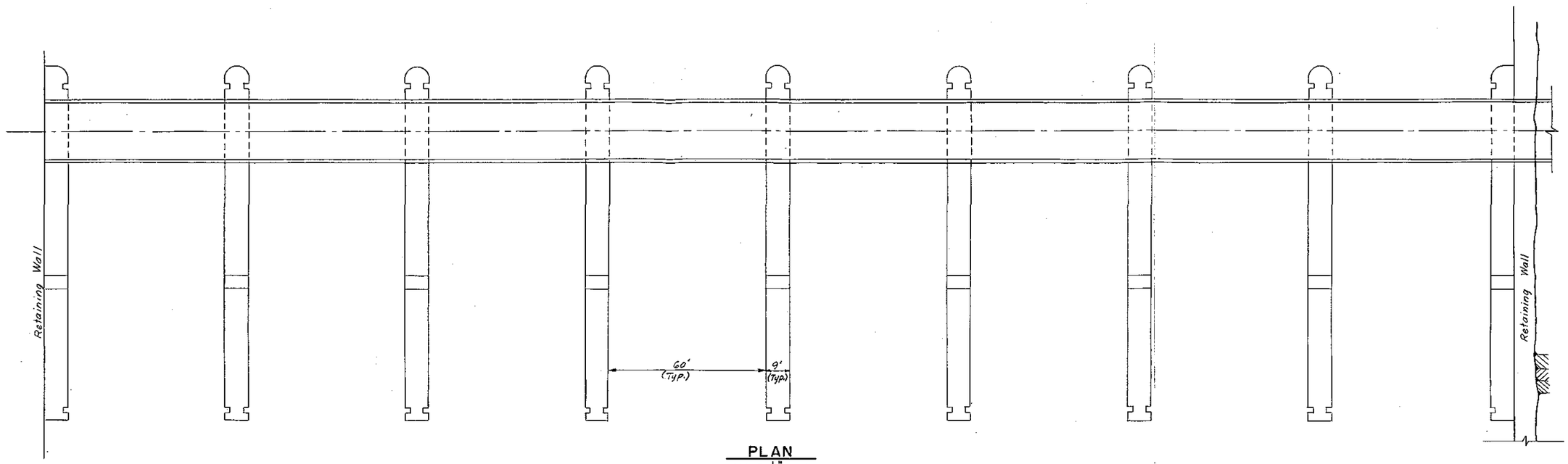
LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY

610 FOOT POWER POOL

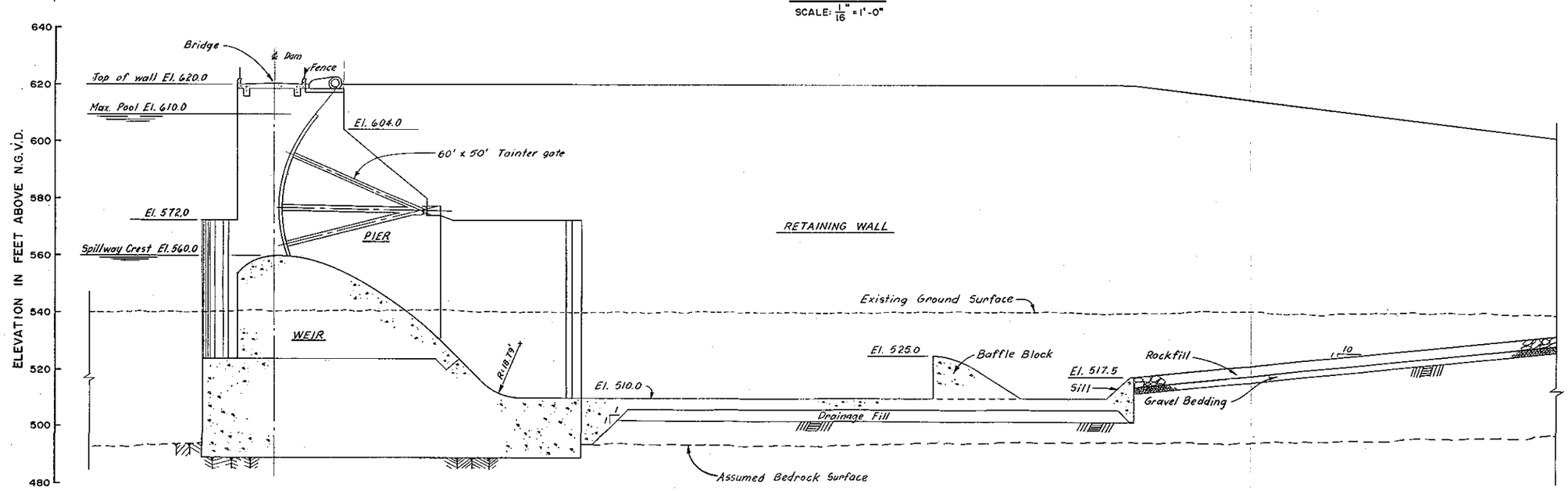
PROFILE ALONG ℄ OF DAM

NOVEMBER 1982



PLAN

SCALE: $\frac{1}{16}$" = 1'-0"



TYPICAL SPILLWAY SECTION

SCALE: $\frac{1}{16}$" = 1'-0"

GRAPHIC SCALE

$\frac{1}{16}$" = 1'-0" 8' 0 8' 16' 24' 32' 40'

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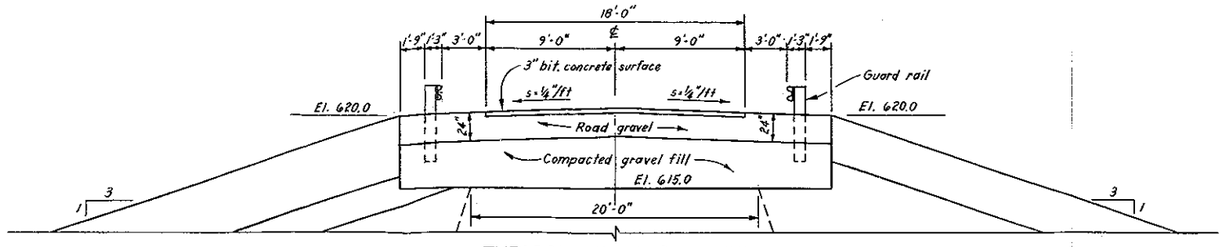
LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY

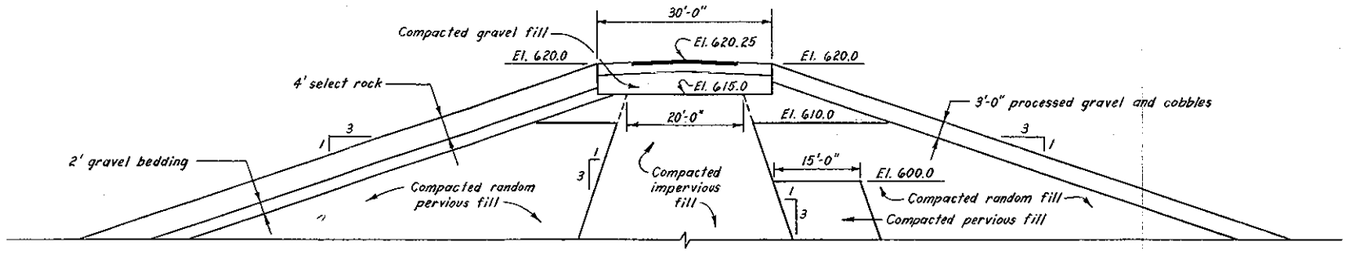
610-FOOT POWER POOL

SPILLWAY PLAN AND SECTION

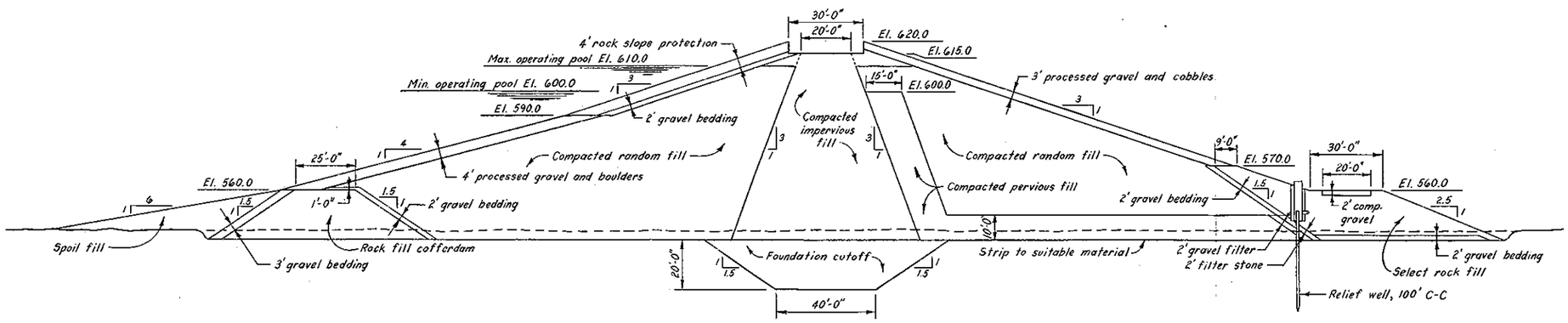
NOVEMBER 1982



TYPICAL ROAD SECTION
SCALE: 1" = 4'



TOP OF DAM
SCALE: 1" = 10'



TYPICAL SECTION
SCALE: 1" = 20'

GRAPHIC SCALES

DEPARTMENT OF THE ARMY
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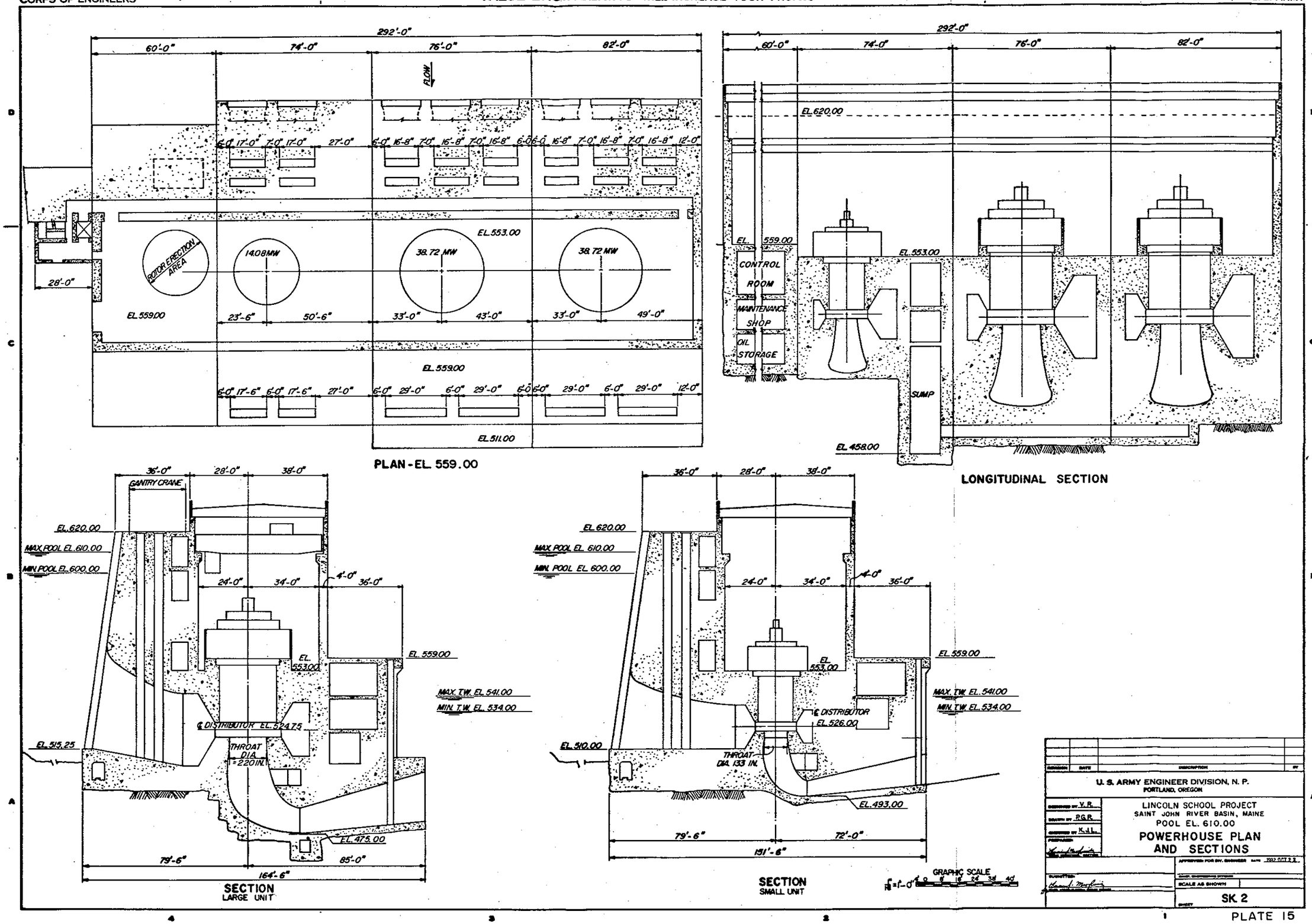
CORPS OF ENGINEERS
WALTHAM, MASS.

WATER RESOURCES DEVELOPMENT PROJECT
ST. JOHN RIVER BASIN, MAINE

LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY

610 FOOT POWER POOL
TYPICAL DAM SECTIONS

NOVEMBER 1982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60'-0"
74'-0"
76'-0"
82'-0"
FLOW
ROTOR ERECTION AREA
14.08 MW
38.72 MW
38.72 MW
EL. 553.00
EL. 559.00
EL. 559.00
EL. 511.00
28'-0"
23'-6"
50'-6"
33'-0"
43'-0"
33'-0"
49'-0"
PLAN - EL. 559.00
EL. 620.00
EL. 559.00
EL. 553.00
CONTROL ROOM
MAINTENANCE SHOP
OIL STORAGE
SUMP
EL. 458.00
LONGITUDINAL SECTION
GANTRY CRANE
EL. 620.00
MAX. POOL EL. 610.00
MIN. POOL EL. 600.00
EL. 553.00
EL. 559.00
MAX. T.W. EL. 541.00
MIN. T.W. EL. 534.00
℄ DISTRIBUTOR EL. 524.75
THROAT DIA. = 220 IN.
EL. 515.25
EL. 475.00
79'-6"
85'-0"
164'-6"
SECTION
LARGE UNIT
EL. 620.00
MAX. POOL EL. 610.00
MIN. POOL EL. 600.00
EL. 553.00
EL. 559.00
MAX. T.W. EL. 541.00
MIN. T.W. EL. 534.00
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EL. 510.00
THROAT DIA. 133 IN.
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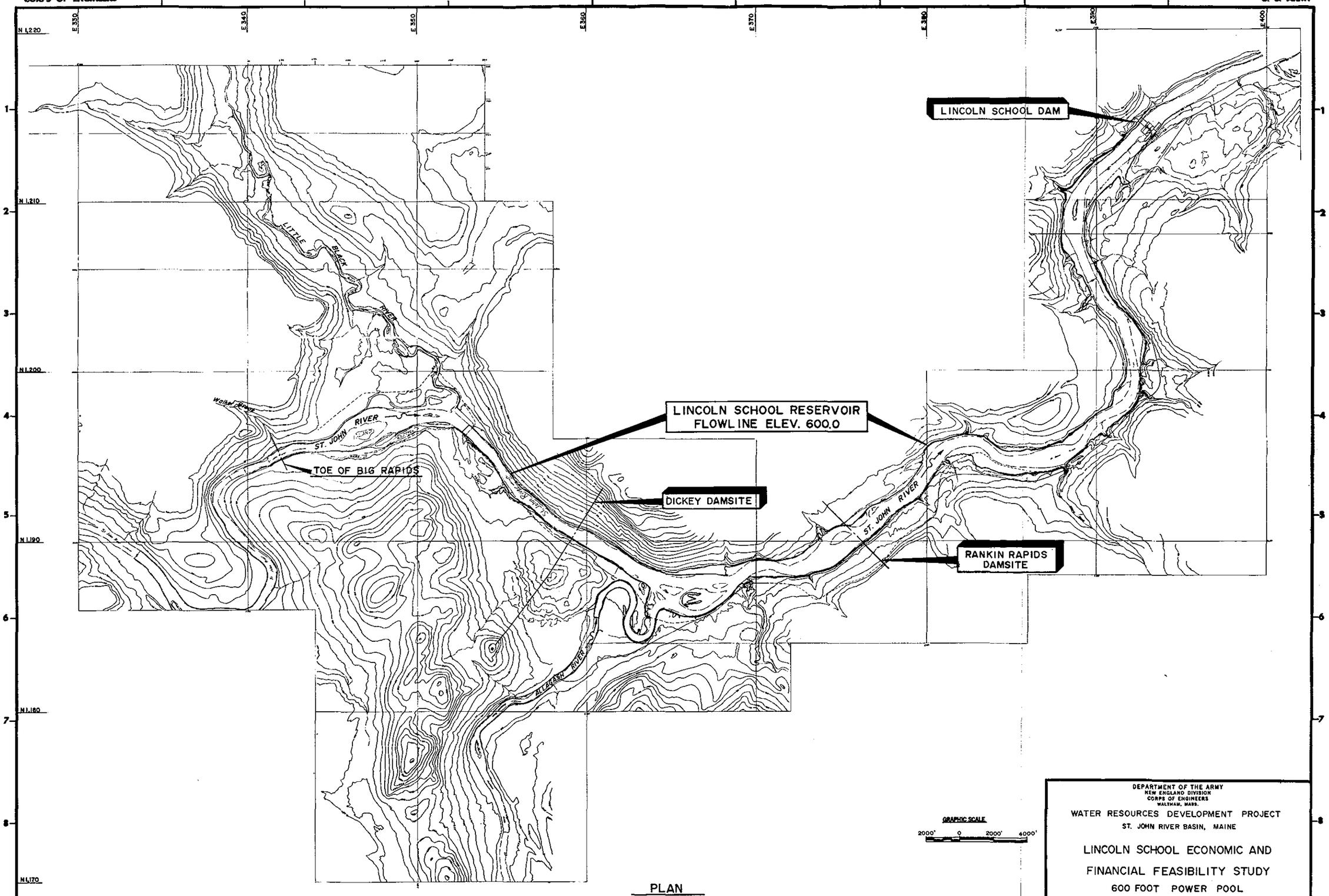
79'-6"
72'-0"
151'-6"
SECTION
SMALL UNIT
GRAPHIC SCALE
U. S. ARMY ENGINEER DIVISION, N. P.
PORTLAND, OREGON
LINCOLN SCHOOL PROJECT
SAINT JOHN RIVER BASIN, MAINE
POOL EL. 610.00
POWERHOUSE PLAN AND SECTIONS
SCALE AS SHOWN
SK. 2

CORPS OF ENGINEERS U. S. ARMY



PLAN
SCALE: 1" = 2000'

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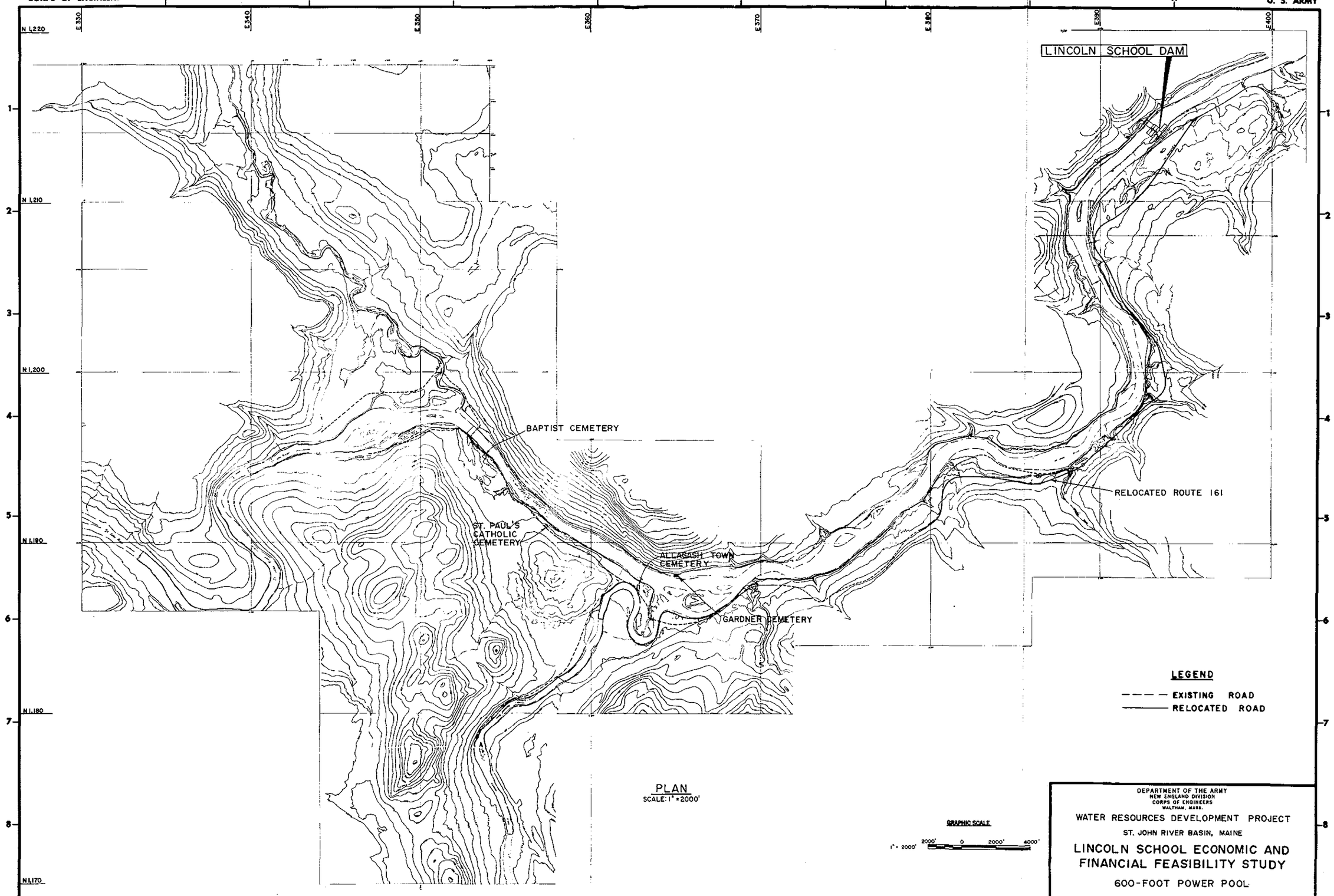
CORPS OF ENGINEERS
WALTHAM, MASS.

WATER RESOURCES DEVELOPMENT PROJECT
ST. JOHN RIVER BASIN, MAINE

LINCOLN SCHOOL ECONOMIC AND
FINANCIAL FEASIBILITY STUDY
600 FOOT POWER POOL
RESERVOIR PLAN
NOVEMBER 1982

PLATE 16

CORPS OF ENGINEERS U. S. ARMY



PLAN
SCALE: 1" = 2000'

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

WATER RESOURCES DEVELOPMENT PROJECT

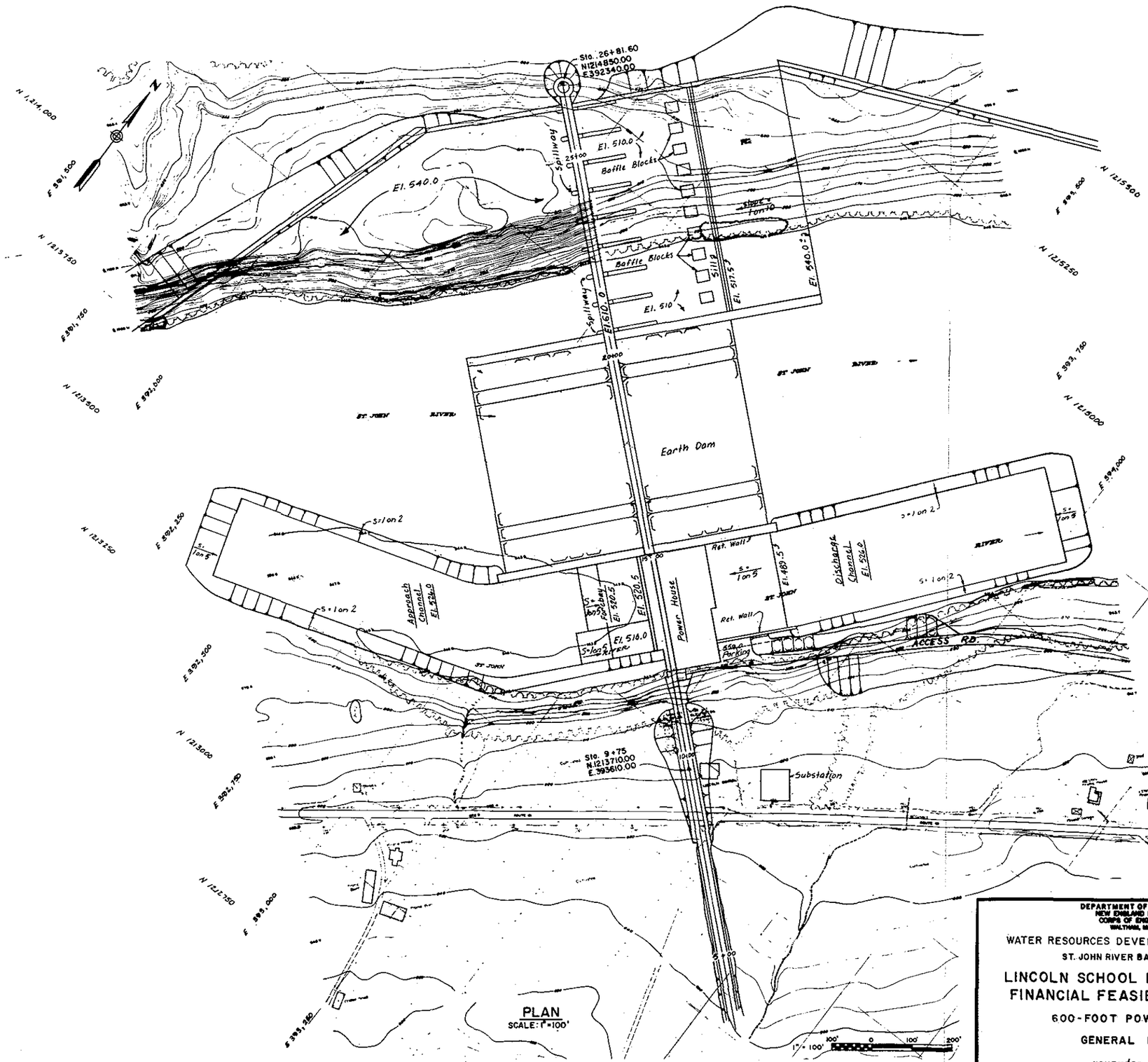
ST. JOHN RIVER BASIN, MAINE

LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY

600-FOOT POWER POOL

HIGHWAY & CEMETERY RELOCATION

NOVEMBER 1962



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CORPS OF ENGINEERS
WALTHAM, MASS.

WATER RESOURCES DEVELOPMENT PROJECT

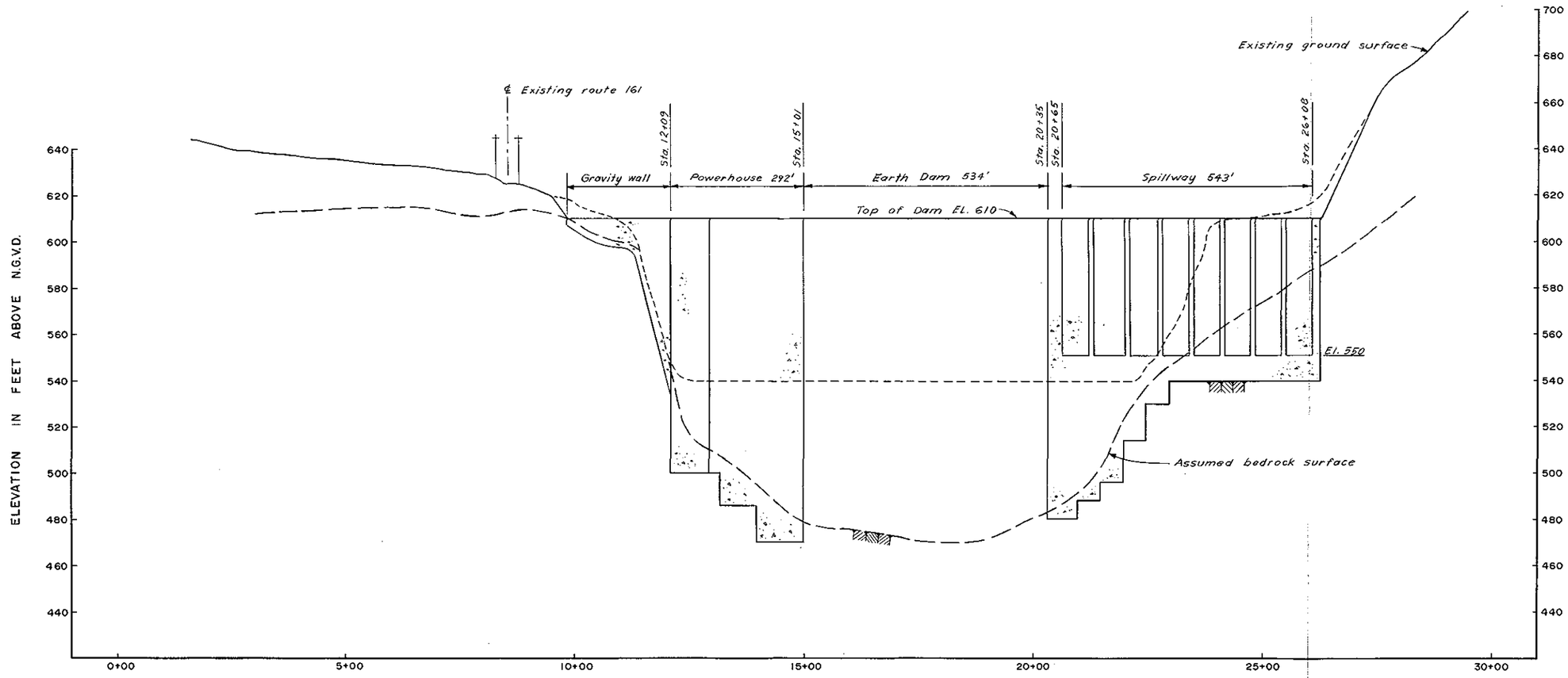
ST. JOHN RIVER BASIN, MAINE

LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY

600-FOOT POWER POOL

GENERAL PLAN

NOVEMBER 1982



℄ DAM PROFILE

SCALE: HORIZ. 1" = 100'
VERT. 1" = 20'

GRAPHIC SCALES

1" = 100' 100' 0 100' 200'

1" = 20' 20' 0 20' 40'

DEPARTMENT OF THE ARMY
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WALTHAM, MASS.

WATER RESOURCES DEVELOPMENT PROJECT

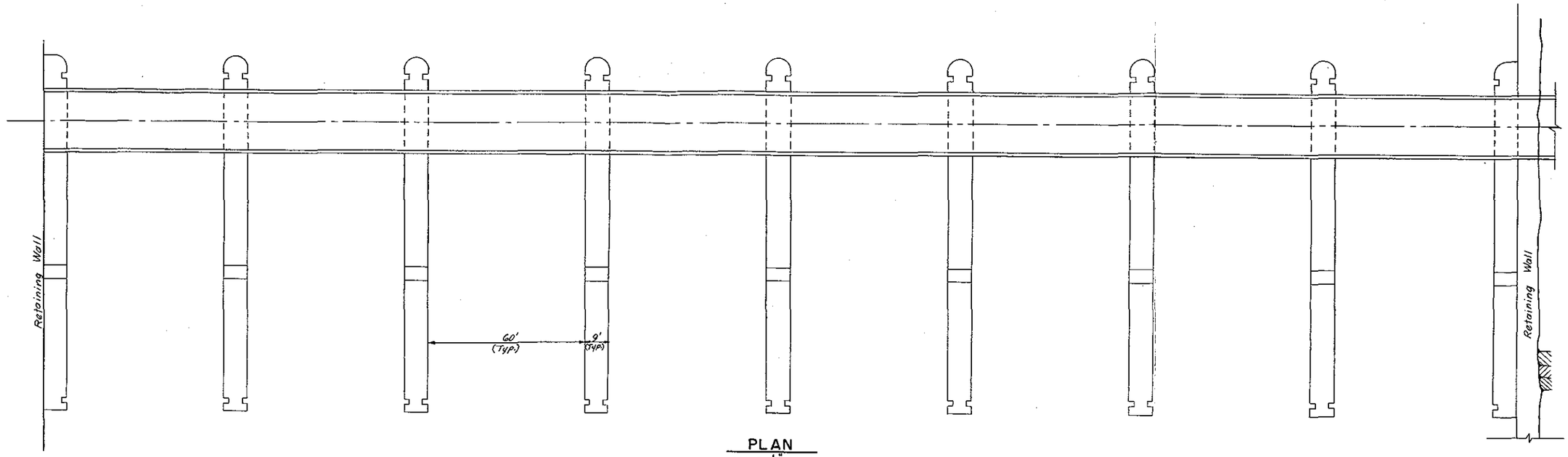
ST. JOHN RIVER BASIN, MAINE

LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY

600-FOOT POWER POOL

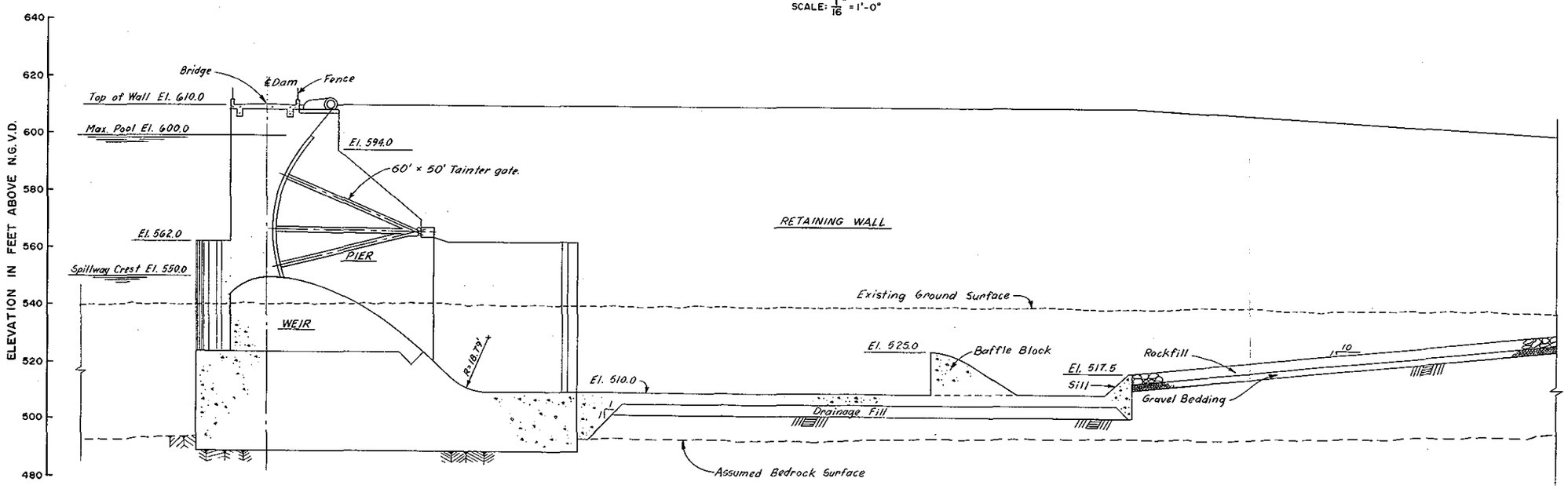
PROFILE ALONG ℄ OF DAM

NOVEMBER 1982



PLAN

SCALE: $\frac{1}{16}$" = 1'-0"



TYPICAL SPILLWAY SECTION

SCALE: $\frac{1}{16}$" = 1'-0"

GRAPHIC SCALE

$\frac{1}{16}$" = 1'-0" 8' 0 8' 16' 24' 32' 40'

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

WATER RESOURCES DEVELOPMENT PROJECT

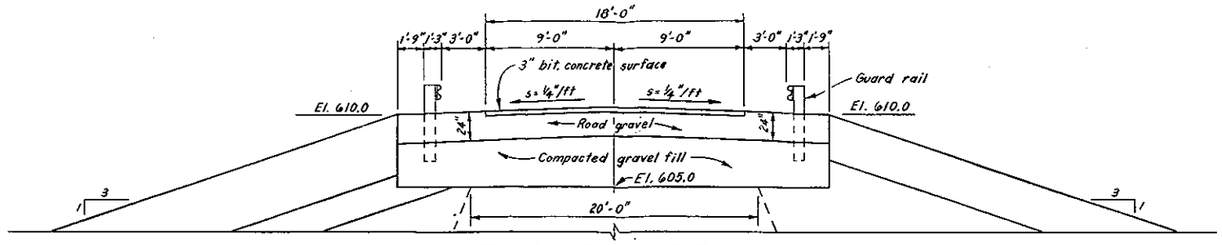
ST. JOHN RIVER BASIN, MAINE

LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY

600-FOOT POWER POOL

SPILLWAY PLAN AND SECTION

NOVEMBER 1982



TYPICAL ROAD SECTION

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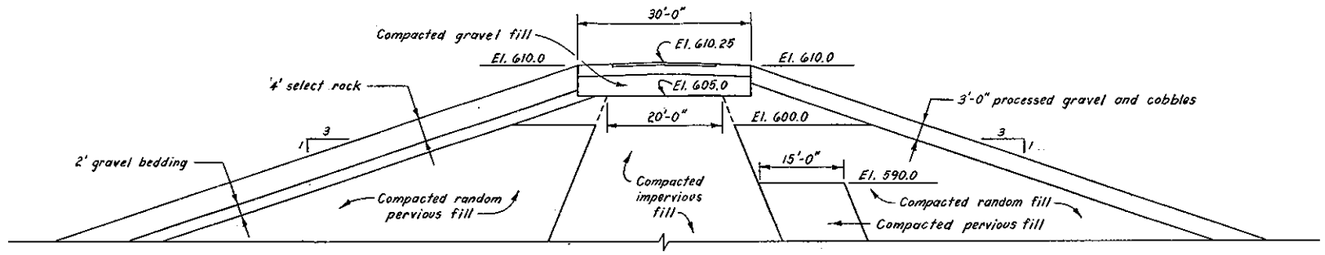
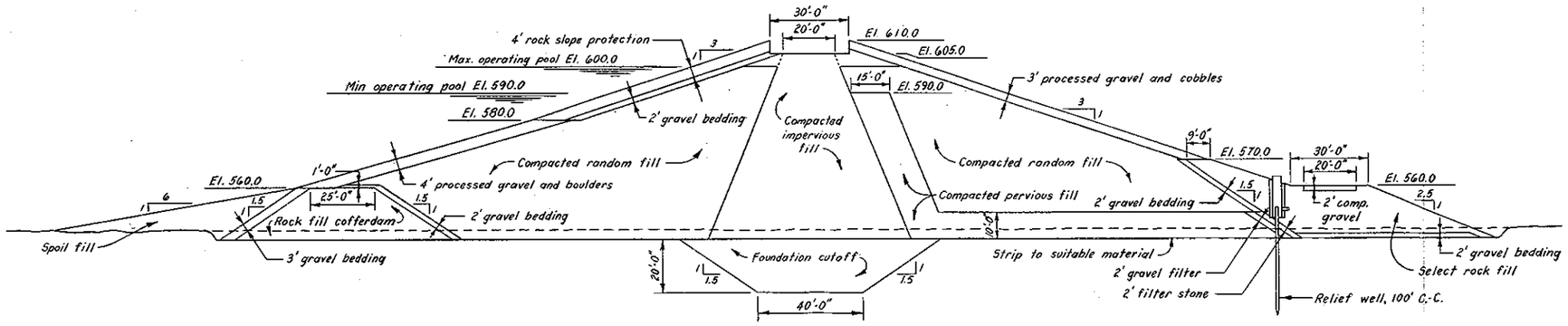


TOP OF DAM

SCALE: 1" = 10'



TYPICAL SECTION

SCALE: 1" = 20'

GRAPHIC SCALES

1" = 4' 4' 0 4' 8'

1" = 10' 10' 0 10' 20'

1" = 20' 20' 0 20' 40'

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

WATER RESOURCES DEVELOPMENT PROJECT

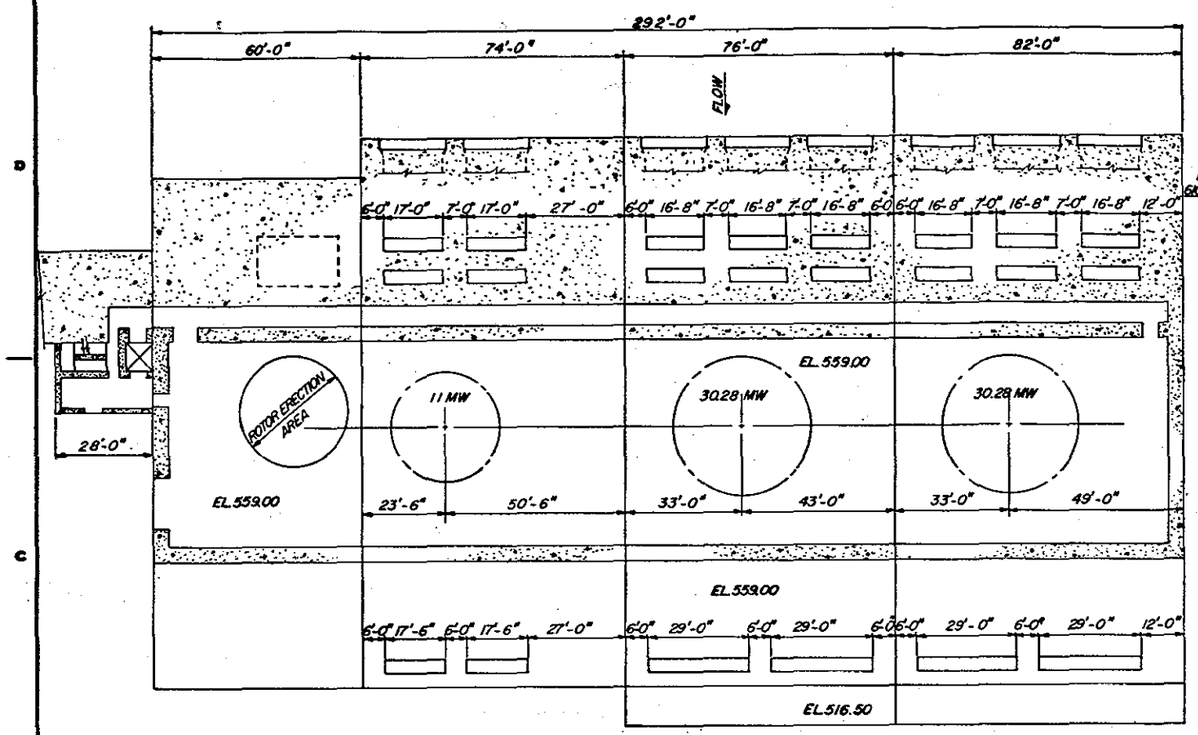
ST. JOHN RIVER BASIN, MAINE

LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY

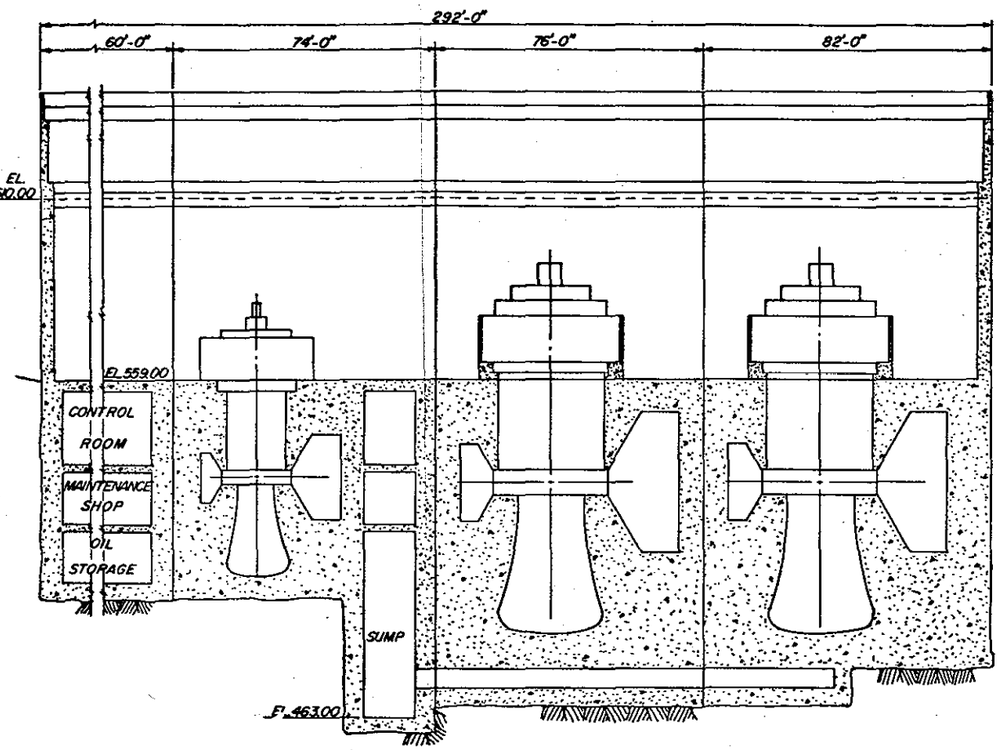
600-FOOT POWER POOL

TYPICAL DAM SECTIONS

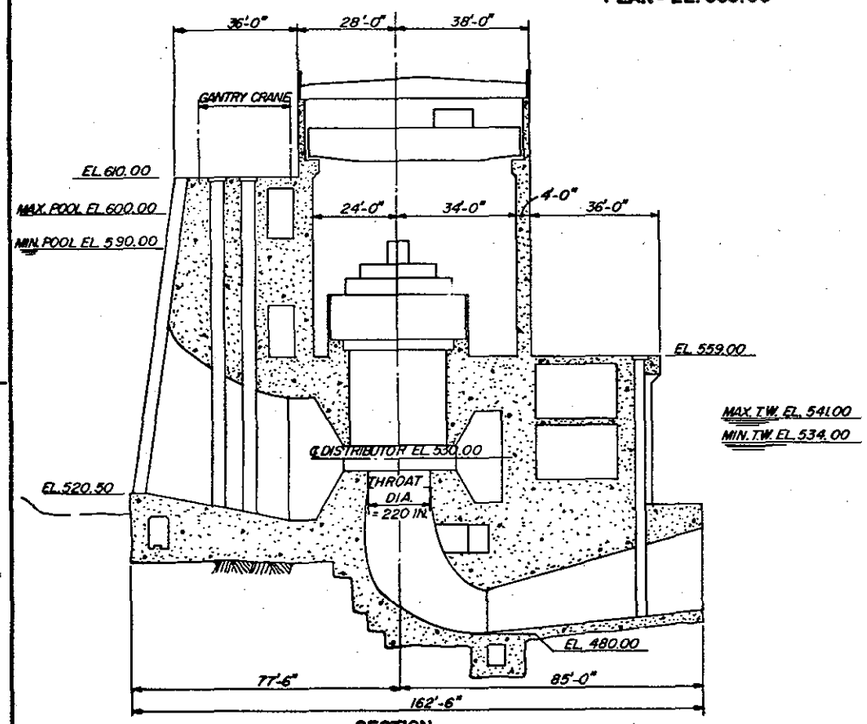
NOVEMBER 1982



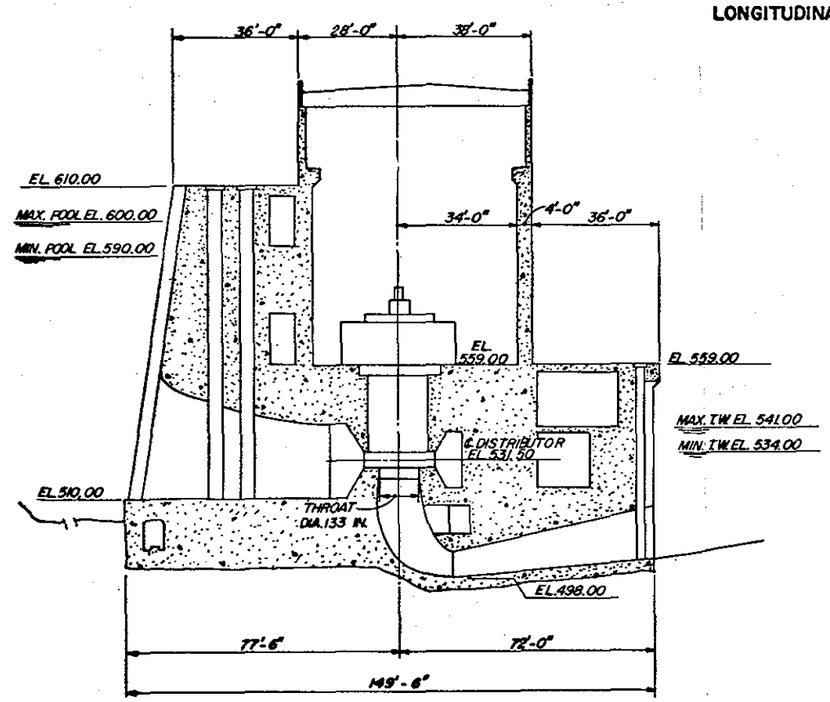
PLAN - EL. 559.00



LONGITUDINAL SECTION



SECTION
LARGE UNIT



SECTION
SMALL UNIT

GRAPHIC SCALE 1" = 1'-0" 0 8 16 24 32 40'

U. S. ARMY ENGINEER DIVISION, N. P.
PORTLAND, OREGON

LINCOLN SCHOOL PROJECT
SAINT JOHN RIVER BASIN, MAINE
POOL EL. 600.00

POWERHOUSE PLAN AND SECTIONS

DESIGNED BY V.R.
DRAWN BY P.G.R.
CHECKED BY K.J.L.
SCALE AS SHOWN
SHEET SK. 3

WATER RESOURCES DEVELOPMENT PROJECT
SAINT JOHN RIVER BASIN
LINCOLN SCHOOL HYDROELECTRIC PROJECT
MAINE

APPENDIX A

SPILLWAY DESIGN FLOOD

HYDROLOGIC ENGINEERING SECTION
WATER CONTROL BRANCH
ENGINEERING DIVISION

NOVEMBER 1982

WATER RESOURCES DEVELOPMENT
SAINT JOHN RIVER BASIN
LINCOLN SCHOOL HYDROELECTRIC PROJECT
MAINE

APPENDIX A
SPILLWAY DESIGN FLOOD

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WATER RESOURCES DEVELOPMENT
SAINT JOHN RIVER BASIN
LINCOLN SCHOOL HYDROELECTRIC PROJECT
MAINE

APPENDIX A
SPILLWAY DESIGN FLOOD

1. GENERAL

The spillway of the Lincoln School Hydroelectric Project would be designed to safely discharge the probable maximum flood. This flood was computed by applying probable maximum rainfall excess plus snowmelt to adopted unit hydrographs in accordance with procedures set forth in EM 1110-2-1405, "Flood Hydrograph Analysis and Computations" dated 31 August 1959.

In past studies for the Dickey-Lincoln School complex, the Lincoln School spillway was designed to discharge the probable maximum flow from the uncontrolled Allagash watershed plus the coincident peak discharge from Dickey as modified by surcharge storage. Without the surcharge storage effect of Dickey, the probable maximum flood discharge at Lincoln School is increased from the former 318,500 cfs to the present design discharge of 613,000 cfs. This appendix presents the hydrologic analysis of the spillway design flood at Lincoln School without the upstream Dickey project. Included are sections on unit hydrograph analysis, probable maximum precipitation and snowmelt determinations, design flood computations, design headwater and tailwater and spillway requirements.

2. REFERENCES

Hydrologic analyses of the spillway design floods for the formerly planned twin dams, Dickey-Lincoln School complex, were presented in the following Design Memoranda:

a. Dickey-Lincoln School Lakes, Design Memorandum No. 2, Section III, "Dickey Dam - Spillway Design Flood", May 1975.

b. Dickey-Lincoln School Lakes Design Memorandum No. 2, Section IV, "Lincoln School Dam - Spillway Design Flood", April 1976.

3. WATERSHED DESCRIPTION

The Saint John River basin with a total drainage area of 21,600 square miles, shown on figure A-1, is located in northern Maine and in

the adjacent Canadian Provinces of Quebec and New Brunswick, between the watersheds of the St. Lawrence River to the north and the Penobscot River to the south. A map delineating the upper Saint John watershed above Fort Kent, Maine (D.A. = 5,960 square miles) and above the Lincoln School damsite is shown on figure A-2. The Lincoln School damsite is located on the Saint John River about 19 miles above Fort Kent and about 10 miles below the mouth of the Allagash River tributary. The drainage area of the Saint John River at Lincoln School is 4,086 square miles. This area is made up of 2,700 square miles of Saint John River watershed above the USGS gage at Dickey, 1,250 square miles of Allagash River area above the gage at Allagash and an intervening local area between the two gages and Lincoln School of 136 square miles. Both the upper Saint John and Allagash are entirely wooded gently rolling watersheds with numerous swamps and ponds. Elevations vary from about 1,900 feet NGVD in the upper southwestern end of the watershed to 545 feet NGVD at the Lincoln School damsite. The average gradient of the Saint John River above Lincoln School is about 7 feet per mile and the Allagash tributary about 4 feet per mile.

4. STREAMFLOW RECORDS

Streamflow is recorded on the Saint John River at Dickey, Maine upstream of the Allagash River and on the Allagash River at Allagash, Maine, by the US Geological Survey. The gage at Dickey, with a drainage area of 2,700 square miles, has been in operation since 1947. The gage on the Allagash River at the town of Allagash, with a drainage area of 1,250 square miles, has been in operation since 1932. Average monthly flows as recorded at the two gages are listed in table A-1. The five peak flows of record at the two gage sites and the computed peak flows at the Lincoln School site, based on the gage records are listed in table A-2. Values are listed both for all seasons and for the nonsnowmelt summer season, June through November.

5. UNIT HYDROGRAPH ANALYSIS

The Lincoln School watershed was divided into two subwatersheds for unit hydrograph analysis. The Saint John River above the former Dickey damsite (D.A. = 2,725 square miles) was treated as one subwatershed and the Allagash at the gage plus the remaining local to Lincoln School (D.A. = 1,361 square miles) as the other subwatershed. Unit hydrograph analyses were previously performed for the two subwatersheds and reported in the referenced 1975 and 1976 design memoranda. In the earlier studies a unit graph was developed for the Dickey watershed without Dickey Lake and then unit graphs were developed for computing inflows to a full Dickey Lake. Earlier information developed for the Dickey watershed without

TABLE A-1

MONTHLY FLOWS

	St. John River at Dickey, Maine D.A. = 2,700 sq. mi. 1947-1981			Allagash River near Allagash, Maine D.A. = 1,250 sq. mi. 1932-1981			St. John River at Lincoln School D.A. = 4,086 sq. mi. 1947-1981
	Mean (cfs)	Maximum (cfs)	Minimum (cfs)	Mean (cfs)	Maximum (cfs)	Minimum (cfs)	Mean (cfs)
January	1,301	3,059	341	671	1,865	192	2,080
February	1,105	3,902	201	554	2,224	119	1,793
March	1,611	9,249	378	720	3,610	181	2,450
April	12,740	27,790	3,989	4,141	10,100	623	17,562
May	17,200	35,100	5,660	7,032	13,550	2,631	25,082
June	4,548	10,840	1,152	2,315	4,554	719	6,968
July	2,677	9,041	904	1,426	4,053	365	4,060
August	2,846	11,740	265	1,182	5,292	165	4,235
September	2,772	7,655	397	1,097	3,133	122	4,050
October	3,435	11,280	690	1,229	4,121	149	4,734
November	3,955	10,180	605	1,513	4,628	235	5,609
December	2,589	9,781	624	1,137	4,549	215	3,930
Annual	4,745	7,193	2,843	1,925	2,899	989	6,900

TABLE A-2

PEAK FLOWS
ALL SEASON

Saint John River at Dickey, Maine (DA = 2,700 sq. mi.) 1947-1981		Allagash River Near Allagash Gage (DA = 1250 sq. mi.) 1947-1981		Saint John River at Lincoln School (DA = 4086 sq. mi.) 1947-1981	
Date	Discharge (cfs)	Date	Discharge (cfs)	Date	Discharge (cfs)
29 Apr 79	86,800	17 May 61	28,000	29 Apr 79	117,840
7 Aug 81	76,100	29 Apr 73	27,200	15 May 61	101,160
10 May 69	71,400	29 Apr 79	26,700	29 Apr 73	95,870
15 May 61	71,200	2 May 74	24,800	10 May 69	95,470
25 Apr 58	70,200	10 May 69	20,500	2 May 74	94,100

SUMMER SEASON
(JUNE - NOVEMBER)

Date	Discharge (cfs)	Date	Discharge (cfs)	Date	Discharge (cfs)
7 Aug 81	76,100	11 Aug 76	20,100	7 Aug 81	87,735
12 Aug 76	50,800	29 Jun 54	11,700	11 Aug 76	69,870
10 Nov 63	35,000	9 Nov 63	11,600	10 Nov 63	47,450
1 Jun 79	33,100	1 Jun 61	10,100	1 Jun 79	44,395
30 Nov 50	31,700	18 Aug 81	10,000	29 Jun 54	43,830

Dickey Lake was utilized in the current unit graph analysis for the Lincoln School project without Dickey.

The unit hydrograph studies reported in 1975 and 1976 involved detailed analyses of selected nonsnowmelt rainfall-runoff events. Current studies utilized the earlier study results plus included an analysis of the rainfall-snowmelt flood of record experienced in April 1979. The unit hydrograph analysis of the April 1979 event on each of the two subwatersheds was as follows:

a. The total volume of runoff in the recorded flood hydrographs was determined.

b. The time distribution of the total rainfall-snowmelt excess was estimated based on recorded daily rainfalls, temperatures and the timing of the recorded hydrographs.

c. Using the adopted rainfall-snowmelt runoff distribution and the HEC-1 computer program: "Flood Hydrograph Package", unit hydrographs were determined which would produce a reasonable reproduction of the recorded hydrographs.

The April 1979 flood analysis for the Dickey and Allagash subwatersheds is graphically illustrated on figure A-3.

It was determined that the unit hydrographs developed using the record April 1979 flood event were quite comparable to those previously developed through analysis of lesser nonsnowmelt events. Therefore, the same unit graphs were adopted for use in both snowmelt and nonsnowmelt flood computations.

The unit hydrograph developed for the Allagash watershed was adjusted to reflect the added draingage area between the mouth of the Allagash and the Lincoln School site. The hydrograph was adjusted by direct drainage area ratio. Also, in accordance with EM 1110-2-1405, the peak ordinates of all developed unit graphs were increased 50 percent for design to reflect the increased runoff rate expected under greater and more intense rainfall. Pertinent data on the adopted spillway design unit hydrographs for the two subwatersheds are listed in table A-3.

6. PROBABLE MAXIMUM RAINFALL AND SNOWMELT

a. General. The probable maximum flood was analyzed with various probable maximum storm orientations over the Lincoln School watershed:

TABLE A-3

UNIT HYDROGRAPH CHARACTERISTICS

	Saint John River at Dickey	Allagash Plus Local
D.A. (sq. miles)	2,725	1,361
TR (hrs.)	6	6
Q_p (cfs)	46,500	21,500
q (csm)	17.2	15.8
T_p (hrs.)	19	14
C_T	1.43	1.20
$C_p 640$	327	221
L (miles)	112	91
L_{ca} (miles)	50	40
S (ft/mile)	7	4

(1) Storm centered over Allagash watershed, residual over Dickey.

(2) Storm centered over Dickey watershed, residual over Allagash.

(3) Storm centered between Allagash and Dickey subwatersheds.

Comparative floods were also developed using the all season probable maximum rainfall without snowmelt and the spring season (April-May) probable maximum rainfall with snowmelt.

b. Precipitation. Precipitation data was taken from a special report entitled: "Probable Maximum Precipitation for the Saint John River above Dickey Damsite and Between Dickey and Lincoln School Damsites" dated December 1966.

This report was prepared by the Hydrometeorological Branch of the US Weather Bureau at the request of the Corps of Engineers. A copy of this report was included as Appendix A in the referenced 1975 Spillway Design Flood Design Memoranda for Dickey Dam.

The all season probable maximum rainfall over the two subwatersheds, with the storm centered over the Allagash (most critical storm orientation) is shown in table A-4. The spring season (April-May) probable maximum rainfall was reported by the Weather Bureau to be 86 percent of the all season rainfall. Minimum rainfall losses for infiltration, surface detention, evapotranspiration, etc. were assumed 0.05 inches per hour.

c. Snowmelt. Snowmelt was computed using the following formula taken from volume 4, "Hydrologic Engineering Methods for Water Resources Development" dated 1973.

$$M = .09 + (.029 + .0084\ KW + .007R)(T-TF)$$

where:

M = Snowmelt in inches
k = Convection minus condensation melt constant for a basin which represents the mean exposure of the basin: 0.3 for a densely forested basin to 1.0 for an unforested basin.
W = Wind speed in miles per hour at 50 feet above the snow
R = Rainfall in inches per day
T = Air temperatures in degrees Fahrenheit at the 10-foot level
TF = Temperature of the snowpack in degrees Fahrenheit, usually assumed to be 32° Fahrenheit for a melting snowpack

Snowmelt was computed assuming a temperature of 51° Fahrenheit (average for May), with a wind speed of 10 miles per hour, a constant k equal to .3, and the May probable maximum precipitation. The resulting probable maximum snowmelt is listed in table A-4.

7. SPILLWAY DESIGN FLOOD

The spillway design flood at Lincoln School was computed by applying the probable maximum rainfall, with and without snowmelt, to the adopted subwatershed unit hydrographs and combining two hydrographs at Lincoln School. The developed hydrographs were added to an assumed base flow of 20,430 cfs at Lincoln School equivalent to 5 cfs per square mile of watershed.

Because of the relatively small amount of surcharge storage at Lincoln School no storage routing was performed and it was assumed outflow equalled inflow.

Floods were computed using the all season PMP storm with various storm orientations, and the spring season PMP with snowmelt. The condition resulting in the highest rate of flow at Lincoln School was with the spring season probable maximum storm, plus snowmelt, centered over the Allagash, and the residual over the Dickey watershed. The resulting peak discharge at Lincoln School was 613,000 cfs which was adopted as the spillway design flood discharge.

This spillway design flood at Lincoln School is 92 percent greater than the original Lincoln School design flood with the upstream Dickey project. The original flood of 318,500 cfs resulted from the all season PMP centered over the Allagash producing a peak flow from the Allagash and local area of 210,300 cfs and a coincident peak Dickey outflow of 97,500 cfs.

Comparative flood discharges without the Dickey project are listed in table A-5. The development of the adopted Lincoln School spillway design flood is graphically illustrated on figures A-4 and A-5.

8. LINCOLN SCHOOL HEAD POOL

The Lincoln School project would be equipped with tainter gates of sufficient size and number to make discharges up to the magnitude of the spillway design flood, with a maximum head pool level not to exceed 5 feet of surcharge above maximum power pool level. The five feet design surcharge is provided to permit the development of a gate opening schedule. The guide taking line for the head pool would be to the 5-foot surcharge elevation as previously determined in Real Estate studies for the Dickey-Lincoln School

TABLE A-4

PROBABLE MAXIMUM RAINFALL
AND SNOWMELT

Time (Hrs)	Allagash Watershed Plus Local (D.A. = 1,361 sq. mi.)			Dickey Watershed (D.A. - 2,725 sq. mi.)		
	All Season Rainfall (inches)	Spring Season Rainfall (inches)	Snowmelt (inches)	Residual All Season Rainfall (inches)	Residual Spring Season Rainfall (inches)	Snowmelt (inches)
6	.1	.08	.30	.09	.08	.30
12	.1	.08	.30	.09	.08	.30
18	.2	.17	.32	.2	.17	.32
24	.3	.26	.32	.3	.26	.32
30	.6	.52	.59	.5	.43	.55
36	2.1	1.81	.59	1.8	1.55	.55
42	6.9	5.93	.59	5.9	5.07	.55
48	.8	.69	.59	.7	.60	.55
54	.3	.26	.32	.3	.26	.32
60	.2	.17	.32	.2	.17	.32
66	.1	.08	.30	.09	.08	.30
72	.1	.08	.30	.09	.08	.30
Totals	11.8	10.14	4.85	10.3	8.82	4.67

TABLE A-5

PROBABLE MAXIMUM FLOOD DISCHARGES

Storm Event	Allagash & Local Watershed Flow (D.A. = 1,361 sq. mi.)	Dickey Watershed Flow (D.A. = 2,725 sq. mi.)	Lincoln School Flow (D.A. = 4,086 sq. mi.)
All season PMP centered over Allagash, residual over Dickey	193,800	340,300	518,300
All season PMP centered over Dickey, residual over Allagash	154,000	374,200	515,600
All season PMP centered between Allagash and Dickey	172,000	358,000	516,500
Spring season PMP centered over Allagash with snowmelt	223,800	402,200	613,000*

*Adopted Lincoln School spillway design flood discharge

Lakes complex. The Lincoln School dam would be designed for 5 feet of freeboard above maximum design surcharge, in accordance with EC 1110-2-27, thus top of dam would be 10 feet above maximum power pool.

In summary, if a maximum power pool elevation of 620 feet NGVD was selected, the design surcharge along with the land taking would be to elevation 625 and top of dam would be elevation 630 feet NGVD. Similarly, if a maximum power pool of 610 or 600 feet NGVD was selected, the required surcharge, guide taking and top of dam elevations would be reduced 10 and 20 feet, respectively. A storage capacity curve for the Lincoln School head pool is shown in figure A-6. Because of the relatively small amount of surcharge storage capacity, the spillway design flood was not routed through storage and it was assumed outflow would equal inflow.

9. TAILWATER RATING

Tailwater levels at the Lincoln School damsite are a function of both the discharge of the Saint John River and the concurrent flow of the St. Francis River located about 1 mile downstream of the proposed damsite. Therefore, it was necessary to develop a series of tailwater rating curves at Lincoln School reflecting various contributions from the St. Francis River. These curves were expanded to include flows up to the probable maximum discharge of 613,000 cfs. The computer program, "Water Surface Profiles", developed by the Corps of Engineers Hydrologic Engineering Center, Davis, California was utilized to develop these rating curves. The relatively flat nature of the Saint John River necessitated a hydraulic analysis beginning approximately 6 miles downstream from the damsite utilizing normal flow depth. This analysis was performed utilizing channel surveys and available overbank data from the most recent mapping of the area.

The tailwater rating curves developed indicate that under the most remote condition of concurrent SDF flows on the Saint John at Lincoln School and on the St. Francis River, that the tailwater elevation at Lincoln School dam would be approximately elevation 581 feet NGVD. Tailwater to this elevation would not have any significant effect on spillway capacity. The developed tailwater rating curves are shown on figure A-7.

10. SPILLWAY REQUIREMENTS

The spillway requirements at Lincoln School would be provided by eight 50-foot high by 60-foot wide tainter gates, or the equivalent, capable of passing the revised spillway design discharge of 613,000 cfs with a maximum surcharge head of 55 feet. It was determined that the flow could be discharged with a very minimum of seven gates though eight gates were adopted. This is twice the number of gates originally required at Lincoln School in tandem with the upstream Dickey project.

Discharge capacity through the tainter gate openings was computed using the following formula from EM 1110-2-1603:

$$Q = C\left[L - 2\,(N\,K_p + K_q)H_e\right]H_e^{3/2}$$

Q = Discharge in cfs

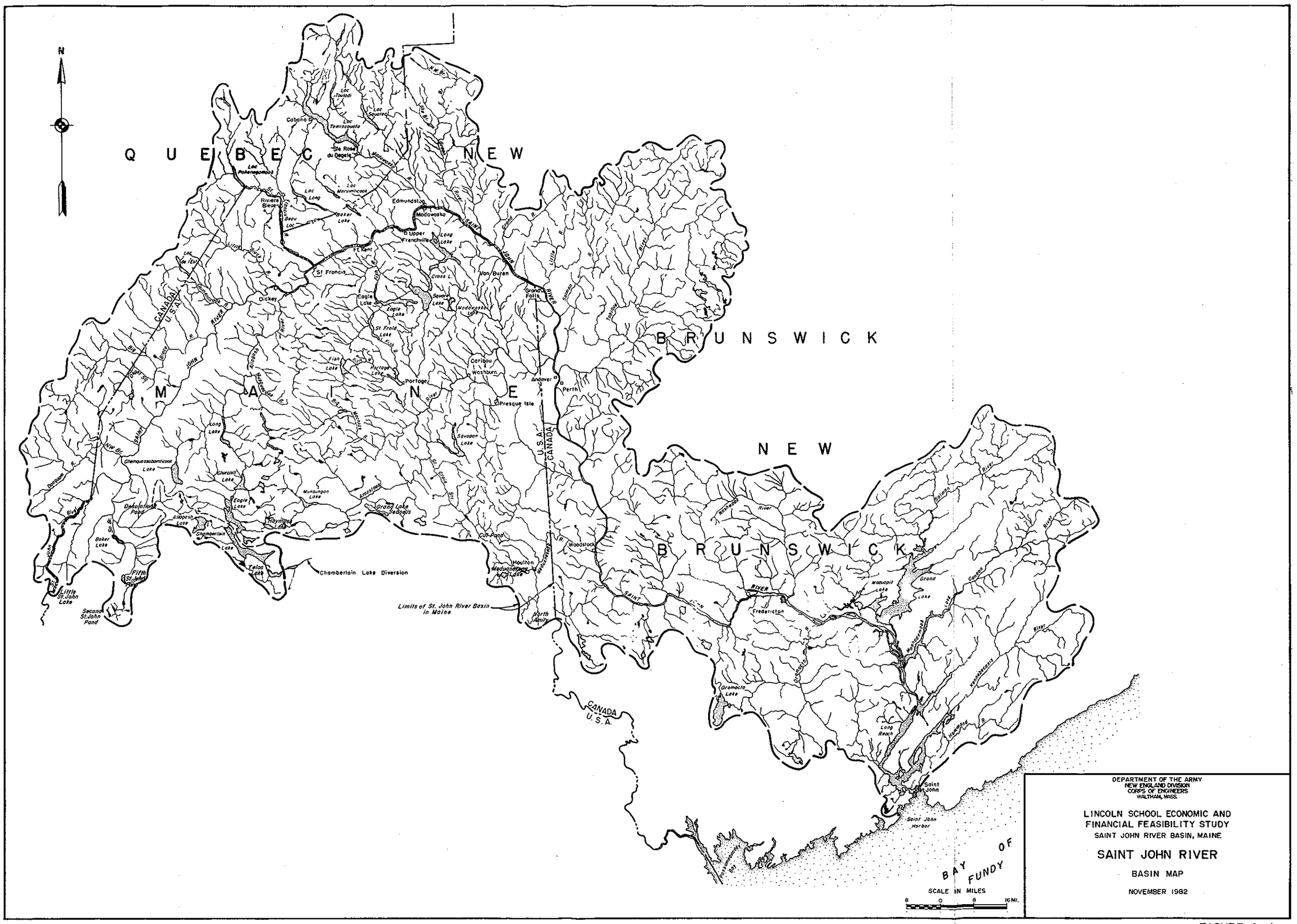
c = Discharge coefficient equal to 3.85 for H_e/H_d of 1.0 and P/H_d of 0.25

L = Total width of bays

N = Number of piers

K_p & K_q = Pier and abutment coefficients, 0.015 and 0.18, respectively

H_e = Design head equals 55 feet



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WALTHAM, MASS.

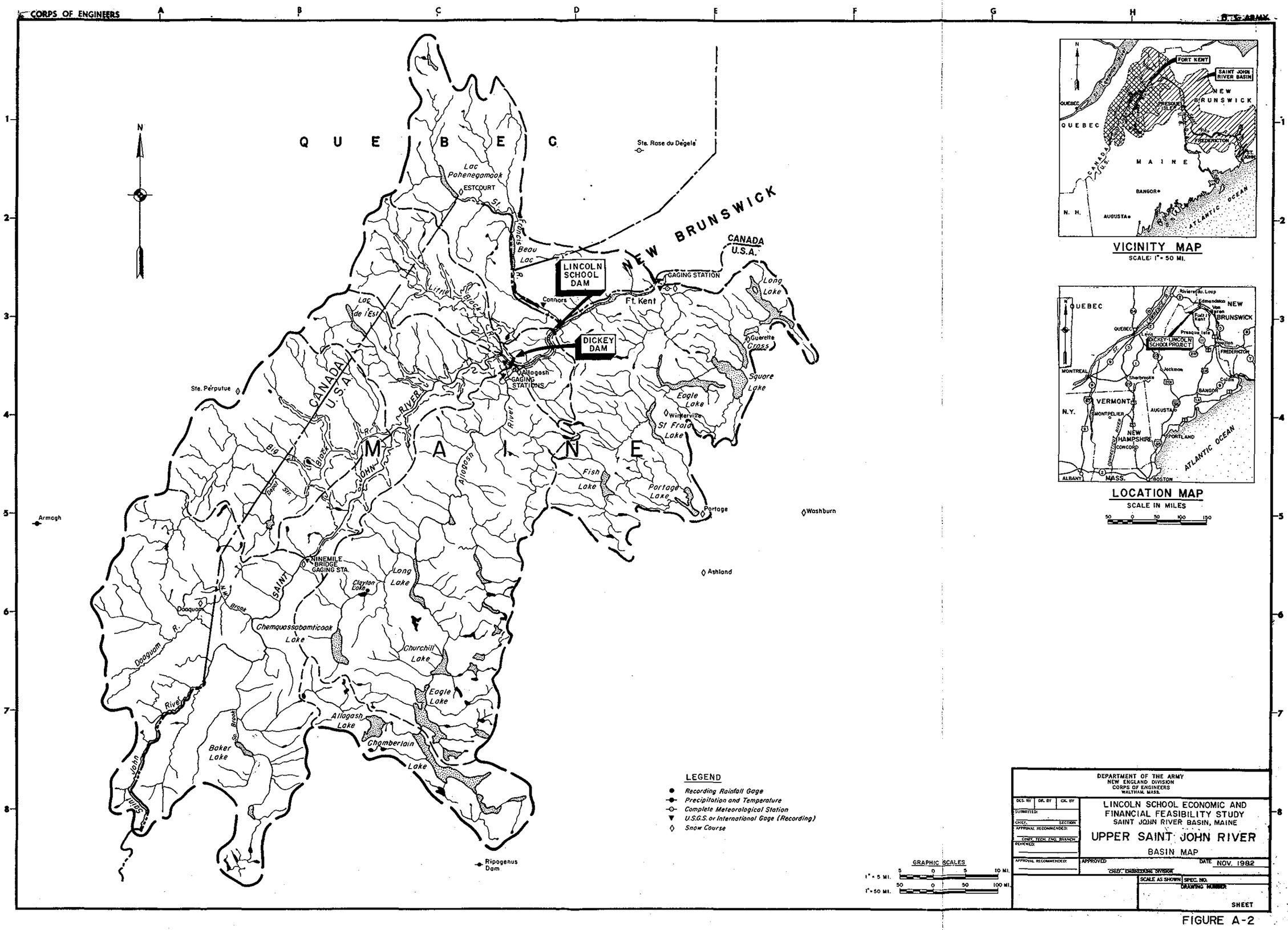
LINCOLN SCHOOL ECONOMIC AND
FINANCIAL FEASIBILITY STUDY
SAINT JOHN RIVER BASIN, MAINE

SAINT JOHN RIVER

BASIN MAP

NOVEMBER 1982

FIGURE A-1


CORPS OF ENGINEERS
U.S. ARMY
QUEBEC
NEW BRUNSWICK
MAINE
CANADA
U.S.A.
Lac Pohenegamook
ESTCOURT
Ste. Rose du Degele
Beau Lac
LINCOLN SCHOOL DAM
DICKEY DAM
GAGING STATION
Ft. Kent
Connors
Long Lake
Guerette Cross
Square Lake
Eagle Lake
Winterville
St Froid Lake
Fish Lake
Portage Lake
Portage
Washburn
Ashland
Allagash
GAGING STATIONS
Lac de l'Est
Little Black
Ste. Perpetue
Armagh
Big Black
Depot Str.
SAINT JOHN RIVER
Allagash River
NINEMILE BRIDGE GAGING STA.
Clayton Lake
Long Lake
Chemquassabamticook Lake
Churchill Lake
Eagle Lake
Allagash Lake
Chamberlain Lake
Baker Lake
Daaquam
Daaquam R.
N.W. Brook
So. Brook
Saint John River
Ripogenus Dam
LEGEND
Recording Rainfall Gage
Precipitation and Temperature
Complete Meteorological Station
U.S.G.S. or International Gage (Recording)
Snow Course
GRAPHIC SCALES
1" = 5 MI.
1" = 50 MI.
FORT KENT
SAINT JOHN RIVER BASIN
NEW BRUNSWICK
QUEBEC
MAINE
FREDERICTON
ST. JOHN
BANGOR
AUGUSTA
N. H.
ATLANTIC OCEAN
VICINITY MAP
SCALE: 1" = 50 MI.
QUEBEC
NEW BRUNSWICK
DICKEY-LINCOLN SCHOOL PROJECT
MONTREAL
VERMONT
N.Y.
MONTPELIER
NEW HAMPSHIRE
CONCORD
PORTLAND
AUGUSTA
BANGOR
ALBANY
MASS.
BOSTON
ATLANTIC OCEAN
LOCATION MAP
SCALE IN MILES
DEPARTMENT OF THE ARMY
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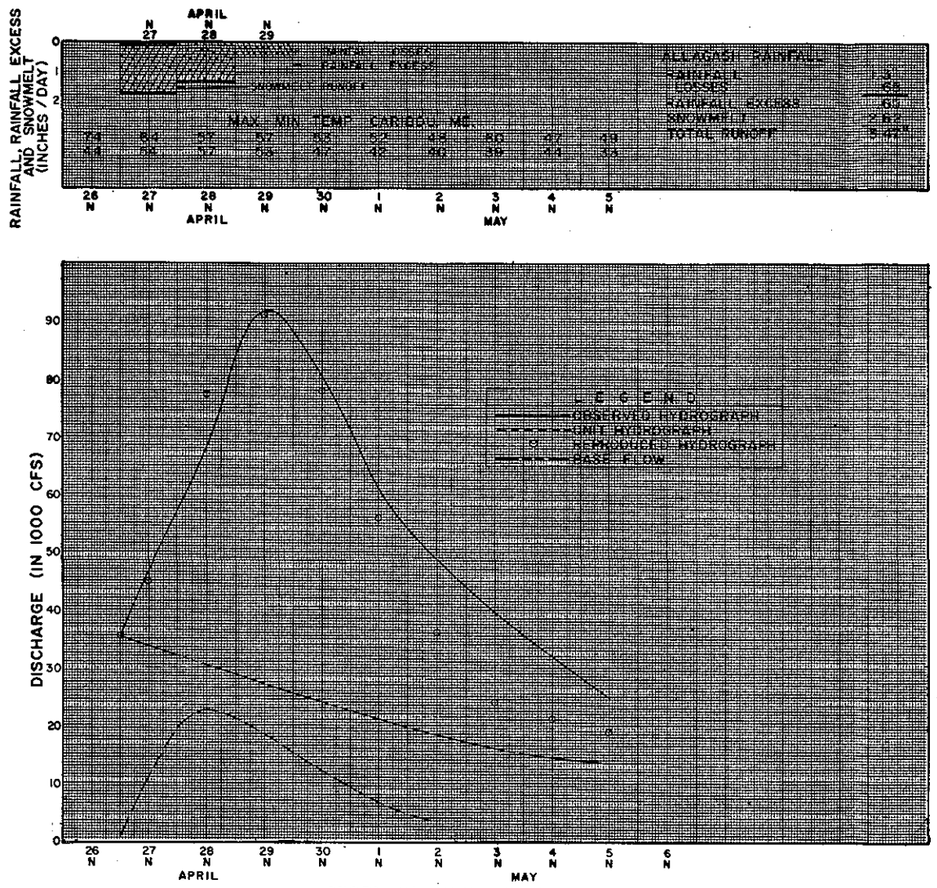
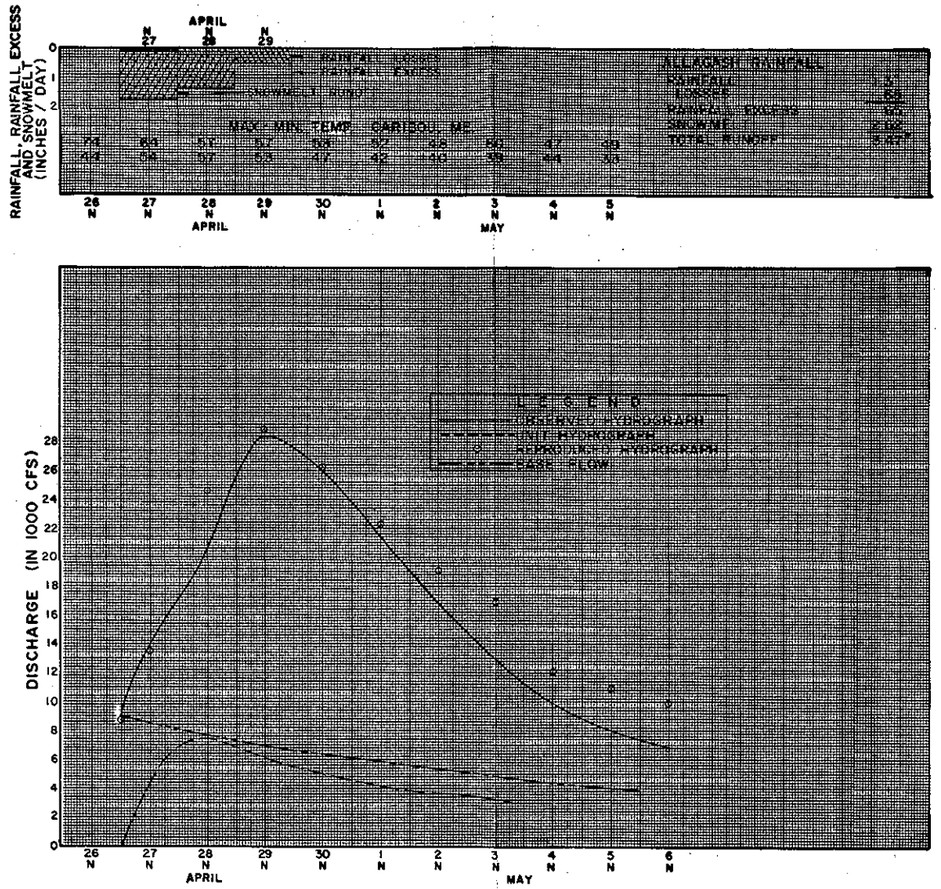
LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY
SAINT JOHN RIVER BASIN, MAINE
UPPER SAINT JOHN RIVER
BASIN MAP
DATE NOV. 1982
SCALE AS SHOWN
SHEET

FIGURE A-2



STORM OF APRIL 1979
ST. JOHN RIVER AT DICKEY GAGE
(DA = 2700 SQ. MI.)



STORM OF APRIL 1979
ALLAGASH RIVER AT ALLAGASH GAGE
(DA = 1250 SQ. MI.)

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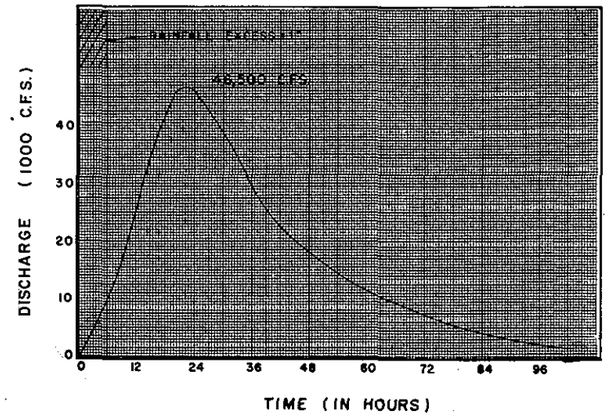
LINCOLN SCHOOL ECONOMIC AND
FINANCIAL FEASIBILITY STUDY
SAINT JOHN RIVER BASIN, MAINE

STORM OF APRIL 1979

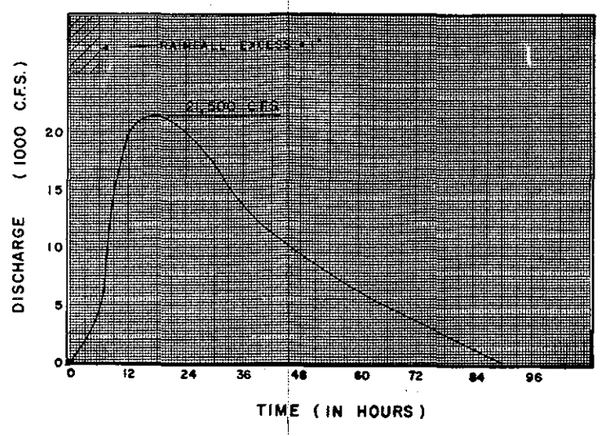
UNIT HYDROGRAPH ANALYSIS

NOVEMBER 1982

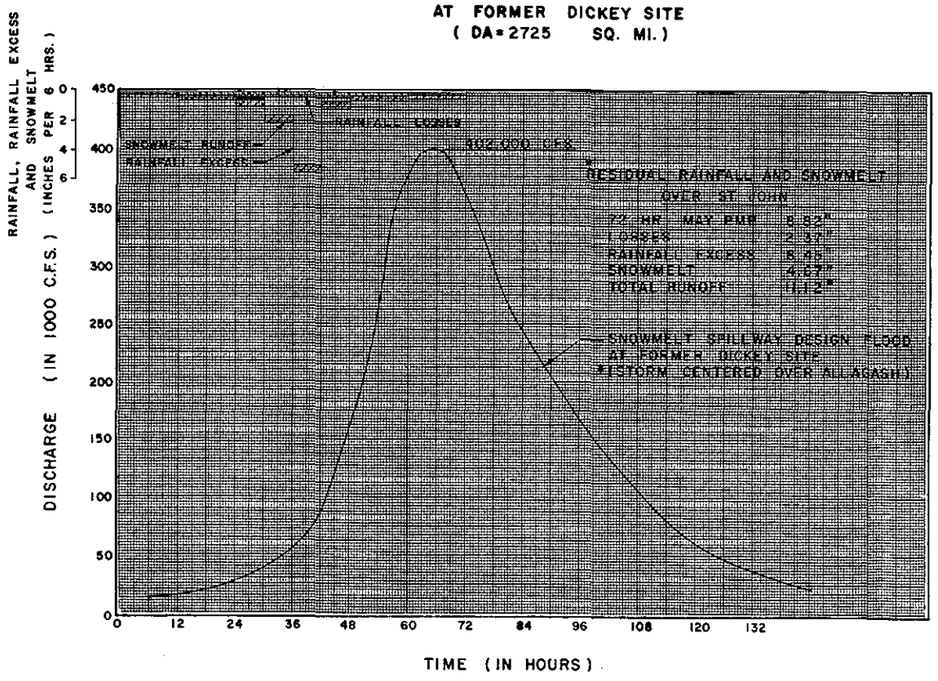
FIGURE A-3



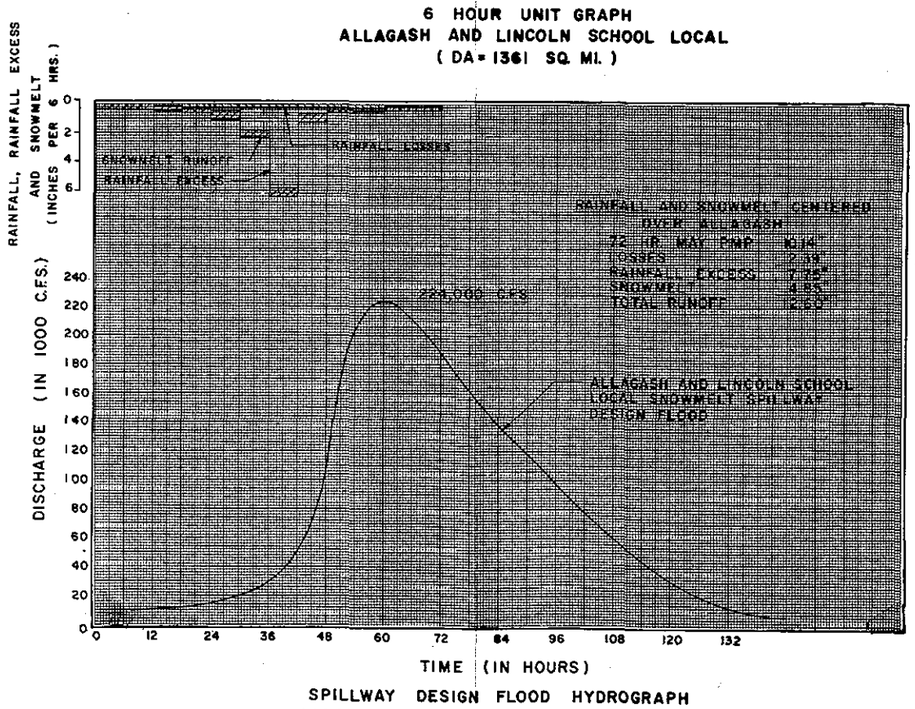
6 HOUR UNIT GRAPH
AT FORMER DICKEY SITE
(DA = 2725 SQ. MI.)



6 HOUR UNIT GRAPH
ALLAGASH AND LINCOLN SCHOOL LOCAL
(DA = 1361 SQ. MI.)



SPILLWAY DESIGN FLOOD HYDROGRAPH
AT FORMER DICKEY SITE
(DA = 2725 SQ. MI.)



SPILLWAY DESIGN FLOOD HYDROGRAPH
ALLAGASH AND LINCOLN SCHOOL LOCAL
(DA = 1361 SQ. MI.)

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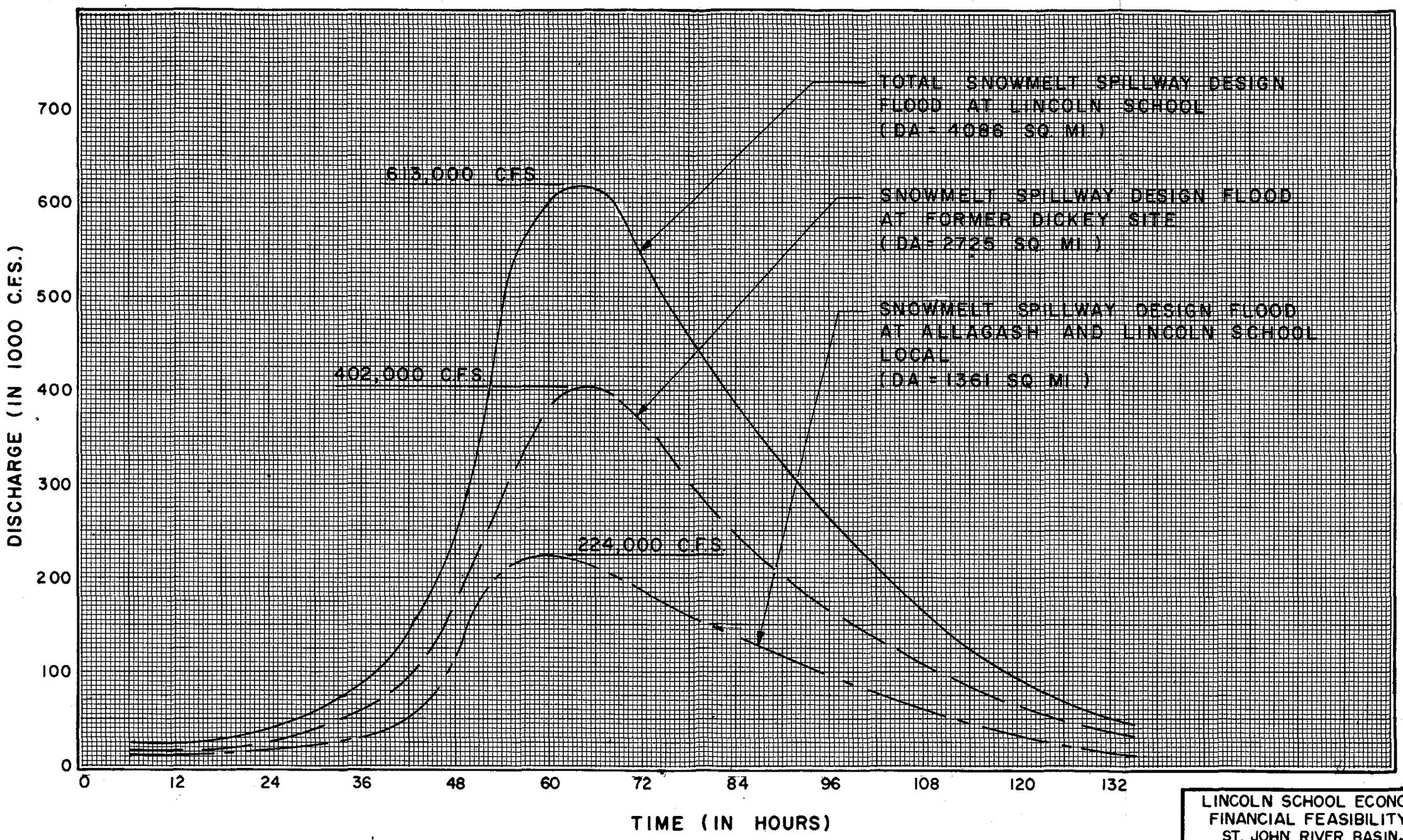
LINCOLN SCHOOL ECONOMIC AND
FINANCIAL FEASIBILITY STUDY
SAINT JOHN RIVER BASIN, MAINE

SNOWMELT SPILLWAY DESIGN

FLOOD COMPONENTS
AT
LINCOLN SCHOOL

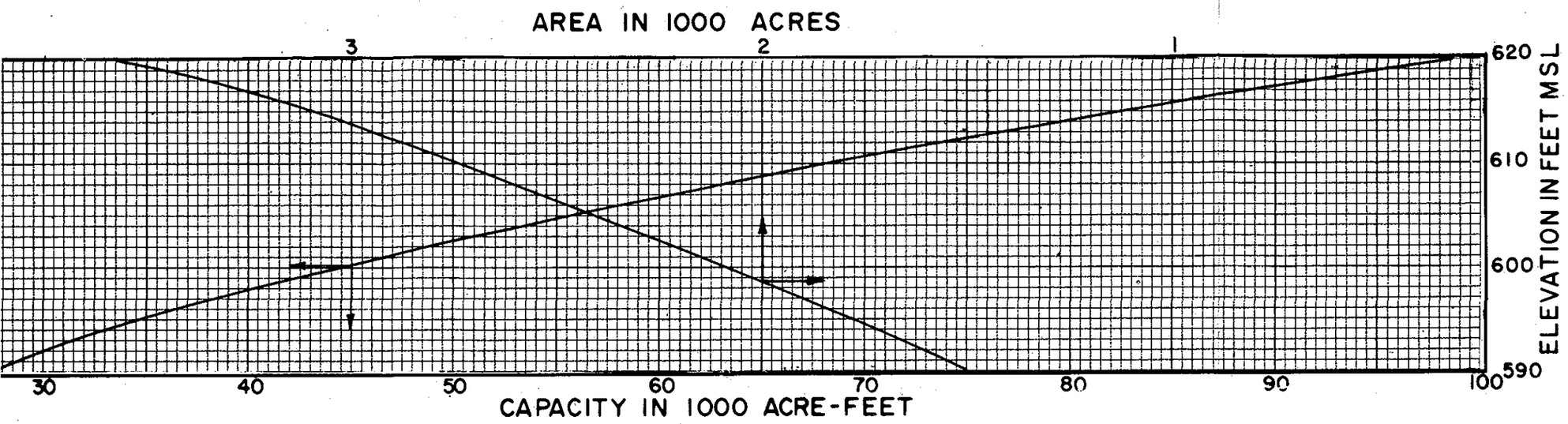
NOVEMBER 1982

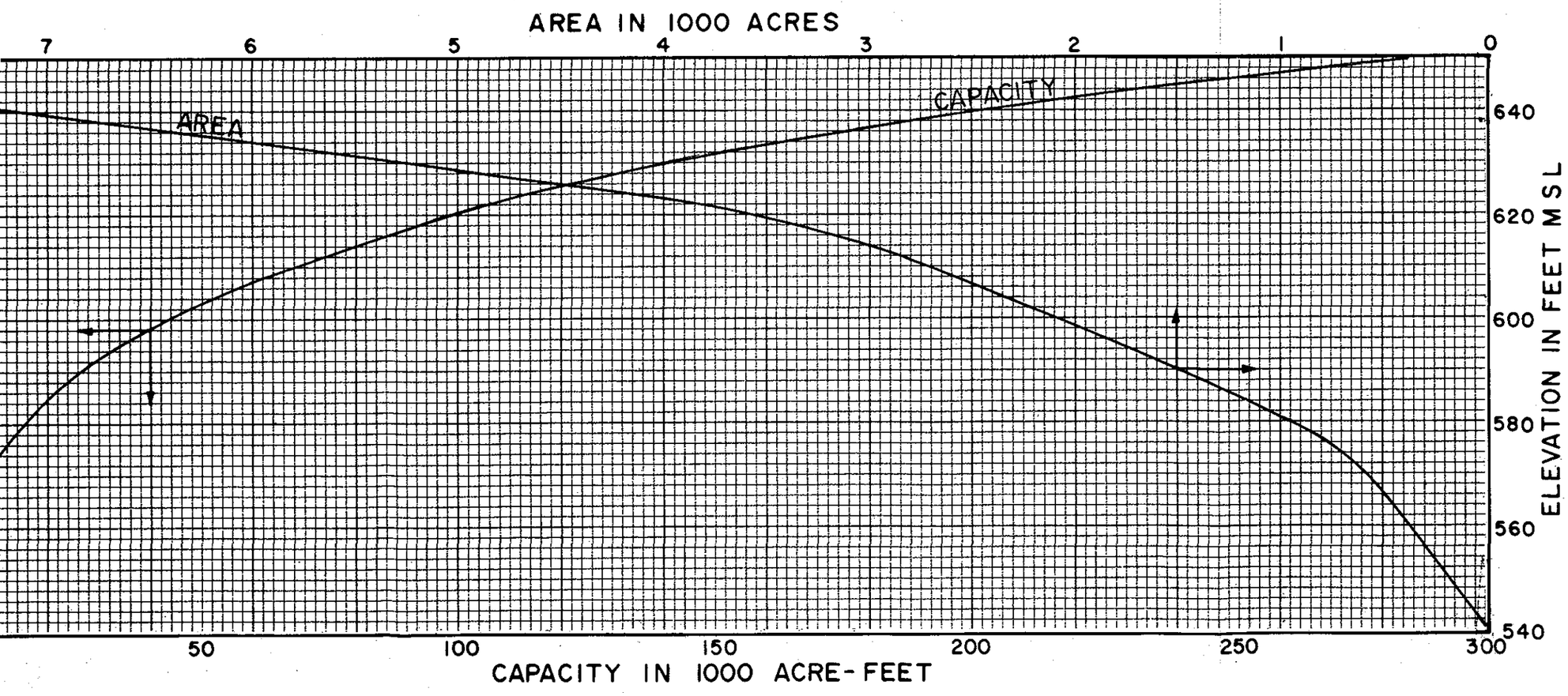
FIGURE A-4



LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY
ST. JOHN RIVER BASIN, MAINE
SNOWMELT
SPILLWAY DESIGN FLOW
AT
LINCOLN SCHOOL
NOVEMBER 1982

FIGURE A-5



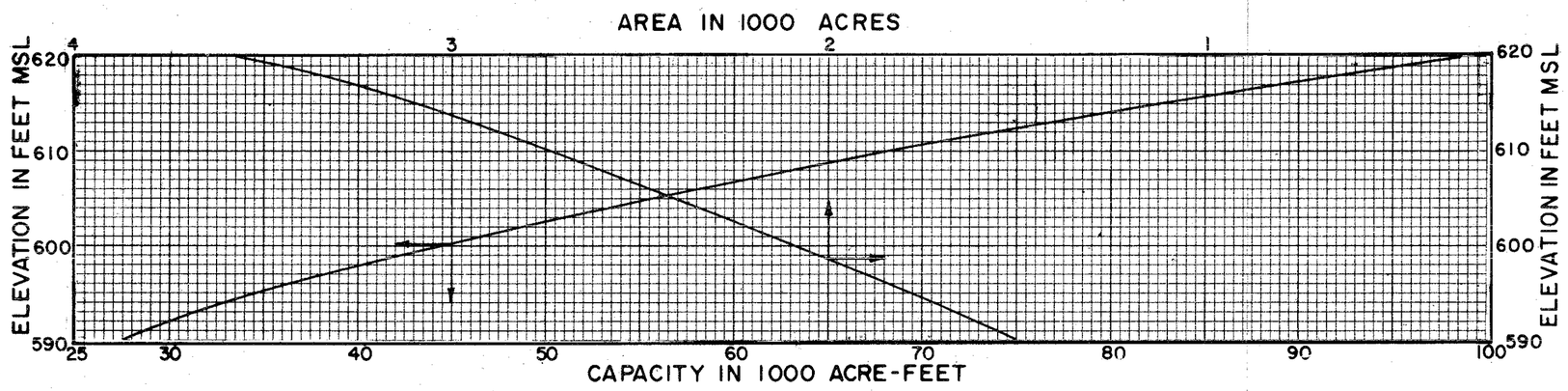


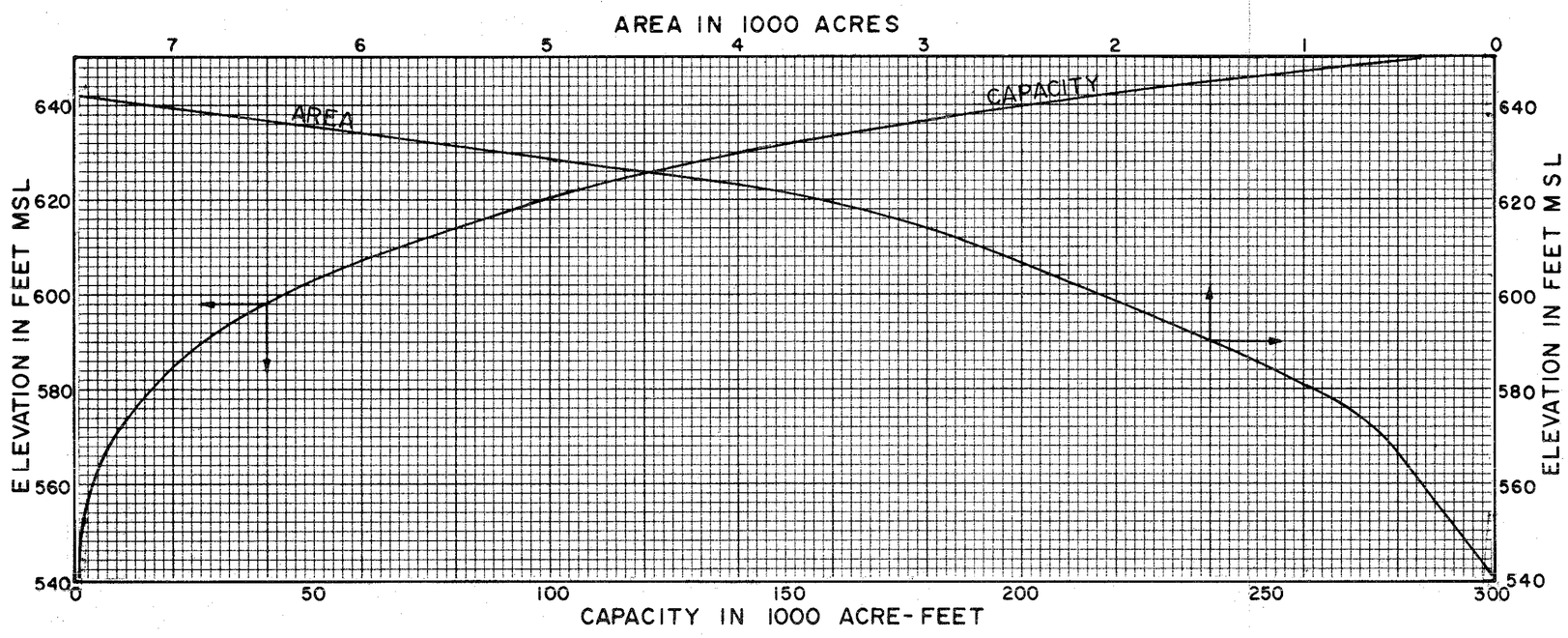
LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY
ST. JOHN RIVER BASIN, MAINE

RESERVOIR AREA-CAPACITY
(WITHOUT DICKEY)

NOVEMBER 1982

FIGURE A-6



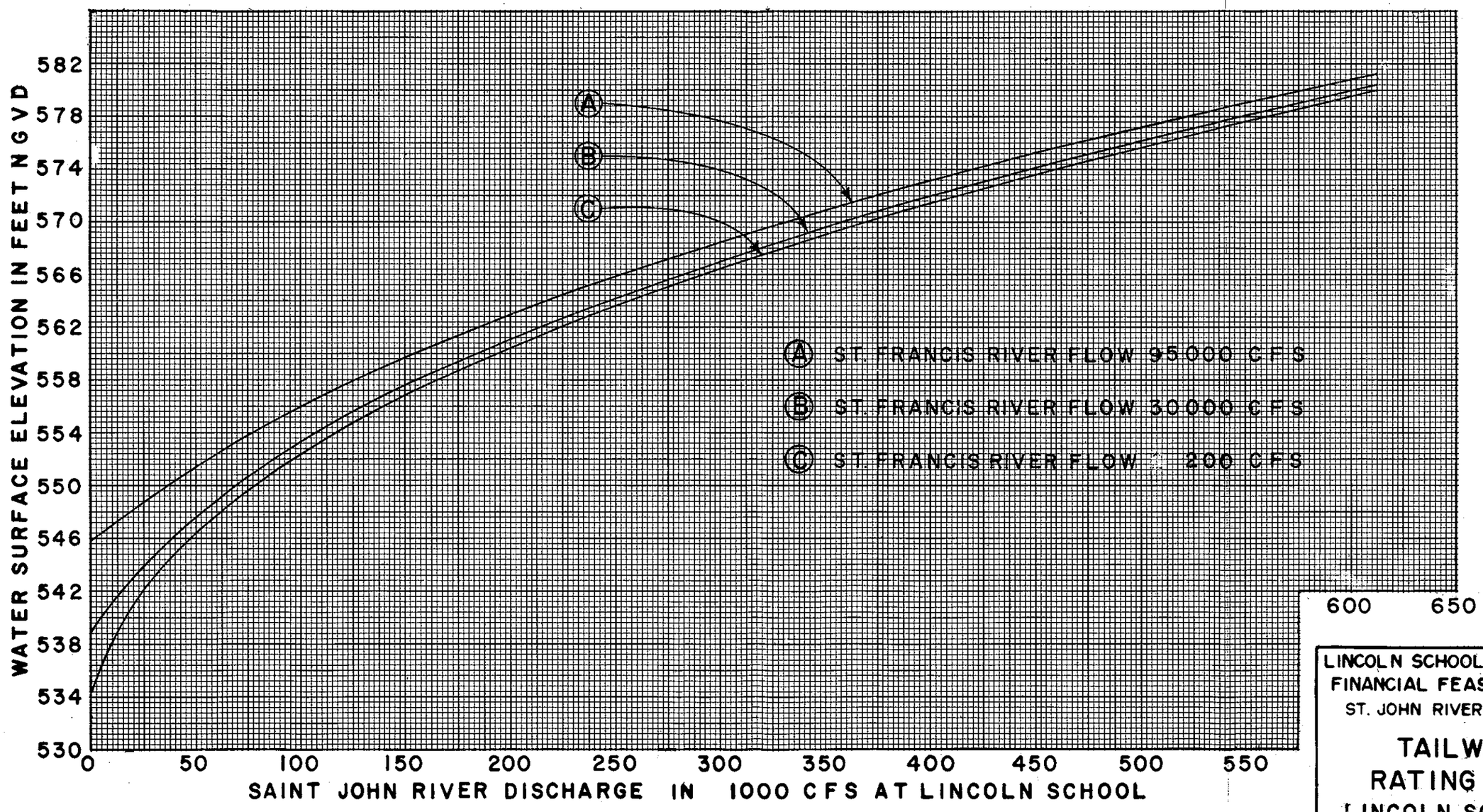


LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY
ST. JOHN RIVER BASIN, MAINE

RESERVOIR AREA-CAPACITY (WITHOUT DICKEY)

NOVEMBER 1982

FIGURE A-6



LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY
ST. JOHN RIVER BASIN, MAINE

TAILWATER RATING CURVE
LINCOLN SCHOOL DAM

NOVEMBER 1982

FIGURE A-7

WATER RESOURCES DEVELOPMENT PROJECT
SAINT JOHN RIVER BASIN
LINCOLN SCHOOL HYDROELECTRIC PROJECT
MAINE

APPENDIX B

STREAM DIVERSION AT LINCOLN SCHOOL

HYDROLOGIC ENGINEERING SECTION
WATER CONTROL BRANCH
ENGINEERING DIVISION

NOVEMBER 1982

WATER RESOURCES DEVELOPMENT PROJECT
SAINT JOHN RIVER BASIN
LINCOLN SCHOOL HYDROELECTRIC PROJECT
MAINE

APPENDIX B

STREAM DIVERSION AT LINCOLN SCHOOL

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B-2	Diversion Plan Phase II

WATER RESOURCES DEVELOPMENT
SAINT JOHN RIVER BASIN
LINCOLN SCHOOL HYDROELECTRIC PROJECT, MAINE

APPENDIX B

STREAM DIVERSION AT LINCOLN SCHOOL

1. GENERAL

The control and diversion of riverflows during construction of the Lincoln School project would be accomplished by building the dam in phases and cofferdamming first one side then the other side of the river channel. This appendix presents hydrologic discussion and data regarding the diversion of flows for construction. Included are sections on the frequency and magnitude of flows to be diverted, both all season and during the normal low flow summer season, the adopted design diversion floods, and the hydraulics of the diversion plans.

2. WATERSHED DESCRIPTION

The Lincoln School damsite is located on the Saint John River about 17 miles above Fort Kent and about 10 miles below the mouth of the Allagash River tributary. At the damsite the width of the river is about 1,000 feet and its gradient 4.5 feet per mile. The drainage area of the Saint John River at Lincoln School is 4,086 square miles. This area is made up of 2,700 square miles of Saint John River watershed above the USGS gage at Dickey, 1,250 square miles of Allagash River area above the gage at Allagash and intervening local area between the two gages and Lincoln School of 136 square miles. A map delineating the upper Saint John watershed above Fort Kent, Maine (D.A. = 5,960 square miles) and above the Lincoln School damsite is shown on figure A-2. Both the upper Saint John water- and Allagash are entirely wooded gently rolling watersheds with numerous swamps and ponds. Peak rates and volumes of runoff normally occur during the spring snowmelt season with minimum flows generally occurring both in late summer and late winter.

3. STREAMFLOW RECORDS

The US Geological Survey gaging stations at Dickey and Allagash measure the combined runoff from 3,950 square miles of watershed area or about 97 percent of the total watershed at the Lincoln School damsite. The gage at Dickey, with a drainage area of 2,700 square miles, has been in operation since 1947. The gage on the Allagash River, at the town of Allagash, with a drainage area of 1,250 square miles, has been in operation since 1932. Average monthly and annual flows for the periods of record, are listed in table B-1. Flows at Lincoln School were increased by

TABLE B-1

SAINT JOHN RIVER BASIN

MONTHLY FLOWS

	St. John River at Dickey, Maine D.A. = 2,700 sq. mi. 1947-1981			Allagash River near Allagash, Maine D.A. = 1,250 sq. mi. 1932-1981			St. John River at Lincoln School D.A. = 4,086 sq. mi. 1947-1981
	Mean (cfs)	Maximum (cfs)	Minimum (cfs)	Mean (cfs)	Maximum (cfs)	Minimum (cfs)	Mean (cfs)
January	1,301	3,059	341	671	1,865	192	2,080
February	1,105	3,902	201	554	2,224	119	1,793
March	1,611	9,249	378	720	3,610	181	2,450
April	12,740	27,790	3,989	4,141	10,100	623	17,562
May	17,200	35,100	5,660	7,032	13,550	2,631	25,082
June	4,548	10,840	1,152	2,315	4,554	719	6,968
July	2,677	9,041	904	1,426	4,053	365	4,060
August	2,846	11,740	265	1,182	5,292	165	4,235
September	2,772	7,655	397	1,097	3,133	122	4,050
October	3,435	11,280	690	1,229	4,121	149	4,734
November	3,955	10,180	605	1,513	4,628	235	5,609
December	2,589	9,781	624	1,137	4,549	215	3,930
Annual	4,745	7,193	2,843	1,925	2,899	989	6,900

drainage area ratio to adjust for the intervening 136 square miles of local drainage area.

4. FLOODS OF RECORD

a. All Season

The greatest floods in the upper Saint John River basin, with respect to both peak discharge and total volume, have historically occurred during the spring snowmelt season. Annual precipitation approximates 36 inches and is distributed fairly uniformly throughout the year. However, much of the winter precipitation occurs as snow and accumulates throughout the winter. The snowpack usually reaches a maximum in late March or early April. Average water content of the spring snowpack is about 8 inches with maximums as high as 13 inches. The melt of the snowpack in late April or May, combined with spring rains, has been the most frequent cause of floods on the Saint John River. The record snowmelt flood at Lincoln School occurred on 29 April 1979 with a peak discharge of about 118,000 cfs as estimated from gage records at the Dickey and Allagash gages. This flow was a result of several days of 60 to 70 degree temperatures followed by about 1.4 inches of rainfall on the 27th through the 29th of April. The resulting total runoff volume was 8.7 inches. Other major snowmelt floods occurred in May 1974, April 1973, May 1969 and May 1961. Recorded discharges for these floods are listed in table B-2.

b. Summer Season

During the non-snowmelt season, maximum flows have been produced by intense rainfall usually associated with dying hurricanes or other moisture-laden lows moving inland from the Atlantic Ocean. Generally the significant non-snowmelt type floods are those preceded by extended periods of abnormally high precipitation producing abnormally high antecedent soil moisture conditions.

Volumes of summertime floods are less than those of the springtime, but peak discharge rates of summer floods are of prime importance with respect to cofferdam design. The record non-snowmlet flood at the Lincoln School site occurred during the summer of 1981 with a peak discharge of approximately 88,000 cfs on 7 August. This flood was the result of extremely intense storm rainfall in the upper Saint John basin on the 6th and 7th, with many areas receiving up to 10 inches of rain. This floodflow was about 25 percent greater than the second greatest summer season flow during the 35 year period of record.

The five peak flows of record at both the Dickey gage and the Allagash gage, along with the computed peak flows at the Lincoln School site are listed in table B-2. Values are listed for both the all-season and the summer season, June through November.

5. PEAK DISCHARGE FREQUENCIES

All season and summer season peak discharge frequency curves at Lincoln School were developed by statistical analysis of historical data. One day high flow values at both the Dickey and Allagash gages were analyzed for their common period of record: 1947-1981, using a Log-Pearson type III distribution. The resulting Dickey discharge frequencies were multiplied by a factor of 1.05 to adjust for the 136 square mile intermediate drainage area and then added to the developed discharge frequencies for the Allagash River for their common period of record. It was realized that adding the two discharge frequency curves did not allow for any desynchronization of peak runoff from the two watershed, however, the effect on the derived Lincoln School curve was considered minute. To verify this assumption, period of record daily flows were analyzed at Dickey and Allagash to determine the 10 greatest coincident peak flows. These ten peak flows were assigned Weibull plotting positions and compared with the developed frequency curves. The data were plotted on the previously developed statistical peak discharge frequency curves for both the all season and summer seasons and there was found to be good agreement, as illustrated on figure B-1.

6. STAGE-DISCHARGE RATING AT LINCOLN SCHOOL DAMSITE

A stage-discharge rating was developed at the Lincoln School damsite for flows up to the maximum flood of record, by backwater computations using the Corps of Engineers HEC-2 computer program: "Water Surface Profiles". The relatively flat nature of the Saint John River necessitated a hydraulic analysis beginning approximately 6 miles downstream from the damsite. Backwater computations were made using available channel cross sectional surveys, a Manning's channel roughness coefficient "n" of 0.03 and expansion and contraction coefficients of 0.3 and 0.1, respectively. The developed stage-discharge rating curve is shown on figure B-2.

River stages at Lincoln School are a function of both the discharge of the Saint John River and the concurrent flow of the St. Francis River located about 1 mile downstream of the proposed damsite. The St. Francis has a drainage area of 550 square miles, therefore, its concurrent floodflow might be in the order of 13 percent of the Saint John flow at Lincoln School. Comparative stage-discharge curves are shown for coincident St. Francis flows of 200 and 30,000 cfs, respectively.

TABLE B-2

SAINT JOHN RIVER BASIN

PEAK FLOODS OF RECORD
ALL SEASON

Saint John River at Dickey, Maine (DA = 2,700 sq. mi.) 1947-1981		Allagash River Near Allagash Gage (DA = 1250 sq. mi.) 1947-1981		Saint John River at Lincoln School (DA = 4086 sq. mi.) 1947-1981	
Date	Discharge (cfs)	Date	Discharge (cfs)	Date	Discharge (cfs)
29 Apr 79	86,800	17 May 61	28,000	29 Apr 79	117,840
7 Aug 81	76,100	29 Apr 73	27,200	15 May 61	101,160
10 May 69	71,400	29 Apr 79	26,700	29 Apr 73	95,870
15 May 61	71,200	2 May 74	24,800	10 May 69	95,470
25 Apr 58	70,200	10 May 69	20,500	2 May 74	94,100

SUMMER SEASON
(JUNE - NOVEMBER)

Date	Discharge (cfs)	Date	Discharge (cfs)	Date	Discharge (cfs)
7 Aug 81	76,100	11 Aug 76	20,100	7 Aug 81	87,735
12 Aug 76	50,800	29 Jun 54	11,700	11 Aug 76	69,870
10 Nov 63	35,000	9 Nov 63	11,600	10 Nov 63	47,450
1 Jun 79	33,100	1 Jun 61	10,100	1 Jun 79	44,395
30 Nov 50	31,700	18 Aug 81	10,000	29 Jun 54	43,830

7. PLAN OF DIVERSION

To facilitate the control of water during construction, the Lincoln School project would be built in two phases, cofferdamming off first one side of the river channel and then the other side. The spillway structure would be built and the associated approach and discharge channels excavated on the left side of the river during phase I. The phase I work area would be dewatered by the construction of a cellular cofferdam, extending approximately 450 feet into, or about midway across, the Saint John River channel. Prior to the construction of the phase I cofferdam, a small island in the right side of the river channel would be removed to minimize the constriction of flows during phase I construction.

The cofferdammed area would be excavated for the spillway structure and associated approach and discharge channels down to elevation 540 feet NGVD. The spillway structure, including gate piers, would then be constructed, with the invert of the bays initially raised only to elevation 540 NGVD. These lowered gate bays would then serve for the diversion of flows during phase II construction.

For phase II construction, the right side of the river would be dewatered by building cofferdams upstream and downstream from the partially completed spillway structure. The powerhouse, its entrance and exit channels, and the earthen dam embankment would be constructed in phase II. Lastly, after both phase I and II construction, the spillway bays would be bulkheaded, one at a time, the gate sills raised to elevation 570 for 620 pool plan, 560 for 610 plan or 550 for 600 plan and the spillway gates installed. It has been estimated that phase I construction would encompass two construction seasons and phase II, three seasons. Plans of the two phase construction sequence are shown on plates B-1 and B-2.

8. DESIGN DIVERSION FLOODS

a. Discharges: Both construction season (June-November) and all season design diversion floods for the Lincoln School project were selected based on: the relative magnitude and frequency of high flows, the relative height of cofferdams required to protect against various design flows, the period of time required for project construction, and the consequences of cofferdam overtopping.

All season floodflows range from about 100,000 cfs for a 10 percent chance (10 year) frequency to 120,000 cfs for the flood of record. The difference in river stage between the two flows is only about 2 feet, therefore, the higher all season flood of record flow of 120,000 cfs was selected as the all season design diversion flood.

The construction season floodflows range from about 50,000 cfs for 10 percent chance (10 year) frequency to 88,000 cfs for the construction season flood of record. The difference in river stage between these two flows is about 4 feet. Therefore, where considerable savings in cofferdam costs can be realized without undue risk, temporary cofferdams for short period construction may be designed to the 10 percent chance flood level. However, all main cofferdams to be used throughout a construction season will be designed for the construction season flood of record. Also all cofferdams to be used for more than one construction season will be built at least to the construction season design level the first season and to the all season design diversion flood level (about 3 feet higher) prior to the following spring runoff.

b. Water Surface Profiles: Water surface profiles for both the all season and construction season diversion floods were determined by backwater computations using the computer program "HEC-2". Starting water surface elevations were based on the established tailwater rating curve downstream of the damsite and computations were continued upstream for both phase I and II construction conditions. Cross sections through the construction area were developed from the phase I and II construction plans shown on plates B-1 and B-2. Backwater computations through the area were also performed under natural pre-project conditions for comparative purposes. Computations were made using a Manning's roughness coefficient "n" of .030 and expansion and contraction coefficients of 0.5 and 0.3, respectively. The computed water surface profiles for the all season and construction season design diversion flood discharges are shown on figures B-3 and B-4. The pre-project natural profiles are also shown for comparative purposes. During phase I, under all season design flood conditions, the water surface elevations immediately upstream of the construction site would be increased 2 to 3 feet over natural pre-project conditions. During phase II construction, with the same design flow, elevations immediately upstream would be increased 5 to 6 feet.

c. Flow Velocities: During phase I construction the minimum width of channel for flow diversion would be about 540 feet. In phase II, the minimum cross sectional flow area would be through the 8-60 foot wide spillway gate bays with inverts raised only to elevation 540 feet NGVD. During phase I, the all season design flow velocities would be increased from a pre-project natural condition of about 6 ft/sec to a maximum through the constricted diversion section of about 12 ft/sec. Under phase II construction, all season floodflow velocities through the gate bays would be about 18 ft/sec. Maximum velocities during phase II, other than at the gate bays would be about 14 ft/sec.

9. FREEBOARD

Freeboard on a flood dike or wall is the vertical distance measured from the computed design water surface profile to the top of the wall or dike. Freeboard is provided to make some allowance for possible unaccounted factors and variations in resistance and other coefficients from those assumed in design. A minimum of 2 feet of freeboard, which is somewhat greater than 5 percent of flow depth, was adopted for further planning and design of construction cofferdams at Lincoln School.

10. COFFERDAM HEIGHTS

The cofferdams for phase I construction, including freeboard, would vary in height between 21 to 23 feet for the design summer season flood and 24 to 26 feet for the design all season flood. The elevation of the all season phase I cofferdam would vary from elevation 555 at the downstream end to elevation 559 feet NGVD at the upstream end.

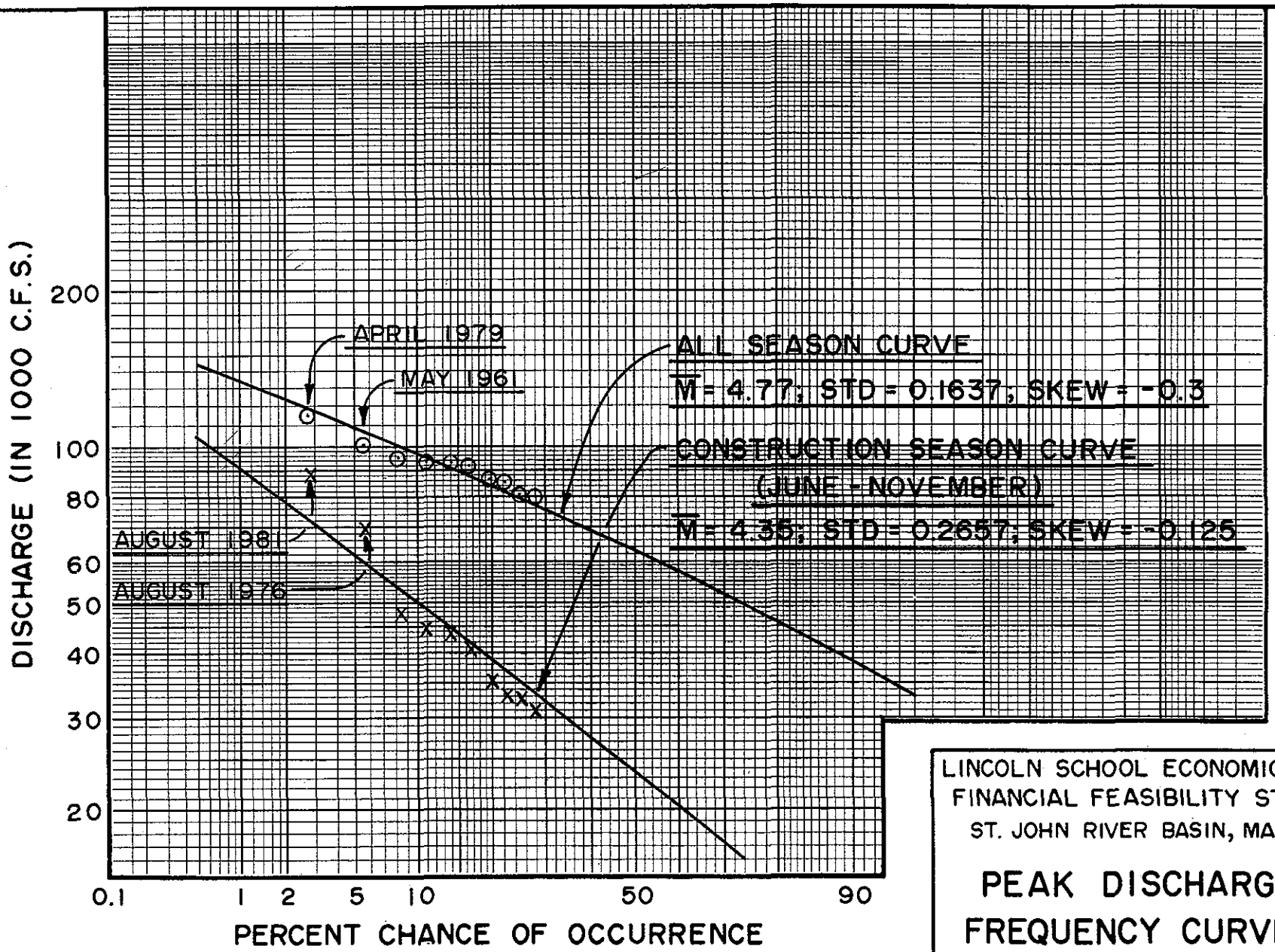
Cofferdam heights for phase II construction, including freeboard, would vary between 21 to 26 feet for the design summer season flood, and 24 to 29 feet for the all season flood. The elevation of the all season phase II cofferdam would vary from elevation 555 at the downstream end to 562 feet NGVD at the upstream end.

11. EFFECTS OF COFFERDAM OVERTOPPING

If a cofferdam is overtopped by floodwaters there is a chance it will fail, and in many cases there would be a resulting flood surge downstream. Usually the higher the cofferdam the greater the potential flood surge. The designer is often faced with either adopting a low cofferdam height with increased probability of overtopping or a high cofferdam height with reduced chance of overtopping but with increased flood surge potential in the event of overtopping. Though high cofferdams would be required in the construction of Lincoln School, the two phase plan of construction would minimize the downstream flood surge potential in the event of cofferdam overtopping or intentional breaching during floodflow conditions. Resulting flood damages would be limited mainly to the construction site.

In the event of design floodflows during construction, the river stage upstream of the damsite would only be about 2-3 feet higher in phase I and 5-6 feet higher in phase II, than under natural preproject conditions. A five-foot upstream surcharge above the normal 21 foot river stage would be rapidly dissipated downstream and would produce little added flooding downstream in the event of cofferdam failure or intentional breaching. The construction site, however, would experience extreme flooding (depths

to 25 feet) in the event of overtopping. Therefore, a plan for personnel evacuation from low areas of the construction in the event of floodflows approaching design conditions, would be a part of any overall plan for the construction of Lincoln School.

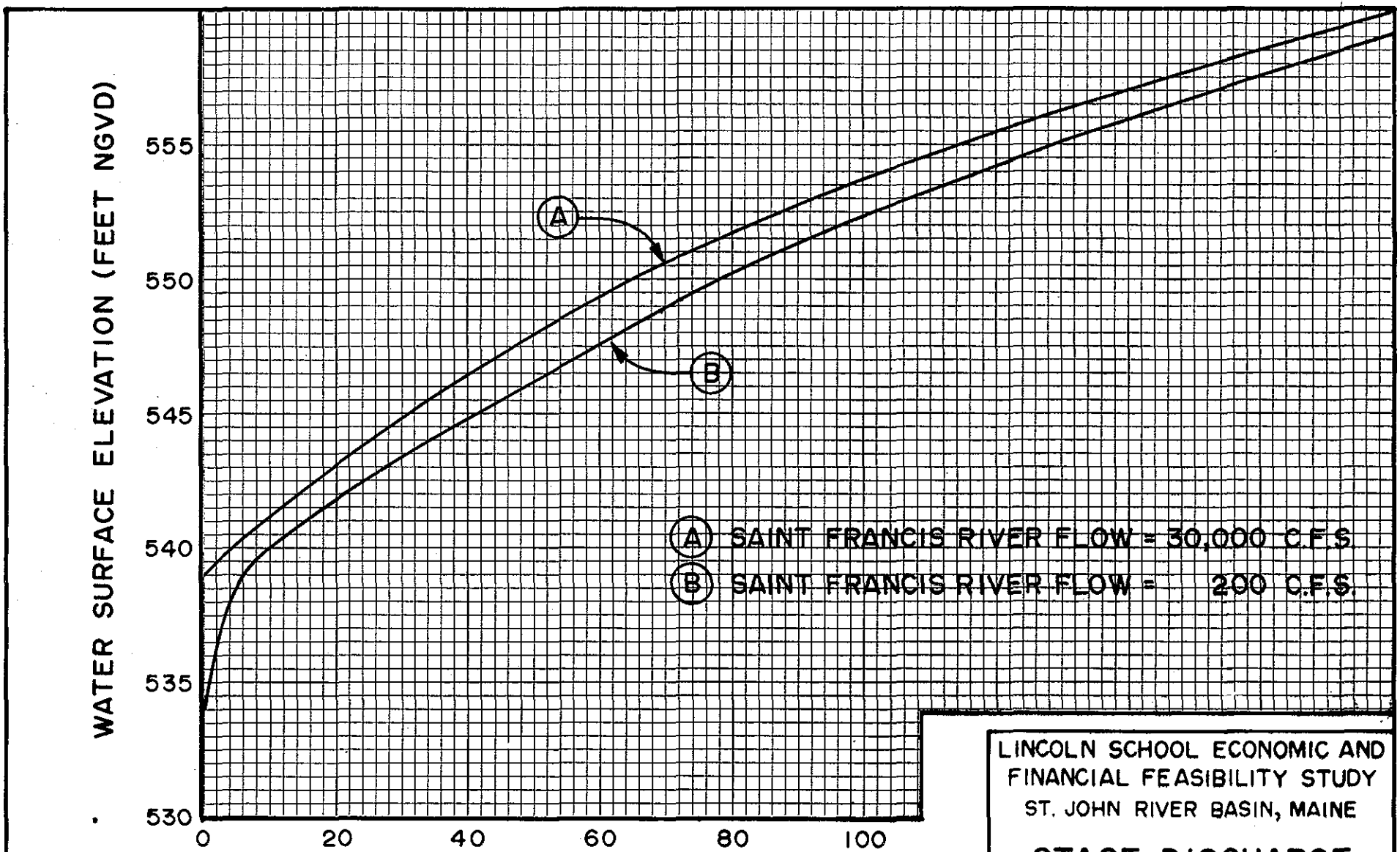


LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY
ST. JOHN RIVER BASIN, MAINE

PEAK DISCHARGE FREQUENCY CURVES

NOVEMBER 1982

FIGURE B-1



LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY
ST. JOHN RIVER BASIN, MAINE

STAGE-DISCHARGE CURVES

NOVEMBER 1982

FIGURE B-2

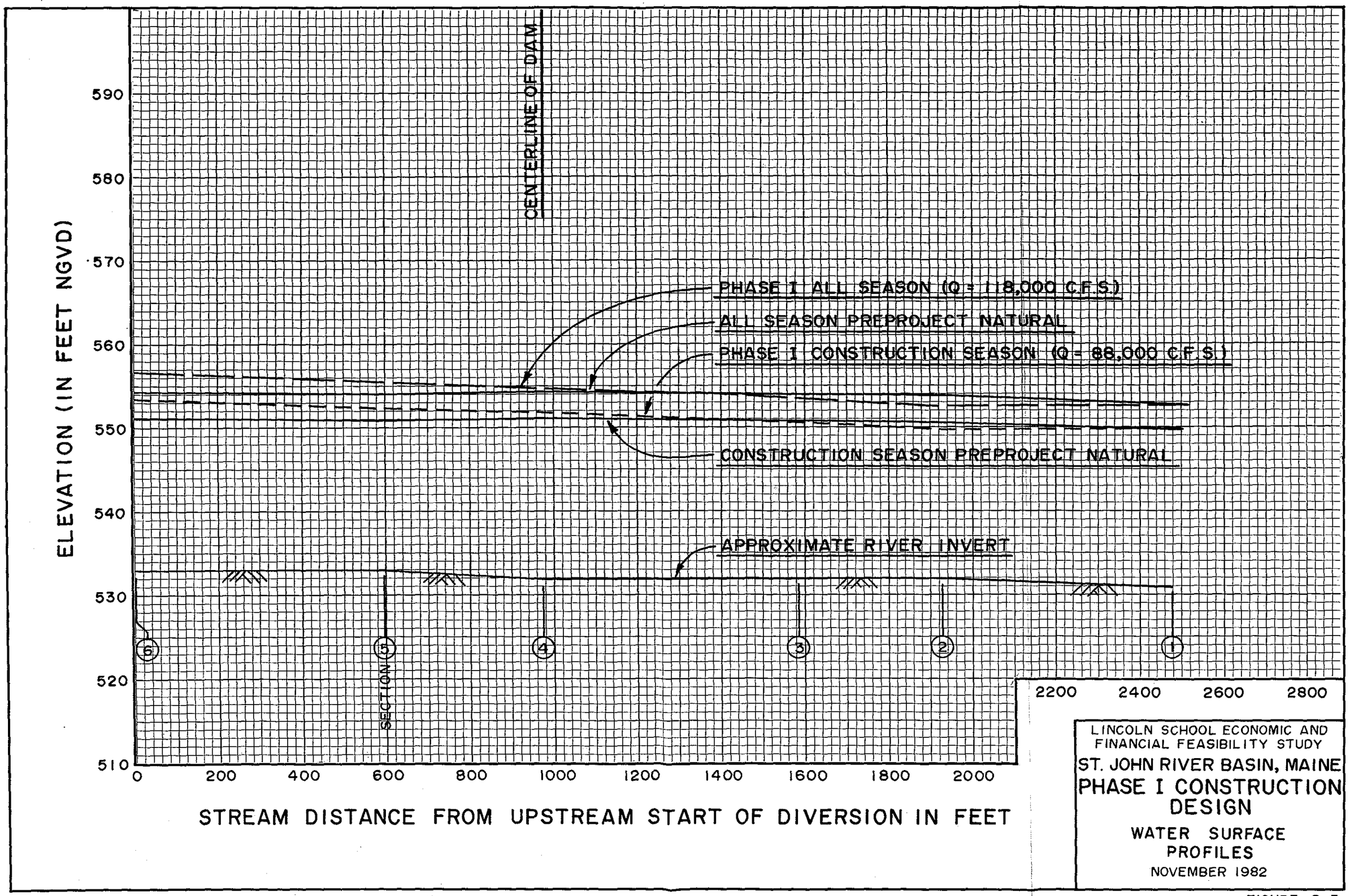

CENTERLINE OF DAM
PHASE I ALL SEASON (Q = 118,000 C.F.S.)
ALL SEASON PREPROJECT NATURAL
PHASE I CONSTRUCTION SEASON (Q = 88,000 C.F.S.)
CONSTRUCTION SEASON PREPROJECT NATURAL
APPROXIMATE RIVER INVERT
SECTION
ELEVATION (IN FEET NGVD)
590
580
570
560
550
540
530
520
510
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
STREAM DISTANCE FROM UPSTREAM START OF DIVERSION IN FEET
LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY
ST. JOHN RIVER BASIN, MAINE
PHASE I CONSTRUCTION DESIGN
WATER SURFACE PROFILES
NOVEMBER 1982

FIGURE B-3

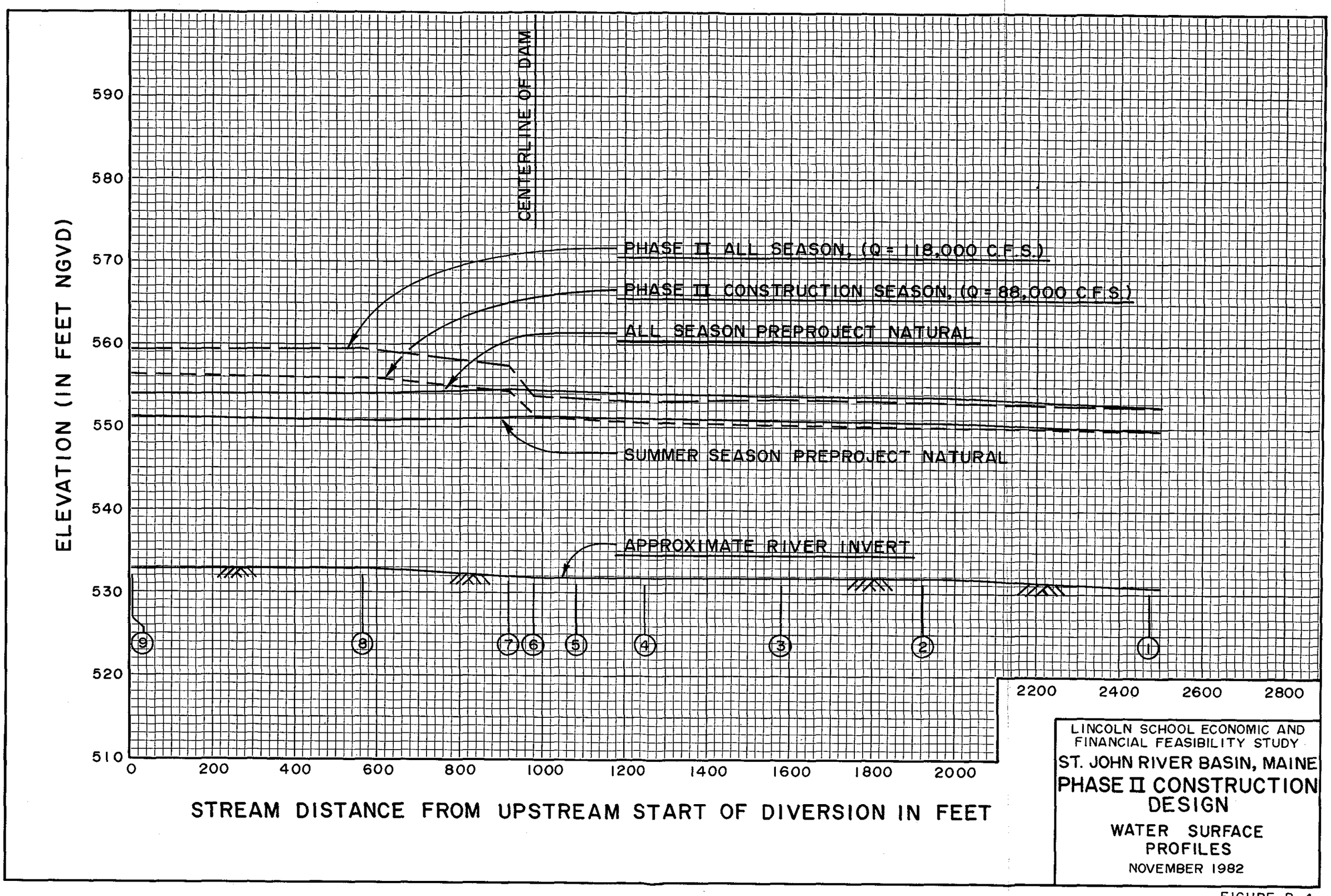
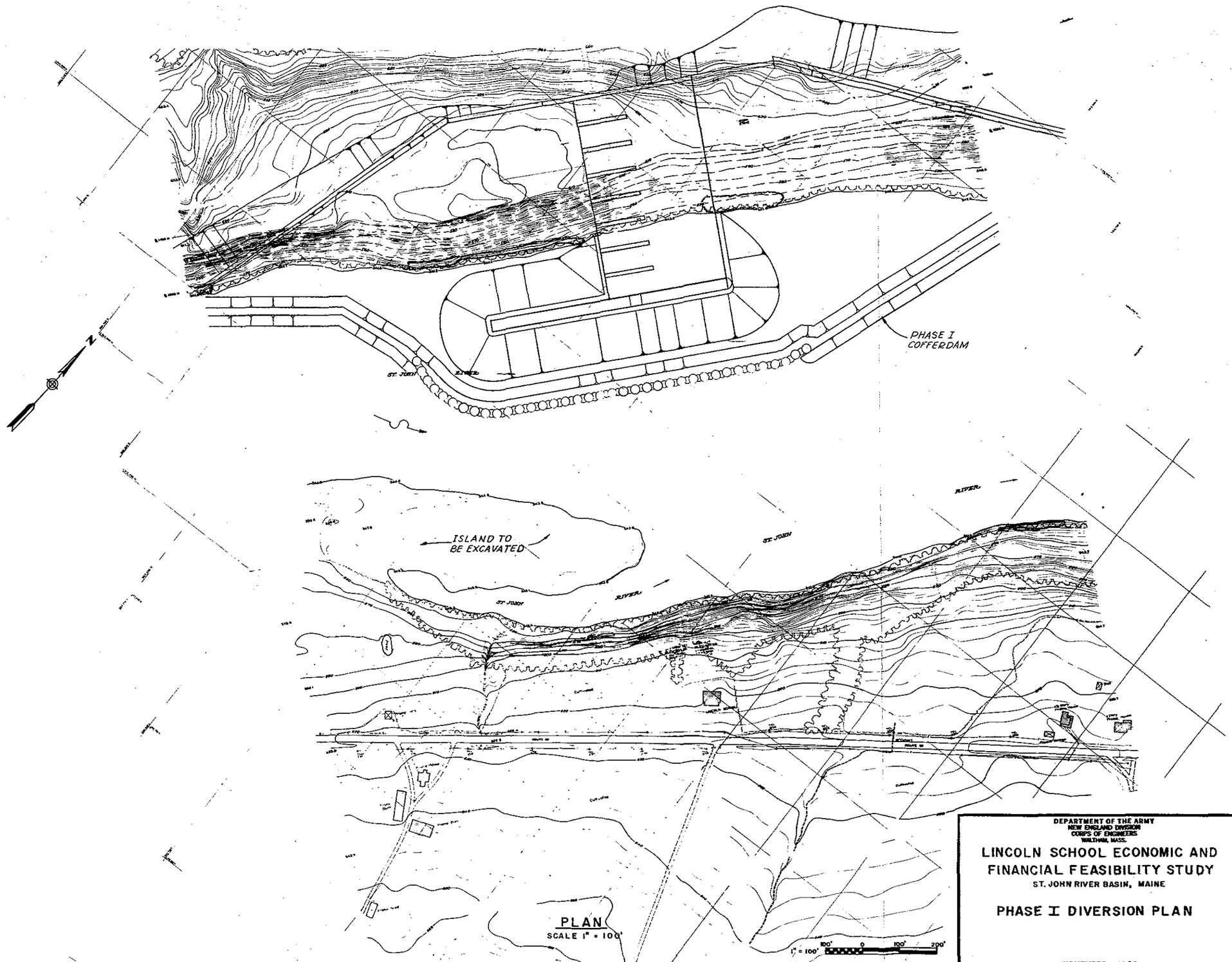

CENTERLINE OF DAM
PHASE II ALL SEASON, (Q = 118,000 C.F.S.)
PHASE II CONSTRUCTION SEASON, (Q = 88,000 C.F.S.)
ALL SEASON PREPROJECT NATURAL
SUMMER SEASON PREPROJECT NATURAL
APPROXIMATE RIVER INVERT
ELEVATION (IN FEET NGVD)
590
580
570
560
550
540
530
520
510
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
9
8
7
6
5
4
3
2
1
STREAM DISTANCE FROM UPSTREAM START OF DIVERSION IN FEET
LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY
ST. JOHN RIVER BASIN, MAINE
PHASE II CONSTRUCTION DESIGN
WATER SURFACE PROFILES
NOVEMBER 1982

FIGURE B-4

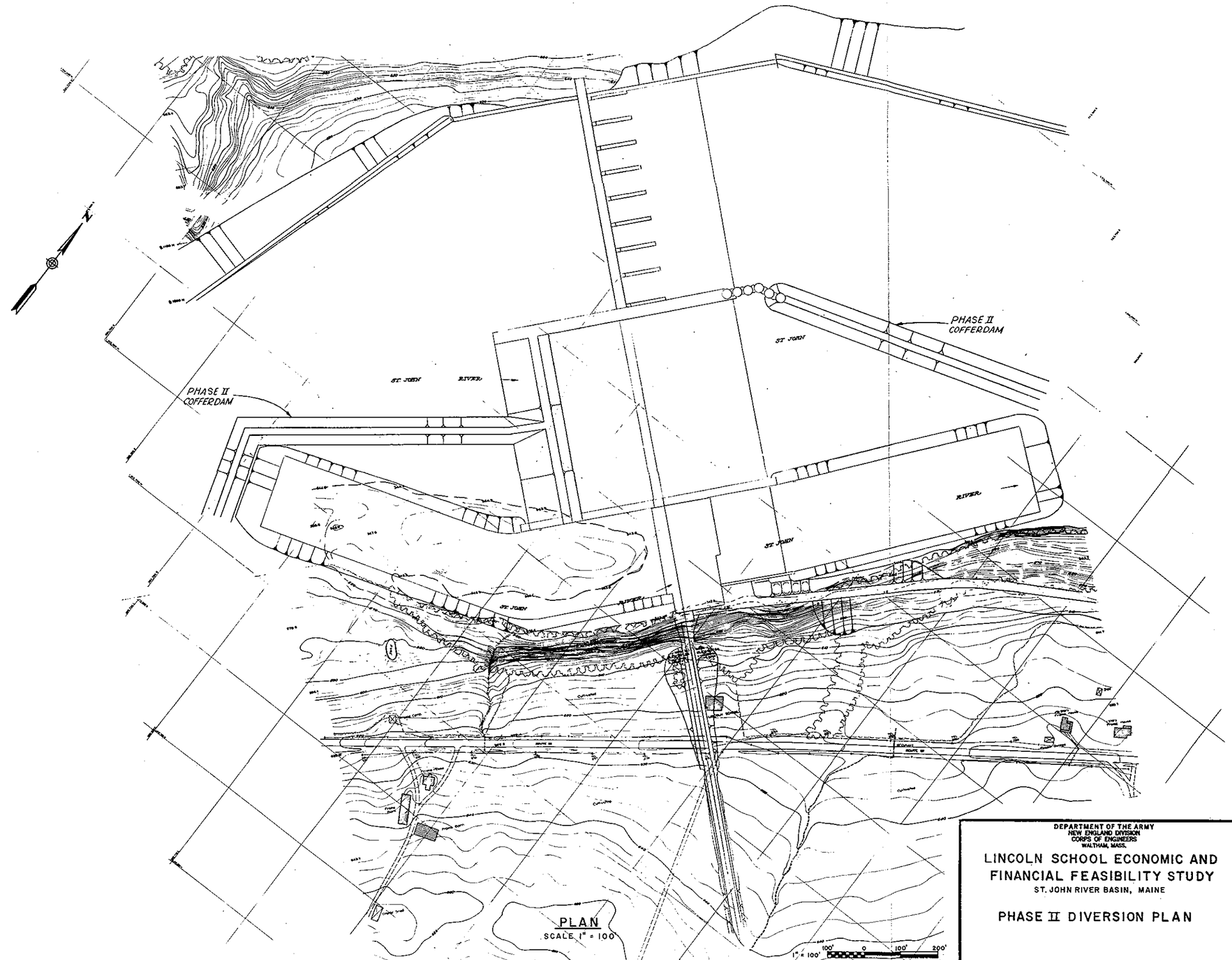


DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

LINCOLN SCHOOL ECONOMIC AND
FINANCIAL FEASIBILITY STUDY
ST. JOHN RIVER BASIN, MAINE

PHASE I DIVERSION PLAN

NOVEMBER 1982



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

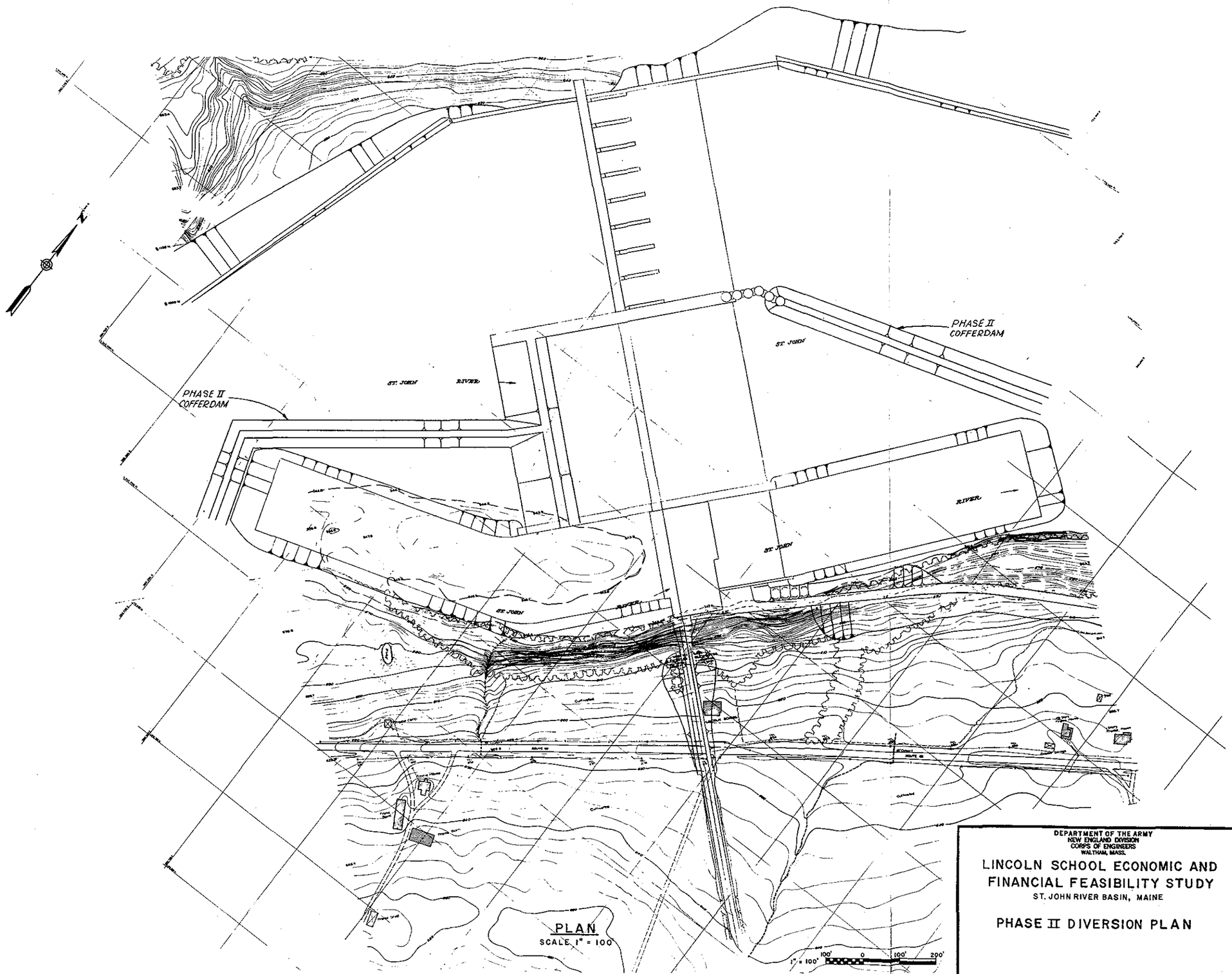
LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY

ST. JOHN RIVER BASIN, MAINE

PHASE II DIVERSION PLAN

NOVEMBER 1982

PLATE B-2



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

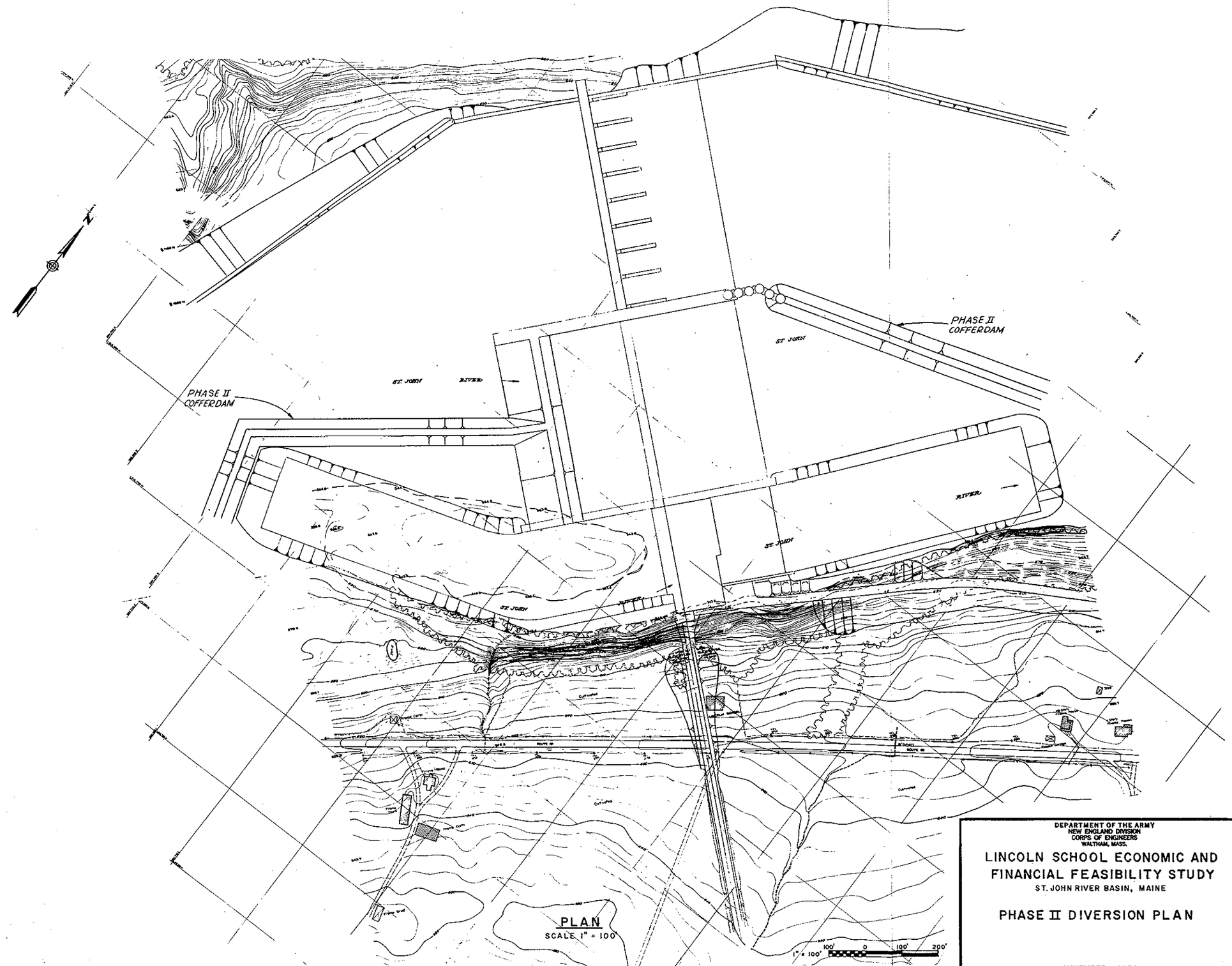
LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY

ST. JOHN RIVER BASIN, MAINE

PHASE II DIVERSION PLAN

NOVEMBER 1982

PLATE B-2



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

LINCOLN SCHOOL ECONOMIC AND FINANCIAL FEASIBILITY STUDY

ST. JOHN RIVER BASIN, MAINE

PHASE II DIVERSION PLAN

NOVEMBER 1982

PLATE B-2

APPENDIX C

PROJECT ESTIMATES

- DAMS AND APPURTENANCES
- TRANSMISSION FACILITIES

SELECTED PLAN
620 Ft. Pool Elevation
110.87 MW

LINCOLN SCHOOL HYDROELECTRIC PROJECT

ESTIMATE OF COSTS

(October 1982 Price Levels)

Description	Quantity	Unit	Unit Price	Amount
01. Lands and Damages	1	Job	L.S.	$10,000,000
	Contingencies 20%			2,000,000
Total 01. Lands and Damages				$12,000,000
02. Relocations				
1. Roads				
Roads	1	Job	L.S.	$11,850,000
Lands	1	Job	L.S.	340,000
2. Cemeteries and Utilities				
Cemeteries	1	Job	L.S.	280,000
Utilities	1	Job	L.S.	500,000
	Subtotal 02. Relocations			$12,970,000
	Contingencies 15%			1,940,000
Total 02. Relocations				$14,910,000
03. Reservoir				
Clearing	2,500	Acre	$970.00	$2,425,000
	Contingencies 15%			365,000
Total 03. Reservoir				$2,790,000

SELECTED PLAN
620 Ft. Pool Elevation
110.87 MW

LINCOLN SCHOOL HYDROELECTRIC PROJECT

ESTIMATE OF COSTS

(October 1982 Price Levels)

Description	Quantity	Unit	Unit Price	Amount
04. Dam				
1. Site Clearing	1	Job	L.S.	$43,000
	Subtotal-1. Site Clearing			$43,000
2. Embankment				
Diversion and Control of Water	1	Job	L.S.	$5,000,000
Stripping Including Grubbing	60,000	c.y.	1.46	88,000
Excavation, Cutoff Trench	28,000	c.y.	1.43	40,000
Excavation				
Impervious Borrow	137,000	c.y.	1.52	208,000
Pervious Borrow	396,000	c.y.	1.31	519,000
Compacted Impervious Fill	110,000	c.y.	0.38	42,000
Compacted Random Fill	332,000	c.y.	0.27	90,000
Compacted Pervious Fill	53,000	c.y.	0.27	14,000
Selected Rock Fill for Toe	21,000	c.y.	13.52	284,000
Random Rock Fill from Excavation	22,000	c.y.	2.00	44,000
Gravel Bedding	12,000	c.y.	4.13	50,000
Rock Slope Protection	10,000	c.y.	13.51	135,000
Gravels	4,900	c.y.	3.50	17,000
Processed Gravel Slope Protection	21,000	c.y.	2.03	43,000
Relief Wells, Piezometers and Settlement Gages	1	Job	L.S.	117,000
Roadway and Guard Rail	534	l.f.	72.00	38,000
	Subtotal-2. Embankment			$6,729,000

SELECTED PLAN
620 Ft. Pool Elevation
110.87 MW

LINCOLN SCHOOL HYDROELECTRIC PROJECT

ESTIMATE OF COSTS

(October 1982 Price Levels)

Description	Quantity	Unit	Unit Price	Amount
04. Dam (cont'd)				
3. Spillway Channel				
Excavation Earth	1,100,000	c.y.	1.51	$1,661,000
Excavation Rock	850,000	c.y.	6.73	5,720,000
Subtotal-3. Spillway Channel				$7,381,000
4. Spillway Structure				
Foundation Grouting and Rock Bolts	1	Job	L.S.	930,000
Concrete Moss	125,000	c.y.	70.00	$8,750,000
Concrete, Reinforced	117,000	c.y.	220.00	25,740,000
Tainter Gates and Hoists	1	Job	L.S.	1,260,000
Electrical System	1	Job	L.S.	160,000
Miscellaneous	1	Job	L.S.	660,000
Subtotal-4. Spillway Structure				$37,500,000

SELECTED PLAN
620 Ft. Pool Elevation
110.87 MW

LINCOLN SCHOOL HYDROELECTRIC PROJECT

ESTIMATE OF COSTS

(October 1982 Price Levels)

Description	Quantity	Unit	Unit Price	Amount
5. Non-Overflow Wall				
Excavation	4,800	c.y.	1.51	$7,000
Foundation Grouting	1	Job	L.S.	10,000
Foundation Rock Treatment	1	Job	L.S.	12,000
Concrete, Mass	13,000	c.y.	70.00	910,000
Subtotal-5. Non-Overflow Wall				$939,000
Subtotal-.04 Dam				$52,592,000
Contingencies 15%				7,888,000
Total-04. Dam				$60,480,000
07. Power Facilities				
1. Powerhouse	Estimated by NPD			$28,311,000
2. Turbines & Generators	Estimated by NPD			22,287,000
3. Accessory Electrical Equipment	Estimated by NPD			2,418,000
4. Auxilliary Systems and Equipment	Estimated by NPD			4,092,000
5. Switchyards	Estimated by NPD			764,000
6. Site Prep. & Special Items	Estimated by NPD			1,740,000

Selected - 4

SELECTED PLAN
620 Ft. Pool Elevation
110.87 MW

LINCOLN SCHOOL HYDROELECTRIC PROJECT

ESTIMATE OF COSTS

(October 1982 Price Levels)

Description	Quantity	Unit	Unit Price	Amount
07. Power Facilities (Cont'd)				
7. Power Channels				
Excavation Earth	301,000	c.y.	1.51	$455,000
Excavation Rock	9,900	c.y.	6.73	67,000
Subtotal-07. Power Facilities				$60,134,000
Contingencies 15%				9,016,000
Total-07. Power Facilities				$69,150,000
08. Roads and Bridges				
Access Roads	1	Job	L.S.	$280,000
Contingencies 15%				40,000
Total-08. Roads and Bridges				$320,000

SELECTED PLAN
620 Ft. Pool Elevation
110.87 MW

LINCOLN SCHOOL HYDROELECTRIC PROJECT

ESTIMATE OF COSTS

(October 1982 Price Levels)

Description	Quantity	Unit	Unit Price	Amount
18. Cultural Resources Preservation				
Preservation Measures	1	Job	L.S.	$180,000
		Contingencies 15%		30,000
Total-18. Cultural Resources Preservation				$210,000
19. Building, Grounds & Facilities				
Permanent Housing	1	Job	L.S.	$150,000
Roads and Utilities	1	Job	L.S.	100,000
Service Buildings	1	Job	L.S.	185,000
Scenic Turnout	1	Job	L.S.	25,000
Canoe Takeouts	1	Job	L.S.	100,000
	Subtotal-19. Buildings, Grounds and Facilities			$560,000
		Contingencies 15%		80,000
Total-19. Buildings, Grounds and Facilities				$640,000

LINCOLN SCHOOL HYDROELECTRIC PROJECT

ESTIMATE OF COSTS

(October 1982 Price Levels)

Description	Quantity	Unit	Unit Price	Amount
20. Permanent Operating Equipment				
Front Loader/Backhoe w/Snowblower	1	L.S.	90,000	$90,000
Sedan	1	L.S.	8,000	8,000
10-Wheel Dump Truck	1	L.S.	45,000	45,000
4-Wheel Drive Truck w/plow	1	L.S.	9,500	9,500
Tractor w/Flail Mower	1	L.S.	22,000	22,000
Boat and Motor	1	L.S.	5,000	5,000
Mowers (3)	1	L.S.	7,000	7,000
Snowmobiles, Chainsaws	1	L.S.	9,000	9,000
Communications Module & Mobile Radios	1	L.S.	6,000	6,000
Misc. Shop Equip & Tools	1	L.S.	23,500	23,500
	Subtotal-20. Permanent Operating Equipment			$225,000
	Contingencies 15%			35,000
Total-20. Permanent Operating Equipment				$260,000
30. Engineering and Design (8%± Dir. Constr. Costs)				$11,850,000
31. Supervision and Administration (7% ± Dir. Constr. Costs)				$10,390,000
TOTAL PROJECT FIRST COST				$183,000,000

OPTIONAL PL
610 Ft. Pool Elev.
89.7 MW

LINCOLN SCHOOL HYDROELECTRIC PROJECT

ESTIMATE OF COSTS

(October 1982 Price Levels)

Description	Quantity	Unit	Unit Price	Amount
01. Lands and Damages	1	Job	L.S.	$6,400,000
	Contingencies		20%	1,300,000
Total 01. Lands and Damages				$7,700,000
02. Relocations				
1. Roads				
Roads	1	Job	L.S.	$8,000,000
Lands	1	Job	L.S.	320,000
2. Cemeteries and Utilities				
Cemeteries	1	Job	L.S.	280,000
Utilities	1	Job	L.S.	480,000
	Subtotal-02. Relocations			$9,080,000
	Contingencies		15%	1,360,000
Total 02. Relocations				$10,440,000
03. Reservoir				
Clearing	1700	Acre	$970.00	$1,650,000
	Contingencies		15%	250,000
Total 03. Reservoir				$1,900,000

610 Ft Option - 1

LINCOLN SCHOOL HYDROELECTRIC PROJECT

ESTIMATE OF COSTS

(October 1982 Price Levels)

Description	Quantity	Unit	Unit Price	Amount
04. Dam				
1. Site Clearing	1	Job	L.S.	$43,000
	Subtotal-1 Site Clearing			$43,000
2. Embankment				
Diversion and Control of Water	1	Job	L.S.	$5,000,000
Stripping Including Grubbing	42,000	c.y.	1.46	61,000
Excavation, Cutoff Trench	28,000	c.y.	1.43	40,000
Excavation				
Impervious Borrow	121,000	c.y.	1.52	184,000
Pervious Borrow	287,000	c.y.	1.31	376,000
Compacted Impervious Fill	93,000	c.y.	0.38	35,000
Compacted Random Fill	232,000	c.y.	0.27	63,000
Compacted Pervious Fill	44,000	c.y.	0.27	12,000
Selected Rock Fill for Toe	21,000	c.y.	13.52	284,000
Random Rock Fill from Excavation	22,000	c.y.	2.00	44,000
Gravel Bedding	10,000	c.y.	4.13	41,000
Rock Slope Protection	10,000	c.y.	13.51	135,000
Gravels	4,900	c.y.	3.50	17,000
Processed Gravel Slope Protection	17,000	c.y.	2.03	35,000
Relief Wells, Piezometers and Settlement Gages	1	Job	L.S.	117,000
Roadway and Guard Rail	534	l.f.	72.00	38,000
	Subtotal-2. Embankment			$6,482,000

610 Ft. Option - 2

OPTIONAL PLAN
610 Ft. Pool Elev.
89.7 MW

LINCOLN SCHOOL HYDROELECTRIC PROJECT

ESTIMATE OF COSTS

(October 1982 Price Levels)

Description	Quantity	Unit	Unit Price	Amount
04. Dam (cont'd)				
3. Spillway Channel				
Excavation Earth	1,100,000	c.y.	1.51	$1,661,000
Excavation Rock	850,000	c.y.	6.73	5,720,000
Subtotal-3. Spillway Channel				$7,381,000
4. Spillway Structure				
Foundation Grouting and Rock Bolts	1	Job	L.S.	930,000
Concrete Moss	113,000	c.y.	70.00	7,910,000
Concrete, Reinforced	107,000	c.y.	220.00	23,540,000
Tainter Gates and Hoists	1	Job	L.S.	1,260,000
Electrical System	1	Job	L.S.	160,000
Miscellaneous Items	1	Job	L.S.	660,000
Subtotal-4. Spillway Structure				$34,460,000

610 Ft Option - 3

OPTIONAL PLAN
610 Ft. Pool Elev.
89.7 MW

LINCOLN SCHOOL HYDROELECTRIC PROJECT

ESTIMATE OF COSTS

(October 1982 Price Levels)

Description	Quantity	Unit	Unit Price	Amount
5. Non-Overflow Wall				
Excavation	4,200	c.y.	1.51	$6,000
Foundation Grouting	1	Job	L.S.	10,000
Foundation Rock Treatment	1	Job	L.S.	10,000
Concrete, Mass	10,000	c.y.	70.00	700,000
Subtotal-5. Non-Overflow Wall				$726,000
Subtotal-04. Dam				49,092,000
Contingencies 15%				7,368,000
Total-04. Dam				$56,460,000
07. Power Facilities				
1. Powerhouse	Estimated by NPD			26,570,000
2. Turbines & Generators	Estimated by NPD			21,329,000
3. Accessory Electrical Equipment	Estimated by NPD			2,413,000
4. Auxilliary Systems and Equipment	Estimated by NPD			3,897,000
5. Switchyards	Estimated by NPD			680,000
6. Site Prep. & Special Items	Estimated by NPD			1,650,000

610 Ft Option - 4

LINCOLN SCHOOL HYDROELECTRIC PROJECT

ESTIMATE OF COSTS

(October 1982 Price Levels)

OPTIONAL PLAN
610 Ft. Pool Elev.
89.7 MW

Description	Quantity	Unit	Unit Price	Amount
07. Power Facilities (Cont'd)				
7. Power Channels				
Excavation Earth	296,000	c.y.	1.51	$447,000
Excavation Rock	7,000	c.y.	6.73	47,000
	Subtotal 07. Power Facilities			$57,033,000
	Contingencies 15%			8,557,000
Total-07. Power Facilities				$65,590,000
08. Roads and Bridges				
Access Roads	1	Job	L.S.	$280,000
	Contingencies 15%			40,000
Total-08. Roads and Bridges				$320,000

610 Ft Option - 5

LINCOLN SCHOOL HYDROELECTRIC PROJECT

ESTIMATE OF COSTS

(October 1982 Price Levels)

OPTIONAL PLAN
610 Ft. Pool Elev.
89.7 MW

Description	Quantity	Unit	Unit Price	Amount
18. Cultural Resources Preservation				
Preservation Measures	1	Job	L.S.	$90,000
	Contingencies 15%			10,000
Total-18. Cultural Resources Preservation				$100,000
19. Building, Grounds & Facilities				
Permanent Housing	1	Job	L.S.	$150,000
Roads and Utilities	1	Job	L.S.	100,000
Service Buildings	1	Job	L.S.	185,000
Scenic Turnout	1	Job	L.S.	25,000
Canoe Takeouts	1	Job	L.S.	100,000
	Subtotal-19. Buildings, Grounds and Facilities			$560,000
	Contingencies 15%			80,000
Total-19. Buildings, Grounds and Facilities				$640,000

LINCOLN SCHOOL HYDROELECTRIC PROJECT

ESTIMATE OF COSTS

(October 1982 Price Levels)

OPTIONAL PLAN
610 Ft. Pool Elev.
89.7 MW

Description	Quantity	Unit	Unit Price	Amount
20. Permanent Operating Equipment				
Front Loader/Backhoe w/Snowblower	1	L.S.	$90,000	$90,000
Sedan	1	L.S.	8,000	8,000
10-Wheel Dump Truck	1	L.S.	45,000	45,000
4-Wheel Drive Truck w/plow	1	L.S.	9,500	9,500
Tractor w/Flail Mower	1	L.S.	22,000	22,000
Boat and Motor	1	L.S.	5,000	5,000
Mowers (3)	1	L.S.	7,000	7,000
Snowmobiles, Chainsaws	1	L.S.	9,000	9,000
Communications Module & Mobile Radios	1	L.S.	6,000	6,000
Misc. Shop Equip & Tools	1	L.S.	23,500	23,500
	Subtotal-20. Permanent Operating Equipment			$225,000
	Contingencies			35,000
Total-20. Permanent Operating Equipment				$260,000
30. Engineering and Design (8%± Dir. Constr. Costs)				$11,000,000
31. Supervision and Administration (7% ± Dir. Constr. Costs)				9,630,000
TOTAL PROJECT FIRST COST				$164,000,000

610 Ft Option - 7

LINCOLN SCHOOL HYDROELECTRIC PROJECT

ESTIMATE OF COSTS

(October 1982 Price Levels)

OPTIONAL PLAN
600 Ft. Pool Elev.
70.13 MW

Description	Quantity	Unit	Unit Price	Amount
01. Lands and Damages	1	Job	L.S.	$4,100,000
	Contingencies 20%			800,000
Total 01. Lands and Damages				$4,900,000
02. Relocations				
1. Roads				
Roads	1	Job	L.S.	$4,750,000
Lands	1	Job	L.S.	220,000
2. Cemeteries and Utilities				
Cemeteries	1	Job	L.S.	-
Utilities	1	Job	L.S.	340,000
	Subtotal-02. Relocations			$5,310,000
	Contingencies 15%			800,000
Total 02. Relocations				$6,110,000
03. Reservoir				
Clearing	840	Acre	970.00	815,000
	Contingencies 15%			125,000
Total 03. Reservoir				$940,000

600 Ft Option -1

LINCOLN SCHOOL HYDROELECTRIC PROJECT

ESTIMATE OF COSTS

(October 1982 Price Levels)

OPTIONAL PLAN
600 Ft Pool Elev.
70.13 MW

Description	Quantity	Unit	Unit Price	Amount
04. Dam				
1. Site Clearing	1	Job	L.S.	$43,000
	Subtotal-1 Site Clearing			$43,000
2. Embankment				
Diversion and Control of Water	1	Job	L.S.	$5,000.000
Stripping Including Grubbing	37,000	c.y.	1.46	54,000
Excavation, Cutoff Trench	28,000	c.y.	1.43	40,000
Excavation				
Impervious Borrow	112,000	c.y.	1.52	170,000
Pervious Borrow	214,000	c.y.	1.31	280,000
Compacted Impervious Fill	84,000	c.y.	0.38	32,000
Compacted Random Fill	165,000	c.y.	0.27	45,000
Compacted Pervious Fill	37,000	c.y.	0.27	10,000
Selected Rock Fill for Toe	21,000	c.y.	13.52	284,000
Random Rock Fill from Excavation	22,000	c.y.	2.00	44,000
Gravel Bedding	9,000	c.y.	4.13	37,000
Rock Slope Protection	10,000	c.y.	13.51	135,000
Gravels	4,900	c.y.	3.50	17,000
Processed Gravel Slope Protection	12,000	c.y.	2.03	24,000
Relief Wells, Piezometers and Settlement Gages	1	Job	L.S.	117,000
Roadway and Guard Rail	534	L.F.	72.00	38,000
	Subtotal-2. Embankment			$6,327,000

600 Ft Option - 2

OPTIONAL PLAN
600 Ft. Pool Elev
70.13 MW

LINCOLN SCHOOL HYDROELECTRIC PROJECT

ESTIMATE OF COSTS

(October 1982 Price Levels)

Description	Quantity	Unit	Unit Price	Amount
04. Dam (cont'd)				
3. Spillway Channel				
Excavation Earth	1,100,000	c.y.	1.51	$1,661,000
Excavation Rock	850,000	c.y.	6.73	5,720,000
Subtotal-31. Spillway Channel				$7,381,000
4. Spillway Structure				
Foundation Grouting and Rock Bolts	1	Job	L.S.	930,000
Concrete Moss	94,000	c.y.	70.00	6,580,000
Concrete, Reinforced	98,000	c.y.	220.00	21,560,000
Tainter Gates and Hoists	1	Job	L.S.	1,260,000
Electrical System	1	Job	L.S.	160,000
Miscellaneous	1	Job	L.S.	660,000
Subtotal-4. Spillway Structure				$31,150,000

600 Ft Option - 3

OPTIONAL PLAN
600 Ft. Pool Elev.
70.13 MW

LINCOLN SCHOOL HYDROELECTRIC PROJECT

ESTIMATE OF COSTS

(October 1982 Price Levels)

Description	Quantity	Unit	Unit Price	Amount
5. Non-Overflow Wall				
Excavation	2,100	c.y.	1.51	$3,000
Foundation Grouting	1	Job	L.S.	10,000
Foundation Rock Treatment	1	Job	L.S.	9,000
Concrete, Mass	6,400	c.y.	70.00	448,000
	Subtotal-5 Non-Overflow Wall			$470,000
	Subtotal-04. Dam			$45,371,000
	Contingencies 15%			6,809,000
Total-04. Dam				$52,180,000
07. Power Facilities				
1. Powerhouse	Estimate by NPD			$25,087,000
2. Turbines & Generators	Estimate by NPD			20,246,000
3. Accessory Electrical Equipment	Estimate by NPD			2,413,000
4. Auxilliary Systems and Equipment	Estimate by NPD			3,682,000
5. Switchyards	Estimate by NPD			590,000
6. Site Prep. & Special Items	Estimate by NPD			1,600,000

600 Ft Option - 4

OPTIONAL PLAN
600 Ft. Pool Elev
70.13 MW

LINCOLN SCHOOL HYDROELECTRIC PROJECT

ESTIMATE OF COSTS

(October 1982 Price Levels)

Description	Quantity	Unit	Unit Price	Amount
07. Power Facilities (Cont'd)				
7. Power Channels				
Excavation Earth	290,000	c.y.	1.51	$438,000
Excavation Rock	4,700	c.y.	6.73	32,000
	Subtotal-07. Power Facilities			$54,088,000
	Contingencies 15%			8,112,000
Total-07. Power Facilities				$62,200,000
08. Roads and Bridges				
Access Roads	1	Job	L.S.	$280,000
	Contingencies 15%			40,000
Total-08. Roads and Bridges				$320,000

600 Ft Option - 5

LINCOLN SCHOOL HYDROELECTRIC PROJECT

ESTIMATE OF COSTS

(October 1982 Price Levels)

Description	Quantity	Unit	Unit Price	Amount
18. Cultural Resources Preservation				
Preservation Measures	1	Job	L.S.	$90,000
	Contingencies 15%			10,000
Total-18. Cultural Resources Preservation				$100,000
19. Building, Grounds & Facilities				
Permanent Housing	1	Job	L.S.	$150,000
Roads and Utilities	1	Job	L.S.	100,000
Service Buildings	1	Job	L.S.	185,000
Scenic Turnout	1	Job	L.S.	25,000
Canoe Takeouts	1	Job	L.S.	100,000
	Subtotal-19. Buildings, Grounds and Facilities			$560,000
	Contingencies 15%			80,000
Total-19. Buildings, Grounds and Facilities				$640,000

OPTIONAL PLAN
600 Ft Pool Elev
70.13 MW

LINCOLN SCHOOL HYDROELECTRIC PROJECT

ESTIMATE OF COSTS

(October 1982 Price Levels)

Description	Quantity	Unit	Unit Price	Amount
20. Permanent Operating Equipment				
Front Loader/Backhoe w/Snowblower	1	L.S.	90,000	$90,000
Sedan	1	L.S.	8,000	8,000
10-Wheel Dump Truck	1	L.S.	45,000	45,000
4-Wheel Drive Truck w/plow	1	L.S.	9,500	9,500
Tractor w/Flail Mower	1	L.S.	22,000	22,000
Boat and Motor	1	L.S.	5,000	5,000
Mowers (3)	1	L.S.	7,000	7,000
Snowmobiles, Chainsaws	1	L.S.	9,000	9,000
Communications Module & Mobile Radios	1	L.S.	6,000	6,000
Misc. Shop Equip & Tools	1	L.S.	23,500	23,500
	Subtotal-20. Permanent Operation Equipment			$225,000
	Contingencies 15%			35,000
Total-20. Permanent Operating Equipment				$260,000
30. Engineering and Design (8%± Dir. Constr. Costs)				$9,800,000
31. Supervision and Administration (7% ± Dir. Constr. Costs)				$8,550,000
TOTAL PROJECT FIRST COST				$146,000,000

TABLE I

Lincoln School Lakes Project Transmission Costs

	Investment ($000)			Annual Cost ($000)		
	Constr. Cost	IDC	Total Invest.	I&A	O&M	Total
A. 138-kV Line to Flo's Inn Substation						
Lines: Wood H-Frame	10,920	2,040	12,960	1,076	109	1,185
Substations	1,270	193	1,463	130	38	168
Totals	12,190	2,233	14,423	1,206	147	1,353
B. 138-kV Line to Edmundston Substation						
Lines: Wood H-Frame	7,880	1,472	9,352	776	79	855
Substations	1,270	193	1,463	130	38	168
Totals	9,150	1,665	10,815	906	117	1,023

Department of Energy
Bonneville Power Administration
Division of System Engineering
May 1982

WP-EOF-0381L

TABLE II

Lincoln School Lakes Project Transmission
Construction Costs

A. Table I with Line to Flo's Inn

Lines	Miles	Investment ($000)	
Lincoln School-Fish River 69-kV @ $100,000/Mile	18	1,800	
Lincoln School-Flo's Inn 138-kV @ $152,000/Mile	60	9,120	
		10,920	
Line Terminals	**No**	**Investment ($000)**	
Lincoln School, 69-kV @ 80,000 ea.	1	80	
Lincoln School, 138-kV @306,000 ea.	1	306	
Fish River, 69-kV @ 80,000 ea.	1	80	
Flo's Inn, 138-kV @306,000	1	306	
Transformer			
69/138-kV Transformer, 80 MW		498	
TOTAL FOR SUBSTATIONS		1,270	
GRAND TOTAL			12,190

B. Table I with Line to Edmundston

Lines	Miles	Investment ($000)	
Lincoln School-Fish River, 69-kV @ $100,000/Mile	18	1,800	
Lincoln School-Edmundston, 138-kV @ $152,000/Mile	40	6,080	
TOTAL FOR LINES		7,880	
TOTAL FOR SUBSTATIONS		1,270	
GRAND TOTAL			9,150

Department of Energy
Bonneville Power Administration
Division of System Engineering
May 1982

WP-EOF-0381L

Table III

Lincoln School Lakes Project Transmission
(IDC and Annual Cost Ratios)

A. INTEREST DURING CONSTRUCTION (IDC)
(as percent of construction costs)

Facility	IDC @ 7 7/8%
Transmission Lines	18.7
Substations	15.2

B. INTEREST AND AMORTIZTION (I&A)
(as percent of total investment 1/)

Facility	Service-Life Years	Annual I&A @7 7/8%
Wood-Pole Lines	38	8.3
Substation	28	8.9

OPERATION & MAINTENANCE (O&M)
(as percent of construction cost)

Facility	O&M
Wood-Pole Lines	1.0
Substations	3.0

1/ Total Investment = Construction Cost + IDC

Department of Energy
Bonneville Power Administration
Division of System Engineering
May 1982

WP-EOF-0381L

TABLE I

Lincoln School Lakes Project Transmission Costs

	Investment ($000)			Annual Cost ($000)		
	Constr Cost	IDC	Total Invest.	I&A	O&M	Total
A. 138kV Line to Flo's Inn Substation						
Lines: Wood H-Frame	15,480	2,895	18,375	1,525	184	1,709
Substations	1,825	277	2,102	184	63	250
Totals	17,305	3,172	20,477	1,712	247	1,959
B. 138-kV Line to Edmundston Substation						
Lines: Wood H-Frame	10,920	2,042	12,962	1,076	130	1,206
Substations	1,825	277	2,102	187	63	250
Totals	12,745	2,319	15,064	1,263	193	1,456

Note: Revised to reflect increased transmission costs for 100-150 MW power plant capacities - per verbal guidance from BPA 8 and 21 Sep 82.

TABLE II

Lincoln School Lakes Project Transmission

Construction Costs

A. Table I with Line to Flo's Inn

Lines	Miles	Investment ($000)	
Lincoln School-Fish River 69-kV @ $100,000/Mile	18	1,800	
Lincoln School-Flo's Inn 138-kV @ $228,000 Mile	60	13,680	
		15,480	
Line Terminals	**No**	**Investment ($000)**	
Lincoln School, 69 kV @ $80,000 ea.	1	80	
Lincoln School, 138 kV @ $459,000 ea.	1	459	
Fish River, 69-kV @ $80,000 ea.	1	80	
Flo's Inn, 138 kV @ $459,000 ea.	1	459	
Transformer			
69/138-kV Transformer, 120 MW		747	
TOTAL FOR SUBSTATIONS		1,825	
GRAND TOTAL			17,305

B. Table I with Line to Edmundston

Lines	Miles	Investment ($000)	
Lincoln School-Fish River 69-kV @ $100,000/Mile	18	1,800	
Lincoln School-Edmundston 138-kV @ $228,000	40	9,120	
TOTAL FOR LINES		10,920	
TOTAL FOR SUBSTATIONS		1,825	
GRAND TOTAL			12,745

NOTE: Revised to reflect increased transmission costs for 100-150 MW power plant capacities-per verbal guidance from BPA, 8 & 21 Sep 82

APPENDIX D

COORDINATION CORRESPONDENCE

-DEPARTMENT OF ENERGY-

- BONNEVILLE POWER ADMINSTRATION (BPA)
- FEDERAL ENERGY REGULATORY COMMISSION (FERC)
- SOUTHEASTERN POWER ADMINISTRATION (SEPA)

-US ARMY CORPS OF ENGINEERS-

- NORTH PACIFIC DIVISION (NPD)

-DEPARTMENT OF INTERIOR-

- US FISH AND WILDLIFE SERVICE (USF&WS)

-STATE OF MAINE-

Department of Energy
Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208

In reply refer to: EOF

MAY 14 1982

Joe B. Fryar, Chief
Engineering Division
Corps of Engineers, New England Division
424 Trapelo Road
Waltham, Massachusetts 02254

Dear Mr. Fryar:

We have prepared a preliminary estimate of the cost of transmission from the Lincoln School Project as requested in your letter of April 14, 1982.

The cost of transmission with interest during construction from the Lincoln School Project to the 138-kV Flo's Inn Substation is estimated at about $14,000,000. The corresponding cost to deliver the power at Edmundston is approximately $11,000,000. These facilities would be required for any capacity within the range of 45 MW to 85 MW.

Either plan includes a 69-kV line from Lincoln School to Fish River Substation, and a 69/138-kV transformer at Lincoln School. Since the Maine Power System is relatively weak (peak demand about 100 MW), it is assumed that the Lincoln generation would be connected to a stronger bus. The 138-kV substations at Edmundston and Flo's Inn are both connected to the larger power systems in that region.

Tables 1 and 2 indicate the investment and annual costs for the two plans at 7 7/8 %. The costs of the facilities are itemized in Table 2. The factors used for calculating annual costs and interest costs are shown in Table 3. These costs are based on preliminary plans. Powerflow and environmental investigations will be required to firm up the plans and estimates. Please let us know if we can be of further assistance.

Sincerely,

Dennis M. Porter

Dennis Porter, Chief
Branch of System Planning

Enclosures (3)

TABLE I

Lincoln School Lakes Project Transmission Costs

	Investment ($000)			Annual Cost ($000)		
	Constr. Cost	IDC	Total Invest.	I&A	O&M	Total
A. 138-kV Line to Flo's Inn Substation						
Lines: Wood H-Frame	10,920	2,040	12,960	1,076	109	1,185
Substations	1,270	193	1,463	130	38	168
Totals	12,190	2,233	14,423	1,206	147	1,353
B. 138-kV Line to Edmundston Substation						
Lines: Wood H-Frame	7,880	1,472	9,352	776	79	855
Substations	1,270	193	1,463	130	38	168
Totals	9,150	1,665	10,815	906	117	1,023

Department of Energy
Bonneville Power Administration
Division of System Engineering
May 1982

WP-EOF-0381L

TABLE II

Lincoln School Lakes Project Transmission
Construction Costs

A. Table I with Line to Flo's Inn

Lines	Miles	Investment ($000)	
Lincoln School-Fish River 69-kV @ $100,000/Mile	18	1,800	
Lincoln School-Flo's Inn 138-kV @ $152,000/Mile	60	9,120	
		10,920	
Line Terminals	**No**	**Investment ($000)**	
Lincoln School, 69-kV @ 80,000 ea.	1	80	
Lincoln School, 138-kV @306,000 ea.	1	306	
Fish River, 69-kV @ 80,000 ea.	1	80	
Flo's Inn, 138-kV @306,000	1	306	
Transformer			
69/138-kV Transformer, 80 MW		498	
TOTAL FOR SUBSTATIONS		1,270	
GRAND TOTAL			12,190

B. Table I with Line to Edmundston

Lines	Miles	Investment ($000)	
Lincoln School-Fish River, 69-kV @ $100,000/Mile	18	1,800	
Lincoln School-Edmundston, 138-kV @ $152,000/Mile	40	6,080	
TOTAL FOR LINES		7,880	
TOTAL FOR SUBSTATIONS		1,270	
GRAND TOTAL			9,150

Department of Energy
Bonneville Power Administration
Division of System Engineering
May 1982

WP-EOF-0381L

Table III

Lincoln School Lakes Project Transmission
(IDC and Annual Cost Ratios)

A. INTEREST DURING CONSTRUCTION (IDC)
(as percent of construction costs)

Facility	IDC @ 7 7/8%
Transmission Lines	18.7
Substations	15.2

B. INTEREST AND AMORTIZTION (I&A)
(as percent of total investment 1/)

Facility	Service-Life Years	Annual I&A @7 7/8%
Wood-Pole Lines	38	8.3
Substation	28	8.9

OPERATION & MAINTENANCE (O&M)
(as percent of construction cost)

Facility	O&M
Wood-Pole Lines	1.0
Substations	3.0

1/ Total Investment = Construction Cost + IDC

Department of Energy
Bonneville Power Administration
Division of System Engineering
May 1982

WP-EOF-0381L

FEDERAL ENERGY REGULATORY COMMISSION
NEW YORK REGIONAL OFFICE
26 FEDERAL PLAZA, ROOM 2207
NEW YORK, NEW YORK 10278

July 22, 1982

Colonel C.E. Edgar III,
Division Engineer
Department of the Army
New England Division,
Corps of Engineers
424 Trapelo Road
Waltham, MA 02254

Dear Colonel Edgar:

In response to your letter of April 13, 1982, and in accordance with subsequent discussion with members of your staff, we have determined at-market power values for the proposed Lincoln School hydroelectric project on the St. John River in Northern Maine, using a Federal interest rate of 7-7/8 percent. We have also addressed the methodologies used in our analysis and the selection of the Lincoln School market area. As requested, power values were calculated for installed capacities ranging from 45 to 85 Mw (in increments of 10 Mw) with corresponding annual plant factors from 34 to 52 percent.

Capacity and energy values as of October 1982 (snapshot) were first computed based on current fuel prices. Energy values were also derived using life cycle cost (LCC) and displaced energy cost (DEC) techniques. The snapshot capacity values may be used in conjunction with the LCC energy values to yield total LCC power benefits. Benefits determined using a DEC methodology do not include a capacity component. Both LCC and DEC energy values use the Department of Energy (DOE) energy escalation projections released in November 1981. This projection lists fuel cost escalations for the period 1982 - 2006. After 2006, fuel prices were considered to increase along with general rate of inflation; i.e., no increase using constant dollars.

It is our policy to consider generation with annual plant factors up to and including 17 percent (corresponding to 1500 hours annual operation) as the peaking band on the selected market load curve; plant factors over 17 percent and up to 40 percent (corresponding to 3,500 hours annual operation), as the intermediate range; and 40 percent and over for base load. Project alternatives, employed in evaluating proposed hydro projects, are oil fired combustion turbines for peaking; cycling coal for intermediate bands; and conventional coal fired units for base load operation. The capital cost of a base load, coal-fired, generating station consisting of a single 600 megawatt unit in New England is estimated at $1,410/kW under federal financing at October 1982 price levels, while the capital cost of a single 400 MW unit cycling coal plant is $990/kW. Heat rates are taken at 9,500 Btu/kWh for the base load coal plant and 11,000 Btu/kWh for the cycling coal. Fuel costs were obtained from a May 1982 phone survey of utilities in New England, and escalated to October 1982. The cost for coal is $2.50/million Btu, heavy oil is $4.90/million Btu and light oil is $7.10/million Btu.

Snapshot at-market power values consisting of two components, represent a summation of all the annualized costs of constructing and operating a power plant and required transmission for the year following an assumed on line date during October 1982. The capacity component reflects the fixed costs associated with the construction and operation of the project alternative, with interest expense accounting for the largest portion. The energy, or variable component consists mainly of the cost of fuel consumed. In the case of the LCC values, the snapshot energy values are used as a starting point but are escalated to reflect the increased fuel costs for the 100 year period following the projected project on line date of 1990. All energy costs were discounted to 1990 to obtain their present worth and then summed. A capital recovery factor was then applied to yield the levelized LCC energy value. The process for calculating the DEC energy value is essentially similar, but in this case it is the cost of the energy displaced in the project market area for each of the 100 years follwing 1990 which is escalated. The methodology for the displaced energy costs analysis is based on the recently issued Water Resources Council task force report entitled "Implementing Procedures for Evaluating Hydropower Benefits." The annual load duration curves for New England were synthesized from data supplied by NEPLAN for 1981 and future load projections from the Northeast Power Coordinating Council (NPCC) reliability report, submitted to DOE, and the NEPLAN "Red Book". The type of generation displaced was then taken from capacity band stackings put into the annual load duration curve. The projections of capacity changes were also taken from the NPCC reliability report and the NEPLAN "Red Book." These provide information through the year 2002. After 2002 and through 2090, it was assumed that there would be no further change in the types of generation displaced.

Lincoln School was examined for its use both in a Maine and a New England market on both an annual and a spring-season load duration curve for 1990. Our analysis indicates that Nepool is the more suitable market area for the Lincoln School project. Lincoln School will directly displace much more costly oil fired generation if used in NEPOOL than if used exclusively on the Maine load. The bulk of the energy output of Lincoln School under all five study schemes is available in the spring and early summer; in both Maine and New England this is a period of low electrical demand. During this period, substantially less oil fired generation is used in Maine, compared to the relatively greater amounts in the other five New England states. During the winter months when Maine and New England experience their electrical peak, Lincoln School produces little energy and has virtually no dependable capacity. Thus, the chief value of the output of Lincoln School is as displacement energy duiring the spring and early summer, and as such is most valuable in New England as a whole through Nepool rather than in Maine alone.

Estimated at-market power values for Lincoln School are shown below. They reflect the cost of assumed 345 kV transmission required for delivery of output from the base load and cycling coal alternatives to market. The capacity values, rounded to the nearest dollar, are applicable to the project's dependable capacity and the energy values, rounded to the nearest mill, are applicable to the average annual generation.

Lincoln School At-Market Power Values

(Federal Financing - 7-7/8 % interest)

Project Capacity	Mw	45	55	65	75	85
Plant Factor	%	34	36	40	45	52
Alternative /1	Type	CCP	CCP	BCP	BCP	BCP
Power Values						
Oct.'82						
Capacity	$/KW	138	138	199	199	199
Energy	mills/KWH	31	32	24	25	27
Life Cycle Cost						
Energy	mills/KWH	40	41	31	33	35
Displaced Energy						
Energy	mills/KWH	115	115	115	115	101

/1 CCP - Cycling Coal Plant
BCP - Base Coal Plant

If we can be of further assistance in your study, do not hesitate to contact us.

Sincerely,

James D. Hebson

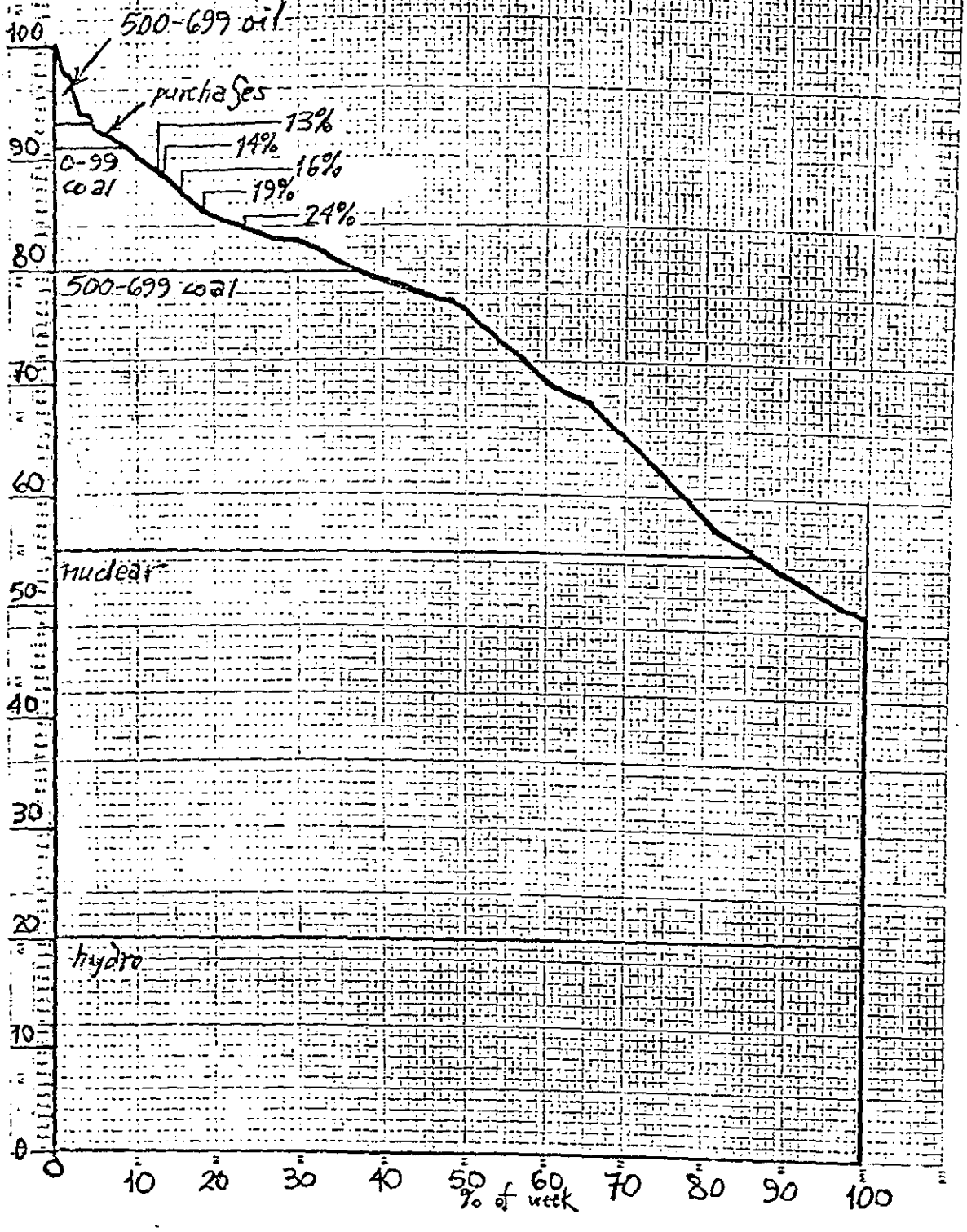
James D. Hebson
Regional Engineer

Attachments

Winter 1989-1990
& 1990-1991
Maine

January 1990

State of Maine January 1990 loadduration curve



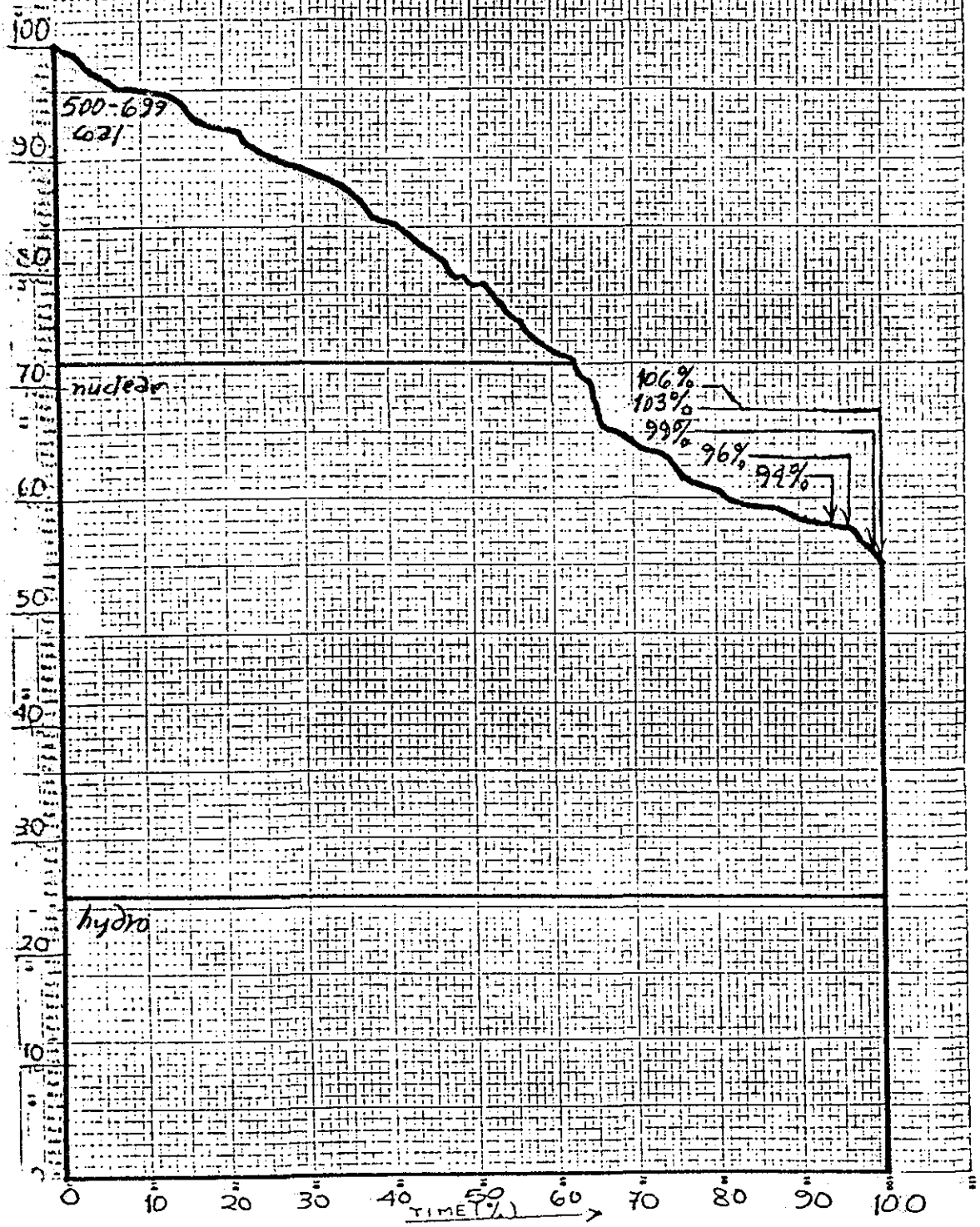
Incl. 2

Spring-Fall 1990

Maine

May 1990

State of Maine May 1990 loadduration curve

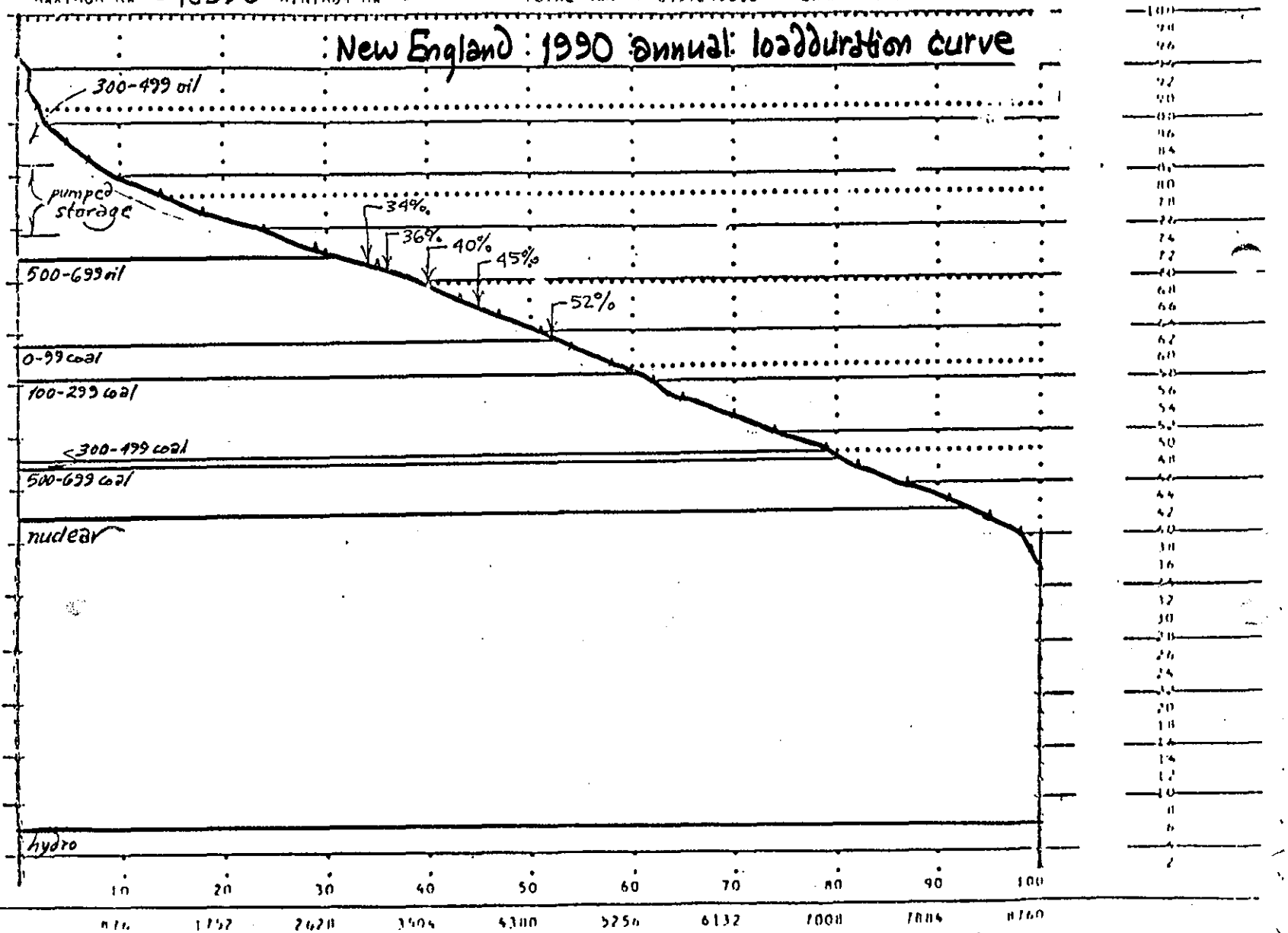


Incl 3

LOAD DURATION DATA NEW ENGLAND POWER EXCHANGE WINTER 1989 - 1990

(annual curve)

MAXIMUM MW = 18350 MINIMUM MW = TOTAL MWH = 84572950.0 LOAD FACTOR =



Tab 4

LOAD DURATION DATA FOR 1981 - NEW ENGLAND POWER EXCHANGE

JANUARY 1990

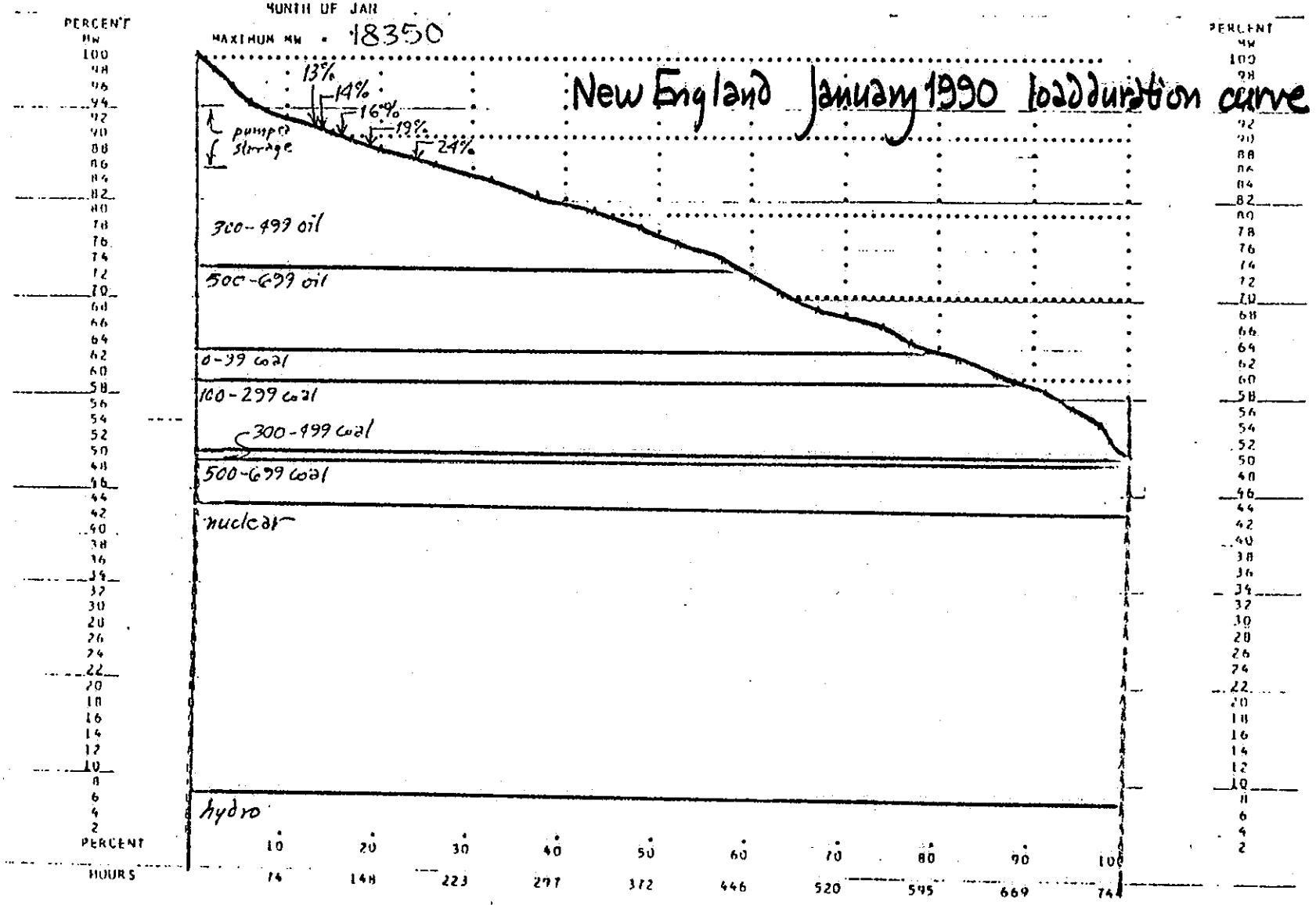


Fig 5

MAY 1990

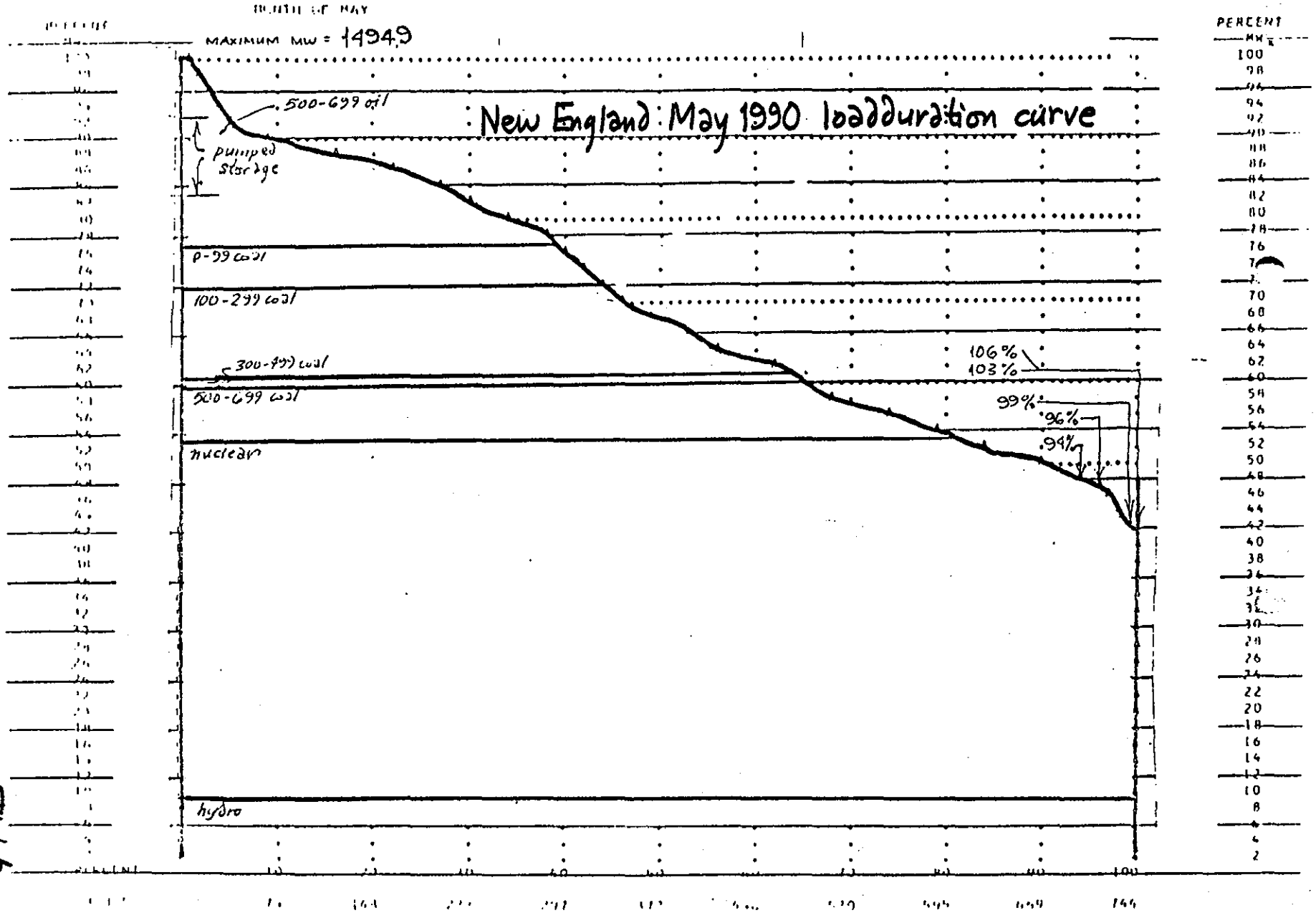


Fig 6

FEDERAL ENERGY REGULATORY COMMISSION
NEW YORK REGIONAL OFFICE
26 FEDERAL PLAZA, ROOM 2207
NEW YORK, NEW YORK 10278

November 3, 1982

Colonel Carl B. Sciple,
Division Engineer
Department of the Army
New England Division,
Corps of Engineers
424 Trapelo Road
Waltham, MA 02254

Dear Colonel Sciple:

In response to your letter of September 24, 1982, and in accordance with subsequent discussion with members of your staff, we have determined at-market power values for the proposed Lincoln School hydroelectric project on the St. John River in Northern Maine, using Federal interest rates of 7-7/8 and 10 percent. As requested, power values were calculated for nameplate capabilities of 110.87, 89.70, and 70.13 Mw with corresponding annual plant factors of 28.0, 29.3, and 31.1 percent, respectively. These values replace those furnished you in our July 22, 1982 letter.

Capacity and energy values as of October 1982 (snapshot) were first computed based on current fuel prices. Energy values were also derived using life cycle cost (LCC) and displaced energy cost (DEC) techniques. The snapshot capacity values may be used in conjunction with the LCC energy values to yield total LCC power benefits. Benefits determined using a DEC methodology do not include a capacity component. Both LCC and DEC energy values use the Department of Energy (DOE) energy escalation projections released in November 1981. This projection lists fuel cost escalations for the period 1982 - 2006. After 2006, fuel prices were considered to increase along with general rate of inflation; i.e., no increase using constant dollars.

It is our policy to consider generation with annual plant factors up to and including 17 percent (corresponding to 1500 hours annual operation) as the peaking band on utility load curves; plant factors over 17 percent and up to 40 percent (corresponding to 3,500 hours annual operation), as the intermediate range; and 40 percent and over for base load. Project alternatives employed in evaluating proposed hydro projects are oil fired combustion turbines for peaking duty; cycling coal for intermediate load curve bands; and conventional coal fired units for base load operation. The three proposed Lincoln School developments under study fall in the range of plant factors using a cycling coal alternative. The capital cost of a single 400 MW unit cycling coal plant is estimated at $990/Kw for 7-7/8 percent interest and $1050/Kw for 10 percent interest. The heat rates of the cycling coal plant was taken at 11,000 Btu/kWh. Fuel costs obtained from an October 1982 phone survey of individual utilities in New England, were $1.90/million Btu for coal, $4.70 for heavy oil, and $8.00 for light oil. The costs of coal and heavy oil are lower than our May 1982 survey, while the cost of light oil is higher. As a result, the changes in fuel costs have a corresponding effect on the Lincoln School energy value.

Snapshot at-market capacity and energy values represent a summation of all the annualized costs of constructing and operating a power plant and required transmission as of October 1982. The capacity component in $/KW/YR reflects the fixed costs associated with the construction and operation of the project alternative, with interest expense accounting for the largest portion. The energy, or variable component in mills/KWH consists mainly of the cost of fuel consumed. In the case of the LCC values, the snapshot energy values are used as a starting point but are escalated to reflect the increased fuel costs for the 100 year period following the projected project on-line date of 1990. All energy costs were discounted to 1990 to obtain their present worth and then summed. A capital recovery factor was then applied to yield the levelized LCC energy value. The process for calculating the DEC energy value is essentially similar, but in this case it is the cost of the energy displaced in the selected power market area which is escalated. The methodology for the displaced energy costs analysis is based on the Water Resources Council task force report entitled, "Implementing Procedures for Evaluating Hydropower Benefits", dated December 1981. The annual load duration curves for New England were synthesized from data contained in NEPLAN and Northeast Power Coordinating Council (NPCC) reports. The type of generation displaced was then determined from the capacity band stackings on the annual load duration curve. Projected capacity changes are available from the NPCC and NEPLAN reports through the year 2002. After 2002 and through 2090 it was assumed that there would be no further changes in the types of generation displaced.

In using the displaced energy cost power values it must be noted that the band stackings for NEPEX do not include any of the prospective long-term imports from Canada currently being considered. The NPCC and NEPLAN reports do not show any significant Canadian purchases after 1989. As shown in the following table, present plans for New England have imports from Canada declining from 460 Mw in 1982/3 to a constant 27Mw in 1989/90.

Winter Season	Canadian Purchases (MW)	Total Purchases (MW)
1982/3	460	613
1983/4	462	615
1984/5	462	614
1985/6	278	429
1986/7	276	427
1987/8	46	197
1988/9	46	197
1989/90	27	178
1990/1	27	178
1991/2	27	178

A large scale purchase of capacity and associated energy from Canada (several thousand megawatts are now contemplated) would push New England's high cost oil-fired generation upwards - or even off - the load curve. This could move lower cost oil, coal generation, or the Canadian purchases into the capacity factor band occupied by Lincoln School. This would sharply lower the value of Lincoln School energy based on displaced energy costs. Hence, if the contracts for Canadian imports are formally announced by New England, it will be necessary to recalculate the power values for the Lincoln School project.

Estimated at-market power values for Lincoln School are shown below. They reflect the cost of assumed 345 kV transmission required for delivery of output from the cycling coal alternatives to market. The capacity values, rounded to the nearest dollar, are applicable to the project's dependable capacity and the energy values, rounded to the nearest mill, are applicable to the average annual generation.

Lincoln School At-Market Power Values /1

(Federal Financing)

		7-7/8 % interest			10 % interest		
Project Capacity	Mw	110.87	89.70	70.13	110.87	89.70	70.13
Plant Factor	%	28.0	29.3	31.1	28.0	29.3	31.1
Power Values							
Oct.1982 Capacity	$/KW/YR	136	136	136	166	166	166
Energy	mills/KWH	16	18	20	16	18	20
Life Cycle Cost Energy	mills/KWH	21	23	26	20	23	25
Displaced Energy Energy	mills/KWH	150	150	149	143	143	143

/1 All developments use a cycling coal plant as the alternative.

If we can be of further assistance in your study, do not hesitate to contact us.

Sincerely,

James D. Hebson

James D. Hebson
Regional Engineer

FEDERAL ENERGY REGULATORY COMMISSION
NEW YORK REGIONAL OFFICE
26 FEDERAL PLAZA, ROOM 2207
NEW YORK, NEW YORK 10278

November 22, 1982

Colonel Carl B. Sciple
Division Engineer
Department of the Army
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, MA 02254

Dear Colonel Sciple:

Reference is made to our letter of November 3, 1982, providing at market power values for the proposed Lincoln School hydroelectric project in response to Mr. Fryar's request of September 24, 1982. The values submitted included an energy value based on displaced energy costs (DEC) and the escalation of fuel prices according to Department of Energy (DOE) guidelines. On October 20, 1982, Mr. M. Givens of your staff informally requested that DEC energy values also be furnished based on current fuel costs, assuming no escalation in the future.

The cycling coal alternative and all associated costs and technical and operating parameters employed in our November 3 submittal remain in effect for the three development schemes under consideration - 110.87 MW, 89.70 MW, and 70.13 MW. Since the cost of displaced energy bands and their positions on New England's load curve vary with changes in projected capacity mixes and in the annual load duration curves, the use of present worth and levelization techniques was necessary for determination of a levelized DEC energy value.

Based on the above, the DEC energy value applicable to all three proposed Lincoln School installations for the 7 7/8 percent Federal interest rate is 59 mills/Kwh.

If we can be of further assistance to you in your study, do not hesitate to contact us.

Sincerely,

James D. Hebson

James D. Hebson
Regional Engineer

Department of Energy
Southeastern Power Administration
Elberton, Georgia 30635

November 17, 1982

Division Engineer
New England Division, Corps of Engineers
Department of the Army
424 Trapelo Road
Waltham, Massachusetts 02254

Dear Sir:

In response to your letter NEDED-E, dated September 23, 1982, and signed by Joe B. Fryar, we have analyzed the Lincoln School Hydroelectric Project for financial feasibility.

Since the bulk of the energy output of Lincoln School is available in the spring and early summer and there is virtually no dependable capacity, we confirm the conclusion that the chief value of Lincoln School is as displacement energy during the spring and early summer, and as such is most valuable in New England as a whole through Nepool rather than in Maine alone.

Financial feasibility of a project depends upon a fifty year analysis, and in this case the Department of Energy interest rate is 9-1/2 percent. Total power costs must be amortized over a 50-year period, and an interest rate based on the yield of long-term government bonds at the time construction is initiated must be used.

Pertinent cost information related to the power financial feasibility study for three assumptions is as follows:

	COSTS ALLOCATED TO POWER		
	110.87 MW 620 Ft. Pool	89.7 MW 610 Ft. Pool	70.13 MW 600 Ft. Pool
Construction Cost	$183,000,000	$164,000,000	$146,000,000
Interest During Construction	50,300,000	45,100,000	40,200,000
Total Investment	$233,300,000	$209,100,000	$186,200,000
Transmission Cost	$ 12,740,000	$ 9,150,000	$ 9,150,000
Interest During Construction	2,830,000	2,030,000	2,030,000
Total Investment	$ 15,570,000	$ 11,180,000	$ 11,180,000
Total Project Investment	$248,870,000	$220,280,000	$197,380,000

EQUAL ANNUAL CHARGES

Interest & Amortization	$23,900,000	$21,150,000	$18,950,000
Operation & Maintenance	730,000	675,000	675,000
Major Replacements	860,000	820,000	770,000
Wheeling Costs	1,120,000	910,000	710,000
Total Charges	$26,610,000	$23,555,000	$21,105,000
Average Annual Energy (MWH)	272,000	230,000	191,000

Based upon the theory of selling the power as displacement energy, the annual charges for each type of installation divided by the average annual energy will produce the following rates required to cover the charges:

1. 97.8 mills for the 620 ft. pool
2. 102.4 mills for the 610 ft. pool
3. 110.5 mills for the 600 ft. pool

Rates presently charged to preference customers vary substantially in the New England area, but 57 mills appears to be among the higher overall rates paid by wholesale customers.

A recent study estimated that hydroelectric plant charges trail other non-hydro plants by 3 percent in escalation of costs. If the 57 mills is escalated by 3 percent per year for eight years to get a rate for the year 1990, the rate would still be only 72 mills.

Therefore, all three construction assumptions are not financially feasible under present criteria.

While the conclusion expressed immediately above is SEPA's official position, we would like to call to your attention one further analysis using an assumption that you might find interesting. The assumption involved escalation of the energy rate of 72 mills in 1990 to the year 2040, or for 50 years, at an annual increase of 3 percent. Using appropriate present worth and annuity factors, it was found that the energy rate would average 140 mills for the 50-year period. It was also determined that the rate would reach 110 mills, required for a 600 ft. pool elevation project, between the 14th and 15th year of operation.

Sincerely,

for

Harry C. Geisinger
Administrator

DISPOSITION FORM

For use of this form, see AR 340-15; the proponent agency is TAGO.

REFERENCE OR OFFICE SYMBOL	SUBJECT
NPDEN-HD JBY 7.7.82	Lincoln School Hydroelectric Project, Maine

TO Commander
New England Division
ATTN: Malcom Giveus

FROM Acting Chief, HEDB, NPD

DATE 30 June 1982
Ratnieks/dc/4917

CMT 1

Attached are the results of the scoping studies for the Lincoln School Powerhouse. Included are the P.H. construction and equipment costs, a summary of the turbine selection data, and a tabulation of P.H. dimensions

FOR THE COMMANDER:

H.A. Hoadley

H.A. HOADLEY, P.E.
Acting Chief, Hydro-Electric Design Branch

6 Incl
3 cost sheets
Dimension Summary
2 Turbine Data Summary

PROJECT: LINCOLN SCHOOL

DATE: June 29, 1982

PLANT CAPACITY: Pool El. 620.

PRICE LEVEL DATE: Oct 1, 1982

FEATURE	SCHEME 1 85.26 MW H = 76 FT Q = 14520 CFS	SCHEME 2 98.37 MW H = 76 FT. Q = 16680 CFS	SCHEME 3 110.87 MW H = 76 FT Q = 18840 CFS
1. POWERHOUSE			
1.1 Excavation (Rock) *	182,000.	177,690.	255,800.
1.2 Reinforced Concrete	19,701,500.	21,039,370.	22,285,840.
1.3 Misc. Building Items	364,000.	374,700.	391,600.
1.4 Bulkhead, Guides & Struct Steel	3,258,000.	3,515,500.	3,956,000.
1.5 Architectural	1,100,000.	1,188,000.	1,278,000.
2. TURBINES AND GENERATORS			
2.1 Turbines ~~& Generators~~	9,720,000.	10,728,000.	11,681,000.
2.2 Excitation Equipment & Generators	7,835,000.	9,007,000.	9,594,000.
2.3 Governor	489,000.	505,000.	516,000.
2.4 Cooling System	269,000.	271,000.	272,000.
3. ACCESSORY ELECTRICAL EQUIP.			
3.1 Switchgear, Breakers & Busses	630,000.	630,000.	635,000.
3.2 Station Service Unit	85,000.	85,000.	85,000.
3.3 Control System	312,970.	312,970.	312,970.
3.4 Misc. Electrical Systems	1,312,000.	1,345,000.	1,385,000.
4. AUXILIARY SYSTEMS & EQUIP.			
4.1 Heating and Ventilating	265,000.	280,000.	290,000.
4.2 Station, Brake & Governor Air	90,000.	91,000.	91,000.
4.3 Unwatering & Drainage Systems	345,000.	347,000.	347,000.
4.4 Gantry Crane, Tailrace, Hoist & Misc.	1,736,300.	1,879,000.	1,960,000.
4.5 Misc. Mechanical Systems	251,000.	253,000.	254,000.
4.6 Bridge Crane	930,000.	1,150,000.	1,150,000.
5. SWITCHYARD			
5.1 Power Transformer	637,000.	688,000.	739,000
5.2 Disconnects & Elec. Equip.	25,000.	25,000.	25,000.
6. SITE PREPARATION & SPECIAL ITEMS			
6.1 Mobilization & Preparation	1,500,000.	1,600,000.	1,700,000.
Sub-Total	51,037,770.	55,486,230.	59,204,210.
Contingency @ 15% ±	7,656,230.	8,323,770.	8,880,690.
TOTAL	58,694,000.	63,810,000.	68,084,900.

* Cofferdam by N.E.D.

Tab 1

PROJECT: LINCOLN SCHOOL

DATE: June 29, 1982

PLANT CAPACITY: Pool El. 610.00

PRICE LEVEL DATE: Oct. 1, 1982

FEATURE	SCHEME 4 H = 66 FT. 69 MW Q = 13540 CFS	SCHEME 5 H = 66 FT 79.35 MW Q = 16270 CFS	SCHEME 6 H = 66 FT 89.7 MW Q = 17560 CFS
1. POWERHOUSE			
1.1 Excavation (Rock)*	124,500.	144,500.	215,500.
1.2 Reinforced Concrete	18,738,000.	19,886,500.	21,345,000.
1.3 Misc. Building Items	364,000.	374,700.	391,600.
1.4 Bulkhead, Guides & Struct Steel	3,180,500.	3,374,500.	3,304,500.
1.5 Architectural	1,040,000.	1,111,000.	1,313,000.
2. TURBINES AND GENERATORS			
2.1 Turbines ~~& Generators~~	9,200,000.	10,198,000.	11,151,000.
2.2 Excitation Equipment Generators	7,617,000.	8,069,000.	9,195,000.
2.3 Governor	477,000.	491,000.	504,000.
2.4 Cooling System	251,000.	264,000.	270,000.
3. ACCESSORY ELECTRICAL EQUIP.			
3.1 Switchgear, Breakers & Busses	630,000.	630,000.	630,000.
3.2 Station Service Unit	85,000.	85,000.	85,000.
3.3 Control System	312,970.	312,970.	312,970.
3.4 Misc. Electrical Systems	1,312,000.	1,345,000.	1,385,000.
4. AUXILIARY SYSTEMS & EQUIP.			
4.1 Heating and Ventilating	245,000.	255,000.	270,000.
4.2 Station, Brake & Governor Air	84,000.	88,000.	90,000.
4.3 Unwatering & Drainage Systems	321,000.	339,000.	346,000.
4.4 Gantry Crane, Tailrace, Hoist & Misc.	1,736,300.	1,796,000.	1,879,000.
4.5 Misc. Mechanical Systems	234,000.	247,000.	252,000.
4.6 Bridge Crane	930,000.	985,000.	1,060,000.
5. SWITCHYARD			
5.1 Power Transformer	558,000.	614,000.	655,000.
5.2 Disconnects & Elec. Equip.	25,000.	25,000.	25,000.
6. SITE PREPARATION & SPECIAL ITEMS			
6.1 Mobilization & Preparation	1,450,000.	1,500,000.	1,600,000
Sub-Total	48,915,270.	52,135,170.	56,279,570.
Contingency @15%±	7,337,730.	7,820,330.	8,442,430.
TOTAL	56,253,000.	59,955,500.	64,722,000.

* Cofferdam by N.E.D.

Item 8

PROJECT: LINCOLN SCHOOL

DATE: June 29, 1982

PLANT CAPACITY: POOL EL. 600.00

PRICE LEVEL DATE: Oct. 1, 1982

FEATURE	SCHEME 7 H = 56 FT 53.92 MW Q = 12 460 cfs	SCHEME 8 H = 56 FT. 62.04 MW Q = 14 310 cfs	SCHEME 9 H = 56 FT. 70.13 MW Q = 16 190 cfs.
1. POWERHOUSE			
1.1 Excavation (Rock) *	94,000.	124,000.	163,700.
1.2 Reinforced Concrete	17,344,000.	19,245,500.	20,041,900.
1.3 Misc. Building Items	364,000.	374,700.	391,600.
1.4 Bulkhead, Guides & Struct Steel	3,164,000.	3,251,500.	3,114,500.
1.5 Architectural	985,000.	1,164,000.	1,375,000.
2. TURBINES AND GENERATORS			
2.1 Turbines ~~& Generators~~	8,837,000.	9,757,000.	10,695,000.
2.2 Excitation Equipment & Generators	6,258,000.	7,920,000.	8,617,000.
2.3 Governor	463,000.	477,000.	487,000.
2.4 Cooling System	228,000.	246,000.	257,000.
3. ACCESSORY ELECTRICAL EQUIP.			
3.1 Switchgear, Breakers & Busses	580,000.	630,000.	630,000.
3.2 Station Service Unit	85,000.	85,000.	85,000.
3.3 Control System	312,970.	312,970.	312,970.
3.4 Misc. Electrical Systems	1,312,000.	1,345,000.	1,385,000.
4. AUXILIARY SYSTEMS & EQUIP.			
4.1 Heating and Ventilating	205,000.	225,000.	240,000.
4.2 Station, Brake & Governor Air	76,000.	82,000.	87,000.
4.3 Unwatering & Drainage Systems	290,000.	315,000.	329,000.
4.4 Gantry Crane, Tailrace, Hoist & Misc.	1,641,000.	1,673,000.	1,801,000.
4.5 Misc. Mechanical Systems	213,000.	230,000.	240,000.
4.6 Bridge Crane	865,000.	930,000.	985,000.
5. SWITCHYARD			
5.1 Power Transformer	470,000.	517,000.	565,000.
5.2 Disconnects & Elec. Equip.	25,000.	25,000.	25,000.
6. SITE PREPARATION & SPECIAL ITEMS			
6.1 Mobilization & Preparation	1,315,000.	1,470,000.	1,600,000.
Sub-Total	45,126,970.	50,399,670.	53,427,670.
Contingency @ 15% ±	6,770,030.	7,560,030.	8,014,330.
TOTAL	51,897,000.	57,959,700.	61,442,000.

* Cofferdam by N.E.D.

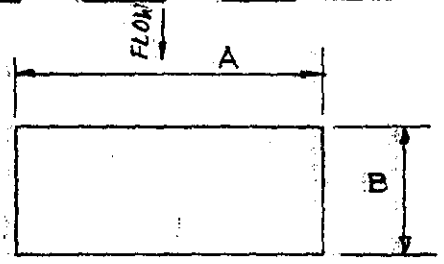
Exhibit 3

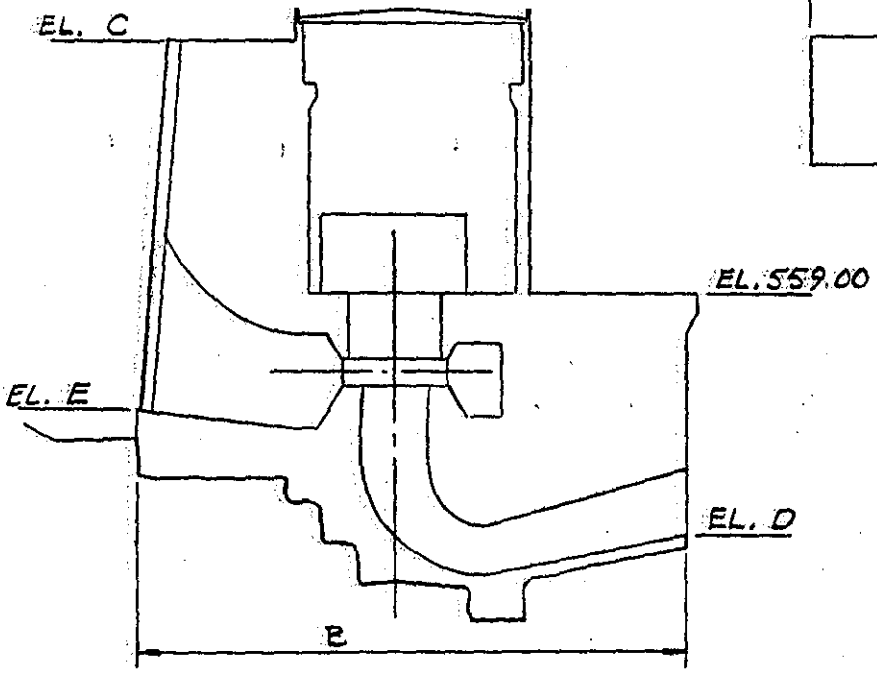
U. S. ARMY ENGINEER DIVISION, NORTH PACIFIC — HYDRO-ELECTRIC DESIGN BRANCH

PROJECT LINCOLN SCHOOL

SUBJECT P.H. DIMENSIONS SUMMARY SCOPING STUDY

BY V.R. DATE 29 June 82 CHECKED _____ PART _____ PAGE _____ OF _____





SCHEME	MAX. POOL	DIMENSIONS				
		A ft.	B ft	C	D	E
1	EL. 620.	274.	154.	EL. 630.	EL. 481.	EL. 513.
2	620.	282.	160.	630.	477.	512.
3	620.	292.	167.	630.	475.	510.
4	610.	274.	152.	620.	486.	517.
5	610.	282.	158.	620.	483.	516.
6	610.	292.	165.	620.	480.	515.
7	600.	274.	151.	610.	491.	513.
8	600.	282.	156	610.	488	521.
9	600.	292.	163	610.	485	520.

NPD Form 7A
June 1962

Clearprint
10th Grid - RP
Translucent Grid

Incl 4

U. S. ARMY ENGINEER DIVISION, NORTH PACIFIC — HYDRO-ELECTRIC DESIGN BRANCH

PROJECT Lincoln School

SUBJECT PRELIMINARY TURBINE SELECTION

BY LLS DATE 15JUN82 CHECKED RJW PART 1 PAGE 4 OF 5.

SUMMARY OF ALL SCHEMES

	Head (ft)	Diameter (inches)	Speed (rpm)	H_s* (ft)	Turbine output power (MW)	Flow Δ (cfs)
Scheme 1						
Large	76	195.3	116.1	14.2	37.67	6280
Small		108.4	211.8	12.0	11.61	1960
Scheme 2						
Large	76	208.1	109.1	14.5	42.79	7120
Small		121.1	189.5	12.25	14.49	2440
Scheme 3						
Large	76	220.1	102.9	14.6	47.87	7960
Small		132.7	171.4	13.2	17.40	2920
Scheme 4						
Large	66	195.3	105.9	8.9	30.51	5860
Small		108.4	189.5	7.75	9.39	1820
Scheme 5						
Large	66	208.1	100	9.0	34.62	6650
Small		121.1	171.4	7.6	11.73	2270
Scheme 6						
Large	66	220.1	94.7	9.25	38.72	7420
Small		132.7	156.5	7.8	14.08	2720
Scheme 7						
Large	56	195.3	97.3	3.7	23.84	5390
Small		108.4	180.0	2.0	7.34	1680
Scheme 8						
Large	56	208.1	92.3	3.6	27.07	6110
Small		121.1	156.5	2.4	9.17	2090
Scheme 9						
Large	56	220.1	87.8	3.8	30.28	6840
Small		132.7	144	2.35	11.01	2510

NPD Form 7A June 1962

Clearprint 10th Grid - RP Translucent Grid

*-All are below TW.El. (minimum)

Δ - Approximate values

Incl 5

U. S. ARMY ENGINEER DIVISION, NORTH PACIFIC — HYDRO-ELECTRIC DESIGN BRANCH

PROJECT Lincoln School

SUBJECT PRELIMINARY TURBINE SELECTION

BY LLS DATE 15JUN82 CHECKED RJW PART 1 PAGE 5 OF 5

	Head (ft)	Requested Gen. Output Power (MW) 100%	115%	Calculated Gen. Output Power (MW) [115%]	Requested flow (cfs)	Calculated flow (cfs)
Scheme 1	76	70	80.5	85.26	14,000	14,520
Scheme 2	76	80	92	98.37	16,000	16,680
Scheme 3	76	90	103.5	110.87	18,000	18,840
Scheme 4	66	60	69	69	14,000	13,540
Scheme 5	66	69	79.35	79.35	16,000	15,570
Scheme 6	66	78	89.7	89.7	18,000	17,560
Scheme 7	56	51	58.65	53.92	14,000	12,460
Scheme 8	56	59	67.85	62.04	16,000	14,310
Scheme 9	56	66	75.90	70.13	18,000	16,190

NPD Form 7A
June 1962

Clearprint
10th Grid - RP
Translucent Grid

Incl 6

Engineering Div

DISPOSITION FORM

For use of this form, see AR 340-15; the proponent agency is TAGO.

REFERENCE OR OFFICE SYMBOL	SUBJECT
NPDEN-HD	Lincoln School-Hydroelectric Project, Maine

TO Commander
New England Division
ATTN: Malcolm E. Givens

FROM Chief, HEDB, NPD

DATE 27 August 82
Ratnieks/tw/4917

CMT 1

1. Attached are the results of the scoping studies for Lincoln School Powerhouse as requested by telephone 25 August, 1982.

2. Costs for Schemes 1A through 9A are based on a powerhouse with 3 large units, one small unit, and one erection bay.

3. Costs for schemes 1B through 9B are based on a powerhouse with 4 large units, one small unit, and one erection bay.

FOR THE COMMANDER:

LUCIEN J. MROCZKIEWICZ
Chief, Hydro-Electric Design Branch

8 Incl.
6 cost sheets
2 Dimension summaries

PROJECT: Lincoln Gorge

DATE: Aug 26 1982

PLANT CAPACITY: Peak Fl. 620

PRICE LEVEL DATE: Oct. 1, 1982

FEATURE	SCHEME 1A 122.13 MW	SCHEME 2A 140.01 MW	SCHEME 3A 157.79 MW
1. POWERHOUSE			
1.1 Excavation	243,000	237,000	341,000
1.2 Reinforced Concrete	24,782,500	26,527,000	28,321,000
1.3 Misc. Building Items	458,000	427,500	498,000
1.4 Bulkhead, Guides & Struct Steel	4,356,000	4,664,600	5,252,000
1.5 Architectural	1,384,000	1,490,000	1,624,000
2. TURBINES AND GENERATORS			
2.1 Turbines & ~~Generators~~	13,503,000	14,891,000	16,206,000
2.2 Excitation Equipment & Generators	11,041,000	12,696,000	13,197,000
2.3 Governor	663,000	684,000	693,000
2.4 Cooling System	386,000	386,000	387,000
3. ACCESSORY ELECTRICAL EQUIP.			
3.1 Switchgear, Breakers & Busses	903,000	897,000	904,000
3.2 Station Service Unit	122,000	121,000	121,000
3.3 Control System	449,000	445,500	445,500
3.4 Misc. Electrical Systems	1,880,000	1,914,000	1,971,000
4. AUXILIARY SYSTEMS & EQUIP.			
4.1 Heating and Ventilating	380,000	398,000	413,000
4.2 Station, Brake & Governor Air	129,000	129,500	129,500
4.3 Unwatering & Drainage Systems	430,000	434,000	437,000
4.4 Gantry Crane, Tailrace, ~~Hoist~~ & Misc.	1,836,300	1,979,000	2,060,000
4.5 Misc. Mechanical Systems	360,000	360,000	361,500
4.6 Bridge Crane	930,000	1,150,000	1,150,000
5. SWITCHYARD			
5.1 Power Transformer	767,000	847,000	945,000
5.2 Disconnects & Elec. Equip.	36,000	56,000	36,000
6. SITE PREPARATION & SPECIAL ITEMS			
6.1 Mobilization & Preparation	1,950,000	2,121,000	2,265,000
Sub-Total	66,933,800	72,834,600	77,762,500
Contingency @ 15%	10,040,800	10,925,000	11,664,400
TOTAL	76,979,600	83,759,600	89,426,900

Tab 1

PROJECT: Lincoln School

DATE: Aug 26 1982

PLANT CAPACITY: Pool El. 620

PRICE LEVEL DATE: Oct. 1, 1982

FEATURE	SCHEME 1B 159.04 MW	SCHEME 2B 181.95 MW	SCHEME 3B 204.70 MW
1. POWERHOUSE			
1.1 Excavation	328,000	319,800	460,500
1.2 Reinforced Concrete	29,863,000	32,015,000	34,356,000
1.3 Misc. Building Items	552,000	570,000	604,000
1.4 Bulkhead, Guides & Struct Steel	5,354,500	5,814,000	6,548,000
1.5 Architectural	1,667,000	1,799,000	1,970,000
2. TURBINES AND GENERATORS			
2.1 Turbines & ~~Generators~~	17,286,000	19,054,000	20,731,000
2.2 Excitation Equipment & Generators	14,247,000	16,385,000	17,306,000
2.3 Governor	837,000	863,000	880,000
2.4 Cooling System	508,000	501,000	502,000
3. ACCESSORY ELECTRICAL EQUIP.			
3.1 Switchgear, Breakers & Busses	1,189,500	1,165,000	1,172,400
3.2 Station Service Unit	160,500	157,000	157,000
3.3 Control System	591,000	579,000	578,000
3.4 Misc. Electrical Systems	2,477,000	2,487,500	2,557,000
4. AUXILIARY SYSTEMS & EQUIP.			
4.1 Heating and Ventilating	500,000	518,000	535,500
4.2 Station, Brake & Governor Air	170,000	168,000	168,000
4.3 Unwatering & Drainage Systems	521,000	522,000	527,000
4.4 Gantry Crane, Tailrace & Hoist	1,936,300	2,079,000	2,160,000
4.5 Misc. Mechanical Systems	474,000	468,000	469,000
4.6 Bridge Crane	930,000	1,150,000	1,150,000
5. SWITCHYARD			
5.1 Power Transformer	959,000	1,036,000	1,131,000
5.2 Disconnects & Elec. Equip.	47,000	46,000	46,000
6. SITE PREPARATION & SPECIAL ITEMS			
6.1 Mobilization & Preparation	2,418,000	2,631,000	2,820,000
Sub-Total	83,015,800	90,327,300	96,828,400
Contingency @ 15%	12,452,400	13549,000	14,524,300
TOTAL	95,468,200	103,876,300	111,352,700

Incl 2

PROJ : LINCOLN SCHOOL

DAT Aug 26, 1982

PLANT CAPACITY: POOL EL. 610.00

PRICE LEVEL DATE: OCT 1, 1982

FEATURE	SCHEME 4A 98.87 MW.	SCHEME 5A 113.28 MW	SCHEME 6A 127.64 MW
1. POWERHOUSE			
1.1 Excavation	166,000	193,000	287,000
1.2 Reinforced Concrete	23,568,000	25,023,500	27,070,000
1.3 Misc. Building Items	458,000	471,500	497,000
1.4 Bulkhead, Guides & Struct Steel	4,197,000	4,463,000	4,261,800
1.5 Architectural	1,308,000	1,398,000	1,665,000
2. TURBINES AND GENERATORS			
2.1 Turbines & ~~Generators~~	12,795,000	14,167,000	15,477,000
2.2 Excitation Equipment & Generators	10,759,000	11,364,000	12,923,000
2.3 Governor	647,000	665,000	682,000
2.4 Cooling System	360,000	377,000	384,000
3. ACCESSORY ELECTRICAL EQUIP.			
3.1 Switchgear, Breakers & Busses	903,000	899,000	896,500
3.2 Station Service Unit	122,000	121,000	121,000
3.3 Control System	448,500	447,000	445,000
3.4 Misc. Electrical Systems	1,880,000	1,920,000	1,970,000
4. AUXILIARY SYSTEMS & EQUIP.			
4.1 Heating and Ventilating	351,000	364,000	384,000
4.2 Station, Brake & Governor Air	120,000	126,000	128,000
4.3 Unwatering & Drainage Systems	403,000	426,000	436,000
4.4 Gantry Crane, Tailrace ~~& Hoist~~	1,836,300	1,896,000	1,979,000
4.5 Misc. Mechanical Systems	335,000	352,500	358,600
4.6 Bridge Crane	930,000	985,000	1,060,000
5. SWITCHYARD			
5.1 Power Transformer	677,000	750,000	796,000
5.2 Disconnects & Elec. Equip.	36,000	36,000	36,000
6. SITE PREPARATION & SPECIAL ITEMS			
6.1 Mobilization & Preparation	1,869,000	1,993,000	2,156,000
Sub-Total	64,148,800	68,437,500	74,012,900
Contingency @ 15%	9,625,300	10,265,600	11,102,000
TOTAL	73,794,100	78,703,100	85,114,900

Ind 3

PLANT CAPACITY: Pool El. 610.00 PRICE LEVEL DATE: Oct. 1, 1982

FEATURE	SCHEM 4B 128.76 MW	SCHEME 5B 150.21 MW	SCHEME 6B 165.85 MW
1. POWERHOUSE			
1.1 Excavation	234,000	260,000	[illegible]
1.2 Reinforced Concrete	28,398,000	30,160,500	32,795,000
1.3 Misc. Building Items	552,000	568,000	602,000
1.4 Bulkhead, Guides & Struct Steel	5,213,700	5,552,000	5,219,000
1.5 Architectural	1,576,000	1,685,000	2,017,000
2. TURBINES AND GENERATORS			
2.1 Turbines & ~~Generators~~	16,390,000	18,136,000	19,803,000
2.2 Excitation Equipment & Generators	13,901,000	14,659,000	16,651,000
2.3 Governor	817,000	839,000	860,000
2.4 Cooling System	468,400	500,000	499,000
3. ACCESSORY ELECTRICAL EQUIP.			
3.1 Switchgear, Breakers & Busses	1,176,000	1,192,500	1,165,000
3.2 Station Service Unit	159,000	161,000	157,000
3.3 Control System	584,000	592,500	578,600
3.4 Misc. Electrical Systems	2,448,000	2,546,000	2,561,000
4. AUXILIARY SYSTEMS & EQUIP.			
4.1 Heating and Ventilating	457,000	483,000	499,000
4.2 Station, Brake & Governor Air	157,000	166,500	166,500
4.3 Unwatering & Drainage Systems	485,000	513,000	526,000
4.4 Gantry Crane, Tailrace & Hoist	1,936,300	1,996,000	2,079,000
4.5 Misc. Mechanical Systems	436,600	467,000	465,000
4.6 Bridge Crane	930,000	985,000	1,060,000
5. SWITCHYARD			
5.1 Power Transformer	811,000	907,000	945,000
5.2 Disconnects & Elec. Equip.	47,000	47,000	46,000
6. SITE PREPARATION & SPECIAL ITEMS			
6.1 Mobilization & Preparation	2,315,000	2,473,000	2,672,000
Sub-Total	79,482,000	84,889,000	91,754,100
Contingency @ 15%	11,922,300	12,733,400	13,763,100
TOTAL	91,404,300	97,622,400	105,517,200

Incl 4

PROJECT: Lincoln School

DATE: Aug 26, 1982

PLANT CAPACITY: Pool El. 600.00

PRICE LEVEL DATE: Oct. 1, 1982

FEATURE	SCHEME 7A 77.28 MW	SCHEME 8A 88.57 MW	SCHEME 9A 99.80 MW
1. POWERHOUSE			
1.1 Excavation	125,000	165,000	218,000
1.2 Reinforced Concrete	21,867,000	24,144,000	25,568,000
1.3 Misc. Building Items	459,000	470,000	495,600
1.4 Bulkhead, Guides & Struct Steel	4,122,000	4,282,000	4,008,500
1.5 Architectural	1,242,000	1,460,300	1,740,000
2. TURBINES AND GENERATORS			
2.1 Turbines & ~~Generators~~	12,274,000	13,557,000	14,845,000
2.2 Excitation Equipment & Generators	10,288,000	11,129,000	12,134,000
2.3 Governor	628,000	646,000	659,000
2.4 Cooling System	327,000	351,000	366,000
3. ACCESSORY ELECTRICAL EQUIP.			
3.1 Switchgear, Breakers & Busses	831,000	900,000	897,000
3.2 Station Service Unit	122,000	121,000	121,000
3.3 Control System	448,600	447,000	445,000
3.4 Misc. Electrical Systems	1,880,400	1,920,000	1,971,000
4. AUXILIARY SYSTEMS & EQUIP.			
4.1 Heating and Ventilating	294,000	321,000	341,500
4.2 Station, Brake & Governor Air	109,000	117,000	124,000
4.3 Unwatering & Drainage Systems	364,000	396,000	415,000
4.4 Gantry Crane, Tailrace & Hoist	1,741,000	1,773,000	1,901,000
4.5 Misc. Mechanical Systems	305,000	328,400	341,500
4.6 Bridge Crane	865,000	930,000	985,000
5. SWITCHYARD			
5.1 Power Transformer	546,000	640,000	702,000
5.2 Disconnects & Elec. Equip.	36,000	36,000	36,000
6. SITE PREPARATION & SPECIAL ITEMS			
6.1 Mobilization & Preparation	1,766,000	1,924,000	2,043,000
Sub-Total	60,640,000	66,057,700	70,157,100
Contingency @ 15%	9,096,000	9,908,700	10,523,600
TOTAL	69,736,000	75,966,400	80,680,700

Tab 5

PROJECT: Lincoln School

DATE: Aug. 26, 1982

PLANT CAPACITY: Pool El. 600.00

PRICE LEVEL DATE: Oct. 1, 1982

FEATURE	SCHEME 7B 100.65 MW	SCHEME 8B 115.10 MW	SCHEME 9B 129.48 MW
1. POWERHOUSE			
1.1 Excavation	169,000	223,000	295,000
1.2 Reinforced Concrete	26,390,400	29,043,000	30,693,000
1.3 Misc. Building Items	554,000	565,500	599,700
1.4 Bulkhead, Guides & Struct Steel	5,080,400	5,312,400	4,903,000
1.5 Architectural	1,499,000	1,757,000	2,106,000
2. TURBINES AND GENERATORS			
2.1 Turbines & ~~Generators~~	15,711,000	17,357,000	18,995,000
2.2 Excitation Equipment & Generators	13,318,000	14,338,000	15,651,000
2.3 Governor	793,000	815,000	831,000
2.4 Cooling System	425,600	456,000	474,500
3. ACCESSORY ELECTRICAL EQUIP.			
3.1 Switchgear, Breakers & Busses	1,083,000	1,169,000	1,163,000
3.2 Station Service Unit	159,000	158,000	157,000
3.3 Control System	584,000	581,000	578,000
3.4 Misc. Electrical Systems	2,449,000	2,495,000	2,557,000
4. AUXILIARY SYSTEMS & EQUIP.			
4.1 Heating and Ventilating	382,600	417,000	443,000
4.2 Station, Brake & Governor Air	142,000	152,000	161,000
4.3 Unwatering & Drainage Systems	438,000	477,000	500,000
4.4 Gantry Crane, Tailrace Hoist	1,841,000	1,873,000	2,001,000
4.5 Misc. Mechanical Systems	398,000	427,000	443,000
4.6 Bridge Crane	865,000	930,000	985,000
5. SWITCHYARD			
5.1 Power Transformer	636,000	725,000	836,000
5.2 Disconnects & Elec. Equip.	47,000	47,000	47,000
6. SITE PREPARATION & SPECIAL ITEMS			
6.1 Mobilization & Preparation	2,189,000	2,380,000	2533000
Sub-Total	75,154,000	81,697,900	86,952,200
Contingency @ 15%	11,273,100	12,254,700	13,042,800
TOTAL	86,427,100	93,952,600	99,995,000

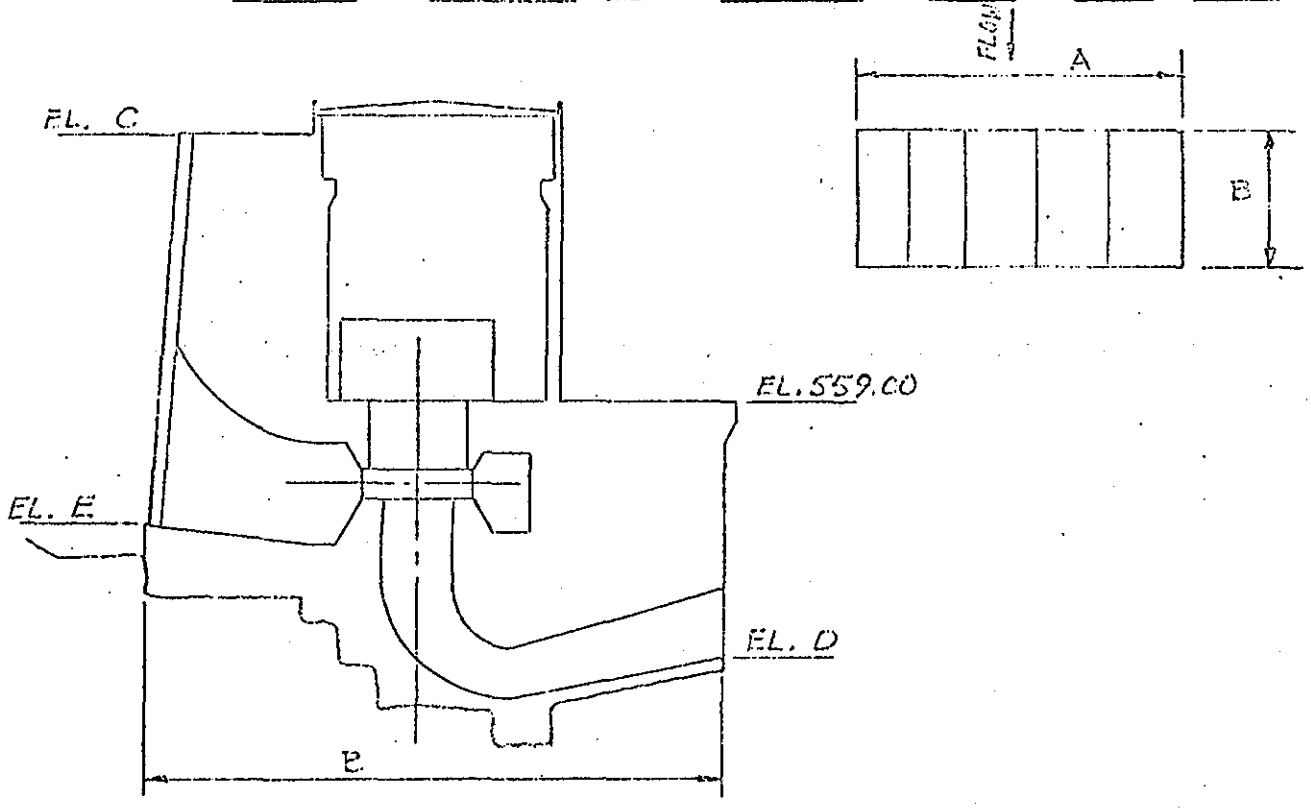
Incl 6

U. S. ARMY ENGINEER DIVISION, NORTH PACIFIC — HYDRO-ELECTRIC DESIGN BRANCH

PROJECT LINCOLN SCHOOL

SUBJECT P.H. DIMENSIONS SUMMARY SCOPING STUDY

BY V.R. DATE 26 Aug 82. CHECKED _____ PART _____ PAGE _____ OF _____



SCHEME	MAX. POOL	DIMENSIONS A ft.	B ft	C	D	E
1A	EL. 620.	344.	154.	EL. 630.	EL. 481.	EL. 513.
2A	620.	354.5	160.	630.	477.	512.
3A	620.	368	167.	630.	475.	510.
4A	610.	344	152.	620.	486.	517.
5A	610.	354.5	158.	620.	483.	516.
6A	610.	368	165.	620.	480.	515.
7A	600.	344	151.	610.	491.	513.
8A	600.	354.5	156	610.	488	521.
9A	600.	368.	163	610.	485	520.

NPD Form 7A
June 1962

Clearprint
1015 Grid - RP
Translucent Grid

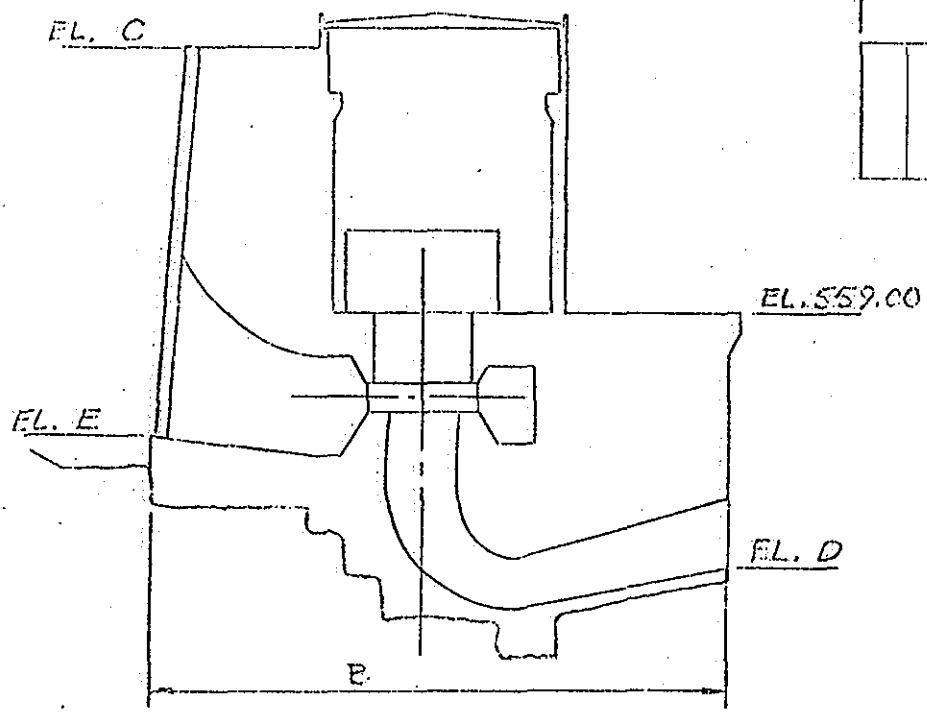
Incl 7

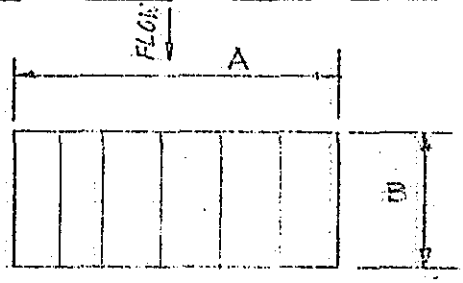
U. S. ARMY ENGINEER DIVISION, NORTH PACIFIC HYDRO-ELECTRIC DESIGN BRANCH

PROJECT LINCOLN SCHOOL

SUBJECT P.H. DIMENSIONS SUMMARY SCOPING STUDY

BY V.R. DATE 26 Aug '82 CHECKED _____ PART _____ PAGE _____ OF _____





SCHEME	MAX. POOL	DIMENSIONS A ft.	B ft.	C	D	E
1B	EL. 620.	414	154.	EL. 630.	EL. 481.	EL. 513.
2B	620.	427	160.	630.	477.	512.
3B	620.	444	167.	630.	475.	510.
4B	610.	414	152.	620.	486.	517.
5B	610.	427	158.	620.	483.	516.
6B	610.	444	165.	620.	480.	515.
7B	600.	414	151.	610.	491.	513.
8B	600.	427	156	610.	488	521.
9B	600.	444	163	610.	485	520.

NPD Form 7A
June 1962

Clearprint
10th Grid - RP
Translucent Grid

Incl #8

DISPOSITION FORM

For use of this form, see AR 340-15; the proponent agency is TAGO.

REFERENCE OR OFFICE SYMBOL	SUBJECT
NPDEN-HD	Lincoln School Hydroelectric Project, Main

TO: Commander
New England Dist
ATTN: Malcolm E. Givens

FROM: Chief, NPDEN-HD

DATE: 8 Oct 82
Ratnieks/sak/4917

CMT 1

Inclosed you will find the following portions of the study for developing hydroelectric power at Lincoln School:

1. Revision A, Cost Estimates for schemes 3, 6, and 9.

2. Sketches (Half-size prints on vellum)

   a. Sk-1 Pool El. 620
      Powerhouse Plan and Sections.

   b. Sk-2 Pool El. 610
      Powerhouse Plan and Sections.

   c. Sk-3 Pool El. 600
      Powerhouse Plan and Sections.

FOR THE COMMANDER:

H.A. Hoadley

Incl
as

H.A. HOADLEY, P.E.
Acting Chief, Hydro-Electric Design Branch

PROJECT: Lincoln School

DATE: Oct. 8, 1982

PLANT CAPACITY: Pool El. 620, 610 / 8 600

PRICE LEVEL DATE: Oct 1, 1982

FEATURE	Scheme 3 Rev. A. H=76 ft Q=18890 cfs 110 MW	Scheme 6 Rev. A H=66 ft Q=17560 cfs 89.7 MW	Scheme 9 rev. A H=56 ft Q=16190 cfs 70 MW
1. POWERHOUSE			
1.1 Excavation	270,800.	215,500.	163,700.
1.2 Reinforced Concrete	22,415,000.	21,345,000.	20,041,900.
1.3 Misc. Building Items	391,600.	391,600.	391,600.
1.4 Bulkhead, Guides & Struct Steel	3,956,000.	3,304,500.	3,114,500.
	1,278,000.	1,313,000.	1,375,000.
2. TURBINES AND GENERATORS			
2.1 Turbines ~~& Generators~~	11,905,000.	11,360,000.	10,885,000.
2.2 Excitation Equipment & Generators	9,594,000.	9,195,000.	8,617,000.
2.3 Governor	516,000.	504,000.	487,000.
2.4 Cooling System	272,000.	270,000.	257,000.
3. ACCESSORY ELECTRICAL EQUIP.			
3.1 Switchgear, Breakers & Busses	635,000.	630,000.	630,000.
3.2 Station Service Unit	85,000.	85,000.	85,000.
3.3 Control System	312,970.	312,970.	312,970.
3.4 Misc. Electrical Systems	1,385,000.	1,385,000.	1,385,000.
4. AUXILIARY SYSTEMS & EQUIP.			
4.1 Heating and Ventilating	290,000.	270,000.	240,000.
4.2 Station, Brake & Governor Air	91,000.	90,000.	87,000.
4.3 Unwatering & Drainage Systems	347,000.	346,000.	329,000.
4.4 Gantry Crane, Tailrace	1,960,000.	1,879,000.	1,801,000.
4.5 Misc. Mechanical Systems	254,000.	252,000.	240,000.
4.6 Bridge Crane	1,150,000.	1,060,000.	985,000.
5. SWITCHYARD			
5.1 Power Transformer	739,000.	655,000.	565,000.
5.2 Disconnects & Elec. Equip.	25,000.	25,000.	25,000.
6. SITE PREPARATION & SPECIAL ITEMS			
6.1 Mobilization & Preparation	1,740,000.	1,650,000.	1,600,000.
Sub-Total	59,612,370.	56,538,570.	53,617,670.
Contingency @15% ±	8,942,630.	8,481,430.	8,043,330.
TOTAL	68,555,000.	65,020,000.	61,661,000.

DISPOSITION FORM

For use of this form, see AR 340-15; the proponent agency is TAGO.

REFERENCE OR OFFICE SYMBOL	SUBJECT
NPDEN-HD	Lincoln School Hydroelectric Project, Maine

TO	FROM	DATE	CMT 1
Commander New England Dist. ATTN: Malcolm E. Givens	Ch, NPDEN-HD	22 October 82 Ratnieks/tw/4917	

Inclosed you will find half size prints (on vellum) of the following drawings:

1) SK-1 Pool El. 620 Powerhouse Plan and Sections

2) SK-2 Pool El. 610 Powerhouse Plan and Sections

3) SK-3 Pool El. 600 Powerhouse Plan and Sections

FOR THE COMMANDER:

Incl.
as

LUCIEN J. MROCZKIEWICZ, P.E.
Acting Ch, Hydro-Electric Design Br.

DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is TAGO.

REFERENCE OR OFFICE SYMBOL	SUBJECT
NPDEN-HD	Lincoln School Hydropower Studies

TO ~~Commander~~
USAED, New England Div.
ATTN: NEDED-E
Mr. Malcolm Givens

FROM ~~Chief, HEDB, NPD~~

DATE ~~9 November 1982~~
Ratnieks/dc/3844

CMT 1

We have reviewed your scoping study procedure for Lincoln School Powerhouse and offer the following suggestions for your consideration:

1) The scoping procedures used do not appear to be consistent with Corps' policy. As a result, the powerhouse sizes for the various pool elevations considered are somewhat undersized. Each powerhouse size appears to be one generating unit too small. The magnitude of this size reduction is about 30 to 47 megawatts or about 42 percent of the total plant size. This is a sizeable amount of capacity to forego.

2) Corps policy states that a net benefit analysis should be used in project scoping unless good reasons can support some other procedure-reference ER 1105-2-40, as published in the Federal Register, (Copy Attached). As you are aware, the Department of the Army is currently reviewing planning guidlines that place even greater emphasis on maximum net benefits to meet the National Economic Development Plan.

3) Your scoping procedure developed two sets of curves. One set of curves show the net-benefits vs. installed capacity. The second set of curves show the benefit-to-cost ratio vs. installed capacity. The optimum plant size selection should have used the net-benefit curves. The net-benefit curve is very flat between a three unit (one small unit and 2 large units) plant and a four unit (one small unit and 3 large units) plant. In this case, the larger plant size is definitely indicated.

FOR THE COMMANDER:

H.A. Hoadley

Incl
as

H.A. HOADLEY, P.E.
Acting Chief, Hydro-Electric Design Branch

United States Department of the Interior

FISH AND WILDLIFE SERVICE
ECOLOGICAL SERVICES
P.O. BOX 1518
CONCORD, NEW HAMPSHIRE 03301

Colonel Carl B. Sciple
Division Engineer
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254

OCT 29 1982

Dear Colonel Sciple:

This letter is intended to aid your planning efforts for the development of hydroelectric power at the Lincoln School site on the St. John River, Aroostook County, Maine. It has been prepared under authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

We understand that three power pool elevations are being considered: 600 feet, 610 feet, and 620 feet, National Geoditic Vertical Datum (NGVD). The surface areas of the three potential pools are 2,000, 2,700 and 3,600 acres, respectively. The top elevation of the dam would be 10 feet above each power pool providing 5 feet for spillway surcharge and 5 feet of freeboard. The spillway would consist of eight taintor gates on a concrete overflow weir with the crest elevation of the weir being 50 feet below the elevation of the power pools. Approach and discharge channels for the spillway would be constructed on the left bank of the river.

The power plant would be constructed between the right abutment of the river and the embankment section. Intake facilities would be at the bottom of the pool and water would pass directly through the dam to the powerhouse.

The project would be operated with some daily and weekly storage regulation based on changing load and marketing conditions. The upper 10 feet of the power pool would be utilized for any pondage operation. It is envisioned that head pool fluctuations would range from zero to between 2 to 3 feet on a daily basis and from zero to between 7 and 10 feet on a weekly basis.

Minimum outflow would equal inflow when inflow was less than 1,000 cfs, and 1,000 cfs when inflows exceeded 1,000 cfs. Daily tailwater fluctuations would vary from zero to 3 to 4 feet on the average with some greater fluctuations during occasional peaking operation.

The fish and wildlife resources of the area have been adequately described in your Final Environmental Impact Statement, Dickey-Lincoln School Lakes, Maine, and, for the most part, need not be repeated in this letter.

Our major environmental concerns regarding the proposed project include: (1) endangered species, (2) loss of terrestrial habitat, (3) loss of stream habitat, (4) downstream flows, and (5) fish-passage facilities.

On May 5, 1978, the Corps requested formal Section 7 Consultation from this Service regarding the proposed Dickey-Lincoln School Lakes project, and its impacts on the recently listed Endangered Furbish lousewort (Pedicularis furbishiae). The Service rendered its biological opinion on June 27, 1978, and concluded that if a specified conservation program was successfully implemented the continued existence of this Endangered Species is not likely to be jeopardized. It also specified that if the project is modified, the Section 7 Consultation must be reinitiated. Therefore, we recommend that formal Section 7 Consultation be initiated at the appropriate planning stage of the Lincoln School project.

The Corps provided preliminary information concerning the area of the various habitat types within the proposed pool areas. This information was utilized in conjunction with the HEP analysis of the Dickey-Lincoln School Lakes project 1/ to make a preliminary determination of habitat unit losses and the area required for mitigation. Habitat types within the pool areas and the areas that were evaluated are shown in Table 1.

Habitat types within the three proposed pool areas were evaluated based on the target years, habitat unit values, criteria for change in habitat types and the management potential unit values as established for the HEP analysis contained in Supplement No. 3. 1/ The annual habitat unit losses or gains resulting from this application of HEP are shown for the various power pools in Tables 2-4. Total annualized habitat unit losses are 36,393; 57,369; and 89,890 for the power pools at NGVD elevations of 600 feet, 610 feet, and 620 feet, respectively.

The area that would be required to mitigate these habitat unit losses is determined for each habitat type by dividing the habitat unit loss by the management potential unit value. Table 5 depicts management potential unit values, habitat unit losses, and the mitigation acreage required by habitat types for the three power pool areas. The total mitigation acreage that would be required would be 4,509 acres, 6,525 acres, and 9,977 acres for the power pools at NGVD elevations of 600 feet, 610 feet, and 620 feet, respectively.

It should be recognized that the total mitigation acreage shown in Table 5, for each power pool, represents a minimum acreage figure. HEP as applied to the Dickey-Lincoln School Lakes project evaluated only forested and wetland types. Agricultural land and shrubland (alder, dogwood, willow) were not evaluated. Therefore, these habitat types which constitute over 20 percent of the power pool areas (excluding urban and water) were not evaluated in this application of HEP. Current policy requires that clearing of the reservoir would extend three feet above each maximum pool elevation. This area was not evaluated due to a lack of data on acreage and habitat types. Deer yards within the project area (4 acres at elev. 610 feet and 126 acres at elev. 620 feet) and those that might be adversely impacted along the edge of the power pools were not evaluated. All of these terrestrial habitats would have to be evaluated and the mitigation requirements determined during future project planning. In addition, HEP as ap-

1/ U.S. Fish and Wildlife Service, November 8, 1979. Supplement No. 3 to the Conservation and Development Report dated January 4, 1978, Dickey-Lincoln School Lakes Project, Maine.

plied to the Dickey-Lincoln School Lakes project would have to be critically reviewed for its applicability to the much smaller area of the Lincoln School power pools.

Streams in the project area can be characterized as excellent brook trout water in the tributaries, and seasonal brook trout water in the lower reaches of larger tributaries and in the main stem. There are also small numbers of landlocked salmon present in the main stem. Approximately 16, 22 and 29 miles of stream habitat would be inundated by the power pools at NGVD elevations of 600 feet, 610 feet, and 620 feett, respectively. The loss of this stream habitat would be difficult, if not impossible, to mitigate.

The power pools might be able to provide a fishery for brook trout and landlocked salmon, however, the magnitude of this potential fishery needs to be fully investigated. Such investigations should include dissolved oxygen and temperature profiles, impacts of reservoir drawdown, and impacts of sport and forage fish and nutrients being discharged through the outlet works.

Under the current plan of operation, the downstream area would be subjected to a severely modified stream flow regimen. During peaking operations, the downstream area would be flush with water while during periods of storage there would be a dearth of water in the downstream area. Daily tailwater fluctuations varying from zero to 3 or 4 feet on the average (greater during peaking operations) would probably disrupt biological communities and result in a reduction of overall productivity in the downstream area.

The minimum outflow would equal inflow when inflow was less than 1,000 cfs, and 1,000 cfs when inflows exceed 1,000 cfs. These flows are entirely inadequate to sustain indigenous aquatic organisms during times of the year critical to their survival and maintenance. The 1,000 cfs minimum flow represents only 39 percent of the median August flow of 2,562 cfs. This median August flow is the minimum aquatic base flow as defined by our New England Area Flow Regulation Policy. As an alternative to this aquatic base flow of 2,562 cfs, we would recommend that the Service's Instream Flow Method be used to determine flow regimes adequate to sustain or enhance downstream aquatic resources. We believe that the St. John River is of sufficient importance to justify use of this method. In addition, the impacts of potential dissolved oxygen and temperature changes and fluctuating water levels in the downstream area should be fully investigated with a view toward improving existing conditions so as to partially offset stream fishing losses in the pool area.

Brook trout and landlocked salmon are indigenous migratory fish of the St. John River that currently have free access to the area above the Lincoln School Dam site. While Atlantic salmon historically did not go upstream beyond Grand Falls, we understand that there is a distinct possibility of their introduction above this barrier by private clubs in Canada. This endeavor could eventually lead to the State of Maine and the Province of New Brunswick, Canada sponsoring the introduction of Atlantic salmon to the upper reaches of the St. John River. Therefore, we recommend that fish-passage facilities be included in the Lincoln School planning process and be throughly investigated.

Table 5. Area Required for Mitigation
(Habitat Unit Losses/Management Potential Unit Value)

Habitat Type	Management Potential Unit Value 1/	Power Pool at Elevation 600 ft. N.G.V.D.		Power Pool at Elevation 610 ft. N.G.V.D.		Power Pool at Elevation 620 ft. N.G.V.D.	
		Habitat Unit Losses	Acres Required	Habitat Unit Losses	Acres Required	Habitat Unit Losses	Acres Required
Softwood Mature	10.3	13,853	1,345	20,383	1,979	36,524	3,546
Softwood-Hardwood Mature	11.5	10,008	870	15,023	1,036	23,830	2,072
Hardwood Mature	12.8	1,534	120	1,664	130	2,359	184
Shallow Fresh Marsh	3.4	6,176	1,816	8,408	2,473	9,706	2,855
Hardwood Regeneration	13.9	1,005	72	2,297	165	4,023	289
Hardwood-Softwood Mature	12.3	2,382	194	7,328	596	9,842	800
Softwood Regeneration	16.2	861	53	1,318	81	2,201	136
Poplar-Birch	14.8	574	39	948	64	1,405	95
TOTAL		36,393	4,509	57,369	6,524	89,890	9,977

1/ Represents annualized values for the St. John area as contained in our November 8, 1979, Supplement No. 3 to the Conservation and Development Report dated January, 1978, Dickey-Lincoln School Lakes Project, Maine.

Table 1. Existing Habitat Types within the Proposed Pool areas and the areas that were evaluated 1/

Habitat Type	Pool Areas: Elev. 600 ft. NGVD (acres)	Elev. 610 ft. NGVD (acres)	Elev. 620 ft. NGVD (acres)
Softwood Mature	238	347	626
Softwood-Hardwood Mature	185	263	400
Hardwood Mature	9	7	10
Shallow Fresh Marsh	119	149	172
Hardwood Regeneration	26	78	146
Hardwood-Softwood Mature	41	109	148
Softwood Regeneration	35	52	82
Popular-Birch	3	9	16
Area Evaluated	656	1,014	1,600
Agricultural	99	143	193
Shrub (alder, dogwood, willow)	173	227	246
Other (urban, etc.)	69	102	127
River	1,000 + 2/	1,211	1,389
Not Evaluated	1,341	1,683	1,955
TOTAL AREA	1,977	2,697	3,555

1/ Areas based on data provided by the Corps of Engineers. These data were grouped into the habitat types evaluated for the Dickey-Lincoln School Lakes Project.

2/ Total area of river not provided.

Table 2. Annual Habitat Unit Losses for Power Pool Area at Elevation 600 feet N.G.V.D.

		Future Without Project				Future With Project			Net Effect
Habitat Type	Target Year	Habitat Unit Value 1/	Acres 1/	Habitat Units	Habitat Unit Change	Acres	Habitat Units	Habitat Unit Change	Annual Habitat Unit Losses (-) Gains (+)
Softwood - Mature	0	42.4	238	10,091	0	238	10,091	0	
	10	47.3	241	11,399	+ 1,308	0	0	- 10,091	
	30	57.2	244	13,957	+ 3,866	0	0	- 10,091	
	100	67.0	250	16,750	+ 6,659	0	0	- 10,091	
		Annualized Habitat Unit Change			+ 4,267			- 9,586	- 13,853
Softwood - Hardwood Mature	0	46.0	185	8,510	0	185	8,510	0	
	10	49.8	180	8,964	+ 454	0	0	- 8,510	
	30	57.4	176	10,102	+ 1,592	0	0	- 8,510	
	100	65.0	181	11,765	+ 3,255	0	0	- 8,510	
		Annualized Habitat Unit Change			+ 1,924			- 8,084	- 10,008
Hardwood - Mature	0	53.2	9	479	0	9	479	0	
	10	56.6	15	849	+ 370	0	0	- 479	
	30	63.3	21	1,329	+ 850	0	0	- 479	
	100	70.0	33	2,310	+ 1,813	0	0	- 479	
		Annualized Habitat Unit Change			+ 1,079			- 455	- 1,534
Shallow Fresh Marsh	0	59.4	119	7,069	0	119	7,069	0	
	10	59.4	119	7,069	0	0	0	- 7,069	
	30	59.4	119	7,069	0	0	0	- 7,069	
	100	59.4	119	7.069	0	0	0	- 7,069	
		Annualized Habitat Unit Change			0			- 6,176	- 6,176

1/ The habitat unit values and change in habitat types are based on the values and criteria established in our November 8, 1979, Supplement No. 3 to the Conservation and Development Report dated January, 1978, Dickey-Lincoln School Lakes Project, Maine.

Table 2. ntinued

Habitat Type	Target Year	Future Without Project: Habitat Unit Value 1/	Acres 1/	Habitat Units	Habitat Unit Change	Future With Project: Acres	Habitat Units	Habitat Unit Change	Net Effect: Annual Habitat Unit Losses (-) Gains (+)
Hardwood Regeneration									
	0	54.7	26	1,422	0	26	1,422	0	
	10	55.5	26	1,443	+ 21	0	0	- 1,422	
	30	57.0	25	1,425	+ 3	0	0	- 1,422	
	100	63.0	7	441	- 981	0	0	- 1,422	
	Annualized Habitat Unit Change				- 346			- 1,351	- 1,005
Hardwood-Softwood Mature	0	47.0	41	1,927	0	41	1,927	0	
	10	51.8	40	2.072	+ 145	0	0	- 1,927	
	30	61.4	39	2,395	+ 468	0	0	- 1,927	
	100	71.0	40	2,840	+ 913	0	0	- 1,927	
	Annualized Habitat Unit Change				+ 552			- 1,830	- 2,382
Softwood Regeneration									
	0	43.2	35	1,512	0	35	1,512	0	
	10	43.2	32	1,382	- 130	0	0	- 1,512	
	30	43.2	29	1,253	- 259	0	0	- 1,512	
	100	43.2	6	259	-1,253	0	0	1,512	
	Annualized Habitat Unit Change				- 575			- 1,436	- 861
Popular-Birch									
	0	49.9	3	150	0	3	150	0	
	10	53.3	3	160	+ 10	0	0	- 150	
	30	60.2	3	181	+ 31	0	0	- 150	
	100	67.0	20	1,340	+1,190	0	0	- 150	
	Annualized Habitat Unit Change				+ 432			- 142	- 574
TOTAL ANNUALIZED HABITAT UNIT LOSSES OR GAINS									- 36,393

Table 3. Annual Habitat Unit Losses for Power Pool Area at Elevation 610 feet N.G.V.D.

		Future Without Project				Future With Project			Net Effect
Habitat Type	Target Year	Habitat Unit Value 1/	Acres 1/	Habitat Units	Habitat Unit Change	Acres	Habitat Units	Habitat Unit Change	Annual Habitat Unit Losses (-) Gains (+)
Softwood - Mature	0	42.4	347	14,713	0	347	14,713	0	
	10	47.3	351	16,606	+ 1,889	0	0	- 14,713	
	30	57.2	355	20,306	+ 5,593	0	0	- 14,713	
	100	67.0	371	24,857	+ 10,144	0	0	- 14,713	
	Annualized Habitat Unit Change				+ 6,386			- 13,977	- 20,383
Softwood-Hardwood Mature	0	46.0	263	12,098	0	263	12,098	0	
	10	49.8	262	13,048	+ 950	0	0	- 12,098	
	30	57.4	261	14,981	+ 2,883	0	0	- 12,098	
	100	65.0	278	18,070	+ 5,972	0	0	- 12,098	
	Annualized Habitat Unit Change				+ 3,530			- 11,493	- 15,023
Hardwood - Mature	0	53.2	7	372	0	7	372	0	
	10	56.6	15	849	+ 477	0	0	- 372	
	30	63.3	23	1,456	+ 1,084	0	0	- 372	
	100	70.0	36	2,520	+ 2,148	0	0	- 372	
	Annualized Habitat Unit Change				+ 1,311			- 353	- 1,664
Shallow Fresh Marsh	0	59.4	149	8,851	0	149	8,851	0	
	10	59.4	149	8,851	0	0	0	- 8,851	
	30	59.4	149	8,851	0	0	0	- 8,851	
	100	59.4	149	8,851	0	0	0	- 8,851	
	Annualized Habitat Unit Change				0			- 8,408	- 8,408

1/ The habitat unit values and change in habitat types are based on the values and criteria established in our November 8, 1979, Supplement No. 3 to the Conservation and Development Report dated January, 1978, Dickey-Lincoln School Lakes Project, Maine.

Table 3. ntinued

Habitat Type	Target Year	Future Without Project: Habitat Unit Value 1/	Acres 1/	Habitat Units	Habitat Unit Change	Future With Project: Acres	Habitat Units	Habitat Unit Change	Net Effect: Annual Habitat Unit Losses (-) Gains (+)
Hardwood Regeneration									
	0	54.7	78	4,267	0	78	4,267	0	
	10	55.5	68	3,774	- 493	0	0	- 4,267	
	30	57.0	58	3,306	- 961	0	0	- 4,267	
	100	63.0	11	693	- 3,574	0	0	- 4,267	
	Annualized Habitat Unit Change				- 1,757			- 4,054	- 2,297
Hardwood-Softwood Mature	0	47.0	109	5,123	0	109	5,123	0	
	10	51.8	112	5,802	+ 679	0	0	- 5,123	
	30	61.4	115	7,061	+ 1,938	0	0	- 5,123	
	100	71.0	132	9,372	+ 4,249	0	0	- 5.123	
	Annualized Habitat Unit Change				+ 2,461			- 4,867	- 7,328
Softwood Regeneration									
	0	43.2	52	2,246	0	52	2,246	0	
	10	43.2	48	2,074	- 172	0	0	- 2,246	
	30	43.2	44	1,901	- 345	0	0	- 2,246	
	100	43.2	10	432	- 1,814	0	0	- 2,246	
	Annualized Habitat Unit Change				- 816			- 2,134	- 1,318
Popular-Birch									
	0	49.9	9	449	0	9	449	0	
	10	53.3	9	480	+ 31	0	0	- 449	
	30	60.2	9	542	+ 93	0	0	- 449	
	100	67.0	27	1,809	+ 1,360	0	0	- 449	
	Annualized Habitat Unit Change				+ 522			- 426	- 948
TOTAL ANNUALIZED HABITAT UNIT LOSSES OR GAINS									- 57,369

Table 4. Annual Habitat Uni. Losses for Power Pool Area
at Elevation 620 feet N.G.V.D.

		Future Without Project				Future With Project			Net Effect
Habitat Type	Target Year	Habitat Unit Value 1/	Acres 1/	Habitat Units	Habitat Unit Change	Acres	Habitat Units	Habitat Unit Change	Annual Habitat Unit Losses (-) Gains (+)
Softwood-Mature	0	42.4	626	26,542	0	626	26,542	0	
	10	47.3	630	29,799	+ 3,257	0	0	- 26,542	
	30	57.2	634	36,265	+ 9,723	0	0	- 26,542	
	100	67.0	671	44,957	+ 18,415	0	0	- 26,542	
	Annualized Habitat Unit Change				+ 11,309			- 25,215	- 36,524
Softwood-Hardwood Mature	0	46.0	400	18,400	0	400	18,400	0	
	10	49.8	405	20,169	+ 1,769	0	0	- 18,400	
	30	57.4	410	23,534	+ 5,134	0	0	- 18,400	
	100	65.0	449	29,185	+ 10,785	0	0	- 18,400	
	Annualized Habitat Unit Change				+ 6,350			- 17,480	- 23,830
Hardwood-Mature	0	53.2	10	532	0	10	532	0	
	10	56.6	21	1,189	+ 657	0	0	- 532	
	30	63.3	31	1,962	+ 1,430	0	0	- 532	
	100	70.0	53	3,710	+ 3,178	0	0	- 532	
	Annualized Habitat Unit Change				+ 1,854			- 505	- 2,359
Shallow Fresh Marsh	0	59.4	172	10,217	0	172	10,217	0	
	10	59.4	172	10,217	0	0	0	- 10,217	
	30	59.4	172	10,217	0	0	0	- 10,217	
	100	59.4	172	10,217	0	0	0	- 10,217	
	Annualized Habitat Unit Change				0			- 9,706	- 9,706

1/ The habitat unit values and change in habitat types are based on the values and criteria established in our November 8, 1979, Supplement No. 3 to the Conservation and Development Report dated January, 1978, Dickey-Lincoln School Lakes Project, Maine.

Table 4. Continued

Habitat Type	Target Year	Future Without Project: Habitat Unit Value 1/	Acres 1/	Habitat Units	Habitat Unit Change	Future With Project: Acres	Habitat Units	Habitat Unit Change	Net Effect: Annual Habitat Unit Losses (-) Gains (+)
Hardwood Regeneration									
	0	54.7	146	7,986	0	146	7,986	0	
	10	55.5	124	6,882	- 1,104	0	0	- 7,986	
	30	57.0	103	5,871	- 2,115	0	0	- 7,986	
	100	63.0	18	1,134	- 6,852	0	0	- 7,986	
	Annualized Habitat Unit Change				- 3,516			- 7,539	- 4,023
Hardwood-Softwood Mature	0	47.0	148	6,956	0	148	6,956	0	
	10	51.8	154	7,977	+ 1,021	0	0	- 6,956	
	30	61.4	160	9,824	+ 2,868	0	0	- 6,956	
	100	71.0	184	13,064	+ 6,108	0	0	- 6,956	
	Annualized Habitat Unit Change				+ 3,582			- 6,260	- 9,842
Softwood Regeneration									
	0	43.2	82	3,542	0	82	3,542	0	
	10	43.2	78	3,370	- 172	0	0	- 3,542	
	30	43.2	74	3,197	- 345	0	0	- 3,542	
	100	43.2	17	734	- 2,808	0	0	- 3,542	
	Annualized Habitat Unit Change				- 1,164			- 3,365	- 2,201
Popular-Birch									
	0	49.9	16	798	0	16	798	0	
	10	53.3	16	853	+ 55	0	0	- 798	
	30	60.2	16	963	+ 165	0	0	- 798	
	100	67.0	36	2,412	+ 1,614	0	0	- 798	
	Annualized Habitat Unit Change				+ 647			- 758	- 1,405
TOTAL ANNUALIZED HABITAT UNIT LOSSES OR GAINS									- 89,890

Table 5. Area Required for Mitigation
(Habitat Unit Losses/Management Potential Unit Value)

Habitat Type	Management Potential Unit Value 1/	Power Pool at Elevation 600 ft. N.G.V.D.		Power Pool at Elevation 610 ft. N.G.V.D.		Power Pool at Elevation 620 ft. N.G.V.D.	
		Habitat Unit Losses	Acres Required	Habitat Unit Losses	Acres Required	Habitat Unit Losses	Acres Required
Softwood Mature	10.3	13,853	1,345	20,383	1,979	36,524	3,546
Softwood-Hardwood Mature	11.5	10,008	870	15,023	1,036	23,830	2,072
Hardwood Mature	12.8	1,534	120	1,664	130	2,359	184
Shallow Fresh Marsh	3.4	6,176	1,816	8,408	2,473	9,706	2,855
Hardwood Regeneration	13.9	1,005	72	2,297	165	4,023	289
Hardwood-Softwood Mature	12.3	2,382	194	7,328	596	9,842	800
Softwood Regeneration	16.2	861	53	1,318	81	2,201	136
Poplar-Birch	14.8	574	39	948	64	1,405	95
TOTAL		36,393	4,509	57,369	6,524	89,890	9,977

1/ Represents annualized values for the St. John area as contained in our November 8, 1979, Supplement No. 3 to the Conservation and Development Report dated January, 1978, Dickey-Lincoln School Lakes Project, Maine.

STATE OF MAINE
OFFICE OF THE GOVERNOR
AUGUSTA, MAINE
04888

JOSEPH E. BRENNAN
GOVERNOR

September 24, 1982

Colonel Carl B. Sciple
Commander and Division Engineer
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, MA 02254

Dear Col. Sciple:

I understand that you plan to release your report on the feasibility of dams at Lincoln School in November or December, and have asked that I designate an agency to serve as your point of contact here in Maine.

Please be advised that I wish the Maine State Planning Office to continue to play this role as they have for the last several years. Richard Barringer, Director, may be reached at State House Station #38, 184 State Street, Augusta, Maine 04333.

I look forward to working with you on this and other matters of mutual interest and concern. And I extend my very best wishes for a happy and successful tour with the New England Division.

Sincerely,

Joseph E. Brennan

JOSEPH E. BRENNAN
Governor

JEB/bls

cc: Richard Barringer, SPO

STATE OF MAINE
OFFICE OF THE GOVERNOR
AUGUSTA, MAINE
04333

JOSEPH E. BRENNAN
GOVERNOR

March 2, 1983

Colonel Carl B. Sciple
Division Commander
New England Division
Army Corps of Engineers
424 Tapelo Road
Waltham, MA 02254

Dear Colonel Sciple:

My Administration has reviewed your report on the feasibility of Lincoln School and find it to be a professionally competent piece of work.

I request that before you issue your final report on Lincoln School you provide us with some additional information, including:

1. The rationale for the method you used to determine the project's financial feasibility, and alternative methodologies that might have been used;

2. A reevaluation of the market value of Lincoln School power;

3. The assumptions you used regarding future oil prices and rationale for these assumptions; and

4. A more precise determination of long-range electricity supplies in New England, including the impact of imported Quebec hydropower, on the feasibility of Lincoln School.

I have asked the Maine Departments of Conservations, Inland Fisheries and Wildlife, and Transportation to provide you with their comments on the environmental impacts directly. The information I allude to in (1) on the likely value of Lincoln School power is available from the Maine Office of Energy Resources.

I appreciate your attention to issues of interest and concern to the people of Maine; and hope you will be able to turn your attention to the questions I raise at an early time.

With best wishes,

Sincerely,

Joseph E. Brennan

JOSEPH E. BRENNAN
Governor

JEB/bls

cc: The Honorable William Cohen
The Honorable George Mitchell
The Honorable Olympia Snowe
The Honorable John McKernan
Richard Barringer, Director, State Planning Office
Constance Irland, Acting Director, Office of Energy Resources

Joseph E. Brennan
Governor

State of Maine
Executive Department
OFFICE OF ENERGY RESOURCES
State House Station 53
Augusta, Maine 04333
(207) 289-3811

Constance J. Irland
Acting Director

March 22, 1983

Mr. Mel Givens
Army Corps of Engineers
424 Trapelo Road
Waltham, MA 02254

Dear Mr. Givens:

It was a pleasure talking to you on the phone. Pam Heidell and I have reviewed the Corps report on the economic and financial feasibility of the Lincoln School dam. As a whole, the report is an extremely useful document. This letter summarizes our comments on the report and suggests analytical issues which the Office of Energy Resources believes need to be addressed in greater detail before a determination on the feasibility or desirability of the project can be made.

I. SEPA financial analysis:

A. The use of first year sales revenues as a comparison to levelized busbar costs is not the best indicator of the financial feasibility of the project. Net present value techniques, such as the FERC analysis of levelized displaced energy savings is a much better indicator of financial feasibility. SEPA's first year revenues analysis is a conservative measure of the project's financial feasibility and one which does not conform to normal business financial analysis. Indeed, several hydropower projects financed by Maine's private utilities and paid for by Maine consumers have been built on the basis of long-term benefits rather than first year financial coverage. One example of this is the Brunswick dam redevelopment project which is presently under construction and will yield a levelized busbar cost of approximately 11 cents/kwh in the mid-1980's.

B. SEPA's financial analysis is not consistent with financial analyses of federal power projects done elsewhere in the country. As we discussed on the phone, regional federal power marketing agencies such as SEPA analyze new federal power projects by folding in the costs of the new project with already existing federal

projects in the region. This rate base type of treatment (similar to that used by private utilities) yields average costs for the combination of existing and new projects well below marginal costs for new projects. Since New England has no existing federal power projects, the Lincoln project appears to be unfairly burdened financially in comparison to federal projects in regions with existing federal power projects. In other words, if the Lincoln School project were located in the Pacific Northwest it would probably meet the financial test imposed by SEPA due to the fact that the low cost of existing federal power projects (some built many years ago) would be averaged with the cost of the Lincoln School project. The average cost of power provided by the package of federal projects in the region would be compared to the market value of the power. Thus it appears that new federal projects are not evaluated in a consistent manner and New England is disadvantaged in comparison to other regions.

C. SEPA's analysis and the FERC DEC analysis do not include the effect of Lincoln School on the price Maine and New England will pay for Canadian power. Canadian power exports are generally priced at some percentage (e.g. 80%) of the buyer's marginal generating cost. Hydropower development in New England will work to decrease the price of Canadian imports, by decreasing New England's marginal generating cost over the long term (this is discussed further below).

II. Project configuration:

A. Cursory analysis of Table 4-1 shows that there is very little variation in turbine sizes among the 27 alternatives considered. Alternatives warranting possible further investigation include a combination of large and small turbines which might make more efficient use of the flow during critical winter months.

B. Daily/weekly load fitting is recognized in the Corps report. There may be opportunities to enhance this capability somewhat with a small turbine. The Corps states that the dam's output is not dispatchable in the NEPOOL system, however, this appears to be contradicted in the sections of the report dealing with daily/weekly load fitting.

III. System integration:

A. The FERC system operation analysis is based on NEPOOL planning which is deficient in several respects. The deficiencies in the NEPOOL plans are important and reliance on such plans creates an unrealistic picture of future power supplies in Maine and New England.

First, NEPOOL does not adequately reflect opportunities for purchases of Canadian hydropower. Second, it assumes that all power plants identified early in the process as likely coal conversion candidates will be converted. Third, the NEPOOL Plan overstates future nuclear power production. Fourth, it does not adequately account for retirement of nuclear plants which will probably occur in the 1995-2010 time frame when the 35 year Nuclear Regulatory Commission licenses expire for the Yankee nuclear units in Massachusetts, Connecticut, Vermont and Maine. Fifth, it does not reflect increasing forced outage rates in aging nuclear plants.

These points have significance far beyond a determination of the economic and financial feasibility of Lincoln School. Accurate analysis of hydro development in Maine as well as development of renewable resource cogeneration facilities at paper plants, lumber mills and other industrial facilities requires that Maine's utility planning accurately reflect realistic developments within the utility industry. FERC engineer James Hebson's letter of November 3, 1982 in which he states that Canadian power imports would perhaps eliminate New England's reliance on oil-fired generation is probably inaccurate due to his reliance on NEPOOL's official plans rather than up-to-date developments within the industry. OER's analysis of NEPOOL plans, including discussions with utility executives and state regulators throughout New England and review of expert testimony presented before the Maine and New Hampshire Public Utilities Commissions, indicates that NEPOOL's coal conversion plans and nuclear power production figures are over-stated. Many of the coal conversion projects (1000 MW is probably a reasonable estimate) are no longer under serious consideration by utility companies or state regulators. These projects have been evaluated and put on the shelf for various financial, engineering or environmental reasons. NEPOOL's nuclear power production figures are based on an assumed capacity factor of 70%, which does not reflect past performance (the historic average is approximately 60%) or likely future performance. In fact, according to expert testimony presented before the Maine PUC, future

performance of these nuclear plants is likely to decline as the plants get older. Reducing the future nuclear production figures to the historical average 60% capacity factor is equivalent to reducing future New England nuclear power production by approximately 7 billion kwh per year. This is equivalent to the annual output of a 1300 MW plant. If nuclear plant performance declines somewhat to a 50% capacity factor, this would lower production an additional 7 billion kwh per year below NEPOOL's estimates.

For these reasons, the capacity band stackings super-imposed on the load duration curves (Hebson letter of July 22, 1982) are probably inaccurate. These inaccuracies do not effect the Lincoln School analysis (FERC determined that oil generation would be displaced) but Mr. Hebson's subsequent letter of November 3, 1982 in which he states that Canadian imports could eliminate oil-fired generation in New England creates an impression that the OER believes is mistaken. The seriousness of this issue is reflected in the present debate in Maine over future hydropower development within the state. Hydropower opponents are fond of saying that Canadian imports will solve our electricity supply situation and therefore there is no need to develop Maine hydropower. Mr. Hebson's analysis has added fuel to this fire. The OER believes this is an unfortunate situation for two reasons. First, despite the importation of large quantities of Canadian power, oil-fired generation will continue to play a major role in regional electricity supply in the forseeable future (approximately 50% of present New England electricity supply is oil-fired and 55% of this oil is consumed in base loaded units) unless Maine and New England continue the difficult process of encouraging wise development of indigenous resources including hydropower and wood-fired cogeneration facilities. Second, Canadian exports are priced at a percentage (typically 60-80%) of the buyer's marginal generating cost. This is the case for the PASNY-Hydro Quebec contract in New York, the recent contract between CMP and the New Brunswick Electric Power Commission, and is likely to be the basis of the NEPOOL-Hydro Quebec contract. Thus, the persistence of oil-fired generation in the NEPOOL system will act to keep the price of New England's Canadian imports high. This is one of the principal conclusions of a recent DOE report entitled "U.S.-Canadian Electricity Trade."

Basically, the price of Canadian power is directly tied to the cost of the power it replaces in the NEPOOL system. The Canadian price is presently based on oil prices (oil is the marginal fuel in the NEPOOL system).

If oil prices go up the contract price of Canadian power will automatically go up. The short term benefits of Canadian power purchases are substantial (the savings are guaranteed) and this opportunity is being pursued vigorously. However, it would be a serious mistake to forgo development of our own renewable resources on the basis of such trade. Development of local hydropower and cogeneration potential as well as a concerted effort to conserve electricity in Maine and New England can work towards the long term goal of reducing high cost oil imports, reducing Canadian power prices and providing Maine industries and business with reasonably priced, reliable electricity supplies. The benefits of such a strategy extend far beyond the market value of the oil displaced.

IV. Marketability of the power:

A. The preference market for federal power is the public power market in the region. This is based on FERC wholesale rates in the region. Although this market is given preference for the power it appears unlikely that Lincoln School output can be marketed to these public power systems because the FERC wholesale rates are likely to remain below the project's busbar costs. The NEPOOL system as a whole represents a much broader market. Financial arrangements between federal power marketers and regional power pools run by investor owned utilities are unknown to the OER staff. One idea worth comment is a financial arrangement between the federal government and NEPOOL whereby the Army Corps of Engineers would construct the dam and NEPOOL would cover the financial costs once it is in service.

B. If the power can be marketed to NEPOOL at a price above the levelized busbar cost, the federal government can recover its costs. Since this levelized busbar cost, as calculated by SEPA, is below long-term projections of NEPOOL's marginal costs, the opportunity to sell the power to NEPOOL at a sufficient price to meet federal financial requirements may exist.

V. Comparison with current New England utility investments:

One useful indicator of the future value of the Lincoln School power is a comparison with utility projects slated to come on line in the late 1980's and early 1990's. These include the Millstone 3 and Seabrook I & II nuclear units. Recent cost estimates indicate that the cost of power from these units will be 20 cents per kwh or perhaps more. These projects are more expensive than Lincoln School on a per kwh basis.

The Office of Energy Resources appreciates the opportunity to comment on the draft report. Thank you for your attention to these comments.

Sincerely,

Steve Buchsbaum
Resource Economist

SB/rm

cc: David Flanagan, Governor's Office
Constance Irland, Acting Director, OER
Pam Heidell, Hydropower Planner, OER
Alec Giffen, State Planning Office
Norman Leonard, Acting Chief Electrical Engineer, PUC

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254

REPLY TO
ATTENTION OF:

June 15, 1983

Engineering-Project Management

Mr. John Kerry
Director
Executive Department
Maine Office of Energy Resources
State House, Station 53
Augusta, Maine 04333

Dear Mr. Kerry:

I am writing in response to the letter from your office dated March 22, 1983, which presented your agency's comments on the draft report of the Economic and Financial Feasibility Study for the Lincoln School Hydroelectric project.

The issues raised in Parts I, III, IV and V of your comment letter are in the Department of Energy's (DOE) area of expertise and are best addressed by appropriate elements of that Federal agency. I therefore requested the Federal Energy Regulatory Commission and the Southeastern Power Administration to prepare responses to these comments. Their responses are attached and will be incorporated into the final report document.

The following discussion is in regard to your office's comments under Part II - Project configuration.

The Lincoln School project was scoped using multiples of large units in combination with a single smaller unit. The individual turbines are capable of operating efficiently with flows ranging from about 40 to 105 percent of their respective design capacities. Units were, therefore, sized to permit efficient system operation for a wide range of flows. For example, with alternate plan 3, the small unit was sized to operate efficiently for flows ranging from about 1,000 to 2,900 cfs and the large units from about 2,900 to 7,900 cfs, thus the overall system would be capable of operating efficiently for all generating flows from 1,000 to 18,800 cfs.

Admittedly, adding another smaller unit would permit limited generation during periods when flows were less than 1,000 cfs (approximately 10 percent of the time) and also provide an added increment of generation when flows are greater than 18,800 cfs

(also about 10 percent of the time). Adding a smaller unit with a design capacity of approximately 1,000 cfs would permit efficient generation with flows as low as 400 cfs. Such a unit would increase project size (generating capacity) by about 5 percent and the average annual energy would be increased about 3.5 percent, with about 2 percent due to increased high flow generation and 1.5 percent by low flow generation.

The addition of a mini low flow unit might be feasible and advisable if it were determined that there is a need for limited generation during low flow periods. The cost of the unit could also be partially offset by the added generation provided during high flows. However, it is readily apparent that the value of the potential increase of only 3.5 percent in project energy when reduced by the cost of the added unit will have little if any impact on the overall feasibility of the project.

With reference to load fitting, Section 5.06 of the report entitled "Operational Characteristics" states that "the Lincoln School project would be operated basically as a run-of-river plant with only limited daily and weekly load fitting by storage regulation." This statement is not considered contradictory with other statements in the report that note the project's output is not dispatchable to meet the demands in the system. As stated, the project would be a run-of-river plant and over any significant period of time the distribution of generation output would be dependent on river flows. Under some flow conditions, the small storage capacity would be used to distribute the generation over a day or week to reflect the general shape of the load curve; e.g., reduced or limited generation during nighttime or weekend periods and higher levels of generation during daylight and weekday periods. This does not, however, constitute dispatchable power which can be reliably assigned and called upon to meet a given portion of the load. The load could materialize when flow conditions would not permit the required level of generation and vice versa.

Your office's review and comments are appreciated. I might add that all of the comments and the related responses will be included in the final report. We are now processing the final report and anticipate its release late this month.

Sincerely,

Joe B. Fryar, P.E.

Joe B. Fryar, P.E.
Chief, Engineering Division

Enclosure

Copy Furnished:

Honorable Joseph Brennan
Governor
State of Maine
Augusta, Maine 04333

Maine State Planning Office
State House, Station 38
Augusta, Maine 04333

FEDERAL ENERGY REGULATORY COMMISSION
NEW YORK REGIONAL OFFICE
26 FEDERAL PLAZA, ROOM 2207
NEW YORK, NEW YORK 10278

June 1, 1983

Mr. Joe B. Fryar
Chief, Engineering Division
Department of the Army
New England Division,
Corps of Engineers
424 Trapelo Road
Waltham, MA 02254

Dear Mr. Fryar:

Reference is made to your letter of April 1, 1983, regarding the proposed Lincoln School Hydroelectric Project in northern Maine. We have reviewed the material furnished with your letter, and our comments are presented below. In line with your request, they have been limited to the discussion in Sections III and V of the March 22 letter from Maine's Office of Energy Resources (OER) to Mr. Givens of NED.

In general, Section III deals with alleged deficiencies in NEPOOL planning and in the input from this office concerning the evaluation of Lincoln School power and its utilization on the NEPOOL load curve. In addressing these issues, it may be helpful to place Lincoln School in its proper perspective with respect to NEPOOL, the market taken for the project's output. According to NEPLAN's April 1, 1983, "New England Forecast Reports" the New England 1982/83 winter peak was 15,619 megawatts, with corresponding 1982 energy requirements of 85,288 million kilowatt-hours. NEPLAN projects these to increase to 20,900 megawatts for the winter of 1998/1999 and 120,140 million kilowatt-hours in 1998. For the various schemes of project development considered in your study, Table 4-1 in the draft report indicates generating capacities ranging from 53.92 to 204.7 megawatts and corresponding average annual energy outputs of 174 and 320 million kilowatt-hours, respectively. From Table 4-4, the dependable/intermittent capacity varies from 29 to 51 megawatts. The selected plan would have an installed capacity of 110.9 megawatts, dependable/intermittent capacity of 45 megawatts, and average annual energy of 272 million kilowatt-hours. The following table shows the estimated project power as a percentage of NEPOOL's actual 1982/83 and projected 1998/99 peak demands and annual energy requirements.

	Lincoln School Power	
	1982 (%)	1998 (%)
Generating Capacity in Percent of NEPOOL Peak		
Maximum	1.31	0.98
Selected Plan	0.71	0.53
Minimum	0.35	0.26
Average Annual Energy in Percent of NEPOOL Energy		
Maximum	0.38	0.27
Selected Plan	0.32	0.23
Minimum	0.20	0.14
Dependable Capacity in Percent of NEPOOL Peak		
Maximum	0.33	0.24
Select Plan	0.29	0.22
Minimum	0.19	0.14

While Lincoln School undeniably has value as a renewable resource, the above table would appear to indicate that, regardless of the plan of development and regardless of the NEPOOL load levels reached in the 1990's, the project would not have a major impact on the total New England load. To round out the picture of the relevance of Lincoln School to NEPOOL, it is also helpful to consider its operating limitations. Streamflow of the St. John River varies widely, both seasonally and annually. As shown in Table 3-2 of the Draft Report, only in April and May does the average monthly flow at Lincoln School exceed 7000 cfs (17,562 and 25,082 cfs, respectively). As a run-of-river project having no upstream storage, energy production at Lincoln School will, therefore, basically follow streamflow patterns. As a result, dependable capacity and operation at full load are severely restricted, and monthly generation is extremely uneven. Also, according to the Draft Report, the generation in just three months (April, May, and June) accounts for a little over 50 percent of the average annual project output of 272 million kilowatt-hours; and when natural streamflows are less than 1000 cfs (expected about 15% of the time, or about 55 days per year) the project will not generate.

It is somewhat difficult to respond to the assertion in Section III of the OER letter that our analysis of system operations is based on deficient planning by NEPOOL. According to OER, the deficiencies occur in five areas. This office has been involved for many years in the on-going studies of, first, Dickey-Lincoln School and now Lincoln School alone. This involvement has centered mainly on the market for and value of project power. Our investigation has

basically depended on data and information provided, both formally and informally, by New England utilities, NEPOOL, and the Northeast Power Coordinating Council. We have found this material to be satisfactory and adequate for study purposes. Obviously, there can, and will be differences of opinion concerning the future direction that the utility industry will take as determined by the particular prejudices, assumptions, criteria, and parameters employed.

OER is critical of NEPOOL for not reflecting opportunities for the purchase of Canadian hydropower in its future plans. While possibilities for power interchanges among utilities are frequently explored, the nature and responsibilities of electric utilities are such that they cannot make firm future plans based on "opportunities", but must rely on signed contracts, or formal agreements. For example, the final agreements for the purchase of NEPOOL of 33 billion kilowatt-hours over an eleven year period from Hydro-Quebec were signed last February 11. This was more than three months after our November 3, 1982 letter to NED, and even longer since the data on which the letter was based became available. We recognized the possibility of a large scale Canadian purchase; but again, until final agreement was reached, it was just a possibility. In fact, in our November 3 letter it was indicated that recalculation of Lincoln School power values would be necessary if, and when the Canadian contract was formally announced.

The remaining four alleged deficiencies relate to the number of coal conversion projects, future nuclear power production, retirement of nuclear plants, and nuclear forced outage rates. It would appear that all involve matters of opinion. With respect to the issue of coal conversions, which OER feels is overstated, NEPOOL in this year's forecast report, indicates actual conversions totalling 1600 megawatts (summer rating) in 1981 and 1982, and projects an additional 1776 megawatts in the 1983-88 period. The other three deficiencies deal with the future production, retirements, and forced outage rates of nuclear units, and are matters of judgment and speculative in nature.

Section III is inaccurate in certain respects with reference to our letters of July 22 and November 3, 1982. The November 3 letter does not say "Canadian power imports would perhaps eliminate New England's reliance on oil-fired generation ....", as claimed by OER. Our letter does say, "A large scale purchase of capacity and associated energy from Canada ... would push New England high cost oil-fired generation upwards - or even off the load curve. This could move lower cost oil, coal generation, or the Canadian purchase into the capacity factor band occupied by Lincoln School". This is significantly different from the OER interpretation. Again, in a related discussion concerning our capacity band stacking on NEPOOL load duration curves, OER is critical of the rationale associated with the load curve analysis. We have never concluded that Canadian power would completely displace oil-fired generation in New England, as implied by OER. Some would be displaced, and some would be rearranged on the load curve.

OER contends that the price of Canadian power is directly tied to the power it replaces on NEPOOL, and is presently based on NEPOOL oil prices. This is not true of the recently negotiated contract with Hydro-Quebec. The agreement provides for the sale of 33 billion kilowatt-hours to NEPOOL over eleven years, starting in 1986, at 80 percent of NEPOOL's average cost of generation using fossil fuel. Obviously, given current price structures and New England's continuing dependence on oil, the average cost of coal and oil-fired generation com-

bined is certain to be less than the cost of oil produced energy only.

With regard to Section V, we have only a few minor comments concerning OER's use of scheduled nuclear units as an indicator of the future value of Lincoln School. It might be noted that beyond those units under construction, the future of nuclear is extremely uncertain, which might make their use for comparison purposes questionable. As for the nuclear cost estimate, perhaps in no other area of utility construction are costs so unpredictable. The evaluation procedures employed by this office in providing NED and other Corps offices power values for proposed Federal hydroelectric projects have developed over the years. Essentially, the value of a proposed project is measured by the cost of power from the most likely alternative. It is our current practice to consider coal-fired base load units and cycling units as alternatives for the base load and intermediate load bands of the load curve respectively, and oil-fired combustion turbine units for the peak portion. Because of the widespread opposition to nuclear power and its uncertain future, it is currently no longer considered a viable option as a base load alternative.

In summary, it would appear that the criticisms of OER relate not so much to our findings and conclusions regarding the use of Lincoln School on the NEPOOL load curve, as to the data base and procedures employed in the analysis. Our study efforts have been largely based on the system planning by NEPOOL, which OER finds unacceptable. The size of the project, relative to NEPOOL, and its widely fluctuating output characteristics, we feel, justify the assumptions and approach followed.

Thank you for the opportunity to comment. If we can be of further assistance, please contact us.

Sincerely,

James D. Hebson

James D. Hebson
Regional Engineer

Department of Energy
Southeastern Power Administration
Elberton, Georgia 30635

June 10, 1983

Mr. Joe B. Fryar, P. E.
Chief, Engineering Division
New England Division, Corps of Engineers
Department of the Army
424 Trapelo Road
Waltham, Massachusetts 02254

Dear Mr. Fryar:

In response to your letter of April 4, 1983, we have reviewed the letter from the Office of Energy Resources (OER) of the State of Maine and herein provide our comments on Sections I, IV, and V of their letter.

Section 1-A. The requirements for establishing financial feasibility are established by Section 5 of the Flood Control Act of 1944. One of the guidelines established by the act requires that rates be set at a level to recover all costs of the hydroelectric project that are allocated to power including the amortization of the debt over a reasonable number of years. Based on this requirement, procedures have been established to insure that revenue levels are established to recover all costs in a timely manner. The Flood Control Act also requires that rates be reviewed and approved by the Federal Energy Regulatory Commission. It is the Commission's responsibility to insure that the rates are adequate to repay all of the costs.

As of this time, the procedures do not allow a power marketing administration to establish a revenue level that is noncompensatory in anticipation that revenue levels will be increased at a future time as market conditions warrant.

A project in the Alaska Power Administration area was granted specific legislative authorization to set rates at a noncompensatory level for a specified period of time.

Section 1-B. SEPA has maintained a policy of evaluating projects as a system where the projects are electrically and hydraulically integrated with other Federal projects. In this way, costs of the projects are folded together. However, in New England, there are no Federal projects which can be integrated with the Lincoln School Project. Therefore, there are no costs which can be merged with the Lincoln School costs.

Section IV-A. The Flood Control Act of 1944 requires that SEPA give preference to publicly owned utilities. However, this does not preclude SEPA from marketing power to investor owned utilities in the NEPOOL in the event that no preference customers want the power.

Section IV-B. The SEPA evaluation, as discussed in the letter of November 17, 1982, was prepared to determine financial feasibility and marketability to any customer. The analysis of the current rates charged to resale customers is one method to judge the marketability of the power. The 57-mill number quoted in that letter is a rate of an investor owned utility that is in NEPOOL, and probably represents average cost of power. We used this figure to determine the likelihood that an investor owned utility or any other utility would be willing to purchase the power, and we believed and continue to believe that it is extremely unlikely that the power could be sold in the early years for the rates necessary to recover the costs.

Section V. We are not in a position to express an opinion on the projected costs of the three nuclear projects discussed in Section V. However, the evaluation did consider that some energy costs would be in excess of the average costs of the project.

Sincerely,

Curtis H. Bell
Acting Administrator

DEPARTMENT OF
INLAND FISHERIES AND WILDLIFE
284 STATE STREET
STATE HOUSE STATION 41
AUGUSTA, MAINE 04333

GLENN H. MANUEL
COMMISSIONER

J. WILLIAM PEPPARD
DEPUTY COMMISSIONER

March 23, 1983

Colonel Carl B. Sciple
Division Commander
New England Division
Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254

Dear Colonel Sciple:

I have asked my staff to review the "Natural Resource Considerations" section of the Draft Water Resources Development, Saint John River Basin, Lincoln School Hydroelectric Project, Maine, Economic and Financial Feasibility Study, dated November, 1982. I offer the following comments based upon their review.

Wildlife

The effect of innundation on the deer wintering area located on the "Little Black River" is of concern to this Department. The statements made on Page 11-9 and 11-10 of the draft review indicates that a pool elevation of 620 NGVD would flood the lower five miles of the Little Black River resulting in a loss of about 126 acres of deer wintering area.

Analysis of the only USGS topo sheet (1930) available to us indicates that a pool elevation of 620 NGVD would flood approximately 10½ miles of the Little Black River from its confluence with the St. John River.

If our data sources are accurate, considerably more than four acres (at 610 NGVD) and 126 acres (at 620 NGVD) of deer wintering area would be influenced.

Fisheries

The comment on Page II-7 which states, "... potential development of the reservoir as a seasonal coldwater and/or year round warmwater fishery." is not in keeping with the fisheries management objectives of this Department. The St. John River Drainage above Grand Falls currently has no warmwater sports fish, a condition which we hope will continue.

Sincerely,

Glenn H Manuel
MCJ-DEPUTY

Glenn H. Manuel
Commissioner

GHM:cs

cc: State Planning Office
Ashland Headquarters

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254

REPLY TO
ATTENTION OF:

April 14, 1983

Planning Division
Impact Analysis Branch

Mr. Glenn H. Manual
Commissioner
Maine Department of Inland
Fisheries and Wildlife
284 State Street
State House Station 41
Augusta, Maine 04333

Dear Mr. Manual:

This letter is in response to your March 23, 1983 letter concerning the draft Economic and Financial Feasibility report for hydropower development at Lincoln School, Maine. The data pertaining to stream miles and deer yards inundated by the 610 and 620 ft. elevation power pools are based on photogrammetric surveys in the project area prepared in 1966 for the New England Division. This mapping, at a scale of 1:4800 with 10 foot contour intervals, is more detailed than the 1930 USGS topo sheet. The more current photogrammetric mapping shows the upstream limit of the 620 ft. pool to be in the vicinity of the Little Black River's confluence with Johnson Brook and the 610 ft. pool to be slightly downstream of its' confluence with Kelly Brook. It is acknowledged that this differs from that shown on the USGS topo sheet, however, we consider the more recent and detailed mapping to be a more correct data source for this remote area.

Should you require further information, please contact Mr. David Tomey, of my staff, at (617) 647-8139 or Mr. Malcolm Givens, the Project Manager, at (617) 647-8310.

Sincerely,

Joseph L. Ignazio
Chief, Planning Division

STATE OF MAINE
Department of Environmental Protection

MAIN OFFICE: RAY BUILDING, HOSPITAL STREET, AUGUSTA
MAIL ADDRESS: State House Station 17, Augusta, 04333

JOSEPH E. BRENNAN
GOVERNOR

HENRY E. WARREN
COMMISSIONER

March 24, 1983

Colonel Carl B. Sciple
Division Commander
New England Division
Army Corps of Engineers
424 Trapelo Road
Waltham, MA 02254

Dear Colonel Sciple:

As per the Executive Department, State of Maine's request, we have reviewed the draft document on the Lincoln School Hydroelectric Project, Maine.

The most significant impact is the loss of 3,000 acres of terrestrial habitat which is replaced with a regulated aquatic resource of some questionable value to recreation. The creation of habitat or the exchange of one habitat type for another is sometimes environmentally sound but in this case marginal simply due to the location.

The impact to water quality in the reservoir will be a temporary loss of dissolved oxygen for a few years until the impoundment sediments stabilize. This probably is not likely to be a problem due to the short residence time of the water (30 days maximum) and the bottom drawdown and discharge. The above two factors would prevent permanent stratification of the impoundment during the summer months.

My technical staff conclude that the water quality in the impoundment, after equilibrium, should be the same as the inflow and outflow.

I thank you for the opportunity to comment on the well prepared draft.

Sincerely,

HENRY E. WARREN
COMMISSIONER

HEW/MS/w

cc: Richard Barringer
Matthew Scott
Mark Hutchins

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
TRANSPORTATION BUILDING
STATE HOUSE STATION 16 AUGUSTA, MAINE 04333

mdot

GEORGE N. CAMPBELL, JR.
Commissioner

March 28, 1983

Colonel Carl B. Sciple
Division Commander
New England Division
Army Corps of Engineers
424 Trapelo Road
Waltham, Mass. 02254

Re: Lincoln School

Dear Colonel Sciple:

We have reviewed the Lincoln School Draft Economic and Financial Feasibility Study and have no comments to make regarding transportation related concerns.

Thank you for the opportunity to comment.

Very truly yours,

George N. Campbell, Jr.
Commissioner

GNCjr:rr

cc: R. Barringer

STATE OF MAINE
DEPARTMENT OF CONSERVATION
STATE HOUSE STATION 22
AUGUSTA, MAINE 04333
TEL. 207-289-2211

JOSEPH E. BRENNAN
GOVERNOR

RICHARD B. ANDERSON
COMMISSIONER

March 31, 1983

Colonel Carl B. Sciple
Division Commander
New England Division
Army Corps of Engineers
Trapelo Road - 424
Waltham, MA 02254

Dear Colonel Sciple:

I have reviewed your report on the feasibility of Lincoln School and would like to offer the following comments.

I do not find that the sections on recreational impacts fully describes effects that the impoundment will have on recreationists. Since the St. John is currently an important fishing and canoeing river, there needs to be full discussion on what measures could be applied to those portions of the river and/or lake impoundment that will be affected by the dam. Specifically, by flooding or, at the very least, altering the character of the Big Rapids, more people than do now will leave the river at sites upstream from Big Rapids. I am concerned that the access sites upstream from Big Rapids be both adequate in numbers and in good enough condition to absorb the additional traffic that they are likely to receive.

Secondly, the study does not adequately describe how the impounded area might be used recreationally. I am not confident that the daily fluctuations will allow for easy access or use of the site.

I appreciate being able to review this study.

Sincerely,

Richard B. Anderson

Richard B. Anderson
Commissioner

RBA/ehp

APPENDIX E

OPERATION AND MAINTENANCE

APPENDIX E
OPERATION AND MAINTENANCE

Organization and Responsibilities

The various functions of the water regulation operations at Lincoln School would demand close cooperation and coordination among the power marketing agency, the Corps of Engineers, New England and New Brunswick power companies, Fish and Game Agencies, local interests and others to provide the maximum benefits to the region. The administration of the regulation programs would at all times reflect full and due consideration of these interests. Functional water regulation and physical operation and maintenance of the project would be the responsibility of the New England Division. On-site project responsibility would be assigned to an Engineer-in-Charge.

Staffing Required

General

The staffing of the Lincoln School Power Project would consist of Administration personnel, Power Plant Operation personnel, and General Maintenance personnel. The organizational chart for the Operation and Maintenance of the project is shown on Table E-1. Administrative and technical support for the project will be provided by New England Divsion Headquarters.

Staffing

a. The administration staff would consist of the following:

NO.	POSITION	RATE
1	Engineer-in-Charge (facilites engineer)	GS-12
1	Park Ranger	GS-09
1	Administrative Ass't	GS-07
1	Clerk-stenographer	GS-04

The total annual cost for personnel in the Administration staff is estimated to be $83,000.

b. The Power Plant Operation staff would consist of the following:

NO	POSITION	RATE
1	Power Plant Superintendent (Chief electrician)	WS-08
1	Chief Plant Operator	WG-10
1	Electronic Technician	WG-09
4	Plant Operators	WG-08

The total annual cost for personnel in the Power Plant Operation staff is estimated to be $120,000.

c. The General Maintenance staff would consist of the following:

NO.	POSITION	RATE
1	Maintenance Superintendent (Master Mechanic)	WS-07
1	Machinist	WG-08
1	Equipment Operator	WG-07
1	Laborer	WG-05

The total annual cost for personnel in the General Maintenance staff is estimated to be $67,000.

In summary, the number of personnel to operate and maintain the Lincoln School Power Project would be:

Administration staff	4
Power Plant Operation Staff	7
General Maintenance Staff	4
Total	15

TABLE NO. E-1
STAFFING ORGANIZATION CHART

Administration Section

1 - Engineer-in-Charge (facilities engineer)
1 - Park Ranger
1 - Admin Ass't/Budget Ass't
1 - Clerk/stenographer

Power Plant Operation Section

1 - Power Plant Superintendent (Chief Electrician)
1 - Chief Plant Operator
1 - Electronic Technician
4 - Plant Operators

General Maintenance Section

1 - Maintenance Superintendent (Master Mechanic)
1 - Machinist
1 - Equipment Operator
1 - Laborer

Supervision and Operation

The Engineer-in-Charge would have the responsibility of the entire project. He would have direct supervision over the administrative staff, power plant superintendent, and the maintenance superintendent. The Power Plant Operation staff, under the direct supervision of the Power Plant Superintendent, would be responsible for the proper functioning and routine maintenance of the power plant equipment. A proposed shift schedule for the Power Plant Operations staff is shown on Table No. E-2. The General Maintenance staff, under the direction of the Maintenance Superintendent, would be responsible for the proper functioning of the dam structures, dikes, grounds, buildings, utilities, reservoir, and support for maintenance of the power plant.

TABLE NO. E-2
POWER PLANT STAFFING SCHEDULE

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
First Shift	Power Plant Super.	Power Plant Super.	Power Plant Super.	Power Plant Super.	Power Plant Super.		
	Chief Plant Oper.	Chief Plant Oper.	Chief Plant Oper.			Chief Plant Oper.	Chief Plant Oper.
Second Shift	Plant Oper.	Plant Oper.	Plant Oper.	Plant Oper.	Plant Oper.		
	Plant Oper.			Plant Oper.	Plant Oper.	Plant Oper.	Plant Oper.
Third Shift	Plant Oper.	Plant Oper.	Plant Oper.	Plant Oper.	Plant Oper.		
			Plant Oper.	Plant Oper.	Plant Oper.	Plant Oper.	Plant Oper.

Maintenance Facilities

Project requirements dictate that two (2) utility buildings must be constructed for the proper functioning and maintenance of the project.

The main utility building would have space alloted for administrative offices, storage and stock rooms, boiler/utility room, flammable materials storage room, workshops, garage (2-bay), and toilets. This building would occupy an area of 2,600 sq. ft. (40' x 60') and could be constructed for approximately $150,000.

An unheated garage/utility building would consist of an open garage and storage area for non-temperature sensitive materials. This building would cover an area of 1,400 sq. ft. (35' x 40') and could be constructed for approximately $35,000.

Employee Housing

Current policy dictates that no Government-furnished housing shall be provided for employees at any Government facility. However, ER415-2-301, "Construction Policies and Practices," states in part that housing facilities for operating personnel will be constructed when housing is inadequate within either the immediate vicinity of the project or within a reasonable commuting distance.

A housing survey previously conducted in Allagash, St. Francis and St. John for the Dickey-Lincoln School studies revealed that there is an acute shortage of rental units and of single family dwellings which are for sale in these three communities. There are no apartment complexes in these towns. The turnover of dwellings is very low and the few dwellings which are sold each year in these locales are usually sold to a relative or to a person having strong ties to that community.

The existing dwellings that would be acquired within the project area are mostly of the older type which do not lend themselves to feasibile renovation and relocation. Also, it is anticipated that many of the property owners within the project area would request salvage rights on their dwellings.

It is anticipated that at least two key operating personnel would have to be available on a full-time basis. Therefore, for the purpose of this study, costs for two Government furnished housing facilities are included based on the results of the earlier housing survey. It is estimated that these facilities would cost approximately $150,000. Should the project proceed into more definitive design and construction stages, reevaluations of the housing conditions would be required to verify and justify the need for Government furnished housing.

Equipment

Permanent operating equipment includes all equipment necessary for reservoir and ground maintenance, communications, transportation and powerhouse maintenance. The cost for this equipment typically required is as follows:

ITEM	COST
Front loader/backhoe with snowblower attachment	$ 90,000
10 wheel dump truck	45,000
Tractor with flail mower	22,000
Boat and motor	5,000
Riding mower	4,500
Two (2) non-riding mowers	2,500
4-wheel drive, 1/2-ton pickup with snowplow attachment	9,500
Sedan	8,000
Two (2) snowmobiles	7,000
Two (2) chainsaws	2,000
Main communication base module and mobile radio(s)	6,000
Miscellaneous shop equipment, tools, etc.	23,500
Total permanent Operating Equipment	$225,000

The annual cost associated with permanent operating equipment, capital equipment, tools, utilities and supplies is estimated to be $60,000.

Annual Cost of Operation and Maintenance

a. Annual On-Site Costs

a. Administration Staff	$ 83,000
b. Power Plant Operation Staff	120,000
c. General Maintenance Staff	67,000
Subtotal	$270,000
10% Government Contributions	27,000
Subtotal	$297,000
27% Division Overhead	80,000
Total Annual On-Site Labor Cost	$377,000
Total Annual cost for equipment, tools, supplies and utilities	60,000
Service contracts (Hired Labor)	15,000
Total Annual On-Site Cost	$452.000

b. Annual Off-Site Costs

Engineering Division	$ 42,500
Real Estate Division	6,000
Construction Division	5,000
Operations Division	4,500
Planning Division	2,000
Subtotal	$ 60,000
10% Government Contributions	6,000
Subtotal	$ 66,000
29% Technical Overhead	19,000
Subtotal	85,000
27% Division Overhead	23,000
Total Off-Site Cost	$108,000

c. Total Annual Operation and Maintenance Costs

Total On-Site Costs	$452,000
Total Off-Site Costs	108,000
Total Annual Cost	$560,000

APPENDIX F

IMPACTS OF PROPOSED PROJECT

APPENDIX F

Impacts of the Proposed Project

Introduction:

The proposed project would impact the socioeconomic, historic/ archaeological and natural resources in the project area. A detailed description of these resources may be found in the Appendices to the Final Environmental Impact Statement for the Dickey-Lincoln School Lakes Project issued by the Corps of Engineers, New England Division. Appendices C, C Supplement and C Supplement 2 dealt with the socioeconomic environment; Appendix D with the historical/ archaeological environment; and Appendices E, E Supplement, F, F Supplement, F Supplement 2 and G Revised with the natural enviroment. Each impact discussion below is preceded by a brief description of the resources present.

The degree of project impact on the resources is mainly a function of power pool elevation. The three alternative elevations investigated are 600 ft, 610 ft, and 620 ft, National Geodetic Vertical Datum (NGVD). Impacts for each pool elevation are summarized in Table F-1. The indicated values were generated by comparison of the pool elevations with baseline data developed during previous studies. It must be emphasized that the quantities are preliminary in nature and are subject to change should further study be undertaken.

TABLE F-1
SUMMARY OF PROJECT CHARACTERISTICS AND IMPACTS OF THE PROPOSED POOL ELEVATIONS

Project Characteristics			
Target Power Pool Elevation (ft, NGVD)	600	610	620
Reservoir Surface Area (acres)	2000	2700	3600
Reservoir Depth (ft)	60	70	80
Annual Pool Fluctuation (ft)	4	4	4
Socioeconomic Concerns			
Year-Round Households Relocated	60	82	140
Other Properties Relocated (Commercial, Institutional)	9	14	19
Active Agricultural land Inundated (acres)	99	143	193
Commercial Timber Lands Taken (acres)	300	375	1035
Historic/Archaeological Concerns			
Archaeological Sites Inundated	1	1	2
Natural Resource Concerns			
Total Stream Habitat Inundated(miles)	16.4	22.4	28.8
St. John River Mainstem	12.1	14.7	14.9
Little Black River	0	1.4	5.1
Allagash River*	2.3	3.5	4.9
Other Tributaries	2.0	2.8	3.9
Periodically Inundated Zone (acres)	160	220	440
Total Forest Habitat Inundated (acres)	560	824	1368
Softwoods	279	381	707
Hardwoods	36	45	67
Mixed forest	245	398	594
Wetlands Inundated (acres)	119	149	172
Shrubland/Abandoned Fields Inundated (acres)	176	252	314
Deer Wintering Habitat Inundated (acres)	0	4	126
Recreational Concerns			
Whitewater Stream Inundated (feet)	0	2000	3000

*Below Allagash Wilderness Waterway

SOCIOECONOMIC CONSIDERATIONS

Socioeconomic Profile

The site for the proposed Lincoln School Dam is along the St. John River in the town of St. Francis where the now abandoned Lincoln School is located. In 1980, population in St. Francis totalled 839, a 3.5 percent increase over the 1970 population of 811. Between 1930 and 1980 St. Francis' population peaked in 1940 at 1,489, declining until 1970. Since 1970, however, it has shown a slight increase. St. Francis is located in Aroostook County, which had a population of 91,331 in 1980, a 2.9 percent decrease from its 1970 population. Ft. Kent is the largest town within a 20 mile radius (within U.S.) of St. Francis with a 1980 population of 4,826. The proposed impoundment area extends into the town of Allagash, lying west of St. Francis. In 1980, Allagash had a population of 448, a decrease of 1.8 percent since 1970.

People residing in St. Francis are primarily of French-speaking Canadian and Acadian backgrounds, while those in Allagash are largely of Scotch-Irish heritage, whose ancestors migrated from New Brunswick. A social survey performed in 1976 revealed that principal jobs of men were woods work, machine operation, and skilled crafts. Women who worked for wages were employed in service work, clerical and sales jobs, and the professional-technical categories, especially teaching.

Those communities lying closest to the project site are expected to feel significant social and economic impacts. In addition to St. Francis and Allagash, where the project would be located, these communities are likely to include St. John, Fort Kent, Wallagrass, Eagle Lake, and New Canada. Some impacts, especially employment, are likely to reach many more communities throughout northern Aroostook County.

Housing units in St. Francis increased 14.8 percent from 256 in 1970 to 294 in 1980. The social survey indicated that there is a perceived shortage of homes in St. Francis and Allagash as well as in other neighboring communities. Other communities in the area indicated that the availability of housing was adequate to meet the needs of the current population. Madawaska approximately 30 miles east of St. Francis was the closest community that expressed an ability to accommodate an increase of population without adverse housing impacts. A lack of rental units was a factor in all communities within the area.

St. Francis, Wallagrass, Eagle Lake, and Fort Kent have public water systems which are capable of accommodating some growth. Residents in other communities depend on private wells for water. With the exception of Fort Kent, communities in the area rely on on-site subsurface systems, the majority of which are septic tanks. Fort Kent has a municipal sewerage system and treatment plant with capacity to accommodate the increased usage. Most communities dispose of their solid waste in open burning dumps; some of these do not meet State requirements. St. Francis

has a sanitary landfill area and is in need of a new site. Public works functions are performed partially by the communities and partially by the State or county, and appear to be meeting local needs. Social services, except for program provided through the churches, are provided on a county-wide basis. Ft. Kent is the only community with practicing doctors and a hospital. Most communities in northern Maine have combined educational facilities within several School Administrative Districts.

Farming and forestry are the major economic sectors in Aroostook County, and processing food and timber involves 80 percent of the industrial sector. However, over the past 20 years, employment in agriculture, forestry, and fishing has decreased while increasing in manufacturing and services. Unemployment in Aroostook County is high and has exceeded 10 percent over the past decade. This rate is the third highest among Maine counties.

Commercial forests cover 86 percent of Aroostook County. Very little of St. Francis' land is commercial forests, whereas about 87 percent of Allagash's 86,400 acres is held by commercial timberland interests. Agriculture is the second largest land use in the county, consuming 12.8 percent of the county's total area. Potatoes are the principal crop, followed by peas, buckwheat, and sugar beets. The manufacturing that takes place generally involves the processing of forest and agricultural products and is concentrated around population centers.

Socioeconomic Impacts

Significant impacts would be experienced during both the construction and post-construction phases of project implementation.

Impacts During Construction

During construction, or over the short term, major impacts would result from the influx of construction workers placing demands on housing and local services. The peak construction workforce has been estimated at 300 for the 5-year construction period. During the winter, the labor force would average 30 workers and during the construction season (May to October), it would average 150.

Communities expected to absorb the project-related population increases would be those located closest to the project site and would include St. Francis, Allagash, St. John, Ft. Kent, and perhaps Wallagrass and Eagle Lake. Although Ft. Kent may be the furthest of these, it would be chosen as a place or residence because its size allows it to offer services not available in the smaller communities. A small percentage of workers may even choose further locations.

Housing needs of the incoming workforce could be met by (1) workers bringing their own mobile homes, (2) a labor camp offered by the contractor, and (3) residences within the local communities. With limited

housing availability, it is expected that many construction workers moving into the area would bring their own trailers or mobile homes. Competition for the housing that is available may cause an increase in rents and market values.

Local businesses would experience an increase in business because of increase services and goods demanded by the labor force. For the Dickey-Lincoln project it was estimated that every 10 direct construction jobs would result in 5.5 secondary or tertiary jobs created in the local economy. Construction activities may attract retail and service establishments into the area which are not currently available or are of low quality, benefitting permanent residents.

Impacts would be felt throughout the community infrastructure. These impacts would be dependent upon the concentration of construction workers and their families within the community or the proximity of a labor camp. Services that could be affected include water supply, sewage and solid waste disposal, education, medical, social, and public works. Inmigrants may also wish to participate in local organizations and local churches or even form their own.

Public water systems exist in St. Francis, Wallagrass, Eagle Lake, and Fort Kent and would be able to accommodate some degree of increased usage. Workers locating in other communities would have to develop their own wells. Solid waste disposal capabilities are already limited and increased waste loads would tax the existing systems.

School systems in the area would receive some increase in enrollment, although it would be minor because of the size of the workforce likely to stay year-round. School Administrative District (SAD) #27 located in Fort Kent is likely to receive the most new students since it absorbs students from St. Francis, St. John, Fort Kent, and Wallagrass. This district would be able to handle some enrollment increases. Allagash belongs to SAD #10 which needs more classroom space and a new vocational education facility.

The increase in residents would increase the demand on health services and may result in a shortage. Likelihood of accidents would increase with the construction activities. Social services, mental health counselling, and family planning services would also experience an increased demand.

The highway system would receive increased traffic during construction. Major routes that would be affected include Route 161 between Ft. Kent and the site and Route 11 between Eagle Lake and Ft. Kent. Increased volumes would result with the daily commuting of workers, family related trips (shopping, etc.), and the movement of equipment and supplies to the project site. Portions of Route 161 would be permanently relocated as well. With the increased traffic some additional maintenance and construction may be necessary to maintain acceptable roadway conditions and safety standards.

Impacts During Operation

At the end of construction it is expected that many workers would leave the area. However, population in the area after completion of construction would be higher than without the project. The operational phase of the project would require 15 workers. These workers would establish permanent residences in the local area.

With the phase down of construction, construction workers would depart and the number of jobs and consumer demand for goods and services in the area would decline. Many local residents would become unemployed as business volumes decreased. Demand on municipal services would also decline.

Since northern Aroostook County citizens are used to seasonal adaptations and temporary work commitments, it is likely that as the construction phase ends, little impact would remain. Deep-seated cultural identities would retain the character of the communities.

The creation of the impoundment area would result in significant land use changes in Allagash and St. Francis. Pool height plays the major role for determining the magnitude of some long term impacts, including the number of households to be relocated, commercial establishments to be displaced, and acres of timberlands and agricultural lands to be lost.

The lowest pool level proposed, one at 600', would require the relocation of a total of 60 year-round households, 16 in Allagash and 44 in St. Francis. A pool level of 610' would mean the displacement of 82 year-round households, 37 in Allagash and 45 in St. Francis. The highest pool level of 620' would result in the relocation of 140 households, 90 in Allagash and 50 in St. Francis. Home, business and road relocations would be phased in during the construction period.

The maximum number of homes that could be relocated in Allagash represent approximately 55 percent of all Allagash homes. The maximum number in St. Francis is about 17 percent of the total number of homes. Both communities have sufficient land area to accommodate relocations within their own boundaries. Relocation plans would be discussed locally and take into consideration local concerns in order to minimize impacts and retain the communities' character. Configuration of housing layouts would differ from the existing. Provisions for relocating the displaced families are covered under the Uniform Relocation Assistance and Real Property Acquisition Policy Act, which is designed to ensure equitable treatment of relocated residents under law. Impacts, however, are sure to vary from family to family and would be tempered by individuals' perceptions. In some cases, relocation could result in an upgraded home that could be more costly to maintain.

Forestry lands, wetlands and rivers, and agricultural lands would be impacted in addition to developed areas. The magnitude of the impacts on

these uses would be dictated by the final pool elevation. Table F-1 displays the acreage figures and home and business relocations as they would occur at each pool height.

Historical Archaeological Considerations

Archaeological studies for the Dickey-Lincoln School Lakes project were undertaken during 1976 and 1980. These surveys located 40 prehistoric archaeological sites and one historic archaeological district. Of these, 12 prehistoric sites and the historic archaeological district were considered eligible for inclusion in the National Register of Historic Places. The prehistoric sites appear to have been short duration camps dating from ca. 8,000 BC to just before European contact, while the historic district is a late 19th-early 20th century settlement. Detailed discussion of these sites may be found in Appendix D and Appendix D (Supplement) of the Dickey-Lincoln School Lakes Project environmental impact statement.

The currently proposed Lincoln School project would affect a maximum of two prehistoric archaeological sites located during the 1976 survey. These sites have been declared eligible for inclusion in the National Register of Historic Places. As with other sites located during the survey, these appear to have been camping areas for prehistoric groups travelling along the river, hunting and foraging in the vicinity, and appear to date from the period between 1000 BC and European contact.

At flow line elevation 600 ft and 610 ft NGVD, one prehistoric site located during the archaeological surveys undertaken in 1976 would be destroyed or heavily damaged by innundation and pool fluctuations. At flow line el. 620 ft. NGVD a second site would also be impacted. As both sites have been declared eligible for inclusion in the National Register of Historic Places, mitigation of impacts upon them would be required prior to project construction.

NATURAL RESOURCE CONSIDERATIONS

Aquatic Ecosystem:

The aquatic habitat in the St. John River Basin upstream of the proposed Lincoln School dam consists of approximately 3450 miles of continuously flowing and intermittent streams as well as a number of lakes, ponds, and beaver impoundments. The streams provide habitat for approximately 20 species of coldwater and warmwater fish of which eastern brook trout (*Salvelinus fontinalis*) is the most important game species. A small number of landlocked Atlantic salmon escape from stocked downstream lakes and occasionally may be found upstream of Allagash. Recent surveys of the streams tributary to the St. John River mainstem indicate approximately 66, 97 and 95 percent of the stream miles are rated fair to excellent for brook trout spawning, nursery and adult holding areas, respectively. The St. John River mainstem and its larger tributaries, such as

the Little Black River are generally wide, shallow and exposed. Water temperatures exceed 70°F during the warmer summer months and thereby force coldwater species to retreat to the smaller less exposed tributaries where the better quality habitat occurs. Insect fauna are rich and varied and provide forage for the trout population as well as other species.

Construction of the proposed dam would inundate a total 16.4 miles of stream habitat at the 600 ft. pool elevation, 22.4 miles at the 610 ft. pool elevation and 28.8 miles at the 620 ft. elevation (Table F-1). Table F-1 indicates that the St. John River mainstem and its two large tributaries, the Little Black and Allagash Rivers, comprise approximately 86-87% of these mileage values. The proposed impoundment would not inundate the Allagash River above West Twin Brook which is protected by the Federal Wild and Scenic Rivers Act of 1968 (16 U.S.C. 1271-1287). Only the lower portion of the tributaries to the large streams would be inundated. A 1976 survey of the Negro, Wiggins and Aegan Brooks indicated that the lower portion of these streams contained fair to good adult holding habitat for brook trout as well as other species. The vast majority of the good and excellent spawning, nursery, and adult holding habitats occur well above all three power pool elevations and would not be affected by the proposed project. No ponds or lakes would be inundated under any of the pool elevations.

The proposed dam would create a standing water habitat of 2000 acres at the 600 ft pool, 2700 acres at the 610 ft pool and 3600 acres at the 620 ft pool. Reservoir depths would be 60, 70, or 80 ft for each respective pool.

The natural temperatures of the Allagash and St. John Rivers would influence the impoundment's thermal regime. Both streams are subject to extended periods of warm, low flows during summer and early fall. As a result, Lincoln School Lake would tend to be a warm water body during summer and would probably be weakly to moderately stratified by surface heat exchange processes. The short detention time, the hydraulic gradient along the pool's length and the daily withdrawal from the bottom outlet gates will act to prevent strong thermally induced density stratification. The lake is expected to be well oxygenated throughout its depth and will have other water quality characteristics reflecting the quality of the influent streams which presently meet State water quality standards.

Future water quality studies would be accomplished to assess the potential development of the reservoir as seasonal coldwater and/or year round warmwater fishery.

Creation of the reservoir would shift the present stream-associated plants and animal species to those associated with standing water habitat.

As discussed in section 5.06, the project would be operated run-of-the-river during most operating times. Pool fluctuations would be minimal or non-existent when streams flows fall below 1000 cfs and hydropower

operations are shut down. When the flows are above this value, there may be some storage regulation for limited daily and weekly load fitting operations depending upon the available flows. Although the upper 10 ft. of the reservoir would be available for regulation, pool elevations would likely flucturate 1-2 feet on a daily basis and up to 3-4 ft. on a weekly basis. Such fluctuations would create a periodically inundated zone (PIZ) around the perimeter of the proposed reservoir. This fluctuation combined with wave action and ice scour during winter would cause instability or erosion along exposed shoreline areas. Such instability would limit the establishment of shoreline plants and animals which could provide habitat and forage for fish. The area of the PIZ at dependent upon the pool elevation. Assuming a maximum fluctuation of 4 ft., a 160 acre area would be expected with the 600 ft. power pool, a 220 acre area with 610 ft. pool and 440 acre area with 620 ft. pool.

The quality of the downstream riverine environment would be dictated by releases from the dam. Temperatures and dissolved oxygen levels would be similar to the reservoir inflows except during the summer. Bottom withdrawal of the midly stratified lake during summer would release slightly cooler and less oxygenated waters than those of the inflows. Daily operation would vary downstream flows from zero to one or two feet on the average with fluctuations up to five feet during occasional peaking operations. The species composition and diversity of the downstream plants and animals associated with the St. John mainstem and its banks would be altered by such changes. Elimination of intolerant species and lowering of community diversity would be most marked near the dam site and decrease further downstream.

To maintain indigenous downstream aquatic organisms during times of the year critical to their survival and maintenance, the U.S. Fish and Wildlife Service has recommended in their 29 October 1982 Planning aid letter minimum releases of 2562 cubic feet per second (CFS). Future water quality studies would incorporate an instream flow analysis to determine if operational modes can accommodate this recommendation, or what minimum downstream releases would be consistant with project purposes.

The U.S. Fish and Wildlife Service has indicated that private clubs in Canada may introduce Atlantic salmon above the downstream historical barrier of Grand Falls, New Brunswick. The Corps would investigate the need and feasibility of providing passage ways should this occur.

Terrestrial Ecosystem:

The St. John River Basin upstream of the Lincoln School site is covered with nearly 2.5 million acres of second growth forest interspersed with wetlands, agricultural land and shrub land. Table F-2 indicates the acreages and percentages of each general cover type within the maximum impoundment area. The forest consists primarily of the softwoods, red spruce and balsam fir, and softwood - northern hardwood mixtures with small stands of northern hardwoods and poplar-birch associations. Much of

the forest acreage is commercially harvested and/or leased by private industry and land companies. Wetlands in the project area consist of seasonally flooded flats and shrub swamps. The streamside habitat supports a variety of rare and unusual plants. Most notable is the Furbish Lousewort (Pedicularis furbishiae) which is currently on the Federal Endangered Species List.

Table F-2. Relative Area of Existing Cover Types in Project Area

COVER TYPE	ACREAGE	PERCENT OF TOTAL
Forest	1368	63.1
Shrubland	314	14.5
Agricultural Land	193	8.9
Wetland	172	7.9
Structural	122	5.6
Total Land	2169	100.0

The project area also provides habitat for a diverse community of northeastern mammals, birds, reptiles, amphibians, and invertebrates. White-tailed deer is the most intensely managed wildlife species. The white-tailed deer is at the northern limit of its geographic range. Winter survival is dependent on the availability and quality of deer wintering habitat or "yards". Land owners cooperate with the State of Maine to manage their forestry practices to maintain or improve deer habitat. The Maine Department of Inland Fisheries and Wildlife indicated that the streamside deer yards along the Little Black River are of good quality and are generally heavily used by deer.

Table F-1 indicates that the reservoir would inundate 560 acres of forests at the 600 ft. elevation, 824 acres at 610 ft. elevation and 1368 acres at the 620 ft. elevation, NGVD. Softwood and softwood-hardwood mixed stands comprise the largest portions of those acreages. Inundation would be generally limited by the steepness of the valley walls on the lower portion of the impoundments. The 620 ft. impoundment would inundate wetland habitats along the lower five miles of the Little Black River where the topography is very gradual. About one and a half miles would be inundated under the 610 ft. pool.

Riparian habitat which supports Federal and State designated rare plants would also be inundated upstream and downstream of the dam site. These areas support populations of the Federally listed Furbish lousewort. Formal consultation with the U.S. Fish and Wildlife Service would be required under Section 7 of the Endangered Species Act. Mitigation measures similar to that generated for the Dickey-Lincoln School Lakes Project would be developed.

Impacts to wildlife generally would be proportional with the acreages of inundated terrestrial habitat shown in Table F-1. Upon inundation,

wild life would perish or move to adjacent lands. This displacement of survivors would put increased pressure on existing populations which are already fully utilizing the availble habitat.

The U. S. Fish and Wildlife Service has evaluated the lost habitat using its Habitat Evaluation Procedures for each pool elevation. The annual loss or gains are indicated in Tables 2-4 of their 29 October 1982 letter exhibited in Appendix D. According to their analysis total annualized habitat aggregate to 4509 acres for the 600 ft. pool, 6525 acres for the 610 ft. pool and 9977 acres for the 620 ft. pool, NGVD. These figures are preliminary and further study would be required to determine acceptable levels of mitigation.

Of particular concern is the loss of deer wintering habitat which is critical for over winter survival. Based on available information provided by the State of Maine, no deer yards would be inundated by the 600 ft pool, about 4 acres by the 610 ft pool and about 126 acres by the 620 ft pool. These areas occur on either side of the lower portion of the Little Black River. Mitigation of these losses would also require acquisition of lands for enhancement of deer carrying capacity through timber management practices. Again, detailed analyses would be conducted at a later stage of planning in cooperation with State and Federal resource agencies should further study be directed.

Recreational Resources:

The upper St. John River is one of the longest segments of free flowing, near wilderness rivers in the northeastern United States. Significant recreational opportunities in the area include canoeing, fishing, hunting and wilderness camping.

A major white water canoeing reach of the St. John River mainstem is described by the 1971 "Appalachian Mountain Club's New England . Canoeing Guide" as a two mile stretch located about 2 miles upstream of its confluence with the Little Black River. Creation of the reservoir would eliminate stream canoeing along the impounded portion of the St. John River mainstem. The degree of impact would be relative to the inundated stream miles listed in Table F-1 for each pool elevation. The 600 ft. elevation pool would not inundate the Big Rapids. The 610 ft. pool would inundate approximately 2000 ft. of the rapids generally in the more gentle portion at the foot of the rapids. The 620 ft. pool would inundate approximately 3000 ft. of the rapids with 1000 ft. being in the steeper portion.

The impoundments would reduce access to stream fishing by the number of inundated stream miles indicated in Table F-1. The significance of this impact is reduced because the impounded mainstem does not offer good brook trout adult holding area during summer and offers marginal streamside access for anglers on the steep banks above the dam site. Also, the creation of the lake fishery may partially offset the loss of the stream

fishery in terms of fishing use. Stream brook trout fishing above the impoundment would remain popular and would not be affected by the project.

Hunting opportunities would be reduced by the loss of habitat. However, the hunting "supply" would continue to exceed demand and therefore no significant changes in utilization of project land would be expected.

About three campsites occur within the Lincoln School project area. The more commonly used site is operated by the Town of Allagash and is located at the foot of Big Rapids near the confluence of the mainstem and Walker Brook. This site may be encroached by the 620 ft or 610 ft pools, NGVD. The other two sites are located downstream and would be eliminated by all pool elevations. Loss of the three sites would not have a significant effect on the camping use of the project area.

Transmission Facilities:

The new Lincoln School power substation would be connected with two existing substations by construction of above-the-ground transmission lines. An 18 mile long 69 kilovolt (kv) line would be connected at Fort Kent, Maine and by a 40 mile long 138 kv line at Edmundston, New Brunswick. Impacts associated with the lines would ultimately depend upon the corridors chosen. Although use of existing rights of way would be pursued as much as possible, there could be crossings of sensitive aquatic, wetland and terrestrial habitats.

Crossings of aquatic habitat usually involve increased sedimentation from construction activities, increased stream temperatures due to removal of bank vegetation and herbicide runoff from maintenance activities.

Crossings on land would require clearing of about 100 ft. corridor of vegetation throughout the length. This could remove significant or rare plants or alter their habitats. The clearing generally may have positive and negative effects on resident wildlife, depending upon the species. The clearing would create edge habitat which could increase general wildlife diversity and productivity. Clearing may also enhance movement and dispersion of isolated populations. A significant negative effect would be the removal or fragmentation of significant habitat.

Specific impacts would be identified and assessed when the corridors are chosen. Appropriate mitigation measures, if necessary, would be developed at that time.