FISHWAY PASSAGES

SEPTEMBER, 1983

THE UNIVERSITY OF NEW HAMPSHIRE · 1923 ·

DEPARTMENT OF CIVIL ENGINEERING

COLLEGE OF ENGINEERING & PHYSICAL SCIENCES

University of New Hampshire

FISHWAY PASSAGES

SEPTEMBER, 1983

SUBMITTED BY

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INTRODUCTION

This project investigated the existing and potential usage of the Denil Fishway on New Hampshire rivers and streams and developed for the Town of Exeter a FERC Exemption Package on two sites along the Exeter River. Part 1 of this report identifies those characteristics of the Denil Fishway perteinent for a passageway installation at a hydropower generating site. The data is presented to be used as an aid for perspective hydropower developers. The information can serve as reference material for preliminary hydropower feasibility studies. The information also serves to acquaint a developer with the ecological parameters associated with the migration of fish up New Hampshire rivers and streams. To assist a developer in laying out a hydropower generating site details of a typical Denil Fishway are shown on a construction drawing.

The second part of this report is a FERC Exemption Package with supporting drawings. A Denil Fishway passage is installed at each of the two sites covered by the Exemption. The poor performance of the Denil Fishway at the Exeter Dam stimulated the interest in this study. Personnel at the Federal Fish and Game Department will assist the Town of Exeter's engineers in determining the final design details of the interface between the selected hydropower hardware and the passageway intake. Final design of the hardware will not be determined until a developer has been selected. The Town of Exeter can proceed in the development of the two sites by submitting the Exemption Package to FERC.

PART 1

DENIL FISHWAY PASSAGEWAYS

FISHWAY PASSAGES

Hydropower has recently become a rapidly growing source of energy in the New Hampshire area. Hydropower is not new to the area, the recent interest, is in the renovation of sites that were abondoned 20 and 30 years ago. Dams were first introduced in many New Hampshire rivers in the early 1700s which terminated the migration of fish. The State and Federal Fish and Game Departments are using this renovation period to return migratory fish to selected rivers and streams. The State Fish and Game Department has designated in the past 15 years certain rivers and streams in New Hampshire for the migration of fish. They have also selected the Denil Fishway passage for use at all low head hydopower sites. The Denil fishway is an inclined concrete passageway which attracts fish by it's discharge of water. The fishways are designed to allow selected fish to migrate upstream to spawn. New Hampshire presently has many active fishways along four major river basins. There are many parameters associated with the design of the Fishway to meet site requirements. Fish and Game Department personnal assist hydropower developers in determining final design parameters. The purpose of this report is to familiarize a low-head hydro developer with the Denil Fishway passage and to give cost estimates which can be used for preliminary economic studies.

1.0 HISTORY

There are twenty-two fishways along the New Hampshires lakes and streams. The map developed by the U.S. Fish and Game Department shows the locations of these fishways as well as which species of anadromous fish pass through each fishway. To introduce fish back into the rivers the New Hampshire Fish and Game Department runs eight hatchery and rearing stations which, with the aid of federal hatcheries in Massachusetts and a state hatchery in Maine, stock N.H. lakes and streams with trout and salmon. The Fish and Game's 1981 annual report gives a detailed list of fish stocked by county. The Brook, Rainbow, and Brown trout as well as the Land-locked and Coho salmon make up the largest percent of fish stocked in N.H. (see Table 1).

2.0 FISH PARAMETERS

The major purpose of a fishway is to assure the passage of fish up river to spawn. Therefore it is relevant to design a fish ladder applicable to the needs of the fish using it. By varying degrees, fish are sensitive to changes within their environment. Changes in the velocity, temperature, light intensity, depth, contamination, oxygen levels, sound, and water pressure can affect fish behavior and in turn can affect the success of a fish ladder. Thus it is important that a fishway be properly designed.

2.1 SWIMING SPEEDS

The swimming speeds of fish must be considered when developing fishways, as fish must be able to adapt to water velocities incurred by a dam and it's fishway. Fish swim at three primary speeds; cruising, sustained, and darting speeds. Cruising speed can be maintained for long periods of time, and is used in the migration process, while sustained speeds can only be maintained for several minutes, and used when passages may be difficult, sometimes due to turbulent waters. Darting speed refers to a single effort used mainly for capturing food and as a means for escape. Swimming speeds can change with the oxygen level and temperature of the water.

TABLE 1

LIBERATION OF PRIMARY FISH IN NEW HAMPSHIRE STREAMS

County	Rainbow Trout	Brown Trout	Brook Trout	Coho Salmon	Atlantic Salmon	Chinook Salmon
Belnap	6,500	2,700	21,340			
Carroll	18,462	2,000	34,250			
Chesire	3,950	5,300	12,905			
Coos	52,250	14,450	153,525			
Grafton	18,292	6,800	75,595		35,000	
Hillsboro	21,100	10,200	64,545			
Merrimack	22,000	9,400	37,240			
Rockingham	29,700	8,200	37,105	266,537		97,957
Strafford	5,400	500	18,850			
Sullivan	8,750	4,100	18,525			
TOTAL	186,404	63,650	473,880	266,537	35,000	97,957

2.2 FLOW VELOCITY

Fish are very sensitive to changes in water velocities. Most fish by instinct travel upstream in the river's strongest current, as calmer water hints to a divergence from the main course of the river leading upstream. Thus the water emitted from the mouth of the fish ladder must be strong enough to lure fish into the ladder. A significant change in velocity may effect the efficiency of the fishway passage. Fish traveling at one velocity may refuse to enter water whose velocity differs from theirs, whether it be faster or slower. It is therefore important to make velocity transitions smooth, to prevent fish from refusing to enter areas of fast moving water. Some adult fish seek higher velocities where obstructions are present (if the water velocity is below darting speed). The water velocity in any fishway passage must be kept well below darting speeds to allow successful fish passage.

2.3 TEMPERATURE

Temperature changes due to man-made obstructions can also affect fish migration. Adult fish may either stop migrating or die if subjected to extreme temperatures. Fish have a certain level of tolerance in which they can survive. A substantial deviation from this tolerance can lead to death. There is presently no evidence as to whether fish avoid warmer or colder water which is within their tolerance range. There is evidence that fish do avoid high temperature areas which approach their tolerance level. Fish which are exposed to high temperatures within their tolerance level for long periods of time may move to higher temperatures more willingly than fish which are exposed to cooler temperatures for a long period of time. This form of conditioning may be useful when fish ladders are designed. Table 2 shows the upper, lower and preferred tolerance levels of various fish.

Table 2 Temperature

Fish	Preferred	Lower Lethal	Upper Lethal	Minimum Dissovl. Oxygen	Optimum Ph Level
Brook Trout	47-52	32	77	4 ppm	5-9
Rainbow Trout	54-66	32	85	4 ppm	5-9
Brown Trout	40-70	32	75	4 ppm	5-9
Coho Salmon	40-60	32	80	3 ppm	5-9
Chinook Salmon	45-58	32	77	3 ppm	5-9
Land-Lock Salmon	40-70	32	75	4 ppm	5-9

2.4 LIGHT INTENSITY

Forms of artificial guidance which coinside closely to natural guidance mechanisms are used in guiding fish in their trek upstream. Light intensity is one such factor. Whether it be the sun or artificial lighting, fish tend to avoid light at high intensities, moving toward lower intensities, such as shaded areas. Artificial barriers are also used to guide fish into specified areas. Fish may become conditioned to certain stimuli over a period of time. Thus artificial barriers and slight noises caused by dams may not have a large effect on fish over a long period of time. Changes in depth and pressure may cause fish to avoid cetain areas, but it is difficult to say which stimuli has the greatest effect on fish as it depends on what the fish have become accustomed to.

2.5 OXYDATION

Stream oxyidation and Ph levels must be within certain ranges in order to maintain fish life. The accepted minimum level of dissolved oxygen is 5 ppm (parts per million), while the best level is near saturation. There is danger if fish remain in water that is supersaturated with nitrogen, as it may cause death. No specific Ph level has been determined, but it is recommended to that it remain between 6.7 and 8.3.

3.0 FISHWAY DESIGN

All aspects of a pre-existing dam are considered in order to design a fishway best suited for that particular site. Table 3 refers to a list a dam parameters needed to design a fishway. Fish & Game Department personnal design fishways with the information provided in the list.

All fishways in New Hampshire are of a similiar design due to the similiarity in their existing dam construction. The general type is the Denil Fishway passage. A fish ladder allows fish to jump the height of the dam by means of successive smaller jumps through pools of turbulent water along an inclined passageway. The enclosed blue print illustrates a typical design for the Denil Fishway.

TABLE 3 SUMMARY OF PERTINENT PROJECT DATA

1. Site Specifications

Location -	
Owner -	
Year Constructed (Dam) -	
Year Constructed (Powerhouse) -	
F.P.C. License Application Number -	
Drainage Area -	(sq. miles)
Average river discharge -	(cfs)
River miles above mouth -	(miles)
Next upstream dam -	
Dam type -	
Dam height -	(ft)
Normal headwater elevation (full pond) -	(ft)
Normat tailwater elevation -	(ft)
Gross operating head -	(ft)
Spillway control -	
Tailrace channel length -	(ft)
Reservoir length -	(miles)

2. Power Generation Data

Type of plant -	
Powerhouse location -	
Powerhouse length -	

Installed Capacity

Number of units -	
Nameplate generating capacity -	(kilowatts)
Normal plant discharge -	(cfs)
Turbine type -	
Turbine runner elevation -	(ft)
Generating capacity (each unit) -	(kilowatts)
Turbine flow (each unit) -	(cfs)

3. Existing Fish Passage Facilities

3.1 DENIL FISHWAY

The Denil Fishway systems consist of four primary elements:

1) Retention Pool
2) Fish Ladder
3) Dam Structure
4) Control Gates

The New Hampshire Fish and Game Department uses a typical design for each of the four components. However, the design details of each are very much site specific. Explanations and descriptions of the elements and cost ranges are presented to assist hydropower developers in preparing project cost estimates. The State and Federal Fish and Game Department personnel assist Hydropower developers in the final design and approval of fishway systems (see Table 4).

3.2 RETENTION POOLS

Retention pools are normally required to augment the entrance flow to fishways. A retention pool is a small pool of water between the downstream face of the main dam and a small downstream dam (i.e. retention pool dam). Normally the fishway discharge flow is only a fraction of the stream flow. The retention pools are designed to control the transition zone between the stream and the discharge flow at the entrance to a fishway system. Attraction to the entrance is achieved by placing the entrance at the upper most reach of the navigable stream and by establishing a flow at the system entrance that is equal to or slightly greater then the natural stream flow.

Fish navigate upstream by sensing the direction of the strongest upstream current. They always seek an upstream position, they will not travel downstream to seek a new upstream path.

Normal elevations for retention pools range from 1 to 4 feet. Stop logs are placed in the retention pool dam for controlling the pond elevation. The most effective location in the retention pool for the entrance to the fishway passage is along a shoreline.

TABLE 4

PROPOSED FISH PASSAGE FACILITIES DESIGN PARAMETERS

1. Design Population (number/species)

2. Upstream Migrant Facilities

A. Fish Collection Facility (Drwy #)

Location -	
Number of fish entrances -	
Gated fish entrance width -	(Tailrace)
-	(Spillway)
Entrance gate type -	(Tailrace)
-	(Spillway)
Entrance jet velocity range -	(fps)
Total attraction flow -	(cfs)
Auxiliary water source -	
Flow diffusion chambers -	
Diffusion chamber exit flow velocity -	(fps max.)
Diffusion chamber grating size -	(in)

B. Fishway (Drwg #)

Number required -	
Type -	Denil

Fishway Operating Range

Maximum headwater elevation -	(ft)
Minimum " " -	(ft)
Maximum tailwater elevation (Tailrace) -	(ft)
Minimum " " " -	(ft)
Trash rack at fishway exit (Spacing) -	(in)

Miscellaneous (Counting device, Stop PLanks, Saftey railings, access ladders)

3. Downstream Migrant Facilities

* If subsequent turbine studies indicate a high rate of injury and/or mortality to downstream migrants protection devices must be designed.

If the entrance is located at the shoreline, the attraction outflow should approximate 3% of the adjacent discharge from either a spillway or bay area. At small projects, 3% of the average annual stream flow during the time of fish passage should provide adequate attraction flows. If the fishway can not supply this quantity, the flow would have to be supplemented from the hydropower discharge. Placement of a small hydropower discharge in the vicinity of a fishway entrance may sufficiently augment the attraction flow. Attraction problems can frequently be minimized by also manipulating the turbine discharge to obtain the best conditions at the fishway entrance or to lead the fish to the fishway entrance.

At low head installations vertical temperature gradients within a pool servere enough to inhibit fish movement is not likely. However it is best to have the water temperature of the fishway passage water the same as the upstream river temperature where the fish enter from the fishway passage. Entrance attraction velocities should be commensurate with the fish's ability to swim and should not exceed the sustained speed, but may equal as much as twice the cruising speed. Typical entrance velocities range from 4 to 8 ft/s. For purposes of design, it may be assumed that fish will requre 2.5 to 4 min to pass through a vertical foot of fishway system.

3.3 FISH LADDER

The design of a typical Denil Fishway passage as shown on the enclosed blue print can be used for estimating and for material takeoffs. The average cost for the Denil Fishway is in the range of $4,000.00 per vertical foot of passage. This includes the retention pool, thus the cost estimate should only be used as very preliminary estimate. The Denil Fishway also requires a good maintenace program. The relationship of the baffle to the open area is critical. The open area tends to accumulate deris which must be continuously removed for the fishway to remain functional. The annual operating and maintenance costs for a Denil Fishway ranges between 2 to 3% of the unit cost.

3.4 DAM AND GATES

The retention dam and gates are shown on the drawing. The length, height and location of the dam is site specific. A cross section of a typical dam is given. The gates/stop logs at the dowstream end of the passage are shown. Flow control gates at the upstream end of the passage are not shown, these are site specific. The State Fish and Game personnal maintain the fishways during the migratory season, this includes the management of the gates.

4.0 FISH MIGRATION

Table 5 lists the time of migration of some of the fish in N.H.. The ladders operate as early as March and April and are monitored until migration ceases due to high water temperatures. The ladders can then be closed until the fall months when migration resumes, until the water becomes too cold then the ladders are closed again. There is no exact time requirement for the ladders to be running, as it depends on the particular season and the migration patterns of the fish. Fish ladders in N.H. are checked daily during the spring and fall months when migration is the heaviest.

TABLE 5 MIGRATION

Fish	Migratory	Time of Migration	Time of Spawning
Brook Trout	NO	--	Sept-Dec
Rainbow Trout	NO	--	April-May
Brown Trout	NO	--	Oct-Dec
Coho Salmon	YES	Sept-Jan	Sept-Dec
Chinook Salmon	Yes	Oct-Dec	Oct-Dec
Land-Lock Salmon	YES	Oct-Dec	Oct-Dec

5.0 COST ESTIMATES

The cost of building and maintaining a fishway at a small scale hydroelectric site varies from site to site. The cost includes developing, design, construction, and operating costs. Environmental factors including weather conditions, flood precautions, and accessability must also be considered. Figures given by the New Hampshire Fish and Game Department reveal cost estimates for the New Hampshire area to be approximately $4000.00 per vertical foot. A major part of the operating cost is incurred by the cost needed to supply attraction water to the fishway. The cost of this water supplied by gravity is determined by it's power value, had it gone through the generating system. Attraction water at 10 cubic feet per second supplied by an existing river with a 10 foot head, for three months, would figure to be a $1800 loss in power value, or the cost of operating a fishway.

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   February 1973

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   Number AD/A-006-404

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   Recieved through;
   Natinal Technical Information Service (NTIS)
   U.S. Department of Commerce
   Number ORNL/TM-7396

3) 1981 Annual Report - Division of Inland and Marine Fisheries, New Hampshire Fish and Game Department.

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5) Biological Survey of the Lakes and Ponds in the Sullivan, Merrimack, Belnap and Strafford Counties. New Hampshire Fish and Game Department, Bernard W. Corson - Director Survey Report # 8b Concord New Hampshire.

6) Biological Survey of the Lakes and Ponds in the Chesire, Hillsboro, and Rockingham Counties. New Hampshire Fish and Game Department, Bernard W. Corson - Director Survey Report # 8c Concord, New Hampshire.

PART 2

APPLICATION FOR EXEMPTION

Part 2 FERC Exemption Package

A FERC Exemption package was prepared for the two Exeter dam sites a) the Pickpocket and b) the Exeter. The package has been submitted to seven state and federal agencies. To date four have submitted approvals. The Water Resources Board and the State and Federal Fish and Game Departments will be receiving an update to the original application package reflecting the results of this study. A copy of the proposed penstock location at the Exeter River Dam will be submitted to Mr. Ben Rizzo of the United States Department of the Interior Fish and Wildlife Service for review. As part of this project the problems the State Fish and Game Department have had at the Exeter Dam site were discussed with him.

It is recommended that the Town of Exeter submit the Exemption Application package to FERC. Once the exemption has been granted the town will have the right for two years to initiate hydropower development on the sites. If construction is not initiated within the allocated time the exemption will be void. During the two year period however, no other developer can file on the site with FERC. Once construction is completed the town will have the right to generate hydropower for the duration of the exemption, 50 years. The Town will be in a position to desseminate RFP's once the exemption has been awarded. It is recommended that the Town Selectman establish a committee to oversee hydropower development in Exeter.

APPLICATION FOR EXEMPTION OF TWO SMALL HYDROELECTRIC POWER PROJECTS
FROM LICENSING

1. Applicants full name and address:

The Town of Exeter, N.H.
10 Front Street
Exeter, New Hampshire 03800
Atten: Charles H. Goodspeed, P.E.

2. Location of Projects:

	Exeter Dam	Pickpocket Dam
State	New Hampshire	New Hampshire
County	Rockingham	Rockingham
Town	Exeter	Exeter
Stream	Exeter River	Exeter River
State #	82.01	29.07

3. Project description and proposed mode of operation:

Existing Facilities

The two Exeter, N.H. hydroelectric projects are located on the Exeter River, dam 82.01 "Exeter Dam" is located at the entrance to the Squamscott River and dam 29.07 "Pickpocket Dam" is located approximately 5 miles upstream from dam 82.01. Both dams are located in the town of Exeter. The Pickpocket Dam is on the Exeter-Brentwood town line. The sites consist of all properties, water and flowage rights all of which were conveyed to the Town of Exeter in 1981 by Clemson-Milliken Fabrics, Inc.

Dam 82.01 The existing dam is a reinforced concrete gravity structure founded on ledge with an overall length of 140 feet with a 111 foot spillway and a hydraulic height of 9 feet. Approximately fifty feet downstream from the Exeter Dam and at a crest elevation 9 feet below the Exeter Dam crest is a second reinforced concrete gravity structure with a hydraulic height of 3 feet, constructed for a retention pool. Four foot long stoplogs are used in the structure to allow for retention pool control.

The Exeter Dam was built in 1914, rehabilitated in 1938 and extensively rehabilitated in 1968. The dam was inspected under Phase I of the National Dam Inspection Program early in 1977. The dam, classified as small in size, was recorded as being in good condition. The Exeter Dam commands a drainage area of 102.7 square miles with a normal pond area of approximately 36 acres (at the spillway crest elevation of 36.5 MSL) and a normal storage capacity of 545 acre feet. The 111 foot long spillway has a flood discharge capacity of 2000 cfs. The remainder of the dam consists of an intake structure leading to a 7 ft high by 14 ft wide reinforced concrete penstock, a spillway gate and a fish ladder. The Town of Exeter maintains the fish ladder under the rules established by the New Hampshire Fish and Game Department. These rules will continue to be followed when the hydro-electric retrofit is in operation. The approximately 2000 ft long penstock has been sealed off and two taps installed: (a) a nine inch diameter pipe running into a mill building, however the new mill ownership will not have the rights to the water for manufacturing processes but only for fire protection, (b) a four inch diameter pipe at String Bridge used to gravity fill fire apparatus. The intake apparatus, wheel and gear controls for two equal sized wooden penstock gates and trash rack, are in good working condition.

The existing spillway gate is a four foot six inch by five foot wooden gate with wheel and gear control. The existing gate is in good working condition.

Dam 29.07 - The existing dam is a reinforced concrete gravity structure founded on ledge with an overall length of 234 feet, with a 130 foot spillway and with a hydraulic height of 8 feet. Three foot flashboards were used on the dam. The dam was inspected in 1977 and was classified in good condition. Approximately 30 feet downstream from the Pickpocket Dam at a crest elevation 8 feet lower is a reinforced concrete gravity structure with a hydraulic height of 3 feet, constructed for a retention pool. Four foot long stoplogs are used in the retention dam to allow for pool control.

Dam 29.07 commends a drainage area of 86.2 square miles with a normal pond area of approximately 22 acres (at spillway crest elevation of 103.8 MSL) and a normal storage capacity of 350 acre feet. The 130 foot long spillway has a flood discharge capacity of 2400 cfs. The remainder of the dam consists of a stone faced earth embankment, a fish ladder and a spillway gate. The spillway gate is in good working order. The gate mechanism and trash racks are in good operating condition; adaptation of the gate orifice will be done to accept a penstock per final plans. The fish ladder is maintained in a similar manner by the Town of Exeter and the rules will continue to be followed when the hydro-electric retrofit is in operation.

Proposed Development Plan

The Exeter plan will use similar turbine/generator sets with an installed capacity of approximately 160 kilowatts at each site. The turbines will be tube type having a head range from 6.56 feet to 14.4 feet with a design head of 10.83 feet at a design flow of 187 cfs. The yearly average flow at the Exeter Dam is approximately 160 cfs. The yearly average flow (i.e. October through June) exceeds 200 cfs. The average flows at the Pickpocket Dam are slightly smaller, however for economic reasons similar turbine generator installations will be used at both sites. Penstocks will be installed from the dam spillway gates to a discharge hole below the retention dam. (see figure 1). Some excavation of the river bed will be required for the tail race. No fill will be placed in the river only a small amount of excavation will be required for the discharge. Construction will be performed during the dry season at which time all the dam discharge water will be diverted through the fishladders and by removing the stoplogs in the retention.

The selected turbines will operate at 250 rpm. The turbines will be directly connected to a three phase, synchronous run generator rated to match the turbine.

The installation of direct drive low speed generators will provide high reliability and eliminate the losses incurred through the use of speed increases.

The Exeter sites will operate under a run of river mode with net operating heads of approximately 10 feet. The sites will be fully automated and controlled by a Digital Processing Unit (DPU). The DPU, in addition to providing automatic synchronizing, generator field control, and water flow (gate) control will also monitor the following parameters.

WITH BREAKER CLOSED

- Line Volts
- Line Voltage Balance
- Watts, VARS
- Frequency
- Shaft RPM
- Fields Amps

WITH BREAKER OPEN

- Line Volts
- Line Voltage Balance
- Voltage Differance across Breaker
- Shaft RPM

Protective relays (overcurrent, generator field and stator ground, over temperature etc.) will also be incorporated in each system. A site manager will check the installations daily, and will respond immediately in the event of an alarm. Power output will be continuously recorded and furnished to the Public Service Company of New Hampshire for system monitoring.

The total output per site (estimated at 600,000 KWH per year) will be sold to the Public Service Company of New Hampshire in accordance with the New Hampshire law governing the sale of energy under the Limited Electrical Energy Producers. Act (LEEPA).

The total project costs are estimated at $105,000 per dam. Charles Goodspeed is acting as the Town's agent in developing the projects.

4. No lands of the United States are affected by the remodeling of the Town of Exeter hydroelectric sites.

5. The entire output will be sold to the local franchised utility (the Public Service Company of New Hampshire) in accordance with New Hampshire laws governing sale by limited electrical energy producers, for distribution to its customers.

6. Construction of the projects is planned to start in the first dry season (summer) immediately following the issuance of the exemption by the Commission and are scheduled to be completed within eighteen months from the issuance of the exemption.

7. Environmental Report

The approximately 103 square miles of watershed consists primarily of fields, wooded hills and natural swamps. The project would in no way affect these areas as the dams are in place and the project will be operated intermittantly as a run of the river operation.

The ponds behind both dams provide fishing for many citizens. The imponded water behind Dam No. 82.01 serves as the Town of Exeter's fire protection, drinking water and Philips Exeter's heating system (for water circulation only). There is one commercial building that is effected each spring by the seasonal high water in the river, this project will have no effect on these conditions. These uses of the river water will not be subjected to any ill effects as a result from the two turbine-generator installations. Ducks and other birds are visible in the area. The vegetation is limited to grass, pine trees, hard maple trees, oak trees, poplar trees and alders. The proposed hydro operations would not affect the quality of the river as the project would be operated as a run of the river operation.

Dear :

The Town of Exeter is planning two small scale Hydro-electric projects on the Exeter River in Exeter, New Hampshire. The projects are on the Exeter Dam, State No. 82.01, and the Pickpocket Dam, State No. 29.07. The construction of the two dams is concrete and were classified in 1977 as being in good condition. Each dam has a concrete fish ladder operated by the Town of Exeter under the rules and regulations of the New Hampshire Fish and Game Department.

The feasibility study conducted by the Town Planning Office and the University of New Hampshire (Prof. Chalres H. Goodspeed, Department of Civil Engineering) indicated an economically feasible generating capacity in the range of 100KW to 150KW for the Exeter Dam. The Pickpocket Dam is within 3 miles upstream thus has approximately the same Flow Duration curve, since both dams have nearly the same head and flow similar equipment will be installed at both locations. The turbines will be installed at the erosion dams to utilize the total available head. The installations will be operated intermittantly as run of river plants.

The Town of Exeter is preparing to file for Exemptions on each dam through a single application package, the Town solicits your input as required by the Federal Energy Regulatory Commission.

Sincerely yours,

Charles H. Goodspeed, P.E.
Town Ageny, Hydro-electric Projects

State of New Hampshire
Water Resources Board
37 Pleasant Street
Concord, N.H. 03301

The State of New Hampshire
Water Supply and Pollution Control Commission
Hazen Drive - P.O. Box 95
Concord, N.H. 03301

New Hampshire Department of Resources
and Economic Development
P.O. Box 856
Concord, N.H. 03301

State of New Hampshire Fish and Game Department
Box 2003
34 Bridge Street
Concord, N.H. 03301

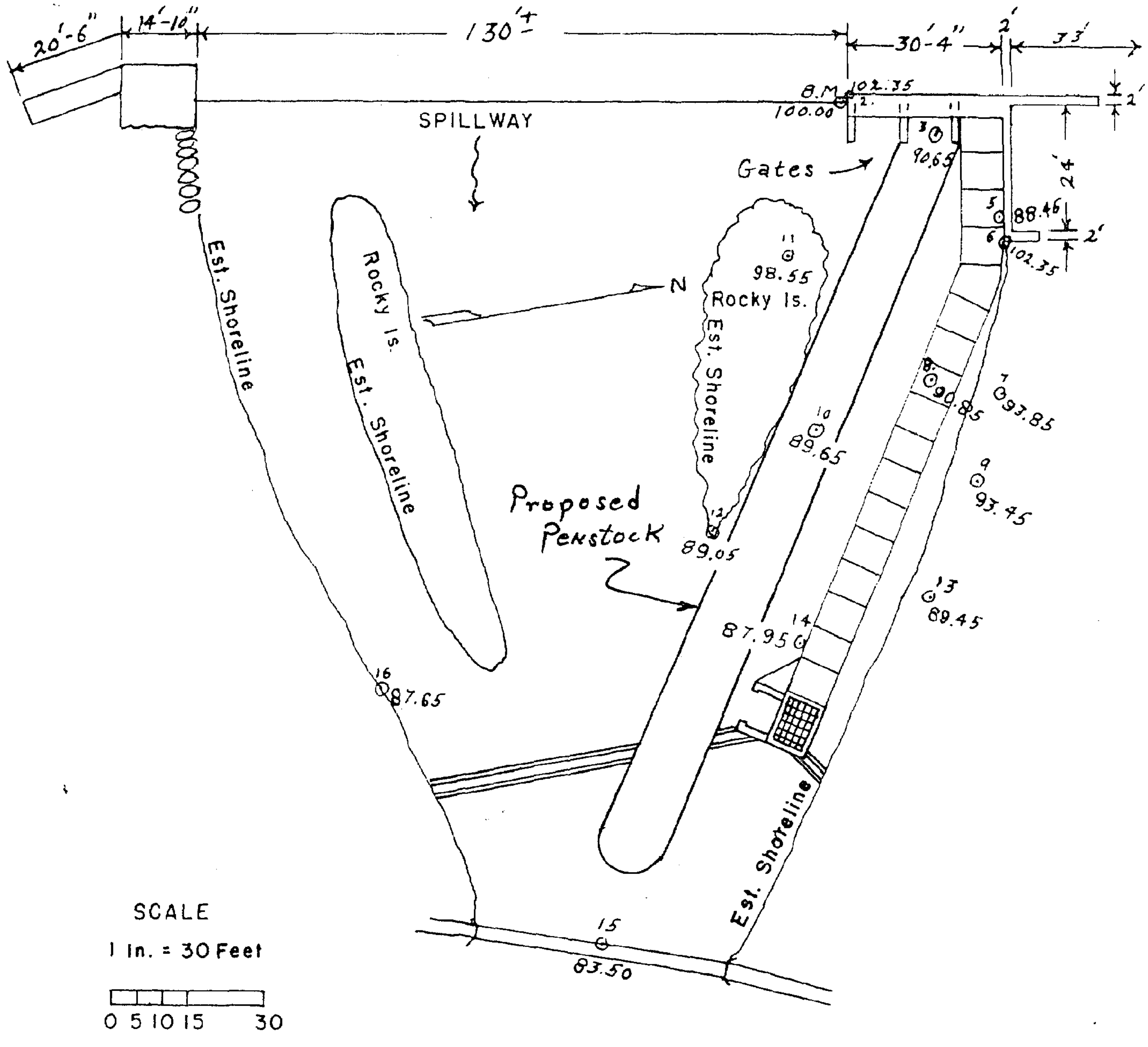
United States Department of the Interior
Fish and Wildlife Service
Ecological Services
P.O. Box 1518
Concord, N.H. 03301

United States Department of the Interior
Office of the Secretary
Washington, D.C. 20240

United States Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Service
Services Division
Habitat Protection Branch
7 Pleasant Street
Gloucester, MA 01930

FIGURE 1 PENSTOCK LOCATIONS

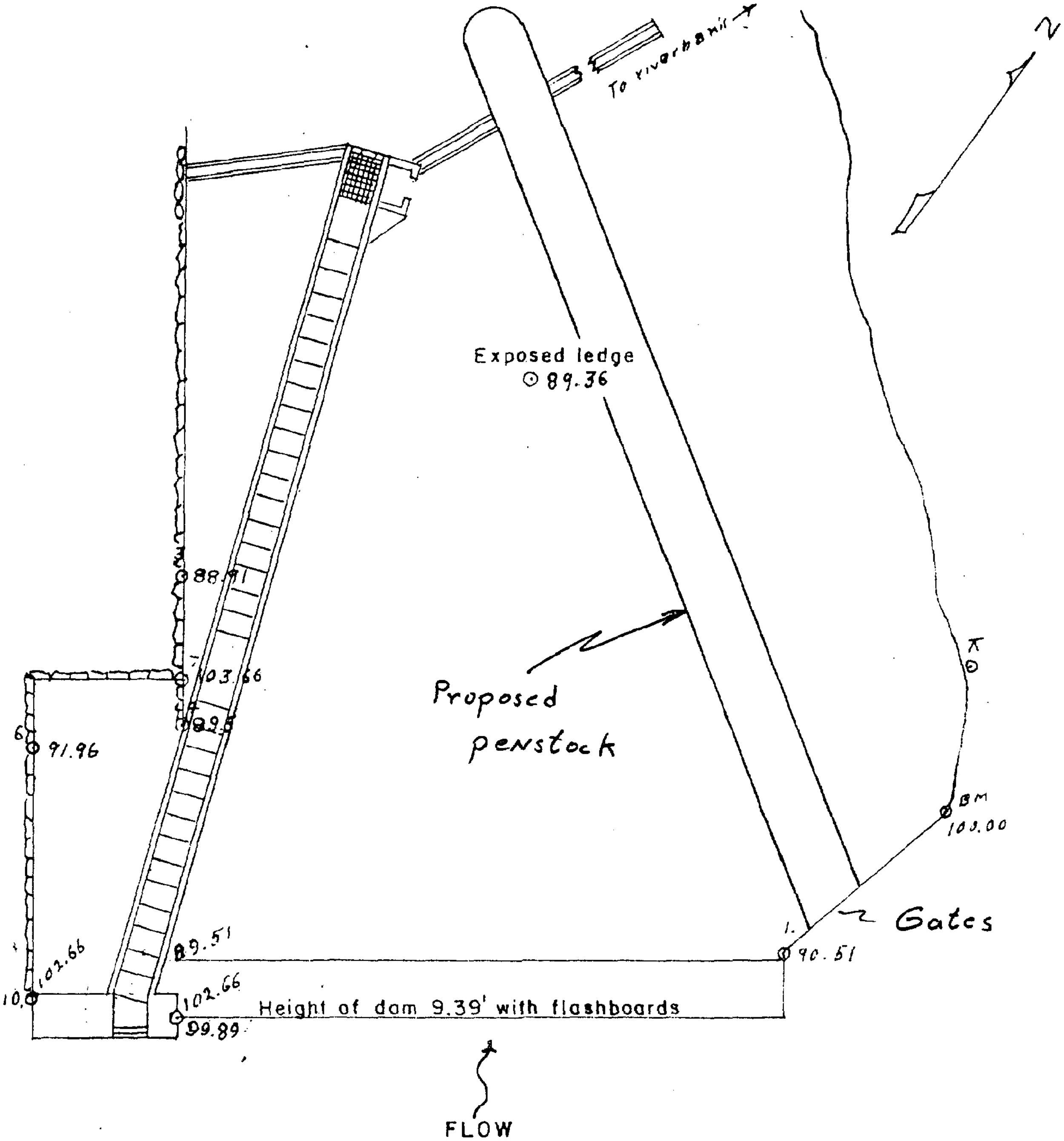
The following two drawings locate the proposed penstocks. Turbine/Generator units will be installed in the penstocks.



FISH LADDER LOCATION

PICKPOCKET DAM

EXETER, N.H.



FISH LADDER LOCATION

EXETER RIVER DAM

EXETER, N.H.

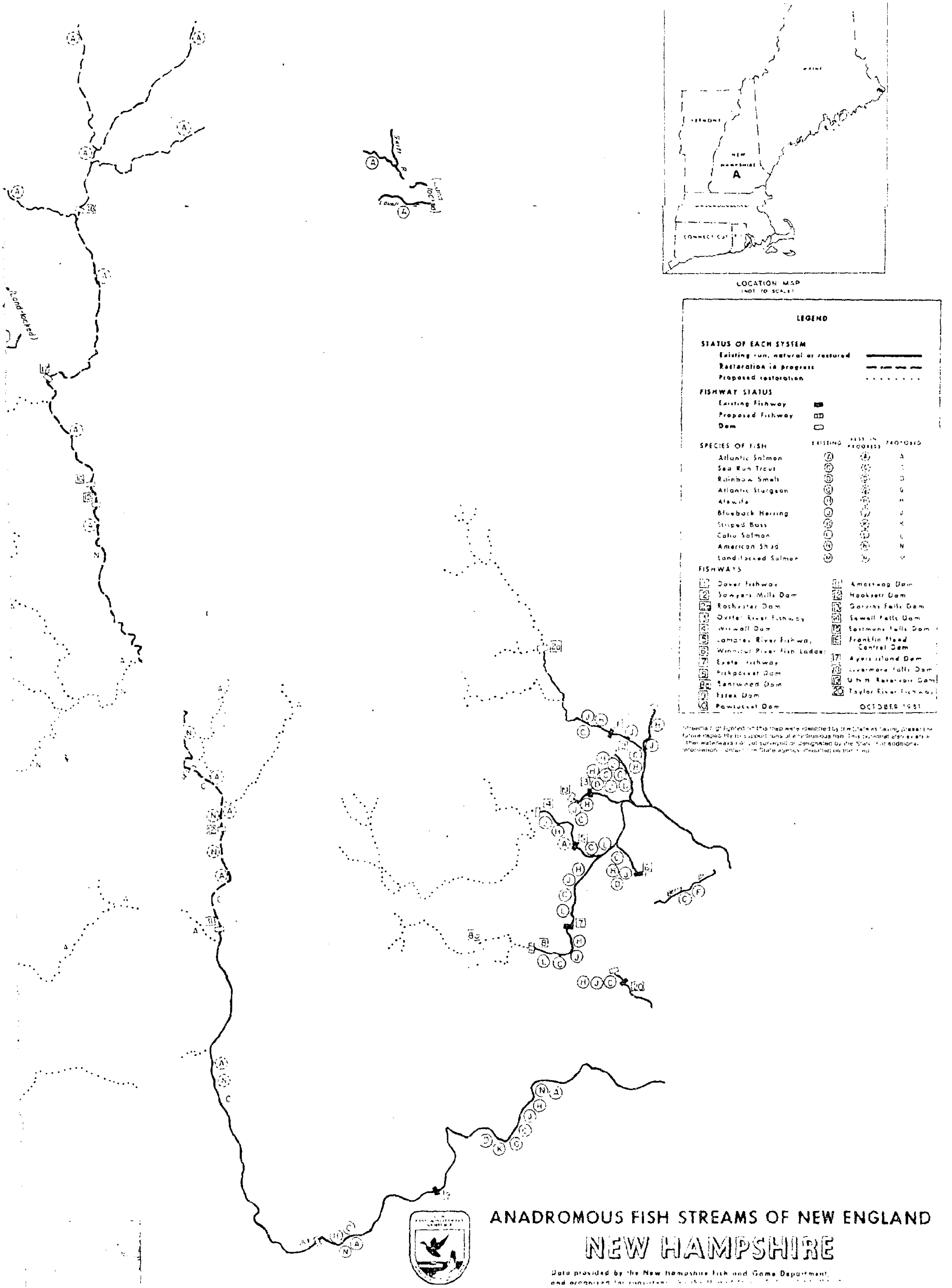
SCALE

1 In. = 20 Ft.

0 10 20

MAP

U.S. Fish and Game Department



ANADROMOUS FISH STREAMS OF NEW ENGLAND

NEW HAMPSHIRE

Data provided by the New Hampshire Fish and Game Department